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# Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM) 

10 - 16 May 2013
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# International Council for the Exploration of the Sea Conseil International pour l'Exploration de la Mer 

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## Executive Summary

The ICES Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM) met in ICES Headquarters during May 10-16 2013. There were 24 stocks in its remit distributed from ICES Divisions IIIa to IXa though mostly distributed in Sub Areas VII, VIII and IX. There were 17 participants (of whom 2 participated part time and 2 by correspondence). The group was tasked with carrying out stock assessments and catch forecasts and providing a first draft of the ICES advice for 2013 for 11 stocks. Several stocks, nine functional units for Nephrops and some of the new stocks from last year's WG were listed as "biennial 2nd year". For those stocks, catch and abundance indices information was updated. In addition, three new stocks were also added to the terms of reference in 2013 (two stocks of sea bass and one stock of striped red mullet).

Analytical assessments using age-structured models were conducted for the southern stocks of megrim and the Bay of Biscay sole, whereas the two hake stocks and one southern stock of anglerfish were assessed using models that allow the use of only length-structured data (no age data). A surplus-production model, without age or length structure, was used to assess the second southern stocks of anglerfish. No analytical assessments have been provided for the northern stocks of anglerfish or megrim after 2006. For anglerfish this is mostly due to ageing problems and to an increase in discards in recent years, for which there is no reliable data at the stock level. For megrim, there have been severe deficiencies in the input data, of which several still remain. The state of stocks for which no analytical assessment could be performed was inferred from examination of commercial LPUE or CPUE data and from survey information.

Both hake stocks and both southern megrim stocks are scheduled for benchmark assessments at the start of 2014. The WGHMM meeting spent some time planning this benchmark (see Annex N) together with longer term benchmarks (2015 and after, see section 1.).

A recurrent issue significantly constrained the group's ability to address the terms of reference this year. Despite a deadline of 4 weeks before the meeting, data for several stocks were still not available at the start of the meeting which lead to increase in workload during the working group, as in that case, the assessments could not be carried out in National Laboratories prior to the meeting as mentioned in the ToRs. This is an important matter of concerns for the group members.

Section 1 of the report presents a summary by stock and discusses general issues. Section 2 provides descriptions of the relevant fishing fleets and surveys used in the assessment of the stocks. Sections 3 to 13 contain the single stock assessments. This year a new section has been created for the new stocks. Several annexes follow. Additionally, the WG ToRs this year included a reconsideration of the reference points for northern hake (see Annex T) and an assessment of the progress on the interssessional work made on the use of SS3 to the anglerfish stocks (Lophius budegassa and L. piscatorius) in Divisions VIIb-k and VIIIa,b (see Annex R).

### 1.1 Terms of Reference

2012/2/ACOM11 The Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim [WGHMM], chaired by Michel Bertignac (France), will meet in ICES HQ, 10-16 May 2013 to:
a) Address generic ToRs for Regional and Species Working Groups (see table below).
b) Assess the progress on the benchmark preparation of megrim (Lepidorhombus boscii) in Divisions VIIIc and IXa ,megrim (Lepidorhombus whiffiagonis) in Divisions VIIIc and IXa, hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock), and hake in Division VIIIc and IXa (Southern stock);
c) Assess the progress on the interssessional work made on the use of SS3 to the anglerfish stocks (Lophius budegassa and L. piscatorius) in Divisions VIIb-k and VIIIa,b, as recommended by WKFLAT 2012;
d) Assess the progress on the interssessional work made on the use of SS3 to the black anglerfish stock (Lophius budegassa) in Divisions VIIIc and IXa, as recommended by WKFLAT 2012.
e) With reference to the recommendation of WKMSYREF, reconsider MSY reference points for northern hake. If possible, also establish precautionary reference points. The application of updated reference points will, however, be contingent on the availability of up to date fishery data to calculate relevant values

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting. The data to perform the assessment should be available 4 weeks before the meeting. This will be coordinated as indicated in the table below.

WGHMM will report by 24 May for the attention of ACOM. The group will report on the ACOM guidelines on reopening procedure of the advice before 14 October and will report on reopened advice before 29 October.

| Fish <br> Stock | Stock Name | Stock Coor- <br> dinator | Assess. <br> Coord. 1 | Assess. <br> Coord. 2 | Advice |
| :--- | :--- | :---: | :---: | :---: | :---: |
| anp- <br> 78 ab | Anglerfish (L. piscatorius) in Divi- <br> sions VIIb-k and VIIIa,b | Spain/UK | Spain/UK | France/UK | Update |
| anb- <br> 78 ab | Anglerfish (Lophius budegassa) in <br> Divisions VIIb-k and VIIIa,b | Spain/UK | Spain/UK | France/UK | Update |
| anb- <br> 8c9a | Anglerfish (Lophius budegassa) in <br> Divisions VIIIc and IXa | Portugal | Portugal | Portugal | Update |
| Anp- <br> 8c9a | Anglerfish (L. piscatorius) in Divi- <br> sions VIIIc and IXa | Spain | Spain | Spain | Update |
| Bss-8ab | Sea bass in Divisions VIIIa,b | UK |  |  | Update <br> WGNEW* |
| Bss- <br> 8c9a | Sea bass in Divisions VIIIc and IXa | FR |  | Update <br> WGNEW* |  |
| hke- | Hake in Division IIIa, Subareas IV, | France | France | Spain | Update |


| nrtn | VI and VII and Divisions VIIIa,b,d (Northern stock); |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| hkesoth | Hake in Division VIIIc and IXa (Southern stock); | Spain | Spain | Portugal | Update |
| $\begin{aligned} & \mathrm{mgb} \\ & 8 \mathrm{c} 9 \mathrm{a} \end{aligned}$ | Megrim (Lepidorhombus boscii) in Divisions VIIIc and IXa | Spain | Spain |  | Update |
| $\begin{aligned} & \text { mgw- } \\ & \text { 8c9a } \end{aligned}$ | Megrim (Lepidorhombus whiffiagonis) in Divisions VIIIc and IXa | Spain | Spain |  | Update |
| mgw-78 | Megrim (L. whiffiagonis) in Subarea VII \& Divisions VIIIa,b,d,e | Spain | Spain |  | Re-examine |
| sol-bisc | Sole in Divisions VIIIa,b,d (Bay of Biscay) | France | France |  | Update |
| sol-8c9a | Sole in Divisions VIIIc and IXa | Portugal | ? | ? | Multiyear |
| ple-89a | Plaice in Subarea VIII and Division IXa | ? | ? | ? | $\begin{aligned} & \text { Biennial } \\ & 2^{\text {nd }} \text { vear } \end{aligned}$ |
| pol-89a | Pollack in Subarea VIII and Division IXa | ? | ? | ? | $\begin{aligned} & \text { Biennial } \\ & 2^{\text {nd }} \text { year } \\ & \hline \end{aligned}$ |
| whg- <br> 89a | Whiting in Subarea VIII and Division IXa | ? | ? | ? | $\begin{aligned} & \text { Biennial } \\ & 2^{\text {nd }} \text { year } \\ & \hline \end{aligned}$ |
| gug-89a | Grey gurnard in Subarea VIII and Division IXa | ? | ? | ? | $\begin{aligned} & \text { Biennial } \\ & 2^{\text {nd }} \text { year } \end{aligned}$ |
| Mutwest | Striped red mullet in Subarea VI, VIII and Divisions VIIa-c, e-k and IXa (Western area) |  |  |  | $\begin{aligned} & \text { Biennial } \\ & 2^{\text {nd }} \text { year } \end{aligned}$ |
| $\begin{array}{\|l\|} \text { nep- } \\ 2324 \\ \hline \end{array}$ | Nephrops in Divisions VIIIa,b (Bay of Biscay, FU 23, 24) | France | France |  | $\begin{aligned} & \text { Biennial } \\ & 2^{\text {nd }} \text { year } \end{aligned}$ |
| NepVIIIc |  |  |  |  |  |
| nep-25 | Nephrops in North Galicia (FU 25) | Spain | Spain |  | Biennial $2^{\text {nd }}$ year |
| nep-31 | Nephrops in the Cantabrian Sea (FU 31) | Spain | Spain |  | $\begin{gathered} \begin{array}{c} \text { Biennial 2 } 2^{\text {nd }} \\ \text { year } \end{array} \\ \hline \end{gathered}$ |
| $\begin{aligned} & \text { Nep- } \\ & \text { IXa } \\ & \hline \end{aligned}$ |  |  |  |  |  |
| $\begin{aligned} & \text { nep- } \\ & 2627 \end{aligned}$ | Nephrops in West Galicia and North Portugal (FU 26-27) | Spain/Portugal | Spain/ Portugal | Portugal/ Spai | Biennial $2^{\text {nd }}$ year |
| $\begin{aligned} & \text { nep- } \\ & 2829 \end{aligned}$ | Nephrops in South-West and South Portugal (FU 28-29) | Spain/Portugal | Spain/ Portugal | Portugal/ Spai n | Biennial 2 ${ }^{\text {nd }}$ year |
| nep-30 | Nephrops in Gulf of Cadiz (FU 30) | Spain/Portugal | Spain/ Portugal | Portugal/ Spai n | $\begin{gathered} \text { Biennial 2nd } \\ \text { year } \end{gathered}$ |

* Finalise advice based on draft prepared by WGNEW


### 1.2 Summary by Stock

The stocks assessed within WGHMM are distributed from ICES Division IIIa to IXa (Figure 1.1). Figure 1.2 shows the distribution areas of the Nephrops Functional Units (FUs).

## Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock)

Hake is caught in nearly all fisheries in Subareas VII and VIII and also in some fisheries in Subareas IV and VI. Spain accounts for the main part of the landings, followed by France. Stock landings have been steadily increasing throughout the last decade, from 36700 t in 2001 to 79700 t in 2011, the highest value since 1963. In 2012, landings were 75 200t, which is well above the 2012 TAC ( 55100 t ).

The Northern hake emergency plan (EC 1162/2001, EC 2602/2001 and EC 494/2002) was followed by a recovery plan in 2004 (EC 811/2004). The recovery plan aims at achieving a spawning stock biomass (SSB) of $140000 \mathrm{t}\left(\mathrm{B}_{\mathrm{pa}}\right)$. This is to be achieved by limiting fishing mortality to $\mathrm{F}=0.25\left(\mathrm{~F}_{\mathrm{pa}}\right)$ and by allowing a maximum change in TAC between consecutive years of $15 \%$. ICES advised in 2008 that the northern hake stock had met the SSB target in the recovery plan for two consecutive years (2006 and 2007). The recovery plan indicates that, in such a situation, a long-term management plan should be implemented. Such a plan is currently under development by the EC.

This stock had a benchmark assessment in February 2010 (WKROUND, ICES 2010a), where main issues tackled were the fact that growth of this species is faster than previously assumed and that ages have been overestimated in the past. As no new ageing criterion has been developed, WKROUND replaced the previous age-based assessment model (XSA) with a new one (Stock Synthesis) which permits the use of only length data and has the capability to estimate fish growth together with population dynamics and exploitation levels. Discards have also been incorporated in the new assessment, with landings and discards data entered at "fleet" level and quarterly. The benchmark assessment started in 1990, the year up to which data at this finer level of disaggregation have been recovered. Only abundance indices from research surveys (i.e. no commercial CPUEs) have been used for tuning.
In 2010, WGHMM updated the northern hake assessment in the Autumn using a reduced time series due to the unavailability of 2009 French landings data before that time. The reduced length of the assessed period (from year 1990) and the fact that no large fish are present in the commercial catches or survey abundance indices during this period, made the assessment uncertain, particularly in the most recent years. The WG in 2010 was of the view that, whereas the overall trends estimated by the assessment were representative of stock development, the actual rates of increase and decrease of SSB and F in the most recent years were very uncertain. The WG in 2010 accepted the assessment only as indicative of stock trends and did not present short term projections.

For the 2011 WG it was possible to recover commercial data (landings and length frequency distributions) by fleet for years 1978-1989, albeit on an annual rather than a quarterly basis. This allowed extending the assessment period back to 1978, as was the case with the previous XSA assessment. The incorporation of these earlier years has improved the model's ability to determine the degree to which levels of fishing reduced hake abundance during the mid 80 s and the 90 s and, thus, provides a clearer perspective of the historical stock development.

This year, an update assessment (following the stock annex specifications) was carried out but an important retrospective pattern was detected along the whole historical series. The group decided to fix the growth parameters (a parameter which is estimated in the update assessment ) at the values estimated during WGHMM 2011. This removed the retrospective pattern observed in the update assessment.

The recruitment appears to fluctuate without substantial trend over the whole series. After a high recruitment in 2008 ( 631 million), there are 3 consecutive years of low recruitment (between 160 and 230 millions). In the last year it increases sharply again and reaches its historical maximum ( 743 million).From high levels at the start of the series ( 130000 t in 1980), the SSB has decreased steadily to a low level at the end of the 90 s ( 44500 t in 1998). Since that year, SSB has increased to the highest value of the series in 2012 (277 794 t ). The fishing mortality is calculated as the average annual F for sizes $15-80 \mathrm{~cm}$. 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 70 s and early 80 s to values around 1.0 during the 90s. They declined sharply afterwards to 0.24 in 2011 and 2012.

In 2010, the WG proposed an Fmsy proxy based on the benchmark assessment. The same value was kept by the WG in 2011, 2012 and this year. Further work on reference points will be conducted in the near future.

Details about the assessment of this stock are provided in Section 3 and Annex C.

## Hake in Divisions VIIIc and IXa

Hake in Divisions VIIIc and IXa is caught in a mixed fishery by Spanish and Portuguese trawlers and artisanal fleets. Spain accounts for the main part of the landings. Total landings in 2011 were 17072 t and 14573 t in 2012. Total discards in 2011 were 1893 t and 1992 in 2012. Total catches were 18965 t and 16565 in 2011 and 2012, representing a $13 \%$ catch reduction The agreed TAC for Southern Hake in 2012 was 12299 t and in 2013 is 14144 t .

A Recovery Plan for southern hake and Iberian Nephrops was enacted in 2006 (EC 2166/2005). This plan aims to rebuild the stock to within safe biological limits, corresponding to 35000 t of $\operatorname{SSB}\left(\mathrm{B}_{\mathrm{pa}}\right)$, driving fishing mortality to 0.27 . A fishing mortality rate reduction of $10 \%$ should be applied every year, with a constraint of $15 \%$ maximum change in TAC between any two consecutive years. The regulation also includes effort management measures. The plan is in the process of being revised jointly by STECF/ICES and developing towards FMSY targets, with the possible inclusion of anglerfish stocks. This is, however, work under development and no new plan has yet emerged.

The southern hake stock had a benchmark assessment in February 2010 (WKROUND, ICES 2010a). As for northern hake, growth and age reading were main issues and WKROUND replaced the previous age-based assessment model (Bayesian statistical catch-at-age) with a new one (GADGET) which permits the use of only length data and can estimate fish growth together with population dynamics and exploitation levels. Discards and the Gulf of Cádiz area were incorporated in the benchmark assessment.

For SSB, the current assessment indicates a strong decreasing trend from the mid 1980s until the late 1990s, when the historic minimum is reached. After that, SSB shows a general increasing trend, accelerating in recent years, and reaches 20900 t in 2012. The recruitment is highly variable and presents two different periods: one from 1982 to 2003 with mean figures around 70 million, ranging from 40 to 120, and a recent period from 2004 to 2012 with a mean of 114 million ranging from 60 to 160 million. Fishing mortality increased from the beginning of the time series ( $\mathrm{F}=0.36$ in 1982) peaking in 1995 at 1.18; declining to 0.77 in 1999 and remaining relatively stable until 2009 ( $\mathrm{F}=0.95$ ). There was a further decline in recent years to 0.57 in 2012.

In 2010, WGHMM proposed an FMSY proxy based on the benchmark assessment and the same value was kept by the WG in 2011, 2012 and this year.

Details on the assessment of this stock are in Section 7 and Annex G.

## Anglerfish (Lophius piscatorius and L. budegassa) in Divisions VIIb-k and VIIIa,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. Spain and France together contribute about $80 \%$ of total stock landings. The TAC for both species combined was set at 38900 t for 2012 and at 31118 t for 2013. Landings were estimated at 36384 t in 2012. 2012 landings are the biggest of the 10 last years and the fifth larger of the time series and estimated landings are .

Age determination problems and an increase in discards in recent years have prevented the performance of an analytical assessment since 2007. Since then, the assessment is based on examining commercial LPUEs and survey data (biomass, abundance indices and length distributions from surveys). Four surveys are available, covering between them the whole distribution area of the stocks and with little overlap between them.

For L. piscatorius the available data indicate that the biomass has been increasing as a consequence of the good recruitment observed in 2001, 2002 and 2004 and has stabilised in recent years. There is evidence of good recruitments in 2008, 2009, 2010 and 2011. 2008 and 2009 recruitments have entered the fishery giving one of the higher yields of the time series.

For L. budegassa survey data indicate that the biomass has shown a continuous increase since the mid 2000's as a consequence of several good incoming recruitments. There is good evidence of a strong incoming recruitment from 2008. The EVHOE-WIBTS-Q4 shows evidence of a medium level of recruitment in 2010 and the last two years has recorded its historical maximum. Data from the two available surveys show contradictory signals for 2009, 2011 and 2012 recruitments.

Measures should be taken to ensure good survival of recent recruitments. For both anglerfish species, data from surveys tracking recent good recruitment give scope for growth studies that should be initiated as soon as possible.

More details on the anglerfish assessment can be found in Section 4 and Annex D.

## Anglerfish (L. piscatorius and L. budegassa) in Divisions VIIIc and IXa

Both species are caught in mixed bottom trawl fisheries and in artisanal fisheries using mainly fixed nets. The two species are usually landed together for the majority of commercial categories and they are recorded together in the ports' statistics. Landings of both species combined in 2012 were 2281 t . The combined TAC was set at 3300 t for 2012 and 2475 t for 2013.

A benchmark assessment was carried out in 2012 for these stocks. Age determination problems prevent the application of an age-structured model. The two species are assessed separately, using a surplus-production model (software ASPIC), tuned with commercial LPUE series for L. budegassa and a length based SS3 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 around 6,500 tonnes. No biomass reference points have been determined for this stock. Fishing mortality peaked during the
late 1980's but has since declined and is currently stable and close to Fmsy (0.19). 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 (Figure 8.2.4) indicate a steady decrease since the begin-ning of the series to below BMSY in 2001, since then a slight recovery was observed, been in 2012 at 70\% of BMSY. Fishing mortality remained at high levels between late eighties and late nineties, dropping after that. In 2012, fishing mortality is estimated to be below FMSY.

Although the stocks are assessed separately, they are managed together.
More details are provided in Section 8 and Annex H.

## Megrim (Lepidorhombus whiffiagonis) in Divisions VIIb-k and VIIIa,b,d

L. whiffiagonis in Div. VIIb-k and VIIIa,b,d is caught in a mixed demersal fishery catching anglerfish, hake and Nephrops, both as a targeted species and as valuable bycatch. The 2012 TAC was set at 20106 t and 2013 TAC 19101 t . Landings in 2012 were ( 12080 t ). Discarding of smaller megrim is substantial and also includes individuals above the minimum landing size of 20 cm . The discards estimate for 2012 are, 2902 t

The stock was assessed with XSA until 2006, but severe deficiencies in the input data made it impossible to continue conducting an analytical assessment. There was some improvement of the data situation in 2009, although a number of important issues remained to be resolved (see Annex P, concerning stock data problems). The stock underwent a benchmark in 2012 at which the commercial CPUE series were revised and discard data compiled for a number of important fleets. A Bayesian catch at age model was investigated but due to underlying issues with the catch at age data could only be considered to be indicative of trends in the fishery and therefore not sufficient to form the basis of projections.

It was not possible to update this assessment in 2013 using the Bayesian catch at age model. As no estimates of the stock population structure and SSB were available, the the assessment is based on the analysis of trends of survey and commercial abundance indices. Catch, landing, discard data and survey indices do not indicate important change in the levels of recruitment and abundance of the stocks. The stock appears stable at the present level of fishing..
Details of the available data and analysis carried out during the WG are provided in Section 5 and Annex E.

## Megrims (L. whiffiagonis and L. boscii) in Divisions VIIIc and IXa

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 2012 were 1900 t (of which $60 \%$ correspond to $L$. whiffiagonis), above the TAC of 1214 t , which is set for both species combined. The agreed combined TAC for megrim and four-spot megrim in ICES Divisions VIIIc and IXa was 1214 in 2012 and 1214 in 2013.

The species are assessed separately, using XSA for each of them. Update assessments were conducted this year. For L. whiffiagonis, a survey and two commercial LPUE series (one of which ended in 2003) are used for tuning the XSA. For L. boscii, the same
survey and one of the commercial LPUE series (although stopped in 1999) are used for tuning.
For L. whiffiagonis the assessment indicates that SSB has been in general decline throughout the main part of the time series. SBB in 2011 and 2012 has increased sharply from a low value observed in 2010. Fishing mortality has also declined since the late 1980s and reached its lowest value in 2010. F has increased in 2011 and 2012 and is currently just above FMSY. The reference points are considered to be preliminary and have been derived from an assessment that does not include discards.

For L. boscii the assessment indicates that SSB decreased progressively between 1988 and 2001, with a slight increasing trend thereafter. SSB in 2012 is the second highest value of the series. F has fluctuated through time but since 1998 has remained very constant at values of around 0.3. The value of 0.09 in 2012 is the lowest value of the series, a significant drop from previous year. Both high and low recruitments are seen throughout the whole time series.

There are no biological reference points defined for these stocks. The WG proposed F MSY values in 2010, which were maintained this year. $_{\text {2 }}$

Details of the assessments are presented in Section 9 and Annex I.

## Sole in Divisions VIIIa,b (Bay of Biscay)

Bay of Biscay sole is caught in ICES Divisions VIIIa 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). Landings in 2012 were 4317 t , whereas the TAC was 4250 t .

In 2006 a multiannual plan for the sustainable exploitation of the stock of sole in the Bay of Biscay (EC regulation 388/2006) was established, which set the objective of bringing SSB above $13000 \mathrm{t}\left(\mathrm{B}_{\mathrm{pa}}\right)$ in 2008. This was to be attained by gradually reducing the fishing mortality rate ( $10 \%$ annual reduction), while constraining the TAC change to a maximum of $15 \%$ between consecutive years. ICES advised in 2009 that the SSB target had been met in 2008. According to the plan, the Council should therefore decide on a long-term fishing mortality target and a rate of reduction to be applied in order to reach it. This has not yet happened although work is currently under development jointly by STECF and ICES.

A benchmark for this stock took place at the start of 2011, in the ICES workshop WKFLAT (ICES, 2011b). The assessment approved at the benchmark is based on XSA, as was the previous assessment. The benchmark decided to exclude the tuning series corresponding to the RESSGASC survey, as this survey was last conducted in 2002 and was no longer contributing to final population estimates. At the benchmark, two additional CPUE series from commercial fleets were incorporated for tuning. The main reason for this decision was that the two commercial series previously used for tuning (composed of appropriately chosen groups of trawlers from the ports of La Rochelle and Les Sables d'Olonne) were displaying less and less effort and it was considered that they might soon no longer be representative of stock abundance. This was considered to be the case already in last year's assessment. Assessment are thus now carried out without the inclusion of the 2010 tuning data from La Rochelle and Les Sables fleets.

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

Up to now, no recruitment indices were available for tuning the assessment. The benchmark workshop recommended the inclusion of the ORHAGO survey in order to provide such information. The survey started in 2007. This year, the inclusion of the ORHAGO survey (FR-ORHAGO) has been explored to compare the assessment with and without this survey.
The benchmark kept the previous reference points, so $B_{p a}$ remains at 13000 t . However, as a consequence of the changes introduced at the benchmark, the time series of SSB estimates was revised upwards during the 1980s and slightly downwards for recent years, with the consequence that SSB is now estimated to be a bit below $\mathrm{B}_{\mathrm{pa}}$ during the 1999-2010 period. Since 2010, the SSB is above Bpa. F has been at lower levels since 2003, at around $\mathrm{F}_{\mathrm{pa}}$ (0.42). It is estimated to be below $\mathrm{F}_{\mathrm{pa}}$ in 2010 and 2011 and above $\mathrm{F}_{\mathrm{pa}}$ in 2012. The XSA recruitment estimate in the terminal year is very uncertain and was, as usual, overwritten by a short GM series from 1993 to the antepenultimate assessment year.

An Fmsy value of 0.26 was proposed for this stock by WGHMM in 2010 and kept this year.

Details on the assessment are in Section 6 and Annex F of the report.

## Nephrops in ICES Division VIIIa,b

There are two Functional Units in ICES Division VIIIa,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 5900 t in 1988 to 3100 t in 2000. After that year, they increased again to around 3700 t , staying at that level for some time. Since 2006 landings have been around 3,300 t . In 2012 landings declined at 2520t. The agreed TAC for 2013 was 3899 t (the same as for 2012).

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

This stock underwent an inter-benchmark protocol in 2012. The outcome of this process was inconclusive with a recommendation that the work undertaken should be considered in a full benchmark setting.
The stock was assessed in 2012 using XSA, although the results were considered only indicative of stock trends. ICES concluded that the SSB has been relative stable over most of the assessment period. Fishing mortality has been declining in recent years. Recruitment has shown a downwards trend in recent years. ICES advised on the basis of data-limited stocks for which a biomass index is available and uses a harvest control rule based on an index-adjusted status quo catch.
The advice from last year is biennial and valid for 2013 and 2014. This year, no assessment has been carried out and only an update of data has been done.
Details can be found in Section 10 and Annex J.

## Nephrops in ICES Division VIIIc

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

Nephrops are caught in the mixed bottom trawl fishery in the North and Northwest Iberian Atlantic. The fishery takes place throughout the year, with the highest landings in Spring and Summer. At present, the trawl fleet comprises three main components: baca bottom trawl, high vertical opening trawl (HVO) and bottom pair trawl, of which only the baca trawl catches Nephrops. Landings in 2012 from the two FUs combined were 31 t , well below the TACs of 82 t and 74 t which were set for the whole of Division VIIIc for 2012 and 2013, respectively.

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).

FU 25 (North Galicia): Landings were reported only by Spain. Since the early 90s landings declined from about 400 t to less than 100 t in 2003. In the period 2004-2012, landings show a continuous decreasing trend up to 21 t in the last year. In 2012, 11 t were recorded as unallocated landings. The LPUE from the main commercial fleet shows an overall declining trend, with some fluctuations and reaching its three lowest values in 2008-2010.

FU 31 (Cantabrian Sea): Landings reported by Spain (the only participant in the fishery) are available for the period 1983-2010. The highest landings were recorded in 1989 and 1990, with 177 t and 174 t , respectively. Since 1996 landings have declined sharply from 129 t to less than 10 t in the period 2009-2011. In 2012, landings were 10t.

Both FUs were assessed in 2012. The advice for these Nephrops stocks is biennial and valid for 2013 and 2014. ICES advises on the basis of the precautionary considerations that catches should be zero.

Additional details are provided in Section 11 and Annex K of the report.

## Nephrops in ICES Division IXa

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

Landings in 2012 from the five FUs combined were 353 t . The TAC set for the whole Division IXa was 273 t and 246 t for 2012 and 2013.

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).

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

Landings are reported by Spain and minor quantities by Portugal. Spanish fleets fish in FU 26 and FU 27, whereas Portuguese artisanal fleets fish with traps in FU 27. During 1975-1989 landings fluctuated between 600 and 800 t , with a strong downward trend starting from 1990. After 2004, landings have been below 50 t every year. Only $8 t$ were landed in 2010.

This year, no assessment has been carried out and only an update of data has been done. The advice for these Nephrops stocks is biennial and valid for 2013 and 2014. ICES advised on the basis of the precautionary considerations that catches should be zero.

FU 28+29 (SW and S Portugal): Nephrops is taken by a multi-species 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 deepwater rose shrimp, with different but overlapping depth distributions. In years of high rose shrimp abundance, the fleet directs its effort preferably to this species.

Until 1992 landings fluctuated around $480 t$, subsequently falling drastically until 132 t in 1996. After that, landings increased again substantially until 2004, at which point a new decreasing trend started. Landings were 229 t in 2012.

This stock underwent an inter-benchmark protocol in 2012 with an inconclusive outcome. Considerable effort had been devoted to obtaining an appropriately standardised LPUE index from the crustacean trawl fleet, which takes into account the mixed nature of the fishery and the shifts between different target species. In addition a revised XSA was presented. Although the LPUE standardisation was considered to be appropriate the XSA assessment was not accepted as indicative of stock trends and the assessment of this stock is based on CPUE and effort trends with the overall conclusion that the stock is stable at the current rate of exploitation.

The working group recommends that the stock undergoes a full benchmark process in the near future.

This year, no assessment has been carried out and only an update of data has been done. The advice for these stocks is biennial and valid for 2013 and 2014. Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 110 tonnes.

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 fluctuated around 100 t until year 2000, subsequently increasing to much higher levels (over 200 t ). They have been decreasing again since 2006, with a big drop in 2008. Landings in 2012 were 116 t . Estimated directed effort at Nephrops has decreased substantially since 2005. This could be a consequence of several effort regulation measures established in very recent years and other factors such as bad weather conditions and an industry strike in 2008. Landings of rose shrimp increased in 2008, indicating a possible change in the objectives of the fishery.

This year, no assessment has been carried out and only an update of data has been done. The advice for these Nephrops stocks is biennial and valid for 2011 and 2012.

Based on the ICES approach for data-limited stocks, ICES advised that catches should be no more than 90 tonnes

The five Nephrops FUs (assessed as 3 separate stocks) are managed jointly, with a single TAC set for the whole of Division IXa. 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 12 and Annex L.

### 1.3 Data available

As in previous years, data for 2013 were prepared in advance of the meeting and all revisions to data are referred to in the appropriate stock sections. WGHMM has again experienced significant delays and issues regarding data delivery. Despite a deadline of 4 weeks before the meeting, data for several stocks were still not available at the start of the meeting which lead to increase in workload during the working group, as in that case, the assessments could not be carried out in National Laboratories prior to the meeting as mentioned in the ToRs.

This is a major matter of concerns for the working group members.
The main data problems detected by the Working Group and for which action is required are described in the "Stock Data Problems" table included in Annex V and in Annex P of the WG report.

In many cases, national statistics for recent years are either not currently available officially or are of a preliminary nature. As a consequence, the official landings (http://www.ices.dk/fish/statlant.asp) provided to ICES by statistical offices are of limited relevance for the assessments. As last year, specific issues relating to the provision of data to the working group arose during the meeting this year. These issues affected the work that could be conducted during the meeting and are described in more detail in section 1.4.1

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 VII, as well as for the Nephrops FUs in VIIIc and IXa, or to a combination of species in the cases of anglerfish and megrim.

Biological sampling levels by country and stock are summarised in Table 1.3.

### 1.4 Stock Data Problems Relevant to Data Collection

WGHMM identified the following issues for further discussion by the PGCCDBS in relation to stock data problems relevant to data collection. These are listed in the table included in Annex V of the report

### 1.5 Issues that arose during the WGHMM meeting

### 1.5.1 Revision of the MSY reference points

WGHMM was asked to address the following Terms of Reference:
ToRe ) With reference to the recommendation of WKMSYREF, reconsider MSY reference points for northern hake. If possible, also establish precautionary reference points. The application of updated reference points will, however, be contingent on the availability of up to date fishery data to calculate relevant values.

The answer to this ToR is given in annex T of the report.

### 1.5.2 Unallocated landings

As in last year, data for Spanish landings were provided to the working group by The Spanish Authority for Fisheries (the Secretaria General de Pesca or SGP). Again this year, some concerns were raised regarding the data provided which in some instances indicated a marked reduction in landings from previous years. It was not possible to attribute these reductions in landings to any observed changes in the fishery such as a reduction in fishing effort, a marked decline in stock biomass or an increase in discard levels. The group concluded that the landings data for 2011 and 2012 provided by SGP could not be used to update the assessment models in 2013 as the differences could affect the coherence of stock historical series. Instead and in order to get the best possible assessment of the stock status, the group decided to use the scientific estimates of landings. The differences between the two data sets have been added to the unallocated landings category.

### 1.5.3 Use of InterCatch by WGHMM

As for 2012, little progress has been made by the group with regards to the use of InterCatch. Last year the WG stock coordinators compiled a table indicating whether or not InterCatch has been used for their stocks and the reasons for not using it. The same table applies this year. The 2011 WG agreed to define common "InterCatch fleets" (which essentially correspond to Level 5 DCF métiers) to facilitate the use of InterCatch in future years and to promote consistency between countries and stocks.

A presentation of the Intercatch database was made by Henrik Kjems-Nielsen from the ICES secretariat. It highlighted the key role played by of the implementation of formal data calls in the progress made in the use of Intercacth for several working groups (WGNSSK was given as an example). Concerns were raised by the group on the development of two databases for the compilation of commercial fishery data (Fishframe and Intercatch). According to Henrik Kjems-Nielsen, ICES Intercatch database is currently the most appropriate tool to use until the planned Regional Data Bases are fully established and operational.
The group agreed to engage in the data call process in 2014. A pilot trial will be conducted between September and December 2013 using 2012 data, and the final setup will be officialised by a data call issued by ICES early 2014.

### 1.5.4 Overviews

Mark Dickey-Collas presented progress made by ICES towards the ecosystem approach and the integration of broader scientific disciplines into the advice. The objective is to move towards Integrated Ecosystem Assessments. This work is lead by integrated Ecosystem Assessment Groups. Benchmark workshop are also playing an important role in that process. ICES is thus developing regional benchmark meeting with the hope that they will facilitate the interaction between various disciplines. Furthermore. ICES is developing ecosystem overviews designed to inform expert groups on each ecoregions : the key signals within the environment and ecosystem, the activity and pressure inside the ecoregion, the state of the ecosystem. Such overviews have been produced for several ecoregions : the Baltic sea, the North sea and the Celtic sea. Due to lack of participants with sufficient knowledge of the Bay of Biscay at WKECOVE, iy was not possible to develop an ecosystem overview for that region. This work will be carried out during 2013 and a preliminary version of the overview for the Bay of Biscay should be available to WGHMM in 2014. WGHMM welcomes this initiative.

### 1.5.5 Indicators of stock size

This section relates to the Generic ToR d) Propose indicators of stock size (or of changes in stock size) that could be used to decide when an update assessment is required and suggest threshold \% (or absolute) changes that the EG thinks should trigger an update assessment on a stock by stock basis could lead to substantial workload reductions. The proposal is to update assessments and advice only if the perception of the stock has changed significantly. If no update, the advice would be the same as the previous year (same advice as last year - SALY). ACOM asks for a technical work on a stock by stock basis by EGs to identify stock size indicators and suggest threshold \% change for each stock that might trigger a new assessment and possibly new advice. A workshop is planned in the autumn 2013 to standardize thresholds for an implementation in 2014.

Although the response of the Working Group members to this initiative was mainly positive, WGHMM had several concerns. The main discussion carried in WGHMM can be summarised as follows :

- The group considered that, due to time constraints associated with the assessment work, it was not feasible to provide any stock by stock guidance in terms of indicators and associated threshold during the working group.
- It was suggested that such work could be carried out during benchmark workshops.
- Once selected, indicators would need to be carefully evaluated by simulations before implementation.
- Indicators need to be tailored on a stock by stock basis to account for each stock characteristics (life history traits, fishery characteristics, etc.)
- For a stock under full assessment (Category 1), if the assessment is not updated, what will happen in terms of data collection. Is there any risk of decrease in the data quality?
- Some members of the group would be ready to attend the workshop planned in autumn.


### 1.5.6 Progress made with the use of SS3 for Anglerfish stocks

There are two terms of reference for WGHMM relating to the progress made for the use the SS3 on the two anglerfish stocks in areas VIIb-k and VIIIa,b,c (ToR c) and the anglerfish stock (Lophius budegassa) in areas VIIIc and IXa (ToR d).

### 1.5.6.1 Anglerfish stocks in areas VIIb-k and VIIIa,b,c

Both anglerfish stocks in Areas VIIb-k and VIIIa,b,d have been updated to include the 2011 and 2012 data. Minor adjustment to the input control files for both stocks were made to adjust the parameter bounds to provide better selectivity estimation for the fleets and the SPPGFS-WIBTS-Q4 index of abundance for the Lophius piscatorius stock.

For the Lophius budegassa stock further changes were made to combine fleets and remove the estimated extended time series of landings and the dummy survey fleet, included to control the depletion of the stock from its virgin biomass estimate. The results of the updated WKFLAT benchmark assessments are provided in annex R.

The recommendation from the WKFLAT 2012 benchmark to aid the progression of the use of SS3 has not been implemented with regards to the studies required to pro-
vide relevant information on the biology of the two species, specifically growth and maturity. Both models use biological information from other Lophius stocks, and there are uncertainties around their appropriateness for these two stocks, for example, the growth of the $L$. budegassa stock uses the parameters estimates from L. budegassa in the Mediterranean Sea. The Mediterranean stock does not reach the same maximum lengths seen in this stock.

The next steps require further work on the input data to obtain the best aggregations of fleet, temporal and length information, the provision of standardised commercial CPUEs and length compositions, discards and length compositions. Discarded length compositions are needed as this stock discards high quantities of small anglerfish, anglerfish of $<500$ grams in weight due to European market regulation.

### 1.5.6.2 Anglerfish stocks in areas VIIIc and IXa

Little progress has been made with the Lophius budegassa in area VIIIc and IXa SS3 model. Some work has been done to train a new ilicia age reader in order to get a more appropriate growth model. Length frequencies were provided to the benchmark in 2012, but the use of the SS3 in the L. Piscatorius revealed that some refinements in the length frequency aggregations must be done, for example changing the size of length bin classes in order to avoid strong scattered peaks when raising to the total catch.

### 1.5.7 Stock annexes

This year the stock annexes that were still missing (Plaice in Subarea VIII and Division IXa, Pollack in Subarea VIII and Division IXa, Whiting in Subarea VIII and Division IXa, Grey gurnard in Subarea VIII and Division IXa, Striped red mullet in Subarea VI, VIII and Divisions VIIa-c, e-k and IXa, Sea bass in Divisions VIIIa,b, Sea bass in Divisions VIIIc and IXa and Sole in Divisions VIIIc and IXa) have been prepared and are presented as Annexes S of the WG report. Hence, all stocks assessed by this WG now have a stock annex.

### 1.5.8 DLS category

WGHMM reviewed the DLS target categories proposed for its stocks. The group broadly agreed with the suggestions made for target DLS categories. The categorisation proposed by WGHMM is presented in the table below. The group proposed to move upward several stocks in the categorisation. This includes the stocks of Nephrops in FU 23-24, FU 28-29 and in FU 30 which are potentially classified as category 1. The group proposed those stocks for a benchmark in 2015 in order to help in that process. The group also considered that for the stock of Pollack in Subarea VIII and Division IXa there is currently not enough biological information to allow for an upgrade in category 4 and that this stock should remain in category 5 for the moment.

| Stock | ADG | 2012 DLS <br> Category | Target DLS Category (provisional, for WG consideration) | Target DLS <br> Category <br> proposed by <br> WGHMM | Comments |
| :---: | :---: | :---: | :---: | :---: | :---: |
| mgw-78 | ADGCS | 3.2.0 | 1 | 1 | Benchmark planned in 2016 |
| nep-2324 | ADGBBI | 3.2.0 | 3 | 1 | Benchmark in 2015 |
| ple-89a | ADGBBI | 5.2.0 | 4 | 4 | Some biological samples are available |
| sol-8c9a | ADGBBI | 5.2.0 | 4 | 4 | Some biological samples are available |
| whg-89a | ADGBBI | 5.2.0 | 4 | 4 | Some biological samples are available |
| ang-78ab | ADGCS | 3.2.0 | 1 | 1 | Benchmark planned in 2016 |
| nep-25 | ADGBBI | 3.1.4 | 3 | 3 |  |
| nep-2627 | ADGBBI | 3.1.4 | 3 | 3 |  |
| nep-2829 | ADGBBI | 3.2.0 | 3 | 1 | Benchmark in 2015 |
| nep-30 | ADGBBI | 3.2.0 | 3 | 1 | Benchmark in 2015 |
| nep-31 | ADGBBI | 3.1.4 | 3 | 3 |  |
| pol-89a | ADGBBI | 5.2.0 | 4 | 5 | Not enough biological information to get cat 4 in the near future |
| mur-west | ADGWIDE | 5.2.0 | 4 | 4 | Some biological samples are available |
| gug-89a | ADGBBI | 6.2.0 | 6 | 6 |  |
| bss-8ab | ADGBBI | 5.2.0 | 4 | 4 | Could potentially use a length (or age?)-based method. |

### 1.5.9 Benchmarks

The following table summarises WGHMM proposals for short and long-term benchmarking.

| Name | Assement <br> status | Latest <br> Benchmark | Benchmark <br> next year | Planning <br> Year +2 | Further <br> Planning | Comments |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |

### 1.5.9.1 Benchmark planning

The WG reviewed the situation this year and decided to go ahead with all benchmarks proposed for the start of 2014. The ICES benchmark preparation tables by stock were revised during the WG meeting, identifying the tasks that should be conducted inter-sessionally (during the second half of 2013). These updated tables and relevant comments regarding the 2014 benchmarks are included in Annex N ("Benchmark planning for 2014").

### 1.5.9.2 Longer-term benchmark planning

WGHMM is also developing a longer-term perspective for the benchmark process. Issues that should be addressed in the next round of benchmarks have been listed, even though they are several years in the future. Several benchmarks are thus proposed :
a) several stocks of Nephrops (FU 23-24, FU 28-29 and in FU 30) in 2015 in order to develop length-based stock assessment methods.
b) at longer term (2016-2017), the group proposed a benchmark for all anglerfish stocks of WGHMM, preferably in conjunction with the anglerfish stocks (Lophius piscatorius and L. budegassa) in Division IIIa, Subarea IV, VI from the other ICES EWG WGCSE to address issues related to biology of the species (growth and maturity), compilation of data on discards and to develop quantitative stock assessments method.
c) the stock of megrim (Lepidorhombus whiffiagonis) in Divisions VIIb-k and VIIIa,b,d to review the basic data and envisage the use of alternative stock assessment model. This may be carried out in conjunction with the anglerfish benchmark as the species are caught together in the same mixed fishery.
d) on longer term without precise date, the stock of Sole in the Bay of Biscay to include discards in the assessment, reconsider the maturity ogive and mean weights at age currently used, set recruitment age at age 1 (currently age 2 ) and to update reference points.

### 1.5.10 Letter from WKNARC

The Working Group for National Age Reader Coordinators sent a letter to the chair of WGHMM regarding the "the need and value of uncertainty estimates in age readings". WKNARC was enquiring if the stock assessed within the working group was in need of age validation and if the working group would encourage further effort put into the quality grading system and the translation into values applicable for a statistically based assessment model. WGHMM welcomes this initiative. Several stocks from the group would be potentially interested in age validation and in the inclusion of ageing uncertainty in the assessment. This includes the following stocks: Megrim in VII and VIIIabd, Megrim in VIIIc and IXa and Sole in VIIIabd. It was mentioned that for megrim stocks, PGCCDBS has already planned a large-scale age exchange for 2014 and coordinators of these stocks suggested to wait for the output of this workshop before engaging into further work on that issue.

### 1.5.11 New species

The terms of reference for WGHMM listed several new species this year for which advice is required in 2012. This year WGHMM developed a specific stock sections for
the new stocks which were described in an annex last year. Advice sheets for these stocks have also been drafted.

### 1.5.12 Mixed Fisheries considerations

For the fisheries which are in the remit of WGHMM, the mixed-fisheries approach is being currently applied in two European South-western areas, Celtic Sea (VIIfg) and Iberian waters (VIIIc-IXa), as particular case studies of the Interreg European cooperation project GEPETO (Atlantic Area Programme, no 2011-1/159). After compiling data and address some methodological issues, the next step for the Iberian waters case study will be to present preliminary mixed-fisheries forecasts for most of the WGHMM Iberian stocks at the next WGMIXFISH-METH meeting planned for August 2013.

### 1.6 Assessment and forecast auditing process

This year WGHMM has carried out internally an audit of individual assessments and forecasts. WGHMM stocks subjected to review are shown in the Table below and the designated auditor is named on the last column. 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. WGHMM considers that this initiative does not reduce workload. It was not possible to carry out the audit during the meeting, and this task was completed after. Furthermore, the group considers that an internal audit does not guarantee enough objectivity.

| Fish Stock | Stock Name | Stock <br> Coord. | Assessment <br> Coord. 1 | Advice | Review |
| :--- | :--- | :--- | :--- | :--- | :--- |
| anp-78ab | Anglerfish (L. <br> piscatorius) in <br> Divisions VIIb-k <br> and VIIIa,b | Spain/UK | Spain/UK | Update | Cristina Silva |
| anb-78ab | Anglerfish (Lophius <br> budegassa) in <br> Divisions VIIb-k <br> and VIIIa,b | Spain/UK | Spain/UK | Update | Ricardo Alpoim |
| anb-8c9a | Anglerfish (Lophius <br> budegassa) in <br> Divisions VIIIc and <br> IXa | Portugal | Portugal | Update | Esther Abad/Ane <br> Anp-8c9a |
| Anglerfish (L. <br> piscatorius) in <br> Divisions VIIIc and <br> IXa | Spain | Spain | Update | Yolanda Vila |  |
| hke-nrtn | Hake in Division <br> IIIa, Subareas IV, VI <br> and VII and <br> Divisions VIIIa,b,d <br> (Northern stock); | Spain | Spain | Update | Lisa Readdy |
| hke-soth | Hake in Division <br> VIIIc and IXa <br> (Southern stock); | Spain | Spain | Update | Eoghan Kelly |
| mgb-8c9a | Megrim <br> (Lepidorhombus <br> boscii) in Divisions <br> VIIIc and IXa | Spain | Spain | Update | José Castro |


| mgw-8c9a | Megrim <br> (Lepidorhombus <br> whiffiagonis) in <br> Divisions VIIIc and <br> IXa | Spain | Spain | Muriel Lissardy |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
| mgw-78 | Megrim (L. <br> whiffiagonis) in <br>  <br> Divisions <br> VIIIa,b,d,e | Spain | Spain | Re- <br> examin <br> e | Iñaki Quincoces |
| sol-bisc | Sole in Divisions <br> VIIIa,b,d (Bay of <br> Biscay) | France | France | Update | Santiago Cervino |

Table 1.3 Biological sampling levels by stock and country. Number of fish measured and aged from landings in 2012


* Vessels
** Categories
*** Ages, surveys
****Boxes/hauls (for sampling onboard)
*****Otoliths collected and prepared but not read

Table 1.3 (continued)

|  |  | Hake |  | Nephrops |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | IIIa, IV, VI, VII \& VIIIa, | VIIIc \& IXa | VIIIab FU 23-24 | VIIIc FU 25-31 | IXa FU 26-30 |
| Scotland (UK) | No. lengths <br> No. ages <br> No. samples* | 1695 164 53 |  |  |  |  |
| E \& W (UK) | No. lengths <br> No. ages <br> No. samples* | 8274 672 115 |  |  |  |  |
| France | No. lengths <br> No. Ages***** <br> No. samples*** | 42803 710 |  | 23996 363 |  |  |
| Portugal | No. lengths <br> No. ages*** <br> No. samples* | - | $\begin{array}{r} 22074 \\ 0 \\ 397 \end{array}$ |  |  | 8854 39 |
| Republic of Ireland | No. lengths <br> No. ages***** <br> No. samples* | 8221 $N A$ 155 |  |  |  |  |
| Spain | No. lengths <br> No. ages <br> No. samples* | 81154 NA 284 | $\begin{array}{r} 45697 \\ 0 \\ 536 \\ \hline \end{array}$ |  | 1690 39 | 1856 36 |
| Total | No. lengths No. ages | 142164 | 67771 | 23996 0 | 1690 | 10710 |
| Total No. in in landings (thou | ternational usands) | NA | 33836 | 219358 | 203 | 9734 |
| No. Measured annual numbe | as \% of caught | NA | 0.2 | 0.01 | 0.83 | 0.1 |



Figure 1.1. Map of ICES Divisions. Northern (IIIa, IV, VI, VII and VIIIabd) and Southern (VIIIc and IXa) Divisions with different shading.


Figure 1.2. ICES Division VIII and IXa. Nephrops Functional Units. Division VIIIab (Management Area N): FUs 23-24. Division VIIIc (Management Area O): FUs 25 and 31. Division IXa (Management Area Q): FUs 26-30.

## 2 Description of Commercial Fisheries and Research Surveys

### 2.1 Fisheries description

This Section describes the fishery units relevant for 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 VII and Divisions VIIIa,b,d).

The fleets operating in the ICES Subarea VII and Divisions VIIIabd are used in this WG following the Fishery Units (FU) defined by the "ICES Working Group on Fisheries Units in sub-areas VII and VIII" (ICES, 1991):

| Fishery Unit | Description | Sub-area |
| :--- | :--- | :--- |
| FU1 | Long-line in medium to deep water | VII |
| FU2 | Long-line in shallow water | VII |
| FU3 | Gill nets | VII |
| FU4 | Non-Nephrops trawling in medium to deep water | VII |
| FU5 | Non-Nephrops trawling in shallow water | VII |
| FU6 | Beam trawling in shallow water | VII |
| FU8 | Nephrops trawling in medium to deep water | VII |
| FU9 | Nephrops trawling in shallow to medium water | VIII |
| FU10 | Trawling in shallow to medium water | VIII |
| FU12 | Long-line in medium to deep water | VIII |
| FU13 | Gill nets in shallow to medium water | VIII |
| FU14 | Trawling in medium to deep water | VIII |
| FU15 | Miscellaneous | VII \& VIII |
| FU16 | Outsiders | IIIa, IV, V \& VI |
| FU00 | French unknown |  |

Under the implementation of the mixed fisheries approach in the ICES WG's new information updating some national fleet segmentations was presented in WGHMM reports in the last few years, 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 new information in relation to the métiers definition did not change the Fishery Units used in the single stock assessments. However, the hierarchical disaggregation of FU into métiers is essential not only for carrying out mixed-fisheries assessments, but also for a deeper understanding of the fisheries behaviour.

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 new 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 new 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 new sampling design, established since 2009, which can affect the fishery data
supplied to this WG, it has been agreed to detail the métiers related with the stocks assessed by this WG, trying to find the correspondence with the Fishing Units.

Data for stock assessment are typically provided to stock coordinators either still according to the old FUs and the traditional tuning fleets or to the DCF métiers. In the case of discards and/or biological data, even though 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 METIER (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 | $\begin{aligned} & \text { GNS_DEF_100- } \\ & 219 \_0 \_0 \end{aligned}$ | 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 ( $70-99 \mathrm{~mm}$ ) |  | X | X | X |
|  |  | $\begin{aligned} & \text { OTB_DEF_100- } \\ & 119 \_0 \_0 \end{aligned}$ | Bottom otter trawl directed to demersal fish ( $100-119 \mathrm{~mm}$ ) |  |  | X | X |
| FU5 | OTB_DEF |  | Otter trawl directed to demersal Fish shallow water |  |  |  | X |
| FU6 | TBB_DEF |  | Beam trawl |  |  |  | X |
| FU8 | OTB_CRU |  |  |  |  |  |  |
| FU9 | OTB_CRU | OTB_CRU_70-99_0_0 | Bottom otter trawl directed to crustaceans ( $70-99 \mathrm{~mm}$ ) | X | X |  | X |
| FU10 | OTB_DEF |  |  |  |  |  |  |
| FU12 | LLS_DEF | LLS_DEF_0_0_0 | Set longline directed to demersal fish | X |  | X |  |
| FU13 | GNS_DEF | GNS_DEF_45-59_0_0 | Set gillnet directed to demersal fish ( $45-59 \mathrm{~mm}$ ) | X |  |  |  |
|  |  | GNS_DEF_>=100_0_0 | Set gillnet directed to demersal fish (at least 100 mm ) | X |  | X |  |
| FU14 | OTB_DEF | OTB_DEF_>=70_0_0 | Bottom otter trawl directed to demersal fish (at least 70 mm ) | X |  | X |  |
|  | OTB_MCF | OTB_MCF _>=70_0_0 | Bottom otter trawl directed to mixed cephalopods 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 |  |  |  |
|  | OTB_CRU | OTB_CRU _>=70_0_0 | Bottom otter trawl | X |  |  |  |


| FU | Fleet for InterCatch | DCF METIER (Level 6) | DESCRIPTION | FR | IR | SP | UK |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | directed to crustaceans (at least 70 mm ) |  |  |  |  |
|  | OTT_CRU | OTT_CRU _>=70_0_0 | Multi-rig otter trawl directed to crustaceans (at least 70 mm ) | 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 |  |  |  |  |
| FU16 | OTB_DEF | $\begin{aligned} & \text { OTB_DEF_100- } \\ & 119 \_0 \_0 \end{aligned}$ | Bottom otter trawl directed to demersal fish ( $100-119 \mathrm{~mm}$ ) | 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 |  |  |  |  |
| 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 $<12 \mathrm{~m}$ ) (GNx or GTx)
Offshore-gillnets (French gillnetters with length > 12 m ) (GNx or GTx)
Inshore-trawlers (French trawlers with length < 12 m ) ( $\mathrm{OTx}, \mathrm{TBx}, \mathrm{PTx}$ )
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 VIIIc and IXa).

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 for several years 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 VIIIc and IXa North |
|  | Gillnet | Gillnet fleet using "volanta" gear ( 90 mm mesh size) for targeting hake in Division VIIIc |
|  |  | Gillnet fleet using "rasco" gear ( 280 mm mesh size) for targeting anglerfish in Division VIIIc |
|  | Long Line | Long line fleet targeting a variety of species (hake, great fork beard, conger) in Division VIIIc |
|  | Northern Artisanal | Miscellaneous fleet exploiting a variety of species in Divisions VIIIc and IXa North |
|  | Southern <br> Artisanal | Miscellaneous fleet exploiting a variety of species in Division IXa South (Gulf of Cádiz) |
|  | Northern Trawl | Miscellaneous fleet operating in Divisions VIIIc and IXa North composed of bottom pair trawlers 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 ( $>5 \mathrm{~m}$ of vertical opening) targeting mackerel and horse mackerel. |
|  | Southern <br> Trawl | Bottom otter trawlers operating in Division IXa 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 IXa involving gillnet ( 80 mm mesh size), trammel ( 100 mm mesh size), long line and other gears. Species caught: hake, octopus, pout, horse mackerel and others |
|  | Trawl | Trawl fleet opertaing in Portuguese waters of Division IXa copmpounded by bottom otter trawlers targeting crustaceans (55 mesh size), and bottom oter trawlers targeting different species of fish ( 65 mm mesh size). |

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

The correspondence between Fishing Units and DCF métiers has been also compiled for the southern stocks fleets and is presented in the following table. As for the CelticBiscay shelf, sampling inconsistencies among biological and commercial data make the use of the DCF Level 5 preferable to introduce Iberian data in InterCatch. This reaggregation affects the Spanish gillnet operating in the Northern Spanish waters, because the set gillnet ("beta") directed to hake (GNS_DEF_60-79_0_0) and the set gillnet ("volanta") also targeting hake (GNS_DEF_80-99_0_0) must be sampled together. It must taken into account that the set gillnet using more than 280 mm mesh size
(GNS_DEF_280_0_0) targets mostly anglerfish and cannot be distinguished at Level 5 (the level proposed for the InterCatch fleets) from the two gillnet métiers previously mentioned (which are directly mainly to hake). So a revision of the current InterCatch fleet proposal may be required in this case (to be decided by the WG by midSeptember, as stated at the start of Section 2.1).

| COUNTRY | FU | Fleet for InterCatch | METIERS (Level 6) | DESCRIPTION <br> (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 |  |
|  | Northern Arisanal |  | 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 <br> Trawl | PTB_DEF | $\begin{aligned} & \text { PTB_DEF _> = } \\ & 55 \_0 \_0 \end{aligned}$ | Pair bottom trawl directed to 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_DEM | OTB_DEM_>=55_0_0 | Otter bottom trawl directed to demersal species (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 ( $60-69 \mathrm{~mm}$ ) |  | 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 WGHMM in 2010, the DCF acronym and the new ICES survey acronym which will be used throughout this WG report and Stock Annexes. The new survey acronyms used this year were provided by ICES Secretariat, aiming for consistency across all ICES Expert Groups. When ICES Secretariat has not included a survey in the list for which it has provided acronyms, the WGHMM 2010 acronym will remain in use.

| Survey | WGHMM 2010 acronym | DCF acronym | ICES survey acronym as of 2011 |
| :---: | :---: | :---: | :---: |
| Spanish groundfish survey quarter 4 | SP-GFS | IBTS-EA-4Q | SpGFS-WIBTS-Q4 |
| Spanish Porcupine groundfish survey | SP-PGFS | IBTS-EA | SpPGFS-WIBTS-Q4 |
| Spanish Cadiz groundfish survey - Autumn | SP-GFS-caut |  | SPGFS-caut-WIBTS-Q4 |
| Spanish Cadiz groundfish survey - Spring | SP-GFS-cspr |  | SPGFS-cspr-WIBTS-Q1 |
| Portuguese groundfish survey <br> - October | P-GFS-oct | IBTS-EA-4Q | PtGFS-WIBTS-Q4 |
| Portuguese groundfish survey <br> - July (terminated) | P-GFS-jul |  | ---- |
| Portuguese crustacean trawl survey / Nephrops TV survey offshore Portugal | P-CTS | UWFT (FU 2829) | PT-CTS (UWTV (FU 28-29)) |
| Portuguese winter groundfish survey/Western IBTS 1st quarter | PESCADA-BD |  | PtGFS-WIBTS-Q1 |
| French EVHOE groundfish survey | EVHOE | IBTS-EA-4Q | EVHOE-WIBTS-Q4 |
| French RESSGASC groundfish survey (ended in 2002) | RESSGASC |  | ---- |
| French Bay of Biscay sole beam trawl survey | ORHAGO |  | ORHAGO |
| French Nephrops survey in Bay of Biscay | LANGOLF |  | LANGOLF |
| UK west coast groundfish survey (ended in 2004) | UK-WCGFS |  | ----- |
| UK Western English Channel Beam Trawl Survey |  |  | UK-WECBTS |
| UK Bottom Trawl Survey |  |  | EN-CEFAS-A, B |
| English fisheries science partnership survey | EW-FSP |  | FSP-Eng-Monk |
| Irish groundfish survey | IGFS | IBTS-EA-4Q | IGFS-WIBTS-Q4 |

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

### 2.2.1 Spanish groundfish survey (SpGFS-WIBTS-Q4)

The SpGFS-WIBTS-Q4 covers the northern Spanish shelf comprised in ICES Division VIIIc and the northern part of IXa, 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 $3^{\text {rd }}$ quarter (September) and finishes in the $4^{\text {th }}$ quarter.

### 2.2.2 Spanish Porcupine groundfish survey (SpPGFS-WIBTS-Q4)

The SpPGFS-WIBTS-Q4 occurs at the end of the $3^{\text {rd }}$ quarter (September) and start of the $4^{\text {th }}$ 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 VIIb-k, which corresponds to the Porcupine Bank and the adjacent area in western Irish waters between $180-800 \mathrm{~m}$. The survey area covers $45880 \mathrm{Km}^{2}$ 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 IXa, the Gulf of Cádiz, and collect data on the distribution, relative abundance, and biology of commercial fish species. The area covered is $7224 \mathrm{Km}^{2}$ and extends from $15-800 \mathrm{~m}$. The primary species of interest are hake, horse mackerel, wedge sole, sea breams, mackerel and Spanish mackerel. Data and abundance indices are also collected and estimated for other demersal fish species and invertebrates such as rose and red shrimps, Nephrops and cephalopod molluscs.

### 2.2.4 Portuguese groundfish survey October (PtGFS-WIBTS-Q4)

PtGFS-WIBTS-Q4 extends from latitude $41^{\circ} 20^{\prime} \mathrm{N}$ to $36^{\circ} 30^{\prime} \mathrm{N}$ (ICES Div. IXa) and from 20 to 500 m 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, seabream and Nephrops), mainly to monitor the abundance and distribution of hake and horse mackerel recruitment. The surveys aim to carry out ca. 90 stations per year.

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

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

Nephrops fishing grounds. In 2008 and 2009, the crustacean trawl survey conducted in Functional Units 28 and 29, was combined with an experimental video sampling.

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

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

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

The EVHOE-WIBTS-Q4 survey covers the Celtic Sea with ICES Divisions VIIfghj, and the French part of the Bay of Biscay in divisions VIIIab. 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, monkfishes and megrim) leaving at least two stations per stratum and 140 valid tows are planned every year although this number is dependent on available sea time.

### 2.2.8 French RESSGASC groundfish survey (RESSGASC)

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

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

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

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

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

### 2.2.11 UK west coast groundfish survey (UK-WCGFS)

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

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

The FSP-Eng-Monk survey, part of the English fisheries science partnership programme, has been carried out every year since 2003 with 208 valid hauls in 2010. The aims of the survey are to investigate abundance and size composition of anglerfish on the main UK anglerfish fishing grounds off the southwest coast of England within ICES subdivisions VIIe-h.

### 2.2.13 English Western English Channel Beam Trawl Survey

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

### 2.2.14 English Bottom Trawl Survey

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

### 2.2.15 Irish groundfish survey (IGFS-WIBTS-Q4)

The IGFS-WIBTS-Q4 is carried out in 4th quarter in divisions VIa, VIIbcgj, though only part of VIa and the border of Division VIIc, in depths of $30-600 \mathrm{~m}$. The annual target is 170 valid tows of 30 minute duration which are carried out in daylight hours at a speed of 4 knots. Data is 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).

## 3 Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock)

Type of assessment: update (stock benchmarked in 2010), stock on observation list. Data revisions: Spanish landings from 2011 and French length frequency distribution from 2011.
Review Group issues: Concerns about the low discards in the projection. The reason is the underestimation of discards by the model and that only the discards of some fleets are included in the model. Not addressed during the meeting. To be analysed in the next benchmark.

### 3.1 General

### 3.1.1 Stock definition and ecosystem aspects

This section is described in the Stock Annex (Annex C).

### 3.1.2 Fishery description

The general description of the fishery is now presented in the Stock Annex.
There has been a reduction in the Spanish fishing capacity through the last years: the Spanish vessels with licence that operate in the area have been reduced in a $29.4 \%$ from 2007 to 2012.

### 3.1.3 Summary of ICES advice for 2013 and management for 2012 and 2013

## ICES advice for 2013

In 2013 no assessment was carried out due to incomplete catch data. The advice was based on the short term projections of 2011 assessment. ICES advised on the basis of the transition to MSY approach that landings in 2013 should be no more than 51900 t .
MSY approach
The stock is considered to be above any potential MSY Btrigger. Following the ICES MSY framework implies fishing mortality to be reduced to 0.24 , resulting in landings of 39400 tonnes in 2012. This is expected to lead to an SSB of 138000 tonnes in 2013.
Following the transition scheme towards the ICES MSY framework implies fishing mortality be reduced to 0.33 and corresponding to landing of 51900 tonnes. This is expected to lead to an SSB of 125000 tonnes in 2013. Like the main stocks of the EU, the Northern hake stock is managed by a TAC and quotas. The TACs for recent years are presented below:

| TAC (t) | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| IIIa, IIIb,c,d (EC Zone) | 1588 | 1627 | 1552 | 1661 | 1661 | 1661 | 1661 |
| IIa (EC Zone), IV | 1850 | 1896 | 1808 | 1935 | 1935 | 1935 | 1935 |
| Vb (EC Zone), VI, VII, <br> XII, XIV | 29541 | 30281 | 28879 | 30900 | 30900 | 30900 | 30900 |
| VIIIa,b,d,e | 19701 | 20196 | 19261 | 20609 | 20609 | 20609 | 20609 |
| Total Northern Stock <br> [IIa-VIIIabd] | 52680 | 54000 | 51500 | 55105 | 55105 | 55105 | 55105 |

## Management for 2012 and 2013

The minimum legal sizes for fish caught in Sub areas IV-VI-VII and VIII is set at 27 cm total length ( 30 cm in Division IIIa) since 1998 (Council Reg. no 850/98).

From 14th of June 2001, an Emergency Plan was implemented by the Commission for the recovery of the Northern hake stock (Council Regulations N ${ }^{\circ} 1162 / 2001,2602 / 2001$ and 494/2002). In addition to a TAC reduction, 2 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 VII and the other in Sub area VIII, where a 100 mm minimum mesh size is required for all otter-trawlers, whatever the amount of hake caught.

There are explicit management objectives for this stock under the EC Reg. No $811 / 2004$ implementing measures for the recovery of the northern hake stock. It is aiming at increasing the quantities of mature fish to values equal to or greater than 140000 t . This is to be achieved by limiting fishing mortality to 0.25 and by allowing a maximum change in TAC between years of $15 \%$.

Due to the new perspective of historical stock trends, resulting from the new assessment, the previously defined precautionary reference points are no longer appropriate. In particular, the absolute levels of spawning biomass, fishing mortality, and recruitment have shifted to different scales. As a consequence, the TAC corresponding to the current recovery plan (EC Reg. No. 811/2004) should not be considered, because the plan uses target values based on precautionary reference points that are no longer appropriate.

In 2012 ICES advised on the basis of the transition to the MSY approach that landings in 2013 should be no more than 51900 t .

### 3.2 Data

### 3.2.1 Commercial catches and discards

Total landings from the Northern stock of hake by area for the period 1961-2012 as used by the WG are given in Table 3.1. They include landings from Division IIIa, Subareas IV, VI and VII, and Divisions VIIIa,b,d, as reported to ICES. Unallocated landings are also included in the table; they are high over the first decade (1961-1970), when the uncertainties in the fisheries statistics were high. In last 2 data years, 2011 and 2012, they have increased again due to differences between official statistics and scientific estimations. The group decided to use scientific estimates to carry out the assessment. Table 1 of the Stock Annex provides a historical perspective of the level of aggregation at which landings have been available to the WG.

Except for 1995, landings decreased steadily from 66500 t in 1989 to 35000 t in 1998. Up to 2003, landings fluctuated around 40000 t . Since then, with the exception of 2006, landings have been increasing up to 79700 t in 2011, the highest value since 1963. Landings in 2012 were 75 200, well above the 2012 TAC ( 55105 t ).

The discard data sampling and data availability are presented in the Stock Annex. Table 3.2 presents discard data available to the group from 1999 to 2012.

### 3.2.2 Biological sampling

The sampling level is given in Table 1.3.
Length compositions of 2012 landings by Fishery Unit and quarter were provided by Ireland, Spain, France, Scotland, UK(E\&W) and Denmark.

Length compositions samples are not available for all FUs of each country in which landings are observed (see Stock Annex). Only the main FUs are sampled (Table 3.3).

### 3.2.3 Abundance indices from surveys

Four surveys provide relative indices of hake abundance over time. The French RESSGASC survey was conducted in the Bay of Biscay from 1978 to 2002, the EVHOE-WIBTS-Q4 survey conducted in the Bay of Biscay and in Celtic Sea with a new design since 1997, the SpPGFS-WIBTS-Q4 survey conducted on the Porcupine Bank since 2001, and the Irish Groundfish Survey (IGFS-WIBTS-Q4) beginning in 2003 in the west of Ireland and the Celtic Sea. A brief description of each survey is given in the Stock Annex. Figure 3.1 presents the abundances indices obtained for these surveys.

From 1985 until the end of the survey in 2002, the index from RESSGASC followed a slightly decreasing trend.

Throughout the available time series, the abundance index provided by EVHOE-WIBTS-Q4 showed three peaks in 2002, 2004, and 2008. The index obtained in 2012 reach the highest value of the series, $193 \%$ higher than previous year index.

The abundance index provided by IGFS-WIBTS-Q4 follows a similar trend, so that from the 2008 peak, the abundance index obtained in 2012 achieves the higher value of the series, $268 \%$ higher than previous year index.

For the SpPGFS-WIBTS-Q4 survey conducted on Porcupine's Bank since 2001, the abundance index follows an increasing trend since 2003, reaching its highest value in 2009 and slightly decreases in 2010 and 2011. The abundance index in 2012 is moderately higher than 2011 index ( $+7 \%$ ).

The spatial distribution of the EVHOE-WIBTS-Q4 index for hakes from 0 to 20 cm is given in Figure 3.2 for the most recent years. It is apparent from this figure that interannual variations in abundance are different between areas (VII and VIII). In 2012, both areas display large abundance, even higher than in 2008, another year with high abundance index over recent years.

### 3.2.4 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 1982-2012 are given in Table 3.4ab and Figure 3.3ab.

Since 1985, the LPUE of A Coruña trawlers operating in Subarea VII has fluctuated, with an increasing trend reaching its maximum value in2011, which has been interrupted in 2012 with a moderate decrease. Over the same period, LPUE from Vigo trawlers operating in Subarea VII followed a slightly decreasing trend, becoming less variable during the last 15 years. It must be taken into account that while A Coruña trawl fleet is targeting hake, the Vigo trawl fleet is directed to megrim, taking hake only as bycatch.

LPUE from Ondarroa and Pasajes pair trawlers operating in Divisions VIIIa,b,d have followed similar trends and have been quite variable. The highest two peak values have been observed in 1995 and 2002. For Ondarroa, very large increases in LPUE have been observed in 2008 and 2009, with the largest value observed in 2009. Since then indices has been decreasing, although not up to the low levels of the beginning of the time series. Its LPUE remained at this high level in 2010. In 2005 both fleets experienced a decrease in effort (expressed in number of days), which corresponds to a decrease in number of vessels. This decrease has continued further for the Pasajes pair trawlers which were at a very low level of effort in 2007 (105 days only) and stopped their operations in 2008.

For the Ondarroa "Baka" trawlers fishing in Subareas VI show a marked increase since 2003, achieving its highest values in 2012. Ondarroa "Baka" trawlers in Subarea VII targeting hake and megrim until 1996 and megrim and anglerfish with lower hake LPUE since then. The Ondarroa baka trawlers in VIIIabd and also VII and Div. VIIIa,b,d, the Pasajes "Bou" trawlers fishing in Subarea VIII and the trawlers from Santander trawlers in VIIIa,b,d do not show there is no marked particular trend in the LPUE. However, in this fishing area, these fleets are not targeting hake.

Due to important reductions in the availability of log-book information in recent years for both French fleets from Les Sables and Lesconil, LPUE values for the years 1996 onwards have low reliability. Effort and LPUE for the period 1987-2003 are given in Table 3.4b and presented in Figure 3.3b only for the period 1987-1995.

The LPUE series of the two most important Spanish longline fleets operating in VII (Celeiro and Burela) have been rather stable over time, but their a marked increased experimented these last years until 2011 shows a decrease in 2012. This same pattern is also present in A Coruña longliners fishing in VII, although it is not quite as strong. It is to be noted however that for gill-netters and long liners, LPUEs expressed in $\mathrm{kg} /$ day may not be the most appropriate.

### 3.2.5 Assessment

An update of 2011 assessment was carried out using data up to year 2012. The results showed large retrospective patterns (Figure 3.10) and convergence problems. Several alternative fits, using different starting parameters and fixing Von Bertalanffy parameters, were performed in order to explain the discrepancies in assessment results obtained in consecutive years. Results of some of those sensitivity analyses are presented below.

## Model

The Stock Synthesis 3 (SS3) assessment model (Methot, 2009) 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).

### 3.2.5.1 Sensitivity analysis.

### 3.2.5.2 Update assessment.

Residuals of the fits to the surveys $\log$ (abundance indices) are presented in Figure 3.4. The greater part of the upward trend in relative abundance observed in all three contemporary trawl surveys (EVHOE-WIBTS-Q4, SpPGFS-WIBTS-Q4 and IGFS-WIBTSQ4) has been captured by the model. However the model is not able to explain the
high increase on the last 3 years in EVHOE-WIBTS-Q4 and IGFS-WIBTS-Q4 surveys. Pearson residuals of their length frequency distributions show a "fairly random" behaviour with no particular trend or lack of fit until 2008 (Figure 3.5, where blue and red circles denote positive and negative residuals, respectively). From 2009, for IGFS and EVHOE surveys, the residuals for almost all the individuals larger than 15 cm are always positive. Residuals of the length frequency distributions of the commercial fleets landings and discards (not presented in this report but available on the Sharepoint) show almost the same patterns, as mentioned in the benchmark report (ICES, 2010a). The pearson residuals of LONGLINE fleet for large individuals are positive since 2008.

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 3.6 presents selectivity (for the total catch; black lines) and retention functions by fleet (red and green lines) estimated by the model. For the Spanish trawl fleets in VII and VIII, a retention function is estimated for years 19781997 and another one for 1998-present. This change in retention was clearly noticed when examining the length frequency distributions of the landings and might be due to a stricter enforcement of the minimum landing size. For the French trawlers targeting Nephrops in VIII, the same retention function is assumed throughout the entire assessment period (1978-present). The assessment currently assumes that the other commercial fleets do not discard fish, although this assumption should be revised as more information on discards becomes available.

The assessment model also estimates the growth rate $K$ from a von Bertalanffy growth model (with L infinite fixed at 130 cm , in accordance with the Stock Annex). Growth parameters obtained this year and in previous years are shown in table 3.5. Growth parameters obtained in 2010 and 2011 assessments are similar, but they differ substantially with those obtained in this year update assessment. K and L1 have decreasing and increasing trends respectively in last 2 years. The update assessment estimates K as $0.147,17 \%$ lower than 2011 assessment's estimate. Figure 3.7 shows Von Bertalanffy curves obtained using the growth parameters obtained along years. 2010 and 2011 curves are almost identical but the curve obtained this year produces quite slower growth. The curve obtained using data up to 2011, is in the middle of the curves estimated in 2010 and this year assessments.

Retrospective analysis obtained in the update assessment using data up to year 2012 is shown in Figure 3.8. There were differences from year to year assessment for the three indicators shown, recruitment, SSB and F. When you add more years into the assessment the recruitment and SSB are revised upwards over all the historical series and fishing mortality is revised downwards. Assessment using data up to year 2008 and 2009 gave similar results, but after 2009 the time series differ considerably year by year.

### 3.2.5.3 Fixed growth.

An alternative fit was carried out fixing growth parameters to those obtained in WGHMM2011 assessment.

Residuals of the fits to the surveys $\log ($ abundance indices) are presented in Figure 3.9. The greater part of the upward trend in relative abundance observed in all three contemporary trawl surveys (EVHOE-WIBTS-Q4, SpPGFS-WIBTS-Q4 and IGFS-WIBTSQ4) has been captured by the model. However the model is not able to explain the
high increase on the last 3 years in EVHOE-WIBTS-Q4 and IGFS-WIBTS-Q4 surveys. Pearson residuals of their length frequency distributions show a "fairly random" behaviour with no particular trend or lack of fit until 2008 (Figure 3.10, where blue and red circles denote positive and negative residuals, respectively). From 2009, for IGFS and EVHOE surveys, the residuals for individuals larger than 15 cm are always positive. 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 almost the same patterns, as mentioned in the benchmark report (ICES, 2010a). The pearson residuals of LONGLINE fleet for large individuals are positive since 2008.

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 3.11 presents selectivity (for the total catch; black lines) and retention functions by fleet (red and green lines) estimated by the model. For the Spanish trawl fleets in VII and VIII, a retention function is estimated for years 19781997 and another one for 1998-present. This change in retention was clearly noticed when examining the length frequency distributions of the landings and might be due to a stricter enforcement of the minimum landing size. For the French trawlers targeting Nephrops in VIII, the same retention function is assumed throughout the entire assessment period (1978-present). The assessment currently assumes that the other commercial fleets do not discard fish, although this assumption should be revised as more information on discards becomes available.
Figure (3.12) shows the retrospective analysis of this fit. This sensitivity run showed less retrospective bias than that observed in the update assessment. The F and SSB time series obtained in consecutive years matched perfectly with each other.

### 1.1.1.1 Conclusion

Survey residuals and selectivity's were similar for both assessments. Small differences were found for example in the residuals of EVHOE survey. Figure 3.13 shows the comparison between 2011 assessment results (the last approved assessment), the update assessment and the assessment with fixed growth parameters. For the three indicators shown, recruitment, SSB and F there were differences between update assessment and the assessment carried out in WGHMM 2011. The recruitment and SSB in 2013 fit are revised upwards over all the historical series and fishing mortality is revised downwards. For the fit with fixed growth parameters SSB and F time series are similar to the WGHMM 2011 time series until 2005. After 2005, SSB and F time series diverge; the fit with fixed growth parameters estimates higher SSB and lower F than in WGHMM 2011.

Recent signals from the data used in the assessment (among the highest landings in the historical series available, very large increase in recruitment in 2012 as indicated in a consistent way by the two main abundance indices used in the assessment) and other relevant data such a huge increase in discards from the Scottish fleets suggest that the stock abundance is increasing sharply. This apparent and rapid changes in the relative levels of some of the data used in the assessment drives the model to significantly change the value of $K$ (reduction of $K$ from 0.17 to 0.14 ) in order to find a better likelihood. As K is assumed constant over the whole historical data series, this change in K may cause retrospective revisions in the assessment back to the start of the time series. Setting $K$ at the value estimated in previous assessment provides stability in the historical perspective of stock development. The working group considers that such a setting, although not strictly consistent with the stock annex, provides
the best possible options for this year assessment. The issue needs however further investigations which will be carried out inter-seasonally and during the next benchmark planned for early 2014.

The working group decided to accept the assessment fixing growth parameters as final assessment and as the basis to give advice for 2014. From here, all the tables and figures have been obtained using the assessment with fixed growth.

### 3.2.6 Historic trends in biomass, fishing mortality and recruitment

Summary results from SS3 are given in Table 3.6 and Figure 3.14. In 2012 and 2011, F (average of F-at-length over lengths $15-80 \mathrm{~cm}$ ) was estimated at 0.24 , and SSB at 277 794 t.

For recruitment, fluctuations appear to be without substantial trend over the whole series. After a high recruitment in 2008 (631 million), there are 3 consecutive years of low recruitment (between 160 and 230 millions). In the last year it increases sharply again and reaches its historical maximum ( 743 million).

From high levels at the start of the series ( 130000 t in 1980), the SSB has decreased steadily to a low level at the end of the 90s (44 500 t in 1998). Since that year, SSB has increased to the highest value of the series in 2012 ( 277794 t). From 2007 to 2011 the SSB experienced high increases from year to year (between $30 \%$ and $75 \%$ ). The increase level in 2012 decreased to a $6 \%$.

The fishing mortality is calculated as the average annual F for sizes $15-80 \mathrm{~cm}$. 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 70 s and early 80 s to values around 1.0 during the 90s. They declined sharply afterwards to 0.24 in 2011 and 2012. From 2007 to 2011 F decreased from year to year around a $20 \%$.

### 3.3 Catch options and prognosis

### 3.3.1 Short - Term projection

Options for short term projection are indicated in the Stock Annex
For the current projection, unscaled $F$ is used, corresponding to $F(15-80 \mathrm{~cm})=0.24$.
The recruitment used for projections in this WG is the GM calculated from 1978 to the final assessment year minus 2.

Landings in 2014 and SSB in 2015 predicted for various levels of fishing mortality in 2014 are given in Table 3.7 and Figure 3.15. Maintaining status quo F in 2014 is expected to result in an increase in landings with respect to 2013 and an increase in SSB in 2015 with respect to 2014.

### 3.3.2 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 3.8 and Figure 3.16. The F-multiplier in Table 3.8 is with respect to status quo $F$ (average $F$ in the final 3 assessment years, 2010-2012). Considering the yield and SSB per recruit curves, $\mathrm{F}_{\text {max }}, \mathrm{F}_{0.1}, \mathrm{~F}_{35 \%}$ and $\mathrm{F}_{30 \%}$ are respectively estimated to be $122 \%, 83 \%, 86 \%$ and $101 \%$ of status quo $F$. The maximum equilibrium yield per recruit is less than $4 \%$ above the equilibrium yield at $\mathrm{F}_{\text {sq }}$.

### 3.4 Biological reference points

The benchmark carried out in 2010 (ICES 2010a) led to a complete re-start relative to the previous assessment which was based on age data now demonstrated to be biased. Thus, the PA reference points are no longer appropriate.

Fmsy has been set to 0.24, the value proposed by WGHMM in 2010 based on F30\% (the fishing rate that would reduce the spawning biomass per recruit to $30 \%$ of its unfished level). As can be seen in Table 3.9, F30\% is still estimated equal to 0.24 in this year's assessment.

According to the guidelines provided by WKFRAME (ICES, 2010b; ICES, 2011), for stocks fished at a level well above $\mathrm{F}_{\mathrm{MSY}}$ (as this is the case for northern hake), B $\mathrm{Ba}_{\mathrm{A}}$ could be used as a preliminary operational trigger point which could be revised once we get better knowledge of the biomass distribution under the condition of fishing at Fmsy. As explained above, the $B_{\text {pa }}$ value previously used for the northern hake stock is no longer appropriate and the WG is not proposing any MSY- $B_{\text {trigger }}$ this year.

During the working group and based on the working document WD8 the relevance of current and alternative Fmsy values was analysed. A detailed description of the work and results is presented in Annex T of this report.

|  | Type | Value | Technical basis |
| :---: | :---: | :---: | :---: |
| MSY | MSY Btrigger | Not defined |  |
| Approach | FmsY | 0.24 | $\mathrm{F}_{30 \% \text { SPR }}$ as estimated in WGHMM 2010 |
| Precautionary <br> Approach | Blim | Not defined |  |
|  | $\mathrm{B}_{\mathrm{pa}}$ | Not defined |  |
|  | Flim | Not defined |  |
|  | $\mathrm{F}_{\mathrm{pa}}$ | Not defined |  |

### 3.5 Comments on the assessment

The northern hake assessment was completely revised during the WKROUND benchmark workshop (ICES, 2010a). The new assessment shifted to a length-based approach using the Stock Synthesis assessment model. This approach allows direct use of length-composition data and explicit modelling of a retention process that partitions total catch into discarded and retained portions. No age data are used in the new assessment.

This year the working group did not accept the update assessment as described in the stock annex. The main reason was a marked retrospective pattern when more recent data were incorporated into the assessment. Furthermore, it was suspected that there could be convergence problems. Fixing the growth parameters to the value estimated in WGHMM 2011 assessment permitted to remove the strong retrospective pattern observed when growth parameters are estimated. An update assessment with fixed growth parameters was thus accepted by the WG.

In recent years, SS3 estimates a high rate of decrease in F and of increase in SSB; it leads to levels of F and SSB not seen in the historic time series. The sharp increase in SSB is the direct consequence of a series of good recruitments in 2006-2008 and a high growth rate estimated by SS3 in 2011 ( $\mathrm{K}=0.177$, consistent with the growth rate estimated from tagging data (de Pontual et al., 2009). The recent trends are consistent
with increasing landings (Table 3.1) and increasing LPUEs (Table 3.4) but the Working Group considers that the rate of increase and decrease of those trends remains uncertain and may be over-estimated. Incorporating tuning information about large fish, not readily available at present, may help stabilize the SSB estimates The WG considers that for future benchmark planned in 2014 it is crucial to obtain an abundance index, for example a CPUE of Longline, to calibrate this part of the population.
Finally, the retrospective analysis (Figure 3.12) shows that only recruitment is sensitive to the exclusion of recent data.

The assessment includes discards of several commercial fleets. To account for the large uncertainties associated with the estimations of discards in weight, the discard data are entered in the assessment model assuming a CV of $50 \%$ (see Stock Annex). This leads, for some fleets, to low estimates of discards compared to the observations (not presented in this report but available on the WG Share-point) and, as a consequence, the projections of discards are also very low when compared with recent observed values (as can be noticed by comparing Tables 3.6 and 3.2). As a consequence of the high increase in stock abundance and low catch quotas discards have experienced a big increase in recent years for some fleets. A large proportion of the discards are not included in the assessment because the fleet they belong to does not included discards. The historical discard time series of those fleets should be reconstructed to include them into the assessment.

The assessment is consistent with the assessment conducted by WGHMM in 2011 (Figure 3.13).

### 3.6 Management considerations

There are strong indications of an increase in SSB and a decrease in fishing mortality. The increase in SSB is the consequence of several strong incoming recruitments, in particular, the 2006-2008 year classes. However the increase rate should be taken with caution as limited information is currently available on the variation in abundance of large fish. It must be also noted that the fast growth rate estimated by the model combined with the assumed high natural mortality rate ( $\mathrm{M}=0.4$ since the 2010 benchmark) generates a rapid turn-over of the hake stock dynamic. This means that short term predictions in SSB and landings are strongly related to variations in recruitment. The recruitment in last two years is not included in the calculation of the short-term forecasts recruitment.

Table 3.1. Northern hake estimated of landings ('000 t) by area for 1961-2010.
Table 3.1. Northern Hake. Estimates of catches ('000 t) by area for 1961-2010.

|  |  |  | Landings |  |  | Discards (2) | Catches (3) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Year | IVa+VI | VII | VIIIa, b | Unallocated | Total | Total | Total |
| 1961 | - | - | - | 95.6 | 95.6 | - | 95.6 |
| 1962 | - | - | - | 86.3 | 86.3 | - | 86.3 |
| 1963 | - | - | - | 86.2 | 86.2 | - | 86.2 |
| 1964 | - | - | - | 76.8 | 76.8 | - | 76.8 |
| 1965 | - | - | - | 64.7 | 64.7 | - | 64.7 |
| 1966 | - | - | - | 60.9 | 60.9 | - | 60.9 |
| 1967 | - | - | - | 62.1 | 62.1 | - | 62.1 |
| 1968 | - | - | - | 62.0 | 62.0 | - | 62.0 |
| 1969 | - | - | - | 54.9 | 54.9 | - | 54.9 |
| 1970 | - | - | - | 64.9 | 64.9 | - | 64.9 |
| 1971 | 8.5 | 19.4 | 23.4 | 0 | 51.3 | - | 51.3 |
| 1972 | 9.4 | 14.9 | 41.2 | 0 | 65.5 | - | 65.5 |
| 1973 | 9.5 | 31.2 | 37.6 | 0 | 78.3 | - | 78.3 |
| 1974 | 9.7 | 28.9 | 34.5 | 0 | 73.1 | - | 73.1 |
| 1975 | 11.0 | 29.2 | 32.5 | 0 | 72.7 | - | 72.7 |
| 1976 | 12.9 | 26.7 | 28.5 | 0 | 68.1 | - | 68.1 |
| 1977 | 8.5 | 21.0 | 24.7 | 0 | 54.2 | - | 54.2 |
| 1978 | 8.0 | 20.3 | 24.5 | -2.2 | 50.6 | - | 50.6 |
| 1979 | 8.7 | 17.6 | 27.2 | -2.4 | 51.1 | - | 51.1 |
| 1980 | 9.7 | 22.0 | 28.4 | -2.8 | 57.3 | - | 57.3 |
| 1981 | 8.8 | 25.6 | 22.3 | -2.8 | 53.9 | - | 53.9 |
| 1982 | 5.9 | 25.2 | 26.2 | -2.3 | 55.0 | - | 55.0 |
| 1983 | 6.2 | 26.3 | 27.1 | -2.1 | 57.5 | - | 57.5 |
| 1984 | 9.5 | 33.0 | 22.9 | -2.1 | 63.3 | - | 63.3 |
| 1985 | 9.2 | 27.5 | 21.0 | -1.6 | 56.1 | - | 56.1 |
| 1986 | 7.3 | 27.4 | 23.9 | -1.5 | 57.1 | - | 57.1 |
| 1987 | 7.8 | 32.9 | 24.7 | -2.0 | 63.4 | - | 63.4 |
| 1988 | 8.8 | 30.9 | 26.6 | -1.5 | 64.8 | - | 64.8 |
| 1989 | 7.4 | 26.9 | 32.0 | 0.2 | 66.5 | - | 66.5 |
| 1990 | 6.7 | 23.0 | 34.4 | -4.2 | 60.0 | - | 60.0 |
| 1991 | 8.3 | 21.5 | 31.6 | -3.4 | 58.1 | - | 58.1 |
| 1992 | 8.6 | 22.5 | 23.5 | 2.1 | 56.6 | - | 56.6 |
| 1993 | 8.5 | 20.5 | 19.8 | 3.3 | 52.1 | - | 52.1 |
| 1994 | 5.4 | 21.1 | 24.7 | 0.0 | 51.3 | * | 51.3 |
| 1995 | 5.3 | 24.1 | 28.1 | 0.1 | 57.6 | - | 57.6 |
| 1996 | 4.4 | 24.7 | 18.0 | 0.0 | 47.2 | - | 47.2 |
| 1997 | 3.3 | 18.9 | 20.3 | -0.1 | 42.5 | - | 42.5 |
| 1998 | 3.2 | 18.7 | 13.1 | 0.0 | 35.1 | - | 35.1 |
| 1999 | 4.3 | 24.0 | 11.6 | 0.0 | 39.8 | * | 39.8 |
| 2000 | 4.0 | 26.0 | 12.0 | 0.0 | 42.0 | * | 42.0 |
| 2001 | 4.4 | 23.1 | 9.2 | 0.0 | 36.7 | - | 36.7 |
| 2002 | 2.9 | 21.2 | 15.9 | 0.0 | 40.1 | - | 40.1 |
| 2003* | 3.3 | 25.4 | 14.4 | 0.0 | 43.2 | * | 43.2 |
| 2004* | 4.4 | 27.5 | 14.5 | 0.0 | 46.4 | * | 46.4 |
| 2005* | 5.5 | 26.6 | 14.5 | 0.0 | 46.6 | 4.0 | 50.6 |
| 2006* | 6.1 | 24.7 | 10.6 | 0.0 | 41.5 | * | 41.5 |
| 2007* | 7.0 | 27.5 | 10.6 | 0.0 | 45.1 | 2.1 | 47.2 |
| 2008* | 10.7 | 22.8 | 14.3 | 0.0 | 47.8 | 3.5 | 51.3 |
| 2009* | 13.1 | 25.3 | 20.4 | 0.0 | 58.8 | 7.1 | 65.9 |
| 2010* | 14.2 | 33.5 | 25.1 | 0.0 | 72.8 | 6.5 | 79.3 |
| 2011* | 18.8 | 18.6 | 16.6 | 25.7 | 79.7 | 8.0 | 87.7 |
| 2012* | 22.4 | 22.2 | 16.7 | 13.9 | 75.2 | 14.6 | 89.8 |
|  |  |  |  |  |  |  |  |
| (1) Spanish data for 1961-1972 not revised, data for Sub-area VIII for 1973-1978 include data for |  |  |  |  |  |  |  |
| Divisions VIIIa,b only. Data for 1979-1981 are revised based on French surveillance data. |  |  |  |  |  |  |  |
| Divisions IIIa and IVb,c are included in column "IIIa, IV and VI" only after 1976. |  |  |  |  |  |  |  |
| There are some unallocated landings ( moreover for the period 1961-1970). |  |  |  |  |  |  |  |
| (2) Discard estimates from observer programmes. In years marked with *, |  |  |  |  |  |  |  |
| partial discard estimates are available and used in the assessment. |  |  |  |  |  |  |  |
| For remaining y ears for which no values are presented, |  |  |  |  |  |  |  |
| some estimates are available but not considered valid and thus not used in the assessment |  |  |  |  |  |  |  |
| In the years with data only Spanish discards and discards from French Nephrops trawlers are included.(3) From 1978 total catches used for the Working Group. |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

Table 3.2. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Summary of discards data available (weight ( $\mathbf{t}$ ) in bold, numbers ('000) in italic)).


Table 3.3. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Landings (L) and Length Frequency Distribution (LFD) provided in 2010.

Table 3.3. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock) Landings (L) and Length Frequency Distribution (LFD) provided in 2012

| Country |  | France | Ireland | Spain | UK(E+W) | Scotland | Denmark | Others |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |
| Unit | Quarter |  |  |  |  |  |  |  |
|  | 1 |  |  | L+LFD |  |  |  |  |
| 1 | 2 |  |  | L+LFD |  |  |  |  |
|  | 3 |  |  | L+LFD |  |  |  |  |
|  | 4 |  |  | L+LFD |  |  |  |  |
| 2 | 1 | L+LFD |  |  |  |  |  |  |
|  | 2 | L+LFD |  |  |  |  |  |  |
|  | 3 | L+LFD |  |  |  |  |  |  |
|  | 4 | L+LFD |  |  |  |  |  |  |
|  | 1 | L+LFD | L + LFD | L+LFD | L+LFD |  |  |  |
| 3 | 2 | L+LFD | L + LFD | L+LFD | L+LFD |  |  |  |
|  | 3 | L+LFD | L + LFD | L+LFD | L+LFD |  |  |  |
|  | 4 | L+LFD | L + LFD | L+LFD | L+LFD |  |  |  |
|  | 1 | L+LFD |  | L+LFD |  |  |  |  |
| 4 | 2 | L+LFD |  | L+LFD |  |  |  |  |
|  | 3 | L+LFD |  | L+LFD |  |  |  |  |
|  | 4 | L+LFD |  | L+LFD | L+LFD |  |  |  |
|  | 1 | L+LFD | L+LFD |  | L+LFD |  |  |  |
| 5 | 2 | L+LFD | L+LFD |  | L+LFD |  |  |  |
|  | 3 | L+LFD | L+LFD |  | L+LFD |  |  |  |
|  | 4 | L+LFD | L+LFD |  | L+LFD |  |  |  |
|  | 1 |  | L+LFD |  | L+LFD |  |  |  |
| 6 | 2 |  | L+LFD |  | L+LFD |  |  |  |
|  | 3 |  | L+LFD |  | L+LFD |  |  |  |
|  | 4 |  | L+LFD |  | L+LFD |  |  |  |
|  | 1 | L+LFD | L+LFD |  |  |  |  |  |
| 8 | 2 | L+LFD | L+LFD |  |  |  |  |  |
|  | 3 | L+LFD | L+LFD |  |  |  |  |  |
|  | 4 | L+LFD | L+LFD |  |  |  |  |  |
|  | 1 | L+LFD |  |  |  |  |  |  |
| 9 | 2 | L+LFD |  |  |  |  |  |  |
|  | 3 | L+LFD |  |  |  |  |  |  |
|  | 4 | L+LFD |  |  |  |  |  |  |
|  | 1 | L+LFD |  |  |  |  |  |  |
| 10 | 2 | L+LFD |  |  |  |  |  |  |
|  | 3 | L+LFD |  |  |  |  |  |  |
|  | 4 | L+LFD |  |  |  |  |  |  |
|  | 1 | L+LFD |  | L+LFD |  |  |  |  |
| 12 | 2 | L+LFD |  | L+LFD |  |  |  |  |
|  | 3 | L+LFD |  | L+LFD |  |  |  |  |
|  | 4 | L+LFD |  | L+LFD |  |  |  |  |
|  | 1 | L+LFD |  | L+LFD |  |  |  |  |
| 13 | 2 | L+LFD |  | L+LFD |  |  |  |  |
|  | 3 | L+LFD |  | L+LFD |  |  |  |  |
|  | 4 | L+LFD |  | L+LFD |  |  |  |  |
|  | 1 |  |  | L+LFD |  |  |  |  |
| 14 | 2 |  |  | L+LFD |  |  |  |  |
|  | 3 |  |  | L+LFD |  |  |  |  |
|  | 4 |  |  | L+LFD |  |  |  |  |
|  | 1 |  |  |  |  |  |  | L |
| 15 | 2 |  |  |  |  |  |  | L |
|  | 3 |  |  |  |  |  |  | L |
|  | 4 |  |  |  |  |  |  | L |
|  | 1 |  | L | L+LFD | L | L+LFD | L+LFD | L |
| 16 | 2 |  | L | L+LFD | L | L+LFD | L+LFD | L |
|  | 3 |  | L | L+LFD | L | L+LFD | L+LFD | L |
|  | 4 |  | L | L+LFD | L | L+LFD | L+LFD | L |
|  | 1 | L |  |  |  |  |  |  |
| 00 | 2 | L |  |  |  |  |  |  |
|  | 3 | L |  |  |  |  |  |  |
|  | 4 | L |  |  |  |  |  |  |

Table 3.4.a Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Effort and LPUE values of commercial fleets.

Table 3.4.a. Hake in Division Illa, Subareas IV, VI and VII and Divisions VIIla,b,d (Northern stock) Effort and LPUE values of commercial fleets estimated by National laboratories.


Table 3.4.b. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Effort and LPUE values of commercial fleets.

| Table 3.4.b. | $\begin{array}{l}\text { Hake in Division Illa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock) } \\ \text { Effort and LPUE values of commercial fleets estimated by National laboratories. }\end{array}$ |
| :--- | :--- |


| Sub-area VI |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Ondarra traw in VI |  |  |
| Year | Landingst | Effort(day | PUE[Kg/day |
| 1994 | 164 | 635 | 259 |
| 1995 | 164 | 624 | 262 |
| 1996 | 259 | 695 | 372 |
| 1997 | 127 | 710 | 179 |
| 1998 | 89 | 750 | 118 |
| 1999 | 197 | 855 | 230 |
| 2000 | 243 | 763 | 318 |
| 2001 | 239 | 1123 | ${ }^{213}$ |
| 2002 | 233 | 1234 | 189 |
| 2003 | 138 | 718 | 193 |
| 2004 | 306 | 411 | 743 |
| 2005 | 291 | 337 | 864 |
| 2006 | 304 | 368 | 827 |
| 2007 | 265 | 335 | 791 |
| 2008 | 451 | 349 | 1293 |
| 2009 | 383 | 380 | 1008 |
| 2010 | 580 | 394 | 1472 |
| 2011 | 489 | 339 | 1443 |
| 2012 | 902 | 355 | 2542 |


| sub-area VII | A Coruña long line in VII |  |  | Celeirio long line in VII |  |  | Burela long line in VIII |  |  | Ondarroa traw in vilt |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Year | Landings(t) | Effort(days) | LPUE(Kg/day | Landingst | Effort(days) | LPUEEKg/day | Landingst | Effor(days) | LPUE/(Kg/day | Landingst | Effor(days) | LPUE(KgI/day |
| 1985 | 3577 | 4788 | 747 | na | na | na | na | na | na | na | na | na |
| 1986 | 3038 | 4128 | 736 | na | na | na | na | na | na | na | na | na |
| 1987 | 2832 | 4467 | 634 | na | na | na | na | na | na | na | na | na |
| 1988 | 3141 | 3766 | 834 | na | na | na | na | na | na | na | na | na |
| 1989 | 2631 | 3503 | 751 | na | na | na | na | na | na | na | na | na |
| 1990 | 2342 | 3682 | 636 | na | na | na | na | na | na | na | na | na |
| 1991 | 2223 | 3217 | 691 | na | na | na | na | na | na | na | na | na |
| 1992 | 2464 | 2627 | 938 | na | na | na | na | na | na | na | na | na |
| 1993 | 2797 | 2568 | 1089 | na | na | na | na | na | na | 538 | 1094 | 492 |
| 1994 | 2319 | 2641 | 878 | 4062 | 6516 | 623 | 2278 | 3804 | 599 | 1084 | 980 | 1106 |
| 1995 | 2507 | 2161 | 1160 | 5209 | 6420 | 811 | 2905 | 3444 | 843 | 528 | 1214 | 435 |
| 1996 | 2111 | 1669 | 1265 | 5988 | 6720 | 891 | 3245 | 3636 | 892 | 291 | 1170 | 249 |
| 1997 | 830 | 900 | 922 | 4174 | 6144 | 679 | 2299 | 3540 | 649 | 109 | 540 | 202 |
| 1998 | 292 | 372 | 784 | 2817 | 4668 | 603 | 1639 | 3000 | 546 | 137 | 1196 | 115 |
| 1999 | 323 | 395 | 817 | 3447 | 4980 | 692 | 1982 | 2880 | 688 | 195 | 1384 | 141 |
| 2000 | 281 | 276 | 1018 | 3699 | 4440 | 833 | 2282 | 2928 | 779 | 249 | 1850 | 135 |
| 2001 | ${ }^{229}$ | ${ }^{276}$ | 830 | 3383 | 3756 | 901 | 3034 | 3672 | 826 | 164 | 1451 | 113 |
| 2002 | 214 | 300 | 712 | 2769 | 3984 | 695 | 2399 | 3732 | 643 | 195 | 949 | 206 |
| 2003 | 648 | 1188 | 545 | 3386 | 4404 | 769 | 2514 | 3636 | 691 | 112 | 1022 | 110 |
| 2004 | 280 | 312 | 899 | 3990 | 4596 | 868 | 3255 | 3852 | 845 | 111 | 910 | 122 |
| 2005 | 199 | 288 | 691 | 4177 | 3930 | 1063 | 3074 | 3507 | 876 | 76 | 544 | 140 |
| 2006 | 256 | 312 | 822 | 4372 | 4560 | 959 | 3639 | 5184 | 702 | 102 | 487 | 210 |
| 2007 | 271 | 520 | 520 | 5039 | 5712 | 882 | 4367 | 6300 | 693 | 66 | 476 | 138 |
| 2008 | 233 | 288 | 810 | 4302 | 5184 | 830 | 4058 | 4884 | 831 | 17 | 105 | 162 |
| 2009 | 214 | 192 | 1116 | 4959 | 4624 | 1072 | 5146 | 4536 | 1135 | 0 | 0 |  |
| 2010 | 315 | 375 | 839 | 7630 | 5556 | 1373 | 9141 | 5736 | 1594 | 49 | ${ }^{138}$ | 354 |
| 2011 | 443 | 350 | 1265 | 9672 | 5172 | 1870 | 10908 | 5988 | 1822 | 65 | 57 | 1145 |
| 2012 | 217 | 253 | ${ }_{858}$ | 6621 | 6720 | 985 | 7440 | 6984 | 1065 | 0 | 0 |  |


| Year | A Coruña gillnet in VII |  |  | Celeifo gillnet in VIII |  |  | Ondaroa gillet in VIII |  |  | Burela gilnet in VII |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Landings(t) | Effort(days) | PUE[Kg/day | Landings(t) | Effort(days) | LPUE[Kg/day | Landingst) | Effor(days) | LPUE(KgIday | Landingst) | Eflor(days) | LPUE[Kg/day |
| 1998 | 192 | ${ }^{324}$ | 593 | 818 | 1572 | 520 | 34 | ${ }^{73}$ | 462 | 238 | 444 | 536 |
| 1999 | 206 | 252 | 817 | 805 | 1068 | 754 | 50 | 58 | 869 | 451 | 444 | 1016 |
| 2000 | 237 | 204 | 1162 | 994 | 1308 | 760 | 81 | 84 | 969 | 353 | 600 | 588 |
| 2001 | 188 | 168 | 1119 | 674 | 1008 | 669 | 118 | 117 | 1007 | 215 | 252 | 852 |
| 2002 | 217 | 156 | 1388 | 631 | 912 | 692 | 189 | 132 | 1429 | 223 | 276 | 807 |
| 2003 | 126 | 192 | 656 | 454 | 660 | 688 | 0 | 0 |  | 280 | 348 | 805 |
| 2004 | 135 | 144 | 937 | 513 | 756 | 679 | 0 | 0 |  | 260 | 264 | 983 |
| 2005 | 326 | 300 | 1087 | 624 | 857 | 728 | 0 | 0 | - | 228 | 230 | 992 |
| 2006 | 182 | 180 | 1011 | 497 | 924 | 537 | 0 | 0 | - | 56 | 144 | 388 |
| 2007 | 118 | 516 | 229 | 680 | 1524 | 446 | 0 | 0 |  | 99 | 348 | 284 |
| 2008 | 32 | 48 | 675 | 501 | 804 | 624 | 0 | 0 | - | 115 | 228 | 503 |
| 2009 | 12 | 15 | 823 | 779 | 948 | 822 | 0 | 0 | - | 15 | 36 | 413 |
| 2010 | 31 | 24 | 1292 | 498 | 660 | 754 | 0 | 0 |  | na | na |  |
| 2011 | 2 | na | na | 805 | 1068 | 754 | 0 | 0 |  | 88 | 106 | 830 |
| 2012 | 11 | 14 | 786 | 588 | 1080 | 544 | 0 | 0 | . | 0 | 0 |  |


| Sub-area vill | Ondarroa tram in $\mathrm{Vlla} \mathrm{l}, \mathrm{b}, \mathrm{d}^{\text {a }}$ |  |  | Santander tram in VIIla, b, d |  |  | Aviles long line in villa, b,d |  |  | Aviles gillnet in VIIIa, , , d |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Year | Landings(t) | Effor(days) | LPUE(Kg/day | Landings(t) | Eftort | LPUE[(Kg/day | Landingst(t) | Efiort(days) | LPUEK(Kg/day | Landings(t) | Effort(days) | LPUE(Kg/day |
| 1993 | 2244 | 5590 | 401 | na | na | na | na | na | na | na | na | na |
| 1994 | 2817 | 5619 | 501 | 175 | 640 | 273 | 1145 | 2340 | 489 | na | na | na |
| 1995 | 2069 | 4474 | 463 | 131 | 620 | ${ }^{211}$ | 1145 | 2184 | 524 | na | na | na |
| 1996 | 944 | 4378 | 216 | 62 | 530 | 117 | 819 | 2184 | 375 | na | na | na |
| 1997 | 2348 | 4286 | 548 | 65 | 805 | 81 | 700 | 1896 | 369 | na | na | na |
| 1998 | 287 | 3002 | 96 | 95 | 1445 | 66 | 353 | 1044 | 338 | ${ }^{218}$ | 780 | 279 |
| 1999 | 81 | 2337 | 34 | 89 | 1830 | 49 | 567 | 1392 | 407 | 213 | 564 | 378 |
| 2000 | 157 | 2227 | 70 | 79 | 1520 | 52 | 553 | 1344 | 411 | 219 | 492 | 445 |
| 2001 | 341 | 2118 | 161 | 94 | 1590 | 59 | 893 | 1974 | 453 | 482 | 780 | 618 |
| 2002 | 321 | 2107 | 152 | 252 | 1260 | 200 | 314 | 744 | 423 | 392 | 504 | 778 |
| 2003 | 230 | 2296 | 100 | 212 | 1405 | 151 | 513 | 828 | 620 | n/a | n/a | na |
| 2004 | 165 | ${ }^{2159}$ | 76 | ${ }^{200}$ | 995 | 201 | 592 | na | na | 885 | n/a | na |
| 2005 | 257 | 2263 | 114 | 120 | 596 | 202 | na | na | na | n/a | n/a | na |
| 2006 | ${ }^{216}$ | 2398 | 90 | 83 | 636 | 131 | 310 | 1075 | 288 | 406 | 1054 | 385 |
| 2007 | 296 | 2098 | 141 | 105 | 1278 | 82 | na | na | na | na | na | na |
| 2008 | 543 | 2017 | 269 | na | na | na | na | na | na | na | na | na |
| 2009 | 741 | 1807 | 410 | 120 | 1278 | 94 | 368 | 252 | 1461 | 1215 | 1116 | 1089 |
| 2010 | 405 | 1358 | 298 | 69 | 774 | 89 | 520 | n/a | na | 1658 | na | na |
| 2011 | 241 | 1384 | 174 | 45 | 454 | 99 | 347 | 249 | 1393 | 1099 | 670 | 1640 |
| 2012 | 207 | 1384 | 150 | 25 | 274 | 91 | 309 | 182 | 1698 | 90 | 38 | 2370 |



Table 3.5. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Von Bertalanffy growth parameters estimated by the assessment model year by year since 2010.

Table 3.5 Growth parameters estimated by the assessment models in different years.

|  | 2013 | 2012* | 2011 | 2010 |
| :---: | :---: | :---: | :---: | :---: |
| K | 0.147 | 0.159 | 0.177 | 0.175 |
| L1 | 14.75 | 14.67 | 15.84 | 15.61 |
| Linf | 130 |  |  |  |

* No assessment was run in 2012 working group. The parameters were obtained this years using data up to 2012, thus simulating 2012 assessment.

Table 3.6. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Summary of landings and assessment results.

Table 3.6. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Summary of landings and assessment results.


Table 3.7. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Catch option table.

| SSB(2013) | Rec proj | F(15-80cm) | Catch(2013) | Land(2013) |
| ---: | :---: | ---: | ---: | ---: |
| SSB(2014) |  |  |  |  |
| 260690 | 314536 | 0.24 | 73263 | 69440 |


| Fmult | Fcatch(15-80cm) | Catch(2014) | Land(2014) | Disc(2014) | SSB(2015) |
| ---: | ---: | ---: | ---: | ---: | ---: |
| 0 | 0 | 0 | 0 | 0 | 417456 |
| 0.1 | 0.0243 | 9438 | 9195 | 243 | 408018 |
| 0.2 | 0.0486 | 18651 | 18168 | 483 | 398799 |
| 0.3 | 0.0729 | 27644 | 26924 | 719 | 389796 |
| 0.4 | 0.0971 | 36422 | 35469 | 953 | 381002 |
| 0.5 | 0.1214 | 44991 | 43808 | 1183 | 372412 |
| 0.6 | 0.1457 | 53355 | 51945 | 1409 | 364022 |
| 0.7 | 0.17 | 61519 | 59886 | 1633 | 355827 |
| 0.8 | 0.1943 | 69489 | 67635 | 1854 | 347822 |
| 0.9 | 0.2186 | 77268 | 75197 | 2071 | 340003 |
| 1 | 0.2429 | 84862 | 82576 | 2286 | 332365 |
| 1.1 | 0.2672 | 92275 | 89777 | 2498 | 324904 |
| 1.2 | 0.2914 | 99511 | 96804 | 2707 | 317615 |
| 1.3 | 0.3157 | 106574 | 103661 | 2913 | 310495 |
| 1.4 | 0.34 | 113468 | 110353 | 3116 | 303539 |
| 1.5 | 0.3643 | 120198 | 116882 | 3316 | 296744 |
| 1.6 | 0.3886 | 126768 | 123254 | 3514 | 290106 |
| 1.7 | 0.4129 | 133181 | 129472 | 3709 | 283621 |
| 1.8 | 0.4372 | 139440 | 135539 | 3901 | 277285 |
| 1.9 | 0.4614 | 145551 | 141460 | 4091 | 271096 |
| 2 | 0.4857 | 151515 | 147237 | 4278 | 265048 |

Table 3.8. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Yield per recruit summary table.

| SPR level | Fmult | $F(15-80 \mathrm{~cm})$ | YPR(catch) | YPR(landings) | SSB PR |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 0 | 0 | 0 | 0 | 3.2 |  |
| 0.87 | 0.1 | 0.02 | 0.06 | 0.06 | 2.79 |  |
| 0.76 | 0.2 | 0.05 | 0.12 | 0.11 | 2.44 |  |
| 0.67 | 0.3 | 0.07 | 0.15 | 0.15 | 2.15 |  |
| 0.59 | 0.4 | 0.1 | 0.19 | 0.18 | 1.90 |  |
| 0.53 | 0.5 | 0.12 | 0.21 | 0.21 | 1.68 |  |
| 0.47 | 0.6 | 0.15 | 0.23 | 0.22 | 1.49 |  |
| 0.42 | 0.7 | 0.17 | 0.24 | 0.24 | 1.33 |  |
| 0.37 | 0.8 | 0.19 | 0.25 | 0.25 | 1.19 |  |
| 0.34 | 0.9 | 0.22 | 0.26 | 0.25 | 1.07 |  |
| 0.30 | 1 | 0.24 | 0.26 | 0.26 | 0.97 |  |
| 0.27 | 1.1 | 0.27 | 0.27 | 0.26 | 0.87 |  |
| 0.25 | 1.2 | 0.29 | 0.27 | 0.26 | 0.79 |  |
| 0.23 | 1.3 | 0.32 | 0.27 | 0.26 | 0.72 |  |
| 0.21 | 1.4 | 0.34 | 0.27 | 0.26 | 0.66 |  |
| 0.19 | 1.5 | 0.36 | 0.26 | 0.26 | 0.60 |  |
| 0.17 | 1.6 | 0.39 | 0.26 | 0.25 | 0.55 |  |
| 0.16 | 1.7 | 0.41 | 0.26 | 0.25 | 0.50 |  |
| 0.15 | 1.8 | 0.44 | 0.26 | 0.25 | 0.46 |  |
| 0.13 | 1.9 | 0.46 | 0.25 | 0.24 | 0.43 |  |
| 0.12 | 2 | 0.49 | 0.25 | 0.24 | 0.40 |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  | SPR level | Fmult | F(15-80cm) | YPR(catch) | YPR(landings) | SSB PR |
| Fmax | 0.24 | 1.22 | 0.3 | 0.27 | 0.26 | 0.78 |
| F0.1 | 0.36 | 0.83 | 0.2 | 0.25 | 0.25 | 1.16 |
| F35\% | 0.35 | 0.86 | 0.21 | 0.25 | 0.25 | 1.13 |
| F30\% | 0.3 | 1.01 | 0.24 | 0.26 | 0.26 | 0.96 |






Figure 3.1. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Abundance indices from surveys.


Figure 3.2. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Spatial distribution of hake ( $0-20 \mathrm{~cm}$ ) indices from EVHOE-WIBTS-Q4 survey from 2005 to 2010.


Figure 3.3a. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). LPUE and effort from commercial fleets estimated by national laboratories.


Figure 3.3b. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). LPUE and effort for commercial fleets estimated by national laboratories.


Figure 3.4. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Residuals of the fits to the surveys $\log (a b u n d a n c e ~ i n d i c e s)$. For RESSGASC, fits are by quarter.


Figure 3.5. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,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 3.5 (continued). Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,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.

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Figure 3.5. (continued) Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Pearson residuals of the fit to the length distributions of the surveys abundance indices. Blue and red denote positive and negative residuals, respectively.


Figure 3.6. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Selection patterns and retention functions at length by fleet estimated by SS3.


Figure 3.6 (continued). Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Selection patterns and retention functions at length estimated by SS3.


Figure 3.7. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Von Bertalanffy growth curves estimated by the assessment model year by year since 2010.


Figure 3.8. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Retrospective plot from SS3.


Figure 3.9. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern
 quarter.


Figure 3.10. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,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.


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Figure 3.10 (continued). Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,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 3.10. (continued) Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Pearson residuals of the fit to the length distributions of the surveys abundance indices. Blue and red denote positive and negative residuals, respectively.


Figure 3.11. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Selection patterns and retention functions at length by fleet estimated by SS3.


Figure 3.11 (continued). Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Selection patterns and retention functions at length estimated by SS3.


Figure 3.12. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Retrospective plot from SS3.


Figure 3.13. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock) Comparison of assessments, 2011 assessment (dashed black line), 2013 update assessment (red solid line) and 2013 assessment using fixing growth parameters (green line).


Figure 3.14. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Summary plot of stock trends.


Figure 3.15. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Short term projections


Figure 3.16. Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock). Equilibrium yield and SSB per recruit.

## 4 ANGLERFISH (Lophius piscatorius and Lophius budegassa) in Divisions VIIb-k and VIIIa,b,d

There was no accepted assessment for either L. piscatorius or L. budegassa in 2007. The Working Group in 2007 found that the input data showed deficiencies, especially as discarding was known to be increasing and that ageing problems had become more obvious. The stock went through a benchmark process during 2012 (WKFLAT 2012) but no analytical assessment was found acceptable.

## L. piscatorius and L. budegassa:

Type of assessment in 2013: Update.
Data revisions this year: 2011 landings series

## Review Group issues:

The RG agrees with the WG conclusion that recent catches appear to be sustainable, as suggested by increasing surveys and LPUE. More reliable and complete survey, landings, and discard data is necessary to attempt an analytical analysis of the stock in the future.

### 4.1 General

### 4.1.1 Summary of ICES advice for 2013 and management for 2012 and 2013

ICES advice for 2013
Effort in fisheries that catch anglerfish should not increase.
Management applicable for 2012 and 2013
The TAC applied to both species and including Division VIIa was set at 38900 t for 2012 and at 31118 t for 2013.
Since $1^{\text {st }}$ February 2006 a ban on gillnet at depth greater than 200 m was set in Subareas VI a,b and VIIb,c,j,k.

### 4.1.2 Landings

There has been a revision of landings for the year 2011 marked in Table 4.1-1.
Landings have increased since 2000 and have fluctuated around 33000 t since 2003. The landings of both species combined were estimated to be 32174 t in 2008, 28455 t in 2009, 29686 t in 2010 and 28357 t in 2011. Estimated landings of 36384 t in 2012 are at the highest level over the last 10 years and the fifth highest of the time series (Table 4.1-1).

### 4.1.3 Discards

Estimation of discards has been carried out by some countries. This information shows that an increasing proportion of small fish of both species are caught and discarded. After an extensive analysis of discard data by WKFLAT 2012, discard estimates were considered not to be precise enough to be used in the assessment.

Table 4.1-1. Anglerfish in Divisions VIIb-k and VIIIa,b,d -Total landings from 1984 to 2012 Working Group estimates

| Year | VIlb-k | VIIla,b,d | Total |
| :---: | :---: | :---: | :---: |
| 1977 |  |  | 19895 |
| 1978 |  |  | 23445 |
| 1979 |  |  | 29738 |
| 1980 |  |  | 38880 |
| 1981 |  |  | 39450 |
| 1982 |  |  | 35285 |
| 1983 |  |  | 38280 |
| 1984 | 28847 | 7909 | 36756 |
| 1985 | 28491 | 7161 | 35652 |
| 1986 | 25987 | 5897 | 31883 |
| 1987 | 22295 | 7233 | 29528 |
| 1988 | 22494 | 5983 | 28477 |
| 1989 | 24674 | 5276 | 29950 |
| 1990 | 23434 | 5950 | 29384 |
| 1991 | 20256 | 4684 | 24940 |
| 1992 | 17412 | 3530 | 20942 |
| 1993 | 16517 | 3507 | 20024 |
| 1994 | 18023 | 3841 | 21864 |
| 1995 | 21822 | 4862 | 26684 |
| 1996 | 24153 | 6102 | 30255 |
| 1997 | 23928 | 5846 | 29774 |
| 1998 | 23295 | 4876 | 28171 |
| 1999 | 21845 | 3143 | 24988 |
| 2000 | 18129 | 2456 | 20585 |
| 2001 | 19534 | 2875 | 22409 |
| 2002 | 22648 | 3571 | 26220 |
| 2003 | 28552 | 4681 | 33233 |
| 2004 | 29510 | 5640 | 35150 |
| 2005 | 27908 | 5167 | 33075 |
| 2006 | 26795 | 4823 | 31618 |
| 2007 | 30121 | 5213 | 35334 |
| 2008 | 26724 | 5032 | 31756 |
| 2009 | 22733 | 5193 | 27926 |
| 2010 | 23338 | 5542 | 28880 |
| 2011* | 22458 | 5900 | 28357 |
| 2012** | 27380 | 9004 | 36384 |

[^0]
### 4.2 Anglerfish (L. piscatorius) in Divisions VIIb-k and VIIIa,b,d

### 4.2.1 Data

### 4.2.1.1 Commercial Catch

The Working Group estimates of landings of L. piscatorius by fishery unit (defined in Section 2 of the report) are given in Table 4.2-1 Lophius piscatorius in Divisions VIIb-k and VIIIa,b,d - Landings in tonnes by Fishery Unit.

The landings have declined steadily from 23666 t in 1986 to 12766 t in 1992, then increased to 22162 t in 1996 and declined to 13941 t in 2000. The landings have increased since then reaching the maximum of the time series in 2007 (28 977 t). The 2008 value show a $16 \%$ drop at 24376 t. In 2009 the decreasing trend continued with a $24 \%$ drop ( 18844 t ) and in 2010 landings recovered to historic mean levels at 19521 t .

A revision of the 2011 landings provided an estimated of 20370 t . The 2012 landing showed an increase to 26837 t , which is the third largest recorded landings of the time series.

### 4.2.1.2 Commercial LPUE

Effort and LPUE data for the four Spanish fleets and English FU6 were available in 2011 and 2012 (Table 4.2-2 L. piscatorius in Divisions VIIb-k and VIIIa,b,d- Effort and LPUE data and Figure 4.2-1 L. piscatorius in Divisions VIIb-k and VIIIa,b,d- Effort and LPUE data). Fishing effort for most fleets showed a decrease until the mid 1990's. Effort remained relatively stable thereafter, until 2012 when a sharp decrease in SPVIGO7 (28 \% reduction) and SP-CORUTR7 (46 \% reduction) was recorded.

All the commercial LPUE series decreased steadily until 1992. Since then, they have increased up to 2007 except for the 2 BAKA fleets. Most showed a decline in 2008. In 2009 and 2010 EW-FU06 and both BAKA fleets showed an increasing trend but SPVIGO7 and SP-CORUTR7 showed a decreasing one. In 2011 all available fleets showed an increasing trend that continues in 2012 for all fleets with the exception of EW-FU06.

### 4.2.1.3 Surveys data

### 4.2.1.3.1 The French EVHOE-WIBTS-Q4 survey

This survey covers the highest proportion of the area of stock distribution. Standardised biomass and abundance indices are given in Figure 4.2-2 L. piscatorius in Divisions VIIb-k and VIIIa,b,d- Time-series of the EVHOE-WIBTS-Q4 survey indices weight (left) and numbers (right) per 30 minutes tow from 1997 to 2012 and the length distributions in Figure 4.2-3 - L. piscatorius in Divisions VIIb-k and VIIIa,b,d. Time-series of the EVHOE-WIBTS-Q4 Length distributions in Nb per 30 minutes tow from 1997 to 2012.

The biomass indices show a continuous increase from 2000 to 2007 and a decrease thereafter, with the 2010 index value in between those from 2000 and 2001. In 2011 the indices were as high as the 2005 value and the 2012 value recorded the historical maximum. Abundance in numbers shows four peaks in 2001, 2002, 2004 and to a lesser extent 2008. Since 2008 the abundance in numbers remains stable.

The length distribution shows that these peaks in numbers of abundance correspond to strong incoming year-classes that can be tracked from year to year with modes between 10-25 cm for the first age group (in 2001, 2002, 2004, 2008, 2009, 2010 and 2011),
$25-45$ for the second $(2002,2003,2005,2009,2010$ and 2011) and $45-55$ for the third (2003, 2004, 2005, 2010 and 2011), although, the third mode is not as clearly defined.

These year classes are now still present in the recent survey catches at larger sizes and account for the higher biomass index. The length distribution in 2009 and 2010 indicates two good recruitments at the level seen in 2008, although not as strong as in 2001, 2002 and 2004. 2011 and 2012 recruitment seems to be at medium levels.

In Figure 4.2-4 and, Figure 4.2-5 the distribution of recruits (identified as individuals of less than 23 cm ) show that contrasting with the years 2001, 2002 and 2004 where the recruits were found in both Celtic Sea and Bay of Biscay areas along the shelf, the recruits were found almost only south of the Celtic Sea and in the Bay of Biscay in 2008 and 2009. The results from 2010 to 2012 show a uniform distribution of recruits through the sampling area of the survey.

### 4.2.1.3.2 The Spanish Porcupine Groundfish Survey (SPPGFS (WIBTS-Q4))

This survey was initiated in 2001 and covers the Porcupine Bank. Standardised biomass and abundance indices are given in Figure 4.2-6 and the length distributions in Figure 4.2-7. Although covering a small area of the total stock distribution, similar pulses of recruitment are detected in 2001 and to a lower extent in the years 2002 to 2004. In 2010 a recruitment level similar to 2002-2004 was found. In 2011 the recruitment level was low and in 2012 the recruitment returned to medium values.

In 2008 problems with the survey gear affected its geometry. It is very difficult to assess how these changes in gear behaviour have affected abundance indices; apparently the effect has not been dramatic in any species, though in both species of the genus Lophius a remarkable decrease has been found. Monkfish biomass stratified abundance index is within the limits of the survey's time series, with values close to those found in the beginning of the series, while the stratified index in number is the lowest of the time series after three years of a slight but steady decrease. The recruitment in 2008 was approximated with the number of individuals smaller than 21 cm , and results continue to be poor as in the previous four years since 2005. For 2009 results were very similar to the ones from 2008 for all the parameters studied.

### 4.2.1.3.3 The Irish Groundfish Survey (IGFS-WIBTS-Q4)

Abundance indices in numbers per square kilometer from this survey are given in Table 4.2-3. They show the same drop as the EVHOE-WIBTS-Q4 and the SPPGFS (WIBTS-Q4) after the peak in 2004. The 2009 index showed a recovery in abundance, although it was still lower than the 2005 value. In 2010 and 2011 a value close to the 2004 maximum has been found. In 2012 a value similar to the 2009 medium level was recorded. Due to the overall low numbers caught in some years the length distributions are not presented.

### 4.2.1.3.4 The English Fisheries Science Partnership survey

This survey covers a fraction of the areas VIIe, VIIf, VIIg and VIIh. Trends in biomass and abundance are not presented as more detailed analysis of trends in abundance and biomass is needed.

Length distribution of L. piscatorius catches are available and presented in Figure 4.2-8. Here again the high recruitment of 2004 is detected and can be easily tracked in 2005 with a mode at $25-45 \mathrm{~cm}$ and in 2006 with a mode at $45-60 \mathrm{~cm}$, as in the EVHOE-WIBTS-Q4 survey. The pulse of recruitment observed in the EVHOE-WIBTS-Q4 survey in 2008 was also present in the FSP-ENG-MONK survey. For 2009 the highest
value of the series for recruitment was recorded by the survey and the good recruitment for 2008 was tracked too. In 2010 three different modes are evident corresponding to a good recruitment and the surviving individual from 2008 and 2009 recruitments. In 2011 a similar pattern to 2010 was found with three different modes related to a good recruitment and corresponding to the good recruitments found in 2009 and 2010. In 2012 a medium level recruitment was found.

### 4.2.2 Conclusion

LPUE's and survey data (biomass, abundance indices and length distributions) give indication that the biomass has been increasing as a consequence of the good recruitment observed in 2001, 2002 and 2004 and has stabilised in recent years. There is evidence of good recruitments in 2008, 2009, 2010 and 2011. 2008 and 2009 recruitments have entered the fishery giving one of the higher yields of the time series.

The Working Group concludes that in view of the available data, continuing fishing at present levels should not harm the stock.

Preliminary information on discards shows that an increasing proportion of small fish are caught and discarded.

Measures should be taken to ensure good survival of the good incoming recruitments.

### 4.2.3 Comments on the assessment

Data from surveys tracking recent good recruitment give scope for growth studies and ageing validation that should be initiated as soon as possible.

Table 4.2-1 Lophius piscatorius in Divisions VIIb-k and VIIIa,b,d - Landings in tonnes by Fishery Unit.


Table 4.2-2 L. piscatorius in Divisions VIIb-k and VIIIa,b,d- Effort and LPUE data

| EFFORT | $\begin{gathered} \text { SP-VIGO7 } \\ \text { in Sub-Area VII } \\ \text { ('000 days*HP) } \end{gathered}$ | SP-CORUTR7 <br> in Sub-Area VII <br> ('000 days*HP) | French Benthic trawlers* Celtic Sea FU04 ('000 hrs) | French Benthic Twin Trawls Celtic Sea ('000 hrs) | French Benthic trawlers* Bay of Biscay FU14 ('000 hrs) | French Benthic Twin Trawls Bay of Biscay ('000 hrs) | EW FU06 Beam trawlers in VII ('00 days) | SP-BAKON7 (days) | SP-BAKON8 <br> (days) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1986 | 6875 | 9527 | 418 |  | 123 |  |  |  |  |
| 1987 | 6662 | 10453 | 349 |  | 199 |  |  |  |  |
| 1988 | 6547 | 10886 | 334 |  | 150 |  |  |  |  |
| 1989 | 7585 | 10483 | 378 |  | 187 |  |  |  |  |
| 1990 | 8021 | 9630 | 380 |  | 208 |  |  |  |  |
| 1991 | 7822 | 8522 | 380 |  | 210 |  |  |  |  |
| 1992 | 6370 | 5852 | 331 |  | 186 |  | 100 |  |  |
| 1993 | 5988 | 5001 | 274 |  | 159 |  | 114 | 1094 | 5590 |
| 1994 | 5655 | 4990 | 249 |  | 148 |  | 116 | 980 | 5619 |
| 1995 | 5070 | 4403 | 287 |  | 174 |  | 127 | 1214 | 4474 |
| 1996 | 5416 | 3746 | 196 | 121 | 144 | 19 | 126 | 1170 | 4378 |
| 1997 | 5058 | 3738 | 178 | 133 | 133 | 33 | 126 | 540 | 4286 |
| 1998 | 5360 | 3684 | 182 | 134 | 117 | 40 | 121 | 1196 | 3002 |
| 1999 | 5084 | 3512 | 110 | 110 | 83 | 59 | 115 | 1384 | 2337 |
| 2000 | 5519 | 2773 | 165 | 104 | 87 | 49 | 104 | 1850 | 2227 |
| 2001 | 5678 | 2356 | 135 | 133 | 61 | 66 | 186 | 1451 | 2118 |
| 2002 | 5041 | 2258 | 116 | 120 | 57 | 75 | 111 | 949 | 2107 |
| 2003 | 5437 | 2597 | 147 | 136 | 68 | 81 | 166 | 1022 | 2296 |
| 2004 | 5347 | 2292 | 160 | 133 | 78 | 89 | 174 | 910 | 2159 |
| 2005 | 5246 | 2120 | 127 | 137 | 83 | 121 | 109 | 544 | 2263 |
| 2006 | 5392 | 2257 | 140 | 145 | 72 | 101 | 94 | 487 | 2398 |
| 2007 | 5812 | 2323 | 149 | 152 | 48 | 127 | 97 | 476 | 2098 |
| 2008 | 5432 | 1640 | 118 | 126 | 58 | 113 | 138 | 105 | 2017 |
| 2009 | 5155 | 1626 |  |  |  |  | 75 | 0 | 1807 |
| 2010 | 4843 | 1988 |  |  |  |  | 77 | 138 | 1358 |
| 2011 | 4553 | 1725 |  |  |  |  | 82 | 57 | 1384 |
| 2012 | 3276 | 937 |  |  |  |  | 84 | 0 | 1384 |
| LPUE | Vigo in Sub-Area VII (kg/days*HP) | La Coruna in Sub-Area VII (kg/days*HP) | French Benthic trawlers* Celtic Sea FU04 (kg/10 hrs) | French Benthic Twin Trawls Celtic Sea (kg/10 hrs) | French Benthic trawlers* Bay of Biscay FU14 (kg/10 hrs) | French Benthic Twin Trawls Bay of Biscay (kg/10 hrs) | EW (FU06) Beam trawlers in VII (kg/10 days) | SP-BAKON7 (kg/day) | SP-BAKON8 (kg/day) |
| 1986 | 286 | 383 | 143 |  | 131 |  |  |  |  |
| 1987 | 235 | 326 | 142 |  | 119 |  |  |  |  |
| 1988 | 182 | 272 | 132 |  | 110 |  |  |  |  |
| 1989 | 210 | 236 | 102 |  | 61 |  |  |  |  |
| 1990 | 206 | 228 | 104 |  | 85 |  |  |  |  |
| 1991 | 184 | 234 | 82 |  | 55 |  |  |  |  |
| 1992 | 188 | 200 | 56 |  | 35 |  | 94 |  |  |
| 1993 | 268 | 172 | 60 |  | 42 |  | 93 | 60 | 23 |
| 1994 | 289 | 187 | 111 |  | 75 |  | 81 | 73 | 44 |
| 1995 | 410 | 131 | 131 |  | 84 |  | 77 | 99 | 56 |
| 1996 | 520 | 212 | 117 | 159 | 81 | 113 | 110 | 130 | 70 |
| 1997 | 440 | 245 | 105 | 133 | 78 | 84 | 117 | 132 | 71 |
| 1998 | 451 | 193 | 95 | 113 | 60 | 66 | 111 | 134 | 66 |
| 1999 | 428 | 136 | 52 | 76 | 42 | 44 | 95 | 125 | 34 |
| 2000 | 203 | 182 | 87 | 73 | 34 | 45 | 109 | 186 | 31 |
| 2001 | 239 | 170 | 103 | 119 | 56 | 85 | 82 | 184 | 61 |
| 2002 | 469 | 218 | 138 | 152 | 69 | 120 | 123 | 218 | 72 |
| 2003 | 598 | 286 | 191 | 186 | 102 | 154 | 80 | 274 | 76 |
| 2004 | 563 | 249 | 134 | 188 | 87 | 172 | 93 | 249 | 119 |
| 2005 | 591 | 356 | 170 | 146 | 99 | 133 | 144 | 287 | 100 |
| 2006 | 568 | 383 | 183 | 196 | 108 | 137 | 175 | 221 | 89 |
| 2007 | 611 | 409 | 233 | 214 | 118 | 151 | 202 | 261 | 71 |
| 2008 | 466 | 542 | 214 | 190 | 97 | 122 | 106 | 171 | 101 |
| 2009 | 350 | 252 |  |  |  |  | 198 |  | 144 |
| 2010 | 298 | 454 |  |  |  |  | 250 | 217 | 132 |
| 2011 | 417 | 384 |  |  |  |  | 266 | 484 | 157 |
| 2012 | 599 | 526 |  |  |  |  | 235 |  | 212 |

Table 4.2-3 - L. piscatorius in Divisions VIIb-k and VIIIa,b,d- Abundance indices in Nb/sq Km from 2003 to 2010from the IGFS-WIBTS-Q4.

| Year | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Nb/sqKm | 68,9 | 91,5 | 63,5 | 32,3 | 21,3 | 19,7 | 45,2 | 84,4 | 80,6 | 49,6 |



Figure 4.2-1 L. piscatorius in Divisions VIIb-k and VIIIa,b,d- Effort and LPUE data


Figure 4.2-2 L. piscatorius in Divisions VIIb-k and VIIIa,b,d- Time-series of the EVHOE-WIBTSQ4 survey indices Kg (left) and Nb (right) per 30 minutes tow from 1997 to 2011


Figure 4.2-3 - L. piscatorius in Divisions VIIb-k and VIIIa,b,d. Time-series of the EVHOE-WIBTSQ4 Length distributions in Nb per 30 minutes tow from 1997 to 2011


Figure 4.2-4 - L. piscatorius in Divisions VIIb-k and VIIIa,b,d, distribution of recruits (lt < $\mathbf{2 3} \mathbf{~ c m}$ ) in Nb per 30m observed in the EVHOE-WIBTS-Q4 surveys from 1997 to 2004.


Figure 4.2-5 - L. piscatorius in Divisions VIIb-k and VIIIa,b,d, distribution of recruits (lt < 23 cm ) in Nb per 30m observed in the EVHOE-WIBTS-Q4 surveys from 2005 to 2012.


Figure 4.2-6 - L. piscatorius in Divisions VIIb-k and VIIIa,b,d- Time-series of the SPPGFS (WI-BTS-Q4) survey indices Kg (left) and Nb (right) per 30 minutes tow from 2001 to 2011


Figure 4.2-7 - L. piscatorius in Divisions VIIb-k and VIIIa,b,d- Time-series of the SPPGFS (WI-BTS-Q4) Length distributions in Nb per 30 minutes tow from 2001 to 2012


Figure 4.2-8 - L. piscatorius in Divisions VIIb-k and VIIIa,b,d- Time-series of the FSP-ENGMONK Length distributions in Nb per meter beam per hour tow from 2003 to 2012

### 4.3 Anglerfish (L. budegassa) in Divisions VIIb-k and VIIIa,b,d

### 4.3.1 Data

### 4.3.1.1 Commercial Catch

The Working Group estimates of landings of L. budegassa by fishery unit (defined in Section 2) are given in Table 4.3-1.

The landings have fluctuated over the studied period between 5720 t to 9632 t with a succession of high (1989-1992, 1996-1998 and 2003) and low values (1994, 2001 and 2006). The total estimated landings have dropped from 2003 to 2006 and since then have risen to the third highest of the time-series in 2010 with 9359 t landed and the second highest in 2012.

The preliminary information on discards shows that an increasing proportion of small fish are caught and discarded.

### 4.3.1.2 Commercial LPUE

Effort and LPUE data were available in 2012 for the four Spanish fleets, and for the English EW-FU06 (Table 4.3-2 and 4.3-1). Fishing effort for most fleets shows a decrease until the early 2000's. Effort remained relatively stable thereafter, with the exception of SP-BAKON7 which disappeared in 2009 but reappeared again in 2010 with 2008 effort levels and disappeared again in 2012. In 2012 a sharp decrease in SPVIGO7 (28 \% reduction) and SP-CORUTR7 (46 \% reduction) was found.

LPUEs from SP-BAKON7 show an increasing trend from 1993 to 2000. Since then LPUEs have fluctuated with increasing trends since 2006 and conflicting trends for the most recent period. In the last three years SP- BAKON7 has shown an increasing trend, while EW-FU06 and SP-BAKON8 are stable. The 2010 SP-CORUTR7 LPUE has a revised figure for 2010 from 93 down to 19 which is similar to its historic levels. In 2012 SP-VIGO7 and SP-BAKON8 showed the series maximum and SP-CORUTR7 the second highest value, whereas EW-FU06 showed a decreasing trend.

### 4.3.1.3 Surveys data

### 4.3.1.3.1 The French EVHOE-WIBTS-Q4 survey

This survey covers the highest proportion of the area of stock distribution. Standardised biomass and abundance indices are given in Figure 4.3-2. The biomass index shows patterns of increase and decrease over the time-series, with a continuous increase from 2005 to its maximum value in 2008 followed again by a decrease to 20032005 levels. The most recent year shows an increase to the second highest level of the time-series. The abundance index shows a similar pattern to reach its highest values in the time series in 2008. In 2009 and 2010 the indices returned to 2004-2005 levels, 2011 shows another increase in abundance followed with the third highest result of the series in 2012.

The length distributions (Figure 4.3-3.) show that the abovementioned results correspond to strong incoming year-classes from 2004 until 2008 that can be tracked from year to year with modes between $10-17 \mathrm{~cm}$ for the first age group (since 2004), 18 - 32 for the second (2005, 2007 and 2008), 33-45 for the third and 50-55 for the fourth (more obvious in 2008).

For 2009 the length distribution does not show a strong signal of recruitment nor can the signal from 2008's strong recruitment be followed. 2010 shows a medium level
recruitment and the last two years, 2011 and 2012, gives the strongest signals of the time series for recruits.

The localisation of juveniles (individuals less than 16 cm ) caught during the survey from 1997 to 2008 show two nursery areas one in the western Celtic Sea and another in the north-western area of the Bay of Biscay (Figure 4.3-4. and Figure 4.3-5.), in 2008, juveniles are also found in more southern area of the Bay of Biscay in deeper waters. In 2010 to 2012 the normal pattern was found again with a more confined distribution in the western Celtic Sea.

### 4.3.1.3.2 The English Fisheries Science Partnership survey.

This survey samples a fraction of each of the areas VIIe, VIIf, VIIg and VIIh. The survey covers a restricted area of the species distribution but the pulses of recruitment observed in the EVHOE-WIBTS-Q4 surveys are also present in the FSP-ENG-MONK survey in the following year. Length distribution of L. budegassa catches are available and presented in Figure 4.3-6 .

For 2009 the English survey has recorded its historical maximum for recruitment and the good recruitment can be tracked from 2008. In 2010 to 2012 the recruitment returned to low levels and the good recruitments from 2008 and 2009 can be followed.

The first mode of this survey's length distributions tends to be found at slightly larger lengths than the first mode of the EVHOE-WIBTS-Q4 survey and strong recruitment signal according to EVHOE-WIBTS-Q4 in a given year tends to be followed by a strong signal around $16-28 \mathrm{~cm}$ for this survey in the following year. However the strong incoming year-class from the EVHOE-WIBTS-Q4 in 2011 does not appear in the FSP-ENG-MONK in 2012.

### 4.3.1.3.3 Other surveys

The other surveys (IGFS-WIBTS-Q4 and SPPGFS (WIBTS-Q4)) are covering areas mostly outside the preferred area of distribution of the species. Therefore information is too scarce to be presented.

### 4.3.2 Conclusion

Survey data give indication that the biomass has shown a continuous increase since the mid 2000's as a consequence of several good incoming recruitments. There is good evidence of a strong incoming recruitment from 2008. The EVHOE-WIBTS-Q4 shows evidence of a medium level of recruitment in 2010 and the last two years has recorded its historical maximum. Data from the two available surveys show contradictory signals for 2009, 2011 and 2012 recruitments.

The Working Group concludes that in view of the available data, continuing fishing at present level should not harm the stock.

Preliminary information on discards shows that an increasing proportion of small fish are caught and discarded.

Measures should be taken to ensure good survival of recent recruitment.

### 4.3.3 Comments on the assessment

As for L. piscatorius, data from surveys tracking recent good recruitment give scope for growth studies and ageing validation that should be initiated as soon as possible. It is noted that this should be easier than for L. piscatorius given the length distribu-
tion observed in recent years in the EVHOE-WIBTS-Q4 survey and the last four years in the English Fisheries Science Partnership programme FSP-ENG-MONK survey.

Table 4.3-3 Lophius budegassa in Divisions VIIb-k and VIIIa,b,d - Landings in tonnes by Fishery Unit.


Table 4.3-4 L. budegassa in Divisions VIIb-k and VIIIa,b,d- Effort and LPUE data

| EFFORT | SP-VIGO7 <br> in Division VII <br> ('000 days*HP) | SP-CORUTR7 <br> in Division VII <br> ('000 days*HP) | French Benthic trawlers* Celtic Sea FU04 ('000 hrs) | French Benthic Twin Trawls Celtic Sea ('000 hrs) | French Benthic trawlers* Bay of Biscay FU14 ('000 hrs) | French Benthic Twin Trawls Bay of Biscay ('000 hrs) | EW FU06 Beam trawlers in VII ('00 days) | SP-BAKON7 <br> (days) | SP-BAKON8 <br> (days) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1986 | 6875 | 9527 | 418 |  | 123 |  |  |  |  |
| 1987 | 6662 | 10453 | 349 |  | 199 |  |  |  |  |
| 1988 | 6547 | 10886 | 334 |  | 150 |  |  |  |  |
| 1989 | 7585 | 10483 | 378 |  | 187 |  |  |  |  |
| 1990 | 8021 | 9630 | 380 |  | 208 |  |  |  |  |
| 1991 | 7822 | 8522 | 380 |  | 210 |  |  |  |  |
| 1992 | 6370 | 5852 | 331 |  | 186 |  | 100 |  |  |
| 1993 | 5988 | 5001 | 274 |  | 159 |  | 114 | 1094 | 5590 |
| 1994 | 5655 | 4990 | 249 |  | 148 |  | 116 | 980 | 5619 |
| 1995 | 5070 | 4403 | 287 |  | 174 |  | 127 | 1214 | 4474 |
| 1996 | 5416 | 3746 | 196 | 121 | 144 | 19 | 126 | 1170 | 4378 |
| 1997 | 5058 | 3738 | 178 | 133 | 133 | 33 | 126 | 540 | 4286 |
| 1998 | 5360 | 3684 | 182 | 134 | 117 | 40 | 121 | 1196 | 3002 |
| 1999 | 5084 | 3512 | 108 | 110 | 83 | 59 | 115 | 1384 | 2337 |
| 2000 | 5519 | 2773 | 160 | 103 | 87 | 49 | 104 | 1850 | 2227 |
| 2001 | 5678 | 2356 | 127 | 133 | 60 | 66 | 186 | 1451 | 2118 |
| 2002 | 5041 | 2258 | 114 | 120 | 56 | 75 | 111 | 949 | 2107 |
| 2003 | 5437 | 2597 | 144 | 134 | 65 | 78 | 166 | 1022 | 2296 |
| 2004 | 5347 | 2292 | 155 | 129 | 75 | 88 | 174 | 910 | 2159 |
| 2005 | 5246 | 2120 | 137 | 135 | 81 | 118 | 109 | 544 | 2263 |
| 2006 | 5392 | 2257 | 140 | 145 | 72 | 101 | 94 | 487 | 2398 |
| 2007 | 5952 | 2323 | 149 | 152 | 48 | 127 | 97 | 476 | 2098 |
| 2008 | 5840 | 1640 | 118 | 126 | 58 | 113 | 138 | 105 | 2017 |
| 2009 | 5852 | 1626 |  |  |  |  | 75 | 0 | 1807 |
| 2010 | 5607 | 1988 |  |  |  |  | 77 | 138 | 1358 |
| 2011 | 4553 | 1725 |  |  |  |  | 82 | 57 | 1384 |
| 2012 | 3276 | 937 |  |  |  |  | 84 |  | 1384 |
| LPUE | Vigo in Division VII (kg/days*HP) | La Coruna in Division VII (kg/days*HP) | French Benthic trawlers* Celtic Sea FU04 (kg/10 hrs) | French Benthic Twin Trawls Celtic Sea (kg/10 hrs) | French Benthic trawlers* Bay of Biscay FU14 (kg/10 hrs) | French Benthic Twin Trawls Bay of Biscay (kg/10 hrs) | EW (FU06) Beam trawlers in VII (kg/10days) | SP-BAKON7 <br> (kg/day) | SP-BAKON8 <br> (kg/day) |
| 1986 | 339 | 37 | 38 |  | 51 |  |  |  |  |
| 1987 | 294 | 16 | 25 |  | 48 |  |  |  |  |
| 1988 | 265 | 42 | 39 |  | 53 |  |  |  |  |
| 1989 | 272 | 25 | 47 |  | 65 |  |  |  |  |
| 1990 | 250 | 29 | 52 |  | 62 |  |  |  |  |
| 1991 | 231 | 30 | 44 |  | 54 |  |  |  |  |
| 1992 | 248 | 14 | 48 |  | 53 |  | 28 |  |  |
| 1993 | 194 | 15 | 43 |  | 50 |  | 30 | 51 | 55 |
| 1994 | 203 | 20 | 44 |  | 60 |  | 11 | 108 | 61 |
| 1995 | 286 | 8 | 51 |  | 47 |  | 7 | 120 | 49 |
| 1996 | 304 | 12 | 47 | 65 | 42 | 58 | 12 | 173 | 57 |
| 1997 | 383 | 12 | 50 | 63 | 44 | 48 | 7 | 273 | 42 |
| 1998 | 319 | 9 | 54 | 64 | 62 | 68 | 15 | 229 | 78 |
| 1999 | 369 | 9 | 38 | 55 | 57 | 63 | 12 | 329 | 85 |
| 2000 | 257 | 19 | 61 | 50 | 57 | 73 | 9 | 265 | 56 |
| 2001 | 304 | 3 | 37 | 41 | 49 | 71 | 5 | 198 | 37 |
| 2002 | 389 | 30 | 46 | 48 | 40 | 66 | 8 | 232 | 71 |
| 2003 | 600 | 16 | 57 | 53 | 45 | 64 | 7 | 242 | 65 |
| 2004 | 490 | 13 | 38 | 46 | 35 | 55 | 6 | 185 | 92 |
| 2005 | 522 | 18 | 59 | 56 | 43 | 58 | 13 | 140 | 72 |
| 2006 | 479 | 13 | 25 | 27 | 44 | 56 | 8 | 179 | 70 |
| 2007 | 393 | 11 | 31 | 28 | 50 | 64 | 10 | 256 | 70 |
| 2008 | 547 | 5 | 48 | 43 | 68 | 86 | 16 | 248 | 74 |
| 2009 | 666 | 18 |  |  |  |  | 30 |  | 118 |
| 2010 | 584 | 19 |  |  |  |  | 34 | 326 | 117 |
| 2011 | 590 | 45 |  |  |  |  | 32 | 590 | 112 |
| 2012 | 692 | 42 |  |  |  |  | 25 |  | 204 |



Figure 4.3-7 L. budegassa in Divisions VIIb-k and VIIIa,b,d- Effort and LPUE data



Figure 4.3-8 L. budegassa in Divisions VIIb-k and VIIIa,b,d- Time-series of the EVHOE-WIBTSQ4 survey's indices Kg (left) and $\mathbf{N b}$ (right) per 30 minutes tow from 1997 to 2011


Figure 4.3-9 - L. budegassa in Divisions VIIb-k and VIIIa,b,d- Time-series of the EVHOE-WIBTSQ4 length distributions in Nb per 30 minutes tow from 1997 to 2011.


Figure 4.3-10 - L. budegassa in Divisions VIIb-k and VIIIa,b,d, distribution of recruits (lt < 16 cm) in Nb per 30m observed in the EVHOE-WIBTS-Q4 surveys from 1997 to 2004.


Figure 4.3-11 - L. budegassa in Divisions VIIb-k and VIIIa,b,d, distribution of recruits ( $\mathbf{l t}<\mathbf{1 6} \mathbf{~ c m}$ ) in Nb per 30m observed in the EVHOE-WIBTS-Q4 surveys from 2005 to 2011.


Figure 4.3-12 - L. budegassa in Divisions VIIb-k and VIIIa,b,d- Time-series of the FSP-ENGMONK length distributions in Nb per 30 minutes tow from 2003 to 2011.

## 5 Megrim (Lepidorhombus whiffiagonis) in Divisions VIIb-k and VIIIa,b,d

Assessment type: Same Advice as Last Year has been done for this stock. This stock was benchmarked in 2012 in WKFLAT. This type of assessment is based on survey trends; trends in population parameters from the Benchmark results; and a more detailed trend study on abundance of age groups from surveys and commercial fleets. WKLIFE2 pointed out that "If there are doubts about the method applied, the advice should be re examined in 2013, e.g. Megrim (Lepidorhombus whiffiagonis) in Divisions VIIb-k and VIIIa,b,d"

Data revisions this year: no major data revision has been carried out, this has been done in the benchmark workshop in 2012.

## Review Group for the Celtic Sea Ecosystem (RGCSE) comments:

Stock assessment: Trends Based on Model. The RG was unable to provide detailed recommendations for a handful of species due to insufficient data, including: Megrim in Divisions VIIb-k and VIIIa,b,d.

Due to lack of data availability, mainly unattainable information on Spanish landings along with Spanish and French discards in the terminal year (2011), the WGHMM could not update the benchmark method. The RG agrees that an analytical assessment is not possible with incomplete catch data. However, based on survey and fishery trends the stock appears to be stable. The RG suggests that catches should remain constant, but without landings or discard data from the Spanish fleet it is difficult to assess what catch was in 2011.

## Reply to Review Group comments:

In 2013, stock data for years 2011 and 2012 has been updated for all countries except for French discards. This information jointly with survey trends have been used for giving advice.

### 5.1 General

### 5.1.1 Fishery description

Megrim in the Celtic Sea, west of Ireland, and in the Bay of Biscay are caught in a mixed fishery predominantly by Spanish followed by Irish, UK and French demersal vessels. In 2012, the four countries together have reported around $86 \%$ of the total landings (Table 5.1.1.1.). Estimates of total landings (including unreported or missreported landings) and catches (landings+discards) as used by the Working Group up to 2012 are shown in Table 5.1.1.2 In 2012, Spanish official data for years 2011 and 2012 has been included.

### 5.1.2 Summary of ICES Advice for 2013 and Management applicable for 2012 and 2013

ICES advice for 2013
Based on the ICES approach for data limited stocks, ICES advises that landings should be no more than 12000 tonnes.

Management applicable for 2012 \& 2013
The 2012 TAC was set at 20106 t and 2013 TAC 19101 t , including a $5 \%$ contribution of $L$. boscii in the landings for which stock there is no assessment.

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

### 5.2 Data

### 5.2.1 Commercial catches and discards

Stock catches for the period 1984-2012, as estimated by the WG, are given in Table 5.1.1.2.

Spanish data in 2012 as in 2011 has been provided by SGP, the official national administration responsible for fishery statistics. In previous years catches have been estimated by the WG based on IEO and AZTI scientific estimations.

During Benchmark 2012, France landing data series were reviewed from 1999 onwards and final landings were provided for 2010 and 2011. Minor revisions were made for the Irish and Spanish landings and they are included in this revised data series.

Landings in 2012 are slightly higher than in 2011 (1\%), reaching up to 12080 t .
Discard data for 2011 and 2012 for UK were preliminar. Ireland provided discard raised data. Spain also provided discards data for 2011 and 2012. France did not provided discard data since 1999, as data appear to be very uncertain in relation to sampling level affecting their representatively.
Discard data available by country and the procedure to derive them are summarised in Table 5.2.1.1. The discards decrease in year 2000 can be partly explained by the reduction in the minimum landing size from 25 cm to 20 cm . Since 2000, an increasing trend in the discards has been observed. This could be explained by the MLS plus due to the large number of small fish caught until 2004. In 2005, the decrease in the number of small fish resulted in a large decrease of discards (Figure 5.2.1.1). In 2006 discards increased again around $23 \%$, especially in ages 4 and 5, while a decrease occurred till 2008. In 2010, discards increased in almost $40 \%$ close to levels of 2003. In 2011 and 2012, discards decreased $25 \%$ and $14 \%$ respectively.

In 2012, United Kingdom (England and Wales), and Ireland provide discard data since 2000. France does not provide this data, which led to an artificial decrease in the amount of total discards. The group states strongly the importance of incorporating annual estimates of discards to obtain consistent data along the whole data series. Maybe also discards could explain some possible recruitment that could not be completely registered in the catch at age matrix and LPUEs.

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

|  | $\mathbf{2 0 0 0}$ | $\mathbf{2 0 0 1}$ | $\mathbf{2 0 0 2}$ | $\mathbf{2 0 0 3}$ | $\mathbf{2 0 0 4}$ | $\mathbf{2 0 0 5}$ | $\mathbf{2 0 0 6}$ | $\mathbf{2 0 0 7}$ | $\mathbf{2 0 0 8}$ | $\mathbf{2 0 0 9}$ | $\mathbf{2 0 1 0}$ | $\mathbf{2 0 1 1}$ | $\mathbf{2 0 1 2}$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Discard <br> ratio (\%) | 11 | 13 | 15 | 20 | 27 | 17 | 22 | 17 | 19 | 16 | 25 | 22 | 19 |

### 5.2.2 Biological sampling

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

## Age

France provided ALKs and consequently completed number and weights at age up to 2012. Spain, Ireland and UK (England and Wales) provided number at age for discards and landings up to 2012.

Age distribution for landings and discards from 1999 to 2012 are presented in Figure 5.2.2.1

## Lengths

Table 5.2.2.1 shows the available original length composition of landings by Fishing Unit in 2012. Spanish length composition was standardised by total number of individuals, as lengths were provided but not raising was applied to the official landings.

The length compositions of the landings show an increase between 1990 and 1992 and, subsequently, a constant decrease until a rapid increase starting in 2000 (Figure 5.2.1.1) due to the change in MLS. Up to 2006, mean lengths stay relatively stable in the recent years with a decrease in length of discards. In 2012 increased the mean length of discarded fishes.

### 5.2.3 Surveys data

UK survey Deep Waters (UK-WCGFS-D, Depth > 180 m ) and UK Survey Shallow Waters (UK-WCGFS-S, Depth < 180 m ) indices for the period 1987-2004 and French EVHOE survey (EVHOE-WIBTS-Q4) results for the period 1997-2012 are summarised in Table 5.2.3.1.

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

EVHOE-WIBTS-Q4 indices for age 1 showed no evident general trend. Oscillations of high and low values are present from 2002 to 2007. In 2008 indices decreased sharply with a slight increase till 2010. In 2011, the lowest value of the series reached but in 2012 it has increased again.

An abundance index in ages was provided for the Spanish Porcupine Ground Fish Survey (SpPGFS-WIBTS-Q4) from 2001 to 2012, and from Irish Groundfish Survey (IGFS-WIBTS-Q4) from 2003-2012. For the last four years of the data series, both surveys provide the lowest values of the age 1 . Otherwise, when comparing abundance indices in total numbers, both surveys show an increasing trend the last 3 years 2010 to 2012.

When comparing Spanish, French and Irish biomass indices some contradictory signals are detected (Figure 5.2.3.1). The EVHOE-WIBTS-Q4 index decreased from 2001 until 2005 and since then has sharply increased. In 2012, it slightly decreased. The SpPGFS-WIBTS-Q4 biomass index appears to fluctuate without trend, with the lowest value of the period attained in 2008. However, some concerns about the good performance of the gear in 2008 were raised and thus the 2008 index may not be entirely reliable. In 2009, these performance problems were solved and the index increased for the last 4 years of the series.For EVHOE-WIBTS-Q4 and SpPGFS-WIBTS-Q4 surveys, abundance index in weight shows an increasing trend since 2006.

Irish Ground Fish Survey (IGFS-WIBTS-Q4) gives the highest estimates in 2005 with a decrease in trend to 2007 and increasing again till 2009 in agreement with EVHOE-WIBTS-Q4. In 2010 a sharp decreased occurred in contradiction with the French and Spanish surveys. In 2011 a slight increase occurred in agreement with Spanish survey and in 2012 an important decreased was observed again.

For a more detailed inspection of the abundances indices of different age groups, these were inspected along the whole data series for surveys (Figure 5.2.3.2). Ages groups were identified as: i) age $1+$ age 2 ; ii) age $3+$ age $4+$ age 5 and iii) age $6+$ age 7 +age 8+age 9+age 10+. The most abundant age group was ii) at the beginning and the end of the data series for all the surveys. Age group i) appear most abundant during years 2005 to 2008. In 2012, surveys show contradictory signals for different age grouping. As a consequence it is difficult to conclude on the recent abundance trends by age group. It must be noted, however that for the EVHOE survey age 3+age 4+age 5 shows continuous increasing trends since 2004.

It must be noted that the areas covered by the three surveys almost do not overlap (Figure 5.2.3.3). 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.

### 5.2.4 Commercial catch and effort data

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

The general level of effort is described in Figure 5.2.4.1. SP-CORUTR7 and SPVIGOTR7 fleets have decreased since 1991, stabilising the last years of the series. SPVIGOTR7 showed a very slight increase in 2007, decreasing slightly till 2012. SPCANTAB7 remains quite stable since 1991 and decreased slightly since 2000. In 2009, no effort has been deployed by this fleet but in 2010, some trips were recorded, for year 2011 and 2012 no effort was deployed. The effort of the French benthic trawlers fleet in the Celtic Sea decreased from 1991 to 1994, then increased in 1995-1996 and decreasing again in 1999. Since then, effort has been fluctuating up and down for the last 10 years. Since French logbook data were only partially available since 1999, only the LPUE data can be considered.

Commercial series of catch-at-age and effort data were available for three Spanish fleets in Subarea VII (Figure 5.2.4.2): A Coruña (SP-CORUTR7) from 1984-2011 (in year 2012 there were LPUE data instead of CPUE, so data series was not updated), Cantábrico (SP-CANTAB7) from 1984-2010 as no effort has been deployed by this fleet in subarea VII during the last two years and Vigo (SP-VIGOTR7) from 19842012. The CPUE of SP-CORUTR7 has fluctuated until 1990, when it started decreasing, with a slight increase in 2007. In 2011, CPUE for this fleet sharply increased. Over the same period, SP-VIGOTR7 has remained relatively stable until 1999, when it started to increase, reaching in 2004 the historical maximum. In 2005 a sharp decrease occurred, increasing slightly again in 2006 and 2007. The CPUE of SP-VIGOTR7, has had a sharp increase in 2009. SP-CANTAB7 has been fluctuating up to 1999 and then a general increasing trend is observed. No LPUE value is available for this fleet in 2009, as no effort was deployed. In 2010, LPUEs increased as a result of some trips being deployed in area VII but in 2011 and 2012 no effort was deployed.

From 1985 to 2008, LPUEs from four French trawling fleets: FR-FU04, Benthic Bay of Biscay, Gadoids Western Approaches and Nephrops Western Approaches were available. (Table 5.2.4.1.\& Figure 5.2.4.3). FR-FU04, Benthic Bay of Biscay, Gadoids Western Approaches and Nephrops Western Approaches were revised and new series included. However no data for 2009, 2010 and 2011 were provided as effort deployed by these fleet was considered, at the time of the analysis, unreliable.

The LPUE of all French bottom trawlers fleets decreased from 1988 to 1991 and remained relatively stable until 1994 (Figure 5.2.4.3). Since then, both benthic fleets have shown increasing LPUE until 1997 and 1998. Benthic trawlers in VIIIa,b,d follow a decreasing trend while the FU04: Benthic Western Approaches remained at an increasing trend until 2002, then a sharp decreasing trend is observed till 2004. From then, LPUE has increased and remain stable for the last 3 years of the series. From 1996, the demersal fleet LPUE started decreasing. No update of LPUE information for 2009 and 2010 was provided for French fleets.

The LPUE of all Irish beam trawlers fleets oscillates up and down since 2000 to 2006 following a decreasing trend. From 2007 an increase in the LPUE is observed (Figure 5.2.4.4).

Summarizing no particular LPUE changes have been observed, so no stock changes is observed.

An analysis of the abundance indices of different age groups along the whole data series for commercial fleets was carried out (Figure 5.2.4.5). Ages groups were identified as: i) age $1+$ age 2 ; ii) age $3+$ age $4+$ age 5 and iii) age 6+age $7+$ age $8+$ age $9+$ age $10+$. For Spanish and Irish commercial fleets, the most abundant age group was ii) at the beginning and the end of the data series. Age group i) appear more abundant than older ages (ii) during years 2003 and 2004 and 2006 to 2010 in the Spanish fleet. French fleets appear to land mostly old individual at the beginning of the data series, while same quantities of medium age fish (group ii) and old fish (group iii) are presented till 2008. In general a marked decrease in abundance index of old fish was observed for French fleet. In 2010, Spanish and Irish fleets show contradictory signals for different age grouping. Whereas Spanish fleet identified a positive increase for all age groups in 2010, Irish fleet identified that positive estimate for old fish in 2012.

Based on ages groups, summarizing no particular LPUE changes have been observed, so no stock changes is observed.

### 5.3 Assessment

### 5.3.1 Data Exploratory Analysis

In summary, the stock catch-at-age matrix shows three periods: 1984-1989; 1990-1998 and 1999-2010.

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

Several exploratory analyses were carried out on the data with the software R. The results are described below.

The analysis of the standardized log abundance indices revealed, no special trend in EVHOE-WIBTSQ4 survey (Figure 5.3.1.1). Otherwise, in SpPGFS-WIBTS-Q4 negative values for older ages from 2007 to 2011 but positive for older ages in 2012. The analysis of the standardized log abundance indices revealed year trends for VIGO99and the same decrease in the index of old individuals was detected by this fleet in 2008
and 2009. In 1999 and 2000, VIGO99 showed negative high values for ages 1 and 2. IRTBB was the only fleet that showed positive values for older ages from year 2010 onwards.

The time-series of catch at age (Figure 5.3.1.2) showed very low catches of ages $1-5$ from 1984 to 1989. From 2004 to 2012, the catch of older ages ( $>6$ ) was remarkably low, whereas catches of ages 1 and 2 increased markedly from 2003. This could be a result of an underestimation of catches of these ages (specially age 1 ) before this year due, most probably, to the sparseness of discard data in that period. For ages 6 and older, large discrepancies in the amount caught before and after 1990 are apparent, with large catches of these ages before 1990 and a decrease to almost no individuals caught at the end of the data series.

The analysis of the landings are presented since 1990 (Figure 5.3.1.3). Landings of ages 1 and 2 decreased from the beginning of the series to the last years. When analysing landings of ages older than 5 , differences in the patterns were also quite apparent. In fact, older ages have almost disappeared from the landings in recent years, as already discussed in relation to the catch.

The signal coming from the discard data showed that at the beginning of the dataseries there were no discards of age 1 (Figure 5.3.1.4). Discards of this age increased along the dataseries, particularly from 2003. Ages 4, 5, and 6 appeared to be highly discarded in year 2004. From year 2010 to 2012, ages 1 to 3 appear to be highly discarded.

### 5.3.2 Model

The model explored during the benchmark is an adaptation of one developed originally for the southern hake stock, published in Fernández et al. (2010). It is a statistical catch-at-age model that allows incorporating data at different levels of aggregation in different years and also allows for missing discards data by certain fleets and/or in some years. These are all relevant features in the megrim stock. The model is fitted in a Bayesian context, using the freely available software WinBUGS (Lunn et al., 2009). The model is described in Annex E of this report and also in WKFLAT 2012 report.

### 5.3.3 Results

Following the WKLIFE2 suggestion the advice was "re-examined", so the model was run with two more years 2011 and 2012 of data. First, trial runs of the model with few iterations were done to check if the data fit the model. When final data were ready and final run was initiated, computational problems arised with the servers of the institute where the model was run and no reliable output was obtained. Since a final run takes around 36 hours to give an output it was not possible to obtain any reliable result concerning stock population structure and SSB during the days of the Working Group.

### 5.4 Conclusions

As no estimates of the stock population structure and SSB are available, the basis for the assessment are:

- The analysis of trends of Survey Indices.
- An analysis of the abundance of the ages of each of the fleets by means of grouping ages (Group i: ages $1+2$; Group ii: ages 3,4 , and 5 and Group iii: ages $6,78,9$ and $10+$ ). The objective is to discern for any possible change in abundance in young, intermediate and old ages along the data series.

Catch, landing and discard data and survey indices do not appear to indicate the presence of important change in trends of recruitment or the overall biomass.
In the context of the current trend analysis and in view of available data, the Group concludes that the stock appears stable at the present level of fishing.

### 5.5 Short term and medium term forecasts

No analytical assessment resulted available for this stock consequently no forecast is either provided.

### 5.6 Biological reference points

The calculation of possible reference points was not considered appropriate at this time due to the lack of analytical analysis.

### 5.7 Recommendations on the procedure for assessment updates and further work

It needs to be pointed out that stock data from countries should be available one month before the group starts as it was set, otherwise there is not enough time during the group to make preliminary runs to obtain the best fit of the model. Specially for the Bayesian model applied to this stock which takes around 36 hours to run and it is not operational to work on during the meeting.

The group states strongly the importance of delivering reliable Spanish and French data, including annual estimates of discards to explain some of the recruitment processes detected in the analysis and not completely registered in the catch at age matrix and LPUEs.

It appears unlikely that time until future Working Groups would be enough for: i) solving data availability, ii) reviewing their quality, iii) new model trials and even iv) exchange of experiences between researches working in same species but different stocks.

That is why it would be recommended that:
a ) Resources could be made available for a real improvement in the assessment of this stock. A pilot project is suggested for in a depth treatment of data analysis and improvement and model selection.
b) If no resources are available, interseasonal work between this WG and next working group will be focused in the improvement of the data quality.

Some recommendations are done in ANNEX O and P.

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

|  | 1984 | 1985 | 1986 | 1987 | 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 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| France |  |  | 4896 | 5056 | 5206 | 5452 | 4336 | 3709 | 4104 | 3640 | 3214 | 3945 | 4146 | 4333 | 4232 | 3751 | 4173 | 3645 | 2929 | 3203 | 2758 | 2787 | 2726 | 2733 | 2383 | 1316 | 1728 | 1599 | 1603 |
| Spain |  |  | 10242 | 8772 | 9247 | 9482 | 7127 | 7780 | 7349 | 6526 | 5624 | 6129 | 5572 | 5472 | 4870 | 4615 | 6047 | 7575 | 8797 | 8340 | 7526 | 5841 | 5916 | 6895 | 5402 | 8062 | 7095 | 3847 | 3997 |
| U.K. |  |  | 2048 | 1600 | 1956 | 1451 | 1380 | 1617 | 1982 | 2131 | 2309 | 2658 | 2493 | 2875 | 2492 | 2193 | 2185 | 1710 | 1787 | 1732 | 1622 | 1764 | 1509 | 1462 | 1387 | 1842 | 1810 | 1845 | 1744 |
| Ireland |  |  | 1563 | 1561 | 995 | 2548 | 1381 | 1956 | 2113 | 2592 | 2420 | 2927 | 2699 | 1420 | 2621 | 2597 | 2512 | 2767 | 2413 | 2249 | 2288 | 2155 | 1751 | 1763 | 1514 | 1918 | 2283 | 2227 | 3047 |
| Belgium |  |  | 178 | 125 | 173 | 300 | 147 | 32 | 52 | 40 | 117 | 203 | 199 | 130 | 129 | 149 | 115 | 80 | 62 | 163 | 106 | 156 | 99 | 195 | 167 | 261 | 261 | 330 | 609 |
| Unallocated |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2074 | 1080 |
| Total landings | 16659 | 17865 | 18927 | 17114 | 17577 | 19233 | 14370 | 15094 | 15600 | 14929 | 13684 | 15862 | 15109 | 14230 | 14345 | 13305 | 15031 | 15778 | 15987 | 15687 | 14300 | 12703 | 12000 | 13048 | 10853 | 13348 | 13178 | 11923 | 12080 |
| Total discards | 2169 | 1732 | 2321 | 1705 | 1725 | 2582 | 3284 | 3282 | 2988 | 3108 | 2700 | 3206 | 3026 | 3066 | 5371 | 3297 | 1870 | 2262 | 2813 | 4008 | 5240 | 2578 | 3368 | 2703 | 2531 | 2604 | 4406 | 3340 | 2902 |
| Total catches | 18828 | 19597 | 21248 | 18819 | 19302 | 21815 | 17654 | 18376 | 18588 | 18037 | 16384 | 19068 | 18135 | 17296 | 19716 | 16601 | 16901 | 18040 | 18800 | 19695 | 19539 | 15281 | 15369 | 15750 | 13384 | 15952 | 17590 | 15263 | 14988 |
| Agreed TAC (1) |  |  |  | 16460 | 18100 | 18100 | 18100 | 18100 | 18100 | 21460 | 20330 | 22590 | 21200 | 25000 | 25000 | 20000 | 2000 | 16800 | 14900 | 16000 | 20200 | 21500 | 20400 | 20400 | 20400 | 20400 | 20106 | 20106 | 19101 |

Table 5.1.1.2. Megrim (L. whiffiagonis) in Divisions VIIb-k and VIIIa,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 | 16602 | 20000 |
| 2000 | 15031 | 1870 | $1690{ }^{\circ}$ | 20000 |
| 2001 | 15778 | 2262 | 18040 | 16800 |
| 2002 | 15987 | 2813 | 18800 | 14900 |
| 2003 | 15687 | 4008 | 19695 | 16000 |
| 2004 | 14300 | 5240 | 19539 | 20200 |
| 2005 | 12703 | 2578 | 15281 | 21500 |
| 2006 | 12000 | 3368 | 15369 | 20425 |
| 2007 | 13048 | 2703 | 15750 | 20425 |
| 2008 | 10853 | 2531 | 13384 | 20425 |
| 2009 | 13348 | 2604 | 15952 | 20425 |
| 2010 | 13185 | 4406 | 17590 | 20106 |
| 2011(*) | 11923 | 3340 | 15263 | 20106 |
| 2012(*) | 12080 | 2902 | 14982 | 19101 |

(1) for both megrim species and VIIa included
$\left(^{*}\right)$ Spanish official data are included

Table 5.2.1.1 Megrim (L.whiffiagonis) in VIIb-k and VIIIa,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 | - | SP04 | IR | UK |
| 2005 | - | SP05 | IR | UK |
| 2006 | - | SP06 | IR | UK |
| 2007 | - | SP07 | IR | UK |
| 2008 | - | SP08 | IR | UK |
| 2009 | - | SP09 | IR | UK |
| 2010 | - | SP10 | IR | UK |
| 2011 | - | SP11 (*) | IR | UK |
| 2012 | - | SP12 (*) | IR | UK |

- In bold: years where discards sampling programs provided information
- In (): years for which the length distribution of discards has been deriver
(*) Scientific estimates were provided

Table 5.2.2.1 Megrim (L.whiffiagonis) in Divisions VIIb-k and VIIIa,b,d. Original Length composition by fleet (thousands) has been deployed. No raised to the total landings. No length frequencies for Belgium are available. Spanish length distribution has been scaled to the official landings.


Table 5.2.3.1. Megrim (L. whiffiagonis) in Divisions VIIb-k and VIIIa,b,d. Abundance Indices for UK-WCGFS-D, UK-WCGFS-S, IGFS, SP-PGFS and EVHOE.


Table 5.2.3.1 (cont). Megrim (L. whiffiagonis) in Divisions VIIb-k and VIIIa,b,d. Abundance Indices by kilograms and numbers by 30 minutes haul duration.

| IGFSAge |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | fort | 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 | 141 | 487 | 350 | 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 | 5 |
| 2012 | 100 | - 4 | 24 | 141 | 140 | 108 | 52 | 36 | 16 | 9 | 33 |
| SP-PGFS |  |  |  |  |  |  |  |  |  |  |  |
|  | fort | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |  |
| 2001 | 100 | - 43 | 1770 | 2208 | 2842 | 3434 | 1941 | 1357 | 487 | 132 |  |
| 2002 | 100 | - 6 | 972 | 2064 | 3068 | 4265 | 2471 | 1209 | 340 | 118 |  |
| 2003 | 100 | 12 | 979 | 2292 | 3997 | 5653 | 3090 | 1393 | 417 | 144 |  |
| 2004 | 100 | - 6 | 597 | 2841 | 4524 | 4616 | 2550 | 932 | 405 | 126 |  |
| 2005 | 100 | - 65 | 541 | 532 | 1934 | 6987 | 4183 | 2193 | 407 | 100 |  |
| 2006 | 100 | - 4 | 1426 | 1144 | 2592 | 3739 | 2619 | 713 | 161 | 88 |  |
| 2007 | 100 | - 24 | 3937 | 5613 | 2836 | 2884 | 1444 | 681 | 191 | 66 |  |
| 2008 | 100 | 10 | 189 | 1595 | 3872 | 2861 | 1282 | 863 | 197 | 58 |  |
| 2009 | 100 | - 4 | 360 | 445 | 3584 | 4840 | 1122 | 605 | 273 | 86 |  |
| 2010 | 100 | 30 | 236 | 1604 | 1913 | 5030 | 1732 | 366 | 165 | 114 |  |
| 2011 | 100 | - 31 | 328 | 975 | 2087 | 3274 | 4256 | 1195 | 265 | 156 |  |
| 2012 | 100 | - 4 | 133 | 584 | 3177 | 2408 | 2697 | 2450 | 975 | 330 |  |
| FR-EVHOEFS Abundance Indices by kilograms and numbers by 30 minutes haul duration |  |  |  |  |  |  |  |  |  |  |  |
|  | /30' | $\mathrm{Nb} / 30$ |  |  |  |  |  |  |  |  |  |
| 1997 | 1,98 | 12,35 |  |  |  |  |  |  |  |  |  |
| 1998 | 2,20 | 13,96 |  |  |  |  |  |  |  |  |  |
| 1999 | 1,82 | 13,43 |  |  |  |  |  |  |  |  |  |
| 2000 | 1,42 | 11,14 |  |  |  |  |  |  |  |  |  |
| 2001 | 2,21 | 17,04 |  |  |  |  |  |  |  |  |  |
| 2002 | 2,03 | 16,55 |  |  |  |  |  |  |  |  |  |
| 2003 | 1,77 | 13,14 |  |  |  |  |  |  |  |  |  |
| 2004 | 1,50 | 10,67 |  |  |  |  |  |  |  |  |  |
| 2005 | 1,43 | 9,88 |  |  |  |  |  |  |  |  |  |
| 2006 | 1,7 | 15,63 |  |  |  |  |  |  |  |  |  |
| 2007 | 1,96 | 14,6 |  |  |  |  |  |  |  |  |  |
| 2008 | 2,05 | 13,65 |  |  |  |  |  |  |  |  |  |
| 2009 | 2,5 | 14,8 |  |  |  |  |  |  |  |  |  |
| 2010 | 2,57 | 15,53 |  |  |  |  |  |  |  |  |  |
| 2011 | 3,21 | 17,14 |  |  |  |  |  |  |  |  |  |
| 2012 | 2,97 | 17,69 |  |  |  |  |  |  |  |  |  |
| SP-PGFS Abundance Indices by kilograms and numbers by 30 minutes haul duration |  |  |  |  |  |  |  |  |  |  |  |
|  | /30' | Nb/30' |  |  |  |  |  |  |  |  |  |
| 2001 | 6,80 | 143,34 |  |  |  |  |  |  |  |  |  |
| 2002 | 6,66 | 147,00 |  |  |  |  |  |  |  |  |  |
| 2003 | 8,15 | 180,79 |  |  |  |  |  |  |  |  |  |
| 2004 | 7,45 | 167,47 |  |  |  |  |  |  |  |  |  |
| 2005 | 8,28 | 170,17 |  |  |  |  |  |  |  |  |  |
| 2006 | 6,03 | 125,37 |  |  |  |  |  |  |  |  |  |
| 2007 | 7,31 | 177,38 |  |  |  |  |  |  |  |  |  |
| 2008 | 5,99 | 109,70 |  |  |  |  |  |  |  |  |  |
| 2009 | 8,11 | 113,68 |  |  |  |  |  |  |  |  |  |
| 2010 | 8,52 | 112,56 |  |  |  |  |  |  |  |  |  |
| 2011 | 9,82 | 126,60 |  |  |  |  |  |  |  |  |  |
| 2012 | 10,82 | 130,21 |  |  |  |  |  |  |  |  |  |
| IGFS Abundance Indices by numbers by 10 square kilometers |  |  |  |  |  |  |  |  |  |  |  |
| 2003 | 1227 |  |  |  |  |  |  |  |  |  |  |
| 2004 | 1926 |  |  |  |  |  |  |  |  |  |  |
| 2005 | 2254 |  |  |  |  |  |  |  |  |  |  |
| 2006 | 2039 |  |  |  |  |  |  |  |  |  |  |
| 2007 | 725 |  |  |  |  |  |  |  |  |  |  |
| 2008 | 1247 |  |  |  |  |  |  |  |  |  |  |
| 2009 | 1724 |  |  |  |  |  |  |  |  |  |  |
| 2010 | 1103 |  |  |  |  |  |  |  |  |  |  |
| 2011 | 1227 |  |  |  |  |  |  |  |  |  |  |
| 2012 | 583 |  |  |  |  |  |  |  |  |  |  |

Table 5.2.4.1. Megrim (L. whiffiagonis) in Divisions VIIb-k and VIIIa,b,d. French and Spanish CPUEs for different bottom trawl fleets.

|  | French (single and twin bottom trawls combined) CPUE (kg/h) |  |  |  | Spanish CPUE (kg/(100day*100 hp)) |  |  | Irish LPUE ('000 h) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Year | 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 | 58,5 | 135,3 | 10,0 |
| 2006 | 2,5 | 4,8 | 0,3 | 3,6 | 1,4 | 76,4 | 146,1 | 7,5 |
| 2007 | 2,4 | 5,1 | 0,4 | 2,9 | 2,4 | 87,9 | 144,3 | 8,5 |
| 2008 | 2,2 | 4,6 | 0,5 | 3,1 | 3,0 | 37,6 | 114,0 | 8,4 |
| 2009 | NA | NA | NA | NA | 8,3 | 0,0 | 173,2 | 10,3 |
| 2010 | NA | NA | NA | NA | 7,9 | 38,8 | 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 |



Figure 5.2.1.1. Megrim (L.whiffiagonis) in Divisions VIIb-k and VIIIa,b,d. Length composition of catches for the years 1999 to 2012. Numbers of individuals in thousand tns.


Figure 5.2.2.1. Megrim (L.whiffiagonis) in Divisions VIIb-k and VIIIa,b,d. Age composition of catches for the years 1999 to 2012.


Figure 5.2.3.1. Megrim (L. whiffiagonis) in Divisions VIIb-k and VIIIa,b,d. Scaled Biomass Indices for EVHOE, SP-PGFS.


Figure 5.2.3.2. Megrim (L. whiffiagonis) in Divisions VIIb-k and VIIIa,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 5.2.3.3. Station positions for the IBTS Surveys carried out in the Western and North Sea Area in the autumn/winter of 2008. (From IBTSWG 2009 Report). Just to be used as general location of the Surveys.


Figure 5.2.4.1. Megrim (L. whiffiagonis) in Divisions VIIb-k and VIIIa,b,d. Evolution of effort for different bottom trawler fleets.


Figure 5.2.4.2. Megrim (L. whiffiagonis) in Divisions VIIb,c,e-k and VIIIa,b,d. Spanish CPUE for different bottom trawler fleets.


Figure 5.2.4.3. Megrim (L. whiffiagonis) in Divisions VIIb,c,e-k and VIIIa,b,d. French LPUE for different bottom trawler fleet.

## Irish Otter trawlers



Figure 5.2.4.4. Megrim (L. whiffiagonis) in Divisions VIIb,c,e-k and VIIIa,b,d. Irish LPUE for beam trawl fleet.


Figure 5.2.4.5. Megrim (L. whiffiagonis) in Divisions VIIb-k and VIIIa,b,d. Abundance Indices for SP-VIGOTR7, FR-FU04 and IRTBB by ages grouped: i) $1+2$; ii) $3+4+5$ and iii) $6+7+8+9+10^{+}$.


Figure 5.3.1.1. Megrim (L. whiffiagonis) in Divisions VIIb-k and VIIIa,b,d. Bubble plots of the standardized $\log$ abundance indices of the surveys and commercial fleets used as tuning fleets.


Figure 5.3.1.2. Megrim (L. whiffiagonis) in Divisions VIIb-k and VIIIa,b,d. Bubble plots for catch numbers at age from 1984 to 2012.

Landed numbers-at-age 1990-2012
(each age standardised separately by subtracting mean and dividing by standard deviation)


Figure 5.3.1.3. Megrim (L. whiffiagonis) in Divisions VIIb-k and VIIIa,b,d. Bubble plots for landing numbers at age from 1990 to 2012.


Figure 5.3.1.4. Megrim (L. whiffiagonis) in Divisions VIIb-k and VIIIa,b,d. Bubble plots for discarded numbers at age from 1990 to 2012.

Type of assessment in 2013: update.
Data revisions this year: Compared to last year assessment, there is only very limited change in data due to small revisions of 2011 landings and of 2011 commercial LPUE.

## Review Group issues:

- The RG appreciates that EG has followed its recommendation to investigate the implications of XSA not converging after 30 iterations (but converging after 58 iterations) and acknowledges that the difference in the output of the model are marginal.
- The assessment is currently not using any survey index. A new survey has started in 2007 to overcome this lack. During the last benchmark (2011), the survey was too short to be included in the assessment, but WKFLAT (2011) recommended to consider the inclusion of the survey as soon the series is 5 years long. The RG noticed that the survey index for ages 1 and 2 seems to reflect quite well the strength of incoming recruitment and suggested to explore the inclusion of the survey index in the next assessment as the time series is now long enough.
- For the next benchmark, the RG suggestions are to estimate and include discards, to add the ORHAGO survey time series and to use annually varying maturity ogives.


### 6.1 General

### 6.1.1 Ecosystem aspects

See Stock Annex

### 6.1.2 Fishery description

See Stock Annex

### 6.1.3 Summary of ICES advice for 2013 and management applicable to 2012

 and 2013
## ICES advice for 2013:

Since 2010 the ICES advice is to decrease the fishing mortality step by step to the Fmsy ( 0.26 for the Bay of Biscay sole) until 2015.

The advice provided for 2013:
ICES advises on the basis of the transition to the MSY approach that landings in 2013 should be no more than 3500 t .

## Management applicable to 2012 and 2013

The sole landings in the Bay of Biscay are subject to a TAC regulation. The 2012 TAC was set at 4250 t (as in 2011). The 2013 TAC is set at 4100 t . The minimum landing size is 24 cm and the minimum mesh size is 70 mm for trawls and 100 mm for fixed nets, when directed on sole. Since 2002, the hake recovery plan has increased the minimum mesh size for trawl to 100 mm in a large part of the Bay of Biscay but since

2006 trawlers using a square mesh panel were allowed to use 70 mm mesh size in this area.

Since the end of 2006, the French vessels must have a Special Fishing Permit when their sole annual landing is above 2 t or to be allowed to have more than 100 kg on board.

The Belgian vessel owners get monthly non-transferable individual quota for sole. The amount is related to the capacity of the vessel.

A regulation establishing a management plan has been adopted in February 2006. The objective was to bring the spawning stock biomass of Bay of Biscay sole above the precautionary level of 13000 tonnes in 2008 by gradually reducing the fishing mortality rate on the stock. Once this target is reached, the Council has to decide on a long-term target fishing mortality and a rate of reduction in the fishing mortality for application until the target has been reached. However, although the stock was estimated above the SSB target in 2008 by ICES in 2009, the long-term target fishing mortality rate and the associated rate of reduction have not yet been set.

### 6.2 Data

### 6.2.1 Commercial catches and discards

The WG estimates of landings and catches are shown in Table 6.1a. The WG landing estimates are the figure obtained by crossing auction sales, available logbooks and data communicated by the administrations of countries involved in the Bay of Biscay sole fishery. The French catches are predominant. Since 2005, the same method has been used to estimate them and, because they are nearly exclusively landed in Bay of Biscay harbours, the record of the auction sales allows thus to consider that the reliability of theirs estimates is satisfactory all along the series.

The official landings are lower up to 2008 than the WG landings estimates but they become largely higher in 2009-2010 because since 2009, a new method 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 and which have been modified in 2011. Consequently the official and the WG landing estimates are closer in 2011-2012. However, the WG method to estimate landings is considered to continue to provide the best available estimates of the landing series.

The 2011 landings estimate was revised less than 0.2 \% higher to 4632 t .
In 2002, landings were increased to 5486 t by hydrodynamic conditions very favourable to the fixed nets' fishery (frequent strong swell periods in the first quarter). In the absence of such apparently rare conditions, the landings in 2003-2008 were ranging from between 4000 t and 4800 t before falling to 3650 t in 2009 and increasing to 4632 t in 2011 (Table 6.1a).
The 2012 landings figure ( 4317 t ) is $1.8 \%$ above the landings predicted by the 2012 WG at status quo mortality ( 4240 t ).
Discards estimates were provided for the French offshore trawler fleet from 1984 to 2003 using the RESSGASC surveys. Because these estimates depend largely on some questionable hypothesis, their monitoring was not continued in 2004 and they are no longer used in the assessment. However, this survey allowed affirmation that the discards of offshore trawlers are low at age 2 and above. This low level has been confirmed by observations at sea in recent years. These observations have also shown
that discards of beam trawlers and gillnetters are generally low but that the inshore trawlers fleet may have occasionally high discards of sole. Unfortunately, they are difficult to estimate because the effort data of inshore trawlers are not precise enough to allow estimating them by relevant areas. However, the French and Belgian discards data should be analysed as soon as possible to investigate if these difficulty can be circumvented before a future benchmark.

### 6.2.2 Biological sampling

The quarterly French sampling for length compositions is by gear (trawl or fixed net) and by boat length (below or over 12 m long). The split of the French landings in these components is made as described in Stock Annex. The 2011 split was not revised because of the very small correction in the database (Table 6.1 b ).

Length compositions are available on a quarterly basis from 1984 for the French fleets and from 1994 for the Belgian beam trawlers. The 2012 sampling level is given in table 1.3. The French length distributions are shown on Figures 6.1 a, b \& c from 1984 onwards. The relative length distribution of landings in 2012 is shown by country in Table 6.2.

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, noticed by preceding WGs, are still present. A work was carried out in the beginning of 2012 (PGCCDBS, 2012) to compare the age reading methods. The conclusion is that there was no bias between readers from the three countries using otoliths prepared with the staining technique. All readers produced the same age estimates (i.e. no bias) of otoliths with or without staining.

However, a likely effect of the weight at age samples process may also be presumed (weight-length relationship used in France and straight estimate in Belgium) and should be investigated. International age compositions are estimated using the same procedure as in previous years, as described in Stock Annex. International mean weights at age of the catch are French-Belgian quarterly weighted mean weights. The catch numbers at age are shown in Table 6.3 and Figures 6.2 a \& b, and the mean catch weight at age in Table 6.4.

### 6.2.3 Abundance indices from surveys

Since 2007, a new 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. The series was presented to the WKFLAT 2011 which considered that this series should be used to tune the assessment in the near future.

At the 2013 meeting of the WGBEAM 2013, several CPUE series were compared. The one based on all the reference stations and carried out by daylight was estimated to provide the abundance index to retain for the Bay of Biscay sole.

Given this agreement on the index calculation method and because the ORHAGO time-series is now long enough (6 years in 2012) for the tuning process in the assessment, an interim benchmark by correspondence was organized for the approval of the inclusion of the ORHAGO survey in the 2013 assessment. All consulted experts were in favor of this inclusion (see Annex XX). Consequently the 2013 WGHMM assessment is carried out according to a 2013 revised stock annex, which adds the ORHAGO survey to the tuning files. However, for this first inclusion, the WGHMM considers necessary to explore the effect of the new use of the ORHAGO survey. The results obtained with and without this time-series are presented all along this docu-
ment, the first according to the 2012 stock annex and the second according to the 2013 stock annex.

The figures or tables labeled "a" present the XSA diagnosis, XSA outputs and predictions without the Orhago survey in the tuning data (2012 stock annex) and those labeled " $b$ " present the same results when the Orhago survey is included in the tuning process (2013 stock annex).
The figure 6.3 shows the Orhago time series by age group excepted at age 0 , for which the ORHAGO series is not considered to provide a reliable abundance index. At other ages, the big year class 2007 can be followed, from year to year up to 2012. In this terminal year, and for the ages 4 to $8+$, an increase in catchability is suspected because the CPUE increase at all these ages in that year but without any explanation for it.

### 6.2.4 Commercial catch- effort data

The French La Rochelle and Les Sables trawler series of commercial fishing effort data and LPUE indices were completely revised in 2005. A selection of fishing days (or trips before 1999) was made by a double threshold (sole landings $>10 \%$ and nephrops landings $<=10 \%$ ) for a group of vessels. The process is described in the Stock Annex.

The risk that the sole $10 \%$ threshold may lead to an underestimate of the decrease in stock abundance was pointed out by RG in 2010. This general point is acknowledged by this working group. However in this particular case using the knowledge about the fishery this threshold was set to avoid the effect of changing target species, which may also affect the trend in LPUE. Indeed, the choice of target species may affect effort repartition between sole major habitat and peripheral areas where sole abundance is lower. Because $10 \%$ is a minimum for sole percentage in catch when carrying out mixed species trawling on sole grounds, according to fishermen, this percentage was retained to ensure that sole LPUE are not driven by a fishing strategy evolution (the targeting of cephalopods more particularly).

The La Rochelle LPUE series (FR-ROCHELLE) shows a decreasing trend from 1990 to 2001. Later on, the series does not exhibit any trend but some up and down variations (Table 6.5.a and Figure 6.4). The Les Sables d'Olonne LPUE series (FR-SABLES) shows also a declining trend up to 2003. Thereafter, it shows a short increase in 20042005 but the trend is flat from 2005 onwards.

Two new series of tuning were added to the assessment according to the WKFLAT 2011: the Bay of Biscay offshore trawler fleet ( $14-18 \mathrm{~m}$ ) in the second quarter (FR-BB-OFF-Q2) and the Bay of Biscay inshore trawler fleet ( $10-12 \mathrm{~m}$ ) 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.

The Belgian LPUE series was relatively constant from 1990 to 1996, declined severely afterwards until 2002 but has increased in 2003 to return to the 1997-2000 level (Figure 6.4). Later on, its trend was flat until 2009, but it changed to an increasing one in 2010. After a low decrease in 2011, the 2012 LPUE increase again to be close to the highest value in the time-series which was recorded in 1991.

For the Orhago survey, the trend of the CPUE are similar to those of the commercial tuning fleets available in recent years and, more particularly, it is close to the trend of the Belgian beam trawler fleet.

### 6.3 Assessment

### 6.3.1 Input data

See stock annex

### 6.3.2 Model

As in previous years, the model chosen by the Group to assess this stock was XSA.
The age range in the assessment is $2-8+$, as last year assessment.
The year range used is 1984-2012.

## Catch-at-age analysis and Data screening

The results of exploratory XSA runs, which are not included in this report, are available in ICES files.

A separable VPA was run to screen the catch-at-age data. The same settings as last year were used: terminal $F$ of 0.6 on age 4 and terminal $S$ of 0.9 . There were no anomalous residuals apparent in recent years.

Four commercial LPUE series are used in the assessment: La Rochelle offshore trawlers (FR-ROCHELLE) and Les Sables d'Olonne offshore trawlers (FR-SABLES) 1991 to 2009, the Bay of Biscay offshore trawlers in the second quarter (FR-BB-OFF-Q2) and the Bay of Biscay inshore trawlers in the last quarter (FR-BB-IN-Q4) 2000 to last year. The data for these four tuning series are in table 6.6.

The table below summarizes the available information on the commercial tuning fleets and the survey.

| FLEET TYPE | ACRONYM | PERIOD AGE | RANGE | LANDING CONTRIBU- |
| :--- | :--- | :--- | :---: | :---: |
| TION |  |  |  |  |
| Offshore otter trawlers | FR-SABLES | $1991-2009$ | $1-8$ | $<1 \%$ |
| Offshore otter trawlers | FR-ROCHELLE | $1991-2009$ | $1-8$ | $<1 \%$ |
| Inshore otter trawlers | FR-BB-IN-Q4 | $2000-2012$ | $1-8$ | $<1 \%$ |
| Offshore otter trawlers | FR-BB-OFF-Q2 | $2000-2012$ | $1-8$ | $<1 \%$ |
| Beam trawler survey | FR-ORHAGO | $2007-2012$ | $0-8$ | $0 \%$ |

XSA tuning runs (low shrinkage s.e. $=2.5$, no taper, other settings as in last year tuning) were carried out on data from each fleet individually. The results show no trend and small residuals for all fleets (Figure 6.5a \& b) except for the FR-BB-OFF-Q2 for age 2 in 2009, 2010 and 2011 and for FR-ORHAGO at age 1 in 2007 and at age 6 in 2008 and in 2010.

## Result of XSA runs

This year, the Orhago survey CPUE (FR-ORHAGO) (table 6.6) is included but a comparative run without this survey is also presented.
The final XSA was run using the same settings than in last year assessment.
The Figure 6.2 b shows a better distribution of catches at age, between age 3 and 5 . The strong age 4 last year is found in the age 5 this year which is much more important. The catches are then distributed over three ages, not just two, like last year.

The comparative run without the ORHAGO time-series added to the commercial tuning fleets, was carried out applying the same settings than with this survey, to show the sensitivity of the assessment to the inclusion of the survey. Outputs are very simi-
lar (Figure 6.6) in the two runs for the fishing mortality and the SSB but the recruitment estimate in the terminal year is slightly lowered when the ORHAGO time series is added. Despite this limited changes, the weight of the ORHAGO survey in age estimate is major, far above the weight of other fleets from age 2 to 6 (Table 6.7 b ), $95 \%$ for age $2,70 \%$ for age 3 , and $55 \%$ for age 4 for example.

|  |  |  | 2012 XSA |  |  | 2013 <br> XSA |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Catch data |  |  | $84-11$ |  |  | $84-12$ |
| Catch age range |  |  | $2-8+$ |  |  | $2-8+$ |
| Fleets | FR - SABLES | $91-09$ | $2-7$ | FR - SABLES | $91-09$ | $2-7$ |
|  | FR - ROCHELLE | $91-09$ | $2-7$ | FR - ROCHELLE | $91-09$ | $2-7$ |
|  | FR-BB-IN-Q4 | $00-11$ | $3-7$ | FR-BB-IN-Q4 | $00-12$ | $3-7$ |
|  | FR-BB-OFF-Q2 | $00-11$ | $2-6$ | FR-BB-OFF-Q2 | $00-12$ | $2-6$ |
| Taper |  |  |  | FR-ORHAGO | $07-12$ | $2-8$ |
| Ages catch dep. |  |  | No |  |  | No |
| Q plateau |  |  | No |  |  | No |
| F shrinkage se |  |  | 1.5 |  |  | 6 |
| Year range |  |  | 5 |  |  | 1.5 |
| age range |  |  |  |  |  | 5 |
| Fleet se |  |  | 0.2 |  |  | 3 |
| F bar range |  |  | $3-6$ |  |  | $3-6$ |

The results are given in Table 6.7a without FR-ORHAGO \& 6.7 b with FR-ORHAGO. The log-catchability residuals are shown in Figure $6.5 \mathrm{a} \& \mathrm{~b}$ and retrospective results in Figure $6.7 \mathrm{a} \& \mathrm{~b}$. The retrospective pattern shows both (with or without FR-ORHAGO) an F overestimation and an SSB underestimation in 2011. The F overestimation may be due to the revision in estimated $F$ values at age 3 and 4 which seems generated by the difficulty in the XSA tuning to handle the progression of the strong 2007 year class in the catch at age matrix. The SSB underestimation is linked to this F overestimation at age 3 and 4 , but also at age 2 , of which $32 \%$ contributes to the SBB.

In the runs without FR-ORHAGO, only the fleet FR-BB-OFF-Q2 provides information on survivors at age 2. At age 3, only the fleets FR-BB-IN-Q4 and FR-BB-OFF-Q2 provide estimates, the FR-BB-IN-Q4 one being 1.5 times higher than the FR-BB-OFF-Q2 one, both with about the same weight. At age 4, the FR-BB-OFF-Q2 fleet has the highest weight with an estimate which is in the same range than the FR-BB-IN-Q4 one.
FR-SABLES and FR-ROCHELLE fleets provide estimates at age 5 and above. At age 5, FR-SABLES and FR-ROCHELLE provide estimates which are lower than the FR-BB-IN-Q4 and FR-BB-OFF-Q2 estimates, but their weights area also low. For age 6 and 7 the 4 fleets are very close.

When the FR-ORHAGO survey is added, the scaled weights are very different in the XSA outputs. The survey drives largely the estimates from age 2 to 5 with weights comprised between $95 \%$ at age 2 and $41 \%$ at age 5. The ORHAGO estimated survivors at age 2 are about the double than the one provided by the FR-BB-OFF-Q2. At other ages, the commercial fleet estimated survivors and the survey estimate are in the same range of magnitude for the commercial fleets added at the WKFLAT in 2011 (FR-BB-IN-Q4 and FR-BB-OFF-Q2). It is also the case at age 6 and 7 for the two old commercial fleets, age 5 being different but these fleets having minor weights at this age.

Fishing mortalities and stock numbers at age are given in Tables $6.8 \mathrm{a} \& \mathrm{~b}$ and $6.9 \mathrm{a} \&$ b respectively. The results are summarised in Table 6.10 a \& b. Trends in yield, F, SSB and recruitments are plotted in Figure 6.8 a \& b. Fishing mortality in 2012 is estimated by XSA to have been at 0.45 without the FR-ORHAGO and 0.46 with FRORHAGO. Fishing mortality in 2010 is estimated at 0.37 for both XSA runs, a bit lower than the last year WG report value (0.39).

### 6.3.3 Assessment results

### 6.3.3.1 Estimating year class abundance

In the 2012 assessment, the 2011 recruitment estimate ( 4 million age 2 fish) was replaced by the GM93-09 because of the lack of reliability of the recruitment estimated from XSA, as illustrated by the retrospective analysis. The 2011 recruitment is estimated to be 20.3 million age 2 fish in the 2013 assessment (without Orhago) and 20.4 million (with Orhago), which is the same level than 2010 value, below the long-term average ( $\mathrm{GM}_{93-10}=22.7$ million for both runs).

The 2010 year class is estimated to be at 14.2 millions 2 year olds by XSA without Orhago and 10.2 millions with Orhago. However, the 2011 ORHAGO abundance index at age 1 does not show that the 2010 year class is far below the average. Considering also the retrospective patterns with and without ORHAGO time series, the WG considered that the reliability of XSA recruitment estimate in terminal year remains too low to change the usual process of overwriting it by the GM93-10, as in previous WG assessment and according to the stock annex. The XSA estimate was consequently overwritten by a series GM from 1993 up to two years before the terminal years (2010), as in preceding assessments, since there is observed fall in stock numbers at age 2 after 1993. This $\mathrm{GM}_{93-10}$ is also used to estimate subsequent recruitments. The WG agreed to keep this calculation of the GM to be homogeneous with the previous assessment.

Recruitment at age 2

| Year class | Thousands | Basis | Survey | Commercial | Shrinkage |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 2009 | 20331 | XSA | $0 \%$ | $65 \%$ | $35 \%$ |
| 2009 (with Orhago) | 20426 | XSA | $94.6 \%$ | $3.5 \%$ | $1.9 \%$ |
| 2010 | 22685 | GM(93-10) |  |  |  |
| 2010 (with Orhago) | 22673 | $\mathrm{GM}(93-10)$ |  |  |  |
| 2011 \& subsequent | 22685 | $\mathrm{GM}(93-10)$ |  |  |  |
| 2011 \& subsequent (with <br> Orhago) | 22673 | $\mathrm{GM}(93-10)$ |  |  |  |

### 6.3.3.2 Historic trends in biomass, fishing mortality and recruitment

A full summary of the time series of XSA results is given in Table $6.10 \mathrm{a} \& \mathrm{~b}$ and illustrated in Figure 6.8 a \& b.

Since 1984, fishing mortality gradually has increased, peaked in 2002 and decreased substantially the following two years. It increased in 2005 and, later on stabilized at around 0.42 (= Fpa). Fishing mortality was 0.37 in 2010 and 2011, and 0.46 in 2012. The fishing mortalities in 2010 and 2011 are lower than the value calculated at the last year working group. The SSB trend in earlier years increases from 12300 t in 1984 to 16500 t in 1993, afterwards it shows a continuous decrease to 9700 t in 2003. After a 22 \% increase between 2003 and 2006, the SSB remains close to 11800 t from 2007 to 2009. Since 2010, the SSB is above Bpa ( 13000 t ). The SSB value for 2011 is reassess
from 13400 t to 15800 t ( 15900 t with Orhago). This increase can be partly explained by the large underestimate of stock number at age 2 in 2011 in last year assessment, age group of which $32 \%$ contributes to the SBB. It is estimated to 14700 t (with or without Orhago) in 2012, a bit lower ( $7 \%$, or $8 \%$ with Orhago) than in 2011,

The recruitment values are lower since 1993. Between 2004 and 2008 the series is stable around 17 or 18 million and the 2007 year class is the highest value since 1984, as it was expected from the ORHAGO survey indices (Figure 6.3).

### 6.3.4 Catch options and prognosis

The exploitation pattern is the mean over the period 2010-2012 (over 2010-2011 at age 2), considering the absence of trend in F in the last three years of the assessment (Figure $6.7 \mathrm{a} \& \mathrm{~b}$ ). This status quo F is estimated at 0.4 for the run with and without Orhago.

The recruits at age 2 from 2013 to 2015 are assumed equal to $\mathrm{GM}_{93}-10$. Stock numbers at age 3 in 2013 are derived from GM93-10 reduced by total estimated mortality (M plus the average $F$ at age 2 for years 2010 and 2011). Stock numbers at ages 4 and above in 2013 are the XSA survivors estimates.

Weights at age in the landings are the 2010-2012 means using the new fresh/gutted transformation coefficient of French landing which was changed from 1.11 to 1.04 in 2007. Weights at age in the stock are the 2010-2012 means using the old fresh/gutted transformation coefficient of French landing (1.11). The predicted spawning biomass is consequently still comparable to the biomass reference point of the management plan.

### 6.3.4.1 Short term predictions

Input values for the catch forecast are given in Table $6.11 \mathrm{a} \& \mathrm{~b}$.
The landings forecasts is 4389 t in 2013 ( 4359 t without Orhago) (TAC is set at 4100 t ), less than $2 \%$ higher than the 2012 landings ( 4317 t ).

Assuming recruitment at GM93-10, the SSB is predicted to increase to 16200 t in 2013 and to 16700 t in 2014, fishing at status quo F in 2013. It will continue to grow at status quo F, to reach 17400 t in 2015 (Tables 6.12a and 6.13a).

The multifleet prediction with the Orhago survey in the tuning data and assuming recruitment at $\mathrm{GM}_{93}-10$, the SSB is predicted to 16400 t in 2013 and to 16800 t in 2014, fishing at status quo F in 2013. It will continue to grow at status quo F , to reach above 17400 t in 2015 (Tables 6.12b and 6.13b).

The prediction with and without the Orhago survey are very close.
The proportional contributions of recent year classes to the landings in 2014 and to the SSB in 2015 are given in Table 6.14 a \& b. Year classes for which GM93-10 recruitment has been assumed (2010 to 2013) contribute $64 \%$ of the 2013 landings ( $63 \%$ without ORHAGO) and 59 \% of the 2015 SSB ( $60 \%$ without ORHAGO).

### 6.3.4.2 Yield and Biomass Per Recruit

Results for yield and SSB per recruit without Orhago, conditional on status quo F, are given in Table 6.15 a \& b, and in Figure 6.9 a. The $\mathbf{F}_{\text {sq }}(0.4)$ is $5 \%$ above $\mathbf{F}_{\text {max }}(0.38)$ and 52 \% higher than $\mathbf{F}_{0.1}$ (0.19). Long-term equilibrium landings and SSB (at F status quo and assuming GM recruitment) are estimated to be 4762 t and 18640 t respectively (Table 6.15a \& b).

For the result with the Orhago survey, the $\mathbf{F}_{\text {sq }}(0.4)$ is $4 \%$ above $\mathbf{F}_{\max }(0.39)$ and $51 \%$ higher than $\mathrm{F}_{0.1}$ (0.2). Long-term equilibrium landings and SSB (at F status quo and assuming GM recruitment) are estimated to be 4739 t and 18565 t respectively (Table 6.15 c \& d).

For the yield and the biomass per recruit the result of the run with and without Orhago are very close too.

### 6.3.5 Biological reference points

WGHMM 2010 proposals for MSY approach reference points are given below with technical basis with the value adopted for the precautionary approach reference points:

|  | TYPE | Value | Technical basis |
| :---: | :---: | :---: | :---: |
| MSY | MSY Btrigger | 13000 t | Bpa |
| Approach | Fmsy | 0.26 | Fmax (as estimated by WGHMM 2010) because no stock-recruitment relationship, limited variations of recruitment, Fishing mortality pattern known with a low uncertainty |
|  | Blim | Not defined |  |
| Precautionary | $\mathrm{B}_{\mathrm{pa}}$ | 13000 t | The probability of reduced recruitment increases when SSB is below 13000 t , based on the historical development of the stock. |
| Approach | Flim | 0.58 | Based on the historical response of the stock. |
|  | $\mathrm{F}_{\mathrm{pa}}$ | 0.42 | Flim * 0.72 |

The WKFLAT 2011 decided that $\mathrm{F}_{\max }$ remains unchanged as well as Fmsy which is set to $\mathrm{F}_{\max }$. This year the $\mathrm{F}_{\max }$ is higher than the WG 2011 and 2012 estimates, but the WG 2012 decided to not change the $\mathrm{F}_{\mathrm{msy}}$ outside a benchmark procedure.

The basis for setting Flim was kept (historical response of the stock) and its value remains coherent with the historical SSB trend. Consequently, $\mathrm{F}_{\mathrm{pa}}$ is unchanged.

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

### 6.3.6 Comments on the assessment

## Sampling

The sampling level (table 1.3) for this stock is considered to be satisfactory.
The ORHAGO survey provides information on several year classes at age 2. This series is now used in the assessment but still too short to assess its quality for an estimate of the incoming recruitment from a retrospective analysis. At other ages, it might be particularly useful to have a survey in the tuning file in the near future because the new use of electronic logbooks has caused some obvious wrong recordings of effort which limit available commercial tuning data in 2012 and maybe in future years.

Stopping the use of fleets of La Rochelle and Les Sables tuning series led to a paucity of information at age 2 in 2012, which were only provided by the Offshore Q2 tuning fleet. That is no more the case with incorporation of the ORHAGO survey in the assessment.

The same age reading method is now adopted by France and Belgium, however a discrepancy still exist between French and Belgian weights at age which has to be investigated.

## Discarding

Available data on discards have shown that discards may be important at age 1. Discard at age 2 were assumed to be low in the past because the high commercial value of the sole catches but there are some reports of high-grading practices due to the landing limits adopted by some producers' organisations. The data available for discards do not seem representative to use them in the assessment but the WKFLAT 2011 and the review group recommended that further work should include investigation on the monitoring of the inshore trawlers discards.

## Consistency

The retrospective results show that the XSA recruitment estimate in terminal year is very uncertain; it was consequently overwritten with a GM estimate, as in previous WG assessments. This GM estimate has a very large contribution in predicted landings and SSB. Furthermore, it is worth noting that variability of the recruit series has increased since 2001 and that, in recent period, the use of GM estimate has led several times to forecast an increase in SSB which was superior to the one observed in following years.

The retrospective pattern in F shows an overestimation in 2011 (Figure 6.7 a \& b) which is due to the estimated F values at age 3 and 4 . The strong 2007 year class seems to have generated this decrease in the quality of XSA tuning when 2011 is the terminal year in the assessment.

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 is considered to provide representative LPUE of change in stock abundance by limiting the effect of long term change in fishing power (technological creep) and of change in fishing practices in the sole fishery.

The figure 6.10 shows the difference between the assessments in 2012 and in 2013, with and without the Orhago survey in the tuning data. SSB in 2011 is revised upwards and F in 2011 revised downward, for the reason exposed before for the retrospective pattern.

## Misreporting

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

## Industry input

A meeting with representatives of the fishing industry was held in France prior to the WG to present the data used by the 2013 WGHMM to assess the state of the Bay of Biscay sole stock. The French fishing industry agreed with the data used in the assessment.

## Recommendation

The quality of the ORHAGO survey to serve as a tuning index has been confirmed by the 2013 assessment, as well as that of the two commercial tuning fleets added in 2011 by the WKFLAT to give a relevant abundance signal. Consequently, the addition of the ORHAGO survey to the tuning fleets improves and validates the quality of the Bay of Biscay sole assessment and the WGHMM recommends that this survey continue to be carried out.

### 6.3.7 Management considerations

The assessment indicates that SSB has decreased continuously to 9700 t in 2003, since a peak in 1993 ( 16500 t ), has increased to 12400 t in 2006 but it remains close to $11800 t$ thereafter and above to 13000 t in 2010, 2011 and 2012. It is estimated to be 16400 t (above Bpa $=13000 \mathrm{t}$ ) in 2013 assuming GM93-10 recruitment for 2012.

The assessment without the Orhago survey provides the same past trends but SSB is estimated slightly lower in 2013 (16 200 t ).

The (EC) 388/2006 management plan is agreed for the Bay of Biscay sole but a longterm F target has not yet been set. This plan was not evaluated by ICES.

Table 6.1 a: Bay of Biscay sole (Division VIIIa,b). Internationals landings and catches used by the Working Group (in tonnes).


Table 6.1 b : Bay of Biscay sole (Division VIIIa,b). Contribution (in \%) to the total landings by differents fleets.

| Year | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Shrimp trawlers | 7 | 7 | 8 | 11 | 6 | 5 | 4 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 |
| Inshore trawlers | 29 | 28 | 27 | 25 | 31 | 29 | 30 | 25 | 27 | 25 | 17 | 13 | 13 | 12 | 13 |
| Offshore otter trawlers | 61 | 62 | 60 | 60 | 59 | 60 | 45 | 45 | 47 | 46 | 41 | 41 | 39 | 31 | 28 |
| Offshore beam trawlers | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 3 | 5 | 5 | 7 | 7 | 6 |
| Fixed nets | 3 | 3 | 5 | 4 | 4 | 6 | 20 | 26 | 20 | 24 | 35 | 39 | 40 | 49 | 52 |
| Year | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| Shrimp trawlers | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Inshore trawlers | 11 | 13 | 12 | 11 | 10 | 5 | 8 | 9 | 7 | 8 | 9 | 7 | 8 | 9 | 6 |
| Offshore otter trawlers | 29 | 26 | 26 | 30 | 30 | 24 | 21 | 24 | 18 | 24 | 23 | 21 | 19 | 21 | 19 |
| Offshore beam trawlers | 6 | 9 | 8 | 7 | 8 | 10 | 8 | 8 | 6 | 7 | 8 | 8 | 9 | 9 | 7 |
| Fixed nets | 52 | 53 | 54 | 52 | 52 | 61 | 63 | 59 | 70 | 60 | 60 | 63 | 64 | 61 | 69 |


| Year | 2009 | 2010 |  | 2011 |
| :---: | ---: | ---: | ---: | ---: |
| Shrimp trawlers | 0 | 0 | 0 | 0 |
| Inshore trawlers | 6 | 8 | 7 | 7 |
| Offshore otter trawlers | 21 | 19 | 17 | 17 |
| Offshore beam trawlers | 10 | 11 | 8 | 9 |
| Fixed nets | 63 | 61 | 67 | 66 |

Table 6.2: Bay of Biscay Sole-2012
French and Belgian relative length distribution of landings

| Length(cm) | France | Belgium |
| :---: | :---: | :---: |
| 20 | 0.00 | 0.00 |
| 21 | 0.00 | 0.00 |
| 22 | 0.09 | 0.00 |
| 23 | 1.74 | 0.26 |
| 24 | 5.01 | 4.26 |
| 25 | 6.65 | 8.10 |
| 26 | 7.76 | 11.33 |
| 27 | 10.07 | 12.79 |
| 28 | 10.51 | 12.33 |
| 29 | 11.37 | 10.01 |
| 30 | 11.48 | 10.13 |
| 31 | 10.64 | 7.05 |
| 32 | 7.19 | 6.93 |
| 33 | 4.83 | 4.66 |
| 34 | 3.13 | 3.75 |
| 35 | 2.32 | 2.42 |
| 36 | 1.54 | 1.75 |
| 37 | 1.30 | 1.28 |
| 38 | 1.04 | 1.02 |
| 39 | 0.83 | 0.63 |
| 40 | 0.64 | 0.46 |
| 41 | 0.50 | 0.48 |
| 42 | 0.38 | 0.16 |
| 43 | 0.27 | 0.10 |
| 44 | 0.23 | 0.02 |
| 45 | 0.15 | 0.03 |
| 46 | 0.11 | 0.02 |
| 47 | 0.11 | 0.02 |
| 48 | 0.04 | 0.00 |
| 49 | 0.03 | 0.00 |
| 50 | 0.02 | 0.00 |
| 51 | 0.01 | 0.00 |
| 52 | 0.01 | 0.00 |
| 53 | 0.00 | 0.00 |
| 54 | 0.00 | 0.00 |
| 55 | 0.00 | 0.00 |
| Total | 100.00 | 100.00 |

Table 6.3: Bay of Biscay Sole, Catch number at age (in thousands)

| Year | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Age |  |  |  |  |  |  |  |  |  |  |
| 2 | 5901 | 8493 | 6126 | 3794 | 4962 | 4918 | 7122 | 4562 | 4640 | 1897 |
| 3 | 3164 | 4606 | 4208 | 5634 | 5928 | 6551 | 6312 | 6302 | 7279 | 7816 |
| 4 | 2786 | 2479 | 2673 | 3578 | 4191 | 3802 | 4423 | 4512 | 4920 | 6879 |
| 5 | 2034 | 1962 | 2301 | 2005 | 2293 | 3147 | 2833 | 2083 | 2991 | 3661 |
| 6 | 1164 | 906 | 1512 | 1482 | 1388 | 2046 | 972 | 1113 | 2236 | 1625 |
| 7 | 880 | 708 | 1044 | 690 | 874 | 967 | 1018 | 1063 | 1124 | 566 |
| +gp | 1181 | 729 | 1235 | 714 | 766 | 499 | 870 | 981 | 951 | 708 |
| TOTALNUM | 17110 | 19883 | 19099 | 17897 | 20402 | 21930 | 23550 | 20616 | 24141 | 23152 |
| TONSLAND | 4038 | 4251 | 4805 | 5086 | 5382 | 5845 | 5916 | 5569 | 6550 | 6420 |
| SOPCOF \% | 107 | 103 | 102 | 102 | 101 | 101 | 100 | 102 | 100 | 100 |
| Year | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
| 2 | 2603 | 3249 | 3027 | 3801 | 4096 | 2851 | 5677 | 3180 | 5198 | 4274 |
| 3 | 5502 | 5663 | 5180 | 9079 | 5550 | 5113 | 7015 | 6528 | 4777 | 6309 |
| 4 | 8803 | 6356 | 5409 | 5380 | 6351 | 4870 | 5143 | 4948 | 4932 | 2236 |
| 5 | 5040 | 3644 | 2343 | 3063 | 2306 | 2764 | 2542 | 1776 | 3095 | 1220 |
| 6 | 1968 | 1795 | 1697 | 1578 | 1237 | 1314 | 955 | 899 | 1269 | 729 |
| 7 | 970 | 843 | 1366 | 692 | 785 | 902 | 421 | 513 | 615 | 377 |
| +gp | 696 | 986 | 1319 | 877 | 1188 | 977 | 444 | 486 | 432 | 250 |
| TOTALNUM | 25582 | 22536 | 20341 | 24470 | 21513 | 18791 | 22197 | 18330 | 20318 | 15395 |
| TONSLAND | 7229 | 6205 | 5854 | 6259 | 6027 | 5249 | 5760 | 4836 | 5486 | 4108 |
| SOPCOF \% | 100 | 100 | 100 | 100 | 101 | 100 | 101 | 101 | 101 | 101 |
| Year | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |  |
| 2 | 3411 | 3976 | 3535 | 3885 | 3173 | 2860 | 2084 | 1516 | 1283 |  |
| 3 | 5415 | 3464 | 4436 | 5181 | 4794 | 3986 | 7707 | 5222 | 4653 |  |
| 4 | 3291 | 3738 | 2747 | 2615 | 2886 | 2233 | 3758 | 8347 | 4276 |  |
| 5 | 917 | 2309 | 2012 | 1419 | 1353 | 1501 | 1272 | 1019 | 3785 |  |
| 6 | 661 | 991 | 1030 | 1262 | 938 | 946 | 484 | 570 | 1002 |  |
| 7 | 272 | 461 | 530 | 686 | 892 | 541 | 269 | 275 | 230 |  |
| +gp | 333 | 508 | 1537 | 946 | 1193 | 960 | 284 | 516 | 497 |  |
| TOTALNUM | 14300 | 15447 | 15827 | 15994 | 15229 | 13027 | 15858 | 17465 | 15726 |  |
| TONSLAND | 4002 | 4539 | 4793 | 4363 | 4299 | 3650 | 3966 | 4632 | 4317 |  |
| SOPCOF \% | 101 | 102 | 101 | 100 | 100 | 102 | 100 | 100 | 100 |  |

Table 6.4: Bay of Biscay Sole, Catch weight at age (in $\mathbf{~ k g}$ )

| Year | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Age |  |  |  |  |  |  |  |  |  |  |
| 2 | 0.121 | 0.106 | 0.102 | 0.141 | 0.134 | 0.136 | 0.131 | 0.143 | 0.146 | 0.145 |
| 3 | 0.168 | 0.174 | 0.173 | 0.201 | 0.19 | 0.188 | 0.179 | 0.192 | 0.196 | 0.197 |
| 4 | 0.213 | 0.252 | 0.245 | 0.285 | 0.272 | 0.258 | 0.241 | 0.26 | 0.262 | 0.267 |
| 5 | 0.269 | 0.313 | 0.328 | 0.376 | 0.357 | 0.354 | 0.348 | 0.325 | 0.341 | 0.341 |
| 6 | 0.329 | 0.39 | 0.409 | 0.467 | 0.495 | 0.437 | 0.436 | 0.437 | 0.404 | 0.439 |
| 7 | 0.368 | 0.457 | 0.498 | 0.497 | 0.503 | 0.543 | 0.601 | 0.535 | 0.49 | 0.569 |
| +gp | 0.573 | 0.698 | 0.657 | 0.682 | 0.604 | 0.799 | 0.854 | 0.715 | 0.715 | 0.677 |
| SOPCOFAC | 1.0712 | 1.0302 | 1.0197 | 1.0248 | 1.008 | 1.0055 | 1.0039 | 1.0183 | 1.0004 | 1.0008 |
| Year | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
| Age |  |  |  |  |  |  |  |  |  |  |
| 2 | 0.147 | 0.16 | 0.159 | 0.142 | 0.161 | 0.177 | 0.171 | 0.152 | 0.171 | 0.18 |
| 3 | 0.195 | 0.206 | 0.204 | 0.193 | 0.212 | 0.219 | 0.207 | 0.22 | 0.208 | 0.226 |
| 4 | 0.251 | 0.252 | 0.268 | 0.256 | 0.257 | 0.246 | 0.276 | 0.265 | 0.263 | 0.307 |
| 5 | 0.324 | 0.308 | 0.319 | 0.319 | 0.335 | 0.305 | 0.343 | 0.341 | 0.32 | 0.361 |
| 6 | 0.421 | 0.403 | 0.399 | 0.406 | 0.41 | 0.404 | 0.452 | 0.428 | 0.466 | 0.487 |
| 7 | 0.569 | 0.484 | 0.453 | 0.502 | 0.501 | 0.533 | 0.573 | 0.519 | 0.592 | 0.657 |
| +gp | 0.774 | 0.658 | 0.625 | 0.678 | 0.7 | 0.582 | 0.755 | 0.619 | 0.681 | 0.642 |
| SOPCOFAC | 1.0016 | 1.0023 | 0.9998 | 1.0048 | 1.0091 | 1.0006 | 1.0066 | 1.01 | 1.0122 | 1.0056 |
| Year | 2004 | 2005 | 2006 | 2007* | 2008* | 2009* | 2010* | 2011* | 2012* |  |
| Age |  |  |  |  |  |  |  |  |  |  |
| 2 | 0.19 | 0.189 | 0.195 | 0.176 | 0.174 | 0.17 | 0.179 | 0.193 | 0.186 |  |
| 3 | 0.227 | 0.226 | 0.242 | 0.225 | 0.229 | 0.215 | 0.206 | 0.223 | 0.226 |  |
| 4 | 0.29 | 0.298 | 0.282 | 0.298 | 0.287 | 0.275 | 0.272 | 0.253 | 0.257 |  |
| 5 | 0.391 | 0.367 | 0.347 | 0.326 | 0.352 | 0.317 | 0.337 | 0.342 | 0.308 |  |
| 6 | 0.493 | 0.43 | 0.42 | 0.388 | 0.392 | 0.361 | 0.414 | 0.432 | 0.368 |  |
| 7 | 0.643 | 0.468 | 0.455 | 0.419 | 0.401 | 0.447 | 0.477 | 0.489 | 0.408 |  |
| +gp | 0.81 | 0.656 | 0.533 | 0.511 | 0.519 | 0.601 | 0.768 | 0.606 | 0.586 |  |
| SOPCOFAC | 1.0104 | 1.0153 | 1.0136 | 1.0026 | 1 | 1.0158 | 1.0019 | 1.0046 | 1.0019 |  |

Table 6.5 a : Bay of Biscay sole LPUE and indices of fishing effort for French offshore trawlers.

| Year | CPUE |  | LPUE La Rochelle offshore trawlers of French sole fishery$(\mathrm{kg} / \mathrm{h})$ | LPUE <br> Les Sables offshore trawlers of French sole fishery $(\mathrm{kg} / \mathrm{h})$ | LPUE <br> Other harbours * offshore trawlers of French sole fishery $(\mathrm{kg} / \mathrm{h})$ | LPUE <br> All <br> offshore trawlers of French sole fishery $(\mathrm{kg} / \mathrm{h})$ | effort index <br> All <br> offshore trawlers of French sole fishery $(1000 \mathrm{~h})$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Inshore (10-12 m) trawlers of French sole fishery | $\begin{aligned} & \text { Offshore }(14-18 \mathrm{~m}) \\ & \quad \text { trawlers of } \\ & \text { French sole fishery } \end{aligned}$ |  |  |  |  |  |
|  | Q4 | Q2 |  |  |  |  |  |
| 1984 | - | - | 6.0 | 6.9 | 5.0 | 5.9 | 557 |
| 1985 | - | - | 5.6 | 6.5 | 4.3 | 4.9 | 454 |
| 1986 | - | - | 7.2 | 7.2 | 4.5 | 5.5 | 526 |
| 1987 | - | - | 6.6 | 5.9 | 4.6 | 5.4 | 816 |
| 1988 | - | - | 6.4 | 6.7 | 4.1 | 5.1 | 944 |
| 1989 | - | - | 5.5 | 6.1 | 4.5 | 5.1 | 996 |
| 1990 | - | - | 7.1 | 6.3 | 4.9 | 5.7 | 975 |
| 1991 | - | - | 6.5 | 6.5 | 4.7 | 5.4 | 954 |
| 1992 | - | - | 5.4 | 5.6 | 4.9 | 5.1 | 884 |
| 1993 | - | - | 4.6 | 6.4 | 4.9 | 5.2 | 791 |
| 1994 | - | - | 5.0 | 6.6 | 5.8 | 5.6 | 944 |
| 1995 | - | - | 4.6 | 5.4 | 5.0 | 5.2 | 742 |
| 1996 | - | - | 4.9 | 6.0 | 5.0 | 5.4 | 628 |
| 1997 | - | - | 4.1 | 5.3 | 4.6 | 4.7 | 774 |
| 1998 | - | - | 4.2 | 5.3 | 4.2 | 4.2 | 834 |
| 1999 | - | - | 3.7 | 5.9 | 4.2 | 4.5 | 524 |
| 2000 | 5.7 | 3.5 | 4.0 | 5.7 | 4.7 | 4.7 | 577 |
| 2001 | 5.9 | 3.4 | 3.4 | 4.0 | 5.2 | 4.7 | 454 |
| 2002 | 4.8 | 4.1 | 4.4 | 5.0 | 4.6 | 4.6 | 430 |
| 2003 | 5.8 | 3.9 | 4.1 | 3.9 | 4.8 | 4.6 | 447 |
| 2004 | 5.4 | 3.6 | 4.0 | 4.1 | 4.7 | 4.4 | 448 |
| 2005 | 5.1 | 3.4 | 3.9 | 5.2 | 4.2 | 4.2 | 495 |
| 2006 | 5.9 | 2.2 | 3.4 | 5.4 | 4.5 | 4.5 | 465 |
| 2007 | 4.9 | 3.7 | 3.5 | 5.3 | 4.6 | 4.5 | 440 |
| 2008 | 4.0 | 3.2 | 4.1 | 5.6 | 4.6 | 4.5 | 468 |
| 2009 | 4.4 | 2.1 | 3.3 | 5.2 | na | na | na |
| 2010 | 4.5 | 3.5 | 3.6 | 5.7 | na | na | na |
| 2011 | 4.5 | 3.5 | na | na | na | na | na |
| 2012 | 6.2 | 3.6 | na | na | na | na | na |

* French offshore trawlers in other harbours than in La Rochelle and Les Sables
na : non available

Table $6.5 \mathbf{b}$ : Bay of Biscay sole fishing effort and LPUE for Belgian beam trawlers.

| Year | Landing (t) | Effort (1000 h) | LPUE (kg/h) |
| :---: | :---: | :---: | :---: |
| 1976 | 26.3 | 1.7 | 15.5 |
| 1977 | 64.4 | 3.4 | 18.7 |
| 1978 | 29.8 | 1.7 | 17.7 |
| 1979 |  |  |  |
| 1980 | 33.1 | 1.9 | 17.9 |
| 1981 | 4.1 | 0.3 | 16.4 |
| 1982 | 20.5 | 1.1 | 18.6 |
| 1983 | 10.2 | 0.6 | 17.3 |
| 1984 |  |  |  |
| 1985 | 26.7 | 1.6 | 17.2 |
| 1986 | 52.0 | 2.8 | 18.4 |
| 1987 | 124.0 | 7.7 | 16.1 |
| 1988 | 134.7 | 5.6 | 24.1 |
| 1989 | 311.0 | 16.7 | 18.6 |
| 1990 | 309.4 | 9.0 | 34.3 |
| 1991 | 400.5 | 9.8 | 41.0 |
| 1992 | 452.9 | 14.8 | 30.6 |
| 1993 | 399.7 | 10.7 | 37.5 |
| 1994 | 467.6 | 13.5 | 34.6 |
| 1995 | 446.7 | 13.5 | 33.0 |
| 1996 | 459.8 | 13.6 | 33.9 |
| 1997 | 435.4 | 16.2 | 26.9 |
| 1998 | 463.1 | 17.8 | 26.1 |
| 1999 | 498.7 | 20.8 | 24.0 |
| 2000 | 459.2 | 19.2 | 23.9 |
| 2001 | 368.2 | 17.5 | 21.1 |
| 2002 | 310.6 | 16.5 | 18.8 |
| 2003 | 295.8 | 12.5 | 23.6 |
| 2004 | 318.7 | 12.2 | 26.2 |
| 2005 | 365.1 | 15.0 | 24.3 |
| 2006 | 392.9 | 16.7 | 23.5 |
| 2007 | 404.2 | 16.3 | 24.8 |
| 2008 | 305.1 | 12.9 | 23.6 |
| 2009 | 363.3 | 16.2 | 22.5 |
| 2010 | 451.3 | 13.1 | 34.3 |
| 2011 | 386.4 | 12.7 | 30.4 |
| 2012 | 385.2 | 9.7 | 39.5 |

Table 6.6: Sole 8ab, available tuning data (landings); SOLE VIIIa,b commercial landings (N in $10^{* *}-3$ ) and survey catch - Fishing effort in hours; Series, year and range used in tuning are shown in bold type

| FR - SABLES |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Year | Fishing effort | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1991 | 33763 | 30.5 | 242.1 | 332.8 | 194.7 | 73.8 | 32.4 | 23.6 | 19.5 |
| 1992 | 30445 | 3.7 | 236.8 | 285.8 | 130.2 | 59.5 | 32.1 | 15.0 | 11.9 |
| 1993 | 34273 | 3.7 | 152.0 | 441.3 | 224.0 | 75.7 | 27.0 | 8.0 | 10.9 |
| 1994 | 20997 | 1.2 | 94.1 | 157.4 | 184.3 | 77.3 | 24.2 | 13.4 | 10.8 |
| 1995 | 31759 | 7.3 | 173.4 | 228.1 | 177.1 | 69.1 | 34.1 | 15.9 | 19.5 |
| 1996 | 31518 | 13.0 | 193.0 | 222.6 | 169.8 | 55.6 | 37.8 | 29.4 | 23.2 |
| 1997 | 27040 | 5.0 | 140.9 | 290.9 | 114.2 | 49.0 | 26.7 | 10.6 | 11.4 |
| 1998 | 16260 | 0.8 | 86.9 | 112.1 | 113.6 | 31.4 | 13.8 | 8.1 | 7.7 |
| 1999 | 12528 | 0.0 | 64.9 | 53.2 | 39.7 | 26.8 | 15.0 | 15.2 | 17.6 |
| 2000 | 11271 | 3.4 | 81.3 | 121.3 | 45.0 | 15.7 | 8.4 | 4.7 | 4.7 |
| 2001 | 9459 | 2.3 | 32.9 | 64.5 | 35.2 | 9.5 | 5.5 | 3.1 | 2.2 |
| 2002 | 10344 | 7.2 | 76.9 | 60.3 | 37.5 | 19.3 | 8.4 | 3.9 | 1.7 |
| 2003 | 7354 | 1.5 | 38.9 | 49.1 | 14.3 | 7.8 | 4.0 | 1.7 | 0.6 |
| 2004 | 6909 | 2.7 | 38.4 | 36.5 | 22.7 | 5.7 | 3.8 | 1.7 | 1.8 |
| 2005 | 6571 | 6.6 | 46.4 | 26.6 | 25.2 | 15.3 | 6.4 | 3.3 | 3.2 |
| 2006 | 6223 | 7.7 | 63.1 | 29.7 | 11.9 | 6.6 | 3.7 | 2.4 | 6.3 |
| 2007 | 5954 | 1.0 | 32.6 | 28.4 | 18.0 | 12.4 | 10.6 | 6.6 | 8.2 |
| 2008 | 4321 | 0.0 | 22.8 | 22.8 | 16.4 | 8.1 | 5.2 | 4.9 | 7.8 |
| 2009 | 3577 | 0.7 | 23.0 | 22.2 | 9.8 | 7.1 | 4.2 | 2.4 | 5.7 |
| FR - ROCHEL |  |  |  |  |  |  |  |  |  |
| Year | Fishing effort | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1991 | 15250 | 14.7 | 134.8 | 157.4 | 88.9 | 30.3 | 11.6 | 6.7 | 5.5 |
| 1992 | 12491 | 0.8 | 99.4 | 130.1 | 58.7 | 21.2 | 9.1 | 4.5 | 2.8 |
| 1993 | 12146 | 0.6 | 53.3 | 126.5 | 51.8 | 17.2 | 6.4 | 2.1 | 2.0 |
| 1994 | 8745 | 0.7 | 42.4 | 56.5 | 52.9 | 19.4 | 6.4 | 2.7 | 1.5 |
| 1995 | 4260 | 1.9 | 25.9 | 31.3 | 20.7 | 7.2 | 2.4 | 1.1 | 1.1 |
| 1996 | 10124 | 10.6 | 113.1 | 74.6 | 34.3 | 8.8 | 5.0 | 3.1 | 2.8 |
| 1997 | 12491 | 3.8 | 74.1 | 117.6 | 35.8 | 12.6 | 7.3 | 2.6 | 2.6 |
| 1998 | 10841 | 1.6 | 77.7 | 65.4 | 57.9 | 11.3 | 4.7 | 2.9 | 2.8 |
| 1999 | 8311 | 0.0 | 53.7 | 31.6 | 19.0 | 10.1 | 6.4 | 4.3 | 2.1 |
| 2000 | 8334 | 4.8 | 64.0 | 44.4 | 19.2 | 6.7 | 2.8 | 1.5 | 2.5 |
| 2001 | 7074 | 2.3 | 24.7 | 39.9 | 23.7 | 5.5 | 3.3 | 1.9 | 1.8 |
| 2002 | 6957 | 9.0 | 89.2 | 36.3 | 11.8 | 5.4 | 2.3 | 1.3 | 0.4 |
| 2003 | 5028 | 2.2 | 37.8 | 40.0 | 9.1 | 3.7 | 1.7 | 0.5 | 0.2 |
| 2004 | 1899 | 1.0 | 12.1 | 11.8 | 4.4 | 1.0 | 0.7 | 0.3 | 0.4 |
| 2005 | 3292 | 2.4 | 17.3 | 10.5 | 8.8 | 5.2 | 2.4 | 1.1 | 1.3 |
| 2006 | 2304 | 1.5 | 11.0 | 8.3 | 3.9 | 2.4 | 1.3 | 0.6 | 1.9 |
| 2007 | 2553 | 0.2 | 12.3 | 21.5 | 4.5 | 1.8 | 1.6 | 0.7 | 1.0 |
| 2008 | 1887 | 0.2 | 11.3 | 14.6 | 5.4 | 2.1 | 1.1 | 1.1 | 1.5 |
| 2009 | 1176 | 0.1 | 4.8 | 7.1 | 2.3 | 1.3 | 0.7 | 0.4 | 0.6 |
| FR-BB-IN-Q4 |  |  |  |  |  |  |  |  |  |
| Year | Fishing effort | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 2000 | 1432 | 4.06 | 20.99 | 11.21 | 3.34 | 1.00 | 0.34 | 0.23 | 0.09 |
| 2001 | 1785 | 18.00 | 37.05 | 6.54 | 2.02 | 0.77 | 0.66 | 0.31 | 0.51 |
| 2002 | 2276 | 15.06 | 23.83 | 11.09 | 1.62 | 1.00 | 0.99 | 0.64 | 0.51 |
| 2003 | 2913 | 1.65 | 29.53 | 32.18 | 4.54 | 0.87 | 0.53 | 0.38 | 0.50 |
| 2004 | 3081 | 4.25 | 24.42 | 24.00 | 8.76 | 3.48 | 2.96 | 0.56 | 1.38 |
| 2005 | 4855 | 9.43 | 45.05 | 15.54 | 12.48 | 5.06 | 2.02 | 1.06 | 2.58 |
| 2006 | 6381 | 21.38 | 76.18 | 24.79 | 6.16 | 4.23 | 3.57 | 2.39 | 5.56 |
| 2007 | 3656 | 2.51 | 31.72 | 14.81 | 6.69 | 3.43 | 2.84 | 0.63 | 2.02 |
| 2008 | 3585 | 0.57 | 13.76 | 15.68 | 8.50 | 2.95 | 1.65 | 1.22 | 1.23 |
| 2009 | 3615 | 2.66 | 47.84 | 14.71 | 3.36 | 1.81 | 1.53 | 0.64 | 1.37 |
| 2010 | 4277 | 1.46 | 21.44 | 32.92 | 9.29 | 2.96 | 0.92 | 0.43 | 1.04 |
| 2011 | 4334 | 2.88 | 34.42 | 19.14 | 11.55 | 3.04 | 1.52 | 0.67 | 1.37 |
| 2012 | 2685 | 1.05 | 9.00 | 19.97 | 13.49 | 7.12 | 1.41 | 0.92 | 1.11 |

Table 6.6: cont $^{\prime} \mathrm{d}$

| FR-BB-OFF-Q2 |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Year | Fishing effort | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 2000 | 5567 | 0.00 | 22.92 | 28.32 | 23.17 | 9.54 | 2.72 | 0.90 | 1.66 |
| 2001 | 5039 | 0.01 | 14.87 | 30.25 | 20.82 | 5.69 | 3.64 | 1.42 | 1.08 |
| 2002 | 5604 | 0.01 | 36.79 | 33.91 | 17.16 | 9.07 | 4.09 | 2.12 | 0.53 |
| 2003 | 3324 | 0.02 | 22.88 | 27.61 | 6.99 | 1.85 | 0.81 | 0.08 | 0.03 |
| 2004 | 4809 | 0.00 | 13.97 | 43.91 | 14.51 | 1.37 | 0.70 | 0.26 | 0.40 |
| 2005 | 4535 | 3.67 | 13.13 | 19.61 | 16.22 | 5.78 | 0.56 | 0.43 | 0.57 |
| 2006 | 2235 | 0.00 | 3.50 | 9.56 | 2.91 | 1.50 | 0.97 | 0.33 | 0.31 |
| 2007 | 4013 | 0.00 | 13.41 | 46.11 | 6.41 | 1.18 | 1.69 | 0.24 | 0.54 |
| 2008 | 3211 | 0.00 | 16.58 | 23.51 | 7.36 | 2.33 | 0.40 | 0.83 | 0.49 |
| 2009 | 968 | 0.00 | 0.70 | 5.05 | 1.69 | 0.53 | 0.16 | 0.10 | 0.22 |
| 2010 | 2279 | 0.00 | 1.55 | 27.23 | 7.96 | 2.16 | 0.12 | 0.03 | 0.07 |
| 2011 | 2882 | 0.00 | 0.97 | 12.40 | 23.98 | 1.61 | 0.82 | 0.39 | 1.11 |
| 2012 | 2049 | 0.00 | 4.08 | 14.38 | 7.40 | 4.78 | 0.48 | 0.34 | 0.42 |
| FR-ORHAGO |  |  |  |  |  |  |  |  |  |
| Year | Fishing effort | 1 | 2 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 |
| 2007 | 100 | 59.8 | 140.5 | 79.2 | 27.5 | 11.3 | 8.9 | 1.5 | 1.0 |
| 2008 | 100 | 340.3 | 126.7 | 69.8 | 22.1 | 4.1 | 2.4 | 2.8 | 1.2 |
| 2009 | 100 | 80.9 | 441 | 87.7 | 17.5 | 4.2 | 1.7 | 0.4 | 2.0 |
| 2010 | 100 | 167.8 | 184.5 | 152.1 | 19.6 | 2.4 | 0.1 | 0.9 | 0.6 |
| 2011 | 100 | 93.9 | 175.8 | 60.2 | 23.3 | 3 | 1.5 | 1.7 | 2.9 |
| 2012 | 100 | 62.4 | 86.4 | 99.6 | 53.8 | 21.9 | 5.3 | 3.2 | 5.6 |

# Table 6.7a: XSA tuning diagnostic without Orhago survey 



Time series weights :

Tapered time weighting not applied
Catchability analysis :
Catchability independent of stock size for all ages

Catchability independent of age for ages $>=6$
Terminal population estimation :
Survivor estimates shrunk towards the mean $F$
of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates are shrunk $=1.500$

Minimum standard error for population
estimates derived from each fleet $=$. 200
Prior weighting not applied

Tuning converged after 55 iterations

Regression weights
, $1.000,1.000,1.000,1.000,1.000,1.000,1.000,1.000,1.000,1.000$

Fishing mortalities

| Age, | 2003, | 2004, | 2005, | 2006, | 2007, | 2008, | 2009, | 2010, | 2011, | 2012 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2, | . 202, | . 233, | . 255, | . 214, | . 255, | . 192, | . 086 , | . 110, | . 082 , | 100 |
| 3 , | . 469, | . 377, | . 350 , | . 444, | . 490, | . 504, | . 347 , | . 313, | . 391 , | . 340 |
| 4, | . 442 , | . 423, | . 430, | . 457, | . 452 , | . 493, | . 411, | . 566 , | . 581, | . 566 |
| 5, | . 415, | . 290 , | . 526, | . 385 , | . 402 , | . 396 , | . 456 , | . 386 , | . 259 , | . 502 |
| 6, | . 596 , | . 368 , | . 515, | . 417, | . 393, | . 449, | . 471, | . 230 , | . 266 , | 387 |
| 7 , | . 762 , | . 409, | . 419, | . 507, | . 479, | . 472, | . 448, | . 209, | . 178, | . 146 |

XSA population numbers (Thousands)

|  | AGE |  |  |
| :--- | :--- | :--- | :--- |
| YEAR | 2, | 3, | 4, |

7,
$2003, \quad 2.45 \mathrm{E}+04,1.77 \mathrm{E}+04,6.58 \mathrm{E}+03,3.78 \mathrm{E}+03,1.71 \mathrm{E}+03,7.43 \mathrm{E}+02$,
$2004,1.72 \mathrm{E}+04,1.81 \mathrm{E}+04,1.00 \mathrm{E}+04,3.83 \mathrm{E}+03,2.26 \mathrm{E}+03,8.52 \mathrm{E}+02$,
$2005,1.86 \mathrm{E}+04,1.23 \mathrm{E}+04,1.12 \mathrm{E}+04,5.94 \mathrm{E}+03,2.59 \mathrm{E}+03,1.42 \mathrm{E}+03$,
2006 , $1.93 \mathrm{E}+04,1.30 \mathrm{E}+04,7.87 \mathrm{E}+03,6.62 \mathrm{E}+03,3.18 \mathrm{E}+03,1.40 \mathrm{E}+03$,
$2007,1.82 \mathrm{E}+04,1.41 \mathrm{E}+04,7.56 \mathrm{E}+03,4.51 \mathrm{E}+03,4.08 \mathrm{E}+03,1.89 \mathrm{E}+03$,
$2008, \quad 1.91 \mathrm{E}+04,1.27 \mathrm{E}+04,7.80 \mathrm{E}+03,4.35 \mathrm{E}+03,2.73 \mathrm{E}+03,2.49 \mathrm{E}+03$,
$2009,3.63 \mathrm{E}+04,1.43 \mathrm{E}+04,6.96 \mathrm{E}+03,4.31 \mathrm{E}+03,2.65 \mathrm{E}+03,1.58 \mathrm{E}+03$,
$2010,2.10 \mathrm{E}+04,3.01 \mathrm{E}+04,9.15 \mathrm{E}+03,4.17 \mathrm{E}+03,2.47 \mathrm{E}+03,1.50 \mathrm{E}+03$,
$2011,2.03 \mathrm{E}+04,1.70 \mathrm{E}+04,1.99 \mathrm{E}+04,4.70 \mathrm{E}+03,2.57 \mathrm{E}+03,1.78 \mathrm{E}+03$,
$2012,1.42 \mathrm{E}+04,1.70 \mathrm{E}+04,1.04 \mathrm{E}+04,1.01 \mathrm{E}+04,3.28 \mathrm{E}+03,1.78 \mathrm{E}+03$,

## Table 6.7a:cont'd

Estimated population abundance at 1st Jan 2013
$0.00 \mathrm{E}+00,1.16 \mathrm{E}+04, \quad 1.09 \mathrm{E}+04,5.34 \mathrm{E}+03,5.53 \mathrm{E}+03,2.02 \mathrm{E}+03$,
Taper weighted geometric mean of the VPA populations:
$2.41 \mathrm{E}+04,1.82 \mathrm{E}+04,1.11 \mathrm{E}+04,6.04 \mathrm{E}+03,3.26 \mathrm{E}+03,1.80 \mathrm{E}+03$,

Standard error of the weighted Log(VPA populations) :

| , | . 2342 , |  |  | . 2346 , | . 2695 , |  | 2770, | . 2795 , |  | . 3852 , |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 |  |  |  |  |  |  |  |  |  |  |  |
| Log catchability residuals. |  |  |  |  |  |  |  |  |  |  |  |
| Fleet : FR-SABLES |  |  |  |  |  |  |  |  |  |  |  |
| Age |  | 1991, | 1992 |  |  |  |  |  |  |  |  |
|  | 2 | , -.22, | -. 13 |  |  |  |  |  |  |  |  |
|  | 3 , | , .11, | -. 18 |  |  |  |  |  |  |  |  |
|  | , | , .14, | -. 26 |  |  |  |  |  |  |  |  |
|  | 5 , | , .09, | -. 15 |  |  |  |  |  |  |  |  |
|  | 6 , | , -. 18, | . 18 |  |  |  |  |  |  |  |  |
|  | 7 , | , -.06, | -. 15 |  |  |  |  |  |  |  |  |
| Age , |  | 1993, | 1994, | 1995, | 1996, | 1997, | 1998, | 1999, | 2000, | 2001, | 2002 |
|  | 2 , | , -.37, | -. 40, | -. 07 , | -. 20, | -. 11, | -. 02, | -.17, | . 21 , | -.16, | . 22 |
|  | 3 , | , .17, | -. 10, | -. 17, | -. 02, | . 21, | . 00 , | -. 41, | . 40 , | . 08, | . 26 |
|  | 4 , | , -.08, | . 38, | .15, | . 02 , | . 02, | . 45, | -. 21 , | . 15, | -.05, | . 15 |
|  | 5 , | , -.10, | . 24, | . 01 , | -. 11, | -. 23, | .16, | . 28, | -. 07 , | -. 26 , | . 35 |
|  | 6 , | , -. 39, | . 04 , | -. 24, | . 25 , | -.01, | -. 39, | . 42 , | -.04, | -. 21, | . 37 |
|  | 7 , | , -. 27 , | . 18 , | . 06 , | . 47, | -. 01, | . 10, | . 54, | . 07 , | -. 24 , | . 08 |
| Age |  | , 2003, | 2004, | 2005, | 2006, | 2007, | 2008, | 2009, | 2010, | 2011, | 2012 |
|  | 2 | , -.12, | . 30 , | . 47, | . 78 , | . 24, | . 12 , | -.37, | 99.99, | 99.99, | 99.99 |
|  | 3 | , .01, | -. 29 , | -.18, | -.03, | -.09, | . 12, | . 09 , | 99.99, | 99.99, | 99.99 |
|  |  | , -. 29, | -.19, | -.15, | -. 47, | . 02, | . 24 , | -.01, | 99.99, | 99.99, | 99.99 |
|  | 5 , | , -.16, | -.48, | . 22 , | -. 74, | . 33, | . 26 , | . 35 , | 99.99, | 99.99, | 99.99 |
|  | 6 , | , .04, | -.33, | .17, | -. 57, | . 27 , | . 30 , | . 32 , | 99.99, | 99.99, | 99.99 |
|  | 7 , | , .09, | -.14, | . 07 , | -. 14, | . 60, | . 35, | . 27 , | 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 , | 2, | 3, | 4, | 5, | 6, | 7 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Mean Log q, | -15.0829, | -14.5298, | -14.4902, | -14.6791, | -14.6758, | -14.6758, |
| S.E(Log q), | .3081, | .1986, | .2325, | .2995, | .2962, | .2707, |

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

| 2, | 4.64, | -3.136, | 33.30, | .04, | 19, | 1.17, | -15.08, |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 3, | .98, | .130, | 14.42, | .64, | 19, | .20, | -14.53, |
| 4, | .80, | 1.411, | 13.44, | .74, | 19, | .18, | -14.49, |
| 5, | 1.04, | -.151, | 14.93, | .44, | 19, | .32, | -14.68, |
| 6, | 1.37, | -.986, | 17.14, | .30, | 19, | .41, | -14.68, |
| 7, | .73, | 2.408, | 12.62, | .82, | 19, | .16, | -14.58, |

## Table 6.7a:cont'd

Fleet : FR-ROCHELLE

| Age | , | 1991, | 1992 |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2 | , | -.08, | -. 17 |  |  |  |  |  |  |  |  |
| 3 | , | . 20 , | -. 03 |  |  |  |  |  |  |  |  |
| 4 | , | . 45 , | . 14 |  |  |  |  |  |  |  |  |
| 5 | , | . 47, | . 18 |  |  |  |  |  |  |  |  |
| 6 | , | .12, | . 35 |  |  |  |  |  |  |  |  |
| 7 | , | .02, | . 08 |  |  |  |  |  |  |  |  |
| Age | , | 1993, | 1994, | 1995, | 1996, | 1997, | 1998, | 1999, | 2000, | 2001, | 2002 |
| 2 | , | -.45, | -.39, | -.03, | . 34 , | -.05, | . 21 , | -.02, | . 20 , | -.22, | . 70 |
| 3 | , | . 00 , | -.21, | -. 10, | . 06 , | . 12, | -.09, | -.48, | -. 26 , | -.07, | . 19 |
| - | , | -. 20, | . 31, | . 32, | -.14, | -.07, | . 48 , | -.24, | -. 10, | . 15, | -. 31 |
| 5 | , | -. 07, | . 20 , | . 23, | -. 34, | -. 34, | . 02, | . 19, | -. 15, | -. 04 , | -. 05 |
| 6 | , | -. 25, | . 12, | -. 35, | -. 10, | . 00 , | -.53, | . 52, | -. 30, | .10, | . 01 |
| 7 | , | -.03, | -.01, | -. 06 , | -.11, | -. 11, | . 02, | . 22, | -.23, | . 10, | -. 08 |
| Age | , | 2003, | 2004, | 2005, | 2006, | 2007, | 2008, | 2009, | 2010, | 2011, | 2012 |
| 2 |  | . 17, | . 37, | . 11, | -. 04 , | . 05 , | . 18 , | -.89, | 99.99, | 99.99, | 99.99 |
| 3 | , | . 23, | -.09, | -. 38, | -.27, | . 52, | . 54, | .11, | 99.99, | 99.99, | 99.99 |
| 4 | , | -. 05, | -.24, | -. 21 , | -.29, | -.21, | . 26 , | -.05, | 99.99, | 99.99, | 99.99 |
| 5 | , | -.05, | -.46, | . 31, | -.28, | -.28, | . 21 , | . 24 , | 99.99, | 99.99, | 99.99 |
| 6 |  | .11, | -.19, | . 42 , | -.08, | -.24, | . 12 , | .18, | 99.99, | 99.99, | 99.99 |
| 7 |  | -.21, | -.04, | . 20, | .00, | -. 26 , | . 22 , | 13, | 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 , | 2, | 3, | 4, | 5, | 6, |
| ---: | ---: | ---: | ---: | ---: | ---: |
| Mean Log q, | -15.0172, | -14.5711, | -14.7932, | -15.1533, | -15.2131, |
| S.E(Log q), | .3441, | .2708, | .2586, | .2603, | .2714, |

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

| 2, | 2.13, | -1.622, | 20.58, | .11, | 19, | .70, | -15.02, |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 3, | 1.14, | -.496, | 15.26, | .41, | 19, | .32, | -14.57, |
| 4, | .77, | 1.481, | 13.54, | .71, | 19, | .19, | -14.79, |
| 5, | .84, | .843, | 14.11, | .62, | 19, | .22, | -15.15, |
| 6, | 1.56, | -1.488, | 19.27, | .29, | 19, | .41, | -15.21, |
| 7, | .85, | 1.878, | 14.05, | .90, | 19, | .11, | -15.22, |

Fleet : FR-BB-IN-Q4

| Age |  | 1993, | 1994 | 1995, | 19 | 1997, | 1998, | 1999, | 2000, | 2001 | 200 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | No data | for | is fl | t at | is a |  |  |  |  |  |
| 3 |  | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | . 24 , | -.37, | 2 |
| 4 |  | , 99.99, | 99.99, | 99.99, | 99.99, | 99.99 | 99.99, | 99.99, | . 37 , | -.52, | -. 70 |
| 5 |  | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | . 12 , | -.29, | -. 0 |
| 6 |  | , 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | -. 45, | . 07 , | 67 |
| 7 |  | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | -.18, | -.14, | . 62 |
| Age |  | , 2003, | 2004, | 2005, | 200 | 2007, | 2008, | 2009, | 2010, | 2011, | 201 |
|  |  | , No data | for | is fle | at | s age |  |  |  |  |  |
|  |  | . 67, | . 22 , | -.31, | -.09, | -.08, | .10, | -. 22 , | -. 36, | -. 27, |  |
|  |  | , .12, | . 28 , | . 07 , | -.53, | . 15 , | . 41 , | -.48, | . 23, | -.33, |  |
|  |  | -.68, | . 53, | . 22 , | -. 47, | . 28 , | .18, | -. 26 , | . 04 , | -. 18, |  |
|  |  | -. 29, | . 90 , | . 05, | . 06 , | . 12, | . 05 , | . 01 , | -. 81, | -.32, |  |
|  |  | . 36 , | . 25 , | -.07, | . 56 , | -.55, | -.15, | -.36, | -1.08, | -.85, |  |

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, | 7 |
| ---: | ---: | ---: | ---: | ---: | ---: |
| Mean Log q, | -14.4606, | -14.8995, | -15.2253, | -15.1608, | -15.1608, |
| S.E (Log q), | .3136, | .4788, | .3741, | .4410, | .5245, |

## Table 6.7a:cont'd

Regression statistics :

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

| Age, Slope, |  |  |  |  |  |  |  |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | 1.11, | -.267, | 15.00, | .34, | 13, | .36, | -14.46, |
| 3, | 1.10, | -.185, | 15.49, | .23, | 13, | .55, | -14.90, |
| 4, | .68, | 1.201, | 13.07, | .56, | 13, | .25, | -15.23, |
| 5, | 1.03, | -.054, | 15.41, | .18, | 13, | .48, | -15.16, |
| 6, | 4.58, | -1.902, | 44.09, | .02, | 13, | 2.10, | -15.29, |

1

Fleet : FR-BB-OFF-Q2


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

| Age , | 2, | 3, | 4, | 5, | 6 |
| ---: | ---: | ---: | ---: | ---: | ---: |
| Mean Log q, | -15.9161, | -14.5150, | -14.7538, | -15.4117, | -15.9410, |
| S.E (Log q), | 1.0004, | .3294, | .2976, | .5812, | .8405, |

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

| 2, | -2.28, | -1.200, | -3.73, | .01, | 13, | 2.24, | -15.92, |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 3, | 1.53, | -.899, | 17.09, | .21, | 13, | .51, | -14.51, |
| 4, | .62, | 2.412, | 12.62, | .78, | 13, | .16, | -14.75, |
| 5, | .63, | .919, | 12.89, | .36, | 13, | .37, | -15.41, |
| 6, | 40.34, | -.853, | 333.87, | .00, | 13, | 34.30, | -15.94, |

Terminal year survivor and $F$ summaries :
Age 2 Catchability constant w.r.t. time and dependent on age

Year class $=2010$

| Fleet, |  | Estimated, | Int, | Ext, | Var, | N, | Scaled, | Estimated |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| , |  | Survivors, | s.e, | s.e, | Ratio, | , | Weights, | F |
| FR-SABLES | , | 1., | . 000 , | . 000 , | . 00 , | 0, | . 000 , | . 000 |
| FR-ROCHELLE | , | 1., | . 000 , | . 000 , | . 00 , | 0 , | . 000 , | .000 |
| FR-BB-IN-Q4 | , | 1., | . 000 , | . 000 , | . 00 , | 0 , | . 000 , | . 000 |
| $\mathrm{FR}-\mathrm{BB}-\mathrm{OFF}-\mathrm{Q} 2$ | , | 14359., | 1.038, | . 000 , | . 00 , | 1, | . 654 , | . 082 |
| F shrinkage mean |  | 7810., | 1.50, |  |  |  | . 346 , | . 145 |

Weighted prediction :

| Survivors, | Int, | Ext, | N, | Var, | F |
| :---: | :---: | :---: | :---: | :---: | :---: |
| at end of year, | s.e, | S.e, | , | Ratio, |  |
| $11630 .$, | .85, | .36, | 2, | .419, | .100 |

## Table 6.7a:cont'd

Age 3 Catchability constant w.r.t. time and dependent on age
Year class $=2009$

| Fleet, |  | Estimated, Survivors, | Int, s.e, | Ext, s.e, | Var, Ratio, | N, | Scaled, Weights, | $\begin{gathered} \text { Estimated } \\ \mathrm{F} \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| FR-SABLES | , | 1. | . 000 , | . 000 , | . 00 , | 0, | . 000 , | . 000 |
| FR-ROCHELLE | , | 1., | . 000 , | . 000 , | . 00 , | 0 , | . 000 , | .000 |
| FR-BB-IN-Q4 | , | 13412., | . 325, | . 000 , | . 00 , | 1, | . 485 , | . 285 |
| FR-BB-OFF-Q2 | , | 9010., | . 325 , | . 550, | 1.69, | 2, | . 483, | . 400 |
| F shrinkage mean |  | 8728., | 1.50, |  |  |  | . 032, | . 410 |

Weighted prediction :

| Survivors, | Int, | Ext, | N, | Var, | F |
| :--- | :--- | :--- | :--- | :--- | :--- |
| at end of year, | S.e, | S.e, | , | Ratio, |  |
| $10915 .$, | .23, | .25, | 4, | 1.095, | .340 |

1
Age 4 Catchability constant w.r.t. time and dependent on age
Year class $=2008$

| Fleet, |  | Estimated, | Int, | Ext, | Var, | N, | Scaled, | Estimated |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| , |  | Survivors, | s.e, | s.e, | Ratio, | , | Weights, | F |
| FR-SABLES | , | 1., | . 000 , | . 000 , | . 00 , | 0 , | . 000 , | . 000 |
| FR-ROCHELLE | , | 1., | . 000 , | . 000 , | . 00 , | 0 , | . 000 , | . 000 |
| FR-BB-IN-Q4 | , | $6503 .$, | . 277, | . 590, | 2.13, | 2, | . 372 , | . 486 |
| $\mathrm{FR}-\mathrm{BB}-\mathrm{OFF}-\mathrm{Q} 2$ | , | $4691 .$, | . 228 , | . 253 , | 1.11, | 3, | . 600 , | . 624 |
| F shrinkage mean |  | 6233., | 1.50, |  |  |  | . 028 , | . 502 |

Weighted prediction :

| Survivors, | Int, | Ext, | N, | Var, | F |
| :---: | :---: | :---: | :---: | :---: | :---: |
| at end of year, | s.e, | s.e, | , | Ratio, |  |
| $5339 .$, | .18, | .22, | 6, | 1.221, | .566 |

Age 5 Catchability constant w.r.t. time and dependent on age

Year class $=2007$

| Fleet, |  | Estimated, Survivors, | Int, | Ext, s.e, | Var, Ratio, | N, | Scaled, Weights, | Estimated <br> F |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| FR-SABLES | , | 3813., | . 316, | . 000 , | . 00 , | 1, | . 115, | . 665 |
| FR-ROCHELLE | , | 2266., | . 353, | . 000 , | . 00 , | 1, | . 092 , | . 951 |
| FR-BB-IN-Q4 | , | 6383., | . 241, | . 335 , | 1.39, | 3, | . 390 , | .447 |
| $\mathrm{FR}-\mathrm{BB}-\mathrm{OFF}-\mathrm{Q} 2$ | , | 6489., | . 221, | . 213, | . 97 , | 4, | . 381 , | . 441 |
| F shrinkage mean |  | $7766 .$, | 1.50, |  |  |  | . 022 , | . 381 |

Weighted prediction :

| Survivors, | Int, | Ext, | N, | Var, | F |
| :---: | :---: | :---: | :---: | :---: | :---: |
| at end of year, | s.e, | s.e, | , | Ratio, |  |
| $5529 .$, | .14, | .17, | 10, | 1.193, | .502 |

1
Age 6 Catchability constant w.r.t. time and dependent on age

Year class $=2006$

| Fleet, |  | Estimated, Survivors, | Int, s.e, | Ext, s.e, | $\begin{gathered} \text { Var, } \\ \text { Ratio, } \end{gathered}$ | N, | Scaled, Weights, | $\begin{aligned} & \text { Estimated } \\ & \mathrm{F} \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| FR-SABLES | , | 2234., | .172, | . 012, | . 07 , | 2, | . 237 , | . 355 |
| FR-ROCHELLE |  | 2307 | . 219, | . 035 , | . 16, | 2, | . 144 , | . 346 |
| FR-BB-IN-Q4 |  | 1826. | . 221, | . 079, | . 36 | 4, | . 345 , | 420 |
| $\mathrm{FR}-\mathrm{BB}-\mathrm{OFF}-\mathrm{Q} 2$ | , | 1943. | . 221, | .147, | . 66 , | 5, | . 258 , | . 399 |
| F shrinkage mean |  | 2179., | 1.50, |  |  |  | . 015 , | . 363 |

## Table 6.7a:cont'd



Table 6.7b: XSA tuning diagnostic with Orhago survey


Time series weights :

Tapered time weighting not applied
Catchability analysis :
Catchability independent of stock size for all ages
Catchability independent of age for ages $>=6$
Terminal population estimation :
Survivor estimates shrunk towards the mean $F$
of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates are shrunk $=1.500$

Minimum standard error for population
estimates derived from each fleet $=\quad .200$
Prior weighting not applied

Tuning converged after 59 iterations
1
Regression weights
, $1.000,1.000,1.000,1.000,1.000,1.000,1.000,1.000,1.000,1.000$

| Fishing mortalities |  |  |  |  |  |  |  |  |  |  |
| ---: | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Age, | 2003, | 2004, | 2005, | 2006, | 2007, | 2008, | 2009, | 2010, | 2011, | 2012 |

XSA population numbers (Thousands)
YEAR 2, 3, 4, 5, 6,
7,
$2003,2.46 \mathrm{E}+04, \quad 1.78 \mathrm{E}+04,6.59 \mathrm{E}+03,3.79 \mathrm{E}+03,1.71 \mathrm{E}+03,7.46 \mathrm{E}+02$,
$2004,1.72 \mathrm{E}+04,1.82 \mathrm{E}+04,1.01 \mathrm{E}+04,3.83 \mathrm{E}+03,2.27 \mathrm{E}+03,8.55 \mathrm{E}+02$, 2005 , $1.86 \mathrm{E}+04,1.23 \mathrm{E}+04,1.13 \mathrm{E}+04,5.99 \mathrm{E}+03,2.60 \mathrm{E}+03,1.42 \mathrm{E}+03$, $2006,1.94 \mathrm{E}+04,1.30 \mathrm{E}+04,7.87 \mathrm{E}+03,6.71 \mathrm{E}+03,3.22 \mathrm{E}+03,1.41 \mathrm{E}+03$, $2007,1.84 \mathrm{E}+04,1.42 \mathrm{E}+04,7.57 \mathrm{E}+03,4.51 \mathrm{E}+03,4.15 \mathrm{E}+03,1.94 \mathrm{E}+03$, $2008,1.89 \mathrm{E}+04,1.29 \mathrm{E}+04,7.88 \mathrm{E}+03,4.36 \mathrm{E}+03,2.73 \mathrm{E}+03,2.56 \mathrm{E}+03$, $2009,3.70 \mathrm{E}+04,1.41 \mathrm{E}+04,7.16 \mathrm{E}+03,4.38 \mathrm{E}+03,2.66 \mathrm{E}+03,1.57 \mathrm{E}+03$, 2010 , $1.99 \mathrm{E}+04,3.08 \mathrm{E}+04,8.99 \mathrm{E}+03,4.35 \mathrm{E}+03,2.54 \mathrm{E}+03,1.51 \mathrm{E}+03$,
$2011,2.04 \mathrm{E}+04,1.61 \mathrm{E}+04,2.05 \mathrm{E}+04,4.56 \mathrm{E}+03,2.73 \mathrm{E}+03,1.84 \mathrm{E}+03$,
$2012,1.02 \mathrm{E}+04,1.70 \mathrm{E}+04,9.57 \mathrm{E}+03,1.06 \mathrm{E}+04,3.15 \mathrm{E}+03,1.93 \mathrm{E}+03$,

## Table 6.7b: cont'd

Estimated population abundance at 1st Jan 2013
$0.00 \mathrm{E}+00,7.99 \mathrm{E}+03,1.10 \mathrm{E}+04,4.59 \mathrm{E}+03,6.00 \mathrm{E}+03,1.90 \mathrm{E}+03$,
Taper weighted geometric mean of the VPA populations:
$2.38 \mathrm{E}+04,1.82 \mathrm{E}+04,1.11 \mathrm{E}+04,6.06 \mathrm{E}+03,3.27 \mathrm{E}+03,1.81 \mathrm{E}+03$,
Standard error of the weighted Log(VPA populations) :
, .2686, .2364, .2713, .2791, .2773, .3853,

Log catchability residuals.
Fleet : FR-SABLES


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

| Age , | 2, | 3, | 4, | 5, | 6, | 7 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Mean Log q, | -15.0853, | -14.5317, | -14.4947, | -14.6835, | -14.6813, | -14.6813, |
| S.E (Log q), | .3084, | .1991, | .2325, | .3000, | .2979, | .2638, |

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

| 2, | 4.61, | -3.154, | 33.17, | .04, | 19, | 1.16, | -15.09, |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 3, | .97, | .143, | 14.41, | .64, | 19, | .20, | -14.53, |
| 4, | .79, | 1.494, | 13.39, | .74, | 19, | .18, | -14.49, |
| 5, | 1.04, | -.156, | 14.94, | .43, | 19, | .32, | -14.68, |
| 6, | 1.39, | -1.029, | 17.28, | .29, | 19, | .41, | -14.68, |
| 7, | .73, | 2.426, | 12.67, | .83, | 19, | .16, | -14.59, | 1

Fleet : FR-ROCHELLE

| Age, | 1991, | 1992 |
| ---: | ---: | ---: |
| 2, | -.08, | -.17 |
| 3, | .20, | -.03 |
| 4, | .46, | .14 |
| 5 | .48, | .19 |
| 6 | , | .13, |
| 7 | .02, | .08 |

## Table 6.7b: cont'd

| Age | , | 1993, | 1994, | 1995, | 1996, | 1997, | 1998, | 1999, | 2000, | 2001, | 2002 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2 | , | -.44, | -.39, | -.03, | . 34, | -. 04 , | . 21, | -.01, | . 20 , | -.22, | 70 |
| 3 |  | . 00 , | -. 20, | -.10, | . 06 , | . 12, | -.09, | -.48, | -. 26 , | -.07, | 20 |
| 4 | , | -. 20 , | . 31, | . 32, | -. 14, | -.06, | . 49, | -.23, | -.09, | . 15, | . 31 |
| 5 | , | -.07, | . 21, | . 23, | -. 34, | -. 35, | . 02 , | . 19, | -. 15, | -. 04 , | -. 05 |
| 6 | , | -. 25, | . 12, | -.35, | -. 10, | . 00 , | -.53, | . 52, | -. 30, | 10, | . 01 |
| 7 |  | -.03, | -.02, | -.07, | -.12, | -.11, | . 02 , | . 21 , | -. 24 , | 10, | . 0 |
| Age | , | 2003, | 2004, | 2005, | 2006, | 2007, | 2008, | 2009, | 2010, | 2011, | 2012 |
| 2 |  | .16, | . 37 , | .11, | -. 04 , | . 03, | . 20, | -.91, | 99.99, | 99.99, | 99.99 |
| 3 |  | . 22, | -.09, | -.38, | -.27, | . 52, | . 52, | .13, | 99.99, | 99.99, | 99.99 |
| 4 |  | -.05, | -.24, | -.21, | -.29, | -.21, | . 25 , | -.08, | 99.99, | 99.99, | 99.99 |
| 5 |  | -.05, | -.45, | . 30 , | -.29, | -.27, | . 21 , | . 23 , | 99.99, | 99.99, | 99.99 |
| 6 |  | .11, | -.19, | . 42 , | -.10, | -. 26 , | . 12, | .18, | 99.99, | 99.99, | 99.99 |
| 7 |  | -.21, | . 04, | . 20, | . 00 , | -.28, | . 19, | 13, | 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 , | 2, | 3, | 4, | 5, | 6, | 7 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Mean Log q, | -15.0196, | -14.5731, | -14.7976, | -15.1576, | -15.2186, | -15.2186, |
| S.E(Log q), | .3469, | .2679, | .2591, | .2598, | .2738, | .1448, |

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

| 2, | 2.20, | -1.676, | 20.96, | .10, | 19, | .73, | -15.02, |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 3, | 1.13, | -.451, | 15.19, | .42, | 19, | .31, | -14.57, |
| 4, | .76, | 1.549, | 13.50, | .72, | 19, | .19, | -14.80, |
| 5, | .84, | .855, | 14.11, | .62, | 19, | .22, | -15.16, |
| 6, | 1.59, | -1.538, | 19.48, | .28, | 19, | .42, | -15.22, |
| 7, | .86, | 1.703, | 14.15, | .90, | 19, | .12, | -15.23, |


| Fleet : FR-BB-IN-Q4 |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Age | , | 1993, | 1994, | 1995, | 1996, | 1997, | 1998, | 1999, | 2000, | 2001, | 2002 |
| 2 |  | No dat | for t | is fle | et at | his age |  |  |  |  |  |
| 3 |  | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | . 24, | -. 37, | . 26 |
| 4 | , | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | . 37 , | -. 53, | -. 71 |
| 5 |  | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | . 13, | -. 27 , | -. 08 |
| 6 | , | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | -.44, | . 08 , | . 68 |
| 7 | , | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | -. 18, | -. 13, | . 62 |
| Age $\begin{array}{r}\text { a } \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7\end{array}$ | , | 2003, | 2004, | 2005, | 2006, | 2007, | 2008, | 2009, | 2010, | 2011, | 2012 |
|  |  | No dat | for t | is fle | $t$ at t | is age |  |  |  |  |  |
|  | , | . 66 , | . 21, | -.31, | -.09, | -.09, | . 08, | -. 20, | -.39, | -.19, | . 20 |
|  | , | . 11, | . 27 , | . 06 , | -. 53, | . 14, | . 39, | -.53, | . 25, | -. 38, | 1.08 |
|  | , | -. 67, | . 54, | . 22 , | -. 47, | . 29, | .19, | -.27, | -.01, | -. 13, | . 53 |
|  |  | -. 28 , | . 90, | . 06 , | . 05 , | . 10, | . 06 , | . 01 , | -.83, | -. 39, | . 01 |
|  |  | . 36 , | . 25, | -. 07 , | . 56 , | -. 57, | -.18, | -.35, | -1.08, | -. 88, | -. 17 |

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, | 7 |
| :---: | ---: | ---: | ---: | ---: | ---: |
| ean Log q, | -14.4600, | -14.8963, | -15.2383, | -15.1708, | -15.1708, |
| . E (Log q), | .3082, | .5091, | .3654, | .4492, | .5322, |

## Table 6.7b: cont'd

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, | 1.11, | -.262, | 14.97, | .35, | 13, | .36, | -14.46, |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 4, | 1.28, | -.408, | 16.49, | .17, | 13, | .67, | -14.90, |
| 5, | .71, | 1.093, | 13.29, | .56, | 13, | .26, | -15.24, |
| 6, | 1.11, | -.159, | 15.98, | .16, | 13, | .52, | -15.17, |
| 7, | 4.82, | -2.003, | 46.02, | .02, | 13, | 2.21, | -15.31, |

Fleet : FR-BB-OFF-Q2

| Age | , | 1993, | 1994, | 1995, | 1996, | 1997, | 1998, | 1999, | 2000, | 2001, | 2002 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2 |  | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | . 41 , | . 45 , | 86 |
| 3 |  | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | -.42, | -.13, | 22 |
| 4 | , | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | . 37 , | . 25 , | 16 |
| 5 |  | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | . 80 , | . 53, | 86 |
| 6 |  | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | 99.99, | . 75 , | 1.21, | 1.45 |
| 7 |  | No data | for | is fle | t at | is age |  |  |  |  |  |
| Age | , | 2003, | 2004, | 2005, | 2006, | 2007, | 2008, | 2009, | 2010, | 2011, | 2012 |
| 2 |  | . 91, | . 42, | . 35 , | -. 32, | . 50, | . 88, | -1.79, | -1.22, | -1.96, | 53 |
| 3 |  | . 15, | .18, | -. 18, | -. 21 , | . 71, | . 35, | -.13, | -.09, | -.42, | -. 02 |
| 4 |  | . 00 , | -.08, | -.02, | -. 65, | -. 41, | -.08, | -.29, | . 24, | . 28 , | 24 |
| 5 |  | -. 12, | -.85, | . 29, | -. 52, | -. 94 , | . 00 , | -.27, | . 26 , | -.35, | . 30 |
| 6 | 6 , | . 44, | -. 44, | -. 68, | . 32, | .03, | -. 75, | -.43, | -1.62, | . 00 , | -. 28 |

No data for this fleet at this age

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

| Age , | 2, | 3, | 4, | 5, | 6 |
| ---: | ---: | ---: | ---: | ---: | ---: |
| Mean Log q, | -15.8887, | -14.5144, | -14.7518, | -15.4221, | -15.9497, |
| S.E (Log q), | 1.0092, | .3178, | .3044, | .5756, | .8422, |

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

| 2, | -4.79, | -1.254, | -18.71, | .00, | 13, | 4.72, | -15.89, |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 3, | 1.44, | -.819, | 16.62, | .24, | 13, | .46, | -14.51, |
| 4, | .64, | 2.124, | 12.71, | .76, | 13, | .17, | -14.75, |
| 5, | .66, | .873, | 13.05, | .37, | 13, | .38, | -15.42, |
| 6, | $* * * * *$, | -.882, | $* * * * * *$, | .00, | 13, | 117.34, | -15.95, |

1
Fleet : FR-ORHAGO

| Age | 2003, | 2004, | 2005, | 2006, | 2007, | 2008, | 2009, | 2010, | 2011, | 2012 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2 | 99.99, | 99.99, | 99.99, | 99.99, | -.03, | -. 21, | . 27 , | . 04 , | -.06, | -. 02 |
| 3 | 99.99, | 99.99, | 99.99, | 99.99, | . 15, | . 12, | . 13, | -. 14, | -. 31, | . 06 |
| 4 | 99.99, | 99.99, | 99.99, | 99.99, | . 26 , | . 03 , | -. 19, | -. 14 , | -.81, | 86 |
| 5 | , 99.99, | 99.99, | 99.99, | 99.99, | . 84, | -. 15, | -. 08, | -. 70 , | -. 62, | . 71 |
| 6 | , 99.99, | 99.99, | 99.99, | 99.99, | 1.30, | . 47, | . 17 , | -2.84, | -. 18 , | 1.08 |
| 7 | , 99.99, | 99.99, | 99.99, | 99.99, | . 36 , | . 69, | -. 77, | -.13, | . 27, | 82 |

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

| Age, | 2, | 3, | 4, | 5, | 6, | 7 |
| :---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Mean Log q, | -9.1392, | -9.4136, | -9.9849, | -10.9854, | -11.6192, | -11.6192, |
| S.E(Log q), | .1572, | .1863, | .5499, | .6499, | 1.4965, | .6291, |

## Table 6.7b: cont'd

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

| 2, | .81, | 1.473, | 9.28, | .94, | 6, | .12, | -9.14, |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 3, | 1.42, | -1.155, | 9.28, | .65, | 6, | .26, | -9.41, |
| 4, | 5.37, | -1.415, | 13.58, | .03, | 6, | 2.69, | -9.98, |
| 5, | .50, | 1.295, | 9.77, | .63, | 6, | .31, | -10.99, |
| 6, | .16, | 1.755, | 8.56, | .52, | 6, | .20, | -11.62, |
| 7, | .30, | 2.302, | 8.69, | .73, | 6, | .13, | -11.41, |

1
Terminal year survivor and $F$ summaries :

Age 2 Catchability constant w.r.t. time and dependent on age
Year class $=2010$

| Fleet, |  | Estimated, | Int, | Ext, | Var, | N, | Scaled, | Estimated |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| , |  | Survivors, | s.e, | S.e, | Ratio, | , | Weights, | F |
| FR-SABLES | , | 1., | . 000 , | . 000 , | . 00 , | 0 , | . 000 , | . 000 |
| FR-ROCHELLE | , | 1., | . 000 , | . 000 , | . 00 , | 0 , | . 000 , | .000 |
| FR-BB-IN-Q4 | , | 1., | . 000 , | . 000 , | . 00 , | 0 , | . 000 , | .000 |
| $\mathrm{FR}-\mathrm{BB}-\mathrm{OFF}-\mathrm{Q} 2$ | , | 13606. | 1.047, | . 000 , | . 00 , | 1, | . 035 , | . 086 |
| FR-ORHAGO | , | 7845. | . 200, | . 000 , | . 00 , | 1, | . 946 , | . 145 |

Weighted prediction :

| Survivors, | Int, | Ext, | N, | Var, | F |
| :--- | :--- | :--- | :--- | :--- | :--- |
| at end of year, | S.e, | S.e, | , | Ratio, |  |
| $7994 .$, | .19, | .07, | 3, | .365, | .142 |

Age 3 Catchability constant w.r.t. time and dependent on age

Year class $=2009$

| Fleet, |  | Estimated, Survivors, | Int, s.e, | Ext, s.e, | Var, <br> Ratio, | N, | Scaled, Weights, | Estimated F |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| FR-SABLES | , | 1., | . 000, | . 000 , | . 00 , | 0 , | . 000 , | . 000 |
| FR-ROCHELLE | , | 1. | . 000 , | . 000 , | . 00 , | 0 , | . 000 , | .000 |
| FR-BB-IN-Q4 | , | 13406., | . 320 , | . 000 , | . 00 , | 1, | . 143 , | . 285 |
| FR-BB-OFF-Q2 | , | 9119., | . 315 , | . 538, | 1.71, | 2, | .147, | . 396 |
| FR-ORHAGO | , | 11012., | . 142 , | . 059 , | . 41, | 2, | . 700 , | . 338 |
| F shrinkage mean | , | 8675., | 1.50, |  |  |  | . 009, | . 412 |

Weighted prediction :

| Survivors, | Int, | Ext, | N, | Var, | F |
| :---: | :---: | :---: | :---: | :---: | :---: |
| at end of year, | s.e, | s.e, | , | Ratio, |  |
| $10993 .$, | .12, | .11, | 6, | .886, | .338 |

1
Age 4 Catchability constant w.r.t. time and dependent on age

Year class $=2008$


Weighted prediction :
Survivors, Int, Ext, N, Var, F

| 4588., | .11, | .15, | 9, 1.334, |
| ---: | ---: | ---: | ---: |
| Table 6.7b: cont'd |  |  |  |

Age 5 Catchability constant w.r.t. time and dependent on age
Year class $=2007$

| Fleet, |  | Estimated, Survivors, | Int, | Ext, s.e, | Var, Ratio, | N, | Scaled, Weights, | Estimated F |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| FR-SABLES | , | 4065. | . 316 , | . 000 , | . 00, | 1, | . 068 , | . 634 |
| FR-ROCHELLE | , | 2417., | . 356 , | . 000 , | . 00 , | 1, | . 053, | . 912 |
| $\mathrm{FR}-\mathrm{BB}-\mathrm{IN}-\mathrm{Q} 4$ | , | 6643., | . 239, | . 325 , | 1.36, | 3 , | . 229, | . 433 |
| $\mathrm{FR}-\mathrm{BB}-\mathrm{OFF}-\mathrm{Q} 2$ | , | 6728., | . 220 , | . 212 , | . 96 , | 4, | . 223, | . 429 |
| FR-ORHAGO | , | 6336. | . 140 , | . 202 , | 1.44, | 4, | . 415 , | . 450 |
| F shrinkage mean | , | 7868. | 1.50, |  |  |  | . 012, | . 377 |

Weighted prediction :

| Survivors, | Int, | Ext, | N, | Var, | F |
| :---: | :---: | :---: | :---: | :---: | :---: |
| at end of year, | S.e, | S.e, | Ratio, | Ration |  |
| $6000 .$, | .10, | .12, | 14, | 1.215, | .470 |

1
Age 6 Catchability constant w.r.t. time and dependent on age
Year class $=2006$

| Fleet, |  | Estimated, Survivors, | Int, s.e, | Ext, | Var, <br> Ratio, | N, | Scaled, Weights, | $\begin{gathered} \text { Estimated } \\ \mathrm{F} \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| FR-SABLES | , | 2137., | .172, | . 010, | . 06 , | 2, | .167, | . 369 |
| FR-ROCHELLE | , | 2204. | . 218 , | . 033, | . 15 , | 2, | . 102, | . 359 |
| $\mathrm{FR}-\mathrm{BB}-\mathrm{IN}-\mathrm{Q} 4$ | , | 1789., | . 222 , | . 077 , | . 35, | 4, | . 247 , | . 427 |
| FR-BB-OFF-Q2 | , | 1860., | . 222 , | .140, | . 63, | 5, | .184, | . 414 |
| FR-ORHAGO | , | 1785. | .144, | .144, | 1.00, | 5, | . 288 , | . 428 |
| F shrinkage mean | , | 2230., | 1.50, |  |  |  | . 011, | . 356 |

Weighted prediction :

| Survivors, | Int, | Ext, | N, | Var, | F |
| :---: | :---: | :---: | :---: | :---: | :---: |
| at end of year, | s.e, | S.e, | , | Ratio, |  |
| $1900 .$, | .09, | .05, | 19, | .588, | .407 |

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 6
Year class $=2005$


Weighted prediction :

| Survivors, | Int, | Ext, | N, | Var, | F |
| :---: | :---: | :---: | :---: | :---: | :---: |
| at end of year, | s.e, | S.e, | Ratio, |  |  |
| $1523 .$, | .08, | .07, | 23, | .813, | .134 |

Table 6.8a: Bay of Biscay Sole, Fishing mortality (F) at age

|  | YEAR <br> AGE | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 2 | 0.2965 | 0.3598 | 0.2573 | 0.1741 | 0.2168 | 0.2024 | 0.2651 | 0.1438 | 0.1483 | 0.0833 | 0.1099 |
|  | 3 | 0.2429 | 0.3535 | 0.2707 | 0.3542 | 0.3982 | 0.4357 | 0.3831 | 0.3523 | 0.3184 | 0.3534 | 0.3266 |
|  | 4 | 0.3356 | 0.2719 | 0.3174 | 0.3455 | 0.4299 | 0.4257 | 0.5234 | 0.46 | 0.4531 | 0.497 | 0.7499 |
|  | 5 | 0.3476 | 0.3717 | 0.3865 | 0.3706 | 0.3457 | 0.59 | 0.5746 | 0.443 | 0.5585 | 0.6375 | 0.7366 |
|  | 6 | 0.3194 | 0.229 | 0.4835 | 0.4093 | 0.4204 | 0.523 | 0.3208 | 0.4111 | 1.0827 | 0.5964 | 0.7546 |
|  | 7 | 0.3351 | 0.2916 | 0.397 | 0.3762 | 0.3999 | 0.5148 | 0.4746 | 0.611 | 0.8382 | 0.7902 | 0.7722 |
|  | +gp | 0.3351 | 0.2916 | 0.397 | 0.3762 | 0.3999 | 0.5148 | 0.4746 | 0.611 | 0.8382 | 0.7902 | 0.7722 |
| 0 | FBAR 3-6 | 0.3114 | 0.3065 | 0.3645 | 0.3699 | 0.3986 | 0.4936 | 0.4504 | 0.4166 | 0.6032 | 0.5211 | 0.6419 |
|  | YEAR | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|  | 2 | 0.1559 | 0.1142 | 0.1844 | 0.2115 | 0.1308 | 0.2729 | 0.22 | 0.2463 | 0.2024 | 0.2335 | 0.2551 |
|  | 3 | 0.3275 | 0.3529 | 0.5127 | 0.3957 | 0.393 | 0.4782 | 0.5088 | 0.5251 | 0.4693 | 0.377 | 0.3498 |
|  | 4 | 0.6793 | 0.5261 | 0.665 | 0.7294 | 0.6362 | 0.7661 | 0.65 | 0.807 | 0.442 | 0.4235 | 0.4297 |
|  | 5 | 0.7152 | 0.5046 | 0.5679 | 0.5932 | 0.7267 | 0.7195 | 0.5787 | 1.0021 | 0.4145 | 0.2903 | 0.5257 |
|  | 6 | 0.5596 | 0.7714 | 0.6703 | 0.4174 | 0.7132 | 0.5241 | 0.5306 | 0.9647 | 0.5956 | 0.3675 | 0.5146 |
|  | 7 | 0.7623 | 0.9962 | 0.7424 | 0.7444 | 0.5404 | 0.4596 | 0.5259 | 0.7533 | 0.7619 | 0.4091 | 0.4191 |
|  | +gp | 0.7623 | 0.9962 | 0.7424 | 0.7444 | 0.5404 | 0.4596 | 0.5259 | 0.7533 | 0.7619 | 0.4091 | 0.4191 |
| 0 | FBAR 3-6 | 0.5704 | 0.5387 | 0.604 | 0.5339 | 0.6173 | 0.622 | 0.567 | 0.8247 | 0.4804 | 0.3646 | 0.455 |
|  | YEAR | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | FBAR * |  |  |  |
|  | 2 | 0.2144 | 0.2549 | 0.1915 | 0.0865 | 0.1104 | 0.0816 | 0.0998 | 0.0973 |  |  |  |
|  | 3 | 0.4437 | 0.4898 | 0.504 | 0.3468 | 0.3133 | 0.3906 | 0.3404 | 0.3481 |  |  |  |
|  | 4 | 0.4574 | 0.4523 | 0.4928 | 0.4115 | 0.5656 | 0.5805 | 0.5664 | 0.5708 |  |  |  |
|  | 5 | 0.3847 | 0.4021 | 0.396 | 0.4558 | 0.3863 | 0.2586 | 0.5015 | 0.3822 |  |  |  |
|  | 6 | 0.417 | 0.3934 | 0.4487 | 0.4708 | 0.2304 | 0.266 | 0.3868 | 0.2944 |  |  |  |
|  | 7 | 0.5071 | 0.4794 | 0.4725 | 0.4478 | 0.2094 | 0.1776 | 0.146 | 0.1777 |  |  |  |
|  | +gp | 0.5071 | 0.4794 | 0.4725 | 0.4478 | 0.2094 | 0.1776 | 0.146 |  |  |  |  |
| 0 | FBAR 3-6 | 0.4257 | 0.4344 | 0.4604 | 0.4212 | 0.3739 | 0.3739 | 0.4488 |  |  |  |  |

Table 6.8b: Bay of Biscay Sole, Fishing mortality (F) at age (with Orhago survey)

| YEAR <br> AGE |  | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 2 | 0.2965 | 0.3598 | 0.2572 | 0.1741 | 0.2168 | 0.2022 | 0.265 | 0.1437 | 0.1483 | 0.0833 | 0.1097 |
|  | 3 | 0.2429 | 0.3534 | 0.2706 | 0.3539 | 0.398 | 0.4357 | 0.3826 | 0.352 | 0.318 | 0.3532 | 0.3263 |
|  | 4 | 0.3356 | 0.2719 | 0.3173 | 0.3454 | 0.4294 | 0.4254 | 0.5233 | 0.4592 | 0.4527 | 0.4961 | 0.7493 |
|  | 5 | 0.3476 | 0.3716 | 0.3864 | 0.3704 | 0.3456 | 0.589 | 0.5738 | 0.4429 | 0.5569 | 0.6364 | 0.734 |
|  | 6 | 0.3193 | 0.2289 | 0.4833 | 0.4091 | 0.4201 | 0.5226 | 0.3199 | 0.4102 | 1.0819 | 0.5932 | 0.7519 |
|  | 7 | 0.3351 | 0.2915 | 0.3969 | 0.3761 | 0.3996 | 0.5142 | 0.474 | 0.6083 | 0.8348 | 0.7888 | 0.764 |
| +gp |  | 0.3351 | 0.2915 | 0.3969 | 0.3761 | 0.3996 | 0.5142 | 0.474 | 0.6083 | 0.8348 | 0.7888 | 0.764 |
| 0 | FBAR 3-6 | 0.3113 | 0.3064 | 0.3644 | 0.3697 | 0.3983 | 0.4932 | 0.4499 | 0.4161 | 0.6024 | 0.5197 | 0.6404 |
| YEAR <br> AGE |  | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|  | 2 | 0.1559 | 0.1142 | 0.1843 | 0.2115 | 0.1308 | 0.2728 | 0.2198 | 0.2455 | 0.2014 | 0.2335 | 0.2549 |
|  | 3 | 0.3269 | 0.3527 | 0.5124 | 0.3954 | 0.3929 | 0.478 | 0.5084 | 0.5246 | 0.4671 | 0.3744 | 0.3498 |
|  | 4 | 0.6785 | 0.5244 | 0.6643 | 0.7287 | 0.6355 | 0.7656 | 0.6496 | 0.8057 | 0.4414 | 0.4205 | 0.4254 |
|  | 5 | 0.7141 | 0.5034 | 0.5647 | 0.592 | 0.7252 | 0.7179 | 0.5781 | 1.0006 | 0.4133 | 0.2896 | 0.5197 |
|  | 6 | 0.5559 | 0.7689 | 0.6676 | 0.4136 | 0.7104 | 0.5222 | 0.5284 | 0.9623 | 0.5937 | 0.366 | 0.5129 |
| +gp |  | 0.7565 | 0.9817 | 0.7373 | 0.7382 | 0.5325 | 0.4564 | 0.5226 | 0.7472 | 0.7574 | 0.4069 | 0.4164 |
|  |  | 0.7565 | 0.9817 | 0.7373 | 0.7382 | 0.5325 | 0.4564 | 0.5226 | 0.7472 | 0.7574 | 0.4069 | 0.4164 |
| 0 | FBAR 3-6 | 0.5688 | 0.5373 | 0.6023 | 0.5324 | 0.616 | 0.6209 | 0.5661 | 0.8233 | 0.4789 | 0.3626 | 0.4519 |
| YEAR <br> AGE |  | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | FBAR * |  |  |  |
|  | 2 | 0.2131 | 0.2511 | 0.1937 | 0.0848 | 0.1164 | 0.0812 | 0.1421 | 0.1132 |  |  |  |
|  | 3 | 0.4431 | 0.4858 | 0.493 | 0.352 | 0.3057 | 0.4182 | 0.3384 | 0.3541 |  |  |  |
|  | 4 | 0.4574 | 0.4514 | 0.4862 | 0.3976 | 0.5792 | 0.5587 | 0.6348 | 0.5909 |  |  |  |
|  | 5 | 0.3789 | 0.4022 | 0.3948 | 0.4462 | 0.3672 | 0.2681 | 0.4701 | 0.3685 |  |  |  |
|  | 6 | 0.4094 | 0.3847 | 0.4489 | 0.4686 | 0.2236 | 0.2481 | 0.4066 | 0.2928 |  |  |  |
|  | 7 | 0.5043 | 0.4659 | 0.4565 | 0.448 | 0.2081 | 0.1712 | 0.1342 | 0.1712 |  |  |  |
|  | +gp | 0.5043 | 0.4659 | 0.4565 | 0.448 | 0.2081 | 0.1712 | 0.1342 |  |  |  |  |
|  | FBAR 3-6 | 0.4222 | 0.431 | 0.4557 | 0.4161 | 0.369 | 0.3733 | 0.4625 |  |  |  |  |

Table 6.9a: Bay of Biscay Sole, Stock number at age (start of year)

|  | YEAR | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 2 | 24175 | 29544 | 28387 | 24956 | 26765 | 28215 | 32147 | 35807 | 35383 | 24939 | 26293 |
|  | 3 | 15423 | 16261 | 18654 | 19859 | 18972 | 19498 | 20852 | 22313 | 28060 | 27603 | 20762 |
|  | 4 | 10273 | 10945 | 10332 | 12876 | 12610 | 11528 | 11411 | 12864 | 14195 | 18466 | 17541 |
|  | 5 | 7282 | 6645 | 7546 | 6806 | 8247 | 7423 | 6815 | 6118 | 7347 | 8164 | 10165 |
|  | 6 | 4476 | 4654 | 4146 | 4639 | 4251 | 5281 | 3723 | 3471 | 3555 | 3803 | 3905 |
|  | 7 | 3249 | 2943 | 3349 | 2313 | 2788 | 2526 | 2832 | 2444 | 2082 | 1089 | 1895 |
|  | $\begin{aligned} & \text { +gp } \\ & \text { TOTAL } \end{aligned}$ | 4346 | 3022 | 3947 | 2385 | 2434 | 1298 | 2410 | 2243 | 1749 | 1353 | 1351 |
| 0 |  | 69223 | 74014 | 76362 | 73835 | 76068 | 75770 | 80191 | 85261 | 92372 | 85418 | 81912 |
|  |  | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|  | 2 | 23655 | 29479 | 23729 | 22586 | 24440 | 24987 | 16929 | 25034 | 24525 | 17220 | 18563 |
|  | 3 | 21315 | 18314 | 23795 | 17855 | 16541 | 19403 | 17209 | 12293 | 17708 | 18125 | 12337 |
|  | 4 | 13552 | 13900 | 11644 | 12894 | 10877 | 10103 | 10883 | 9362 | 6579 | 10021 | 11249 |
|  | 5 | 7498 | 6217 | 7432 | 5418 | 5626 | 5209 | 4249 | 5141 | 3780 | 3826 | 5937 |
|  | 6 | 4403 | 3318 | 3396 | 3811 | 2709 | 2461 | 2295 | 2156 | 1708 | 2259 | 2590 |
|  | 7 | 1661 | 2277 | 1388 | 1572 | 2271 | 1201 | 1319 | 1222 | 743 | 852 | 1416 |
|  | TOTAL | 1930 | 2180 | 1748 | 2363 | 2448 | 1261 | 1243 | 853 | 490 | 1039 | 1554 |
| 0 |  | 74015 | 75684 | 73131 | 66500 | 64912 | 64626 | 54128 | 56060 | 55532 | 53343 | 53646 |
|  | YEAR | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | GMST 84-** | AMST 84-** |  |
|  | AGE |  |  |  |  |  |  |  |  |  |  |  |
|  | 2 | 19260 | 18154 | 19137 | 36297 | 20955 | 20331 | 14202 | 0 | 24684 | 25243 |  |
|  | 3 | 13014 | 14064 | 12731 | 14298 | 30123 | 16979 | 16954 | 11630 | 18261 | 18792 |  |
|  | 4 | 7868 | 7556 | 7798 | 6959 | 9146 | 19925 | 10396 | 10915 | 10897 | 11238 |  |
|  | 5 | 6623 | 4506 | 4350 | 4310 | 4173 | 4701 | 10089 | 5339 | 5979 | 6180 |  |
|  | 6 | 3176 | 4079 | 2727 | 2649 | 2472 | 2566 | 3284 | 5529 | 3285 | 3412 |  |
|  | 7 | 1401 | 1894 | 2490 | 1576 | 1497 | 1777 | 1779 | 2019 | 1801 | 1937 |  |
|  | +gp | 4044 | 2600 | 3316 | 2784 | 1577 | 3328 | 3839 | 4393 |  |  |  |
| 0 | TOTAL | 55385 | 52853 | 52550 | 68874 | 69942 | 69605 | 60543 | 39824 |  |  |  |

( ) age 2 replaced by GM 93-2010 = 22685
( ) age 3 replaced by GM e-(F10-11+M) =

22685
18601

Table 6.9b: Bay of Biscay Sole, Stock number at age (start of year) (with Orhago survey) - Numbers*10**-3


Table 6.10a: Bay of Biscay Sole, Summary (without SOP correction)
Terminal Fs derived using XSA (With F shrinkage)
RECRUITS TOTALBIO TOTSPBIO LANDINGS YIELD/SSB FBAR 3-6 Age 2

| 1984 | 24175 | 14822 | 12326 | 4038 | 0.328 | 0.311 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 1985 | 29544 | 16068 | 13375 | 4251 | 0.318 | 0.307 |
| 1986 | 28387 | 17086 | 14493 | 4805 | 0.332 | 0.365 |
| 1987 | 24956 | 18682 | 15501 | 5086 | 0.328 | 0.370 |
| 1988 | 26765 | 18542 | 15388 | 5382 | 0.350 | 0.399 |
| 1989 | 28215 | 17822 | 14500 | 5845 | 0.403 | 0.494 |
| 1990 | 32147 | 18449 | 14869 | 5916 | 0.398 | 0.450 |
| 1991 | 35807 | 19166 | 14856 | 5569 | 0.375 | 0.417 |
| 1992 | 35383 | 20597 | 16038 | 6550 | 0.408 | 0.603 |
| 1993 | 24939 | 19974 | 16442 | 6420 | 0.391 | 0.521 |
| 1994 | 26293 | 19378 | 15929 | 7229 | 0.454 | 0.642 |
| 1995 | 23655 | 17749 | 14326 | 6205 | 0.433 | 0.570 |
| 1996 | 29479 | 17849 | 13915 | 5854 | 0.421 | 0.539 |
| 1997 | 23729 | 16574 | 13413 | 6259 | 0.467 | 0.604 |
| 1998 | 22586 | 16555 | 13339 | 6027 | 0.452 | 0.534 |
| 1999 | 24440 | 16070 | 12432 | 5249 | 0.422 | 0.617 |
| 2000 | 24987 | 15617 | 11945 | 5760 | 0.482 | 0.622 |
| 2001 | 16929 | 13129 | 10649 | 4836 | 0.454 | 0.567 |
| 2002 | 25034 | 13254 | 9834 | 5486 | 0.558 | 0.825 |
| 2003 | 24525 | 13435 | 9692 | 4108 | 0.424 | 0.480 |
| 2004 | 17220 | 14291 | 11280 | 4002 | 0.355 | 0.365 |
| 2005 | 18563 | 14623 | 11663 | 4539 | 0.389 | 0.455 |
| 2006 | 19260 | 15548 | 12393 | 4793 | 0.387 | 0.426 |
| 2007 | 18154 | 14626 | 11687 | 4363 | 0.373 | 0.434 |
| 2008 | 19137 | 14654 | 11664 | 4299 | 0.369 | 0.460 |
| 2009 | 36297 | 16828 | 11748 | 3650 | 0.311 | 0.421 |
| 2010 | 20955 | 17790 | 13887 | 3966 | 0.286 | 0.374 |
| 2011 | 20331 | 19486 | 15790 | 4632 | 0.293 | 0.374 |
| 2012 | $(14202)$ | 17448 | 14746 | 4317 | 0.2928 | 0.4488 |

Arith.
$\begin{array}{lllllll}\text { Mean } & 24693 & 16762 & 13383 & 5153 & 0.388 & 0.4826\end{array}$
0 Units (Thousands) (Tonnes) (Tonnes) (Tonnes)
GM 93-2010 $=\quad 22685$

Table 6.10b: Bay of Biscay Sole, Summary (with Orhago survey) (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

| RECRUITS TOTALBIO TOTSPBIO LANDINGS YIELD/SSB FBAR 3-6Age 2 |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1984 | 24178 | 14824 | 12328 | 4038 | 0.328 | 0.311 |
| 1985 | 29549 | 16071 | 13377 | 4251 | 0.318 | 0.306 |
| 1986 | 28400 | 17091 | 14497 | 4805 | 0.332 | 0.364 |
| 1987 | 24965 | 18690 | 15507 | 5086 | 0.328 | 0.370 |
| 1988 | 26767 | 18551 | 15396 | 5382 | 0.350 | 0.398 |
| 1989 | 28237 | 17834 | 14510 | 5845 | 0.403 | 0.493 |
| 1990 | 32161 | 18465 | 14882 | 5916 | 0.398 | 0.450 |
| 1991 | 35839 | 19190 | 14876 | 5569 | 0.374 | 0.416 |
| 1992 | 35394 | 20619 | 16058 | 6550 | 0.408 | 0.602 |
| 1993 | 24954 | 19997 | 16463 | 6420 | 0.390 | 0.520 |
| 1994 | 26335 | 19416 | 15962 | 7229 | 0.453 | 0.640 |
| 1995 | 23667 | 17784 | 14358 | 6205 | 0.432 | 0.569 |
| 1996 | 29490 | 17889 | 13953 | 5854 | 0.420 | 0.537 |
| 1997 | 23740 | 16603 | 13440 | 6259 | 0.466 | 0.602 |
| 1998 | 22591 | 16588 | 13371 | 6027 | 0.451 | 0.532 |
| 1999 | 24447 | 16109 | 12470 | 5249 | 0.421 | 0.616 |
| 2000 | 24999 | 15637 | 11963 | 5760 | 0.482 | 0.621 |
| 2001 | 16939 | 13145 | 10664 | 4836 | 0.454 | 0.566 |
| 2002 | 25105 | 13280 | 9852 | 5486 | 0.557 | 0.823 |
| 2003 | 24637 | 13480 | 9721 | 4108 | 0.423 | 0.479 |
| 2004 | 17219 | 14344 | 11328 | 4002 | 0.353 | 0.363 |
| 2005 | 18577 | 14684 | 11721 | 4539 | 0.387 | 0.452 |
| 2006 | 19359 | 15631 | 12462 | 4793 | 0.385 | 0.422 |
| 2007 | 18394 | 14778 | 11804 | 4363 | 0.370 | 0.431 |
| 2008 | 18942 | 14779 | 11804 | 4299 | 0.364 | 0.456 |
| 2009 | 37000 | 16999 | 11838 | 3650 | 0.308 | 0.416 |
| 2010 | 19941 | 17794 | 14001 | 3966 | 0.283 | 0.369 |
| 2011 | 20426 | 19565 | 15889 | 4632 | 0.292 | 0.373 |
| 2012 | (10183) | 16818 | 14663 | 4317 | 0.2944 | 0.4625 |
| Arith. |  |  |  |  |  |  |
| Mean | 24567 | 16781 | 13419 | 5153 | 0.3869 | 0.4815 |
| 0 Units | (Thousands) | (Tonnes) | (Tonnes) | (Tonnes) |  |  |
| GM 93-2010 = | 22673 |  |  |  |  |  |

Table 6.11a: Multifleet prediction input data
Sole in Bay of Biscay
Multi fleet input data

Input Fs are 2010-2011 means at age 2
Input Fs are 2010-2012 means at age 3 to 8
Catch and stock wts are 2010-2012 means
Recruits are 1993-2010 GM
unscaled F

MFDP version 1a
Run: 2012
Time and date: 11:49 30/04/2013
Fbar age range (Total) : 3-6
Fbar age range Fleet 1 : 3-6

| e | N | M | Mat | PF | PM | Stock Wt | Landings | ding WT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |
| 2 | 22685 | 0.1 | 0.32 | 0 | 0 | 0.198 | 0.0960 | 0.186 |
| 3 | 18647 | 0.1 | 0.83 | 0 | 0 | 0.232 | 0.3481 | 0.218 |
| 4 | 10915 | 0.1 | 0.97 | 0 | 0 | 0.277 | 0.5708 | 0.261 |
| 5 | 5339 | 0.1 | 1 | 0 | 0 | 0.348 | 0.3821 | 0.329 |
| 6 | 5529 | 0.1 | 1 | 0 | 0 | 0.426 | 0.2944 | 0.405 |
| 7 | 2019 | 0.1 | 1 | 0 | 0 | 0.483 | 0.1777 | 0.458 |
| 8 | 4393 | 0.1 | 1 | 0 | 0 | 0.689 | 0.1777 | 0.653 |


| 2014 |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Age | N | M | Mat | PF | PM | Stock Wt | F Landings | Landing WT |
| 2 | 22685 | 0.1 | 0.32 | 0 | 0 | 0.198 | 0.0960 | 0.186 |
| 3 |  | 0.1 | 0.83 | 0 | 0 | 0.232 | 0.3481 | 0.218 |
| 4 |  | 0.1 | 0.97 | 0 | 0 | 0.277 | 0.5708 | 0.261 |
| 5 |  | 0.1 | 1 | 0 | 0 | 0.348 | 0.3821 | 0.329 |
| 6 |  | 0.1 | 1 | 0 | 0 | 0.426 | 0.2944 | 0.405 |
| 7 |  | 0.1 | 1 | 0 | 0 | 0.483 | 0.1777 | 0.458 |
| 8 |  | 0.1 | , | 0 | 0 | 0.689 | 0.1777 | 0.653 |


| Age | N | M | Mat | PF | PM | Stock Wt | F Landings | Landing WT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2 | 22685 | 0.1 | 0.32 | 0 | 0 | 0.198 | 0.0960 | 0.186 |
| 3 |  | 0.1 | 0.83 | 0 | 0 | 0.232 | 0.3481 | 0.218 |
| 4 |  | 0.1 | 0.97 | 0 | 0 | 0.277 | 0.5708 | 0.261 |
| 5 |  | 0.1 | 1 | 0 | 0 | 0.348 | 0.3821 | 0.329 |
| 6 |  | 0.1 | 1 | 0 | 0 | 0.426 | 0.2944 | 0.405 |
| 7 |  | 0.1 | 1 | 0 | 0 | 0.483 | 0.1777 | 0.458 |
| 8 |  | 0.1 | 1 | 0 | 0 | 0.689 | 0.1777 | 0.653 |

Input units are thousands and kg - output in tonnes

Table 6.11b: Multifleet prediction input data (with Orhago survey)

Sole in Bay of Biscay
Multi fleet input data
MFDP version 1a
Run: 2012_O_
Time and date: 17:04 02/05/2013
Fbar age range (Total) : 3-6
Fbar age range Fleet $1: 3-6$

Input Fs are 2010-2011 means at age 2
Input Fs are 2010-2012 means at age 3 to 8
Catch and stock wts are 2010-2012 means
Recruits are 1993-2010 GM
unscaled $F$

2013

| Age | N | M | Mat | PF | PM | Stock Wt | F Landings | Landing WT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2 | 22673 | 0.1 | 0.32 | 0 | 0 | 0.198 | 0.0988 | 0.186 |
| 3 | 18585 | 0.1 | 0.83 | 0 | 0 | 0.232 | 0.3541 | 0.218 |
| 4 | 10993 | 0.1 | 0.97 | 0 | 0 | 0.277 | 0.5909 | 0.261 |
| 5 | 4588 | 0.1 | 1 | 0 | 0 | 0.348 | 0.3685 | 0.329 |
| 6 | 6000 | 0.1 | 1 | 0 | 0 | 0.426 | 0.2928 | 0.405 |
| 7 | 1900 | 0.1 | 1 | 0 | 0 | 0.483 | 0.1712 | 0.458 |
| 8 | 4810 | 0.1 | 1 | 0 | 0 | 0.689 | 0.1712 | 0.653 |



| 2015 |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Age | N | M | Mat | PF | PM | Stock Wt | F Landings | Landing WT |
| 2 | 22673 | 0.1 | 0.32 | 0 | 0 | 0.198 | 0.0988 | 0.186 |
| 3 |  | 0.1 | 0.83 | 0 | 0 | 0.232 | 0.3541 | 0.218 |
| 4 |  | 0.1 | 0.97 | 0 | 0 | 0.277 | 0.5909 | 0.261 |
| 5 |  | 0.1 | 1 | 0 | 0 | 0.348 | 0.3685 | 0.329 |
| 6 |  | 0.1 | 1 | 0 | 0 | 0.426 | 0.2928 | 0.405 |
| 7 |  | 0.1 | 1 | 0 | 0 | 0.483 | 0.1712 | 0.458 |
| 8 |  | 0.1 | 1 | 0 | 0 | 0.689 | 0.1712 | 0.653 |

Input units are thousands and kg - output in tonnes

Table 6.12a: Bay of Biscay Sole Multifleet prediction, management option table

| MFDP version 1a | Basis |
| :--- | :--- |
| Run: 2012 | $F(\mathbf{2 0 1 3})=$ mean $F(\mathbf{1 0 - 1 1})$ unscaled (age 2) |
| Time and date: 11:49 30/04/2013 | $F(\mathbf{2 0 1 3})=$ mean $F(\mathbf{1 0 - 1 2 )}$ unscaled (age 3 |
| Fbar age range (Total) : 3-6 | $\mathbf{R 1 1 - 1 3 = G M ( 9 3 - 1 0 ) = \mathbf { 2 2 . 7 } \text { million }}$Fbar age range Fleet $1: 3-6$ |

2013

| Biomass | SSB | Landings <br> FMult | Landings <br> FBar | Yield |
| :---: | :---: | :---: | :---: | :---: |
| 20069 | 16183 | 1.000 | 0.3989 | 4359 |

2014

|  | Landings <br> Biomass |  |  |  | SSB | Landings |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| FMult | FBar | Landing Yield | Biomass | SSB |  |  |
| 20622 | 16727 | 0.0000 | 0.0000 | 0 | 26634 | 22624 |
| . | 16727 | 0.1000 | 0.0399 | 519 | 26004 | 22006 |
| . | 16727 | 0.2000 | 0.0798 | 1020 | 25397 | 21412 |
| . | 16727 | 0.3000 | 0.1197 | 1502 | 24813 | 20839 |
| . | 16727 | 0.4000 | 0.1595 | 1968 | 24250 | 20288 |
| . | 16727 | 0.5000 | 0.1994 | 2417 | 23707 | 19757 |
| . | 16727 | 0.6000 | 0.2393 | 2850 | 23184 | 19246 |
| . | 16727 | 0.7000 | 0.2792 | 3269 | 22680 | 18752 |
| . | 16727 | 0.8000 | 0.3191 | 3673 | 22193 | 18277 |
| . | 16727 | 0.9000 | 0.3590 | 4063 | 21724 | 17819 |
| . | 16727 | 1.0000 | 0.3989 | 4440 | 21271 | 17377 |
| . | 16727 | 1.1000 | 0.4388 | 4804 | 20835 | 16950 |
| . | 16727 | 1.2000 | 0.4786 | 5156 | 20413 | 16539 |
| . | 16727 | 1.3000 | 0.5185 | 5496 | 20006 | 16141 |
| . | 16727 | 1.4000 | 0.5584 | 5825 | 19612 | 15758 |
| . | 16727 | 1.5000 | 0.5983 | 6143 | 19232 | 15388 |
| . | 16727 | 1.6000 | 0.6382 | 6451 | 18865 | 15030 |
| . | 16727 | 1.7000 | 0.6781 | 6749 | 18510 | 14685 |
| . | 16727 | 1.8000 | 0.7180 | 7038 | 18167 | 14351 |
| . | 16727 | 1.9000 | 0.7578 | 7317 | 17835 | 14028 |
| . | 16727 | 2.0000 | 0.7977 | 7587 | 17514 | 13716 |

Bpa $=13000 \mathrm{t}$
$\mathrm{Fpa}=0.42$
Input units are thousands and kg - output in tonnes

Table 6.12b: Bay of Biscay Sole Multifleet prediction, management option table (with Orhago survey)

MFDP version 1 a
Run: 2012_O_
Time and date: 17:04 02/05/2013
Fbar age range (Total) : 3-6
Fbar age range Fleet 1 : 3-6

## Basis

$F(2013)=$ mean $F(10-11)$ unscaled (age 2)
$F(2013)=$ mean $F(10-12)$ unscaled (age 3
R11-13 $=\mathbf{G M}(93-10)=22.7$ million

2013

| Biomass | SSB | Landings <br> FMult | Landings <br> FBar | Yield |
| :---: | :---: | :---: | :---: | :---: |
| 20244 | 16360 | 1.0000 | 0.4016 | 4389 |

2014

| Biomass | SSB | Landings FMult | Landings FBar | Landing Yield | $2015$ <br> Biomass | SSB |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 20704 | 16814 | 0.0000 | 0.0000 | 0 | 26729 | 22722 |
| . | 16814 | 0.1000 | 0.0402 | 520 | 26097 | 22103 |
| . | 16814 | 0.2000 | 0.0803 | 1021 | 25489 | 21507 |
| . | 16814 | 0.3000 | 0.1205 | 1504 | 24904 | 20934 |
| . | 16814 | 0.4000 | 0.1606 | 1970 | 24340 | 20382 |
| . | 16814 | 0.5000 | 0.2008 | 2419 | 23797 | 19851 |
| . | 16814 | 0.6000 | 0.2409 | 2852 | 23274 | 19339 |
| . | 16814 | 0.7000 | 0.2811 | 3270 | 22769 | 18847 |
| . | 16814 | 0.8000 | 0.3212 | 3674 | 22283 | 18372 |
| . | 16814 | 0.9000 | 0.3614 | 4063 | 21815 | 17914 |
| . | 16814 | 1.0000 | 0.4016 | 4439 | 21363 | 17473 |
|  | 16814 | 1.1000 | 0.4417 | 4802 | 20927 | 17047 |
| . | 16814 | 1.2000 | 0.4819 | 5153 | 20506 | 16637 |
| . | 16814 | 1.3000 | 0.5220 | 5493 | 20099 | 16241 |
| . | 16814 | 1.4000 | 0.5622 | 5821 | 19707 | 15859 |
| . | 16814 | 1.5000 | 0.6023 | 6138 | 19328 | 15490 |
| . | 16814 | 1.6000 | 0.6425 | 6445 | 18962 | 15133 |
| . | 16814 | 1.7000 | 0.6826 | 6742 | 18608 | 14789 |
| . | 16814 | 1.8000 | 0.7228 | 7029 | 18266 | 14457 |
| . | 16814 | 1.9000 | 0.7630 | 7307 | 17936 | 14135 |
| . | 16814 | 2.0000 | 0.8031 | 7576 | 17616 | 13824 |

$\mathrm{Bpa}=13000 \mathrm{t}$
$\mathrm{Fpa}=0.42$
Input units are thousands and kg - output in tonnes

Table 6.13a: Bay of Biscay sole - Detailed predictions
MFDP version 1a
Run: 2012
Time and date: 11:49 30/04/2013
Fbar age range (Total) : 3-6
Fbar age range Fleet 1 : 3-6

| Year: 2013 F multiplier: |  |  |  | Fleet1 HCFba 0.3989 |  |  | SSB(Jan) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Age | Landings <br> F | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) |  | SSNos(ST) | SSB(ST) |
| 2 | 0.096 | 1978 | 368 | 22685 | 4499 | 7259 | 1440 | 7259 | 1440 |
| 3 | 0.3481 | 5232 | 1142 | 18647 | 4332 | 15477 | 3596 | 15477 | 3596 |
| 4 | 0.5708 | 4539 | 1183 | 10915 | 3020 | 10588 | 2929 | 10588 | 2929 |
| 5 | 0.3821 | 1619 | 533 | 5339 | 1858 | 5339 | 1858 | 5339 | 1858 |
| 6 | 0.2944 | 1345 | 544 | 5529 | 2357 | 5529 | 2357 | 5529 | 2357 |
| 7 | 0.1777 | 313 | 143 | 2019 | 975 | 2019 | 975 | 2019 | 975 |
| 8 | 0.1777 | 682 | 445 | 4393 | 3028 | 4393 | 3028 | 4393 | 3028 |
| Total |  | 15707 | 4359 | 69527 | 20069 | 50604 | 16183 | 50604 | 16183 |


| Year: 2014 F multiplier: 1 |  |  |  | Fleet1 HCFba 0.3989 |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Age | $\begin{aligned} & \text { Landings } \\ & \mathrm{F} \\ & \hline \end{aligned}$ | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) | SSB(Jan) | SSNos(ST) | SSB(ST) |
| 2 | 0.096 | 1978 | 368 | 22685 | 4499 | 7259 | 1440 | 7259 | 1440 |
| 3 | 0.3481 | 5232 | 1142 | 18647 | 4332 | 15477 | 3596 | 15477 | 3596 |
| 4 | 0.5708 | 4954 | 1291 | 11912 | 3296 | 11555 | 3197 | 11555 | 3197 |
| 5 | 0.3821 | 1692 | 557 | 5581 | 1942 | 5581 | 1942 | 5581 | 1942 |
| 6 | 0.2944 | 802 | 325 | 3297 | 1405 | 3297 | 1405 | 3297 | 1405 |
| 7 | 0.1777 | 578 | 265 | 3727 | 1799 | 3727 | 1799 | 3727 | 1799 |
| 8 | 0.1777 | 754 | 492 | 4857 | 3348 | 4857 | 3348 | 4857 | 3348 |
| Total |  | 15989 | 4440 | 70707 | 20622 | 51753 | 16727 | 51753 | 16727 |


| Year: 2015 F multiplier: 1 |  |  |  | Fleet1 HCFba 0.3989 |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Age | Landings <br> F | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) | SSB(Jan) | SSNos(ST) | SSB(ST) |
| 2 | 0.096 | 1978 | 368 | 22685 | 4499 | 7259 | 1440 | 7259 | 1440 |
| 3 | 0.3481 | 5232 | 1142 | 18647 | 4332 | 15477 | 3596 | 15477 | 3596 |
| 4 | 0.5708 | 4954 | 1291 | 11913 | 3296 | 11555 | 3197 | 11555 | 3197 |
| 5 | 0.3821 | 1847 | 608 | 6091 | 2120 | 6091 | 2120 | 6091 | 2120 |
| 6 | 0.2944 | 838 | 339 | 3446 | 1469 | 3446 | 1469 | 3446 | 1469 |
| 7 | 0.1777 | 345 | 158 | 2222 | 1073 | 2222 | 1073 | 2222 | 1073 |
| 8 | 0.1777 | 1009 | 659 | 6503 | 4483 | 6503 | 4483 | 6503 | 4483 |
| Total |  | 16202 | 4565 | 71507 | 21271 | 52554 | 17377 | 52554 | 17377 |

[^1]Table 6.13b: Bay of Biscay sole - Detailed predictions (with Orhago survey)
MFDP version 1 a
Run: 2012_O
Time and date: 17:04 02/05/2013
Fbar age range (Total) : 3-6
Fbar age range Fleet 1 : 3-6

| Year: 2013 F multiplier: 1 |  |  |  | Fleet1 HCFba 0.4016 |  |  | SSB(Jan) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Age | $\begin{aligned} & \text { Landings } \\ & \mathrm{F} \\ & \hline \end{aligned}$ | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) |  | SSNos(ST) | SSB(ST) |
| 2 | 0.0988 | 2031 | 378 | 22673 | 4497 | 7255 | 1439 | 7255 | 1439 |
| 3 | 0.3541 | 5289 | 1155 | 18585 | 4318 | 15426 | 3584 | 15426 | 3584 |
| 4 | 0.5909 | 4690 | 1223 | 10993 | 3041 | 10663 | 2950 | 10663 | 2950 |
| 5 | 0.3685 | 1350 | 444 | 4588 | 1597 | 4588 | 1597 | 4588 | 1597 |
| 6 | 0.2928 | 1453 | 588 | 6000 | 2558 | 6000 | 2558 | 6000 | 2558 |
| 7 | 0.1712 | 285 | 130 | 1900 | 917 | 1900 | 917 | 1900 | 917 |
| 8 | 0.1712 | 721 | 471 | 4810 | 3316 | 4810 | 3316 | 4810 | 3316 |
| Total |  | 15820 | 4389 | 69549 | 20244 | 50642 | 16360 | 50642 | 16360 |


| Year: 2014 F multiplier: |  |  |  | Fleet1 HCFba 0.4016 |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Age | Landings <br> F | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) | SSB(Jan) | SSNos(ST) | SSB(ST) |
| 2 | 0.0988 | 2031 | 378 | 22673 | 4497 | 7255 | 1439 | 7255 | 1439 |
| 3 | 0.3541 | 5290 | 1155 | 18585 | 4318 | 15426 | 3584 | 15426 | 3585 |
| 4 | 0.5909 | 5035 | 1313 | 11802 | 3265 | 11448 | 3167 | 11448 | 3171 |
| 5 | 0.3685 | 1621 | 533 | 5509 | 1917 | 5509 | 1917 | 5509 | 1935 |
| 6 | 0.2928 | 695 | 281 | 2872 | 1224 | 2872 | 1224 | 2872 | 1228 |
| 7 | 0.1712 | 607 | 278 | 4051 | 1955 | 4051 | 1955 | 4051 | 1959 |
| 8 | 0.1712 | 767 | 501 | 5116 | 3527 | 5116 | 3527 | 5116 | 3524 |
| Total |  | 16047 | 4439 | 70608 | 20704 | 51677 | 16814 | 51677 | 16814 |


| Year: 2015 F multiplier: 1 |  |  |  | Fleet1 HCFba 0.4016 |  |  | SSB(Jan) | SSNos(ST) | SSB(ST) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Age | Landings <br> F | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) |  |  |  |
| 2 | 0.0988 | 2031 | 378 | 22673 | 4497 | 7255 | 1439 | 7255 | 1439 |
| 3 | 0.3541 | 5290 | 1155 | 18585 | 4318 | 15426 | 3584 | 15426 | 3585 |
| 4 | 0.5909 | 5036 | 1313 | 11802 | 3265 | 11448 | 3167 | 11448 | 3171 |
| 5 | 0.3685 | 1740 | 572 | 5914 | 2058 | 5914 | 2058 | 5914 | 2062 |
| 6 | 0.2928 | 835 | 338 | 3448 | 1470 | 3448 | 1470 | 3448 | 1484 |
| 7 | 0.1712 | 291 | 133 | 1939 | 936 | 1939 | 936 | 1939 | 938 |
| 8 | 0.1712 | 1048 | 685 | 6990 | 4818 | 6990 | 4818 | 6990 | 4819 |
| Total |  | 16270 | 4573 | 71352 | 21363 | 52421 | 17473 | 52421 | 17473 |

Input units are thousands and kg - output in tonnes

Table 6.14a: Stock numbers of recruits and their source for recent year classes used in predictions and the relative (\%) contributions to landings and SSB (by weight) of these year classes


Sole in VIIIa,b : Year-class \% contribution to
a) 2014 landings

b) 2015 SSB


Table 6.14b: Stock numbers of recruits and their source for recent year classes used in predictions and the relative (\%) contributions to landings and SSB (by weight) of these year classes (with Orhago survey)

| Year-class |  |  | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Stock No. (thousands) |  |  | 19941 | 20426 | 22673 | 22673 | 22673 | 22673 |
| of |  | year-olds |  |  |  |  |  |  |
| Source |  |  | XSA | XSA | GM93-2010 | GM93-2010 | GM93-2010 | 93-2010 |
| Status Quo F: |  |  |  |  |  |  |  |  |
| \% in | 2013 | landings | 10.1 | 27.9 | 26.3 | 8.6 | - | - |
| \% in | 2014 |  | 6.3 | 12.0 | 29.6 | 26.0 | 8.5 | - |
| \% in | 2013 | SSB | 9.8 | 18.0 | 21.9 | 8.8 | - | - |
| \% in | 2014 | SSB | 7.3 | 11.5 | 18.8 | 21.3 | 8.5 | - |
| \% in | 2015 | SSB | 5.4 | 8.5 | 11.8 | 18.1 | 20.5 | 8.2 |

## Sole in VIIla,b : Year-class \% contribution to



Table 6.15a: Bay of Biscay Sole Multifleet Yield per recruit
MFYPR version $2 a$
Run: 2012_
Time and date: 11:50 30/04/2013
Yield per results

| Landings <br> FMult | Landings <br> Fbar | CatchNos | Yield | StockNos | Biomass | SpwnNosJan | SSBJan | SpwnNosSpwn |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 10.5083 | 5.4469 | 9.6499 | 5.2695 | 9.6499 |
| 0.1000 | 0.0399 | 0.1969 | 0.0820 | 8.5415 | 4.1766 | 7.6857 | 3.9998 | 7.6857 |
| 0.2000 | 0.0798 | 0.3353 | 0.1322 | 7.1602 | 3.3009 | 6.3069 | 3.1247 | 6.3069 |
| 0.3000 | 0.1197 | 0.4364 | 0.1635 | 6.1521 | 2.6745 | 5.3012 | 2.4989 | 5.3012 |
| 0.4000 | 0.1595 | 0.5124 | 0.1831 | 5.3941 | 2.2135 | 4.5456 | 2.0386 | 4.5456 |
| 0.5000 | 0.1994 | 0.5711 | 0.1953 | 4.8105 | 1.8666 | 3.9642 | 1.6922 | 3.9642 |
| 0.600 | 0.2393 | 0.6172 | 0.2026 | 4.3520 | 1.6006 | 3.5080 | 1.4268 | 3.5080 |
| 0.7000 | 0.2792 | 0.6542 | 0.2069 | 3.9858 | 1.3934 | 3.1439 | 1.2201 | 3.1439 |
| 0.8000 | 0.3191 | 0.6842 | 0.2091 | 3.6889 | 1.2298 | 2.8492 | 1.0570 | 2.8492 |
| 0.9000 | 0.3590 | 0.7089 | 0.2099 | 3.4450 | 1.0990 | 2.6074 | 0.9268 | 2.6074 |
| 1.0000 | 0.3989 | 0.7294 | 0.2099 | 3.2424 | 0.9934 | 2.4069 | 0.8217 | 2.4069 |
| 1.1000 | 0.4388 | 0.7467 | 0.2094 | 3.0721 | 0.9071 | 2.2387 | 0.7360 | 2.2387 |
| 1.2000 | 0.4786 | 0.7615 | 0.2085 | 2.9277 | 0.8361 | 2.0962 | 0.6654 | 2.0962 |
| 1.3000 | 0.5185 | 0.7741 | 0.2074 | 2.8041 | 0.7771 | 1.9746 | 0.6069 | 1.9746 |
| 1.4000 | 0.5584 | 0.7851 | 0.2062 | 2.6974 | 0.7277 | 1.8697 | 0.5579 | 1.8697 |
| 1.5000 | 0.5983 | 0.7946 | 0.2050 | 2.6045 | 0.6860 | 1.7787 | 0.5167 | 1.7787 |
| 1.6000 | 0.6382 | 0.8030 | 0.2038 | 2.5230 | 0.6505 | 1.6990 | 0.4816 | 1.6990 |
| 1.7000 | 0.6781 | 0.8105 | 0.2026 | 2.4510 | 0.6200 | 1.6288 | 0.4516 | 1.6288 |
| 1.8000 | 0.7180 | 0.8171 | 0.2015 | 2.3870 | 0.5937 | 1.5666 | 0.4258 | 1.5666 |
| 1.9000 | 0.7578 | 0.8231 | 0.2004 | 2.3298 | 0.5709 | 1.5110 | 0.4033 | 1.5110 |
| 2.0000 | 0.7977 | 0.8285 | 0.1994 | 2.2782 | 0.5509 | 1.4611 | 0.3838 | 1.4611 |


| Reference point | F multiplier | Absolute F |
| :--- | :---: | :---: |
| Fleet1 Landings Fbar(3-6) | 1.0000 | 0.3989 |
| FMax | 0.9460 | 0.3773 |
| F0.1 | 0.4790 | 0.1911 |
| F35\%SPR | 0.4527 | 0.1806 |

Weights in kilograms

Table 6.15b: Bay of Biscay Sole Multifleet Yield per recruit (Long term equilibrium)
Long-term equilibrium at F status quo

| landings | SSB |
| :---: | :---: |
| Yield ${ }^{*}$ GM | SSBSpwn *GM |
| 4762 | 18640 |

GM (93-10) for recruits (age 2) 22685

Table 6.15c: Bay of Biscay Sole Multifleet Yield per recruit (with Orhago survey)
MFYPR version $2 a$
Run: 2012_O_
Time and date: 17:05 02/05/2013
Yield per results

| Landings <br> FMult | Landings <br> Fbar | CatchNos | Yield | StockNos | Biomass | SpwnNosJan | SSBJan | SpwnNosSpwn | SSBSpwn |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 10.5083 | 5.4469 | 9.6499 | 5.2695 | 9.6499 | 5.2695 |
| 0.1000 | 0.0402 | 0.1955 | 0.0806 | 8.5556 | 4.1877 | 7.6998 | 4.0110 | 7.6998 |  |
| 0.2000 | 0.0803 | 0.3338 | 0.1304 | 7.1749 | 3.3136 | 6.3217 | 3.1375 | 6.3217 | 3.0110 |
| 0.3000 | 0.1205 | 0.4353 | 0.1616 | 6.1628 | 2.6854 | 5.3121 | 2.5099 | 5.3121 | 2.5099 |
| 0.4000 | 0.1606 | 0.5119 | 0.1813 | 5.3998 | 2.2217 | 4.5514 | 2.0468 | 4.5514 | 2.0468 |
| 0.5000 | 0.2008 | 0.5710 | 0.1937 | 4.8112 | 1.8720 | 3.9652 | 1.6977 | 3.9652 | 1.6977 |
| 0.6000 | 0.2409 | 0.6176 | 0.2012 | 4.3484 | 1.6035 | 3.5047 | 1.4298 | 3.5047 | 1.4298 |
| 0.7000 | 0.2811 | 0.6549 | 0.2056 | 3.9786 | 1.3943 | 3.1372 | 1.2211 | 3.1372 | 1.2211 |
| 0.8000 | 0.3212 | 0.6852 | 0.2079 | 3.6789 | 1.2290 | 2.8397 | 1.0564 | 2.8397 | 1.0564 |
| 0.9000 | 0.3614 | 0.7101 | 0.2089 | 3.4329 | 1.0970 | 2.5958 | 0.9249 | 2.5958 | 0.9249 |
| 1.0000 | 0.4016 | 0.7309 | 0.2090 | 3.2286 | 0.9904 | 2.3936 | 0.8188 | 2.3936 | 0.8188 |
| 1.1000 | 0.4417 | 0.7483 | 0.2085 | 3.0571 | 0.9034 | 2.2242 | 0.7324 | 2.2242 | 0.7324 |
| 1.2000 | 0.4819 | 0.7631 | 0.2077 | 2.9118 | 0.8319 | 2.0809 | 0.6613 | 2.0809 | 0.6613 |
| 1.3000 | 0.5220 | 0.7758 | 0.2066 | 2.7876 | 0.7725 | 1.9587 | 0.6024 | 1.9587 | 0.6024 |
| 1.4000 | 0.5622 | 0.7868 | 0.2055 | 2.6804 | 0.7228 | 1.8534 | 0.5532 | 1.8534 | 0.5532 |
| 1.5000 | 0.6023 | 0.7964 | 0.2043 | 2.5873 | 0.6809 | 1.7622 | 0.5118 | 1.7622 | 0.5118 |
| 1.6000 | 0.6425 | 0.8049 | 0.2032 | 2.5057 | 0.6453 | 1.6825 | 0.4766 | 1.6825 | 0.4766 |
| 1.7000 | 0.6826 | 0.8123 | 0.2020 | 2.4337 | 0.6148 | 1.6123 | 0.4466 | 1.6123 | 0.4466 |
| 1.8000 | 0.7228 | 0.8190 | 0.2009 | 2.3698 | 0.5886 | 1.5501 | 0.4208 | 1.5501 | 0.4208 |
| 1.9000 | 0.7630 | 0.8249 | 0.1999 | 2.3126 | 0.5658 | 1.4947 | 0.3984 | 1.4947 | 0.3984 |
| 2.0000 | 0.8031 | 0.8303 | 0.1990 | 2.2612 | 0.5458 | 1.4451 | 0.3789 | 1.4451 | 0.3789 |


| Reference point | F multiplier | Absolute F |
| :--- | :---: | :---: |
| Fleet1 Landings Fbar(3-6) | 1.0000 | 0.4016 |
| FMax | 0.9601 | 0.3855 |
| F0.1 | 0.4867 | 0.1955 |
| F35\%SPR | 0.4547 | 0.1826 |

Weights in kilograms

Table 6.15d: Bay of Biscay Sole Multifleet Yield per recruit (Long term equilibrium) (with Orhago survey)

Long-term equilibrium at F status quo

| landings | SSB |
| :---: | :---: |
| Yield ${ }^{*}$ GM | SSBSpwn ${ }^{*}$ GM |
| 4739 | 18565 |

GM (93-10) for recruits (age 2)
22673


Figure 6.1 a:


Figure 6.1 b:
Bay of Biscay sole French length distribution from 1994 to 2003
Total French landings
Discard estimates of the French offshore trawler fleet (1994 to 2003)


Figure 6.1 c: Bay of Biscay sole French length distribution from 2004 to 2011






Figure 6.2 a: Bay of Biscay sole landings and discards age distributions from 1984 to 1999 (numbers in thousands)






2003


2007



Figure 6.2 b:



2011


Bay of Biscay sole landings and discards age distributions from 2000 to 2011 ; landings age distribution since 2004 (numbers in thousands)

Total landings
Discard estimates of the French offshore trawlers fleet


Figure 6.3: Orhago survey time series


Figure 6.4: Bay of Biscay sole (Division VIIIa,b). LPUE trends of the 5 available commercial tuning fleets and CPUE of the ORHAGO survey (for sole greater than the minimum landing size, i.e. 24 cm )


Figure 6.5a: Bay of Biscay sole (Division VIIIa,b)

```
-1 -2 - 3 - 4 -5 - 6 - 7
```

XSA (No Taper, mean q, s.e. shrink $=1.5$, s.e. $\min =.2$ )

LOG CATCHABILITY RESIDUAL PLOTS (XSA)




Figure 6.5b: Bay of Biscay sole (Division VIIIa,b)

## (with Orhago survey)

XSA (No Taper, mean q, s.e. shrink = 1.5, s.e. $\min =.2$ )


XSA (No Taper, mean q, s.e. shrink = 1.5, s.e. $\min =.2$ )


Figure 6.6: Bay of Biscay sole (Division VIIIa,b) - comparison WG13 with and without Orhago


Figure 6.7a: Bay of Biscay sole (Division VIIIa,b) - Retrospective results
(No taper, $q$ indep. stock size all ages, $q$ indep. of age $>=6$, shr. $=1.5$ )


Figure 6.7b: Bay of Biscay sole (Division VIIIa,b) - Retrospective results (with Orhago survey)
(No taper, $q$ indep. stock size all ages, $q$ indep. of age $>=6$, shr. $=1.5$ )


Figure 6.8a: Sole in Division VIIIa,b (Bay of Biscay) - Trends for Landings, F, R, SSB


Figure 6.8b: Sole in Division VIIIa,b (Bay of Biscay) - Trends for Landings, F, R, SSB (with Orhago survey)


MFYPR version 2a
Run: 2012
Time and date: 11:50 30/04/2013

| Reference point | F multiplier | Absolute $\mathbf{F}$ |
| :--- | :---: | :---: |
| Fleet1 Landings Fbar(3-6) | 1.0000 | 0.3989 |
| FMax | 0.9460 | 0.3773 |
| F0.1 | 0.4790 | 0.1911 |
| F35\%SPR | 0.4527 | 0.1806 |

## Weights in kilograms



MFDP version 1a
Run: 2012
Time and date: 11:49 30/04/2013
Fbar age range (Total) : 3-6
Fbar age range Fleet $1: 3-6$

Input units are thousands and kg - output in tonnes

Figure 6.9a: Sole in Division VIIIa,b (Bay of Biscay)



MFYPR version 2a MFDP version 1a
Run: 2012_O
Time and date: 17:05 02/05/2013

| Reference point | F multiplier | Absolute F |
| :--- | :---: | :---: |
| Fleet1 Landings Fbar(3-6) | 1.0000 | 0.4016 |
| FMax | 0.9601 | 0.3855 |
| F0.1 | 0.4867 | 0.1955 |
| F35\%SPR | 0.4547 | 0.1826 |
|  |  |  |

Run: 2012 O
Time and date: 17:04 02/05/2013
Fbar age range (Total) : 3-6
Fbar age range Fleet 1 : 3-6
Input units are thousands and kg - output in tonnes

Figure 6.9b: Sole in Division VIIIa,b (Bay of Biscay) (with Orhago survey)


Figure 6.10: Bay of Biscay sole (Division VIIIa,b) - WG12 / WG13 (with and without Orhago survey) comparison

## 7 Southern Stock of Hake

### 7.1 General

The type of assessment is "update" based on a previous benchmark assessment (WKROUND, 2010). Last year the model could not be updated because of unreliable landings data.

Data revisions: landings length distribution for years 2009 and 2010 did not included landings from the Cadiz fleets. These amounts are relatively small although they represent an important part of small fish. These data have been corrected.

Review comments have been addressed along the report

### 7.1.1 Fishery description

Fishery description is available in the Stock Annex (Annex G).

### 7.1.2 ICES advice for 2013 and Management applicable to 2012 and 2013.

## ICES Advice for 2013

ICES advised, on the basis of the transition to the MSY approach, that landings in 2013 should be no more than 10600 t .

## Management Applicable for 2012 and 2013

Hake is managed by TAC, effort control and technical measures. The agreed TAC for Southern Hake in 2012 was 12299 t and in 2013 is 14144 t.

A Recovery Plan for southern hake was enacted in 2006 (CE 2166/2005). This plan aims to rebuild the stock to within safe biological limits by decreasing fishing mortality a maximum of $10 \%$ at year with a TAC constrain of $15 \%$. SSB target ( 35000 t ) is not considered suitable under the new assessment model. This regulation includes effort management in addition to TAC measures, set in Reg. EU Council 39/2013 (annex IIb)

Since 2006, a $10 \%$ annual reduction of fishing days at sea was applied to all vessels, although with some exclusions. In 2012, vessels that landed less than 5 tonnes of hake in 2009 or 2010 are excluded. The effort from fishing trips which retain $<3 \%$ hake are excluded from the regulation.

Technical measures applied to this stock include: (i) minimum landing size of 27 cm , (ii) protected areas, and (iii) minimum mesh size. These measures are set depending on areas and gears by several national regulations.

According to the Spanish Regulations in 2012 and 2013 the fishing options have been shared by quarters and individual trawlers (ARM/3158/2011 and Res. 28-12-2012 SGMAR). The Portuguese regulations also established a closure for trawling off the southwest coast of Portugal between December and February.

### 7.2 Data

### 7.2.1 Commercial Catch: landings and discards

## Catches: landings and discards

Southern Hake catches by country and gear for the period 1972-2012, as estimated by the WG, are given in Table 7.1. In contrast to previous years, official landings figures from Spain were presented. The discrepancy between national landings and scientific estimates was included as unallocated landings.

In 2012, Portuguese landings were 2607 t , slightly above those from 2011 (2 214 t ). Spanish official landings in 2011 ( 6462 t ) and 2012 ( 5831 t ) are considered unreliable compared with those from previous years (16 839 in 2009 or 13033 in 2012). Unallocated landings are 8396 t in 2011 ( $49 \%$ of total landings) and 6136 t in $2012(42 \%$ of total landings). Total landings in 2011 were 17072 t and 14573 t in 2012. Total discards in 2011 were 1893 t and 1992 in 2012. Total catches were 18965 t and 16565 in 2011 and 2012, representing a $13 \%$ catch reduction.

## Biological Sampling

The sampling levels in 2012 are summarized in Table 1.3.

## Length Composition

Table 7.2 presents the length compositions of catches (landings and discards) and mean length for 2012. Mean size in landings is 36.6 cm and 19.9 cm for discards, similar to previous years.

## Growth, Length-weight relationship and $M$

An international length-weight relationship for the whole period has been used since 1999 (see Stock Annex G). The assessment model follows a constant von Bertalanffy model with fixed Linf $=130 \mathrm{~cm}, \mathrm{t}_{0}=0$ and estimating k parameter. Natural mortality was assumed to be 0.4 year $^{-1}$ for all ages and years.

## Maturity ogive

The stock is assessed with annual maturity ogives for males and females together. The maturity proportion in this assessment year is shown in Figure 7.2. L50 in 2012 is 31.5 cm , which is less than in previous years when L50 was relatively stable around $36-37 \mathrm{~cm}$.

### 7.2.2 Abundance indices from surveys

Biomass, abundance and recruitment indices for the Portuguese and Spanish surveys respectively are presented in Table 7.3 and Table 7.4 and Figure 7.3. The Spanish (SpGFS-WIBTS-Q4 and SPGFS-caut-WIBTS-Q4) and the Portuguese (PtGFS-WIBTSQ4) surveys are used to tune the model, by fitting the model estimates to the observed length proportions and survey trends.
Since 1989 the Portuguese Autumn survey (PtGFS-WIBTS-Q4) has shown variable abundance indices with a minimum in 1987 and maximum in 2009. The survey was not performed in 2012. The Spanish groundfish survey (SpGFS-WIBTS-Q4) shows low values for biomass and abundance in early 2000s. These values increased from
early 2000s and peaked to historical maximum in 2009 and have remained stable since.

The recruitment indices of the SpGFS-WIBTS-Q4, SPGFS-caut-WIBTS-Q4 and PtGFS-WIBTS-Q4 (Figure 7.3) were highly variable in the past showing good recruitments in recent years. In 2012, SpGFS-WIBTS-Q4 and SPGFS-caut-WIBTS-Q4 are around the historical mean.

## Commercial catch-effort data

Effort and landings series are collected from Portuguese logbooks and compiled by IPMA. Spanish sales notes and Owners Associations data were compiled by IEO to estimate fleet effort until 2012 and are presented in figure 7.4 and table 7.5. These data are scientific estimations based on some selected flees from some harbours. Since the fleet dynamics are complex and considers temporal movements among harbours, this values are mainly valid for LPUE trends and their use to follow landings or effort trends may be done with caution.

The two fleets included in the assessment model are SP-CORUTR and P-TR. SPCORUTR peaks at 2011 with 47 Kg per fishing day and 100 HP . In 2012 the LPUE is the second best with 42, similar than the mean in 2008-12. P-TR data for 2011 and 2012 are not available. The LPUE trend was increasing until 2010, with a peak of 43 $\mathrm{Kg} /$ hour (standardized series). Data for SP-CORUTRP, SP-VIMATR, SP-SANTTR have never been included in the model and were not available in 2012.

The standardized CPUE from the Portuguese bottom-trawl fleet targeting roundfish has been routinely calculated by fitting a GLM to log-book data on landings and effort.. Since 2012, log-book data have been received in different formats compared with previous years. Additionally, 2012 data were only partially available due to the implementation of the electronic log-books in mid-year. For the moment only the last paper-based log-books were standardised. as catch and effort data were unavailable for 2011 and 2012. These situations require some time to be corrected and therefore it is expected that during 2013 it be possible to regain a degree of control over the way data are processed. Consequently, estimates of Portuguese bottom-trawl CPUE for 2011 and 2012 were not be available for the WG meeting.

### 7.3 Assessment

The assessment carried out used the gadget model (length-age based) as decided by WKROUND (2010) and described on the stock annex (Annex G).

### 7.3.1 Model diagnostics

Likelihood profiles for each parameter estimated by the model are presented in Figure 7.5. This analysis is carried out in each parameter individually and it does not guarantee that the model found an absolute minimum. It allows checking that the minimization algorithm found a minimum. The values on the horizontal axes of the plots represent multiplicative factors with respect to the estimated parameter value. To check for convergence the minimum likelihood value must correspond to the estimated parameter value (i.e. the multiplier 1). The change in likelihood may be very large if the model gives "understoking", i.e. if it is not able to produce enough fish to subtract the observed catches from the modelled population. Due to the distinct impact each parameter has on the likelihood value, the plots are presented scaled and unscaled. In Figure 7.5, all parameter estimates correspond to the minimum of the likelihood.

Residuals for surveys and abundance indices (SpGFS-WIBTS-Q4 and PtGFS-WIBTSQ4) and commercial fleets (SP-CORUTR and P-TR) are presented in Fig 7.6a-b, grouped in 15 cm classes (from 4 to 49 in surveys and 25 to 70 cm in commercial fleets). Most residuals are within the range of -1 to 1 ( $\pm 1$ s.d.). Surveys' residuals show a random distribution without any trend.. PtGFS-WIBTS-Q4 was not performed in 2012. Regarding commercial fleets, P-TR (25-40 cm) was not available for 2011 and 2012. P-TR ( $25-40 \mathrm{~cm}$ ) shows a downwards trends in more recent years. The difficulty of these indices to follow the abundance generated by the recent increase in recruitment may be due to the fact that discards are not included in the computation of it. Apart from this, the fits are quite consistent.

Figures 7.6 (c-i) present bubble plots of residuals for proportions at length. These proportions are grouped by 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 (7.6-d) and discards (7.6f). The residual analysis shows that there is an underestimation (positive residuals) in the most exploited lengths and overestimation on the larger sizes (negative residuals). Such patterns are not of major concern once that the residuals' values are quite small (maximum $\sim 0.3$ ). The model takes into account the data precision when weighting the individual likelihood components (defined in Stock Annex), so data sets with larger model residuals will have less impact on the overall model fit.

### 7.3.2 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 7.7. The selection patterns of different "fleets" of catches (catches in 1982-93; landings in 1994-2010; discards 1992-2010 and Cadiz landings (1982-2004) are presented in the upper plot. The pattern corresponding to catches during 1982-93 shows higher relative efficiency for smaller fish (when compared with catches from 1994 onwards), which is in agreement with our assumption that before 1992 (when the minimum landing size was implemented) the importance of discards was relatively lower. The discards (1992-12) and landings (1994-2012) selection patterns are used for projections.

Survey selection patterns are presented in the lower selection pattern 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.
The von Bertalanffy k parameter was estimated to be 0.164 , similar to the previous assessment (0.165).

## Historic trends in biomass, fishing mortality, yield and recruitment

Model estimates of abundance at length in the beginning of the $4^{\text {th }}$ quarter are presented in Figure 7.8. The figure shows a general increase of small fish after 2004 that contributes to an increase of large fish in more recent years.

Table 7.6 and Figure 7.9 present summary results with estimated annual values for fishing mortality (averaged over ages 1-3), recruitment (age 0 ) and SSB, as well as observed landings and discards.

The recruitment (age 0) is highly variable and presents two different periods: one from 1982 to 2003 with mean figures around 70 million, ranging from 40 to 120, and a recent period from 2004 to 2012 with a mean of 114 million ranging from 60 to 160 million. Following the technical annex, 2012 recruitment was substituted with the geometric mean of years 1989-11. The parameter is usually poorly estimated as shown by the retrospective pattern (Fig 7.10). Fishing mortality increased from the beginning of the time series ( $\mathrm{F}=0.36$ in 1982) peaking in 1995 at 1.18; declining to 0.77 in 1999 and remaining relatively stable until 2009 ( $\mathrm{F}=0.95$ ). There was a further decline in recent years to 0.57 in 2012. The SSB was very high at the beginning of the time series with values around 40000 t , then decreased to a minimum of 5900 t in 1998. Since then biomass has continuously increased reaching 20900 in 2012.

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

Figure 7.10 presents the results of the assessments performed using the retrospective data series from 2012-2008. There is a clear trend in the retrospective pattern for recruitment, F and SSB. The recruitment shows high variability with a tendency to be overestimated. SSB also shows a tendency to be overestimated in contrast to F which is underestimated.

### 7.4 Catch options and prognosis

### 7.4.1 Short-term projections

The methodology used this year was developed during the benchmark (WKROUND, 2010) and described in the Stock Annex (Annex G). Results are presented in Fig. 7.11 and Table 7.7. Note that GADGET is length based and F multipliers do not apply linearly, e.g. if Fmult is $1, \mathrm{~F}$ is 0.57 and if Fmult $=0.5$ produces F is 0.27 .

In 2013 the expected SSB is 25392 t . Fsq for the intermediate year (2013) is estimated as the average of the last 3 assessment years and scaled to the $F$ in last year since there is a reduction trend in F for recent years. Recruitment for 2012 was not accepted because of the uncertainties shown in the retrospective analysis. Recruitment used for projections in years 2012-14 was the geometric mean of 1989-2011 (81 100 thousands)

During the intermediate year, 2013, the expected yield (landings) is 17723 t and the SSB at the end of the year is expected to be 27393 t .

Different F multipliers applied in 2014 provide management alternatives according to different scenarios. Under Fsq (0.57) the expected yield would be 18155 t and SSB in 2015 would be 26627 t. Decreasing F by $10 \%$ ( 0.51 ), the yield and SSB would be 16750 and 28934 t . With the MSY transition scheme F would be 0.33 , yield 12025 t and SSB 36861 t . If landings in 2014 correspond to a $15 \%$ increase with respect to the 2013 TAC, then landings are 12266 t , corresponding to $\mathrm{F}=0.49$ and SSB in 2015 is 29 717 t . At Fmax $(F m s y$ proxy $=0.24$ ) yield in 2014 would be 9171 t and SSB in 201341 764 t.

### 7.4.2 Yield and biomass per recruit analysis

F producing maximum landings per recruit was estimated following the Stock Annex (Annex G). This results in $\mathrm{Fmax}=0.24$ and $\mathrm{F} 0.1=0.17$ (Figure 7.12). The same as last year.

Next table shows the expected figures for different reference Fs.

|  | $F(1-3)$ | Yield/R |  | SSB/R |  |
| :--- | :---: | :---: | :---: | :---: | :---: |
| Fsq | 0.57 | 0.19 | 0.28 |  |  |
| Fmax | 0.24 | 0.24 | 0.87 |  |  |
| F0.1 | 0.17 | 0.23 | 1.20 |  |  |
| F35\%SPR | 0.2 | 0.23 | 1.05 |  |  |

### 7.5 Biological reference points

Fmax ( $\mathrm{F}=0.24$ ) is the Southern hake Fmsy proxy. No other reference points are defined.

### 7.6 Comments on the assessment

This assessment is a biennial update since no reliable landings were available last year. The assessment procedure followed the Southern hake stock annex although two indexes could not be updated (PtGFS-WIBTS-Q4 and P-TR).

The assessment results show good recruitment in recent years. However, recruitment in the terminal year is unreliable. Surveys show that 2012 recruitment abundance ( $<20$ cm ) is around the historical mean.

Catches have declined since 2009 and F follows a similar decreasing trend. However, F in 2012 was 0.57 which is well above Fmax ( 0.24 ). SSB continues the increasing trend observed in recent years. Given the lack of abundance indices for large fish at the beginning of the time series, the SSB estimates for this period may be considered with caution.

The retrospective pattern shows a trend to overestimate SSB and underestimate F

### 7.7 Management considerations

An important part of landings are unallocated in 2011 (49\%) and 2012(43\%) and total catches are well above the advised TAC. Exceeding the TAC may compromise the goals of the recovery plan.

There are indications of good recruitment since 2005. In 2012 the survey indices show that recruitment is aroud the historic mean.

F in 2012 continues to be above Fmax. The stock is being overexploited.
The retrospective pattern shows overestimation of SSB and underestimation of F. the impact on the advised TAC is relatively minor since both processes balance each other. The forecasted increase in SSB may be lower than predicted due to indications of overestimation and should be treated with caution.

Hake is a top predator which is caught in a multispecies fishery and decisions on hake management will have an impact on the trophic chain that was not accounted for in this assessment.

Table 7.1 HAKE SOUTHERN STOCK. Catch estimates ('000 t) by country and gear, 1972-2012

|  | SPAIN |  |  |  |  |  |  |  |  | PORTUGAL |  |  |  | FRANCE | UNALLOCATED | TOTAL |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| YEAR | ART | GILLNET | LONGLINE | Cd-Trw | Pr-Bk TRW | Pa-Trw | Ba-Trw | DISC | LAND | ART | TRAWL | DISC | LAND | TOTAL |  | DISC | LAND | CATCH |
| 1972 | 7.10 | - | - | - | 10.20 |  |  |  | 17.3 | 4.70 | 4.10 | - | 8.8 |  |  | - | 26.1 | 26.1 |
| 1973 | 8.50 | - | - | - | 12.30 |  |  |  | 20.8 | 6.50 | 7.30 | - | 13.8 | 0.20 |  | - | 34.8 | 34.8 |
| 1974 | 1.00 | 2.60 | 2.20 | - | 8.30 |  |  |  | 14.1 | 5.10 | 3.50 | - | 8.6 | 0.10 |  | - | 22.8 | 22.8 |
| 1975 | 1.30 | 3.50 | 3.00 | - | 11.20 |  |  |  | 19.0 | 6.10 | 4.30 | - | 10.4 | 0.10 |  | - | 29.5 | 29.5 |
| 1976 | 1.20 | 3.10 | 2.60 | - | 10.00 |  |  |  | 16.9 | 6.00 | 3.10 | - | 9.1 | 0.10 |  | - | 26.1 | 26.1 |
| 1977 | 0.60 | 1.50 | 1.30 | - | 5.80 |  |  |  | 9.2 | 4.50 | 1.60 | - | 6.1 | 0.20 |  | - | 15.5 | 15.5 |
| 1978 | 0.10 | 1.40 | 2.10 | - | 4.90 |  |  |  | 8.5 | 3.40 | 1.40 | - | 4.8 | 0.10 |  | - | 13.4 | 13.4 |
| 1979 | 0.20 | 1.70 | 2.10 | - | 7.20 |  |  |  | 11.2 | 3.90 | 1.90 | - | 5.8 | - |  | - | 17.0 | 17.0 |
| 1980 | 0.20 | 2.20 | 5.00 | - | 5.30 |  |  |  | 12.7 | 4.50 | 2.30 | - | 6.8 | - |  | - | 19.5 | 19.5 |
| 1981 | 0.30 | 1.50 | 4.60 | - | 4.10 |  |  |  | 10.5 | 4.10 | 1.90 | - | 6.0 | - |  | - | 16.5 | 16.5 |
| 1982 | 0.27 | 1.25 | 4.18 | 0.49 | 3.92 |  |  |  | 10.1 | 5.01 | 2.49 | . | 7.5 | - |  | - | 17.6 | 17.6 |
| 1983 | 0.37 | 2.10 | 6.57 | 0.57 | 5.29 |  |  |  | 14.9 | 5.19 | 2.86 | - | 8.0 | - |  | - | 22.9 | 22.9 |
| 1984 | 0.33 | 2.27 | 7.52 | 0.69 | 5.84 |  |  |  | 16.7 | 4.30 | 1.22 | - | 5.5 | - |  | - | 22.2 | 22.2 |
| 1985 | 0.77 | 1.81 | 4.42 | 0.79 | 5.33 |  |  |  | 13.1 | 3.77 | 2.05 | - | 5.8 | - |  | - | 18.9 | 18.9 |
| 1986 | 0.83 | 2.07 | 3.46 | 0.98 | 4.86 |  |  |  | 12.2 | 3.16 | 1.79 | - | 4.9 | 0.01 |  | - | 17.2 | 17.2 |
| 1987 | 0.53 | 1.97 | 4.41 | 0.95 | 3.50 |  |  |  | 11.4 | 3.47 | 1.33 | . | 4.8 | 0.03 |  | - | 16.2 | 16.2 |
| 1988 | 0.70 | 1.99 | 2.97 | 0.99 | 3.98 |  |  |  | 10.6 | 4.30 | 1.71 | - | 6.0 | 0.02 |  | - | 16.7 | 16.7 |
| 1989 | 0.56 | 1.86 | 1.95 | 0.90 | 3.92 |  |  |  | 9.2 | 2.74 | 1.85 | - | 4.6 | 0.02 |  | - | 13.8 | 13.8 |
| 1990 | 0.59 | 1.72 | 2.13 | 1.20 | 4.13 |  |  |  | 9.8 | 2.26 | 1.14 | - | 3.4 | 0.03 |  | - | 13.2 | 13.2 |
| 1991 | 0.42 | 1.41 | 2.20 | 1.21 | 3.63 |  |  |  | 8.9 | 2.71 | 1.25 | - | 4.0 | 0.01 |  | - | 12.8 | 12.8 |
| 1992 | 0.40 | 1.48 | 2.05 | 0.98 | 3.79 |  |  | 0.14 | 8.7 | 3.77 | 1.33 | 0.33 | 5.1 | - |  | 0.5 | 13.8 | 14.3 |
| 1993 | 0.37 | 1.26 | 2.74 | 0.54 | 2.67 |  |  | 0.24 | 7.6 | 3.04 | 0.87 | 0.44 | 3.9 | - |  | 0.7 | 11.5 | 12.2 |
| 1994 | 0.37 | 1.90 | 1.47 | 0.32 |  | 0.82 | 1.90 | 0.29 | 6.8 | 2.30 | 0.79 | 0.71 | 3.1 | - |  | 1.0 | 9.9 | 10.9 |
| 1995 | 0.37 | 1.59 | 0.96 | 0.46 |  | 2.34 | 2.94 | 0.93 | 8.6 | 2.56 | 1.03 | 1.18 | 3.6 | - |  | 2.1 | 12.2 | 14.3 |
| 1996 | 0.23 | 1.15 | 0.98 | 0.98 |  | 1.46 | 2.17 | 0.91 | 7.0 | 2.01 | 0.76 | 0.99 | 2.8 | - |  | 1.9 | 9.7 | 11.6 |
| 1997 | 0.30 | 1.04 | 0.76 | 0.88 |  | 1.32 | 1.78 | 1.07 | 6.1 | 1.52 | 0.90 | 1.20 | 2.4 | - |  | 2.3 | 8.5 | 10.8 |
| 1998 | 0.32 | 0.75 | 0.62 | 0.53 |  | 0.88 | 1.95 | 0.57 | 5.0 | 1.67 | 0.97 | 1.11 | 2.6 | - |  | 1.7 | 7.7 | 9.4 |
| 1999 | 0.33 | 0.60 | 0.00 | 0.57 |  | 0.87 | 1.59 | 0.35 | 4.0 | 2.12 | 1.09 | 1.17 | 3.2 | - |  | 1.5 | 7.2 | 8.7 |
| 2000 | 0.26 | 0.85 | 0.15 | 0.58 |  | 0.83 | 1.98 | 0.62 | 4.7 | 2.09 | 1.16 | 1.21 | 3.3 | - |  | 1.83 | 7.90 | 9.7 |
| 2001 | 0.32 | 0.55 | 0.11 | 1.20 |  | 1.06 | 1.12 | 0.37 | 4.4 | 2.02 | 1.20 | 1.29 | 3.2 | - |  | 1.66 | 7.58 | 9.2 |
| 2002 | 0.22 | 0.58 | 0.12 | 0.88 |  | 1.37 | 0.75 | 0.38 | 3.9 | 1.81 | 0.97 | 1.11 | 2.8 | - |  | 1.49 | 6.70 | 8.2 |
| 2003 | 0.37 | 0.43 | 0.17 | 1.25 |  | 1.36 | 1.07 | 0.41 | 4.7 | 1.13 | 0.96 | 1.05 | 2.1 | - |  | 1.46 | 6.74 | 8.2 |
| 2004 | 0.48 | 0.42 | 0.13 | 1.06 |  | 1.66 | 1.13 | 0.22 | 4.9 | 1.27 | 0.80 | 0.69 | 2.1 | - |  | 0.91 | 6.94 | 7.9 |
| 2005 | 0.72 | 0.63 | 0.09 | 0.88 |  | 2.77 | 1.14 | 0.38 | 6.2 | 1.10 | 0.96 | 1.60 | 2.1 | - |  | 1.98 | 8.30 | 10.3 |
| 2006 | 0.48 | 0.71 | 0.35 | 0.63 |  | 4.70 | 1.81 | 2.65 | 8.7 | 1.22 | 0.91 | 0.61 | 2.1 | - |  | 3.26 | 10.80 | 14.1 |
| 2007 | 0.83 | 1.80 | 0.89 | 0.50 |  | 6.71 | 2.07 | 1.19 | 12.8 | 1.41 | 0.72 | 1.31 | 2.1 | - |  | 2.50 | 14.93 | 17.4 |
| 2008 | 1.12 | 2.64 | 1.51 | 0.53 |  | 6.32 | 2.44 | 1.45 | 14.6 | 1.27 | 0.94 | 0.86 | 2.2 | - |  | 2.31 | 16.77 | 19.1 |
| 2009 | 1.41 | 2.92 | 2.10 | 0.55 |  | 7.37 | 2.54 | 0.98 | 16.9 | 1.39 | 0.96 | 1.96 | 2.4 | - |  | 2.93 | 19.24 | 22.2 |
| 2010 | 0.72 | 1.71 | 1.88 | 0.68 |  | 6.33 | 1.71 | 1.00 | 13.0 | 1.61 | 0.73 | 0.58 | 2.3 | 0.36 |  | 1.58 | 15.74 | 17.3 |
| 2011 | 0.42 | 1.09 | 0.76 | 0.53 |  | 2.18 | 1.48 | 1.21 | 6.5 | 1.72 | 0.49 | 0.74 | 2.2 |  | 8.40 | 1.95 | 17.07 | 19.0 |
| 2012 | 0.34 | 0.85 | 1.08 | 0.50 |  | 1.64 | 1.42 | 1.35 | 5.8 | 1.79 | 0.81 | 0.71 | 2.6 |  | 6.14 | 2.06 | 14.57 | 16.6 |

Table 7.2 HAKE SOUTHERN STOCK - length compositions (thousands)g ii


Table 7.3 HAKE SOUTHERN STOCK - Portuguese groundfish surveys; biomass, abundance and recruitment indices

| Year | Winter (ptGFS-WIBTS-Q1) |  |  |  |  | Summer |  |  |  |  | Autumn (ptGFS-WIBTS-Q4) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Biomass (kg/h) |  | Abundance (N/h) |  |  | Biomass (kg/h) |  | Abundance (N/h) |  |  | Biomass (kg/h) |  | Abundance ( $\mathrm{N} / \mathrm{h}$ ) |  |  |  |
|  | Mean | s.e. | Mean | s.e. | hauls | Mean | s.e. | Mean | s.e. | hauls | Mean | s.e. | Mean | s.e. | n/hour < <br> 20 cm (1) | hauls |
| 1979* |  |  |  |  |  | 11.7 |  | 80.4 |  | 55 | 9.5 |  | na |  |  | 55 |
| 1980* (**) | 11.3 |  | 178.1 |  | 36 | 15.4 |  | 153.0 |  | 63 | 12.5 |  | 108.7 |  |  | 62 |
| 1981 ( Autumn "*) | 10.7 | 0.7 | 122.4 | 15.5 | 67 | 9.9 | 1.3 | 87.8 | 15.5 | 69 | 24.4 | 0.5 | 734.8 | 29.3 |  | 111 |
| 1982 | 18.1 | 2.5 | 265.6 | 37.5 | 69 | 11.0 | 2.7 | 93.0 | 32.8 | 70 | 10.6 | 1.8 | 119.5 | 34.7 |  | 190 |
| 1983 ( Autumn **) | 27.0 | 6.0 | 530.5 | 151.0 | 69 | 15.1 | 2.3 | 120.5 | 20.8 | 98 | 13.4 | 0.5 | 121.8 | 4.8 |  | 117 |
| 1984 |  |  |  |  |  | 14.3 | 0.8 | 170.7 | 15.6 | 101 | 11.0 | . 7 | 128.7 | 8.4 | 86.7 | 150 |
| 1986 |  |  |  |  |  | 27.4 | 1.8 | 249.4 | 15.1 | 118 | 17.7 | 1.2 | 165.6 | 28.4 | 90.2 | 117 |
| 1987 |  |  |  |  |  |  |  |  |  |  | 8.6 | 0.9 | 37.4 | 3.7 | 7.3 | 81 |
| 1988 |  |  |  |  |  |  |  |  |  |  | 15.3 | 1.7 | 177.8 | 30.8 | 111.7 | 98 |
| 1989 |  |  |  |  |  | 11.9 | 0.9 | 80.8 | 8.6 | 114 | 8.4 | 0.5 | 59.6 | 4.6 | 19.8 | 130 |
| 1990 |  |  |  |  |  | 9.8 | 1.0 | 95.6 | 13.5 | 98 | 11.8 | 1.0 | 157.2 | 26.3 | 97.2 | 107 |
| 1991 |  |  |  |  |  | 14.2 | 1.2 | 104.2 | 11.3 | 119 | 20.9 | 4.3 | 195.3 | 41.5 | 92.3 | 80 |
| 1992 | 14.5 | 1.2 | 176.4 | 32.3 | 88 | 10.9 | 1.1 | 74.1 | 11.4 | 81 | 11.7 | 1.7 | 65.2 | 11.1 | 18.8 | 51 |
| 1993 | 9.0 | 0.7 | 78.7 | 16.8 | 75 | 11.3 | 1.7 | 105.0 | 34.7 | 66 | 5.5 | 0.8 | 54.4 | 12.9 | 28.4 | 58 |
| 1994 |  |  |  |  |  |  |  |  |  |  | 9.9 | 1.0 | 98.9 | 12.1 | 52.9 | 77 |
| 1995 |  |  |  |  |  | 15.0 | 1.4 | 129.3 | 16.3 | 81 | 14.8 | 1.7 | 85.8 | 10.7 | 7.9 | 80 |
| 1996*********) |  |  |  |  |  |  |  |  |  |  | 9.2 | 1.1 | 109.9 | 17.8 | 18.2 | 63 |
| 1997 |  |  |  |  |  | 19.0 | 1.4 | 206.5 | 16.9 | 86 | 24.6 | 9.3 | 208.0 | 92.5 | 62.1 | 51 |
| 1998 |  |  |  |  |  | 10.5 | 0.8 | 71.6 | 8.6 | 87 | 15.6 | 2.0 | 140.6 | 21.7 | 75.9 | 64 |
| 1999*** |  |  |  |  |  | 11.8 | 0.7 | 116.2 | 10.1 | 65 | 11.6 | 1.5 | 118.3 | 17.1 | 14.4 | 71 |
| 2000 |  |  |  |  |  | 16.4 | 1.6 | 123.0 | 15.2 | 88 | 11.8 | 1.8 | 102.7 | 19.9 | 49.2 | 66 |
| 2001 |  |  |  |  |  | 16.6 | 1.7 | 132.5 | 14.2 | 83 | 15.6 | 2.8 | 164.2 | 38.5 | 89.9 | 58 |
| 2002 |  |  |  |  |  |  |  |  |  |  | 13.0 | 2.1 | 117.6 | 26.9 | 60.6 | 66 |
| 2003 *** |  |  |  |  |  |  |  |  |  |  | 9.8 | 1.0 | 94.2 | 8.0 | 11.9 | 71 |
| 2004 *** |  |  |  |  |  |  |  |  |  |  | 18.4 | 3.3 | 402.3 | 85.2 | 78.2 | 79 |
| 2005 | 17.7 | 2.6 | 384.0 | 53.8 | 68 |  |  |  |  |  | 19.0 | 1.9 | 214.2 | 23.5 | 131.7 | 87 |
| 2006 | 16.0 | 2.0 | 377.5 | 55.4 | 66 |  |  |  |  |  | 16.5 | 1.8 | 126.2 | 11.0 | 54.7 | 88 |
| 2007 | 22.4 | 3.4 | 609.1 | 114.1 | 63 |  |  |  |  |  | 25.8 | 2.8 | 370.2 | 46.7 | 240.0 | 96 |
| 2008 | 31.1 | 4.8 | 700.6 | 170.8 | 67 |  |  |  |  |  | 34.6 | 4.3 | 293.6 | 33.9 | 87.7 | 87 |
| 2009 |  |  |  |  |  |  |  |  |  |  | 37.5 | 4.4 | 476.4 | 75.9 | 318.6 | 93 |
| 2010 |  |  |  |  |  |  |  |  |  |  | 38.2 | 4.3 | 418.0 | 49.8 | 249.8 | 87 |
| $\begin{aligned} & 2011 \\ & 2012 \end{aligned}$ |  |  |  |  |  |  |  |  |  |  | 18.7 | 1.5 | 272.9 | 25.2 | 179.4 | 86 |

all data concerns 20 mm cod end mesh size except data marked with * which concerns 40 mm
(**) all area not covered
RV Capricornio, other years RN Norueg
Strata depth:
from 1979
from 1989 to 2004 covers $20-500 \mathrm{~m}$ depth
since 2005 covers $20-500 \mathrm{~m}$ depth
since 2002 tow duration is 30 min for autumn survey

Table 7.4 HAKE SOUTHERN STOCK - Spanish groundfish surveys; abundances and recruitment indices
for total area (Mino - Bidasoa). Biomass for Cadiz surveys.
for total area (Mino - Bidasoa). Biomass for Cadiz surveys.

| Year | Spanish Survey (SpGFS-WIBTS-Q4) (/30 min) |  |  |  |  |  | Cadiz Survey (SPGFS-caut-WIBTS-Q4) (hour) |  |  |  | Cadiz Survey (SPGFS-cspr-WIBTS-Q4) (hour) |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Biomass index ( Kg ) |  | Abundance Index ( $\mathrm{n}^{\circ}$ ) |  |  | $\begin{gathered} \hline \text { Recruits }(<20 \mathrm{~cm}) \\ \text { Mean } \\ \hline \hline \end{gathered}$ | Biomass index ( Kg ) |  | Rec ( 20 cm ) |  | Biomass index ( Kg ) |  | Rec ( $<20 \mathrm{~cm}$ ) |  |
|  | Mean | s.e. | Hauls | Mean | s.e. |  | 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 | 68 335 |  |  |  |  | 4.66 7.66 | 1.28 1.14 | 30 31 | 71.5 72.7 |
| 1996 | ${ }^{6.54}$ | 0.59 | 114 | 345.2 | 40.5 | 335 |  |  |  |  | 7.66 | 1.14 | 31 | 72.7 |
| 1997 1998 | 7.27 3.36 | 0.78 0.28 | 119 | 421.4 75.9 | 56.5 8.7 | 410 65 | $\begin{aligned} & 5.28 \\ & 2.66 \end{aligned}$ | $\begin{aligned} & 2.77 \\ & 0.42 \end{aligned}$ | $\begin{aligned} & 27 \\ & 34 \end{aligned}$ | $\begin{aligned} & 26.7 \\ & 6.6 \end{aligned}$ | $\begin{aligned} & 3.34 \\ & 2.93 \end{aligned}$ | $\begin{aligned} & 0.52 \\ & 0.67 \end{aligned}$ | $\begin{aligned} & 30 \\ & 31 \end{aligned}$ | 72.5 18.6 |
| $\begin{aligned} & 1998 \\ & 1999 \end{aligned}$ | $\begin{aligned} & 3.36 \\ & 3.35 \end{aligned}$ | $\begin{aligned} & 0.28 \\ & 0.25 \end{aligned}$ | $\begin{aligned} & 114 \\ & 116 \end{aligned}$ | $\begin{aligned} & 75.9 .3 \\ & 95 \end{aligned}$ | $\begin{aligned} & 8.7 \\ & 10.6 \\ & 10.6 \end{aligned}$ | $\begin{aligned} & 65 \\ & 89 \end{aligned}$ | $\begin{aligned} & 2.66 \\ & 2.71 \end{aligned}$ | $\begin{aligned} & 0.42 \\ & 0.44 \end{aligned}$ | $\begin{aligned} & 34 \\ & 38 \end{aligned}$ | $\begin{aligned} & 6.6 \\ & 23.9 \\ & \end{aligned}$ | $\begin{aligned} & 2.93 \\ & 3.93 \end{aligned}$ | $\begin{aligned} & 0.67 \\ & 0.37 \end{aligned}$ | 31 38 | 18.6 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 | ${ }_{37}$ | 48.2 | 3.75 | 0.50 | ${ }_{3}^{42}$ | 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 |

Table 7.5 HAKE SOUTHERN STOCK. Landings (tonnes), Catch per unit effort and effort for trawl fleets


Table 7.6. Southern Hake Stock Assessment summary

| Year | Mort (1-3) | $\mathbf{R}$ (million) | SSB ('000 tn) | Land ('000 tn) | Disc ('000 tn) | Catch ('000 tn) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1982 | 0.36 | 98.4 | 41.1 | 17.6 |  | 17.6 |
| 1983 | 0.44 | 81.5 | 45.8 | 22.9 |  | 22.9 |
| 1984 | 0.45 | 69.5 | 43.1 | 22.2 |  | 22.2 |
| 1985 | 0.42 | 44.1 | 43.2 | 18.9 |  | 18.9 |
| 1986 | 0.45 | 41.0 | 40.0 | 17.2 |  | 17.2 |
| 1987 | 0.51 | 50.1 | 36.8 | 16.2 |  | 16.2 |
| 1988 | 0.65 | 71.2 | 27.0 | 16.7 |  | 16.7 |
| 1989 | 0.65 | 78.1 | 19.9 | 13.8 |  | 13.8 |
| 1990 | 0.69 | 82.3 | 16.3 | 13.2 |  | 13.2 |
| 1991 | 0.69 | 69.9 | 16.5 | 12.8 |  | 12.8 |
| 1992 | 0.84 | 52.5 | 15.6 | 13.8 | 0.5 * | 14.3 |
| 1993 | 0.90 | 60.9 | 12.8 | 11.5 | 0.7 * | 12.2 |
| 1994 | 0.89 | 119.4 | 9.0 | 9.9 | 1.0 * | 10.9 |
| 1995 | 1.18 | 51.3 | 7.2 | 12.2 | 2.1 * | 14.3 |
| 1996 | 1.14 | 100.4 | 8.6 | 9.7 | 1.9 * | 11.6 |
| 1997 | 1.16 | 80.3 | 6.7 | 8.5 | 2.3 * | 10.8 |
| 1998 | 0.93 | 59.3 | 5.9 | 7.7 | 1.7 * | 9.4 |
| 1999 | 0.77 | 65.9 | 7.6 | 7.2 | 1.5 * | 8.7 |
| 2000 | 0.86 | 69.5 | 9.0 | 7.9 | 1.8 * | 9.7 |
| 2001 | 0.84 | 49.1 | 9.3 | 7.6 | 1.7 * | 9.2 |
| 2002 | 0.80 | 69.8 | 9.7 | 6.7 | 1.5 * | 8.2 |
| 2003 | 0.82 | 60.0 | 9.5 | 6.7 | 1.5 * | 8.2 |
| 2004 | 0.71 | 79.4 | 9.5 | 6.9 | 0.9 | 7.9 |
| 2005 | 0.75 | 125.5 | 9.8 | 8.3 | 2.0 | 10.3 |
| 2006 | 0.86 | 96.7 | 11.4 | 10.8 | 3.3 | 14.1 |
| 2007 | 0.90 | 159.1 | 13.4 | 14.9 | 2.5 | 17.4 |
| 2008 | 0.89 | 117.9 | 13.4 | 16.8 | 2.3 | 19.1 |
| 2009 | 0.95 | 112.0 | 14.8 | 19.2 | 2.9 | 22.2 |
| 2010 | 0.70 | 69.4 | 14.7 | 15.4 | 1.6 | 16.9 |
| 2011 | 0.73 | 145.3 | 18.6 | 17.1 | 1.9 | 19.0 |
| 2012 | 0.57 | 81.1 | 20.9 | 14.6 | 2.1 | 16.6 |

2010 landings do not include 0.36 t from france

* estimated from survey abundance, discards and discards/landings rate Recruitment $2012=81100$ million (geo mean 1989-11)

Table 7.7. Short term projections

|  | SSB 2013 | BIO 2013 | F 2013 = F 2012 | Yield 2013 |  | Catch 2013 | SSB 2014 | BIO 2014 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| number | 25392 | 33572 | 0.57 | 17723 | 19640 | 27393 | 34229 |  |


| Fmult | F 2014 | Yield 2014 |  | Catch 2014 | SSB 2015 |  |
| :--- | ---: | ---: | ---: | ---: | :--- | :---: |
| 0.00 | 0.00 | 23 | 25 | 58009 |  |  |
| 0.1 | 0.05 | 2264 | 2465 | 53960 |  |  |
| 0.20 | 0.11 | 4420 | 4815 | 50106 |  |  |
| 0.30 | 0.16 | 6470 | 7052 | 46480 |  |  |
| 0.40 | 0.22 | 8419 | 9180 | 43070 |  |  |
| 0.44 | 0.24 | 9171 | 10001 | 41764 Fmax |  |  |
| 0.50 | 0.27 | 10270 | 11202 | 39867 | $36861-15 \%$ |  |
| 0.60 | 0.33 | 12025 | 13123 | 34043 | Ftrans |  |
| 0.70 | 0.39 | 13688 | 14944 | 33232 TAC 13 $=14144$ |  |  |
| 0.73 | 0.41 | 14170 | 15472 | 31403 |  |  |
| 0.80 | 0.45 | 15262 | 16670 | $29717+15 \%$ |  |  |
| 0.87 | 0.49 | 16266 | 17772 | 28934 |  |  |
| 0.90 | 0.51 | 16750 | 18304 | 26627 Fsq |  |  |
| 1.00 | 0.57 | 18155 | 19848 | 24474 |  |  |
| 1.10 | 0.63 | 19479 | 21307 | 22466 |  |  |
| 1.20 | 0.69 | 20726 | 22682 | 20596 |  |  |
| 1.30 | 0.76 | 21898 | 23977 | 18857 |  |  |
| 1.40 | 0.82 | 22998 | 25195 | 17242 |  |  |
| 1.50 | 0.89 | 24029 | 26338 | 15744 |  |  |
| 1.60 | 0.95 | 24994 | 27410 |  |  |  |

There is a EC Recovery Plan (-10\% annual F redution; +-15\% TAC constrain)
Fmsy proxi $=$ Fmax (0.24)
No B trigger decided
No other Biological Reference Points
TAC 2013 = 14144 (-+15\% [12 022-16 266])
$F$ transition $\min \left(0.2^{*} F 2010+0.8^{*} \mathrm{Fmax}\right)=0.33$
Recruitment $=81.1$ mill (geo mean 1989-09)


Figure 7.1. Length distribution of catches used in the assessment. Landings (1982-12) plus Cadiz landings from 1994-2004. Discards from 1992-12. Minimum landing size (MLS) since 1992 at 27 cm .


Figure 7.2 Maturity ogives from 1908 to 2012


FIGURE 7.3 HAKE SOUTHERN STOCK - Recruitment and biomass Indices from groundfish surveys


FIGURE 7.4 HAKE SOUTHERN STOCK - LPUE and fishing effort trends for trawl fleets



















Figure 7.5. Gadget convergence with likelihood profiles. Free scaled (upper panel) and fixed scaled (lower panel)


Figure 7.6 Diagnostics Residuals (a); observed vs. expected length proportions (b-h);
(7.6 a) Survey residuals by 15 cm groups (4-19, 19-34, 34-49 cm)

( 7.6 b) LPUE residuals by 15 cm groups (25-40, 40-55, 55-70 cm)

( 7.6 c). Bubble plot for landings length distribution from 1982 to 1993.

Raw proportion at length residuals - Land94-12

(7.6 d). Bubble plot for landings length distribution from 1994 to 2010.
(7.6 e). Bubble plot for Cadiz landings length distribution from 1982 to 2004.

## Raw proportion at length residuals - Disc


(7.6 f). Bubble plot for Discards length distribution for years 1993,97,99, 2004-2010

Raw proportion at length residuals - ptGFS-WIBTS-Q4

( 7.6 g ) Bubble plot for Portuguese demersal survey (ptGFS-WIBTS-Q4)

(7.6 h) Bubble plot for North Spain demersal survey (stGFS-WIBTS-Q4)

(7.6 i) Bubble plot for South Spain (Cadiz) demersal survey (stGFS-caut-WIBTS-Q4)

## Selection Pattern

## Catch



Surveys



Figure 7.7. Selection pattern (upper panel) and and von Bertalanffy growth with $k$ parameter estimated by the model (lower panel)


Figure 7.8. Population length distribution.


Figure 7.9. Summary plot. SSB and removals (catch, landings and discards) in ' 000 t . Recruitment in ‘000000 individuals.

Retrospective Pattern




Figure 7.10. Retrospective plot

Short Term Projections



Figure 11. Short term advice

## Equilibrium Projections



Figure 12. Long term yield and SSB per recruit

## Stock-Recruitment



Figure 7.13 Stock-Recruitment plot.

## 8 Anglerfish (Lophius piscatorius and L. budegassa) in Divisions VIIIc and IXa

L. piscatorius and L. budegassa

Type of assessment in 2013: Update (the assessment models and settings were approved in the benchmark WKFLAT-2012).

Software used: SS3 for L. piscatorius and ASPIC for L. budegassa.
Data revisions this year: Spanish landings in 2011 for L. piscatorius and for $L$. budegassa.

## RG2012 comments:

The editorial comments from the Review Group have been addressed and errors have been fixed for the present report. Further comments were not accomplished:
L. piscatorius

RG: "Table 1 in the stock annex has not included the settings for the 2012 assessment." The Table 1 makes reference to historical assessments so it only includes previous assessment approaches. The current assessment is explained in detail in the text.

RG: "Need to show some comparison with previous assessment to have an idea of the change in the historical perception of the stock due to the new assessment method." This comparison was carried out in the benchmark WKFLAT2012 when the new assessment model was approved.

## L. budegassa:

RG: "The difference between the catch composition in the Spanish and Portuguese fisheries should be explored." It was considered to be explored at the next benchmark.

RG: "There is a lack of summary table showing F, SSB and $R$ - data is only present in a figure very nice with a comparison between the former and the present assessment, however an explanation for the very large discrepancy would be nice." The summary table with F, SSB and R is not suitable for the results from an ASPIC assessment model, as this information is not estimated by this stock production model.

RG: "We could not find the annex $M$ were most of the assessment results seem to be given." The WG agreed not produce an Annex and to upload the assessment results in the ICES SharePoint.

### 8.1 General

Two species of anglerfish, Lophius piscatorius and L. budegassa, are found in ICES Divisions VIIIc and IXa. 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 VIIIc and IXa and Portuguese
landings of Division IXa are derived from their relative proportions in market samples.

The benchmark assessment of anglerfish in Division VIIIc and IXa was carried out in 2012, a new assessment using Stock Synthesis (SS3) for L. piscatorius was approved and new settings and data were incorporate to the ASPIC model for L. budegassa.

The ageing estimation problems, detected in a previous benchmarck (see WGHMM2007 report) continue unsolved for L. piscatorius (ICES, 2012) and no new studies were carried out for L. budegassa. The grow pattern inferred from markrecapture and length composition analysis (Landa et al., 2008) was used in the assessment of L. piscatorius.

### 8.2 Summary of ICES advice for 2013 and management for 2012 and 2013 <br> ICES advice for 2013:

As both species of anglerfish are caught in the same fisheries and are subject to a combined TAC, the same multiplicative factor for current fishing mortality is assumed for both species. The change is driven by L. piscatorius, as it is the species in poorest condition. Following the ICES MSY transition implies fishing mortality to be reduced by $19 \%$.

ICES advises the following landings for 2013 on the basis of the MSY transition:
L. piscatorius: less than $1350 t$; L. budegassa: less than $740 t$; Combined anglerfish: less than 2090 t.

## Management applicable for 2012 and 2013:

The two species are managed under a common TAC that was set at 3300 t for 2012 and 2475 t for 2013.

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

### 8.3 Anglerfish (L. piscatorius) in Divisions VIIIc and IXa

### 8.3.1 General

### 8.3.1.1 Ecosystem aspects

The ecosystem aspects of the stock are common with L. budegassa and are described in the Stock Annex (Annex H).

### 8.3.1.2 Fishery description

L. piscatorius is 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, Annex H).
The length distribution of the landings is considerably different between both fisheries, with the gillnet landings showing higher mean lengths compared to the trawl landings. Since 2001 to 2012, the Spanish landings were on average $45 \%$ from the trawl fleet (mean lengths in 2012 of 57 cm and 55 cm in Divisions VIIIc and IXa, respectively) and $55 \%$ from the gillnet fishery (mean length of 78 cm in Division VIIIc
in 2012). For the same period, Portuguese landings were on average $10 \%$ from bottom trawlers (mean length of 61 cm in 2012) and $90 \%$ from the artisanal fleet (mean length of 64 cm in 2012).

### 8.3.2 Data

### 8.3.2.1 Commercial catches and discards

Total landings by country and gear for the period 1978-2012, as estimated by the WG, are given in Table 8.1.1. Spanish landings for 2011 and 2012 have been provided by the official national administration responsible for fishery statistics in Spain.

Spanish discards estimates of L. piscatorius in weight and associated coefficient of variation (CV) are shown in the Table 8.1.2. For the available time series anglerfish discards represent less than $12 \%$ of Spanish trawl catches. An increase in estimated discards was observed in 2004, 2005 and 2006 in relation to previous years. The maximum value of the time series occurred in 2012 with 63 t .
L. piscatorius discards in the Portuguese trawl fisheries are considered negligible (Fernández \& Prista, 2012).

### 8.3.2.2 Biological sampling

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

The sampling levels for 2012 are shown in Table 1.3. The metier sampling adopted in Spain and Portugal in 2009, following the requirement of the EU Data Collection Framework, can have an effect in the provided data. Spanish sampling levels are similar to previous years but an important reduction of Portuguese sampling levels was observed since 2009.

## Length composition

Table 8.1.3 gives the annual length compositions by ICES division, country and gear for 2012.

The annual length compositions for all fleets combined for the period 1986-2012 are presented in Figure 8.1.1.

Landings in number, the mean length and mean weight in the landings between 1986 and 2012 are showed in Table 8.1.4. The lowest total number in landings (year 2001) is $4 \%$ of the maximum value (year 1988). After 2001, increases were observed up to 2006, with decreases every year since then to year 2011. Mean lengths and mean weights in the landings increased sharply between 1995 and 2000. In 2002 low values of mean lengths and mean weights were observed, around the minimum of the time series, due to the increase in smaller individuals. After that, increases were observed reaching 71 cm in 2010.

## Biological information

The growth pattern used in the assessment follows a von Bertalanffy model with fixed $\mathrm{k}=0.11$ and Linf estimated by the model. Length-weight relationship, maturity ogive and natural mortality used in the assessment are described in the Stock Annex (Annex H).

### 8.3.2.3 Abundance indices from surveys

Spanish and Portuguese survey results for the period 1983-2012 are summarized in Table 8.1.5. Portuguese survey was not performed for 2012.

The abundance index from Spanish survey Sp-GFS-WIBTS-Q4 is shown in Figure 8.1.2. Since 2000 the highest abundance values were detected in 2001 and 2006, since this year a downward trend was observed. In 2011, the abundance and biomass indices decreased by $44 \%$ and $40 \%$, respectively, relative to 2010 values. In 2012 an increase in the index in biomass was observed, although the index in number continued to decline.

### 8.3.2.4 Commercial catch-effort data

Landings, effort and LPUE data are given in Table 8.1.6 and Figure 8.1.3 for Spanish trawlers (Division VIIIc) from the ports of Santander and Avilés since 1986, for A Coruña since 1982 and for the Portuguese trawlers (Division IXa) since 1989. A Coruña fleet series (landings, effort and LPUE) were updated to incorporate years at the beginning of the series (1982-1985). Three series are presented for A Coruña fleet: A Coruña port for trips that are exclusively landed in the port, A Coruña trucks for trips that are landed in other ports and A Coruña fleet that takes into account all the trips of the fleet.

For each fleet the proportion of the landings in the stock is also given in the table. In 2007 a data series from the artisanal fleet from the port of Cedeira in Division VIIIc was provided. This LPUE series is annually standardized to incorporate a new year data, latest available standardized series, from 1999 to 2011, is presented. The necessary information for year 2012 was not available to update the standardization of Cedeira effort series. Standardized effort provided for Portuguese trawl fleets (19892008) and their corresponding LPUEs are also given in Table 8.1.6, but not represented in Figure 8.1.3.

All fleets show a general decrease in landings during the eighties and early nineties. A slight landings increase in 1996 and 1997 can be observed in all fleets. From 2000 to 2005 Spanish fleets of A Coruña, Avilés and Cedeira show an increase in landings while the Portuguese fleets are stabilized at low levels. Since 2005 to 2012 landings from A Coruña and Cedeira fleets showed an overall decreasing trend. Proportion in total landings is higher for the Cedeira and A Coruña fleets. Landings for both Portuguese fleets increased in 2011.

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

LPUEs from all available fleets show a general decline during the eighties and early nineties followed by some increase. From 2002 to 2005 LPUEs increased for all fleets. This general LPUE trend is consistent between fleets including the artisanal fleet. In 2009 and 2010 an important increase of Cedeira LPUE was observed. Portuguese fleets shown a one-off increase in 2011.

### 8.3.3 Assessment

A new model assessment was adopted in 2012 benchmark. The assessment approved in the benchmark was updated with 2011 and 2012 data.

### 8.3.3.1 Input data

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

### 8.3.3.2 Model

The Stock Synthesis 3 (SS3) software was selected to be used in the assessment (Methot, 2000). The description of the model including the structure, settings, and parameters assumptions are provided in the Stock Annex.

### 8.3.3.3 Assessment results

The model diagnosis is carried out means the analysis of residuals of abundance indices. Residual plots of the fits to the abundance indices are shown in Figure 8.1.4. Although some minor trends have been detected, as it happens for A Coruña indices from 1995 to 2000, it can be considered that the model follows trends of the abundance indices used in the model (A Coruña, Cedeira and the Spanish survey). Pearson residual plots are presented for the model fits to the length-composition data of the abundance indices (Figure 8.1.5). There were not detected specific patterns in any of the abundance indices. Some high positive residual are evident for A Coruña indices in the first and second quarter. Nevertheless, the model fits reasonably well.

The model estimates size-based selectivity functions for commercial fleets (Figure 8.1.6) and for population abundance indices (Figure 8.1.7). All the selection patterns were assumed constant over the time. The selection pattern for the Spanish trawl fleet is efficient for a wide range of lengths, since the smaller fishes until very large individuals. The Spanish artisanal fleet is most efficient in a narrow length range and for large fish, mainly from 75 to 90 cm . The Portuguese trawl fleet selection pattern indicates that this fishery is most efficient in the length range between 30 and 60 cm . This selection pattern shows strange selection over larger fish that could be an effect of an insufficient length sampling.

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

### 8.3.3.4 Historic trends in biomass, fishing mortality and recruitment

Table 8.1.7 and Figure 8.1.8 provide the summary of results from the assessment model and observed landings. Maximum values of recruitment are recorded at the beginning of the time series $(1982,1986$ and 1987) with values over the 3.9 millions. Along the time series other high recruitment values were detected in 1989, 1994, 1995 and 2001. Since 2006 the recruitment has been below 1 millon. Landings steadily decreased from 3.6 Kt in 2005 to 0.98 Kt in 2011, coinciding with the decrease in F, from 0.37 in 2005 to 0.14 in 2011. Respect to 2011 landings and F increased in 2012 by $29 \%$ and $21 \%$ respectively. Since 2005 to 2010 SSB was at stable medium values around 6.5 kt, increasing to 7.1 kt in 2012.

### 8.3.3.5 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 (2012), two years (2012 and 2011), three years $(2012,2011,2010)$ and four years $(2012,2011,2010,2009)$ of data (Figure 8.1.9). The recruitment shows a slight sensitivity to the exclusion of recent years especially at the beginning of the series, the current assessment tends to underestimate the recruitment during this period. Although the SSB follows a similar tendency for the whole time series, the current assessment shows an overestimation of SSB from 1982 to 1990 and from 1996 to the last year. The F trends were quite stable in the retrospective pattern but, the current assessment shows an underestimation of F during the period from 1982 to 1998. In spite of the presence of moderate retrospective pattern, the assessment was accepted for projections.

### 8.3.4 Catch options and prognosis

### 8.3.4.1 Short-term projections

This year the projections were performed on the basis of present assessment.
For fishing mortality, the F status quo equal to 0.18 , estimated as the average of fishing mortality the last three years $\mathrm{F}_{2010-2012}$ over lengths $30-130 \mathrm{~cm}$, was used for 2013. In the case of recruitment, the geometric mean of the whole period (1980-2012) was used following one of the options indicated in the Stock Annex.

Projected landings in 2014 and SSB at the beginning of 2015 for different management options in 2014 are presented in Table 8.1.8. Under F status quo scenario in 2014 is expected an increase in landings with respect to 2013, and an increase in SSB in 2015 with respect to 2014.

### 8.3.4.2 Yield and biomass per recruit analysis

The summary table of Yield and SSB per recruit analysis is given in Table 8.1.9 and in Figure 8.1.10. The F that maximizes the yield per recruit, $\mathrm{F}_{\text {max, }}$, is estimated in 0.29 over the Fsq (0.18) and corresponding with a level of $13 \%$ of SSB per recruit.

The $\mathrm{F}_{0.1}$, rate of fishing mortality at which the slope of the YPR curve falls to $10 \%$ of its value at the origin, is equal to 0.19 and it is corresponding with a $24 \%$ of $\operatorname{SSB} / \mathrm{R}$. The fishing mortality of $\mathrm{F}_{30 \%}, 35 \%$ and $40 \%$ is estimated in $0.15,0.13$ and 0.11 respectively.

The status quo F is below $\mathrm{F}_{\text {max }}$ and $\mathrm{F}_{0.1}$, and above from any of the reference points based on SSB per recruit analysis (Figure 8.1.10).

### 8.3.5 Biological Reference Points of stock biomass and yield.

Fmsy has been set to 0.19 , the value proposed by the Working Group in 2012 based on $\mathrm{F}_{0.1}$. No proposals for MSY-Btrigger has been presented. $\mathrm{F}_{0.1}$ is still estimated equal to 0.19 in the present assessment (Table 8.1.9).

### 8.3.6 Comments on the assessment

The spawning stock biomass has remained stable at medium levels since 2005. Fishing mortality in 2012 has been estimated as the second lowest value of the whole series. An overall decrease in landings occurred from 3.6 kt in 2005 to 1.3 kt in 2012.

### 8.3.6.1 Quality considerations

Before the assessment being approved, alternative runs for the assessment were proposed to improve the converge level and likelihood value. The low bound of the parameter 2 that defines the selectivity of the abundance index SPCORTR8c was widen (run5) and the use of estimated values from the WKFLAT 2012 assessment as starting points (run4) were tested. Run5 presented the lowest likelihood value and was selected to perform the assessment. However its retrospective pattern indicated that the model was sensitive to remove one year of data and the converge was not possible. Taking into account this converge problem and to keep consistent results from year to the next, run4 was finally selected as the approved assessment. It is important to note that the model seems to be sensitive to changes in the initial values of parameters.

### 8.3.7 Management considerations

Management considerations are describing for both anglerfish stocks in section 8.3.

## References

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

ICES, 2012. Report of the Anglerfish (Lophius piscatorius) illicia and otoliths exchange 2011. 61 pp.
Landa, L., Duarte, R. and I. Quincoces. 2008. Growth of white anglerfish (Lophius piscatorius) tagged in the Northeast Atlantic, and a review of age studies on anglerfish. ICES Journal of Marine Science 65: 72-80.

Table 8.1.1. ANGLERFISH (L. piscatorius ) - Divisions VIIIc and IXa.
Tonnes landed by the main fishing fleets for 1978-2012 as determined by the Working Group.

| Year | Div. VIIIC |  |  | Div. IXa |  |  |  | Div. VIIIc+IXa |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | SPAIN |  | TOTAL | $\begin{gathered} \hline \text { SPAIN } \\ \hline \text { Trawl } \end{gathered}$ | PORTUGAL |  | TOTAL |  |
|  | Trawl | Gillnet |  |  | Trawl | Artisanal |  | TOTAL |
| 1978 | n/a | n/a | n/a | 258 |  | 115 | 373 |  |
| 1979 | n/a | n/a | n/a | 319 |  | 225 | 544 |  |
| 1980 | 2806 | 1270 | 4076 | 401 |  | 339 | 740 | 4816 |
| 1981 | 2750 | 1931 | 4681 | 535 |  | 352 | 887 | 5568 |
| 1982 | 1915 | 2682 | 4597 | 875 |  | 310 | 1185 | 5782 |
| 1983 | 3205 | 1723 | 4928 | 726 |  | 460 | 1186 | 6114 |
| 1984 | 3086 | 1690 | 4776 | 578 | 186 | 492 | 1256 | 6032 |
| 1985 | 2313 | 2372 | 4685 | 540 | 212 | 702 | 1454 | 6139 |
| 1986 | 2499 | 2624 | 5123 | 670 | 167 | 910 | 1747 | 6870 |
| 1987 | 2080 | 1683 | 3763 | 320 | 194 | 864 | 1378 | 5141 |
| 1988 | 2525 | 2253 | 4778 | 570 | 157 | 817 | 1543 | 6321 |
| 1989 | 1643 | 2147 | 3790 | 347 | 259 | 600 | 1206 | 4996 |
| 1990 | 1439 | 985 | 2424 | 435 | 326 | 606 | 1366 | 3790 |
| 1991 | 1490 | 778 | 2268 | 319 | 224 | 829 | 1372 | 3640 |
| 1992 | 1217 | 1011 | 2228 | 301 | 76 | 778 | 1154 | 3382 |
| 1993 | 844 | 666 | 1510 | 72 | 111 | 636 | 819 | 2329 |
| 1994 | 690 | 827 | 1517 | 154 | 70 | 266 | 490 | 2007 |
| 1995 | 830 | 572 | 1403 | 199 | 66 | 166 | 431 | 1834 |
| 1996 | 1306 | 745 | 2050 | 407 | 133 | 365 | 905 | 2955 |
| 1997 | 1449 | 1191 | 2640 | 315 | 110 | 650 | 1075 | 3714 |
| 1998 | 912 | 1359 | 2271 | 184 | 28 | 497 | 710 | 2981 |
| 1999 | 551 | 1013 | 1564 | 79 | 9 | 285 | 374 | 1938 |
| 2000 | 269 | 538 | 808 | 107 | 4 | 340 | 451 | 1259 |
| 2001 | 231 | 294 | 525 | 57 | 16 | 190 | 263 | 788 |
| 2002 | 385 | 341 | 726 | 110 | 29 | 168 | 307 | 1032 |
| 2003 | 911 | 722 | 1633 | 312 | 29 | 305 | 645 | 2278 |
| 2004 | 1260 | 1269 | 2528 | 264 | 27 | 335 | 626 | 3154 |
| 2005 | 1378 | 1622 | 3000 | 371 | 29 | 244 | 643 | 3644 |
| 2006 | 1166 | 1247 | 2413 | 260 | 29 | 260 | 549 | 2963 |
| 2007 | 955 | 1009 | 1964 | 181 | 13 | 192 | 386 | 2350 |
| 2008 | 894 | 1168 | 2062 | 138 | 11 | 127 | 275 | 2337 |
| 2009 | 850 | 1058 | 1909 | 213 | 10 | 148 | 371 | 2280 |
| 2010 | 313 | 955 | 1268 | 158 | 2 | 119 | 279 | 1547 |
| 2011 | 262 | 470 | 733 | 118 | 46 | 80 | 244 | 976 |
| 2012 | 355 | 600 | 955 | 134 | 6 | 163 | 302 | 1257 |

Table 8.1.2. ANGLERFISH (L. piscatorius ) - Divisions VIIIc and IXa.
Weight and percentage of discards for Spanish trawl fleet.

| Year | Weight $(\mathrm{t})$ | CV | \% Trawl Catches |
| :---: | :---: | :---: | :---: |
| 1994 | 20.9 | 34.05 | 2.4 |
| 1995 | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ |
| 1996 | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ |
| 1997 | 5.4 | 68.13 | 0.3 |
| 1998 | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ |
| 1999 | 0.8 | 71.30 | 0.1 |
| 2000 | 5.7 | 33.64 | 1.5 |
| 2001 | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ |
| 2002 | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ |
| 2003 | 25.1 | 54.42 | 2.0 |
| 2004 | 48.2 | 32.53 | 3.1 |
| 2005 | 44.1 | 30.97 | 2.5 |
| 2006 | 43.7 | 48.33 | 3.0 |
| 2007 | 17.1 | 28.44 | 1.5 |
| 2008 | 4.9 | 56.47 | 0.5 |
| 2009 | 20.0 | 26.11 | 3.6 |
| 2010 | 11.5 | 36.87 | 2.4 |
| 2011 | 22.6 | 19.27 | 5.6 |
| 2012 | 62.6 | 43.65 | 11.4 |
| n/a: not available |  |  |  |
| CV: coefficient of variation |  |  |  |

Table 8.1.3. $\quad$ ANGLERFISH (L. piscatorius ) - Divisions VIIIc and IXa.
Length composition by fleet in 2012 (thousands).

| Length (cm) | Div. VIIIc |  |  | Div. IXa |  |  |  | $\xrightarrow{\text { Div. VIIIc+1Xa }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | SPAIN |  | TOTAL | $\begin{gathered} \hline \text { SPAIN } \\ \hline \text { Trawl } \end{gathered}$ | PORTUGAL |  | TOTAL |  |
|  | Trawl | Gillnet |  |  | Trawl | Artisanal |  | total |
| 14 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 15 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 16 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 18 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 19 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 20 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 21 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 23 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 24 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 26 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 27 | 0.005 | 0.000 | 0.005 | 0.005 | 0.000 | 0.00 | 0.01 | 0.01 |
| 28 | 0.066 | 0.000 | 0.066 | 0.000 | 0.000 | 0.00 | 0.00 | 0.07 |
| 29 | 0.168 | 0.000 | 0.168 | 0.045 | 0.042 | 0.00 | 0.09 | 0.25 |
| 30 | 0.519 | 0.000 | 0.519 | 0.203 | 0.000 | 0.00 | 0.20 | 0.72 |
| 31 | 0.787 | 0.000 | 0.787 | 0.067 | 0.000 | 0.00 | 0.07 | 0.85 |
| 32 | 0.976 | 0.000 | 0.976 | 0.319 | 0.000 | 0.00 | 0.32 | 1.30 |
| 33 | 1.771 | 0.000 | 1.771 | 0.354 | 0.000 | 0.00 | 0.35 | 2.13 |
| 34 | 2.178 | 0.000 | 2.178 | 1.226 | 0.000 | 0.00 | 1.23 | 3.40 |
| 35 | 2.448 | 0.000 | 2.448 | 0.779 | 0.000 | 0.00 | 0.78 | 3.23 |
| 36 | 3.391 | 0.000 | 3.391 | 1.004 | 0.000 | 0.00 | 1.00 | 4.39 |
| 37 | 3.309 | 0.000 | 3.309 | 0.804 | 0.042 | 0.00 | 0.85 | 4.16 |
| 38 | 2.590 | 0.000 | 2.590 | 1.415 | 0.000 | 0.00 | 1.41 | 4.01 |
| 39 | 3.300 | 0.000 | 3.300 | 1.990 | 0.042 | 0.00 | 2.03 | 5.33 |
| 40 | 3.517 | 0.000 | 3.517 | 0.912 | 0.000 | 0.00 | 0.91 | 4.43 |
| 41 | 2.989 | 0.000 | 2.989 | 1.712 | 0.105 | 0.00 | 1.82 | 4.81 |
| 42 | 3.075 | 0.000 | 3.075 | 1.564 | 0.000 | 12.04 | 13.60 | 16.68 |
| 43 | 3.000 | 0.000 | 3.000 | 0.868 | 0.000 | 0.00 | 0.87 | 3.87 |
| 44 | 2.735 | 0.000 | 2.735 | 1.812 | 0.042 | 0.00 | 1.85 | 4.59 |
| 45 | 2.525 | 0.011 | 2.537 | 1.792 | 0.000 | 0.00 | 1.79 | 4.33 |
| 46 | 2.665 | 0.019 | 2.685 | 2.439 | 0.000 | 0.00 | 2.44 | 5.12 |
| 47 | 2.280 | 0.008 | 2.288 | 0.573 | 0.013 | 0.60 | 1.18 | 3.47 |
| 48 | 1.900 | 0.034 | 1.934 | 1.065 | 0.009 | 0.00 | 1.07 | 3.01 |
| 49 | 2.401 | 0.000 | 2.401 | 1.008 | 0.000 | 0.00 | 1.01 | 3.41 |
| 50 | 1.703 | 0.189 | 1.892 | 1.765 | 0.009 | 0.00 | 1.77 | 3.67 |
| 51 | 1.649 | 0.055 | 1.704 | 0.980 | 0.009 | 0.00 | 0.99 | 2.69 |
| 52 | 1.270 | 0.262 | 1.532 | 0.731 | 0.013 | 0.02 | 0.76 | 2.29 |
| 53 | 1.419 | 0.296 | 1.715 | 1.261 | 0.138 | 0.00 | 1.40 | 3.11 |
| 54 | 1.431 | 0.217 | 1.647 | 0.645 | 0.000 | 0.27 | 0.92 | 2.57 |
| 55 | 1.611 | 0.461 | 2.073 | 0.499 | 0.050 | 0.06 | 0.61 | 2.69 |
| 56 | 2.363 | 0.335 | 2.698 | 0.524 | 0.074 | 0.26 | 0.86 | 3.56 |
| 57 | 1.561 | 0.763 | 2.324 | 0.165 | 0.050 | 0.27 | 0.49 | 2.81 |
| 58 | 1.263 | 0.587 | 1.849 | 0.460 | 0.050 | 0.03 | 0.54 | 2.39 |
| 59 | 1.213 | 0.766 | 1.980 | 0.244 | 0.050 | 0.00 | 0.29 | 2.27 |
| 60 | 1.805 | 1.549 | 3.354 | 0.657 | 0.036 | 0.00 | 0.69 | 4.05 |
| 61 | 1.393 | 1.521 | 2.914 | 0.380 | 0.155 | 0.03 | 0.57 | 3.48 |
| 62 | 1.328 | 1.517 | 2.845 | 0.708 | 0.101 | 0.00 | 0.81 | 3.65 |
| 63 | 2.058 | 2.361 | 4.419 | 0.262 | 0.000 | 0.02 | 0.28 | 4.70 |
| 64 | 2.076 | 1.800 | 3.876 | 0.526 | 0.000 | 0.00 | 0.53 | 4.40 |
| 65 | 1.970 | 1.851 | 3.822 | 0.397 | 0.000 | 0.02 | 0.41 | 4.24 |
| 66 | 1.824 | 3.060 | 4.884 | 0.752 | 0.074 | 3.16 | 3.98 | 8.87 |
| 67 | 1.755 | 2.689 | 4.444 | 0.475 | 0.000 | 0.00 | 0.48 | 4.92 |
| 68 | 1.367 | 2.806 | 4.173 | 0.391 | 0.074 | 0.03 | 0.50 | 4.67 |
| 69 | 1.492 | 2.917 | 4.409 | 0.390 | 0.063 | 3.48 | 3.93 | 8.34 |
| 70 | 2.180 | 3.328 | 5.508 | 0.393 | 0.048 | 0.63 | 1.07 | 6.58 |
| 71 | 0.975 | 3.034 | 4.009 | 0.729 | 0.000 | 0.00 | 0.73 | 4.74 |
| 72 | 1.690 | 3.000 | 4.689 | 0.349 | 0.000 | 1.66 | 2.01 | 6.70 |
| 73 | 1.913 | 3.077 | 4.990 | 0.175 | 0.000 | 0.02 | 0.19 | 5.18 |
| 74 | 1.160 | 2.361 | 3.521 | 0.526 | 0.038 | 0.00 | 0.56 | 4.09 |
| 75 | 1.232 | 3.488 | 4.721 | 0.292 | 0.013 | 1.20 | 1.51 | 6.23 |
| 76 | 1.239 | 2.486 | 3.725 | 0.605 | 0.000 | 0.00 | 0.61 | 4.33 |
| 77 | 0.920 | 2.181 | 3.101 | 0.206 | 0.023 | 0.69 | 0.92 | 4.02 |
| 78 | 0.393 | 2.075 | 2.469 | 0.208 | 0.038 | 0.66 | 0.90 | 3.37 |
| 79 | 1.110 | 2.039 | 3.148 | 0.138 | 0.000 | 0.93 | 1.07 | 4.22 |
| 80 | 0.895 | 2.334 | 3.229 | 0.244 | 0.038 | 1.42 | 1.71 | 4.94 |
| 81 | 1.243 | 2.078 | 3.322 | 0.327 | 0.000 | 0.05 | 0.37 | 3.70 |
| 82 | 0.893 | 1.827 | 2.720 | 1.231 | 0.000 | 0.03 | 1.26 | 3.98 |
| 83 | 0.730 | 1.990 | 2.720 | 0.241 | 0.000 | 0.02 | 0.26 | 2.98 |
| 84 | 0.787 | 1.907 | 2.694 | 0.154 | 0.000 | 2.16 | 2.32 | 5.01 |
| 85 | 0.832 | 1.541 | 2.373 | 0.177 | 0.038 | 0.06 | 0.28 | 2.65 |
| 86 | 0.791 | 1.653 | 2.444 | 0.219 | 0.000 | 0.19 | 0.41 | 2.86 |
| 87 | 0.913 | 1.640 | 2.553 | 0.064 | 0.000 | 0.24 | 0.31 | 2.86 |
| 88 | 0.760 | 1.549 | 2.310 | 0.276 | 0.000 | 0.10 | 0.38 | 2.69 |
| 89 | 0.277 | 1.414 | 1.691 | 0.608 | 0.000 | 0.02 | 0.63 | 2.32 |
| 90 | 0.722 | 1.329 | 2.051 | 0.174 | 0.000 | 0.17 | 0.34 | 2.39 |
| 91 | 0.270 | 0.938 | 1.208 | 0.076 | 0.000 | 0.00 | 0.08 | 1.28 |
| 92 | 0.379 | 1.357 | 1.736 | 0.145 | 0.000 | 0.00 | 0.15 | 1.88 |
| 93 | 0.314 | 0.843 | 1.157 | 0.035 | 0.000 | 0.64 | 0.68 | 1.83 |
| 94 | 0.551 | 0.831 | 1.381 | 0.076 | 0.000 | 0.00 | 0.08 | 1.46 |
| 95 | 0.352 | 0.639 | 0.990 | 0.317 | 0.000 | 0.02 | 0.33 | 1.32 |
| 96 | 0.419 | 0.885 | 1.304 | 0.273 | 0.000 | 0.27 | 0.54 | 1.85 |
| 97 | 0.333 | 0.610 | 0.942 | 0.079 | 0.000 | 0.16 | 0.24 | 1.18 |
| 98 | 0.514 | 0.798 | 1.312 | 0.136 | 0.026 | 0.10 | 0.26 | 1.57 |
| 99 | 0.289 | 0.710 | 0.999 | 0.026 | 0.000 | 0.05 | 0.07 | 1.07 |
| $100+$ | 1.496 | 6.728 | 8.224 | 0.660 | 0.036 | 1.97 | 2.67 | 10.89 |
| TOTAL | 108 | 87 | 194 | 43 | 2 | 34 | 79 | 273 |
| Tonnes | 262 | 470 | 733 | 118 | 6 | 163 | 302 | 1257 |
| Mean Weight (g) | 2432 | 5424 | 3767 | 2729 | 3643 | 4823 | 3841 | 4602 |
| Mean length ( cm ) | 56.9 | 77.6 | 66.1 | 55.1 | 60.6 | 64.5 | 59.2 | 64.1 |
| Measured weight (t) | 9.0 | 24.7 | 33.7 | 2.8 | 0.1 | 1.1 | 4.0 | 37.7 |

Table 8.1.4. ANGLERFISH (L. piscatorius ). Divisions VIIIc and IXa.
Numbers, mean weight and mean length of landings between 1986 and 2012.

| Year | Total (thousands) | Mean Weight $(\mathrm{g})$ | Mean Length (cm) |
| :---: | :---: | :---: | :---: |
| 1986 | 1872 | 3670 | 61 |
| 1987 | 2806 | 1832 | 44 |
| 1988 | 2853 | 2216 | 50 |
| 1989 | 1821 | 2744 | 54 |
| 1990 | 1677 | 2261 | 49 |
| 1991 | 1657 | 2197 | 50 |
| 1992 | 1256 | 2692 | 54 |
| 1993 | 857 | 2719 | 54 |
| 1994 | 704 | 2850 | 54 |
| 1995 | 876 | 2093 | 48 |
| 1996 | 1153 | 2564 | 52 |
| 1997 | 1043 | 3560 | 60 |
| 1998 | 583 | 5113 | 68 |
| 1999 | 290 | 6674 | 71 |
| 2000 | 190 | 6885 | 72 |
| 2001 | 127 | 6189 | 64 |
| 2002 | 381 | 2766 | 50 |
| 2003 | 784 | 2907 | 54 |
| 2004 | 809 | 3456 | 61 |
| 2005 | 856 | 4259 | 63 |
| 2006 | 923 | 3211 | 58 |
| 2007 | 553 | 4251 | 62 |
| 2008 | 540 | 4327 | 63 |
| 2009 | 492 | 4630 | 64 |
| 2010 | 288 | 5569 | 71 |
| 2011 | 244 | 4603 | 60 |
| 2012 | 273 |  | 64 |
|  |  |  |  |

Table 8.1.5. ANGLERFISH (L. piscatorius ). Divisions VIIIc and IXa.
Abundance indices from Spanish and Portuguese surveys.


Table 8.1.6. ANGLERFISH (L. piscatorius) - Divisions VIIIc and IXa.
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.



Table 8.1.7. ANGLERFISH (L. piscatorius ) - Division VIIIc and IXa.
Summary of the assessment results.

| Year | Recruit Age0 <br> (thousands) | Total Biomass <br> $(\mathrm{t})$ | Total SSB <br> $(\mathrm{t})$ | Landings <br> $(\mathrm{t})$ | Yield/SSB | F <br> $(30-130 \mathrm{~cm})$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1980 | 447 | 13520 | 7490 | 4817 | 0.64 | 0.32 |
| 1981 | 1748 | 15334 | 9998 | 5566 | 0.56 | 0.33 |
| 1982 | 6286 | 14850 | 11351 | 5782 | 0.51 | 0.37 |
| 1983 | 3045 | 13952 | 10430 | 6113 | 0.59 | 0.49 |
| 1984 | 777 | 13975 | 8887 | 6031 | 0.68 | 0.51 |
| 1985 | 1594 | 13359 | 8742 | 6139 | 0.70 | 0.53 |
| 1986 | 5782 | 11169 | 8183 | 6870 | 0.84 | 0.82 |
| 1987 | 3919 | 7619 | 5107 | 5139 | 1.01 | 0.93 |
| 1988 | 1805 | 7504 | 3509 | 6321 | 1.80 | 1.40 |
| 1989 | 2876 | 5828 | 2646 | 4995 | 1.89 | 1.18 |
| 1990 | 2401 | 4782 | 2325 | 3790 | 1.63 | 0.88 |
| 1991 | 999 | 4696 | 2187 | 3640 | 1.66 | 0.85 |
| 1992 | 1143 | 4475 | 2189 | 3382 | 1.54 | 0.89 |
| 1993 | 1332 | 3598 | 1977 | 2329 | 1.18 | 0.67 |
| 1994 | 2793 | 3437 | 1937 | 2007 | 1.04 | 0.57 |
| 1995 | 2247 | 3974 | 2039 | 1835 | 0.90 | 0.38 |
| 1996 | 507 | 5895 | 2898 | 2956 | 1.02 | 0.41 |
| 1997 | 187 | 7100 | 4013 | 3715 | 0.93 | 0.46 |
| 1998 | 181 | 6586 | 4561 | 2981 | 0.65 | 0.38 |
| 1999 | 450 | 5665 | 4542 | 1939 | 0.43 | 0.29 |
| 2000 | 538 | 4993 | 4270 | 1256 | 0.29 | 0.24 |
| 2001 | 3033 | 4720 | 3984 | 788 | 0.20 | 0.18 |
| 2002 | 1674 | 5409 | 4060 | 1034 | 0.25 | 0.20 |
| 2003 | 443 | 7542 | 4667 | 2279 | 0.49 | 0.30 |
| 2004 | 1580 | 9027 | 5852 | 3156 | 0.54 | 0.32 |
| 2005 | 1197 | 9338 | 6864 | 3646 | 0.53 | 0.37 |
| 2006 | 1313 | 8865 | 6684 | 2932 | 0.44 | 0.36 |
| 2007 | 602 | 8527 | 6372 | 2349 | 0.37 | 0.30 |
| 2008 | 442 | 8677 | 6535 | 2338 | 0.36 | 0.28 |
| 2009 | 647 | 8547 | 6766 | 2280 | 0.34 | 0.29 |
| 2010 | 870 | 8012 | 6656 | 1548 | 0.23 | 0.21 |
| 2011 | 696 | 7995 | 6663 | 976 | 0.15 | 0.14 |
| 2012 | 684 | 8661 | 7107 | 1257 | 0.18 | 0.17 |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Table 8.1.8. ANGLERFISH (L. piscatorius) - Divisions VIIIc and IXa.
Catch option table.

| SSB(2013) | Rec proj | $F(30-130 c m)$ | Land(2013) | SSB(2014) |
| :---: | :---: | :---: | :---: | :---: |
| 7482 | 1143 | 0.18 | 1330 | 7869 |
| Fmult | Fland <br> $(30-130 c m)$ | Landings(2014) | SSB(2015) |  |
|  |  |  |  |  |
| 0 | 0 | 0 | 9715 |  |
| 0.1 | 0.02 | 153 | 9557 |  |
| 0.2 | 0.04 | 304 | 9403 |  |
| 0.3 | 0.05 | 451 | 9251 |  |
| 0.4 | 0.07 | 596 | 9102 |  |
| 0.5 | 0.09 | 737 | 8956 |  |
| 0.6 | 0.11 | 876 | 8813 |  |
| 0.7 | 0.12 | 1013 | 8672 |  |
| 0.8 | 0.14 | 1146 | 8535 |  |
| 0.9 | 0.16 | 1277 | 8399 |  |
| 1 | 0.18 | 1406 | 8267 |  |
| 1.1 | 0.19 | 1532 | 8136 |  |
| 1.2 | 0.21 | 1656 | 8009 |  |
| 1.3 | 0.23 | 1777 | 7883 |  |
| 1.4 | 0.25 | 1896 | 7760 |  |
| 1.5 | 0.26 | 2013 | 7639 |  |
| 1.6 | 0.28 | 2128 | 7521 | 7404 |
| 1.7 | 0.3 | 2240 | 7290 |  |
| 1.8 | 0.32 | 2351 | 7178 |  |
| 1.9 | 0.33 | 2459 | 2565 |  |
| 2 | 0.35 |  |  |  |
|  |  |  |  |  |

Table 8.1.9. ANGLERFISH (L. piscatorius) - Divisions VIIIc and IXa.
Yield and SSB per recruit summary table.

| SPR level | Fmult | $F(30-130 \mathrm{~cm})$ | YPR(land) | SSB/R |
| ---: | ---: | ---: | ---: | ---: |
| 1.00 | 0.0 | 0.00 | 0.00 | 53.42 |
| 0.86 | 0.1 | 0.02 | 0.43 | 46.04 |
| 0.75 | 0.2 | 0.04 | 0.78 | 39.78 |
| 0.65 | 0.3 | 0.05 | 1.07 | 34.47 |
| 0.56 | 0.4 | 0.07 | 1.31 | 29.95 |
| 0.49 | 0.5 | 0.09 | 1.51 | 26.10 |
| 0.43 | 0.6 | 0.11 | 1.66 | 22.81 |
| 0.37 | 0.7 | 0.12 | 1.79 | 19.99 |
| 0.33 | 0.8 | 0.14 | 1.89 | 17.58 |
| 0.29 | 0.9 | 0.16 | 1.97 | 15.51 |
| 0.26 | 1.0 | 0.18 | 2.04 | 13.72 |
| 0.23 | 1.1 | 0.19 | 2.09 | 12.18 |
| 0.20 | 1.2 | 0.21 | 2.12 | 10.85 |
| 0.18 | 1.3 | 0.23 | 2.15 | 9.70 |
| 0.16 | 1.4 | 0.25 | 2.17 | 8.70 |
| 0.15 | 1.5 | 0.26 | 2.18 | 7.82 |
| 0.13 | 1.6 | 0.28 | 2.18 | 7.06 |
| 0.12 | 1.7 | 0.30 | 2.18 | 6.39 |
| 0.11 | 1.8 | 0.32 | 2.18 | 5.81 |
| 0.10 | 1.9 | 0.33 | 2.17 | 5.29 |
| 0.09 | 2.0 | 0.35 | 2.16 | 4.84 |


|  | SPR level | Fmult | $F(30-130 \mathrm{~cm})$ | YPR(land) | SSB/R |
| :--- | ---: | ---: | ---: | ---: | ---: |
| Fmax | 0.13 | 1.66 | 0.29 | 2.18 | 6.68 |
| F0.1 | 0.24 | 1.06 | 0.19 | 2.07 | 12.77 |
| F40\% | 0.40 | 0.64 | 0.11 | 1.72 | 21.48 |
| F35\% | 0.35 | 0.75 | 0.13 | 1.84 | 18.74 |
| F30\% | 0.30 | 0.87 | 0.15 | 1.95 | 16.09 |



Figure 8.1.1. ANGLERFISH (L. piscatorius) - Divisions VIIIc and IXa.
Length distributions of landings (thousands for 1986 to 2012).


## Figure 8.1.2

ANGLERFISH (L. piscatorius) - Divisions VIIIc and IXa.

Trawl and gillnet landings, effort and LPUE data between 1982-2012.


Figure 8.1.3
ANGLERFISH (L. piscatorius) - Divisions VIIIc and IXa.

Abundance index from survey Sp-GFS-WIBTS-Q4 in numbers/30 min. Bars represent $95 \%$ confidence intervals.


Figure 8.1.4 ANGLERFISH (L. piscatorius) - Divisions VIIIc and IXa.
Residuals of the fits to the surveys in $\log$ (abundance indices). A Coruña and Cedeira are by quarters.


Figure 8.1.5 ANGLERFISH (L. piscatorius) - Divisions VIIIc and IXa.

Pearson residuals of the fit to the length distributions of the abundance indices. Blue=positive residuals and red=negative residuals.


Figure 8.1.5 (continued)


Figure 8.1.5 (continued)


Figure 8.1.6 ANGLERFISH (L. piscatorius) - Divisions VIIIc and IXa.

Relative selection patterns at length by fishery estimated by SS3.


Figure 8.1.7 ANGLERFISH (L. piscatorius) - Divisions VIIIc and IXa.

Relative selection patterns at length by abundance index estimated by SS3. A Coruña and Cedeira indices are by quarter.


Figure 8.1.8 ANGLERFISH (L. piscatorius) - Divisions VIIIc and IXa.

Summary plots of stock trends.


Figure 8.1.9 ANGLERFISH (L. piscatorius) - Divisions VIIIc and IXa.

Retrospective plots from SS3.

Yield and Spawning Stock Biomass per Recruit


Figure 8.1.10 ANGLERFISH (L. piscatorius) - Divisions VIIIc and IXa.

Yield and SSB per recruit plot. Estimated reference points and Fsq are indicated.

### 8.4 Anglerfish (Lophius budegassa) in Divisions VIIIc and IXa

### 8.4.1 General

### 8.4.1.1 Ecosystem aspects

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

### 8.4.1.2 Fishery description

L. budegassa is caught by Spanish and Portuguese bottom trawlers and gillnet fisheries. As with L. piscatorius, it is an important target species for the artisanal fleet, while it is a by catch for the trawl fleet targeting hake or crustaceans (see Stock Annex, Annex M).

The length distribution of the landings is considerably different between both fisheries, with the gillnet landings showing higher mean lengths compared to the trawl landings. Since 2003, the Spanish landings were on average split $87 \%$ from the trawl fleet (mean lengths in 2012 of 46 cm in both Divisions VIIIc and IXa) and $13 \%$ from the artisanal fleet (mean length of 63 cm in 2012 in Division VIIIc). Portuguese landings, for the same period, were on average split, $27 \%$ from the trawl fleet (mean length of 47 cm in 2012) and $73 \%$ from the artisanal fleet (mean length of 54 cm in 2012).

### 8.4.2 Data

### 8.4.2.1 Commercial catches and discards

Total landings of L. budegassa by country and gear for the period 1978-2012, as estimated by the Working Group, are given in Table 8.2.1. Spanish landings for 2011 and 2012 have been provided by the official national administration responsible for fishery statistics in Spain. See historical landings analysis in the Stock Annex. From 2002 to 2007 landings increased to 1301 t , decreasing afterwards to near 790 t in 2010 and 2011, but in 2012 catches reached 1024 t .

Spanish trawl discards estimates of L. budegassa in weight and associated coefficient of variation (CV) are shown in Table 8.2.2. The estimated Spanish discards rate observed from 1994 to 2012, shows two picks, in 2006 (92 t) and $2010(61$ t), for the rest of the years discards could be considered negligible. The coefficient of variation for weight data varied from $24 \%$ to $99 \%$.
Sampling effort and percentage of occurrence of L. budegassa discards in the trawl Portuguese fisheries were presented for the 2004-2012 period (WD6). The maximum occurrence of discards in the trawl fleet targeting fish was $2 \%$ (sampling effort varies between 83 and 194 hauls per year). The maximum occurrence of discards in the trawl fleet targeting crustaceans was $8 \%$ (sampling effort varies between 30 and 111 hauls per year). Due to the low frequency of discards, it is not possible apply to anglerfish, the algorithm used in the WD for hake, at that moment discards estimates have not been calculated. L. budegassa discards, in the Portuguese trawl fisheries, seems to be negligible.

### 8.4.2.2 Biological sampling

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

The sampling levels for 2012 are shown in Table 1.3. The metier sampling adopted in Spain and Portugal in 2012, following the requirement of EU Data Collection Framework, can have an effect on the provided data. Spanish sampling levels are similar to previous years but an important reduction of Portuguese sampling levels was observed in 2009-2011, in 2012 Portugal increased the sampling effort.

## Length composition

Table 8.2.3 gives the annual length compositions by ICES division, country and gear for 2012. The annual length compositions between 1986 and 2012 are presented in Figure 8.2.1.

In 2002 an increase of smaller individuals is apparent (around $30-35 \mathrm{~cm}$ ), that is confirmed in the 2003 length distribution. In 2006 and 2007 there was an increase in the number of smaller individuals which was confirmed by the lowest annual mean lengths ( 37 and 39 cm ) observed since 1986. Since 2008 these small fish were not observed. The total annual landings in numbers and the annual mean length and mean weight are in Table 8.2.4.

In 2005 the total number of landed individuals was low, being $9 \%$ of the maximum value (year 1987). In 2006 and 2007 the number of landed fish more than doubled the 2005 number. The number of landed fish decreased to a minimum in 2009. Since then the number increased, while mean weight and length continued at relative high levels.

### 8.4.2.3 Abundance indices from surveys

Spanish and Portuguese survey results for the period 1983-2012 are summarized in Table 8.2.5. The Portuguese survey was not performed in 2012. Considering the very small amount of caught anglerfish in the two surveys, these indices were not considered to reflect the change in the abundance of this species.

### 8.4.2.4 Commercial catch-effort data

Landings, effort and LPUE data are given in Table 8.2.6 and Figure 8.2.2 for Spanish trawlers from ports of Santander, Avilés and A Coruña (all in Division VIIIc) since 1986 and for Portuguese trawlers (Division IXa) since 1989. The latest available standardized series data from the artisanal fleet from the port of Cedeira in Division VIIIc was provided. The necessary information for year 2012 was not available to update the standardization of Cedeira effort series. For each fleet the proportion related to the total landings is also given in the table.

Excluding the Avilés and Santander fleets, from the late eighties to mid-nineties the overall trend in landings for all fleets was decreasing. A slight increase was observed from 1995 to 1998 in all fleets. The A Coruña trawler fleet showed in 2002 the most important drop in landings and in relative proportion of total landings. The lowest observed landings for both trawlers and gillnets was in 2009. Since 2010 an increase of catches were observed specially in the Portuguese fleets.

Effort trends are analysed in section 8.1.2.4.
LPUEs of Spanish Aviles and Santander fleets show high values during the second half of the 90 's, while the Portuguese fleets have fluctuated. Spite the variability, from 2000 to 2005, a decreasing trend was observed for all fleets, since then a slightly increasing trend can be observed.

### 8.4.3 Assessment

In WKFLAT2012 the assessment of the status of each anglerfish species was carried out separately, the white anglerfish based on SS3 model and the black anglerfish based on ASPIC (Prager, 1994; Prager, 2004). This year an update of that assessment was carried out.

### 8.4.3.1 Input data

At the WKFLAT2012 it was accepted, as the basis for advice, to run the ASPIC model with the following data series:

- Spanish fleet 'A Coruña': the longest of the potential tuning series and represents the bulk of the fishery (SPCORTR8c: 1982-2012).
- Portuguese Trawler fleet directing to crustaceans (PT.crust.tr: 1989-2012).
- Portuguese Trawler fleet directing to groundfish (PT.fish.tr: 1989-2012).

The input data are presented in Table 8.2.7.

### 8.4.3.2 Model

The ASPIC (version 5.34.8) model (which implements the Schaeffer population growth model) was used for the WKFLAT 2012 assessment. Runs were performed conditioning on yield rather than on effort. The model options, the starting estimates and the minimum and maximum constraints of each parameter are indicated in the input file (Table 8.2.7).

### 8.4.3.3 Assessment results

Using the Stock Annex/WKFLAT2012 settings, with the inclusion of the new 2011 and 2012 data, the fit of the ASPIC model gets worse than the one performed at the benchmark. The model continues to show strong sensitivity to the starting guess settings (B1/K, MSY, K, seed and q's) leading to different levels of B/Bmsy and F/Fmsy, nevertheless it keeps the trends in the relative biomass and fishing mortality (see section 8.2.3.4 - Sensitive Analyses). The results show great uncertainty and variability and must be dealt with caution. As changing the input starting guess do not change considerably the results of the short term projections, the model was accepted, with caution, to give the magnitude of the advice.

The correlation coefficient between input fleets is acceptable but the $r$ square between observed and fitted CPUE values are low (assessment results were uploaded in the ICES SharePoint in the Data folder). Point estimates and bias-corrected bootstrap confidence intervals for parameters are presented in Table 8.2.8, whereas Figure 8.2.3 plots observed and estimated CPUEs for each of the series used in the model. $\mathrm{B}_{2013} / \mathrm{B}_{\text {MSY }}$ and $\mathrm{F}_{2012} / \mathrm{F}_{\text {MSY }}$ have respectively $39.53 \%$ and $-12.71 \%$ of bias and both have more than $50 \%$ relative inter-quartile ranges. Biomass in 2013 is estimated to be $68 \%$ of BMSY with $95 \%$ bias-corrected confidence interval between $18 \%$ and $121 \%$. Fishing mortality in 2012 is estimated to be 0.81 times FmsY with $95 \%$ bias-corrected confidence interval between 0.55 and 2.30 times FmSY. MSY is estimated to be 1881 t with $95 \%$ CI from 1492 t to 3549 t .

Trends in relative biomass (Figure 8.2.4) indicate a steady decrease since the beginning of the series till 2001, since then a slight recovery was observed, been in 2013 at $68 \%$ of $\mathrm{B}_{\text {mSy. }}$. Fishing mortality remained at high levels between late eighties and late nineties, dropping after that. In 2012, fishing mortality is estimated to be below Fmsy.

Comparison between the assessment (2011) prior to benchmark, the 2012 benchmark assessment and the 2013 update are showed in Table 8.2.9 and Figure 8.2.5. The historic perspective of the stock is very different from the previous model, due to the inclusion of the series "A Coruna" that gives more information of the catches and also covers more time since it goes back in time further. The difference between the 2012 and 2013 assessments shows how much the model is sensitive to the inclusion of the two last points.

### 8.4.3.4 Sensitive analyses

The sensitive analyses done between several settings of the model can be summarized in three steps:

- Between old model (2 series: PT.crust.tr and PT.fish.tr) and after benchmark (3 series) model, as was recommended by the benchmark (Table 8.2.9).
- The stability of the "2013 settings" model by changing $+/-10 \%,+/-25 \%$ and $+/-$ $50 \%$ the starting guess for $B 1 / K, M S Y, K$ and the seed (Table 8.2.10).
- Between "benchmark settings" and "2013 settings" models and the results of the projections using both models, by changing $+/-25 \%$ the starting guess for B1/K, MSY, $K$ and the seed (Table 8.2.11 and Table 8.2.12).
"2013 settings" model is equal to "benchmark settings" model except for the starting guess for $q$ 's.
The use of the 3 series is better than the old model with only 2 series. Adding the 2011 and 2012 data the fit of the model declined, using the exact starting guess for $B 1 / K$, MSY, K, seed and $q$ 's used during the 2012 benchmark (WKFLAT2012) and reported in the Stock Annex. It is difficult to choose what is the best fit (it was not possible during the WGHMM2013 meeting) by changing the starting guess of these parameters, the model gives different results for the same value of the Total Objective Function. It seems that the sensitivity to the variation of the starting guesses is hard to overcome leading to a great instability of the model. Regardless this variability in the results (e.g. B relative to Bmsy, F relative to Fmsy) which impairs the knowledge of the state of the stock, the results of the projections do not show the same variability allowing to give the magnitude of the advice.


### 8.4.4 Projections

Projections were performed based on the "benchmark settings" ASPIC estimates. The projected $\mathrm{B} / \mathrm{Bmsy}_{\text {my }}$ and yield are presented in Table 8.2.13, where each column corresponds to a fishing mortality scenario. Projections were performed for F status quo (assumed as the average of the last 3 years - F 2010-2012), Fmsy, Ftrans $\left(0.2^{*}\right.$ F2010 +0.8 FMSY $)$ and with zero catches. A set of projections were performed with the necessary F reductions to obtain 2014 yield for both anglerfish species combined corresponding to the 2013 TAC ( 2475 t) and $+/-15 \% 2013$ TAC. Projections using the same multiplicative factor of F status quo for L. piscatorius in the scenarios MSY approach and MSY transition were also performed. The reason for this projection scenarios is that both L. budegassa and L. piscatorius $\mathrm{F}_{2012}$ are below $\mathrm{F}_{\text {MSY, }}$ been L. piscatorius $\mathrm{F}_{2012}$ nearest $\mathrm{F}_{\mathrm{MSY}}$, so this stock will drive the management strategy.
For L. budegassa, fishing mortality equal to F status quo in 2014 is expected to keep the stock below Bmsy in 2014. The biomass is expected to increase in near future under all fishing mortality scenarios examined (Table 8.2.13).

### 8.4.5 Biological Reference Points

WKFLAT (ICES, 2012) endorsed the basis for MSY reference points previously assumed by ICES (i.e. FMSY based on the ASPIC output and a proxy for MSY Btrigger as $50 \%$ of BMSY of the ASPIC output).

### 8.4.6 Comments on the assessment

With the inclusion of the Spanish "A Coruña" series the assessment improved related to preview considerations but still show some weak points such as high $80 \%$ confidence intervals, contributing to uncertainty in the assessment results.

The stability of the aspic model continued to be the major issue.
During the benchmark (WKFLAT 2012) the same model (SS3) applied to the white anglerfish was tested for the black anglerfish with some promising results but need to be tested more carefully before its application. SS3 is a length-based model so the length sampling is key information for this stock. A benchmark for this stock was considered during the WG, 2016 was mentioned as a tentative year for the benchmark but not before.

### 8.4.7 Management considerations

Management considerations are in section 8.3.

Table 8.2.1. ANGLERFISH (L. budegassa) - Divisions VIIIc and IXa.
Tonnes landed by the main fishing fleets for 1978-2012 as determined by the Working Group.

| Year | Div. VIIIC |  |  | Div. IXa |  |  |  | Div. VIIIc+IXa |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | SPAIN |  | TOTAL | SPAIN | POR | JGAL |  |  |
|  | Trawl | Gillnet |  | Trawl | Trawl | Artisanal | TOTAL | TOTAL |
| 1978 | n/a | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ | 248 | n/a | 107 | 355 | 355 |
| 1979 | n/a | n/a | n/a | 306 | $\mathrm{n} / \mathrm{a}$ | 210 | 516 | 516 |
| 1980 | 1203 | 207 | 1409 | 385 | $\mathrm{n} / \mathrm{a}$ | 315 | 700 | 2110 |
| 1981 | 1159 | 309 | 1468 | 505 | $\mathrm{n} / \mathrm{a}$ | 327 | 832 | 2300 |
| 1982 | 827 | 413 | 1240 | 841 | n/a | 288 | 1129 | 2369 |
| 1983 | 1064 | 188 | 1252 | 699 | $\mathrm{n} / \mathrm{a}$ | 428 | 1127 | 2379 |
| 1984 | 514 | 176 | 690 | 558 | 223 | 458 | 1239 | 1929 |
| 1985 | 366 | 123 | 489 | 437 | 254 | 653 | 1344 | 1833 |
| 1986 | 553 | 585 | 1138 | 379 | 200 | 847 | 1425 | 2563 |
| 1987 | 1094 | 888 | 1982 | 813 | 232 | 804 | 1849 | 3832 |
| 1988 | 1058 | 1010 | 2068 | 684 | 188 | 760 | 1632 | 3700 |
| 1989 | 648 | 351 | 999 | 764 | 272 | 542 | 1579 | 2578 |
| 1990 | 491 | 142 | 633 | 689 | 387 | 625 | 1701 | 2334 |
| 1991 | 503 | 76 | 579 | 559 | 309 | 716 | 1584 | 2162 |
| 1992 | 451 | 57 | 508 | 485 | 287 | 832 | 1603 | 2111 |
| 1993 | 516 | 292 | 809 | 627 | 196 | 596 | 1418 | 2227 |
| 1994 | 542 | 201 | 743 | 475 | 79 | 283 | 837 | 1580 |
| 1995 | 924 | 104 | 1029 | 615 | 68 | 131 | 814 | 1843 |
| 1996 | 840 | 105 | 945 | 342 | 133 | 210 | 684 | 1629 |
| 1997 | 800 | 198 | 998 | 524 | 81 | 210 | 815 | 1813 |
| 1998 | 748 | 148 | 896 | 681 | 181 | 332 | 1194 | 2089 |
| 1999 | 565 | 127 | 692 | 671 | 110 | 406 | 1187 | 1879 |
| 2000 | 441 | 73 | 514 | 377 | 142 | 336 | 855 | 1369 |
| 2001 | 383 | 69 | 452 | 190 | 101 | 269 | 560 | 1013 |
| 2002 | 173 | 74 | 248 | 234 | 75 | 213 | 522 | 770 |
| 2003 | 279 | 49 | 329 | 305 | 68 | 224 | 597 | 926 |
| 2004 | 250 | 120 | 370 | 285 | 50 | 267 | 603 | 973 |
| 2005 | 273 | 97 | 370 | 283 | 31 | 214 | 527 | 897 |
| 2006 | 323 | 124 | 447 | 541 | 39 | 121 | 701 | 1148 |
| 2007 | 372 | 68 | 440 | 684 | 66 | 111 | 861 | 1301 |
| 2008 | 386 | 70 | 456 | 336 | 40 | 119 | 495 | 951 |
| 2009 | 301 | 148 | 449 | 172 | 34 | 114 | 320 | 769 |
| 2010 | 352 | 81 | 432 | 197 | 70 | 84 | 351 | 784 |
| 2011 | 256 | 68 | 324 | 279 | 75 | 119 | 474 | 798 |
| 2012 | 207 | 61 | 267 | 231 | 156 | 370 | 757 | 1024 |

Table 8.2.2 ANGLERFISH (L. budegassa) - Divisions VIIIc and IXa. Weight and percentage of discards for Spanish trawl fleet.

| Year | Weight $(\mathrm{t})$ | CV | \% Trawl Catches |
| :---: | :---: | :---: | :---: |
| 1994 | 6.1 | 24.4 | 0.6 |
| 1995 | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ |
| 1996 | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ |
| 1997 | 21.3 | 35.2 | 1.6 |
| 1998 | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ |
| 1999 | 19.7 | 43.7 | 1.6 |
| 2000 | 8.7 | 35.1 | 1.1 |
| 2001 | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ |
| 2002 | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ | $\mathrm{n} / \mathrm{a}$ |
| 2003 | 1.1 | 53.6 | 0.2 |
| 2004 | 8.1 | 70.2 | 1.5 |
| 2005 | 13.6 | 45.6 | 2.4 |
| 2006 | 92.0 | 56.8 | 9.6 |
| 2007 | 0.3 | 98.8 | 0.0 |
| 2008 | 1.9 | 59.4 | 0.3 |
| 2009 | 29.3 | 53.8 | 5.8 |
| 2010 | 61.2 | 63.2 | 10.0 |
| 2011 | 12.4 | 33.2 | 2.3 |
| 2012 | 5.8 | 52.8 | 1.3 |

$\mathrm{n} / \mathrm{a}$ : not available
CV: coefficient of variation

| Table 8.2.3 | ANGLER <br> Length cor | L. budeg on by fle | ) - Division landings in | Ic and IXa (thousand |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Div. VIII |  |  |  |  |  | Div. VIIIc+IXa |
|  |  |  |  | SPAIN |  | GAL |  |  |
| Length (cm) | Trawl | Gillnet | TOTAL | Trawl | Trawl | Artisanal | TOTAL | TOTAL |
| 14 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | ${ }^{0.000}$ | 0.000 |
| 15 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 16 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 18 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 19 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 20 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 21 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 23 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 24 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 26 | 0.021 | 0.000 | 0.021 | 0.155 | 0.000 | 0.000 | 0.155 | 0.176 |
| 27 | 0.036 | 0.000 | 0.036 | 0.348 | ${ }^{0.000}$ | 0.000 | 0.348 | 0.384 |
| 28 | 0.206 | 0.000 | 0.206 | 0.192 | 0.000 | 0.000 | 0.192 | 0.399 |
| 29 | 0.560 | 0.000 | 0.560 | 0.155 | 0.102 | 0.144 | 0.402 | 0.961 |
| 30 | 1.557 | 0.000 | 1.557 | 0.394 | 0.000 | 0.000 | 0.394 | 1.951 |
| 31 | 2.515 | 0.000 | 2.515 | 0.331 | 0.004 | 0.000 | 0.335 | 2.850 |
| 32 | 5.933 | 0.000 | 5.933 | 0.215 | 0.460 | 0.291 | 0.966 | 6.900 |
| 33 | 7.042 | 0.000 | 7.042 | 0.881 | 0.438 | 0.579 | 1.898 | 8.940 |
| 34 | 7.315 | 0.000 | 7.315 | 0.792 | 1.842 | 0.144 | 2.778 | 10.093 |
| 35 | 8.437 | 0.000 | 8.437 | 1.087 | 1.074 | 0.340 | 2.501 | 10.938 |
| 36 | 9.989 | 0.000 | 9.989 | 1.405 | 1.721 | 0.187 | 3.313 | 13.303 |
| 37 | 8.372 | 0.000 | 8.372 | 2.069 | 3.942 | 0.479 | 6.490 | 14.862 |
| 38 | 6.557 | 0.000 | 6.557 | 5.745 | 4.339 | 1.090 | 11.175 | 17.731 |
| 39 | 6.837 | 0.000 | 6.837 | 4.591 | 4.650 | 1.804 | 11.044 | 17.882 |
| 40 | 6.350 | 0.000 | 6.350 | 4.063 | 3.236 | 1.270 | 8.569 | 14.918 |
| 41 | 4.988 | 0.080 | 5.068 | 4.933 | 5.008 | 3.068 | 13.009 | 18.077 |
| 42 | 5.191 | 0.000 | 5.191 | 7.083 | 5.442 | 2.915 | 15.440 | 20.631 |
| 43 | 7.012 | 0.018 | 7.030 | 5.581 | 4.344 | 2.908 | 12.833 | 19.863 |
| 44 | 5.523 | 0.000 | 5.523 | 4.948 | 2.620 | 4.293 | 11.861 | 17.383 |
| 45 | 4.574 | 0.046 | 4.619 | 4.777 | 3.197 | 3.764 | 11.737 | 16.357 |
| 46 | 4.620 | 0.104 | 4.724 | 5.130 | 2.812 | 3.852 | 11.794 | 16.518 |
| 47 | 4.003 | 0.084 | 4.087 | 2.666 | 2.212 | 5.579 | 10.457 | 14.544 |
| 48 | 2.853 | 0.191 | 3.044 | 3.863 | 1.390 | 3.063 | 8.316 | 11.359 |
| 49 | 2.300 | 0.084 | 2.384 | 2.548 | 1.298 | 2.764 | 6.610 | 8.994 |
| 50 | 2.255 | 0.238 | 2.494 | 3.314 | 0.798 | 4.614 | 8.725 | 11.218 |
| 51 | 1.923 | 0.385 | 2.308 | 1.517 | 1.204 | 3.736 | 6.458 | 8.765 |
| 52 | 1.889 | 0.458 | 2.346 | 2.479 | 1.379 | 2.591 | 6.449 | 8.796 |
| 53 | 1.431 | 0.471 | 1.902 | 1.869 | 1.561 | 5.655 | 9.085 | 10.986 |
| 54 | 0.784 | 0.240 | 1.025 | 3.231 | 1.128 | 8.094 | 12.453 | 13.477 |
| 55 | 1.264 | 0.328 | 1.592 | 1.958 | 2.120 | 3.107 | 7.184 | 8.777 |
| 56 | 1.260 | 0.545 | 1.804 | 2.087 | 2.740 | 15.306 | 20.133 | 21.937 |
| 57 | 1.410 | 0.628 | 2.038 | 1.741 | 2.017 | 16.124 | 19.882 | 21.920 |
| 58 | 1.229 | 0.515 | 1.744 | 2.352 | 2.670 | 6.683 | 11.705 | 13.449 |
| 59 | 1.101 | 0.735 | 1.836 | 2.237 | 0.810 | 4.481 | 7.528 | 9.364 |
| 60 | 1.083 | 1.038 | 2.121 | 1.885 | 0.605 | 10.945 | 13.435 | 15.556 |
| 61 | 1.008 | 0.599 | 1.607 | 1.869 | 1.172 | 0.910 | 3.951 | 5.559 |
| 62 | 1.797 | 0.758 | 2.555 | 1.522 | 1.069 | 3.952 | 6.543 | 9.098 |
| 63 | 0.833 | 0.617 | 1.450 | 1.303 | 0.904 | 1.774 | 3.981 | 5.432 |
| 64 | 1.005 | 0.470 | 1.475 | 1.952 | 1.131 | 1.098 | 4.181 | 5.656 |
| 65 | 1.026 | 0.598 | 1.624 | 1.175 | 0.518 | 4.424 | 6.117 | 7.741 |
| 66 | 0.917 | 0.749 | 1.666 | 1.711 | 1.165 | 1.238 | 4.114 | 5.780 |
| 67 | 0.740 | 0.629 | 1.370 | 0.791 | 0.186 | 0.962 | 1.939 | 3.309 |
| 68 | 0.622 | 0.639 | 1.261 | 0.565 | 0.114 | 0.316 | 0.994 | 2.255 |
| 69 | 0.412 | 0.610 | 1.022 | 0.754 | 0.436 | 0.999 | 2.189 | 3.211 |
| 70 | 0.263 | 0.601 | 0.864 | 0.623 | 0.296 | 0.135 | 1.054 | 1.918 |
| 71 | 0.256 | 0.356 | 0.612 | 0.277 | 0.074 | 0.026 | 0.377 | 0.990 |
| 72 | 0.583 | 0.580 | 1.163 | 0.630 | 0.164 | 0.064 | 0.857 | 2.020 |
| 73 | 0.492 | 0.240 | 0.732 | 0.536 | 0.042 | 0.135 | 0.713 | 1.444 |
| 74 | 0.264 | 0.340 | 0.603 | 0.475 | 0.078 | 0.101 | 0.654 | 1.257 |
| 75 | 0.182 | 0.205 | 0.387 | 0.169 | 0.350 | 0.120 | 0.639 | 1.027 |
| 76 | 0.153 | 0.129 | 0.282 | 0.457 | 0.158 | 0.585 | 1.200 | 1.483 |
| 77 | 0.235 | 0.181 | 0.416 | 0.532 | 0.030 | 0.000 | 0.562 | 0.978 |
| 78 | 0.123 | 0.000 | 0.123 | 0.565 | 0.585 | 0.135 | 1.285 | 1.408 |
| 79 | 0.204 | 0.030 | 0.234 | 0.426 | 0.000 | 0.000 | 0.426 | 0.660 |
| 80 | 0.250 | 0.111 | 0.360 | 0.313 | 0.000 | 0.000 | 0.313 | 0.673 |
| 81 | 0.105 | 0.009 | 0.114 | 0.272 | 0.074 | 0.302 | 0.648 | 0.762 |
| 82 | 0.028 | 0.000 | 0.028 | 0.312 | 0.109 | 0.025 | 0.446 | 0.474 |
| 83 | 0.028 | 0.046 | 0.073 | 0.589 | 0.206 | 0.443 | 1.237 | 1.310 |
| 84 | 0.072 | 0.135 | 0.206 | 0.396 | 0.035 | 0.000 | 0.431 | 0.637 |
| 85 | 0.078 | 0.080 | 0.158 | 0.138 | 0.035 | 0.000 | 0.173 | 0.331 |
| 86 | 0.072 | 0.000 | 0.072 | 0.180 | 0.011 | 0.588 | 0.780 | 0.852 |
| 87 | 0.057 | 0.080 | 0.137 | 0.151 | 0.238 | 0.261 | 0.650 | 0.787 |
| 88 | 0.000 | 0.000 | 0.000 | 0.279 | 0.064 | 0.147 | 0.490 | 0.490 |
| 89 | 0.000 | 0.000 | 0.000 | 0.243 | 0.028 | 0.000 | 0.270 | 0.270 |
| 90 | 0.039 | 0.000 | 0.039 | 0.081 | 0.000 | 0.000 | 0.081 | 0.120 |
| 91 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 92 | 0.000 | 0.000 | 0.000 | 0.275 | 0.000 | 0.000 | 0.275 | 0.275 |
| 93 | 0.000 | 0.000 | 0.000 | 0.092 | 0.000 | 0.135 | 0.226 | 0.226 |
| 94 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 95 | 0.000 | 0.000 | 0.000 | 0.014 | 0.077 | 0.135 | 0.225 | 0.225 |
| 96 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 97 | 0.021 | 0.000 | 0.021 | 0.000 | 0.000 | 0.000 | 0.000 | 0.021 |
| 98 | 0.000 | 0.021 | 0.021 | 0.000 | 0.000 | 0.000 | 0.000 | 0.021 |
| 99 | 0.000 | 0.000 | 0.000 | 0.011 | 0.000 | 0.000 | 0.011 | 0.011 |
| $100+$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.276 | 0.000 | 0.276 | 0.276 |
| TOTAL | 140 | 15 | 155 | 108 | 77 | 139 | 324 | 479 |
| Landings (t) | 207 | 61 | 267 | 231 | 156 | 370 | 757 | 1024 |
| Mean Weight (g) | 1474 | 4037 | 1721 | 2133 | 2026 | 2665 | 2336 | 2137 |
| Mean Length (cm) | 43.0 | 62.9 | 44.9 | 50.0 | 47.3 | 54.1 | 51.1 | 49.1 |
| Measured weight (t) | 5.5 | 1.6 | 7.1 | 3.8 | 2.0 | 1.6 | 3.7 | 10.8 |

Table 8.2.4 ANGLERFISH (L. budegassa) - Divisions VIIIc and IXa.
Number, mean weight and mean length of landings between 1986 and 2012.

|  | 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 | 525 | 1518 | 49 |
| 2012 | 479 | 2137 | 49 |
|  |  |  | 49 |

Table 8.2.5 ANGLERFISH (L. budegassa) - Divisions VIIIc and IXa. Abundance indices from Spanish and Portuguese surveys.

| Year | SpGFS-WIBTS-Q4 |  |  |  |  | PtGFS-WIBTS-Q4 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | September-October (total area M iño-Bidasoa) |  |  |  |  | October |  |  |
|  | Hauls | $\mathrm{kg} / 30 \mathrm{~min}$ |  | $\mathrm{N} / 30 \mathrm{~min}$ |  | Hauls | $\mathrm{N} / 60 \mathrm{~min}$ | $\mathrm{kg} / 60 \mathrm{~min}$ |
|  |  | Yst | Sst | Yst | Sst |  |  |  |
| 1983 | 145 | 0.68 | 0.17 | 0.50 | 0.09 | 117 | n/a | n/a |
| 1984 | 111 | 0.60 | 0.17 | 0.60 | 0.11 | na | n/a | n/a |
| 1985 | 97 | 0.46 | 0.11 | 0.50 | 0.07 | 150 | n/a | n/a |
| 1986 | 92 | 1.42 | 0.32 | 2.50 | 0.33 | 117 | n/a | n/a |
| 1987 | ns | ns | ns | ns | ns | 81 | n/a | n/a |
| 1988 | 101 | 2.27 | 0.38 | 1.50 | 0.21 | 98 | n/a | n/a |
| 1989 | 91 | 0.45 | 0.10 | 0.90 | 0.21 | 138 | 0.23 | 0.19 |
| 1990 | 120 | 1.52 | 0.47 | 1.50 | 0.22 | 123 | 0.11 | 0.17 |
| 1991 | 107 | 0.83 | 0.14 | 0.60 | 0.10 | 99 | + | 0.02 |
| 1992 | 116 | 1.16 | 0.19 | 0.80 | 0.11 | 59 | + | + |
| 1993 | 109 | 0.90 | 0.20 | 0.90 | 0.13 | 65 | 0.02 | 0.04 |
| 1994 | 118 | 0.75 | 0.17 | 1.00 | 0.12 | 94 | 0.06 | 0.09 |
| 1995 | 116 | 0.72 | 0.12 | 1.00 | 0.11 | 88 | 0.02 | 0.08 |
| 1996* | 114 | 0.95 | 0.17 | 1.30 | 0.18 | 71 | 0.27 | 0.50 |
| 1997 | 116 | 1.16 | 0.20 | 0.97 | 0.11 | 58 | 0.03 | 0.01 |
| 1998 | 114 | 0.88 | 0.18 | 0.57 | 0.09 | 96 | 0.02 | 0.12 |
| 1999* | 116 | 0.43 | 0.12 | 0.26 | 0.06 | 79 | 0.08 | 0.07 |
| 2000 | 113 | 0.66 | 0.18 | 0.40 | 0.08 | 78 | 0.13 | 0.13 |
| 2001 | 113 | 0.19 | 0.06 | 0.52 | 0.10 | 58 | + | + |
| 2002 | 110 | 0.26 | 0.09 | 0.33 | 0.07 | 67 | 0 | 0 |
| 2003* | 112 | 0.36 | 0.11 | 0.35 | 0.10 | 80 | 0.22 | 0.21 |
| 2004* | 114 | 0.76 | 0.23 | 0.44 | 0.12 | 79 | 0.14 | 0.21 |
| 2005 | 116 | 0.64 | 0.20 | 1.62 | 0.30 | 87 | 0.01 | + |
| 2006 | 115 | 1.08 | 0.22 | 1.16 | 0.19 | 88 | 0.02 | 0.46 |
| 2007 | 117 | 0.59 | 0.12 | 0.48 | 0.08 | 96 | 0.02 | 0.03 |
| 2008 | 115 | 0.35 | 0.09 | 0.29 | 0.05 | 87 | 0.07 | 0.36 |
| 2009 | 117 | 0.30 | 0.08 | 0.35 | 0.08 | 93 | 0.02 | + |
| 2010 | 127 | 0.35 | 0.09 | 0.53 | 0.09 | 87 | 0.09 | 0.18 |
| 2011 | 111 | 0.63 | 0.15 | 0.52 | 0.08 | 86 | 0.02 | 0.06 |
| 2012 | 115 | 0.61 | 0.10 | 0.74 | 0.11 | ns | ns | ns |

Yst = stratified mean
Sst $=$ mean standar error
ns = no survey
$\mathrm{n} / \mathrm{a}=$ not available
$+=$ less than 0.01

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


Table 8.2.7 ANGLERFISH (L. budegassa) - Divisions VIIIc and IXa.
ASPIC input settings and data.
FIT \#\# Run type (FIT, BOT, or IRF)
Southern Anglerfish - ank
LOGISTIC YLD SSE
2 \#\# Verbosity
100095 \#\# Number of bootstrap trials, <= 1000
110000 \#\# 0=no MC search, 1=search, 2=repeated srch; N trials
1.0000E-08 \#\# Convergence crit. for simplex
3.0000E-08 8 \#\# Convergence crit. for restarts, N restarts
1.0000E-04 \#\# Conv. crit. for F; N steps/yr for gen. model
8.0000 \#\# Maximum F when cond. on yield
1.0 \#\# Stat weight for B1>K as residual (usually 0 or 1 )

3 \#\# Number of fisheries (data series)
8.5900E-01 1.2000E+00 9.8100E-01 \#\# Statistical weights for data series
0.6 \#\# B1/K (starting guess, usually 0 to 1 )
$1.81126 \mathrm{E}+03$ \#\# MSY (starting guess)
$1.81126 \mathrm{E}+04$ \#\# K (carrying capacity) (starting guess)
8.2523E-04 1.1196E-07 2.7279E-07 \#\# q (starting guesses -- 1 per data series)

111111 \#\# Estimate flags ( 0 or 1) (B1/K,MSY,K,q1...qn)
$1.81126 \mathrm{E}+023.62252 \mathrm{E}+03$ \#\# Min and max constraints -- MSY
$1.81126 \mathrm{E}+03$ 3.62252E+05 \#\# Min and max constraints -- K
1025957 \#\# Random number seed
33 \#\# Number of years of data in each series

| SPCORTR8c |  |  | PT.crust.tr |  | PT.fish.tr |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CC |  |  | 11 |  | I1 |  |
| 1980 | -1.00E+00 | $2.11 \mathrm{E}+03$ | 1980 | $-1.00 \mathrm{E}+00$ | 1980 | $-1.00 \mathrm{E}+00$ |
| 1981 | -1.00E+00 | $2.30 \mathrm{E}+03$ | 1981 | $-1.00 \mathrm{E}+00$ | 1981 | $-1.00 \mathrm{E}+00$ |
| 1982 | $1.03 \mathrm{E}+01$ | $2.37 \mathrm{E}+03$ | 1982 | -1.00E+00 | 1982 | $-1.00 \mathrm{E}+00$ |
| 1983 | $1.50 \mathrm{E}+01$ | $2.38 \mathrm{E}+03$ | 1983 | -1.00E+00 | 1983 | -1.00E+00 |
| 1984 | $1.18 \mathrm{E}+01$ | $1.93 \mathrm{E}+03$ | 1984 | $-1.00 \mathrm{E}+00$ | 1984 | -1.00E+00 |
| 1985 | 5.61E+00 | $1.83 \mathrm{E}+03$ | 1985 | -1.00E+00 | 1985 | $-1.00 \mathrm{E}+00$ |
| 1986 | $8.71 \mathrm{E}+00$ | $2.56 \mathrm{E}+03$ | 1986 | $-1.00 \mathrm{E}+00$ | 1986 | $-1.00 \mathrm{E}+00$ |
| 1987 | $1.94 \mathrm{E}+01$ | $3.83 \mathrm{E}+03$ | 1987 | $-1.00 \mathrm{E}+00$ | 1987 | $-1.00 \mathrm{E}+00$ |
| 1988 | $1.37 \mathrm{E}+01$ | $3.70 \mathrm{E}+03$ | 1988 | -1.00E+00 | 1988 | -1.00E+00 |
| 1989 | $7.74 \mathrm{E}+00$ | $2.58 \mathrm{E}+03$ | 1989 | $1.17 \mathrm{E}-03$ | 1989 | $3.51 \mathrm{E}-03$ |
| 1990 | $6.49 \mathrm{E}+00$ | $2.33 \mathrm{E}+03$ | 1990 | $1.41 \mathrm{E}-03$ | 1990 | $4.29 \mathrm{E}-03$ |
| 1991 | $5.56 \mathrm{E}+00$ | $2.16 \mathrm{E}+03$ | 1991 | $1.22 \mathrm{E}-03$ | 1991 | $3.65 \mathrm{E}-03$ |
| 1992 | $5.41 \mathrm{E}+00$ | $2.11 \mathrm{E}+03$ | 1992 | $1.32 \mathrm{E}-03$ | 1992 | 3.97E-03 |
| 1993 | $4.47 \mathrm{E}+00$ | $2.23 \mathrm{E}+03$ | 1993 | 8.53E-04 | 1993 | $2.37 \mathrm{E}-03$ |
| 1994 | $3.89 \mathrm{E}+00$ | $1.58 \mathrm{E}+03$ | 1994 | 6.37E-04 | 1994 | $1.50 \mathrm{E}-03$ |
| 1995 | $8.28 \mathrm{E}+00$ | $1.84 \mathrm{E}+03$ | 1995 | 5.82E-04 | 1995 | $1.11 \mathrm{E}-03$ |
| 1996 | $9.05 \mathrm{E}+00$ | $1.63 \mathrm{E}+03$ | 1996 | 7.03E-04 | 1996 | $1.62 \mathrm{E}-03$ |
| 1997 | $7.65 \mathrm{E}+00$ | $1.81 \mathrm{E}+03$ | 1997 | $8.79 \mathrm{E}-04$ | 1997 | $1.60 \mathrm{E}-03$ |
| 1998 | $1.09 \mathrm{E}+01$ | $2.09 \mathrm{E}+03$ | 1998 | $1.45 \mathrm{E}-03$ | 1998 | 3.16E-03 |
| 1999 | $1.24 \mathrm{E}+01$ | $1.88 \mathrm{E}+03$ | 1999 | $1.72 \mathrm{E}-03$ | 1999 | $3.85 \mathrm{E}-03$ |
| 2000 | $9.55 \mathrm{E}+00$ | $1.37 \mathrm{E}+03$ | 2000 | $1.56 \mathrm{E}-03$ | 2000 | $4.04 \mathrm{E}-03$ |
| 2001 | $9.40 \mathrm{E}+00$ | $1.01 \mathrm{E}+03$ | 2001 | 6.86E-04 | 2001 | $2.27 \mathrm{E}-03$ |
| 2002 | $3.74 \mathrm{E}+00$ | $7.70 \mathrm{E}+02$ | 2002 | 7.54E-04 | 2002 | $2.00 \mathrm{E}-03$ |
| 2003 | $4.89 \mathrm{E}+00$ | $9.26 \mathrm{E}+02$ | 2003 | 7.14E-04 | 2003 | 2.17E-03 |
| 2004 | $3.63 \mathrm{E}+00$ | $9.72 \mathrm{E}+02$ | 2004 | $1.07 \mathrm{E}-03$ | 2004 | $1.90 \mathrm{E}-03$ |
| 2005 | $2.76 \mathrm{E}+00$ | $8.97 \mathrm{E}+02$ | 2005 | 6.34E-04 | 2005 | $1.38 \mathrm{E}-03$ |
| 2006 | $4.69 \mathrm{E}+00$ | $1.15 \mathrm{E}+03$ | 2006 | 8.01E-04 | 2006 | $1.73 \mathrm{E}-03$ |
| 2007 | $6.39 \mathrm{E}+00$ | $1.30 \mathrm{E}+03$ | 2007 | 1.53E-03 | 2007 | 3.98E-03 |
| 2008 | 8.69E+00 | $9.51 \mathrm{E}+02$ | 2008 | $1.50 \mathrm{E}-03$ | 2008 | 3.56E-03 |
| 2009 | 5.05E+00 | 7.69E+02 | 2009 | $1.14 \mathrm{E}-03$ | 2009 | $2.65 \mathrm{E}-03$ |
| 2010 | $8.75 \mathrm{E}+00$ | $7.84 \mathrm{E}+02$ | 2010 | $1.75 \mathrm{E}-03$ | 2010 | 2.37E-03 |
| 2011 | $7.71 \mathrm{E}+00$ | $7.98 \mathrm{E}+02$ | 2011 | 2.15E-03 | 2011 | 3.91E-03 |
| 2012 | 8.17E+00 | $1.02 \mathrm{E}+03$ | 2012 | $1.44 \mathrm{E}-03$ | 2012 | $2.15 \mathrm{E}-03$ |

Table 8.2 8 ANGLERFISH (L. budegassa) - Divisions VIIIc and IXa.
ASPIC results: parameter estimates, non parametric bootstrap relative bias and bias corrected confidence interval, interquartil (IQ) range and relative range. Ye(2011): equilibrium yield available in 2013; Y(Fmsy): yield availabe at Fmsy in 2013; Ye2013/MSY: equilibrium yield available in 2013 as proportion of MSY;finsy (1): fishing effort rate at MSY for SPCORTR8c; fimsy (2): fishing effort rate at MSY for P-TRC; finsy (3): fishing effort rate at MSY for P-TRF.

| Parameter | WG2013 (WKFLAT2012/Stock Annex settings) |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Bootstrap Confidence Interval |  |  |  | Relative |  |
|  | Point estimates | Relative bias | Lower $80 \%$ | Higher 80\% | Lower 95\% | Higher 95\% |  |  |
| B1/K | 0.44 | 68.28\% | 0.17 | 0.81 | 0.15 | 1.06 | 0.24 | 53.10\% |
| K | 58390 | -4.90\% | 41480 | 286200 | 32700 | 325800 | 111400 | 190.80\% |
| q(1) | $4.22 \mathrm{E}-04$ | -1.66\% | $2.65 \mathrm{E}-04$ | 6.49E-04 | $1.71 \mathrm{E}-04$ | 7.60E-04 | $1.95 \mathrm{E}-04$ | 46.10\% |
| $\mathrm{q}(2)$ | $6.78 \mathrm{E}-08$ | -0.19\% | $4.10 \mathrm{E}-08$ | $1.05 \mathrm{E}-07$ | $2.49 \mathrm{E}-08$ | $1.28 \mathrm{E}-07$ | $3.31 \mathrm{E}-08$ | 48.80\% |
| q(3) | $1.58 \mathrm{E}-07$ | 0.16\% | $8.84 \mathrm{E}-08$ | $2.37 \mathrm{E}-07$ | $5.25 \mathrm{E}-08$ | $2.90 \mathrm{E}-07$ | $7.47 \mathrm{E}-08$ | 47.40\% |
| MSY | 1881 | -5.25\% | 1628 | 3428 | 1492 | 3549 | 1108 | 58.90\% |
| $\mathrm{Ye}(2013)$ | 1693 | -8.89\% | 1523 | 2396 | 1394 | 2724 | 449 | 26.50\% |
| Y.(Fmsy) | 1054 | -0.63\% | 1041 | 1098 | 1033 | 1119 | 31 | 2.90\% |
| Bmsy | 29190 | -4.90\% | 20740 | 143100 | 16350 | 162900 | 55710 | 190.80\% |
| Fmsy | 0.064 | 21.14\% | 0.014 | 0.085 | 0.004 | 0.102 | 0.039 | 60.20\% |
| $\mathrm{fmsy}(1)$ | 152.7 | 28.42\% | 82.31 | 181.1 | 61.09 | 220.8 | 44.26 | 29.00\% |
| fmsy(2) | 950500 | 27.26\% | 593200 | 1136000 | 440300 | 1393000 | 246200 | 25.90\% |
| fmsy(3) | 408400 | 27.34\% | 237700 | 479100 | 179700 | 588700 | 114500 | 28.00\% |
| B./Bmsy | 0.68 | 39.53\% | 0.26 | 0.98 | 0.18 | 1.21 | 0.35 | 51.20\% |
| F./Fmsy | 0.81 | -12.71\% | 0.67 | 1.64 | 0.55 | 2.30 | 0.47 | 58.70\% |
| Ye./MSY | 0.90 | -1.35\% | 0.56 | 0.98 | 0.42 | 1.00 | 0.22 | 24.70\% |
| q2/q1 | $1.61 \mathrm{E}-04$ | 1.59\% | $1.37 \mathrm{E}-04$ | $1.81 \mathrm{E}-04$ | $1.29 \mathrm{E}-04$ | $1.96 \mathrm{E}-04$ | $2.40 \mathrm{E}-05$ | 15.00\% |
| q3/q1 | $3.74 \mathrm{E}-04$ | 1.83\% | $3.23 \mathrm{E}-04$ | $4.36 \mathrm{E}-04$ | $3.03 \mathrm{E}-04$ | 4.69E-04 | $5.53 \mathrm{E}-05$ | 14.80\% |

Table 8.2.9 ANGLERFISH (L. budegassa ) - Divisions VIIIc and IXa.

| Outputs | WG2011 | WKFLAT2012 | WG2013 (add 2011 and 2012 data) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $\begin{gathered} \hline \text { Benchmark } \\ \text { Settings } \\ \hline \end{gathered}$ | $\begin{gathered} 2013 \\ \text { Settings } \end{gathered}$ | 2 series |
| B1/K | 0.40 | 0.93 | 0.44 | 0.72 | 0.41 |
| MSY | 2515 | 1375 | 1881 | 1541 | 2511 |
| K | 11700 | 43910 | 58390 | 42580 | 11360 |
| q(1) | - | 3.09E-04 | $4.22 \mathrm{E}-04$ | 3.96E-04 | - |
| q(2) | 4.65E-07 | $4.85 \mathrm{E}-08$ | $6.78 \mathrm{E}-08$ | 6.41E-08 | 5.03E-07 |
| q(3) | 1.12E-06 | 1.17E-07 | 1.58E-07 | 1.49E-07 | 1.17E-06 |
| TOF | $9.49 \mathrm{E}+00$ | $1.07 \mathrm{E}+01$ | $1.14 \mathrm{E}+01$ | $1.14 \mathrm{E}+01$ | $1.20 \mathrm{E}+01$ |
| mse | $2.43 \mathrm{E}-01$ | $1.60 \mathrm{E}-01$ | 1.57E-01 | 1.57E-01 | 2.80E-01 |
| rmse | $4.93 \mathrm{E}-01$ | $4.01 \mathrm{E}-01$ | 3.96E-01 | 3.96E-01 | 5.29E-01 |
| CI | 0.4754 | 0.5015 | 0.2162 | 0.3825 | 0.4871 |
| CN | 1.0000 | 1.0000 | 0.9438 | 1.0000 | 1.0000 |
| Rest | 152 | 111 | 19 | 39 | 149 |
| Error | 0 | 0 | 0 | 0 | 0 |
| r sq 1 | - | 0.181 | 0.165 | 0.170 | - |
| rsq 2 | -0.436 | 0.010 | 0.132 | 0.120 | -0.677 |
| rsq 3 | -0.549 | 0.052 | 0.029 | 0.034 | -1.123 |
| Y.@Fmsy | 2332 | 1436 | 1300 | 1488 | 2711 |
| Bmsy | 5850 | 21950 | 29190 | 21290 | 5680 |
| Fmsy | 0.430 | 0.063 | 0.064 | 0.072 | 0.442 |
| B./Bmsy | 0.912 | 1.040 | 0.684 | 0.964 | 1.100 |
| F./Fmsy | 0.386 | 0.522 | 0.806 | 0.695 | 0.417 |

Table 8.2.10 ANGLERFISH (L. budegassa) - Divisions VIIIc and IXa.

|  | $\begin{gathered} -50 \% \\ 0.3 \end{gathered}$ | $\begin{gathered} -25 \% \\ 0.45 \end{gathered}$ | $\begin{gathered} -10 \% \\ 0.54 \end{gathered}$ | WGHMM 2013 | $\begin{gathered} +10 \% \\ 0.66 \end{gathered}$ | $\begin{gathered} +25 \% \\ 0.75 \end{gathered}$ | $\begin{gathered} +50 \% \\ 0.9 \end{gathered}$ | Variation <br> MSY <br> Low Bound <br> Hy Bound | $\begin{gathered} -50 \% \\ 906 \\ 91 \\ 1811 \end{gathered}$ | $\begin{gathered} -25 \% \\ 1358 \\ 136 \\ 2717 \end{gathered}$ | $\begin{gathered} -10 \% \\ 1630 \\ 163 \\ 3260 \end{gathered}$ | WGHMM 2013 |  | $\begin{aligned} & +25 \% \\ & 2264 \end{aligned}$ | $\begin{aligned} & +50 \% \\ & 2717 \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |  |  |  | +10\% |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  | 1811 | 1992 |  |  |
|  |  |  |  | 0 |  |  |  |  |  |  |  | 181 | 199 | 226 | $272$ |
|  |  |  |  | 0.6 |  |  |  |  |  |  |  | 3623 | 3985 | 4528 | 5434 |
| Outputs |  |  |  |  |  |  |  | Outputs |  |  |  |  |  |  |  |
| B1/K | 0.49 | 0.45 | 0.51 | 0.44 | 0.21 | 0.47 | 0.26 | B1/K | 0.50 | 0.65 | 0.38 | 0.44 | 0.59 | 0.61 | 1.23 |
| msy | 1789 | 1875 | 1755 | 1881 | 3166 | 1831 | 2659 | msy | 1767 | 1588 | 2057 | 1881 | 1649 | 1624 | 5434 |
| K | 54340 | 58110 | 52830 | 58390 | 111800 | 56150 | 91020 | K | 53370 | 44900 | 65950 | 58390 | 47930 | 46690 | 181000 |
| q(1) | $4.18 \mathrm{E}-04$ | 4.22E-04 | 4.16E-04 | 4.22E-04 | $4.38 \mathrm{E}-04$ | 4.20E-04 | 4.35E-04 | q(1) | $4.17 \mathrm{E}-04$ | 4.04E-04 | 4.27E-04 | $4.22 \mathrm{E}-04$ | 4.10E-04 | 4.07E-04 | 4.16E-05 |
| q(2) | $6.73 \mathrm{E}-08$ | 6.78E-08 | 6.70E-08 | 6.78E-08 | $6.99 \mathrm{E}-08$ | 6.76E-08 | 6.96E-08 | q(2) | 6.71E-08 | 6.52E-08 | 6.85E-08 | 6.78E-08 | 6.60E-08 | 6.57E-08 | 6.30E-09 |
| q(3) | 1.57E-07 | 1.58E-07 | 1.56E-07 | 1.58E-07 | $1.63 \mathrm{E}-07$ | 1.57E-07 | 1.62E-07 | q(3) | 1.56E-07 | 1.52E-07 | 1.59E-07 | 1.58E-07 | $1.54 \mathrm{E}-07$ | $1.53 \mathrm{E}-07$ | 1.47E-08 |
| TOF | $1.14 \mathrm{E}+01$ | $1.14 \mathrm{E}+01$ | $1.14 \mathrm{E}+01$ | $1.14 \mathrm{E}+01$ | $1.14 \mathrm{E}+01$ | $1.14 \mathrm{E}+01$ | $1.14 \mathrm{E}+01$ | TOF | 1.14E+01 | $1.14 \mathrm{E}+01$ | $1.14 \mathrm{E}+01$ | 1.14E+01 | 1.14E+01 | 1.14E+01 | 1.26E+01 |
| mse | $1.57 \mathrm{E}-01$ | 1.57E-01 | $1.57 \mathrm{E}-01$ | $1.57 \mathrm{E}-01$ | $1.57 \mathrm{E}-01$ | 1.57E-01 | 1.57E-01 | mse | $1.57 \mathrm{E}-01$ | $1.57 \mathrm{E}-01$ | 1.57E-01 | 1.57E-01 | 1.57E-01 | $1.57 \mathrm{E}-01$ | 1.72E-01 |
| rmse | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 | rmse | $3.96 \mathrm{E}-01$ | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 | $4.15 \mathrm{E}-01$ |
| CI | 0.2415 | 0.2177 | 0.2529 | 0.2162 | 0.0944 | 0.2293 | 0.1202 | CI | 0.2488 | 0.3397 | 0.1816 | 0.2162 | 0.2993 | 0.3145 | 0.3000 |
| CN | 0.9885 | 0.9466 | 1.0000 | 0.9438 | 0.7990 | 0.9671 | 0.7618 | CN | 1.0000 | 1.0000 | 0.8807 | 0.9438 | 1.0000 | 1.0000 | 0.5713 |
| Rest | 13 | 7 | 9 | 19 | 16 | 13 | 22 | Rest | 33 | 315 | 13 | 19 | 221 | 92 | 42 |
| Error | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Error | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| r sq 1 | 0.166 | 0.165 | 0.167 | 0.165 | 0.159 | 0.166 | 0.161 | r sq 1 | 0.167 | 0.169 | 0.164 | 0.165 | 0.168 | 0.169 | 0.050 |
| rsq 2 | 0.130 | 0.132 | 0.129 | 0.132 | 0.138 | 0.131 | 0.137 | rsq 2 | 0.130 | 0.124 | 0.134 | 0.132 | 0.126 | 0.125 | -0.026 |
| rsq 3 | 0.030 | 0.029 | 0.030 | 0.029 | 0.024 | 0.029 | 0.025 | rsq 3 | 0.030 | 0.033 | 0.028 | 0.029 | 0.032 | 0.032 | -0.015 |
| Y.@Fmsy | 1331 | 1302 | 1345 | 1300 | 1140 | 1316 | 1175 | Y.@Fmsy | 1339 | 1443 | 1256 | 1300 | 1399 | 1416 | 10040 |
| Bmsy | 27170 | 29060 | 26410 | 29190 | 55910 | 28080 | 45510 | Bmsy | 26680 | 22450 | 32980 | 29190 | 23960 | 23340 | 90490 |
| Fmsy | 0.066 | 0.065 | 0.066 | 0.064 | 0.057 | 0.065 | 0.058 | Fmsy | 0.066 | 0.071 | 0.062 | 0.064 | 0.069 | 0.070 | 0.060 |
| B./Bmsy | 0.737 | 0.687 | 0.760 | 0.684 | 0.354 | 0.712 | 0.435 | B./Bmsy | 0.752 | 0.906 | 0.603 | 0.684 | 0.844 | 0.868 | 1.895 |
| F.Fmsy | 0.786 | 0.805 | 0.777 | 0.806 | 0.930 | 0.795 | 0.900 | F./Fmsy | 0.780 | 0.719 | 0.837 | 0.806 | 0.744 | 0.734 | 0.099 |
|  |  |  |  | WGHMM 2013 |  |  |  |  |  |  |  |  |  |  |  |
| Variation | -50\% | -25\% | -10\% | 0 | +10\% | +25\% | +50\% |  |  |  |  |  |  |  |  |
| K | 9056 | 13584 | 16301 | 18113 | 19924 | 22641 | 27169 |  |  |  |  | GHMM 201 |  |  |  |
| Low Bound | 906 | 1358 | 1630 | 1811 | 1992 | 2264 | 2717 | Variation | -50\% | -25\% | -10\% | 0 | +10\% | +25\% | +50\% |
| Hy Bound | 181126 | 271689 | 326027 | 362252 | 398477 | 452815 | 543378 | seed | 512979 | 769468 | 923361 | 1025957 | 1128553 | 1282446 | 1538936 |
| Outputs |  |  |  |  |  |  |  | Outputs |  |  |  |  |  |  |  |
| B1/K | 0.39 | 0.51 | 0.57 | 0.44 | 0.40 | 0.75 | 0.39 | B1/K | 0.43 | 0.57 | 0.62 | 0.44 | 0.54 | 0.55 | 0.50 |
| MSY | 2035 | 1755 | 1667 | 1881 | 2009 | 1522 | 2023 | MSY | 1925 | 1670 | 1609 | 1881 | 1704 | 1689 | 1763 |
| к | 64980 | 52820 | 48760 | 58390 | 63920 | 41490 | 64560 | к | 60560 | 48850 | 46070 | 58390 | 50530 | 49800 | 53150 |
| q(1) | $4.27 \mathrm{E}-04$ | 4.17E-04 | 4.11E-04 | 4.22E-04 | $4.26 \mathrm{E}-04$ | 3.93E-04 | 4.26E-04 | q(1) | $4.22 \mathrm{E}-04$ | 4.12E-04 | 4.05E-04 | $4.22 \mathrm{E}-04$ | $4.13 \mathrm{E}-04$ | $4.13 \mathrm{E}-04$ | 4.17E-04 |
| q(2) | $6.84 \mathrm{E}-08$ | 6.70E-08 | 6.62E-08 | $6.78 \mathrm{E}-08$ | $6.83 \mathrm{E}-08$ | 6.37E-08 | 6.83E-08 | q(2) | 6.78E-08 | 6.63E-08 | 6.54E-08 | 6.78E-08 | 6.66E-08 | 6.65E-08 | 6.71E-08 |
| q(3) | $1.59 \mathrm{E}-07$ | 1.56E-07 | 1.54E-07 | 1.58E-07 | $1.59 \mathrm{E}-07$ | 1.48E-07 | 1.59E-07 | q(3) | $1.58 \mathrm{E}-07$ | 1.54E-07 | 1.52E-07 | $1.58 \mathrm{E}-07$ | 1.55E-07 | 1.55E-07 | 1.56E-07 |
| TOF | 1.14E+01 | $1.14 \mathrm{E}+01$ | 1.14E+01 | 1.14E+01 | 1.14E+01 | $1.14 \mathrm{E}+01$ | $1.14 \mathrm{E}+01$ | TOF | 1.14E+01 | $1.14 \mathrm{E}+01$ | $1.14 \mathrm{E}+01$ | 1.14E+01 | $1.14 \mathrm{E}+01$ | 1.14E+01 | 1.14E+01 |
| mse | $1.57 \mathrm{E}-01$ | 1.57E-01 | $1.57 \mathrm{E}-01$ | $1.57 \mathrm{E}-01$ | $1.57 \mathrm{E}-01$ | 1.57E-01 | 1.57E-01 | mse | $1.57 \mathrm{E}-01$ | 1.57E-01 | 1.57E-01 | 1.57E-01 | $1.57 \mathrm{E}-01$ | 1.57E-01 | 1.57E-01 |
| rmse | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 | rmse | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 | 3.96E-01 |
| CI | 0.1853 | 0.2529 | 0.2901 | 0.2162 | 0.1896 | 0.4066 | 0.1871 | CI | 0.2054 | 0.2889 | 0.3233 | 0.2162 | 0.2726 | 0.2793 | 0.2502 |
| CN | 0.8876 | 1.0000 | 1.0000 | 0.9438 | 0.8957 | 1.0000 | 0.8911 | CN | 0.9251 | 1.0000 | 1.0000 | 0.9438 | 1.0000 | 1.0000 | 1.0000 |
| Rest | 12 | 18 | 14 | 19 | 7 | 234 | 7 | Rest | 136 | 18 | 12 | 19 | 105 | 33 | 15 |
| Error | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Error | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| r sq 1 | 0.164 | 0.167 | 0.168 | 0.165 | 0.164 | 0.171 | 0.164 | r sq 1 | 0.165 | 0.168 | 0.169 | 0.165 | 0.167 | 0.168 | 0.167 |
| rsq 2 | 0.134 | 0.129 | 0.127 | 0.132 | 0.133 | 0.119 | 0.133 | rsq 2 | 0.132 | 0.127 | 0.124 | 0.132 | 0.128 | 0.128 | 0.130 |
| rsq 3 | 0.028 | 0.030 | 0.032 | 0.029 | 0.028 | 0.034 | 0.028 | rsq 3 | 0.029 | 0.031 | 0.032 | 0.029 | 0.031 | 0.031 | 0.030 |
| Y.@Fmsy | 1261 | 1344 | 1388 | 1300 | 1266 | 1512 | 1263 | Y.@Fmsy | $1.29 \mathrm{E}+03$ | $1.39 \mathrm{E}+03$ | $1.43 \mathrm{E}+03$ | 1300 | $1.37 \mathrm{E}+03$ | $1.38 \mathrm{E}+03$ | $1.34 \mathrm{E}+03$ |
| Bmsy | 32490 | 32490 | 24380 | 29190 | 31960 | 20750 | 32280 | Bmsy | 3.03E+04 | $2.44 \mathrm{E}+04$ | $2.30 \mathrm{E}+04$ | 29190 | $2.53 \mathrm{E}+04$ | $2.49 \mathrm{E}+04$ | $2.66 \mathrm{E}+04$ |
| Fmsy | 0.063 | 0.066 | 0.068 | 0.064 | 0.063 | 0.073 | 0.063 | Fmsy | $6.36 \mathrm{E}-02$ | 6.84E-02 | 6.99E-02 | 0.064 | $6.75 \mathrm{E}-02$ | 6.78E-02 | 6.63E-02 |
| B./Bmsy | 0.612 | 0.760 | 0.828 | 0.684 | 0.623 | 0.993 | 0.617 | B./Bmsy | $6.60 \mathrm{E}-01$ | 8.26E-01 | $8.82 \mathrm{E}-01$ | 0.684 | $7.97 \mathrm{E}-01$ | 8.09E-01 | $7.55 \mathrm{E}-01$ |
| F.Fmsy | 0.833 | 0.777 | 0.750 | 0.806 | 0.829 | 0.683 | 0.832 | F./Fmsy | $8.16 \mathrm{E}-01$ | 8.26E-0 | 7.29E- | 0.806 | 7.62E-01 | $7.58 \mathrm{E}-01$ | 7.79E-01 |

Table 8.2.11 ANGLERFISH (L. budegassa ) - Divisions VIIIc and IXa.
Sensitive analyses of the "benchmark settings" by changing $+/-25 \%$ starting guess for $B 1 / K, M S Y, K$ and the seed, with projections.


Table 8.2.12 ANGLERFISH (L. budegassa ) - Divisions VIIIc and IXa.
Sensitive analyses of the " 2013 settings" by changing $+/-25 \%$ starting guess for $B 1 / K, M S Y, K$ and the seed, with projections.


Table 8.2.13. ANGLERFISH (L. budegassa ) - Divisions VIIIc and IXa.
Point estimates of B/BMSY(from 2013 to 2015) and Yield (from 2013 to 2015) for projections with $F$ status quo (Fsq), FMSY, zero catches. Reductions to obtain yields equal to 2013 TAC, and $+/-15 \% 2013$ TAC are also presented. The value of $\mathrm{F} 2013 / \mathrm{FMSY}$ is equal to Fsq (mean F of 2010-2012) in all scenarios proposed. Values for F/FMSY are also given.

Fis hing mortality trends in relation to $\mathrm{F}_{\mathrm{MSY}}$

| year | L. piscatorius <br> MSYApproach | L. piscatorius <br> MSYTransition | Fsq | F MSY | zero catches | $-15 \%$ TAC $=2104 \mathrm{t}$ | TAC=2475 t | $+15 \% \mathrm{TAC}=2846 \mathrm{t}$ |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2013 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 |
| 2014 | 0.85 | 0.87 | 0.71 | 1.00 | 0.00 | 0.67 | 0.80 | 0.93 |
| 2015 | 0.85 | 0.87 | 0.71 | 1.00 | 0.00 | 0.67 | 0.80 | 0.93 |
| 2016 | 0.85 | 0.87 | 0.71 | 1.00 | 0.00 | 0.67 | 0.80 | 0.93 |
| 2017 | 0.85 | 0.87 | 0.71 | 1.00 | 0.00 | 0.67 | 0.80 | 0.93 |

Biomass trends in relation to $\mathrm{B}_{\text {MSY }}$

|  | L. piscatorius <br> MSYApproach | L. piscatorius <br> MSYTransition | Fsq | FMSY | zero catches | $-15 \%$ TAC $=2104 \mathrm{t}$ | TAC=2475t | $+15 \%$ TAC $=2846 \mathrm{t}$ |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| year | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 |
| 2013 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 |
| 2014 | 0.73 | 0.73 | 0.74 | 0.72 | 0.77 | 0.74 | 0.73 | 0.73 |
| 2016 | 0.75 | 0.75 | 0.76 | 0.74 | 0.83 | 0.77 | 0.75 | 0.74 |
| 2017 | 0.77 | 0.77 | 0.79 | 0.75 | 0.90 | 0.79 | 0.78 | 0.76 |
| 2018 | 0.79 | 0.78 | 0.81 | 0.76 | 0.96 | 0.82 | 0.80 | 0.77 |

Yield

| year | L. piscatorius <br> MSYApproach | L. piscatorius <br> MSYTransition | Fsq | FMSY | zero catches | $-15 \%$ TAC $=2104 \mathrm{t}$ | TAC=2475t | $+15 \%$ TAC $=2846 \mathrm{t}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2013 | 934 | 934 | 934 | 934 | 934 | 934 | 934 | 934 |
| 2014 | 1153 | 1179 | 969 | 1349 | 0 | 915 | 1083 | 1253 |
| 2015 | 1184 | 1210 | 1004 | 1374 | 0 | 951 | 1117 | 1282 |
| 2016 | 1215 | 1240 | 1039 | 1397 | 0 | 986 | 1149 | 1309 |
| 2017 | 1245 | 1269 | 1073 | 1420 | 0 | 1020 | 1181 | 1336 |



Figure 8.2.1 ANGLERFISH (L. budegassa) - Divisions VIIIc and IXa.
Length distributions of landings (thousands for 1986 to 2012).


Figure 8.2.2
ANGLERFISH (L. budegassa) - Divisions VIIIc and IXa.
Trawl and gillnet landings, effort and LPUE data between 1986-2012.


Figure 8.2.3. ANGLERFISH (L. budegassa)- Divisions VIIIc and IXa. Observed CPUE for the three commercial fleets and estimated values by the model.


Figure 8.2.4. ANGLERFISH (L. budegassa) - Divisions VIIIc and IXa. Confidence intervals (80\%) of the F/FMSY and B/BMSY ratios.


Figure 8.2.5. ANGLERFISH (L. budegassa) - Divisions VIIIc and IXa. Trends of the F/Fmsy and B/Bmsy ratios from the 2007 - 2011 WG, 2012 benchmark and 2013 WG assessments.

### 8.5 Anglerfish (L. piscatorius and L. budegassa) in Divisions VIIIc and IXa

The total anglerfish (Lophius) landings are given in Table 8.3.1 by ICES division, country and fishing gear. The general trend reflects the trends described for each species, with landings increasing in the early eighties and reaching maximum in 1986 $(9433 \mathrm{t})$ and $1988(10021 \mathrm{t})$, and decreasing after that to the minimum in $2001(1801 \mathrm{t})$ and 2002 (1802 t). From 2002 to 2005 landings increased reaching 4541 t . Since then, landings decreased and in 2011 were the lowest of the time series with 1774 t ( 976 t L. piscatorius and 798 t L. budegassa).

The species proportion in the landings has changed since 1986. In the beginning of the time series (1980-1986) L. piscatorius represented more than $70 \%$ of the total anglerfish landings. After 1986 the proportion of L. piscatorius decreased and since 1999 both species had approximately the same weight in the annual landings. From 2002 to 2010 L. piscatorius again gained more importance but in the last two years this species only represented $55 \%$ total landings.
The TAC ( 3300 t in 2012 and 2475 t in 2013) is set for both species of anglerfish combined. The reported landings in 2012 were $69 \%$ of the established TAC.

The landings, effort and LPUE data series of the combined species are presented in Table 8.3.2 and Figure 8.3.1. During the late 1980s and early 1990s a decrease in LPUE is observed for all series while an increase is apparent in the middle of the 1990s. Since then, LPUE values have decreased and reached the minimum of the series in 2001 for the A Coruña fleet and in 2000 for the Portuguese fleets. Both Portuguese trawl fleets show afterwards an increasing trend till 2007 but since then a declined in LPUE was observed till 2010, while the data available for the Spanish fleets indicates stability or an increasing trend. The Portuguese fleets LPUEs show an increase in 2011.

### 8.5.1 Assessment

The Working Group has performed assessments for each species separately (Sections 8.1 and 8.2).

### 8.5.2 Comments on the assessment

The benchmark assessment of anglerfish in Division VIIIc and IXa was carried out in 2012, a new assessment using Stock Synthesis (SS3) for L. piscatorius was approved and new settings and data were incorporate to the ASPIC model for L. budegassa.

The update of the assessments including data for 2011 and 2012 was carried out by this WG, being the latest assessment for both anglerfish approved used to carry out the projections.
As the models used are different for each anglerfish species comments on the assessment are done for each species separately (Sections 8.1 and 8.2).

### 8.5.3 Biological Reference Points

Biological Reference Points are assumed differentially for each species (Sections 8.1 and 8.2).

### 8.5.4 Management considerations

Lophius piscatorius and L. budegassa are subject to a common TAC ( 3300 t in 2012 and 2475 t in 2013), so the joint status of these species should be taken into account when formulating management advice. Combined landings in 2012 ( 2281 t ) were $69 \%$ of the TAC. Both species of anglerfish are reported together because of their similarity but are assessed separately.

Both stocks status are based on the present updated assessment. L. piscatorius fishing mortality has decreased from 2005 to 2011, and for 2012 was estimated to be $26 \%$ higher than in previous year. SSB has been increasing since 1994 and remained stable with slight fluctuations from 2005. Landings decreased since 2005 to 2011, and after two significant consecutive drops of $32 \%$ and $37 \%$ in 2010 and in 2011, landings increased in 2012. Under F status quo scenario in 2014 is expected an increase in landings with respect to 2013, and an increase in SSB in 2015 with respect to 2014.
L. budegassa fishing mortality remained at high levels between late eighties and late nineties, dropping after that. In 2012, fishing mortality was estimated to be below $\mathrm{F}_{\mathrm{msy}}$. Trends in relative biomass indicate a steady decrease since the beginning of the series to below $\mathrm{B}_{\text {MSY }}$ in 2001, since then a slight recovery was observed, been in 2013 at $68 \%$ of Bmsy. Fishing mortality equal to F status quo in 2013 is expected to keep the stock below Bmsy in 2014. The biomass is expected to be below Bmsy in 2014 under all fishing mortality scenarios examined.

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

Although these stocks are assessed separately they are managed together. Due to the differences in the current status of the individual stocks, it is difficult to give common advice.

Table 8.3.1 ANGLERFISH (L. piscatorius and L. budegassa) - Divisions VIIIc and IXa.
Tonnes landed by the main fishing fleets for 1978-2012 as determined by the Working Group.

| Year | Div. VIIIc |  |  | Div. IXa |  |  |  | Div. VIIIc+1Xa |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | SPAIN |  | TOTAL | $\frac{\text { SPAIN }}{\text { Trawl }}$ | PORTUGAL |  | TOTAL |  |
|  | Trawl | Gillnet |  |  | Trawl | Artisanal |  | TOTAL |
| 1978 | $\mathrm{n} / \mathrm{a}$ | n/a | n/a | 506 | n/a | 222 | 728 | n/a |
| 1979 | n/a | n/a | n/a | 625 | n/a | 435 | 1060 | n/a |
| 1980 | 4008 | 1477 | 5485 | 786 | n/a | 654 | 1440 | 6926 |
| 1981 | 3909 | 2240 | 6149 | 1040 | n/a | 679 | 1719 | 7867 |
| 1982 | 2742 | 3095 | 5837 | 1716 | n/a | 598 | 2314 | 8151 |
| 1983 | 4269 | 1911 | 6180 | 1426 | n/a | 888 | 2314 | 8494 |
| 1984 | 3600 | 1866 | 5466 | 1136 | 409 | 950 | 2495 | 7961 |
| 1985 | 2679 | 2495 | 5174 | 977 | 466 | 1355 | 2798 | 7972 |
| 1986 | 3052 | 3209 | 6261 | 1049 | 367 | 1757 | 3172 | 9433 |
| 1987 | 3174 | 2571 | 5745 | 1133 | 426 | 1668 | 3227 | 8973 |
| 1988 | 3583 | 3263 | 6846 | 1254 | 344 | 1577 | 3175 | 10021 |
| 1989 | 2291 | 2498 | 4789 | 1111 | 531 | 1142 | 2785 | 7574 |
| 1990 | 1930 | 1127 | 3057 | 1124 | 713 | 1231 | 3068 | 6124 |
| 1991 | 1993 | 854 | 2847 | 878 | 533 | 1545 | 2956 | 5802 |
| 1992 | 1668 | 1068 | 2736 | 786 | 363 | 1610 | 2758 | 5493 |
| 1993 | 1360 | 959 | 2319 | 699 | 306 | 1231 | 2237 | 4556 |
| 1994 | 1232 | 1028 | 2260 | 629 | 149 | 549 | 1327 | 3587 |
| 1995 | 1755 | 677 | 2432 | 814 | 134 | 297 | 1245 | 3677 |
| 1996 | 2146 | 850 | 2995 | 749 | 265 | 574 | 1589 | 4584 |
| 1997 | 2249 | 1389 | 3638 | 838 | 191 | 860 | 1889 | 5527 |
| 1998 | 1660 | 1507 | 3167 | 865 | 209 | 829 | 1903 | 5070 |
| 1999 | 1116 | 1140 | 2256 | 750 | 119 | 692 | 1561 | 3817 |
| 2000 | 710 | 612 | 1322 | 485 | 146 | 675 | 1306 | 2628 |
| 2001 | 614 | 364 | 978 | 247 | 117 | 459 | 823 | 1801 |
| 2002 | 559 | 415 | 974 | 344 | 104 | 380 | 828 | 1802 |
| 2003 | 1190 | 771 | 1961 | 617 | 96 | 529 | 1242 | 3203 |
| 2004 | 1510 | 1389 | 2898 | 549 | 77 | 602 | 1229 | 4127 |
| 2005 | 1651 | 1719 | 3370 | 653 | 60 | 458 | 1171 | 4541 |
| 2006 | 1490 | 1371 | 2861 | 801 | 68 | 381 | 1250 | 4111 |
| 2007 | 1327 | 1076 | 2404 | 866 | 78 | 303 | 1247 | 3651 |
| 2008 | 1280 | 1238 | 2518 | 473 | 50 | 246 | 770 | 3288 |
| 2009 | 1151 | 1207 | 2358 | 386 | 43 | 262 | 691 | 3049 |
| 2010 | 665 | 1036 | 1701 | 355 | 72 | 203 | 630 | 2331 |
| 2011 | 518 | 539 | 1056 | 397 | 122 | 199 | 718 | 1774 |
| 2012 | 562 | 661 | 1222 | 365 | 161 | 533 | 1059 | 2281 |




Figure 8.3.1
ANGLERFISH (L. budegassa and L. piscatorius) - Divisions VIIIc and IXa. Trawl and gillnet landings, effort and LPUE data between 1982-2012.

## 9 Megrims in Divisions VIIIc and IXa

## Lepidorhombus whiffiagonis:

Type of assessment in 2013: Update.
Data revisions this year: Spanish landings and unallocated landings have been added for 2011.

Review Group issues for L.whiffiagonis: Following recommendations from RG in 2012, the following actions were taken:

1) Axis in Figure 9.1.5 has been changed.

## Lepidorhombus boscii:

Type of assessment in 2013: Update.
Data revisions this year: Spanish landings and unallocated landings have been added for 2011.

Review Group issues for L. boscii:
Technical comments on the need to find an alternative tuning fleet for this stock and including discards data in the assessment were mentioned. These aspects will be addressed in the next benchmark.

### 9.1 General

### 9.1.1 Ecosystem aspects

See Stock annex for ecosystem aspects related to megrim assessment.

### 9.1.2 Fishery description

See Stock annex for fishery description.

### 9.1.3 Summary of ICES advice for 2013 and management for 2012 and 2013

ICES advice for 2013 (as extracted from ICES Advice 2012, Book 7):
Following the ICES MSY framework implies fishing mortality to be reduced to 0.08 for L. whiffiagonis and to 0.18 for L. boscii. For L. whiffiagonis this results in landings of 110 t in 2013 and expected SSB of 1210 t in 2014. For L. boscii this results in landings of 780 t in 2013 and expected SSB of 5210 t in 2014. This corresponds to 890 t of landings in 2013 for both species combined. As both species of megrim (L.whiffiagonis and L.boscii) are caught in the same fisheries and are subject to a combined TAC, the same proportional reduction from current fishing mortality is assumed for both species. The reduction necessary for L.boscii to reach $\mathrm{F}_{\text {mSY }}$ is applied, as it is the species whose current fishing levels are further from Fmsy.

Management applicable for 2012 and 2013:
The agreed combined TAC for megrim and four-spot megrim in ICES Divisions VIIIc and IXa was 1214 in 2012 and 1214 in 2013.

### 9.2 Megrim (L. whiffiagonis) in Divisions VIIIc and IXa

### 9.2.1 General

See general section for both species.

### 9.2.2 Data

### 9.2.2.1 Commercial catches and discards

Working Group estimates of landings for the period 1986 to 2012 are given in Table 9.1.1. Official landings figures from Spain were presented for 2011 and 2012. The discrepancy between official and scientific estimates is included in the column "Unallocated".. The total estimated international landings in Divisions VIIIc and IXa for 2012 was 288 t . Landings reached a peak of 977 t in 1990, followed by a steady decline to 117 t in 2002. Some increase in landings has been observed since then, but landings have again decreased annually since 2007. The landings in 2010 were the lowest value of the entire series. 2011 and 2012 values represent important increments in the landings of the stock. Historical landings for both species combined are shown in Figure 9.1.1. In 2012, international landings are 1094 t , being a decrease in relation to previous years.

Discards estimates are available for Spain in the years displayed in Table 9.1.2(a). Discards in number represent between $10-45 \%$ of the total catch, with the exception of the year 2007 when discards have been very low and 2011 with discards extremely high. Discards data are not used in this assessment because of the lack of data in several years of the series. Discard/Total Catch ratio and estimated CV are shown in the same table. In Table 9.1.2(b), the available series of years with Spanish discards in numbers-at-age for L. whiffiagonis are presented. With the exception of 1994, 1997 and 2006, discarded numbers are largest at age 1.

### 9.2.2.2 Biological sampling

Annual length compositions of total stock landings are displayed in Figure 9.1.2 for the period 1986 - 2012 and in Table 9.1.3. (a),. The bulk of sampled specimens corresponds to fish of 22-32 cm.

Sampling levels for both species are given in Table 1.3.
Mean lengths and mean weights in landings since 1990 are shown in Table 9.1.3(b). The mean length and mean weight values in 2010 are the highest in the historic series. Mean length in 2012 is the second highest.

Age compositions of landings are presented in Table 9.1.4 and weights-at-age of landings in Table 9.1.5, from 1986 to 2012. These values were also used as the weights-atage in the stock.

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

### 9.2.2.3 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 (SpGFS-WIBTS-Q4) survey indices are summarised in Table 9.1.6. In 2012, Portuguese surveys were not conducted due to budgetary constraints of national scope turned unfeasible to repair the R/V.

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

The Spanish survey (SpGFS-WIBTS-Q4) covers the distribution area and depth strata of this species in Spanish waters (covering both VIIIc and IXa). Total biomass and abundance indices from this survey were higher during the period 1988-1990, subsequently declining to lower mean levels, which are common through the rest of the time series. There has been an overall declining trend in the abundance index after year 2000, with the values for 2008 and 2009 being the two lowest in the entire series. In 2011, the index increases significantly, being the highest value in the last 10 years, going to decline in 2012 to a value similar to 2010 (Figure 9.1.3(a), bottom right panel).

The Spanish survey recruitment indices for ages 0 and 1 indicate an extremely weak year class in 1993, followed by better recruitments, except for relatively low values for the 1997 and 1998 year classes. The 1999 year class appears to be relatively strong compared to those from previous years, but the 2000 to 2005 year classes again appear to be low. The survey indicates extremely low values at age 0 for years 20062008, with 2006 and 2008 being equal worst with 1993 in the historic series. In 2009, the age 0 index is the highest after 2001, whereas the age 1 index is the second lowest in the series. In 2010, there is a very important increase in age 1, being the highest value since 1996. In 2012 ages 1 and 0 are in very low levels.

Catch numbers-at-age per unit effort and effort values for the Spanish survey are given in Table 9.1.7. In addition, Figure 9.1.3(b) displays a bubble plot of $\log$ (survey in-dices-at-age), with the values for each age standardised by subtracting the mean and dividing by the standard deviation over the years. The size of the bubbles is related to the magnitude of the standardised value, with white and black bubbles corresponding to positive and negative values, respectively. Only the years used to tune the XSA assessment are represented. The figure indicates that the survey is quite good at tracking cohorts through time and highlights the weakness of the last few cohorts. The big age 1 index in 2010 is also detected in this figure and can be followed, presenting age 2 in 2011 and age 3 in 2012 the highest values of the entire series.

### 9.2.2.4 Commercial catch-effort data

Fishing effort and LPUE data were available for the period 1986-2012 for the Spanish trawlers from A Coruña (SP-CORUTR8c) fishing in Division VIIIc. The commercial LPUE and effort data of the Portuguese trawlers fishing in Division IXa covers the period 1988 - 2012 (Table 9.1.8 and Figure 9.1.3(a)). No effort information from the Avilés fleet (SP-AVILESTR) fishing in Division VIIIc is available after 2003.

### 9.2.2.5 Commercial fleets used in the assessment to tune the model

Before 1993, A Coruña (SP-CORUTR8c) effort was generally stable, with a decreasing trend observed after that year. The 2011 effort value is the lowest in the series. In 2012, effort shows an increase. The LPUE shows relatively high stable values for 1986 - 1992. Since 1998 LPUE has declined, but is increasing since 2010.

Avilés (SP-AVILESTR) effort has decreased throughout the whole period to a very low level in 2003. LPUE shows an increasing trend between 1986 and 1990, with a sharp decrease in 1991. Since then, it has had a further upward and downward fluctuation, with a peak in 1997, reaching its lowest value in 2003. No effort data are available for this fleet after 2003.

Landed numbers-at-age per unit effort and effort data for these fleets are given in Table 9.1.7.

Figure 9.1.3(c) displays bubble plots of standardised log (landed numbers-at-age per unit effort) values for these commercial fleets, with the standardisation performed by subtracting the mean and dividing by the standard deviation over the years. Only the years used to tune the XSA are represented. The panel corresponding to A Coruña trawl fleet clearly indicates below average values since about year 2003 till 2011, when above average values are shown again.

### 9.2.2.6 Commercial fleets not used in the assessment to tune the model

Portuguese effort values are quite variable, except in 1999 and 2000 when they are significantly lower (Table 9.1.8 and Figure 9.1.3(a)). The LPUE shows a steep decrease between 1990 and 1992, and has since remained at low levels, with the exception of a peak in 1997-1998. LPUE for 2012 is quite similar to 2011 value, being both below the average of the time series.

### 9.2.3 Assessment

An update assessment was conducted, according to the Stock Annex specifications. Assessment years are 1986-2012 and ages 1-7+.

### 9.2.3.1 Input data

It follows the Stock Annex, incorporating the 2011 and 2012 landed numbers-at-age and the 2011 and 2012 indices from A Coruña (SP-CORUTR8c) tuning fleet and the Spanish survey (SpGFS-WIBTS-Q4). The Avilés tuning fleet (SP-AVILESTR) is only available until 2003. See Table 9.1.7.

### 9.2.3.2 Model

### 9.2.3.3 Data screening

The top panel of Figure 9.1.4 shows landings proportions at age, indicating that the bulk of the landings consisted of ages 1 and 2 before 1994, shifting after that mostly to ages 2 to 4 . The bottom panel of the same figure displays standardised (subtracting the mean and dividing by the standard deviation over the years) proportions at age, indicating the same change around the mid 1990's, with proportions at age decreasing for ages 1 and 2 and increasing for the older ages. Some weak and strong cohorts can be noticed in this figure, particularly around the mid 1990's. The 2010 year shows an increase in landings of older ages, especially ages 4 to $7+$. The high abundance of age 0 in the Spanish survey in 2009 can have influence in the high values of ages 2 and 3 in 2011 and 2012. Visual inspection of Figures 9.1.3(b) and 9.1.3(c) indicates that all tuning series are good up to age 5 in relation to their internal consistency. Age 6 is harder to track along cohorts, particularly for the Spanish survey and the A Coruña trawl fleet. These figures also indicate a certain degree of agreement between the three tuning indices.

### 9.2.3.4 Final run

XSA model was selected for use in this assessment. Model description and settings are the same used last year and are detailed in the Stock Annex.

The retrospective analysis shows a small but consistent pattern of overestimation of SSB and underestimation of F and recruitment in recent years (Figure 9.1.5).

### 9.2.3.5 Assessment results

As has been the case in the last few years, there were convergence problems with the XSA run. The results presented correspond to a run of 120 iterations, as increasing the number of iterations led to larger total absolute residuals value between iterations.

Diagnostics from the XSA run are presented in Table 9.1.9 and log catchability residuals plotted in Figure 9.1.6. For all tuning fleets the magnitude of the residuals is larger for older ages. Residuals in SP-CORUTR8c in the last years present mainly positive values. Until 1997 many of the survey residuals were negative, whereas many are positive since 1999. Since 2008, there appears to be a change towards negative survey residuals again. Several year effects are apparent in all tuning series.

Fishing mortality and population numbers at age from the final XSA run are given in Tables 9.1.10 and 9.1.11, respectively, and summary results presented in Table 9.1.12 and Figure 9.1.7(a).
Fishing mortality is estimated to have increased in 2011 and 2012, after the lowest estimated value reached in 2010, which may be explained by the relatively high landings in these last years. The SSB values in 2007-2010 are the lowest in the series. 2011 and 2012 SSB values are significantly higher and similar to those that occurred in the nineties. After a very high recruitment (at age 1) value in the series in 2010, the last two years show a decrease.

Bubble plots of standardised (by subtracting the mean and dividing by the standard deviation over the years) estimated F-at-age and relative F-at-age (F-at-age divided by Fbar) are presented in Figure 9.1.7(b). The top panel of the figure indicates that fishing mortality has been lower for all ages since about year 2000. The reduction occurred earlier for ages 1 and 2, at around 1994. In terms of the relative exploitation pattern-at-age (bottom panel of the figure), the most obvious changes are the reduction for ages 1 and 2 around 1994 and the increase for age 3 soon after that. This might be related to discarding practices, which are not accounted for in the current assessment, which is based just on landings. There is no clear pattern over time in the age 4 selection, whereas for ages 5 and older there seems to have been an increase during the mid to late 1990's but they have since come back down to lower values. Since 2010, there appears to have been an increase of the relative exploitation towards older ages, with high values above the average for ages 5 to $7+$.

### 9.2.3.6 Year class strength and recruitment estimations

The 2009 year class is estimated to have 8.5 million fish at 1 year of age, based on the Spanish survey (SpGFS-WITBS-Q4) (46\% of weight), one commercial fleet (SPCORUTR8c) ( $36 \%$ of weight), P-shrinkage ( $16 \%$ of the weight) and F shrinkage ( $2 \%$ ).

The 2010 year class is estimated to have 3.9 million individuals at 1 year of age based on the information from the Spanish survey (SpGFS-WIBTS-Q4) ( $63 \%$ of weight) and one commercial fleet (SP-CORUTR8c) (19\% of weight). P-shrinkage and F-shrinkage contributed $16 \%$ and $2 \%$ of the weight, respectively.

The 2011 year class is estimated to have 1.9 million fish at 1 year of age, based on the Spanish survey (SpGFS-WIBTS-Q4) (70\% of weight), P-shrinkage ( $25 \%$ of the weight) and F shrinkage (5\%).

In accordance with the stock annex specifications, GM recruitment is computed over years 1998-2010. 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 |
| :--- | :--- | :--- | :--- | :--- | :--- |
| 2009 | 8509 | XSA | $46 \%$ | $36 \%$ | $18 \%$ |
| 2010 | 3946 | XSA | $63 \%$ | $19 \%$ | $18 \%$ |
| 2011 | 1955 | XSA | $70 \%$ |  | $30 \%$ |
| 2012 | 2601 | GM $(98-10)$ |  |  |  |

### 9.2.3.7 Historic trends in biomass, fishing mortality and recruitment

From Table 9.1.12 and Figure 9.1.7, we see that SSB decreased from 2563 t in 1990 to 944 t in 1995. From 1996 to 2003, it remained relatively stable at low levels with an average value of around 1100 t . Starting from 2004, SSB is estimated to have been even lower, 801 t in2004. The values for 2004-2010 are the lowest in the series, with SSB in $2009(605 \mathrm{t})$ corresponding to the lowest value. In 2010 the SSB value is 761 t , still very low. SSB values of 1254 and 1513 corresponding to years 2011 and 2012 are significant increases.
F has declined in recent years from the high levels observed prior to 1995 (Fbar, for ages 2-4, in the range of 0.30-0.46 before 1995) and the high value reached in 1998 (0.38). Fbar increased every year between 2003 and 2006 (Fbar=0.35 in 2006), but has decreased every year since then, reaching in 2010 the lowest value of the entire series at 0.08 . In the last two years $F$ is increasing again being 0.19 in 2012.

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. The 1994 year class is the second lowest value in the time series. Since 1998 recruitment has been continuously at low levels (recruitment in 2008 is estimated to be the lowest value of the series). In 2010 a good recruitment occurred, with a value more similar to those estimated for the previous decade. However, in 2011 and 2012, values of recruitments are decreasing to low levels again, in particular the last year.

### 9.2.3.8 Catch Options and prognosis

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

### 9.2.3.9 Short-term projections

The input data for deterministic short-term predictions are shown in Table 9.1.13. The exploitation pattern used was the unscaled average of 2010-2012 (corresponding to Fbar $=0.14$, F status quo). Management options for catch prediction are in Table 9.1.14. Figure 9.1.8 shows the short-term forecast summary. The detailed output by age group assuming status quo F for 2013-2015 is given in Table 9.1.15.

Under status quo F, landings in 2013 and 2014 are predicted to be 236 t and 284 t respectively. SSB would decrease from the 1345 t estimated for 2013 to 1278 t in 2014 and to 1185 t in 2015.

The contributions of recent year classes to the predicted landings in 2014 and SSB in 2015, assuming GM98-10 recruitment, are presented in Table 9.1.16. The assumed GM9810 age 1 recruitment for the 2012 and 2013 year classes contributes $4 \%$ to landings in 2014 and $34 \%$ to the predicted SSB at the beginning of 2015. Megrim starts to contribute strongly to SSB at 2 years of age (see maturity ogive in Table 9.1.13).

### 9.2.3.10Yield and biomass per recruit analysis

The results of the yield- and SSB-per-recruit analyses are in Table 9.1.17 (see also left panel of Figure 9.1.8, which plots yield-per-recruit and SSB-per-recruit versus Fbar). Assuming status quo exploitation $(F b a r=0.14)$ and $\mathrm{GM}_{98-10}$ for recruitment, the equilibrium yield would be around 196 t with an SSB of 1044 t .

### 9.2.4 Biological reference points

The stock-recruitment time series is plotted in Figure 9.1.9. Most of the high recruitment values are at the beginning, and the first four correspond to years in which a combined ALK was used. Ignoring the first 4 years, both low and high recruitments have been estimated. However, all recruitment values since 1998 have been low, with the only exception of 2010.

See Stock Annex for information about Biological reference points.
WGHMM 2010 was asked to provide an FMSY value for this stock. Possible proxies considered for $\mathrm{F}_{\text {MSY }}$ were in the range of $\mathrm{F}_{\text {max }}, \mathrm{F} 0.1$ and $\mathrm{F} 35 \%$ and $\mathrm{F} 40 \%$. $\mathrm{F}_{\text {max }}$ is not well defined for this stock, as the yield-per-recruit curve generally shows a very flat top.
In order to establish a proxy, a rough exercise including discards was conducted in WGHMM 2010 (see description and results in the Stock Annex). The following sensitivity table also complemented the discards exercise and has been updated in this WG:

|  | WG2005 | WG2006 | WG2007 | WG2008 | WG2009 | WG2010 | WG2011 | WG2013 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| FMax | 0.35 | 0.36 | 0.38 | 0.39 | 0.37 | 0.32 | 0.24 | 0.28 |
| F0.1 | 0.15 | 0.16 | 0.16 | 0.18 | 0.17 | 0.14 | 0.10 | 0.09 |
| F35\% | 0.21 | 0.22 | 0.22 | 0.23 | 0.22 | 0.21 | 0.18 | 0.17 |
| F40\% |  |  |  |  |  | 0.17 | 0.14 | 0.13 |

$\mathrm{F}_{\mathrm{MSY}}=0.17$ was preliminarily proposed in WGHMM 2010, corresponding to $\mathrm{F} 40 \%$ as calculated in that WG. Even though all biological reference points have been estimated to be lower in WG2011, it seems precipitate to change the 0.17 value proposed as Fmsy last year. However, this FMSY value should still be considered as preliminary and $_{\text {m }}$ is likely to be revised as further work continues on this assessment (particularly when including discards information and developing an assessment model providing uncertainty estimates).

### 9.2.5 Comments on the assessment

The inclusion of discards in the assessment would be likely to have an influence in the perception of the state of the stock. With the exception of years 2007 for which we get much lower discard estimates and 2011 with extremely high estimates, discards in number represent between $10-45 \%$ of the total catch and they are thought to be important for younger ages. It is therefore recommended to continue with the collection of discards data to provide annual estimates with a view to incorporate them in the assessment soon.

The behaviour of commercial fleets with regards to landings of age 1 individuals appears to have changed in time. Hence, data from commercial fleets used for tuning is only taken for ages 2 and older. However, the Spanish survey (SpGFS-WIBTS-Q4) provides good information on age 1 abundance.

Comparison of this assessment with the one performed in 2011 shows different trends for final years F and recruitment and similar for SSB, but with high increases (Figure 9.1.10).

Megrim starts to contribute strongly to SSB at 2 years of age. Around $35 \%$ of the predicted SSB in 2015 relies on year classes for which recruitment has been assumed to be GM98-10.

### 9.2.6 Management considerations.

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

Table, 9.1.1 Megrim (L. whiffiagonis) in Divisions VIIIc, IXa. Total landings (t).

| Year | Spain |  |  | Portugal | Unallocated | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | VIIIc | IXa*** | Total | IXa |  |  |
| 1986 | 508 | 98 | 606 | 53 |  | 659 |
| 1987 | 404 | 46 | 450 | 47 |  | 497 |
| 1988 | 657 | 59 | 716 | 101 |  | 817 |
| 1989 | 533 | 45 | 578 | 136 |  | 714 |
| 1990 | 841 | 25 | 866 | 111 |  | 977 |
| 1991 | 494 | 16 | 510 | 104 |  | 614 |
| 1992 | 474 | 5 | 479 | 37 |  | 516 |
| 1993 | 338 | 7 | 345 | 38 |  | 383 |
| 1994 | 440 | 8 | 448 | 31 |  | 479 |
| 1995 | 173 | 20 | 193 | 25 |  | 218 |
| 1996 | 283 | 21 | 305 | 24 |  | 329 |
| 1997 | 298 | 12 | 310 | 46 |  | 356 |
| 1998 | 372 | 8 | 380 | 66 |  | 446 |
| 1999 | 332 | 4 | 336 | 7 |  | 343 |
| 2000 | 238 | 5 | 243 | 10 |  | 253 |
| 2001 | 167 | 2 | 169 | 5 |  | 175 |
| 2002 | 112 | 3 | 115 | 3 |  | 117 |
| 2003 | 113 | 3 | 116 | 17 |  | 134 |
| 2004 | 142 | 1 | 144 | 5 |  | 149 |
| 2005 | 120 | 1 | 121 | 26 |  | 147 |
| 2006 | 173 | 2 | 175 | 35 |  | 210 |
| 2007 | 139 | 2 | 141 | 14 |  | 155 |
| **2008 | 114 | 2 | 116 | 17 |  | 133 |
| 2009 | 74 | 2 | 77 | 7 |  | 84 |
| 2010 | 66 | 8 | 74 | 10 |  | 83 |
| *2011 | 109 | 3 | 111 | 34 | 14 | 159 |
| *2012 | 164 | 3 | 167 | 18 | 103 | 288 |

***IXa is without Gulf of Cádiz
** Data revised in WG2010

* Official data by country and unallocated landings

Table. 9.1.2(a) Megrim (L. whiffiagonis) in Divisions VIIIc, IXa. Discard/Total Catch ratio and estimated CV for Spain

| Year | 1994 | 1997 | 1999 | 2000 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011* | 2012 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Weight Ratio | 0.03 | 0.14 | 0.12 | 0.13 | 0.11 | 0.07 | 0.14 | 0.08 | 0.00 | 0.08 | 0.13 | 0.06 | 0.36 | 0.10 |
| CV | 50.83 | 32.23 | 33.4 | 48.41 | 19.93 | 29.24 | 43.17 | 31.62 | 55.01 | 58.8 | 52.9 | 61.6 | 23.7 | 28.8 |
| Number Ratio | 0.10 | 0.38 | 0.34 | 0.45 | 0.26 | 0.16 | 0.28 | 0.21 | 0.01 | 0.20 | 0.36 | 0.27 | 0.75 | 0.36 |

*All discard data re vised in WG2011
*Data revised in WG2013

Table. 9.1.2(b) Megrim (L. whiffiagonis) in Divisions VIIIc, IXa. Discards in numbers at age (thousands) for Spanish trawlers

|  | 1994 | 1997 | 1999 | 2000 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011* | 2012 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0 | 104 | 41 | 270 | 27 | 0 | 4 | 20 | 0 | 0 | 0 | 96 | 16 | 12 | 8 |
| 1 | 93 | 453 | 471 | 611 | 239 | 164 | 223 | 19 | 11 | 126 | 142 | 119 | 2044 | 808 |
| 2 | 136 | 857 | 284 | 160 | 57 | 28 | 61 | 108 | 0 | 86 | 21 | 6 | 346 | 85 |
| 3 | 51 | 142 | 197 | 73 | 12 | 6 | 38 | 115 |  | 8 | 15 | 1 | 1 | 41 |
| 4 | 3 | 1 | 26 | 19 | 4 | 5 | 11 | 28 |  | 5 | 7 | 2 | 2 | 2 |
| 5 | 1 | 5 | 6 |  | 0 | 3 | 4 | 13 |  | 2 | 7 | 0 | 0 | 1 |
| 6 |  | 3 |  |  |  | 2 | 1 | 4 |  | 0 | 3 | 1 | 0 | 1 |
| 7 |  |  |  |  |  | 1 | 0 | 0 |  |  | 1 | 0 | 0 | 0 |

Table 9.1.3(a) Megrim (L. whiffiagonis) Divisions VIIIc and IXa. Annual length distributions in landings in 2012.

| Length (cm) | Total |
| :---: | :---: |
| 10 |  |
| 11 |  |
| 12 |  |
| 13 |  |
| 14 |  |
| 15 |  |
| 16 |  |
| 17 |  |
| 18 |  |
| 19 | 1.4 |
| 20 | 4.9 |
| 21 | 19.3 |
| 22 | 70.5 |
| 23 | 115.1 |
| 24 | 164.4 |
| 25 | 222.3 |
| 26 | 192.5 |
| 27 | 163.7 |
| 28 | 195.3 |
| 29 | 151.5 |
| 30 | 124.4 |
| 31 | 82.1 |
| 32 | 67.7 |
| 33 | 46.0 |
| 34 | 31.0 |
| 35 | 21.2 |
| 36 | 15.9 |
| 37 | 12.3 |
| 38 | 11.4 |
| 39 | 13.8 |
| 40 | 14.1 |
| 41 | 9.3 |
| 42 | 4.5 |
| 43 | 4.8 |
| 44 | 3.0 |
| 45 | 2.2 |
| 46 | 1.5 |
| 47 | 0.4 |
| 48 | 0.1 |
| 49 | 0.1 |
| $50+$ |  |
| Total | 1767 |

## Table 9.1.3(b) Megrim (L. whiffiagonis) Divisions VIIIc and IXa.

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 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 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 | 25.3 | 26.2 | 26.7 | 26.6 | 27.6 | 29.4 | 27.6 | 28.2 |
| Mean weight (g) | 105 | 108 | 129 | 108 | 124 | 121 | 120 | 118 | 119 | 127 | 134 | 124 | 137 | 134 | 137 | 127 | 137 | 148 | 147 | 163 | 187 | 160 | 163 |

Table 9.1.4 Megrim (L. whiffiagonis) in Divisions VIIIc and IXa. Landed numbers at age.

| Catch numbe | age | Number | **-3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| YEAR | 1986 | 1987 | 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 |
| AGE |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\left.{ }^{*}\right)^{0}$ | (15) | (0) | (0) | (0) | (8) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) |
| 1 | 1013 | 2020 | 2977 | 760 | 4230 | 1018 | 1062 | 519 | 40 | 509 | 198 | 82 | 77 | 20 | 9 | 40 | 31 | 129 | 46 | 123 | 91 | 79 | 7 | 28 | 30 | 7 | 4 |
| 2 | 1952 | 2303 | 3344 | 1903 | 2135 | 2352 | 392 | 1703 | 432 | 36 | 1486 | 1062 | 882 | 240 | 122 | 305 | 151 | 242 | 236 | 215 | 418 | 161 | 284 | 90 | 33 | 455 | 224 |
| 3 | 668 | 752 | 1038 | 678 | 775 | 801 | 677 | 312 | 1784 | 254 | 37 | 1011 | 1205 | 960 | 598 | 300 | 310 | 265 | 205 | 401 | 467 | 232 | 207 | 144 | 52 | 93 | 909 |
| 4 | 639 | 394 | 738 | 631 | 868 | 690 | 1120 | 526 | 549 | 620 | 279 | 76 | 881 | 693 | 507 | 244 | 86 | 175 | 242 | 160 | 248 | 297 | 148 | 95 | 110 | 129 | 169 |
| 5 | 501 | 289 | 530 | 501 | 329 | 643 | 591 | 357 | 624 | 241 | 502 | 362 | 214 | 442 | 361 | 220 | 164 | 80 | 184 | 152 | 170 | 142 | 166 | 73 | 97 | 139 | 207 |
| 6 | 201 | 80 | 181 | 190 | 376 | 141 | 77 | 102 | 330 | 69 | 147 | 305 | 328 | 105 | 83 | 160 | 80 | 54 | 100 | 86 | 106 | 81 | 60 | 57 | 80 | 97 | 108 |
| +gp | 194 | 71 | 130 | 253 | 558 | 59 | 68 | 36 | 119 | 72 | 81 | 116 | 149 | 207 | 161 | 118 | 37 | 48 | 71 | 41 | 36 | 56 | 35 | 28 | 43 | 77 | 145 |
| TOTALNUM | 5168 | 5909 | 8938 | 4916 | 9271 | 5704 | 3987 | 3555 | 3878 | 1801 | 2733 | 3014 | 3735 | 2667 | 1841 | 1387 | 860 | 993 | 1084 | 1177 | 1536 | 1048 | 907 | 515 | 445 | 997 | 1766 |
| TONSLAND | 659 | 497 | 817 | 714 | 977 | 614 | 516 | 383 | 479 | 218 | 329 | 356 | 446 | 343 | 253 | 175 | 117 | 134 | 149 | 147 | 210 | 155 | 133 | 84 | 83 | 159 | 288 |
| SOPCOF \% | 95 | 95 | 95 | 99 | 99 | 100 | 100 | 100 | 100 | 101 | 102 | 100 | 101 | 101 | 101 | 101 | 100 | 101 | 100 | 98 | 100 | 100 | 100 | 100 | 100 | 103 | 101 |

(*) Age 0 was not used in the assessment.
Table 9.1.5 Megrim (L. whiffiagonis) in Divisions VIIIc and IXa. Landed weights at age (kg).

| Mean weight at age |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| YEAR |  | 1986 | 1987 | 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 |
| AGE |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 1 | 0.045 | 0.049 | 0.045 | 0.051 | 0.041 | 0.039 | 0.034 | 0.036 | 0.046 | 0.06 | 0.054 | 0.056 | 0.046 | 0.056 | 0.056 | 0.058 | 0.058 | 0.056 | 0.0623 | 0.0610 | 0.0633 | 0.0652 | 0.0587 | 0.0648 | 0.0617 | 0.0573 | 0.0557 |
|  | 2 | 0.102 | 0.084 | 0.09 | 0.102 | 0.098 | 0.091 | 0.095 | 0.08 | 0.069 | 0.071 | 0.088 | 0.083 | 0.07 | 0.07 | 0.072 | 0.085 | 0.082 | 0.089 | 0.0850 | 0.0798 | 0.0917 | 0.0884 | 0.0915 | 0.0906 | 0.0938 | 0.1051 | 0.1028 |
|  | 3 | 0.121 | 0.092 | 0.103 | 0.122 | 0.129 | 0.108 | 0.125 | 0.117 | 0.1 | 0.102 | 0.121 | 0.102 | 0.099 | 0.089 | 0.094 | 0.088 | 0.115 | 0.116 | 0.1094 | 0.1105 | 0.1228 | 0.1095 | 0.119 | 0.1345 | 0.1168 | 0.1327 | 0.1378 |
|  | 4 | 0.164 | 0.143 | 0.15 | 0.164 | 0.166 | 0.146 | 0.155 | 0.147 | 0.13 | 0.127 | 0.128 | 0.126 | 0.13 | 0.119 | 0.121 | 0.118 | 0.119 | 0.15 | 0.1297 | 0.1426 | 0.1589 | 0.144 | 0.1467 | 0.1603 | 0.1684 | 0.1305 | 0.1593 |
|  | 5 | 0.216 | 0.176 | 0.191 | 0.224 | 0.207 | 0.173 | 0.209 | 0.195 | 0.15 | 0.165 | 0.164 | 0.141 | 0.155 | 0.16 | 0.161 | 0.148 | 0.162 | 0.194 | 0.1574 | 0.1647 | 0.1816 | 0.1971 | 0.188 | 0.1881 | 0.2029 | 0.1915 | 0.1679 |
|  | 6 | 0.316 | 0.314 | 0.29 | 0.293 | 0.241 | 0.252 | 0.321 | 0.237 | 0.19 | 0.212 | 0.211 | 0.199 | 0.189 | 0.216 | 0.215 | 0.172 | 0.206 | 0.252 | 0.2038 | 0.1994 | 0.228 | 0.236 | 0.2465 | 0.2492 | 0.2277 | 0.2351 | 0.2264 |
| +gp |  | 0.477 | 0.415 | 0.424 | 0.52 | 0.369 | 0.42 | 0.534 | 0.538 | 0.344 | 0.34 | 0.354 | 0.341 | 0.324 | 0.296 | 0.296 | 0.256 | 0.388 | 0.382 | 0.3197 | 0.3801 | 0.3925 | 0.3657 | 0.4091 | 0.408 | 0.3706 | 0.3634 | 0.3512 |
| SOPCOFAC |  | 0.95 | 0.95 | 0.95 | 0.99 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.01 | 1.02 | 1.00 | 1.01 | 1.01 | 1.01 | 1.01 | 1.00 | 1.01 | 1.00 | 0.98 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.03 | 1.01 |

Table 9.1.6 Megrim (L. whiffiagonis) Divisions VIIIc, IXa. Abundance and Recruitment indices from Portuguese and Spanish surveys.


Table 9.1.7 Megrim (L. whiffiagonis) in Divisions VIIIc and IXa. Tuning data.

FLT01: SP-CORUTR8c. 1000 Days by 100 HP (thousand) (*) 19862011

| 1 | 1 | 0 | 1 |  |  |  |  |  |  |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 1 | 7 |  |  |  |  |  |  | Eff. |  |
| 10 | 34.4 | 91.2 | 37.7 | 45.2 | 38.7 | 14.8 | 8.5 | 39.8 | 1986 |
| 10 | 242.1 | 187.3 | 62.2 | 32.6 | 25.9 | 9.2 | 7.5 | 34.7 | 1987 |
| 10 | 67.8 | 215.4 | 75.8 | 71.3 | 54.0 | 19.0 | 9.5 | 42.2 | 1988 |
| 10 | 12.6 | 87.8 | 36.3 | 46.6 | 35.8 | 13.1 | 8.8 | 44.4 | 1989 |
| 10 | 22.1 | 80.4 | 48.6 | 81.3 | 34.5 | 36.3 | 36.5 | 44.4 | 1990 |
| 10 | 13.1 | 107.9 | 47.0 | 59.7 | 61.9 | 15.1 | 5.4 | 40.4 | 1991 |
| 10 | 5.7 | 23.7 | 66.6 | 144.5 | 91.3 | 11.8 | 10.0 | 38.9 | 1992 |
| 10 | 0.2 | 42.5 | 20.4 | 49.2 | 37.8 | 9.7 | 1.6 | 44.5 | 1993 |
| 10 | 0.0 | 3.5 | 52.5 | 28.8 | 42.2 | 30.1 | 6.3 | 39.6 | 1994 |
| 10 | 51.1 | 3.2 | 15.4 | 33.6 | 12.1 | 3.3 | 2.3 | 41.5 | 1995 |
| 10 | 1.2 | 54.7 | 2.7 | 17.6 | 46.7 | 14.7 | 8.6 | 35.7 | 1996 |
| 10 | 0.9 | 32.6 | 49.7 | 5.0 | 25.4 | 23.6 | 8.1 | 35.2 | 1997 |
| 10 | 0.5 | 15.3 | 42.5 | 52.9 | 15.0 | 30.9 | 13.9 | 32.6 | 1998 |
| 10 | 0.7 | 7.9 | 40.4 | 42.5 | 35.0 | 9.7 | 19.5 | 30.2 | 1999 |
| 10 | 1.2 | 5.5 | 36.8 | 50.8 | 48.6 | 12.3 | 14.4 | 30.1 | 2000 |
| 10 | 1.9 | 18.3 | 18.4 | 22.1 | 23.7 | 19.3 | 13.5 | 29.9 | 2001 |
| 10 | 1.7 | 10.6 | 35.9 | 9.9 | 27.1 | 14.3 | 5.6 | 21.8 | 2002 |
| 10 | 20.2 | 15.0 | 15.6 | 15.7 | 9.5 | 7.8 | 6.7 | 18.5 | 2003 |
| 10 | 1.4 | 7.5 | 8.5 | 12.8 | 12.1 | 9.0 | 8.4 | 21.1 | 2004 |
| 10 | 3.9 | 8.4 | 18.6 | 8.5 | 9.1 | 5.6 | 3.8 | 20.7 | 2005 |
| 10 | 2.2 | 11.6 | 16.1 | 11.3 | 8.6 | 6.2 | 2.5 | 19.3 | 2006 |
| 10 | 7.8 | 11.7 | 13.2 | 16.9 | 10.2 | 6.1 | 4.9 | 21.2 | 2007 |
| 10 | 0.1 | 14.2 | 13.1 | 9.7 | 10.6 | 3.6 | 2.4 | 20.2 | 2008 |
| 10 | 4.2 | 12.0 | 15.7 | 8.8 | 6.1 | 4.1 | 2.0 | 16.2 | 2009 |
| 10 | 1.1 | 4.8 | 8.3 | 17.4 | 16.8 | 12.4 | 7.0 | 13.7 | 2010 |
| 10 | 1.7 | 95.3 | 19.5 | 26.9 | 22.5 | 11.2 | 6.6 | 11.5 | 2011 |
| 10 | 1.1 | 51.2 | 186.1 | 32.4 | 36.1 | 13.2 | 8.6 | 21.1 | 2012 |
| 10 | 10. |  |  |  |  |  |  |  |  |

$\begin{array}{llllllllll}10 & 1.1 & 51.2 & 186.1 & 32.4 & 36.1 & 13.2 & 8.6 & 21.1 & 2012\end{array}$
FLT02: SP-AVILESTR. 1000 Days by 100 HP (thousand) (*) 19862003

| 1 | 1 | 0 | 1 |  |  |  |  |  |  |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 1 | 7 |  |  |  |  |  |  | Eff. |  |
| 10 | 251 | 317 | 263 | 128 | 112 | 94 | 56 | 10.8 | 1986 |
| 10 | 410 | 327 | 355 | 168 | 101 | 117 | 39 | 8.3 | 1987 |
| 10 | 1177 | 731 | 605 | 288 | 125 | 156 | 69 | 9.0 | 1988 |
| 10 | 750 | 461 | 484 | 227 | 130 | 156 | 61 | 8.1 | 1989 |
| 10 | 3704 | 805 | 191 | 147 | 39 | 42 | 60 | 8.5 | 1990 |
| 10 | 870 | 759 | 203 | 89 | 74 | 13 | 7 | 7.7 | 1991 |
| 10 |  |  |  |  |  |  |  | 0.0 | 1992 |
| 10 | 544 | 705 | 43 | 47 | 25 | 12 | 9 | 7.6 | 1993 |
| 10 | 17 | 154 | 479 | 119 | 116 | 45 | 21 | 9.6 | 1994 |
| 10 | 34 | 2 | 36 | 117 | 58 | 22 | 12 | 6.1 | 1995 |
| 10 | 117 | 689 | 12 | 101 | 223 | 64 | 54 | 4.5 | 1996 |
| 10 | 88 | 812 | 573 | 31 | 141 | 118 | 43 | 4.7 | 1997 |
| 10 | 18 | 349 | 424 | 263 | 59 | 79 | 43 | 5.4 | 1998 |
| 10 | 10 | 105 | 382 | 252 | 156 | 36 | 67 | 6.8 | 1999 |
| 10 | 25 | 48 | 210 | 201 | 128 | 31 | 46 | 4.5 | 2000 |
| 10 | 43 | 234 | 226 | 142 | 135 | 98 | 100 | 1.8 | 2001 |
| 10 | 46 | 132 | 199 | 54 | 78 | 45 | 39 | 2.7 | 2002 |
| 10 | 23 | 76 | 95 | 63 | 28 | 22 | 25 | 2.5 | 2003 |

19882012

| 1 | 1 | 0.75 | 0.8 |  |  |  |  |  |  |  |  |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 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 | 0.7 | 0.27 | 0.04 |  | 118 | 1994 |  |
| 1 | 7.38 | 0.20 | 0.5 | 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 |  |

Table 9.1.8 Megrim (L. whiffiagonis). LPUE data by fleet in Divisions VIIIc and IXa.

| Year | A Coruña Trawl in VIIIc |  |  | Avilés Trawl in VIIIc |  |  | Portugal trawl in IXa |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Landings (t) | Effort | LPUE ${ }^{1}$ | Landings (t) | Effort | LPUE ${ }^{1}$ | Landings (t) | Effort | LPUE ${ }^{2}$ |
| 1986 | 156 | 39.8 | 3.92 | 141 | 10.8 | 13.04 |  |  |  |
| 1987 | 155 | 34.7 | 4.47 | 102 | 8.3 | 12.23 |  |  |  |
| 1988 | 263 | 42.2 | 6.24 | 180 | 9.0 | 19.94 | 74.9 | 38.5 | 1.95 |
| 1989 | 196 | 44.4 | 4.41 | 143 | 8.1 | 17.75 | 92.2 | 44.7 | 2.06 |
| 1990 | 270 | 44.4 | 6.08 | 266 | 8.5 | 31.33 | 86.0 | 39.0 | 2.20 |
| 1991 | 211 | 40.4 | 5.22 | 102 | 7.7 | 13.28 | 85.5 | 45.0 | 1.90 |
| 1992 | 255 | 38.9 | 6.55 | 56 | na |  | 32.6 | 50.9 | 0.64 |
| 1993 | 121 | 44.5 | 2.72 | 67 | 7.6 | 8.76 | 31.7 | 44.2 | 0.72 |
| 1994 | 108 | 39.6 | 2.73 | 96 | 9.6 | 9.95 | 25.8 | 45.8 | 0.56 |
| 1995 | 28 | 41.5 | 0.67 | 50 | 6.1 | 8.16 | 21.4 | 37.0 | 0.58 |
| 1996 | 72 | 35.7 | 2.01 | 67 | 4.5 | 14.72 | 22.2 | 46.5 | 0.48 |
| 1997 | 75 | 35.2 | 2.12 | 83 | 4.7 | 17.70 | 41.5 | 33.4 | 1.24 |
| 1998 | 90 | 32.6 | 2.78 | 74 | 5.4 | 13.78 | 60.1 | 43.1 | 1.39 |
| 1999 | 73 | 30.2 | 2.40 | 83 | 6.8 | 12.21 | 4.3 | 25.3 | 0.17 |
| 2000 | 79 | 30.1 | 2.63 | 41 | 4.5 | 9.26 | 6.9 | 27.0 | 0.25 |
| 2001 | 49 | 29.9 | 1.65 | 24 | 1.8 | 13.01 | 1.3 | 43.1 | 0.03 |
| 2002* | 36 | 21.8 | 1.66 | 21 | 2.7 | 7.78 | 1.0 | 31.2 | 0.03 |
| 2003* | 25 | 18.5 | 1.36 | 13 | 2.5 | 5.06 | 15.3 | 40.5 | 0.38 |
| 2004 | 22 | 21.1 | 1.06 | 27 | na |  | 3.4 | 35.4 | 0.10 |
| 2005 | 18 | 20.7 | 0.88 | 35 | na |  | 19.0 | 42.6 | 0.45 |
| 2006 | 18 | 19.3 | 0.94 | 29 | na |  | 26.3 | 40.3 | 0.65 |
| 2007** | 23 | 21.2 | 1.10 | 12 | na |  | 10.5 | 43.8 | 0.24 |
| 2008** | 17 | 20.2 | 0.82 | 11 | na |  | 14.4 | 38.4 | 0.37 |
| 2009 | 12 | 16.2 | 0.76 | 12 | na |  | 6.0 | 49.3 | 0.12 |
| 2010 | 19 | 13.7 | 1.37 | 25 | na |  | 7.3 | 48.0 | 0.15 |
| 2011 | 28 | 11.5 | 2.46 | 32 | na |  | 24.8 | 49.4 | 0.50 |
| 2012 | 94 | 21.1 | 4.45 | 10 | na |  | 14.5 | 36.0 | 0.40 |

${ }^{1}$ 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

Table 9.1.9. Megrim (L. whiffiagonis) in Divisions VIIIc and IXa. Tuning diagnostic.


Time series weights :
Tapered time weighting not applied
Catchability analysis:
Catchability dependent on stock size for ages < 5

Regression type $=\mathrm{C}$
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 5
Catchability independent of age for ages $>=5$
Terminal population estimation :
Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates are shrunk $=1.500$

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

Prior weighting not applied
Tuning had not converged after 120 iterations

Total absolute residual between iterations
119 and $120=.01722$

Final year F values

| Age | 1 | 2 | 3 | 4 | 5 | 6 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
| Iteration ** | 0.0023 | 0.08 | 0.2113 | 0.2657 | 0.999 | 0.3839 |
| Iteration ** | 0.0023 | 0.0799 | 0.2115 | 0.2644 | 0.9871 | 0.3802 |
| Regression weights |  |  |  |  |  |  |


| Fishing mortalities <br> Age |  |  |  |  |  |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  |  | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | 0.055 | 0.018 | 0.060 | 0.051 | 0.039 | 0.006 | 0.018 | 0.004 | 0.002 | 0.002 |  |
|  | 0.146 | 0.136 | 0.111 | 0.296 | 0.119 | 0.191 | 0.1 | 0.027 | 0.075 | 0.08 |  |
|  | 0.182 | 0.177 | 0.358 | 0.373 | 0.265 | 0.221 | 0.139 | 0.077 | 0.1 | 0.212 |  |
| 4 | 0.178 | 0.251 | 0.204 | 0.394 | 0.433 | 0.270 | 0.149 | 0.15 | 0.278 | 0.264 |  |
| 5 | 0.191 | 0.287 | 0.247 | 0.348 | 0.412 | 0.461 | 0.207 | 0.224 | 0.288 | 0.987 |  |
| 6 | 0.113 | 0.388 | 0.211 | 0.273 | 0.277 | 0.305 | 0.282 | 0.368 | 0.367 | 0.38 |  |

XSA population numbers (Thousands)

|  | AGE |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
| YEAR |  | 1 | 2 | 3 | 4 | 5 |$\quad 6$

Estimated population abundance at 1st Jan 2013

$$
\begin{array}{llllll}
0 & 1600 & 2440 & 3490 & 508 & 113
\end{array}
$$

Taper weighted geometric mean of the VPA populations:

$$
\begin{array}{llllll}
4070 & 3250 & 2160 & 1340 & 798 & 410
\end{array}
$$

Standard error of the weighted $\log$ (VPA populations) :

$$
\begin{array}{llllll}
0.7238 & 0.6702 & 0.5752 & 0.4903 & 0.4073 & 0.4145
\end{array}
$$

Log catchability residuals.
Fleet: SP-CORUTR8c

| Age |  | 1990 | 1991 | 1992 |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1 No data for this fleet at this age |  |  |  |  |  |  |  |  |  |  |
|  | 2 | 0.32 | 0.74 | 0.2 |  |  |  |  |  |  |  |
|  | 3 | 0.03 | -0.18 | 0.39 |  |  |  |  |  |  |  |
|  | 4 | 0.25 | 0.18 | 0.61 |  |  |  |  |  |  |  |
|  | 5 | 0.41 | 0.89 | 1.37 |  |  |  |  |  |  |  |
|  | 6 | 0.2 | 0.36 | 0.17 |  |  |  |  |  |  |  |
| Age |  | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|  | 1 No data for this fleet at this age |  |  |  |  |  |  |  |  |  |  |
|  | 2 | -0.25 | -1.21 | -0.24 | 0.26 | -0.29 | -0.64 | -0.65 | -0.28 | 0.17 | -0.17 |
|  | 3 | -0.18 | -0.18 | -0.41 | -0.73 | -0.14 | -0.29 | -0.11 | 0.2 | 0.33 | 0.38 |
|  | 4 | 0.18 | 0.06 | -0.31 | -0.37 | -0.4 | -0.05 | -0.23 | 0.09 | -0.14 | -0.08 |
|  | 5 | 0.26 | 0.78 | -0.47 | 0.08 | -0.09 | 0.25 | 0.1 | 0.19 | -0.4 | -0.05 |
|  | 6 | 0.15 | 1.08 | -0.55 | 0.22 | 0.63 | 1.26 | 0.95 | -0.34 | -0.21 | -0.51 |
| Age |  | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|  | 1 No data for this fleet at this age |  |  |  |  |  |  |  |  |  |  |
|  | 2 | 0.27 | -0.28 | -0.31 | 0.23 | 0.3 | 0.33 | 0.73 | -0.23 | 0.35 | 0.66 |
|  | 3 | -0.21 | -0.42 | 0.15 | -0.07 | 0.17 | 0.1 | 0.14 | 0.12 | 0.41 | 0.48 |
|  | 4 | -0.27 | -0.4 | -0.45 | -0.08 | 0.09 | -0.02 | -0.21 | 0.1 | 0.81 | 0.62 |
|  | 5 | -0.59 | -0.78 | -1.03 | -0.85 | -0.33 | -0.34 | -0.86 | -0.06 | 0.12 | 1.42 |
|  | 6 | -0.92 | -0.17 | -1.1 | -0.95 | -0.68 | -0.83 | -0.71 | 0.33 | 0.02 | 0.12 |

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

| Age | 5 | 6 |
| :--- | ---: | ---: |
| Mean $\log q$ | -5.4974 | -5.4974 |
| S.E(Log q) | 0.6663 | 0.6677 |

Regression statistics :

Ages with q dependent on year class strength

Age Slope $t$-value Intercept RSquare No Pts Reg s.e Mean Log q

| 2 | 0.74 | 1.603 | 7.44 | 0.64 | 23 | 0.49 | -7.25 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | ---: |
| 3 | 0.72 | 2.411 | 6.81 | 0.78 | 23 | 0.32 | -6.5 |
| 4 | 0.65 | 2.233 | 6.39 | 0.67 | 23 | 0.35 | -6.01 |

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

| 5 | 0.76 | 0.812 | 5.76 | 0.36 | 23 | 0.51 | -5.5 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 6 | 1.13 | -0.327 | 5.51 | 0.25 | 23 | 0.76 | -5.56 |

Fleet: SP-AVILESTR

| Age |  | 1990 | 1991 | 1992 |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1 No data for this fleet at this age |  |  |  |  |  |  |  |  |  |  |
|  | 2 | -0.08 | 0.08 | 99.99 |  |  |  |  |  |  |  |
|  | 3 | -0.18 | -0.32 | 99.99 |  |  |  |  |  |  |  |
|  | 4 | -0.08 | -0.35 | 99.99 |  |  |  |  |  |  |  |
|  | 5 | -0.63 | -0.09 | 99.99 |  |  |  |  |  |  |  |
|  | 6 | -0.8 | -0.95 | 99.99 |  |  |  |  |  |  |  |
| Age |  | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|  | 1 No data for this fleet at this age |  |  |  |  |  |  |  |  |  |  |
|  | 2 | -0.21 | 0.06 | -0.63 | -0.07 | 0 | -0.12 | -0.11 | 0.2 | 0.41 | 0.25 |
|  | 3 | -0.64 | 0.11 | -0.77 | -0.41 | 0.3 | 0.07 | 0.24 | 0.25 | 0.94 | 0.44 |
|  | 4 | -0.72 | 0.25 | -0.24 | -0.01 | -0.12 | 0.36 | 0.28 | 0.3 | 0.36 | 0.17 |
|  | 5 | -1.31 | 0.65 | -0.04 | 0.63 | 0.48 | 0.46 | 0.44 | 0 | 0.2 | -0.14 |
|  | 6 | -0.8 | 0.33 | 0.18 | 0.81 | 1.08 | 1.04 | 1.12 | -0.56 | 0.29 | -0.5 |
| Age |  | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|  | 1 No data for this fleet at this age |  |  |  |  |  |  |  |  |  |  |
|  | 2 | 0.21 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
|  | 3 | -0.01 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
|  | 4 | -0.2 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
|  | 5 | -0.65 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
|  | 6 | -1.04 | 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 | 5 | 6 |
| :--- | ---: | ---: |
| Mean $\log q$ | -4.3448 | -4.3448 |
| S.E(Log q) | 0.5811 | 0.8265 |

Regression statistics :

Ages with q dependent on year class strength
Age Slope t -value Intercept RSquare No Pts Reg s.e Mean Log q

| 2 | 0.4 | 4.958 | 6.91 | 0.86 | 13 | 0.27 | -5.04 |
| ---: | ---: | ---: | ---: | ---: | :--- | :--- | :--- |
| 3 | 0.6 | 1.491 | 6 | 0.56 | 13 | 0.49 | -4.81 |
| 4 | 0.78 | 0.962 | 5.29 | 0.64 | 13 | 0.34 | -4.72 |

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

| 5 | 0.79 | 0.508 | 4.86 | 0.34 | 13 | 0.47 | -4.34 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 6 | 2.21 | -1.204 | 2.22 | 0.08 | 13 | 1.79 | -4.33 |

Fleet : SP-GFS®

| Age |  | 1990 | 1991 | 1992 |  |  |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | 1 | -0.23 | -0.42 | -0.08 |  |  |  |  |  |  |  |  |
|  | 2 | 0.02 | -0.3 | -0.48 |  |  |  |  |  |  |  |  |
|  | 3 | 0.07 | -0.76 | -0.35 |  |  |  |  |  |  |  |  |
|  | 4 | 0.26 | -0.09 | -0.05 |  |  |  |  |  |  |  |  |
|  | 5 | 0.41 | 0.11 | 0.47 |  |  |  |  |  |  |  |  |
|  | 6 | 0.2 | -0.53 | -0.64 |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |  |
|  | 1 | 0.01 | -1.03 | -0.17 | 0.11 | -0.02 | 0.03 | 0.29 | 0.77 | 0.17 | 0.47 |  |
|  | 2 | -0.01 | -0.81 | -0.54 | -0.06 | 0.03 | -0.11 | 0.37 | 0.62 | 0.6 | 0.41 |  |
|  | 3 | -0.86 | 0.19 | -1.05 | -0.84 | 0 | 0.18 | 0.41 | 0.4 | 0.24 | 0.79 |  |
|  | 4 | -0.04 | 0.05 | -0.3 | -0.33 | -0.07 | -0.14 | -0.1 | 0.32 | 0.33 | -0.24 |  |
|  | 5 | -0.26 | 0.31 | -0.04 | -0.2 | -0.04 | 0.03 | 0.23 | 0.3 | 0.08 | 0.16 |  |
|  | 6 | -0.61 | -0.03 | -0.24 | 0.13 | -0.01 | 1.02 | 1.42 | -0.03 | -0.46 | -0.68 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |  |
|  | 1 | 0.25 | 0.15 | 0.45 | 0.09 | 0.37 | -0.2 | -0.55 | -0.18 | -0.16 | -0.12 |  |
|  | 2 | 0.11 | 0.25 | 0.01 | 0.25 | 0.04 | 0.26 | -0.04 | -0.67 | 0.19 | -0.14 |  |
|  | 3 | 0.09 | 0.12 | 0.57 | 0.23 | 0.39 | 0.28 | 0.35 | -0.69 | 0.32 | -0.07 |  |
|  | 4 | -0.07 | 0.04 | 0.31 | 0.16 | 0.36 | 0.03 | 0.21 | -0.07 | -0.23 | -0.34 |  |
|  | 5 | -0.33 | -0.29 | 0.41 | 0.09 | 0.21 | -0.11 | -0.41 | -0.35 | -0.25 | -0.54 |  |
|  | 6 | -1.17 | 0.46 | -0.15 | -0.07 | -0.11 | -0.6 | -0.12 | 0.35 | -0.07 | -0.43 |  |

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

| Age | 5 |  |
| :--- | ---: | ---: |
| Mean $\log q$ |  | 6 |
| S.E(Log q) |  | -6.25 |

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 | 0.55 | 3.649 | 7.67 | 0.75 | 23 | 0.39 | -7.27 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 2 | 0.64 | 2.846 | 7.29 | 0.74 | 23 | 0.38 | -6.91 |
| 3 | 0.86 | 0.736 | 6.87 | 0.56 | 23 | 0.52 | -6.75 |
| 4 | 0.68 | 3.152 | 6.71 | 0.83 | 23 | 0.22 | -6.53 |

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

| 5 | 0.72 | 2.731 | 6.35 | 0.82 | 23 | 0.18 | -6.25 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 6 | 1.48 | -1.157 | 6.54 | 0.22 | 23 | 0.83 | -6.35 |

Terminal year survivor and F summaries

Age 1 Catchability dependent on age and year class strength

Year class $=2011$

| Fleet | Int |  | Ext | Var |  | N | Scaled <br> Weights |  | EstimatedF |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | s.e | s.e |  | Ratio |  |  |  |  |
| SP-CORUTR8c | 1 | 0 |  | 0 | 0 |  | 0 | 0 | 0 |
| SP-AVILESTR | 1 | 0 |  | 0 | 0 |  | 0 | 0 | 0 |
| SP-GFS® | 1417 | 0.401 |  | 0 | 0 |  | 1 | 0.699 | 0.003 |
| P shrinkage mean 3248 |  | 0.67 |  |  |  |  |  | 0.251 | 0.001 |
| F shrinkage mean | 260 | 1.5 |  |  |  |  |  | 0.05 | 0.014 |

Weighted prediction :

| Survivors at end of year | Int | Ext | N |  | Var | F |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | s.e | s.e |  |  | Ratio |  |
|  | 0.34 | 0.4 |  | 3 | 1.187 | 0.002 |

Age 2 Catchability dependent on age and year class strength

Year class $=2010$

| Fleet |  | Int | Ext | Var | N | Scaled | Estimated |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | s.e | s.e | Ratio |  | Weights | F |
| SP-CORUTR8c | 4725 | 0.511 | 0 | 0 | 1 | 0.186 | 0.042 |
| SP-AVILESTR | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| SP-GFS® | 2092 | 0.277 | 0.011 | 0.04 | 2 | 0.632 | 0.092 |
| P shrinkage mean | 2164 | 0.58 |  |  |  | 0.159 | 0.09 |
| F shrinkage mean | 1875 | 1.5 |  |  |  | 0.023 | 0.103 |

Weighted prediction:

| Survivors |  | Int | Ext | N |  | Var | F |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| at end of year | s.e | s.e |  | Ratio |  |  |  |
|  | 2440 | 0.22 | 0.16 |  | 5 | 0.717 | 0.08 |

Age 3 Catchability dependent on age and year class strength
Year class $=2009$


Age 4 Catchability dependent on age and year class strength

Year class $=2008$

| Fleet | Int |  | Ext | Var | N | Scaled |  | Estimated |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | s.e | s.e | Ratio |  |  | Weights | F |
| SP-CORUTR8c | 741 | 0.217 | 0.206 | 0.95 |  | 3 | 0.338 | 0.188 |
| SP-AVILESTR | 1 | 0 | 0 | 0 |  | 0 | 0 | 0 |
| SP-GFS® | 354 | 0.176 | 0.153 | 0.87 |  | 4 | 0.519 | 0.359 |
| P shrinkage mean | 798 | 0.41 |  |  |  |  | 0.133 | 0.175 |
| F shrinkage mean | 521 | 1.5 |  |  |  |  | 0.01 | 0.257 |

Weighted prediction :
$\left.\begin{array}{llllllll}\begin{array}{l}\text { Survivors } \\ \text { at end of year }\end{array} & & \text { Int } & \text { Ext } & \mathrm{N} & & \text { Var } & \mathrm{F} \\ & 508 & 0.13 & \text { s.e } & & & \text { Ratio }\end{array}\right]$

Age 5 Catchability constant w.r.t. time and dependent on age

Year class $=2007$

| Fleet |  | Int | Ext | Var | N | Scaled | Estimated |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | s.e | s.e | Ratio |  | Weights | F |
| SP-CORUTR8c | 207 | 0.21 | 0.25 | 1.19 | 4 | 0.329 | 0.645 |
| SP-AVILESTR | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| SP-GFS® | 79 | 0.155 | 0.099 | 0.64 | 5 | 0.648 | 1.213 |
| F shrinkage mean | 496 | 1.5 |  |  |  | 0.023 | 0.32 |
| Weighted prediction : |  |  |  |  |  |  |  |
| Survivors at end of year | Int | Ext | N | Var | F |  |  |
|  | s.e | s.e |  | Ratio |  |  |  |
| 113 | 0.13 | 0.19 | 10 | 1.535 | 0.987 |  |  |

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

Year class $=2006$

| Fleet |  | Int | Ext | Var | N | Scaled | Estimated |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | s.e | s.e | Ratio |  | Weights | F |
| SP-CORUTR8c | 244 | 0.202 | 0.035 | 0.18 | 5 | 0.334 | 0.337 |
| SP-AVILESTR | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| SP-GFS® | 201 | 0.146 | 0.11 | 0.75 | 6 | 0.652 | 0.397 |
| F shrinkage mean | 154 | 1.5 |  |  |  | 0.014 | 0.491 |
| Weighted prediction : |  |  |  |  |  |  |  |
| Survivors at end of year | Int | Ext | N | Var | F |  |  |
|  | s.e | s.e |  | Ratio |  |  |  |
| 214 | 0.12 | 0.07 | 12 | 0.574 | 0.38 |  |  |

Table 9.1.10. Megrim (L. whiffiagonis) Div. VIIIc and IXa. Estimates of fisihing mortality at age. Run title : Megrim (L. whiffiagonis.) in Divisions VIIIc and IXa At 8/05/2013 14:16

Terminal Fs derived using XSA (With F shrinkage)

| Table 8 |  |  |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| YEA | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |  |
|  |  |  |  |  |  |  |  |  |
| AGE |  |  |  |  |  |  |  |  |
| 1 | 0.1326 | 0.2051 | 0.3654 | 0.0925 | 0.4889 | 0.2706 | 0.1205 |  |
| 2 | 0.3305 | 0.5003 | 0.6167 | 0.4222 | 0.404 | 0.559 | 0.158 |  |
| 3 | 0.249 | 0.2037 | 0.4422 | 0.2372 | 0.3028 | 0.2589 | 0.3055 |  |
| 4 | 0.4531 | 0.2278 | 0.3159 | 0.5327 | 0.5423 | 0.4855 | 0.7027 |  |
| 5 | 0.7984 | 0.3807 | 0.5452 | 0.3682 | 0.5942 | 1.0539 | 1.0609 |  |
| 6 | 0.5041 | 0.2722 | 0.4376 | 0.3819 | 0.5243 | 0.5531 | 0.3193 |  |
| +gp | 0.5041 | 0.2722 | 0.4376 | 0.3819 | 0.5243 | 0.5531 | 0.3193 |  |
| FBAR 2. | 0.3442 | 0.3106 | 0.4583 | 0.3973 | 0.4164 | 0.4345 | 0.3887 |  |


| Table 8 |  |  |  |  |  |  |  |  |  | Fishing mortality (F) at age |  |  |  |  |  |  |  |
| :---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| YEA | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| AGE |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 0.1442 | 0.0348 | 0.0686 | 0.0281 | 0.0145 | 0.0226 | 0.0112 | 0.0032 | 0.0155 | 0.0141 |  |  |  |  |  |  |  |
| 2 | 0.2888 | 0.1717 | 0.0397 | 0.292 | 0.2065 | 0.2134 | 0.0912 | 0.0876 | 0.1431 | 0.0746 |  |  |  |  |  |  |  |
| 3 | 0.182 | 0.5593 | 0.1444 | 0.0522 | 0.3311 | 0.3826 | 0.3802 | 0.3432 | 0.3216 | 0.2119 |  |  |  |  |  |  |  |
| 4 | 0.4142 | 0.5604 | 0.3829 | 0.2338 | 0.1445 | 0.5408 | 0.3966 | 0.3543 | 0.2282 | 0.1425 |  |  |  |  |  |  |  |
| 5 | 0.5055 | 1.3607 | 0.5155 | 0.6187 | 0.5403 | 0.7647 | 0.579 | 0.3706 | 0.2554 | 0.2363 |  |  |  |  |  |  |  |
| 6 | 0.5078 | 1.3574 | 0.4968 | 0.6982 | 1.0095 | 1.5751 | 1.1655 | 0.1983 | 0.2782 | 0.1384 |  |  |  |  |  |  |  |
| +gp | 0.5078 | 1.3574 | 0.4968 | 0.6982 | 1.0095 | 1.5751 | 1.1655 | 0.1983 | 0.2782 | 0.1384 |  |  |  |  |  |  |  |
| FBAR 2. | 0.295 | 0.4304 | 0.189 | 0.1927 | 0.2273 | 0.3789 | 0.2893 | 0.2617 | 0.2309 | 0.143 |  |  |  |  |  |  |  |

Table 8 Fishing mortality (F) at age
$\begin{array}{lllllllllllll}\text { YEA } & 2003 & 2004 & 2005 & 2006 & 2007 & 2008 & 2009 & 2010 & 2011 & 2012 & \text { FBAR 10-12 }\end{array}$
AGE
$\begin{array}{llllllllllll}1 & 0.0552 & 0.0182 & 0.0598 & 0.0506 & 0.0387 & 0.006 & 0.0184 & 0.0039 & 0.002 & 0.0023 & 0.0027\end{array}$
$\begin{array}{lllllllllll}0.1457 & 0.1356 & 0.111 & 0.2956 & 0.119 & 0.1905 & 0.0998 & 0.0272 & 0.0752 & 0.0799 & 0.0608\end{array}$
$\begin{array}{llllllllllll}3 & 0.1816 & 0.177 & 0.3576 & 0.3731 & 0.2655 & 0.2211 & 0.1392 & 0.077 & 0.0996 & 0.2115 & 0.1293\end{array}$
$\begin{array}{lllllllllll}0.1776 & 0.2512 & 0.2041 & 0.3938 & 0.4328 & 0.2704 & 0.1493 & 0.1501 & 0.2777 & 0.2644 & 0.2307\end{array}$
$\begin{array}{llllllllllll}5 & 0.1912 & 0.2872 & 0.2472 & 0.348 & 0.4118 & 0.4615 & 0.2071 & 0.2242 & 0.2876 & 0.9871 & 0.4996\end{array}$

| 6 | 0.1134 | 0.388 | 0.2106 | 0.273 | 0.2773 | 0.3051 | 0.2823 | 0.3681 | 0.3667 | 0.3802 | 0.3717 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

$\begin{array}{llllllllllll}+g p & 0.1134 & 0.388 & 0.2106 & 0.273 & 0.2773 & 0.3051 & 0.2823 & 0.3681 & 0.3667 & 0.3802\end{array}$
$\begin{array}{lllllllllll}\text { FBAR 2. } & 0.1683 & 0.1879 & 0.2242 & 0.3542 & 0.2724 & 0.2273 & 0.1295 & 0.0847 & 0.1508 & 0.1853\end{array}$

Table 9.1.11. Megrim (L. whiffiagonis) Div. VIIIc and IXa. Estimates of stocks numbers at age

Run title : Megrim (L. whiffiagonis.) in Divisions VIIIc and IXa
At 8/05/2013 14:16

Terminal Fs derived using XSA (With F shrinkage)

| Table 10 |  |  |  |  |  |  |  |  |  |  | Stock number at age (start of year) |  |  |  | Numbers*10**-3 |  |
| :---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| YEA | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| AGE |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 9017 | 12040 | 10749 | 9511 | 12089 | 4746 | 10339 |  |  |  |  |  |  |  |  |  |
| 2 | 7665 | 6466 | 8030 | 6107 | 7099 | 6070 | 2964 |  |  |  |  |  |  |  |  |  |
| 3 | 3349 | 4509 | 3210 | 3548 | 3278 | 3880 | 2842 |  |  |  |  |  |  |  |  |  |
| 4 | 1938 | 2138 | 3011 | 1689 | 2292 | 1983 | 2452 |  |  |  |  |  |  |  |  |  |
| 5 | 1007 | 1009 | 1394 | 1798 | 812 | 1091 | 999 |  |  |  |  |  |  |  |  |  |
| 6 | 561 | 371 | 564 | 662 | 1018 | 367 | 311 |  |  |  |  |  |  |  |  |  |
| +gp | 536 | 327 | 402 | 874 | 1496 | 152 | 273 |  |  |  |  |  |  |  |  |  |
| TOTAL | 24073 | 26859 | 27360 | 24188 | 28084 | 18289 | 20180 |  |  |  |  |  |  |  |  |  |


| Table 10 |  | Stock number at age (start of year) |  |  |  | Numbers* $10{ }^{* *}-3$ |  |  | 2001 | 2002 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| YEA | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |  |  |
| AGE |  |  |  |  |  |  |  |  |  |  |
| 1 | 4270 | 1292 | 8483 | 7902 | 6286 | 3803 | 1985 | 3098 | 2879 | 2444 |
| 2 | 7504 | 3027 | 1021 | 6484 | 6290 | 5072 | 3044 | 1607 | 2529 | 2321 |
| 3 | 2072 | 4603 | 2087 | 804 | 3964 | 4189 | 3355 | 2275 | 1206 | 1794 |
| 4 | 1714 | 1414 | 2154 | 1479 | 624 | 2331 | 2340 | 1878 | 1322 | 716 |
| 5 | 994 | 928 | 661 | 1203 | 958 | 442 | 1111 | 1288 | 1079 | 861 |
| 6 | 283 | 491 | 195 | 323 | 530 | 457 | 169 | 510 | 728 | 684 |
| +gp | 99 | 173 | 201 | 176 | 198 | 202 | 326 | 984 | 534 | 315 |
| TOTAL | 16937 | 11927 | 14802 | 18371 | 18852 | 16498 | 12330 | 11642 | 10276 | 9135 |



Table 9.1.12 Megrim (L. whiffiagonis) in Divisions VIIIc and IXa. Summary of landings and XSA results.

Run title : Megrim (L. whiffiagonis.) in Divisions VIIIc and IXa

At 8/05/2013 14:16

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

RECRUITS TOTALBIO TOTSPBIO LANDINGS YIELD/SSB FBAR 2-4
Age 1

| 1986 | 9017 | 2561 | 2215 | 659 | 0.2975 | 0.3442 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
| 1987 | 12040 | 2283 | 1840 | 497 | 0.2701 | 0.3106 |
| 1988 | 10749 | 2589 | 2197 | 817 | 0.3718 | 0.4583 |
| 1989 | 9511 | 2869 | 2486 | 714 | 0.2872 | 0.3973 |
| 1990 | 12089 | 2960 | 2563 | 977 | 0.3811 | 0.4164 |
| 1991 | 4746 | 1791 | 1614 | 614 | 0.3805 | 0.4345 |
| 1992 | 10339 | 1823 | 1563 | 516 | 0.3302 | 0.3887 |
| 1993 | 4270 | 1563 | 1401 | 383 | 0.2733 | 0.295 |
| 1994 | 1292 | 1204 | 1144 | 479 | 0.4186 | 0.4304 |
| 1995 | 8483 | 1287 | 944 | 218 | 0.231 | 0.189 |
| 1996 | 7902 | 1612 | 1273 | 329 | 0.2585 | 0.1927 |
| 1997 | 6286 | 1665 | 1381 | 356 | 0.2578 | 0.2273 |
| 1998 | 3803 | 1468 | 1317 | 446 | 0.3386 | 0.3789 |
| 1999 | 1985 | 1212 | 1117 | 343 | 0.307 | 0.2893 |
| 2000 | 3098 | 1339 | 1213 | 253 | 0.2086 | 0.2617 |
| 2001 | 2879 | 1066 | 934 | 175 | 0.1874 | 0.2309 |
| 2002 | 2444 | 1026 | 914 | 117 | 0.128 | 0.143 |
| 2003 | 2655 | 1134 | 1019 | 134 | 0.1315 | 0.1683 |
| 2004 | 2814 | 933 | 801 | 149 | 0.1861 | 0.1879 |
| 2005 | 2341 | 939 | 826 | 147 | 0.1779 | 0.2242 |
| 2006 | 2038 | 925 | 823 | 210 | 0.2552 | 0.3542 |
| 2007 | 2297 | 817 | 704 | 155 | 0.2202 | 0.2724 |
| 2008 | 1286 | 695 | 628 | 133 | 0.2116 | 0.2273 |
| 2009 | 1694 | 687 | 605 | 84 | 0.1389 | 0.1295 |
| 2010 | 8509 | 1121 | 761 | 83 | 0.109 | 0.0847 |
| 2011 | 3946 | 1476 | 1254 | 159 | 0.1268 | 0.1508 |
| 2012 | 1955 | 1618 | 1513 | 288 | 0.1904 | 0.1853 |

Arith.

| Mean <br> Units | 5203 <br> (Thousands) | 1506 <br> (Tonnes) | 1298 <br> (Tonnes) | 349 <br> (Tonnes) | 0.2472 | 0.2731 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |

Table 9.1.13. Megrim (L. whiffiagonis) in Division VIIIc, IXa. Prediction with management option table: Input data

MFDP version 1a
Run: MEG
Time and date: 15:23 08/05/2013
Fbar age range: 2-4

2013 Stock Natural Maturity Prop. of F Prop. of M Weight Exploit Weight

| Age |  | size | mortality | ogive | bef. Spaw. bef. Spaw. in Stock pattern |  |  |  | CWt |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1 | 2601 | 0.2 | 0.34 | 0 | 0 | 00.058 | 0.003 | 0.058 |
|  | 2 | 1602 | 0.2 | 0.9 | 0 | 0 | 00.101 | 0.061 | 0.101 |
|  | 3 | 2440 | 0.2 | 1 | 0 | 0 | 00.129 | 0.129 | 0.129 |
|  | 4 | 3489 | 0.2 | 1 | 0 | 0 | 00.153 | 0.231 | 0.153 |
|  | 5 | 508 | 0.2 | 1 | 0 | 0 | 00.187 | 0.500 | 0.187 |
|  | 6 | 113 | 0.2 | 1 | 0 | 0 | 00.230 | 0.372 | 0.230 |
|  | 7 | 495 | 0.2 | 1 | 0 | 0 | $0 \quad 0.362$ | 0.372 | 0.362 |

2014 Stock Natural Maturity Prop. of F Prop. of M Weight Exploit Weight

| Age |  | size | mortality | ogive | bef. Spaw. | bef. Spaw. | in Stock | pattern | CWt |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1 | 2601 | 0.2 | 0.34 | 0 | 0 | 0.058 | 0.003 | 0.058 |
|  | 2 |  | 0.2 | 0.9 | 0 | 0 | 0.101 | 0.061 | 0.101 |
|  | 3 |  | 0.2 | 1 | 0 | 0 | 0.129 | 0.129 | 0.129 |
|  | 4 |  | 0.2 | 1 | 0 | 0 | 0.153 | 0.231 | 0.153 |
|  | 5 |  | 0.2 | 1 | 0 | 0 | 0.187 | 0.500 | 0.187 |
|  | 6 |  | 0.2 | 1 | 0 | 0 | 0.230 | 0.372 | 0.230 |
|  | 7 |  | 0.2 | 1 | 0 | 0 | 0.362 | 0.372 | 0.362 |

2015 Stock Natural Maturity Prop. of F Prop. of M Weight Exploit Weight
Age

|  | size | mortality | ogive | bef. Spaw. bef. Spaw. in Stock pattern | CWt |  |  |  |
| :--- | ---: | ---: | ---: | ---: | :--- | :--- | :--- | :--- |
| 2 | 2601 | 0.2 | 0.34 | 0 | 0 | 0.058 | 0.003 | 0.058 |
| 2. | 0.2 | 0.9 | 0 | 0 | 0.101 | 0.061 | 0.101 |  |
| 3. | 0.2 | 1 | 0 | 0 | 0.129 | 0.129 | 0.129 |  |
| 4. | 0.2 | 1 | 0 | 0 | 0.153 | 0.231 | 0.153 |  |
| 5. | 0.2 | 1 | 0 | 0 | 0.187 | 0.500 | 0.187 |  |
| 6. | 0.2 | 1 | 0 | 0 | 0.230 | 0.372 | 0.230 |  |
| 7. | 0.2 | 1 | 0 | 0 | 0.362 | 0.372 | 0.362 |  |

Input units are thousands and kg - output in tonnes

Table 9.1.14. Megrim (L. whiffiagonis) in Div. VIIIc and IXa catch forecast: management option table

MFDP version 1 a
Run: MEG
Megrim (L. whiffiagonis.) in Divisions VIIIc and IXa
Time and date: 15:23 08/05/2013
Fbar age range: 2-4

| 2013 |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Biomass | SSB | FMult | FBar | Landings |
| 1461 | 1345 | 1 | 0.1403 | 236 |

20142015

| Biomass | SSB | FMult | FBar | Landings | Biomass | SSB |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1400 | 1278 | 0 | 0 | 0 | 1617 | 1495 |
| . | 1278 | 0.1 | 0.014 | 33 | 1580 | 1459 |
| . | 1278 | 0.2 | 0.0281 | 66 | 1545 | 1423 |
| . | 1278 | 0.3 | 0.0421 | 97 | 1511 | 1389 |
| . | 1278 | 0.4 | 0.0561 | 126 | 1478 | 1357 |
| . | 1278 | 0.5 | 0.0701 | 155 | 1447 | 1325 |
| . | 1278 | 0.6 | 0.0842 | 183 | 1416 | 1295 |
| . | 1278 | 0.7 | 0.0982 | 210 | 1387 | 1266 |
| . | 1278 | 0.8 | 0.1122 | 235 | 1359 | 1238 |
| . | 1278 | 0.9 | 0.1263 | 260 | 1332 | 1211 |
| . | 1278 | 1 | 0.1403 | 284 | 1306 | 1185 |
| . | 1278 | 1.1 | 0.1543 | 307 | 1281 | 1160 |
| . | 1278 | 1.2 | 0.1683 | 329 | 1257 | 1136 |
| . | 1278 | 1.3 | 0.1824 | 351 | 1234 | 1113 |
| . | 1278 | 1.4 | 0.1964 | 371 | 1212 | 1090 |
| . | 1278 | 1.5 | 0.2104 | 391 | 1190 | 1069 |
| . | 1278 | 1.6 | 0.2245 | 411 | 1169 | 1048 |
| . | 1278 | 1.7 | 0.2385 | 429 | 1149 | 1028 |
| . | 1278 | 1.8 | 0.2525 | 447 | 1130 | 1009 |
| . | 1278 | 1.9 | 0.2665 | 465 | 1111 | 990 |
| . | 1278 | 2 | 0.2806 | 482 | 1093 | 972 |

Input units are thousands and kg - output in tonnes

Table 9.1.15. Megrim (L. whiffiagonis) in Divisions VIIIc and IXa. Single option prediction: Detail Tables.

MFDP version 1a
Run: MEG
Time and date: 15:23 08/05/2013
Fbar age range: 2-4

| Year: <br> Age | 2013 F multiplier: |  |  | 1 Fbar: |  | 0.1403 |  | SSB(Jan) | SSNos(ST) | SSB(ST) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | F | CatchNos | Yield | ockNos | Biomass | SSNos(Jan) |  |  |  |
|  | 1 | 0.0027 | 6 | 0 | 2601 | 151 | 884 | 51 | 884 | 51 |
|  | 2 | 0.0608 | 86 | 9 | 1602 | 161 | 1442 | 145 | 1442 | 145 |
|  | 3 | 0.1294 | 269 | 35 | 2440 | 315 | 2440 | 315 | 2440 | 315 |
|  | 4 | 0.2307 | 654 | 100 | 3489 | 533 | 3489 | 533 | 3489 | 533 |
|  | 5 | 0.4996 | 183 | 34 | 508 | 95 | 508 | 95 | 508 | 95 |
|  | 6 | 0.3717 | 32 | 7 | 113 | 26 | 113 | 26 | 113 | 26 |
|  | 7 | 0.3717 | 140 | 51 | 495 | 179 | 495 | 179 | 495 | 179 |
| Total |  |  | 1370 | 236 | 11248 | 1461 | 9371 | 1345 | 9371 | 1345 |

Year: $\quad 2014$ F multiplier: $\quad 1$ Fbar: 0.1403

| Age | F | CatchNos | Yield StockNos Biomass |  |  |  |  | SSNos(Jan) | SSB(Jan) | SSNos(ST) |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | SSB(ST) |  |  |  |  |  |  |  |  |  |
|  | 1 | 0.0027 | 6 | 0 | 2601 | 151 | 884 | 51 | 884 | 51 |
| 2 | 0.0608 | 114 | 11 | 2124 | 214 | 1911 | 192 | 1911 | 192 |  |
| 3 | 0.1294 | 136 | 18 | 1234 | 159 | 1234 | 159 | 1234 | 159 |  |
| 4 | 0.2307 | 329 | 50 | 1755 | 268 | 1755 | 268 | 1755 | 268 |  |
| 5 | 0.4996 | 815 | 153 | 2268 | 425 | 2268 | 425 | 2268 | 425 |  |
| 6 | 0.3717 | 71 | 16 | 252 | 58 | 252 | 58 | 252 | 58 |  |
| 7 | 0.3717 | 97 | 35 | 343 | 124 | 343 | 124 | 343 | 124 |  |
| Total |  | 1569 | 284 | 10578 | 1400 | 8649 | 1278 | 8649 | 1278 |  |

Year: 2015 F multiplier: 1 Fbar: 0.1403

| Age | F | CatchNos | Yield StockNos Biomass |  |  |  |  |  | SSNos(Jan) | SSB(Jan) |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | 1 | 0.0027 | 6 | 0 | 2601 | 151 | 884 | 51 | 884 | 51 |
| 2 | 0.0608 | 114 | 11 | 2124 | 214 | 1911 | 192 | 1911 | 192 |  |
| 3 | 0.1294 | 180 | 23 | 1636 | 211 | 1636 | 211 | 1636 | 211 |  |
| 4 | 0.2307 | 166 | 25 | 888 | 136 | 888 | 136 | 888 | 136 |  |
| 5 | 0.4996 | 410 | 77 | 1141 | 214 | 1141 | 214 | 1141 | 214 |  |
| 6 | 0.3717 | 319 | 73 | 1127 | 259 | 1127 | 259 | 1127 | 259 |  |
| 7 | 0.3717 | 95 | 34 | 336 | 122 | 336 | 122 | 336 | 122 |  |
| Total |  | 1291 | 245 | 9853 | 1306 | 7924 | 1185 | 7924 | 1185 |  |

Input units are thousands and kg - output in tonnes


Megrim (L. whiffiagonis) in Divisions VIIIc and IXa : Year-class \% contribution to


Table 9.1.17. Megrim (L. whiffiagonis) in Divisions VIIIc and IXa, yield per recruit results.

MFYPR version 2a
Run: MEG
Time and date: 15:46 08/05/2013
Yield per results

| FMult | Fbar | CatchNos | Yield | StockNos | Biomass | SpwnNosJan | SSBJan | SpwnNosSpwn | SSBSpwn |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.0 | 0.0000 | 0.0000 | 0.0000 | 5.5167 | 1.0807 | 4.7748 | 1.0340 | 4.7748 | 1.0340 |
| 0.1 | 0.0140 | 0.0952 | 0.0243 | 5.0423 | 0.9199 | 4.3004 | 0.8732 | 4.3004 | 0.8732 |
| 0.2 | 0.0281 | 0.1649 | 0.0402 | 4.6958 | 0.8048 | 3.9540 | 0.7581 | 3.9540 | 0.7581 |
| 0.3 | 0.0421 | 0.2182 | 0.0511 | 4.4313 | 0.7188 | 3.6895 | 0.6721 | 3.6895 | 0.6721 |
| 0.4 | 0.0561 | 0.2603 | 0.0586 | 4.2225 | 0.6524 | 3.4807 | 0.6058 | 3.4807 | 0.6058 |
| 0.5 | 0.0701 | 0.2945 | 0.0640 | 4.0532 | 0.6000 | 3.3114 | 0.5533 | 3.3114 | 0.5533 |
| 0.6 | 0.0842 | 0.3228 | 0.0678 | 3.9129 | 0.5575 | 3.1712 | 0.5109 | 3.1712 | 0.5109 |
| 0.7 | 0.0982 | 0.3468 | 0.0706 | 3.7945 | 0.5227 | 3.0528 | 0.4760 | 3.0528 | 0.4760 |
| 0.8 | 0.1122 | 0.3674 | 0.0726 | 3.6931 | 0.4935 | 2.9514 | 0.4469 | 2.9514 | 0.4469 |
| 0.9 | 0.1263 | 0.3853 | 0.0741 | 3.6051 | 0.4690 | 2.8635 | 0.4223 | 2.8635 | 0.4223 |
| 1.0 | 0.1403 | 0.4010 | 0.0752 | 3.5279 | 0.4479 | 2.7863 | 0.4013 | 2.7863 | 0.4013 |
| 1.1 | 0.1543 | 0.4150 | 0.0760 | 3.4594 | 0.4298 | 2.7178 | 0.3831 | 2.7178 | 0.3831 |
| 1.2 | 0.1683 | 0.4275 | 0.0765 | 3.3982 | 0.4140 | 2.6566 | 0.3673 | 2.6566 | 0.3673 |
| 1.3 | 0.1824 | 0.4388 | 0.0769 | 3.3430 | 0.4001 | 2.6014 | 0.3534 | 2.6014 | 0.3534 |
| 1.4 | 0.1964 | 0.4491 | 0.0772 | 3.2929 | 0.3878 | 2.5514 | 0.3412 | 2.5514 | 0.3412 |
| 1.5 | 0.2104 | 0.4585 | 0.0774 | 3.2472 | 0.3769 | 2.5056 | 0.3302 | 2.5056 | 0.3302 |
| 1.6 | 0.2245 | 0.4671 | 0.0775 | 3.2051 | 0.3670 | 2.4636 | 0.3204 | 2.4636 | 0.3204 |
| 1.7 | 0.2385 | 0.4751 | 0.0776 | 3.1663 | 0.3582 | 2.4248 | 0.3116 | 2.4248 | 0.3116 |
| 1.8 | 0.2525 | 0.4825 | 0.0777 | 3.1303 | 0.3502 | 2.3889 | 0.3035 | 2.3889 | 0.3035 |
| 1.9 | 0.2665 | 0.4894 | 0.0777 | 3.0968 | 0.3429 | 2.3554 | 0.2962 | 2.3554 | 0.2962 |
| 2.0 | 0.2806 | 0.4959 | 0.0777 | 3.0655 | 0.3362 | 2.3240 | 0.2895 | 2.3240 | 0.2895 |


| Reference point | F multiplier | Absolute F |
| :--- | ---: | ---: |
| Fbar(2-4) | 1 | 0.1403 |
| FMax | 2.0169 | 0.2829 |
| F0.1 | 0.6229 | 0.0874 |
| F35\%SPR | 1.2375 | 0.1736 |
| Flow | 0.4206 | 0.0590 |
| Fmed | 1.2585 | 0.1766 |
| Fhigh | 11.1147 | 1.5593 |

Weights in kilograms


* Spanish Landings of 2008 revised in WG2010 from original value presented

Figure 9.1.1 Historical landings and biomass indices of Spanish survey of megrims (both species combined).


Figure 9.1.2 Megrim (L. whiffiagonis) in Divisions VIIIc and IXa. Annual length compositions of landings ('000)

## Landings of megrim



LPUEs of megrim in Div. VIIIc, IXa.


Megrim in Div. VIII, IXa. Effort


Spanish Survey Abundance Megrim Index in Div. VIIIc, IXa.

Portuguese Trawl Effort of 2007 and 2008 revised in WG2010 from original value presented
Figure 9.1.3(a) Megrim (L.whiffiagonis) in Divisions VIIIc, IXa. Landings ( $\mathbf{t}$ ), Efforts, LPUEs and Abundance Indices.

Standardized log (abundance index at age) from survey SpGFS-WIBTS-Q4 (black bubbles means $<0$ )


Figure 9.1.3(b): Megrim (L. whiffiagonis) in Divisions VIIIc \& IXa

Standardized $\log$ (abundance index at age) from A Coruña VIIIc trawl fleet (black bubble means < 0)

years
Standardized $\log$ (abundance index at age) from Avilés VIIIc trawl fleet (black bubble means < 0)


Figure 9.1.3(c): Megrim (L. whiffiagonis) in Divisions VIIIc \& IXa

## Landings proportions at age



Standardized landings proportions at age (black bubble means < 0)


Figure 9.1.4. Megrim (L. whiffiagonis) in Divisions VIIIc \& IXa.


Figure 9.1.5. Megrim (L. whiffiagonis) in Divisions VIIIc and IXa. Retrospective XSA


Figure 9.1.6. Megrim in Divisions VIIIc and IXa. LOG CATCHABILITY RESIDUAL PLOTS (XSA)

TOTAL INTERNATIONAL LANDINGS


RECRUITMENT (AT AGE 1)


FISHING MORTALITY


SPAWNING STOCK BIOMASS (SSB)


Figure 9.1.7(a) Megrim (L. whiffiagonis) in Divisions VIIIc and IXa. Stock Summary

Standardized F-at-age (black bubbles means <0)


Standardized relative F-at-age (black bubble means < 0)


Figure 9.1.7(b): Megrim (L. whiffiagonis) in Divisions VIIIc \& IXa


MFYPR version 2a
Run: MEG
Time and date: 15:46 08/05/2013

| Reference point | F multiplier | Absolute F |
| :--- | :---: | :---: |
| Fbar(2-4) | 1.0000 | 0.1403 |
| FMax | 2.0169 | 0.2829 |
| F0.1 | 0.6229 | 0.0874 |
| F35\%SPR | 1.2375 | 0.1736 |
| Flow | 0.4206 | 0.0590 |
| Fmed | 1.2585 | 0.1766 |
| Fhigh | 11.1147 | 1.5593 |



MFDP version 1a
Run: MEG
Megrim (L. whiffiagonis.) in Divisions VIIIc and IXa Time and date: 15:23 08/05/2013

Fbar age range: 2-4

Input units are thousands and kg - output in tonnes
Weights in kilograms

Figure 9.1.8. Megrim (L. whiffiagonis) in Divisions VIIIc and IXa, forecast summary


Figure 9.1.9. Megrim (L.whiffiagonis) in Divisions VIIIc and IXa. SSB-Recruitment plot. (numbers in graph, 1987-2010, are recruitment years)


Figure 9.1.10. Megrim (L. whiffiagonis) in Div. VIIIc and IXa. Recruits, SSB and F estimates from WG11 and WG13

### 9.3 Four-spot megrim (Lepidorhombus boscii)

### 9.3.1 General

See general section for both species.

### 9.3.2 Data

### 9.3.2.1 Commercial catches and discards

The WG estimates of four-spot megrim international landings for the period 1986 to 2012 are given in Table 9.2.1. Official landings figures from Spain were presented for 2011 and 2012. The discrepancy between official and scientific estimates is included in the column "Unallocated". Landings reached a peak of 2629 t in 1989 and have generally declined since then to their lowest value of 720 t in 2002. There has been some increase again in the last few years. Landings in 2010 are 1297 t , the highest value after 1995. After a similar value in 2011, landings in 2012 are 806 t , a significant drop.

Discards estimates are available for Spanish trawlers in some years. Annual discards of four-spot megrim are estimated to be from around 190 t to 520 t along the whole time series. Discard / Total Catch ratio and CV are presented in Table 9.2.2(a), where discards in number represent between 39-63\% of the total catch. Discards are not incorporated in this assessment due to the lack of data in some years of the series. Spanish discards in numbers at age are shown in Table 9.2.2(b), indicating that the bulk of discards (in numbers) is for ages 1 to 3

### 9.3.2.2 Biological sampling

Annual length compositions of total stock landings are given in Figure 9.2.1 for the period 1986-2012. .

Mean length and weights in landings since 1990 are shown in the Table 9.2.3(b).
Due to very low landings in the age 0 group over the whole period (see Table 9.2.4), the values of these landings were replaced by zeros in the assessment.

Weights-at-age of landings (given in Table 9.2.5) were also used as weights-at-age in the stock. There is some variability in the weights-at-age through the historical time series.

For more information about biological data see Stock Annex.

### 9.3.2.3 Abundance indices from surveys

Portuguese and Spanish survey indices are summarised in Table 9.2.6.
Two Portuguese surveys, named "Crustacean" (PT-CTS(UWTV(FU28-29))) and "October" (PtGFS-WIBTS-Q4), provide indices for 2010. The October survey was conducted with a different vessel and gear in 2003 and 2004. Excluding these two years, the biomass indeces from this survey in 2007 and 2011 were the highest observed since 1994, whereas the value in 2010 is the second lowest in the series. In 2011, both the biomass and abundance indices from the Crustacean survey are the highest in the time series. In 2012, Portuguese Survey was not carried out due to budgetary constraints of national scope turned unfeasible to repair the R/V.

Total biomass, abundance and recruitment indices from the Spanish Groundfish Survey (SpGFS-WIBTS-Q4) are also presented in Table 9.2.6. Total biomass indices from this survey generally remained stable after a maximum level in 1988 till 2003, when a
very low value was obtained (as done in previous years, the 2003 index has been excluded from the assessment, as it was felt to be too much in contradiction with the rest of the time series). This was followed by a period of higher values, with a high one in 2005. In 2012, the biomass and the abundance indices are the highest of the series. The recruitment index for age 0 in 2009 was very high and also in 2009. After two years in low levels, in 2012 the recruitment index show a small increase. The high index in 2009 applies to all ages and not just the recruitment age, except to age 1 that reflects the low value of age 0 previous year (see Table 9.2.7, which gives abundance indices by age, and the top panel of Figure 9.2.2, which is a bubble plot of $\log$ (abundance index at age) standardised by subtracting the mean and dividing by the standard deviation over the years). In 2012, only age 1 index is below average, whereas indices for the other ages are very high. From Figure 9.2.2, the survey appears to have been quite good at tracking cohorts, in the last ten years, good cohorts of 2005 and 2009 can be followed, specially the second one..

### 9.3.2.4 Commercial catch-effort data

Landed numbers-at-age per unit effort and effort data were available for commercial Spanish trawl fleets based in A Coruña (SP-CORUTR8c, for years 1986-2012) and Avilés (SP-AVILESTR, for years 1986-2003), fishing in ICES Division VIIIc (see Table 9.2.7). 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 9.2.8 displays landings (in tonnes), fishing effort and LPUE for the two Spanish trawl fleets just mentioned for the period 1988-2012 and for the Portuguese trawl fleet fishing in Division IXa for the period 1988-2012 (see also Figure 9.2.3). After very high value in 2010, the LPUE of A Coruña is decreasing in 2011 and 2012.a.

## Commercial fleets used in the assessment to tune the model

A Coruña trawl fleet (SP-CORUTR8c) was used for tuning, considering only values until 1999, as indicated in the Stock Annex. The effort of this fleet had been generally stable until year 1993, after which a steady declined started. A low effort value was reached in 2003, when restrictions imposed on fishing activity due to the Prestige oil spill influenced effort. A stable period followed this value till year 2008, when effort is declining again to its lowest value in the series, reached in 2010. In 2012, this value is high compared to those of previous years.

## Commercial fleets not used in the assessment to tune the model

The effort of the Avilés trawl fleet (SP-AVILESTR) decreased along the whole period, reaching very low levels in the last years of the available data series.

The effort of the Portuguese trawl fleet appears to fluctuate within stable bounds, with the lowest values corresponding to 1999 and 2000. It shows a slightly declining trend through the 1990s until these two lowest years and a slightly increasing one since then, decreasing again in 2012.

The LPUE series from the Avilés trawl fleet (SP-AVILESTR) shows a generally upwards trend until 1995 and a decreasing one from then till 2003, the last year of this series. The LPUE of the Portuguese trawl fleet has generally declined since 1992, with an increase in the last year till 2010, when the values started a decreasing trend.

### 9.3.3 Assessment

The assessment is an update of the one performed in WGHMM2011 and follows the Stock Annex specifications incorporating the 2011 and 2012 data. The assessment corresponds to years 1986-2012 and ages 0-7+. Using the settings specified in the Stock Annex, the model did not work. The reason has not been identified, but an alternative solution has adopted, applying a Taper time of 23 years instead of 20.
As in previous years, due to the very low and irregular landings of age 0 individuals, values corresponding to age 0 in the catch-at-age matrix (displayed in Table 9.2.4) were replaced by zeros.

### 9.3.4 Model

## Data screening

Figure 9.2 .4 is a bubble plot representing catch proportions at age, clearly indicating that the bulk of the landings generally corresponds to ages 2 to 4 . The bottom panel of Figure 9.2.4 is another bubble plot corresponding to standardized catch proportions at age, indicating that age composition of landings in 2012 is fairly typical of what has been observed in recent years.

Very weak cohorts corresponding to year classes of 1993 and 1998 can be clearly identified from the standardized catch proportions at age matrix and good cohorts corresponding to year classes of 1991, 1992, 1995 and 2005 can also be tracked (bottom panel of Figure 9.2.4).

## Final XSA run

Settings for this year's assessment were the same ones used in the last assessment and are detailed in the Stock Annex.

The retrospective analysis shows no particular worrying features (Figure 9.2.5).

### 9.3.4.1 Assessment results

Diagnostics from the XSA final run are presented in Table 9.2.9 and log catchability residuals plotted in Figure 9.2.6. Note that because of the taper weighting used (tricubic over 23 years), tuning (and, therefore, residuals) starts in year 1990. Diagnostics and residuals are similar to those found in the previous assessment. Many of the survey residuals are negative until the mid 1990's. After that, survey residuals are variable. Mostly negative residuals are obtained for the survey indices in 2004, 2006 and 2008. The fact that in many recent years survey residuals are either positive or negative for most ages may be indicative of year effects in the survey.

Since the commercial fleet data are stopped in 1999, they do not intervene directly in the estimates of survivors at the end of 2012. Hence, survivor estimates are given by the survey and P-shrinkage for ages 0 to 2 , and only by the survey for ages 3 to 6 . Fshrinkage gets very low weight, due to the large s.e. value set for it (1.5).

Table 9.2.10 presents the fishing mortality-at-age estimates. Fbar $\left(=\mathrm{F}_{2-4}\right)$ is estimated to be 0.09 in 2012, being extremely low in relation to the range of F values estimated for the last decade.

Population numbers-at-age estimates are presented in Table 9.2.11.

### 9.3.4.2 Year class strength and recruitment estimations

The 2010 year class estimate is 29 million individuals, obtained by averaging estimates coming from the Spanish survey tuning data ( $73 \%$ of weight), P-shrinkage ( $25 \%$ weight) and F-shrinkage ( $2 \%$ weight).

The 2011 year class estimate is 26 million individuals, estimated from the Spanish survey ( $43 \%$ of weight), P-shrinkage ( $53 \%$ weight) and F-shrinkage ( $4 \%$ weight).

The 2012 year class estimate is 31 million individuals, obtained by averaging a lower value coming from the Spanish survey ( $20 \%$ weight) and a higher one from Pshrinkage ( $80 \%$ weight).

Following the procedure stated in the Stock Annex, the geometric mean of estimated recruitment over the years 1990-2010 has been used for computation of 2013 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 |
| :---: | :---: | :--- | :--- | :---: | :---: |
| 2010 | 29383 | XSA | $73 \%$ | - | $27 \%$ |
| 2011 | 26657 | XSA | $43 \%$ | - | $57 \%$ |
| 2012 | 31269 | XSA | $20 \%$ | - | $80 \%$ |
| 2013 | 26724 | GM $_{90-10}$ |  |  |  |

### 9.3.4.3 Historic trends in biomass, fishing mortality, and recruitment

Estimated fishing mortality and population numbers-at-age from the XSA run are given in Tables 9.2.10 and 9.2.11. Further results, including SSB estimates, are summarised in Table 9.2.12 and Figure 9.2.7(a).

SSB varies around 3205 t in 2001, the lowest value and 7914 t in 1988, the highest. Value in 2012 is the second highest of the series, 7575 t .

Recruitment has fluctuated around 30 million fish during all the series. Very weak year classes are found in 1993 and 1998. The highest value occurred in 2009, while 2012 value is similar to the mean, with 31 million fish.

Estimates of fishing mortality values show two different periods: an initial one with higher values from 1989 to 1996 and, following a sharp decrease in 1997, a second period stabilised at a lower level, with small ups and downs. The value of 0.09 in 2012 is the lowest value of the series, a significant drop.

There seems to be interannual variability in the relative fishing exploitation pattern at age (F over Fbar, see Figure 9.2.7(b), bottom panel), with alternating periods of time with higher and lower relative exploitation pattern on the older ages.

### 9.3.5 Catch options and prognosis

Projection settings follow the Stock Annex specifications. The exploitation patternused (F status quo) was the unscaled average of 2010-2012, which gives an Fbar value of 0.17 . Although this year the value of Fbar is significantly low, the option of scale the fishing mortality to the final year was not adopted. More information about the fishing activity of the fleet is needed to confirm if this is a realistic trend.

### 9.3.5.1 Short-term projections

The input data for deterministic short-term projections are given in Table 9.2.13Table 9.2.14 gives the management options for 2014, and their consequences in terms of projected landings and stock biomass. Figure 9.2.8 (right panel) plots short-term yield and SSB versus Fbar.

The detailed output by age group, assuming F status quo for 2013-2015, is given in Table 9.2.15. Under this scenario, projected landings for 2013 and 2014 are 1807 and 1854 t , respectively.

Under F status quo, projected SSB values for 2014 and 2015 are about 7779 t in 2014 and 7126 t in 2015.

The contributions of recent year classes to the projected landings and SSB are presented in Table 9.2.16 (under F status quo). The year classes for which GM90-10 recruitment is assumed no contribute to landings in 2014 and with a $20 \%$ to SSB in 2015.

### 9.3.5.2 Yield and biomass per recruit analysis

The analysis is conducted following the Stock Annex specifications and results presented in Table 9.2.17. The left panel of Figure 9.2.8 plots yield-per-recruit and SSB-per-recruit versus Fbar.

Under F status quo (Fbar=0.17), yield-per-recruit is 0.04 kg and SSB-per-recruit is 0.212 kg . Assuming $\mathrm{GM} 90-10$ recruitment of 26 million, the equilibrium yield would be around 1162 t with an SSB value of 5655 t .

### 9.3.5.3 Biological reference points

Stock-recruitment data from before 1990 are not considered reliable. For the remaining years there is no evidence of reduced recruitment at the lower SSB levels observed (Figure 9.2.9). At present, there is no new information to define biomass reference points $B_{l i m}$ and $B_{p a}$ for this stock.

See Stock Annex for more information about Biological reference points.

In previous Working Groups, reference points were not proposed because of the interannual variability detected in the relative exploitation pattern-at-age. However, WGHMM 2010 was asked to provide an Fmsy value for this stock. Possible proxies considered for FMSY were in the range of Fmax, F0.1 and F35\% and F40\%. Fmax is not well defined for this stock, as the yield-per-recruit curve generally shows a very flat top.

In order to establish a proxy, a rough exercise to assess the impact of discards was conducted in WGHMM 2010 (see description and results in the stock annex). The following sensitivity table also complemented the discards exercise and has been updated in this WG:

|  | WG2005 | WG2006 | WG2007 | WG2008 | WG2009 | WG2010 | WG2011 | WG2012 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Fmax | 0.63 | 0.48 | 0.55 | 0.57 | 0.62 | 0.39 | 0.37 | 0.26 |
| F0.1 | 0.27 | 0.17 | 0.18 | 0.14 | 0.18 | 0.14 | 0.15 | 0.09 |
| F35percent | 0.31 | 0.26 | 0.27 | 0.25 | 0.28 | 0.24 | 0.24 | 0.19 |
| F40percent |  |  |  |  |  | 0.18 | 0.19 | 0.14 |

$\mathrm{F}_{\mathrm{MS}}=0.18$ was preliminarily proposed in WGHMM 2010, corresponding to $\mathrm{F} 40 \%$ as calculated in that WG, for consistency with the rationale followed for L. whiffiagonis..

This Fmsy value should still be considered as preliminary and is likely to be revised as further work continues on this assessment (particularly when including discards information and developing an assessment model providing uncertainty estimates).

### 9.3.6 Comments on the assessment

One commercial fleet (SP-CORUTR8c) and the Spanish survey (SpGFS-WIBTS-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. Only data up to year 1999 were used, as the increasing use of a type of trawl gear (targeting horse mackerel and with very few four-spot megrim catches) in the traditional Baca trawl fishery. This makes difficult to compare effort values from recent years with those from earlier years. 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.

Comparison of this assessment with the one performed in 2011shows results quite different for the last years (Figure 9.2.10). Recruitment and SSB values are higher and with an increasing trend at the end of the series. F values are lower with a significantly decrease the last year.

Four-spot megrim starts to contribute strongly to SSB at 2 years of age, with $20 \%$ of the predicted SSB in 2015 relying on year classes with recruitment assumed to be given by GM90-10.

The fact that discards data are not used in the assessment of this stock may modify the perception of its state. Discards data were not used in this assessment because of the lack of data in some years of the series. Discards in number represent between 39$63 \%$ of the total catch. Including discards would produce a more real picture of fishing exploitation and stock dynamics. It could also have an impact on biological reference points and predictions.

### 9.3.7 Management considerations

This assessment indicates that SSB decreased substantially between 1988 and 2001, the year with lowest SSB, and that there has been a smooth increasing trend between 2001 and 2008, with some drop in 2009 and a slight increase since then. Fishing at status quo F (Fbar=0.17) during 2013 and 2014 would result in some biomass decrease from the 2012 value.

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.

### 9.4 Combined Forecast for Megrims (L. whiffiagonis and L. boscil)

Figure 9.3.1 plots total international landings and estimated stock trends for both species of megrim in the same graph, in order to facilitate comparisons.

The two species of megrim are included in the landings from ICES Divisions VIIIc and IXa. Both are taken as by-catch in mixed bottom trawl fisheries. Assuming status quo $F$ for both species in 2013 (average of estimated F over 2010-2012, corresponding to Fbar=0.14 for L. whiffiagonis and Fbar=0.17 for L. boscii), Figure 9.3 .2 gives the com-
bined predicted landings for 2014 and individual SSB for 2015, under different multiplying factors of their respective status quo F values. The combined projected values for the two species have been computed as the sum of the individual projected values obtained for each species separately under its assumed exploitation pattern. As usual, the exploitation pattern for each species has been assumed to remain constant during the forecast period.

At status quo F (average F over 2010-2012) for both species, predicted combined landings in 2014 are 3579 t and individual SSBs in 2015 are 972 t for L. whiffiagonis and 5758 t for L. boscii.

Table 9.2.1. Four-spot megrim (L. boscii) in Divisions VIIIc and IXa. Total landings (t).

| Year | Spain |  |  | Portugal | Unallocated | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | VIIIc | IXa*** | Total | IXa |  |  |
| 1986 | 799 | 197 | 996 | 128 |  | 1124 |
| 1987 | 995 | 586 | 1581 | 107 |  | 1688 |
| 1988 | 917 | 1099 | 2016 | 207 |  | 2223 |
| 1989 | 805 | 1548 | 2353 | 276 |  | 2629 |
| 1990 | 927 | 798 | 1725 | 220 |  | 1945 |
| 1991 | 841 | 634 | 1475 | 207 |  | 1682 |
| 1992 | 654 | 938 | 1592 | 324 |  | 1916 |
| 1993 | 744 | 419 | 1163 | 221 |  | 1384 |
| 1994 | 665 | 561 | 1227 | 176 |  | 1403 |
| 1995 | 685 | 826 | 1512 | 141 |  | 1652 |
| 1996 | 480 | 448 | 928 | 170 |  | 1098 |
| 1997 | 505 | 289 | 794 | 101 |  | 896 |
| 1998 | 725 | 284 | 1010 | 113 |  | 1123 |
| 1999 | 713 | 298 | 1011 | 114 |  | 1125 |
| 2000 | 674 | 225 | 899 | 142 |  | 1041 |
| 2001 | 629 | 177 | 807 | 124 |  | 931 |
| 2002 | 343 | 247 | 590 | 130 |  | 720 |
| 2003 | 393 | 314 | 707 | 169 |  | 876 |
| 2004 | 534 | 295 | 829 | 177 |  | 1006 |
| 2005 | 473 | 321 | 794 | 189 |  | 983 |
| 2006 | 542 | 348 | 891 | 201 |  | 1092 |
| 2007 | 591 | 295 | 886 | 218 |  | 1104 |
| **2008 | 546 | 262 | 808 | 172 |  | 980 |
| 2009 | 577 | 342 | 919 | 215 |  | 1134 |
| 2010 | 616 | 484 | 1100 | 197 |  | 1297 |
| 2011 | 499 | 368 | 867 | 181 | 212 | 1260 |
| 2012 | 245 | 231 | 476 | 98 | 231 | 806 |
| ${ }^{* * *}$ I X a is without Gulf of Cádiz |  |  |  |  |  |  |
| ** Data revised in WG2010 |  |  |  |  |  |  |
| * Official | by country and | unallocated | dings |  |  |  |

Table. 9.2.2(a) Megrim (L. boscii) in Divisions VIIIc, IXa. Discard/Total Catch ratio and estimated CV for Spain

| Year | 1994 | 1997 | 1999 | 2000 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011* | 2012 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Weight Ratio | 0.30 | 0.28 | 0.24 | 0.29 | 0.21 | 0.30 | 0.32 | 0.27 | 0.25 | 0.20 | 0.23 | 0.19 | 0.20 | 0.34 |
| CV | 23.2 | 11.2 | 14.4 | 16.5 | 10.2 | 23.1 | 24.0 | 48.4 | 18.3 | 22.6 | 21.1 | 18.8 | 16.0 | 15.5 |
| Number Ratio | 0.50 | 0.63 | 0.59 | 0.61 | 0.47 | 0.55 | 0.55 | 0.42 | 0.47 | 0.42 | 0.39 | 0.62 | 0.50 | 0.60 |

**All discard data revised in WG2011
*Data revised in WG2013

Table. 9.2.2(b) Megrim (L. boscii) in Divisions VIIIc, IXa. Discards in numbers at age (thousands) for Spanish trawlers

|  | 1994 | 1997 | 1999 | 2000 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011* | 2012 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0 | 678 | 256 | 2933 | 354 | 238 | 33 | 10 | 1 | 100 | 202 | 2 | 2879 | 30 | 682 |
| 1 | 2741 | 3273 | 3954 | 6148 | 4479 | 6393 | 3515 | 1233 | 3248 | 2342 | 1525 | 10362 | 5132 | 5313 |
| 2 | 4134 | 6099 | 2734 | 1207 | 989 | 3053 | 5482 | 2497 | 4541 | 2374 | 2490 | 1301 | 3595 | 2480 |
| 3 | 2710 | 2108 | 1815 | 1888 | 495 | 693 | 609 | 1445 | 757 | 1384 | 1970 | 696 | 544 | 1057 |
| 4 | 581 | 146 | 1088 | 1218 | 50 | 163 | 183 | 486 | 105 | 52 | 480 | 283 | 174 | 15 |
| 5 | 189 | 90 | 3 | 171 | 2 | 27 | 56 | 168 | 44 | 10 | 51 | 83 | 37 | 5 |
| 6 | 55 | 3 | 0 | 12 | 0 |  | 23 | 22 | 7 | 3 | 7 | 11 | 1 | 2 |
| 7 | 11 | 0 | 1 | 2 |  |  | 6 | 9 | 1 | 3 |  | 1 |  | 0 |
| 8 | 0 |  |  |  |  |  | 1 |  |  |  |  |  |  | 5 |
| 9 | 0 |  |  |  |  |  | 1 |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Table 9.2.3(a) Four-spot megrim (L. boscii) in Divisions VIIIc and IXa Length compositions of landings in 2012 ('000 fish)

| Length (cm) | Total |
| :---: | :---: |
| 10 |  |
| 11 |  |
| 12 |  |
| 13 |  |
| 14 |  |
| 15 | 1.5 |
| 16 | 27.2 |
| 17 | 65.3 |
| 18 | 141.1 |
| 19 | 366.4 |
| 20 | 696.4 |
| 21 | 984.5 |
| 22 | 1027.6 |
| 23 | 927.7 |
| 24 | 787.2 |
| 25 | 567.1 |
| 26 | 464.6 |
| 27 | 352.9 |
| 28 | 283.1 |
| 29 | 170.7 |
| 30 | 121.6 |
| 31 | 73.4 |
| 32 | 44.5 |
| 33 | 21.2 |
| 34 | 11.7 |
| 35 | 6.9 |
| 36 | 3.3 |
| 37 | 1.6 |
| 38 | 1.4 |
| 39 | 0.7 |
| 40 | 0.2 |
| 41 | 0.1 |
| 42 | 0.1 |
| 43 |  |
| 44 | 0.0 |
| 45 | 0.0 |
| 46 | 0.1 |
| 47 |  |
| 48 | 0.0 |
| 49 |  |
| 50+ |  |
| Total | 7150 |

Table 9.2.3(b) Megrim (L. boscii) Divisions VIIIc and IXa.
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 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 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 | 22.7 | 22.9 | 23.5 | 23.6 | 23.6 | 24.1 | 23.7 | 23.7 |
| Mean weight (g) | 116 | 118 | 122 | 128 | 111 | 96 | 107 | 112 | 109 | 113 | 121 | 114 | 105 | 101 | 98 | 97.0 | 99.4 | 109.1 | 109.7 | 110.7 | 118.4 | 112.2 | 112.0 |

## Table 9.2.4 Four-spot megrim (L. boscii) in Divisions VIIIc, IXa. Landed numbers at age.

| YEAR | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 19 | 94 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 01 | 2 | 3 | 2004 | 2005 | 2006 | 2007 | 08 | 2009 | 2010 | 2011 | 2012 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| AGE |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\left({ }^{*}\right) 0$ | (4) | (1) | (9) | (2) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) |
| 1 | 110 | 2283 | 1525 | 733 | 1444 | 1160 | 846 | 546 | 83 | 1421 | 397 | 35 | 45 | 38 | 45 | 167 | 190 | 367 | 392 | 123 | 34 | 9 | 15 | 21 | 15 | 12 | 16 |
| 2 | 3475 | 11580 | 10092 | 7140 | 5184 | 3679 | 2667 | 2334 | 2915 | 2205 | 2136 | 1244 | 1204 | 1161 | 655 | 1138 | 2389 | 2802 | 2515 | 2522 | 2735 | 1606 | 1561 | 646 | 1063 | 1101 | 558 |
| 3 | 3690 | 5073 | 5455 | 5392 | 1885 | 3328 | 4000 | 2096 | 4515 | 6138 | 1267 | 2870 | 4236 | 2781 | 1645 | 1251 | 2361 | 2873 | 3084 | 2995 | 4506 | 2633 | 3495 | 2917 | 2872 | 2297 | 2361 |
| 4 | 3940 | 3593 | 4779 | 5909 | 3829 | 1911 | 5179 | 3799 | 2268 | 5596 | 3814 | 744 | 2940 | 3908 | 2782 | 2393 | 743 | 1476 | 2439 | 1841 | 2153 | 2600 | 2152 | 4160 | 3534 | 2983 | 1562 |
| 5 | 1132 | 1344 | 2366 | 3479 | 2311 | 2650 | 2200 | 1151 | 1612 | 1056 | 1896 | 1624 | 698 | 1402 | 1849 | 1870 | 387 | 499 | 1128 | 1370 | 988 | 1865 | 993 | 1611 | 2446 | 2821 | 1373 |
| 6 | 849 | 569 | 1161 | 1778 | 1383 | 1028 | 738 | 635 | 839 | 582 | 204 | 1066 | 829 | 235 | 785 | 937 | 236 | 447 | 279 | 779 | 252 | 848 | 351 | 633 | 485 | 1208 | 889 |
| +gp | 229 | 141 | 463 | 630 | 803 | 479 | 67 | 278 | 446 | 280 | 551 | 443 | 349 | 488 | 838 | 357 | 359 | 142 | 337 | 393 | 219 | 460 | 295 | 222 | 437 | 413 | 390 |




$\left(^{*}\right)$ Age 0 was not used in the assessment.
Data revised in WG2010 from original value presented

## Table 9.2.5 Four-spot megrim (L. boscii) in Divisions VIIIc, IXa. Mean weights at age in landings (kg).

 AGE
$\begin{array}{lllllllllllllllllllllllllllllllllllll}1 & 0.022 & 0.036 & 0.039 & 0.043 & 0.028 & 0.033 & 0.032 & 0.023 & 0.033 & 0.043 & 0.038 & 0.032 & 0.033 & 0.036 & 0.035 & 0.042 & 0.042 & 0.043 & 0.040 & 0.049 & 0.03 & 0.04 & 0.04 & 0.03 & 0.03 & 0.03 & 0.04 & \end{array}$ $\begin{array}{llllllllllllllllllllllllllllllllllllll}2 & 0.046 & 0.053 & 0.057 & 0.066 & 0.065 & 0.073 & 0.073 & 0.074 & 0.069 & 0.066 & 0.062 & 0.056 & 0.063 & 0.070 & 0.080 & 0.069 & 0.071 & 0.071 & 0.066 & 0.060 & 0.07 & 0.07 & 0.08 & 0.06 & 0.07 & 0.06 & 0.06\end{array}$
$\begin{array}{llllllllllllllllllllllllllllllllll}3 & 0.065 & 0.071 & 0.079 & 0.090 & 0.106 & 0.117 & 0.110 & 0.118 & 0.092 & 0.092 & 0.074 & 0.080 & 0.086 & 0.090 & 0.086 & 0.091 & 0.103 & 0.094 & 0.086 & 0.087 & 0.09 & 0.09 & 0.09 & 0.08 & 0.09 & 0.08 & 0.08\end{array}$ $\begin{array}{llllllllllllllllllllllllllllllllll}4 & 0.095 & 0.094 & 0.104 & 0.112 & 0.141 & 0.125 & 0.125 & 0.143 & 0.121 & 0.100 & 0.112 & 0.097 & 0.112 & 0.101 & 0.100 & 0.106 & 0.128 & 0.125 & 0.111 & 0.111 & 0.11 & 0.12 & 0.11 & 0.11 & 0.11 & 0.1 & 0.11\end{array}$ $\begin{array}{lllllllllllllllllllllllllllll}5 & 0.132 & 0.127 & 0.139 & 0.145 & 0.156 & 0.166 & 0.161 & 0.178 & 0.153 & 0.146 & 0.137 & 0.126 & 0.142 & 0.147 & 0.132 & 0.123 & 0.170 & 0.142 & 0.132 & 0.123 & 0.14 & 0.12 & 0.15 & 0.14 & 0.14 & 0.13 & 0.13\end{array}$ $\begin{array}{lllllllllllllllllllllllllllllll}6 & 0.160 & 0.152 & 0.168 & 0.167 & 0.184 & 0.191 & 0.226 & 0.220 & 0.181 & 0.169 & 0.213 & 0.180 & 0.180 & 0.197 & 0.170 & 0.166 & 0.210 & 0.201 & 0.175 & 0.133 & 0.18 & 0.15 & 0.2 & 0.18 & 0.18 & 0.17 & 0.16\end{array}$ $\begin{array}{llllllllllllllllllllllllllllllllllll}+g p & 0.265 & 0.242 & 0.281 & 0.276 & 0.273 & 0.264 & 0.359 & 0.297 & 0.245 & 0.256 & 0.232 & 0.252 & 0.294 & 0.268 & 0.228 & 0.255 & 0.247 & 0.247 & 0.235 & 0.198 & 0.24 & 0.2 & 0.24 & 0.29 & 0.27 & 0.24 & 0.2\end{array}$


* Data revised in WG2010 from original value presented

Table 9.2.6 Four-spot megrim (L. boscii) Divisions VIIIc, IXa.
Abundance and Recruitment indices of Portuguese and Spanish surveys.

|  | Biomass Index |  |  |  |  |  | Abundance index |  |  |  | Recruitment index |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |  |  |  | $\begin{gathered} \hline \text { At age } 1 \\ \hline \text { Portugal }(\mathrm{n}) \\ \hline \end{gathered}$ | At age 0 At age 1 |  |
|  | Portug | al (k/h) |  | Spain (k | ( min) |  | Portugal ( $\mathrm{n} / \mathrm{h}$ ) |  | Spain (n/30 min) |  |  |  |  | $0 \mathrm{~min})$ |
|  | 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 |

$+\quad$ less than 0.04
ns no survey
$\begin{array}{ll}\text { ns } & \text { no survey } \\ \text { A } & \text { Portuguese October Survey with different vessel and gear (Capricórnio and CAR net) }\end{array}$
$\begin{array}{ll}\text { A } & \text { Portuguese October Survey with different vessel and gear (Capricornio and CAR net) } \\ \text { B } & \text { Portuguese Crustacean Survey covers partial area only with a different Vessel (Mestre Costeiro) }\end{array}$ Revised in WGHMM2011


FLT03: SPGFS-WIBTS-Q4 ( $\mathrm{n} / 30 \mathrm{~min}$ ) 19882012
$\begin{array}{lll}1 & 0.8 & 0.8\end{array}$
0 7 Eff.
$\begin{array}{lllllllll}2.9 & 24.6 & 20.6 & 7.3 & 1.9 & 1.1 & 0.4 & 0.3 & 101 \\ 1988\end{array}$
$\begin{array}{llllllllll}8.5 & 16.7 & 8.4 & 3.6 & 2.1 & 1.1 & 0.3 & 0.1 & 91 & 1989\end{array}$ $\begin{array}{lllllllll}0.4 & 19.1 & 13.0 & 2.2 & 2.8 & 1.6 & 0.7 & 0.4 & 120 \\ 1990\end{array}$ $\begin{array}{lllllllllll}2.5 & 9.3 & 9.3 & 3.7 & 1.6 & 1.0 & 0.2 & 0.1 & 107 & 1991\end{array}$ $\begin{array}{llllllllll}2.4 & 35.0 & 4.1 & 4.1 & 2.1 & 1.0 & 0.4 & 0.0 & 116 & 1992\end{array}$ $\begin{array}{lllllllll}0.3 & 21.4 & 16.7 & 2.3 & 1.5 & 0.5 & 0.4 & 0.2 & 109 \\ 1993\end{array}$ $\begin{array}{llllllllll}3.5 & 2.9 & 11.2 & 6.3 & 1.5 & 0.7 & 0.4 & 0.4 & 118 & 1994\end{array}$ $\begin{array}{lllllllll}1.9 & 19.6 & 2.4 & 4.4 & 3.2 & 0.3 & 0.2 & 0.2 & 116 \\ 1995\end{array}$ $\begin{array}{lllllllll}3.6 & 20.6 & 14.4 & 1.4 & 1.9 & 2.4 & 0.3 & 0.3 & 114 \\ 1996\end{array}$ $\begin{array}{llllllllll}3.5 & 13.3 & 14.0 & 8.7 & 1.1 & 1.5 & 1.0 & 0.3 & 116 & 1997\end{array}$ $\begin{array}{llllllllll}0.3 & 9.6 & 10.0 & 9.2 & 3.6 & 0.7 & 0.8 & 0.3 & 114 & 1998\end{array}$ $\begin{array}{lllllllll}0.9 & 7.5 & 10.9 & 6.0 & 2.9 & 1.0 & 0.2 & 0.3 & 116 \\ 1999\end{array}$ $\begin{array}{llllllllll}1.1 & 14.0 & 5.4 & 5.2 & 4.1 & 1.7 & 0.6 & 0.9 & 113 & 2000\end{array}$ $\begin{array}{lllllllll}0.6 & 17.0 & 12.7 & 4.7 & 3.8 & 2.2 & 1.0 & 0.7 & 113 \\ 2001\end{array}$ $\begin{array}{lllllllllll}1.0 & 10.0 & 12.7 & 7.4 & 1.8 & 0.7 & 0.3 & 0.6 & 110 & 2002\end{array}$ $\begin{array}{llllllllll}0.7 & 5.0 & 4.1 & 4.1 & 1.7 & 0.6 & 0.5 & 0.3 & 112 & 2003\end{array}$ $\begin{array}{lllllllll}1.2 & 21.1 & 11.3 & 6.1 & 2.7 & 0.8 & 0.2 & 0.5 & 114 \\ 2004\end{array}$ $\begin{array}{lllllllll}4.7 & 17.7 & 22.4 & 11.2 & 4.0 & 1.6 & 0.6 & 0.7 & 116 \\ 2005\end{array}$ $\begin{array}{lllllllll}0.6 & 14.7 & 13.3 & 8.2 & 2.5 & 1.0 & 0.5 & 0.6 & 115 \\ 2006\end{array}$ $\begin{array}{llllllllll}0.9 & 11.3 & 21.3 & 10.2 & 4.9 & 1.4 & 0.7 & 0.3 & 117 & 2007\end{array}$ $\begin{array}{llllllllll}0.4 & 8.1 & 11.7 & 7.9 & 2.6 & 0.8 & 0.5 & 0.3 & 115 & 2008\end{array}$ $\begin{array}{llllllllll}3.4 & 7.4 & 13.6 & 14.1 & 9.6 & 3.1 & 1.1 & 0.5 & 117 & 2009\end{array}$ $\begin{array}{lllllllll}0.6 & 34.2 & 16.6 & 10.8 & 7.2 & 2.2 & 0.5 & 0.6 & 114 \\ 2010\end{array}$ $\begin{array}{lllllllllll}1 & 0.9 & 8.9 & 33.8 & 13.8 & 7.7 & 2.8 & 0.9 & 0.5 & 111 & 2011\end{array}$ $\begin{array}{llllllllll}1 & 1.7 & 11.6 & 22.1 & 31.1 & 9.6 & 3.4 & 1.7 & 1.0 & 115 \\ 2012\end{array}$

Table 9.2.8 Four-spot megrim (L. boscii). LPUE data by fleet in Divisions VIIIc, IXa.

| Year | A Coruña Trawl in VIIIc |  |  | Avilés Trawl in VIIIc |  |  | Portugal trawl in IXa |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Landings( t ) | Effort | LPUE ${ }^{1}$ | Landings(t) | Effort | LPUE ${ }^{1}$ | Landings(t) | Effort | LPUE ${ }^{2}$ |
| 1986 | 682 | 39.8 | 17.1 | 45 | 10.8 | 4.1 |  |  |  |
| 1987 | 811 | 34.7 | 23.4 | 60 | 8.3 | 7.2 |  |  |  |
| 1988 | 706 | 42.2 | 16.7 | 102 | 9.0 | 11.3 | 146 | 38.5 | 3.8 |
| 1989 | 593 | 44.4 | 13.3 | 79 | 8.1 | 9.8 | 183 | 44.7 | 4.1 |
| 1990 | 692 | 44.4 | 15.6 | 142 | 8.5 | 16.8 | 164 | 39.0 | 4.2 |
| 1991 | 680 | 40.4 | 16.8 | 83 | 7.7 | 10.9 | 166 | 45.0 | 3.7 |
| 1992 | 542 | 38.9 | 13.9 | 56 | na |  | 280 | 50.9 | 5.5 |
| 1993 | 615 | 44.5 | 13.8 | 58 | 7.6 | 7.6 | 180 | 44.2 | 4.1 |
| 1994 | 303 | 39.6 | 7.7 | 118 | 9.6 | 12.3 | 146 | 45.8 | 3.2 |
| 1995 | 359 | 41.5 | 8.7 | 127 | 6.1 | 20.7 | 121 | 37.0 | 3.3 |
| 1996 | 219 | 35.7 | 6.1 | 64 | 4.5 | 14.1 | 155 | 46.5 | 3.3 |
| 1997 | 244 | 35.2 | 6.9 | 81 | 4.7 | 17.3 | 76 | 33.4 | 2.3 |
| 1998 | 355 | 32.6 | 10.9 | 67 | 5.4 | 12.5 | 83 | 43.1 | 1.9 |
| 1999 | 324 | 30.2 | 10.7 | 74 | 6.8 | 10.8 | 73 | 25.3 | 2.9 |
| 2000 | 389 | 30.1 | 12.9 | 54 | 4.5 | 12.1 | 93 | 27.0 | 3.4 |
| 2001 | 431 | 29.9 | 14.4 | 27 | 1.8 | 14.6 | 89 | 43.1 | 2.1 |
| 2002 | 234 | 21.8 | 10.7 | 26 | 2.7 | 9.5 | 97 | 31.2 | 3.1 |
| 2003 | 168 | 18.5 | 9.1 | 13 | 2.5 | 5.0 | 117 | 40.5 | 2.9 |
| 2004 | 241 | 21.1 | 11.4 | 27 | na |  | 111 | 35.4 | 3.1 |
| 2005 | 189 | 20.7 | 9.1 | 48 | na |  | 140 | 42.6 | 3.3 |
| 2006 | 198 | 19.3 | 10.3 | 35 | na |  | 149 | 40.3 | 3.7 |
| 2007* | 232 | 21.2 | 10.9 | 22 | na |  | 165 | 43.8 | 3.8 |
| 2008* | 288 | 20.2 | 14.3 | 15 | na |  | 146 | 38.4 | 3.8 |
| 2009 | 195 | 16.2 | 12.1 | 44 | na |  | 183 | 49.3 | 3.7 |
| 2010 | 276 | 13.7 | 20.1 | 54 | na |  | 150 | 48.0 | 3.1 |
| 2011 | 203 | 11.5 | 17.6 | 35 | na |  | 134 | 49.4 | 2.7 |
| 2012 | 274 | 21.1 | 13.0 | 15 | na |  | 78 | 36.0 | 2.2 |

${ }^{1}$ 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

Table 9.2.9. Four-spot megrim (L.boscii) in Divisions VIIIc and IXa. Tuning diagnostic.

Lowestoft VPA Version 3.1
7/05/2013 13:59
Extended Survivors Analysis
Four spot megrim (L. boscii) Division VIIIc and IXa
CPUE data from file fleetb.txt
Catch data for 27 years. 1986 to 2012. Ages 0 to 7 .


XSA population numbers (Thousands)

> AGE

YEAR
$0 \quad 1$
12

3
4
5
6
$2003308002090016600 \quad 10800 \quad 5840 \quad 1400 \quad 1600$ $2004 \quad 2.50 \mathrm{E}+04 \quad 2.52 \mathrm{E}+04 \quad 1.68 \mathrm{E}+04 \quad 1.11 \mathrm{E}+04 \quad 6.27 \mathrm{E}+03 \quad 3.44 \mathrm{E}+03 \quad 6.96 \mathrm{E}+02$ 2005 3.64E $+042.04 \mathrm{E}+04 \quad 2.03 \mathrm{E}+04 \quad 1.15 \mathrm{E}+04 \quad 6.27 \mathrm{E}+03 \quad 2.92 \mathrm{E}+03 \quad 1.80 \mathrm{E}+03$ $2006 \quad 3.67 \mathrm{E}+04 \quad 2.98 \mathrm{E}+04 \quad 1.66 \mathrm{E}+04 \quad 1.43 \mathrm{E}+04 \quad 6.67 \mathrm{E}+03 \quad 3.47 \mathrm{E}+03 \quad 1.15 \mathrm{E}+03$ 2007 2.93E+04 3.00E $+04 \quad 2.44 \mathrm{E}+04 \quad 1.11 \mathrm{E}+04 \quad 7.66 \mathrm{E}+03 \quad 3.51 \mathrm{E}+03 \quad 1.95 \mathrm{E}+03$ $2008 \quad 3.08 \mathrm{E}+04 \quad 2.40 \mathrm{E}+04 \quad 2.46 \mathrm{E}+04 \quad 1.85 \mathrm{E}+04 \quad 6.73 \mathrm{E}+03 \quad 3.92 \mathrm{E}+03 \quad 1.19 \mathrm{E}+03$ $2009 \quad 7.57 \mathrm{E}+04 \quad 2.52 \mathrm{E}+04 \quad 1.96 \mathrm{E}+04 \quad 1.87 \mathrm{E}+04 \quad 1.20 \mathrm{E}+04 \quad 3.56 \mathrm{E}+03 \quad 2.31 \mathrm{E}+03$ $2010 \quad 2.94 \mathrm{E}+04 \quad 6.20 \mathrm{E}+04 \quad 2.06 \mathrm{E}+04 \quad 1.55 \mathrm{E}+04 \quad 1.27 \mathrm{E}+04 \quad 6.05 \mathrm{E}+03 \quad 1.46 \mathrm{E}+03$ $20112.67 \mathrm{E}+042.41 \mathrm{E}+045.07 \mathrm{E}+041.59 \mathrm{E}+041.01 \mathrm{E}+047.19 \mathrm{E}+032.74 \mathrm{E}+03$ $2012 \quad 3.13 \mathrm{E}+04 \quad 2.18 \mathrm{E}+04 \quad 1.97 \mathrm{E}+04 \quad 4.05 \mathrm{E}+04 \quad 1.10 \mathrm{E}+04 \quad 5.55 \mathrm{E}+03 \quad 3.33 \mathrm{E}+03$

Estimated population abundance at 1st Jan 2013

$$
\begin{array}{lllllll}
0 & 25600 & 17900 & 15600 & 31100 & 7560 & 3310
\end{array}
$$

Taper weighted geometric mean of the VPA populations:

$$
\begin{array}{lllllll}
29100 & 23300 & 18700 & 13400 & 7360 & 3600 & 1560
\end{array}
$$

Standard error of the weighted $\log$ (VPA populations)

$$
\begin{array}{lllllll}
0.3926 & 0.4127 & 0.4335 & 0.4937 & 0.4351 & 0.4395 & 0.5089
\end{array}
$$

Log catchability residuals.

Fleet : SP-CORUTR8c

| Age |  | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 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 | -0.21 | 0.25 | 0.17 |  |  |  |
|  | 4 | 99.99 | 99.99 | 99.99 | 99.99 | 0.27 | -0.2 | 0.47 |  |  |  |
|  | 5 | 99.99 | 99.99 | 99.99 | 99.99 | -0.06 | 0.71 | 0.37 |  |  |  |
|  | 6 | 99.99 | 99.99 | 99.99 | 99.99 | -0.18 | 0.4 | 0.33 |  |  |  |
| Age |  | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|  | 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 | 0.5 | -0.53 | 0.15 | -0.63 | -0.49 | 0.41 | 0.31 | 99.99 | 99.99 | 99.99 |
|  | 4 | 0.75 | 0.12 | -0.15 | -0.17 | -0.67 | 0.31 | 0.17 | 99.99 | 99.99 | 99.99 |
|  | 5 | 0.06 | 0.08 | 0.21 | -0.6 | -0.28 | 0.38 | 0.03 | 99.99 | 99.99 | 99.99 |
|  | 6 | 0.35 | 0.08 | 0.28 | -0.28 | 0.13 | 0.25 | 0.39 | 99.99 | 99.99 | 99.99 |
| Age |  | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|  | 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 | -6.4556 | -5.6529 | -5.192 | -5.192 |
| S.E(Log q) | 0.5819 | 0.5077 | 0.4362 | 0.3864 |

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.
Age Slope t-value Intercep RSquare No Pts Reg s.e Mean Q

| 3 | 0.69 | 0.215 | 7.36 | 0.74 | 10 | 0.93 | -6.46 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 4 | 0.68 | 0.372 | 6.7 | 0.88 | 10 | 0.67 | -5.65 |
| 5 | 2.35 | -0.629 | 1.39 | 0.55 | 10 | 1.47 | -5.19 |
| 6 | 0.99 | 0.016 | 5.03 | 0.9 | 10 | 0.73 | -5 |
| 1 |  |  |  |  |  |  |  |

Fleet : SP-GFS®

| Age |  | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | 0 | 99.99 | 99.99 | 99.99 | 99.99 | -0.64 | 0.5 | 0.51 |  |  |  |
|  | 1 | 99.99 | 99.99 | 99.99 | 99.99 | 0.48 | -0.07 | 1.11 |  |  |  |
|  | 2 | 99.99 | 99.99 | 99.99 | 99.99 | -0.25 | -0.55 | -0.99 |  |  |  |
|  | 3 | 99.99 | 99.99 | 99.99 | 99.99 | -1.23 | -1.04 | -0.73 |  |  |  |
|  | 4 | 99.99 | 99.99 | 99.99 | 99.99 | -0.59 | -0.97 | -0.58 |  |  |  |
|  | 5 | 99.99 | 99.99 | 99.99 | 99.99 | -0.26 | -0.29 | -0.27 |  |  |  |
|  | 6 | 99.99 | 99.99 | 99.99 | 99.99 | -0.83 | -1.46 | -0.28 |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|  | 0 | -0.5 | 1.21 | 0.41 | 1.46 | 1.71 | -0.35 | 0.21 | 0.15 | -0.52 | 0.06 |
|  | 1 | 0.46 | -1.27 | 0.69 | 0.53 | 0.27 | 0.05 | 0.34 | 0.5 | 0.59 | -0.23 |
|  | 2 | -0.2 | -0.58 | -1.03 | 0.08 | -0.25 | -0.25 | 0.14 | -0.04 | 0.2 | 0.09 |
|  | 3 | -0.82 | -0.75 | -0.86 | -0.67 | 0.04 | -0.19 | -0.22 | -0.13 | 0.52 | 0.16 |
|  | 4 | -0.78 | -0.35 | -0.57 | -0.87 | -0.26 | -0.1 | -0.57 | 0.21 | 0.39 | 0.24 |
|  | 5 | -0.93 | -0.24 | -0.41 | 0.14 | -0.09 | 0.39 | -0.43 | -0.12 | 1.03 | -0.59 |
|  | 6 | -0.37 | -0.14 | -0.28 | 0.17 | 0.05 | 0.13 | -0.13 | -0.02 | 0.16 | -0.11 |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|  | 0 | 99.99 | 0.22 | 1.29 | -0.9 | -0.26 | -1.22 | 0.21 | -0.58 | -0.13 | 0.38 |
|  | 1 | 99.99 | 0.67 | 0.61 | -0.05 | -0.44 | -0.69 | -0.88 | 0.45 | -0.57 | -0.08 |
|  | 2 | 99.99 | -0.11 | 0.49 | 0.11 | 0.18 | -0.55 | -0.17 | 0.03 | -0.05 | 0.39 |
|  | 3 | 99.99 | -0.11 | 0.43 | -0.03 | 0.35 | -0.47 | 0.06 | 0.01 | 0.19 | -0.02 |
|  | 4 | 99.99 | -0.15 | 0.12 | -0.37 | 0.19 | -0.37 | 0.42 | -0.02 | 0.3 | 0.25 |
|  | 5 | 99.99 | -0.57 | 0.47 | -0.46 | 0.3 | -0.88 | 0.92 | -0.04 | 0.01 | 0.26 |
|  | 6 | 99.99 | -0.18 | -0.04 | -0.03 | 0.07 | -0.03 | 0.02 | -0.16 | -0.11 | 0.14 |

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 $\log q$ | -6.9412 | -7.0062 | -7.2594 | -7.2594 |
| S.E(Log q) | 0.3285 | 0.3453 | 0.5625 | 0.1331 |

Regression statistics :

Ages with q dependent on year class strength

Age Slope t -value Intercep RSquare No Pts Reg s.e Mean $\log \mathrm{q}$

| 0 | 1.05 | -0.093 | 10 | 0.23 | 22 | 0.78 | -10.01 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 1 | 1.46 | -1.161 | 6.11 | 0.37 | 22 | 0.58 | -7.35 |
| 2 | 1.19 | -0.908 | 6.37 | 0.67 | 22 | 0.33 | -6.93 |

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

| Age | Slope | t-value | Intercep | RSquare No Pts | Reg s.e | Mean Q |  |  |
| :--- | :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  |  |  |  |  |  |  |  |  |
|  | 3 | 1.19 | -0.858 | 6.44 | 0.64 | 22 | 0.4 | -6.94 |
| 4 | 0.98 | 0.101 | 7.05 | 0.64 | 22 | 0.35 | -7.01 |  |
|  | 5 | 1.05 | -0.109 | 7.21 | 0.29 | 22 | 0.62 | -7.26 |
|  | 6 | 0.9 | 1.688 | 7.29 | 0.96 | 22 | 0.11 | -7.29 |

Terminal year survivor and F summaries :
Age 0 Catchability dependent on age and year class strength
Year class $=2012$

| Fleet |  | nt s.e | $\begin{aligned} & \text { Ext } \\ & \text { s.e } \end{aligned}$ | Var <br> Ratio | N | Scaled <br> Weights | Estimated F |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| SP-CORUTR8c | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| SP-GFS* | 37333 | 0.82 | 0 | 0 | 1 | 0.202 | 0 |
| P shrinkage mean | 23271 | 0.41 |  |  |  | 0.798 | 0 |
| F shrinkage mean | 0 | 1.5 |  |  |  | 0 | 0 |

Weighted prediction :

| Survivors | Int | Ext | N |  | Var | F |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| at end of year | s.e | s.e |  |  | Ratio |  |
| 25604 | 0.37 | 0.42 |  | 2 | 1.145 |  |

Age 1 Catchability dependent on age and year class strength
Year class $=2011$

| Fleet |  | $\begin{aligned} & \text { Int } \\ & \text { s.e } \end{aligned}$ | $\begin{aligned} & \text { Ext } \\ & \text { s.e } \end{aligned}$ | Var <br> Ratio | N | Scaled <br> Weights | Estimated F |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| SP-CORUTR8c | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| SP-GFS* | 16185 | 0.485 | 0.021 | 0.04 | 2 | 0.425 | 0.001 |
| P shrinkage mean | 18713 | 0.43 |  |  |  | 0.531 | 0.001 |
| F shrinkage mean | 26152 | 1.5 |  |  |  | 0.044 | 0.001 |
| Weighted prediction : |  |  |  |  |  |  |  |
| Survivors | Int | Ext | N | Var | F |  |  |
| at end of year | s.e | s.e |  | Ratio |  |  |  |
| 17857 | 0.32 | 0.08 | 4 | 0.269 | 0.001 |  |  |

Age 2 Catchability dependent on age and year class strength
Year class $=2010$



Age 3 Catchability constant w.r.t. time and dependent on age Year class $=2009$

| Fleet | Int |  | Ext | Var | N | Scaled |  | Estimated |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | s.e | s.e | Ratio |  |  | Weights | F |
| SP-CORUTR8c | 1 | 0 | 0 | 0 |  | 0 | 0 | 0 |
| SP-GFS* | 32098 | 0.229 | 0.092 | 0.4 |  | 4 | 0.975 | 0.064 |
| F shrinkage mean | 8385 | 1.5 |  |  |  |  | 0.025 | 0.227 |

Weighted prediction :

| Survivors | Int | Ext | N |  | Var | F |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| at end of year | s.e | s.e |  |  | Ratio |  |
| 31054 | 0.23 | 0.13 |  | 5 | 0.58 | 0.067 |

Age 4 Catchability constant w.r.t. time and dependent on age Year class $=2008$

| Fleet | Int |  |  | Var <br> Ratio | N | Scaled Weights |  | Estimated F |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | s.e | s.e |  |  |  |  |  |
| SP-CORUTR8c | 1 | 0 | 0 | 0 |  | 0 | 0 | 0 |
| SP-GFS® | 7732 | 0.187 | 0.195 | 1.04 |  | 5 | 0.979 | 0.168 |
| F shrinkage mean | 2601 | 1.5 |  |  |  |  | 0.021 | 0.434 |

Weighted prediction :

| Survivors | Int | Ext | N |  | Var | F |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| at end of year | s.e | s.e |  |  | Ratio |  |
|  | 0.19 | 0.19 |  | 6 | 1.003 | 0.171 |

Age 5 Catchability constant w.r.t. time and dependent on age Year class $=2007$


Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5 Year class $=2006$

| Fleet |  | $\begin{aligned} & \text { Int } \\ & \text { s.e } \end{aligned}$ | $\begin{aligned} & \text { Ext } \\ & \text { s.e } \end{aligned}$ | Var <br> Ratio | N | Scaled <br> Weights | Estimated F |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| SP-CORUTR8c | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| SP-GFS® | 1888 | 0.175 | 0.105 | 0.6 | 7 | 0.973 | 0.355 |
| F shrinkage mean | 3922 | 1.5 |  |  |  | 0.027 | 0.187 |
| Weighted prediction : |  |  |  |  |  |  |  |
| Survivors | Int | Ext | N | Var | F |  |  |
| at end of year | s.e | s.e |  | Ratio |  |  |  |
| 1926 | 0.18 | 0.11 | 8 | 0.607 | 0.349 |  |  |

Table 9.2.10 Four-spot megrim (L. boscii) in Divisions VIIIc and IXa. Estimates of fisihing mortality at age.

Run title : Four spot megrim (L. boscii) Division VIIIc and IXa
At 7/05/2013 14:02



| YEAR | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | FBAR 10-12 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| AGE |  |  |  |  |  |  |  |  |  |  |  |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0.0196 | 0.0173 | 0.0067 | 0.0013 | 0.0003 | 0.0007 | 0.0009 | 0.0003 | 0.0006 | 0.0008 | 0.0005 |
| 2 | 0.2062 | 0.1812 | 0.1477 | 0.2008 | 0.0756 | 0.0727 | 0.0371 | 0.0587 | 0.0243 | 0.0318 | 0.0383 |
| 3 | 0.347 | 0.3681 | 0.3409 | 0.4269 | 0.3031 | 0.2341 | 0.189 | 0.2294 | 0.1737 | 0.0665 | 0.1566 |
| 4 | 0.3278 | 0.5622 | 0.3922 | 0.4411 | 0.4704 | 0.4361 | 0.4836 | 0.3679 | 0.3962 | 0.1715 | 0.3119 |
| 5 | 0.5002 | 0.4496 | 0.7292 | 0.378 | 0.8833 | 0.3288 | 0.6929 | 0.5918 | 0.5685 | 0.3192 | 0.4932 |
| 6 | 0.3685 | 0.5856 | 0.6517 | 0.276 | 0.6569 | 0.3947 | 0.3611 | 0.4581 | 0.6674 | 0.3491 | 0.4915 |
| +gp | 0.3685 | 0.5856 | 0.6517 | 0.276 | 0.6569 | 0.3947 | 0.3611 | 0.4581 | 0.6674 | 0.3491 |  |
| FBAR 2-4 | 0.2937 | 0.3705 | 0.2936 | 0.3563 | 0.283 | 0.2477 | 0.2366 | 0.2187 | 0.1981 | 0.0899 |  |

Table 9.2.11 Four-spot megrim (L. boscii) in Divisions VIIIc and IXa. Estimates of stock numbers at age.

Run title : Four spot megrim (L. boscii ) Division VIIIc and IXa At 7/05/2013 14:02

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 |

YEAR $198619871988 \quad 1989 \quad 1990 \quad 1991 \quad 1992$

| AGE |  |  |  |  |  |  |  |
| :---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 0 | 53109 | 33784 | 37926 | 33702 | 20818 | 41942 | 38742 |
| 1 | 48991 | 43482 | 27660 | 31051 | 27593 | 17044 | 34339 |
| 2 | 34644 | 40011 | 33534 | 21266 | 24759 | 21285 | 12905 |
| 3 | 21276 | 25220 | 22280 | 18324 | 10951 | 15580 | 14097 |
| 4 | 12399 | 14081 | 16058 | 13306 | 10124 | 7260 | 9745 |
| 5 | 4387 | 6587 | 8277 | 8823 | 5547 | 4824 | 4215 |
| 6 | 3347 | 2567 | 4177 | 4636 | 4076 | 2451 | 1552 |
| +gp | 896 | 632 | 1653 | 1625 | 2344 | 1128 | 139 |
| OTAL 179050 | 166364 | 151565 | 132733 | 106211 | 111514 | 115733 |  |


| Table 10 S |  | Stock number at age (start of year) |  |  |  | Numbers*10**-3 |  |  | 2001 | 2002 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| YEAR | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |  |  |
| AGE |  |  |  |  |  |  |  |  |  |  |
| 0 | 12021 | 28589 | 34021 | 22960 | 17657 | 9287 | 19680 | 23899 | 25045 | 25520 |
| 1 | 31719 | 9842 | 23406 | 27854 | 18798 | 14456 | 7603 | 16113 | 19566 | 20505 |
| 2 | 27349 | 25475 | 7983 | 17878 | 22445 | 15359 | 11795 | 6191 | 13151 | 15869 |
| 3 | 8152 | 20280 | 18220 | 4540 | 12704 | 17251 | 11485 | 8606 | 4476 | 9738 |
| 4 | 7923 | 4778 | 12518 | 9363 | 2571 | 7805 | 10291 | 6887 | 5558 | 2533 |
| 5 | 3292 | 3049 | 1860 | 5186 | 4215 | 1432 | 3730 | 4890 | 3121 | 2385 |
| 6 | 1460 | 1654 | 1038 | 567 | 2530 | 1981 | 541 | 1785 | 2330 | 863 |
| +gp | 631 | 866 | 491 | 1517 | 1039 | 824 | 1109 | 1882 | 878 | 1303 |
| TOTAL | 92547 | 94532 | 99536 | 89864 | 81959 | 68395 | 66234 | 70251 | 74125 | 78716 |



AGE

| 0 | 30802 | 24953 | 36415 | 36696 | 29299 | 30788 | 75683 | 29383 | 26657 | 31269 | 0 | 26724 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

$\begin{array}{llllllllllll}1 & 20894 & 25219 & 20429 & 29814 & 30044 & 23988 & 25207 & 61964 & 24056 & 21825 & 25604\end{array}$

| 2 | 16616 | 16775 | 20293 | 16615 | 24379 | 24590 | 19626 | 20619 | 50718 | 19685 | 17857 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |


| 3 | 10830 | 11069 | 11458 | 14332 | 11128 | 18506 | 18720 | 15484 | 15919 | 40528 | 15616 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |


| 4 | 5836 | 6268 | 6272 | 6671 | 7657 | 6729 | 11989 | 12687 | 10079 | 10955 | 31054 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |


| 5 | 1401 | 3443 | 2925 | 3469 | 3514 | 3916 | 3562 | 6052 | 7190 | 5552 | 7559 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

$\begin{array}{llllllllllll}\text { +gp } & 505 & 831 & 896 & 997 & 1043 & 991 & 803 & 1302 & 926 & 1452 & 2764\end{array}$
TOTAL 8848889251100485109749109010110698157898148949138287134600103760

Table 9.2.12 Four-spot megrim (L. boscii) in Divisions VIIIc and IXa. Summary of landings and XSA results.

Run title : Four spot megrim (L. boscii) Division VIIIc and IXa

At 7/05/2013 14:02

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)


Table 9.2.13 Four-spot megrim (L. boscii) in Divisions VIIIc and IXa.
Prediction with management option table: Input data
MFDP version 1a
Run: LDB
Time and date: 20:44 07/05/2013
Fbar age range: 2-4

2013 Stock Natural Maturity Prop. of F Prop. of M Weight Exploit Weight Age size mortality ogive bef. Spaw. bef. Spaw. in Stock pattern CWt

| 0 | 26724 | 0.2 | 0 | 0 | 0 | 0.003 | 0.000 | 0.003 |
| :--- | ---: | ---: | ---: | :--- | :--- | :--- | :--- | :--- |
| 1 | 25604 | 0.2 | 0.55 | 0 | 0 | 0.036 | 0.001 | 0.036 |
| 2 | 17857 | 0.2 | 0.86 | 0 | 0 | 0.066 | 0.038 | 0.066 |
| 3 | 15616 | 0.2 | 0.97 | 0 | 0 | 0.086 | 0.157 | 0.086 |
| 4 | 31054 | 0.2 | 0.99 | 0 | 0 | 0.105 | 0.312 | 0.105 |
| 5 | 7559 | 0.2 | 1 | 0 | 0 | 0.133 | 0.493 | 0.133 |
| 6 | 3306 | 0.2 | 1 | 0 | 0 | 0.171 | 0.492 | 0.171 |
| 7 | 2764 | 0.2 | 1 | 0 | 0 | 0.237 | 0.492 | 0.237 |

2014 Stock Natural Maturity Prop. of F Prop. of M Weight Exploit Weight

| Age | size | mortality | ogive | bef. Spaw. bef. Spaw. in Stock pattern | CWt |  |  |  |
| :---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 0 | 26724 | 0.2 | 0 | 0 | 0 | 0.003 | 0.000 | 0.003 |
| 1. | 0.2 | 0.55 | 0 | 0 | 0.036 | 0.001 | 0.036 |  |
| 2. | 0.2 | 0.86 | 0 | 0 | 0.066 | 0.038 | 0.066 |  |
| 3. | 0.2 | 0.97 | 0 | 0 | 0.086 | 0.157 | 0.086 |  |
| 4. | 0.2 | 0.99 | 0 | 0 | 0.105 | 0.312 | 0.105 |  |
| 5. | 0.2 | 1 | 0 | 0 | 0.133 | 0.493 | 0.133 |  |
| 6. | 0.2 | 1 | 0 | 0 | 0.171 | 0.492 | 0.171 |  |
| 7. | 0.2 | 1 | 0 | 0 | 0.237 | 0.492 | 0.237 |  |

2015 Stock Natural Maturity Prop. of F Prop. of M Weight Exploit Weight

| Age | size | mortality | ogive | bef. Spaw. bef. Spaw. in Stock pattern | CWt |  |  |  |
| :---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 0 | 26724 | 0.2 | 0 | 0 | 0 | 0.003 | 0.000 | 0.003 |
| 1. | 0.2 | 0.55 | 0 | 0 | 0.036 | 0.001 | 0.036 |  |
| 2. | 0.2 | 0.86 | 0 | 0 | 0.066 | 0.038 | 0.066 |  |
| 3. | 0.2 | 0.97 | 0 | 0 | 0.086 | 0.157 | 0.086 |  |
| 4. | 0.2 | 0.99 | 0 | 0 | 0.105 | 0.312 | 0.105 |  |
| 5. | 0.2 | 1 | 0 | 0 | 0.133 | 0.493 | 0.133 |  |
| 6. | 0.2 | 1 | 0 | 0 | 0.171 | 0.492 | 0.171 |  |
| 7. | 0.2 | 1 | 0 | 0 | 0.237 | 0.492 | 0.237 |  |

[^2]Table 9.2.14. Megrim (L. boscii) in Div. VIIIc and IXa catch forecast: management option table

MFDP version 1a
Run: LDB
Four spot megrim (L. boscii) Division VIIIc and IXa
Time and date: 20:44 07/05/2013
Fbar age range: 2-4

| 2013 <br> Biomass | SSB | FMult | FBar | Landings |
| ---: | ---: | ---: | ---: | ---: |
| 9029 | 8287 |  | 1 | 0.1689 |


| 2014 <br> Biomass | SSB | FMult | FBar | Landings | Biomass | SSB |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 8463 | 7779 | 0 | 0 | 0 | 9867 | 9202 |
| . | 7779 | 0.1 | 0.0169 | 221 | 9617 | 8952 |
| . | 7779 | 0.2 | 0.0338 | 434 | 9378 | 8713 |
| . | 7779 | 0.3 | 0.0507 | 638 | 9148 | 8484 |
| . | 7779 | 0.4 | 0.0676 | 833 | 8929 | 8265 |
| . | 7779 | 0.5 | 0.0844 | 1021 | 8718 | 8054 |
| . | 7779 | 0.6 | 0.1013 | 1201 | 8516 | 7853 |
| . | 7779 | 0.7 | 0.1182 | 1374 | 8322 | 7660 |
| . | 7779 | 0.8 | 0.1351 | 1541 | 8137 | 7474 |
| . | 7779 | 0.9 | 0.152 | 1700 | 7959 | 7297 |
| . | 7779 | 1 | 0.1689 | 1854 | 7788 | 7126 |
| . | 7779 | 1.1 | 0.1858 | 2001 | 7624 | 6963 |
| . | 7779 | 1.2 | 0.2027 | 2142 | 7467 | 6806 |
| . | 7779 | 1.3 | 0.2196 | 2279 | 7316 | 6656 |
| . | 7779 | 1.4 | 0.2364 | 2409 | 7172 | 6511 |
| . | 7779 | 1.5 | 0.2533 | 2535 | 7033 | 6373 |
| . | 7779 | 1.6 | 0.2702 | 2656 | 6899 | 6239 |
| . | 7779 | 1.7 | 0.2871 | 2773 | 6771 | 6112 |
| . | 7779 | 1.8 | 0.304 | 2885 | 6648 | 5989 |
| . | 7779 | 1.9 | 0.3209 | 2993 | 6530 | 5871 |
| . | 7779 | 2 | 0.3378 | 3097 | 6416 | 5758 |

Input units are thousands and kg - output in tonnes

Table 9.2.15 Four-spot megrim (L. boscii) in Divisions VIIIc and IXa. Single option prediction. Detail Tables.

MFDP version 1a
Run: LDB
Time and date: 20:44 07/05/2013
Fbar age range: 2-4

Year: 2013 F multiplier: 1 Fbar: 0.1689

| Age | F | CatchNos Yield StockNos Biomass | SSNos(Jan) | SSB(Jan) | SSNos(ST) | SSB(ST) |  |  |  |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | 0 | 0 | 0 | 26724 | 89 | 0 | 0 | 0 | 0 |
| 1 | 0.0006 | 13 | 0 | 25604 | 922 | 14082 | 507 | 14082 | 507 |
| 2 | 0.0383 | 608 | 40 | 17857 | 1179 | 15357 | 1014 | 15357 | 1014 |
| 3 | 0.1565 | 2056 | 177 | 15616 | 1343 | 15148 | 1303 | 15148 | 1303 |
| 4 | 0.3119 | 7580 | 798 | 31054 | 3271 | 30743 | 3238 | 30743 | 3238 |
| 5 | 0.4932 | 2689 | 358 | 7559 | 1005 | 7559 | 1005 | 7559 | 1005 |
| 6 | 0.4915 | 1173 | 201 | 3306 | 565 | 3306 | 565 | 3306 | 565 |
| 7 | 0.4915 | 981 | 232 | 2764 | 655 | 2764 | 655 | 2764 | 655 |
| Total |  | 15100 | 1807 | 130484 | 9029 | 88959 | 8287 | 88959 | 8287 |

Year: 2014 F multiplier: 1 Fbar: 0.1689

| Age | F | CatchNos Yield StockNos Biomass |  |  |  |  |  |  |  | SSNos(Jan) | SSB(Jan) |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | 0 | 0 | 0 | 0 | 26724 | 89 | 0 | 0 | 0 | SSNos(ST) | SSB(ST) |
| 1 | 0.0006 | 11 | 0 | 21880 | 788 | 12034 | 433 | 12034 | 433 |  |  |
| 2 | 0.0383 | 713 | 47 | 20951 | 1383 | 18018 | 1189 | 18018 | 1189 |  |  |
| 3 | 0.1565 | 1853 | 159 | 14071 | 1210 | 13649 | 1174 | 13649 | 1174 |  |  |
| 4 | 0.3119 | 2669 | 281 | 10933 | 1152 | 10823 | 1140 | 10823 | 1140 |  |  |
| 5 | 0.4932 | 6621 | 881 | 18613 | 2476 | 18613 | 2476 | 18613 | 2476 |  |  |
| 6 | 0.4915 | 1341 | 229 | 3779 | 646 | 3779 | 646 | 3779 | 646 |  |  |
| 7 | 0.4915 | 1079 | 256 | 3040 | 720 | 3040 | 720 | 3040 | 720 |  |  |
| Total |  | 14287 | 1854 | 119991 | 8463 | 79956 | 7779 | 79956 | 7779 |  |  |

Year: 2015 F multiplier: 1 Fbar: 0.1689

| Age | F | CatchNos Yield StockNos Biomass |  |  |  |  |  |  |  | SSNos(Jan) | SSB(Jan) |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | 0 | 0 | 0 | 0 | 26724 | 89 | 0 | 0 | 0 | 0 |  |
| 1 | 0.0006 | 11 | 0 | 21880 | 788 | 12034 | 433 | 12034 | 433 |  |  |
| 2 | 0.0383 | 610 | 40 | 17903 | 1182 | 15397 | 1016 | 15397 | 1016 |  |  |
| 3 | 0.1565 | 2174 | 187 | 16509 | 1420 | 16014 | 1377 | 16014 | 1377 |  |  |
| 4 | 0.3119 | 2405 | 253 | 9851 | 1038 | 9753 | 1027 | 9753 | 1027 |  |  |
| 5 | 0.4932 | 2331 | 310 | 6553 | 872 | 6553 | 872 | 6553 | 872 |  |  |
| 6 | 0.4915 | 3302 | 565 | 9306 | 1591 | 9306 | 1591 | 9306 | 1591 |  |  |
| 7 | 0.4915 | 1212 | 287 | 3415 | 809 | 3415 | 809 | 3415 | 809 |  |  |
| Total |  | 12044 | 1643 | 112142 | 7788 | 72472 | 7126 | 72472 | 7126 |  |  |

Input units are thousands and kg - output in tonnes


Four-spot megrim (L. boscii) in Divisions VIIIc and IXa : Year-class \% contribution to
a) 2014 landings

Table 9.2.17 Four-spot megrim (L. boscii) in Divisions VIIIc and IXa. Yield per recruit results.

MFYPR version 2a
Run: LDB
Time and date: 21:27 07/05/2013
Yield per results

| FMult | Fbar | CatchNos | Yield | StockNos | Biomass | SpwnNosJan | SSBJan | SpwnNosSpwn SSBSpwn |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0 | 0 | 0 | 0 | 5.5167 | 0.5944 | 4.0334 | 0.5697 | 4.0334 | 0.5697 |
| 0.1 | 0.0169 | 0.0914 | 0.0161 | 5.0617 | 0.4919 | 3.5786 | 0.4672 | 3.5786 | 0.4672 |
| 0.2 | 0.0338 | 0.1532 | 0.0258 | 4.754 | 0.4239 | 3.2711 | 0.3992 | 3.2711 | 0.3992 |
| 0.3 | 0.0507 | 0.1982 | 0.0319 | 4.5312 | 0.3758 | 3.0484 | 0.3511 | 3.0484 | 0.3511 |
| 0.4 | 0.0676 | 0.2324 | 0.0359 | 4.3617 | 0.34 | 2.8791 | 0.3154 | 2.8791 | 0.3154 |
| 0.5 | 0.0844 | 0.2594 | 0.0386 | 4.2279 | 0.3125 | 2.7455 | 0.2879 | 2.7455 | 0.2879 |
| 0.6 | 0.1013 | 0.2815 | 0.0404 | 4.1193 | 0.2908 | 2.637 | 0.2662 | 2.637 | 0.2662 |
| 0.7 | 0.1182 | 0.2998 | 0.0417 | 4.029 | 0.2731 | 2.5469 | 0.2486 | 2.5469 | 0.2486 |
| 0.8 | 0.1351 | 0.3154 | 0.0426 | 3.9526 | 0.2586 | 2.4706 | 0.234 | 2.4706 | 0.234 |
| 0.9 | 0.152 | 0.3288 | 0.0431 | 3.8869 | 0.2464 | 2.405 | 0.2219 | 2.405 | 0.2219 |
| 1 | 0.1689 | 0.3405 | 0.04 | 3.8296 | 0.2361 | 2.3478 | 0.21 | 2.3478 | 0.2116 |
| 1.1 | 0.1858 | 0.3508 | 0.0438 | 3.779 | 0.2272 | 2.2974 | 0.2027 | 2.2974 | 0.2027 |
| 1.2 | 0.2027 | 0.3601 | 0.044 | 3.734 | 0.2195 | 2.2526 | 0.195 | 2.2526 | 0.195 |
| 1.3 | 0.2196 | 0.3684 | 0.0441 | 3.6936 | 0.2127 | 2.2123 | 0.1882 | 2.2123 | 0.1882 |
| 1.4 | 0.2364 | 0.3759 | 0.0441 | 3.6571 | 0.2068 | 2.1758 | 0.1823 | 2.1758 | 0.1823 |
| 1.5 | 0.2533 | 0.3828 | 0.0442 | 3.6237 | 0.2014 | 2.1427 | 0.177 | 2.1427 | 0.177 |
| 1.6 | 0.2702 | 0.3891 | 0.0441 | 3.5932 | 0.1967 | 2.1123 | 0.1722 | 2.1123 | 0.1722 |
| 1.7 | 0.2871 | 0.3949 | 0.0441 | 3.5651 | 0.1924 | 2.0843 | 0.1679 | 2.0843 | 0.1679 |
| 1.8 | 0.304 | 0.4003 | 0.0441 | 3.539 | 0.1885 | 2.0583 | 0.164 | 2.0583 | 0.164 |
| 1.9 | 0.3209 | 0.4053 | 0.044 | 3.5148 | 0.1849 | 2.0342 | 0.1605 | 2.0342 | 0.1605 |
| 2 | 0.3378 | 0.41 | 0.044 | 3.4922 | 0.1817 | 2.0118 | 0.1572 | 2.0118 | 0.1572 |


| Reference point | F multiplier | Absolute F |
| :---: | :---: | :---: |
| Fbar(2-4) | 1 | 0.1689 |
| FMax | 1.5194 | 0.2566 |
| F0.1 | 0.5129 | 0.0866 |
| F35\%SPR | 1.1408 | 0.1927 |
| Flow | 0.4906 | 0.0829 |
| Fmed | 1.4947 | 0.2524 |
| Fhigh | 4.6384 | 0.7834 |

Figure 9.2.1 Four-spot megrim (L. boscii) in Divisions VIIIc and IXa. Annual length compositions of landings ('000)


Standardized $\log ($ abundance index at age) from SpGFS-WIBTS-Q4
(black bubble means < 0)


Standardized log(abundance index at age) from A Coruña VIIIc trawl fleet
(black bubble means < 0)


Figure 9.2.2: Four-spot megrim (L. boscii) in Divisions VIIIc\&IXa

## Landings of four-spot megrim



LPUEs of four-spot megrim in Div. VIIIc, IXa.


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


## Landings proportions at age



Standardized landings proportions at age (black bubble means < 0)


Figure 9.2.4. Four-spot megrim (L. boscii) in Divisions VIIIc \& IXa.


Figure 9.2.5. Four-spot megrim (L. boscii) in Divisions VIIIc and IXa. Retrospective XSA


Figure 9.2.6. Four spot megrim (L. boscii) in Divisions VIIIc and IXa. LOG CATCHABILITY RESIDUAL PLOTS (XSA)


Figure 9.2.7(a). Four-spot megrim (L. boscii) in Divisions VIIIc and IXa. Stock Summary

Standardized F-at-age (black bubbles means <0)


Standardized relative F-at-age (black bubble means < 0)

years
Figure 9.2.7(b): Four-spot megrim (L. boscii) in Divisions VIIIc\&IXa


Weights in kilograms
Figure 9.2.8. Four-spot megrim (L. boscii) in Divisions VIIIc and IXa. Forecast summary


Figure 9.2.9. Four spot megrim (L.boscii) in Divisions VIIIc and IXa. SSB-Recruitment plot.


Figure 9.2.10. Four-spot megrim (L. boscii) Recruits, SSB and Fs from WG11 and WG13


Figure 9.3.1. Stock trends for both stocks. Megrin and Four-spot megrim in Divisions VIIIc and IXa.


Figure 9.3.2. Megrims (L. whiffiagonis and L. boscii) in Divisions VIIIc and IXa.

## 10 Nephrops (Divisions VIII ab, FU 23-24)

Type of assessment
ICES description
Functional Units
no assessment in 2013
VIIIa, b
Bay of Biscay North, VIII a (FU 23)
Bay of Biscay South, VIII b (FU 24)

### 10.1 General

### 10.1.1 Ecosystem aspects

This section is detailed in Stock Annex.

### 10.1.2 Fishery description

The general features of the fishery are given in Stock Annex.

### 10.1.3 ICES Advice for 2013

Exploitation boundaries in relation to precautionary considerations: The advice given in 2012 for this Nephrops stock is biennial and valid for 2013 and 2014. This year ICES adopts the transition to the MSY approach as basis for advice, which corresponds to reducing catch.

### 10.1.4 Management applicable for 2012 and 2013

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 2013 was 3899 t (the same as for 2012) whereas the ICES recommendation was to reduce catch. In 2012, total nominal landings reached 2520 t .

For a long-time, a minimum landing size of 26 mm CL ( 8.5 cm total length) was adopted by the French producers' organisations (larger than the EU MLS set at 20 mm CL i.e. 7 cm total length). Since December 2005, a new French MLS regulation (9 cm total length) has been established. This change has already significantly impacted on the data used by the WG (see report WGHMM 2007).

A mesh change was implemented in 2000 and the minimum codend mesh size in the Bay of Biscay was 70 mm instead of the former 55 mm for Nephrops, which had replaced 50 mm mesh size in 1990-91. 100 mm mesh size is required in the Hake box. Since 2006, it should be noted that Nephrops trawlers were allowed to fish in the hake box with the mesh size of 70 mm once they have adopted a square mesh panel of 100 mm .

As annotated in the Official Journal of the European Union (p.4, art. 27): "In order to ensure sustainable exploitation of the hake and Norway lobster stock and to reduce discards, the use of the latest developments as regards selective gears should be permitted in ICES zones 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 whole areas VIIIa, VIIIb applicable from the $1^{\text {st }}$ 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 vessels ( $\approx 80 \%$; mainly Districts of South Brittany) chose the increase of the codend mesh size, but the ventral squared panel was also adopted (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 (200 in 2010). In the beginning of 2006, the French producers' organisations adopted new additional regulations such as monthly quotas which had some effects on fishing effort limitation.

### 10.2 Data

### 10.2.1 Commercial catches and discards

Total catches, landings and discards, of Nephrops in division VIIIa,b for the period 1960-2012 are given in Table 10.1.

Throughout the mid-60's, the French landings gradually increased to a peak value of 7000 t in 1973-1974, then fluctuated between 4500 and 6000 t during the 80 's and the mid-90's. An increase has been noticeable during the early 2000's. Landings declined in 2012 (2520 t) whereas a higher level was observed in the recent period ( 3398 t and 3559 t respectively in 2010 and 2011). The landings since 2008 have been reached under the new selectivity regulations. It is excepted that these landings should be higher under the previous selectivity parameters, but the accurate effect of the new devices remains unknown.

Males usually predominate in the landings (sex ratio defined as number of females divided by total fluctuating between 0.31 and 0.46 for the overall period 1987-2012). Females are less accessible in winter because of burrowing and, also, they have a lower growth rate. The female proportion in landings slightly increased up to the early 2000's, but this trend was not systematically confirmed in recent years because of a less typical seasonal fishing profile affecting sex ratio and because of the MLS increase (December 2005). Although, in 2012 the proportion of females was substantially increased compared to 2011 ( 0.41 instead of 0.31 ). For removals, the increasing trend of sex ratio has remained for 2000's: the discarded proportion has been higher since the early 2000's mainly after the adoption of larger MLS before the new selectivity regulations.
Discards represent most of the catches of the smallest individuals as indicated by the available data (Figure 10.1). The average weight of discards per year in the period up to late 90's (not routinely sampled) is about 1480 t whereas discard estimates of the recent sampled years (2003-2012) reached a higher level of 2110 t . This change in the amount of discards could be due to the restriction of individual quotas (notably applied since 2006), the strength of the recent recruitments and the change in the MLS (which tends to increase the discards), although the change in the selectivity should tend to reduce the discards. The relative contribution of each of these three factors remains unknown. In 2012, 118 million individuals were estimated to have been discarded $(1010 \mathrm{t})$ against 101 million landed $(2520 \mathrm{t})$.

### 10.2.2 Biological sampling

Discard data by sampling on board are available for 1987, 1991, 1998 and since 2003. For the intermediate years up to 2002, since the former WGNEPH, numbers discarded at length were derived by the "proportional method" calculating discards by sex for years with no sampling onboard by applying identical quarterly LFDs of the pre-
ceding 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 interdependence throughout the time series, therefore, lack of contrast for annual recruitment. IBP Nephrops 2012 even not finally conclusive investigated the probabilistic (logistic) approach developed for the WGHMM since 2007 (Table 10.2; see Stock Annex) and compared with the previous discard derivation. The probabilistic calculation provides wider variations on number of removals for age group 1 and 2 (see Table 10.3 in report WGHMM 2012) after conversion of the size composition to an age one. The WGHMM 2012 chose the probabilistic method: the derivation is performed by sex and quarter using logistic function describing the s-shaped hand-sorting onboard and assuming symmetrical densities of probability for yearly LFDs as tested on years with sampling onboard before MLS change (up to 2005).

Since 2003, discards have been estimated from sampling catches programme on board Nephrops trawlers ( 411 trips and 1258 hauls have been sampled over 10 years). The analytical investigations, estimates and variances, are provided in the Stock Annex. In spite of improvements in agreement between logbook declarations and auction hall sales ( $89 \%$ of landings were cross-validated item by item between sales and logbooks in 2007, but this percentage dropped in 2008: 69\% and slightly increased after 2009), the total number of trips is usually not well known and needs to be estimated. This can be done using the number of auction hall sales, when boats conduct daily trips, which is the case in the northern part of the fishery, but not in the southern one. Discard sampling from the southern part of the fishery was occasionally carried out in the past (2005 and since 2010).

The length distribution of landings, discards, catches and removals are presented in Tables 10.3.a-d, Tables 10.4.a-d and in Figure 10.1. Removals at length are obtained by adding the landings and "dead discards" and applying a discard mean survival rate of $30 \%$ (Charuau et al., 1982; recent studies suggest that discard survival is higher than the historical reference; see impact of higher survival rate in assessment and prognosis in WD 1). Combined sexes mean lengths are presented for catches, landings and discards in Figure 10.2.

### 10.2.3 Abundance indices from surveys

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: $2^{\text {nd }}$ quarter, hours of trawling: around dawn and dusk and fishing gear: twin trawl). This survey (called LANGOLF; see Stock Annex) occurs once a year in May and its sampling design is stratified using sedimentary strata. Therefore, as regards the investigations carried out during the IBP Nephrops 2012, its results for abundance indices have been included since the WGHMM 2012.

### 10.2.4 Commercial catch-effort data.

Commercial fleets used in the assessment to tune the model
Up to 1998, the majority of the vessels were not obliged to keep logbooks because of their size and fishing forms were established by inquiries. Since 1999, logbooks became compulsory for all vessels longer than 10 m . The available log-book data cannot be currently considered as representative for the fishing effort of the whole fishery during the overall time series. Hence, since 2004, it was attempted to define a better effort index.

Effort data indices, landings and LPUE for the "Le Guilvinec District" Nephrops trawlers in the $2^{\text {nd }}$ quarter are available for the overall time series (Table 10.5; Figure 10.3). Effort increased from 1987 to 1992, but there has been a decreasing trend since then. The downwards trend in effort can be explained by the decrease in the number of fishing vessels following the decommissioning schemes implemented by the EU. The LPUEs of the "Le Guilvinec district" $2^{\text {nd }}$ Quarter Nephrops fleet are reasonably stable, fluctuating around a long-term average of $13.1 \mathrm{~kg} /$ hour (Figure 10.3), with a maximum level occurring in 1988, 2001 and 2010 ( $16.5,16.7$ and $18.6 \mathrm{~kg} / \mathrm{h}$ respectively). In 2011, LPUE decreased ( $15.1 \mathrm{~kg} / \mathrm{h}$ ) and remained stable in 2012 ( $15.2 \mathrm{~kg} / \mathrm{h}$ ).

Changes in fishing gear efficiency and individual catch capacities of vessels, imply that the time spent at sea may not be a good indicator of effective effort and hence LPUE trends are possibly biased. Since the early 90 's, the number of boats using twintrawls increased ( $10 \%$ in 1991, more than $90 \%$ in recent years) and also the number of vessels using rock-hopper gear. Moreover, an increase in onboard computer technology has occurred. The effects of these changes are difficult to quantify as twintrawling is not always recorded explicitly in the fisheries statistics and improvement due to computing technology is not continuous for the overall time series.

Annual age compositions for the "Le Guilvinec district" $2^{\text {nd }}$ Quarter tuning series (Table 10.6) were obtained by using the ratios of Quarter 2-fleet-landings to TotalQuarter 2-landings. The Table 10.6 also provides age compositions for the LANGOLF survey series initiated in 2006.

### 10.3 Assessment

No assessment was carried out in 2013

### 10.4 Catch options and prognosis

No catch option and prognosis is provided in 2013.

### 10.5 Biological reference points

As usually for Nephrops stocks in the Bay of Biscay, $\mathrm{F}_{\max }$ calculated in the biennal assessmen is well defined. Moreover, variations on annual recruitment are weak, thus, mean $R$ is a good proxy over the whole time series. $\mathrm{F}_{35 \% \text { SPR }}$ is a less pertinent proxy for Fmsy as there is no evidence of SSB/R relationship and SSB remains stable at intermediate levels during the overall period. $\mathrm{F}_{\max }$ is proposed as $\mathrm{F}_{\text {msy }}$ proxy

### 10.6 Comments on the assessment

The continuation of the French Nephrops trawlers sampling programme onboard will avoid the use of "derived" data for missing years. The discard derivation by applying probability concepts as performed by WGHMM since the IBP Nephrops result in more contrast in recruitment, more regular residuals of Log catchabilities and better consistency in retrospective pattern for recruitment, especially the exploratory run with simulated discards for 2006.

## Information from the fishing industry

There have been different meetings between the French fishing industry and scientists since the investigations of the IBP Nephrops 2012. The industry has not provided any additional quantitative information, but they supported information on landings and fishing effort compiled by the WG. The partnership commented on the application of one tuning series involved in the northern part of the fishery and its extrapola-
tion to the southern one. They underlined the heterogeneous feature of the whole area of the stock and encouraged the integration of the scientific independent tuning series provided from the survey LANGOLF which covers the whole Bay of Biscay. Moreover, they emphasized the necessity of applying additional tuning commercial information on the southern part of fishery. The perception of the stock trends by the industry generally reflects the signals given by the data used during the recent assessments of the stock.

### 10.7 Management considerations

There is no proposal for precautionary reference points for this stock. Recruitment level in the early 2000's (2004 and 2005) was probably higher than historical average values, but it remains uncertain and contributes significantly to uncertainty of catches in the short-term.

The use of selective devices for Nephrops since 2008 resulted in reduced discards (in number), but it is not currently obvious to dissociate selectivity effects from that linked to the positive signal of recruitment in the middle 2000's.

The license system in operation since 2004 and the restrictions applied by the Producers' Organisations since 2006 should increase the regulation of inputs by limiting the fishing time.

### 10.8 References

Charuau A., Morizur Y., Rivoalen J.J., 1982. Survival of discarded Nephrops norvegicus in the Bay of Biscay and in the Celtic Sea. ICES-CM-1982/B:13.

Table 10.1. Nephrops in FUs 23-24 Bay of Biscay (VIIla,b) - Estimates of catches (t) by FU for 1960-2012

| Year | Landings (1) |  |  |  |  | Total Discards | $\begin{gathered} \hline \text { Catches } \\ \hline \text { Total } \\ \hline \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | FU 23-24 (2) | FU 23 | FU 24 | Unallocated (MA N)(3) | Total VIIIa,b | FU 23-24 |  |
|  | VIIIa, b | VIIIa | VIIIb | (MA N) | used by WG | VIIIa, ${ }^{\text {b }}$ | 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 | 4138 | 10013 |
| 1989 | - | 4253 | 582 | 77 | 4835 | 3007 | 7842 |
| 1990 | 1 | 4613 | 359 | 87 | 4972 | 644 | 5616 |
| 1991 | 1 | 4353 | 401 | 55 | 4754 | 1213 | 5967 |
| 1992 | 0 | 5123 | 558 | 47 | 5681 | 1217 | 6897 |
| 1993 | 0 | 4577 | 532 | 49 | 5109 | 974 | 6084 |
| 1994 | 0 | 3721 | 371 | 27 | 4092 | 717 | 4809 |
| 1995 | 0 | 4073 | 380 | 14 | 4452 | 687 | 5139 |
| 1996 | 0 | 4034 | 84 | 15 | 4118 | 487 | 4606 |
| 1997 | 2 | 3450 | 147 | 41 | 3610 | 914 | 4523 |
| 1998 | 2 | 3565 | 300 | 40 | 3865 | 1453 | 5318 |
| 1999 | 2 | 2873 | 337 | 26 | 3209 | 1092 | 4301 |
| 2000 | 0 | 2848 | 221 | 36 | 3069 | 1337 | 4406 |
| 2001 | 1 | 3421 | 309 | 22 | 3730 | 2628 | 6358 |
| 2002 | 2 | 3323 | 356 | 36 | 3679 | 2535 | 6214 |
| 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 |

(1) WG estimates
(2) landings from VIIIa and VIIIb aggregated until 1974
(3) outside FU 23-24

Table 10.2. Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) - Derivation and estimations of discards
1987 sampled
1988 from 1987's logistic function of sorting by quarter+density of probability 1989 from 1987's logistic function of sorting by quarter+density of probability 1990 from 1987's logistic function of sorting by quarter+density of probability 1991 sampled
1992 from 1991's logistic function of sorting by quarter+density of probability 1993 from 1991's logistic function of sorting by quarter+density of probability 1994 from 1991's logistic function of sorting by quarter+density of probability 1995 from 1991's logistic function of sorting by quarter+density of probability 1996 from 1991's logistic function of sorting by quarter+density of probability
1997 from 1991's logistic function of sorting by quarter+density of probability 1998 sampled
1999 from 1998's logistic function of sorting by quarter+density of probability 2000 from 1998's logistic function of sorting by quarter+density of probability 2001 from 1998's logistic function of sorting by quarter+density of probability 2002 from 1998's logistic function of sorting by quarter+density of probability 2003 sampled
2004 sampled
2005 sampled
2006 sampled
2007 sampled
2008 sampled
2009 sampled
2010 sampled
2011 sampled
2012 sampled

Table 10.3.a Nephrops in FUs 23-24 Bay of Biscay (VIIla,b) landings length distributions in 1987-1999

| Landings |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CL mm/ | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 |
| 16 | 0 | 158 | 59 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 |
| 17 | 149 | 230 | 77 | 12 | 35 | 62 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 331 | 553 | 131 | 64 | 30 | 0 | 0 | 31 | 20 | 0 | 0 | 0 | 0 |
| 19 | 1296 | 1886 | 901 | 48 | 79 | 138 | 0 | 72 | 61 | 0 | 0 | 0 | 0 |
| 20 | 3129 | 4227 | 2791 | 529 | 474 | 450 | 464 | 206 | 341 | 48 | 448 | 25 | 72 |
| 21 | 6476 | 8882 | 7039 | 1947 | 1572 | 1595 | 1285 | 482 | 1573 | 414 | 1313 | 288 | 219 |
| 22 | 13501 | 16050 | 12971 | 5913 | 4733 | 3948 | 3878 | 2824 | 2395 | 1311 | 2799 | 985 | 849 |
| 23 | 21337 | 25374 | 18073 | 10910 | 7854 | 9701 | 7398 | 5366 | 5523 | 2799 | 4638 | 3171 | 1888 |
| 24 | 24339 | 33950 | 21960 | 13293 | 15521 | 20948 | 11949 | 9650 | 8731 | 6071 | 10005 | 6484 | 4032 |
| 25 | 32476 | 36294 | 25650 | 16440 | 19747 | 27876 | 21011 | 15079 | 14348 | 13239 | 19837 | 13980 | 10717 |
| 26 | 29670 | 29808 | 22747 | 18205 | 22106 | 26617 | 23732 | 18312 | 19769 | 16779 | 19380 | 13535 | 10590 |
| 27 | 28086 | 28380 | 22091 | 16109 | 21900 | 28410 | 26044 | 21181 | 25126 | 18384 | 22823 | 16602 | 12724 |
| 28 | 24925 | 26017 | 19087 | 19595 | 21214 | 32091 | 27580 | 20488 | 20914 | 15744 | 19466 | 14432 | 12058 |
| 29 | 18703 | 20920 | 14227 | 16250 | 17138 | 24760 | 20627 | 16527 | 15909 | 16332 | 20878 | 11832 | 9448 |
| 30 | 18407 | 17862 | 13688 | 12055 | 14762 | 19828 | 21414 | 15903 | 19164 | 20214 | 21487 | 16335 | 16187 |
| 31 | 11419 | 13156 | 9037 | 11088 | 12408 | 14281 | 13452 | 11207 | 13333 | 14009 | 9791 | 8539 | 9209 |
| 32 | 10185 | 12822 | 8410 | 8540 | 8635 | 12786 | 12711 | 11490 | 13667 | 14392 | 9622 | 9237 | 9745 |
| 33 | 8528 | 8848 | 7127 | 10649 | 7273 | 9297 | 11369 | 7022 | 7117 | 8576 | 6334 | 5947 | 6000 |
| 34 | 5926 | 7812 | 6967 | 10543 | 7987 | 7318 | 7355 | 6684 | 7584 | 6524 | 4816 | 6619 | 5910 |
| 35 | 5763 | 5935 | 6214 | 7637 | 5425 | 5928 | 6307 | 5646 | 4677 | 6578 | 4737 | 6700 | 5267 |
| 36 | 4033 | 5064 | 4532 | 6274 | 4979 | 4998 | 4608 | 4337 | 3709 | 4133 | 2568 | 5308 | 4291 |
| 37 | 4024 | 3754 | 3545 | 4841 | 4541 | 4195 | 4089 | 3752 | 3496 | 4226 | 2135 | 4722 | 3230 |
| 38 | 3131 | 3106 | 3193 | 4966 | 2993 | 3933 | 2991 | 2771 | 2879 | 2788 | 1142 | 3527 | 2588 |
| 39 | 2151 | 2778 | 2154 | 3339 | 2869 | 2987 | 2290 | 1841 | 1746 | 1596 | 927 | 2169 | 2186 |
| 40 | 2425 | 2159 | 2175 | 2766 | 2414 | 2574 | 2206 | 1738 | 2015 | 1956 | 982 | 3084 | 2353 |
| 41 | 1375 | 1753 | 1461 | 1951 | 2076 | 1546 | 1452 | 1150 | 1123 | 1250 | 520 | 1558 | 1362 |
| 42 | 1350 | 1542 | 1130 | 1668 | 1662 | 1599 | 1111 | 1118 | 1558 | 1142 | 508 | 1490 | 1124 |
| 43 | 1150 | 1209 | 1087 | 1908 | 1495 | 1348 | 1069 | 687 | 1039 | 610 | 370 | 1049 | 761 |
| 44 | 965 | 704 | 1192 | 1401 | 1089 | 1050 | 745 | 500 | 915 | 414 | 219 | 748 | 708 |
| 45 | 641 | 581 | 1194 | 955 | 1058 | 766 | 684 | 550 | 700 | 464 | 253 | 902 | 429 |
| 46 | 645 | 689 | 669 | 713 | 666 | 734 | 584 | 353 | 460 | 374 | 135 | 525 | 424 |
| 47 | 509 | 391 | 641 | 715 | 431 | 567 | 417 | 407 | 437 | 397 | 140 | 327 | 276 |
| 48 | 343 | 333 | 526 | 863 | 636 | 588 | 456 | 270 | 494 | 264 | 92 | 382 | 104 |
| 49 | 290 | 254 | 378 | 470 | 377 | 263 | 145 | 178 | 254 | 205 | 57 | 132 | 151 |
| 50 | 319 | 216 | 351 | 230 | 263 | 256 | 238 | 273 | 255 | 179 | 76 | 154 | 159 |
| 51 | 135 | 241 | 240 | 181 | 210 | 107 | 126 | 156 | 214 | 123 | 38 | 191 | 58 |
| 52 | 192 | 48 | 180 | 335 | 180 | 159 | 202 | 107 | 175 | 77 | 30 | 115 | 93 |
| 53 | 137 | 70 | 150 | 121 | 124 | 111 | 55 | 136 | 91 | 84 | 26 | 156 | 23 |
| 54 | 111 | 112 | 218 | 99 | 189 | 94 | 120 | 77 | 55 | 75 | 11 | 93 | 11 |
| 55 | 76 | 85 | 187 | 53 | 63 | 61 | 128 | 66 | 91 | 53 | 9 | 114 | 16 |
| 56 | 111 | 41 | 123 | 26 | 28 | 66 | 50 | 49 | 47 | 62 | 12 | 7 | 5 |
| 57 | 74 | 39 | 116 | 43 | 34 | 61 | 72 | 36 | 77 | 48 | 8 | 31 | 14 |
| 58 | 39 | 65 | 70 | 2 | 11 | 68 | 58 | 47 | 88 | 48 | 9 | 14 | 5 |
| 59 | 32 | 60 | 36 | 13 | 17 | 28 | 13 | 31 | 36 | 30 | 8 | 10 | 2 |
| 60 | 21 | 7 | 30 | 5 | 24 | 7 | 54 | 26 | 32 | 9 | 5 | 8 | 4 |
| 61 | 21 | 15 | 15 | 4 | 11 | 0 | 25 | 12 | 4 | 4 | 0 | 0 | 3 |
| 62 | 0 | 0 | 21 | 10 | 0 | 44 | 3 | 8 | 0 | 9 | 1 | 10 | 0 |
| 63 | 19 | 13 | 10 | 0 | 3 | 28 | 0 | 5 | 20 | 4 | 5 | 4 | 0 |
| 64 | 0 | 7 | 0 | 0 | 0 | 14 | 7 | 10 | 0 | 0 | 0 | 0 | 0 |
| 65 | 8 | 0 | 4 | 0 | 0 | 0 | 30 | 16 | 4 | 0 | 0 | 4 | 2 |
| 66 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 20 | 2 | 4 | 0 | 0 |
| 67 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 3 | 0 | 0 | 0 | 0 | 0 |
| 68 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 69 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 |
| 71 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| 72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 74 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 288974 | 324498 | 244875 | 213779 | 217338 | 274286 | 240638 | 188879 | 202294 | 182041 | 188694 | 161549 | 135304 |
| Weights | 5397 | 5875 | 4835 | 4972 | 4754 | 5681 | 5109 | 4092 | 4452 | 4118 | 3610 | 3865 | 3209 |


| Total Disc |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CL mm/s | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
| 10 | 0 | 1318 | 75 | 0 | 0 | 546 | 199 | 134 | 185 | 82 | 1325 | 0 | 93 |
| 11 | 0 | 2152 | 152 | 0 | 114 | 807 | 313 | 208 | 279 | 125 | 1611 | 85 | 150 |
| 12 | 0 | 3508 | 308 | 0 | 0 | 1190 | 491 | 323 | 419 | 191 | 1952 | 128 | 240 |
| 13 | 0 | 5695 | 624 | 1 | 93 | 1749 | 768 | 501 | 627 | 291 | 2354 | 162 | 384 |
| 14 | 78 | 9194 | 1261 | 2 | 258 | 2556 | 1198 | 774 | 936 | 441 | 2823 | 660 | 613 |
| 15 | 2074 | 14706 | 2539 | 7 | 1249 | 3708 | 1858 | 1189 | 1388 | 666 | 3364 | 1741 | 977 |
| 16 | 3974 | 23183 | 5074 | 22 | 2240 | 5320 | 2854 | 1811 | 2040 | 999 | 3980 | 1861 | 1548 |
| 17 | 13577 | 35760 | 9995 | 71 | 4638 | 7521 | 4326 | 2727 | 2961 | 1484 | 4671 | 3527 | 2433 |
| 18 | 29288 | 53448 | 19148 | 235 | 10619 | 10421 | 6429 | 4034 | 4221 | 2171 | 5432 | 5003 | 3776 |
| 19 | 28370 | 76547 | 34910 | 766 | 12852 | 14070 | 9295 | 5825 | 5877 | 3114 | 6254 | 5991 | 5753 |
| 20 | 60253 | 230038 | 153497 | 2426 | 22797 | 18408 | 12961 | 8143 | 7938 | 4347 | 7125 | 12091 | 8534 |
| 21 | 45446 | 129602 | 100993 | 31048 | 18043 | 23225 | 17283 | 10932 | 10337 | 5862 | 8028 | 9973 | 12205 |
| 22 | 51268 | 61144 | 47652 | 26066 | 24289 | 17350 | 17709 | 13186 | 9925 | 7591 | 14964 | 23278 | 16667 |
| 23 | 23074 | 25627 | 17991 | 11687 | 15611 | 20991 | 15746 | 11862 | 12053 | 6558 | 10661 | 21641 | 17635 |
| 24 | 7213 | 10004 | 6496 | 3836 | 13741 | 20860 | 12123 | 10225 | 9074 | 6765 | 10758 | 19750 | 15698 |
| 25 | 2686 | 3535 | 2479 | 1516 | 14722 | 13478 | 10054 | 7645 | 7037 | 6720 | 10252 | 20487 | 18666 |
| 26 | 672 | 1008 | 694 | 570 | 7131 | 6137 | 5513 | 4390 | 4741 | 4030 | 4720 | 10676 | 8465 |
| 27 | 270 | 335 | 240 | 181 | 1711 | 3200 | 2863 | 2452 | 2817 | 2088 | 2639 | 7502 | 4774 |
| 28 | 0 | 117 | 70 | 78 | 999 | 1759 | 1449 | 1143 | 1117 | 874 | 1096 | 3019 | 2202 |
| 29 | 0 | 32 | 20 | 25 | 138 | 654 | 517 | 434 | 415 | 431 | 584 | 1357 | 813 |
| 30 | 0 | 10 | 7 | 7 | 291 | 256 | 268 | 208 | 249 | 263 | 287 | 686 | 695 |
| 31 | 0 | 3 | 2 | 2 | 97 | 94 | 84 | 69 | 84 | 89 | 64 | 129 | 208 |
| 32 | 0 | 1 | 1 | 1 | 0 | 39 | 40 | 34 | 42 | 45 | 30 | 481 | 115 |
| 33 | 0 | 0 | 0 | 0 | 0 | 14 | 18 | 11 | 11 | 13 | 10 | 231 | 38 |
| 34 | 0 | 0 | 0 | 0 | 0 | 6 | 6 | 5 | 6 | 5 | 4 | 151 | 20 |
| 35 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 88 | 10 |
| 36 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 48 | 5 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 74 | 2 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 44 | 1 |
| 39 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| 46 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 47 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 57 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 58 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 59 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 62 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 64 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 66 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 67 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 68 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 69 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 71 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 74 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 268244 | 686969 | 404228 | 78546 | 151634 | 174362 | 124368 | 88267 | 84780 | 55250 | 104994 | 150995 | 122720 |
| Weights | 1767 | 4123 | 2634 | 627 | 1213 | 1354 | 1007 | 741 | 706 | 495 | 805 | 1453 | 1148 |

Table 10.3.c Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) catches length distributions in 1987-1999.

| Total catc |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CL mm/\ | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
| 10 | 0 | 1318 | 75 | 0 | 0 | 546 | 199 | 134 | 185 | 82 | 1325 | 0 | 93 |
| 11 | 0 | 2152 | 152 | 0 | 114 | 807 | 313 | 208 | 279 | 125 | 1611 | 85 | 150 |
| 12 | 0 | 3508 | 308 | 0 | 0 | 1190 | 491 | 323 | 419 | 191 | 1952 | 128 | 240 |
| 13 | 0 | 5695 | 624 | 1 | 93 | 1749 | 768 | 501 | 627 | 291 | 2354 | 162 | 384 |
| 14 | 78 | 9194 | 1261 | 2 | 258 | 2556 | 1198 | 774 | 936 | 441 | 2823 | 660 | 613 |
| 15 | 2074 | 14706 | 2539 | 7 | 1249 | 3708 | 1858 | 1189 | 1388 | 666 | 3378 | 1741 | 977 |
| 16 | 3974 | 23341 | 5134 | 22 | 2240 | 5320 | 2854 | 1811 | 2040 | 999 | 3994 | 1861 | 1548 |
| 17 | 13727 | 35990 | 10072 | 83 | 4673 | 7583 | 4326 | 2727 | 2961 | 1484 | 4671 | 3527 | 2433 |
| 18 | 29620 | 54001 | 19279 | 299 | 10649 | 10421 | 6429 | 4065 | 4241 | 2171 | 5432 | 5003 | 3776 |
| 19 | 29666 | 78433 | 35810 | 814 | 12931 | 14209 | 9295 | 5897 | 5938 | 3114 | 6254 | 5991 | 5753 |
| 20 | 63382 | 234265 | 156289 | 2955 | 23271 | 18858 | 13425 | 8348 | 8279 | 4394 | 7573 | 12116 | 8605 |
| 21 | 51922 | 138484 | 108031 | 32996 | 19615 | 24820 | 18569 | 11413 | 11910 | 6276 | 9341 | 10260 | 12424 |
| 22 | 64770 | 77194 | 60622 | 31979 | 29023 | 21298 | 21587 | 16010 | 12320 | 8902 | 17764 | 24263 | 17516 |
| 23 | 44411 | 51001 | 36064 | 22597 | 23464 | 30692 | 23143 | 17227 | 17576 | 9357 | 15299 | 24812 | 19523 |
| 24 | 31551 | 43954 | 28456 | 17129 | 29262 | 41808 | 24072 | 19876 | 17805 | 12836 | 20763 | 26235 | 19730 |
| 25 | 35162 | 39829 | 28130 | 17956 | 34469 | 41355 | 31065 | 22724 | 21385 | 19960 | 30089 | 34467 | 29383 |
| 26 | 30342 | 30817 | 23441 | 18775 | 29237 | 32754 | 29245 | 22702 | 24510 | 20810 | 24100 | 24211 | 19056 |
| 27 | 28357 | 28715 | 22331 | 16290 | 23611 | 31610 | 28907 | 23633 | 27943 | 20472 | 25462 | 24104 | 17498 |
| 28 | 24925 | 26134 | 19157 | 19672 | 22213 | 33851 | 29028 | 21631 | 22031 | 16618 | 20563 | 17450 | 14261 |
| 29 | 18703 | 20952 | 14247 | 16275 | 17276 | 25413 | 21145 | 16961 | 16324 | 16763 | 21463 | 13189 | 10261 |
| 30 | 18407 | 17871 | 13696 | 12061 | 15053 | 20084 | 21682 | 16111 | 19413 | 20478 | 21774 | 17021 | 16882 |
| 31 | 11419 | 13159 | 9038 | 11090 | 12505 | 14375 | 13535 | 11276 | 13418 | 14098 | 9856 | 8668 | 9417 |
| 32 | 10185 | 12823 | 8410 | 8541 | 8635 | 12825 | 12751 | 11524 | 13710 | 14436 | 9652 | 9718 | 9860 |
| 33 | 8528 | 8848 | 7128 | 10650 | 7273 | 9311 | 11387 | 7033 | 7128 | 8589 | 6344 | 6178 | 6038 |
| 34 | 5926 | 7812 | 6967 | 10543 | 7987 | 7324 | 7361 | 6688 | 7590 | 6529 | 4820 | 6770 | 5930 |
| 35 | 5763 | 5935 | 6214 | 7637 | 5425 | 5931 | 6309 | 5648 | 4678 | 6580 | 4739 | 6787 | 5277 |
| 36 | 4033 | 5064 | 4532 | 6274 | 4979 | 4999 | 4609 | 4338 | 3709 | 4134 | 2568 | 5356 | 4295 |
| 37 | 4024 | 3754 | 3545 | 4841 | 4541 | 4195 | 4089 | 3753 | 3496 | 4227 | 2135 | 4796 | 3232 |
| 38 | 3131 | 3106 | 3193 | 4966 | 2993 | 3933 | 2991 | 2771 | 2879 | 2788 | 1142 | 3571 | 2589 |
| 39 | 2151 | 2778 | 2154 | 3339 | 2869 | 2987 | 2290 | 1841 | 1746 | 1596 | 927 | 2205 | 2186 |
| 40 | 2425 | 2159 | 2175 | 2766 | 2414 | 2574 | 2206 | 1738 | 2015 | 1956 | 982 | 3140 | 2353 |
| 41 | 1375 | 1753 | 1461 | 1951 | 2076 | 1546 | 1452 | 1150 | 1123 | 1250 | 520 | 1558 | 1363 |
| 42 | 1350 | 1542 | 1130 | 1668 | 1662 | 1599 | 1111 | 1118 | 1558 | 1142 | 508 | 1490 | 1124 |
| 43 | 1150 | 1209 | 1087 | 1908 | 1495 | 1348 | 1069 | 687 | 1039 | 610 | 370 | 1055 | 762 |
| 44 | 965 | 704 | 1192 | 1401 | 1089 | 1050 | 745 | 500 | 915 | 414 | 219 | 778 | 708 |
| 45 | 641 | 581 | 1194 | 955 | 1058 | 766 | 684 | 550 | 700 | 464 | 253 | 904 | 429 |
| 46 | 645 | 689 | 669 | 713 | 666 | 734 | 584 | 353 | 460 | 374 | 135 | 525 | 424 |
| 47 | 509 | 391 | 641 | 715 | 431 | 567 | 417 | 407 | 437 | 397 | 140 | 327 | 276 |
| 48 | 343 | 333 | 526 | 863 | 636 | 588 | 456 | 270 | 494 | 264 | 92 | 382 | 104 |
| 49 | 290 | 254 | 378 | 470 | 377 | 263 | 145 | 178 | 254 | 205 | 57 | 132 | 151 |
| 50 | 319 | 216 | 351 | 230 | 263 | 256 | 238 | 273 | 255 | 179 | 76 | 154 | 159 |
| 51 | 135 | 241 | 240 | 181 | 210 | 107 | 126 | 156 | 214 | 123 | 38 | 191 | 58 |
| 52 | 192 | 48 | 180 | 335 | 180 | 159 | 202 | 107 | 175 | 77 | 30 | 115 | 93 |
| 53 | 137 | 70 | 150 | 121 | 124 | 111 | 55 | 136 | 91 | 84 | 26 | 156 | 23 |
| 54 | 111 | 112 | 218 | 99 | 189 | 94 | 120 | 77 | 55 | 75 | 11 | 93 | 11 |
| 55 | 76 | 85 | 187 | 53 | 63 | 61 | 128 | 66 | 91 | 53 | 9 | 114 | 16 |
| 56 | 111 | 41 | 123 | 26 | 28 | 66 | 50 | 49 | 47 | 62 | 12 | 7 | 5 |
| 57 | 74 | 39 | 116 | 43 | 34 | 61 | 72 | 36 | 77 | 48 | 8 | 31 | 14 |
| 58 | 39 | 65 | 70 | 2 | 11 | 68 | 58 | 47 | 88 | 48 | 9 | 14 | 5 |
| 59 | 32 | 60 | 36 | 13 | 17 | 28 | 13 | 31 | 36 | 30 | 8 | 10 | 2 |
| 60 | 21 | 7 | 30 | 5 | 24 | 7 | 54 | 26 | 32 | 9 | 5 | 8 | 4 |
| 61 | 21 | 15 | 15 | 4 | 11 | 0 | 25 | 12 | 4 | 4 | 0 | 0 | 3 |
| 62 | 0 | 0 | 21 | 10 | 0 | 44 | 3 | 8 | 0 | 9 | 1 | 10 | 0 |
| 63 | 19 | 13 | 10 | 0 | 3 | 28 | 0 | 5 | 20 | 4 | 5 | 4 | 0 |
| 64 | 0 | 7 | 0 | 0 | 0 | 14 | 7 | 10 | 0 | 0 | 0 | 0 | 0 |
| 65 | 8 | 0 | 4 | 0 | 0 | 0 | 30 | 16 | 4 | 0 | 0 | 4 | 2 |
| 66 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 20 | 2 | 4 | 0 | 0 |
| 67 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 3 | 0 | 0 | 0 | 0 | 0 |
| 68 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 69 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 |
| 71 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| 72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 74 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 557218 | 1011467 | 649102 | 292325 | 368972 | 448648 | 365006 | 277146 | 287074 | 237291 | 293688 | 312544 | 258025 |
| Weights | 7164 | 9997 | 7470 | 5599 | 5967 | 7034 | 6116 | 4833 | 5159 | 4614 | 4415 | 5318 | 4357 |

Table 10.3.d Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) removals length distributions in 1987-1999.

| Removals= | dings+ | ches ( | rviva | 30\%) |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CL mm/ | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
| 10 | 0 | 922 | 52 | 0 | 0 | 382 | 139 | 94 | 130 | 57 | 928 | 0 | 65 |
| 11 | 0 | 1507 | 106 | 0 | 80 | 565 | 219 | 146 | 195 | 88 | 1128 | 60 | 105 |
| 12 | 0 | 2455 | 216 | 0 | 0 | 833 | 344 | 226 | 293 | 134 | 1366 | 89 | 168 |
| 13 | 0 | 3987 | 437 | 0 | 65 | 1224 | 538 | 351 | 439 | 203 | 1648 | 114 | 269 |
| 14 | 55 | 6436 | 883 | 1 | 181 | 1789 | 839 | 542 | 655 | 309 | 1976 | 462 | 429 |
| 15 | 1452 | 10294 | 1777 | 5 | 875 | 2595 | 1301 | 832 | 972 | 466 | 2369 | 1219 | 684 |
| 16 | 2782 | 16386 | 3611 | 15 | 1568 | 3724 | 1998 | 1268 | 1428 | 699 | 2800 | 1302 | 1084 |
| 17 | 9654 | 25262 | 7074 | 62 | 3282 | 5326 | 3028 | 1909 | 2072 | 1039 | 3270 | 2469 | 1703 |
| 18 | 20833 | 37967 | 13534 | 229 | 7464 | 7294 | 4500 | 2855 | 2974 | 1520 | 3802 | 3502 | 2643 |
| 19 | 21155 | 55469 | 25338 | 584 | 9075 | 9987 | 6507 | 4150 | 4175 | 2180 | 4378 | 4194 | 4027 |
| 20 | 45306 | 165254 | 110239 | 2228 | 16432 | 13336 | 9537 | 5906 | 5898 | 3090 | 5436 | 8489 | 6045 |
| 21 | 38288 | 99604 | 77733 | 23681 | 14202 | 17852 | 13384 | 8134 | 8809 | 4518 | 6933 | 7269 | 8763 |
| 22 | 49389 | 58851 | 46327 | 24159 | 21736 | 16093 | 16274 | 12054 | 9343 | 6624 | 13274 | 17280 | 12516 |
| 23 | 37489 | 43313 | 30667 | 19090 | 18781 | 24395 | 18420 | 13669 | 13960 | 7390 | 12101 | 18320 | 14232 |
| 24 | 29387 | 40953 | 26507 | 15979 | 25139 | 35550 | 20435 | 16808 | 15083 | 10807 | 17535 | 20310 | 15021 |
| 25 | 34356 | 38768 | 27386 | 17501 | 30052 | 37311 | 28048 | 20431 | 19274 | 17944 | 27014 | 28321 | 23783 |
| 26 | 30141 | 30514 | 23233 | 18604 | 27098 | 30913 | 27591 | 21385 | 23088 | 19601 | 22684 | 21008 | 16516 |
| 27 | 28276 | 28615 | 22259 | 16236 | 23098 | 30650 | 28048 | 22897 | 27098 | 19846 | 24670 | 21853 | 16066 |
| 28 | 24925 | 26099 | 19136 | 19649 | 21914 | 33323 | 28594 | 21288 | 21696 | 16356 | 20234 | 16545 | 13600 |
| 29 | 18703 | 20942 | 14241 | 16268 | 17235 | 25217 | 20989 | 16831 | 16199 | 16633 | 21287 | 12782 | 10017 |
| 30 | 18407 | 17868 | 13693 | 12059 | 14965 | 20008 | 21602 | 16049 | 19338 | 20399 | 21688 | 16815 | 16674 |
| 31 | 11419 | 13158 | 9038 | 11089 | 12476 | 14347 | 13510 | 11255 | 13392 | 14072 | 9836 | 8629 | 9354 |
| 32 | 10185 | 12823 | 8410 | 8541 | 8635 | 12813 | 12739 | 11514 | 13697 | 14423 | 9643 | 9574 | 9826 |
| 33 | 8528 | 8848 | 7128 | 10649 | 7273 | 9306 | 11382 | 7030 | 7124 | 8585 | 6341 | 6109 | 6027 |
| 34 | 5926 | 7812 | 6967 | 10543 | 7987 | 7322 | 7360 | 6687 | 7588 | 6527 | 4819 | 6725 | 5924 |
| 35 | 5763 | 5935 | 6214 | 7637 | 5425 | 5930 | 6309 | 5647 | 4678 | 6580 | 4738 | 6761 | 5274 |
| 36 | 4033 | 5064 | 4532 | 6274 | 4979 | 4999 | 4609 | 4338 | 3709 | 4133 | 2568 | 5341 | 4294 |
| 37 | 4024 | 3754 | 3545 | 4841 | 4541 | 4195 | 4089 | 3753 | 3496 | 4226 | 2135 | 4774 | 3231 |
| 38 | 3131 | 3106 | 3193 | 4966 | 2993 | 3933 | 2991 | 2771 | 2879 | 2788 | 1142 | 3558 | 2589 |
| 39 | 2151 | 2778 | 2154 | 3339 | 2869 | 2987 | 2290 | 1841 | 1746 | 1596 | 927 | 2195 | 2186 |
| 40 | 2425 | 2159 | 2175 | 2766 | 2414 | 2574 | 2206 | 1738 | 2015 | 1956 | 982 | 3123 | 2353 |
| 41 | 1375 | 1753 | 1461 | 1951 | 2076 | 1546 | 1452 | 1150 | 1123 | 1250 | 520 | 1558 | 1363 |
| 42 | 1350 | 1542 | 1130 | 1668 | 1662 | 1599 | 1111 | 1118 | 1558 | 1142 | 508 | 1490 | 1124 |
| 43 | 1150 | 1209 | 1087 | 1908 | 1495 | 1348 | 1069 | 687 | 1039 | 610 | 370 | 1053 | 761 |
| 44 | 965 | 704 | 1192 | 1401 | 1089 | 1050 | 745 | 500 | 915 | 414 | 219 | 769 | 708 |
| 45 | 641 | 581 | 1194 | 955 | 1058 | 766 | 684 | 550 | 700 | 464 | 253 | 904 | 429 |
| 46 | 645 | 689 | 669 | 713 | 666 | 734 | 584 | 353 | 460 | 374 | 135 | 525 | 424 |
| 47 | 509 | 391 | 641 | 715 | 431 | 567 | 417 | 407 | 437 | 397 | 140 | 327 | 276 |
| 48 | 343 | 333 | 526 | 863 | 636 | 588 | 456 | 270 | 494 | 264 | 92 | 382 | 104 |
| 49 | 290 | 254 | 378 | 470 | 377 | 263 | 145 | 178 | 254 | 205 | 57 | 132 | 151 |
| 50 | 319 | 216 | 351 | 230 | 263 | 256 | 238 | 273 | 255 | 179 | 76 | 154 | 159 |
| 51 | 135 | 241 | 240 | 181 | 210 | 107 | 126 | 156 | 214 | 123 | 38 | 191 | 58 |
| 52 | 192 | 48 | 180 | 335 | 180 | 159 | 202 | 107 | 175 | 77 | 30 | 115 | 93 |
| 53 | 137 | 70 | 150 | 121 | 124 | 111 | 55 | 136 | 91 | 84 | 26 | 156 | 23 |
| 54 | 111 | 112 | 218 | 99 | 189 | 94 | 120 | 77 | 55 | 75 | 11 | 93 | 11 |
| 55 | 76 | 85 | 187 | 53 | 63 | 61 | 128 | 66 | 91 | 53 | 9 | 114 | 16 |
| 56 | 111 | 41 | 123 | 26 | 28 | 66 | 50 | 49 | 47 | 62 | 12 | 7 | 5 |
| 57 | 74 | 39 | 116 | 43 | 34 | 61 | 72 | 36 | 77 | 48 | 8 | 31 | 14 |
| 58 | 39 | 65 | 70 | 2 | 11 | 68 | 58 | 47 | 88 | 48 | 9 | 14 | 5 |
| 59 | 32 | 60 | 36 | 13 | 17 | 28 | 13 | 31 | 36 | 30 | 8 | 10 | 2 |
| 60 | 21 | 7 | 30 | 5 | 24 | 7 | 54 | 26 | 32 | 9 | 5 | 8 | 4 |
| 61 | 21 | 15 | 15 | 4 | 11 | 0 | 25 | 12 | 4 | 4 | 0 | 0 | 3 |
| 62 | 0 | 0 | 21 | 10 | 0 | 44 | 3 | 8 | 0 | 9 | 1 | 10 | 0 |
| 63 | 19 | 13 | 10 | 0 | 3 | 28 | 0 | 5 | 20 | 4 | 5 | 4 | 0 |
| 64 | 0 | 7 | 0 | 0 | 0 | 14 | 7 | 10 | 0 | 0 | 0 | 0 | 0 |
| 65 | 8 | 0 | 4 | 0 | 0 | 0 | 30 | 16 | 4 | 0 | 0 | 4 | 2 |
| 66 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 20 | 2 | 4 | 0 | 0 |
| 67 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 3 | 0 | 0 | 0 | 0 | 0 |
| 68 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 69 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 |
| 71 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| 72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 74 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 476745 | 805376 | 527834 | 268762 | 323482 | 396340 | 327696 | 250666 | 261640 | 220716 | 262190 | 267245 | 221208 |
| Weights | 6634 | 8760 | 6679 | 5411 | 5603 | 6628 | 5814 | 4610 | 4947 | 4465 | 4173 | 4882 | 4013 |

Table 10.4.a Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) landings length distributions in 2000-2012

| Landings |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CL mm/ | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 20 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 14 | 13 | 0 | 14 | 0 | 25 | 5 | 4 | 12 | 0 | 0 | 0 | 0 |
| 19 | 11 | 38 | 0 | 0 | 14 | 27 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 20 | 116 | 284 | 107 | 87 | 47 | 82 | 5 | 4 | 77 | 37 | 14 | 22 | 35 |
| 21 | 433 | 643 | 925 | 280 | 249 | 270 | 70 | 14 | 191 | 73 | 75 | 6 | 25 |
| 22 | 1015 | 2116 | 1122 | 661 | 899 | 771 | 131 | 18 | 208 | 288 | 252 | 11 | 235 |
| 23 | 2531 | 6261 | 5513 | 1614 | 2194 | 2588 | 227 | 48 | 322 | 473 | 386 | 111 | 334 |
| 24 | 5462 | 8915 | 10061 | 3966 | 5664 | 6511 | 822 | 188 | 721 | 1929 | 1238 | 515 | 1399 |
| 25 | 11357 | 17106 | 12951 | 8164 | 10930 | 13678 | 2844 | 1201 | 2742 | 3670 | 3940 | 1803 | 3843 |
| 26 | 10212 | 13745 | 21403 | 13297 | 13998 | 17811 | 6376 | 5684 | 6319 | 8258 | 8499 | 4773 | 7875 |
| 27 | 11528 | 17098 | 19433 | 17614 | 16094 | 22006 | 12010 | 9439 | 10891 | 12759 | 14173 | 7520 | 11079 |
| 28 | 12639 | 15835 | 22074 | 18572 | 15350 | 21879 | 14647 | 13248 | 12640 | 15732 | 15390 | 8991 | 11920 |
| 29 | 11473 | 13779 | 16559 | 16843 | 14808 | 18027 | 14591 | 12516 | 12890 | 13524 | 15340 | 9602 | 11120 |
| 30 | 13888 | 16168 | 18105 | 17264 | 14143 | 15570 | 13690 | 12219 | 10726 | 13271 | 15736 | 8821 | 9636 |
| 31 | 9828 | 11316 | 9989 | 13345 | 12353 | 12634 | 11814 | 10698 | 9772 | 10859 | 12749 | 8253 | 8393 |
| 32 | 8936 | 11335 | 10284 | 11276 | 10322 | 9907 | 9694 | 9274 | 8845 | 9310 | 11366 | 6954 | 7414 |
| 33 | 6333 | 8250 | 7813 | 8253 | 8020 | 7800 | 8421 | 7859 | 7436 | 7086 | 8851 | 6175 | 6069 |
| 34 | 5225 | 6185 | 5308 | 6195 | 6298 | 6537 | 7112 | 6539 | 6425 | 5985 | 7140 | 5467 | 4505 |
| 35 | 4895 | 5213 | 4309 | 4653 | 4673 | 5100 | 5135 | 6529 | 5366 | 4568 | 5852 | 4541 | 3507 |
| 36 | 3242 | 4037 | 3157 | 3818 | 3308 | 3369 | 4104 | 4735 | 3867 | 3697 | 3626 | 4260 | 2649 |
| 37 | 2946 | 2901 | 2049 | 3075 | 2875 | 2597 | 3196 | 3839 | 3121 | 2565 | 3024 | 3648 | 1976 |
| 38 | 2687 | 2369 | 2224 | 2660 | 2098 | 2380 | 2662 | 2639 | 2398 | 1871 | 2247 | 3911 | 1563 |
| 39 | 2027 | 2297 | 1559 | 2174 | 1683 | 1650 | 1956 | 2245 | 2043 | 1491 | 1630 | 3472 | 1314 |
| 40 | 1862 | 1908 | 1398 | 1936 | 1555 | 1628 | 1599 | 1711 | 1633 | 1190 | 1280 | 3296 | 1103 |
| 41 | 1020 | 941 | 764 | 1423 | 1188 | 1154 | 1171 | 1227 | 1190 | 878 | 966 | 2740 | 878 |
| 42 | 797 | 863 | 632 | 1403 | 889 | 953 | 990 | 1111 | 1015 | 742 | 742 | 2497 | 635 |
| 43 | 534 | 530 | 640 | 1054 | 774 | 842 | 741 | 710 | 805 | 540 | 560 | 2157 | 558 |
| 44 | 413 | 383 | 432 | 810 | 707 | 640 | 633 | 746 | 706 | 473 | 509 | 1762 | 536 |
| 45 | 421 | 523 | 416 | 808 | 613 | 605 | 595 | 518 | 536 | 396 | 442 | 1177 | 478 |
| 46 | 248 | 294 | 328 | 535 | 485 | 415 | 479 | 373 | 405 | 307 | 305 | 1024 | 441 |
| 47 | 213 | 368 | 241 | 456 | 388 | 353 | 440 | 311 | 361 | 262 | 290 | 858 | 378 |
| 48 | 205 | 188 | 188 | 339 | 313 | 339 | 382 | 257 | 294 | 245 | 237 | 656 | 381 |
| 49 | 177 | 183 | 79 | 206 | 318 | 288 | 319 | 237 | 262 | 196 | 204 | 557 | 212 |
| 50 | 154 | 160 | 115 | 253 | 306 | 276 | 287 | 190 | 228 | 156 | 160 | 501 | 160 |
| 51 | 109 | 135 | 73 | 170 | 214 | 176 | 246 | 163 | 201 | 115 | 135 | 383 | 132 |
| 52 | 85 | 102 | 46 | 150 | 152 | 184 | 201 | 138 | 116 | 110 | 120 | 296 | 128 |
| 53 | 133 | 82 | 51 | 120 | 111 | 142 | 137 | 140 | 121 | 98 | 97 | 198 | 96 |
| 54 | 63 | 40 | 20 | 80 | 90 | 104 | 156 | 115 | 95 | 63 | 95 | 271 | 93 |
| 55 | 75 | 53 | 30 | 57 | 47 | 109 | 137 | 79 | 73 | 75 | 79 | 152 | 58 |
| 56 | 18 | 24 | 13 | 23 | 86 | 69 | 117 | 60 | 67 | 54 | 75 | 132 | 46 |
| 57 | 20 | 46 | 6 | 47 | 49 | 58 | 134 | 70 | 41 | 31 | 67 | 98 | 48 |
| 58 | 16 | 29 | 6 | 22 | 27 | 43 | 134 | 45 | 40 | 48 | 47 | 105 | 52 |
| 59 | 7 | 26 | 3 | 10 | 32 | 41 | 85 | 33 | 19 | 23 | 48 | 79 | 33 |
| 60 | 2 | 21 | 11 | 8 | 10 | 19 | 115 | 33 | 23 | 14 | 42 | 48 | 22 |
| 61 | 8 | 7 | 0 | 5 | 5 | 28 | 40 | 23 | 7 | 8 | 30 | 39 | 15 |
| 62 | 1 | 2 | 0 | 4 | 3 | 16 | 21 | 9 | 9 | 9 | 16 | 55 | 18 |
| 63 | 0 | 5 | 1 | 1 | 5 | 9 | 19 | 9 | 7 | 10 | 7 | 23 | 11 |
| 64 | 4 | 0 | 0 | 0 | 8 | 8 | 18 | 10 | 6 | 3 | 16 | 12 | 8 |
| 65 | 1 | 0 | 1 | 0 | 1 | 14 | 11 | 9 | 1 | 3 | 9 | 11 | 7 |
| 66 | 0 | 0 | 0 | 1 | 1 | 6 | 10 | 1 | 0 | 2 | 3 | 11 | 3 |
| 67 | 0 | 0 | 0 | 0 | 1 | 5 | 8 | 1 | 0 | 2 | 3 | 6 | 1 |
| 68 | 0 | 0 | 0 | 0 | 2 | 4 | 7 | 3 | 0 | 0 | 4 | 7 | 0 |
| 69 | 0 | 0 | 0 | 1 | 0 | 1 | 6 | 2 | 0 | 1 | 1 | 2 | 2 |
| 70 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 0 | 0 | 0 | 1 | 2 | 0 |
| 71 | 0 | 0 | 0 | 1 | 0 | 1 | 5 | 0 | 0 | 0 | 1 | 1 | 0 |
| 72 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 74 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 1 | 0 |
| 75 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 1 |
| Total | 133383 | 172819 | 180442 | 163771 | 154405 | 179758 | 128777 | 117273 | 115274 | 123504 | 138120 | 108011 | 101424 |
| Weights | 3069 | 3730 | 3679 | 3886 | 3571 | 3991 | 3447 | 3176 | 3030 | 2987 | 3398 | 3559 | 2520 |

Table 10.4.b Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) discards length distributions in 2000-2012.

| Total Disc |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CL mm/\ | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| 10 | 186 | 950 | 1268 | 28 | 0 | 0 | 0 | 22 | 0 | 82 | 0 | 0 | 0 |
| 11 | 291 | 1341 | 1817 | 0 | 0 | 94 | 0 | 171 | 38 | 135 | 2 | 0 | 0 |
| 12 | 455 | 1890 | 2597 | 70 | 363 | 413 | 70 | 202 | 98 | 79 | 0 | 237 | 0 |
| 13 | 710 | 2654 | 3696 | 294 | 1722 | 1085 | 234 | 122 | 235 | 177 | 97 | 596 | 532 |
| 14 | 1104 | 3713 | 5233 | 636 | 3152 | 3190 | 1138 | 900 | 389 | 291 | 83 | 834 | 665 |
| 15 | 1710 | 5164 | 7354 | 1198 | 5548 | 7287 | 3102 | 1288 | 189 | 1157 | 155 | 941 | 1425 |
| 16 | 2631 | 7126 | 10227 | 3386 | 6784 | 13528 | 7810 | 2959 | 1027 | 2315 | 822 | 1230 | 4544 |
| 17 | 4008 | 9732 | 14027 | 5927 | 8836 | 15094 | 11655 | 3636 | 1832 | 3059 | 1333 | 2430 | 4737 |
| 18 | 6016 | 13110 | 18895 | 8078 | 10161 | 19795 | 16139 | 4590 | 2626 | 4843 | 2309 | 3630 | 8066 |
| 19 | 8843 | 17354 | 24883 | 11506 | 17361 | 19522 | 25891 | 5244 | 6473 | 6485 | 3532 | 4546 | 8024 |
| 20 | 12628 | 22483 | 31890 | 12142 | 19250 | 22265 | 39742 | 8735 | 11444 | 12766 | 5692 | 7227 | 10125 |
| 21 | 17372 | 28397 | 39629 | 18597 | 25898 | 32409 | 54220 | 11585 | 15630 | 16772 | 7699 | 10393 | 12145 |
| 22 | 25140 | 49505 | 24662 | 21416 | 25210 | 35523 | 69870 | 17930 | 24730 | 18701 | 11689 | 15161 | 14034 |
| 23 | 22623 | 54819 | 48438 | 28429 | 26756 | 40041 | 70094 | 24086 | 27560 | 21693 | 13672 | 13837 | 12904 |
| 24 | 21146 | 34491 | 39179 | 26501 | 21343 | 36279 | 55408 | 30615 | 29638 | 24105 | 16963 | 15551 | 14889 |
| 25 | 20177 | 30416 | 22841 | 23211 | 20085 | 30222 | 52660 | 32917 | 28007 | 20736 | 14670 | 16545 | 10873 |
| 26 | 8496 | 11137 | 17386 | 17357 | 12006 | 19003 | 38812 | 27376 | 23127 | 14205 | 11852 | 10047 | 7747 |
| 27 | 4780 | 6340 | 8069 | 9680 | 6436 | 8498 | 20124 | 20567 | 10129 | 9188 | 8558 | 8127 | 4304 |
| 28 | 2630 | 2658 | 4129 | 6187 | 3487 | 4603 | 10263 | 10365 | 5893 | 5927 | 5986 | 3201 | 919 |
| 29 | 1245 | 1183 | 1494 | 2537 | 2115 | 1201 | 4188 | 4464 | 3225 | 3163 | 3360 | 2086 | 588 |
| 30 | 679 | 665 | 876 | 1605 | 1901 | 1600 | 2578 | 2868 | 1923 | 3261 | 1876 | 2011 | 680 |
| 31 | 273 | 226 | 214 | 1326 | 1115 | 1417 | 1109 | 1316 | 925 | 1824 | 1274 | 1246 | 125 |
| 32 | 112 | 114 | 119 | 574 | 735 | 526 | 592 | 737 | 454 | 839 | 716 | 492 | 200 |
| 33 | 40 | 47 | 44 | 313 | 503 | 296 | 544 | 484 | 421 | 671 | 350 | 265 | 13 |
| 34 | 17 | 20 | 21 | 261 | 385 | 553 | 411 | 537 | 1025 | 830 | 274 | 272 | 145 |
| 35 | 8 | 7 | 7 | 176 | 424 | 260 | 230 | 265 | 206 | 332 | 242 | 174 | 24 |
| 36 | 3 | 4 | 4 | 113 | 108 | 46 | 73 | 336 | 78 | 197 | 55 | 59 | 3 |
| 37 | 2 | 1 | 1 | 83 | 74 | 246 | 25 | 299 | 153 | 188 | 162 | 149 | 146 |
| 38 | 1 | 1 | 1 | 93 | 31 | 116 | 99 | 40 | 93 | 269 | 16 | 97 | 68 |
| 39 | 0 | 1 | 0 | 15 | 139 | 147 | 0 | 3 | 369 | 55 | 33 | 24 | 0 |
| 40 | 0 | 0 | 0 | 37 | 73 | 37 | 169 | 47 | 0 | 66 | 38 | 25 | 3 |
| 41 | 0 | 0 | 0 | 34 | 60 | 20 | 0 | 40 | 0 | 8 | 4 | 0 | 0 |
| 42 | 0 | 0 | 0 | 4 | 12 | 31 | 0 | 20 | 53 | 0 | 4 | 157 | 0 |
| 43 | 0 | 0 | 0 | 14 | 13 | 0 | 0 | 11 | 0 | 38 | 0 | 4 | 4 |
| 44 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 14 | 6 | 0 | 0 |
| 45 | 0 | 0 | 0 | 13 | 0 | 0 | 36 | 0 | 0 | 0 | 0 | 5 | 0 |
| 46 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 |
| 47 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 |
| 49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 |
| 51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 57 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 58 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 0 | 0 | 0 | 0 |
| 59 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 62 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 64 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 66 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 67 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 68 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 69 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 71 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 74 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 163330 | 305547 | 329002 | 201841 | 222102 | 315346 | 487288 | 214788 | 198031 | 174480 | 113530 | 121603 | 117935 |
| Weights | 1455 | 2537 | 2620 | 1977 | 1932 | 2698 | 4544 | 2411 | 2123 | 1833 | 1275 | 1263 | 1012 |

Table 10.4.c Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) catches length distributions in 2000-2012.

| Total catel |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CL mm/ | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| 10 | 186 | 950 | 1268 | 28 | 0 | 0 | 0 | 22 | 0 | 82 | 0 | 0 | 0 |
| 11 | 291 | 1341 | 1817 | 0 | 0 | 94 | 0 | 171 | 38 | 135 | 2 | 0 | 0 |
| 12 | 455 | 1890 | 2597 | 70 | 363 | 413 | 70 | 202 | 98 | 79 | 0 | 237 | 0 |
| 13 | 710 | 2654 | 3696 | 294 | 1722 | 1085 | 234 | 122 | 235 | 177 | 97 | 596 | 532 |
| 14 | 1104 | 3713 | 5233 | 636 | 3152 | 3190 | 1138 | 900 | 389 | 291 | 83 | 834 | 665 |
| 15 | 1710 | 5164 | 7354 | 1198 | 5548 | 7287 | 3102 | 1289 | 189 | 1157 | 155 | 941 | 1425 |
| 16 | 2631 | 7126 | 10227 | 3386 | 6784 | 13528 | 7810 | 2959 | 1027 | 2315 | 822 | 1230 | 4544 |
| 17 | 4008 | 9732 | 14027 | 5947 | 8843 | 15094 | 11655 | 3636 | 1832 | 3059 | 1333 | 2430 | 4737 |
| 18 | 6031 | 13122 | 18895 | 8092 | 10161 | 19820 | 16144 | 4593 | 2638 | 4843 | 2309 | 3630 | 8066 |
| 19 | 8854 | 17392 | 24883 | 11506 | 17376 | 19549 | 25891 | 5244 | 6473 | 6485 | 3532 | 4546 | 8024 |
| 20 | 12744 | 22767 | 31997 | 12229 | 19297 | 22348 | 39747 | 8738 | 11521 | 12803 | 5706 | 7249 | 10160 |
| 21 | 17805 | 29040 | 40555 | 18877 | 26146 | 32679 | 54289 | 11598 | 15820 | 16845 | 7775 | 10398 | 12170 |
| 22 | 26155 | 51621 | 25784 | 22077 | 26109 | 36293 | 70001 | 17948 | 24938 | 18989 | 11941 | 15171 | 14269 |
| 23 | 25155 | 61081 | 53951 | 30042 | 28950 | 42629 | 70322 | 24134 | 27882 | 22167 | 14058 | 13948 | 13238 |
| 24 | 26608 | 43406 | 49240 | 30467 | 27006 | 42790 | 56230 | 30803 | 30359 | 26034 | 18202 | 16065 | 16288 |
| 25 | 31534 | 47522 | 35792 | 31376 | 31015 | 43900 | 55504 | 34119 | 30750 | 24406 | 18610 | 18348 | 14716 |
| 26 | 18708 | 24882 | 38790 | 30654 | 26004 | 36814 | 45189 | 33060 | 29446 | 22463 | 20352 | 14820 | 15622 |
| 27 | 16307 | 23438 | 27502 | 27294 | 22530 | 30504 | 32134 | 30006 | 21020 | 21948 | 22730 | 15647 | 15383 |
| 28 | 15269 | 18493 | 26203 | 24759 | 18837 | 26482 | 24909 | 23613 | 18533 | 21659 | 21375 | 12191 | 12838 |
| 29 | 12718 | 14962 | 18053 | 19381 | 16923 | 19228 | 18779 | 16980 | 16115 | 16687 | 18700 | 11687 | 11708 |
| 30 | 14567 | 16833 | 18981 | 18868 | 16044 | 17170 | 16268 | 15087 | 12649 | 16531 | 17612 | 10832 | 10315 |
| 31 | 10102 | 11542 | 10203 | 14672 | 13469 | 14051 | 12923 | 12014 | 10697 | 12682 | 14024 | 9500 | 8518 |
| 32 | 9048 | 11448 | 10403 | 11849 | 11057 | 10433 | 10286 | 10011 | 9299 | 10150 | 12082 | 7447 | 7614 |
| 33 | 6373 | 8297 | 7857 | 8566 | 8523 | 8095 | 8965 | 8343 | 7857 | 7757 | 9201 | 6440 | 6082 |
| 34 | 5242 | 6204 | 5329 | 6456 | 6684 | 7090 | 7524 | 7076 | 7449 | 6815 | 7414 | 5739 | 4649 |
| 35 | 4903 | 5220 | 4316 | 4829 | 5097 | 5361 | 5366 | 6793 | 5573 | 4900 | 6094 | 4715 | 3531 |
| 36 | 3245 | 4041 | 3161 | 3931 | 3416 | 3415 | 4177 | 5071 | 3945 | 3894 | 3681 | 4319 | 2652 |
| 37 | 2947 | 2903 | 2050 | 3158 | 2949 | 2844 | 3221 | 4138 | 3273 | 2753 | 3186 | 3797 | 2122 |
| 38 | 2688 | 2370 | 2225 | 2752 | 2129 | 2496 | 2760 | 2679 | 2491 | 2139 | 2263 | 4007 | 1632 |
| 39 | 2027 | 2298 | 1560 | 2189 | 1822 | 1797 | 1956 | 2247 | 2412 | 1546 | 1662 | 3496 | 1314 |
| 40 | 1862 | 1908 | 1399 | 1973 | 1628 | 1665 | 1768 | 1758 | 1633 | 1257 | 1318 | 3321 | 1107 |
| 41 | 1020 | 941 | 764 | 1457 | 1248 | 1174 | 1171 | 1267 | 1190 | 886 | 971 | 2740 | 878 |
| 42 | 797 | 863 | 632 | 1407 | 901 | 984 | 990 | 1130 | 1069 | 742 | 746 | 2654 | 635 |
| 43 | 534 | 530 | 641 | 1068 | 787 | 842 | 741 | 722 | 805 | 578 | 560 | 2161 | 563 |
| 44 | 413 | 383 | 432 | 810 | 719 | 640 | 633 | 746 | 706 | 487 | 515 | 1762 | 536 |
| 45 | 421 | 523 | 416 | 821 | 613 | 605 | 631 | 518 | 536 | 396 | 442 | 1182 | 478 |
| 46 | 248 | 294 | 328 | 535 | 485 | 415 | 479 | 373 | 405 | 307 | 312 | 1024 | 441 |
| 47 | 213 | 368 | 241 | 456 | 388 | 353 | 440 | 311 | 361 | 262 | 290 | 865 | 378 |
| 48 | 205 | 188 | 188 | 339 | 313 | 339 | 382 | 257 | 294 | 254 | 237 | 656 | 381 |
| 49 | 177 | 183 | 79 | 206 | 318 | 288 | 319 | 237 | 262 | 196 | 204 | 557 | 212 |
| 50 | 154 | 160 | 115 | 253 | 306 | 276 | 287 | 201 | 228 | 156 | 160 | 501 | 160 |
| 51 | 109 | 135 | 73 | 170 | 214 | 176 | 246 | 163 | 201 | 115 | 135 | 383 | 132 |
| 52 | 85 | 102 | 46 | 150 | 152 | 184 | 201 | 138 | 116 | 110 | 120 | 296 | 128 |
| 53 | 133 | 82 | 51 | 120 | 111 | 142 | 137 | 140 | 121 | 98 | 97 | 198 | 96 |
| 54 | 63 | 40 | 20 | 80 | 90 | 104 | 156 | 115 | 95 | 63 | 95 | 271 | 93 |
| 55 | 75 | 53 | 30 | 57 | 47 | 109 | 137 | 79 | 73 | 75 | 79 | 152 | 58 |
| 56 | 18 | 24 | 13 | 23 | 86 | 69 | 117 | 60 | 67 | 54 | 75 | 132 | 46 |
| 57 | 20 | 46 | 6 | 47 | 49 | 58 | 134 | 70 | 41 | 31 | 67 | 98 | 48 |
| 58 | 16 | 29 | 6 | 22 | 27 | 43 | 134 | 45 | 80 | 48 | 47 | 105 | 52 |
| 59 | 7 | 26 | 3 | 10 | 32 | 41 | 85 | 33 | 19 | 23 | 48 | 79 | 33 |
| 60 | 2 | 21 | 11 | 8 | 10 | 19 | 115 | 33 | 23 | 14 | 42 | 48 | 22 |
| 61 | 8 | 7 | 0 | 5 | 5 | 28 | 40 | 23 | 7 | 8 | 30 | 39 | 15 |
| 62 | 1 | 2 | 0 | 4 | 3 | 16 | 21 | 9 | 9 | 9 | 16 | 55 | 18 |
| 63 | 0 | 5 | 1 | 1 | 5 | 9 | 19 | 9 | 7 | 10 | 7 | 23 | 11 |
| 64 | 4 | 0 | 0 | 0 | 8 | 8 | 18 | 10 | 6 | 3 | 16 | 12 | 8 |
| 65 | 1 | 0 | 1 | 0 | 1 | 14 | 11 | 9 | 1 | 3 | 9 | 11 | 7 |
| 66 | 0 | 0 | 0 | 1 | 1 | 6 | 10 | 1 | 0 | 2 | 3 | 11 | 3 |
| 67 | 0 | 0 | 0 | 0 | 1 | 5 | 8 | 1 | 0 | 2 | 3 | 6 | 1 |
| 68 | 0 | 0 | 0 | 0 | 2 | 4 | 7 | 3 | 0 | 0 | 4 | 7 | 0 |
| 69 | 0 | 0 | 0 | 1 | 0 | 1 | 6 | 2 | 0 | 1 | 1 | 2 | 2 |
| 70 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 0 | 0 | 0 | 1 | 2 | 0 |
| 71 | 0 | 0 | 0 | 1 | 0 | 1 | 5 | 0 | 0 | 0 | 1 | 1 | 0 |
| 72 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 74 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 1 | 0 |
| 75 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 1 |
| Total | 296713 | 478366 | 509443 | 365612 | 376507 | 495103 | 616065 | 332060 | 313305 | 297984 | 251649 | 229614 | 219358 |
| Weights | 4523 | 6267 | 6299 | 5863 | 5503 | 6689 | 7990 | 5587 | 5154 | 4820 | 4673 | 4822 | 3532 |

Table 10.4.d Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) removals length distributions in 2000-2012.

| Removals= | dings+de | tches (dis | survival | : 30\%) |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CL mm/ | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| 10 | 130 | 665 | 888 | 19 | 0 | 0 | 0 | 16 | 0 | 58 | 0 | 0 | 0 |
| 11 | 204 | 939 | 1272 | 0 | 0 | 66 | 0 | 119 | 27 | 94 | 1 | 0 | 0 |
| 12 | 319 | 1323 | 1818 | 49 | 254 | 289 | 49 | 142 | 69 | 56 | 0 | 166 | 0 |
| 13 | 497 | 1858 | 2587 | 206 | 1205 | 760 | 164 | 85 | 164 | 124 | 68 | 417 | 372 |
| 14 | 773 | 2599 | 3663 | 445 | 2206 | 2233 | 797 | 630 | 272 | 204 | 58 | 584 | 466 |
| 15 | 1197 | 3615 | 5148 | 839 | 3883 | 5101 | 2171 | 902 | 132 | 810 | 108 | 658 | 998 |
| 16 | 1842 | 4988 | 7159 | 2370 | 4749 | 9469 | 5467 | 2072 | 719 | 1621 | 575 | 861 | 3181 |
| 17 | 2806 | 6812 | 9819 | 4169 | 6193 | 10565 | 8158 | 2545 | 1282 | 2141 | 933 | 1701 | 3316 |
| 18 | 4226 | 9190 | 13226 | 5669 | 7112 | 13882 | 11302 | 3216 | 1851 | 3390 | 1616 | 2541 | 5646 |
| 19 | 6201 | 12186 | 17418 | 8055 | 12167 | 13692 | 18124 | 3671 | 4531 | 4540 | 2472 | 3183 | 5617 |
| 20 | 8956 | 16022 | 22430 | 8586 | 13522 | 15668 | 27825 | 6118 | 8087 | 8973 | 3998 | 5081 | 7122 |
| 21 | 12593 | 20521 | 28666 | 13298 | 18377 | 22957 | 38024 | 8123 | 11131 | 11813 | 5465 | 7281 | 8527 |
| 22 | 18613 | 36769 | 18385 | 15653 | 18546 | 25636 | 49040 | 12569 | 17519 | 13379 | 8434 | 10623 | 10058 |
| 23 | 18368 | 44635 | 39420 | 21514 | 20924 | 30617 | 49293 | 16909 | 19614 | 15659 | 9957 | 9797 | 9367 |
| 24 | 20264 | 33059 | 37486 | 22517 | 20604 | 31906 | 39608 | 21619 | 21468 | 18803 | 13113 | 11400 | 11821 |
| 25 | 25481 | 38397 | 28940 | 24412 | 24990 | 34834 | 39706 | 24243 | 22348 | 18185 | 14209 | 13385 | 11454 |
| 26 | 16159 | 21541 | 33574 | 25447 | 22402 | 31113 | 33545 | 24847 | 22508 | 18202 | 16796 | 11806 | 13298 |
| 27 | 14873 | 21536 | 25081 | 24390 | 20599 | 27955 | 26097 | 23835 | 17982 | 19191 | 20163 | 13209 | 14092 |
| 28 | 14480 | 17695 | 24964 | 22903 | 17791 | 25101 | 21831 | 20503 | 16765 | 19881 | 19579 | 11231 | 12563 |
| 29 | 12345 | 14607 | 17605 | 18619 | 16289 | 18868 | 17523 | 15641 | 15148 | 15738 | 17692 | 11061 | 11531 |
| 30 | 14363 | 16633 | 18718 | 18387 | 15474 | 16690 | 15495 | 14227 | 12072 | 15553 | 17049 | 10229 | 10111 |
| 31 | 10020 | 11475 | 10138 | 14274 | 13134 | 13626 | 12590 | 11619 | 10419 | 12135 | 13641 | 9126 | 8480 |
| 32 | 9014 | 11414 | 10367 | 11677 | 10836 | 10276 | 10108 | 9790 | 9163 | 9898 | 11867 | 7299 | 7554 |
| 33 | 6361 | 8283 | 7844 | 8472 | 8372 | 8007 | 8802 | 8197 | 7731 | 7556 | 9096 | 6361 | 6078 |
| 34 | 5237 | 6198 | 5323 | 6377 | 6568 | 6924 | 7400 | 6915 | 7142 | 6566 | 7332 | 5657 | 4606 |
| 35 | 4901 | 5218 | 4314 | 4776 | 4970 | 5282 | 5297 | 6714 | 5511 | 4801 | 6021 | 4663 | 3524 |
| 36 | 3244 | 4040 | 3160 | 3897 | 3384 | 3401 | 4155 | 4971 | 3921 | 3835 | 3665 | 4301 | 2651 |
| 37 | 2947 | 2902 | 2050 | 3133 | 2927 | 2770 | 3214 | 4048 | 3228 | 2696 | 3138 | 3753 | 2078 |
| 38 | 2688 | 2370 | 2225 | 2725 | 2120 | 2461 | 2731 | 2667 | 2463 | 2059 | 2258 | 3978 | 1611 |
| 39 | 2027 | 2298 | 1560 | 2184 | 1780 | 1753 | 1956 | 2246 | 2301 | 1529 | 1652 | 3489 | 1314 |
| 40 | 1862 | 1908 | 1399 | 1962 | 1606 | 1654 | 1717 | 1744 | 1633 | 1237 | 1306 | 3313 | 1106 |
| 41 | 1020 | 941 | 764 | 1447 | 1230 | 1168 | 1171 | 1255 | 1190 | 884 | 969 | 2740 | 878 |
| 42 | 797 | 863 | 632 | 1406 | 897 | 975 | 990 | 1125 | 1053 | 742 | 745 | 2607 | 635 |
| 43 | 534 | 530 | 641 | 1064 | 783 | 842 | 741 | 718 | 805 | 567 | 560 | 2160 | 561 |
| 44 | 413 | 383 | 432 | 810 | 715 | 640 | 633 | 746 | 706 | 483 | 514 | 1762 | 536 |
| 45 | 421 | 523 | 416 | 817 | 613 | 605 | 620 | 518 | 536 | 396 | 442 | 1181 | 478 |
| 46 | 248 | 294 | 328 | 535 | 485 | 415 | 479 | 373 | 405 | 307 | 310 | 1024 | 441 |
| 47 | 213 | 368 | 241 | 456 | 388 | 353 | 440 | 311 | 361 | 262 | 290 | 863 | 378 |
| 48 | 205 | 188 | 188 | 339 | 313 | 339 | 382 | 257 | 294 | 251 | 237 | 656 | 381 |
| 49 | 177 | 183 | 79 | 206 | 318 | 288 | 319 | 237 | 262 | 196 | 204 | 557 | 212 |
| 50 | 154 | 160 | 115 | 253 | 306 | 276 | 287 | 198 | 228 | 156 | 160 | 501 | 160 |
| 51 | 109 | 135 | 73 | 170 | 214 | 176 | 246 | 163 | 201 | 115 | 135 | 383 | 132 |
| 52 | 85 | 102 | 46 | 150 | 152 | 184 | 201 | 138 | 116 | 110 | 120 | 296 | 128 |
| 53 | 133 | 82 | 51 | 120 | 111 | 142 | 137 | 140 | 121 | 98 | 97 | 198 | 96 |
| 54 | 63 | 40 | 20 | 80 | 90 | 104 | 156 | 115 | 95 | 63 | 95 | 271 | 93 |
| 55 | 75 | 53 | 30 | 57 | 47 | 109 | 137 | 79 | 73 | 75 | 79 | 152 | 58 |
| 56 | 18 | 24 | 13 | 23 | 86 | 69 | 117 | 60 | 67 | 54 | 75 | 132 | 46 |
| 57 | 20 | 46 | 6 | 47 | 49 | 58 | 134 | 70 | 41 | 31 | 67 | 98 | 48 |
| 58 | 16 | 29 | 6 | 22 | 27 | 43 | 134 | 45 | 68 | 48 | 47 | 105 | 52 |
| 59 | 7 | 26 | 3 | 10 | 32 | 41 | 85 | 33 | 19 | 23 | 48 | 79 | 33 |
| 60 | 2 | 21 | 11 | 8 | 10 | 19 | 115 | 33 | 23 | 14 | 42 | 48 | 22 |
| 61 | 8 | 7 | 0 | 5 | 5 | 28 | 40 | 23 | 7 | 8 | 30 | 39 | 15 |
| 62 | 1 | 2 | 0 | 4 | 3 | 16 | 21 | 9 | 9 | 9 | 16 | 55 | 18 |
| 63 | 0 | 5 | 1 | 1 | 5 | 9 | 19 | 9 | 7 | 10 | 7 | 23 | 11 |
| 64 | 4 | 0 | 0 | 0 | 8 | 8 | 18 | 10 | 6 | 3 | 16 | 12 | 8 |
| 65 | 1 | 0 | 1 | 0 | 1 | 14 | 11 | 9 | 1 | 3 | 9 | 11 | 7 |
| 66 | 0 | 0 | 0 | 1 | 1 | 6 | 10 | 1 | 0 | 2 | 3 | 11 | 3 |
| 67 | 0 | 0 | 0 | 0 | 1 | 5 | 8 | 1 | 0 | 2 | 3 | 6 | 1 |
| 68 | 0 | 0 | 0 | 0 | 2 | 4 | 7 | 3 | 0 | 0 | 4 | 7 | 0 |
| 69 | 0 | 0 | 0 | 1 | 0 | 1 | 6 | 2 | 0 | 1 | 1 | 2 | 2 |
| 70 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 0 | 0 | 0 | 1 | 2 | 0 |
| 71 | 0 | 0 | 0 | 1 | 0 | 1 | 5 | 0 | 0 | 0 | 1 | 1 | 0 |
| 72 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 74 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 1 | 0 |
| 75 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 1 |
| Total | 247714 | 386702 | 410743 | 305060 | 309877 | 400500 | 469879 | 267624 | 253896 | 245640 | 217590 | 193133 | 183978 |
| Weights | 4087 | 5506 | 5513 | 5270 | 4923 | 5880 | 6627 | 4864 | 4517 | 4270 | 4290 | 4443 | 3229 |

Table 10.5. Nephrops in FUs 23-24 Bay of Biscay (VIIla,b). Effort and LPUE values of commercial fleets used in the assessment to tune the model.
Sub-area VIII a,b

|  | Le Guilvinec District Quarter 2 |  |  |
| :---: | :---: | :---: | :---: |
| Year | Landingss(t) | Effort(100h | LPUE(Kg/h) |
| 1987 | 603 | 437 | 13.8 |
| 1988 | 777 | 471 | 16.5 |
| 1989 | 862 | 664 | 13.0 |
| 1990 | 801 | 708 | 11.3 |
| 1991 | 717 | 728 | 9.8 |
| 1992 | 841 | 757 | 11.1 |
| 1993 | 805 | 735 | 11.0 |
| 1994 | 690 | 671 | 10.3 |
| 1995 | 609 | 627 | 9.7 |
| 1996 | 715 | 598 | 12.0 |
| 1997 | 638 | 539 | 11.8 |
| 1998 | 622 | 489 | 12.7 |
| 1999 | 505 | 423 | 11.9 |
| 2000 | 438 | 405 | 10.8 |
| 2001 | 697 | 417 | 16.7 |
| 2002 | 527 | 371 | 14.2 |
| 2003 | 487 | 355 | 13.7 |
| 2004 | 410 | 321 | 12.7 |
| 2005 | 455 | 335 | 13.6 |
| 2006 | 414 | 306 | 13.5 |
| 2007 | 401 | 291 | 13.8 |
| 2008 | 410 | 271 | 15.1 |
| 2009 | 384 | 279 | 13.8 |
| 2010 | 471 | 253 | 18.6 |
| 2011 | 422 | 279 | 15.1 |
| 2012 | 348 | 229 | 15.2 |

Table 10.6. Nephrops in FUs 23-24 Bay of Biscay (VIIIa,b) - Tune data

| bay | of | biscay | TUNE | DATA |  | EFFORT | 100HRS |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 102 |  |  |  |  |  |  |  |  |
| FLEET | QGV | Q2 |  |  |  |  |  |  |  |
| 1987 | 2012 |  |  |  |  |  |  |  |  |
| 1 | 1 | 0.25 | 0.5 |  |  |  |  |  |  |
| 1 | 9 |  |  |  |  |  |  |  |  |
| 436.7 | 2038.3 | 23308.9 | 12847.9 | 5447.0 | 1854.7 | 669.1 | 311.0 | 143.5 | 166.3 |
| 470.6 | 28972.6 | 42380.8 | 17741.0 | 7344.1 | 2398.1 | 884.8 | 379.7 | 199.9 | 292.7 |
| 663.5 | 1727.3 | 29214.9 | 14998.7 | 6871.6 | 2902.0 | 1656.7 | 840.3 | 352.5 | 789.3 |
| 707.8 | 14.8 | 7011.7 | 11214.6 | 8866.1 | 3778.3 | 1833.2 | 796.4 | 362.7 | 370.8 |
| 728.2 | 582.7 | 14687.8 | 13389.3 | 8283.4 | 3342.9 | 1302.1 | 483.7 | 230.6 | 225.7 |
| 756.6 | 3125.8 | 18175.2 | 16982.2 | 8911.9 | 3913.1 | 1446.9 | 491.6 | 189.3 | 242.4 |
| 734.7 | 1267.1 | 11580.2 | 14507.3 | 7818.7 | 3727.3 | 1966.6 | 959.4 | 422.7 | 653.8 |
| 670.6 | 1240.4 | 8637.2 | 15300.1 | 8255.0 | 2373.7 | 941.4 | 429.7 | 233.5 | 445.1 |
| 626.9 | 1267.4 | 9566.6 | 13117.2 | 5886.3 | 2780.2 | 1123.7 | 459.8 | 160.7 | 292.5 |
| 597.9 | 202.9 | 3361.8 | 12308.4 | 8184.4 | 3957.1 | 1551.0 | 743.9 | 307.4 | 371.3 |
| 539.0 | 2142.0 | 10080.5 | 15595.2 | 8362.9 | 2857.5 | 1141.0 | 442.6 | 242.5 | 228.2 |
| 489.2 | 356.2 | 11080.9 | 11486.1 | 6575.5 | 2874.3 | 1431.5 | 789.4 | 426.4 | 527.2 |
| 422.9 | 321.8 | 7782.5 | 9902.4 | 5984.5 | 2805.5 | 973.0 | 546.9 | 250.7 | 253.2 |
| 405.2 | 546.4 | 12609.8 | 7990.1 | 5380.1 | 2441.3 | 991.4 | 381.9 | 231.9 | 255.5 |
| 417.1 | 756.6 | 16194.9 | 13633.8 | 8133.8 | 3818.8 | 1714.6 | 716.9 | 399.1 | 294.8 |
| 371.3 | 11536.0 | 34213.5 | 16231.3 | 5382.2 | 1874.6 | 698.8 | 249.9 | 217.3 | 181.6 |
| 355.4 | 327.4 | 8682.6 | 11086.4 | 6638.4 | 2801.6 | 875.2 | 408.3 | 218.9 | 301.6 |
| 321.5 | 1139.8 | 9987.1 | 8173.1 | 5144.0 | 2674.8 | 1108.2 | 496.3 | 220.1 | 301.7 |
| 335.3 | 1387.2 | 13899.7 | 10879.5 | 5223.3 | 2232.1 | 1109.6 | 462.8 | 196.6 | 292.4 |
| 306.3 | 1402.3 | 20375.5 | 13492.2 | 5326.3 | 1986.9 | 816.6 | 430.1 | 240.4 | 364.8 |
| 291.2 | 205.4 | 6519.2 | 11001.9 | 6020.5 | 1786.9 | 749.7 | 326.1 | 152.5 | 230.7 |
| 270.7 | 287.1 | 10365.2 | 10534.4 | 6389.4 | 2540.6 | 1040.0 | 323.5 | 175.5 | 170.0 |
| 278.8 | 474.1 | 6682.7 | 9893.1 | 5995.8 | 2090.1 | 808.9 | 302.6 | 146.2 | 178.8 |
| 253.0 | 227.7 | 6705.2 | 12069.1 | 7097.9 | 2492.7 | 849.4 | 284.1 | 151.6 | 190.3 |
| 279.0 | 291.4 | 5964.5 | 6823.3 | 4129.1 | 2483.8 | 1135.1 | 501.3 | 279.3 | 481.6 |
| 229.2 | 1196.2 | 5851.6 | 7587.8 | 4443.7 | 1745.2 | 719.3 | 344.3 | 150.0 | 236.5 |
| FLEET | LANGOLF |  |  |  |  |  |  |  |  |
| 2006 | 2012 |  |  |  |  |  |  |  |  |
| 1 | 1 | 0.33333 | 0.41667 |  |  |  |  |  |  |
| 1 | 9 |  |  |  |  |  |  |  |  |
| 11676.7199 | 1364.7 | 19063 | 24106.3 | 10826.1 | 4139.9 | 1973.9 | 830.6 | 327.2 | 408.4 |
| 11676.7199 | 474.9 | 34898.9 | 61416.4 | 33569.6 | 12890.8 | 4532.6 | 1898.8 | 817.7 | 888.2 |
| 11676.7199 | 3664.6 | 32090.2 | 30703.4 | 24628.3 | 13440.8 | 6836.5 | 3324.2 | 1476.8 | 780.2 |
| 11676.7199 | 3997.7 | 26746 | 28962.7 | 18479.3 | 7874.9 | 4281.6 | 1818.5 | 969.7 | 914.6 |
| 11676.7199 | 1806.4 | 47527.6 | 53278.8 | 28579.6 | 10886.8 | 4975.3 | 2093.6 | 1108.3 | 657.3 |
| 11676.7199 | 1572.9 | 56044.7 | 56570.8 | 22607.3 | 7627.4 | 2863.3 | 878.3 | 292.8 | 149.6 |
| 11676.7199 | 3807.7 | 69756.7 | 86085.6 | 39205.8 | 12976.9 | 4403.2 | 1767 | 649.6 | 695.3 |



Figure 10.1. Nephrops in FUs $23-24$ bay of Biscay (VIIIa,b) catches (landings in white and discards in black) length distributions in 1987-2012.

Figure 10.2. Nephrops in FUs 23-24 bay of Biscay (VIIIa,b) - mean length of landings, discards and catches


Figure 10.3. Nephrops in FUs $23-24$ bay of Biscay (VIIla,b) - Effort and LPUE values of commercial fleets used in the assessment to tune the model.
I. Effort

## 11 Nephrops in Division VIIIc

The ICES Division VIIIc includes two Nephrops Functional Units: FU 25, North Galicia and FU 31, Cantabrian Sea.

### 11.1 Nephrops FU 25 (North Galicia)

### 11.1.1 General

### 11.1.1.1 Ecosystem aspects

See Annex K

### 11.1.1.2 Fishery description

See Annex K
11.1.1.3 Summary of ICES Advice for 2013 and management applicable to 2013 and 2014

ICES advice for 2013
The advice for these Nephrops stocks is biennial and valid for 2013 and 2014.
ICES advises on the basis of the precautionary considerations that catches should be zero.

To protect the stock in this Functional Unit, management should be implemented at the Functional Unit level.

Management applicable to 2013 and 2014
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 relatively to the previous year and the TAC set accordingly (Council Regulation (EC) No. 2166/2005). TACs of 82 t and 74 t were set for the whole of Division VIIIc for 2012 and 2013, respectively.

### 11.1.2 Data

### 11.1.2.1 Commercial catches and discards

In previous years landings have been estimated by the WG based on IEO scientific estimations. The information was compiled by IEO from sale sheets and Owners Associations where the Nephrops landings allocation was carried out based on landing port criteria. Since 2011, the Spanish Authority for Fisheries (Secretaría General de Pesca, SGP) who is also the National authority for the Data Collection Framework, established a new policy and general approach in the provision of official data on catches and fishing effort. So, this year, 2011 and 2012 Nephrops official landings are presented in WGHMM 2013.

Unlike the IEO scientific estimates, official landings are derived from logbooks. This source of information allows the landings disaggregation by ICES statistical rectangles. However, a considerable percentage of Nephrops catches ( $6 \%$ in 2011 and $25 \%$ in 2012) were allocated into statistical rectangles that do not belong to any FU in Division VIIIc (WD XXX). To avoid this problem the WG has considered the inclusion of the catches into the closest statistical rectangles in each FU. At the moment it is not
possible to quantify the impact this allocation may have on the estimation of landings by FU. This issue will be further investigated in the near future.

Landings were reported only by Spain. Since the early 90s landings declined from about $400 t$ to less than $100 t$ in 2003. In the period 2004-2012, landings show a continuous decreasing trend up to 21 t in the last year. In 2012, 11 t were recorded as unallocated landings (Table 11.1.1). The time series of the commercial landings (Figure 11.1.1) shows a clear declining trend, with present values representing approximately $1 \%$ of the landings in the 70 s . Discards in this functional unit remain insignificant.

### 11.1.2.2 Biological sampling

Length frequencies by sex of the Nephrops landings are collected as a rule on a monthly basis. The sampling levels are showed in Table 1.3.

The monthly sampling programme of the landings from this FU is considered to be at a sufficient level of intensity to produce reliable length compositions of the landings.

Annual length compositions for males and females combined, mean size and mean weight in the landings are given in Table 11.1.2 for the period 1981-2012 (see also Figure 11.1.2).

Mean sizes in the landings in the last decade, 2000-2012, varied between 37.4 and 48.5 mm CL for the males and between 35.8 and 45.1 mm CL for the females. The maximum value was recorder in 2009, reaching 48.5 and 45.1 mm CL for males and females, respectively. However, a slight reduction of the mean size was observed in 2011 and 2012 (Figure 11.1.1). Since 1982, several regulations were applied to the bottom trawl fishery (i.e. closed areas, fishing plans, changes in mesh sizes from 40 mm to the 70 mm , etc.), but discarding practices and fishing grounds for Nephrops remain basically unchanged. This suggests that the overall increasing trend of mean sizes may reflect a continuous low level of recruitment during the last period of the series.

### 11.1.2.3 Commercial catch-effort data

Fishing effort and LPUE data were available for the A Coruña trawl fleet (SPCORUTR8c) for the period 1986-2010 (Table 11.1.3 and Figure 11.1.1). Fishing effort and LPUE are not available in 2011 and 2012. This fleet accounted for more than $80 \%$ of the Nephrops landings from FU 25 up to 2003, diminishing afterwards but still account for a large proportion of the landings.

The overall trend in fishing effort is decreasing, with effort being in 2010 approximately half the level in 2000. The long time series of effort (1975-2010) (Figure 11.1.1) shows a marked decrease between 1976 and 1987, and then effort remained quite stable (fluctuating around 5000 trips per year) until 1995. Since then, fishing effort decreased to 1700 trips in 2006, with a slight increase in 2007 and 2008. In 2009, fishing effort shows a progressive decrease, recording about 1300 trips in 2010. Effort of the bottom trawl in this fishery is directed primarily at a set of demersal and bottom species, with Nephrops making only a small contribution to the overall landings.

LPUE shows an overall decreasing trend (Figure 11.1.1). After a period of quite variable LPUE until 1993, LPUE remained relatively stable at around $40 \mathrm{~kg} /$ trip between 1993 and 1997. Since then, LPUE has fluctuated at low levels and further declined, mainly in 2008 and 2009 when the lowest values of the time series were recorded (9.9 $\mathrm{kg} /$ trip and $7.3 \mathrm{~kg} /$ trip, respectively). In 2010, the fishing effort increases to 15.6 kg/trip.

### 11.1.3 Assessment

No assessment was carried out in 2013.

### 11.1.4 Biological reference points

There are no reference points defined for this stock.

### 11.1.5 Management Considerations

Nephrops is taken as by catch in the mixed bottom fishery. The overall trend in landings of Nephrops from the North Galicia (FU25) is of a strong decline. Landings have dramatically decreased since the beginning of the series (1975-2012), representing less $4 \%$ of the landings of the beginning of the time series.

Nephrops is managed by TAC and technical measures. The TAC for the whole of Division VIIIc was 91 t in 2011 and 82 t in 2012. Landings of Nephrops from Division VIIIc (FU 25 and FU 31) in 2012 were $21 \mathrm{t}, 25 \%$ of the TAC.

A recovery plan for southern hake and Atlantic Iberian Nephrops stocks was approved in December 2005 (Council Regulation (EC) No 2166/2005) and implemented since January 2006. The management objective is to rebuild the stock to safe biological limits within a period of 10 years. This recovery plan includes 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 $\pm 15 \%$ of the preceding year TAC).

Table 11.1.1. Nephrops FU25, North Galicia. Landings in tonnes.

| Year | Trawl | Unallocated | Total FU |
| :---: | :---: | :---: | :---: |
| 1975 | 731 |  | 731 |
| 1976 | 559 |  | 559 |
| 1977 | 667 |  | 667 |
| 1978 | 690 |  | 690 |
| 1979 | 475 |  | 475 |
| 1980 | 412 |  | 412 |
| 1981 | 318 |  | 318 |
| 1982 | 431 |  | 431 |
| 1983 | 433 |  | 433 |
| 1984 | 515 |  | 515 |
| 1985 | 477 |  | 477 |
| 1986 | 364 |  | 364 |
| 1987 | 412 |  | 412 |
| 1988 | 445 |  | 445 |
| 1989 | 376 |  | 376 |
| 1990 | 285 |  | 285 |
| 1991 | 453 |  | 453 |
| 1992 | 428 |  | 428 |
| 1993 | 274 |  | 274 |
| 1994 | 245 |  | 245 |
| 1995 | 273 |  | 273 |
| 1996 | 209 |  | 209 |
| 1997 | 219 |  | 219 |
| 1998 | 103 |  | 103 |
| 1999 | 124 |  | 124 |
| 2000 | 81 |  | 81 |
| 2001 | 147 |  | 147 |
| 2002 | 143 |  | 143 |
| 2003 | 89 |  | 89 |
| 2004 | 75 |  | 75 |
| 2005 | 63 |  | 63 |
| 2006 | 62 |  | 62 |
| 2007 | 67 |  | 67 |
| 2008 | 39 |  | 39 |
| 2009 | 21 |  | 21 |
| 2010 | 34 |  | 34 |
| 2011* | 44 |  | 44 |
| 2012* | 10 | 11 | 21 |

*Spanish Official Data

Table 11.1.2. Nephrops FU25, North Galicia. Length compositions of landings of landings, mean weight (Kg) and mean length (CL, mm) for the period 1982-2012.


Total number (thousand) Total weight (tomnes) Mean weight $(\mathrm{kg})$
CL Mean length $(\mathrm{mm})$
$\begin{array}{llllllllll}200 & 2001 & 2002 & 2003 & 2004 & 2005 & 2006 & 2007 & 2008 & 2009 \\ 2010 & 2011 & 2012\end{array}$


Figure 11.1.1. Nephrops FU25, North Galicia. Long-term trends in landings, effort, LPUE and mean sizes


Figure 11.1.2. Nephrops FU25, North Galicia. Length distributions in landings for the period 19822012. Y-axe scale has been change from 2008

### 11.2 Nephrops FU 31 (Cantabrian Sea)

### 11.2.1 General

### 11.2.1.1 Ecosystem aspects

See Annex K

### 11.2.1.2 Fishery description

See Annex K
11.2.1.3 Summary of ICES Advice for 2013 and management applicable to 2013 and 2014

ICES advice for 2013
The advice for these Nephrops stocks is biennial and valid for 2012 and 2013.
ICES advises on the basis of the precautionary considerations that catches should be zero.

To protect the stock in this Functional Unit, management should be implemented at the Functional Unit level.

Management applicable to 2013 and 2014
TACs of 82 and 74 t were set for the whole of Division VIIIc for 2012 and 2013, respectively. A fishing effort limitation is also applicable in accordance with the southern hake and Nephrops recovery plan.

### 11.2.2 Data

### 11.2.2.1 Commercial catches and discards

In previous years, landings have been estimated by the WG based on IEO scientific estimations. The information was compiled by IEO from sale sheets and Owners Associations where the Nephrops landings allocation was carried out based on landing port criteria. Since 2011, the Spanish Authority for Fisheries (Secretaría General de Pesca, SGP) who is also the National authority for the Data Collection Framework established a new policy and general approach in the provision of official data on catches and fishing effort. So, this year, 2011 and 2012 Nephrops official landings are presented in WGHMM 2013.
Unlike the IEO scientific estimates, official landings are derived from logbooks. This source of information allows the landings disaggregation by ICES statistical rectangles. However, a considerable percentage of Nephrops catches ( $6 \%$ in 2011 and $25 \%$ in 2012) were allocated into statistical rectangles that do not belong to any FU in Division VIIIc (WD XXX). To avoid this problem the WG has considered the inclusion of the catches into the closest statistical rectangles in each FU. At the moment it is not possible to quantify the impact this allocation may have on the estimation of landings by FU. This issue will be further investigated in the near future.

Nephrops landings from FU 31 are reported by Spain (the only participant in the fishery) (Table 11.2.1 and Figure 11.2.1) and are available for the period 1983-2012. The highest landings were recorded in 1989 and 1990, with 177 t and 174 t , respectively. Since 1996 landings have declined sharply from 129 t to less than 10 t in the period 2009-2011. In 2012, landings were 10 t .

### 11.2.2.2 Biological sampling

Length frequencies by sex of Nephrops landings were collected by the biological sampling programme. The sampling levels are shown in Table 1.3.

Mean size of males and females in the landings fluctuated during 1988-2012 (Figure 11.2.1). Data show a general increasing trend for both sexes to 2010 (Figure 11.2.1), with the highest values in 2009 (males with 55.8 mm and females with 45.9 mm CL). In 2011 and 2012, the mean carapace length decreased slightly in relation to the previous year, similar to the levels observed in 2002. In 2012, mean size was 47 mm and 40 mm in males and females, respectively.

### 11.2.2.3 Commercial catch-effort data

The fishing effort data series includes two bottom trawl fleets operating in the Cantabrian Sea with home harbors in Avilés and Santander. However, fishing effort data from Avilés is not available since 2004 and from the fleet of Santander was not available in 2008. In 2011 and 2012 fishing effort are not available.

The available time series of effort shows a period of relative stability from the early 1980s to the beginning of the 1990s. Since 1992, effort shows a marked downward trend (Figure 11.2.1) with the lowest value recorded in 2005 ( 364 fishing days corresponding to Santander fleet. The increase in the use of other gears (HVO and pair trawl) resulted in the reduction in effort by the baca trawl fleet, the only gear fishing for Nephrops. In 2007 fishing effort increased to 1304 fishing days but it declined again to values about 400 fishing days in 2009 and 2010. Information about fishing effort from the Gijon fleet is presented since 2008 (Figure 11.2.1).

The Santander LPUE series (no data available in 2008, 2011 and 2012) shows fluctuations around the general downward trend (Figure 11.2.1). The LPUE reached the lowest value of the time series in 2009. In 2010, the Santander LPUE increased in almost $50 \%$ respect the previous year. Similarly, the Gijon LPUE increased in the 20082010.

### 11.2.3 Assessment

No assessment was carried out in 2013

### 11.2.4 Management considerations

A recovery plan for southern hake and Atlantic Iberian Nephrops stocks including a fishing effort reduction was implemented and enforced in 2006.

Table 11.2.1. Nephrops FU31, Cantabrian Sea. Landings in tonnes.

| Year | Trawl | Creel | Total |
| :---: | :---: | :---: | :---: |
| 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 | 21 | 1 | 22 |
| 2004 | 17 | 0 | 17 |
| 2005 | 14 | 0 | 14 |
| 2006 | 15 | 0 | 15 |
| 2007 | 19 | 0 | 19 |
| 2008 | 19 | 0 | 19 |
| 2009 | 6 | 0 | 6 |
| 2010 | 8 | 0 | 9 |
| 2011* | 7 | 0 | 7 |
| 2012* | 10 | 0 | 10 |

[^3]

### 11.3 Summary for Division VIIIc

Nephrops in Division VIIIc includes two FUs (North Galicia, FU 25 and Cantabrian Sea, FU 31). Table 11.3.1 shows the landings in Division VIIIc. In previous years landings have been estimated by the WG based on IEO scientific estimation. 2011 and 2012 Nephrops official landings are presented in this year. Landings from both FUs have declined dramatically in recent years. Landings in Division VIIIc were below the TAC in recent years, and therefore the TAC has not been restrictive.

The very low levels of landings from FU 25 and FU 31 and the decreasing LPUE trends to 2010 indicate that both stocks are in very poor condition.

A recovery plan for southern hake and Atlantic Iberian Nephrops stocks was approved in December 2005 (Council Regulation (EC) No 2166/2005) and implemented since January 2006. This recovery plan includes 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 $\pm 15 \%$ of the preceding year TAC). ICES has not evaluated the recovery plan.

Table 11.3.1. Nephrops Division VIllc.
Landings in tonnes by FU and Division VIllc.

| Year | FU 25 | FU 31 | Unallocated | DIVISION VIIIC |
| :---: | :---: | :---: | :---: | :---: |
| 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 | 22 |  | 111 |
| 2004 | 75 | 17 |  | 92 |
| 2005 | 63 | 14 |  | 77 |
| 2006 | 62 | 15 |  | 77 |
| 2007 | 67 | 19 |  | 86 |
| 2008 | 39 | 19 |  | 58 |
| 2009 | 21 | 6 |  | 27 |
| 2010 | 34 | 8 |  | 42 |
| 2011* | 44 | 7 |  | 51 |
| 2012* | 10 | 10 | 11 | 31 |

[^4]
## 12 Nephrops in Division IXa

The ICES Division IXa 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 Cádiz.

### 12.1 Nephrops FU 26-27, West Galicia and North Portugal (Division IXa)

### 12.1.1 General

### 12.1.1.1 Ecosystem aspects

See Annex L

### 12.1.1.2 Fishery description

See Annex L
12.1.2 Summary of ICES Advice for 2013 and management applicable to 2013 and 2014

ICES advice for 2013
The advice for these Nephrops stocks is biennial and valid for 2013 and 2014.
ICES advises on the basis of the precautionary considerations that catches should be zero

To protect the stock in this Functional Unit, management should be implemented at the Functional Unit level.

Management applicable to 2012 and 2013
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).

In order to reduce F on Nephrops stocks in this Division even further, a seasonal ban was introduced in the trawl and creel fishery for two boxes, located in FU 26 and 28, in the peak of the Nephrops fishing season. These boxes are closed for Nephrops fishing in June-August and in May-August, respectively.

ICES has not evaluated the current recovery plan for Nephrops in relation to the precautionary approach.

The TAC set for the whole Division IXa was 273 t and 246 t for 2012 and 2013, respectively, and the maximum number of fishing days per vessel was fixed at 150 and 141 days for Spanish vessels and at 155 and 140 days for Portuguese vessels for these two years (Annex IIb of Council Regulations nos. 43/2012 and 39/2013). The number of fishing days included in these regulations is not applicable to the Gulf of Cadiz (FU 30), which has a different regime.

### 12.1.3 Data

### 12.1.3.1 Commercial catches and discards

In previous years landings have been estimated by the WG based on IEO scientific
estimations. The information was compiled by IEO from sale sheets and Owners Associations where the Nephrops landings allocation was carried out based on landing port criteria. Since 2011, the Spanish Authority for Fisheries (Secretaría General de Pesca, SGP) who is also the National authority for the Data Collection Framework, established a new policy and general approach in the provision of official data on catches and fishing effort. So, this year, 2011 and 2012 Nephrops official landings are presented in WGHMM 2013.

Unlike the IEO scientific estimates, official landings are derived from logbooks. This source of information allows the landings disaggregation by ICES statistical rectangles. However, a considerable percentage of Nephrops catches (27\% in 2011 and 26\% in 2012) were allocated into statistical rectangles that do not belong to any FU in Division IXa (WD XXX). To avoid this problem the WG has considered the inclusion of the catches into the closest statistical rectangles in each FU. At the moment it is not possible to quantify the impact this allocation may have on the estimation of landings by FU. This issue will be further investigated in the near future.

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 it can be considerate as by-catch but is a very valuable species.

Along the time series, landings by the Spanish fleets are mostly from FU 26, together with smaller quantities taken from FU 27 . However, in recent years landings are very low in both FUs. Prior to 1996, no distinction was made between the two FUs, and therefore they are considered together.

Two periods can be distinguished in the time series of landings available 1975-2012 (Figure 12.1.1). During 1975-1989, the mean landing was 680 t , fluctuating between 575 and 800 t approximately. Since 1990 onwards there has been a marked downward trend in landings, being below 50 t from 2005 to present. In 2012, landings recorded the lowest value in the time series ( 8 t ), representing less than $2 \%$ of the landings prior to 1990. Considering functional units separately, landings from FU 26 decreased 13 t in 2012 respect to the respect 2009 while in FU27 landings decreased 10 t . Discards rates are negligible.

Total Portuguese landings from FU 27 have decreased from almost 100 t in 1988 to just 1 t in 2012.

### 12.1.3.2 Biological sampling

Length frequencies by sex of the Nephrops landings are collected monthly. The sampling levels are shown in Table 1.3.

The length frequency distributions were obtained by sampling the commercial landings at the Spanish ports of Marin and Vigo.

Mean size for both sexes shows an increasing trend from 2001 to 2012 with the higher value recorded in 2010 ( 52.0 mm CL in males and 43.7 mm CL in females) (Figure 12.1.1). Annual length compositions for males and females combined, mean size and mean weight in landings for the period 1988-2012 are given in Table 12.1.2 and Figure 12.1.2.

### 12.1.3.3 Commercial catch-effort data

Fishing effort and LPUE estimates are available for Marin trawl fleet (SP-MATR) for
the period 1990-2010 (Table 12.1.3). Fishing effort and LPUE are not available in 2011 and 2012.

The overall trend for the LPUE of SP-MATR is decreasing, with some stability in the 2007-2009 period around $17.5 \mathrm{Kg} /$ trip. In 2010, LPUE dropped to $5 \mathrm{Kg} /$ 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 12.1.1 for complementary information.

### 12.1.4 Assessment

No assessment was carried out in 2013.

### 12.1.5 Biological reference points

There are no reference points defined for this stock.

### 12.1.6 Management Considerations

Nephrops is taken as by catch in a mixed bottom trawl fishery. Landings of Nephrops have substantially declined since 1995. Recent landings represent $1 \%$ 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. Effort in two last years are not available.

A recovery plan for southern hake and Iberian Nephrops stocks was approved in December 2005 (CE 2166/2005) and implemented since January 2006.

The recovery plan includes a procedure for setting the TACs for Nephrops stocks, complemented by a system of fishing effort limitation (i.e. 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 $\pm 15 \%$ of the preceding year TAC). This plan also includes a seasonal closure (June-August) for Nephrops in an area of the West Galicia (FU 26) fishing grounds.

Table 12.1.1. Nephrops FU26-27, West Galicia and North Portugal. Landings in tonnes by Functional Units and country.

| Year | Spain |  | Portugal | Unallocated | Total |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | FU 26** | FU 27 | FU 27 | FU27 | FU 26-27 |
| 1975 | 622 |  |  |  | 622 |
| 1976 | 603 |  |  |  | 603 |
| 1977 | 620 |  |  |  | 620 |
| 1978 | 575 |  |  |  | 575 |
| 1979 | 580 |  |  |  | 580 |
| 1980 | 599 |  |  |  | 599 |
| 1981 | 823 |  |  |  | 823 |
| 1982 | 736 |  |  |  | 736 |
| 1983 | 786 |  |  |  | 786 |
| 1984 | 604 |  | 14 |  | 618 |
| 1985 | 750 |  | 15 |  | 765 |
| 1986 | 657 |  | 37 |  | 694 |
| 1987 | 671 |  | 71 |  | 742 |
| 1988 | 631 |  | 96 |  | 727 |
| 1989 | 620 |  | 88 |  | 708 |
| 1990 | 401 |  | 48 |  | 449 |
| 1991 | 549 |  | 54 |  | 603 |
| 1992 | 584 |  | 52 |  | 636 |
| 1993 | 472 |  | 50 |  | 522 |
| 1994 | 426 |  | 22 |  | 448 |
| 1995 | 501 |  | 10 |  | 511 |
| 1996 | 264 | 50 | 17 |  | 331 |
| 1997 | 359 | 68 | 6 |  | 433 |
| 1998 | 295 | 42 | 8 |  | 345 |
| 1999 | 194 | 48 | 6 |  | 248 |
| 2000 | 102 | 21 | 9 |  | 132 |
| 2001 | 105 | 21 | 6 |  | 132 |
| 2002 | 59 | 24 | 4 |  | 87 |
| 2003 | 39 | 26 | 8 |  | 73 |
| 2004 | 38 | 24 | 9 |  | 71 |
| 2005 | 16 | 16 | 11 |  | 43 |
| 2006 | 15 | 17 | 12 |  | 44 |
| 2007 | 20 | 17 | 10 |  | 47 |
| 2008 | 17 | 12 | 13 |  | 42 |
| 2009 | 16 | 5 | 10 |  | 31 |
| 2010 | 3 | 14 | 4 |  | 21 |
| 2011* | 8 | 8 | 4 | 7 | 27 |
| 2012* | 3 | 4 | 1 |  | 8 |
| *Spanish Official Data |  |  |  |  |  |
| **Prior 1996, landings of Spain recorded in FU 26 include catches in FU 27 |  |  |  |  |  |

Table 12.1.2. Nephrops FU26-27, West Galicia and North Portugal. Length compositions, mean weight (Kg) and mean size (CL, mm) in landings for the 1988-2012 period.





















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Table 12.1.3. Nephrops FU26-27, West Galicia and North Portugal. Fishing effort and LPUE for SPMATR fleet.

|  |  |  |  |
| :---: | :---: | :---: | :---: |
| Year | SP-MATR |  |  |
| Landings (t) | trips |  |  | LPUE (kg/trip)

## Landings FU 26+27



LPUE


## Effort - Bottom trawl fleets



Mean sizes


Figure 12.1.1. Nephrops FU26-27, West Galicia and North Portugal. Long-term trends in landings, effort and mean sizes


Figure 12.1.2. Nephrops FU26-27. West Galicia and North Portugal. Length distributions in landings for the 1988-2012 period.

### 12.2 FU 28-29 (SW and S Portugal)

### 12.2.1 General

### 12.2.2 Ecosystem aspects

See the Stock Annex (in Annex L of WG report)

### 12.2.2.1 Fishery description

See the Stock Annex (in Annex L of WG report)
12.2.2.2 ICES Advice for 2013 and Management applicable for 2013 and 2014

## ICES Advice for 2013

The advice for these stocks is biennial and valid for 2013 and 2014. Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 110 tonnes. Management should be implemented at the Functional Unit level.

## Management applicable for 2013 and 2014

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).
In order to reduce F on Nephrops stocks in Division IXa even further, a seasonal ban was 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 boxes are closed for Nephrops fishing in June-August and in May-August, respectively.

ICES has not evaluated the current recovery plan for Nephrops in relation to the precautionary approach.

The TAC set for the whole Division IXa was 273 and 246 t for 2012 and 2013, respectively, and the maximum number of fishing days per vessel was fixed at 150 and 141 days for Spanish vessels and at 155 and 140 days for Portuguese vessels for these two years (Annex IIb of Council Regulations nos. 43/2012 and 39/2013). The number of fishing days included in these regulations is not applicable to the Gulf of Cadiz (FU 30), which has a different effort management regime.

### 12.2.3 Data

### 12.2.3.1 Commercial catches and discards

Table 12.2.1 and Figure 12.2 .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 but decreased again in recent years. The value landings in 2009-2011 was approximately at the same level ( $\approx$ 150 t), increasing in 2012 (229 t).

Landings from years 2011 and 2012 include for the first time 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 were derived from logbooks. This source of information allows landings disaggregation by ICES statistical rectangles. However, a considerable percentage of Nephrops catches ( $27 \%$ in 2011 and $26 \%$ in 2012) were allocated into statistical rectangles that do not belong to any FU in Division IXa (WD XXX). To avoid this problem the WG has considered the inclusion of the catches into the closest statistical rectangles in each FU. At the moment it is not possible to quantify the impact this allocation may have on the estimation of landings by FU. This issue will be further investigated in the near future.

Males are the dominant component in all landings with exception for 1995 and 1996 when total female landings exceeded male landings (ICES, 2006). For the period 20022011 male to female sex-ratio has been close to 1.5:1. The year 2012 presents a ratio of 2.3:1.

Information on discards and the raising procedure are presented in Prista and Fernandes, 2013 (WD xx). The frequency of Nephrops occurrence in discards samples is very low. Discards are negligible in this fishery and mostly due to quality.

### 12.2.3.2 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 2011 was at the same level as in the years before. The sampling data are raised to the total landings by market category, vessel and month.

The length compositions of the landings are presented in Tables 12.2.2a-b and Figures 12.2.2a-b. The number of samples and measured individuals are presented in Table 1.3.

### 12.2.3.3 Abundance indices from surveys

Since 1997, several groundfish (PtGFS-WIBTS-Q4) and crustacean trawl surveys (PTCTS UWTV FU 28-29) were carried out in FUs 28 and 29. Table 12.2.4 and Figure 12.2.1 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 should provide a better estimation of the abundance for the smaller lengths of Nephrops. There was an increase in the overall biomass index in the period 2003-2005, and also of small individuals in a particular juvenile concentration area in 2005, which could be an indication of higher recruitment.

The R/V "NORUEGA" had some technical problems in 2010 and could not trawl in areas deeper than 600 m . The survey plan had to be adapted accordingly. The CPUE value obtained for 2010, the highest from the series, was probably affected by this change. In 2011, due to engine failure, the survey did not cover the whole area of Nephrops distribution. No CPUE index was presented for this year. Budgetary constraints of national scope turned unfeasible to repair the R/V Noruega and the chartering of another research vessel and therefore no survey was conducted in 2012.

As shown in ICES (2012x), the distribution of survey indices is in very good agreement with the fishery CPUE spatial distribution. The correlation between the annual CPUE from the fishery and the annual biomass index from the Crustacean survey is high. The values for the years 2010 and 2011 have to be corrected to be comparable with former years.

In 2005 and 2007, some experiments to collect UWTV images from the Nephrops fish-
ing 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. In 2010 and 2011, no images were collected due to technical problems of the research vessel. It is not guaranteed that this method can be used for abundance estimation (information presented to SGNEPS 2012 - Study Group of Nephrops Surveys (ICES (2012y)).

### 12.2.3.4Mean sizes

Mean carapace length (CL) data for males and females in the landings and surveys are presented for the period 1994-2012 (Table 12.2.5). Figure 12.2 .1 shows the mean CL trends since 1984. The mean sizes of males and females have fluctuated along the period with no apparent trend.

### 12.2.3.5 Commercial catch-effort data

A standardization of the CPUE series was presented to WGHMM in 2008 (ICES, 2008, Silva, C. - WD 25) applying the generalized linear models (GLMs). The data used for this standardization were the crustacean logbooks for the period 1988-2007. The factors retained for the final model (year, month and vessel category) were those which contribute more than $1 \%$ to the overall variance. The model explains $17 \%$ to $19 \%$ of the variability, when using the CPUE in $\mathrm{kg} /$ day or $\mathrm{kg} /$ haul respectively.
Until 2010, this model was updated each year with the addition of new data.
The issue of effort estimation using standardized CPUE from GLMs or other methods taking into account the flexibility of the fleet in relation to target species was further developed in the WGHMM 2010 (ICES, 2010x) and during WKSHAKE2 (ICES, 2010y). Crustacean vessels are targeting two main species, rose shrimp and Norway lobster, which have different market value. Depending on their abundance/availability, the effort is directed at one species or the other. In 2006, the landings of rose shrimp start to increase showing a change in the objectives of the fishery (Figure 12.2.3).

The effort is estimated using the CPUE of the fleet. If the CPUE of Nephrops decreased due to a change in target species (and consequently, fishing grounds), the effort might be overestimated.

The model of CPUE standardization used until 2010 never explained more than $20 \%$ of the variability (ICES, 2010x). The explanatory variables used were year, month and vessel-category. Considering the behaviour of the fleet in periods of high abundance of rose shrimp, new variables related to the catches of this species and the proportion of Nephrops in the total catch were incorporated. As the distributions of rose shrimp and Nephrops are fishing ground and depth dependent, the availability and use of VMS data could improve the standardization model, as suggested in Silva and AfonsoDias, 2011 (WD to WKCPUEFFORT).

Taking all this into account, new variables as the fishing depth, the catches of rose shrimp and the proportion of Nephrops in the total crustacean catches were incorporated in the new model for CPUE standardization and presented to IBP Nephrops 2012 (Inter-Benchmark Protocol for Nephrops 2012).

The IBP Nephrops did not come to a conclusion about the stock assessment method but the WG has agreed to use this new CPUE standardization for the trends based assessment and standardized effort estimation.

However, as VMS data are only available since 1998, the use of this method has shortened the length of the time series. In the models presented before, the CPUE was expressed in $\mathrm{kg} /$ day and the time series started in 1988. The CPUE in the new model is expressed in $\mathrm{kg} / \mathrm{hour}$, the time series starts 10 years later but the estimation of CPUE is based on more reliable effort data.

The overall analysis of the geo-referenced catches confirms the general preference of rose shrimp and Nephrops for grounds shallower and deeper than 400 m , respectively. These data also confirm that, in years of higher abundance of rose shrimp, a greater effort is allocated to depths shallower than 400 m . In what concerns the distribution of the fishing effort between the two Functional Units, FU29 represents in average $83 \%$ of the total effort. However, the fishing areas (FUs) were found not significantly different and therefore removed from the model.

The factors and levels retained in the final model and updated to include 2011 and 2012 data:

- year: 1998-2012
- month: 1-12
- depth interval: [100, $400[,[400,800[,[800,1500]$
- $\log$ catch of rose shrimp: $[0,2[,[2,5]$
- proportion of Nephrops in the total catch of crustaceans: $[0,0.25[,[0.25,1]$
- and vessel category: A (standard), B and C. These two categories correspond to vessels less or more productive than the standard type.

The choice of the final model was based on the highest value of explained variance and the smallest AIC. The model explains $47 \%$ of the total variability, with the proportion of Nephrops in the crustacean catches as the most important factor (Table 12.2.6).

Figure 12.2.4 shows the annual observed CPUE and the estimates from the model, considering the depth interval class [400, $800[, \log$ catch of rose shrimp class [0, $2[$, the category of proportion of Nephrops $[0.25,1]$ and vessel category A as the reference factors for Nephrops target CPUE.

The correlation found between the CPUE series derived from the model presented here and the biomass indices from the Crustacean surveys (not considering the 2010 estimate, for the reasons explained before) is high and gives confidence that CPUE is reflecting the abundance of Nephrops in FU 28 and 29.

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, 13 th 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 initiated 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 (see table below). 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).

|  |  | No of Fishing Days |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Year | Regulation | All countries | ES | FR | PT |
| 2006 | Council Regulation (EC) No 51/2006 | 240 |  |  | ■■■■互 |
| 2007 | Council Regulation (EC) No 41/2007 | 216 | $\square$ | - | $\square$ |
| 2008 | Council Regulation (EC) No 40/2008 | 194 | $\square$ | $\square \square$ |  |
| 2009 | Council Regulation (EC) No 43/2009 | 175 | ■ | - | $\square$ |
| 2010 | Council Regulation (EU) No 53/2010 | 158 |  |  |  |
| 2011 | Council Regulation (EU) No 57/2011 |  | 158 | 142 | 172 |
| 2012 | Council Regulation (EU) No 43/2012 | - | 150 | 149 | 155 |

Besides this effort reduction, the Council Regulation (EC) No 850/98 was amended with the introduction of two boxes in Division IXa, 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 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.
The effort reduction measures were combined with a national regulation closing the crustacean fishery every year in January (Portaria no. 43, 12 ${ }^{\text {th }}$ January 2006). As a result of these measures, the nominal effort in 2006 to 2011 corresponds to 11 months each year.
In the period 1999-2001, standardized fishing effort increased substantially, remaining high until 2004-2005 (Table 12.2.3 and Figure 12.2.1), with an exceptional drop in 2003. After 2005, the effort presents a decreasing trend until 2009. The effort decline may be related to the effort management measures but also to effort shift to rose shrimp, which presented a large increase in abundance and landings in the period 2007-2011 (Figure 12.2.4).

Despite the effort decline, the Nephrops standardized CPUE presents a decreasing trend in the period 2006-2010, and the values of the last four-year period are below the long term average (1998-2012). The standardized effort increased in the last year due to a higher catch from Portuguese fleet and the declaration of Spanish catches in this year. As stated in section 12.2.2.1, Spanish vessels are licensed for crustaceans in these FUs under a bilateral agreement since 2004, but no official data were available prior to 2011. If Spanish catches were accounted for in previous years, the standardized effort trend could be different and might explain the present CPUE levels.

### 12.2.4 Assessment

No assessment was carried out in 2013.
These FUs has been assessed using XSA until 2010, but the results have been accepted only for trends analysis.

IBP Nephrops 2012 had not come to conclusions at the deadline set in the Terms of Reference (31st March), but noted that, although there were some significant improvements in the tuning fleet data and different XSA model settings have been looked into, there were still some problems of internal consistency.

In 2012, WGHMM considered that XSA shall be abandoned and other methods be tried. Advice in this year was based on survey and fishery CPUE and effort trends.

### 12.2.5 Short-term Projections

No projections were performed.

### 12.2.6 Biological reference points

No biological reference points are defined for these stocks.
Biological reference points estimated on the basis of the Yield per Recruit curve were presented in ICES (2011).

### 12.2.7 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 F relative to the previous year and TAC set accordingly, within the limits of $\pm 15 \%$ of the previous year TAC (Council Regulation (EC) No 2166/2005). The number of allowed fishing days are set in each year regulations (Council Regulations (EC) Nos. 51/2006, 41/2007, 40/2008, 43/2009, 53/2010, 57/2011 and 43/2012).

Besides the recovery plan, the Council Regulation (EC) No 850/98 was amended with the introduction of two boxes in Division IXa, 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, $13^{\text {th }}$ September 2004) closed the crustacean fishery in JanuaryFebruary 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, $12^{\text {th }}$ January 2006).

Portugal and Spain have bilateral agreements for fishing in each other waters. The last agreement was signed in 2003 for 10-year period. Under this agreement a number of trawlers are licensed to fish crustaceans in Portuguese waters. Some information on catches/landings is available for these vessels only for the years 2011 and 2012.

Table 12.2.1. Nephrops in South-West and South Portugal (FU 28-29). Total landings per country (tonnes).

| FU | 28 | 29 | 28+29 |  |  | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Years | Spain | Spain | Portugal |  |  |  |
|  | Traw 1 | Traw 1 | 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 |
| 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 |


| Age/Year | 1984 | 1985 | 1986 | 1987 | 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 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 17 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 18 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 19 |  |  |  |  | 4 | 21 |  |  |  |  | 0 |  |  |  |  |  |  |  |  | 0 |  |  |  | 2 | 0 |  |  |  |  |
| ${ }^{20}$ |  |  | 0 | 16 | 4 |  |  | ${ }^{6}$ | 4 |  |  |  |  |  |  | 4 |  |  |  | 0 |  | 4 |  | 3 | 1 | 0 | 0 |  |  |
| 21 |  | 17 | 9 |  |  | 84 |  | 16 | 37 | 9 |  |  |  |  |  | 3 | 3 | 0 | 2 | 0 | 0 | 33 |  | 5 | 0 | 0 | 0 |  |  |
| 22 | 7 | 5 | 14 | 15 |  | 97 | 9 | 29 | 96 | 38 | 9 |  |  |  | 2 | 0 | 16 | 1 | 2 | 13 | 4 | 51 | 10 | 20 | 8 | 2 |  | 0 | 3 |
| 23 | 24 | 7 | 7 | 8 |  | 143 | 5 | 19 | 55 | 34 |  |  | 8 | 4 |  | 5 | 8 | 3 | 1 | 3 | 15 | 32 | 22 | 31 | 10 | 4 |  | 1 | 0 |
| 24 | 14 | 40 | 121 | 209 | 51 | 272 | 27 | 53 | 202 | 42 | 18 |  | 17 | 9 | 8 | 9 | 20 | 5 | 2 | 11 | 20 | 107 | 53 | 53 | 26 | 29 | 8 | 0 | 8 |
| 25 | 109 | 83 | 115 | 81 | 97 | 229 | 116 | 69 | 181 | 149 | 34 | 3 | 23 | 6 | 16 | 39 | 13 | 6 | 3 | 40 | 45 | 120 | 46 | 65 | 28 | 30 | 10 | 1 | 27 |
| 26 | 250 | 170 | 137 | 446 | 128 | 205 | 182 | 111 | 263 | 72 | 68 | 0 | 36 | 43 | 32 | 33 | 58 | 8 | 11 | 56 | 126 | 153 | 75 | 121 | 32 | 38 | 8 | 3 | 37 |
| 27 | 282 | 326 | 170 | 718 | 208 | 269 | 149 | 94 | 185 | 95 | 77 | 0 | 54 | 95 | 81 | 49 | 85 | 24 | 24 | 87 | 187 | 206 | 94 | 111 | 52 | 63 | 22 | 6 | 47 |
| 28 | 374 | 500 | 289 | 871 | 399 | 280 | 337 | 139 | 506 | 272 | 157 | 0 | 56 | 78 | 65 | 68 | 44 | 24 | 48 | 62 | 205 | 286 | 144 | 141 | 60 | 89 | 14 | 4 | 37 |
| 29 | 439 | 559 | 341 | 727 | 456 | 283 | 415 | 159 | 462 | 382 | 95 | 28 | 38 | 88 | 65 | 109 | 148 | 53 | 60 | 147 | 246 | 330 | 220 | 189 | 62 | 83 | 33 | 5 | 143 |
| 30 | 412 | 742 | 328 | 584 | 442 | 317 | 695 | 239 | 725 | 548 | 187 | 11 | 68 | 104 | 160 | 133 | 87 | 74 | 139 | 248 | 300 | 533 | 290 | 297 | 60 | 129 | 44 | 5 | 158 |
| 31 | 277 | 670 | 389 | 742 | 457 | 230 | 813 | 325 | 755 | 548 | 231 | 24 | 92 | 172 | 129 | 272 | 111 | 92 | 123 | 188 | 277 | 573 | 270 | 256 | 93 | 116 | 75 | 22 | 248 |
| 32 | 373 | 784 | 680 | 806 | 446 | 367 | 866 | 260 | 670 | 674 | 383 | 108 | 151 | 283 | 289 | 88 | 161 | 274 | 233 | 325 | 475 | 757 | 378 | 295 | 129 | 135 | 116 | 32 | 573 |
| 33 | 339 | 531 | 213 | 236 | 428 | 265 | 702 | 133 | 345 | 365 | 149 | 83 | 70 | 90 | 95 | 182 | 92 | 139 | 281 | 248 | 352 | 437 | 247 | 246 | 108 | 80 | 78 | 21 | 329 |
| 34 | 389 | 635 | 609 | 721 | 656 | 328 | 785 | 239 | 451 | 655 | 270 | 215 | 159 | 251 | 269 | 152 | 160 | 224 | 257 | 264 | 352 | 574 | 311 | 327 | 150 | 94 | 104 | 52 | 436 |
| 35 | 478 | 525 | 590 | 245 | 664 | 291 | 755 | 171 | 296 | 475 | 224 | 169 | 147 | 169 | 118 | 175 | 100 | 173 | 274 | 275 | 347 | 333 | 194 | 252 | 121 | 76 | 83 | 31 | 356 |
| 36 | 378 | 463 | 519 | 342 | 572 | 295 | 449 | 138 | 399 | 639 | 221 | 147 | 78 | 154 | 166 | 143 | 158 | 163 | 265 | 195 | 224 | 263 | 168 | 256 | 83 | 59 | 77 | 34 | 248 |
| 37 | 528 | 346 | 322 | 406 | 424 | 356 | 465 | 77 | 351 | 391 | 107 | 262 | 172 | 149 | 167 | 128 | 162 | 167 | 247 | 234 | 167 | 293 | 172 | 224 | 109 | 57 | 78 | 64 | 211 |
| 38 | 496 | 383 | 606 | 355 | 571 | 302 | 479 | 120 | 378 | 344 | 179 | 134 | 113 | 58 | 85 | 75 | 106 | 99 | 254 | 197 | 147 | 226 | 164 | 265 | 73 | 58 | 125 | 69 | 206 |
| 39 | 353 | 309 | 361 | 240 | 326 | 332 | 611 | 126 | 348 | 306 | 95 | 151 | 62 | 46 | 47 | 180 | 81 | 109 | 229 | 174 | 93 | 175 | 100 | 173 | 75 | 61 | 71 | 39 | 126 |
| 40 | 447 | 337 | 323 | 156 | 366 | 316 | 829 | 200 | 248 | 174 | 144 | 232 | 83 | 82 | 83 | 83 | 96 | 159 | 254 | 215 | 165 | 152 | 100 | 188 | 77 | 63 | 84 | 44 | 112 |
| 41 | 247 | 230 | 316 | 335 | 164 | 314 | 797 | 141 | 243 | 158 | 93 | 247 | 78 | 37 | 53 | 184 | 102 | 130 | 163 | 163 | 108 | 129 | 125 | 163 | 102 | 53 | 55 | 49 | 114 |
| 42 | 371 | 246 | 507 | 264 | 215 | 360 | 628 | 174 | 246 | 170 | 168 | 293 | 85 | 33 | 167 | 58 | 91 | 195 | 163 | 168 | 177 | 152 | 190 | 198 | 128 | 105 | 75 | 68 | 140 |
| 43 | 199 | 156 | 198 | 62 | 102 | 364 | 335 | 121 | 242 | 107 | 127 | 65 | 31 | 21 | 43 | 102 | 47 | 181 | 167 | 172 | 113 | 118 | 95 | 82 | 76 | 38 | 51 | 45 | 79 |
| 44 | 194 | 233 | 422 | 215 | 128 | 481 | 553 | 125 | 371 | 179 | 150 | 88 | 42 | 28 | 69 | 63 | 86 | 173 | 122 | 121 | 122 | 176 | 144 | 90 | 61 | 51 | 65 | 43 | 87 |
| 45 | 165 | 144 | 233 | 206 | 93 | 339 | 324 | 90 | 220 | 150 | 87 | 27 | 22 | 21 | 34 | 111 | 61 | 140 | 113 | 103 | 131 | 140 | 96 | 83 | 60 | 25 | 39 | 19 | 52 |
| 46 | 148 | 178 | 189 | 170 | 72 | 231 | 228 | 128 | 167 | 55 | 79 | 58 | 21 | 33 | 38 | 67 | 85 | 144 | 106 | 76 | 103 | 117 | 118 | 71 | 38 | 25 | 26 | 15 | 46 |
| 47 | 129 | 161 | 140 | 74 | 76 | 191 | 202 | 122 | 191 | 96 | 68 | 31 | 38 | 20 | 34 | 59 | 88 | 120 | 111 | 75 | 97 | 113 | 61 | 60 | 48 | 25 | 43 | 18 | 47 |
| 48 | 176 | 212 | 149 | 79 | 85 | 193 | 121 | 62 | 178 | 102 | 78 | 25 | 15 | 9 | 24 | 40 | 55 | 80 | 104 | 83 | 90 | 66 | 54 | 65 | 48 | 23 | 35 | 12 | 30 |
| 49 | 89 | 138 | 104 | 58 | 43 | 73 | 92 | 78 | 111 | 47 | 47 | 16 | 20 | 4 | 13 | 50 | 37 | 79 | 86 | 59 | 58 | 52 | 41 | 38 | 34 | 24 | 23 | 12 | 32 |
| 50 | 91 | 142 | 50 | 34 | 53 | 94 | 58 | 67 | 69 | 30 | 50 | 12 | 9 | 3 | 33 | 32 | 65 | 93 | 103 | 94 | 82 | 69 | 28 | 42 | 36 | 20 | 25 | 11 | 19 |
| 51 | 66 | 120 | 63 | 27 | 34 | 114 | 59 | 44 | 50 | 38 | 29 | 4 | 6 | 7 | 14 | 32 | 34 | 71 | 72 | 65 | 41 | 40 | 30 | 37 | 27 | 17 | 20 | 15 | 17 |
| 52 | 64 | 135 | 66 | 44 | 38 | 77 | 33 | 40 | 35 | 15 | 46 | 11 | 16 | 7 | 31 | 8 | 53 | 88 | 94 | 73 | 65 | 45 | 37 | 48 | 29 | 32 | 30 | 24 | 33 |
| 53 | 45 | 99 | 32 | 37 | 23 | 40 | 19 | 16 | 29 | 18 | 22 | 5 | 6 | 6 | 11 | 13 | 18 | 41 | 69 | 58 | 31 | 22 | 22 | 21 | 24 | 13 | 16 | 9 | 22 |
| 54 | 73 | 101 | 35 | 45 | 22 | 35 | 27 | 29 | 50 | 23 | 18 | 5 | 8 | 16 | 19 | 15 | 31 | 54 | 53 | 57 | 50 | 24 | 33 | 27 | 23 | 19 | 21 | 24 | 32 |
| 55 | 20 | 67 | 25 | 31 | 22 | 37 | 30 | 26 | 29 | 19 | 9 | 3 | 4 | 10 | 8 | 9 | 19 | 34 | 28 | 46 | 26 | 12 | 15 | 10 | 20 | 12 | 14 | 15 | 15 |
| 56 | 20 | 35 | 14 | 20 | 16 | 20 | 30 | 19 | 5 | 5 | 11 | 2 | 4 | 3 | 6 | 13 | 19 | 29 | 43 | 29 | 57 | 14 | 11 | 8 | 15 | 13 | 8 | 25 | 24 |
| 57 | 10 | 33 | 5 | 15 | 12 | 22 | 7 | 10 | 6 | 5 | 11 | 3 | 7 | 16 | 8 | 8 | 19 | 37 | 37 | 25 | 16 | 9 | 6 | 6 | 17 | 11 | 9 | 25 | 20 |
| 58 | 13 | 14 | 8 | 14 | 11 | 17 | 14 |  | 11 | 4 | 6 |  | 5 | 3 | 5 | 4 | 13 | 23 | 26 | 21 | 12 | 9 | 7 | 7 | 20 | 7 | 11 | 45 |  |
| 59 | 7 | 10 | 3 | 9 | 4 | 16 | 5 | 2 | 9 | 3 | 10 | 0 | 5 | 2 | 3 | 4 | 10 | 15 | 16 | 13 | 15 | 8 | 9 | 5 | 11 | 4 | 6 | 19 | 7 |
| 60 | 3 | 6 | 3 | 4 | 3 | 13 | 2 |  | 10 | 8 | 1 | 1 | 1 | 4 | 1 | 1 | 8 | 15 | 25 | 16 | 24 | 12 | 6 | 3 | 9 | 7 | 5 | 13 | 4 |
| 61 | 3 | 1 | 4 | 4 | 1 | 5 |  | 1 | 3 | 2 | 1 | 0 | 1 | 9 | 1 | 2 | 14 | 9 | 11 | 8 | 11 | 8 | 8 | 4 | 8 | 4 | 5 | 7 | 9 |
| 62 | 3 | 1 | 2 | 1 | 2 | 3 |  | 1 | 7 | 5 | 1 |  | 2 | 7 | 1 | 3 | 6 | 10 | 11 | 15 | 16 | 8 | 8 | 3 | 15 | 8 | 6 | 22 |  |
| 63 | 1 | 1 |  | 1 | 1 | 4 |  | 5 | 0 | 1 | 0 |  | 2 | 3 | 0 | 2 | 1 | 4 | 11 | 11 | 7 | 7 | 7 | 1 | 8 | 4 | 6 | 7 | 2 |
| 64 |  | 2 | 0 | 2 | 1 |  |  | 1 | 3 | 1 | 2 |  | 0 | 4 | 0 | 1 | 1 | 9 | 11 | 8 | 10 | 10 | 7 | 1 | 10 | 6 | 5 | 17 | 2 |
| 65 | 0 | 0 |  | 2 | 2 |  |  |  | 3 | 1 | 1 |  | 0 | 4 |  | 0 | 4 | 6 | 5 | 4 | 3 | 10 | 7 | 1 | 9 | 2 | 3 | 9 |  |
| 66 | 0 |  |  | 0 | 1 |  |  |  |  | 1 |  |  | 0 | 4 | 0 |  | 1 | 5 | 8 | 3 | 7 | 3 | 4 | 2 | 11 | 1 | 3 | 5 | 3 |
| 67 | 0 |  |  | 0 | 0 | 0 |  |  | 6 | 5 |  |  |  | 6 | 0 |  |  | 4 | 3 | 5 | 2 | 2 | 6 | 1 | 6 | 1 | 3 | 3 | 3 |
| 68 |  |  |  |  | 0 | 2 |  |  |  | 0 | 1 |  |  | 0 | 0 |  |  | 1 | 6 | 6 | 2 | 3 | 4 | 0 | 8 | 0 | 4 | 3 | 3 |
| 69 |  |  |  | 0 |  |  |  |  |  |  |  |  |  | 0 | 0 |  | 0 | 3 | 3 | 2 | 2 | 2 | 4 | 1 | 4 | 1 | 0 | 2 |  |
| 70 | 0 |  |  | 1 |  | 0 |  |  |  | 2 |  |  |  | 0 | 0 |  | 0 | 6 | 2 | 4 | 3 | 4 | 5 | 0 | 4 | 1 | 0 | 1 | 3 |
| 71 |  |  |  |  |  |  |  |  |  | 0 |  |  |  |  | 0 |  |  | 2 | 2 | 4 | 1 | 1 | 3 | 1 | 2 | 0 | 0 | 0 | 1 |
| 72 |  |  |  | 0 |  | 0 |  |  |  | 1 |  |  |  |  | 0 |  |  | 2 | 2 | 4 | 1 | 3 | 4 | 0 | 3 | 1 | 0 | 1 | 3 |
| 73 |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  |  | 0 | 0 | 1 | 1 | 1 | 2 | 2 |  | 1 | 0 | 0 | 1 | , |
| 74 | 0 |  |  |  |  |  |  |  |  | 1 |  |  |  |  |  |  |  | 0 | 1 | 1 | 1 | 3 | 1 |  | 1 | 1 | 0 | 1 | 1 |
| 75 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 1 | 0 | 0 | 1 | 1 |  | 1 | 1 | 2 | 0 | 1 |
| 76 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0 | 0 | 0 | 0 | 1 |  | 1 | 0 |  | 0 | 0 |
| 77 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0 | 0 | 0 | 1 |  | 1 | 0 | 0 | 0 | 0 |
| 78 |  | 0 |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 1 |  |  | 0 |  |  | 0 |  |
| 79 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  | 0 | 1 | 0 |  | 0 | 0 |  |  | 0 |
| 80 |  |  |  |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  |  | 0 |  |  | 0 |  |
| 81 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  | 0 | 0 |  |  |  |
| 82 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  |  |  | 0 |  | 0 | 0 |  |  |  |
| 83 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  |  |  |  |
| Total | 8106 | 9897 | 8709 | 9679 | 7925 | 8329 | 12255 | 4023 | 9249 | 7463 | 3766 | 2466 | 1854 | 2200 | 2491 | 2811 | 2680 | 3602 | 4486 | 4575 | 5233 | 7036 | 4259 | 4598 | 2280 | 1822 | 1649 | 1018 | 4170 |
| Landings (t) | 292 | 353 | 315 | 277 | 249 | 318 | 351 | 345 | 304 | 232 | 139 | 98 | 65 | 74 | 88 | 116 | 117 | 190 | 222 | 205 | 205 | 231 | 162 | 159 | 114 | 73 | 79 | 72 | 149 |

Table 12.2.2.b. FU 28-29 - Length Composition of Nephrops Females (1984-2012)

| Age/Year | 1984 | 1985 | 1986 | 1987 | 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 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 17 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  |  |
| 18 |  |  |  |  | 4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  |  |  | 0 |  |  |  |  |
| 19 |  | 0 |  |  |  | 35 |  |  |  |  | 0 |  |  |  |  |  |  |  |  | 1 |  |  |  | 2 | 0 |  |  |  |  |
| 20 | 3 | 1 | 7 |  | 8 | 21 |  |  |  | 18 |  |  |  |  |  |  |  | 0 |  | 0 | 0 | 8 |  | 4 | 1 |  |  |  |  |
| 21 | 1 | 1 | 22 | 3 | 21 | 102 |  | 21 | 9 | 49 |  |  |  |  |  |  | 3 | 1 | 0 | 3 | 12 | 48 | 3 | 15 | 2 | 1 |  |  | 7 |
| 22 | 8 | 21 | 30 | 78 |  | 88 | 19 | 11 | 102 | 63 |  |  | 0 | 13 | 2 | 5 | 18 | 0 |  | 3 | 10 | 88 | 14 | 26 | 12 | 1 | 0 |  |  |
| 23 | 66 | 21 | 7 | 31 | 28 | 135 | 15 | 69 | 38 | 21 | 2 |  | 0 | 0 | 4 | 4 | 6 | 7 | 0 | 9 | 43 | 54 | 37 | 34 | 11 | 4 | 1 | 1 |  |
| 24 | 79 | 102 | 118 | 270 | 153 | 258 | 38 | 173 | 164 | 41 | 22 | 2 | 11 | 20 | 15 | 25 | 49 | 7 | 10 | 19 | 62 | 135 | 44 | 53 | 25 | 22 | 10 | 1 | 5 |
| 25 | 228 | 205 | 104 | 357 | 163 | 197 | 138 | 198 | 203 | 191 | 73 |  | 13 | 20 | 25 | 27 | 24 | 15 | 11 | 36 | 101 | 129 | 55 | 130 | 23 | 23 | 11 | 1 | 8 |
| 26 | 272 | 284 | 186 | 684 | 220 | 282 | 140 | 436 | 361 | 111 | 92 | 1 | 35 | 102 | 74 | 94 | 81 | 24 | 15 | 67 | 211 | 272 | 113 | 227 | 38 | 80 | 12 | 3 | 17 |
| 27 | 345 | 491 | 359 | 902 | 429 | 326 | 247 | 418 | 448 | 235 | 134 | 0 | 37 | 77 | 91 | 76 | 139 | 34 | 34 | 67 | 266 | 294 | 152 | 298 | 73 | 138 | 20 | 7 | 40 |
| 28 | 431 | 523 | 322 | 1421 | 471 | 231 | 345 | 598 | 597 | 413 | 170 | 6 | 36 | 152 | 148 | 100 | 64 | 44 | 107 | 98 | 336 | 242 | 179 | 355 | 81 | 170 | 26 | 7 | 51 |
| 29 | 443 | 672 | 419 | 1253 | 516 | 285 | 491 | 590 | 514 | 523 | 269 | 31 | 45 | 178 | 114 | 121 | 171 | 90 | 127 | 173 | 395 | 420 | 392 | 458 | 123 | 149 | 51 | 4 | 130 |
| 30 | 422 | 588 | 381 | 928 | 499 | 317 | 575 | 771 | 599 | 775 | 326 | 104 | 50 | 199 | 199 | 236 | 152 | 131 | 237 | 241 | 406 | 654 | 321 | 365 | 145 | 205 | 67 | 7 | 164 |
| 31 | 487 | 593 | 418 | 948 | 482 | 501 | 639 | 414 | 736 | 752 | 427 | 182 | 95 | 394 | 168 | 263 | 131 | 167 | 195 | 152 | 334 | 565 | 305 | 317 | 129 | 132 | 99 | 26 | 330 |
| 32 | 485 | 653 | 700 | 946 | 766 | 306 | 859 | 807 | 617 | 824 | 558 | 322 | 198 | 502 | 376 | 485 | 283 | 316 | 296 | 360 | 530 | 857 | 510 | 409 | 252 | 209 | 145 | 45 | 397 |
| 33 | 613 | 415 | 406 | 227 | 527 | 314 | 596 | 375 | 430 | 449 | 283 | 251 | 53 | 163 | 116 | 187 | 153 | 184 | 467 | 270 | 433 | 448 | 272 | 253 | 182 | 110 | 91 | 51 | 195 |
| 34 | 618 | 467 | 654 | 774 | 813 | 511 | 734 | 310 | 369 | 359 | 353 | 641 | 209 | 278 | 298 | 346 | 235 | 252 | 429 | 314 | 400 | 462 | 341 | 386 | 177 | 122 | 140 | 96 | 297 |
| 35 | 562 | 563 | 447 | 447 | 460 | 435 | 519 | 284 | 287 | 194 | 246 | 674 | 184 | 150 | 112 | 287 | 193 | 158 | 470 | 255 | 324 | 254 | 249 | 351 | 187 | 103 | 120 | 56 | 165 |
| 36 | 469 | 329 | 316 | 386 | 489 | 274 | 243 | 130 | 267 | 203 | 237 | 811 | 142 | 135 | 166 | 317 | 225 | 174 | 351 | 194 | 222 | 203 | 162 | 213 | 103 | 83 | 144 | 60 | 138 |
| 37 | 505 | 353 | 400 | 223 | 206 | 318 | 189 | 108 | 333 | 154 | 147 | 692 | 267 | 129 | 171 | 201 | 213 | 144 | 302 | 203 | 178 | 182 | 142 | 240 | 121 | 90 | 119 | 73 | 98 |
| 38 | 383 | 284 | 330 | 269 | 265 | 285 | 207 | 135 | 251 | 100 | 128 | 348 | 151 | 39 | 48 | 184 | 85 | 108 | 300 | 206 | 151 | 178 | 152 | 247 | 134 | 83 | 106 | 151 | 76 |
| 39 | 274 | 142 | 211 | 146 | 288 | 148 | 216 | 74 | 176 | 150 | 66 | 194 | 67 | 35 | 59 | 151 | 92 | 112 | 213 | 160 | 113 | 89 | 173 | 138 | 123 | 86 | 95 | 113 | 46 |
| 40 | 171 | 119 | 80 | 119 | 132 | 131 | 230 | 131 | 147 | 110 | 114 | 344 | 120 | 21 | 89 | 111 | 79 | 133 | 186 | 284 | 136 | 84 | 114 | 109 | 125 | 62 | 80 | 68 | 46 |
| 41 | 58 | 106 | 55 | 65 | 128 | 149 | 73 | 39 | 68 | 108 | 77 | 361 | 63 | 31 | 64 | 81 | 66 | 79 | 110 | 170 | 82 | 73 | 129 | 73 | 95 | 83 | 65 | 65 | 37 |
| 42 | 50 | 36 | 133 | 54 | 43 | 127 | 210 | 62 | 69 | 95 | 73 | 165 | 111 | 18 | 84 | 73 | 67 | 91 | 80 | 192 | 122 | 116 | 112 | 56 | 75 | 94 | 52 | 80 | 35 |
| 43 | 30 | 27 | 21 | 40 | 28 | 109 | 58 | 82 | 26 | 43 | 23 | 64 | 29 | 2 | 34 | 38 | 41 | 55 | 87 | 132 | 70 | 70 | 44 | 16 | 30 | 25 | 28 | 80 | 33 |
| 44 | 17 | 13 | 47 | 147 | 27 | 91 | 77 | 6 | 46 | 42 | 43 | 88 | 90 | 18 | 71 | 34 | 49 | 56 | 57 | 75 | 66 | 61 | 46 | 21 | 24 | 43 | 40 | 41 | 27 |
| 45 | 14 | 11 | 27 | 84 | 19 | 27 | 41 | 21 | 40 | 34 | 13 | 54 | 36 | 8 | 22 | 18 | 23 | 29 | 51 | 68 | 66 | 50 | 35 | 18 | 28 | 17 | 25 | 21 | 10 |
| 46 | 7 | 6 | 5 | 40 | 14 | 38 | 31 | 45 | 25 | 37 | 11 | 13 | 15 | 4 | 28 | 18 | 38 | 33 | 40 | 37 | 51 | 39 | 54 | 19 | 14 | 22 | 19 | 11 | 10 |
| 47 | 5 | 3 | 3 | 26 | 9 | 24 | 16 | 7 | 12 | 29 | 7 | 18 | 23 | 3 | 23 | 7 | 52 | 26 | 25 | 25 | 44 | 35 | 23 | 9 | 26 | 16 | 18 | 15 | 11 |
| 48 | 4 | 1 |  | 71 | 11 | 29 | 7 | 15 | 18 | 15 | 4 | 15 | 8 | 2 | 6 | 9 | 25 | 12 | 24 | 28 | 37 | 18 | 11 | 8 | 20 | 7 | 12 | 9 | 5 |
| 49 | 1 | 0 | 3 | 17 | 4 | 9 | 1 | 17 | 17 | 23 | 4 | 1 | 6 | 7 | 6 | 4 | 21 | 15 | 19 | 18 | 24 | 24 | 7 | 7 | 13 | 6 | 7 | 7 | 6 |
| 50 | 1 | 0 |  | 2 | 6 | 3 | 1 | 2 | 32 | 8 | 17 | 1 | 2 | 1 | 6 | 5 | 10 | 15 | 26 | 24 | 20 | 23 | 7 | 3 | 13 | 8 | 7 | 2 | 6 |
| 51 | 0 | 0 | 3 | 4 | 3 | 7 | 2 | 4 | 4 | 5 | 0 |  |  | 1 | 2 | 2 | 10 | 9 | 22 | 14 | 13 | 17 | 11 | 5 | 11 | 3 | 6 | 5 | 6 |
| 52 | 1 |  |  | 5 | 5 | 8 | 1 |  | 5 | 6 | 1 | 1 | 0 | 1 | 1 | 3 | 16 | 6 | 19 | 21 | 13 | 17 | 7 | 3 | 7 | 3 | 4 | 4 | 9 |
| 53 | 2 |  |  | 2 | 3 | 1 |  |  | 9 | 6 | 0 |  |  | 0 | 0 |  | 6 | 6 | 10 | 13 | 8 | 10 | 2 | 1 | 8 | 3 | 2 | 3 | 5 |
| 54 |  |  |  | 4 | 1 | 1 |  |  | 1 | 1 |  |  | 1 | 0 | 1 |  | 5 | 2 | 2 | 14 | 7 | 6 | 9 | 1 | 8 | 1 | 2 | 5 | 5 |
| 55 |  |  |  | 0 | 1 | 1 |  |  | 6 | 2 |  |  |  |  |  |  | 1 | 2 | 3 | 10 | 4 | 5 | 1 | 1 | 3 | 4 | 0 | 5 | 2 |
| 56 |  |  |  | 3 | 0 | 2 |  | 5 | 14 | 5 |  |  |  |  | 0 |  | 3 | 1 | 3 | 7 | 6 | 2 | 1 | 0 | 3 | 0 | 0 | 2 | 1 |
| 57 |  |  |  | 0 | 0 | 1 |  |  | 4 | 1 |  |  | 0 |  | 0 |  | 1 | 0 | 2 | 4 | 2 | 3 | 1 |  | 1 | 0 | 0 | 1 | 3 |
| 58 |  |  |  | 0 |  | 0 |  |  | 4 | 1 |  |  |  |  |  |  |  | 1 | 1 | 1 | 2 | 0 | 1 | 0 | 1 | 1 | 0 | 4 | 2 |
| 59 |  |  |  | 1 | 0 | 0 |  |  |  |  |  |  |  |  |  |  | 0 | 1 | 0 | 0 | 1 | 1 | 1 |  |  | 0 | 0 | 2 | 0 |
| 60 |  |  |  |  | 0 |  |  |  | 1 | 0 |  |  |  |  |  |  |  | 0 |  | 0 |  | 2 |  |  | 1 |  | 0 | 2 | 0 |
| 61 |  |  |  |  |  | 1 |  |  |  |  |  |  |  |  |  |  | 3 | 1 |  | 0 | 1 |  |  |  |  | 0 | 0 | 1 | 0 |
| 62 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0 | 0 | 1 | 0 |  |  |  | 0 | 0 | 0 |
| 63 |  |  |  |  |  |  |  |  | 4 | 1 |  |  |  |  |  |  |  | 0 | 0 |  |  | 0 |  |  |  | 0 | 0 | 2 | 0 |
| 64 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 0 |  | 0 | 0 | 0 |  |  | 0 |
| 65 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0 |  |  |  |  |  | 0 |  |
| 66 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0 |  |  |  | 0 |  |  |  |  |  |  |  |
| 67 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  |
| 68 |  |  |  |  |  |  |  |  | 4 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 69 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 70 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  |  |  |  | 0 |  |  |  |
| 71 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 72 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 73 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 74 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 75 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 76 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 77 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 78 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 79 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 80 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 81 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 82 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 83 Total | 7052 | 7032 | 6218 | 10978 |  | 6126 | 6962 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 6240 |  |  |  |  |  |  |  |
| dings (t) | 169 | 156 | 6218 150 | 1092 |  | 6126 151 | 174 | 134 | 165 | 145 |  |  |  |  | ${ }^{2621}$ |  | 2829 84 | 79 | 1335 | 3969 130 | 5304 140 | ${ }^{6240}$ | 1212 | 114 |  |  |  | 1138 |  |

Table 12.2.3. - SW and S Portugal (FUs 28-29): Effort and CPUE of Portuguese trawlers, 1994-2012 (standardized/revised).

| Year | No. of <br> trawlers | CPUE <br> (t/boat) | Estimated <br> hours | CPUE <br> $(\mathrm{kg} / \mathrm{hour})$ |
| :---: | :---: | :---: | :---: | :---: |
| 1994 | 31 | 7.6 |  |  |
| 1995 | 30 | 9.1 |  |  |
| 1996 | 25 | 5.3 |  |  |
| 1997 | 25 | 5.4 |  |  |
| 1998 | 25 | 6.4 | 40,268 | 4.0 |
| 1999 | 29 | 7.3 | 40,498 | 5.2 |
| 2000 | 33 | 6.1 | 53,929 | 3.7 |
| 2001 | 33 | 8.2 | 84,364 | 3.2 |
| 2002 | 34 | 10.5 | 71,274 | 5.0 |
| 2003 | 35 | 9.6 | 56,427 | 6.6 |
| 2004 | 33 | 10.4 | 82,387 | 4.6 |
| 2005 | 32 | 11.9 | 66,513 | 5.9 |
| 2006 | 30 | 9.1 | 49,329 | 5.9 |
| 2007 | 30 | 9.1 | 53,167 | 5.5 |
| 2008 | 30 | 6.3 | 41,700 | 5.3 |
| 2009 | 30 | 4.4 | 32,061 | 4.7 |
| 2010 | 26 | 5.0 | 31,673 | 4.6 |
| 2011 | 26 | 4.5 | 31,789 | 4.2 |
| $2012^{*}$ | 21 | 10.0 | 46,963 | 4.6 |
| * provisional |  |  |  |  |

Table 12.2.4. - SW and S Portugal (FUs 28-29): Nephrops CPUEs (kg/hour) in research trawl surveys, 1994-2012.

| Year | Demersal surveys |  |  | Crustacean surveys |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | CPUE (kg/hour) |  |  | Month | CPUE |
|  | Summer | Autumn | Winter | of survey |  |
| 1994 | ns | 0.40 | ns | Mai-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 | 2.6 |
| 1998 | 0.7 | 0.02 | ns | Jun-98 | 1.2 |
| 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 | 2.4 |
| 2003 | ns | 0.19 | ns | Jun-03 | 2.6 |
| 2004 | ns | 0.51 | ns | Jun-04 | nr |
| 2005 | ns | 0.09 | 0.16 | Jun-05 | 4.7 |
| 2006 | ns | 0.19 | 0.06 | Jun-06 | 2.4 |
| 2007 | ns | 0.04 | 0.73 | Jun-07 | 2.8 |
| 2008 | ns | 0.13 | 0.25 | Jun-08 | 4.0 |
| 2009 | ns | 0.13 | ns | Jun-09 | 2.0 |
| 2010 | ns | 0.34 | ns | Jun-10 | 6.8 |
| 2011 | ns | 0.11 | ns | Jun-11 | nc |
| 2012 | ns | ns | ns | ns | ns |
| $\mathrm{ns}=$ no survey $\mathrm{nr}=$ not reliable $\mathrm{nc}=$ whole area not covered |  |  |  |  |  |

Table 12.2.5. - SW and S Portugal (FUs 28-29): Mean sizes (mm CL) of male and female Nephrops in Portuguese landings and surveys, 1994-2012.

| 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 |

Table 12.2.6 Analysis of deviance for the Gamma-based GLM model fitted to the positive Nephrops CPUE in the catches.

| Source of <br> variation | Df | Deviance | Resid. Df | Resid. Dev | Pr(>F) | $\%$ <br> explained |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
| NULL |  |  | 64427 | 73673 |  |  |
| year | 14 | 8901.3 | 64413 | 64772 | $<2.2 \mathrm{e}-16$ | $12.1 \%$ |
| qua | 11 | 2584.3 | 64402 | 62187 | $<2.2 \mathrm{e}-16$ | $3.5 \%$ |
| depth.class2 | 2 | 1735.7 | 64400 | 60451 | $<2.2 \mathrm{e}-16$ | $2.4 \%$ |
| catdps | 1 | 2427.7 | 64399 | 58024 | $<2.2 \mathrm{e}-16$ | $3.3 \%$ |
| cat_pnep | 1 | 17798.7 | 64398 | 40225 | $<2.2 \mathrm{e}-16$ | $24.2 \%$ |
| catPRT2 | 2 | 1131.7 | 64396 | 39093 | $<2.2 \mathrm{e}-16$ | $1.5 \%$ |
| Total | $\mathbf{3 1}$ | $\mathbf{3 4 5 7 9 . 4}$ |  |  |  | $\mathbf{4 6 . 9 \%}$ |

AIC: 227589


Figure 12.2.1. 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 CPUE standardization model.

Males


Figure 12.2.2.a $\quad$ SW and S Portugal (FU 28-29) male length distributions for the period 1984-2012.

## Females



Figure 12.2.2.b SW and S Portugal (FU 28-29) female length distributions for the period 1984-2012.

## Portuguese Crustacean Landings



Figure 12.2.3 FUs 28-29: Portuguese Crustacean Landings in the period 1984-2012.


Figure 12.2.4. Comparison of standardized and observed Nephrops CPUE.

### 12.3 Nephrops in FU 30 (Gulf of Cadiz)

### 12.3.1 General

### 12.3.1.1 Ecosystem aspects

See Annex L

### 12.3.1.2 Fishery description

See Annex L
12.3.1.3 ICES Advice for 2013 and Management applicable for 2013 and 2014

ICES Advice for 2013
The advice for these Nephrops stocks is biennial and valid for 2011 and 2012.
Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 90 tonnes.

To protect the stock in this Functional Unit, management should be implemented at the Functional Unit level.

## Management applicable for 2013 and 2014

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).

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 IXa was 273 t for 2012 and 246 t for 2013. respectively, and the maximum number of fishing days per vessel was fixed at 150 and 141 days for Spanish vessels and at 155 and 140 days for Portuguese vessels for these two years (Annex IIb of Council Regulations nos. 43/2012 and 39/2013). The number of fishing days included in these regulations is not applicable to the Gulf of Cadiz (FU 30), which has a different regime.

### 12.3.2 Data

### 12.3.2.1 Commercial catch and discard

In previous years landings have been estimated by the WG based on IEO scientific estimations. The information was compiled by IEO from sale sheets and Owners Associations and the Nephrops landings allocation was carried out based on landing port criteria. Since 2011, the Spanish Authority for Fisheries (Secretaría General de Pesca, SGP) who is also the National authority for the Data Collection Framework, established a new policy and general approach in the provision of official data on catches and fishing effort. So, this year, 2011 and 2012 Nephrops official landings are presented in WGHMM 2013.

Unlike the IEO scientific estimates, official landings are derived from logbooks. This source of information allows the landings disaggregation by ICES statistical rectangles. However, a considerable percentage of Nephrops catches ( $27 \%$ in 2011 and $26 \%$ in 2012) were allocated into statistical rectangles that do not belong to any FU in Divi-
sion IXa (WD XXX). To avoid this problem the WG has considered the inclusion of the catches into the closest statistical rectangles in each FU. At the moment it is not possible to quantify the impact this allocation may have on the estimation of landings by FU. This issue will be further investigated in the near future.
Landings in this FU are reported by Spain and also minor quantities by Portugal. Since 2007 a significant increase in Nephrops landings estimates has been observed in Ayamonte port, which is located in the mouth of the Guadiana River. Landings from this port have been taken into account from Working Group 2010 onwards. This port accounted for more than $30 \%$ of the total FU30 landings in 2007-2010 periods, becoming the most important Nephrops landing port of the Gulf of Cádiz, with Isla Cristina port. Previously, the landings in Ayamonte port were minimal, with the fleet landing in nearby ports. Due to the recent importance of this port, since WGHMM in 2010, its landings have been incorporated in the Gulf of Cadiz time series of landings, as well as directed effort and LPUE from 2002 (Tables 12.3.1 and 12.3.4).

Along the time series, Nephrops landings trends in FU30 have remained unchanged after the incorporation of Ayamonte information from 2002. Total landings decreased from 108 t in 1994 to 49 t in 1996, the lowest value recorded. After that, there has been an increasing trend, reaching 307 t in 2003, dropping to 246 t in 2005-2006 (with the exception for the year 2004 when a decrease of more than $50 \%$ was observed). Since 2006 landings have declined to less 100 t in 2011. Landings in 2012 were 115 t .

The discarding rate of Nephrops in this fishery fluctuates annually but is always low (Table 12.3.2). In 2010, the percentage of discarded Nephrops by weight was half of the previous year, with a value of $1.3 \%$ of discarded Nephrops. No Nephrops discards were recorded in 2011 and 2012. Figure 12.3.2 shows the estimated length frequency distributions of the discarded and retained Nephrops by trip. The mean carapace length has fluctuated along the period with no apparent trend.

### 12.3.2.2 Biological sampling

The sampling level for the species is given in Table 1.3.
Figure 12.3 .3 shows the annual landings length distribution for males, females and both sexes combined during the period 2001-2012. The length composition of landings is biased for the period 2001 to 2005 since the sampling of landings was not stratified by commercial categories (Silva et al., 2006). A new sampling scheme was applied and the information was more reliable. The mean sizes for both sexes remained relatively stable after the sampling scheme was changed, around 29 mm CL for sexes combined.

Since 2009, onboard concurrent samplings are carried out, as required by the new DCF (Reg. EC 1343/2007). Outside of the Nephrops fishing season, a higher proportion of observer trips are likely to not cover Nephrops catches whereas when the directed Nephrops sampling were carried out in harbours in the past, the length distribution of landings were covered in all months. This fact could reduce the consistency of the length distribution of the catches in 2011 and 2012.
Mean size of males, females and sexes combined of Nephrops landings from 2001 to 2012 are shown in Figure 12.3.4. The mean sizes in 2009 increased slightly in $10 \%$ respect the previous year and have remained stable up to 2011. In 2012, an increment of the mean size was observed in both sexes.

### 12.3.2.3 Abundance indices from surveys

The biomass and the abundance indices of Nephrops by depth strata, estimated from the Spanish bottom trawl spring surveys (SPGF-cspr-WIBTS-Q1) carried out from

1993 to 2012 are shown in Table 12.3.3.
In the time series two different periods can be observed. From 1993 to 1998 the overall abundance index trend was decreasing, while from 1998 onwards the index has remained stable although fluctuating widely in some years, except in 2004, which value was the lowest in the time series (Figure 12.3.5). In 2010 the deeper strata (500700 m ) were not sampled due to a reduction in the days of the survey, as a consequence of adverse weather conditions. Therefore, only the abundance index for the strata $200-500 \mathrm{~m}$ is available for 2010 (Table 12.3.3) and its value is similar to the corresponding strata in previous year. In 2011 and 2012 the abundance index decreased. Abundance index trend shows a declining trend since 2005, representing less $70 \%$ in 2012. This survey is not specifically directed to Nephrops and it is not carried out during the main Nephrops fishing season but shows a similar trend to the commercial LPUE in most of the time series but not in two last years.
The length distributions of Nephrops obtained in the Spanish bottom trawl spring surveys (SPGF-cspr-WIBTS-Q1) during the period 2001-2012 are presented in Figure 12.3.6. The time series of Nephrops mean sizes for males, females and combined sexes obtained in these surveys are shown in Figure 12.3.7. No apparent trends are observed. Mean size ranged between 34.6 and 42.9 mm CL for males and between 28.6 and 34.9 mm CL for females.

### 12.3.2.4 Commercial catch- Effort data

Figure 12.3.1 and Table 12.3.4 show directed Nephrops effort estimates and LPUE series modified after the incorporation of data from Ayamonte port since 2002.

The directed fishing effort trend is clearly increasing from 1994 to 2005, and after that the trend is declining to 2008 ( 1150 fishing days). The maximum of the series was reached in 2005 with a value of 4336 fishing days. In 2009, directed effort increased by more than 500 fishing days with respect to the previous year and it remained stable in 2010. The directed fishing effort declined in 2011 although in 2012 was slightly higher than in the previous year.

LPUE obtained from the directed effort shows a gradual decrease from 1994 to 1998. After 1998, the trend slightly increases until 2003. In 2004, the LPUE decreases to the lowest value recorded ( $44.3 \mathrm{Kg} /$ fishing day). LPUE then increased until 2008 around $60 \%$. The incorporation of the Ayamonte data caused an increase of the directed LPUE mainly in 2008 (Figure 12.3.1). Since 2008 LPUE have declined to $50 \mathrm{Kg} /$ fishing day in 2009 and $45.5 \mathrm{Kg} /$ fishing day in 2010 (about $30 \%$ less with respect to 2008). In 2011 and 2012, directed Nephrops LPUE shows a increasing trend.
The overall LPUE trend is quite similar to the abundance survey index in the stratum of 200-700 m from 1996 to 2002 (no survey was carried out in 2003) despite the survey index had fluctuated in some years (Figure 12.3.4). The lowest values were detected in 2004 in both series. In 2008, the abundance survey index was well above the commercial LPUE, however, the abundance index drop in 2009 agrees with the commercial LPUE. This fact may be explaining for the increases of the rose shrimp abundance in 2008. The increased abundance of rose shrimp is believed to have led to a change in the objectives of the fishery, as rose shrimp achieves a higher market value and its fishing grounds are easier to reach because they are shallower ( $90-380 \mathrm{~m}$ ) and closer to the coast. No abundance index data are available in the deeper strata sampled by Spanish bottom trawl spring surveys (SPGF-cspr-WIBTS-Q1) in 2010. In 2011 and 2012, an increase of the directed commercial LPUE was observed but differently, the abundance index of spring survey decreased (Figure 12.3.4).

### 12.3.3 Assessment

No assessment was carried out in 2013.

### 12.3.4 Biological reference points

No reference points are defined for this stock.

### 12.3.5 Management considerations

Nephrops fishery is taken in mixed bottom trawl fisheries, therefore HCRs applied to other species will affect this stock.
A Recovery Plan for the Iberian stocks of hake and Nephrops was approved in December 2005 (CE 2166/2005). This recovery plan includes a reduction of $10 \%$ in F relative to the previous year and TAC set accordingly, within the limits of $\pm 15 \%$ of the previous year TAC. By derogation, a different method of effort management method is applied to the Gulf of Cadiz.
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). All the Fishing Plans establish a continuous period of 56 hours per week without fishing and a single landing event per vessel per day. Since the first Fishing Plan in 2004 a closed fishing season with a gradual increase in the number of days has been implemented ( 45,60 , and 90 days per year). The Fishing plan ARM/2515/2009, established 21 out 90 days of close fishing season in winter 2010 (from $16^{\text {th }}$ January to $22^{\text {nd }}$ January and from $16^{\text {th }}$ February to $14^{\text {th }}$ February). The latest Fishing Plan (ARM/2457/2010) was applied since September 2010 and finished in 2012. This plan reduces the length of the closed fishing season to 45 days, between $24^{\text {th }}$ September and $7^{\text {th }}$ November, plus 5 additional days to be selected by the ship owner during the duration of this Plan. The potential effect of the closed seasons on the Nephrops population has not been evaluated. Additionally, an increase of mesh size to 55 mm or more was implemented at the end of 2009 in order to reduce discards of individuals below the minimum landing size.

Regulations were established by the Regional Administration with the aim of distributing the fishing effort throughout the year (Resolutions: $13^{\text {th }}$ February 2008, BOJA n ${ }^{\text {o }}$ 40; 16 ${ }^{\text {th }}$ February 2009, BOJA no 36; $23^{\text {th }}$ November 2009, BOJA no 235; $15^{\text {th }}$ October 2010, BOJA no 209). These regional regulations control the days and time when the Gulf of Cadiz bottom trawl fleet can enter or leave fishing ports. Although the regulations vary among them, they generally allow a large flexibility during late spring and summer months (e.g. the 2010 Regulation established a continuous period from Monday 3 am to Thursday 9 pm during May-August, that was implemented in 2011), which is the main Nephrops fishing season, with more restricted time period in other months. This flexibility in summer months might have induced fleets from the ports closer to Nephrops grounds, such as Ayamonte or Isla Cristina, to direct their fishing effort to this species. However, the Nephrops directed fishing and landings decreased sharply in 2008 and remained at similar low levels in 2009-2012 period. The increased abundance of rose shrimp is believed to have led to a change in the objectives of the fishery, as rose shrimp achieves a higher market value and its fishing grounds are easier to reach because they are shallower (90-380 m) and closer to the coast.

Table 12.3.1. Nephrops FU30, Gulf of Cadiz: Landings in tonnes.

| Year | Spain** | Portugal | Total |
| :---: | :---: | :---: | :---: |
| 1994 | 108 |  | 108 |
| 1995 | 131 |  | 131 |
| 1996 | 49 |  | 49 |
| 1997 | 97 |  | 97 |
| 1998 | 85 |  | 85 |
| 1999 | 120 |  | 120 |
| 2000 | 129 |  | 129 |
| 2001 | 178 | 4 | 178 |
| 2002 | 262 | 4 | 262 |
| 2003 | 303 | 4 | 307 |
| 2004 | 143 | 4 | 147 |
| 2005 | 243 | 3 | 246 |
| 2006 | 242 | 2 | 215 |
| 2007 | 211 | 1 | 120 |
| 2008 | 117 | 4 | 119 |
| 2009 | 117 | 1 | 107 |
| 2010 | 106 | 93 |  |
| $2011^{*}$ | 115 |  | 97 |
| $2012^{*}$ |  |  | 116 |

*Spanish Official Data
** Ayamonte landings are included since 2002

Table 12.3.2. Nephrops FU30, Gulf of Cádiz: Mean carapace length of the discarded and retained fraction of Nephrops, and percentage of discarded (2005-2012) 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 |

Table 12.3.3. Nephrops FU30, Gulf of Cádiz. Abundance index from Spanish bottom trawl spring surveys (SPGFS-cspr-WIBTS-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 |

ns = no survey
**= no sampled
Table 12.3.4. Nephrops FU30, Gulf of Cádiz. Total landings and landings, LPUE and effort at the bottom trawl fleet making fishing trips with at least $10 \%$ Nephrops catches.

| Year | $* *$ Total landings <br> $\mathbf{( t )}$ | *Landings <br> $(\mathbf{t})$ | *LPUE <br> (kg/day) | *Effort <br> (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 | 93 | 62 | 54.6 | 1135 |
| 2012 | 115 | 80 | 58.0 | 1380 |

[^5]

Figure 12.3.1. Nephrops FU 30, Gulf of Cádiz. Long term trends in landings, Nephrops directed effort and LPUE and mean sizes.


Figure 12.3.2. Nephrops FU 30, Gulf of Cádiz. Length distribution of retained and discarded fractions Nephrops from discards program (2005-2012 period).


Figure 12.3.3. Nephrops FU30, Gulf of Cádiz. Length distributions of landings for the period 20012012.


* 1995 and 2010: strata $500-700 \mathrm{~m}$ no sampled
** 2003: no survey

Figure 12.3.4. Nephrops FU30, Gulf of Cádiz, Abundance index from Spanish bottom trawl spring surveys (SPGFS-cspr-WIBT-Q1) and commercial directed Nephrops LPUE from the bottom trawl fleet.


Figure 12.3.5. Nephrops FU30, Gulf of Cádiz. Length distributions from Spanish bottom trawl surveys (SPGFS-cspr-WIBTS-Q1) for 2001-2012 period.


Figure 12.3.6. Nephrops FU30, Gulf of Cádiz. Mean size in spring bottom trawl surveys (SPGFS-cspr-WIBTS-Q1) for the period 2001-2012.

### 12.4 Summary for Division IXa

ICES Division IXa includes five FUs, which are managed together. The TAC is set for the whole Division. In the period 2008-2011, the landings were below the TAC (see Tables 12.1 and 12.2.). In 2013, landings of FUs 28-29 and 30 increased and surpassed the TAC.

The northernmost stocks (FUs 26-27) continue to be at very low abundance levels. The southern stocks (FUs 28-29 and FU 30) remain low despite a slight increase in recent years. In these FUs, part of the multispecies fleet effort is directed at rose shrimp, reducing the pressure on Nephrops.

The practice of managing three distinctive Nephrops stocks by a joint TAC may lead to unbalanced exploitation of the individual stocks. This is particularly true for this Division where the state of the individual stocks is quite different. Fine scale management of catches and/or effort at a geographic scale that corresponds to the Nephrops stock distribution should be implemented.

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 F relative to the previous year and TAC set accordingly, within the limits of $\pm 15 \%$ of the previous year TAC (Council Regulation (EC) No 2166/2005). By derogation, a different method of effort management method is applied to the Gulf of Cadiz (Article 8, §3).

The Council Regulation (EC) No 850/98 was also amended with the introduction of two boxes, in FU 26 and the other in FU 28. These boxes are closed for Nephrops fishing for three and four months respectively, during the peak of the fishing season (May-August) (Council Regulation (EC) No 2166/2005). By way of derogation, fishing with bottom trawls in these areas and periods are authorised provided that the bycatch of Norway lobster does not exceed $2 \%$ of the total weight of the catch. The same applies to creels that do not catch Nephrops.
A Portuguese regulation (Portaria no. 43, 12 ${ }^{\text {th }}$ January 2006) closes the crustacean fishery in FUs 28-29 in January every year. Also, a closed season of 50 days was established between September and November 2010 and 2011 (ARM/2457/2010) in the Gulf of Cadiz (FU30) bottom trawl fleet by Spanish Administration.
No evaluation of the impact of these closures on the Nephrops stocks in FUs 28-29 and FU 30 has been carried out.
New regulations have been established since 2008 by the Regional Administration with the aim of distributing the fishing effort throughout the year by controlling the days and times when the Gulf of Cadiz bottom trawl fleet can enter or leave fishing ports (Resolution $23^{\text {th }}$ November 2009, BOJA no 235). In 2011, a continued period from Monday 3 am to Thursday 9 pm during May-August has been established (Resolution $24^{\text {th }}$ September 2010, BOJA n ${ }^{\circ} 209$ ), increasing the fishing hours during this period.

Table 12.4-1. Total recorded landings in Division IXa

|  | Division IXa - Management Area $Q$ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | FU $26+27$ Mest Gaticia + North Potugal |  |  |  |  |  |  |  |  | FU $28+29 \mathrm{SW}+$ S Pontigal |  |  |  |  |  | FU30Gulal Cadz |  |  | QTotal |
|  | 26* |  |  | 27 |  |  |  |  | Total | $\begin{array}{\|c\|} \hline 28 \\ \hline \text { Spain } \\ \hline \text { Trawil } \\ \hline \end{array}$ | $\begin{array}{\|c\|} \hline 29 \\ \hline \text { Spain } \\ \hline \text { Trawil } \\ \hline \end{array}$ | $\frac{28+29}{\text { Portugal }}$ |  |  | Total | 30 |  | Total |  |
|  | Portugal | Spain | Total | Potugal |  |  | $\frac{\text { Spain }}{\text { Traw }}$ | Total |  |  |  |  |  |  | $\begin{array}{\|c\|} \hline \text { Potugal } \\ \hline \text { Unaloc } \\ \hline \end{array}$ | $\begin{aligned} & \hline \text { Spain } \\ & \hline \text { Trawi } \end{aligned}$ |  |  |
| Year | Traw | Trawl | Total | Autisanal | Trawl | Total |  |  |  |  |  | Arlisanal | Traw | Total |  |  |  |  |  |
| 1975 |  | 622 | 622 |  |  |  |  |  | 622 | 137 | 1510 |  | 34 | 34 | 1681 |  |  |  | 2303 |
| 1976 |  | 603 | 603 |  |  |  |  |  | 603 | 132 | 1752 |  | 30 | 30 | 1914 |  |  |  | 2517 |
| 1977 |  | 620 | 520 |  |  |  |  |  | 620 | 95 | 1764 |  | 15 | 15 | 1874 |  |  |  | 2494 |
| 1978 |  | 575 | 575 |  |  |  |  |  | 575 | 120 | 1979 |  | 45 | 45 | 2144 |  |  |  | 2719 |
| 1979 |  | 580 | 580 |  |  |  |  |  | 580 | 96 | 1532 |  | 102 | 102 | 1730 |  |  |  | 2310 |
| 19880 |  | 599 | 599 |  |  |  |  |  | 599 | 193 | 1300 |  | 147 | 147 | 1640 |  |  |  | 2239 |
| 1981 |  | 823 | 823 |  |  |  |  |  | 823 | 270 | 1033 |  | 128 | 128 | 1431 |  |  |  | 2254 |
| 1982 |  | 736 | 736 |  |  |  |  |  | 736 | 130 | 117/ |  | 86 | 85 | 1393 |  |  |  | 2129 |
| 1983 |  | 786 | 786 |  |  |  |  |  | 786 |  |  |  | 244 | 244 | 244 |  |  |  | 1030 |
| 1984 |  | 604 | 604 |  | 14 | 14 |  | 14 | 618 |  |  |  | 451 | 451 | 451 |  |  |  | 1079 |
| 1985 |  | 750 | 750 | 4 | 11 | 15 |  | 15 | 765 |  |  |  | 509 | 509 | 509 |  | 297 | 251 | 1531 |
| 19886 |  | 657 | 657 | 9 | 28 | 37 |  | 37 | 694 |  |  |  | 465 | 465 | 465 |  | 221 | 221 | 1380 |
| 1987 |  | 671 | 671 | 19 | 52 | 71 |  | 71 | 742 |  |  | 11 | 498 | 509 | 509 |  | 302 | 302 | 1553 |
| 19888 |  | 631 | 631 | 41 | 55 | 96 |  | 96 | 727 |  |  | 15 | 405 | 420 | 420 |  | 139 | 139 | 1288 |
| 1989 |  | 620 | 620 | 22 | 66 | ${ }^{88}$ |  | 88 | 708 |  |  | 6 | 463 | 469 | 469 |  | 174 | 174 | 1351 |
| 1990 |  | 401 | 401 | 17 | 31 | 48 |  | 48 | 449 |  |  |  | 520 | 524 | 524 |  | 220 | 220 | 1193 |
| 1991 |  | 549 | 549 | 14 | 40 | 54 |  | 54 | 603 |  |  | 5 | 473 | 478 | 478 |  | 226 | 226 | 1307 |
| 1992 |  | 584 | 584 | 15 | 37 | 52 |  | 52 | 636 |  |  | 1 | 469 | 470 | 470 |  | 243 | 243 | 1349 |
| 1993 |  | 472 | 472 | 14 | 36 | 50 |  | 50 | 522 |  |  | 1 | 376 | 377 | 377 |  | 160 | 160 | 1059 |
| 1994 |  | 426 | 426 | 8 | 14 | 22 |  | 22 | 448 |  |  |  | 237 | 237 | 237 |  | 108 | 108 | 793 |
| 1995 |  | 501 | 501 | 1 | 9 | 10 |  | 10 | 511 |  |  | 1 | 272 | 273 | 273 |  | 131 | 131 | 915 |
| 1996 |  | 264 | 264 |  | 17 | 17 | 50 | 67 | 331 |  |  | 4 | 128 | 132 | 132 |  | 49 | 49 | 512 |
| 1997 |  | 359 | 359 |  | 6 | 6 | 68 | 74 | 433 |  |  | 2 | 134 | 136 | 136 |  | 97 | 97 | 666 |
| 1998 |  | 295 | 295 |  | 8 | 8 | 42 | 50 | 345 |  |  | 2 | 159 | 151 | 151 |  | 85 | 85 | 591 |
| 1999 |  | 194 | 194 | 5 | 0 | 6 | 48 | 54 | 248 |  |  | 5 | 206 | 211 | 211 |  | 120 | 120 | 578 |
| 2000 |  | 102 | 102 | 8 | 1 | 9 | 21 | 30 | 132 |  |  | 4 | 197 | 201 | 201 |  | 129 | 129 | 462 |
| 2001 |  | 105 | 105 | 4 | 2 | 6 | 21 | 27 | 132 |  |  | 2 | 269 | 271 | 271 |  | 178 | 178 | 582 |
| 2012 |  | 59 | 59 | 4 | 0 | 4 | 24 | 28 | 87 |  |  | 1 | 358 | 369 | 369 |  | 262 | 262 | 708 |
| 2003 |  | 39 | 39 | 7 | 1 | 8 | 26 | 34 | 73 |  |  | 35 | 335 | 370 | 370 | 4 | 303 | 3017 | 749 |
| 2004 |  | 38 | 38 | 8 | 0 | 9 | 24 | 33 | 71 |  |  | 31 | 345 | 375 | 375 | , | 143 | 147 | 593 |
| 2005 |  | 15 | 16 | 10 | 1 | 11 | 15 | 27 | 43 |  |  | 31 | 360 | 391 | 391 | 3 | 243 | 245 | 679 |
| 2016 |  | 15 | 15 | 12 | 0 | 12 | 17 | 29 | 44 |  |  | 17 | 274 | 291 | 291 | 4 | 242 | 245 | 580 |
| 2007 |  | 20 | 20 | 8 | 1 | 10 | 17 | 27 | 47 |  |  | 18 | 274 | 291 | 291 | 4 | 211 | 214 | 552 |
| 2018 |  | 17 | 17 | 7 | 6 | 13 | 12 | 25 | 42 |  |  | 35 | 188 | 223 | 223 | 3 | 117 | 120 | 384 |
| 2019 |  | 15 | 16 | 4 | 6 | 10 | 5 | 15 | 31 |  |  | 17 | 133 | 151 | 151 | 2 | 117 | 119 | 300 |
| 2010 |  | 3 | 3 | 2 | 2 | 4 | 14 | 19 | 21 |  |  | 15 | 131 | 147 | 147 | 1 | 106 | 107 | 275 |
| 2011" |  | na | na | 2 | 2 | 4 | na | na | na |  |  | 16 | 117 | 133 | 133 | 3 | na | na | na |

Table 12.4.2. Division IXa. TAC and recorded landings

| Year | TAC <br> (tonnes) | Total Landings (tonnes) |
| :---: | :---: | :---: |
| 1995 | 2500 | 915 |
| 1996 | 2500 | 512 |
| 1997 | 2500 | 666 |
| 1998 | 2500 | 591 |
| 1999 | 2000 | 578 |
| 2000 | 1500 | 462 |
| 2001 | 1200 | 582 |
| 2002 | 800 | 693 |
| 2003 | 600 | 718 |
| 2004 | 600 | 593 |
| 2005 | 540 | 690 |
| 2006 | 486 | 580 |
| 2007 | 437 | 552 |
| 2008 | 415 | 384 |
| 2009 | 374 | 300 |
| 2010 | 337 | 275 |
| 2011 | 303 | na |
| 2012 | 273 |  |

## 13 New species:

This year, the WGHMM has been requested to provide information on some new species of the MoU between ICES and the EC, particularly their stocks occurring in European Southern waters:

- European Seabass (Dicentrarchus labrax):
- Division VIIIa,b [bss-8ab]
- Division VIIIc and IXa [bss-8c9a]
- Grey gurnard (Eutrigla gurnardus) in Subarea VIII and Division IXa [gug-89a]
- Plaice (Pleuronectes platessa) in Subarea VIII and Division IXa [ple-89a]
- Pollack (Pollachius pollachius) in Subarea VIII and Division IXa [pol-89a]
- Sole (Solea solea) in Divisions VIIIc and IXa [sol-8c9a]
- Striped red mullet (Mullus surmuletus) in Subarea VI, VIII and Divisions VIIac, e-k and IXa [mur-west]
- Whiting (Merlangius merlangus) in Subarea VIII and Division IXa [whg-89a]

For these stocks, the issues requested were to give advice (ToR a), and also to assess their respective DLS category (ToR e). The provisional target categories proposed by WKLIFE2 (ICES, 2012) needs to be re-examined taking into account the new information available.

### 13.1 European Seabass in Division VIIIa,b

This section refers to the report from WGNEW 2013.

### 13.1.1 Stock ID and sub-stock structure

Bass 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. Stock identity of European seabass was reviewed by WGNEW 2012 and further considered at ICES IBP-NEW 2012.

### 13.1.2 Recommendations for stock identity

The IBP New 2012 reports that it is clear that further studies are needed on sea bass 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 sea bass shoals, to con-firm and quantify the exchange rate of sea bass between sea areas that could form management units for this stock.

In the absence of new information the pragmatic view of WGNEW2013 is to continue to assume the presence of discrete sea bass stocks off southern Ireland and in the Bay of Biscay / IXa. It should be discussed in WGHMM 2014 for this component.

The pragmatic view of IBP-NEW 2012 was to structure the baseline stock assessments into four units:

- Assessment area 1. Sea bass in ICES areas IVbc, VIId, VIIe,h and VIa,f\&g (lack of clear genetic evidence; concentration of area IV bass fisheries in the southern North Sea; seasonal movements of bass across ICES Divisions). This is a relatively data-rich area with data on fishery landings and
length/age composition by fleet; discards estimates; growth and maturity parameters; juvenile surveys, fishery LPUE trends.
- Assessment area 2. Sea bass in Biscay (ICES Sub area VIIIa,b). Available data are fishery landings, with length compositions from 2000; discards from 2009; some fishery LPUE.
- Assessment area 3. Sea bass in VIIIc and IXa (landings, effort, discards)
- Assessment area 4. Sea bass in Irish coastal waters (VIa, VIIb, VIIj). Available data: Recreational fishery catch rates; no commercial fishery operating.

Fishery landings of sea bass are extremely small in Irish coastal waters of VIIa and VIIg and the stock assessment for assessment area 1will not reflect the sea bass populations around the Irish coast, which may be more strongly affiliated to the population in area 4 off southern, western and northern Ireland.

Tagging shows movements of sea bass between VIIIa and southern parts of VIIh/VIIe. A sensitivity analysis of the stock assessment for sea bass includes a combined IV, VII and VIII assessment (assessment areas $1 \& 2$ excluding Irish populations for which there are no commercial fisheries).

### 13.1.3 Fisheries data

### 13.1.3.1 Commercial landings data

Sea bass 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 and by pelagic trawlers, nets and in a mixed bottom trawl fisheries from November to April on pre spawning and spawning grounds when seabass is aggregated. In 2012 nets represent $31 \%$ of the landings of the area, lines (handlines+longlines) $29 \%$, bottom trawl $20 \%$, and pelagic trawl $9 \%$ (but It has to be note that pelagic trawlers were used from 2000 to 2008 to catch around $25 \%$ of the landings of the area decreasing to 9 (the pelagic fishery take place at present essentially in the Channel). In parallel a decrease of landings for liners is also observed from 2007. In France, the market value seabass depends greatly on how its caught, giving added value to certain metiers as liners: according to auction, mean price of seabass sold by liners was $14.92 €$ per kg in 2009 compared with $€ 5.99$ per kg for pelagic trawl, $8.21 €$ per Kg for Bottom trawlers and $8.92 €$ per Kg for nets, reflecting differences in volume landed and fish condition.
Spain is responsible for around $10 \%$ of the catches, mainly with bottom otter trawlers. Discarding is thought to be low because of the high value of the fish; some discards could occurred due to individual quota limitations but are not quantified.Spanish bass landings from Division VIIIa,b,d have increased to around 20 tons in the 90's to around 150 tons in the middle of the 2000's, then to 317 tons in 2011. UK landings from this area are very low, usually inferior to 5 tons per year.Recreational fisheries are an important part of the total removals but these are not accurately quantified. Table 1 presents official and ices landings.

Table 1 : Sea bass in the VIIIab area. ICES and official landings (tons).

| VIIIab | Belgium | France | France | Netherlands | Spain | Spain | $\begin{aligned} & \text { UK(Eng+Wal } \\ & \text { es+N.Irl+Scot } \\ & \text { land) } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Source | official stats | official stats | Ices stats | official stats | official stats | Ices stats | official stats |
| 1978 | 0 | 1146 | 1146 | 0 | 0 |  | 0 |
| 1979 | 0 | 1132 | 1132 | 0 | 0 |  | 0 |
| 1980 | 0 | 1086 | 1086 | 0 | 0 |  | 0 |
| 1981 | 0 |  |  | 0 | 0 |  | 0 |
| 1982 | 0 |  |  | 0 | 0 |  | 0 |
| 1983 | 0 | 1363 | 1363 | 0 | 0 |  | 0 |
| 1984 | 0 | 2886 | 2886 | 0 | 0 |  | 0 |
| 1985 | 0 | 2477 | 2477 | 0 | 0 |  | 0 |
| 1986 | 0 | 2606 | 2606 | 0 | 0 |  | 0 |
| 1987 | 0 | 2474 | 2474 | 0 | 0 |  | 5 |
| 1988 | 0 | 2274 | 2274 | 0 | 0 |  | 15 |
| 1989 | 0 | 2201 | 2201 | 0 | 0 |  | 0 |
| 1990 | 0 | 1678 | 1678 | 0 | 0 |  | 0 |
| 1991 | 0 | 1774 | 1774 | 0 | 17 |  | 0 |
| 1992 | 0 | 1752 | 1752 | 0 | 14 |  | 0 |
| 1993 | 0 | 1595 | 1595 | 0 | 14 |  | 0 |
| 1994 | 0 | 1708 | 1708 | 0 | 17 |  | 0 |
| 1995 | 0 | 1549 | 1549 | 0 | 0 |  | 0 |
| 1996 | 0 | 1459 | 1459 | 0 | 0 |  | 0 |
| 1997 | 0 | 1415 | 1415 | 0 | 0 |  | 0 |
| 1998 | 0 | 1261 | 1261 | 0 | 27 |  | 0 |
| 1999 | 0 | 0 | 2080 | 0 | 11 |  | 0 |
| 2000 | 0 | 2080 | 2295 | 0 | 67 |  | 0 |
| 2001 | 0 | 2020 | 2238 | 3 | 68 |  | 0 |
| 2002 | 0 | 1937 | 2216 | 0 | 176 |  | 0 |
| 2003 | 0 | 2812 | 2497 | 0 | 119 |  | 0 |
| 2004 | 0 | 2561 | 2284 | 0 | 96 |  | 0 |
| 2005 | 0 | 3184 | 2722 | 0 | 74 |  | 0 |
| 2006 | 0 | 3318 | 2707 | 0 | 168 |  | 2 |
| 2007 | 1 | 2984 | 2677 | 0 | 74 | 90 | 1 |
| 2008 | 0 | 1508 | 2600 | 0 | 145 |  | 0 |
| 2009 | 1 | 2339 | 2152 | 0 | 194 | 126 | 0 |
| 2010 | 0 | 2322 | 2089 | 0 | 165 | 140 | 2 |
| 2011 | 1 | 2295 | 2297 | 0 | 311 | 278 | 0 |
| 2012 | 0 | 2325 | 2348 | 0 |  | 201 |  |

### 13.1.4 Commercial discards

## France

Discarding of sea bass by commercial fisheries can occur where fishing takes place in areas with bass smaller than the minimum landing size ( 36 cm in most European countries), and where mesh sizes $<100 \mathrm{~mm}$ are in use. For 2009 it's estimated to be 44 tons, for 201044 tons, for 201120 tons, and 201237 tons.

## Spain

Observer data from Spanish vessels fishing in Areas VIII, have shown there was no seabass discard from 2003.

## Recreational catches

Recreational marine fishery surveys in Europe are still at an early stage in development (ICES WGRFS 2012). A french study targeting sea bass was conducted between 2009 and 2011 in VIIIa, VIIIb, VIIe, VIIh, VIId, Ivc. Estimates of sea bass catches were obtained from a panel of 121 recreational fishermen recruited during a random digit dialling screening survey of 15000 households in the targeted districts (Atlantic and Chanel). The estimated recreational catch of bass in the Bay of Biscay and in the Channel was $3,170 \mathrm{t}$ of which $2,350 \mathrm{t}$ was kept and 830 t released. The precision of the the combined Biscay \& Channel estimate is relatively low (CV $=-26 \%$; note that the figure of $51 \%$ given in IBP-NEW 2012 was incorrect). This makes the confidence interval at $95 \%$ of the average ( 3170 t ) to [1554t;4786t].

### 13.1.5 Appropriate Reference Points (MSY)

IBP-NEW 2012 was not in a position to develop MSY reference points for seabass based on the SS3 runs. Further work is needed to develop biological reference points.

### 13.1.6 Future Research and data requirements

There are several important limitations to knowledge of sea bass populations, and deficiencies in data, that should be addressed in order to improve the assessments and advice for sea bass in the NE Atlantic. IBP-NEW2012 and WGNEW 2013 make the following recommendations:

Robust relative abundance indices are needed for adult bass in all areas. Their absence is a major deficiency which will reduce the accuracy of the assessment and the ability to make meaningful forecasts. The establishment of dedicated surveys on spawning grounds could provide valuable information on trends in abundance and population structure of adult bass as well as providing material for investigating stock structure and linkages with recruitment grounds.
Recruitment indices are needed for a wider geographic range including the Celtic/Irish Sea and Biscay areas.
Further research is needed to better understand the spatial dynamics of sea bass (mixing between ICES areas; effects of site fidelity on fishery impacts; spawning site recruitment ground linkages; environmental influences)

Studies are needed to investigate the accuracy/bias in ageing, and errors due to age sampling schemes historically
Continued estimation of recreational catches 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.

### 13.2 European Seabass Division VIIIc and IXa

This section refers to the report from WGNEW 2013.

### 13.2.1 Fisheries data

### 13.2.1.1 Commercial landings data

Landings series are given in Table 13.2.1 and are derived from :
i) Official statistics recorded in the Fishstat database since around the mid1970s.
ii) Spanish landings for 2007-2011 from sale notes
iii) Portuguese estimated landings from 1986 to 2011 including distinction between Dicentrarchus labrax and punctatus.

Spanish and Portuguese vessels represent almost of the total annual landings in the area IXa and VIIIc. Commercial landings represent 772 tons in 2011. A peak of landings is observed in the early 90 's reaching more than 1000 tons, and lowest landings ( 637 tons) have been observed in 2004. Artisanal fisheries are mainly observed in this area. Off Portugal, estimated total landings of sea bass (hereafter refers only to European sea bass) average 421 tons for the period 1986-2012. Landings had a maximum of 610 tons in 1989, followed by a slight decrease and another increase to a second maximum of 633 tons in 2006. Most landings come from the polyvalent mixed fishery ( $80-99 \%$ ) using mostly gill nets (GNS_DEF_80-99_0_0), trammel nets (GTR_DEF_>=100_0_0) and long-line or hand-line (LLS_DEF_0_0_0). The landings by purse seiners and trawlers represent a small amount.

## Fishery management regulations

Seabass are not subject to EU TACs and quotas. Under EU regulation, the MLS of sea bass in the Northeast Atlantic is 36 cm total length (EC regulation 850/98). A variety of national restrictions on commercial fishing for each metier also apply to sea bass. The measures affecting recreational fisheries in Portugal include gear restrictions, a minimum landing size equal to the commercial fishery MLS $(36 \mathrm{~cm})$, 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.

## Discards estimates

Portugal: Sea bass discards are recorded by the DCF on-board sampling programme. The Portuguese on-board sampling is not covering the Sea Bass fishing area.No discards are observed.

Spain: No bass discards were observed for any metier in the 2003-2011 periods.

## Recreational catches

Recreational marine fishery surveys in Europe are still at an early stage in development (ICES WGRFS 2012).

Table13.2.1 : Sea bass in the IX and VIIIc areas. ICES and official landings (tons).

| Country | 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 | 271 |  | 273 | 701 |

* Preliminary
**-Official landings have been extracted from the Ices Official Catch Statistics Web page (15May 2013) for "BSS" and area VIIIc, IXa and IX (IX has been retained for Portuguese statistics because reported as IXa prior 2007).
***Difference between Ices Statistics and official Statistics are mainly due prior 2006 to Portugal statistics : before 2006 most of the sea bass catches were registered under the code BSE, i.e. (Dicentrarchus sp.). After the DCF implementation there was a progressive increase in the correct identification of species in the official statistics (BSS increase, BSE decrease) who consider Dicentrarchus sp landings minus 2.3\% of Dicentrarchus punctatus based on DCF market and on-board sampling between 2008 and 2012)


### 13.3 Grey gurnard in Subarea VIII and Division IXa

Grey gurnard are caught as bycatch in mixed demersal fisheries and it is thought that the greater part of the catch is discarded. Therefore, landings are unlikely to be a good indicator of total removals. The official catch statistics are incomplete and are often not separated by species. A working document presented this year described that of the 400 t of gurnard landed into Portugal from Division IXa in 2012 only $0.5 \%$ was composed of grey gurnard. This species was also very rarely observed in discard observations and consequently discard estimates were not calculated at the fleet level for the Portuguese fleet. Spanish trawl discards from VIIIc and IXa were found to have declined in recent years to a stable level of $\sim 80 \mathrm{t}$ (Table 13.3.1). French discard data were being compiled and will be available for next year. In general the low abundance of this species in VIII and IXa means that the landings and discards are negligible in comparison to other species of gurnard.

This stock from is currently ranked as a Data Limited Stock in category 6.2 as greater part of the catch is discarded; however, all the stocks covered by the current DCF sampling programme have been proposed to be upgraded to category 4 , because of the availability of biological information. Therefore, survey abundance indices, length frequency distributions, and other biological information is required from the respective National laboratories.

Portuguese and French surveys (PtGFS-WIBTS-Q4 and EVHOE-WIBTS-Q4) provided biomass indices but values are very low and the species was not observed in the latter survey during recent years. Commercial abundance indices were also unavailable.

Biological information from DCF sampling could improve the assessment of this stock. However, the scarcity of this species in the Bay of Biscay and Iberian Peninsula negates the development of an alternative assessment. This species is at the southern extent of its range in the Bay of Biscay and Iberian Peninsula (Table 13.3.2) and perhaps merging of the northern and southern stocks would be sensible.

Table 13.3.1: Grey Gurnard discards by Spain in Subarea VIIIc and Division IXa Note: Raised to fleet using effort

| Year | Discards $(\mathrm{t})$ | CV |
| :--- | :--- | :--- |
| 1994 | 183 | 47 |
| 1997 | 566 | 31 |
| 1999 | 425 | 49 |
| 2000 | 267 | 17 |
| 2003 | 139 | 29 |
| 2004 | 199 | 36 |
| 2005 | 142 | 30 |
| 2006 | 364 | 25 |
| 2007 | 291 | 36 |
| 2008 | 255 | 21 |
| 2009 | 525 | 34 |
| 2010 | 151 | 33 |
| 2011 | 84 | 31 |
| 2012 | 83 | 37 |

Table 13.3.2: Grey gurnard in Subarea VIII and Division IXa. official landings in tonnes. Note: Figures may be unreliable due to inconsistent species split

| YEAR | VIIIA | VIIIB | VIIIC | VIIID | VIIIE | IXA | Grand Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1992 | 17 | 13 |  |  |  |  | 30 |
| 1993 | 19 | 34 |  |  |  |  | 53 |
| 1994 | 17 | 16 |  |  |  |  | 33 |
| 1995 | 31 | 10 |  |  |  |  | 41 |
| 1996 | 32 | 11 |  |  |  |  | 43 |
| 1997 | 43 | 12 |  |  |  |  | 55 |
| 1998 | 46 | 8 |  |  |  |  | 54 |
| 1999 |  | 1 |  |  |  |  | 1 |
| 2000 | 34 | 6 |  | 0 | 0 |  | 40 |
| 2001 | 26 | 11 |  |  |  |  | 37 |
| 2002 | 25 | 5 |  |  |  |  | 30 |
| 2003 | 40 | 7 |  |  |  |  | 47 |
| 2004 | 53 | 10 |  |  |  | 0 | 63 |
| 2005 | 43 | 16 |  |  |  |  | 59 |
| 2006 | 53 | 21 |  | 0 |  |  | 74 |
| 2007 | 54 | 16 | 0 | 0 |  | 4 | 74 |
| 2008 | 4 | 4 |  |  |  | 8 | 16 |
| 2009 | 60 | 39 |  |  |  | 0 | 99 |
| 2010 | 99 | 55 |  | 1 |  |  | 155 |
| 2011 | 100 | 46 | 0 | 1 |  | 0 | 147 |
| 2012 | 109 | 54 | 0 | 3 | 0 | 0 | 167 |

### 13.4 Plaice in Subarea VIII and Division IXa

Plaice is caught as a bycatch by various fleets and gear types covering small-scale artisanal and trawl fisheries. Portugal and France are the major 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 the French data from 200809. Landings may also contain misidentified flounder (Platichthys flesus) as they are often confounded at sales auctions in Portugal.

Plaice was not recorded by either the Spanish or Portuguese discards observation programs.

This stock from is currently ranked as a Data Limited Stock in category 5.2; however, all the stocks covered by the current DCF sampling programme have been proposed to be upgraded to category 4 , because of the availability of biological information (ICES, 2012). Therefore, survey abundance indices, length frequency distributions, and other biological information is required from the respective National laboratories.

Plaice was not present in sufficient numbers to provide survey abundance indices and no commercial indices were available. Other approaches should be considered in order to obtain fishery independent information.

Biological information needs to be analysed. However, issues concerning the quality of landings statistics in addition to the lack of survey or commercial abundance indi-
ces need to be resolved before a new assessment is developed. Also, this species is at the southern extent of its range in the Bay of Biscay and Iberian Peninsula (Table 13.4.1 and Figure 13.4.1) and perhaps merging of the northern and southern stocks would be sensible.

Table 13.4.1: Plaice in Subarea VIII and Division IXa. official landings in tonnes.

| YEAR | VIIIA | VIIIB | VIIIC | VIIID | VIIIE | IXA | Grand Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1992 | 270 | 38 | 15 |  |  | 2 | 325 |
| 1993 | 329 | 25 | 2 | 1 |  | 0 | 357 |
| 1994 | 334 | 31 | 34 |  |  |  | 399 |
| 1995 | 293 | 26 | 12 |  |  |  | 331 |
| 1996 | 223 | 25 | 14 |  |  |  | 262 |
| 1997 | 235 | 20 | 3 | 0 |  | 0 | 258 |
| 1998 | 198 | 21 | 6 |  |  | 0 | 225 |
| 1999 |  | 1 | 3 |  |  | 0 | 4 |
| 2000 | 172 | 36 | 17 | 0 |  | 5 | 230 |
| 2001 | 181 | 20 | 13 | 0 |  | 9 | 223 |
| 2002 | 148 | 21 | 10 |  |  |  | 179 |
| 2003 | 202 | 11 | 4 | 5 |  | 1 | 223 |
| 2004 | 214 | 12 | 5 | 3 |  | 165 | 399 |
| 2005 | 166 | 21 | 13 | 4 |  | 20 | 224 |
| 2006 | 222 | 24 | 2 | 2 | 0 | 3 | 253 |
| 2007 | 203 | 16 | 2 | 0 |  | 43 | 264 |
| 2008 | 96 | 4 | 3 |  |  | 90 | 193 |
| 2009 | 124 | 12 | 5 |  |  | 105 | 246 |
| 2010 | 183 | 16 | 5 | 2 |  | 119 | 325 |
| 2011 | 181 | 9 | 4 | 38 |  | 68 | 300 |
| 2012 | 177 | 8 | 0 | 1 | 0 | 62 | 248 |



Figure 13.4.1: International landings of Plaice by statistical rectangle from 2003-2011

### 13.5 Pollack in Subarea VIII and Division IXa

Landings have been reported by the three countries with quota: France, Spain and Portugal. The respective time series, from 2001 to 2012, of national landings desegregated by gear are shown in Table 13.5.1 below.

This stock from is currently ranked as a Data Limited Stock in category 5.2; however, all the stocks covered by the current DCF sampling programme have been proposed to be upgrade to category 4 , because of the availability of biological information. Therefore, survey abundance indices, length frequency distributions, and other biological information is required from the respective National laboratories.

French and Portuguese surveys show very low catches of these species (pers. com.). Even similar low indices have been obtained by the Spanish survey developed in VIIIc-IXaN (SP_GFS), the occurrence of Pollock is only observed in the last part of the time series (Figure 13.5.1).

Length frequency distributions (LFD) were provided by IEO (Spain) for years 2011 and 2012 by metier. However, as Pollack is scarce in landings, most of samples ( $83 \%$ ) come from the gillnet fleet, due to it has a higher number of metiers than others fleets, as longline. Different mean sizes are obtained depending on the mesh size used (Figure 13.5.2): 46.0 cm (GNS_DEF_60-79_0_0), 46.9 cm (GNS_DEF_80-99_0_0), and 48.8 cm (GNS_DEF_>=100_0_0).

Discards estimates of Pollack in Spanish trawlers were also provided by IEO (Spain) for year 1994, 1997, 1999, 2000, and the period 2003-2012. The low numbers of discards recorded makes it reasonable to assume that landings can be a proxy of catches.

Therefore, from the biological information compiled (scarce due to the low catches of this species in the area), just the LFD could be useful in order to improve the assess-
ment of this stock in the future. However, the time series should be longer and more representative of the different metiers catching Pollack.

Table 13.5.1: Pollack in Subarea VIII and Division IXa: Annual landings (tonnes) by country and gear.

| YEAR | France |  |  | Spain |  |  |  | Portugal | Others | TOTAL |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  | Nets | Trawl | Lines | Others | Longlines | Gillnets | Others | Polyvalent | Trawl | --- |  |
| 2001 | 325 | 136 | 75 | 8 | 31 | 53 | 169 | - | - | 0 | 766 |
| 2002 | 358 | 173 | 36 | 5 | 26 | 28 | 134 | - | - | 0 | 760 |
| 2003 | 570 | 202 | 65 | 3 | 31 | 35 | 146 | - | - | 1 | 1053 |
| 2004 | 542 | 151 | 57 | 4 | 47 | 36 | 222 | 16.5 | 0.1 | - | 1092 |
| 2005 | 378 | 205 | 95 | 6 | 90 | 36 | 161 | 7.8 | 0.6 | 0 | 988 |
| 2006 | 498 | 294 | 92 | 11 | 48 | 29 | 243 | 6.7 | 0.3 | 171 | 1400 |
| 2007 | 565 | 311 | 133 | 19 | 72 | 51 | 210 | 4.5 | 0.4 | 62 | 1433 |
| 2008 | 557 | 263 | 138 | 12 | 147 | 95 | 163 | 33.3 | 0 | 64 | 1506 |
| 2009 | 679 | 224 | 217 | 5 | 101 | 76 | 97 | 2.4 | 0.5 | 41 | 1446 |
| 2010 | - | - | - | - | 167 | 162 | 93 | 1.7 | 0.1 | 44 | 470 |
| 2011 | - | - | - | - | 207 | 199 | 20 | 1.2 | 0.3 | 26 | 455 |
| 2012 | 608 | 170 | 267 | 49 | 123 | 122 | 53 | - | - | - | 1392 |

Pollachius pollachius
Biomass


Number


Figure 13.5.1: Pollack in ICES Subarea VIII and Division IXa: Abundance indices from the Spanish survey in Cantabrian Sea and off Galicia (SP-GFS).


Figure 13.5.2: Pollack in ICES Subarea VIII and Division IXa: length frequency distribution (LFD) of the three main Spanish métiers of gillnet in VIIIc-IXaN.

### 13.6 Sole in Divisions VIIIc and IXa

Landings in 2011 and 2012 have been reported only by Portugal (Table 13.6.1) and discarding is negligible. Majority of Portuguese catches are from area IXa (Table 13.6.2) and carried out by polyvalent fleets (Table 13.6.3). Solea solea is landed together with other flatfish species, namely S. senegalensis (Figure 13.6.1). DCF data were used to estimate the corrected Portuguese landings of the Solea solea (Figure 13.6.2). This analysis indicated that the official statistics are unreliable and the real landings of $S$. solea may be higher or lower than those reported each year. The main reason is that
there is a significant proportion of S. senegalensis included in both S. solea and Solea nep (unspecified) official statistics. This proportion is variable and an estimation using the market sampling is therefore mandatory.

This stock is currently ranked as a Data Limited Stock in category 5.2 as there is information on landings only; however, all the stocks covered by the current DCF sampling programme have been proposed to be upgraded to category 4 , because of the availability of biological information. Therefore, survey abundance indices, length frequency distributions, and other biological information is required from the respective National laboratories.

Solea solea is seldom caught during the Portuguese bottom trawl research surveys (PT-CTS, PtGFS-WIBTS-Q1 and PtGFS-WIBTS-Q4). This species may be found along the Portuguese coast mainly from very shallow waters and estuaries until 100 m depth. The survey data available becomes from a series of research surveys with multiple sampling schemes and carried out at different seasons as was referred in the WGNEW 2012 report. Because of this, survey data is not suitable to use as fisheries independent information.

Compilation of biological information in combination with landings and abundance indices could lead to improvements of this assessment.

Table 13.6.1: Official landings for Solea spp in Divisions VIIIc and IXa

|  | France | Spain | Portugal | Total |
| :---: | :---: | :---: | :---: | :---: |
| 1977 |  |  | 976 | 976 |
| 1978 |  | 310 | 606 | 916 |
| 1979 |  | 152 | 581 | 733 |
| 1980 |  | 166 | 628 | 794 |
| 1981 |  | 155 | 800 | 955 |
| 1982 |  | 275 | 789 | 1064 |
| 1983 |  | 140 | 635 | 775 |
| 1984 |  | 242 | 626 | 868 |
| 1985 | 1 | 370 | 600 | 971 |
| 1986 |  | 444 | 1081 | 1525 |
| 1987 | 1 | 609 | 1176 | 1786 |
| 1988 | 1 | 479 | 1284 | 1764 |
| 1989 |  | 216 | 1443 | 1659 |
| 1990 |  | 214 | 1228 | 1442 |
| 1991 |  | 300 | 1079 | 1379 |
| 1992 | 1 | 190 | 1116 | 1307 |
| 1993 | 1 | 90 | 1330 | 1421 |
| 1994 |  | 50 | 1214 | 1264 |
| 1995 |  | 39 | 1235 | 1274 |
| 1996 |  | 74 | 942 | 1016 |
| 1997 |  | 178 | 804 | 982 |
| 1998 |  | 228 | 730 | 958 |
| 1999 |  | 246 | 641 | 887 |
| 2000 | 7 | 273 | 737 | 1017 |
| 2001 |  | 224 | 760 | 984 |
| 2002 | 1 | 140 | 580 | 721 |
| 2003 | 4 | 322 | 638 | 964 |
| 2004 |  | 165 | 795 | 960 |
| 2005 |  | 274 | 831 | 1105 |
| 2006 | 1 | 154 | 604 | 759 |
| 2007 | 1 | 111 | 392 | 504 |
| 2008 | 1 | 133 | 478 | 612 |
| 2009 | 2 | 139 | 558 | 699 |
| 2010 | 2 | 201 | 623 | 826 |
| 2011 |  |  | 692 | 692 |
| 2012 |  |  | 516 | 516 |

Table 13.6.2: Official landings for Solea solea in Division IXa (Portuguese waters) and the correspondent adjustment made through the DCF market sampling program.

|  | SOL Landings (ton) |  |
| :--- | :--- | :--- |
| Year | official | estimated data through DCF |
| 2003 | 111 | 204 |
| 2004 | 144 | 194 |
| 2005 | 276 | 210 |
| 2006 | 286 | 125 |
| 2007 | 267 | 90 |
| 2008 | 297 | 89 |
| 2009 | 334 | 128 |
| 2010 | 383 | 100 |
| 2011 | 432 | 204 |
| 2012 | 373 | 152 |

Table 13.6.3: Landings by gear type of Solea solea in div IXa (Portuguese waters).

| Year | Demersal <br> trawl | Polyvalent | Purse <br> seine | Total |
| :--- | :--- | :--- | :--- | :--- |
| 2003 | 1.4 | 109.9 | 0.0 | 111 |
| 2004 | 1.8 | 141.9 | 0.1 | 144 |
| 2005 | 5.5 | 269.9 | 0.7 | 276 |
| 2006 | 8.8 | 272.5 | 5.0 | 286 |
| 2007 | 16.7 | 247.1 | 2.8 | 267 |
| 2008 | 18.4 | 277.1 | 1.2 | 297 |
| 2009 | 16.9 | 315.3 | 1.8 | 334 |
| 2010 | 17.2 | 361.9 | 3.6 | 383 |
| 2011 | 27.9 | 402.2 | 2.3 | 432 |
| 2012 | 20.3 | 351.1 | 2.0 | 373 |



Figure 13.6.1: Proportions of the Portuguese landings of S. solea (SOL), S. senegalensis (OAL) and $P$. iascaris (SOS) by year since 2003 estimated through the DCF market sampling program.


Figure 13.6.2: Official and estimated Portuguese landings of Solea solea.

### 13.7 Striped red mullet in Subarea VI, VIII and Divisions VIIa-c, e-k and IXa

Landings have been reported by France, Spain and Portugal (Table 13.7.1) and discarding is negligible. Majority of catches are from area VIII and carried out by bottom trawl fleets. The lack of discards makes it reasonable to assume that landings can be a proxy of catches.

This stock is currently ranked as a Data Limited Stock in category 5.2 as there is information on landings only; however, all the stocks covered by the current DCF sampling programme have been proposed to be upgraded to category 4, because of the availability of biological information. Therefore, survey abundance indices, length frequency distributions, and other biological information is required from the respective National laboratories.

Abundance indices are available from French EVHOE-WIBTS-Q4, UK-WECBTS and EN-CEFAS-A,B survey, although the latter survey was discontinued in 2004. These surveys do not present any trends. The French survey is composed of small fish and could be used as a recruitment index. Portuguese surveys (PtGFS-WIBTS-Q4 and PtCTS-UWTV) have shown that the distribution of this species covers the entire Iberian continental shelf. The stock distribution between Spain and Portugal is uncertain. There are no commercial abundance indices available.

Biological data such as length, weight and maturity has been collected by France since 2007 for Divisions VIIIa,b. An otolith exchange program in 2008 confirmed agreement of individuals from the Bay of Biscay in contrast to the Mediterranean.

Compilation of biological information from DCF sampling in combination with landings and abundance indices could lead to improvements of this assessment. However, the time series needs to be of sufficient duration.

Table 13.7.1: Striped Red Mullet in VI, VIIa-c, VIIe-k, VIII and IXa. official landings in tonnes. Note ${ }^{1}$ : Only French landings in VIII were available for 2012.

| YEAR | VI | VIIA-C | VIIE-K | VIII | IXA | Grand Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1992 | 0 | 2 | 366 | 838 |  | 1206 |
| 1993 | 23 | 3 | 456 | 530 |  | 1012 |
| 1994 | 6 | 10 | 357 | 612 |  | 985 |
| 1995 | 0 | 1 | 461 | 564 |  | 1026 |
| 1996 | 3 | 1 | 814 | 625 | 192 | 1635 |
| 1997 | 0 | 0 | 727 | 646 | 192 | 1565 |
| 1998 | 0 | 0 | 778 | 554 | 7 | 1339 |
| 1999 | 0 | 0 | 111 | 125 | 0 | 236 |
| 2000 | 0 | 4 | 857 | 908 | 14 | 1783 |
| 2001 | 0 | 7 | 1000 | 919 | 34 | 1960 |
| 2002 | 0 | 1 | 773 | 770 | 5 | 1549 |
| 2003 | 6 | 8 | 787 | 1204 | 9 | 2014 |
| 2004 | 0 | 4 | 1243 | 1567 | 55 | 2869 |
| 2005 | 4 | 12 | 1231 | 1424 | 38 | 2709 |
| 2006 | 0 | 1 | 1051 | 1575 | 39 | 2666 |
| 2007 | 1 | 2 | 1236 | 1441 | 267 | 2947 |
| 2008 | 0 | 1 | 1025 | 990 | 296 | 2312 |
| 2009 | 2 | 3 | 717 | 1540 | 243 | 2505 |
| 2010 | 2 | 5 | 749 | 1665 | 331 | 2752 |
| 2011 | 4 | 2 | 719 | 1567 | 309 | 2601 |
| 2012 | - | - | - | 1040 ${ }^{1)}$ | - | - |

### 13.8 Whiting in Subarea VIII and Division IXa

France and Spain are the main participants in this fishery although France has not recorded landings since 2008 (Table 13.8.1). Present fishery statistics are considered to be preliminary as there are concerns about the reliability of the French data from 2008-09. Landings may also contain misidentified Pollack (Pollachius pollachius). Whiting has never been recorded in Spanish discards and is negligible in Portuguese discards. The lack of discards makes it reasonable to assume that landings can be taken as a proxy of catches.

This stock from is currently ranked as a Data Limited Stock in category 5.2 as there is information on landings only; however, all the stocks covered by the current DCF sampling programme have been proposed to be upgrade to category 4 , because of the availability of biological information. Therefore, survey abundance indices, length frequency distributions, and other biological information is required from the respective National laboratories.

Whiting are present in the French EVHOE-WIBTS-Q4 survey from the Bay of Biscay. Adults were not sufficient in number to serve as an SSB indicator but it may provide an index of recruitment. Commercial abundance index is available from Spanish pair trawl fleet in VIIIabd although it has declined to negligible levels in recent years.

Compilation of biological information from DCF sampling could improve the assessment of this stock. However, this species is at the southern extent of its range in the Bay of Biscay and Iberian Peninsula (Table 13.8.1 and Figure 13.8.1) and perhaps merging of the northern and southern stocks would be sensible.

Table 13.8.1: Whiting in Subarea VIII and Division IXa. official landings in tonnes.

| YEAR | VIIIA | VIIIB | VIIIC | VIIID | VIIIE | IXA | Grand Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1992 | 1710 | 671 | 11 | 8 |  |  | 2400 |
| 1993 | 2375 | 699 | 7 | 12 |  |  | 3093 |
| 1994 | 2771 | 851 | 21 | 3 | 1 |  | 3647 |
| 1995 | 2077 | 559 | 2 | 10 |  |  | 2648 |
| 1996 | 1271 | 272 | 17 | 1 |  |  | 1561 |
| 1997 | 1646 | 291 | 6 | 2 |  |  | 1945 |
| 1998 | 1526 | 301 | 3 | 30 |  |  | 1860 |
| 1999 | 72 | 129 | 11 |  |  |  | 212 |
| 2000 | 1048 | 388 | 10 | 1 | 1 |  | 1448 |
| 2001 | 1721 | 527 | 24 | 3 | 6 |  | 2281 |
| 2002 | 1699 | 484 | 9 | 6 | 5 |  | 2203 |
| 2003 | 2057 | 381 | 4 | 6 |  | 3 | 2451 |
| 2004 | 1687 | 390 | 136 | 2 |  | 76 | 2291 |
| 2005 | 1425 | 649 | 1 | 6 |  | 2 | 2083 |
| 2006 | 1091 | 739 | 6 | 3 |  | 2 | 1841 |
| 2007 | 1029 | 871 | 1 | 2 | 2 | 107 | 2012 |
| 2008 | 532 | 425 | 1 | 4 |  | 97 | 1059 |
| 2009 | 1008 | 342 | 3 | 4 |  | 116 | 1473 |
| 2010 | 1863 | 462 | 4 | 9 |  | 114 | 2452 |
| 2011 | 1468 | 447 | 2 | 10 | 0 | 108 | 2035 |
| 2012 | 1447 | 337 | 2 | 11 | 0 | 83 | 1878 |



Figure 13.8.1: International landings of Whiting by statistical rectangle from 2003-2011

### 13.9 Conclusions on the DSL categories proposed

All the stocks analysed in this Section were proposed to be upgraded to category 4, where reliable catch data are available including biological information. Taking into account the new information provided, the WGHMM has decided the following categorization for these storks:

Table 13.9.1: Summary of DLS stocks considered by WGHMM 2013

| Stock <br> CODE | STOCK NAME | DS <br> CATEGORY <br> PROPOSED | WGHMM <br> CONCLUSION |
| :--- | :--- | :--- | :--- |
| bss-8ab | European Seabass (Dicentrarchus labrax) in Division <br> VIIIa,b | 4 |  |
| bss- <br> 8c9a | European Seabass (Dicentrarchus labrax) Division VIIIc <br> and IXa | 4 | 4 |
| gug-89a | Grey gurnard (Eutrigla gurnardus) in Subarea VIII and <br> Division IXa | 4 | 4 |
| Plaice (Pleuronectes platessa) in Subarea VIII and Division <br> IXa | 4 | 4 |  |
| pol-89a | Pollack (Pollachius pollachius) in Subarea VIII and Division <br> IXa | 4 | 4 |
| sol-8c9a | sole (Solea solea) in Divisions VIIIc and IXa |  |  |
| Striped red mullet (Mullus surmuletus) in Subarea VI, VIII <br> mest <br> and Divisions VIIa-c, e-k and IXa (Western area) | 4 | 4 |  |
| whg- <br> $89 a$ | Whiting (Merlangius merlangus) in Subarea VIII and <br> Division IXa | 4 | 4 |

It has been also notice that the negligible catches of some of the stocks here assessed makes it convenient to revise the ICES species ranking for the Southern shelf area. It seems clear that some of these stocks are important in catches in northern areas; however, the scientific effort required to provide coverage of these stocks in southern area could be more usefully applied to other more abundant stocks in the southern area. As an example, other demersal species as conger (Conger conger), bib (Trisopterus luscus), or rose shrimp (Parapenaeus longirostris) show harvest levels close to some of the stocks traditionally assessed by WGHMM.

## Annex A - List of participants

## Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM)

10-16 May 2013

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## Annex B - Working Documents

Thirteen working documents were presented at WGHMM 2013 covering various issues relevant to the work of the group. Abstracts of these papers are presented below. The full documents can be obtained by request to the ICES Secretariat.

## WD1: Maturity-at-age estimates for Irish Demersal Stocks in VIa and VIIabgj 2004-

 12By Hans Gerritsen (Marine Institute, Ireland)


#### Abstract

This document provides maturity-at-age estimates for stocks assessed by the WGCSE and WGHMM. All data are obtained on surveys and commercial sampling carried out by the Marine Institute. Some (relatively minor) differences were found between the ogives used by the working groups and the current findings. Because Irish sampling generally does not cover the full extent of the stocks, it is difficult to determine whether the Irish estimates are unbiased. It is possible that the lack of full spatial coverage can explain some of the differences.


## WD 2: Fisheries and biological data for Sea Bass in the Portuguese continental coast (ICES Division IXa)

By Ana Moreno and Yorgos Stratoudakis (IPMA, Portugal)
Abstract
For Sea Bass in the Portuguese continental coast this working document summarises the current knowledge in the areas of general biology, stock identification and possible management areas, management regulations, fisheries data (landings, discards and catch per unit effort), biological sampling (length compositions) and biological parameters and other research and survey data.

## WD 3: Proposal to expand the boundaries of the Nephrops Functional Units in ICES Division VIIIc and Division IXa

By Yolanda Vila (IEO, Spain)


#### Abstract

Abtract Until 2011 Spanish Nephrops landings provided to the WGHMM have been estimated by the Spanish Oceanographic Institute (Instituto Español de Oceanografía, IEO) scientific staff. These estimations came from sale sheets and Owners Associations information compiled by the IEO. So, the landings allocation to each Functional Unit (FU) was carried out based on landing port criteria. Since 2011, the Spanish Authority for Fisheries (Secretaría General de Pesca, SGP) who is also the National authority for the Data Collection Framework, established a new policy and general approach in the provision of official data on catches and fishing effort. So, this year 2011 and 2012 Nephrops data presented to the 2013 WGHMM come from a different source: logbooks, which allow the landings disaggregation by ICES statistical rectangles. However, a considerable percentage of Nephrops catches were allocated into statistical


rectangles that do not belong to any FU and therefore, they would be considered as catches in "others rectangles" for the total division. To avoid this problem this WD recommends the boundaries extension of these FUs, to a proper landings allocation and/or avoid missing landings from other rectangles in ICES Divisions VIIIc and IXa.

## WD 4: Grey Gurnard: Portuguese data for Division IXa

By Diana Feijó, Alberto Rocha and Cristina Silva (IPMA, Portugal)


#### Abstract

In Portugal, there is little information about the presence of Grey Gurnard (Eutrigla gurnardus). Gurnards are usually landed without species discrimination, making it difficult to assess the fish stock. Data concerning Gurnards landings were collected in DCF sampling program, between 2009 and 2012. In landing ports, random trips were selected and gurnards were sampled for species composition and biological data are collected. This document summarizes the resulting information about Grey Gurnard in Portugal. To complete the biological information, data collected earlier in biological sampling and winter groundfish surveys on Gurnards was used.


## WD 5: Addition of the French ORHAGO Survey in the XSA tuning fleets of Bay of

 Biscay sole stockBy Gérard Biais and Muriel Lissardy (Ifremer, France)


#### Abstract

The beam trawl ORHAGO survey was launched in 2007 to fulfil the need of a fishery independent abundance index for the Bay of Biscay sole stock which has been pointed out since many years by successive ICES WG and their review groups and as well as in ICES advice. The 2007-2011 ORHAGO time-series was added to the 4 tuning series used by the WGHMM to run an XSA in 2012, applying the same settings, to show the sensibility of the last agreed assessment to the addition of the ORHAGO series. Outputs are only slightly changed for the fishing mortality and SSB but the recruitment estimate in the last year is increased to a more realistic value. Despite this limited changes, the weight of the ORHAGO survey in age estimate is major, far above the weight of other fleets from age 2 to 6 . The quality of the ORHAGO survey to serve as a tuning index is then confirmed but also that the two commercial tuning fleets added in 2011 by the WKFLAT give a relevant abundance signal. Regarding this issue, it might be particularly useful to have a survey in the tuning file for the 2013 WGHMM because the new use of electronic logbooks has some caused obvious wrong recordings of effort which limit available commercial tuning data in 2012. Consequently, the addition of the ORHAGO survey to the tuning fleets appears to have potential advantage for improving or validating the quality of the Bay of Biscay sole assessment and the use of this survey for this assessment should not be delayed.


# WD 6: Discards of WGHMM species by the Portuguese bottom otter trawl operating in ICES Division XIa (2004-2012) 

By Nuno Prista and Ana Cláudia Fernandes (IPMA, Portugal)


#### Abstract

We compile the information available on the discards of WGHMM stocks (blackbellied angler, Lophius budegassa; angler, Lophius piscatorius; grey gurnard, Eutrigla gurnardus; European hake, Merluccius merluccius; megrim, Lepidorhombus whifiagonis; four-spot megrim, Lepidorhombus boscii; common sole, Solea solea; plaice, Pleuronectes platessa; pollack, Pollachius pollachius; whiting, Merlangius merlangus; European seabass, Dicentrarchus labrax; striped red mullet, Mullus surmuletus; and Norway lobster, Nephrops norvegicus) produced by Portuguese vessels operating with bottom otter trawl in Portuguese ICES Division IXa. The data was collected by the Portuguese onboard sampling programme (EU DCR/NP) between 2004 and 2012. We describe the on-board sampling programme, estimation algorithms and data quality assurance procedures and provide results for two fisheries: the crustacean bottom otter trawl fishery and the demersal bottom otter trawl fishery. In 2012, the low frequency of occurrence and number of specimens discarded in most species indicated fleet discards are null or negligible for assessment purposes. That was the case of blackbellied angler, European seabass, striped red mullet, plaice, pollack, whiting, grey gurnards, megrims, anglersh and common sole and, to a lesser extent, Norway lobster and fourspot megrim. On the contrary, European hake was present in $60 \%$ and $87 \%$ with 204 tonnes and 504 tonnes discarded and 19.8 cm and 17.2 cm average size in OTB_CRU and OTB_DEF, respectively. The main motifs for discarding the latter species were mainly related minimum landing size (both fisheries) and by-catch limits.


## WD 7: Nephrops FU23-24 (Bay of Biscay) Analytical stock assessment and projections under updated values of survival rate for discards

By Spyros Fifas, Sonia Mehault and Fabien (Ifremer, France)
Studies undertaken on the Nephrops stock of the Bay of Biscay provide many indications that the historically input value for the survival rate of discards may be underestimated compared to the recent experiments. It has been proposed to use higher survival values and thus $55 \%$ should be considered instead of $30 \%$. This working document applies the updated value to examine whether it induces significant changes on the stock assessment and prognosis. It is not easy to decide when to change the survival rate so two explorations were carried out. Firstly, survival rate of $30 \%$ up to 2000 with $55 \%$ afterwards and secondly survival rate gradually increasing from $30 \%$ to $55 \%$ throughout the overall time series 1987-2011. Both analytical investigations were by XSA and were compared to the WGHMM 2012 runs.

## WD 8: Investigations on Fmsy candidates for northern hake

By Michel Bertignac (Ifremer, France), Carmen Fernández (ICES, Denmark) and Dorleta Garcia (IEO, Spain)

[^6]relationships into the analysis and that it should be carried out stochastically. This WD presents the results of a preliminary analysis, which may be used to support a revision of FMSY. It is based on an approach similar to the one developed in the PlotMSY software, adapted to the stock dynamics structure used in the assessment of the Northern hake stock carried out with SS3. The estimation of MSY reference points is carried out by combining the yield per recruit curve with a stock-recruitment relationship, using an approach based on the replacement line and its intersection with the stock recruitment curve. Uncertainty is incorporated through the parameters of the stock-recruitment relationship only. Parameters of this relationship are estimated with ADMB and uncertainties around the estimates are characterised using the MCMC functionalities in ADMB. Results of this preliminary analysis point towards a possible revision of the current FMSY value. However, incorporating more sources of uncertainty is needed in order to analyse the impact of fishing at a selected FMSY on stock biomass (e.g. to obtain a realistic estimate of the probability that long-term SSB is below Blim, which should be very low, of the order of 0.05 or less). It must be ensured that the selected FMSY is within precautionary limits. The analysis would include uncertainty on the biological parameters, such as natural mortality, maturity, mean weight at length, and fishery parameters such as selectivity at length by fleet. Furthermore, the current analysis is based on the last assessment available carried out in 2011, using the 1978-2010 data series. It needs to be updated with more recent data when it becomes available

WD 9: Preliminary stock assessment of the southern stock of hake using Stock Synthesis, a first steps towards an integrated assessment of both stocks of hake in the north-east Atlantic.

By Mathilde Josse (Ifremer, France), Santiago Cerviño (IEO, Spain) and Michel Bertignac (Ifremer, France)
European hake (Merluccius merluccius) is distributed over a wide area in the northeast Atlantic, from Mauritania to Norway. Since the end of the 1970s, ICES (the International Council for the Exploration of the Sea) considers two stocks for the assessment: the so-called southern stock is distributed along the coast of Portugal and Spain (Divisions VIIIc and IXa) and the northern stock is distributed from the border between Spain and France in the south of the Bay of Biscay and Norway (Divisions CIEM IIIa, Sous-zones IV, VI and VII and Divisions VIIIa,b,d). The assessment of those two stocks is carried out using two distinct models using length based data. The assessment of the northern stock is carried out using the integrated stock assessment model Stock-Synthesis and the southern stock is assessed using the stock assessment model Gadget. The hypothesis of two distinct stocks is not based on strong biological evidences and recent genetic studies do not support the assumption of separate populations in the north-east. In this context, an integrative management of north-east Atlantic hake fishery by means of a multidisciplinary assessment is needed. Using a common assessment model will facilitate the comparison of various assumptions regarding population structuring. As a step forward into that direction, an integrated assessment of the two stocks using Stock-Synthesis is being developed. An assessment of the southern stock only using Stock-Synthesis has first been carried out and is presented in this working document.

# WD 10: Hake biological studies from ITSASTEKA project 

By Iñaki Quincoces (AZTI, Spain)


#### Abstract

This working document describes the results of an ecosystem survey and a hake diet study. The ecosystem survey began in 2010 and follows IBTS protocols but also records additional ecological parameters. Thirty stations were sampled each year ranging in depth from 30 to 360 m . Hake abundance indices and length frequency distributions are presented by depth strata. The hake diet study sampled 4692 ungutted hake and recorded the stomach contents in addition to typical biological parameters such as length, total weight, gutted weight, sex and maturity. Where possible the prey species was identified and length and weight was recorded. Diet varied by season and hake size but was dominated by Blue Whiting. Other prey species were sardine, anchovy, horse mackerel, shrimps and hake. A relationship between predator and prey length was found.


## WD 11: Hake priors based on life history theory. Northern hake Case Study

By Santiago Cerviño (IEO, Spain)


#### Abstract

The goal of this work was to provide biological priors for the hake model based on life history invariants theory and hake information from literature. Life history invariants theory predicts that the relationship between some life history parameters is relatively constant. Based on this theory, biological priors might be built based on the expected value of these parameters and their variability estimated from other hake information. Results are presented for natural mortality, growth parameters $\mathrm{L}_{\infty}$ and K and natural mortality.


## WD 12: Abundance index for Bay of Biscay Sole from the ORHAGO survey

By Muriel Lissardy (Ifremer, France)

Since 2007 a beam trawl survey (ORHAGO) is carried out in the fourth quarter (November and the beginning of December) in the Bay of Biscay to get an abundance index for benthic species and particularly for the common sole (Solea solea). This survey is coordinated by the ICES WGBEAM which have approved the calculation method to implement for the Bay of Biscay sole stock abundance index at its 2013 meeting (daylight hauls for a set of reference stations). The quality of this index was analysed by comparing the trends of the log mean standardised CPUE at different ages of each cohort. This analysis shows a good ability of the ORHAGO survey index to track the strongest cohorts. However, the sensibility of the last agreed assessment to the addition of the ORHAGO series is limited. Except the recruitment in the terminal year, the outputs are only slightly changed. Nevertheless, the weights of the ORHAGO survey in the age estimates are major, far above the weights of other fleets from age 2 to 6 . The quality of the ORHAGO survey to serve as a tuning index is then confirmed but also its addition to the tuning series shows that the two commercial tuning fleets added in 2011 by the WKFLAT give relevant abundance signals. Consequently and because the ORHAGO series is now long enough (6 years), its use
should be considered for the assessment of the Bay of Biscay sole stock as it appears to have potential advantage for improving or validating the quality of this assessment.

WD 13: A Bayesian state-space size-structured population dynamics model for northern hake.

By Margarita Rincón (ICMAN-CSIC, Spain), Santiago Cerviño (IEO, Spain), Samu Mäntyniemi (UH, Finland), José Castro (IEO, Spain) and Javier Ruiz (ICMAN-CSIC, Spain)


#### Abstract

In fisheries research bayesian state-space models have been proved to be very useful because of their capacity to include new data while measuring the uncertainty associated to biological and physical processes. The ECOKNOWS (Effective use of ecosystem and biological knowledge in fisheries) project proposes to use bayesian analysis in a general population dynamics model GPDM as a powerful tool to include biological and physical information in management strategies. Results of a preliminary Bayesian model adapting this model to northern hake population dynamics are presented here. The model intends to reproduce as far as possible the structure and main assumptions of the current ICES model. Actually there are some parameters with convergence problems but we are developing a new version considering informative priors for the biological processes which are supposed to ameliorate the estimations.


## Annex C

Quality Handbook Stock Annex C

Stock specific documentation of standard assessment procedures used by ICES.

| Stock | Northern Stock of Hake (Division IIIa, Subareas IV, <br> VI and VII and Divisions VIIIa,b,d) |
| :--- | :--- |
| Working Group: | Assessment of Southern Shelf Stocks of Hake, Monk <br> and Megrim |
| Date: | May 2011 <br> Revised by |

## A. General

## A.1. Stock definition

European hake (Merluccius merluccius) is widely distributed over the Northeast Atlantic shelf, from Norway to Mauritania, with a larger density from the British Islands to the south of Spain (Casey and Pereiro, 1995) and in the Mediterranean and Black sea. Although, as demonstrated by genetic studies (Plá and Roldán, 1994; Roldán et al., 1998), there is no evidence of multiple populations in the Northeast Atlantic, ICES assumes since the end of the 1970s two different stock units: the so called Northern stock, in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d, and the Southern stock in Divisions VIIIc and IXa, along the Spanish and Portuguese coasts. The main argument for this choice was that the Cap Breton canyon (close to the border between the Southern part of Division VIIIb and the more Eastern part of Division VIIIc, i.e. approximately between the French and Spanish borders) could be considered as a geographical boundary limiting exchanges between the two populations.

Hake spawn from February through to July along the shelf edge, the main areas extending from the north of the Bay of Biscay to the south and west of Ireland (Figure 1). After a pelagic life, 0 -group hakes reach the bottom in depths of more than 200 m , then moving to shallower water with a muddy seabed ( $75-120 \mathrm{~m}$ ) by September. There are two major nursery areas: in the Bay of Biscay and off southern Ireland.


Figure 1. Main spawning and nursery areas. Spawning areas sloping downwards from left to right; Nursery areas sloping downwards from right to left. (from Casey and Pereiro, 1995)

## A.2. Fishery

A set of different Fishery Units (FU) has been defined by the ICES Working Group on Fisheries Units in Sub-areas VII and VIII in 1985, in order to study the fishing activity related to demersal species (ICES, 1991a). To take into account the hake catches from other areas, a new Fishery Unit was introduced at the beginning of the nineties (FU 16: Outsiders). This Fishery Unit was created on the basis of combination between mixed areas and mixed gears (trawl, seine, longline, and gillnet). The current FU are defined as follows:

| Fishery Unit | Description | Sub-area |
| :---: | :--- | :---: |
| FU1 | Long-line in medium to deep water | VII |
| FU2 | Long-line in shallow water | VII |
| FU3 | Gillnets | VII |
| FU4 | Non-Nephrops trawling in medium to deep water | VII |
| FU5 | Non-Nephrops trawling in shallow water | VII |
| FU6 | Beam trawling in shallow water | VII |
| FU8 | Nephrops trawling in medium to deep water | VII |
| FU9 | Nephrops trawling in shallow to medium water | VIII |
| FU10 | Trawling in shallow to medium water | VIII |
| FU12 | Long-line in medium to deep water | VIII |
| FU13 | Gillnets in shallow to medium water | VIII |
| FU14 | Trawling in medium to deep water | VIII |
| FU15 | Miscellaneous | VII \& VIII |
| FU16 | Outsiders | IIIa, IV, V \& VI |
| FU00 | French unknown |  |

The main part of the fishery is currently conducted in six Fishery Units, three of them from Subarea VII: FU 4, FU 1 and FU 3, two from Subarea VIII: FU 13 and FU 14 and one in Subareas IIIa, IV, V and VI : FU16.

From the information reported to the Working Group, Spain accounted in recent years for the main part of the landings (around $60 \%$ ) followed by France (around $25 \%)$ UK, Denmark, Ireland, Norway, Belgium, Netherlands, Germany, and Sweden contributing to the remaining.

The minimum landing size for fish caught in Subareas IV, VI, VII and VIII is set at 27 cm total length ( 30 cm in Division IIIa).

From 14th of June 2001, an Emergency Plan was implemented by the Commission for the recovery of the Northern hake stock (Council Regulations Nº1162/2001, 2602/2001 and 494/2002). In addition to a TAC reduction, 2 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 weight of marine organisms retained on board. 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.
- Two areas have been defined, one in Subarea VII and the other in Subarea VIII, where a 100 mm minimum mesh size is required for all otter trawlers, whatever the amount of hake caught.

Council Regulation (EC) No. 1954/2003 established measures for the management of fishing effort in a biologically sensitive area in Subareas VIIb, VIIj, VIIg, and VIIh. Effort exerted within the biologically sensitive area by the vessels of each EU Member State may not exceed their average annual effort (calculated over the period 19982002).

There are explicit management objectives for this stock under the EC Reg. No $811 / 2004$ implementing measures for the recovery of the northern hake stock. It is aiming at increasing the quantities of mature biomass to values equal to or greater than 140000 t . This is to be achieved by limiting fishing mortality to 0.25 and by allowing a maximum change in TAC between years of $15 \%$.

According to ICES in 2007, the northern hake stock has met the SSB target in the recovery plan of 140000 t for two consecutive years (2006 and 2007). Article 3 of the recovery plan indicates that, in such a situation, a management plan should be implemented.

An annual one-month fishing activity stop has been implemented by the Spanish administration since 2004. In 2008, a specific national regulation established a 90-days stop to be distributed from August 2008 to December 2009. Independently of these regulations, some Spanish fleets stopped their activity during some weeks in June 2008 to protest against the increase of petrol prices.

In Subarea VIII, for 2006, 2007 and 2008, otter trawlers using a square mesh panel are allowed to use 70 mm mesh size in the area, mentioned above, where 100 mm minimum mesh size is required for all otter trawlers. (EC Reg. No. 51/2006; EC Reg. 41/2007).

Furthermore, there was a ban on gillnets in Divisions VIa,b and VIIb,c,j,k fishing at more than 200 m of depth (EC Reg. No 51/2006) during the first semester of 2006.

## A.3. Ecosystem aspects

Although a comprehensive study on the role of hake in its ecosystem has not yet been carried out, some partial studies are available. Hake belongs to a very extended and
diverse community of commercial species including megrim, anglerfish, Nephrops, sole, sea bass, ling, blue ling, greater forkbeard, tusk, whiting, blue whiting, Trachurus spp, conger, pout, cephalopods (octopus, Loligidae, Ommastrephidae and cuttlefish), and rays. The relative importance of these species in the hake fishery varies largely in relation to the different gears, sea areas, and countries involved.

Hake is preyed upon by sharks and other fish. Cannibalism on juveniles by adults is also quoted. Adults feed on fish (mainly on blue whiting and other gadoids, sardine, anchovy, and other small pelagic fish); juvenile hake prey mainly upon planktonic crustaceans (above all euphausids, copepods, and amphipods).

Ecological factors or environmental conditions impacting on hake population dynamics are not taken into account at present in the assessment or in the management.

## B. Data

## B.1. Commercial catch

## B.1.1. Landings

The Spanish landings data are based on sales notes and Owners Associations data compiled by IEO; and Basque Country sales notes and Ship Owners data compiled by AZTI. French landings data are based on logbook and auction hall sales.

From 1978 to 1989, landings in weight are available by year, gear (trawl, gillnets and longline), country (UK, France and Spain) and ICES Divisions (Division IVa + SubArea VI, Division VII and Divisions VIII a+b). From 1990 to present, for most of the years, landings in weight by FUs and countries are available on a quarterly basis. In 1992, only data from Spain is available by FU and on a quarterly basis (Table 1).

Table 1. Landings-in-weight (and their level of aggregation) available to the Working Group.

|  | 1978 to 1989 | $1990-1991$ | 1992 | 1993 to Present |  |
| :--- | :---: | :---: | :---: | :---: | :---: |
| By Gear, Country and <br> ICES Divisions | X |  |  |  |  |
| By FU |  |  | X | X | X |
| By year | X |  | X |  |  |
| By quarter |  | X | X |  |  |

* For Spain only

From 1978 to 1989, length-frequency distributions are available by year, gear, country and ICES Divisions. From 1990 to present, length compositions of the landings are not available for all Fishery Units, quarters and countries. Only the main FUs/Countries are sampled. Table 2 presents, as an example, the length distributions available for 2008.

Table 2. Length-frequency distributions provided to the Working Group in 2008.

| FU |  | France | Ireland | Spain | UK(EW) | Scotland |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 01 |  |  | Quarterly |  | Danemark |  |
| 03 | Quarterly |  | Quarterly | Quarterly |  |  |
| 04 |  | Quarterly | Quarterly |  |  |  |
| 05 | Quarterly |  |  | Quarterly |  |  |
| 06 |  |  | Quarterly |  |  |  |
| 09 | Quarterly |  |  |  |  |  |
| 10 | Quarterly |  |  |  |  |  |
| 12 | Quarterly |  | Quarterly |  |  |  |
| 13 | Quarterly |  | Quarterly |  |  |  |
| 14 |  |  | Quarterly |  |  |  |
| 15 |  | Quarterly |  |  | Quarterly | Yearly |
| 16 |  |  | Quarterly |  |  |  |

## B.1.2. Discards

Until 2002, the only discards series available and used by the WG were those of the French artisanal and coastal trawl fisheries in the Bay of Biscay, estimated on the basis of the length compositions obtained during FR-RESSGASC surveys. The RESSGASC survey used for their estimation ended in 2002.

EU countries are now required under the EU Data Collection regulation to collect data on discards.

A new sampling programme of discards in the French Nephrops trawlers fishery of the Bay of Biscay started in June 2002. Estimates obtained by this programme (see Table 3 below) were significantly different (by a factor 2 to 10) from previous estimates for that fishery (estimates are from 532 t in 2006 to 1597 t in 2005). Such discrepancies could be explained by changes in the sampling, changes in the discarding practices, variations in the abundance of small fish or by a combination of the three. The CVs associated with these estimates are around $20 \%$.

Discards are available for Danish trawlers and seiners fishing in Subarea IV from 1995 to 2004 and for gillnetters from 1995 to 2008. Their values are quite variable from year to year from 100 to 800 t .

Additional information on discards was available for the Irish otter trawlers fishery in Subareas VI and VII from 1999 to 2001 and for 2004 and 2005 (values from 32 to 650 t , not raised after 2005) and for UK-EW from 2000 to 2008 (raised only to the trip level).

Estimates of discards for the Spanish trawl fleets operating in the ICES Subarea VII and Divisions VIIIabd are available for 1988, 1989, 1994, from 1999 to 2001 and from 2003 to 2008. In Subarea VII, an increase in estimated discards rate was observed from 2003 to 2008 when compared with previous years. Discards were estimated to vary from very small amounts to more than 1000 t in 2003-2005 and over 2000 t in 2008. CVs were highly variable from $20 \%$ to more than $100 \%$. Fixed gears were also sampled in order to design the Spanish Discards Sampling Programme, but no relevant discards were observed (Pérez et al., 1996).

Table 3. Summary of discards data available (weight (t) in bold, numbers ('000) in italic).

| Fleet/metier sampled | Corresponding Fishery Units | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Spanish Trawl in VII | FU 4 | NA | 137 | NA | NA | NA | 1241 | 1740 | NA | 778 | 2339 | 2033 |
|  |  | NA | 800 | NA | NA | NA | 12497 | 19831 | NA | 6646 | 28615 | 16375 |
| French Nephrops trawl | FU9 | 565 | 341 | 417 | 172 | 1035 | 1359 | 1597 | 532 | 767 | 858 | NA |
| in Villabd |  | 9139 | 7421 | 6407 | 2992 | 23676 | 39550 | 37740 | 18031 | 24277 | 18245 | NA |
| French trawl in VIIlabd | FU10 | 211 | 169 | 100 | 142 | NA | NA | NA | NA | NA | NA | NA |
|  |  | 3053 | 3013 | 1439 | 2253 | NA | NA | NA | NA | NA | NA | NA |
| $\begin{gathered} \hline \text { Spanish trawl in } \\ \text { VIllabd } \\ \hline \end{gathered}$ | FU14 | NA | NA | NA | NA | NA | 30 | 489 | 206 | 471 | 352 | 557 |
|  |  | NA | NA | NA | NA | NA | 451 | 8475 | 3397 | 10002 | 7153 | 7530 |
| Irish trawl and seine in VII | FU15 | 190 | 650 | 194 | NA | NA | 32 | 94 | * | * | * | NA |
|  |  | 1868 | 892 | 1046 | NA | NA | 282 | 629 | * | * | * | 684 |
| $\begin{gathered} \hline \text { UK (EW) trawl in IV } \\ \text { and VII } \\ \hline \end{gathered}$ | FU16 + 4 + 5 | NA | * | * | * |  | * |  | * | * | * | * |
|  |  | NA | * | * | * | * | * | * | * | * | * | * |
| $\begin{gathered} \hline \text { Spanish trawl in } \\ \mathrm{VI} \\ \hline \end{gathered}$ | FU16 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6 | 31 |
|  |  | NA | NA | NA | NA | NA | NA | NA | NA | NA | 11 | 36 |
| Danish trawl and seine | FU16 | 42 | 21 | 142 | 354 | ${ }^{242}$ | ${ }^{206}$ | 814 | 610 | 255 | 190 | 213 |
|  |  | 29 | 38 | 483 | 691 | 479 | 775 | NA | NA | 849 | 642 | 508 |
| Total Weight from sampled fleet (t) Total Number from sampled fleets ('OOO) |  | 1008 | 1319 | 854 | 668 | 1277 | 2868 | 3920 | 738 | 2016 | 3745 | 2277 |
|  |  | 14090 | 12164 | 9376 | 5935 | 24155 | 53555 | 66675 | 21428 | 40925 | 54666 | 17603 |

During the 2003 assessment, the Working Group noted that, although some improvement in discard data availability had been observed (number of fleets sampled and area coverage), sampling does not cover all fleets contributing to hake catches and discard rates of several fleets are simply not known. Furthermore, when data are available, it was not possible to incorporate them into the assessment in a consistent way. As reconstructing an historical series was found problematic, discard estimates were removed from the full time-series of catch data. From 2003 to 2008, the assessment was thus conducted on landings only. After 2008 Working Group assessment, discards estimates from several sampled fleets were used in the assessment. This includes the French Nephrops trawl in VIIIabd discards data from 2003 to present, the Spanish trawl in VII in 1994, 1999, 2000, 2003 to present and the Spanish trawl in VIII abd from 2005 to present.

## B.2. Biological

Mean weight-at-length are estimated from a fixed length-weight relationship $(\mathrm{W}(\mathrm{g})=$ $0.00513^{*} \mathrm{~L}(\mathrm{~cm})^{\wedge} 3.074$; ICES, 1991b).

The parameters of the time invariant logistic maturity ogive, for both sexes combined are: $L_{50}=42.85 \mathrm{~cm}$ and slope $=-0.2$ (ICES, 2010b WD8).

Conventional tagging of European hake (de Pontual et al., 2003) recently opened new avenues for a better understanding of the species biology and population dynamic which have remained controversial for decades (see e.g. Belloc, 1935; Hickling, 1933). The first tagging results provided evidence of substantial growth underestimation (by a factor $\sim 2$ ) due to age overestimation, (de Pontual et al., 2006), thus challenging the internationally agreed age estimation method. More tagging efforts, both off the Northwest Iberian Peninsula (Pineiro et al., 2007) and the Mediterranean Sea (MellonDuval et al., 2010), have recently proved that growth underestimation was not a regional issue. Besides, Ifremer sustained a large tagging effort in the Bay of Biscay from 2004 to 2007 which allowed confirming both the relevance of the fast growth hypothesis and the issues of the otolith-based age estimation current methodology. An ICES workshop (ICES, 2010a) confirmed that the previous internationally agreed ageing method is neither accurate nor precise and provides overestimation of age. A replacement ageing method with sufficient precision and accuracy is currently not available. Conversion from length-to-age using an age-length key and the use of an assessment model relying on a catch-at-age matrix and abundance indices at age as was done until 2008 becomes then problematic. This leads the Working Group to consider the use of a length-based stock assessment model.

In the absence of a direct estimate of natural mortality, a constant value of 0.4 was assumed for all age classes and years. It must be noted that this is a larger value than the one used in assessments conducted until 2008 where M was set to a value of 0.2 . The rationale for this higher value is that if hake growths about two times faster, the hake longevity is reduced by about a half (from age $\sim 20$ to $\sim 10$ ), thus impacting on natural mortality (Hewitt and Hoening, 2005).

## B.3. Surveys

Several research-vessel surveys cover part of the geographical distribution of the Northern hake stock (Figure 2).


Figure 2. Map of East Atlantic groundfish surveys: stratification and trawling positions. FREVHOE correspond to EVHOE-WIBTS-Q4, SP Porc corresponds to SPPGFS-WIBTS-Q4 and IGFS corresponds to IGFS-WIBTS-Q4.

Abundance indices are available from the following research-vessel surveys:
Abundance indices used in the SS3 assessment:
French Evhoe groundfish survey (EVHOE-WIBTS-Q4): years 1997-present. The survey occurs in autumn. The survey uses a GOV trawl with a 20 mm codend liner. It covers the shelf of both the Bay of Biscay and the Celtic Sea.

French Ressgasc groundfish survey (RESSGASC): years 1978 to 2002. Over the years 1978-1997 the RESSGASC surveys were conducted with quarterly periodicity. They were conducted twice a year after that (in spring and autumn). Survey data prior to

1987 have been excluded, because there was a change of vessel at that time. Weather conditions encountered by RESSGASC in 2002 gives to this index a poor reliability and it was decided not to use it. The survey uses a 25 m "Vendéen type" bottom trawl. It covers the Bay of Biscay. The survey ended in 2002.

Spanish Porcupine groundfish survey (SPPGFS-WIBTS-Q4): years 2001 to present. The area covered by this survey is the Porcupine bank extending from longitude $12^{\circ} \mathrm{W}$ to $15^{\circ} \mathrm{W}$ and from latitude $51^{\circ} \mathrm{N}$ to $54^{\circ} \mathrm{N}$, covering depths between 180 and 800 m . The cruises are carried out every year in September on board R/V "Vizconde de Eza", a stern trawler of 53 m and 1800 Kw . Numbers-at-age for this abundance index are estimated from otoliths collected during the survey.

Irish Groundfish Surveys (IGFS-WIBTS-Q4): years 2003 to present. This survey is conducted on board the R.V. Celtic Explorer in autumn in the west of Ireland and the Celtic sea. The survey uses GOV 36/47 (Grande Ouverture Verticale).

Abundance indices not used in the SS3 assessment:
UK WCGFS survey (UK-WCGFS): years 1988 to 2004. This survey was conducted in March in the Celtic sea. It does not include the 0 -age group. Numbers-at-age for this abundance index are estimated from length compositions using a mixed distribution by statistical method. The survey ended in 2004.

## B.4. Commercial cpue

Commercial cpues indices provided to the ICES Working Group are not used in the current SS3 assessment. Landings-per-unit-effort time-series are available from the following fleets:
a ) Trawlers from A Coruña and Vigo fishing in Sub-area VII (SP-CORUTR7 and SP-VIGOTR7), pairtrawlers from Ondarroa and Pasajes fishing in Subarea VIII (SP-PAIRT-ON8 and SP-PAIRT-PA8)

The A Coruña trawler fleet, targeting mainly hake, operates in deeper waters close to the slope in Division VIIb-c, j-k, while the trawler fleet from Vigo, targeting megrim, works in shallower waters in Division VIIj-h and catch hake as bycatch. Both pairtrawler fleets from Ondarroa and Pasajes are targeting hake in the Bay of Biscay.
b) Ondarroa "Baka" trawlers fishing in Subareas VI, VII and Division VIIIa,b,d, Pasajes "Bou" trawlers fishing in Subarea VIII, longliners from A Coruña, Celeiro and Burela fishing in VII, longliners from Avilés in VIIIa,b,d and trawlers from Santander in VIIIa,b,d.

Lpue values of Spanish gillnetters that started to fish hake in Subareas VII and VIII in 1998 are also provided. It is to be noted that only a small number of ships are involved in the gillnet fishery which makes lpues very sensitive to small changes in the number of trips. It is also noted that for gillnetters and longliners, lpues expressed in $\mathrm{kg} /$ day may not be the most appropriate.

Lpue data from two French fleets (Les Sables and Lesconil) fishing in Divisions VIIIa,b,d are also available from Logbooks. Due to important reductions in the availability of logbook information in recent years for both fleets, lpue values for the years 1996 onwards have low reliability. No data have been provided for those two fleets after 2003.

## B.5. Other relevant data

## C. Historical stock development

Model currently used: Stock Synthesis 3 (SS3), (Methot, 2005).
Software used: Stock Synthesis V3.10, Richard Methot, NOAA Fisheries Seattle, WA.
Recent assessments and sensitivity analysis carried out.
An attempt to use a non-equilibrium surplus production model (ASPIC) was carried out in the 2004 WG (ICES, 2005) and preliminary fits of a length based stock assessment model have been presented in 2007 and 2008.

In the 1998 WG it was found that the SSB estimates for 1985-1987 were very sensitive to the q plateau options between age 5,6 , and 7 (which is the last true age). To reduce this effect, it was decided to extend the ten years window to a twelve-year period in order to tune to the longest available and well behaved fleet dataseries. In the 1999 and 2000 assessments, SSB estimates for 1985-1987 were still sensitive to the extent of the tuning period, and the longest (13 years and 14 years respectively) provided the best pattern for these years, whereas other estimates were very similar for other years. In 2001 assessment, it was decided to use the whole tuning data available and a taper time weighting to reduce the influence of the older years. At that time, this choice did not change radically the estimates of trends in F and SSB and those settings were maintained in 2002 to 2003 assessments.

In 2004, the group investigated again the influence of the taper time weighting and runs were conducted without taper and compared with the base-case run using a tricubic taper over a 20 year period. While the group agreed on the rationale behind the use of a taper to down-weight the years for which we may have less confidence, it expressed concerns over the large influence the use of this option has on the perception of the stock dynamics and the inability of the model to account, in a satisfactory manner, for uncertainty in the data.

Due to uncertainties in hake aging, in 2005, 2006 and 2007, the group also conducted a sensitivity analysis using a simulated ALK assuming a faster growth. In each of these years, several runs were thus conducted (An Update from the previous year and a Simulated ALK, see below).

In WGHMM 2007, an update runs from 2006 has been carried out and the SPPGFS-WIBTS-Q4 survey was added to the surveys used to tune the model.

WKROUND 2010 (ICES, 2010b) reviewed the uses of the Stock Synthesis assessment model.

## Current assessment

The assessment is a length-based approach using the Stock Synthesis assessment model. This approach allows direct use of the quarterly length composition data and explicit modelling of a retention process that partitions total catch into discarded and retained portions.

The underlying population can be partitioned in time to include as many seasons within a year as required. This is important where temporal aspects of biology (like growth in the case of hake), or fishing activity dictate finer than annual-level representation, however all the basic input data must then be partitioned to the level of the underlying dynamics.

Recruitment is based on a Beverton-Holt function parameterized to include the equilibrium level of unexploited recruitment (R0) and the steepness (h) parameter, describing the fraction of the unexploited recruits produced at $20 \%$ of the equilibrium spawning biomass level. Annual deviations can be estimated for any portion of the modelled time period (or the whole period), and the expected recruitments are biascorrected to reflect the level of variability (sigmaR, an input quantity) allowed in these deviations.

Growth is described through a von Bertalanffy growth curve with the distribution of lengths for a given age assumed to be normally distributed. The CV of these distributions is structured to include two parameters which can be estimated or fixed, defining the spread of lengths at a young and old age with a linear interpolation between. In addition to growth, the relationships between weight and length, fecundity and length as well as maturity-at-length are all generalized to allow parameters to be estimated or fixed, temporally invariant or not. All model parameters can vary over time either as a function of annual deviations about a mean level, user defined 'blocks' of years in which the parameters differ or a combination of the two.

All model expectations for comparison with data are generated as observations from a 'fleet', either a fishery or a survey/index of abundance. Each fleet has unique characteristics defining relative selectivity across age or size, and can be structured to remove catch or collect observations at a particular time of the year or season. All fleets may be considered completely independent, or parameters may be shared among fleets where appropriate via 'mirroring'.

A suite of selectivity curves including logistic-based shapes of up to eight parameters, power functions and nonparametric forms can be explored through relatively simple modification of the input files.

The kinds of data that model expectations can be fit to include: absolute or relative abundance, length-frequency distributions, age frequency distributions (either total or conditional by length), length-at-age, body weight, and proportion discard. Each of these can be from the retained, discarded or total removals by a specific fleet. Each source has an error distribution (either normal, lognormal or multinomial) associated with it, described by either an input sample size or standard deviation.

## Input data for SS3

The overall fishery prosecuting the northern stock of hake has been categorized into 7 "fleets", 4 of which use trawl gears, whereas the remaining three use gillnet, longline and a combination of several gears (Table 4). They are based on a combination of the Fishery Units described above. For each fleet, estimates of landings in weight and length-frequency distributions are available. For some fleet only, discards in weight and length-frequency distribution are used.

Table 4. Fleets characteristics and data available for SS3 (Length-Frequency distribution (LFD) and weight of landings and discards).

| Fleets | Description | FU | Landings (quarterly) | Discards (quarterly) |
| :---: | :---: | :---: | :---: | :---: |
| SPTRAWL7* | Spanish trawl in VII | 04 | Yearly : 1978-1989 <br> (LFD+tonnage) <br> Quarterly: 1990- <br> 2010(LFD+tonnage) | 1994, 1999, 2000, 2003-2008 (LFD + Weight) |
| FRNEP8 | French trawl targeting Nephrops in VIII | 09 | Yearly : 1978-1989 <br> (tonnage) <br> Yearly : 1985-1989 (LFD) <br> Quarterly : 1990-2010 <br> (LFD+tonnage) | $\begin{aligned} & \text { 2003-2008 } \\ & \text { (LFD + Weight) } \end{aligned}$ |
| SPTRAWL8 | Spanish trawl in VIII | 14 | Yearly : 1978-1989 <br> (LFD+tonnage) <br> Quarterly: 1990- <br> 2010(LFD+tonnage) | $\begin{aligned} & \text { 2005-2008 } \\ & \text { (LFD + Weight) } \end{aligned}$ |
| TRAWLOTH | All other trawl | $\begin{gathered} 05+06+08+ \\ 10 \end{gathered}$ | Yearly : 1978-1989 <br> (LFD+tonnage) <br> Quarterly: 1990-2010 <br> (LFD+tonnage) |  |
| GILLNET | Gillnet all countries | $03+13$ | Yearly : 1978-1989 <br> (LFD+tonnage) <br> Quarterly: 1990-2010 <br> (LFD+tonnage) |  |
| LONGLINE | Longline all countries | $01+02+12$ | Yearly: 1978-1989 <br> (LFD+tonnage) <br> Quarterly: 1990-2010 <br> (LFD+tonnage) |  |
| OTHERS | Everything else all countries | $15+16+00$ | Yearly : 1978-1989 <br> (LFD+tonnage) <br> Quarterly: 1990-2010 <br> (LFD+tonnage) |  |

${ }^{\text {* FU04 (and consequently SPTRAWL7) landings and discards contain small amount from area VI as, in }}$ some cases, the sampling programme does not allow to make the distinction between area VII and VI.

For the two Spanish trawl fisheries, it is thought that discarding became much more substantial starting from 1998. For the French Nephrops fishery, discarding is thought to have occurred already from 1990. The remaining 4 fisheries (TRAWLOTH, GILLNET, LONGLINE, OTHERS) are assumed not to discard any fish.

Several surveys provide relative abundance indices of abundance and length distributions (Table 5).

Table 5. List of surveys used in SS3.

| Surveys | Area | Years | Quarter |
| :--- | :--- | :---: | :---: |
| EVHOE- | Bay of Biscay and Celtic Sea | $1997-\left(y^{*}-1\right)$ | 4 |
| WIBTS-Q4 |  |  |  |
| RESSGASC | Bay of Biscay | $1990-1997$ | $1,2,3$ and 4 |
|  |  | $1998-2001$ | 2 and 4 |
| SPPGFS- | Porcupine Bank | $2001-\left(y^{*}-1\right)$ | 3 |
| WIBTS-Q4 |  |  | 4 |
| IGFS-WIBTS- | North, West and South of Ireland | $2003-\left(y^{*}-1\right)$ | 4 |
| Q4 |  |  |  |

* $y=$ assessment year

No commercial fleet tuning data are used.
SS3 settings (input data and control files):
Years: 1978 to present, 1 area, 4 seasons, both sexes combined.
Length Frequency Distribution are available on a yearly basis from 1978 to 1989 and on a quarterly basis from 1990 to present. No age data are used.

Initial equilibrium catch: annual average of ten years (1980-1989) for each fishery.
Variability for landings, discards and survey abundance indices are entered as standard deviation in log-scale, as follows:

Landings (tonnes): $10 \%$ variability
Discards (tonnes): 50\% variability
Survey abundance indices: variability externally estimated. As the latter represents only the surveys internal variability, extra variability was added (increment to CV in SS3 control file) according to how representative each survey was felt to be of stock abundance (i.e. the area coverage of the survey as compared to the spatial distribution of the stock). Surveys' CV were increased by 0.1 (EVHOE-WIBTS-Q4), 0.2 (RESSGASC, IGFS-WIBTS-Q4), 0.3 (SPPGFS-WIBTS-Q4).

Length compositions were assigned the following sampling sizes in the SS3 input data file, on the basis of how representative they were felt to be ${ }^{1}$ :

Landings: 125 for all fleets, except SPTRAWL7 for which 50 was used for 1990-1997 and 200 was used from 1998 onwards

Discards: 50 for SPTRAWL7 and SPTRAWL8, 80 for FRNEP8
Surveys: 125
The following multipliers were subsequently applied to the latter sample sizes in the SS3 control file:

[^7]Landings and discards: 0.5 for all fleets, except LONGLINE to which a factor of 1 was applied

Surveys: 1 (EVHOE-WIBTS-Q4), 0.525 (RESSGASC, IGFS-WIBTS-Q4), 0.35 (SPPGFS-WIBTS-Q4)
$\mathrm{M}=0.4$.
Von Bertalanffy growth function: Linf=130 cm, K and mean length-at-age 0.75 estimated. Same growth parameters apply to all fish (across morphs, years, etc)

Maturity ogive: length-based logistic, externally estimated and assumed constant over time

Recruitment allocation for Quarter 2 to 3 estimated with respect to Quarter 1. Quarter 2 allocation is time-varying, with annual deviates. Quarter 4 allocation set to 0.

Beverton-Holt stock-recruitment relationship: steepness $h=0.999$, sigma_R=0.4, R0 estimated.

Recruitment deviations starting in 1985.
$F$ estimation method $=2$ (F by fishery and quarter treated as unknown parameters)
Surveys catchabilities constant over time.
RESSGASC survey entered as 4 separate surveys ( 1 per quarter). Catchabilities are quarter-specific but all quarters use the same selectivity-at-length.

Selectivity only length-based (no age selectivity considered)
Selectivity-at-length uses Pattern 24 (double normal function, with 6 parameters) for fleets SPTRAWL7, FRNEP8, SPTRAWL8, GILLNET, LONGLINE and all surveys. TRAWLOTH and OTHERS use Pattern 1 (logistic function, with 2 parameters). When Pattern 24 is used, parameter P5 is not used except for SPTRAWL7 and SPTRAWL8. ${ }^{2}$

Selectivity-at-length constant over all years.
Retention patterns for fisheries with discards: length-logistic with asymptotic retention $=1$ in all cases, and unknown L50 and slope. For SPTRAWL7 and SPTRAWL8, two different patterns of retention over time are assumed, one for years 1990-1997 and the another one from 1998 onwards.

[^8]
## D. Short-term projection

- Model used: length and age-based.
- Software used: Forecast module in SS3.
- Initial stock size. Taken from the SS3 in the last assessment year.
- Natural mortality: Set to 0.4 for all ages in all years.
- Growth model: Von Bertalanffy model, with parameters estimated in the assessment model.
- Maturity-at-length: The same ogive as in the assessment is used for all years.
- Weight-at-length in the stock and in the catch: The same length-weight relationship as in the assessment model.
- Exploitation pattern: Average of the final 3 assessment years (with the possibility of scaling to final year F).
- Intermediate year assumptions: status quo F
- Stock-recruitment model used: Beverton-Holt Stock Recruitment relationship estimated in the assessment, with deviances chosen so that recruitment in the projection years approximately matches the geometric mean of estimated recruitment from 1990 until the final assessment year minus 2.


## E. Medium-term projections

- No medium-term projections are conducted for this stock.


## F. Long-term projections

- Model used: yield and biomass-per-recruit over a range of F values.
- Software used: Forecast module in SS3
- Selectivity pattern: Average of final 3 assessment years.
- Stock and catch weights-at-length: Same length-weight relationship as in the assessment model
- Maturity: Fixed maturity ogive as used in assessment


## G. Biological reference points

|  | WG 1998 | ACFM 1998 | ACFM 2003 | ACOM 2010 |
| :--- | :--- | :--- | :--- | :--- |
| MSY B $_{\text {trigger }}$ |  |  |  | not defined |
| $\mathrm{F}_{\text {MSY }}$ |  |  | 0.24 |  |
| Flim | No proposal | 0.28 ( = Floss WG 98) | $0.35(=$ Floss WG 03) | not defined |
| Fpa | No proposal | $0.20(=$ Flim*e- | $0.25(=$ Flim*e- | not defined |
|  |  | $\left.1.645^{*} 0.2\right)$ | $\left.1.645^{*} 0.2\right)$ |  |
| Blim | No proposal | $120000 \mathrm{t}(\sim$ Bloss $=$ | $100000 \mathrm{t}(\sim$ Bloss $=$ | not defined |
|  |  | B94 $)$ | B94) |  |
| Bpa | 119000 t | $165000 \mathrm{t}(=$ | $140000 \mathrm{t}(=$ | not defined |
|  | $(=$ Bloss= B94) | Blim $\left.^{*} \mathrm{e} 1.645^{*} 0.2\right)$ | Blim*e1.645*0.2) |  |

## H. Other issues

None.

## I. References

Belloc, G. 1935. Etude monographique du merlu Merluccius merluccius L., 3eme partie. Revue des Travaux de l'Office desPeches maritimes, 8: 145-202.

Casey, J and Pereiro, J., 1995.European Hake (M. merluccius) in the Northeast Atlantic. In: Hake: Biology, Fisheries and markets. 125-147, (Chapman \& Hall, London. ISBN).
de Pontual, H., Bertignac, M., Battaglia, A., Bavouzet, G., Moguedet, P., Groison, A.L. 2003. A pilot tagging experiment on European hake (Merluccius merluccius): methodology and preliminary results. ICES journal of Marine Science, 60: 1318-1327.
de Pontual, H., Groison, A.L., Pineiro, C., Bertignac, M. 2006. Evidence of underestimation of European hake growth in the Bay of Biscay, and its relationship with bias in the agreed method of age estimation. ICES Journal of Marine Science, 63: 1674-1681.
Fournier, D., and C. P. Archibald. 1982. A general theory for analyzing catch at age data. Can. J. Fish. Aquat. Sci. 39: 1195-1207.

Hickling, C. F. 1933. The natural history of hake. 4. Age determination and growth rate. UK Ministry of Agriculture, Fisheries and Food, Investigation Series 2, 13(2). 120 pp.

ICES, 1991a. Report of the ICES Working Group on Fisheries Units in Subareas VII and VIII. ICES CM, 1991/Assess:24.

ICES. 1991b. Report of the Working Group on the Assessment of the Stocks of Hake. ICES CM 1991/Assess: 20.181 pp.

ICES, 1993. Report of the Working Group on the Assessment of Southern Shelf Demersal Stocks. ICES CM 1993/Assess : 3.

ICES, 2005. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim. ICES CM 2005/ACFM:02.

ICES 2010a. Report of the Workshop on Age estimation of European hake (WKAEH), 9-13 November 2009, Vigo, Spain. ICES, CM 2009/ACOM:42: 67 pp.

ICES 2010b. Report of the Benchmark Workshop WKROUND, 9-16 February 2010, Copenhagen, Denmark. ICES.
Martín, I. 1991. A preliminary analysis of some biological aspects of hake (Merluccius merluccius) L.1758) in the Bay of Biscay. ICES CM 1991/G : 54.

Mellon-Duval, C., de Pontual, H., Metral, L., Quemener, L. 2010. Growth of European hake (Merluccius merluccius) in the Gulf of Lions based on conventional tagging. ICES Journal of Marine Science, 67: 62-70.

Methot, R., 2000. Technical Description of the Stock Synthesis Assessment Program. NOAA Technical Memorandum NMFS-NWFSC-43. 56p.

Piñeiro, C., Rey, J., de Pontual, H., Goñi, R. 2007. Tag and recapture of European hake (Merluccius merluccius L.) off the Northwest Iberian Peninsula: First results support fast growth hypothesis. Fisheries Research, 88: 150-154.

Pérez, N., P. Pereda, A. Uriarte, V. Trujillo, I. Olaso y S. Lens. 1996. Descartes de la flota española en el área del ICES. Datos y Resúmenes. Vol 2. NIPO : 251-96-013-X.

Pla, C. and Roldán, M. I. 1994. Estructura genética de la merluza europea (Merluccius merluccius) y su relación con la gestión pesquera. In González-Garcés, A. y F.J. Pereiro, ed. "Estado actual de los conocimientos de las poblaciones de Merluza que habitan la plataforma
continental atlántica y mediterránea de la Unión Europea con especial atención a la Península Ibérica". (Vigo, 13 a 17 de Diciembre de 1993). Publicación Privada. Vigo. 1994. pp 327.

Roldán, M.I.; García-Marín, J.L.; Utter, F.M. and Pla, C. 1998. Population genetic structure of European hake, Merluccius merluccius. Nature 81(3): 327-334.

## Annex D Stock Annex- Anglerfish in Divisions VIIb-k and VIIIa,b,d

Quality Handbook<br>Stock Annex D

Stock specific documentation of standard assessment procedures used by ICES.

Stock Anglerfish (L. piscatorius and L. budegassa) in Divisions VIIb-k and VIIIa,b,d<br>Working Group WGHMM, Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim<br>Date 13 March 2012 (WKFLAT, 2012)<br>Revised by Iñaki Quincoces, and Lisa Readdy

## A. General

## A.1. Stock definition

ICES assumes since the end of the 1970s three different stocks for assessment and management purposes: Anglerfish in Division IIa (Norwegian Sea), Division IIIa (Kattegat and Skagerrak), Subarea IV (North Sea), and Subarea VI (West of Scotland and Rockall) (Lophius piscatorius and L. budegassa); Anglerfish in Divisions VIIb-k and VIIIa,b,d (L. piscatorius and L. budegassa) and Anglerfish in Divisions VIIIc and IXa (L. piscatorius and L. budegassa). These stock definitions apply for both anglerfish species White anglerfish (L. piscatorius) and Black anglerfish (L. budegassa). In Divisions VIIbk and VIIIa,b,d, the two species are assessed separately but advised as a single stock since the EU gives a unique TAC for both species.

## A.2. Fishery

Anglerfish are an important component of mixed fisheries taking hake, megrim, sole, cod, plaice, and Nephrops. A trawl fishery by Spanish and French vessels developed in the Celtic Sea and Bay of Biscay in the 1970s, and overall annual landings may have attained $35000-40000 \mathrm{t}$ by the early 1980s. Landings decreased between 1981 and 1993 and since 2000, landings show an increasing trend. France and Spain together still report more than $75 \%$ of the total landings of both species combined. The remainder is taken by the UK and Ireland (around $10 \%$ each) and Belgium (less than $5 \%$ ). Otter trawls (the main gear used by French, Spanish, and Irish vessels) currently take about $80 \%$ of the total landings of L. piscatorius, while around $60 \%$ of UK landings are by beam trawlers and gillnetters. Over $95 \%$ of total international landings of L. budegassa are taken by otter trawlers. There has been an expansion of the French gillnet fishery since the early 1990s in the Celtic Sea and in the north of the Bay of Biscay, mainly by vessels landing in Spain and fishing in medium to deep waters. Otter trawling in medium and deep water in ICES Subarea VII appears to have declined, although the increasing use of twin trawls by French vessels may have increased significantly the overall efficiency of the French fleet.

## A.3. Ecosystem aspects

Lophius piscatorius is a Northeastern Atlantic species, with a distribution area from Norway (Barents Sea) to the Straits of Gibraltar (and including the Mediterranean
and the Black Sea). Lophius budegassa has a more southern distribution from the British islands and Ireland to Senegal (including the Mediterranean and the Black Sea). Though the Working Group assesses two different stocks for each species (VIIIc, IXa stock and VIIb-k, VIIIabd), the boundaries are not based on biological criteria. Recent studies were carried out in genetic and morphometric analysis (GESSAN, 2002; Duarte et al., 2004; Fariña et al., 2004).

The spawning of the Lophius species is very particular, with eggs extruded in a buoyant, gelatinous ribbon that may measure more than 10 m (Afonso-Dias and Hislop, 1996; Hislop et al., 2001; Quincoces et al., 2002). This particular spawning results in a highly clumped distribution of eggs and newly emerged larvae (Hislop et al., 2001) and favourable or unfavourable ecosystem conditions can therefore have important impacts on the recruitment.

## B. Data

The particularity of the data gathering processes for anglerfish species is that, except in Spain, anglerfishes are sold without any species distinction. The overall catch per species is estimated from the species ratio observed in the biological sampling.

Biological sampling is carried out by the countries contributing most catches, but assumptions about species proportion have to be made for countries reporting raw tonnages for species combined. The amount of tonnage with no biological sampling for species composition has been much reduced since the early 2000s and in 2007 these represented less than $8 \%$ of the total Lophius landings. In some countries however, anglerfish are landed as tails only and conversion factors have to be used to estimate total length, which still may introduce errors.

Data are supplied from databases maintained by national Government Departments and research institutions. The figures used in assessment are considered as the best available data at the Working Group time of the year. From year to year, and before the Working Group, small revisions of data could occur. In that case, revised data are explained and incorporated into the historical dataseries for assessment.
Data are supplied on electronic files to a stock coordinator nominated by the ICES Hake Monk and Megrim (formerly Southern Self Demersal Stocks) Working Group, who compiles the international landings, discards and catch-at-age data, and maintains the time-series of such data with the amendments proposed by countries.

## B.1. Commercial catch

Landings data are supplied from databases maintained by national Government Departments and research institutions. Countries providing landings data by quarter and ICES division are Spain, France, Ireland United Kingdom and Belgium.
The derivation used to compute the landings by fishery units and by species is given in the following table.

Anglerfish in Divisions VIIb-k and VIIIa,b,d; Derivation of the historical length compositions, by fishery unit for L. piscatorius and L. budegassa, in Divisions VIIb-k and in VIIIa,b,d.

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| Year | IR-FU04 | IR-FU05 | BE-FU06 | EW-FU03 | EW-FU04 | EwFU05 | EW- <br> FU06 | EW- <br> OTHER | FR- <br> FU03 + <br> FU13 | FR-FU03 | FR-FU04 | FRFU05 | FR-FU08 | FR-FU13 | FR-FU09 | FRFU10 | FR-FU14 | FRunallocated | sp- <br> FU04 | SP- <br> FU14 |
| 1986 | FR-FU04/Q, IR-FU04 annual tonnage/4 | FR-FU05/Q, IR-FU04 annual tonnage/4 | FR-FU04+SPFU04/Q BE annual tonnage/4 | ? | FR- <br> FU04+SP- <br> FU04/Q <br> EW-FU04 <br> annual <br> tonnage/4 | FRFU05/Q EW-FU05 annual tonnage/4 | FR- <br> FU04+SP- <br> FU04/Q <br> EW-FU06 <br> annual <br> tonnage/4 | - | - |  | FR-FU04/Q | FR- <br> FU05/ <br> Q | FR-Fu08/Q |  | FR-Fu09/Q | FRFU10/ Q | FR-FU14/Q | - | SP. <br> FU04/ <br> Q | SP. <br> FU14/ <br> Q |
| 1987 | FR-FU04/Q, IR-FU04 annual tonnage/4 | FR-FU05/Q, IR-FU04 annual tonnage/4 | FR-FU04+SPFU04/Q BE annual tonnage/4 | $?$ | FR- <br> FU04+SP- <br> FU04/Q <br> EW-FUO4 <br> annual <br> tonnage/4 | FR- <br> FU05/Q <br> EW-FU05 <br> annual <br> tonnage/4 | FR- <br> FUO4+SP- <br> FU04/Q <br> EW-FU06 <br> annual <br> tonnage/4 | - | - |  | FR-FU04/Q | FR- <br> FU05/ <br> Q | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | - | sp. FU04/ Q | SP- <br> FU14/ <br> Q |
| 1988 | FR-FU04/Q, IR-FU04 annual tonnage/4 | FR-FU05/Q, IR-FU04 annual tonnage/4 | FR-FU04+SPFU04/Q BE annual tonnage/4 | $?$ | FR-FU04+SP- <br> FU04/Q <br> EW-FU04 <br> annual <br> tonnage/4 | FR- <br> FU05/Q <br> EW-FU05 <br> annual <br> tonnage/4 | FR- <br> FUO4+SP- <br> FU04/Q <br> EW-FU06 <br> annual <br> tonnage/4 | - | - |  | FR-FU04/Q | FR- <br> FU05/ <br> Q | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | - | SPFU04/ Q | SP. <br> FU14/ <br> Q |
| 1989 | FR-FU04/Q IR-FU04 annual tonnage/4 | FR-FU05/Q, IR-FU04 annual tonnage/4 | FR-FUO4+SPFU04/Q BE annual tonnage/4 | $?$ | FR- <br> FU04+SP- <br> FU04/Q <br> EW-FU04 <br> annual <br> tonnage/4 | FR- <br> FU05/Q <br> EW-FU05 <br> annual <br> tonnage/4 | FR-FU04+SP- <br> FU04/Q <br> EW-FU06 <br> quarterly <br> tonnages | . | - |  | FR-FU04/Q | $\begin{aligned} & \text { FR- } \\ & \text { FU05/ } \\ & \text { Q } \end{aligned}$ | FR-FU08/Q |  | FR-FU09/Q | $\begin{aligned} & \text { FR- } \\ & \text { FU10/ } \\ & \text { Q } \end{aligned}$ | FR-FU14/Q | . | sp. FU04/ Q | $\begin{aligned} & \text { SP- } \\ & \text { FU14/ } \\ & \text { Q } \end{aligned}$ |
| 1990 | FR-FU04/Q, IR-FU04 annual tonnage/4 | IR-FU05annual LD | FRFU04+SP. FU04/Q BE annual tonnage/4 | ? | FR- <br> FU04+SP- <br> FU04/Q <br> EW-FUO4 <br> annual <br> tonnage/4 | FR- <br> FU05/Q <br> EW-FU05 <br> annual <br> tonnage/4 | FR- <br> FUO4+SP- <br> FU04/Q <br> EW-FU06 <br> quarterly <br> tonnages | - | - |  | FR-FU04/Q | FR- <br> FU05/ <br> Q | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | - | SP. <br> FU04/ <br> Q | SP. <br> FU14/ <br> Q |


| Country/fu |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Year | IR-FU04 | IR-FU05 | BE-FU06 | EW-FU03 | EW-FU04 | EW- FU05 | EWFU06 | Ew. Other | FR- <br> FU03 + <br> FU13 | FR-FU03 | FR-FU04 | FRFU05 | FR-FU08 | FR-FU13 | FR-FU09 | FRFU10 | FR-FU14 | FRunallocated | SPFU04 | sp. <br> FU14 |
| 1991 | IRL-FU04/Q | IRL-FU05/Q | FR-FU04+SP- <br> FU04/Q <br> BE annual <br> tonnage/4 | FR- <br> FU03/Q, <br> EW-FU03 <br> annual <br> tonnage/4 | FR-FU04+SP- <br> FU04/Q <br> EW-FU04 <br> annual <br> tonnage/4 | EW- <br> FU05/Q | EW- <br> FU06/Q | - | FRFU03/Q |  | FR-FU04/Q | $\begin{aligned} & \text { FR- } \\ & \text { FU05/ } \\ & \text { Q } \end{aligned}$ | FR-FU08/Q |  | FR-FU09/Q | $\begin{aligned} & \text { FR- } \\ & \text { FU10/ } \\ & \text { Q } \end{aligned}$ | FR-FU14/Q | - | sp. <br> FUO4/ <br> Q | sp. <br> FU14/ <br> Q |
| 1992 | FR-FU04+SPFU04/Q, IRFU04 quarterly tonnages | FR- <br> FU05/Q+EW- <br> FU05, IR-FU05 <br> quarterly <br> tonnages | FR- <br> FU04+SP- <br> FU04/Q <br> BE annual <br> tonnage/4 | FR- <br> FU03/Q, <br> EW-FU03 <br> annual <br> tonnage/4 | FR- <br> FU04+SP. <br> FU04/Q <br> EW-FU04 <br> quarterly <br> tonnages | EW- <br> FU05/Q | EW- <br> FU06/Q | - | FRFU03/Q |  | FR-FU04/Q | $\begin{aligned} & \text { FR- } \\ & \text { FU05/ } \\ & \text { Q } \end{aligned}$ | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | - | SP. <br> FU04/ <br> Q | SPFU14/ Q |
| 1993 | FR-FU04+SPFU04/Q, IRFU04 quarterly tonnages | FR- <br> FU05/Q+EW- <br> FU05, IR-FU05 <br> quarterly <br> tonnages | FR- <br> FU04+SP- <br> FU04/Q <br> BE <br> quarterly <br> tonnages | FR- <br> FU03/Q, <br> EW-FU03 <br> annual <br> tonnage/4 | FR- <br> FU04+SP- <br> FU04/Q <br> EW-FU04 <br> quarterly <br> tonnages | EW- <br> FU05/Q | EW- <br> FU06/Q | - | FRFU03/Q |  | FR-FU04/Q | FR- <br> FU05/ <br> Q | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | - | SP. <br> FUO4/ <br> Q | SPFU14/ Q |
| 1994 | IRL-FU04/Q | FR- <br> FU05/Q+EW- <br> FU05, IR-FU05 <br> quarterly <br> tonnages | FR- <br> FU04+SP- <br> FU04/Q <br> BE <br> quarterly <br> tonnages | FR- <br> FU03/Q, <br> EW-FU03 <br> annual <br> tonnage/4 | FR- <br> FU04+SP. <br> FU04/Q <br> EW-FU04 <br> quarterly <br> tonnages | EW- <br> FU05/Q | EW- <br> FU06/Q | - | FRFU03/Q |  | FR-FU04/Q | FR- <br> FU05/ <br> Q | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | - | SP. <br> FU04/ <br> Q | SP- <br> FU14/ <br> Q |
| 1995 | FR-FU04+SPFU04/Q, IRFUO4 quarterly tonnages | FR- <br> FU05/Q+EW- <br> FU05, IR-FU05 <br> quarterly <br> tonnages | EW- <br> FU06/Q/Q <br> BE <br> quarterly <br> tonnages | EW-FU03 | FR-FU04+SPFU04/Q EW-FU04 quarterly tonnages | EW- <br> FU05/Q | EW- <br> FU06/Q | - | FRFU03/Q |  | FR-FU04/Q | $\begin{aligned} & \text { FR- } \\ & \text { FU05/ } \\ & \text { Q } \end{aligned}$ | FR-FU08/Q |  | FR-FU09/Q | $\begin{aligned} & \text { FR- } \\ & \text { FU10/ } \\ & \text { Q } \end{aligned}$ | FR-FU14/Q | $\begin{aligned} & \text { Total LDs } \\ & \text { raised to } \\ & \text { species split } \end{aligned}$ | sp- <br> FU04/ <br> Q | $\begin{aligned} & \text { SP- } \\ & \text { FU14/ } \\ & \mathrm{Q} \end{aligned}$ |


| Country/Fu |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Year | IR-FU04 | IR-FU05 | BE-FU06 | EW-FU03 | EW-FU04 | EW- <br> FU05 | EW- <br> FU06 | EW- <br> OTHER | $\begin{aligned} & \text { FR- } \\ & \text { FU03 + } \\ & \text { FU13 } \end{aligned}$ | FR-FU03 | FR-FU04 | FR- <br> FU05 | FR-FU08 | FR-FU13 | FR-FU09 | FR- <br> FU10 | FR-FU14 | FRUNALLOCATED | SP- <br> FU04 | SP- <br> FU14 |
| 1996 | IRL-FU04/Q | FR- <br> FU05/Q+EW- <br> FU05, IR-FU05 <br> quarterly <br> tonnages | EW- <br> FU06/Q/Q <br> BE <br> quarterly <br> tonnages | FR-FU03 + EW-FU03 quarterly tonnages 95\% allocated to piscatorius all countries quarterly LDs raised to these tonnages | FR- <br> FU04+SP- <br> FU04/Q <br> EW-FU04 <br> quarterly <br> tonnages | EW- <br> FU05/Q | EW- <br> FU06/Q | Total <br> LDs <br> raised <br> to EW <br> species <br> split | FR-FU03 <br> + EW- <br> FU03 <br> quarterly <br> tonnages <br> 95\% <br> allocated <br> to <br> piscato- <br> rius - all <br> countries <br> quarterly <br> LDs <br> raised to <br> these <br> tonnages |  | FR-FU04/Q | FR- <br> FU05/ Q | FR-FU08/Q |  | FR-FU09/Q | FR- <br> FU10/ Q | FR-FU14/Q | Total LDs raised to FR species split | SP- <br> FU04/ Q | SP- <br> FU14/ <br> Q |
| 1997 | IRL-FU04/Q |  | EW- <br> FU06/Q/Q <br> BE <br> quarterly <br> tonnages | FR-FU03 + EW-FU03 quarterly tonnages 95\% allocated to piscatorius all countries quarterly LDs raised to these tonnages | FR- <br> FU04+SP- <br> FU04/Q <br> EW-FU04 <br> quarterly <br> tonnages | EW- <br> FU05/Q | EW- <br> FU06/Q | Total <br> LDs <br> raised <br> to EW <br> species <br> split | FR-FU03 <br> + EW- <br> FU03 <br> quarterly <br> tonnages <br> 95\% <br> allocated <br> to <br> piscato- <br> rius - all <br> countries <br> quarterly <br> LDs <br> raised to <br> these <br> tonnages |  | FR-FU04/Q | FRFU05/ Q | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | Total LDs raised to FR species split | SP- <br> FU04/ <br> Q | SP- <br> FU14/ <br> Q |
| 1998 | IRL-FU04/Q | FR- <br> FU05/Q+EW- <br> FU05, IR-FU05 <br> quarterly <br> tonnages | EW- <br> FU06/Q/Q <br> BE <br> quarterly <br> tonnages | FR- <br> FU03/Q, EW-FU03 quarterly tonnage | FR- <br> FU04+SP- <br> FU04/Q <br> EW-FU04 <br> quarterly <br> tonnages | EW- <br> FU05/Q | EW- <br> FU06/Q | Total <br> LDs raised to EW species split | FR- <br> FU03/Q |  | FR-FU04/Q | FRFU05/ Q | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | Total LDs raised to EW species split | SP- <br> FU04/ <br> Q | SP- <br> FU14/ <br> Q |


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| Year | IR-FU04 | IR-FU05 | BE-FU06 | EW-FU03 | EW-FU04 | $\begin{aligned} & \text { EW- } \\ & \text { FU05 } \end{aligned}$ | EW- FU06 | EWOther | FR- <br> FU03 + <br> FU13 | FR-FU03 | FR-FU04 | FRFU05 | FR-FU08 | FR-FU13 | FR-FU09 | FRFU10 | FR-FU14 | FRunallocated | sp. <br> FU04 | sp. <br> FU14 |
| 1999 | Total LDs and species ratio used | Total LDs and species ratio used | Total LDs and species ratio used | FU05+FU06 <br> LDs raised <br> to FUO3 <br> tonnage, <br> EW 2000 <br> FU03 <br> species <br> ratio | FU05+FU06 <br> LDs raised <br> to FUO4 <br> tonnage, <br> EW 2000 <br> FU04 <br> species <br> ratio | EW- <br> FU05/Q | EW- <br> FU06/Q | Total <br> LDs <br> raised <br> to EW <br> species <br> split | FRFU03/Q |  | FR-FU04/Q | FRFU05/ Q | FR-Fu08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | - | sp. FU04/ Q | SP- <br> FU14/ <br> Q |
| 2000 | Total LDs and species ratio used | Total LDs and species ratio used | and species ratio used | FU05+FU06 <br> LDs raised tonnage, <br> EW 2000 FU03 <br> species ratio | FU05+FU06 <br> LDs raised <br> to FUO4 <br> tonnage, <br> EW 2000 <br> FU04 <br> species <br> ratio | EWFU05/Q | EWFU06/Q | Total <br> LDs <br> raised <br> to EW <br> species <br> split | FRFU03/Q |  | FR-FU04/Q | FR- <br> FU05/ <br> Q | FR-FU08/Q |  | FR-FU09/Q | FR- <br> FU10/ <br> Q | FR-FU14/Q | - | SP- <br> FU04/ <br> Q | SP. <br> FU14/ <br> Q |
| 2001 | Total LDs and species ratio used | Total LDs and species ratio used | Total LDs and species ratio used | FU05+FU06 <br> LDs raised <br> to FUO3 <br> tonnage, <br> EW 2000 <br> FU03 <br> species <br> ratio | FU05+FU06 <br> LDs raised <br> to FUO4 <br> tonnage, <br> EW 2000 <br> species <br> ratio | EW- <br> FU05/Q | EW- <br> FU06/Q | Total <br> LDs <br> raised <br> to EW <br> species <br> split | FRFU03/Q |  | FR-FU04/Q | FR- <br> FU05/ <br> Q | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | - | SPFU04/ Q | SP- <br> FU14/ <br> Q |
| 2002 | Total LDs and species ratio used | Total LDs and species ratio used | Total LD and species ratio used | FU05+FU06 <br> LDs raised <br> to FUO3 <br> tonnage, <br> EW 2000 <br> FU03 <br> species <br> ratio | FU05+FU06 LDs raised to EW-FU04 quarterly tonnages per species | EW- <br> FU05/Q | EW- <br> FU06/Q | Total LDs raised to EW species split | FRFU03/Q |  | FR-FU04/Q | $\begin{aligned} & \text { FR- } \\ & \text { FU05/ } \\ & \text { Q } \end{aligned}$ | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | - | SPFU04/ Q | SP- <br> FU14/ <br> Q |


| Country/Fu |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Year | IR-FU04 | IR-FU05 | Be-fu06 | EW-FU03 | EW-FU04 | EW- <br> FU05 | EW- <br> FU06 | EW- <br> OTHER | $\begin{aligned} & \text { FR- } \\ & \text { FU03 + } \\ & \text { FU13 } \end{aligned}$ | fr-fuo3 | FR-FU04 | FR- <br> FU05 | FR-FU08 | FR-FU13 | FR-FU09 | FR- <br> FU10 | FR-FU14 | FRUNALLOCATED | SP- <br> FU04 | SP- <br> FU14 |
| 2003 | Total LDs and species ratio used | Total LDs and species ratio used | Total LDs <br> and <br> species <br> ratio used | FU05+FU06 <br> LDs raised <br> to FU03 <br> tonnage, <br> EW 2000 <br> FU03 <br> species <br> ratio | FU05+FU06 LDs raised to EW-FU04 Q2 species split used for tonnage | EW- <br> FU05/Q | EW- <br> FU06/Q | Total <br> LDs raised to EW species split | FRFU03/Q |  | FR-FU04/Q | FRFU05/ Q | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | - | SP- <br> FU04/ <br> Q | SP- <br> FU14/ <br> Q |
| 2004 | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | Total LDs and species ratio used | FU05+FU06 <br> LDs raised <br> to FUO3 <br> tonnage, <br> EW 2000 <br> FU03 <br> species <br> ratio | FU05+FU06 <br> LDs raised to EW-FU04 quarterly tonnages per species | EW- <br> FU05/Q | EWFU06/Q | Total <br> LDs raised to EW species split | FRFU03/Q |  | FR-FU04/Q | FRFU05/ Q | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | . | SP- <br> FU04/ <br> Q | SP- <br> FU14/ <br> Q |
| 2005 | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | Total LDs and species ratio used | FU05+FU06 <br> LDs raised to FUO3 tonnage100 \% L. piscatorius assumed | FU05+FU06 <br> LDs raised to EW-FU04 2004 <br> species ratio used except for Q2 (species ratio provided) | EWFU05/Q | EWFU06/Q | Total LDs raised to EW species split | FRFU03/Q |  | FR-FU04/Q | $\begin{aligned} & \text { FR- } \\ & \text { FU05/ } \\ & \text { Q } \end{aligned}$ | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | - | SPFU04/ Q | SP- <br> FU14/ <br> Q |
| 2006 | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | Total LDs <br> and <br> species <br> ratio used | FU05+FU06 <br> LDs raised <br> to FUO3 <br> ton- <br> nage100 \% <br> L. piscatori- <br> us assumed | FU05+FU06 <br> LDs raised to EW-FU04 2004 <br> species ratio used except for Q2 (species ratio provided) | EW- <br> FU05/Q | EW- <br> FU06/Q | Total <br> LDs raised to EW species split | FRFU03/Q |  | FR-FU04/Q | FRFU05/ Q | FR-FU08/Q |  | FR-FU09/Q | FR- <br> FU10/ Q | FR-FU14/Q | - | SP- <br> FU04/ <br> Q | SP- <br> FU14/ <br> Q |


| Country/Fu |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Year | IR-FU04 | IR-FU05 | BE-FU06 | EW-FU03 | EW-FU04 | EW- <br> FU05 | EW- <br> FU06 | EWOther | FRFU03 + FU13 | FR-FU03 | FR-FU04 | FRFU05 | FR-FU08 | FR-FU13 | FR-FU09 | FR- <br> FU10 | FR-FU14 | FRUNALLOCATED | SP- <br> FU04 | SP- <br> FU14 |
| 2007 | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | Total LDs and species ratio used | FU05+FU06 <br> LDs raised to FU03 tonnage100 \% L. piscatorius assumed | FU05+FU06 LDs raised to EW-FU04 2004 species ratio used | EW- <br> FU05/Q | EWFU06/Q | Total LDs raised to EW species split | FRFU03/Q |  | FR-FU04/Q | FRFU05/ Q | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | - | SP- <br> FU04/ Q | SP- <br> FU14/ <br> Q |
| 2008 | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | Total LDs and species ratio used | FU05+FU06 <br> LDs raised to FUO3 tonnage100 \% L. piscatorius assumed | FU05+FU06 <br> LDs raised to EW-FU04 2004 <br> species ratio used | EW- <br> FU05/Q | EWFU06/Q | Total <br> LDs raised to EW species split | FR- <br> FU03/Q |  | FR-FU04/Q | FR- <br> FU05/ <br> Q | FR-FU08/Q |  | FR-FU09/Q | FRFU10/ Q | FR-FU14/Q | - | SP- <br> FU04/ <br> Q | SP- <br> FU14/ <br> Q |
| 2009 | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | Total LDs and species ratio used | FU05+FU06 <br> LDs raised <br> to FUO3 <br> ton- <br> nage100 \% <br> L. piscato- <br> rius <br> assumed | FU05+FU06 LDs raised to EW-FU04 2004 species ratio used | EW- <br> FU05/Q | EWFU06/Q | Total <br> LDs raised to EW species split | - | $\begin{aligned} & \text { FR- } \\ & \text { GNS_DEF_ } \\ & \text { 7/Q } \end{aligned}$ | $\begin{aligned} & \text { FR- } \\ & \text { OTB_DEF_7/Q } \end{aligned}$ | - | $\begin{aligned} & \text { FR- } \\ & \text { OTB_CRU_7/Q } \end{aligned}$ | FRGNS_DEF_8/Q | FROTB_CRU_8/Q | - | $\begin{aligned} & \text { FR- } \\ & \text { GNS_DEF_8/Q } \end{aligned}$ | - | SP- <br> FU04/ Q | SP- <br> FU14/ <br> Q |
| 2010 | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | $\begin{aligned} & \text { IRL- } \\ & \text { FU04+FU05/ } \\ & \text { Q } \end{aligned}$ | Total LDs <br> and <br> species ratio used | FU05+FU06 <br> LDs raised <br> to FUO3 <br> ton- <br> nage100 \% <br> L. piscato- <br> rius <br> assumed | FU05+FU06 <br> LDs raised to EW-FUO4 2004 <br> species ratio used | EW- <br> FU05/Q | EWFU06/Q | Total <br> LDs raised to EW species split | - | $\begin{aligned} & \text { FR- } \\ & \text { GNS_DEF_ } \\ & 7 / Q \end{aligned}$ | FROTB_DEF_7/Q | - | FROTB_CRU_7/Q | FRGNS_DEF_8/Q | FROTB_CRU_8/Q | - | $\begin{aligned} & \text { FR- } \\ & \text { GNS_DEF_8/Q } \end{aligned}$ | - | SP- <br> FU04/ Q | SP- <br> FU14/ <br> Q |

Discards: preliminary information is available but not used due to uncertainties in adequacy of raising methodologies used.

## B.2. Biological

In 2007, WGHMM rejected the XSA age based assessments of both species because of data quality (increased discards not incorporated) and ageing problems clearly identified. Therefore there is no age based data used to assess the stocks. Only length distributions of landings and survey indices are used.

## B.3. Surveys

For the first three surveys presented, a full description can be found on the ICES DATRAS website: http://datras.ices.dk/Home/Descriptions.aspx.

## The French FR-EVHOE survey

This survey covers the largest proportion of the area of stock distribution. It started in 1997.


Map of Survey Stations completed by the EVHOE Survey in 2008.

## The Spanish Porcupine Groundfish Survey (SP-PGFS)

This survey was initiated in 2001 and covers the Porcupine Bank.


Map of area covered by the Porcupine Groundfish Survey.

## The Irish Groundfish Survey (IR-IGFS)

This survey was initiated in 2003 and covers areas around Ireland.


Map of Survey Stations completed by the Irish Groundfish Survey in 2008. Valid = red circles; Invalid = crosses; Intercalibration = blue squares; intercalibration and additional stations not valid for IBTS survey indices $=$ green triangles.

## The English Fisheries Science Partnership survey

This survey traverses Areas VIIe-h and started in 2003.


Map of Survey Stations completed by the EW-FSP Survey in 2011.

A full description of the survey can be found in Section 2.2.12 of the WGHMM 2011 report.

## B.4. Commercial cpue

Effort and lpue data are available for four Spanish trawl fleets (SP-VIGO7, SPCORUTR7, SP-BAKON7 and SP_BAKON8). The French data for the FR-FU04 and FR-FU14 are also provided. Finally UK provides effort and lpue data for EW-FU06.

## B.5. Other relevant data

## C. Assessment: data and method

The assessments of the two species (WG 2011) are based on the analysis of lpues (SPVIGO7, SP-CORUTR7, SP-BAKON7, SP-BAKON8, FR-FU04, FR-FU14 and EWFU06), surveys indices (FR-EVHOE since 1997, SP-PGFS since 2001, IR-IGFS since 2003 and the EW-FSP since 2003 and length distributions from landings and surveys.

## D. Short-term projection

## E. Medium-term projections

## F. Long-term projections

## G. Biological reference points

There are precautionary reference points defined for these stocks. However, considering the underestimation of growth that is now obvious for both species, the reference points from earlier assessments are no longer valid. Reference points will have to be redefined based on an approved analytical assessment.

## H. Other issues

## H.1. Historic development

The analytical assessment was rejected in 2007 and advice was based on analysis of lpues, length frequencies of landings and survey data. In 2008, no new advice was delivered as the information available was considered too weak to provide any advice. The advice given for 2008 was also applicable until 2011. The stocks were reviewed in 2012 by the WKFLAT 2012 not founding an acceptable method for providing analytical assessment and recommended to continue using the analysis of trends for providing non analytical assessment.

## I. References

Afonso-Dias, I.P. and J.R.G. Hislop. 1996. The reproduction of anglerfish Lophius piscatorius Linnaeus from the northwest coast of Scotland. Journal of Fish Biology 49: 18-39.

Duarte, R., Bruno, I., Quincoces, I., Fariña, A.C. and Landa, J. 2004. Morphometric and meristic study of white and black anglerfish (Lophius piscatorius and L. budegassa) from the southwest of Ireland to the south-western Mediterranean. ICES 2004 Annual Science Conference, Vigo (Spain). ICES CM 2004/EE: 22.

Fariña, A.C., Duarte, R., Landa, J., Quincoces, I. and Sánchez, J.A. 2004. Multiple stock identification approaches of anglerfish (Lophius piscatorius and L. budegassa) in western and southern European waters. ICES 2004 Annual Science Conference, Vigo (Spain). ICES CM 2004/EE: 25.

Gessan. 2002. Genetic characterisation and stock structure of the two species of anglerfish (Lophius piscatorius and L. budegassa) of the North Atlantic. Ref.: EU DG XIV Study Contract: 99/013.

Hislop, J. R. G., Gallego, A., Heath, M. R., Kennedy, F.M., Reeves, S.A. and Wright., P.J. 2001. A synthesis of the early life history of the anglerfish, Lophius piscatorius (Linnaeus, 1758) in northern British waters. ICES Journal of Marine Science 58: 70-86.

Quincoces, I., Santurtún, M. and Lucio, P. 1998. Biological aspects of white anglerfish (Lophius piscatorius) in the Bay of Biscay (ICES Division VIIIa, b,d), in 1996-1997. ICES Doc. CM 1998/O:48: 29 pp.

Quincoces, I. 2002. Crecimiento y reproducción de las especies Lophius budegassa Spinola1807, y Lophius piscatorius Linneo 1758, del Golfo de Vizcaya. PhD Thesis. Basque Country University. 276pp.

## Annex E Stock Annex Megrim (Lepidorhombus whiffiagonis) in Divisions VIIb-k and VIIIa,b,d

Quality Handbook
Stock Annex E
Stock specific documentation of standard assessment procedures used by ICES.

| Stock | Megrim (Lepidorhombus whiffiagonis) in Divisions <br> VIIb-k and VIIIa,b,d |
| :--- | :--- |
| Working Group | WGHMM (Working Group on Hake Monk and Me <br> grim from the Southern Waters) |
| Date | Updated March 2012: WKFLAT 2012 |
| Revised by | Marina Santurtún |

## A. General

## A. 1. Stock definition

Since the end of the 1970s ICES has assumed three different stocks for assessment and management purposes: megrim in ICES Subarea VI, megrim in Divisions VIIb-k and VIIIa,b,d and megrim in Divisions VIIIc and IXa. The stock under this Annex is called northern Megrim and defined as megrim in Divisions VIIb-k and VIIIa,b,d.

## A.2. Fishery

Megrim in the Celtic Sea, west of Ireland, and in the Bay of Biscay are caught predominantly by Spanish and French vessels, which together have reported more than $65 \%$ of the total landings, and by Irish and UK demersal trawlers.

French benthic trawlers operating in the Celtic Sea and targeting benthic and demersal species catch megrim as a bycatch.

Spanish fleets catch megrim targeting them and in mixed fisheries for hake, anglerfish, Nephrops and others. Otter trawlers account for the majority of Spanish landings from Subarea VII, the remainder, very low quantities, being taken by netters prosecuting a mixed fishery for anglerfish, hake and megrim on the shelf edge around the 200 m contour to the south and west of Ireland. The catches made by otter trawlers from the port of Vigo comprise around $50 \%$ of the total catches.

Most UK landings of megrim are made by beam trawlers fishing in ICES Divisions VIIe,f,g,h.

Irish megrim landings are largely made by multi-purpose vessels fishing in Divisions VIIb,c,g for gadoids as well as plaice, sole and anglerfish.

|  |  | \% <br> landings <br> (based on <br> 2011 <br> landings <br> data) |  |
| :--- | :--- | :--- | :--- |
| Countries | ICES area | Fisheries |  |

## A.3. Ecosystem aspects

There are two megrim species in the Northeastern Atlantic: megrim (Lepidorhombus whiffiagonis) and four spot megrim (Lepidorhombus boscii).
Megrim (L.whiffiagonis, Walbaum, 1792) is a pleuronectiform fish distributed from the Faroe Islands to Mauritania (from $70^{\circ} \mathrm{N}$ to $26^{\circ} \mathrm{N}$ ) and the Mediterranean Sea, at depths ranging from 50 to 800 metres but more precisely around 100-300 metres (Aubin-Ottenheimer, 1986).
Four spot megrim (L. boscii, Risso 1810) is distributed from the Faroe Islands $\left(63^{\circ} \mathrm{N}\right)$ to Cape Bojador and all around the Mediterranean Sea. It is found between 150-650 m, but mostly between 200-600 m.
Although, there does not appear to be evidence of multiple populations in the Northeast Atlantic, since the end of the 1970s ICES has assumed three different stocks for assessment and management purposes: megrim in Subarea VI, megrim in Divisions VIIb,c,e-k and VIIIa,b,d and megrim in Divisions VIIIc and IXa.

Spawning period of these species goes from January to March. Megrim spawning peak occurs in February (VIIIa,b,d) and March (VII) along the shelf edge. Males reach the first maturity at a lower length and age than females. For both sexes combined, fifty percent of the individuals mature at about 20 cm and about 2.5 year old (BIOSDEF, 1998; Santurtún et al., 2000). Their eggs are spherical, pelagic, with a furrow (stria) in the internal part of the membrane and with a fat globule.

Megrim is a demersal species of small-medium size with a maximum size about 60 cm . It is believed that it has a medium-large lifespan, with a maximum age of about 14-15 years. It lives mainly in muddy bottoms, showing a gradual expansion in bathymetric distribution throughout their lifetimes, where mature males and juve-
niles tend to occupy deep waters, immature females shallower waters and, during the very short period when females are mature, the dynamics remain unclear.

The Bay of Biscay and Iberian shelf are considered as a single biogeographic ecotone (a zone of transition between two different ecosystems) where southern species at the northern edge of their range meet northern species at the southern edge of their range as well as for some other Mediterranean species. Since species at the edge of their range may react faster to climate changes, this area is of particular interest in accounting for effects of climate change scenarios, for instance, in the foodweb models (BECAUSE, 2004).

Megrim belongs to a very extended and diverse community of commercial species and it is caught in mixed fisheries by different gears and in different sea areas. Some of the commercial species that exist in the same ecosystem are hake and anglerfish, however many other species are also found. From the northern to southern areas of the extent of the stock these species include: Octopus, Rajidae, Ommastrephidae, Nephrops norvegicus, Phycis blennoides, Molva molva, Pollachius virens, Trisopterus spp (mainly Trisopterus luscus), Trachurus spp, Sepia officinalis, Loligidae, Micromesistius poutassou, Merlangius merlangus, Scyliorhynus canicula and Pollachius pollachius.

Demersal fish prey on megrim. Megrims are very voracious predators. Prey species include flatfish, sprat, sandeels, dragonets, gobies, haddock, whiting, pout and several squid species.

Adult megrim feed on small bottom dwelling fish, cephalopods and small benthic crustaceans; juvenile megrim feed on small fish and detritivore crustaceans inhabiting deep-lying muddy bottoms (Rodriguez-Marín and Olaso, 1993).

It is believed that megrim movements are more aggregation and disaggregation movements in the same area instead of highly migratory movements between areas (Perez, pers. comm.).

Although a comprehensive study on the role of megrim in the ecosystem of the complete sea area distribution has not been carried out, some general studies are available.

Fisheries modify ecosystems through more impacts on the target resource itself, the species associated to or dependent on it (predators or preys), on the tropic relationships within the ecosystem in which the fishery operates, and on the habitat.

At present, both the multi species aspect of the fishery and the ecological factors or environmental conditions affecting megrim population dynamics are not taken into account in assessment and management. This is due to the lack of knowledge of these issues.

## B. Data

Data are supplied from databases maintained by national Government Departments and research institutions. The figures used in assessment are considered as the best available data at the Working Group time of the year. From year to year, and before the Working Group, small revisions of data could occur. In that case, revised data are explained and incorporated into the historical dataseries for assessment.

Data are supplied on electronic files to a stock coordinator nominated by the ICES Hake, Monk and Megrim (formerly Southern Self Demersal Stocks) Working Group, who compiles the international landings, discards and catch-at-age data, and maintains the time-series of such data with the amendments proposed by countries.

## B.1. Commercial catch

Landings data are supplied from databases maintained by national Government Departments and research institutions. Countries providing landing data by quarter and ICES division are Spain, France, Ireland, United Kingdom and Belgium.

## B.2. Discard data

In many fisheries, discards constitute a major contribution to fishing mortality in younger ages of commercial species. However, relatively few assessments in ICES stock working groups take discards into consideration. This happens mostly due to the long time-series needed (not available for all the fleets involved in the exploitation of most stocks) but also to the large amount of research effort needed to obtain this kind of information (Alverson et al., 1994; Kulka, 1999). The knowledge of discards and their use in stock assessment may also contribute, in cooperation with the industry, to refine fishing and management strategies (Kulka, 1999).

Spain started sampling discards on board commercial vessels in 1988, more specifically the Spanish trawl fleet operating in Subareas VI and VII was firstly target. During 1994, discard sampling was undertaken for other fleets (longliner (EC Project: Pem/93/005)). Sampling discards continued during 1999, 2000 for IV, VII, VIII and IX (EC Project: 98/095) and in 2001, partly just for cephalopods and during the first and last quarter of the year (Bellido et al., 2003; Santurtun et al., 2004). Since 2002 and under the National Sampling Programs, Spain continues sampling discards on board commercial fleets.

Until 2003, the standard procedure used for calculation of the Spanish discards estimators was based on a haul basis as described by Trenkel (2001). However, although these procedures were applied, there was not an estimate of the error and variance in every step of the analysis. Errors were only estimated on a haul basis.

From 2003 onwards and following the recommendation of the Workshop on Discard Sampling Methodology and Raising Procedures held in Charlottenlund (Denmark) in 2003 (Anon, 2003), general guidelines on appropriate sampling strategies and methodologies were described and then, the primary sampling unit was defined as the fishing trip instead of haul.

Discard data available by country and the procedure to derivate them are summarised in Table B.2.1.

From 2000 to 2001 a reduction in the minimum legal size (MLS), from 25 to 20 cm took place.
Since using the French discards from the 1991 survey to obtain estimates for 1999 and subsequent years was considered unreliable, only the Spanish data were used for these years, applied only to the Spanish fleets. This has led to an artificial decrease in the amount of total discards, since no estimates for French fleets were available.

The lack of discards data was considered the main problem with megrim assessment. This fact resulted in an underestimation of the international catch matrix occurs as some main countries (mostly France) involved in the fishery have not provide discard data. The lack of consistency of the catch series, which could cause great bias in assessment, was also a result of only one country (Spain) providing discard data since 1999.

During the WKFLAT (2012): In 2012, Spain, United Kingdom (England and Wales) and Ireland provide discard data since 2000. Still France does not provide these data,
which led to an artificial decrease in the amount of total discards. Discard data deficiencies were partly overcome as United Kingdom (England and Wales) provided discard raised data from 2000 to 2010. Irish discard data were revised and updated and a new dataseries was provided since 1995. Spain provided some minor revised values of discards. France did not provided discard data since 1999, as data appear to be very uncertain in relation to sampling level affecting their representatively.

Table B.2.1. Megrim (L.whiffiagonis) in VIIb-k and VIIIa,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 | - | SP04 | IR | UK |
| 2005 | - | SP05 | IR | UK |
| 2006 | - | SP06 | IR | UK |
| 2007 | - | SP07 | IR | UK |
| 2008 | - | SP08 | IR | UK |
| 2009 | - | SP09 | IR | UK |
| 2009 | - | SP10 | IR | UK |

- In bold: years where discards sampling programs provided information.
- In (): years for which the length distribution of discards has been derived.


## B.3. Biological

Quarterly/annually length/age composition data are supplied from databases maintained by national Government Departments and research institutions. These figures are used as the best available data to carry out the assessment.

France has provided quarterly length distribution by fishery unit and by sex since 1984. For 2002, 2003, 2004 and 2006 French data (length distributions, catch-at-age by FU and ALKs) were not available for the assessment. In 2005 and 2006, length distri-
butions, catch-at-age data by quarter and sex were available. In 2007 and 2008, annual length distributions by sexes were provided. For 2010, no French data were provided to the group. In 2012 (ICES, 2012) France provided revised ALKs and consequently completed number and weights-at-age since 1999.
Annual length compositions of landings are available by country and fishery unit, for the period 1984-1990 by sex. Since 1991, annual length composition has been available for sexes combined for most countries except for France. Since 1999, the length compositions have been available on a quarterly or semestral basis. For Spain, data are available for sexes combined, except in 1993, when data were presented for separate sexes and on an annual basis. As in previous years, derivations were used to provide length compositions where no data other than weights of landings were available.

No ALKs were available for the period 1984-1986, and age compositions for these years were derived from a combined-sex ALK based on age readings from 1987 to 1990.

Quarterly ALKs for separate sexes were available for UK (E\&W). Combined Annual ALKs were applied to their length distributions. Annual age composition of discards and semestral for landings per fleet, based on semestral ALKs for both sexes combined, were available and applied from Spain in Subarea VII and in Divisions VIIIa,b,d. Annual age composition of discards was available based on annual ALKs for both sexes combined were available and applied to Irish and UK (England and Wales) discards. Quarterly age compositions for sexes combined were available for Irish catches for Divisions VIIb, c,e-k.

The following table gives the source of length frequencies and ages for Northern Megrim:

|  | France |  | Ireland |  | Spain |  | UK |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Length distribution | ALK | Length distribution | ALK | Length distribution | ALK | Length distribution | ALK |
| $\begin{aligned} & 1984- \\ & 1990 \end{aligned}$ | Quarter, by sex | (1984- <br> 1986) <br> Synthetic <br> ALKs <br> using age <br> reading <br> from <br> 1987- <br> 1990 | Annual, by sex | (1984- <br> 1986) <br> Synthetic <br> ALKs <br> using age <br> reading <br> from <br> 1987- <br> 1990 | Annual, by sex | (1984- <br> 1986) <br> Synthetic <br> ALKs <br> using age <br> reading <br> from <br> 1987-1990 | Annual by sex | (1984- <br> 1986) <br> Synthetic <br> ALKs <br> using age <br> reading <br> from <br> 1987- <br> 1990 |
| 1991 | Quarter, by sex | Quarter, combined | Annual, combined | Quarter, by sexes | Annual, combined | Semestral, combined | Annual, combined | Quarter, combined |
| 1992 | Quarter, by sex | Quarter, combined | Annual, combined | Quarter, by sexes | Annual, combined | Semestral, combined | Annual, combined | Quarter, combined |
| 1993 | Quarter, by sex | Quarter, combined | Annual, combined | Quarter, by sexes | Annual, by sexes | Semestral, combined | Annual, combined | Quarter, combined |
| 1994 | Quarter, by sex | Quarter, combined | Annual, combined | Quarter, by sexes | Annual, combined | Semestral, combined | Annual, combined | Quarter, combined |
| 1995 | Quarter, by sex | Quarter, combined | Annual, combined | Quarter, by sexes | Annual, combined | Semestral, combined | Annual, combined | Quarter, combined |
| 1996 | Quarter, by sex | Quarter, combined | Annual, combined | Quarter, by sexes | Annual, combined | Semestral, combined | Annual, combined | Quarter, combined |


|  | France |  | Ireland |  | Spain |  | UK |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1997 | Quarter, by sex | Quarter, combined | Annual, combined | Quarter, by sexes | Annual, combined | Semestral, combined | Annual, combined | Quarter, combined |
| 1998 | Quarter, by sex | Quarter, combined | Annual, combined | Quarter, by sexes | Annual, combined | Semestral, combined | Annual, combined | Quarter, combined |
| 1999 | Quarter, by sex | Quarter, combined | Quarter, combined | Quarter, combined | Semestral, combined | Semestral, combined | Quarter, combined | Quarter, by sexes |
| 2000 | Quarter, by sex | Quarter, combined | Quarter, combined | Quarter, combined | Semestral, combined | Semestral, combined | Quarter, combined | Quarter, by sexes |
| 2001 | Quarter, by sex | Quarter, combined | Quarter, combined | Quarter, combined | Semestral, combined | Semestral, combined | Quarter, combined | Quarter, by sexes |
| 2002 | NA | NA | Quarter, combined | Quarter, combined | Semestral, combined | Semestral, combined | Quarter, combined | Quarter, by sexes |
| 2003 | NA | NA | Quarter, combined | Quarter, combined | Semestral, combined | Semestral, combined | Quarter, combined | Quarter, by sexes |
| 2004 | NA | NA | Quarter, combined | Quarter, combined | Semestral, combined | Semestral, combined | Quarter, combined | Quarter, by sexes |
| 2005 | Quarter, by sex | Quarter, by sex | Quarter, combined | Quarter, combined | Semestral, combined | Semestral, combined | Quarter, combined | Quarter, by sexes |
| 2006 | Quarter, by sex | Quarter, by sex | Quarter, combined | Quarter, combined | Semestral, combined | Semestral, combined | Quarter, combined | Quarter, by sexes |
| 2007 | Annual, by sex | NA | Quarter, combined | Quarter, combined | Semestral, combined | Semestral, combined | Quarter, combined | Quarter, by sexes |
| 2008 | Annual, by sex | NA | Quarter, combined | Quarter, combined | Semestral, combined | Semestral, combined | Quarter, combined | Quarter, by sexes |
| 2009 | Quarter, by sex | Quarter, by sex | Quarter, combined | Quarter, combined | Semestral, combined | Semestral, combined | Quarter, combined | Quarter, by sexes |
| 2010 | Quarter, by sex | Quarter, by sex | Quarter, combined | Quarter, combined | Semestral, combined | Semestral, combined | Quarter, combined | Quarter, by sexes |

A fixed natural mortality of 0.2 is used for all age groups and all years both in the assessment and the forecast.

The maturity ogive, obtained by macroscopy, for sexes combined calculated for Subarea VII (BIOSDEF, 1998), has been applied every year. It is as follows:

| Age | $\mathbf{0}$ | $\mathbf{1}$ | $\mathbf{2}$ | $\mathbf{3}$ | $\mathbf{4}$ | $\mathbf{5}$ | $\mathbf{6 +}$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Maturity | 0.00 | 0.04 | 0.21 | 0.60 | 0.90 | 0.98 | 1.00 |

As in previous years, SSB is computed at the start of each year, and the proportions of M and F before spawning were set to zero.

## B. 4 Surveys

UK survey Deep Waters (UK-WCGFS-D, Depth >180 m) and UK Survey Shallow Waters (UK-WCGFS-S, Depth <180 m) indices for the period 1987-2004 and French EVHOE survey (EVHOE-WIBTS-Q4) results for the period 1997-present are available.

An abundance index was provided for the Spanish Porcupine Ground Fish Survey from 2001 to 2010. 2009 data have been incorporated in this update assessment.

Irish Ground Fish Survey (IGFS-WIBTS-Q4) is also from 2003 to present.

Surveys available for the assessment:

| Type | Name | Year range | Age range | Used in the <br> assessment |
| :--- | :--- | :--- | :---: | :--- |
| UK Survey Deep <br> Water | UK-WCGFS-D | $1987-2004$ | $1-10+$ | No |
| UK Survey <br> Shallow Water | UK-WCGFS-S | $1987-2004$ | $1-10+$ | No |
| French EVHOE <br> Survey | EVHOE-WIBTS- <br> Q4 | $1997-$ <br> present | $1-9$ | Yes |
| Spanish <br> Porcupine <br> Ground Fish <br> Survey | SpPGFS-WBIT- | $2001-$ <br> present | $0-10+$ | Yes |
| Irish Ground Fish <br> Survey | IGFS-WIBTS-Q4 | $2003-$ | present | $0-10+$ |

It must be noted that area covered by the three current surveys does not overlap, just the northern component of EVHOE-WIBTS-Q4 and the southern coverage of IGFS-WIBTS-Q4. (Map B.3).

## B. 5 Commercial cpue

Commercial series of fleet-disaggregated catch-at-age and associated effort data were available for three Spanish fleets in Subarea VII (A Coruña (SP-CORUTR7) and Cantábrico (SP-CANTAB7) from 1986 to 2009, and Vigo (SP-VIGOTR7) 1984-2009. From 1985 to 2008, lpue s from four French trawling fleets: FR-FU04, Benthic Bay of Biscay, Gadoids Western Approaches and Nephrops Western Approaches are available.

In 2012, during the WKFLAT (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 TBB with mesh sizes of $80-89 \mathrm{~mm}$, larger mesh sizes are disused since 2006. No update for the French lpues series has been provided to the WKFLAT 2012 for 2009 and 2010 as effort deployed by these fleets was considered, at the time of the analysis, unreliable.

## B. 6 Other relevant data

The group reiterates the importance of incorporating estimates of discards from all main countries involved in the Northern Megrim fishery, specifically France, to obtain consistent data along the whole dataseries and also to detect possible recruitment processes that are not completely registered in the catch-at-age matrix and lpue.

## C. Assessment: data and methods

In 2012, and during the WKFLAT (ICES, 2012), a Bayesian statistical catch-at-age model (described below in 'Model used in Benchmark 2012') showed promising results and seemed to be able to deal with the heterogeneity in the Megrim in Divisions VIIb-k and VIIIa,b,d data.. The model fit to the data was adequate. However, a lack of confidence in the data used made it impossible to accept the absolute values of model results. The lack of confidence in the data also makes it impossible to believe the results of any other model that could be applied to these data. Thus, no precise estimates of development of the stock population structure and SSB are available. The basis for the assessment should be then,

- The analysis of trends of Survey and Commercial Indices.
- For a more detailed analysis, which could be masked by the pooling ages in the above indices, qualitative results of the statistical catch-at-age Bayesian model will be scrutinised.
- A revision of the abundance of the ages of each of the fleets will be analysing by means of grouping ages (Group i: ages $1+2$; Group ii: ages 3,4 , and 5 and Group iii: ages $6,78,9$ and $10+$ ). The objective is to discern for any possible change in abundance in young, intermediate and old ages along the dataseries.


## Summary of the data used for the Benchmark 2012

Catch, landings and discard numbers-at-age data that were used to carry out the assessment:
i) From 1984 to 1990, international catches-at-age.
ii ) From 1990 to present, total international landings-at-age (separately from discards).
iii ) From 1990 to 1998 total international discards at age (separately from landings).

Discards in this period were originally available just for two countries: France and Spain. Total international discards from 1990 to 1998 were calculated raising the Spanish and French discards based on the international landings. However, the discard raising method used (which came from many years ago) has not been exactly clarified.
iv ) For 1999, only Spanish and Irish discards-at-age are available. From 2000 onwards, discards-at-age are available for Ireland, Spain and UK. There was no information for France, Belgium and Northern Ireland. The main part of the missing discards is supposed to correspond to France, as the contribution of the other two nations to the stock landings is very small. France did not provide discards estimates due to the low sampling levels and major problems in the raising procedure.

In summary, the stock catch-at-age matrix shows inconsistencies in the data available for each identified different period: 1984-1989; 1990-1998 and 1999-2010.

The table below summarizes the information of the tuning fleets used.


## Model used in Benchmark 2012

The model explored during the benchmark is an adaptation of one developed originally for the southern hake stock, published in Fernández et al. (2010). It is a statistical catch-at-age model that allows incorporating data at different levels of aggregation in different years and also allows for missing discards data by certain fleets and/or in some years. These are all relevant features in the megrim stock. The model is fitted in a Bayesian context, using the freely available software WinBUGS (Lunn et al., 2009).

## Population dynamics

$N(y, a)$ denotes the number of fish of age $a$ at the beginning of year $y$. In this general model description, the assessment years are labelled as $y=1, \ldots, Y$ and ages as $a=1, \ldots, A+$, where $A-1$ is the last true age and the $A+$ group consists of fish aged $A$ or older. For the megrim stock, the first assessment year is 1984 and the age plus group corresponds to 10+.

Population dynamics follow the usual equations for closed populations. For $y \geq 2$ :

$$
\begin{align*}
& N(y, a)=N(y-1, a-1) \exp [-Z(y-1, a-1)], \text { if } 2 \leq a \leq A-1  \tag{1}\\
& N(y, A+)=N(y-1, A-1) \exp [-Z(y-1, A-1)]+N(y-1, A+) \exp [-Z(y-1, A+)] \tag{2}
\end{align*}
$$

where $Z(y, a)=F(y, a)+M$ and $F(y, a)$ and $M$ are the rates of fishing and natural mortality, respectively. $M=0.2$ is assumed for all ages and years. Annual recruitment of megrim (at age 1 ), $N(y, 1)$, and numbers-at-age in the initial assessment year, $N(1, a)$, are unknown parameters.

## Modelling $F(y, a)$ taking account of discards

The rate of fishing mortality is decomposed into disjoint terms as follows:

$$
\begin{equation*}
F(y, a)=F_{L}(y, a)+\sum_{j=1}^{J} F_{D, j}(y, a) \tag{3}
\end{equation*}
$$

where $F_{L}(y, a)$ and $F_{D, j}(y, a), j=1, \ldots, J$ relate to the total stock landings and discards from each of the $J$ fleets fishing the stock, respectively. The fleets used for the megrim stock correspond to the countries fishing it and are: Spain, Ireland, United Kingdom and Others, where "Others" comprises France together with countries with minor stock catches. The reason for having France grouped together with countries with minor catches is the lack of French discards data, which makes treating France as a separate fleet unrealistic. However, given the volume of catch that France takes from this stock, it would make sense to have France as a separate fleet in the model if those data become available.

The terms making up the fishing mortality are modelled as follows:

$$
\begin{equation*}
F_{L}(y, a)=f(y) r_{L}(y, a), F_{D, j}(y, a)=f(y) r_{D, j}(y, a), j=1, \ldots, J \tag{4}
\end{equation*}
$$

where $f(y)$ is an overall annual factor relating to total fishing effort on the stock and $r_{L}(y, a)$ and $r_{D, j}(y, a)$ for $j=1, \ldots, J$ determine the exploitation pattern or, in other words, the distribution of $F$ among ages and among landings and discards of different fleets. All factors in formulation (4) are positive and for identifiability,
$r_{L}(y, a)$ is set to 1 for an age chosen arbitrarily (this was set as age 9 in the megrim model implementation, an age for which discards are assumed to be 0, i.e. $r_{D, j}(y, 9)=0$ for all fleets; therefore, $f(y)$ is interpreted as the total fishing mortali-ty-at-age 9). Each of the $r(y, a)$ factors, whether it corresponds to landings or discards, is assumed to have the same values for ages $A-1$ and $A+$, so that the fishing mortality of the + group is the same as the fishing mortality of the last true age.

A Normal random walk for $\log \left[r_{L}(y, a)\right]$ is assumed for each age separately. In original (non-logged) scale, this means:

$$
\begin{equation*}
r_{L}(y, a) \sim L N\left(r_{L}(y-1, a), C V_{r c o n d}\right) \tag{5}
\end{equation*}
$$

where the log-Normal ( $L N$ ) distribution is parametrized using the median (first parameter) and coefficient of variation (second parameter). As megrim discarding is believed to have increased over the assessment period, the non-stationary random walk model in Equation (5) is considered appropriate. For each age, the value in the first year of the assessment period, $r_{L}(1, a)$, is an unknown parameter, whereas $C V_{r c o n d}$ has been fixed at $20 \%$ (the value $10 \%$ was also explored in some model runs). The same modelling procedure is applied to $r_{D, j}(y, a)$, separately for each age and fleet $j=1, \ldots, J$, where the values in the first assessment year, $r_{D, j}(1, a)$, are unknown parameters and $C V_{\text {rcond }}$ is fixed at the same value as for $r_{L}(y, a)$.

The annual factor $f(y)$ [Equation (4)] common to all components of $F$ is also unknown. As $f(y)$ is expected to vary slowly in time with no particular trend a priori, a stationary process with time autocorrelation seems appropriate. This is modelled as a multivariate Normal distribution for $(\log [f(1)], \ldots, \log [f(Y)])$ a priori, with the same mean and variance in all years and correlation $\rho^{n}$ between $\log [f(y)]$ values that are $n$ years apart. The resulting marginal prior distribution in original (nonlogged) scale every year is log-Normal:

$$
\begin{equation*}
f(y) \sim L N\left(\operatorname{med}_{f}, C V_{f}\right) \tag{6}
\end{equation*}
$$

with median and CV denoted as med $f_{f}$ and $C V_{f}$, respectively. Considering only non-negative correlations, the extreme $\rho=0$ corresponds to independence between $f(y)$ values over time, whereas $\rho=1$ leads to the same $f(y)$ value in all years. The values $m e d_{f}$ and $C V_{f}$ are fixed and $\rho$ is treated as unknown.

## Observation equations for commercial catch, landings and/or discards data in numbers-at-age

The commercial catch data for the megrim stock have different levels of aggregation depending on the year. Three main time periods can be distinguished in terms of data availability and how they are used in the assessment: (1) years 1984-1989: stock catch numbers-at-age in all years, without any disaggregation into landings and discards or by fleet; (2) years 1990-1998: stock landed numbers-at-age and stock discarded num-bers-at-age in all years, without any disaggregation by fleet; (3) years 1999-present: stock landed numbers-at-age in all years and discarded numbers-at-age disaggregated by fleet for the fleets mentioned earlier, i.e. Spain, Ireland, UK (missing in 1999) and Others (but all years missing). The fact that discards of the Others fleet (composed of France and countries with minor stock catches) are not available means that the stock discards data from 1999 to present are incomplete.

Each of these sources of information is assigned its own observation equations, with a separate equation for each age. For the catch numbers-at-age (years 1984-1989), these are:

$$
\begin{equation*}
\log \left[C^{\mathrm{obs}}(y, a)\right] \sim N\left(\log [\hat{C}(y, a)], \tau_{C}(a)\right) \tag{7}
\end{equation*}
$$

where $C^{\text {obs }}(y, a)$ is the observed and

$$
\begin{equation*}
\hat{C}(y, a)=N(y, a)\{1-\exp [-Z(y, a)]\} F(y, a) / Z(y, a) \tag{8}
\end{equation*}
$$

the model estimated catch numbers-at-age. For the landed numbers-at-age (years 1990-present):

$$
\begin{equation*}
\log \left[L^{\mathrm{obs}}(y, a)\right] \sim N\left(\log [\hat{L}(y, a)], \tau_{L}(a)\right) \tag{9}
\end{equation*}
$$

where $L^{\text {obs }}(y, a)$ is the observed and

$$
\begin{equation*}
\hat{L}(y, a)=N(y, a)\{1-\exp [-Z(y, a)]\} F_{L}(y, a) / Z(y, a) \tag{10}
\end{equation*}
$$

the model-estimated landed numbers-at-age, obtained by applying the Baranov catch equation and using the landings component of $F$. The observation equations for discarded numbers-at-age for the stock total (years 1990-1998) or by fleet (years 1999present) are defined in a similar fashion as Equations (9) and (10), considering the appropriate component of the fishing mortality, i.e. replacing $F_{L}(y, a)$ by $F_{S P D}(y, a)$ (Spanish discards), $F_{I R D}(y, a)$ (Irish discards), $F_{U K D}(y, a)$ (UK discards) and $F_{D}(y, a)=F_{S P D}(y, a)+F_{I R D}(y, a)+F_{U K D}(y, a)+F_{O T D}(y, a)$ (total stock discards). There are no observation equations involving $F_{\text {OTD }}(y, a)$ alone, given that discards of the Others fleets are missing in all years from 1999 to present. This means that information for fitting the $F_{\text {OTD }}(y, a)$ component of the total fishing mortality is very indirect as this component of fishing mortality only in the observation equations for total stock catch-at-age during 1984-1989 and total stock discards-at-age during 1990-1998. In preliminary trial runs of this models it became apparent that it was not possible to get sensible estimates of $F_{\text {OTD }}(y, a)$ for years 1999 and onwards. To circumvent this difficulty it was decided to fix the evolution of $r_{\text {OTD }}(y, a)$ from 1999 according to the formula:

$$
\begin{equation*}
r_{\text {OTD }}(y, a)=r_{\text {OTD }}(y-1, a)[\operatorname{OTLW}(y) / L W(y)] /[\operatorname{OTLW}(y-1) / L W(y-1)] \tag{11}
\end{equation*}
$$

where $L W(y)$ and $O T L W(y)$ denote the total stock landings in weight and the landings of the Others fleet in weight in year $y$, which are both known. The idea here is to say that the discarding pattern-at-age of the Others fleet has not changed since 1998 and that its change in overall level (with the same change in level for all ages) between years can be approximated by the change in overall landings of this fleet with respect to total stock landings. Clearly, this assumption can be debated, but it was the most reasonable way found to constrain the model to produce sensible fits. If discards data become available for the Others fleet, it would be recommendable to
remove this assumption from the model and let $r_{\text {ОТD }}(y, a)$ continue to evolve in time as a random walk (in log-scale) after 1998 too, as originally modelled.

The precision (inverse of variance) parameters of the observation equations, namely, $\tau_{C}(a)$ (catch numbers-at-age), $\tau_{L}(a)$ (landed numbers-at-age), $\tau_{D}(a)$ (discarded numbers-at-age) and $\tau_{D, j}(a), j=1, \ldots, J$ (discarded numbers-at-age for fleet $j=1, \ldots, J)$, reflect the precision of the catch, landings and discards data and are treated as unknown and estimated when fitting the assessment model. In setting prior distributions for these parameters, the well-known relationship between the precision $\tau$ of a Normal prior distribution for the $\log$ of a variable and the CV of the corresponding log-Normal distribution for the original variable (in non-log scale) will be used. This relationship is as follows: if $\log (X) \sim N(\mu, \tau)$, where $\tau$ denotes precision (inverse of variance), then $C V(X)=[\exp (1 / \tau)-1]^{1 / 2}$.

## Observation equations for relative indices of stock abundance

Relative indices of abundance-at-age may be obtained from research surveys or correspond to values of catch per unit of effort of commercial fleets. Let $I_{k}^{\text {obs }}(y, a)$ denote the index corresponding to series $k$, which relates to a certain time portion of the year $\left[\alpha_{k}, \beta_{k}\right] \subseteq[0,1]$. For each year and age for which the index is available, the following observation equation is assumed:

$$
\begin{equation*}
\log \left[I_{k}^{\text {obs }}(y, a)\right] \sim N\left(\log \left[q_{k}(a) N(y, a) \frac{\exp \left[-\alpha_{k} Z(y, a)\right]-\exp \left[-\beta_{k} Z(y, a)\right]}{\left(\beta_{k}-\alpha_{k}\right) Z(y, a)}\right], \tau_{k}(a)\right) \tag{12}
\end{equation*}
$$

The mean of the Normal distribution is the logarithm of the product of the average stock abundance during the period of the year to which the index relates and the catchability $q_{k}(a)$, which is unknown. The index precision, $\tau_{k}(a)$, is considered unknown for all indices explored in the assessment. As explained above, the relationship between the precision of a Normal distribution for the log of a variable and the CV of the corresponding log-Normal distribution for the variable in original scale will be used when setting prior distributions for the precision parameters.

## Data, priors, and computational method

Catch numbers-at-age data correspond to: total stock catch (years 1984-1989), total stock landings (1990-present), total stock discards (1990-1998), Spanish discards (1999-present), Irish discards (1999-present), UK discards (2000 - present, with year 1999 missing). Discards of Others (France and countries with minor stock catches) from 1999-present are missing in all years. Catch and landings correspond to ages 1$10+$. Discards of ages 8 and older are minimal and assumed to be exactly 0 for ease of modelling (except for Spain, for which the very low number of discards from age 7 make it more convenient to assume that discards are 0 already from age 7).
After considering various potential abundance indices available at the benchmark, with the corresponding ranges of available ages, the ones finally explored within the assessment model correspond to the following indices, years and ages: EVHOE-WIBTS-Q4 survey (1997-present, ages 1-5), Porcupine survey (2001-present, ages 18), Vigo bottom-trawl cpue (split into two parts: 1984-1998, ages 2-9; 1999-present, ages 1-9; this splitting was done because of the strong increase in cpue shown by this fleet around the late 1990s and early 2000s, which, after exploration, was considered
much more likely to be caused by an increase in catchability rather than be reflective of a strong increase in megrim abundance) and Irish beam trawl lpue (1995-present, ages 2-7).
In a Bayesian context, all unknown parameters are assigned prior distributions, which are meant to reflect the knowledge available before observing the data. The prior distributions considered are centred at values deemed reasonable according to current knowledge of the stock and the fishery while trying to ensure they are not too narrow, so as not to influence unduly the assessment results. Table 9.9.1.1 lists all the prior choices made for the final run. The parameters of the Gamma prior distribution for the precisions of all observation equations (the $\tau$ parameters towards the bottom of Table 9.9.1.1), were chosen using the well-known statistical fact that if $\log (X) \sim N(\mu, \tau)$, then $C V(X)=[\exp (1 / \tau)-1]^{1 / 2}$, as already mentioned, because it seems easier to think in terms of CVs of the observations than to think in terms of the inverse variance in logarithmic scale. With a $\Gamma(4,0.345)$ prior distribution on $\tau$, the resulting prior distribution for the $C V s$ of the observations in original (nonlogged) scale has median 0.31 and $(0.20,0.61)$ as the $95 \%$ central probability interval. These values become 0.10 and $(0.08,0.15)$, when a $\Gamma(10,0.1)$ prior distribution is used for $\tau$. The prior distributions for the exploitation pattern parameters in the first assessment year ( $y=1$, which corresponds to 1984) reflect the idea that discards were very low at that time. When setting the prior distribution for these parameters, it is useful to remember that $r_{L}(y, 9)=r_{L}(y, 10+)=1$ has been set, so that all other selection-at-age parameters for landings and discards should be interpreted as departures from the fishing exploitation at ages 9 and 10+.
Model fitting was done using MCMC to simulate the posterior distribution (Gilks et al., 1996, provide an accessible introduction to MCMC). This was programmed in the free software WinBUGS and run from R (R Development Core Team, 2009) using the R2WinBUGS package (Sturtz et al., 2005). MCMC simulates the posterior distribution with each draw depending on the one immediately preceding it. As a consequence of this dependence, many iterations are typically needed to obtain a representative sample from the posterior distribution, particularly when this is highly dimensional and strong correlations between some of its dimensions exist. The results for the main runs conducted during the benchmark are based mostly on chains of 48000 iterations. The first 8000 were discarded to eliminate the effect of start-up values, and 5000 equally spaced iterations out of the other 40000 iterations were kept. This was considered enough to provide a good representation of the posterior distribution. Running time was approximately 24 h on a standard desktop PC.

## Sensitivity analysis

In order to find an adequate fit of the model to the data and to test the sensitivity of the results to different model settings more than 30 model configurations were tested before and during the benchmark workshop. First, several models were run until sensible results were obtained, at which point the fine tuning of the model and detailed analysis started.

In a first sensible run, bimodal posterior densities were obtained for some variables, which suggested non convergence of the model, and the rL parameters in ages 1 and experienced a sharp decrease in the first years of the assessment period (1984 to approximately 1987), which did not appear realistic. This suggested that the prior assumed for the values of these parameters in 1984 was centred at unrealistically high values and that the model was using the random walk feature (for the logarithm of
these parameters) to move these parameters to a more appropriate range of values early in the time-series. Thus, in a following run, the length of the MCMC chains was increased (to deal with the convergence issues) and the values of medF (used to set the prior median of population abundances-at-age in 1984, see Table 9.9.1.1) and prior median for rL in 1984 for ages 1 and 2 were changed (decreased) to correct for the behaviour displayed by rL at the beginning of the time-series. It was also observed that the estimated OTD discards of age 5 increased enormously after 1999, which did not make any sense. It was checked that the problem with the estimated OTD discards of age 5 was not a problem of convergence, several alternative model settings were tried in an attempt to solve this extremely unrealistic result, and finally, it could only be solved by modelling $r_{\text {отд }}(y, a)$ from 1999 as was indicated in equation (11). In the results it was also observed that the prior CV of the catch and landings for ages 1 and 2 was too low in relation to the posterior results, so the prior median was increased from $10 \%$ to $30 \%$ in order to have a prior distribution which was not completely at odds with what the data indicated. In later runs it was also assumed that the precision in landings from 1990 to 2010 was equal to the precision in catch from 1984 to 1989. The reason was that, in principle, in the first period there was no incentive to discard or misreport data, so there was, in principle, no reason to expect a lower quality of the 1984-1989 catch data than of the 1990-2010 landings data.

To deal with the high increase in OTD discards of age 5 two structural changes to the model were tried. In the first change it was assumed that OTD discarding pattern-atage had not changed since 1998, and the changes in overall level (with the same change in level for all ages) between years were treated as unknown parameters and estimated by the model based on the available data. This still resulted in very unrealistic estimates of OTD discards in recent years, with very large increases, propagating the problem previously detected just for age 5 to all the ages. The second approach to deal with this problem was the same as the first one (i.e. it was assumed that OTD discarding pattern-at-age had not changed since 1998) but the changes in overall level (with the same change in level for all ages) between years were approximated by the changes in overall landings of the OTD fleet with respect to total stock landings in the same years (see equation (11)). This gave sensible results and the assumption was used in all following runs.

Using the later configuration of the model several runs were tested using different sets of abundance indices. In the light of the results and the exploratory data analysis it was decided to use as abundance indices: EVHOE survey, SPGFS Porcupine survey, IRTBB lpue and VIGO cpue divided into two dataseries (VIGO84 and VIGO99). The VIGO cpue time-series was split to account for the change in catchability around 1999, for which there is now fairly clear support. The ages used in EVHOE and IRGFS indices were reduced to ages $1-5$ and $2-7$, respectively, which are the ages for which the exploratory plots showed some degree of cohort tracking. Besides, the prior median and CV of $\mathrm{f}(\mathrm{y})$ were also changed which did not have high influence on the results.

The CV of the random walk of rL, rIRD, rOTD, rSPD and rUKD, was treated as an unknown parameter in the first configurations, but later it was set at a fixed value. Two alternative values were tested for the CV of the random walk, $10 \%$ and $20 \%$, the results were very similar, but the option of $20 \%$ was chosen because it gave slightly better results. Using the abundance indices listed in the previous paragraph, different configurations were tested and the one described above was selected. This run was selected as possible proposal for the assessment and is the run whose detailed prior
settings are described in Table 9.9.1.1. However several more runs were conducted to test for sensibility of the model selected.

The sensitivity of the model to the prior distribution of recruitment was tested and the results obtained did not vary between runs. Due to the high decrease in the abundance of age 6 and older age groups and the increased difficulty of tracking cohorts at those ages suggested by the data, the model was run using a plus group age at 6 . Two configurations were tried: one using abundance indices up to age 5 and the second one using them up to age $6+$. The MCMC algorithm for these runs was very slow, they took longer than two and four days, respectively, but the results were congruent with those obtained using the 10+ age. The slowness of the MCMC algorithm with a 6+ group was also a sign that the configuration with ten age groups was better. In another two alternative runs, the assumption of constant $f(y)$ across years was tested. This is not a sensible assumption, but it was tested in an attempt to shed light on the high fishing mortalities obtained for older age groups, particularly in later years. Within the constraints imposed by the assumption itself, the results were coherent with what was observed previously.

## D. Short-term projection

No short-term projection was proposed by WKFLAT, considering that the assessment model should only be used as indicative of trends.

## E. Medium-term projections

No medium-term projections are proposed for this stock.

## F. Long-term Projections (until 2006)

No medium-term projections are proposed for this stock.

## G. Biological reference points

Benchmark 2012: The calculation of possible reference points was not considered appropriate at this time due to the lack of analytical analysis.

## H. Other issues

## H.1. Historical development

Starting from 2007, no analytical assessment has been carried out. Assessment is based on discard data (Spanish dataseries and "preliminary" discard data from UK, and IR), catch-at-age data, survey indices and commercial cpues and lpues dataseries of the commercial fleets described in Section B5.

Model used until 2006: XSA. Information on XSA options in the past is provided as background for stock coordinator and reviewers.

Software used: VPA95 Lowestoft suite

Model Options chosen (until 2006):
$\left.\begin{array}{ll}\hline \text { Age recruitment } & \mathbf{1} \\ \hline \text { Taper } & \text { Yes (tricubic) }-20 \\ \hline \text { Plus group } & 10 \\ \hline \text { Tuning range } & \text { All } \\ \hline \text { Ages catch dep. Stock size } & \text { No } \\ \hline \text { Q plateau } & 8 \\ \hline \text { F shrinkage se } & \\ \hline & \text { year range }\end{array}\right) 5.5$

Input data types and characteristics (in 2006 XSA):

|  |  |  |  | Variable from <br> year to year <br> Yes |
| :--- | :--- | ---: | ---: | :--- |
| Caton | Name | Year range | Age range | Yes |

Tuning data (in 2006 XSA):

| Type | Name | Year range | Age range |
| :--- | :--- | :---: | :---: |
| Commercial Tuning <br> fleet | SP - VIGOTR7 | $1984-2005$ | $2-9$ |
| Commercial Tuning <br> fleet | FR - FU04 | $1988-2001$ | $4-9$ |
| Survey | UK-WCGFS-D | $1993-2004$ | $2-3$ |
| Survey | FR - EVHOES | $1997-2005$ | $1-9$ |

## Short-term forecast until 2006

- Model used: Age structured
- Software used: MFDP prediction with management option table and yield-per-recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.
- Initial stock size. Taken from the XSA for age 1 and older. The recruitment-at-age 1 in the last data year is estimated as a short-term GM (1987 onwards).
- Natural mortality: Set to 0.2 for all ages in all years.
- Maturity: The same ogive as in the assessment is used for all years.
- $F$ and $M$ before spawning: Set to 0 for all ages in all years.
- Weight-at-age in the stock: average stock weights for last three years.
- Weight-at-age in the catch: Average weight of the three last years.
- Exploitation pattern: Average of the three last years. Discard F's, are held constant while landings F's are varied in the management option table.
- Intermediate year assumptions: status quo F
- Stock-recruitment model used: None, non-parametric bootstrap for the whole period.
- Procedures used for splitting projected catches: vectors in each of the last three years of the assessment are multiplied by the proportion landed or discarded at age to give partial Fs for landings and discards. The vectors of partial Fs are then averaged over the last three years to give the forecast values.


## Long-term projection until 2006

- Model used: yield and biomass per recruit over a range of $F$ values that may reflect fixed or variable discard F's.
- Software used: MFY or MLA
- Maturity: Fixed maturity ogive as used in assessment.
- Stock and catch weights-at-age: mean of last three years
- Exploitation pattern: mean F array from last three years of assessment (to reflect recent selection patterns).

Procedures used for splitting projected catches: Catches are not split
Reference points prior to 2012

|  | ICES CONSIDERS THAT: | ICES PROPOSED THAT: |
| :--- | :--- | :--- |
| Limit reference points | BLIM is not defined. | B $_{\text {pa }}$ be set at 55000 t. |
|  | FLIM is 0.44. | $\mathrm{~F}_{\mathrm{pa}}$ be set at 0.30. |
| Target reference points |  | F $_{\mathrm{y}}$ is not defined. |

## Technical basis

| $\mathrm{B}_{\text {LIM }}=$ Not defined . | $\mathrm{B}_{\mathrm{pa}}=\mathrm{B}_{\text {loss. }}$. There is no evidence of reduced recruitment at the lowest biomass observed and $B_{p a}$ was therefore set equal to the lowest observed SSB. |
| :---: | :---: |
| $\mathrm{FLIM}^{\text {= Floss }}$. | $\mathrm{F}_{\mathrm{pa}}=\mathrm{F}_{\text {med }}$; this implies a less than $45 \%$ probability that (SSBMT< $\mathrm{B}_{\mathrm{pa}}$ ). |

## 2008 Review group issues

There is a serious shortage of basic information for this stock due to severe deficiencies in the data (lack of updates, gaps in time-series, few data on discards, limited
survey information). There are conflicting signals on stock trends both from surveys and lpue data, and it will require considerable effort to provide a reliable assessment for this stock.

## Data deficiencies in 2008

1 ) Limited discards data available: Only Spanish discard data are used. Some preliminary, not raised, discard data supplied from UK. Ireland raised discard data are provided. No French discard data are delivered.

2 ) Limited survey information, particularly on the strength of the incoming year classes: French EVHOE survey data should be provided.
3 ) Conflicting trends in commercial tuning data: a complete review of the commercial cpues from Ireland is needed. Update cpues of the French tun-ing-series.
4 ) Segmentation on the main commercial fleets used in the assessment should be revised and, if appropriated, applied.

## Data improvement in 2009

1 ) Limited discards data available: French discard data are still not available. UK "preliminary" unraised data were delivered. Spain and Ireland provided raised estimations of discards.
2 ) Substantial improvement in survey information. The EVHOE index-series by age has been updated and revised.

3 ) Revision of Commercial cpue series. The Irish Otter trawl tuning fleet has not yet been revised. French Fleets have been all updated and revised.
4 ) No new fleet segmentation of tuning fleet dataseries has been proposed and consequently no new data have been handled in.

## 2009 Review group issues

- "severe deficiencies in the data" for this stock. There appears to be an ongoing effort to update and revise data for this stock. The lack of discard data from all countries involved in the fishery is of particular concern, as it is likely that the international catch of this stock is underestimated. Only one country has provided discard data since 1999 (Spain) and this is the only time-series incorporated in the assessment.
- Additionally, concern was expressed that survey indices conflict in their depiction of trends in biomass over time. Specifically, the Irish groundfish survey indicated much higher biomass levels in 2004-2006 than the French and Spanish groundfish surveys. Furthermore, commercial catch-effort data show different trends for the fishery in recent years. Lpue from the French fishing fleet appears to be stable since 2005, whereas the cpue of the Spanish fleet indicates an increasing trend since 2005, with a decrease in 2008.
- This stock is targeted as part of a mixed fishery (hake, megrim, sole, cod, plaice, and Nephrops), but this was not noted in the 2009 report. Ecosystem information was not considered in examination of stock trends.


## Data deficiencies in 2009

In 2010, quality has even decreased.

- No estimation for catches for this stock are delivered this year as France has not provided landing data.
- Limited discards: Lack of discards data for all countries and years continues to be a major problem for this stock. No data other than Spanish and Irish dataseries have been provided for the assessment. Only sampling data from United Kingdom were available.
- Commercial tuning data for four French fleets have not been updated. The Irish Otter trawl lpues series has not been revised for the time of the meeting.
- No segmentation of the main commercial fleets used in the assessment has been carried out.


## Improvement of 2010 data

The above data deficiencies should be corrected for the preparation and development of a successful benchmark planned in the 1st quarter of 2010.

## Data improvement during the Benchmark 2012

i) A new Irish trawler index was provided as the result of the revision carried out for the Irish Otter trawl fleet. Irish beam trawl (TBB) data are limited to TBB with mesh sizes of $80-89 \mathrm{~mm}$, larger mesh sizes are disused since 2006.
ii ) France provided revised ALKs and consequently completed number and weights-at-age since 1999.
iii ) Spain, United Kingdom (England and Wales) and Ireland provide discard data since 2000.
iv ) Irish discard data were revised and updated and a new dataseries was provided since 1995.
v ) Spain provided some minor revised values of discards.
vi ) Some minor revisions were carried out for SP-VIGOTR7 due to the incorporation of catches previously not recorded.

## Data deficiencies after Benchmark 2012

i) France did not provided discard data since 1999, as data appear to be very uncertain in relation to sampling level affecting their representatively.
ii ) No update for the French lpues series has been provided to the Benchmark group for 2009 and 2010 as effort deployed by this fleet was considered, at the time of the analysis, unreliable.

## I. References

Alverson, D.L., M.H. Freeberg, S.A. Murawski and J.G. Pope. 1994. A global assessment of fisheries bycatch and discards. FAO Fisheries Technical Paper. 339.
Anon. 2003. Report of ICES Workshop on Discard Sampling Methodology and Raising Procedures. Charlottenlund, Denmark, 2-4 September 2003.

Aubin-Ottenheimer, G. 1986. La cardine (Lepidorhombus whiffiagonisi):étude biologique et dynamique du stock de mer Celtique. Thèse Univ. Paris VI, 197 pp.

BECAUSE. Critical Interactions BEtween Species and their Implications for a PreCAUtionary FiSheries Management in a variable Environment - a Modelling Approach" (BECAUSE) (Ref: European Union 6th FP priority TP 8.1 STREPT Contract no.: 502482).

Bellido, Jose Má., Pérez, N. and Araujo, H. Discard pattern of Hake Southern Stock from the Spanish trawl Fleet. WD presented at the WGHMM 2003, Gijon, Spain.
BIOSDEF. Biological Studies on Demersal Species (Ref.: EU DG XIV Study Contract: 95/038): finished in 1998. Growth and reproduction information was collected and analysed for hake, anglerfish, and megrim in Subarea VII, Division VIIIa,b,d and Division VIIIc \& IXa.

Castro J., M. Rasero and A. Punzón. 2004. A preliminary identification of fisheries for the Spanish trawl fleets in the European Southern Shelf. WD in SGDFF.
Fernández, C., Cerviño, S., Pérez, N., and Jardim, E. 2010. Stock assessment and projections incorporating discard estimates in some years: an application to the hake stock in ICES Divisions VIIIc and IXa. ICES Journal of Marine Science, 67: 1185-1197.

Final Report. Contract Ref. 98/095. 2002. Monitoring of discarding and retention by trawl fisheries in Western Waters and the Irish Sea in relation to stock assessment and technical measures.

Gilks, W. R., Richardson, S., and Spiegelhalter, D. J. 1996. Markov Chain Monte Carlo in Practice. Chapman and Hall. London. 486 pp.

ICES. 2007. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM).
Kulka, D. 1999. The integration of information collected by fishery observers into the fisheries management process: A scientific perspective. The international conference on integrated fisheries monitoring proceedings. Rome, FAO: 249-259.

Lunn, D., Spielgelhalter, D., Thomas, A., and Best, N. 2009. The BUGS project: Evolution, critique, and future directions. Statistics in Medicine, 28: 3049-3067.

R Development Core Team. 2009. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.

Rodriguez-Marín, E. And Olaso, I. 1993. Food composition of the two species of Megrim (Lepidorhombus whiffiagonis and Lepidorhombus boscii) in the Cantabrian Sea. Actes du Illeme Colloque d'Oceanographie du Golfe de Gascogne. Arcachon 1992: 215-219.
Santurtún, M.; Prellezo, R.; Lucio P.; Iriondo A. and Quincoces I. 2004. A first Multivariate approach for the dynamics of the Basque trawl fleet in 2002. Working Document presented to SGDFF. Ostende (Belgium) 26-30 January 2003.

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, 56: 584-591.
Sturtz, S., Ligges, U., and Gelman, A. 2005. R2WinBUGS: a package for running WinBUGS from R. Journal of Statistical Software, 12: 1-16.

Trenkel, V. and M.-J. Rochet. 2001. Towards a theory for discarding behaviour. ICES Doc., CM 2001/V:03. 10 pp.

Quality Handbook
Stock specific documentation of standard assessment procedures used by ICES.

| Stock | Sole (division VIIIab) |
| :--- | :--- |
| Working Group: | Assessment of Southern Shelf Stocks of Hake, Monk <br> and Megrim |
| Date: | WGHMM 2013 |
| Revised by | M. Lissardy |

## A General

## A. 1 Stock definition

The Bay of Biscay sole stock extends on shelf that lies along Atlantic French coast from the Spanish boarder to the West point of Brittany. This shelf forms a geographical unit, being narrow at its two extreme parts, particularly in the south. As sole is chiefly present at less than 150 m , this geography of the living area gives some supports to the absence or only limited exchanges with other southern or northern stocks. However, a tagging experiment carried out in 1992 on two nursery areas has shown that fish may move from southern coast of Brittany to the Iroise sea, in the West of Brittany (KoutsiKopoulos et al., 1993).

Several spawning grounds are known at depth from 30 to 100 m , from south to north (Arbault et al., 1986) :

- in the north of Cap Breton, off the Landes coast,
- between Arcachon and the Gironde estuary,
- in front of La Rochelle,
- in front of the Loire estuary,
- in several but limited areas off the southern coast of Brittany.

Nursery grounds are located in the coastal waters, in bays (Pertuis d'Antioche, Pertuis Breton, Baie de Bourgneuf) and estuaries (Gironde, Loire, Vilaine) (Le Pape et al., 2003a).


Figure 1: Fitted 0-group sole density (number of fish per hectare) in the Bay of Biscay (Le Pape et al., 2003a).

## A. 2 Fishery

The French fleet is the major participant in the Bay of Biscay sole fishery with landings being about $90 \%$ of the total official international landings over the historical series. Most of the remaining part is usually landed by the Belgian fleet.

The fishery is largely a fixed net fishery directed on sole, particularly in the first term on the year. The other component is a French and Belgian trawl fishery. The French trawlers are otter trawlers with mixed species catches (sole, cuttlefish, squid, hake, pout, whiting....). The Belgium trawlers are beam trawlers directed at sole, but monk is an important part of its catch. The French coastal boats of these two fisheries have a larger proportion of young fish in their catch than offshore boats. These boats less than 12 m long contribute to the landings by about one third from 2000 onwards. Sole is a major resource for all these boats, given the price of this species on the market. Although the species is taken throughout the year, the catch of coastal netters is less important in autumn, those of coastal trawlers in winter and those of offshore French boats are heaviest in the first quarter.

Otter trawling predominated until the late 1980s, including a small-mesh shrimp fishery which decreased markedly in the beginning of the 1990s. The fixed fishery begun in the 1980s and it have expanded in the 1990 to account for two third to three quarters of the French landings in the beginning of 2000s. The beam trawl effort increased also rapidly and continuously in the 1990s. It has decreased after 1999 until 2004 but it has returned to its previous 2001-2002 level in 2006-2007. In 2010 it had increased until 11 \% (his max until 1999) On the opposite, the otter trawl effort shows a decreasing trend until 1999 but it is stable since then.

Catches have increased continuously since the beginning of the 1980s, until a maximum was reached in 1994 ( 7400 t ). They have decreased afterwards to $3600-4800 \mathrm{t}$ in 20032010. The year 2009 is the lower and the year 2011 is the higher since 2006 ( 4600 t ).

## A. 3 Ecosystem aspects

The quality and the extent of the nursery grounds have likely a major effect in the dynamic of sole recruitment. Studies in Vilaine bay showed a significant positive relationship between the fluvial discharges in winter-spring and the size of the nursery (Le Pape et al., 2003b). The extent of the river plume influences both the larval supply and the size and biotic capacity of habitats in estuarine nursery grounds and determines the number of juveniles produced.

The WGSSDS looked at the possibility of such effect for the whole Bay of Biscay stock at it 2006 meeting. The relationship between recruitment and river flows was investigated using the Loire river flow in the first half of the year which is considered to be a representative index of the water discharge influences on nursery areas in the Bay of Biscay. Unfortunately, no relationship can be seen between this index and the recruitment at age 2 (Figure 2). The environmental effect is likely to be more complex at the Bay of Biscay scale.

Figure 2: relationship between recruitment at age 2 (as estimated by WGSSDS in 2006) and mean Loire flow in first half year


## B. Data

## B. 1 Commercial Catch

## B.1.1 Discards estimates

Discard data are not included in the assessment because the available discards estimates are limited and, furthermore, may be biased (see thereafter).

## Discards data collected within the DCF regulation framework:

These observations have shown that discards of beam trawlers and gillnetters are generally low but that the inshore trawlers fleet may have occasionally high discards of sole. Unfortunately, they are difficult to estimate because the effort data of inshore trawlers are not precise enough to allow estimating them by relevant areas. However, if one considers the discards have probably been high in 2009 because the 2007 year class seems to have been above the mean according to the ORHAGO survey, and if on uses the observed ratio of discards on landings of the inshore trawler fleet in 2009, which is likely to be an overestimate because the observed trips were mainly in nursery areas, the discards of the inshore trawlers are no more than $5 \%$ of the landings in number.

The French fishing industry agreed with the data used in the assessment but suggested that the use of the discards might improve the assessment because the development of high-grading in some areas. The discards data are available since 2010 but total discards cannot be estimated because we have not an historical series (lack of data between 2004 and 2009).
Discards estimates of the French offshore trawlers provided by the RESSGASC surveys from 1987 to 2003:
Discards estimates of the French offshore trawlers were provided by the French trawl surveys FR-RESSGASC-S from 1987 to 2002. These surveys were carried out each quarter until 1997 and in the second and last quarter from 1998 to 2002.
In 2002, this survey was discontinued because the discards estimates that it provides were estimated to depend on the following questionable assumptions:

1 ) Trawls of the Gwen Drez R/S and the offshore trawlers have the same selectivity,
2 ) Gwen Drez R/S operate in the same area and in the same conditions than the offshore trawlers during the quarter (up to 1997) or the semester of the survey (quarter 4 year $\mathrm{n}+$ quarter 1 year $\mathrm{n}+1$ for November survey year n ; quarter 2 and 3 for may survey).
These discards estimates are been included several years in the assessments. They have represented about 1 to $3 \%$ of the total catches from 1991 to 2003 and less than $0.5 \%$ since in 2002 and 2003. Given their low contribution to the total catch and the uncertainty due to the assumptions on which they are based, they have been no longer used in the assessment, as recommended by ACFM, since 2005.

Their estimation method may be finding in the annexes appended to the 2005 and 2006 WGSSDS reports or in the WGHMM stock annexes from 2007 to 2010 (Bay of Biscay sole stock was moved from WGSSDS to WGHMM in 2007)

## B.1.2 Landing numbers at length

The quarterly French sampling for length compositions is by gear (trawl or fixed net) and boat length (below or over 12 m long). The contributions of each of these components of the French fleet to the landings are estimated by quarter from logbook data, assuming that the landings associated with logbooks are representative of the whole landings. In 2000-2002, surveys on fishing activities by month have provided a likely less biased estimate of landing split by gear than logbooks, which are filled in only by a part of the fleet (50-60\% of the landings in 2000-2002). As logbooks are often recorded in the file with delay, the percentage of landings associated with logbook may be well below preceding years, particularly in the last quarter. In that case, the process is to use logbooks to get a landing split in the last year if it is close to the mean over the three preceding years otherwise the quarterly mean over the three preceding years is used.

## B.1.3 Catch number at age

Age reading method
From 1984 to 2008, the ages in the French landings have been determined by reading otoliths which have been burnt and manually cut. From 1996 onwards, the ages in Belgian landings begun to be determined by reading the age on thin slices of otolith.

In 2005, the ages in French landings begun to be also determined by using this latter method which is the more commonly used for sole age reading. However, in order to estimate the effect of the change in age reading method, from 2005 to 2008 the age reading of French sampled fishes were carried out using the two methods. One otolith was burnt and the second was collected to get thin slices.

Two catch and weight at age 1984-2008 time series can thus be used to carry out two assessments, the set of data differing one from the other in the four terminal years. A comparison of these two assessments was presented to the 2010 WGHMM. It shows only limited differences in the outputs. Consequently, the French catch and weight at age were revised from 2005 onwards at the 2010 WGHMM to use the 2005-2009 data set provided by age reading on otolith slices, which is now the unique age reading method for the Bay of Biscay sole stock.

## ALKs use to get catch at age estimates

Age compositions of the French landings and discards (up to 2003) are estimated using quarterly ALKs. Up to 1998, it is only FR-RESSGASC-S surveys ALKs. From the second half of the 1998 year and up to 2002, the first and third quarters ALKs are obtained from commercial landings samples. In 2003, commercial landing samples are completed by fish caught during a survey which was planned to design gear and methodology for the future survey ORHAGO aiming at a sole abundance index series in the Bay of Biscay. In 2004 and 2005, only market samples are used. From 2006 onwards, market samples are mainly used but the ORHAGO survey series provides age estimates at length for a large part of the landing length distribution in the last quarter of the year. Another survey (Langolf) can provide also some fish in the second quarter. Market samples are used to complete these ALKs for the upper part of the distribution.

Prior to 1994, the age composition of French offshore trawler catches is raised to include Belgian landings. In 1994 and 1995, FR-RESSGASC-S ALKs are applied to Belgian length distributions. From 1996 ahead, catch numbers at age of the Belgian fleet are estimated with Belgian ALKs. French and Belgian age composition are added before being raised to the total international catch except in 2001 where the Belgian age compositions were raised to the total of Belgian and Dutch landings.

## B. 2 Biological

## Weights at Age

French mean weights at age are estimated using quarterly length-weight relationships in which weight are gutted weight multiplicated by the fresh/gutted transformation coefficient of French landing. This latter was changed from 1.11 to 1.04 in 2007. The French mean weights at age in catches are consequently estimated with a fresh/gutted transformation coefficient which is 1.11 up to 2006 and 1.04 from 2007 onwards.

Belgian mean weights at age are straight estimates. International mean weights at age are French-Belgian quarterly weighted mean weights.

Stock weights are set to the catch weights but always using the old fresh/gutted transformation coefficient of French landing (1.11) to have the predicted spawning biomass comparable to the biomass reference point of the management plan (Bpa as estimated in 2006 using mean weights in the stock which were mean weights in the catches).

## Maturity ogive

In assessments up to the 2000 Working Group, a knife-edge maturity was used, assuming a full maturity at age 3 .


During the 4 first months in 2000, the maturity at length and at age was observed on 296 female fish, 112 being between 24 cm and 28 cm long, which is the observed length range for maturity occurrence of sole in Bay of Biscay. The sampling was assumed to be at random within a length class of 1 cm . The maturity ogive was then estimated applying a maturity/age/length key thus obtained to the length distribution of the first quarter in 2000.

The maturity at age was so estimated to be:

| Age | $\leq \mathbf{1}$ | $\mathbf{2}$ | $\mathbf{3}$ | $\mathbf{4}$ | $\geq \mathbf{5}$ |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Mature | 0 | 0.32 | 0.83 | 0.97 | 1 |

## Natural Mortality

Natural mortality is assumed to be 0.1 for all age groups and all years.

## B. 3 Surveys

## RESSGASC surveys

Quarterly RESSGASC survey series are available from 1987 to 2002 but it worth noting that these surveys were carried out to provide hake discard estimates and consequently not well designed for providing sole abundance indices. Each quarter from 1987 to 1998, and thereafter each second and fourth quarter of the year, the survey aimed to catch as commercial fishing boats in the same areas. These series were disrupted in 2003. They have been withdrawn from the assessment by the 2011

WKFLAT because they no longer contribute to the estimates of the terminal population numbers.

## ORHAGO survey

The ORHAGO survey was launched in 2007. The fishing gear is a beam trawl with 40 mm codend. This survey is carried out in November-December in order to have a good catchability of sole at the age 1 . The sampling plan is systematic. 50 hauls are distributed in 10' latitude by 10 ' longitude rectangles all over the sole habitat in the Bay of Biscay. The haul positions are kept unchanged from year to year. This beam trawl survey is coordinated by the WGBEAM to which the results are reported each year since its beginning.

At the 2013 meeting of the WGBEAM 2013, several CPUE series were compared to investigate the effect of missing values for some stations in some years ( 0 to $20 \%$, depending on the year and the day fishing period) and whether fishing at night might provide a better abundance index. The WGBEAM concluded from that analysis that the CPUE times-series based on all the reference stations and on hauls carried out by daylight can be retained to provide a survey abundance index for the Bay of Biscay sole stock. An interim benchmark by correspondence was held consecutively. It agrees the inclusion of the ORHAGO survey time-series in the tuning fleets of the Bay of Biscay sole assessment, considering the need of an independent tuning index, the length of the time-series (6 years) and its ability to track year class strength in following years.

The ORHAGO survey time-series was consequently included in the assessment at the WGHMM 2013.

## B. 4 Commercial CPUE

Four commercial CPUE series are used in the assessment: La Rochelle offshore trawlers (FR-ROCHELLE), Les Sables d'Olonne offshore trawlers (FR-SABLES), the Bay of Biscay offshore trawlers in the second quarter (FR-BB-OFF-Q2) and the Bay of Biscay inshore trawlers in the last quarter (FR-BB-IN-Q4).

These series are provided by boats which are selected to form homogeneous groups and to limit year to year changes in fleet compositions. The following methods were adopted:

- The La Rochelle and the Les Sables d'Olonne offshore trawler fleets are two fixed groups of fishing boats. These fleets were first included in the tuning fleets at the 2005 WGSSDS. They were formed by boats which have landed sole either in La Rochelle (or near La Rochelle) or in Les Sables and for which CPUE data (with sole and Nephrops percentage in catches thresholds indicated thereafter) are available for a minimum number of years ( 10 from 1984 or 7 from 1995 to 2004). The criterion of skippers having declared to have looked for sole in 2003-2004 (IFREMER annual activities survey) was added to avoid inclusion of boats fishing sole sporadically. The La Rochelle vessels are 14 to 20 meters long and the Les Sables vessels are 12 to 23 meters long.
- The Bay of Biscay offshore trawler fleet in the second quarter and the Bay of Biscay inshore trawler fleet in the fourth quarter are formed by fishing boats which have caught sole in Bay of Biscay and for which CPUE data (with sole and Nephrops percentage in catches thresholds indicated thereafter) are available for five years over the ten last years. Furthermore, to limit effect of changes in fishing area, the CPUE were calculated by selecting the statistical rectangles which have
provided a CPUE for more than 5 years from 2000 onwards. After the selection of rectangles, we keep the fishing boats which have caught sole for five years over the ten last years. These tuning series were first included in the tuning process at the 2011 WKFLAT. They were added to the tuning series because the decrease in number of trawlers in La Rochelle or Les Sables fleets due to the decommissioning measures or the change in gear. The inshore vessels are 10 to 12 meters long and the offshore vessels are 14 to 18 meters long.

To take into account changes in fishing areas due to change in targeting species, a minimum percentage of sole in total landing of a trip (data from 1984 to 1998) or of a day (from 1999 onwards) was selected to avoid effects of a shift in target species from sole to cephalopods in recent years. This percentage has been set to $10 \%$ in 2005 for selecting relevant fishing periods for the La Rochelle and Les Sables tuning fleets. It resulted from the advice of fishermen given at a meeting. For defining new tuning fleets in 2011, it was necessary to reduce this percentage to $6 \%$ for increasing the number of available data. This requirement is due to the choice to carry out the work on a more reduced time period than previously (quarter instead of year) and to pay attention to the spatial distribution of effort.

A second threshold was fixed on the percentage of Nephrops in total landing (below or equal to $10 \%$ ) to avoid the inclusion of trips or days during which a large part of effort is devoted to this species.

The effort is in hours. It is not corrected for horse power ( $\mathrm{H} \times 100 \mathrm{~kW}$ ) because this correction is considered introducing more noise, because of the quality of the measurement of horse power, than any improvement in fleets which are constructed to be homogeneous and with limited change in composition over the time period.

Because of the decreasing on the numbers of vessels for Les Sables and the large decreasing on the fishing effort for La Rochelle for 2010, the WGHMM decision is to withdraw the 2010 CPUE value for the Les Sables and La Rochelle.

## C. Assessment: Data and method

Model used: XSA

## Software used: Lowestoft VPA program

The XSA settings to be used were set by the WKFLAT 2011 and revised by the WGHMM are given in the following text table.

|  | WGHMM 2013 |
| :--- | :--- |
| Catch data range | $84-$ last year |
| Catch age range | $2-8+$ |
| Sables d'Olonne offshore trawlers fleets tuning fleet (FR - SABLES) | $1991-2009$ |
|  | $2-7$ |
| La Rochelle offshore trawlers fleets tuning fleet (FR - ROCHELLE) | $1991-2009$ |
| $2-7$ |  |
| Bay of Biscay offshore trawlers in the second quarter tuning fleet (FR-BB- <br> OFF-Q2) | 2000 - last year |
| Bay of Biscay inshore trawlers in the fourth quarter tuning fleet (FR-BB-IN- | 2000 - last year |
| Q4) | $3-7$ |
| Bay of Biscay beam trawler survey in the fourth quarter (FR-ORHAGO) | 2007 - last year |
|  | $2-8$ |
| Taper | No |


| Ages catch dep. Stock size | No |
| :--- | :--- |
| Q plateau | 6 |
| F shrinkage se | 1.5 |
| Year range | 5 |
| age range | 3 |
| Fleet se threshold | 0.2 |
| F bar range | $3-6$ |

Historical review of changes in XSA settings (see text table thereafter):
Age range in the assessment was changed from $0-8+$ to $1-8+$ in 1998, and to $2-8+$ in 2004. In both cases, this change is largely due to the uncertainties in discards estimates.

Because French 1999 catches were not available at the 2000 WG, the 2000 XSA was identical to the 1999 XSA.

The age range of $F$ bar was change from 2-6 to 3-6 at the 2004 WG because the age 2 is not fully recruited. This age range was turned back to 2-6 by ACFM because its implication on reference points. The Review Group asked nevertheless to investigate changing it again to 3-6 in 2005 and ACFM accepted the change to 3-6 in 2006.

Because of the lack of place in the page, the table is in two parts

| WG year XSA | 1998 XSA | $\begin{aligned} & 1999 \& \\ & 2000 \text { XSA } \end{aligned}$ | 2001 XSA | 2002 XSA | 2003 XSA | 2004 XSA | 2005 XSA | 2006 XSA |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Catch data range | 1984-1997 | 1984-1998 | 1984-2000 | 1984-2001 | 1984-2002 | 1984-2003 | 1984-2004 | 1984-2005 |
| Age range in catch data | 1-8+ | 1-8+ | 1-8+ | 1-8+ | 1-8+ | 2-8+ | 2-8+ | 2-8+ |
| FR - SABLES | $\begin{aligned} & 88-97 \\ & 1-7 \end{aligned}$ | $\begin{aligned} & 89-98 \\ & 1-7 \end{aligned}$ | $\begin{aligned} & 84-00 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 84-01 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 84-02 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 84-03 \\ & 2-7 \end{aligned}$ | 91-04 revised $2-7$ | $\begin{aligned} & 91-05 \\ & 2-7 \end{aligned}$ |
| FR - ROCHELLE | $\begin{aligned} & 88-97 \\ & 1-7 \end{aligned}$ | $\begin{aligned} & 89-98 \\ & 1-7 \end{aligned}$ | $\begin{aligned} & 84-00 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 84-01 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 84-02 \\ & 2-7 \end{aligned}$ | removed | 95-04 <br> revised $2-7$ | $\begin{aligned} & 91-05 \\ & \text { corrected } \\ & 2-7 \end{aligned}$ |
| FR - ROCHELLE1 | Not used | Not used | Not used | Not used | Not used | $\begin{aligned} & 84-92 \\ & 2-7 \end{aligned}$ | Removed | Removed |
| FR - ROCHELLE2 | Not used | Not used | Not used | Not used | Not used | $\begin{aligned} & 93-03 \\ & 2-7 \end{aligned}$ | Removed | Removed |
| FR - OTHER | Not used | Not used | Not used | Not used | Not used | Not used | $\begin{aligned} & 95-04 \\ & 2-7 \end{aligned}$ | Removed |
| FR - RESSGASC-S | $\begin{aligned} & 88-97 \\ & 1-7 \end{aligned}$ | $\begin{aligned} & \hline 89-98 \\ & 1-7 \end{aligned}$ | removed | removed | removed | removed | Removed | Removed |
| FR - RESSGASC-S 2 | Not used | Not used | $\begin{aligned} & 87-00 \\ & 2-6 \end{aligned}$ | $\begin{aligned} & 87-01 \\ & 2-6 \end{aligned}$ | $\begin{aligned} & 87-02 \\ & 2-6 \end{aligned}$ | $\begin{aligned} & 87-02 \\ & 2-6 \end{aligned}$ | $\begin{aligned} & \hline 87-02 \\ & 2-6 \end{aligned}$ | $\begin{aligned} & 87-02 \\ & 2-6 \end{aligned}$ |
| FR - RESSGASC-S 3 | Not used | Not used | $\begin{aligned} & 87-97 \\ & 2-6 \end{aligned}$ | removed | removed | removed | Removed | Removed |
| FR - RESSGASC-S 4 | Not used | Not used | $\begin{aligned} & \hline 87-00 \\ & 1-6 \end{aligned}$ | $\begin{aligned} & 87-01 \\ & 1-6 \end{aligned}$ | $\begin{aligned} & 87-02 \\ & 1-6 \end{aligned}$ | $\begin{aligned} & 87-02 \\ & 2-6 \end{aligned}$ | 87-02 | $\begin{aligned} & 87-02 \\ & 2-6 \end{aligned}$ |
| FR-BB-IN-Q4 | Not used | Not used | Not used | Not used | Not used | Not used | Not used | Not used |
| FR-BB-OFF-Q2 | Not used | Not used | Not used | Not used | Not used | Not used | Not used | Not used |
| FR-ORHAGO | Not used | Not used | Not used | Not used | Not used | Not used | Not used | Not used |
| Taper | No | No | Yes | Yes | Yes | No | No | No |
| Tuning range | 10 | 10 | 17 | 18 | 19 | 20 | 14 | 15 |
| Ages catch dep. Stock size | No | No | No | No | No | No | No | No |
| Q plateau | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| F shrinkage se | 1.0 | 1.0 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Year range | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| age range | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Fleet se threshold | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| F bar range | 2-6 | 2-6 | 2-6 | 2-6 | 2-6 | 3-6 | 2-6 | 3-6 |


| WG year XSA | 2007 XSA | 2008 XSA | 2009 XSA | 2010 XSA | 2011 XSA | 2012 XSA | 2013 XSA |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Catch data range | 1984-2006 | 1984-2007 | 1984-2008 | 1984-2009 | 1984-2010 | 1984-2011 | 1984-2012 |
| Age range in catch data | 2-8+ | 2-8+ | 2-8+ | 2-8+ | 2-8+ | 2-8+ | 2-8+ |
| FR - SABLES | $91-06$ <br> corrected 2-7 | $\begin{aligned} & 91-07 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 91-08 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 91-09 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 91-09 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 91-09 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 91-09 \\ & 2-7 \end{aligned}$ |
| FR - ROCHELLE | $91-06$ <br> corrected 2-7 | $\begin{aligned} & 91-07 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 91-08 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 91-09 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 91-09 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 91-09 \\ & 2-7 \end{aligned}$ | $\begin{aligned} & 91-09 \\ & 2-7 \end{aligned}$ |
| FR - ROCHELLE1 | Removed | Removed | Removed | Removed | Removed | Removed | Removed |
| FR - ROCHELLE2 | Removed | Removed | Removed | Removed | Removed | Removed | Removed |
| FR - OTHER | Removed | Removed | Removed | Removed | Removed | Removed | Removed |
| FR - RESSGASC-S | Removed | Removed | Removed | Removed | Removed | Removed | Removed |
| FR - RESSGASC-S 2 | $\begin{aligned} & \hline 87-02 \\ & 2-6 \end{aligned}$ | $\begin{aligned} & \hline 87-02 \\ & 2-6 \end{aligned}$ | $\begin{aligned} & 87-02 \\ & 2-6 \end{aligned}$ | $\begin{aligned} & 87-02 \\ & 2-6 \end{aligned}$ | Removed | Removed | Removed |
| FR - RESSGASC-S 3 | Removed | Removed | Removed | Removed | Removed | Removed | Removed |
| FR - RESSGASC-S 4 | $\begin{aligned} & 87-02 \\ & 2-6 \end{aligned}$ | $\begin{aligned} & 87-02 \\ & 2-6 \end{aligned}$ | $\begin{aligned} & 87-02 \\ & 2-6 \end{aligned}$ | $\begin{aligned} & 87-02 \\ & 2-6 \end{aligned}$ | Removed | Removed | Removed |
| FR-BB-IN-Q4 | Not used | Not used | Not used | Not used | $\begin{aligned} & 00-10 \\ & 3-7 \end{aligned}$ | $\begin{aligned} & 00-11 \\ & 3-7 \end{aligned}$ | $\begin{aligned} & 00-12 \\ & 3-7 \end{aligned}$ |
| FR-BB-OFF-Q2 | Not used | Not used | Not used | Not used | $\begin{aligned} & 00-10 \\ & 2-6 \end{aligned}$ | $\begin{aligned} & 00-11 \\ & 2-6 \end{aligned}$ | $\begin{aligned} & 00-12 \\ & 2-6 \end{aligned}$ |
| FR-ORHAGO | Not used | Not used | Not used | Not used | Not used | Not used | $\begin{aligned} & 07-12 \\ & 2-8 \end{aligned}$ |
| Taper | No | No | No | No | No | No | No |
| Tuning range | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| Ages catch dep. Stock size | No | No | No | No | No | No | No |
| Q plateau | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| F shrinkage se | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Year range | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| age range | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Fleet se threshold | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| F bar range | 3-6 | 3-6 | 3-6 | 3-6 | 3-6 | 3-6 | 3-6 |

## D. Short term projection

Model used: Age structured deterministic projection
Software used: MFDP

## Inputs

Initial stock size:

- Recruitment is the geometric mean of recruitment values XSA over 1993 to three years before the assessment year (short mean because recruitment values are lower since 1993) if the XSA last year recruitment is considered poorly estimated according to the retrospective pattern.
- Recruitment is XSA last year recruitment if this latter one is considered to be accurately estimated according to the retrospective pattern.
- Age group above recruitment is derived from the GM.

Natural mortality: Set to 0.1 for all ages in all years
Maturity: Same ogive used for all years (given in section B.2)
$F$ and $M$ before spawning: None

## Weight at age:

- Weights at age in the landings are the unweighted means over the last 3 years using the new fresh/gutted transformation coefficient of French landing which was changed from 1.11 to 1.04 in 2007.
- Weights at age in the stock are the unweighted means over the last 3 years using the old fresh/gutted transformation coefficient of French landing (1.11). The predicted spawning biomass is consequently comparable to the precautionary biomass reference point (Bpa) set before the change in fresh/gutted transformation coefficient of the French landing.


## Exploitation pattern:

- Fishing mortality at recruiting age is the arithmetic mean over the 2 years before the terminal year if the XSA recruitment estimate is overwritten by a GM.
- Fishing mortalities above recruiting age is the arithmetic mean over the 3 last years of the assessment
- Unscaled if no trend is detected,
- Scaled to the last year's Fbar if a trend is detected.


## Intermediate year assumptions:

Status quo F except if there is some information about the possibility that the TAC may be limiting.

## F. Yield and biomass per recruit / long term projections

Yield per recruit calculations are conducted using the same input values as those used for the short term forecasts.

## G. Biological reference points

|  | Type | Value | Technical basis |
| :---: | :---: | :---: | :---: |
| MSY | MSY Btriger | 13000 t | $\mathrm{B}_{\mathrm{pa}}$ (provisional estimate. MSY Brrigger to be reevaluated). |
| Approach | FMSY | 0.26 | $\mathrm{F}_{\text {max }}$ (as estimated by WGHMM 2010) because no stockrecruitment relationship, limited variations of recruitment, Fishing mortality pattern known with low uncertainty |
| Precaution ary Approach | Blim | Not defined |  |
|  | Bpa | 13000 t | The probability of reduced recruitment increases when SSB is below 13000 t , based on the historical development of the stock. |
|  | Flim | 0.58 | Based on the historical response of the stock. |
|  | $\mathrm{F}_{\mathrm{pa}}$ | 0.42 | Flim * 0.72 |

(unchanged since: 2010)

## H. Other Issues

## None

## I. References

Arbault S., P. Camus and C. Le Bec, 1986. Estimation du stock de sole (Solea vulgaris, Quensel 1806) dans le golfe de Gascogne à partir de la production d'œufs. J. Appl. Ichtyol. , 4, 145156.

KoutsiKopoulos C., D. Dorel, Y. Desaunay, B. Le Cann and A. Forest, 1993. Interaction entre processus physiques et comportement individuel : conséquence sur l'organisation et le fonctionnement du stock de sole (Solea solea L.) du golfe de Gascogne. Les recherches françaises en évaluation quantitative et modélisation des ressources et des systèmes halieutiques. Actes du premier Forum Halieumétrique, Ortom ed., 49-74.

Guichet R., Ph. Moguedet, B. Mesnil and A. Battaglia, 1998. Echantillonnage biologique des rejets de poissons et autres organismes dans le golfe de Gascogne. Rapport final du Contrat BIO ECO 94-054 CEE DG XIV. IFREMER La Rochelle, 121 p.

Le Pape O., Chauvet F., Mahevas S., Lazure L., Guérault G. \& Désaunay, Y. (2003a). Quantitative description of habitat suitability for the juvenile common sole (Solea solea, L.) and contribution of different habitats to the adult population in the Bay of Biscay (France). J. Sea Res. 50, 139-149.

Le Pape O., Désaunay, Y. \& Guérault G. (2003b). Relationship between fluvial discharge and sole (Solea solea) recruitment in the Bay of Biascay (France), ICES Marine Science Symposia 219: 241-248

## Quality Handbook

ANNEX: G - Southern Hake
Stock specific documentation of standard assessment procedures used by ICES.

| Stock | Southern hake (Division VIIIc IXa) |
| :--- | :--- |
| Working Group: | WGHMM (WKROUND2010) |
| Date: | February 2010.( revised May 2011) |
| Revised by | Santiago Cerviño, Ernesto Jardim and Daniel |
|  | Howell |

## A. General

## A.1. Stock definition

Southern hake stock comprises the Atlantic coast of Iberian Peninsula corresponding with the ICES divisions VIIIc and IXa. The Northern limit is in the Spanish - French boundary and the Southern one in Gibraltar Strait. These boundaries were defined based on management considerations without biological basis.

Atlantic and Mediterranean European hake are usually considered as different stocks due to the differences in biology (i.e. growth rate or spawning season) of the populations in both areas. In the North Eastern Atlantic, there is no clear evidence of the existence of multiple hake populations, although Roldán et al. (1998) based on genetic studies states that "the data (...) indicate that the population structure within the Atlantic is more complex than the discrete northern and southern stocks proposed by ICES". It is likely that there is a degree of transfer between the Southern and Northern hake stocks, and recent studies on population genetics support that (Balado et al., 2003; Pita et al., 2010), however there is at present a lack of data to quantify the amount of migrations between stocks.

## A.2. Fishery

Hake in divisions VIIIc and IXa is caught in a mixed fishery by the Spanish and Portuguese fleets (trawls, gillnetters, longliners and artisanal fleets).

The Spanish trawl fleet is quite homogeneous and uses mainly two gears, pair trawl and bottom trawl. The percentage of hake present in the landings is small as there are other important target species (i.e. anglerfishes, megrims, Norway lobster, blue whiting, horse mackerel and mackerel). During recent years there has been an increase in Spanish trawlers using a new High Vertical Opening gear towed by single vessels and targeting the pelagic species listed above. In contrast, the artisanal fleet is very heterogeneous and uses a wide variety of gears; traps, large and small gillnet, long lines, etc. The trawl fleet landings length composition, since the implementation of the minimum landing size in 1991, has a mode around 29-31 cm depending on the year. Artisanal fleets target different components of the stock depending on the gear used. Small gillnets catch smaller fish than gillnets and long lines, which target mainly large fish and have length composition with a mode above 50 cm . Hake is an
important component of the catch for these fleets mainly due to the high prices that reaches in the Iberian markets.

Hake is caught by the Portuguese fleet in the trawl and artisanal mixed fisheries together with other fish species and crustaceans. These include horse mackerel, anglerfish, megrim, mackerel, Spanish mackerel, blue whiting, red shrimp (Aristeus antennatus), rose shrimp (Parapenaeus longirostris) and Norway lobster. The trawl fleet comprises two distinct components - the trawl fleet catching demersal fish ( 70 mm mesh size) and the trawl fleet targeting crustaceans ( 55 mm mesh size). The fleet targeting fish species operates along the entire Portuguese coast at depths between 100 and 200 m . The trawl fleet targeting crustaceans operates mainly in the southwest and south in deeper waters, from 100 to 750 m . The most important fishing harbours from Northern Portugal are: Matosinhos, Aveiro and Figueira Foz, from Central Portugal are: Nazaré, Lisboa and Sines and Southern Portugal are: Portimão and Vila Real Santo António. The artisanal fleet lands hake mainly in the fishing harbours of the Centre. The main fishing harbours are Póvoa do Varzim (North), Sesimbra (Centre) and Olhão (South). Landings recorded by month show that the majority of the hake landings occur from May until October for both fleets.

## A.3. Ecosystem aspects

European hake presents indeterminate fecundity and asynchronous development of the oocytes (Andreu, 1956; Murua et al., 1998; Domínguez-Petit, 2007). It is a serial or batch spawner (Murua et al., 1996). Duration of spawning season at the population level may differ between areas (Pérez and Pereiro, 1985; Alheit and Pitcher, 1995; Ungaro et al., 2001; Domínguez-Petit, 2007); but a latitudinal gradient exists such that the latest peaks of spawning occur in higher latitudes. In general, adults breed when water temperatures reach $10^{\circ}$ or $12^{\circ} \mathrm{C}$, changing their bathymetric distribution depending on the region they are in and the local current pattern, releasing eggs at depths from 50 to 150m (Murua et al., 1996; 1998; Alheit and Pitcher, 1995). In general males mature earlier than females. Size at maturity is determined by densitydependent factors like abundance or age/length population structure and density independent factors like environmental conditions or fishing pressure (Domínguez et al., 2008). L50 varies between areas; in the Atlantic populations is between $40-47 \mathrm{~cm}$ (Lucio et al., 2002; Piñeiro and Saínza, 2003; Domínguez-Petit, 2007) and in the Mediterranean ones between 25 and 40 cm (Alheit and Pitcher, 1995; GarcíaRodríguez and Esteban, 1995; Ungaro et al., 2001). Besides, temporal fluctuations in size at maturity within the population have been also observed what probably reflects changes in growth rate (Domínguez et al., 2008). Changes in maturity parameters affect stock reproductive potential, because smaller and younger females have different reproductive attributes than larger and older individuals (Solemdal, 1997; Trippel et al., 1997). Maternal physiological status, spawning experience (recruit or repeat spawners) or food rations during gametogenesis are all known to alter fecundity, egg and larval quality, as well as duration of the spawning season (Hislop et al., 1978; Kjesbu et al., 1991; Trippel, 1999; Marteinsdottir and Begg, 2002). Change in stock structure entails a compensatory response of age/size at maturity because depletion of large fish can be compensated by increased egg production by young fish (Trippel, 1995).

Hake recruitment indices have been related to environmental factors. High recruitments occur during intermediate oceanographic scenarios and decreasing recruitment is observed in extreme situations. In Galicia and the Cantabrian Sea, generally moderate environmental factors such as weak Poleward Currents,
moderate upwelling and good mesoscale activity close to the shelf lead to strong recruitments. Hake recruitment leads to well-defined patches of juveniles, found in localized areas of the continental shelf. These concentrations vary in density according to the strength of the year-class, although they remain generally stable in size and spatial location. These authors have related the year-on-year repetition of the spatial patterns to environmental conditions. In the eastern, progressively narrowing, shelf of the Cantabrian Sea, years during which there is massive inflow of the eastward shelf-edge current produce low recruitment indices, due to larvae and prerecruits being transported away from spawning areas to the open ocean.

In Portuguese continental waters the abundance of small individuals is higher between autumn and early spring. In the Southwest main concentrations occur at 200-300 m depth, while in the South they are mainly distributed at coastal waters. In the North of Portugal recruits are more abundant between 100-200 m water depths. These different depth-areas associations may be related with the feeding habits of the recruits, since the zooplankton biomass is relatively higher at those areas.

Hake is a highly ichthyophagous species with euphausiids although decapod prawns are an important part of its diet for smaller hake (> 20 cm ). In Galicia and the Cantabrian Sea hake is one of the apex predators in the demersal community, occupying together with anglerfish one of the highest trophic levels (Velasco et al., 2003). Its diet at $>30 \mathrm{~cm}$ is mainly composed of blue whiting, while other species such as horse mackerel and clupeids are only important in shallow waters and in smaller individuals that also feed on other small fishes. Along the Portuguese coast the diet of hake is mainly composed of crustaceans (particularly decapods) and fish. The main food items include blue whiting, sardine, snipefish, decapods and mysids. Cannibalism in the diet of hake is highly variable depending on predator size, alternative prey abundance, year or season. Cannibalism in stomach content observations ranged from 0 to $30 \%$ of total volume, with mean values about $5 \%$ this values produces a high natural mortality in younger ages. An age-length assessment with GADGET taken into account cannibalism was presented in 2009 WGHMM (WD 7). Natural mortality estimation for ages 0 and 1 are substantial reaching values about 1 for age 0 and 0.5 for age 1 . Projections show differences in recovery trajectories when compared with a model without cannibalism.

## B. Data

## B.1. Commercial catch

## Landings

The landings data used in the Southern Hake assessment are based on: (i) Portuguese sales notes compiled by the National Fisheries and Aquaculture Directorate; (ii) Spanish sales notes and owners associations data compiled by IEO; and (iii) Basque Country sales notes and Ship Owners data compiled by AZTI.
All landings since 1994 were reviewed and computed by quarter. From 1982 to 1993 annual landings were split by quarters assuming the same quarter distribution than in 1994.

Landings from the Gulf of Cadiz were compiled and included on the assessment by quarter, following the same procedure as for other landings.

The length distributions of landings were also computed by quarter after 1994. For the previous period it was assumed that the existing annual length distribution was caught in the middle of the year.

## Discards

A Spanish Discard Sampling Programme is being carried out in Divisions VIIIc and IXa North since 1993. The series provides information on discarded catch in weight and number and length distributions for Southern hake. Spanish sampling was carried out in 1994, 1997, 1999-2000 and 2003 onwards. The number of trips sampled by the Spanish program was distributed by three trawl fleets: Baca otter trawl, Pair trawl and HVO (High Vertical Opening) trawl. Total discards were estimated raising sampling with effort. This series was revised and computed by quarter from 2004 onwards.

The Portuguese Discard Sampling Programme started in 2003 (second semester) and is based on a quasi-random sampling of co-operative commercial vessels. Two trawl fleets are sampled in this programme: Crustacean Trawl and Fish Trawl fleets. The discards estimation method was revised to take into account fishing hours as auxiliary variable and include outlier analysis (see Southern hake WD 2).

Both series of discarded weights were rebuilt back to 1992 based on the relations between (i) discards and surveys, and (ii) discards and landings (see Southern hake WD 4), with the aim of integrating them in assessment models.

## B.2. Biological

The sampling of commercial landings is carried out by the Fisheries Institutes involved in the fishery assessment (AZTI, IEO and IPIMAR) since 1982, except in the Gulf of Cadiz were length distribution are available only since 1994.

The length composition sampling design follows a multistage stratified random scheme by quarter, harbour and gear.

An international length-weight relationship for the whole period has been used since 1999 ( $\mathrm{a}=0.00000659, \mathrm{~b}=3.01721$ ).

Age information (otoliths) are collected by IEO, AZTI and IPIMAR and ages determined based on the recommendations of WKAEH (WKAEH, 2009). However, due to doubts on growth patterns and unstable ageing criteria, a von Bertalanffy growth model with $\mathrm{t} 0=0, \operatorname{Linf}=130 \mathrm{~cm}$ and $\mathrm{k} \sim 0.16$ (re-estimated by the model every year) is used. The growth parameters were decided based on (i) tagging data collected for the north stock in French coast (there is no information to assume a different growth (see point A.1), and (ii) k estimates by the assessment models carried out during the Benchmark WK.

Natural mortality was assumed to be 0.4 year- 1 , instead of the past 0.2 . The rationale is that if hake growths about two times faster, the hake longevity is reduced around half (from age $\sim 20$ to $\sim 10$ ). Hewit and Hoening (2005) estimate a relationship among longevity and M that produces a figure around 0.4 . This value was set equal for all ages.

Maturity proportions-at-length was estimated with sexes combined from IEO sampling. Data available from IPIMAR and AZTI since 2004 were not considered due to inconsistencies with the IEO data. Maturity at length used to estimate population mature biomass was estimated with a logistic function (outside GADGET model) for
years 1982 to 2010. There are relevant changes in yearly maturity (Dominguez et al., 2007).

## B.3. Surveys

The Spanish October groundfish (spGFS-WIBTS-Q4) survey uses a stratified random sampling design with half hour hauls and covers the northwest area of Spain from Portugal to France during September/October since 1983 (except 1987).

Two ground fish surveys are carried out annually in the Gulf of Cadiz - in March, from 1994, and in November (spGFS-caut-WIBTS-Q4), from 1997. A stratified random sampling design with 5 bathymetric strata, covering depths between 15 and 700 m , is used in this area, with one hour hauls. Hake otoliths have been collected since 2000.

The Portuguese October groundfish (ptGFS-WIBTS-Q4) has been carried out in Portuguese continental waters since 1979 on board the RV "Noruega" and RV "Capricórnio". Recent work on calibration of these vessels showed a higher catchability of Capricórnio, in particular at lower sizes, as a consequence these years were calibrated. The main objective of this survey is to estimate hake's abundance indices to be used in stock assessment (Anon., 2008). A stratified sampling design was used from 1989 until 2004. In 2005 a new hybrid random-systematic sampling design was introduced, composed by a regular grid with a set of additional random locations (Jardim and Ribeiro Jr., 2007; Jardim and Ribeiro Jr., 2008). The tow duration was 60 minutes until 2001 and reduced to 30 minutes for the subsequent years, based on results of an experiment showing no significant differences in the mean abundance and length distribution between the two tow durations (Cardador personal communication, 2007).
The Portuguese July groundfish (P-GFS-jul) survey has not been conducted since 2002.

A new survey, the Portuguese February groundfish (ptGFS-WIBTS-Q1), and has been carried out since 2005, with the aim of covering hake's spawning season.

## B.4. Commercial CPUE

Effort series are collected from Portuguese logbooks and compiled by IPIMAR, and from Spanish sales notes and Owners Associations data and compiled by IEO.

Landings, LPUE and effort are available for Coruña trawl (SP-CORUTR), Coruña pair trawl (SP-CORUTRP), Vigo/Marin trawl (SP-VIMATR), Santander trawl (SP-SANTR), Cadiz Trawl and Portuguese trawl (P-TR) fleets. Tuning data table (below) shows details about these surveys as well as which of them are used in the assessment model.

The CPUE series (1989-2008) of Portuguese trawlers is standardized using a GLM model with Gamma residuals, a "log" link function and explanatory variables year, zone, engine power, metier, percentage of hake in the catch, level of total catch and level of fishing effort. A working document presented to the benchmark documents the procedure (Southern hake WD 1).

## B.5. Other relevant data

Tagging data from IFREMER have been used to help estimating Bertalanffy's growth parameters.

## C. Historical Stock Development

Until 2009 this stock was assessed with VPA models based on ages estimated from ALK. Since 2010, based on the decisions of the Benchmark a GADGET model was introduced.

## C.1. Description of gadget

Gadget is a shorthand for the "Globally applicable Area Disaggregated General Ecosystem Toolbox", which is a statistical model of marine ecosystems. Gadget (previously known as BORMICON and Fleksibest). Gadget is an age-length structured forward-simulation model, coupled with an extensive set of data comparison and optimisation routines. Processes are generally modelled as dependent on length, but age is tracked in the models, and data can be compared on either a length and/or age scale. The model is designed as a multi-area, multi-area, multi-fleet model, capable of including predation and mixed fisheries issues, however it can also be used on a single species basis. Gadget models can be both very data- and computationally- intensive, with optimisation in particular taking a large amount of time. Worked examples, a detailed manual and further information on Gadget can be found on www.hafro.is/gadget. In addition the structure of the model is described in Begley and Howell (2004), and a formal mathematical description is given in Frøysa et al (2002).

Gadget is distinguished from many stock assessment models used within ICES (such as XSA) in that Gadget is a forward simulation model, and is structured be both age and length. It therefore requires direct modelling of growth within the model. An important consequence of using a forward simulation model is that the plus groups (in both age and length) should be chosen to be large enough that they contain few fish, and the exact choice of plus group does not have a significant impact on the model.

## Setup of a gadget run

There is a separation of model and data within Gadget. The simulation model runs with defined functional forms and parameter values, and produces a modelled population, with modelled surveys and catches. These surveys and catches are compared against the available data to produce a weighted likelihood score. Optimisation routines then attempt to find the best set of parameter values Growth is modelled by calculating the mean growth for fish in each length group for each time step, using a parametric growth function. In the hake model a Von Bertanlanffy function has been employed to calculate this mean growth. The actual growth of fish in a given length cell is then modelled by imposing a beta-binomial distribution around this mean growth. This allows for the fish to grow by varying amounts, while preserving the calculated mean. The beta-binomial is described in Stefansson (2001). The beta-binomial distribution is constrained by the mean (which comes from the calculated mean growth), the maximum number of length cells a fish can grow in a given time step (which is set based on expert judgement about the maximum plausible growth), and a parameter $\beta$, which is estimated within the model. In addition to the spread of growth from the beta-binomial distribution, there is a minimum to this spread due by discretisation of the length distribution.

## Catches

All catches within the model are calculated on length, with the fleets having sizebased catchability. This imposes a size-based mortality, which can affect mean weight and length at age in the population (Kvamme 2005). A fleet (or other preditor) is modelled so that either the total catch in each area and time interval is specified, or this the catch per timestep is estimated. In the hake assessment described here the commercial catch and the discards are set (in kg per quarter), and the surveys are modelled as fleets with small total landings. The total catch for each fleet for each quarter is then allocated among the different length categories of the stock according to their abundance and the catchability of that size class in that fleet.

## Likelihood Data

A significant advantage of using an age-length structured model is that the modelled output can be compared directly against a wide variety of different data sources. It is not necessary to convert length into age data before comparisons. Gadget can use various types of data that can be included in the objective function. Length distributions, age length keys, survey indices by length or age, CPUE data, mean length and/or weight at age, tagging data and stomach content data can all be used. Importantly this ability to handle length date directly means that the model can be used for stocks such as hake where age data is sparse or considered unreliable. Length data can be used directly for model comparison. The model is able to combine a wide selection of the available data by using a maximum likelihood approach to find the best fit to a weighted sum of the datsets.

## Optimisation

The model has two alternative optimising algorithims linked to it, a wide area search simulated annealing Corona et al. (1987) and a local search Hooke and Jeeves algorithim HookeJeeves1961. Simulated annealing is more robust than Hooke and Jeeves and can find a global optima where there are multiple optima but needs about 2-3 times the order of magnitude number of iterations than the Hooke and Jeeves algorithim. The model is able to use both in a single run optimisation, attempting to utilize the strengths of both. Simulated annealing is used first to attempt to reach the general area of a solution, followed by Hooke and Jeeves to rapidly home in on the local solution. This procedure is repeated several times to attempt to avoid converging to a local optimum. The algorithms are not gradient based, and there is therefore no requirement on the likelihood surface being smooth. Consequently neither of the two algorithims returns estimates of the Hessian.

## Likelihood weighting

The total objective function to be minimised is a weighted sum of the different components. Selection of the weights is based on expert knowledge about the quality of the data and the space-time coverage of each data set, and the internal variance of the data set. An internal weight based on individual adjustments of the model (var) is used to reflect the variability of the data set. This was done by optimising the model to each data set in turn, and inverting the resulting objective score to use as a weight for that data set. This has the effect of assigning high weights to low variance data sets, and low weights to low variance ones. It also normalizes the weighted contribution of the different data sets. These weights were then adjusted to account for the length of the data series, the coverage of the area inhabited by the stock, and an expert judgement about the relative quality of the different data. The final column
(\% weight) in the table below gives the final weighted contribution of each data set to the optimised objective function.

Finding these weights is a lengthy procedure, but it does not generally need to be repeated for each assessment. Rather, the current weights can be used for several years. The weighted contribution of the data sets in a new assessment should be computed, and compared against the previous year. Provided the relative contributions are similar then the model results should be comparable between years.

## C.2. Settings for the hake assessment

Population is defined by 1 cm length groups, from $1-130 \mathrm{~cm}$ and the year is divided into four quarters. The age range is 0 to 15 years, with the oldest age treated as a plus group. Recruitment happens in the first and second quarter. The length at recruitment is estimated and mean growth is assumed to follow the von Bertalanffy growth function with Linf=130 and $k$ estimated by the model.

An international length-weight relationship for the whole period has been used since 1999 ( $\mathrm{a}=0.00000659, \mathrm{~b}=3.01721$ ).

Natural mortality was assumed to be 0.4 year $^{-1}$
The commercial landings are modelled as two fllets (1982-93 and 1994-08) with a selection pattern described by a logistic function. Cadiz data is modeled as an independent fleet from 1982-04 (andersen function, see gadget manual for more information) and added to landings fleet from 2005-08. Discards from 1992-08 follows a Andersen function. The same function was used for Spanish survey, Cádiz survey and Portuguese survey. The surveys, on the other hand is modelled as fleet with constant effort and a nonparametric selection pattern that is estimated for three 15 cm length groups.

Data used for the assessment are described below:

| description | period | by quarter | area | Likelihood component |
| :---: | :---: | :---: | :---: | :---: |
| Length distribution of landings | 1994-lastYear | YES | Iberia | Land1.ldist |
| Length distribution of landings | 1982-1993 | NO | Iberia | Land.ldist |
| Length distribution of landings in Cadiz | 1994-lastYear | YES | Gulf of Cadiz | cdLand.ldist |
| Length distribution of Spanish GFS | 1982-lastYear | - | North Spain | SpDem.ldist |
| Length distribution of Spanish GFS | 1989-lastYear | - | Portugal | PtDem.ldist |
| Length distribution of Spanish GFS in Cadiz | 1990-lastYear | - | Gulf of Cadiz | CdAut.ldist |
| Length distribution of discards | 1994, 1998, 1999, 2004-lastYear | YES | Iberia | Disc.ldist |
| Abundace index of Spanish GFS of $4-19$ cm individuals | 1982-lastYear | - | North Spain | SpIndex15cm. 1 |
| Abundace index of Spanish GFS of $20-35 \mathrm{~cm}$ individuals | 1982-lastYear | - | North Spain | SpIndex 15 cm .2 |
| Abundace index of Spanish GFS of $36-51 \mathrm{~cm}$ individuals | 1982-lastYear | - | North Spain | SpIndex 15 cm .3 |
| Abundace index of Portuguese GFS of 4-19 cm individuals | 1989-2011 | - | Portugal | PtIndex 15 cm .1 |
| Abundace index of Portuguese GFS of 20-35 cm individuals | 1989-2011 | - | Portugal | PtIndex 15 cm .2 |
| Abundace index of Portuguese | 1989-2011 | - | Portugal | PtIndex 15 cm .3 |

GFS of $36-51 \mathrm{~cm}$ individuals
Abundace index of Spanish 1994-lastYear YES North Spain SpCPUE15cm. 1 trawlers from A Coruña of 25-39 cm individuals
Abundace index of Spanish 1994-lastYear YES North Spain SpCPUE15cm. 2 trawlers from A Coruña of 40-54 cm individuals
Abundace index of Spanish 1994-lastYear YES North Spain SpCPUE15cm. 3 trawlers from A Coruña of 55-70 cm individuals
Standardized abundace index of 1989-2010 YES Portugal PtCPUE15cm. 1 Portuguese trawlers of 25-39 cm individuals

Standardized index of Portuguese 1989-2010 Y E S Portugal PtCPUE15cm. 2 trawlers of 40-54 cm individuals

Standardized index of Portuguese 1989-2010 YES Portugal PtCPUE15cm. 3 trawlers of $55-70 \mathrm{~cm}$ individuals

Description of the likelihood components weighting procedure and relative contribution to the final total likelihood (Note that relative contribution may change from year to year depending on the new data used to fit the model):

| Likelihood component | var | quarters | quality | area | Multiplicative <br> Weight | Relative <br> contribution |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Land1.ldist | 0.66 | 44 | 2 | 1 | 133.2 | 0.2 |
| Land.ldist | 0.91 | 72 | 3 | 0.9 | 213.9 | 0.32 |
| cdLand.ldist | 2.5 | 52 | 2 | 0.1 | 4.2 | 0.01 |
| SpDem.ldist | 0.87 | 27 | 4 | 0.5 | 62.3 | 0.09 |
| PtDem.ldist | 0.39 | 24 | 4 | 0.4 | 99 | 0.15 |
| CdAut.ldist | 0.38 | 10 | 4 | 0.1 | 10.4 | 0.02 |
| Disc.ldist | 1.04 | 36 | 1 | 0.9 | 31.2 | 0.05 |
| SpIndex15cm.1 | 4.84 | 9 | 4 | 0.5 | 3.7 | 0.01 |
| SpIndex15cm.2 | 0.98 | 9 | 4 | 0.5 | 18.3 | 0.03 |
| SpIndex15cm.3 | 1.2 | 9 | 4 | 0.5 | 15 | 0.02 |
| PtIndex15cm.1 | 3.75 | 8 | 4 | 0.4 | 3.4 | 0.01 |
| PtIndex15cm.2 | 1.34 | 8 | 4 | 0.4 | 9.5 | 0.01 |
| PtIndex15cm.3 | 0.52 | 8 | 4 | 0.4 | 24.5 | 0.04 |
| SpCPUE15cm.1 | 2.37 | 5 | 2 | 0.5 | 2.1 | $<0.01$ |
| SpCPUE15cm.2 | 0.23 | 5 | 2 | 0.5 | 21.5 | 0.03 |
| SpCPUE15cm.3 | 1.55 | 5 | 2 | 0.5 | 3.2 | 0.01 |
| PtCPUE15cm.1 | 0.46 | 6.67 | 2 | 0.4 | 11.6 | 0.02 |
| PtCPUE15cm.2 | 1.39 | 6.67 | 2 | 0.4 | 3.8 | 0.01 |
| PtCPUE15cm.3 | 0.76 | 6.67 | 2 | 0.4 | 7 | 0.01 |

The parameters estimated are:

- The number of fish by age when simulation starts. (ages 1 to 8 ) .8 params
- Recruitment each year. (1982 to 2010). 27 params
- The growth rate ( k ) of the von Bertalanffy growth model.
- Parameter $\beta$ of the beta-binomial distribution.
- The ratio between recruitment in the first and second quarter.
- The selection pattern of:
- the commercial catches (1982-93). 2 params
- Landings (1994-2010) . 2 params
- Cadiz landings (1982-2004) . 3 params
- Discards (1992-10) . 3 params
- Spanish Survey . 3 params
- Portugese Survey . 3 params
- Cadiz autumn Survey . 3 params
- Catchability of :
- Spanish Survey ( 3 groups from 4 cm by 15 cm ) .3 params
- Portugese Survey . (3 groups from 4 cm by 15 cm ) . 3 params
- Spanish CPUE (3 groups from 25 cm by 15 cm ) . 3 params
- Portugese CPUE ( 3 groups from 25 cm by 15 cm ) . 3 params


## 71 parameters in total

The estimation can be difficult because of some or groups of parameters are correlated and therefore the possibility of multiple optima cannot be excluded. The optimisation was started with simulated anneling to make the results less sensitive to the initial (starting) values and then the optimisation was changed to Hooke and Jeeves when the 'optimum' was approached. Multiple optimisation cycles were conducted to ensure that the model had converged to an optimum, and to provide opportunities to escape convergence to a local optimum.

The model fit were analysed with the following diagnostics:

- Profiled likelihood plots. To analize convergence and problematic parameters.
- Plot comparing observed and modeled proportions in fleets (catches, landings or discards). To analize how estimated population abundance and explotation pattern fits observed proportions.
- Plot for residuals in catchability models. To analyze precision and bias in abundance trends.


## D. Short-Term Projection

Model used: Age-length forward projection
Software used: GADGET (script: predict.st.sh)
Initial stock size: estimates at the final of the assessment period estimated by the gadget model, with recruitment replaced by geometric mean (1989-Y-1), if last year recruitment estimate rejected by the group.

Maturity: arithmetic mean of last 3 years
F and $M$ before spawning: NA
Weight at age in the stock: modeled in GADGET with VB parameters and length weight relationship

Weight at age in the catch: modeled in GADGET with VB parameters and length weight relationship

## Exploitation pattern:

GADGET is a length-age based forward projection model, structured by quarter for southern hake. Two different "fleets" are used for projections, landing fleet with a logistic selection pattern, and discards fleet with a Andersen selection pattern. Although each fleet has a constant selection pattern function, the level of exploitation can be distinct by quarter. 8 F multipliers are required for projections ( 2 fleets * 4 quarters), which are computed by averaging the last 3 years by quarter and fleet.

Intermediate year assumptions: If there is a trend in mean $F$ of last 3 years the multipliers are scaled to last year's F bar (ages 1-3), so that a single scaling factor is applied to all quarters. Otherwise the multipliers are not scaled (script: multF.r).

Stock recruitment model used: geometric mean of years 89 to last year minus one.
Procedures used for splitting projected catches: driven by the selection patterns estimated by gadget for each "fleet" (landings and discards).

## E. Medium-Term Projections

NA

## F. Long-Term Projections

F multipliers are set in the way described for short term projections.
Model used: Age-length forward projection until 2100
Software used: GADGET (script: predict.lt.sh)
Maturity: arithmetic mean of last 3 years
F and M before spawning: NA
Weight at age in the stock: modelled in GADGET with VB parameters and length weight relationship

Weight at age in the catch: modelled in GADGET with VB parameters and length weight relationship

Exploitation pattern:
Landings: logistic selection parameters estimated by GADGET.
Discards: Andersen (asimetric) selection parameters estimated by GADGET.
Stock recruitment model used: geometric mean of years 89 to last year minus one.
Procedures used for splitting projected catches: driven by different selection functions (logistic for landings, Andersen for discards) and provide by GADGET.

## G. Biological Reference Points

F max $=0.24$ was set as a proxy for Fmsy
No other BRPs set.

## H. Other Issues and further work

It should be noted that new assessment model have been developed to avoid the reliance on age-based data. This new model is considered to be an improvement on the previous method given the problems related to age data described previously. However both are new, complex, and significantly different from the previous models. It is therefore likely that refinements and updates will be required over the coming years to both models and further consideration given to the data used. The panel (WKROUND, 2010) considers that ICES should be flexible in allowing model improvements during the Assessment Working Groups and on an inter-sessional basis. ICES should therefore ensure that resources are in place to evaluate these improvements.

In the line of previous paragraph it is worth mention that change in projection was caused by a misinterpretation regarding the way GADGET makes projections that drove to wrong results. The definition the 8 F multipliers instead of just 4 (one for each quarter) allows to a correct balance of discards and landings. Using the mean of last 3 years allows avoiding excessive weight of a unexpected data (quarter/fleet).

## I. References

- Alheit, J. and T.J. Pitcher. 1995. Hake: fisheries, ecology and markets. Chapman \& Hall. London. Fish and Fisheries Series. Vol. 15. 478pp.
- Andreu B. 1956. Observaciones sobre el ovario de merluza (Merluccius merluccius) y características del mecanismo de puesta. Investigación Pesquera. Vol. IV: 49- 66.
- Balado, M., M. Perez and P. Presa. 2003. Influence of marine currents on the gene flow among Atlantic populations of Merluccius merluccius. Thalassas 19. 91:92.
- Begley, J., and Howell, D. 2004. An overview of Gadget, the Globally applicable AreaDisaggregated General Ecosystem Toolbox. ICES C.M. 2004/FF:13, 15 pp.
- Domínguez, R., M. Korta, F. Saborido-Rey, H. Murua, M. Sainza and C. Piñeiro. 2007. Changes in size at maturity of European hake Atlantic populations in relation with stock structure and environmental regimes. Journal of Marine Systems. Vol 71: 260-278.
- Domínguez-Petit, R. 2007. Study of reproductive potential of Merluccius merluccius in the Galician Shelf. Doctoral Thesis. University of Vigo (Spain). DOI: 10261/4377.
- Frøysa, K. G., Bogstad, B., and Skagen, D. W. (2002). Fleksibest - an age-length structured fish stock assessment tool with application to Northeast Arctic cod (Gadus morhua L.). Fisheries Research 55: 87-101.
- García-Rodríguez, M. and A. Esteban. 1995. Algunos aspectos sobre la biología y pesca de la merluza mediterránea Merluccius merluccius en la bahía de Santa Pola (sureste de la Península Ibérica). Boletín del Instituto Español de Oceanografía. Vol. 11(1):3-25.

Hewitt, D.A, and J.M. Hoenig. 2005. Comparison of two approaches to estimate natural mortality based on longevity. Fish. Bull. 103: 433-437

- Hislop, J.R.G.; A.P. Ross and J.A. Gauld. 1978. Observations on effects of feeding level on growth and reproduction in haddock, Melanogrammus aeglefinus (L.) in captivity. Journal of Fish Biology. Vol. 13: 85-98.

Jardim, E., Ribeiro Jr., P., 2008. Geostatistical tools for assessing sampling designs applied to a portuguese bottom trawl survey field experience. Scientia Marina 72 (4), 623-630.

Jardim, E., Ribeiro Jr., P. J., 2007. Geostatistical assessment of sampling designs for Portuguese bottom trawl surveys. Fisheries Research 85 (3), 239-247.

- Kjesbu, O.S.; J. Klungsoyr; H. Kryvi; P.R. Witthames and M. Greer Walker. 1991. Fecundity, atresia and egg size os captive Atlantic cod (Gadus morhua) in relation to proximate body composition. Canadian Journal of Fish and Aquativ Science. Vol. 48: 2333-2343.
- Kvamme C (2005) The north-east Atlantic cod (Gadus morhua L.) stock: Gear selectivity and the effects on yield and stock size of changes in exploitation pattern and level. PhD thesis, University of Bergen, Norway.
- Lucio, P.; M. Santurtun; I. Quincoces and H. Murua. 2002. Evolution of the sexual maturity parameters of northern hake between 1987 and 2001. ICES Council Meeting Documents. CM 2002/ L: 36.
- Marteinsdottir, G. and G.A. Begg. 2002. Essential relationships incorporating the influence of age, size and condition on variables required for estimation of reproductive potential in Atlantic cod Gadus morhua. Marine Ecology Progress Series. Vol. 235: 235-256.
- Murua, H. and 1. Motos and D. Marrale. 1996. Reproductive Modality and Batch Fecundity of the European hake Merluccius merluccius. ICES Council Meeting Documents. Reykjiavik. CM1996/G: 40.
- Murua, H.; L. Motos and P. Lucio. 1998. Reproductive modality and batch fecundity of the European hake (Merluccius merluccius 1.) in the Bay of Biscay.CalCOFI Report. No. 39.
- Pérez, N. and F.J. Pereiro. 1985. Reproductive aspects of hake (Merluccius merluccius L.) on the Galician and Cantabrian shelves. Boletin del Instituto Español de Oceanografia. Vol. 2(3): 39-47.
- Piñeiro, C. and M. Saínza. 2003. Age estimation, growth and maturity of the European hake (Merluccius merluccius) from Iberian Atlantic waters. ICES Journal of Marine Science. Vol. 60: 1068-1102.
- Pita. P., P. Presa \& M. Perez. 2010. Gene Flow, Individual Assignment And Genetic Structuring Of European Hake (Merluccius Merluccius) Stocks. Thalassas, 25 (3) Special issue: 129-133
- Solemdal, P. 1997. Maternal effects - A link between the past and the future. Journal of Sea Research. Vol. 37(3-4): 213-227.
- Trippel, E.A. 1995. Age at maturity as a stress indicador in fisheries. BioScience. Vol. 45(11): 759-771.
- Trippel, E.A. 1999. Estimation of stock reproductive potential: history and challenges for Canadian Atlantic gadoid stock assessments. Variations in maturation, growth, condition and spawning stock biomass production in groundfish. Journal of Northwest Atlantic fishery science . Vol. 25: 61-81.
- Trippel, E. A.; M.J. Morgan; A. Fréchet; C. Rollet; A. Sinclair; C. Annand; D. Beanlands and L. Brown. 1997. Changes in age and length at sexual maturity of northwest Atlantic cod, haddock and pollock stocks, 1972-1995. Canadian Technical Report of Fisheries and Aquatic Sciences 2157.120 pp .
- Ungaro, N.; N. Vrgoc and P. Mannini. 2001. The biology and stock assessment of Merluccius merluccius (L.) in the Adriatic Sea: an historical review by geographical management units. FAO Scientific Cooperation to Support Responsible Fisheries in the Adriatic Sea (Adriamed). Italia.: 12pp.
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\begin{array}{cl}\text { Annex H } \quad \text { Stock Annex } & \begin{array}{c}\text { Southern white anglerfish (Lophius } \\
\text { piscatorius) (Divisions VIIIc, IXa) }\end{array} \\
\hline \begin{array}{l}\text { Quality Handbook } \\
\text { Stock specific documentation of standard assessment procedures used by ICES. } \\
\text { Stock } \\
\text { Working Group: }\end{array} & \begin{array}{l}\text { Stock Annex H }\end{array}
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Assessment of Southern Shelf Stocks of Hake, Monk <br>

and Megrim\end{array}\right\}\)| 23/05/2013 |
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| Revised by |

## A. General

## A. 1 Stock definition

The two species of anglerfish (the white, Lophius piscatorius, and the black, L. budegas$s a$ ) are Northeastern Atlantic species; however black anglerfish has a more southerly distribution. White anglerfish is distributed from Norway (Barents Sea) to the Strait of Gibraltar (and including the Mediterranean and the Black Sea) and black anglerfish from the British Isles to Senegal (including the Mediterranean and the Black Sea). Anglerfish occur in a wide range of depths, from shallow waters to at least 1000 m . Information about spawning areas and seasonality is scarce, therefore the stock structure remains unclear. This lack of information is due to their particular spawning behaviour. Anglerfish eggs and larvae are rarely caught in scientific surveys.

ICES gives advice for the management of several anglerfish spp. stocks in European waters: one stock on the Northern Shelf area, that includes anglerfish from the Northern Shelf, Division IIIa, Subarea IV and Subarea VI, and Norwegian Sea, Division IIa, and the stocks on the Southern Shelf area, one in Divisions VIIb-k and VIIIa,b and d and the Southern stocks in Divisions VIIIc and IXa. The stock under this Annex is called Southern White Anglerfish and is defined as white anglerfish in Divisions VIIIc and IXa. The boundaries of anglerfish in Divisions VIIb-k and VIIIa,b and d and Southern Anglerfish stocks were established for management purposes and they are not based on biological or genetic evidences (GESSAN, 2002; Duarte et al., 2004; Fariña et al., 2004).

Although the stock assessment is carried out separately for each species, white and black anglerfish are caught and landed together, due to that, the advice is given for individual and the combined species. There is a unique TAC for both species.

## A. 2 Fishery

Anglerfish in ICES Divisions VIIIc and IXa is exploited by Spanish and Portuguese vessels, since 2000 the Spanish landings being more than $81 \%$ for both anglerfish total reported landings. International catches for these two stocks have increased since the beginning of the 1980s, until a maximum was reached in 1988 (10 021 t ). They have decreased to $1801 \mathrm{t}-1802 \mathrm{t}$ in 2001-2002. In the 2005-2011 period the catches were between

1774 t and 4500 t . Both species are caught on the same grounds by the same fleets and are marked together.

White and black anglerfish are caught together by Spanish and Portuguese bottom trawlers and gillnet fisheries. Spanish and Portuguese bottom trawlers are mixed fisheries. The Spanish bottom-trawl fleet predominantly targets hake, megrim, Norway lobster and anglerfish. Since 2003 the alternative use of a trawl gear with High Vertical Opening (HVO) has taken place in higher proportion relative to previous years. This gear targets horse mackerel and mackerel with very few anglerfish catches. Since 2002, the Spanish landings were on average $61 \%$ from the trawl fleet and $39 \%$ from the gillnet fishery. The Spanish gillnet fishery can use different artisanal gears, but most catches come from "Rasco" that is a specific gear targeting anglerfish.

Anglerfish are caught by Portuguese fleets in trawl and artisanal mixed fisheries. Portuguese landings were on average, from 2002, 19\% from trawlers and $81 \%$ from artisanal fisheries. The trawl fleet has two components, the trawl fleet targeting demersal fish and trawl fleet targeting crustaceans. Since 2005, Portuguese combined species landings were TAC constrained and very low landings were registered during the 4th quarter since then.

Discarding in white anglerfish is considered low for the trawl fishery, based on estimated data for Spanish trawl fleet (ICES, 2011) and information from Portuguese trawl fleet (ICES, 2012a).

Each year, the European Union sets a combined TAC and quota for white and black anglerfish. There is no minimum landing size for anglerfish, but in order to ensure marketing standards a minimum landing weight of 500 g was fixed in 1996 by the Council Regulation (EC) No.2406/96.

As part of the Recovery Plan for the Southern hake and Iberian Nephrops stocks (Council Regulation (EC) No.2166/2005), in force since January of 2006, the fishing effort regulations are affecting the Spanish and Portuguese mixed trawl fisheries. As anglerfish are taken in these mixed trawl fisheries, these stocks are also affected by the recovery plan effort limitation.

## A. 3 Ecosystem aspects

White anglerfish is a benthic species that occur on muddy to gravelly bottoms. It attains a maximum size of around 163 cm corresponding to a weight of approximately 51 kg . Historically white anglerfish has been considered a slow growing species, with a late maturation (Duarte et al., 2001). Nevertheless, new evidences from marrecapture experiments indicate that the anglerfish growth could be faster (Landa et al., 2008).

The ovarian structure of anglerfish differs from most other teleosts. It consists of very long ribbons of a gelatinous matrix, within individual mature eggs floating in separate chambers (Afonso-Dias and Hislop, 1996). The spawning of the Lophius species is very particular, with eggs extruded in a buoyant, gelatinous ribbon that may measure more than 10 m and contain more than a million eggs (Afonso-Dias and Hislop, 1996; Hislop et al., 2001; Quincoces, 2002). Eggs and larvae drift with ocean currents and juveniles settle on the seabed when they reach a length of $5-12 \mathrm{~cm}$. This particular spawning leads to highly clumped distributions of eggs and newly emerged larvae (Hislop et al., 2001) and favourable or unfavourable ecosystem conditions can therefore have major impacts on recruitment.

Due to their particular reproduction aspects (that shows a high parental investment in the offspring) the population dynamics of these species is expected to be highly sensitive to external biological/ecosystem factors.

Vertical displacements of immature and mature white anglerfish from the seabed to the near surface have been recorded in the Northeast Atlantic (Hislop et al., 2001) and are suggested to be related to spawning or feeding.

Improvement of knowledge regarding growth, spawning behaviour, migratory behaviour and juvenile drift are essential to present and future assessment and management of both Southern Anglerfish stocks.

## B. Data

## B. 1 Commercial catch

Landings data are provided by National Government and research institutions of Spain and Portugal. Quarterly landings by country, gear and ICES Division are available from 1978. There were unrecorded landings in Division VIIIc between 1978 and 1979, and it was not possible to obtain the total landings in those years. Portuguese landings were TAC constrained since 2005. Very low landings have been registered during the 4th quarters since then. The Portuguese landings were relatively stable during the first two years, but have decreased substantially from 2006 to 2010. In the last two years Portuguese landings have increased by 16 and $116 \%$ respectively.

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 VIIIc and IXa and Portuguese landings of Division IXa are derived from their relative proportions in market samples.

For white anglerfish the maximum landing of the available series was recorded in 1986 at 6870 t . After that, a general decline to 788 t in 2001 was observed, reaching the minimum of the available series. From 2002 to 2005 landings increased reaching 3644 t . Since 2005 landings have slowly decreased to 976 t in 2011.

## Discards

Since 1994 a Spanish Discard Sampling Programme is being carried out for trawl fleets operating in the ICES Divisions VIIIc and IXa. However, the time-series is not complete and years with discard data are 1994, 1997, 1999, 2000 and from 2003 to 2012. The raising procedure used to estimate discards was based on effort. The Portuguese Discard Sampling Programme recorded anglerfish data from 2004. The frequency of occurrence of white anglerfish in discard samples is very low and its discard is considered negligible.

## B. 2 Biological

## Landing numbers-at-length

Since 2009 the quarterly Spanish and Portuguese sampling for length compositions is by métier and ICES Division. Length data from sampled vessels are summed and the resulting length composition is applied to the quarterly landings of the corresponding métier and ICES Division. The sampled length compositions were raised for each country and SOP corrected to total landings on a quarterly or half yearly basis (when
the sampling levels by quarter were low). The average lengths of trawl caught anglerfish are lower compared to the artisanal fleets.

## Catch numbers-at-age

No catch numbers-at-age are provided to the Working Group. At the WGHMM 2007 meeting (ICES, 2007), age-length keys, based on illicia readings, were used to obtain catch number-at-age for each species. The exploratory analysis of estimates indicated that the biased age reading criterion does not allow following cohorts along years in either of the two species. The last research about white anglerfish ageing, White Anglerfish Illicia and Otoliths Exchange 2011 (ICES, 2012b), highlighted that neither illicia nor otolith age readings have been validated and, in the case of illicia studies, the agreement among readers and the precision were not acceptable. Therefore it was concluded that the available age reading criteria for white anglerfish southern stock is not valid to build an ALK.

## Growth curve

The most recent study about white anglerfish growth in Atlantic integrates results for different growth researches (tag-recapture study, length-frequency of catches, and microstructure analysis of hard parts) (Landa et al., 2008). A von Bertalanffy growth curve fitted to all data provided the parameter values $\operatorname{Linf}=140 \mathrm{~cm}$ and $\mathrm{K}=0.11$. This growth rate is faster than estimated recently using illicia for age estimation.

## Maturity-at-length

Different estimates of maturity ogive based on macroscopic maturity staging are available for white anglerfish (Duarte et al., 2001; Landa et al., 2012). In these studies the difficulty of finding mature females in the field resulted in samplings with low coverage of mature individuals. Besides, the inadequacy in same instances of the macroscopic examination to determine maturity stage, let it to consider a maturity ogive of white anglerfish from other areas. The available study was carried out in ICES Divisions VIIIabd and determined microscopically the maturity stage (Quincoces, 2002). The parameters of maturity ogive are $50 \%$ maturity at 61.84 cm and a slope at 0.1001 .

## Natural mortality

No specific studies about natural mortality of white anglerfish were available. However, taking into consideration its growth rate and the high size that can attain, a constant annual instantaneous natural mortality rate (M) of $0.2 \mathrm{yr}^{-1}$, for all ages and years, is assumed.

## Length-weight relationship

The weight at length relationship was calculated using data from an international project with a sampling that spatially covered a high proportion of the stock and which number of samples (BIOSDEF, 1998):

$$
\mathrm{W}=2.70 \times 10^{-5} \cdot \mathrm{~L}^{2.839}
$$

where $\mathrm{W}=$ weight in kilograms and $\mathrm{L}=$ length in centimetres.

## B. 3 Surveys

## SpGFS-WIBTS-Q4

The Spanish Groundfish Survey aims to collect data on the distribution and relative abundance, and biological information of commercial fish in ICES Divisions VIIIc and Northern IXa. Since 1983 it is annually carried out in fourth quarter (September/October) of the years, except for 1987. Time-series of abundance indices, in weight and in number, and correspondent length composition are available for both anglerfish species. The full time-series of this survey is used in the assessment of white anglerfish since 2012.

## PtGFS-WIBTS-Q4

Portuguese Autumn Groundfish Survey has been carried out in Portuguese continental waters since 1979 in the fourth quarter of the years. Abundance indices for both anglerfish species are available from 1989 to 2011. The abundance values detected by this survey are very low for the whole time-series, being insignificant for some years.

This survey is not used in the assessment of white anglerfish.

## B. 4 Commercial cpue

Six commercial series of landing-effort are available to the WG. Four of them are Spanish fleets in the ICES Division VIIIc and two Portuguese fleets in the ICES Division IXa. The Portuguese trawl fleet was split into fish trawlers and crustacean trawlers (WD12, Duarte et al., 2007 in ICES, 2007) according to the fleet segmentation proposed by the IBERMIX project (WD06, Castro et al., 2007 in ICES, 2007).

## SP-CORTR8C

A Coruña trawl fleet fishing in Division VIIIc is available for years 1982-2012. Data provided for A Coruña trawlers comprise quarterly effort (fishing days per 100 horse power), landings and length composition of landings. This fleet represents an average of $15 \%$ of international catches of white anglerfish along the time-series. A standardized series from 1994 to 2006 is also available for this fleet with annual effort data (in fishing days) and annual lpue.

Data from this commercial lpue series has been used in the white anglerfish assessment since 2007.

## SP-CEDGNS8C

Cedeira gillnet fleet fishing in Division VIIIc is available for years 1999-2011. Data provided for Cedeira gillnets comprise quarterly standardized effort (in soaking days), landings and length composition of landings. This fleet represents an average of $11 \%$ of international catches of white anglerfish since 1999.

Data from this commercial lpue series has been used in the white anglerfish assessment since 2007.

## Other available commercial series of lpues that have never been employed in the assessment are

## PT-TRF9A

Portuguese trawlers targeting fish: years 1989-2012. Data provided for Portuguese trawlers targeting fish comprise quarterly effort (1000 hours trawling with occurrence
of anglerfish), landings and length composition of landings. This fleet represents an average of $1 \%$ of international catches of white anglerfish along the time-series. A standardized series from 1989 to 2008 is also available for this fleet with annual effort data (in 1000 hauls) and annual lpue.

## PT-TRC9A

Portuguese trawlers targeting crustacean: years 1989-2012. Data provided for Portuguese trawlers targeting fish comprise quarterly effort (1000 hours trawling with occurrence of anglerfish), landings and length composition of landings. This fleet represents an average of $1 \%$ of international catches of white anglerfish along the time-series. A standardized series from 1989 to 2008 is also available for this fleet with annual effort data (in 1000 hauls) and annual lpue.

## SP-AVITR8C

Avilés trawl fleet fishing in Division VIIIc is available for years 1986-2003. Data provided for Avilés trawlers comprise quarterly effort (fishing days per 100 horse power), landings and length composition of landings. This fleet represents an average of $6 \%$ of international catches of white anglerfish along the time-series. The effort-series was interrupted in 2003.

## SP-SANTR8C

Santander trawl fleet fishing in Division VIIIc is available for years: years 1986-2010. Data provided for Santander trawlers comprise quarterly effort (fishing days per 100 horse power), landings and length composition of landings. This fleet represents an average of $7 \%$ of international catches of white anglerfish along the time-series. Effort data for 2008 was not provided to the WG.

## C. Assessment: data and method

Until 2011 white anglerfish stock was assessed with a non-equilibrium production model (ASPIC software). Results from growth studies provide a growth pattern for this stock allowing the application of a length-based assessment model. Stock Synthesis is was considered a suitable model to assess this stock by WKFLAT (ICES, 2012a).

## Model

Model used: Stock Synthesis 3 (SS3) (Methot, 2000)
Software used: Stock Synthesis v3.23b (Methot, 2011)
Stock Synthesis 3 (SS3) is an integrated assessment model. SS3 has been used for stock assessment all around the world. The area of highest used is on the US Pacific Coast. SS3 is coded in C++ using Auto-Differentiation Model Builder (http://www.admb-project.org) and available from the NOAA Fisheries Toolbox (http://nft.nefsc.noaa.gov/SS3.html). SS3 has three main characteristics that differentiate it from classical assessment models:

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

The overall SS3 model is subdivided into three submodels. The first submodel simulates the population dynamics, where the basic abundance, mortality and growth functions create a synthetic representation of the true population. The second submodel is the observation submodel. This contains the processes and filters designed to derive expected values for the various types of data. The last submodel is the statistical that quantifies the magnitude of the difference between observed and expected data and employs an algorithm to find the set of parameters that maximizes the goodness-of-fit.

The SS3 model developed for white anglerfish during the WKFLAT 2012 has been designed for a particular set of data and specifications. White anglerfish is harvested by four fleets, and two commercial lpue series and one fishery-independent survey provide information about relative abundance. No discard information is considered. Length composition data are available from both the fisheries and surveys. No age information is available for this stock.

## Input data

Years: 1980-2012.
Model structure:

- Temporal unit: quarterly based data (landings, lpue and length-frequency) were used in SS3 calculations
- Spatial structure: One area.
- Sex: Both sexes combined.

Fleet definition:
Four fleets were defined attending to the gear type and country:

- Spanish trawlers in ICES Division VIIIc-IXa (SPTR8C9A)
- Spanish artisanal in ICES Division VIIIc (SPART8C)
- Portuguese trawlers in ICES Division IXa (PTTR9A)
- Portuguese artisanal in ICES Division IXa (PTART9A)

Landed catches:
Quarterly landings entered the model as biomass (in weight) for the four fleets. Landings data for January 1980 to December 2012 were used to conduct the stock assessment of white anglerfish.

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

Abundance indices:

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

Length composition of data:

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

Length composition of Fleets:

- SPTR8C9A: 1986-2012, quarterly basis. From 1986 to 1988 quarterly length proportions were estimated from an annual proportion using the Data Su-per-Period approach available in SS3.
- SPART8C: 1986-2012, quarterly basis. From 1986 to 1994 quarterly length proportions were estimated from an annual proportion using the Data Su-per-Period approach available in SS3.
- PTTR9A: 1986-2012, quarterly basis. From 1986 to 1988 quarterly length proportions were estimated from an annual proportion using the Data Su-per-Period approach presented in SS3.
- PTART9A: 1986-2012, quarterly basis. From 1986 to 1988 quarterly length proportions were estimated from an annual proportion using the Data Su-per-Period approach present in SS3.

Length composition of Abundance Indices:

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


## Model assumptions and parameters

- Natural mortality: $\mathrm{M}=0.2$ for all ages and years.
- Growth: von Bertalanffy function: $K=0.11$ fixed, $L \max$ and mean length-at-age 0.75 are estimated.
- Maturity ogive: length-based logistic, $L_{50}=61.84$ and slope $=-0.1001$, constant over time.
- Weight-at-length: $\mathrm{a}=2.70 \times 10-5 \mathrm{~b}=2.839$, not estimated.
- Recruitment allocation in Quarter 3.
- Stock-recruitment relationship: Beverton-Holt model: steepness h=0.999, sigmaR=0.4, R0 estimated.
- Selectivity: For all fleets selectivity was only length-based and was modelled as a double normal function. Selectivity varies among fleets, but is assumed to be time-invariant.


## D. Short-term projection

Model used: Stock Synthesis 3.
Software used: ad hoc R code.
Initial stock size: SS3 outputs in the last assessment year.
Natural mortality: Set to 0.2 for all ages in all years.
Growth model: von Bertalanffy function, with parameters estimated in the assessment model.

Maturity-at-length: The same ogive as in the assessment is used for all years.
Weight-at-length in the stock and in the catch: The same length-weight relationship as in the assessment model

Exploitation pattern: Average of the final three assessment years (with the possibility of scaling to final year F).

Intermediate year assumptions: status quo F .
Recruitment: geometric mean of estimated recruitment from 1980 until the final assessment year. If trends in recruitment become evident a shorter range of years could be selected.

## E. Medium-term projections

No medium-term projections are conducted for white anglerfish stock.

## F. Yield and biomass per recruit/long-term projections

Yield per recruit calculations are conducted using the same input values as those used for the short term forecasts.

Model used: yield and biomass-per-recruit over a range of $F$ values.
Software used: ad hoc R code.

## G. Biological reference points

The new assessment methodology developed for white anglerfish in WKFLAT 2012 provides the technical basis to set reference points for this stock. In the WGHMM 2012 possible proxies for $\mathrm{F}_{\text {MSY }}$ were considered among Fmax, $\mathrm{F}_{0.1}, \mathrm{~F}_{30 \%}, \mathrm{~F}_{35 \%}$ and $\mathrm{F}_{40 \%}$.

The following table shows the estimates that were obtained from yield and SSB per recruit analysis:

|  | Fbar |  | Y/R | SSB/R |
| :--- | ---: | ---: | ---: | ---: |
| Fmax | 0.29 | 2.13 | 7.04 |  |
| F0.1 | 0.19 | 2.02 | 13.24 |  |
| F40\% | 0.12 | 1.68 | 22.70 |  |
| F35\% | 0.13 | 1.79 | 20.01 |  |
| F30\% | 0.15 | 1.90 | 17.08 |  |

$\mathrm{F}_{0.1}=0.19$ was set by the WGHMM2012 as proxy of Fmsy.

## H. Other issues

## H. 1 Historical development of assessment

Southern Anglerfish stocks were assessed for the first time in the 1990 ICES WG meeting. Different assessment trials were performed during the subsequent eight years but analytical assessments indicated unrealistic results. The database (both biological and fisheries data) were improved along these years trying to apply an analytical assessment model. Since 1998 a non-equilibrium surplus production model ASPIC (Prager, 1994) was applied to each stock or to the combined stock data. These stock assessments were accepted by the ACFM and used to provide management advice. The assessment of white anglerfish as a separate stock has been carried out
continuously from 2007. In 2012, a new assessment model using Stock Synthesis 3 was approved in the benchmark WKFLAT 2012. This approved model was used to determine the stock status for the first time in WGHMMM 2012 and is the current assessment model for southern white anglerfish stock. The history of white anglerfish assessment from 2007 to 2012 is presented in Table 1.

Table 1. History of southern white anglerfish assessment from 2007 to 2012.

| WG | 2007 | 2008 | 2009 | 2010 | 2011 |  | 2012 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Assessment <br> Model | Nonequilibrium Surplus production model (Prager, 1994a) | No updated | Nonequilibrium Surplus production model (Prager, 1994a) | Nonequilibrium Surplus production model (Prager, 1994a) | Nonequilibrium Surplus production model (Prager, 1994a) | Assessmen <br> Model <br> Model <br> Structure | Stock Synthesis 3 <br> (Methot, 2000) <br> Length based <br> Quarterly <br> based data |
| Software | $\begin{aligned} & \text { ASPIC } \\ & \text { (v. 5.16) } \end{aligned}$ | No updated | $\begin{aligned} & \text { ASPIC } \\ & \text { (v. 5.16) } \end{aligned}$ | $\begin{aligned} & \text { ASPIC } \\ & \text { (v. } 5.34) \end{aligned}$ | ASPIC (v. 5.34.9) | Software | SS3v23b |
| Catch data range | 1980-2006 |  | 1980-2008 | 1980-2009 | 1980-2010 | Catch data range | 1980-2010 |
|  |  |  |  |  |  | Fleets | SPTR8C9A <br> SPART8C <br> PTTR9A <br> PTART9A |
| Cpue Series 1 (years) | SP- <br> CORUTR8c <br> (1986-2006) |  | SP- <br> CORUTR8c <br> (1986-2008) | SP- <br> CORUTR8c <br> (1986-2009) | SP- <br> CORUTR8c <br> (1986-2010) | Abundance Index 1 (by quarter) | SPCORUTR8c (1982-2010) |
| Index of Biomass (years) | SPCEDGNS8c (1999-2006) |  | SP- <br> CEDGNS8c <br> (1999-2008) | SP- <br> CEDGNS8c <br> (1999-2009) | SP- <br> CEDGNS8c <br> (1999-2010) | Abundance Index 2 (by quarter) | SPCEDG <br> N8C <br> (1999- <br> 2010) |
| Error Type | Condition on yield |  | Condition on yield | Condition on yield | Condition on yield | Abundance <br> Index 3 (4r ${ }^{\text {rd }}$ <br> quarter) | $\begin{aligned} & \text { SPGFS (1983- } \\ & \text { 2010) } \end{aligned}$ |
| Number of bootstrap | 500 |  | 500 | 1000 | 1000 | Natural mortality | $\mathrm{M}=0.2$ for all ages and years |
| Maximum <br> F | 8.0 (y-1) |  | 8.0 (y-1) | 8.0 (y-1) | 8.0 (y-1) | Growth | von Bertalanffy <br> $\mathrm{K}=0.11$ fixed <br> Lmax estimated |


| WG | 2007 | 2008 | 2009 | 2010 | 2011 |  | 2012 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Statistical <br> weight <br> B1/K | 1 |  | 1 | 1 | 1 | Maturity ogive | length-base <br> d logistic <br> L50=61.84 <br> slope=- <br> 0.1001 |
| Statistical weight for fisheries | 1,1 |  | 1,1 | 1,1 | 1,1 | Weight-atlength | $\begin{aligned} & a=2.70 \times 10^{-5} \\ & b=2.839 \end{aligned}$ |
| B1-ratio (starting guess) | 0.5 |  | 0.5 | 0.5 | 0.5 | Recruitment <br> allocation | Quarter 3 |
| MSY (starting guess) | 5000 t |  | 5000 t | 5000 t | 5000 t | Stock- <br> Recruitment | Beverton- <br> Holt model <br> $\mathrm{h}=0.999$ <br> sigmaR=0.4 <br> R0 estimat- <br> ed |
| K (starting guess) | 50000 t |  | 50000 t | 50000 t | 50000 t | Selectivity | All fleets: <br> length-based double normal function <br> Varies among fleets <br> Time-invariant |
| q1 (starting guess) | 1d-5 |  | 1d-5 | 1d-5 | 1d-5 |  |  |
| q2 <br> (starting guess) | 1d-6 |  | 1d-6 | 1d-6 | 1d-6 |  |  |
| Estimated parameter | All |  | All | All | All |  |  |
| Min and Max allowable MSY | $\begin{aligned} & 2000(\mathrm{t})- \\ & 10000(\mathrm{t}) \end{aligned}$ |  | $\begin{aligned} & 2000(\mathrm{t})- \\ & 10000 \text { (t) } \end{aligned}$ | $\begin{gathered} 2000(\mathrm{t})- \\ 11.500(\mathrm{t}) \end{gathered}$ | $\begin{aligned} & 2000(\mathrm{t})- \\ & 11500(\mathrm{t}) \end{aligned}$ |  |  |
| Min and <br> Max K | $\begin{gathered} 5000(\mathrm{t})- \\ 500000(\mathrm{t}) \end{gathered}$ |  | $\begin{aligned} & 5000(\mathrm{t})- \\ & 100000(\mathrm{t}) \end{aligned}$ | $\begin{gathered} 5000(\mathrm{t})- \\ 112000(\mathrm{t}) \end{gathered}$ | $\begin{gathered} 5000(\mathrm{t})- \\ 112000(\mathrm{t}) \end{gathered}$ |  |  |
| Random <br> Number Seed | 1964185 |  | 1964185 | 1964185 | 1964185 |  |  |

## I. References

Afonso-Dias, I.P. and J.R.G. Hislop. 1996. The population of anglerfish (Lophius piscatorius) from the northwest coast of Scotland. J. Fish. Biol. 49 (Suppl A): 18-39.

BIOSDEF. 1998. Biological studies of demersal fish. Ref.: EU, DG XIV, Study Contract 95/038.
Castro, J., Cardador, F., Santurtún, M., Punzón, A., Quincoces, I., Silva, C., Duarte, R., Murta, A., Silva, L., Abad, E. and Marín, M. 2007. Proposal of fleet segmentation for the Spanish and Portuguese fleets operating in the Atlantic national waters. ICES CM 2007/ACFM: 21

Duarte, R., Azevedo, M., Landa, J. and Pereda, P. 2001. Reproduction of anglerfish (Lophius budegassa Spinola and Lophius piscatorius Linnaeus) from the Atlantic Iberian coast. Fisheries Research 51: 349-361.

Duarte, R., Bruno, I., Quincoces, I., Fariña, A.C. and Landa, J. 2004. Morphometric and meristic study of white and black anglerfish (Lophius piscatorius and L. budegassa) from the southwest of Ireland to the south-western Mediterranean. ICES 2004 Annual Science Conference, Vigo (Spain). ICES CM 2004/EE: 22.

Duarte, R., Sampedro, P., Landa, J. and Azevedo, M. 2007._Revision of available data (landings, effort, length frequency distributions and age-length keys) from 1996-2005 for an agestructured assessment of Southern anglerfish stocks. ICES CM 2007/ACFM: 21.
Fariña, A.C., Duarte, R., Landa, J., Quincoces, I. and Sánchez, J.A. 2004. Multiple stock identification approaches of anglerfish (Lophius piscatorius and L. budegassa) in western and southern European waters. ICES 2004 Annual Science Conference, Vigo (Spain). ICES CM 2004/EE: 25.

GESSAN. 2002. Genetic characterisation and stock structure of the two species of anglerfish (Lophius piscatorius and L. budegassa) of the North Atlantic. Ref.: EU DG XIV Study Contract: 99/013.

Hislop, J.R.G., Holst, J.C., Skagen, D. 2001. Near-surface captures of post-juvenile anglerfish in the Northeast Atlantic- an unsolved mystery. Journal of Fish Biology 57: 1083-1087.

Hislop, J.R.G., A. Gallego, M.R. Heath, F.M. Kennedy, S.A. Reeves and Wright, P.J. 2001. A synthesis of the early life history of anglerfish, Lophius piscatorius (Linnaeus, 1756) in northern British waters. ICES Journal of Marine Science, 58: 70-86.

ICES. 2007. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM), 8-17 May 2007, Vigo, Spain. ICES CM 2007/ACFM:21. 700 pp.

ICES. 2011. Report of the Working Group on the Assessment of Southern Shelf stocks of Hake, Monk and Megrim (WGHMM), 5-11 May 2011, ICES Headquarters, Copenhagen. ICES CM 2011/ACOM:11.625 pp.
ICES. 2012a. Report of the Benchmark Workshop on Flatfish and Anglerfish (WKFLAT), 1-8 March 2012, Bilbao, Spain. ICES CM 2012/ACOM:47.

ICES. 2012b. Report of the Anglerfish (Lophius piscatorius) illicia and otoliths exchange 2011. 61pp.
Landa, J., Antolínez, A., Castro, B., Ámez, M., Autón, U., Cañás, L., Sampedro, P., Fariña, A.C. 2012. Reproduction of white anglerfish (Lophius piscatorius) caught by the Spanish fleet in Northeastern Atlantic waters. Working Document in WKFLAT 2012.

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

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

Methot, R.D. 2011. User Manual for Stock Synthesis, Model Version 3.23b. NOAA Fisheries Service, Seattle. 167 pp.

Prager, M.H. 1994. A suite of extension to a non-equilibrium surplus-production model. Fish. Bull. 92: 374-389.

Praguer, M.H. 2004. User's manual for ASPIC: a stock production model incorporating covariates (ver. 5) and auxiliary programs. NMFS Beaufort Laboratory Document BL-2004-01, 25 pp .

Quincoces, I. 2002. Crecimiento y reproducción de las especies Lophius budegassa Spinola1807, y Lophius piscatorius Linneo 1758, del Golfo de Vizcaya. PhD Thesis. Basque Country University. 276pp.

## Annex I: Stock Annex <br> Southern megrims (L. whiffiagonis and L. boscii)

Quality Handbook Stock Annex I

Stock specific documentation of standard assessment procedures used by ICES.

| Stock: | Southern megrims (Divisions VIIIc, IXa) |
| :--- | :--- |
| Working Group: | Working Group on the Assessment of Southern Shelf <br> of Hake, Monk and Megrim Stocks (WGHMM) |
| Last Update: | May 2013 |

## A General

## A. 1 Stock definition

The genus Lepidorhombus is represented in eastern Atlantic waters by two species, megrim (L. whiffiagonis) and four-spot megrim (L. boscii). Three stocks of megrims are assessed by ICES: megrim in ICES Subareas IV and VI, megrim in Divisions VIIb-k and VIIIa,b,d and megrim in Divisions VIIIc and IXa. Although the boundaries of the stocks were established only for management purposes, recent genetic studies have proved the existence of at least two populations within the Atlantic Ocean for both species. While L. boscii populations match the stocks defined, L. whiffiagonis needs more detailed studies to refine the boundaries, although in principle would also overlap with the current structure (Danancher and García-Vázquez, 2009).

The stocks under this Annex are called Southern Megrims and include both megrim species in Divisions VIIIc and IXa. Megrim (L. whiffiagonis) is in both ICES Divisions (VIIIc and IXa), with its highest abundance in Division VIIIc. Four-spot megrim (L. boscii) is distributed in both ICES Divisions (VIIIc and IXa), being more southerly present than megrim (Sánchez et al., 2002). There is a certain bathymetric segregation between the two species of megrim. L. boscii has a preferential depth range of 100 to 450 m and L. whiffiagonis of 50 to 300 m (Sanchez et al, 1998).

## A. 2 Fishery

Management of megrim is both by TAC and technical measures. The two species ( $L$. whiffiagonis and L. boscii) are managed under a common TAC. They are caught and recorded together in the landings statistics. It is impossible to manage each species separately under a common TAC. The spatial distribution of the two stocks shows some differences that could be utilized for separate management of the two stocks.

The minimum mesh size for towed gears ranges between 55 and 70 mm , depending on catch species composition. Minimum landing size for the two species changed from 25 to 20 cm in year 2000 (Council Regulation EC 850/98).

Both megrim species are included in the landings from ICES Divisions VIIIc and IXa. The percentage of megrim (L. whiffiagonis) in landings of both species by weight was between $12 \%$ and $37 \%$ over the whole period for which data are available, being mostly above $20 \%$ until year 2000 and mostly below $20 \%$ since that year.

No landings data are available for these stocks before 1986, although some Spanish harbours have longer landings series. Total international landings increased sharply from 1986 to 1989, when they reached 3340 t , and then showed a continuous declining trend until their lowest level of 840 t in 2002. There has been some increase in landings since that year, being 1380 t in 2010, the maximum value of the last decade.
Both species of megrim are taken as by-catch in the mixed bottom trawl fisheries targeting "white fish" by Portuguese and Spanish fleets, and also in small quantities by the Portuguese artisanal fleet. The majority of the catches are taken by Spanish trawlers. Fishing practices of some Spanish trawl fleets have changed in recent years, now focusing more on species such as horse mackerel, blue whiting, or mackerel, and not taking megrim in the catch (Punzón et al, 2010).

Since the early 1990's the Spanish bottom trawl fleet has diversified its fishing strategy, introducing a new trawl gear which targets primarily pelagic species (as horse mackerel and mackerel). This gear, named "jurelera", affects catches of L. boscii more than those of L. whiffiagonis, probably due to differences between the distribution area of both species. The increasing use of "jurelera" gear by trawlers in last years (Castro et al, 2011), has made to reduce the effort of the traditional OTB vessels (using "baca" gear) on megrim species. Also, the fishing ban for all trawlers in grounds within 100 $m$ depth (RD 1441/1999, 10 sept) may affect in the proportion of both species in catches due to their different bathymetric distribution.

The Prestige oil spill in the northwest Spanish coast (November 2002) prompted a redistribution of fishing effort, particularly in the Galician area. Some regulation measures, such as spatial and seasonal closures, were adopted in order to minimise the oil spill impact on fisheries. Some trawl fleets display lower effort in 2003 in relation to later years (Abad et al, 2010).
Horse mackerel, Atlantic mackerel, blue whiting, anglerfish, hake, megrim, different cephalopods and Nephrops account for a high percentage (around 90\%) of all retained species in this multispecies trawl fishery (Castro et al, 2011). A great number of species are caught as by-catch.

Discards are important, particularly for younger ages of both megrim species. Around $10-65 \%$ of the individuals caught are discarded by trawlers (Pérez et al, 2011). Lack of commercial interest, variations in market price, fish size (MLS or market size), storage capacity as well as distance to home port are the main reasons for discarding. Artisanal fleets catch few megrims and discards of all species in these fleets are very low.

Megrims have been affected by the Recovery Plan for the Southern hake and Iberian Nephrops stocks (Council Regulation EC 2166/2005), since January of 2006, with the fishing effort limitation measurements in the Spanish and Portuguese mixed trawl fisheries.

## A. 3 Ecosystem aspects

The Iberian Region along the eastern Atlantic shelf (Divisions VIIIc and IXa) is an upwelling area with high productivity, especially along the Portuguese and Galician coasts; upwelling takes place during late spring and summer (Álvarez-Salgado et al., 2002; Serrano et al., 2008). The region is characterized by a large number of commercial and non-commercial fish species caught for human consumption.

Many flatfish species show a gradual offshore movement of juveniles as they grow. This might indicate that habitat quality for flatfish is size-dependent. Another com-
mon pattern is the annual micro- and macroscale movements and migrations between spawning, feeding and wintering areas (Gibson 1994). Also, most flatfishes are associated with finer sediments, rather than with hard substrata because burying themselves provides some protection from predators and reduces the use of energy (van der Veer et al., 1990, 2000; Beverton and Iles 1992; Bailey 1994; Wennhage and Pihl 2001).

Previous studies on megrim species show that they generally occurred outside zones with hydrographical instabilities that foster the vertical interchange of organic matter (Sánchez and Gil, 1995) and disappear at the mouth of the most important rivers (Sánchez et al., 2001). Both species appear to show a gradual expansion in their bathymetric distribution throughout their lifetimes, with the larger individuals tending to occupy shallower waters than the juveniles. Bearing in mind that the two species have similar characteristics, a certain degree of interspecific competition may be assumed (Sanchez et al, 1998).

Juveniles of these species feed mostly on detritivore crustaceans inhabiting deeplying muddy bottoms. Adult L. boscii feeds mainly on crustaceans inhabiting muddy surfaces (Rodriguez-Marín and Olaso, 1993; Rodriguez-Marín, 2002) as opposed to L. whiffiagonis, which are more ichthyophagous and where rates of crustacean in diet decrease with fish size (Rodriguez-Marín, 2002). None of the two species represent an important part of the diet for the main fish predators in the area. However, Velasco (IEO, Santander, Spain, pers. comm.) observed that they are occasionally present in stomach contents of hake, anglerfish and rays.

The spawning period of these species is short. Mature males can be found from November to March and mature females from December to March, but spawning peaks in March. In southern areas megrims spawn from January to April (BIOSDEF, 1998; study contract 95/038).

The growth rate also varies (Landa et al, 1996; Landa, 1999), growth is quicker in the southern area for both species but the maximum length attained is smaller than in the north. The maximum age for megrim also varies with latitude. In Subarea VII the maximum age of megrim is 14 years, this decreases to 12 years in Divisions VIIIc and IXa (BIOSDEF, 1998; Landa et. al, 2000). The maximum age for four-spot megrim in Divisions VIIIc and IXa is 11 years (Landa et al, 2002, Landa, pers. com.).

## B. Data

## B. 1 Commercial Catch

Landings data are provided by National Government and research institutions of Spain and Portugal. The available series began in 1986

The proportions of each megrim species in Portuguese and Spanish landings are estimated using the relative abundances of the two species of megrim in the sampled landings.

For L. whiffiagonis, landings present an increase for a few years at the beginning of the time series and a general declining trend since then. In 2011 and 2002 landings are increasing. For L. boscii, landings present the same increase at the beginning of the time series; after that, they have generally declined to their lowest value in 2002 and, since then, the general trend is to increase smoothly. A decrease in landings in 2012 is occurred.

## Discards

Discards estimates are available for Spanish trawlers in some years.
Discards data are not yet used in this assessment due to the lack of data in some years of the series. A discarding sampling programme runs regularly since the establishment of the European Data Collection Programme in 2003. Before this year, Spanish discards data are available only for 1994, 1997, 1999 and 2000. The raising procedure used to estimate Spanish discards for the sampled years was based on effort.

## B. 2 Biological

## Landing numbers at length

Annual length compositions of total landings for L. whiffiagonis and L. boscii are available since 1986.

For L. whiffiagonis, length distributions were available for both Spanish and Portuguese landings until 1998, when Portuguese length frequency data were mainly based on samples from Aveiro. Due to the uncertainties of this port since 1999, Spanish length distributions were raised to the total international landings for all subsequent years. Portuguese landings only represent $10 \%$ of the total landings on average.

For L. boscii, length distributions are available for Spanish and Portuguese landings since 1986 and 1998, respectively.

There has been a strong decrease in landings of fish under 15 cm in length since 1994 and under 20 cm in recent years for both species. This change probably results from stricter enforcement of the minimum landing size and a mesh size increase regulation in year 2000.

## Catch numbers at age

Age compositions of landings are based on annual Spanish ALKs since 1990, whereas a survey ALK from 1986 combined with an annual ALK from 1990 was applied to years 1986-1989. Landings weights-at-age are also used as the weights-at-age in the stock. The following parameter values were used in the length-weight relationship (BIOSDEF, 1998):

|  | L. whiffiagonis | L. boscii |
| :--- | :--- | :--- |
| a | 0.006488 | 0.00431 |
| b | 3.0114 | 3.1904 |

Natural mortality is set to 0.2 and assumed constant over all ages and years. This is the same value used for L. whiffiagonis in Divisions VIIb-k and VIIIabd.

The sex combined maturity ogive (BIOSDEF, 1998) is assumed constant over time, with the following proportions of fish mature at each age:

| AGE | $\mathbf{0}$ | $\mathbf{1}$ | $\mathbf{2}$ | $\mathbf{3}$ | $\mathbf{4}$ | $\mathbf{5 +}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| L. whiffiagonis | 0 | 0.34 | 0.90 | 1 | 1 | 1 |
| L. boscii | 0 | 0.55 | 0.86 | 0.97 | 0.99 | 1 |

## B. 3 Surveys

The Portuguese October groundfish survey (PtGFS-WIBTS-Q4) and the Portuguese Crustacean survey (PT-CTS (UWTV (FU 28-29))) and one Spanish groundfish survey (SpGFS-WIBTS-Q4) series are available since 1990, 1997 and 1983, respectively.

It should be taken into consideration that during years 1996, 1999, 2003 and 2004 the October Portuguese survey was carried out with a different vessel and gear from the one used in the rest of the series. The Crustacean survey was performed with different vessels in different years and covers a partial area; in 2004 it had many operational problems.

For these reasons and because indices from these surveys are not considered to be representative of megrim abundance, due to the very low catch rates, only the Spanish survey (SpGFS-WIBTS-Q4) is used in the assessment of the two species. The survey covers the distribution area and depth strata of these species in Spanish waters (covering both VIIIc and IXa). The survey appears to be quite good at tracking cohorts through time for L. whiffiagonis. For L. boscii, the survey signal is also clear until 2002, whereas it seems more blurred in recent years.

## B. 4 Commercial CPUE

LPUE and Fishing Effort data are available for the following fleets: Spanish trawlers based in A Coruña port (SP-CORUTR8c) and fishing in Division VIIIc since 1986, Spanish trawlers based in Avilés port (SP-AVILESTR) and fishing in Division VIIIc for the period 1986-2003, and Portuguese trawlers fishing in Division IXa since 1988. Effort from the Portuguese fleet is estimated from a sample of logbooks from sea trips where megrim occurred in the catch.

## Commercial fleets used in the assessment of L.whiffiagonis to tune the model

- SP-CORUTR8c: This fleet contributed with data of effort (fishing days per 100 horse power), LPUE (as kg per fishing day per 100 horse power) and length composition of landings. In 2003, restrictions imposed on fishing activity due to the Prestige oil spill had an influence on effort.
- SP-AVILESTR: This fleet contributed with data of effort (fishing days per 100 horse power), LPUE (as kg per fishing day per 100 horse power) and length composition of landings. No data are available for this fleet after 2003.
Commercial fleets used in the assessment of L.boscii to tune the model
- SP-CORUTR8c: This fleet contributed with data of effort (fishing days per 100 horse power), LPUE (as kg per fishing day per 100 horse power) and length composition of landings. Due to the increased use of HVO ("jurelera") gear (which catches very little megrim) by this fleet, estimated LPUE values for recent years are not directly comparable with those from earlier years. This affects L.boscii more than L.whiffiagonis because of its spatial distribution. Hence, only LPUE values up to year 1999 from this tuning fleet are used in the assessment of L.boscii.


## C. Historical stock development: Assessment Methods and Settings

These stocks have been assessed with Extended Survivors Analysis (XSA), (Shepherd, 1992), since 1992.

Software used: VPA95 Lowestoft suite.
The input settings of the assessment model and data used in recent years are shown in the next table:

| WG YEAR | 2007 |  | 2008 |  | 2009 |  | 2010 |  | 2011 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Model | XSA |  | XSA |  | XSA |  | XSA |  | XSA |  |
| Software | VPA95 Lowestoft suite |  | VPA95 Lowestoft suite |  | VPA95 Lowestoft suite |  | VPA95 Lowestoft suite |  | VPA95 Lowestoft suite |  |
| Stock | L.whiffiagonis | L.boscii | L.whiffiagonis | L.boscii | L.whiffiagonis | L.boscii | L.whiffiagonis | L.boscii | L.whiffiagonis | L.boscii |
| Catch data range | 1986-2006 | 1986-2006 | 1986-2007 | 1986-2007 | 1986-2008 | 1986-2008 | 1986-2009 | 1986-2009 | 1986-2010 | 1986-2010 |
| Age range in catch data | 1-7+ | 0-7+ | 1-7+ | 0-7+ | 1-7+ | 0-7+ | 1-7+ | 0-7+ | 1-7+ | 0-7+ |
| SP-CORUTR8c | $\begin{gathered} 1990-2006 \\ \text { Ages 2-6 } \\ \hline \end{gathered}$ | $\begin{gathered} 1986-1999 \\ \text { Ages 3-6 } \\ \hline \end{gathered}$ | $\begin{gathered} 1990-2007 \\ \text { Ages 2-6 } \\ \hline \end{gathered}$ | $\begin{gathered} 1986-1999 \\ \text { Ages 3-6 } \\ \hline \end{gathered}$ | $\begin{gathered} 1990-2008 \\ \text { Ages 2-6 } \\ \hline \end{gathered}$ | $\begin{gathered} 1986-1999 \\ \text { Ages 3-6 } \\ \hline \end{gathered}$ | $\begin{gathered} 1990-2009 \\ \text { Ages 2-6 } \\ \hline \end{gathered}$ | $\begin{gathered} 1986-1999 \\ \text { Ages 3-6 } \\ \hline \end{gathered}$ | $\begin{gathered} 1990-2010 \\ \text { Ages 2-6 } \\ \hline \end{gathered}$ | $\begin{gathered} 1986-1999 \\ \text { Ages 3-6 } \\ \hline \end{gathered}$ |
| SP-AVILESTR | $\begin{gathered} 1990-2003 \\ \text { Ages 2-6 } \\ \hline \end{gathered}$ | Not used | $\begin{gathered} 1990-2003 \\ \text { Ages 2-6 } \\ \hline \end{gathered}$ | Not used | $\begin{gathered} 1990-2003 \\ \text { Ages 2-6 } \\ \hline \end{gathered}$ | Not used | $\begin{gathered} 1990-2003 \\ \text { Ages 2-6 } \\ \hline \end{gathered}$ | Not used | $\begin{gathered} 1990-2003 \\ \text { Ages 2-6 } \\ \hline \end{gathered}$ | Not used |
| SpGFS-WIBTS- <br> Q4 survey | $\begin{gathered} 1990-2006 \\ \text { Ages 1-6 } \end{gathered}$ | 1988-2006 <br> (2003 not <br> included) Ages 0-6 | $\begin{gathered} 1990-2007 \\ \text { Ages 1-6 } \end{gathered}$ | 1988-2007 <br> (2003 not <br> included) <br> Ages 0-6 | $\begin{gathered} 1990-2008 \\ \text { Ages 1-6 } \end{gathered}$ | $\begin{gathered} \hline 1988-2008 \\ (2003 \text { not } \\ \text { included) } \\ \text { Ages 0-6 } \\ \hline \end{gathered}$ | $\begin{gathered} 1990-2009 \\ \text { Ages 1-6 } \end{gathered}$ | $\begin{gathered} \hline 1988-2009 \\ (2003 \text { not } \\ \text { included }) \\ \text { Ages 0-6 } \\ \hline \end{gathered}$ | $\begin{gathered} \text { 1990-2010 } \\ \text { Ages 1-6 } \end{gathered}$ | 1988-2010 <br> (2003 not <br> included) <br> Ages 0-6 |
| Taper | No | Tricubic over 20 years | No | Tricubic over 20 years | No | Tricubic over 20 years | No | Tricubic over 20 years | No | Tricubic over 20 years |
| Tuning range | 17 | 21 | 18 | 22 | 19 | 23 | 20 | 24 | 21 | 25 |
| Ages catch dep. stock size | 1-4 | 0-2 | 1-4 | 0-2 | 1-4 | 0-2 | 1-4 | 0-2 | 1-4 | 0-2 |
| Q plateau | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| F shrinkage s.e. | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Shrinkage year range | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Shrinkage age range | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Fleet s.e. threshold | 0.2 | 0.3 | 0.2 | 0.3 | 0.2 | 0.3 | 0.2 | 0.3 | 0.2 | 0.3 |
| $F$ bar range | 2-4 | 2-4 | 2-4 | 2-4 | 2-4 | 2-4 | 2-4 | 2-4 | 2-4 | 2-4 |

## D. Short term projection

Common settings for L. whiffiagonis and L. boscii for deterministic short-term predictions:

- Model used: Age structured.
- Software used: MFDP prediction with management option table and yield per recruit routines.
- Natural mortality: 0.2.
- Maturity: Average maturity ogive for the last three years.
- $\quad \mathrm{F}$ and M before spawning: Set to 0 for all ages in all years.
- Weight-at-age in the stock: Average stock weights for last three years.
- Weight-at-age in the catch: Average weight of the three last years.
- Exploitation pattern: Average of the three last years (normally unscaled although, when appropriately justified, it could be scaled to the final year).
- Intermediate year assumptions: status quo F

Specific settings for L. whiffiagonis:

- Initial stock size for projections. Taken from the XSA survivors for age 2 and older.
- Stock recruitment model used: None. Recruitment at age 1 assumed equal in all projection years (GM from 1998 to final assessment year minus 2).
Specific settings L. boscii for deterministic short-term predictions are:
- Initial stock size for projections. Taken from the XSA survivors for age 1 and older.
- Stock recruitment model used: None. Recruitment at age 0 assumed equal in all projection years (GM from 1990 to final assessment year minus 2).
Estimates of recruitment for years 1986 to 1989 are always excluded for these stocks because age compositions in those years are based on a combined ALK instead of annual ones. Estimates of recruitment for years 1990-1997 are excluded in L. whiffiagonis too because this stock has consistently displayed lower recruitment levels after 1997. The range of years may be revised by the WG in the future, if felt appropriate.
E. Medium term projections

Medium term projections are not conducted for these stocks.

## F. Yield and biomass per recruit / long term projections

Yield per recruit calculations are conducted using the same input values as those used for the short term forecasts.

Model used: yield and biomass per recruit over a range of F values.
Software used: MFYPR.

## G. Biological reference points

The table below shows a summary of the precautionary reference points proposed for L. whiffiagonis in the past. It shows that there are no precautionary reference points defined for this stock.

|  | ACFM 1998 | WG 2000 | ACFM 2000 | WG 2002 | ACFM 2002 |
| :--- | :--- | :--- | :--- | :--- | :--- |


| Flim | Not defined | Not defined | Not defined | Not defined | Not defined |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Fpa | No proposal | No proposal | Not adopted | No proposal | Not adopted |
| Blim | 900 t (Bloss, $=$ =B95 <br> WG98) | Not defined |  |  |  |
| Bpa | $1500 \mathrm{t}($ Blim $\times$ <br> $1.64)$ | 900 t (Bloss,=B95 <br> WG98) | Not adopted | 1500 t (stock <br> history) | Not adopted |

In the WGHMM 2010 meeting, as part of the new ICES MSY framework, possible proxies were considered for $\mathrm{F}_{\text {msy }}$ in the range of $\mathrm{F}_{\text {max }}, \mathrm{F} 0.1$, $\mathrm{F} 35 \%$ and $\mathrm{F} 40 \%$. $\mathrm{F}_{\max }$ is not well defined for this stock, as the yield-per-recruit curve shows a very flat top. It was noted that there has been some variability in these values throughout the years. Furthermore, taking into account that the assessment of this stock and yield-per-recruit calculation ignore the fact that discards exist, a rough sensitivity exercise was conducted in WG2010 taking discards into consideration in an approximate way. The following table compares the results that were obtained from the original analysis (ignoring discards, left side of the table) and the sensitivity exercise (with some assumed landed proportions and increased F on younger ages, right side of the table):

|  | Original analysis |  |  | Sensitivity exercise with discards |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| WG2010 | Fbar | Y_p_R | SSB_p_R | Fbar | Y_p_R | SSB_p_R |
| Fmax | 0.32 | 0.08 | 0.29 | 0.20 | 0.05 | 0.37 |
| F0.1 | 0.14 | 0.07 | 0.48 | 0.13 | 0.05 | 0.50 |
| F35\% | 0.21 | 0.07 | 0.38 | 0.19 | 0.05 | 0.38 |
| F40\% | 0.17 | 0.07 | 0.43 | 0.16 | 0.05 | 0.43 |

Fmax would seem to be particularly affected by whether or not discards are taken into consideration. The F0.1, F35\% and F40\% values are affected to a much lesser extent.

F40\%=0.17 was proposed by WGHMM 2010 as a provisional Fmsy proxy for the L.whiffiagonis stock. This proposal should be considered as preliminary and may be revised as further work on this stock assessment, including the incorporation of discards, takes place.

The table below summarises the history of precautionary reference points for L. boscii and shows that such points are not defined for this stock either.

|  | ACFM 1998 | WG-1999 | WG-2000 | ACFM <br> 2000 | WG-2002 | ACFM <br> 2003 | WG-2003 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Flim | 0.25 <br> (Floss WG98) | No <br> proposal | 0.40 <br> (Floss) |  | Not defined |  |  |
| Fpa | 0.20 <br> (Flim e- <br> $\left.1.645^{*} \sigma\right)$ | No <br> proposal | 0.30 <br> (Flim e- <br> $\left.1.645^{*} \sigma\right)$ | Not <br> adopted | 0.31 (Fmed ) | Not <br> adopted | No <br> proposal |
| Blim | 3400 t <br> (Bloss,=B96 <br> WG98) | 4700 t <br> (Bloss=B96 <br> WG99) |  | Not defined |  |  |  |
| Bpa | 5000 t <br> $($ Blim $\times 1.4)$ | 6500 t | 4700 t <br> $($ Bloss,=B95) | Not <br> adopted | 5000 t <br> $($ Bloss=B95) | Not <br> adopted | No <br> proposal |

In previous Working Groups, reference points were not proposed because of the interannual variability detected in the relative exploitation pattern-at-age. This variability is still occurring. Nevertheless, an attempt was made during WGHMM 2010 to examine possible $\mathrm{F}_{\text {msy }}$ candidates for this stock. The possible proxies considered for $\mathrm{F}_{\text {msy }}$ were the same as for the other megrim species. There has also been some varia-
bility in the values throughout the years. Additionally, the same rough sensitive exercise to assumed discards was performed with the following results:

|  | Original analysis |  |  | Sensitivity exercise with discards |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| WG2010 | Fbar | Y_p_R | SSB_p_R | Fbar | Y_p_R | SSB_p_R |
| Fmax | 0.39 | 0.05 | 0.16 | 0.21 | 0.03 | 0.21 |
| F01 | 0.14 | 0.04 | 0.27 | 0.13 | 0.03 | 0.28 |
| F35\% | 0.24 | 0.04 | 0.21 | 0.21 | 0.03 | 0.21 |
| F40\% | 0.18 | 0.04 | 0.23 | 0.17 | 0.03 | 0.23 |

Fmax would seem to be greatly affected by whether or not discards are taken into consideration. The F0.1, F35\% and F40\% values are much less affected.
$\mathrm{F} 40 \%=0.18$ was proposed by WGHMM 2010 as provisional $\mathrm{F}_{\mathrm{msy}}$ proxy for L. boscii, consistently with the choice made for L.whiffiagonis. This proposal should be considered preliminary and may be revised as further work on this stock assessment, including the incorporation of discards, takes place.

## H. Other Issues

None.

## I. References

Abad, E., Bellido, J.M. y A. Punzón, 2010. Transfer of fishing effort between areas and fishery units in Spanish fisheries as side effects of the Prestige oil spill management measures. Ocean and Coastal Management, 53:107-113.

Álvarez-Salgado, X.A., Beloso, S., Joint, I., Nogueira, E., Chou, L., Pérez, F.F., Groom, S., Cabanas, J.M., Rees, A.P., Elskens, M., 2002. New production of the NW Iberian shelf during the upwelling season over the period 1982-1999. Deep-Sea Research, I 49, 7 1725-1739.

Bailey, K. M. 1994. Predation on juvenile flatfish and recruitment variability. Netherlands Journal of Sea Research, 32: 175-189.

Beverton, R. J. H., and Iles, T. C. 1992. Mortality rates of 0-group plaice (Pleuronectes platessa L.), dab (Limanda limanda L.) and turbot (Scophthalmus maximus L.) in European waters III. Density-dependence of mortality rates of 0-group plaice and some demographic implications. Netherlands Journal of Sea Research, 29: 61-79.

BIOSDEF. 1998. Biological studies of demersal fish. Ref.: EU, DG XIV, Study Contract 95/038.
Castro, J., Marín, M., Costas, G., Abad, E., Punzón, A., Pereiro, J. y Vázquez, A. 2011. ATLAS de las flotas de pesca españolas de aguas europeas atlánticas. Temas de Oceanografía, no 4. Instituto Español de Oceanografía. Ministerio de Ciencia e Innovación. 215 pp.

Gibson R. N., 1994. Impact of habitat quality and quantity on the recruitment of juvenile flatfishes. Netherlands Journal of Sea Research 32:191-206

Danancher, D. and E. García-Vázquez, 2009. Population differentiation in megrim (Lepidorhombus whiffagonis) and four spotted megrim (Lepidorhombus boscii) across Atlantic and Mediterranean waters and implications for wild stock management. Marine Biology (2009) 156:18691880.

Landa, J., Piñeiro, C., and Pérez, N. 1996. Megrim (Lepidorhombus whiffiagonis) growth patterns in the northeast Atlantic. Fisheries Research, 26: 279-294.

Landa, J., 1999. Density-dependent growth of four spot megrim (L. boscii) in the northern Spanish shelf. Fisheries Research, 40: 267-276.

Landa, J. and C. Piñeiro, 2000. Megrim (Lepidorhombus whiffiagonis) growth in the North-eastern Atlantic based on back-calculation of otolith rings. ICES Journal of Marine Science, 57: 10771090.

Landa J, Perez N, and C. Pineiro, 2002. Growth patterns of the four spot megrim (Lepidorhombus boscii) in the northeast Atlantic. Fisheries Research, 55 (1-3): 141-152.

Pérez N., J. Santos, H. Araújo and I. Salinas, 2011. Southern Megrim Species Results from Spanish Discard Sampling Programme. WD to WGHMM11.

Punzón, A., C. Hernández, E. Abad, J. Castro, N. Pérez and V. Trujillo, 2010. Spanish otter trawl fisheries in the Cantabrian Sea. - ICES Journal of Marine Science 67: 1604-1616
Rodriguez-Marín, E. and Olaso, I. 1993. Food composition of the two species of megrim (Lepidorhombus whiffiagonis and Lepidorhombus boscii) in the Cantabrian Sea. Actes du IIIème Colloque d'Oceanographie du Golfe de Gascogne. Arcachon 1992: 215-219

Rodríguez-Marín E., A. Serrano y F. Velasco, 2002. Diferenciación trófica de las dos especies de gallo del Cantábrico respecto a los crustáceos decápodos. XII Simposio Ibérico de Estudios del Bentos Marino Abstracts Book. Gibraltar-La Línea de la Concepción, Spain.

Sánchez, F. and Gil, J. 1995. Influencia de anomalías térmicas de mesoscala sobre la distribución de peces demersales. Actes du IVème Colloque d'Oceanographie du Golfe de Gascogne. Santander 1994: 49-54

Sánchez, F., Pérez, N. and J. Landa, 1998. Distribution and abundance of megrim (Lepidorhombus boscii and Lepidorhombus whiffiagonis) on the northern Spanish shelf. ICES Journal of Marine Science, 55: 494-514

Sánchez, F., Blanco, M. and R. Gancedo, 2002. Atlas de los peces demersales y de los invertebrados de interés comercial de Galicia y el Cantábrico otoño 1997-1999. 158 pp. [ISBN 84-95877-02-3].

Serrano, A., Preciado, I., Abad, E, Sánchez, F., Parra, S. and I. Frutos, 2008. Spatial distribution patterns of demersal and epibenthic communities on the Galician continental shelf (NW Spain). Journal of Marine Systems, 72: 87-100.

Van der Veer, H. W., Pihl, L., and Bergman, M. J. N., 1990. Recruitment mechanisms in North Sea plaice Pleuronectes platessa. Marine Ecology Progress Series, 64: 1-12.

Van der Veer HW, Berghahn R, Miller JM, Rijnsdorp AD, 2000. Recruitment in flatfish, with special emphasis on North Atlantic species: Progress made by the Flatfish Symposia. ICES Journal of Marine Science, 57:202-215.

Wennhage, H. and L. Pihl. 2001. Settlement patterns of newly settled plaice (Pleuronectes plates$s a$ ) in a non-tidal Swedish ford in relation to larval supply and benthic predators. Marine. Biology, 139: (5) 877-889.

## Annex J Stock Annex Bay of Biscay Nephrops (FU 23-24)

Quality Handbook Stock Annex J
Stock specific documentation of standard assessment procedures used by ICES.

| Stock | Bay of Biscay Nephrops (Division VIIIa,b), FU 23-24, <br>  <br> Management Area N |
| :--- | :--- |
| Working Group: | Assessment of Southern Shelf Stocks of Hake, <br> Monk and Megrim |
| Date: | May 2011 |

## A. General

## A.1. Stock definition

Nephrops are distributed in North East Atlantic, from Iceland to South Portugal, in the North Sea and also in the Mediterranean sea, particularly in the western part. Nephrops live on $15-800 \mathrm{~m}$ deep grounds, on muddy substrata. The distribution of this species is more determined by ground type and sea temperature than depth. Nephrops live in burrows dug in the mud. It leaves this burrow during low light periods (at dawn and dusk) to look for food. It can be caught in high quantities during this active time. Nephrops are sedentary. However they can move short distances if adverse factors modify its habitat, like mud disturbance by storms or other mechanical action on the sea bottom.

In the Bay of Biscay, Nephrops grounds correspond to muddy areas: the first one, which is the largest one, is in Division VIIIa and is called "la grande vasière", the second one in Division VIIIb is called "vasière de la Gironde". The overall area extends for around $12000 \mathrm{~km}^{2}$ of surface.

## A.2. Fishery

Nephrops in FUs 23-24 are almost exclusively exploited by French trawlers which have decreased notably throughout the recent fifteen years after conflicts of 1993-1994 and according to different decommissioning schemes.

The general features of the Nephrops fishery, as described in the 2003 Nephrops Working Group report (ICES, 2003) are still valid, but some can now be updated thanks to more precise information collected on vessel activity and economic results. These showed that:

- about 274 boats are currently involved in the Bay of Biscay Nephrops fishery spending an average of 180 days at sea in 2011 ( 139 vessels landed more than 10 t , among them 129 came from the harbours of the Northern part of the fishery).
- the typical Bay of Biscay trawler is 15 m long, with an engine power of 235 kW and a mean age of 19 years, (2005 data)
- the typical crew consists of three members.

In 2003, these vessels generated a total turnover of 82 million $€$. The contribution of Nephrops in the turnover is estimated to be $40 \%$ on average, but varies strongly from
one boat to another. This percentage remained stable during recent years (2007-2011). For $45 \%$ of the vessels, more than half of the turnover is from Nephrops, and this proportion is even higher in the Northern part of the fishery (Southern Brittany). $67 \%$ of the Nephrops trawlers and at least $64 \%$ of associated employment are concentrated in Southern Brittany. As stated, the importance of Nephrops fishing varies between vessels: for $72 \%$ of them it is the principal activity, $12 \%$ are part-time Nephrops trawlers, $10 \%$ fish for Nephrops between 3 and 6 months each year and for $6 \%$ of the vessels it is a marginal activity (reference to the situation in 2003). Other métiers practised by these boats are finfish directed bottom trawling ( $48 \%$ of the fleet) and pelagic trawling ( $2 \%$ ).

The intensity of Nephrops directed fishing varies during the year: $67 \%$ of the total landings take place between April and August, and low quantities are landed in January.

The Nephrops fishery is managed by TAC along with technical measures. The agreed TAC for 2008 was $4320 t$ whereas the ICES recommendation was 3600 t on the basis of 2006's advice as there was no ACFM review in 2007. In 2007, total nominal landings reached 3180 t . In 2009, a TAC of 4104 t was allowed whereas the ICES recommendation was 3400 t i.e. average landings from years 2005-2007. In 2010, the TAC was fixed at 3899 t and the total landings reached 3400 t . In 2011, the TAC remained unchanged whereas the French landings were 3560 t .

For a long-time, a minimum landing size of 26 mm CL ( 8.5 cm total length) was adopted by the French producers' organisations (larger than the EU MLS set at 20 mm CL i.e. 7 cm total length). Since December 2005, a new French MLS regulation (9 cm total length) has been established. This change has already significantly impacted on the data used by the WG last year (see report WGHMM 2007).

A mesh change was implemented in 2000 and the minimum codend mesh size in the Bay of Biscay is 70 mm instead of the former 55 mm for Nephrops, which had replaced 50 mm mesh size in 1990-91. 100 mm mesh size is required in the Hake box. For 2006 and 2007, it should be noted that Nephrops trawlers were allowed to fish in the hake box with the current mesh size of 70 mm once they have adopted a square mesh panel of 100 mm . This derogation was maintained in 2008.

As annotated in the Official Journal of the European Union (p.4, art. 27): "In order to ensure sustainable exploitation of the hake and Norway lobster stock and to reduce discards, the use of the latest developments as regards selective gears should be permitted in ICES zones 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 whole areas VIIIa, VIIIb applicable from the 1 st 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 and (3) an 80 mm codend mesh size.

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. In the beginning of 2006, the French producers' organisations adopted new additional regulations such as monthly quotas which had some effects on fishing effort limitation.

## A.3. Ecosystem aspects

Nephrops are omnivorous but polychetes, crustaceans, molluscs and echinoderms are its favourite prey. Nephrops grow by successive moults like all crustaceans, when renewing their carapace. Mating takes place just after the females moult. Eggs are fertilized when they are laid and they attach under the female abdomen. Berried Nephrops stay most of the time in their burrows. Egg loss is significant during incubation. When they hatch larvae are pelagic for one month, then after metamorphosis the small Nephrops settle on the sea bed.

In the Bay of Biscay, Nephrops of both sexes moult twice a year, before sexual maturity length is reached. Then when they are mature, females moult once a year, but males go on moulting twice a year.

Males are sexually mature when they are about 6.5 cm long ( $20 \mathrm{~mm} C L$ ) and two years old, females when they are about 8 cm long ( 24 mm CL ) and two and a half years old. Incubation takes 7 months in the Bay of Biscay. Egg number increase according to size (a $7-8 \mathrm{~cm}$ long female has a mean egg number around 650, a 9 cm long 800 eggs, a 15 cm long 4000 eggs).

The Bay of Biscay Nephrops fishery has a major impact on the Northern Stock of Hake, because the Nephrops fishing grounds are on a hake nursery. Hake discards are very important. By-catch of other species is not as large.

## B. Data

## B.1. Commercial catch

Nearly all the landings from FUs 23-24 are taken by French trawlers. In recent years, small landings are reported by Belgium from rectangles inside the FUs, and by Spain from rectangles outside the FUs but inside the MA.

Generally speaking, males predominate in the landings but sex ratio analysis shows that up to the early 2000's the proportion of females in the landings had slightly increased reaching $45 \%$ of the total (2004). The sex ratio in landings sloped down in recent years (since 2008) and was equal to 0.31 in 2011: that should be the consequence of the MLS change ( $1^{\text {st }}$ Dec. 2005) and, moreover, of the new selectivity regulations ( $1^{\text {st }}$ April 2008) approving the increase of the caught fraction of males because of their higher growth.

Discard data are available for 1987, 1991, 1998 and have been collected again since June 2002. The numbers discarded at length for the intermediate years up to 2002 were derived and discards since 2003 have been estimated by a sample mean estimator from on board sampling programme.

- In previous assessments (until WGHMM 2010),

Discards represent most of the catches of the 2 younger ages groups (group 1 and 2) as indicated by the available data. The average weight of discards per year on the period 1987-2002 (before DCF; only 3 years were sampled onboard as explained above) was about 1550 tonnes whereas discards since 2003 have reached a higher level (2 230 t ).

## B.2. Biological sampling and methodology

## B.2.1. Generalities

Landings: French sampling plan at auction started in 1984, but only since 1987 the data can be used on quarterly basis. Since 2003, additional database of landings was also provided by sampling routinely performed onboard under the European DCR (Data Collection Regulation) aiming for discard estimates.

Discards: Discard data acquired by sampling on board are available for 1987, 1991, 1998 and since 2003 (Fig. 1). For recent years, discards have been estimated from sampling catches programme on board Nephrops trawlers ( 372 trips and 1140 hauls have been sampled over period 2003-2011). Discards for sampled fishing trips are estimated by ratio estimator using the total landings as auxiliary variable (Talidec et al., 2005). Discard sampling from the southern part of the fishery was carried out only once in the past (2005), thus, the poor set of available data cannot yet be included in the stock assessment.

For intermediate years up to 2002 with no sampling onboard, numbers discarded at length were derived in the following way:

- the estimates for 1987-90 from the data collected during the 1987 discard sampling programme;
- those for 1991-96 from the 1991 sampling programme; and
- those for 1997, 1999-2003 from the 1998 sampling programme.

The derivation method uses ratios at each length between discards and total numbers landed for the two sexes combined.

## B.2.2. Exploratory runs based on probabilistic concepts

Applying discard data from 'sampled' to 'non-sampled' years bears the risk of inconsistency between the different data sets because it induces an inter-dependence between years and also prevents detection of any signal on recruitment strength. Hence, WG investigated additional exploratory runs based on different approaches of derivation of discards for missing years.
In order to eliminate dependence between years due to derivation of missing years from common datasets, WG carried out additional runs based on logistic derivation (i.e. simulation of the hand-sorting of marketable sizes) of discard length frequencies from those of landings year by year.

## B.2.3. Methodology

Overall scheme of this methodology is provided below. At present, this methodology is used only for exploratory runs, with the intention of using it for the main assessment after it has been tested in a benchmark.

## B.2.3.1. Sampled years

The overall programme is based on a stratified random sampling. Discards are estimated for each sampled fishing trip and raised by multiplying by the total number of fishing trip in the stratum. The total number of trips is usually not known, its estimate can be done using the number of auction hall sales in the case of trips of short duration (1 day); that is the case for "Le Guilvinec" district, but not for the Southern part of the fishery. Estimates and variances are provided by haul, trip or segment (i.e. fleet or district). As there is only one sample collected during each fishing operation,
the within-FO variance is estimated by assuming a fixed total sample size, only the species composition and the length frequency being variable. The variance of the observed quantity in each category is estimated by assuming a hyper-geometric distribution.

The ratio between discards and an auxiliary variable was afterwards estimated. The ratio-estimate is more accurate than the simple estimate only if the correlation of discards with the auxiliary variable is larger than half the ratio of the coefficients of variation: $@>C V($ auxiliary var. $) /\left(2^{*} \mathrm{CV}(\right.$ discards $\left.)\right)$ (Cochran, 1977). Total landings were taken into account as auxiliary variable. The ratio of discards over landings by trip is calculated and is then raised using total landings.

## B.2.3.2. Missing years

The integration of a set of independent variables (recruitment strength, density of probability of discards, regulations, market considerations) to extrapolate reliable discard rate from sampled to missing years was already considered by ICES. Indeed, the available common dataset (six years while the years after the MLS change i.e. 2006 and 2007 are excluded) reveals strong correlation for the relationship mean size of discards vs. mean size of landings (after log-log transformation) either on quarterly data (mainly for $2^{\text {nd }}$ and $3^{\text {rd }}$ quarters representing the major part of catches) or on the whole year datasets $\left(\mathrm{R}^{2}=0.96\right)$. This conclusion is valid on both separated sexes or on combined data. Even if year 1987 is removed from the regression, the $\mathrm{R}^{2}$ remains high (0.90)

A new approach based on probabilistic concepts and on relationships between mean sizes of landings and of discards was performed by ICES. The main concepts of the derivation (back-calculation) are summarized as (Fig. 2):

1 ) The first step involves applying hand-sorting selection of retained catches which is explained by s-shaped (logistic) function vs. size. As statistically tested (Fifas et al., 2006), the hand-sorting function is stable within-quarter for given parameters of the exploitation pattern (if mesh size and MLS remain constant within period). The overall time series was divided into three periods (years 1987-1990, 1988-1990 and 1992-1997).

2 ) The second step consists in removing undersized individuals unusual in landings which can generate unreliably extreme values of discards due to sampling problems (very high CV of landings for the extreme size classes). Hence, size classes less than a tested threshold ( $1 \%$ of cumulative landings) were eliminated. This calculation process retains only a part of the initial hand-sorting generated distributions of discards mainly the decreasing part of discarded individuals.
3 ) The third step allows the generation of missing size classes by applying a probability density function which can be symmetrical in regards to the overall symmetry of DLF of discards (Fig. 1; Table XXX). The whole calculation is based on multiple maximum likelihood function. Relationship as between mean sizes of landings and of discards is also included in the final fitting.


Figure 2. Years 2003-2007. Distribution of length frequencies (CL in mm) and confidence intervals (confidence level 1- $\alpha=0.95$ ) for discards estimated by sampling. Data by sex (females above, males below).


Figure 3. Distribution of length frequencies (CL in mm) for discards 2009-2011 and confidence intervals (confidence level 1- $\alpha=0.95$ ). Data by sex (males left, females right).

## B.3. Surveys

A survey called LANGOLF specifically designed to evaluate abundance indices of Nephrops in the Bay of Biscay commenced in 2006 (with the most appropriate season: $2^{\text {nd }}$ quarter, hours of trawling: around dawn and dusk and fishing gear: twin trawl). This survey can provide an independent tuning dataset in addition to the commercial tuning fleet (GV-Q2; see below) considered for the whole historical series since 1987. Until 2011, these data were not included as indices for the stock assessment because of the short time series. As regards IBP Nephrops 2012, the abundance indices provided by the survey were included at the aim of VPA tuning.

This survey is carried out by twin trawling on the area of the Central Mud Bank of the Bay of Biscay ( $\approx 11680 \mathrm{~km}^{2}$ ). The whole area was divided to five sedimentary strata according to the mud composition of sediment and to its origin (Figure 3). The five strata are defined as:
(1) $25 \%$ mud and silt stratum
(2) $75 \%$ mud and silt stratum
(3) Lithoclastic mud<25\% stratum
(4) Carbonated mud<25\% stratum
(5) Calcareous mud<25\% stratum
(noted VV)
(noted VS)
(noted LI)
(noted CB)
(noted CL)

Using either sampling onboard for commercial vessels or VMS available data, it is possible to calculate distribution of the fishing effort for the Nephrops trawling fleet by stratum and by District (Table 1). The provided values are averaged on years 20032005. These values are used in combination with strata surfaces to allocate survey effort by stratum.

Table 1. Distribution (\%) of the fishing effort of the Nephrops trawling fleet by sedimentary stratum and by District (GV=Le Guilvinec; CC+LO=Concarneau and Lorient; S=Southern Districts i.e. outside Brittany).

| stratum | GV | CC + LO | S | Total |
| :--- | :--- | :--- | :--- | :--- |
| VS | 4.43 | 4.89 | 2.80 | $\mathbf{1 2 . 1 2}$ |
| VV | 18.90 | 26.09 | 9.09 | 54.08 |
| CL | 9.10 | 0.00 | 0.00 | 9.10 |
| LI | 0.00 | 11.42 | 8.39 | $\mathbf{1 9 . 8 0}$ |
| CB | 3.50 | 0.00 | 1.40 | 4.90 |
|  | $\mathbf{3 5 . 9 3}$ | $\mathbf{4 2 . 4 0}$ | $\mathbf{2 1 . 6 7}$ | $\mathbf{1 0 0 . 0 0}$ |



Figure 4. Nephrops of the Bay of Biscay (FU 23-24). The Central Mud Bank, the five spatial strata and the distribution of sampling units for 2009's survey.



Figure 5. Nephrops of the Bay of Biscay (FU 23-24). LANGOLF survey 2006-2011. Global indices for biomass and abundance and confidence intervals ( $\alpha=0.05$ ).


Figure 6. Nephrops of the Bay of Biscay (FU 23-24). LANGOLF survey 2006-2011. LFDs by sex and confidence intervals ( $\alpha=0.05$ ).

## B.4. Commercial CPUE

## Commercial fleets used in the assessment to tune the model

The logbook regulation is not particularly well enforced in the Bay of Biscay. Very few skippers regularly fill in their logbooks (in 2003 for example, skippers of 209 out of a total of 266 Nephrops trawlers had filled in their logbook for at least one trip, and 108 for between one and fifty trips). Only $16 \%$ of the 2004 auction sales could be linked to logbook data.

Up to 1998, the majority of the vessels were not compelled to keep logbooks, and fishing forms were established by inquiries. Since 1999 when logbooks became compulsory for all vessels $>10 \mathrm{~m}$, no more inquiries have been carried out to fill in these forms, the consequence being a severe degradation in the quality of the effort data.
The available log-books cannot be considered as representative of the whole fishery, and estimates which used to be calculated in the past are no longer used (as they take into account trips with more than $10 \%$ of Nephrops in value). The current assessment uses the work done in 2004 to define a better effort index as follows:

The fleet which is chosen to calculate the effort index is that of the "Le Guilvinec District", which groups four ports specialised in Nephrops trawling: 40\% of the total Nephrops trawlers are from those ports. The reference period considered is the second quarter. This is the period of maximum availability of Nephrops (as females leave gradually burrows) and the period during which all boats target Nephrops, as opposed to the autumn and winter period when a (variable) proportion of the fleet prefers to target finfish for part of the trip. In the area covered by the Le Guilvinec fleets, fishing trips typically are daily, so the number of sales is equal to the number of trips ${ }^{1}$. The numbers of sales are available from the auction halls database. Fishing hours per trip vary seasonally: from 9 hours from April to October, to 6 hours in the remaining months. The overall effort index was then obtained by summing monthly products of fishing time by number of sales. The "Le Guilvinec District" effort series thus obtained is consistent with the data available before 1999, and is used to calculate LPUEs with landings data from the auction halls.

Because of changes in fishing gear and gear efficiency during the period, the number of hours trawling as such is not appropriate to quantify effort and to calculate LPUEs. In the 1990's, the number of boats using twin-trawls has increased together with that using rockhoppers. Gear efficiency has gone up, but its effect on fishing effort as a whole is difficult to quantify since twin-trawling is not always recorded in the fisheries statistics. An inquiry amongst fishermen has been performed in the frame of the EU project "TECTAC and data processing is in progress to build a time series on gear characteristics and other technical improvements (e.g. GPS). This should allow a better appreciation of 'real' effort.
Other available commercial fleets not used in last assessment to tune the VPA model
None

[^9]
## B.5. Other relevant data

## B.5.1. Selectivity pattern of Nephrops trawls

## B.5.1.1. Existing selection model

Nephrops selection data were collated by ICES WGFTFB in 1995. These have been used to produce a model relating L50 and SR [=deviation of selection=2* $\ln (3) /(\mathrm{L} 75-$ L25)] to mesh size, twine thickness and open meshes round the circumference of the codend.
$\mathrm{L} 50=28.12+0.447$ * $\mathrm{MS}-4.87^{*} \mathrm{Ts}-0.095^{*} \mathrm{MR}$
and
SR $=2.32+3.21$ * Ts
where MS is mesh size in mm, Ts is equivalent nominal single twine thickness mm and MR is number of open meshes round codend circumference. For double twine with thickness Td , it is assumed that a single twine with the same total twine crosssection is equivalent, i.e. Ts = SQRT( 2 * $\mathrm{Td}{ }^{*} \mathrm{Td}$ ). The formulae for L50 and SR should be used with caution and only within the range of codend designs used to derive them. They may be derived using only hauls exhibiting length-related selection.

For the Nephrops trawlers of the Bay of Biscay, the selectivity parameters are given below (Table 2) [all polyethylene material; $\mathrm{SF}=$ selection factor=L50/MS]:

Table 2. FU23-24 Nephrops stock (Bay of Biscay). Selectivity parameters (see draft report WKNEPH, Jan. 06; ICES,CM1995/B:2).

| MS $(\mathrm{mm})$ | 55 | 70 | 80 | 70 | 80 | 100 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| thickness $(\mathrm{mm})$ | 4 | 4 | 4 | 4 | 4 | 4 |
| double | N | Y | Y | N | N | Y |
| Ts | 4 | 5.6569 | 5.6569 | 4.0000 | 4.0000 | 5.6569 |
| nb meshes codend | 100 | 100 | 100 | 100 | 100 | 100 |
| L50 | 23.7250 | 22.3611 | 26.8311 | 30.4300 | 34.9000 | 35.7711 |
| SR | 15.1600 | 20.4785 | 20.4785 | 15.1600 | 15.1600 | 20.4785 |
| SF | 0.4314 | 0.3194 | 0.3354 | 0.4347 | 0.4363 | 0.3577 |

## C. Historical Stock Development

Model used: XSA.
Software used: Lowestoft VPA suite v. 3.1 (Darby and Flatman, 1994).
Up to the 2003 assessment, tuning data were estimates of Nephrops directed effort based on information on the landings composition and the number of hours fished per voyage, averaged on an annual basis.

Discards for sampled fishing trips are raised by multiplying the total number of fishing trips. This total number of trips is usually not known and needs to be estimated, which can be done using the number of auction hall sales, if boats do daily trips, which is the case in the northern part of the fishery, but not in the southern part. Discards from the southern part of the fishery have not yet been sampled, so in order to
obtain an estimate for the whole fishery we used the following ratio of total number of sales to number of sales in the southern part.
Then raised discards of the northern part were multiplied by this ratio. The catch sampling programme in 2005 included trips in the southern part of the fishery. So improvements in discard estimation were expected for future years. Nevertheless, the extension of the sampling design in the Southern part of the fishery could not be routinely applied every year.
Removals at length are obtained by adding up landings and "dead discards" since a discard mean survival rate of $30 \%$ is applied to discards.
The L2AGE slicing program allocates length classes into age groups, using von Bertalanffy growth parameters. The ages obtained are not absolute but relative ones (age groups). This slicing is applied to length distributions by sex and these age distributions are summed to obtain a "sex combined" age distribution.

The natural mortality both sexes combined is assumed to be 0.3 for age groups 1 and 2 , then 0.25 for other age groups.

Since 2006 the WG has introduced some modifications of the maturity parameters by sex. Maturity of males is explained by the first size of functional maturity ( 26 mm CL on data collected in 2004; a strong yearly variability of the size of functional maturity was pointed out: Jégou, 2007). Previously, maturity of females was assumed to be knife-edged whereas now it is described by an s-shaped curve (logistic model with L50 of 21-24 mm CL which is not significantly different to the value already used by WG i.e. 25 mm CL$)$.

The growth parameters, the natural mortality and the maturity ogive by sex and combined are the following (as applied since WGHMM 2006):

Table 3. Usual input parameters (maturity, growth rate, natural mortality) for performing XSA on FU23-24 Nephrops stock.

| Males and immature females: $\mathrm{L} \infty=76, \mathrm{~K}=0.14 ;$ mature females: $\mathrm{L} \infty=56, \mathrm{~K}=0.11$ |  |  |  |  |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| age |  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | $9+$ |
| Size | males | 10 | 19 | 26 | 33 | 38 | 43 | 48 | 51 | 54 |
| (CL mm) | females | 10 | 19 | 26 | 29 | 32 | 34 | 36 | 38 | 40 |
| M | Males | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
|  | females | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
|  | combined | 0.3 | 0.3 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Maturity | Males | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
|  | females | 0 | 0 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
|  | combined | 0 | 0 | 0.75 | 1 | 1 | 1 | 1 | 1 | 1 |

Recruitment is assumed to occur at the $1^{\text {st }}$ January and SSB is calculated at this date.
For the 2004 assessment as explained above a new tuning series was built (a) by choosing another reference fleet (the "Le Guilvinec district") and another reference period (the second quarter, which is much more indicative of the actual directedness of the fleet towards Nephrops) and (b) by adding a second tuning fleet covering the other ports of the Bay of Biscay, with selected Nephrops directed trips in the second quarter too.

This second tuning fleet has not been included since WGHMM 2005, because it is based on log book data whose quality is poor for this fishery.

So only the tuning fleet of "Le Guilvinec District" was kept to carry out the assessment. Annual age compositions were obtained by using the ratios of Quarter 2 -fleetlandings to Total-quarter 2-landings.

Recent input data types and model options chosen are detailed in the following table:

| FR -Q2-QGV | Fleets |  | 2006 XSA |  | 2007 XSA |  | 2008 XSA |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & 1987- \\ & 2005 \end{aligned}$ | $\begin{array}{ll} \text { Ages 1- } & 1 \\ 9+ & 2 \end{array}$ | $\begin{aligned} & 1987- \\ & 2006 \end{aligned}$ | Ages 1-9+ | $\begin{aligned} & 1987 \\ & 2007 \end{aligned}$ | Ages 1- 9+ |  |
|  | Taper |  | Yes (3 over whole time series) |  | Yes <br> (3 over whole time series) |  | Yes <br> (3 over whole time series) |
|  |  | Tuning range | Full |  | Full |  | Full |
|  |  | Age catchability dependent of stock size | y No |  | No |  | No |
|  |  | q plateau | 6 |  | 6 |  | 6 |
|  |  | F shrinkage se | 1.5 |  | 1.5 |  | 1.5 |
|  |  | year range of shrinkage | 5 |  | 5 |  | 5 |
|  |  | age range of shrinkage | 5 |  | 5 |  | 5 |

Note: no assessment was performed in 2009.

## D. Short-Term Projections

Short-term projections are performed using MFDP and MFYPR procedures. In the particular case of the Bay of Biscay Nephrops, it is necessary to prepare data prior to the execution of the modules. Matrix containing numbers of removals by year and by age is computed using MFREP executable (available in ICES libraries) aiming to split into two matrices involving in landings and discards and the same procedure is carried out on matrix of $F$ at age.

Apart from 2009 when no assessment was performed on the stock, short-term projections were provided on annual basis since the incorporation of the stock in the WGHMM (2005). Input for projections carried out for the five last years are commented below.

2006: In the assessment, recruitment 2005 was replaced by $G M(87-04)=679$ million. This GM value was input in projections for recruitments from 2006 onwards. Unscaled Fbar was calculated on years 2003-2005 ( $\mathrm{F}=0.49$ ).

2007: In the assessment, recruitment for 2005 was replaced by R2004 ( $=1006$ million) because the WG adopted arguments for strong recruitment value for this year, but rejected the extremely high value provided by XSA. Two additional runs were also carried out with R2005 replaced either by $\mathrm{GM}(87-04)=672$ million or by $90^{\text {th }}$ percentile of the series 1987-2004 i.e. 860 million. Recruitment 2006 was replaced by GM(87-04) which was also used in projections for recruitments from 2007 onwards. The exploitation patterns for the projection are based on the unscaled average Fs-at-age in the years 2004-2006 ( $\mathrm{F}_{2-5}=0.48$ ). These were then split into landings and dead discards F , based on the scaled values of F discards at age estimated in 2006 because the exploitation pattern was modified due to the MLS change.

2008: In the assessment, recruitments 2006 and 2007 were replaced by $\mathrm{GM}(87-05)=683$ million which was also be input in projections for recruitments from 2008 onwards.

The exploitation patterns for the projection are based on the unscaled average Fs-atage in the years 2005-2007 ( $\mathrm{F}_{2-5}=0.53$ ). As for 2007, these were then split into landings and dead discards F, based on the scaled values of F discards at age estimated in 2006 and 2007 because the exploitation pattern was modified due to the MLS change.

2010: All recruitments estimated by XSA (1987-2009) were accepted by WG, but GM for projections was calculated after excluding R2009 (=722 million) which may not represent the overall historical trend for recruitment level (even if LANGOLF signal seems to agree with relatively high recruitment for this year; the confirmation should be given in the future while this survey will be included as tuning time series). Unscaled Fbar was calculated on years 2007-2009 ( $\mathrm{F}=0.43$ ).

## E. Medium-Term Projections

No analysis was carried out.

## F. Biological Reference Points

There is no reference point for this stock and without any further information the Group decided not to propose any this year.

## G. Other Issues

None.

## References

Cochran, W. G. 1977. Sampling techniques. Wiley series in probability and mathematical statistics, John Wiley \& Sons, New York. 428 pp.

Fifas S., Macher C., Rochet M.J., D’Hardiville C., 2006. Sorting factors in the Nephrops norvegicus French trawl fishery of the Bay of Biscay (VIIIab), Maastricht,CM 2006/K:13. Netherlands,19-23 September 2006.

ICES, 2003. Report of the Working Group on Nephrops stocks. ICES CM 2003/ACFM:18
ICES, 2004. Report of the Working Group on Nephrops stocks. ICES CM 2004/ACFM:19
Jégou C., 2007. Analyse de la variabilité de la maturité sexuelle de la langoustine, Nephrops norvegicus, dans le Golfe de Gascogne. Rapp. $3^{e}$ cycle, Univ. Brest: 22 p.

Talidec C., Rochet M.-J., Bertignac M., Macher C. 2005. Discards estimates of nephrops and hake in the Nephrops trawl fishery of the Bay of Biscay: Methodology and preliminary results for 2003 and 2004. Working Document for the ICES Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim, WGHMM. Lisbon, Portugal, 10-19 may 2005.

Trenkel V.M., Rochet M.J., 2002. Towards a theory for discarding behaviour. ICES CM 2002/V:03 Conan, G.Y., 1978. Average growth curves and life history in a Nephrops population from northern bay of Biscay. ICES CM 1978/K:21.

## Annex K Stock Annex $\quad$ North Galicia (Division VIIIc FU 25)

Quality Handbook Stock Annex K

Stock specific documentation of standard assessment procedures used by ICES.

| Stock | North Galicia (Division VIIIc, FU 25). |
| :--- | :--- |
| Working Group: | Assessment of Southern Shelf Stocks of Hake, <br> Monk and Megrim |
| Date: | 05 May 2010 |
| Revised by | Yolanda Vila and Luis Silva |

## A. General

## A.1. Stock definition

Nephrops stock from FU 25 stretches along the Atlantic area off the northwest Spanish coast, located between Cap Finisterre and the Bay of Ribadeo.

## A.2. Fishery

Nephrops is caught in the mixed bottom trawl fishery in the North and Northwest Iberian Atlantic. The fishery takes place throughout the year, with the highest landings in Spring and Summer. The overall decline of some bottom commercial species in the area has influenced the fishing strategies. The bottom fisheries have targeted a variety of species, including hake, anglerfish, megrim, horse mackerel and mackerel. At present, the trawl fleet comprises three main components: baca bottom trawl, high vertical opening trawl (HVO) and bottom pair trawl (STECF, 2003). Only the baca trawl catches Nephrops. Trawl vessels can change the gear from year to year and, consequently, the target species and fishing effort applied vary. The increasing use of pair trawlers and HVO (fishing for mackerel and horse mackerel) that do not catch Nephrops has reduced the fishing effort on the species in recent years.

The Prestige oil spill off the northwest Spanish coast (November 2002) resulted in the adoption of several temporary regulations to minimize the impact on the fisheries, such as spatial and seasonal closure for fishing fleets. The fishery remained partially closed from January to April 2003.This caused a reduction in fishing effort of the trawl fleet from November 2002 to June 2003.

Nephrops is managed by an annual TAC (applying to the whole of ICES Division VIIIc) and technical measures. European Union regulations establish 20 mm carapace length (CL) as a minimum landing size. Few animals are caught under size. Although Nephrops represents less than $2 \%$ of the total weight landed by the bottom trawl fishery (Fariña, 1996), the species is a very valuable component of the landings.

A recovery plan for southern hake and Atlantic Iberian Nephrops stocks was implemented and enforced since 2006 (EC, 2166/2005). 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.

## A.3. Ecosystem aspects

This geographical area is characterized by episodic upwelling of North Atlantic Central Water during summer.

Nephrops is a burrowing species and occurs on muddy sea bed on the continental shelf and upper slope. The distribution of Nephrops in this area is limited to depths ranging from $90-600 \mathrm{~m}$ in a patch work configuration where the substrate is suitable. Its distribution is more determined by ground type and sea temperature than by depth. Nephrops are sedentary but they can leave their burrows in search of food and for reproduction.

After reaching sexual maturity, males molt more frequently than females, consequently growing faster. Mating takes place just after the females molt. Eggs are fertilized when they are laid and they attach under the female abdomen. Berried Nephrops stay most of the time inside their burrows. Larvae are pelagic for one month after hatching, then after metamorphosis the small Nephrops settle on the sea bed. The emergence patterns of the Nephrops females during the incubation period results in a different exploitation pattern for each sex.

Nephrops are omnivorous, but polychetes, crustaceans, molluscs and echinoderms are their favourite preys. There are not reports on Nephrops' predators in the area.

## B. Data

## B.1. Commercial catch

Landings
Landings are reported only by Spain, with the data based on Spanish sales notes and Owners Associations data compiled by IEO. Fisheries statistics are believed to be reliable. However, during the periods 1998-2001 and 2004-2008 the information sources failed and landings data were obtained from the biological sampling programme, instead of directly from the sale sheets, which makes the quality of estimates more questionable.

Discard
Nephrops discards are negligible in this fishery. Generally, only soft and damaged individuals are discarded (Pérez et al., 1996) and the information is obtained via the onboard discard sampling programme.

## B.2. Biological

Annual length compositions of the commercial landings of Nephrops for both males and females are available since 1980 for the A Coruña trawl fleet. The sampling data are raised to the total landings by market category and month. Starting from 2009 concurrent sampling is carried out, as required by the new DCR (Reg. EC 1343/2007). With the new sampling strategy, five fishing trips of the bottom trawl metier are sampled per month at the auction market in A Coruña port. Information on discards is not taken into account in the estimation of the total catch length distribution due to the low level of discards.

## B.3. Surveys

Abundance indices of Nephrops FU 25 are derived from the Spanish groundfish survey SP-GFS carried out to collect information on abundance of demersal species. The survey uses a stratified random sampling design with half hour hauls and covers the northwest area of Spain, from Portugal to France, during September/October since 1983 (except 1987). Data for 2003 are not considered reliable. The information is not taken into account because the surveys are not designed for Nephrops.

## B.4. Commercial CPUE

Fishing effort and LPUE data are available for A Coruña trawl fleet (SP-CORUTR8c). The fishing effort corresponds to the bottom trawl fleet that fish in a mixed fishery for demersal species (not specifically directed to Nephrops). Fishing effort and LPUE data starting from 1999 exclude the fishing trips that operate with HVO, as this gear (which catches mostly mackerel and horse mackerel) does not catch Nephrops.

## B.5. Other relevant data

## C. Historical Stock Development

Nephrops FU 25 has been regularly assessed since 1990 (ICES, 1990). The last analytical assessment was carried out by the WGHMM in 2006 (ICES, 2006). XSA was applied, using "catch-at age" data generated by the slicing of length distributions employing the L2AGE program. This procedure, introduced in the 1991 Nephrops WG, uses von Bertalanffy growth parameters to determine limits between age classes. The use of slicing to convert length compositions into age compositions is controversial, especially for older age groups ( 3 and older). An assessment for both sexes combined was carried out, although slicing was applied by sex and the results combined to obtain a single catch-at-age matrix for both sexes.

The 2006 XSA assessment was calibrated using data from a single commercial LPUE series, where the definition of fishing effort was based on nominal effort. The results were only accepted as indicative of stock trends.

Model used (until 2006): XSA
Software used: Lowestoft VPA Suite (VPA95.exe), Retvpa02.exe
Input data types and characteristics:

| Parameter | Value | Source |
| :--- | :--- | :--- |
| Discard survival | NA | Not applicable Few discards (<1\% on |
| MALES |  |  |
| Growth-K | 0.160 | (ICES, 1994) |
| Grouth-L(inf) | 70 | $"$ |
| Natural mortalitv-M | 0.2 | " |
| Lenght/weight-a | 0.00043 | (Fariña, 1984) |
| Lenght/weight-b | 3.160 | " |
| FEMALES |  |  |
| Inmature Growth |  |  |
| Growth-K | 0.160 | (ICES, 1994) |
| Growth-L(inf) | 70 | " |
| Natural mortality-M | 0.2 | " |
| Size at maturitv (mm CL) | 28 | (Fariña, 1996) |
| Mature Growth |  |  |


| Growth-K | 0.080 | (ICES, 1994) |
| :--- | :--- | :--- |
| Grouth-L(inf) | 60 | " |
| Natural mortalitv-M | 0.2 | Assumed from Morizur (1982) |
| Lenght/weight-a | 0.00043 | (Fariña, 1984) |
| Lenght/weight-b | 3.160 | " |

XSA run:

| Males + Females | 2006 WGHMM |  |
| :--- | :--- | :--- |
| Tuning Fleets used <br> SP-CORUTR-8c | Assessment Years <br> $1982-2005$ | Assessment Ages <br> $2-9$ |
| First age for normal catchability independent analysis | All ages independent |  |
| First age at which q is considered independent of age | 7 |  |
| Taper | Tricube over 20 yrs |  |
| F shrinkage (SE for mean F) | 1.5 |  |
| F Shrinkage | Final 5 yrs | 3 oldest ages |
| Minimum Log SE for terminal population estimates | 0.3 |  |
| Fbar (age) | $4-7$ |  |
| Recruitment Age | 2 |  |

No improvements in relation to the methodological assessment have been achieved after 2006 and the WG has not attempted any further analytical assessment for this stock. The time series of fisheries data are updated annually and LPUE series used to depict the stock trend.

## D. Short-Term Projection

Not used.

## E. Medium-Term Projections

Not used.

## F. Long-Term Projections

Not used.

## G. Biological Reference Points

There are no biological references points defined for this stock.

## H. Other Issues

## I. References

Fariña, A.C., 1984. Informe de la Campaña "Sisargas83". Inf. Tec. Inst. Esp. Oceanogr., no 25.

Fariña, A.C., 1996. Megafauna de la plataforma continental y talud superior de Galicia. Biología de la cigala Nephrops norvegicus. Doctoral Thesis. Universidad da Coruña. 297 pp.

ICES, 1990. Report of the Working Group on Nephrops stocks. ICES CM 1990/Assess:16

ICES, 1994. Report of the Working Group on Nephrops and Pandalus stocks. ICES CM 1994/Assess: 12.

ICES, 2006. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim. ICES CM 2006/ACFM:01

Morizur, Y., 1982. Estimation de la mortalité pour quelques stocks de langoustine, Nephrops norvegicus. ICES C.M. 1982/K:10

Pérez, N., Pereda, P., Uriarte, A., Trujillo, V., Olaso, I. and Lens, S., 1996. Descartes de la flota española en el área del ICES. Datos y Resúm. Inst. Esp. Oceanogr., 2: 142 pp.
STECF, 2003. Report of the STECF meeting on Hake Technical Measures. Lisbon, 2731. October, 2003

## Annex K Stock Annex Cantabrian Sea (Division VIIIc FU 31)

Quality Handbook Stock Annex K
Stock specific documentation of standard assessment procedures used by ICES.

| Stock | Cantabrian Sea (Division VIIIc, FU 31). |
| :--- | :--- |
| Working Group: | Assessment of Southern Shelf Stocks of Hake, <br> Monk and Megrim |
| Date: | 05 May 2010 |
| Revised by | Yolanda Vila and Luis Silva |

## A. General

## A.1. Stock definition

Nephrops stock from FU 31 extends in two main patches located in the central and in the easternmost Cantabrian Sea respectively.

## A.2. Fishery

The description of these fisheries was updated and reported in STECF (2003). Mackerel and horse mackerel contribute $80 \%$ of the landed species by the baca bottom trawl fleet in the Cantabrian Sea, while hake and Nephrops together represent only $1 \%$ of the total landings by this fleet. Other trawl components operating in the Cantabrian Sea (namely HVO trawl and pair trawl) do not catch Nephrops.

Nephrops is managed in the area by an annual TAC (applying to the whole of ICES Division VIIIc) and technical measures. European Union regulations establish 20 mm carapace length (CL) as a minimum landing size. A recovery plan for southern hake and Atlantic Iberian Nephrops stocks was implemented and enforced since 2006 (EC, $2166 / 2005$ ). 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.

## A.3. Ecosystem aspects

Nephrops is a burrowing species and occurs on muddy sea bed on the continental shelf and upper slope. The distribution of Nephrops in this area is limited to depths ranging from 90-600 m in a patch work configuration where the substrate is suitable. It distribution is more determined by ground type and sea temperature than depth. They are sedentary but they can leave this burrow to look for food and for the reproduction.

After reaching sexual maturity, males molts more frequently than females, consequently growing faster. Mating takes place just after the females molt. Eggs are fertilized when they are laid and they attach under the female abdomen. Berried Nephrops stay most of the time in their burrows. Egg loss is significant during incubation. When they hatch larvae are pelagic for one month, then after metamorphosis the small Nephrops settle on the sea bed. The emergence patterns of the Nephrops females during the incubation period results in a different exploitation pattern for each sex.

Nephrops are omnivorous but polychetes, crustaceans, molluscs and echinoderms are its favourite prey. There are not reports on Nephrops' predators in the area.

## B. Data

## B.1. Commercial catch

## Landings

Landings were reported only by Spain and they are available for the period 19832009. Data used in FU 31 are based on Spanish sales notes and Owners Associations data compiled by IEO.

Discard
Nephrops discards are negligible in this fishery.

## B.2. Biological

Annual length frequencies by sex of Nephrops landings are collected by the sampling program since 1988. The sampling data of Aviles and Santander fleet are raised to the total landings by market category and month.

## B.3. Surveys

Abundance indices of Nephrops FU 31 are derived from the Spanish groundfish survey (SP-GFS) carried out to collect information on abundance of demersal species. The survey uses a stratified random sampling design with half hour hauls and covers the northwest area of Spain, from Portugal to France, during September/October since 1983 (except 1987). Data for 2003 are not considered reliable. The information is not taken into account due to the surveys are not designed for Nephrops.

## B.4. Commercial CPUE

Landings per unit effort data series correspond to two bottom trawl fleets operating in the Cantabrian Sea with home ports in Aviles and Santander. No effort information for Aviles is available after 2003. In 2008 and 2009 fishing effort data are not available for Santander either.

## B.5. Other relevant data

## C. Historical Stock Development

At present, no assessment is carried out in this working group. The low levels of landings and fishing effort are insufficient to carry out an adequate assessment. The last analytical assessment of FU31 was conducted in 2002 (ICES, 2002).
D. Short-Term Projection

Not used.

## E. Medium-Term Projections

Not used.

## F. Long-Term Projections

Not used.

## G. Biological Reference Points

There are no biological references points defined for this stock.

## H. Other Issues

## I. References

ICES, 2002. Report of the Working Group on Nephrops stocks. ICES CM 2002/ACFM: 15.
STECF, 2003. Report of the STECF meeting on Hake Technical Measures. Lisbon, 27-31. October, 2003.

## Annex L: Nephrops FU 26-27

## Quality Handbook

ANNEX: L Nephrops FU26-27
Stock specific documentation of standard assessment procedures used by ICES.

| Stock | West Galician and North Portugal (Division <br> IXa, FU 26-27). |
| :--- | :--- |
| Working Group: | WGHMM |
| Date: | 05 May 2010 |
| Revised by | Yolanda Vila and Luis Silva |

## A. General

## A.1. Stock definition

The Nephrops stock from FU 26 extends along the Atlantic area off the northwestern Spanish coast, south of Cape Finisterre, whereas FU 27 covers the Atlantic area off northern Portugal.

## A.2. Fishery

Nephrops is caught in a mixed bottom trawl fishery, which takes place throughout the year, with the highest Nephrops landings in Spring and Summer. The overall decline of some bottom commercial species in the area has influenced the fishing strategies of the trawl fleets in terms of gear modalities and target species. Targeted species include hake, anglerfish, megrim, horse mackerel, mackerel and a variety of other fish and cephalopods.

The bottom trawl fleet comprises three main components: baca trawl, high vertical opening trawl (HVO) and pair trawl, each targeting different species. Only the baca trawl catches Nephrops. The description of these fisheries was updated and reported in STECF (2003). Trawl vessels can change gear from year to year and, consequently, target species and fishing effort applied vary. The increasing use of pair trawlers and HVO (fishing for mackerel and horse mackerel) that do not catch Nephrops, has reduced fishing effort on the species in recent years.

The Prestige oil spill off the northwest Spanish coast (November 2002) resulted in the adoption of several temporary regulations to minimize the impact on the fisheries, such as spatial and seasonal closure for fishing fleets. The fishery remained partially closed from January to April 2003, causing a reduction in fishing effort.

Nephrops is managed by an annual TAC (applying to the whole of ICES Division IXa) and technical measures. European Union regulations establish 20 mm carapace length (CL) as a minimum landing size. Few animals are caught under size. Although Nephrops represents less than $2 \%$ of the total weight landed by the bottom trawl fishery (Fariña, 1996), the species is a very valuable component of the landings.

A Recovery Plan for southern hake and Atlantic Iberian Nephrops stocks was implemented and enforced since 2006 (EC 2166/2005). 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.

## A.3. Ecosystem aspects

Nephrops is a burrowing species and occurs on muddy sea bed on the continental shelf and upper slope. The distribution of Nephrops in this area is limited to depths ranging from $90-500 \mathrm{~m}$. Main patch configurations are evident in shallower waters ( $80-140 \mathrm{~m}$ ) in the west coast of Galicia. The distribution of Nephrops is more determined by ground type and sea temperature than depth. They are sedentary but they can leave their burrows to look for food and for reproduction purposes.

After reaching sexual maturity, males molt more frequently than females, consequently growing faster. Mating takes place just after the females molt. Eggs are fertilized when they are laid and they attach under the female abdomen. Berried Nephrops stay most of the time in their burrows. Larvae are pelagic for one month after hatching, then after metamorphosis the small Nephrops settle on the sea bed. The emergence patterns of females during the incubation period results in a different exploitation pattern for each sex.

Nephrops are omnivorous but polychetes, crustaceans, molluscs and echinoderms are their favourite preys. There are not reports on Nephrops' predators in the area.

## B. Data

## B.1. Commercial catch

Landings

Landings are reported by Spain and minor quantities by Portugal. The catches are taken by Spanish fleets fishing on the Galicia (FU 26) and North Portugal (FU 27) fishing grounds and by the Portuguese artisanal fleet fishing with traps in FU 27. Prior to 1996 no distinction was made between the two FUs and, therefore, the Spanish landings for that early period are given for the two FUs together. The Spanish data used are based on Spanish sales notes and Owners Associations data compiled by IEO. Landings data are available since 1975 although landings by sex are only available from 1988 onwards.

Discard

Nephrops discards are negligible in this fishery. Generally, only soft and damaged individuals are discarded (Pérez et al., 1996) and the information is obtained via the onboard discard sampling programme.

## B.2. Biological

Length frequencies by sex of the Nephrops landings are collected monthly by the biological sampling programme since 1988. The sampling data from the Marín and Vigo fleets are raised to the total landings by market category and month. Starting from 2009 concurrent sampling is carried out, as required by the new DCR (Reg. EC 1343/2007). With the new sampling strategy, fishing trips of the bottom trawl metier are sampled at the auction markets of Riveira (FU 26), Marin (FU 26) and Vigo (FU
27) ports, with 3, 4 and 2 sampling events per month, respectively. Information on discards is not taken into account in the estimation of the total catch length distribution due to the low level of discards.

## B.3. Surveys

Abundance indices of Nephrops FU 26 are derived from the Spanish groundfish survey SP-GFS carried out to collect information on abundance of demersal species. The survey uses a stratified random sampling design with half hour hauls and covers the northwest area of Spain, from Portugal to France, during September/October since 1983 (except 1987). Data for 2003 are not considered reliable. The information is not taken into account due to the surveys are not designed for Nephrops.

## B.4. Commercial CPUE

Fishing effort and an LPUE data series are available for Marín trawl fleet (SP-MATR) starting from 1994. This fleet accounts for more than $40 \%$ of the landings from these FUs. Time series of fishing effort and LPUE of the bottom trawl fleets with home ports of Muros (1984-2003), Riveira (1984-2004) and Vigo (1995-present) are also available.

## B.5. Other relevant data

## C. Historical Stock Development

The species has been regularly assessed since 1990 (ICES, 1990). The last analytical assessment for this FU was carried out by the WGHMM in 2006 (ICES, 2006). XSA was used with "catch-at age" data generated by slicing length distributions employing the L2AGE program. This procedure, introduced at the 1991 Nephrops WG, uses von Bertalanffy growth parameters to determine limits between age classes. The use of slicing to convert length compositions into age composition is controversial, especially for older age groups ( 3 and older). An assessment with combined sexes was carried out, although the slicing was applied for each sex separately and the resulting catch-at-age matrices by sex added up for the assessment. Prior to 2005 an assessment by sex was carried out but the WG proposed to carry out an assessment for both sexes combined, considering the advantages for management.

The 2006 assessment was calibrated using data from a single commercial LPUE series, where the definition of fishing effort was based on nominal effort. The results were accepted only as indicative of stock trends and not used for projections.

Model used (until 2006): XSA
Software used: Lowestoft VPA Suite (VPA95.exe), Retvpa02.exe

Input data types and characteristics

| Parameter | Value | Source |
| :--- | :--- | :--- |
| Discards survival | NA | Not applicable-Few discards (<1\% on average) |
| MALES |  |  |
| Growth-K | 0.150 | (Fernandez et al., 1986) |
| Grouth-L(inf) | 80 | " |
| Natural mortalitv-M | 0.2 | " |
| Lenght/weight-a | 0.00043 | (Fariña, 1984) |
| Lenght/weight-b | 3.160 | " |
| FEMALES |  |  |
| Inmature Growth | 0.160 | (ICES, 1994) |
| Growth-K | 70 | " |
| Growth-L(inf) | 0.2 | " |
| Natural mortalitv-M | 26 | (Fariña, 1996) |
| Size at maturitv (mm CL) |  |  |
| Mature Growth | 0.080 | (ICES, 1994) |
| Growth-K | 65 | " |
| Grouth-L(inf) | 0.2 | " |
| Natural mortalitv-M | 0.00043 | (Fariña, 1984) |
| Length/weight-a | 3.160 | " |
| Length/weight-b |  |  |

XSA run

| Males+Females | 2006 WGHMM |  |
| :--- | :--- | :--- |
| Tuning Fleets used | Assessment Years <br> SP-MATR | Assessment Ages <br> $2-9$ |
| First age for normal catchability independent analysis | All ages independent |  |
| First age at which q is considered independent of age | 6 |  |
| Taper | Tricube over 20 yrs |  |
| F shrinkage (SE for mean F) | 1.5 |  |
| F Shrinkage | Final 5 yrs | 3 oldest ages |
| Minimum Log SE for terminal population estimates | 0.3 |  |
| Fbar (age) | $3-7$ |  |
| Recruitment Age | 2 |  |

After 2006, no improvements in relation to a methodological assessment were achieved and the WG did not attempt any further analytical assessment for this stock. The time series of fisheries data are updated every year and LPUE series used to depict the stock trends.

## D. Short-Term Projection

Not used.

## E. Medium-Term Projections

Not used.

## F. Long-Term Projections

Not used.

## G. Biological Reference Points

There are no biological references points defined for this stock.

## H. Other Issues

## I. References

Fariña, A.C., 1984. Informe de la Campaña "Sisargas83". Inf. Tec. Inst. Esp. Oceanogr., no 25.
Fariña, A.C., 1996. Megafauna de la plataforma continental y talud superior de Galicia. Biología de la cigala Nephrops norvegicus. Doctoral Thesis. Universidad da Coruña. 297 pp.

Fernández, A., Fariña, A.C. and Penas, E., 1986. Efectos de un cambio de malla en la pesquería de cigala (Nephrops norvegicus L.) de Galicia. Bol. Esp. Oceanogr., 3: 57-74.

ICES, 1990. Report of the Working Group on Nephrops stocks. ICES CM 1990/Assess:16
ICES, 1994. Report of the Working Group on Nephrops and Pandalus stocks. ICES CM 1994/Assess: 12.

ICES, 2006. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim. ICES CM 2006/ACFM:01

Pérez, N., Pereda, P., Uriarte, A., Trujillo, V., Olaso, I. and Lens, S., 1996. Descartes de la flota española en el área del ICES. Datos y Resúm. Inst. Esp. Oceanogr., 2: 142 pp.

## Annex L: Nephrops FU 28-29

## Quality Handbook

ANNEX: L Nephrops FU28-29
Stock specific documentation of standard assessment procedures used by ICES.

Stock Southwest and South Portugal (Division IXa, FUs 28-29)

Working Group:
WGHMM
Date:
16 May 2013 (updated)
Revised by Cristina Silva

## A. General

## A.1. Stock definition

The Norway lobster (Nephrops norvegicus) is distributed along the continental slope off the southwest and south Portuguese coast, at depths ranging from 200 to 800 m . Its distribution is limited to muddy sediments, and requires sediment with a silt and clay content of between $10-100 \%$ to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Although FUs 28 and 29 are different stocklets, landings records are not differentiated and they are assessed together.

## A.2. Fishery

The fishery in FUs 28 and 29 is mainly conducted by Portugal. For the last 25 years, this species has been a very important resource for the demersal trawl fisheries operating in the region. With exception of the years when the abundance of pink shrimp (Parapenaeus longirostris) is extremely high, Nephrops constitutes the main target species of the majority of the crustacean trawl fleet, and is not generally caught as by-catch of other fleets.

The Portuguese trawl fleet comprises two components, namely the trawl fleet fishing for fish and the trawl fleet fishing for crustaceans. The trawl fleet fishing for fish operates off the entire coast while the trawl fleet directed to crustaceans operates mainly in the Southwest and South Portugal, in deep waters, where crustaceans are more abundant. The fish trawlers are licensed to use a mesh size $>=65 \mathrm{~mm}$ and the crustacean trawlers are licensed for two different mesh sizes, 55 mm for catching shrimp and $>=70 \mathrm{~mm}$ for Norway lobster. Demersal fish trawlers that regularly land Nephrops, do in fact target this resource, which in terms of overall profit, represents a significant additional income.

The number of trawlers targeting crustaceans has been fixed at 35 since the early 1990s. However, since the late 1990s, some vessels have been replaced by new ones, better equipped and with a more powerful engine. In 2008, the number of licensed fish trawlers was 69 with an average of $645 \mathrm{HP}, 182$ GRT and 26 m of overall length, whereas the number of crustacean trawlers was 30, with an average of $562 \mathrm{HP}, 177$ GRT and 25 m of overall length.

There are two main target species in the crustacean fishery, which are the Norway lobster and the deepwater rose shrimp. These two species have a different but overlapping depth distribution. Rose shrimp occurs from 100 to 350 meters of depth whereas Norway lobster is distributed from 200 to 800 meters. The number of fishing trips directed to one species or to the other depends on the abundance of these species each year. The number of fishing trips directed to Nephrops increased in 20042005, dropping again in recent years.
The fishery takes place throughout the year, with the highest landings usually being made in the spring and summer.

A Recovery Plan for the southern hake and Iberian Nephrops stocks has been in force since the end of January 2006 (Council Regulation (EC) No. 2166/2005). 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. In order to reduce fishing mortality on Nephrops stocks in this area even further, the Recovery Plan introduced a seasonal ban in the trawl and creel fishery in a box, located in FU 28, for four months in the peak of the Nephrops fishing season (May - August).

Every year, the TAC and the number of fishing days per vessel is regulated.
A Portuguese national regulation (Portaria no. 1142/2004, 13th September 2004) enforced a complete closure of the deepwater crustacean trawl fishery in JanuaryFebruary 2005 and established a ban on Nephrops fishing from 15 September to 15 October. The ban in September-October was already implemented in 2004. This regulation was revoked in January 2006 after the implementation of the Recovery Plan, keeping only one month of closure of the crustacean fishery in January (Portaria no. 43/2006, 12th January 2006). Although these periods do not correspond to the main fishing season for Nephrops, these measures resulted in a reduction of effort.

The minimum landing size (MLS) for Nephrops norvegicus is 20 mm of carapace length (CL) or 70 mm of total length (TL). Discards are negligible and are mainly related to quality (broken or soft shells).

The main by-catch species are blue whiting, hake and anglerfish.

## A.3. Ecosystem aspects

The Norway lobster (Nephrops norvegicus) is distributed along the southwest and south Portuguese coast, at depths ranging from 200 to 800 m . Its distribution along the continental slope is patchy and high abundance areas have been clearly identified.

Differences in the length composition of catches originating from FU28 (SW Portugal) and those originating from FU29 (S Portugal) were observed during the surveys. At present there is no scientific evidence to separate these stocks and consider them two sub-populations. Further work in this area is needed to improve our knowledge about this stock.

Another topic that should be further investigated, is the possible interaction between the stocks found in FU29 and FU30 (Cadiz). Exchanges between the two populations are likely to occur since there are no known physical/geographical constraints limiting this exchange. Aiming for a better understanding of the Nephrops population dynamics, tagging experiments and genetic studies would provide valuable information, which would help to support the issues dealt with during the assessment working groups.

Norway lobster is a benthic species that attains a maximum size of around 80 mm (CL) corresponding to a weight of approximately 400 g . Lobsters spawn from August through to November off the shelf edge in deep waters. After spawning, females carry the eggs for a 3 to 4 month period after which the larvae hatch and become pelagic free swimmers. Larvae move freely in the water column for a short time period before settling into the mud grounds. Females reach the first maturity at 30 mm and males around 28 mm of carapace length (CL) (ICES, 2006).

A comprehensive study into the role of Norway lobsters in the ecosystem has not yet been carried out. It would be particularly useful to have such information, as Nephrops is known to be part of an extended and dynamic community of highly valuable commercial species.

## B. Data

## B.1. Commercial catch

Up to 1992 the estimated landings from FUs 28 and 29 have fluctuated between 450 and 530 t , with a long-term average of about 480 t . Between 1990 and 1996, the landings fell drastically to 132 t . From 1997 to 2005 landings have increased to levels observed during the early 1990s but decreased again in recent years.

Males are the dominant component in all landings with exception of 1995 and 1996 when total female landings exceeded male landings (ICES, 2006a). Male to female sex-ratio has been close to 1.5:1.

A discard sampling program onboard the Portuguese crustacean trawlers started in 2004. Discards of Nephrops are considered negligible in this fishery and mostly due to quality.

## B.2. Biological

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. The sampling data are raised to the total landings by market category, vessel and month. Information on discards is not taken into account in the estimation of the total catch length distributions due to the low level of discards and the lack of defined raising procedures. However, the length distribution of discards confirms the idea that Nephrops is not rejected because of its MLS ( 20 mm of CL) but mainly due to quality problems.

Mean weights-at-age for this stock are estimated from fixed weight-length.
A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females based in Morizur (1982). The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

The size at maturity for females was recalculated at ICES-WKNEPH 2006 to be 30 mm being the same as used in assessments prior to 2008 (ICES, 2006). An asymmetrical log-log relationship was used to estimate the maturity ogive and L50.

A segmented regression was used to estimate the size at maturity for males as the breakpoint in the growth relationship between the appendix masculina and the carapace length. The value estimated for FU 29 was 28.4 mm of CL (ICES, 2006).

Growth parameters were estimated using the Bhattacharya method and tagging experiments (Figueiredo, 1989).
Several factors were considered to potentially affect survival, including duration of the tow and season, and biological characteristics of the individuals (e.g. size, sex and ovigerous condition). Survival was only affected by season (increased mortality in warm months). A global estimate of survival of released lobsters, taking into consideration survival and proportion of the catches for each season, was 35\% (Castro et al., 2003)

Summary:

| INPUT PARAMETERS |  | Value |
| :--- | ---: | :--- |
| Parameter | Source |  |
| Discard Survival | 0.35 |  |
| MALES |  |  |
| Growth - K | 0.200 | Portuguese data (Bhattacharya method) ; tagging (ICES, 1990a) |
| Growth - L(inf) | 70 | " |
| Natural mortality - M | 0.3 | Figueiredo (1989) |
| Size at maturity (mm CL) | 28.4 | ICES (2006) |
| Length/weight - a | 0.00028 | Figueiredo (pers. comm., 1986) |
| Length/weight - b | 3.2229 | " |
| FEMALES |  |  |
| Immature Growth | 0.200 | Portuguese data (Bhattacharya method) ; tagging (ICES, 1990a) |
| Growth - K | 70 | " |
| Growth - L(inf) | 0.3 | Figueiredo (1989) |
| Natural mortality - M | 30 | ICES (1994) |
| Size at maturity (mm CL) |  |  |
| Mature Growth | 0.065 | Portuguese data (Bhattacharya method) ; tagging (ICES, 1990a) |
| Growth - K | 65 | " |
| Growth - L(inf) | 0.2 | Figueiredo (1989) |
| Natural mortality - M | 0.00056 | Figueiredo (pers. comm., 1986) |
| Length/weight - a | 3.0288 | " |
| Length/weight - b |  |  |

## B.3. Surveys

The Portuguese crustacean surveys started in 1981. The surveys were carried out with the research vessels «Mestre Costeiro» and «Noruega» and the main areas covered were the southwest coast (Alentejo or FU 28) and the south coast (Algarve or FU 29). The main objectives were 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).

In 1997, a stratified sampling design was adopted, based on the design for the demersal resources. The sectors and depth strata were the same used for the groundfish surveys, from 200 to 750 meters in the southwest coast and from 100 to 750 meters in the south coast. The number of hauls in each stratum was dependent on Nephrops and rose shrimp abundance variance, with a minimum of 2 stations per stratum. The average total number of stations in the period 1997-2004 was 60 . These surveys were carried out in May-July and had a total duration of 20 days.

Since 2005, sampling was based on a regular grid superimposed on the area of Nephrops distribution. This sampling procedure allows a more powerful use of data, especially considering the use of geostatistical tools. The total duration of the survey was the same ( 20 days) and the haul duration had to be reduced from 60 to 30 minutes in order to cover all the rectangles (77) of the grid.

Sediment samples have been collected since 2005 with the aim to study the characteristics of the Nephrops fishing grounds.

In 2008, the crustacean trawl survey conducted in Functional Units 28 and 29, was combined with an experimental video sampling. The collection of images was limited to 10 stations in FU 28.

A SeaCorder, composed of an MD4000 high resolution colour camera, an MP4 video recorder and a 30 Gb hard drive, was hung at the central point of the headline, pointing forward onto the sea floor with an angle of 45 degrees, approximately (ICES, 2007). A 2-beam laser pointer is attached to the SeaCorder, for measuring purposes (estimation of the width of view and Nephrops and burrows sizes).
The collection of video footage was routinely carried out in each trawl station was routinely carried in 2009. This methodology is being evaluated to see if the data can be used for biomass estimation, length distribution and Nephrops catchability by the trawl gear (ICES, 2009).

The observation of the collected footages shows that the trawling speed and the turbidity were the main problems affecting the clarity of the image and that 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 (ICES, 2012a).

## B.4. Commercial CPUE

A standardization of the CPUE series was presented to WGHMM in 2008 (Silva, C. WD 25) and reviewed in 2009, applying the generalized linear models (GLMs). The data used for this standardization were the crustacean logbooks for the period 19882008. The factors retained for the final model (year, month and vessel category) were those which contribute more than $1 \%$ to the overall variance. The model explains $17 \%$ to $19 \%$ of the variabilility, when using the CPUE in $\mathrm{kg} /$ day or $\mathrm{kg} / \mathrm{haul}$ respectively. The CPUE series was standardised and the effort estimated correspondingly.
The issue of effort estimation using standardized CPUE from GLMs or other methods taking into account the flexibility of the fleet in relation to target species was further developed in the WGHMM 2010 (ICES, 2010a) and during WKSHAKE2 (ICES, 2010b). Crustacean vessels are targeting two main species, rose shrimp and Norway lobster, which have different market value. Depending on their abundance/availability, the effort is directed at one species or the other.
The model of CPUE standardization used until 2010 never explained more than $20 \%$ of the variability (ICES, 2010a). The explanatory variables used were year, month and vessel-category. Considering the behaviour of the fleet in periods of high abundance of rose shrimp, new variables related to the catches of this species and the proportion of Nephrops in the total catch were incorporated. As the distributions of rose shrimp and Nephrops are fishing ground and depth dependent, the availability and use of VMS data were suggested to improve the standardization model (Silva and Afonso-Dias, 2011, WD to WKCPUEFFORT).

Taking all this into account, new variables as the fishing depth, the catches of rose shrimp and the proportion of Nephrops in the total crustacean catches were incorporated in the new model for CPUE standardization and presented to IBP Nephrops 2012 (Inter-Benchmark Protocol for Nephrops 2012).

The IBP Nephrops (ICES, 2012b) did not come to a conclusion about the stock assessment method but the WG has agreed to use this new CPUE standardization for the trends based assessment and standardized effort estimation.

VMS data are only available since 1998 and the use of this method has shortened the length of the time series. In the models presented before, the CPUE was expressed in $\mathrm{kg} /$ day and the time series started in 1988. The CPUE in the new model is expressed in $\mathrm{kg} / \mathrm{hour}$, the time series starts 10 years later but the estimation of CPUE is based on more reliable effort data.

The overall analysis of the geo-referenced catches confirmed the general preference of rose shrimp and Nephrops for grounds shallower and deeper than 400 m , respectively. These data also confirmed that, in years of higher abundance of rose shrimp, a greater effort is allocated to depths shallower than 400 m . In what concerns the distribution of the fishing effort between the two Functional Units, FU29 represents in average $83 \%$ of the total effort. However, the FUs were found not significantly different and therefore removed from the model.

The factors and levels retained in the final model presented to IBP 2012 were updated to include 2011 and 2012 data:

- year: 1998-2012
- month: 1-12
- depth interval: $[100,400[,[400,800[,[800,1500]$
- $\quad \log$ catch of rose shrimp: $[0,2[,[2,5]$
- proportion of Nephrops in the total catch of crustaceans: $[0,0.25[,[0.25,1]$
- and vessel category: A (standard), B and C. These two categories correspond to vessels less or more productive than the standard type.

The choice of the final model was based on the highest value of explained variance and the smallest AIC. The model explains $47 \%$ of the total variability, with the proportion of Nephrops in the crustacean catches as the most important factor.

The depth interval class [400, 800[, the log catch of rose shrimp class [0, 2[, the category of proportion of Nephrops $[0.25,1]$ and the vessel category A are used as the reference factors for Nephrops target CPUE.

## B.5. Other relevant data

## C. Historical Stock Development

In the past, LCA assessments were carried out for males and females separately over a 3-year reference period, in which the stock was considered to be in a steady state. The steady state assumption was questioned due to the decrease of the stock and this method was abandoned (ICES, 2002).

Software used: Lba99g.exe
Age structured XSA assessments have been carried out recently for Nephrops, males and females separately (ICES, 2008), with two tuning fleets: the crustacean fleet and the crustacean survey. The results were considered unreliable for several reasons most importantly, growth and natural mortality assumptions and the use of ageconverted groups by slicing. However, the results have been taken as indicative of stock trends.

Software used:

- For conversion of the length compositions in ages with slicing: L2AGE4.exe
- XSA: Lowestoft VPA Suite (VPA95.exe), Retvpa02.exe, FLR package

| Males | 2006-2010 WGHMM |  |
| :--- | :--- | :--- |
| Tuning Fleets used (First - Last year ; Ages used) | Period |  |
| P-TR: Crustacean Trawl Fleet | Ages |  |
| P-CTS: Crustacean Trawl Survey | $1988-2005$ | $2-7$ |
| $1997-2005$ | $2-7$ |  |
| First age for normal catchability independent | All ages independent |  |
| First age at which q is considered independent of | 6 |  |
| Taper time weight applied? | Tricube over 20 yrs |  |
| F shrinkage (SE for mean F) | 1.5 |  |
| F Shrinkage | Final 5 | 3 oldest |
| Minimum Log SE for terminal population estimates | 0.3 |  |
| Fbar (age) | $2-7$ |  |
| Recruitment Age | 2 |  |


| Females | $2006-2010$ WGHM |  |
| :--- | :---: | :---: |
| Tuning Fleets used (First - Last year ; Ages used) | Period | Ages |
| P-TR: Crustacean Trawl Fleet | $1988-2005$ | $2-12$ |
| P-CTS: Crustacean Trawl Survey | $1997-2005$ | $2-5$ |
| First age for normal catchability independent | All ages independent |  |
| First age at which q is considered independent of age | 11 |  |
| Taper time weight applied? | Tricube over 20 yrs |  |
| F shrinkage (SE for mean F) | 1.5 |  |
| F Shrinkage | Final 5 yrs |  |
| Minimum Log SE for terminal population estimates | 0.3 |  |
| Fbar (age) | $4-10$ |  |
| Recruitment Age | 2 |  |

Other indicators, such as CPUE from the fleet, abundance index from crustacean trawl survey and mean sizes in landings and in surveys have also been used when analysing trends.

## D. Short-Term Projection

Not used

## E. Medium-Term Projections

Not used

## F. Long-Term Projections

Not used

## G. Biological Reference Points

There are no biological reference points defined for this stock.

## H. Other Issues

## I. References

Castro,M., Araujo,A., Monteiro,P., Madeira,A.M., Silvert,W. (2003). The efficacy of releasing caught Nephrops as a management measure. Fisheries Research, 65 (1-3): 475-484.

Figueiredo, M. J., 1989. Preliminary results of the tagging experiments on Nephrops norvegicus in Portuguese waters. 1989. ICES CM 1989/K:25.
ICES, 2002. Report of the Working Group on Nephrops Stocks. Lorient, France, 3-9 April 2002. ICES CM 2002/ACFM:15
ICES, 2006. Report of the Workshop on Nephrops Stocks (WKNEPH), 24-27 January 2006, ICES Headquarters. ICES CM 2006/ACFM:12. 85 pp.

ICES, 2007. Workshop on the Use of UWTV Surveys for Determining Abundance in Nephrops Stocks throughout European Waters. 17-21 April 2007, Heraklion, Crete, Greece. ICES CM 2007/ACFM:14. 198 pp.

ICES, 2008. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM), 30 April - 6 May 2008, ICES Headquarters, Copenhagen. ICES CM 2008/ACOM: 07.613 pp .

ICES, 2009. Report of the Study Group on Nephrops Surveys (SGNEPS), 28 February - 1 March 2009, Aberdeen, UK. ICES CM 2009/LRC:15. 52 pp.
ICES, 2010a. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM), 5-11 May 2010, Bilbao, Spain. ICES CM 2010/ACOM:11. 571 pp.

ICES, 2010b. ICES Workshop on Iberian mixed fisheries management plan evaluation of Southern hake, Nephrops and anglerfish , 22-26 November 2010, Lisbon, Portugal. ICES CM 2010/ ACOM:63. 96 pp.
ICES, 2012a. Report of the Study Group on Nephrops Surveys (SGNEPS), 6-8 March 2012, Ancona, Italy. ICES CM 2012/SSGESST:19. 36 pp.
ICES, 2012b. Report of the Inter Benchmark Protocol on Nephrops (IBPNephrops 2012), March 2012, By correspondence. ICES CM 2012/ACOM:42. 5 pp.
Morizur, Y., 1982. Estimation de la mortalité pour quelques stocks de langoustine, Nephrops norvegicus. ICES C.M. 1982/K:10 (1982)

## Annex L: Nephrops FU 30

## Quality Handbook

ANNEX: L Nephrops FU 30
Stock specific documentation of standard assessment procedures used by ICES.

Stock Gulf of Cadiz (Division IXa, FU 30).
Working Group: WGHMM
Date:
05 May 2010
Revised by
Yolanda Vila and Luis Silva

## A. General

## A.1. Stock definition

The Nephrops stock from FU30 comprises the Spanish waters of the Gulf of Cadiz, defined as the Spanish Suratlantic Region. The western limit of the stock is at the Portuguese border, on the Guadiana River estuary, whereas the eastern border is at the Gibraltar Strait. The Gibraltar Strait separates the Gulf of Cadiz from the Mediterranean Sea and is considered a natural border. On the other hand, the Guadiana River does not seem to be a real boundary for splitting possibly different populations (FUs 29 and 30). This stock limit was decided mainly on management considerations, without any clear biological basis. Possible differences and exchange rates across FUs 29 and 30 should be studied. Tagging experiments and genetic studies could provide valuable information in this respect.

Within FU 30, Nephrops grounds correspond to muddy and sandy areas ranging between 200 to 700 m depth. High fishing effort is particularly carried out around 500 m (Ramos et al., 1996).

## A.2. Fishery

Nephrops in FU 30 is exploited mostly by Spanish trawlers. The bottom trawl fleet of the Gulf of Cadiz is characterized by the multispecifity of its landings (Sobrino, 1994; Jiménez, 2002; 2004). The fleet operates mainly from four coastal localities: Isla Cristina, Sanlúcar de Barrameda, Puerto de Santa María and Huelva. Huelva was the most important Nephrops landing port until 2002, but landings from Isla Cristina and Puerto de Santa María became larger than Huelva landings from that year onwards (Vila et al., 2005). Recent information from the Port of Ayamonte shows that Nephrops landings at this port represent $31 \%$ of the total Nephrops landings from the bottom trawl fleet in FU 30. Ayamonte and Isla Cristina were the main Nephrops landing ports in 2009. Landings are clearly seasonal with high values from April to September (Jiménez, 2002). Nephrops represents $1.5 \%$ of the total trawl landings from the area.

Two main métiers were identified among the trawlers in the past (STECF, 2003). The most common group normally fish in shallow waters ( $30-100 \mathrm{~m}$ ) with a mixture of target species (sparids, cephalopods, wedge sole, hake and horse mackerel). The oth-
er group operates between 90 and 500 m of depth, targeting mainly blue whiting, shrimp, horse mackerel, hake and Norway lobster.

A fleet conversion developed by the public administration at the end of the 1990s homogenized considerably this fleet regarding its technical characteristics and fishing capacity. Jiménez et al. (2004) observed a direct relationship between the capacity of vessel mobility and the bathymetric situation of the fishing. After the fleet conversion, a larger number of vessels could access the more remote and deeper fishing grounds, resulting in an increase of Nephrops directed effort and landings from 2000 to 2004. At present, Nephrops and the others target species of the Gulf of Cádiz bottom trawl fleet are landed by a unique and highly multispecific metier, due to recent changes in the abundance of target species and fleet regulations (see WGHMM 2007 report Section 2).

Different Fishing Plans have been established since 2004 in order to reduce the fishing effort of the bottom trawl fleet in the Gulf of Cádiz (ORDENES APA/3423/2004, APA/2858/2005, APA/2883/2006, APA/2801/2007). The current Fishing Plan (ORDENES ARM/2515/2009, ARM/58/2010) runs from September 2009 until September 2010. The plans generally restrict daily fishing hours, establish two days per week of no fishing and a single landing event per vessel per day. The reduction of daily fishing hours has a direct effect on Nephrops directed effort because the trawl fleet does not have enough time to access the Nephrops fishing grounds, which are located far away from the fishing port. Furthermore, the plan establishes a closed fishing season of 90 days distributed in two periods. The first period took place last year between September 25-November 23 2009, and the second period was established between January 22-February 14 2010).

The effects of the closed seasons on Nephrops population have not yet been evaluated. However, from 2006 onwards, total fleet effort and directed effort decreased even though the closed season was established outside of the main fishing season. Since 2008, the directed fishing effort and the landings of Nephrops are much lower. The increment of the abundance of rose shrimp (Parapenaeus longirostris) has led a change in the objectives of the fishery. This fact, together with the bad weather conditions during 2008 and the remoteness of the Nephrops fishing grounds, probably has an influence on this reduction.

Nephrops is managed in the area by an annual TAC (applying to the whole of ICES Division IXa) and technical measures. The European Union regulations establish 20 mm carapace length (CL) as a minimum landing size. Few animals are caught under size.

For the bottom trawl fleet, the Gulf of Cadiz area has different regulations from the rest of statistical subdivisions in the North Eastern Atlantic, allowing the use of smaller mesh sizes ( 40 mm ). Nevertheless, an increase of mesh size to 55 mm or more was indefinitely implemented in the last Fishing Plan in order to reduce discards of individuals below the minimum landing size.

There is a Recovery Plan for the southern stock of hake and Iberian stocks of Nephrops (EC 2166/2005). Effort limitation measures indicated in the Recovery Plan (and specifically defined in Annex IIb of the annual EC regulation setting TACs) do not affect the Gulf of Cádiz.

## A.3. Ecosystem aspects

Nephrops is a burrowing species and inhabits muddy sea beds on the continental shelf and upper slopes. Its distribution is more determined by ground type and sea temperature than depth. In this area, it is distributed between 200 and 800 m of depth in a patchwork configuration where the substrate is suitable. Nephrops are sedentary but they can leave their burrows to look for food and for reproduction.

After reaching sexual maturity, males molt more frequently than females, consequently growing faster. Mating takes place just after the females molt. Eggs are fertilized when they are laid and they attach under the female abdomen. Berried Nephrops stay most of the time in their burrows. Larvae are pelagic for one month after hatching, then after metamorphosis the small Nephrops settle on the sea bed. The emergence pattern of the Nephrops females during the incubation period results in a different exploitation pattern for each sex. The spawning season occur in summer, mature females are observed in spring and summer while berried females appear starting from August (Vila et al., 2005). Females remain in their burrows during the autumn and winter.

Nephrops are omnivorous, but polychetes, crustaceans, molluscs and echinoderms are their favourite preys.
Further work in this area is needed to improve our knowledge about this stock. The information on the specific Nephrops biology from this area is still scarce.

A comprehensive study into the role of Norway lobsters in the ecosystem would be particularly useful since a habitat of special interest has been observed in deeper waters of the Gulf of Cádiz (OSPAR, 2004). Methane-enriched fluid expelled through a submarine mound, probably formed as a mud volcano in this area, maintains a highly sensitive ecosystem (Díaz del Río et al., 2006).

## B. Data

## B.1. Commercial catch

Landings

Landings are reported by Spain and also minor quantities by Portugal. Spanish data are based on sales notes and Owners Associations data compiled by IEO.

Discard

An annual Spanish Discard Sampling Programme under the EU DCR has been carried out in FU 30 since 2005. Until 2008, fishing trips in the bottom trawl metier were sampled by observers onboard during the Nephrops fishing season (Summer). The number of fishing trips sampled by year ranged between 20 and 30. Based on the new DCR, the discard sampling scheme covers the whole year since 2009 (Reg. EC $1343 / 2007$ ). The 22 total annual number of sampled fishing trips in the bottom trawl metier was distributed among the quarters, with $5,6,6$ and 5 sampled trips in quarters 1 to 4 , respectively. The series provides information on discarded catch in weight and number and length distributions.

## B.2. Biological

Annual length compositions of the commercial landings of Nephrops for both males and females are available since 2001. The sampling followed a multistage stratified random scheme by month in the port of Huelva for the period 2001-2005. These data were raised to the total landings from FU 30. Inconsistencies were found in this series (Silva et al., 2006), due to the fact that not all commercial categories were sampled before 2004. In 2006, a new sampling scheme was introduced, which included sampling in other ports (Isla Cristina, El Puerto de Santa María and Sanlúcar de Barrameda) and excluded the port of Huelva because the landings in this port have decreased. The sampling data were raised to the total landings by market category, port, month and area.

Starting from 2009 concurrent sampling is carried out, as required by the new DCR (Reg. EC 1343/2007). With the new sampling strategy, six fishing trips of the bottom trawl metier are sampled per month onboard vessels from the main landings ports in the Gulf of Cadiz, in order to ensure the widest geographical coverage. At least two fishing trips per month correspond to the deepest strata, where the Nephrops fishing grounds in this FU are located.

Information on discards is not taken into account in the estimation of the total catch length distribution due to the low level of discards.

No new information on biological parameters is available since 2004 (Vila et al., 2005). Carapace length (CL) and total weight (W) relationships were $\mathrm{W}=0.0004^{*} \mathrm{CL}^{3.1018}$ for males, $\mathrm{W}=0.0007^{*} \mathrm{C} L^{2.9657}$ for females and $\mathrm{W}=0.0006^{*} \mathrm{CL}^{3.0237}$ for both sexes. Females' carapace length at first maturity was 29.4 mm . A histology study on female gonads is presently taking place, in order to compare macro and micro maturity scales. This study could improve the estimates of size at first maturity in this sex. Additionally, measurements of appendix masculine are being carried out with the aim of obtaining the size of onset of sexual maturity in males, following the methodology of McQuaid et al. (2006). Biological studies should continue in Nephrops from the Gulf of Cadiz.

## B.3. Surveys

Two ground fish surveys are carried out annually in the Gulf of Cadiz in March (SP-GFS-cspr, since 1994) and November (SP-GFS-caut, since 1997). A stratified random sampling design with five bathymetric strata, covering depths between 15 and 700 m , is used, with one hour hauls.

Neither of these surveys are carried out during the main fishing period of Nephrops (April-September). Berried females are hidden in their burrows in autumn, so only the index from the March survey is considered potentially representative of stock abundance.

## B.4. Commercial CPUE

Effort data used in the Gulf of Cadiz are based on Spanish sales notes and Owners Associations data compiled by IEO.

The estimate of Nephrops directed effort corresponds to daily fishing trips for which Nephrops represent at least $10 \%$ of the total landings in weight.

## B.5. Other relevant data

## C. Historical Stock Development

An LCA assessment of Nephrops of the Gulf of Cadiz (FU 30) was attempted in 2004 for the first time, in the ICES WGNEPH (ICES 2004). The input parameters used are presented in the table below. Given the uncertainties about input parameters, this assessment was considered as preliminary. Also, the steady state assumptions required for LCA assessment are questionable due to the observed trends in landings and effort.

Model used (in 2004): LCA
Software used: Lba
Input data types and characteristics:

| PARAMETERS | VALUE | SOURCE |
| :--- | :--- | :--- |
| Discard Survival | NA | Not aplicable - few discards (<1 \% on average) |
| MALES |  |  |
| Length range (mm) | $18-50$ | Landings (2001-2003) |
| Growth - K | 0.160 | From FU 25 k value |
| Growth - L(inf) | 60 | Lmax from Gulf of Cadiz survevs |
| Natural mortalitv - M | 0.2 | Fernández et al. (1986) |
| Length/weight - a | 0.00043 | Fariña (1984) |
| Length/weight - b | 3.160 | Fariña (1984) |
| FEMALES |  |  |
| Immature Growth | 0.160 | From FU 25 k value |
| Growth - K | 60 | L max from Gulf of Cadiz survevs |
| Growth - L(inf) | 0.2 | Fernández et al. (1986) |
| Natural mortalitv - M | 28 | Average from FU 25 and FU 26-27 values |
| Size at maturitv |  |  |
| FEMALES |  |  |
| Mature Growth | $18-56$ | Landings (2001-2003) |
| Length range (mm) | 0.090 | Average from FU 25 and FU 26-27 |
| Growth - K | 58 | LC max from Gulf of Cadiz landings |
| Growth - L(inf) | 0.2 | Fernández et al. (1986) |
| Natural mortalitv - M | 0.00043 | Fariña (1984) |
| Length/weight - a | 3.160 | Fariña (1984) |
| Length/weight - b |  |  |

Given the inconsistencies in the length compositions from 2001-2005 and the absence of additional information, assessment of this FU has not been carried out so far.

## D. Short-Term Projection

Not used.

## E. Medium-Term Projections

Not used.

## F. Long-Term Projections

Not used.

## G. Biological Reference Points

There are no biological references points defined for this stock.

## H. Other Issues

## I. References

Díaz del Río, V., L.M. Fernández-Salas, J. Gil, F. Ramos and M.P. Jiménez, 2006. Gulf of Cádiz Regional Ecosystem. Working document presented to the WGRED (ICES Working Group for Regional Ecosystem Description).

ICES, 2004. Report of the Working Group on Nephrops Stocks (WGNEPH). ICES CM 2004/ACFM:19.

ICES, 2007. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk, Megrim (WGHMM). ICES CM 2007/ACFM:21.

Jiménez, M. P. (2002). Aplicación de análisis multivariantes para la obtención y estandarización de esfuerzos pesqueros en pesquerías multiespecíficas. Las pesquerías demersales del Golfo de Cádiz. Tesis Doctoral. Universidad de Cádiz, 298 pp.
Jiménez, M.P., I. Sobrino and F. Ramos, 2004. Objetive methods for defining mixed-species trawl fisheries in Spanish waters of the Gulf of Cadiz. Fisheries Research, 67: 195-206.

Fariña, A.C., 1984. Informe de la Campaña ‘Sigurgas 83'. Inf. Tec. Inst. Esp. Ocanogr., No. 25.
Fernandez, A., A.C. Fariña and E. Penas, 1986. Effects of an increase in mesh size in the Nephrops fishery (Nephrops norvegicus L.) of Galicia. Bol. Inst. Esp. Ocanogr., 3, 57-74.

McQuaid, N., R.P. Briggs and D. Roberts, 2006. Estimation of the size of onset of sexual maturity in Nephrops norvegicus (L.). Fisheries Research, 81: 26-36.

Ramos, F., I. Sobrino and M.P. Jiménez, 1996. Cartografía temática de los caladeros de la flota de arrastre en el Golfo de Cádiz. Junta de Andalucía: Informaciones Técnicas, 45-96, 44 pp, 12 mapas.

Silva, L., A.C. Fariña, I. Sobrino and Y. Vila, 2006. Inconsistencies in the annual length compositions series (2001-2005) of Nephrops from the Gulf of Cádiz, FU 30 (ICES division IXa). Working document presented to the WGHMM (Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk, Megrim).
Silva, L., J. Castro, A. Punzón, E. Abad, J.J. Acosta and M. Marín, 2007. Metiers of the Southern Atlantic Spanish bottom trawl fleet (Gulf of Cádiz). Working document presented to the WGHMM (Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk, Megrim).

Sobrino, I., M.P. Jiménez, F. Ramos and J. Baro, 1994. Descripción de las pesquerías demersales de la Región Suratlántica Española. Informe Técnico del Instituto Español de Oceanografía, vol., 151, 79 pp .
STECF, 2003. Report of the STECF meeting on Hake Technical Measures. Lisbon, 27-31. October, 2003.

OSPAR, 2004. Descriptions of habitats on the initial list of OSPAR threatened and/or declining species and habitats. OSPAR Convention for the protection of the marine environment of the north-east Atlantic. 20 pp.

Vila, Y., J. Gil, M.P. Jiménez \& L. Silva, 2005. A brief description about Norway lobster (Nephrops norvegicus) fishery in the Gulf of Cadiz (FU 30) and preliminary biological information. Working document presented to the WGHMM (Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk, Megrim).

## Annex M: Stock Annex Southern black anglerfish (Lophius budegassa) (Divisions VIIIc, IXa)

Stock specific documentation of standard assessment procedures used by ICES.
Stock: Southern black anglerfish (Divisions VIIIc, IXa)
Date:
23/05/2013
Revised by
Ricardo Alpoim (WGHMM2013)

## A General

## A. 1 Stock definition

The two species of anglerfish (the white, Lophius piscatorius, and the black, L. budegas$s a$ ) are North Eastern Atlantic species, however black anglerfish has a more southerly distribution. White anglerfish is distributed from Norway (Barents Sea) to the Straits of Gibraltar (and including the Mediterranean and the Black Sea) and black anglerfish from the British Isles to Senegal (including the Mediterranean and the Black Sea). Anglerfish occur in a wide range of depths, from shallow waters to at least 1000 m . Information about spawning areas and seasonality is scarce, therefore the stock structure remains unclear. This lack of information is due to their particular spawning behaviour. Anglerfish eggs and larvae are rarely caught in scientific surveys.

ICES gives advice for the management of several anglerfish spp. stocks in European waters: one stock on the Northern Shelf area, that includes anglerfish from the Northern Shelf-Division IIIa, Subarea IV and Subarea VI, and Norwegian SeaDivision IIa, and the stocks on the Southern Shelf area, one in Divisions VIIb-k and VIIIa,b and d and the Southern stocks in Divisions VIIIc and IXa. The stock under this Annex is called Southern Black Anglerfish and is defined as black anglerfish in Divisions VIIIc and IXa. The boundaries of anglerfish in Divisions VIIb-k and VIIIa,b and d and Southern Anglerfish stocks were established for management purposes and they are not based on biological or genetic evidences (GESSAN, 2002; Duarte et al., 2004; Fariña et al., 2004).

Although the stock assessment is carried out separately for each species, white and black anglerfish are caught and landed together, due to that, the advice is given for individual and the combined species. There is a unique TAC for both species.

## A. 2 Fishery

Anglerfish in ICES Divisions VIIIc and IXa are exploited by Spanish and Portuguese vessels, since 2000 the Spanish landings being more than $81 \%$ for both anglerfish total reported landings. International catches for this stock have increased since the beginning of the 1980s, until a maximum was reached in 1988 ( 10021 t ). They have decreased to $1801 \mathrm{t}-1802 \mathrm{t}$ in 2001-2002. In the 2003-2011 period the catches were between 2300 t and 4500 t . Both species are caught on the same grounds by the same fleets and are marked together.

White and black anglerfish are caught together by Spanish and Portuguese bottom trawlers and gillnet fisheries. Spanish and Portuguese bottom trawlers are mixed
fisheries. The Spanish bottom trawl fleet predominantly targets hake, megrim, Norway lobster and anglerfish. Since 2003 the alternative use of a trawl gear with High Vertical Opening (HVO) has taken place in higher proportion relative to previous years. This gear targets horse mackerel and mackerel with very few anglerfish catches. Since 2002, the Spanish landings were on average $61 \%$ from the trawl fleet and 39 \% from the gillnet fishery. The Spanish gillnet fishery can use different artisanal gears, but most catches come from "Rasco" that is a specific gear targeting anglerfish.

Anglerfish are caught by Portuguese fleets in trawl and artisanal mixed fisheries. Portuguese landings were on average, from 2002, 19 \% from trawlers and $81 \%$ from artisanal fisheries. The trawl fleet has two components, the trawl fleet targeting demersal fish and trawl fleet targeting crustaceans. Since 2005, Portuguese combined species landings were TAC constrained and very low landings were registered during the $4^{\text {th }}$ quarter since then.

Discarding in black anglerfish is considered low for the trawl fishery, based on estimated data for Spanish trawl fleet (ICES, 2011) and information from Portuguese trawl fleet (ICES, 2012).

Each year, the European Union sets a combined TAC and quota for white and black anglerfish. There is no minimum landing size for anglerfish, but in order to ensure marketing standards a minimum landing weight of 500 g was fixed in 1996 by the Council Regulation (EC) No.2406/96.

As part of the Recovery Plan for the Southern hake and Iberian Nephrops stocks (Council Regulation (EC) No.2166/2005), in force since January of 2006, the fishing effort regulations are affecting the Spanish and Portuguese mixed trawl fisheries. As anglerfish are taken in these mixed trawl fisheries, these stocks are also affected by the recovery plan effort limitation.

## A. 3 Ecosystem aspects

Black anglerfish is a benthic species that occur on muddy to gravelly bottoms. It attains a maximum size of around 93 cm corresponding to a weight of approximately 12 kg . Historically black anglerfish has been considered a slow growing species, with a late maturation (Duarte et al., 2001). Nevertheless, new evidences from marrecapture experiments indicate that the anglerfish growth could be faster (Landa et al., 2008).

The ovarian structure of anglerfish differs from most other teleosts. It consists of very long ribbons of a gelatinous matrix, within individual mature eggs floating in separate chambers (Afonso-Dias and Hislop, 1996). The spawning of the Lophius species is very particular, with eggs extruded in a buoyant, gelatinous ribbon that may measure more than 10 m and contain more than a million eggs (Afonso-Dias and Hislop, 1996; Hislop et al., 2001 and Quincoces, 2002). Eggs and larvae drift with ocean currents and juveniles settle on the seabed when they reach a length of 5-12 cm . This particular spawning leads to highly clumped distributions of eggs and newly emerged larvae (Hislop et al., 2001) and favourable or unfavourable ecosystem conditions can therefore have major impacts on recruitment.

Due to their particular reproduction aspects (that shows a high parental investment in the offspring) the population dynamics of these species is expected to be highly sensitive to external biological/ecosystem factors.

Vertical displacements of immature and mature white anglerfish from the seabed to the near surface have been recorded in the Northeast Atlantic (Hislop et al., 2001) and are suggested to be related to spawning or feeding.

Improvement of knowledge regarding growth, spawning behaviour, migratory behaviour and juvenile drift are essential to present and future assessment and management of both Southern Anglerfish stocks.
B. Data

## B. 1 Commercial Catch

Landings data are provided by National Government and research institutions of Spain and Portugal. Quarterly landings by country, gear and ICES Division are available from 1978. There were unrecorded landings in Division VIIIc between 1978 and 1979, and it was not possible to obtain the total landings in those years. Portuguese landings were TAC constrained since 2005. Very low landings have been registered during the $4^{\text {th }}$ quarters since then. The Portuguese landings were relatively stable during the first two years, but have decreased substantially from 2006 to 2010. In 2011 and 2012 Portuguese landings have increased by 16 and $116 \%$ respectively.

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 VIIIc and IXa and Portuguese landings of Division IXa are derived from their relative proportions in market samples.

After 1980, black anglerfish landings increased and reached a peak of 3832 t in 1987. Since then, landings decreased and reached a minimum in 2002 of 770 t. From 2002 to 2007 landings increased to 1301 t , decreasing afterwards to near 790 t in 2010 and 2011, but in 2012 catches reached 1024 t .

## Discards

Since 1994 a Spanish Discard Sampling Programme is being carried out for trawl fleets operating in the ICES Divisions VIIIc and IXa. However, the time series is not complete and years with discard data are 1994, 1997, 1999, 2000 and from 2003 to 2009. The raising procedure used to estimate discards was based on effort. The Portuguese Discard Sampling Programme recorded anglerfish data from 2004. The frequency of occurrence of black anglerfish in discard samples is very low and their discard is considered negligible.

## B. 2 Biological

## Landing numbers at length

Since 2009 the quarterly Spanish and Portuguese sampling for length compositions is by metier and ICES Division. Length data from sampled vessels are summed and the resulting length composition is applied to the quarterly landings of the corresponding metier and ICES Division. The sampled length compositions were raised for each country and SOP corrected to total landings on a quarterly or half yearly basis (when the sampling levels by quarter were low). The average lengths of trawl caught anglerfish are lower compared to the artisanal fleets.

## Catch numbers at age

No catch numbers at age are provided to the Working Group. At the WGHMM 2007 meeting (ICES, 2007), age length keys, based on illicia readings, were used to obtain catch number at age for each species. The exploratory analysis of estimates indicated that the biased age reading criterion does not allow following cohorts along years in either of the two species. The last research about white anglerfish ageing, White Anglerfish Illicia and Otoliths Exchange 2011 (ICES, 2012), highlighted that neither illicia or otolith age readings have not been validated and, in the case of illicia studies, the agreement among readers and the precision were not acceptable. Therefore it was concluded that the available age reading criteria for white anglerfish southern stock is not valid to build an ALK.

## Growth curve

An agreed growth model is not available for black anglerfish in Divisions VIIIc, IXa.

## Maturity-at-length

Different estimates of maturity ogive at length are available for Lophius bugegassa (Duarte et al., 2001, Quincoces, 2002, Landa et al., 2012). The last study (Landa et al., 2012) indicates, for ICES Div. VIIIc-IXa, a sex ratio of 1:1.01 ( $50.30 \%$ of females) and L50 values of 46.95 cm for combined sexes, 40.97 cm for males and 62.44 cm for females. These values of sex ratio and L50 are within the range given for this species in previous studies.

## Natural mortality

Trial assessment, in the past, of the black anglerfish stock used a natural mortality rate of $0.15 \mathrm{yr}-1$. This value was adopted for all ages and years in the absence of any direct estimates.

## Length-weight relationship

The weight at length relationship was calculated using data from an international project with a sampling that spatially covered a high proportion of the stock and which number of samples (BIOSDEF, 1998):

$$
\mathrm{W}=2.11 \times 10^{-5} \cdot \mathrm{~L}^{2.9198}
$$

where $\mathrm{W}=$ weight in kilograms and $\mathrm{L}=$ length in centimetres.

## B. 3 Surveys

## SpGFS-WIBTS-Q4

The Spanish Groundfish Survey aims to collect data on the distribution and relative abundance, and biological information of commercial fish in ICES Divisions VIIIc and Northern IXa. Since 1983 it is annually carried out in fourth quarter (September/October) of the years, except for 1987. Time series of abundance indices, in weight and in number, and correspondent length composition are available for both anglerfish species.

This survey is not used in the actual assessment of black anglerfish.

## PtGFS-WIBTS-Q4

Portuguese Autumn Groundfish Survey has been carried out in Portuguese continental waters since 1979 in the fourth quarter of the years. Abundance indices for both
anglerfish species are available from 1989 to 2011. This survey was not performed in 2012. The abundance values detected by this survey are very low for the whole time series, being insignificant for some years.

This survey is not used in the actual assessment of black anglerfish.
PtGFS-WIBTS-Q1
Portuguese Winter Groundfish Survey has been carried out in Portuguese continental waters from 2005 till 2008 in the first quarter. Time series of abundance indices, in weight and in number, and correspondent length composition are available for both anglerfish species. The abundance values detected by this survey are very low for the whole time series.

This survey is not used in the actual assessment of black anglerfish.

## PT CTS

Portuguese Crustacean Survey has been carried out in south of the Portuguese coast since 1997 in the second quarter. This survey was not performed in 2012. Time series of abundance indices, in weight and in number, and correspondent length composition are available for both anglerfish species. This survey detects better anglerfish (especially L. budegassa) but the area cover is very small compared with the anglerfish stocks distribution.

This survey is not used in the actual assessment of black anglerfish.
PtGFS (Summer)
Portuguese Summer Groundfish Survey has been carried out in Portuguese continental waters from 1990 till 2001 (except 1994, 1996) in the third quarter. Time series of abundance indices, in weight and in number, and correspondent length composition are available for both anglerfish species. The abundance values detected by this survey are very low for the whole time series, being insignificant for some years.

This survey is not used in the actual assessment of black anglerfish.

## Portuguese deepwater fish survey

Portuguese deepwater fish Survey has been carried out in Portuguese continental waters from 1997 till 2002. No indices are available only raw data.

This survey is not used in the actual assessment of black anglerfish.

## B. 4 Commercial CPUE

Six commercial series of landing-effort are available to the WG. Four of them are Spanish fleets in the ICES Division VIIIc and two Portuguese fleets in the ICES Division IXa. The Portuguese trawl fleet was split into fish trawlers and crustacean trawlers (WD12, Duarte et al., 2007 in ICES, 2007) according to the fleet segmentation proposed by the IBERMIX project (WD06, Castro et al., 2007 in ICES, 2007).

## SP-CORTR8C

A Coruña trawl fleet fishing in Division VIIIc is available for years 1982-2012. Data provided for A Coruña trawlers comprise quarterly effort (fishing days per 100 horse power), landings and length composition of landings. This fleet represents an average of $18 \%$ of international catches of black anglerfish along the time series. A stand-
ardized series from 1994 to 2006 is also available for this fleet with annual effort data (in fishing days) and annual LPUE.

It was agreed (WKFLAT 2012) to use the data from this commercial LPUE series in the black anglerfish assessment.

## SP-CEDGNS8C

Cedeira gillnet fleet fishing in Division VIIIc is available for years 1999-2011. Data provided for Cedeira gillnets comprise quarterly standardized effort (in soaking days), landings and length composition of landings. This fleet represents an average of $1 \%$ of international catches of black anglerfish since 1999.

Information from this commercial series is not used in the actual assessment of black anglerfish.

## PT-TRF9A

Portuguese trawlers targeting fish: years 1989-2012. Data provided for Portuguese trawlers targeting fish comprise quarterly effort (1000 hours trawling with occurrence of anglerfish), landings and length composition of landings. This fleet represents an average of $5 \%$ of international catches of black anglerfish along the time series. A standardized series from 1989 to 2008 is also available for this fleet with annual effort data (in 1000 hauls) and annual LPUE.

Data from this commercial LPUE has been used in the black anglerfish assessment since 2007.

## PT-TRC9A

Portuguese trawlers targeting crustacean: years 1989-2012. Data provided for Portuguese trawlers targeting fish comprise quarterly effort (1000 hours trawling with occurrence of anglerfish), landings and length composition of landings. This fleet represents an average of $3 \%$ of international catches of black anglerfish along the time series. A standardized series from 1989 to 2008 is also available for this fleet with annual effort data (in 1000 hauls) and annual LPUE.

Data from this commercial LPUE has been used in the black anglerfish assessment since 2007.

Other available commercial series of LPUEs that have never been employed in the assessment are:

## SP-AVITR8C

Avilés trawl fleet fishing in Division VIIIc is available for years 1986-2003. Data provided for Avilés trawlers comprise quarterly effort (fishing days per 100 horse power), landings and length composition of landings. This fleet represents an average $3 \%$ of international catches of black anglerfish along the time series. The effort series was interrupted in 2003.

## SP-SANTR8C

Santander trawl fleet fishing in Division VIIIc is available for years: years 1986-2010. Data provided for Santander trawlers comprise quarterly effort (fishing days per 100 horse power), landings and length composition of landings. This fleet represents an average of $3 \%$ of international catches of black anglerfish along the time series. Effort data for 2008 was not provided to the WG.

## C. Assessment Methods and Settings

Until 2011 black anglerfish stock was assessed with a non-equilibrium production model (ASPIC software).

A revised series from the Spanish fleet 'A Coruña' was available at WKFLAT2012, historical survey series data, discard data and other commercial LPUE series. The 'A Coruna' series is the longest of the potential tuning series and represents the bulk of the fishery and it was concluded that this series should be included in the modelling. At WKFLAT2012 three potential models were applied to the data: a Bayesian surplus production model, SS3, and numerous formulations of ASPIC. The SS3 showed promise but it was determined that more exploration would be required before the model could be accepted as the basis for advice. A new formulation of ASPIC which included 3 tuning indices (A Coruña, Portuguese Trawler fleet directing to crustaceans, Portuguese Trawler fleet directing to groundfish) was presented which tracks the central trend in the indices and is more stable than previous assessment. This was accepted as the basis for advice.

Model, input data and settings:
Assessment Model: Non-equilibrium Surplus production model (Prager, 1994; 2004)
Software: ASPIC (v. 5.34.9)
Stock: black anglerfish (L.budegassa)
Catch data range: 1980-2012
CPUE Series 1 (years): PT-TRC9a (1989-2012)
CPUE Series 2 (years): PT-TRF9a (1989-2012)
Index of Biomass (years): SPCORTR8c (1982-2012)
Error Type: Condition on yield
Number of bootstrap: 1000
Maximum F: 8.0 (y-1)
Statistical weight B1/K: 1
Statistical weight for fisheries: 8.59E-01; 1.20E +00 ; 9.81E-01
B1-ratio (starting guess) : 0.6
MSY (starting guess): $1.81126 \mathrm{E}+03 \mathrm{t}$
K (starting guess): 1.81126E+04 t
q1 (starting guess): 8.2523E-04
q2 (starting guess): 1.1196E-07
q3 (starting guess): 2.7279E-07
Estimated parameter: All
Min and Max allowable MSY: $\quad 1.81126 \mathrm{E}+02(\mathrm{t}) ; 3.62252 \mathrm{E}+03(\mathrm{t})$
Min and Max K: 1.81126E+03 (t); 3.62252E+05 (t)
Random Number Seed: 1025957

## D. Short term projection

Model: ASPIC projections (Prager, 1994).
Software: ASPICP
Stock forecasts should use the average of the last 3 years fishing mortality with the possibility of projecting with fishing mortality estimated in the final year depending on trends.
Projections are performed based on ASPIC estimates. Projections are performed for the following scenarios,:

- Reduction of F in the first year from $10 \%$ to $50 \%$.
- $\quad$ F sq (status quo)
- FMSY
- Zero catches

TAC, $-15 \%$ TAC and $+15 \%$ TAC
E. Medium term projections

No medium term projections are conducted for black anglerfish stock.

## F. Yield and biomass per recruit / long term projections

None

## G. Biological reference points

WKFLAT (ICES, 2012) endorsed the basis for MSY reference points previously assumed by ICES (i.e. Fmsy based on the ASPIC output and a proxy for MSY Btrigger as $50 \%$ of Bmsy of the ASPIC output).

## H. Other Issues

## H.1. Historical Development of Assessment

Southern Anglerfish stocks were assessed for the first time in the 1990 ICES WG meeting. Different assessment trials were performed during the subsequent 8 years but analytical assessments indicated unrealistic results. The data base (both biological and fisheries data) were improved along these years trying to apply an analytical assessment model. Since 1998 a non-equilibrium surplus production model ASPIC (Prager, 1994) was applied to each stock or to the combined stock data. These stock assessments were accepted by the ACFM and used to provide management advice. The assessment of black anglerfish as a separate stock has been carried out continuously from 2007. In 2012 during the benchmark (WKFLAT2012) it was agreed to include a third series in the assessment. The history of black anglerfish assessment from 2007 to 2012 is presented in Table 1.

Table 1. History of southern black anglerfish assessment from 2007 to 2012.

| WG | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Assessment Model | Nonequilibrium Surplus production model (Prager, 1994a) | No updated | Nonequilibrium Surplus production model (Prager, 1994a) | Nonequilibrium Surplus production model (Prager, 1994a) | Nonequilibrium Surplus production model (Prager, 1994a) | Nonequilibrium Surplus production model (Prager, 1994a) |
| Software | $\begin{aligned} & \text { ASPIC } \\ & \text { (v. } 5.16 \text { ) } \end{aligned}$ | No updated | $\begin{aligned} & \hline \text { ASPIC } \\ & \text { (v. } 5.24 \text { ) } \end{aligned}$ | $\begin{aligned} & \text { ASPIC } \\ & \text { (v. } 5.34 \text { ) } \end{aligned}$ | ASPIC (v. 5.34.9) | $\begin{aligned} & \hline \text { ASPIC } \\ & \text { (v. 5.34.9) } \end{aligned}$ |
| Catch data range | 1980-2006 |  | 1980-2008 | 1980-2009 | 1980-2010 | 1980-2010 |
| CPUE Series <br> 1 (years) | $\begin{aligned} & \hline \text { PT-TRF9a } \\ & (1989-2006) \end{aligned}$ |  | $\begin{aligned} & \hline \text { PT-TRF9a } \\ & (1989-2008) \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline \text { PT-TRF9a } \\ & (1989-2009) \end{aligned}$ | PT-TRF9a (1989-2010) | $\begin{aligned} & \hline \text { PT-TRC9a } \\ & (1989-2010) \end{aligned}$ |
| CPUE Series 2 (years) |  |  |  |  |  | $\begin{aligned} & \hline \text { PT-TRF9a } \\ & (1989-2010) \end{aligned}$ |
| Index of Biomass (years) | $\begin{aligned} & \text { PT-TRC9a } \\ & (1989-2006) \end{aligned}$ |  | $\begin{aligned} & \text { PT-TRC9a } \\ & \text { (1989-2008) } \end{aligned}$ | $\begin{aligned} & \text { PT-TRC9a } \\ & \text { (1989-2009) } \end{aligned}$ | $\begin{aligned} & \text { PT-TRC9a } \\ & \text { (1989-2010) } \end{aligned}$ | SPCORTR8c <br> (1982-2010) |
| Error Type | Condition on yield |  | Condition on yield | Condition on yield | Condition on yield | Condition on yield |
| Number of bootstrap | 500 |  | 500 | 1000 | 1000 | 1000 |
| Maximum F | 8.0 (y-1) |  | 8.0 (y-1) | 8.0 (y-1) | 8.0 (y-1) | 8.0 (y-1) |
| Statistical weight B1/K | 1 |  | 1 | 1 | 1 | 1 |
| Statistical weight for fisheries | 1,1 |  | 1,1 | 1,1 | 1,1 | $\begin{aligned} & \hline 8.59 \mathrm{E}-01, \\ & 1.20 \mathrm{E}+00, \\ & 9.81 \mathrm{E}-01 \\ & \hline \end{aligned}$ |
| B1-ratio (starting guess) | 0.5 |  | 0.5 | 0.5 | 0.5 | 0.6 |
| MSY <br> (starting <br> guess) | 3000 t |  | 3000 t | 3000 t | 3000 t | 1811.26 t |
| K (starting guess) | 20000 t |  | 20000 t | 20000 t | 20000 t | 18112.6 t |
| q1 (starting guess) | 1d-5 |  | 1d-5 | 1d-5 | 1d-5 | 8.2523E-04 |
| q2 (starting guess) | 1d-4 |  | 1d-4 | 1d-4 | 1d-4 | 1.1196E-07 |
| q3 (starting guess) |  |  |  |  |  | 2.7279E-07 |
| Estimated parameter | All |  | All | All | All | All |
| Min and Max allowable MSY | $\begin{aligned} & 2000(\mathrm{t}) \\ & -10000(\mathrm{t}) \end{aligned}$ |  | $\begin{aligned} & 2000(\mathrm{t}) \\ & -11500(\mathrm{t}) \end{aligned}$ | $\begin{aligned} & 2000(\mathrm{t}) \\ & -10000(\mathrm{t}) \end{aligned}$ | $\begin{aligned} & 2000(\mathrm{t}) \\ & -10000(\mathrm{t}) \end{aligned}$ | $\begin{aligned} & 181.126(\mathrm{t}) \\ & -3622.52(\mathrm{t}) \end{aligned}$ |
| Min and Max K | $\begin{aligned} & \hline 5000(\mathrm{t}) \\ & -500000(\mathrm{t}) \end{aligned}$ |  | $\begin{aligned} & \hline 5000(\mathrm{t}) \\ & -112000(\mathrm{t}) \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 5000(\mathrm{t}) \\ & -100000(\mathrm{t}) \\ & \hline \end{aligned}$ | $\begin{aligned} & 5000(\mathrm{t}) \\ & -100000(\mathrm{t}) \end{aligned}$ | $\begin{gathered} 1811.26(\mathrm{t}) \\ -362252(\mathrm{t}) \\ \hline \end{gathered}$ |
| Random <br> Number <br> Seed | 1964185 |  | 1964185 | 1964185 | 1964185 | 1025957 |

## I. References

Afonso-Dias, I. P. and J.R.G. Hislop. 1996. The population of anglerfish (Lophius piscatorius) from the northwest coast of Scotland. J. Fish. Biol. 49 (Suppl A): 18-39.

BIOSDEF. 1998. Biological studies of demersal fish. Ref.: EU, DG XIV, Study Contract 95/038.
Castro, J., Cardador, F., Santurtún, M., Punzón, A., Quincoces, I., Silva, C., Duarte, R., Murta, A., Silva, L., Abad, E. and Marín, M. 2007. Proposal of fleet segmentation for the Spanish and Portuguese fleets operating in the Atlantic national waters. ICES CM 2007/ACFM: 21

Costas, G., Fariña, C., Sampedro, P., Landa, J., Morlán, R., Azevedo, M., and Duarte, R. 2007. CPUE standardization of artisanal gillnet fishery targeting anglerfish in Northwest of Iberian Peninsula. Working Document in WGHMM2009 ICES CM/2007 K:27.

Duarte, R., Azevedo, M., Landa, J. and Pereda, P. 2001. Reproduction of anglerfish (Lophius budegassa Spinola and Lophius piscatorius Linnaeus) from the Atlantic Iberian coast. Fisheries Research 51: 349-361.

Duarte, R., Bruno, I., Quincoces, I., Fariña, A.C. and Landa, J. 2004. Morphometric and meristic study of white and black anglerfish (Lophius piscatorius and L. budegassa) from the southwest of Ireland to the south-western Mediterranean. ICES 2004 Annual Science Conference, Vigo (Spain). ICES CM 2004/EE: 22.
Duarte, R., Sampedro, P., Landa, J. and Azevedo, M. 2007. Revision of available data (landings, effort, length frequency distributions and age-length keys) from 1996-2005 for an agestructured assessment of Southern anglerfish stocks. ICES CM 2007/ACFM: 21

Fariña, A.C., Duarte, R., Landa, J., Quincoces, I. and Sánchez, J.A. 2004. Multiple stock identification approaches of anglerfish (Lophius piscatorius and L. budegassa) in western and southern European waters. ICES 2004 Annual Science Conference, Vigo (Spain). ICES CM 2004/EE: 25.

GESSAN, 2002. Genetic characterisation and stock structure of the two species of anglerfish (Lophius piscatorius and L. budegassa) of the north Atlantic. Ref.: EU DG XIV Study Contract: 99/013.

Hislop, J. R.G., Holst, J.C., Skagen, D. 2001. Near-surface captures of post-juvenile anglerfish in the North-east Atlantic- an unsolved mystery. Journal of Fish Biology 57: 1083-1087.
Hislop, J. R. G., A. Gallego, M. R. Heath, F. M. Kennedy, S. A. Reeves and Wright, P. J. 2001. A synthesis of the early life history of anglerfish, Lophius piscatorius (Linnaeus, 1756) in northern British waters. ICES Journal of Marine Science, 58, 70-86.

ICES. 2007. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM), 8-17 May 2007, Vigo, Spain. ICES CM 2007/ACFM:21. 700 pp.
ICES. 2011. Report of the Working Group on the Assessment of Southern Shelf stocks of Hake, Monk and Megrim (WGHMM), 5-11 May 2011, ICES Headquarters, Copenhagen. ICES CM 2011/ACOM:11.625 pp.

ICES. 2012. Report of the Benchmark Workshop on Flatfish and Anglerfish (WKFLAT), 1-8March 2012, Bilbao, Spain. ICES CM 2012/ACOM:47.

Landa,J., Antolínez, A., Castro, B., Ámez, M., Barrado, J. and Hernández, C.,2012. Sexual maturity of black anglerfish (Lophius budegassa) caught by the Spanish fleet in north-eastern Atlantic waters.. Working Document n 9 in WKFLAT 2012.
Landa, J., Duarte, R. and I. Quincoces. 2008. Growth of white anglerfish (Lophius piscatorius) tagged in the Northeast Atlantic, and a review of age studies on anglerfish. ICES Journal of Marine Science, 65: 72-80.

Pereda, P. and I. Olaso. 1990. Feeding of hake and monkfish in the non-trawlable area of the shelf of the Cantabrian Sea. ICES Document CM 1990/G:45:10 pp.

Prager, M. H. 1994. A suite of extension to a non-equilibrium surplus-production model. Fish. Bull. 92: 374-389.
Praguer, M. H. 2004. User's manual for ASPIC: a stock production model incorporating covariates (ver. 5) and auxiliary programs. NMFS Beaufort Laboratory Document BL-2004-01, 25pp.

Quincoces, I. 2002. Crecimiento y reproducción de las especies Lophius budegassa Spinola1807, y Lophius piscatorius Linneo 1758, del Golfo de Vizcaya. PhD Thesis. Basque Country University. 276pp.

## Annex N - Benchmark Planning

## Benchmark Planning for 2013

Four stocks within the remit of WGHMM are scheduled to be benchmarked at the start of 2014.

WGHMM continues to take a long term approach to planning and implementing the benchmark process and has drafted work schedules for stocks to be considered for benchmark in 2014.

| Stock | Megrim (Lepidorhombus boscii) <br> in Divisions VIIIc and Ixa and <br> Megrim (Lepidorhombus <br> whiffiagonis) in Divisions VIIIc <br> and IXa (mgw89 and mgb89) |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- |


| Stock | Northern Hake |  |
| :--- | :--- | :--- |
| Stock coordinator | Name: Dorleta Garcia | Email: dgarcia@azti.es |
| Stock assessor | Name: : Dorleta Garcia / Castro José | Email: Email: jose.castro@vi.ieo.es |
| Data contact | Name: : Dorleta Garcia | Email: dgarcia@azti.es |


| Issue | Problem/Aim | Work needed / <br> possible direction of solution | Data needed to be able to do this: are these available / where should these come from? | External expertise needed at benchmark <br> type of expertise / proposed names |
| :---: | :---: | :---: | :---: | :---: |
|  | Stock definition | Combined assessment (North and South) | Carry out assessment intersessionally | Rick Methot/Jim Ianelli |
| Tuning series | Little information on abundance of large fish | Incorporation of CPUE from commercial fleets catching adults (Longline/Gillnet) | Catch and Effort data of fleets (Available from Spain-France) <br> Will depend on data availability |  |
| Discards | Discards of some fleets not yet included (SS3 fleets : OTHERTRAWL and OTHERS ) | Raising of samples available, Incorporation into the assessment model | Discards data (Available from France/Denmark/Ireland/UK/Scotland) (Datacall?) |  |


| Issue | Problem/Aim | Work needed / <br> possible direction of solution | Data needed to be able to do this: are these available / where should these come from? | External expertise needed at benchmark <br> type of expertise / proposed names |
| :---: | :---: | :---: | :---: | :---: |
| Biological Parameters | Setting of M/K/Linf | Sensitivity of assessment to $M$, choice of M. Sensitivity to Growth | No data needed/Meta-analysis for priors | Rick Methot/Jim Ianelli |
| Assessment method | Sensitivity of assessment, poor convergence. | Sensitivity analysis on parameter settings and hypothesis (i.e. selectivity functions, growth) and on error distribution hypothesis. <br> Optimisation criteria, ADMB | No data needed | Rick Methot/Jim Ianelli |
|  | Consider reducing model complexity | Group datasets and model reparameterisation (reduce number of fleets, consider only 2 morphs etc.) |  | Rick Methot/Jim Ianelli |
| Biological Reference Points | Revision of reference points due to extension of data series and expected improvement of the assessment during benchmark | Stochastic projections. Yield analysis. Based on WKMSYREF. |  | Rick Methot/Jim Ianelli |
|  |  |  |  |  |

Proposal for 2014 Southern hake benchmark. Date is conditioned to interseasonal work presented in WGHMM 2013

| Stock | Southern Hake |  |
| :--- | :--- | :--- |
| Stock coordinator | Name Santiago Cerviño | Email: santiago.cervino@vi.ieo.es |
| Stock assessor | Name: Santiago Cerviño and Joao Pereira | Email: santiago.cervino@vi.ieo.es <br> Email: jpereira@ipma.pt |
| Data contact | Name: Santiago Cerviño and Joao Pereira | Email: santiago.cervino@vi.ieo.es |


| Issue | Problem/Aim | Work needed / <br> possible direction of solution | $\frac{\text { Data needed to be able to do }}{\text { this: are these available/ }}$ <br> where should these come from? | External expertise needed at benchmark <br> type of expertise/proposed names |
| :--- | :--- | :--- | :--- | :--- |
| Catches | Catches in the past (before 1982) | Direct implementation on the model. | Ask national DB (Sp and Pt) |  |
| CPUEs | Little information on abundance of large fish, <br> particularly in the past | Incorporation of CPUE from commercial <br> fleets catching adults | Catch and Effort data of available <br> fleets. <br> Ask national DB (Sp and Pt) |  |
| Biological Param- <br> eters (growth and <br> mortality) | Hake is sex dimorphic specie. Accounting for <br> differences on growth, maturity and mortality <br> by sex. | Explore life history invariants to support <br> new parameters (Linf, k, M, etc) | Explore literature about life histo- <br> ry in other hakes. | GADGET <br> iel.howell@imr.no) |


| Issue | Problem/Aim | Work needed / <br> possible direction of solution | Data needed to be able to do this: are these available / where should these come from? | External expertise needed at benchmark type of expertise / proposed names |
| :---: | :---: | :---: | :---: | :---: |
| Reproductive potential | Males and females together may cause bias in reproductive potential estimation. Consider reproductive potential. | Move to a female SSB. <br> Explore eggs production at length | Sex ratios, female maturity and egg production by length class. <br> Data already available | GADGET expert: Daniel Howell |
| Trophic relationships | Hake is an active cannibal species having a great impact on M at younger classes. | Develop the process into GADGET. Most of the work is done although the fit is not good. | Stomach content, trophic information. <br> Already available. | GADGET expert: Daniel Howell |
| Recruitment | Current models assume recruitment happens in first and second quarters although hake spawns all the year. | Extend the model to recruitment in all quarters and explore different sizes in different seasons. |  | GADGET expert: Daniel Howell |
|  | Stock definition | Combined assessment (North and South) | Carry out assessment intersessionally |  |
|  | Reference points review | Stochastic projections, length based F and S/R relationship |  |  |

## Annex O-Recommendations

| Recommendation | For follow up by: |
| :--- | :--- |
| 1. The EWG notices that several of the new stocks as- | ICES Secretariat / ACOM |
| sessed this year have negligible catches and that there |  |
| are distributed mainly in more northerly areas. This |  |
| includes the stocks of Grey gurnard in Subarea VIII and |  |
| Division IXa [gug-89a] and Plaice (Pleuronectes plates- |  |
| sa) in Subarea VIII and Division IXa [ple-89a]. The sci- |  |
| entific effort required to provide coverage of these less |  |
| abundant stocks in the southern area could be more |  |
| useful if applied to current stocks in the EWG. |  |


| 2. In order to provide an analytical assessment for all | ICES Secretariat / ACOM |
| :--- | :--- |
| ICES stocks of anglerfish, the EWG considers that | PGCCDBS |
| further work is needed on data and biological | ??? |
| parameters. This includes the availability of data on |  |
| discards, the production of appropriate tuning indices |  |
| and CPUE's for both species and all stocks and the |  |
| analysis of biological and length information already |  |
| available from scientific surveys. Furthermore, the |  |
| EWG recommends that in order to help validate |  |
| growth as well as provide information on migration |  |
| patterns international tagging studies be initiated. |  |
| 3.Following the inclusion of several new species in <br> recent years, the EWG working group considers that its <br> acronym name "WGHMM" no longer reflects the | ICES Secretariat / ACOM |
| stocks for which it is asked to provide advice. The WG |  |
| recommends that his acronym be changed into WGBIE |  |
| = Working Group for the Bay of Biscay and the Iberic |  |
| waters Ecoregion |  |

## Annex P: Collaboration with RACs and ask from PGCCDBS for a project to address data deficiencies

In January 2011 WKDDRAC agreed that collaboration between ICES and RACs was important to address the data deficiencies that currently undermine the quantity and quality of assessments (ICES, 2011). This first meeting defined the problem and types of data deficiencies and data needs, identified existing initiatives, discussed the need to involve key stakeholders, and explored the range of possible remedial measures. During the second coordination meeting on data deficiency among scientists, the industry and administrations (ICES WKDDRAC2), stocks without analytical assessments, due to data deficiencies, were identified in each RAC area, in order to prioritise stocks of immediate concern based on the benchmarking schedule and stakeholders views. Where possible the nature of the data problems, the groups (scientists, Member State fisheries authorities or fisheries stakeholders) with principal responsibility for resolving specific problems and potential remedial actions were listed.

The meeting concluded a number of points in order to strength assessments of WGHMM stocks with data deficiencies, which are summarized as follows:

- Strong communications between scientists, fisheries managers and fisheries stakeholders is required to address:
- Changing fishing patterns and fishing strategies. This is a prerequisite to reintegrate some CPUE into assessments.
- Upcoming benchmarks. Here, the "pedigree" matrix tool can be a useful focal point for dialogue between stock coordinators and industry.
- Accurate recording of landings. This is the backbone for most stock assessments, perceived as a key uncertainty by scientists.
- Industry cooperation with DCF by:
- Applying self-sampling programmes.
- Developing fully documented fisheries ("reference fleets") and, where appropriate, sentinel fisheries. For this, RACs and Member States promotion of fisheries and science partnership is requested.
- By cooperating on tagging studies.

Under this collaboration framework opened by ICES, SWWRAC and NWWRAC have contacted WGHMM to recall issues identified during the second workshop in data deficiencies. Both RACs have summarised in detail data deficiencies in stocks comprised under WGHMM. The WG acknowledge this new push in moving forward with the recommendations identified above. Regarding the way in how to formalise this dialogue, the use of already existing structures were found the most convenient (i.e. ICES WGs, Benchmarks, RAC Focus groups): establishing ad hoc groups with clear objectives, calendars and always with a long term view.

After consultations and various meetings the following working plan was agreed and recommended by the RCM in 2012:

Objective 1. Improvement of the discard data (Megrim and Anglerfish)

1. Historical data (2000-2011). If historical data can be obtained, previous to this period, will be also incorporated.
a. Data recovery: need of French discard data. This proposal will assure the man power required from extracting discard data stored in national data bases and delivered it to responsible researcher.
b. To contrast and analyse these discard data with the fishing industry to detect and identify possible changes in exploitation patterns, reasons for discarding...
2. From 2012 onwards:
a. Workshops with SWWRAC associated members to explain de importance of obtaining discard data from megrim and anglerfish relevant metiers with the objective of improving assessment and management. The result of this action will be to facilitate sampling on board.

Objective 2. Tuning fleets (Megrim and Anglerfish):

1. Revision of the French trawling data series in Subarea VII. The objective is to obtain the best data series corresponding to that fishery metier catching or targeting megrim significantly to be used in the analytical assessment as commercial abundance indices. Effort data is basic for the creation of these indices. These effort data will be worked out under this objective.
2. Revision of the Basque "Baka" Otter trawl fleet to check for suitability in being included as new commercial abundance indices.

For both actions: data availability and results of the analysis will be contrasted with the industry.

Objective 3. Biological parameters (Anglerfish):

1. Reproductive parameters.
a. Scientific work: revision of the maturity ogives already existing. Data analysis of the new data collected in b
b. Industry involvement: All countries (France, Spain, UK and Ireland). Support in the collection of biological data. Development of a simple "on board sampling method" based on: identification of main metiers to be sampled, season of the year, simple visual protocol of maturity stages for identification by industry on board. If fish are processed, the possibility of collecting gonads on board will be assessed with the industry
2. Growth parameters (Angler fish):

The age estimation of white anglerfish (Lophius piscatorius) in the ICES area for stock assessment has been traditionally based on two different calcified structures (CS), the illicium (used by the majority of the European countries) and the sagitta otolith (used only by two countries). Growth studies alternative to the age estimates on CS of white anglerfish, such as tagging-recapture (Laurenson et al., 2005; Landa et al., 2008a), daily growth (Wright et al., 2002) and length frequency distributions of catches (Dupouy et al., 1986; Thangstad et al., 2002; Jónsson, 2007), showed that the growth pattern estimated using the traditional standardized age estimation criterion based on illicia (Duarte et al., 2002) was underestimated and that criterion was not accurate,
although it was standardized and used in several age estimation anglerfish workshops (Anon 1991, 1997, 1999; Landa et al., 2002; Duarte et al, 2005). The age estimation using illicia of a decadal time-series was performed for the southern stock assessment of white anglerfish using the traditional standardized age estimation criterion (Duarte et al., 2002). A catch-at-age by year matrix was built, but inconsistencies in cohort tracking were found (Azevedo et al., 2008).
Modifications in the methodology of illicia preparation and in the traditional standardized age estimation criterion have allowed obtaining a new age estimation criterion on illicia (Landa, pers. com.). Using it, the catches-at-age have been able to be more successfully tracked. Therefore this new criterion was judged to be more accurate and it was used for the age estimation in the "Anglerfish (Lophius piscatorius) illicia and otoliths exchange 2011" (a working document presented to the 2012 PGCCDBS Meeting). The results of this exchange have showed similar results to those from the 2004 workshop (Duarte et al., 2005):
i) Illicia and otoliths age readings comparison. Strong discrepancies between illicia and otoliths readings were found. It is not possible to use the age estimates of both CS together, illicia and otoliths, for stock assessment purposes.
ii ) Illicia. Although the relative bias values among the assessment readers can be considered good, the agreement values and precision suggest that they are not still sufficiently acceptable for building a valid ALK. The research for a reliable criterion for age estimation of white anglerfish based on CS is more advanced in illicia than for otoliths. There is an illicia age estimation criterion that allows cohort tracking (indirect age validation) but only in the Porcupine Bank of the Atlantic.
iii ) Otoliths. The age estimation of white anglerfish, based on otoliths, is difficult mainly due to the occurrence of confusing false annuli and to the increase of opacity with age. The location of the first annulus is also a problem, even among expert readers, in the last and present exchanges. There have also been advances in daily growth studies (Wright et al., 2002; Woodroffe et al., 2003) that can help locate the first annulus more precisely.
Further research should enhance our knowledge of the true growth of white anglerfish by developing and using methodologies that allow validation, before the attempt to standardize reading criteria. It is unproductive to go further in estimating white anglerfish growth patterns and age without progress being made in age validation (Duarte et al., 2005). Improving the precision in the absence of accuracy cannot, under any account, guarantee data quality (de Pontual et al., 2006).

A collaborative study among several European countries could be based on the following issues:
i) Indirect growth validation using the new illicia ageing criterion for testing if cohort tracking is possible in other areas (after the age estimation a timeseries of illicia, similar to what has been done in the Porcupine Bank).
ii ) Direct growth validation studies. The tagging-recapture of specimens of white anglerfish could be very useful to a further advance on growth validation, especially on that of the large specimens, were validated information is very scarce. Tagging is a direct method of validating the growth of a fish during its time at liberty. Two tagging programs have been undertaken for white anglerfish, one on the Atlantic northern shelf stock (Lauren-
son et al., 2005) and another on the two stocks of the Atlantic southern shelf (Landa et al., 2008b). Acceptable recovery rates were obtained in both studies (3.8-4.5\%). Given the difficulty of tagging a large number of specimens of this species, it was not possible to obtain information from specimens which had spent much time at liberty. Most of the available information from those tagging-recapture programs corresponded to information from small and medium specimens, but not from large specimens. Despite this, invaluable information was obtained to advance on the validation of the growth pattern of white anglerfish, and to obtain more information on the movements and interaction between stocks (Laurenson et al., 2005; Landa et al., 2008b).

Objective 4. Other important parameters to be obtained:
Scientist and SWWRAC will require from national administrations high resolution spatial data (VMSs/AIS). Main objective is to get a better functioning and knowledge of: effort distribution, fleet dynamics and CPUEs. The importance of this objective is based on the actual situation of all data being transmitted electronically and the rapid disappearance of the hand written logbooks. However, some administrations appear to be reluctant to provide of these data to scientist for assessment and management purposes.

Objective 5. Exchange of knowledge with scientist assessing other Megrim and Anglerfish stocks.

WS 1. Data deficiencies and methodological possibilities (identification of problems and proposal of solutions)

Objective 6. Choosing and Feeding the most suitable assessment models.
Different model trials based of the results of WS 1.
WS 2. Comparison of resulting assessment for different stocks and methodologies looking for consistency in analysis and results.

## Justification of why a dedicated research project:

No progress can be expected if no international commitment to work compromise for countries exploiting on data and methods to assess these stocks is obtained. However it appears unlikely that time between possible future Benchmarks and Working Groups would be enough for: i) solving data availability, ii) reviewing their quality, iii) new model trials and even iv) exchange of experiences between researches working in same species but different stocks. That is why it would be recommended that resources could be made available for a real improvement in the assessment of this stock. A pilot project is suggested for in a depth treatment of data analysis and improvement and model selection.

This collaborative project proposal was rejected by the EC but the SWWRAC, NWWRAC and the PGCDDBS still considered in their 2013 meeting that a project like the mentioned is necessary if a better assessment of anglerfish and megrim is wanted.

The WGHMM and the WGCSE agree that a collaborative study about biology and fishery data improvement for anglerfishes and megrims for IV VI, VII, VIII and IXa is necessary in order to improve the assessment provided by ICES.

## Annex Q: Term of Reference for 2014

## WGHMM - Working Group on Hake, Monk and Megrim

2012/2/ACOM:11 The Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim [WGHMM], chaired by Michel Bertignac (France), will meet in Lisbon, 7-13 May 2014 to:
a ) Address generic ToRs for Regional and Species Working Groups (see table below).

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting. The data to perform the assessment should be available 4 weeks before the meeting. This will be coordinated as indicated in the table below.

WGHMM will report by 20 May for the attention of ACOM. The group will report on the ACOM guidelines on reopening procedure of the advice before 14 October and will report on reopened advice before 29 October.

| Fish Stock | Stock Name | Stock Coordinator | Assess. Coord. 1 | Assess. <br> Coord. 2 | Advice |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { anp- } \\ & \text { 78ab } \end{aligned}$ | Anglerfish (L. piscatorius) in Divisions VIIb-k and VIIIa,b | Spain/UK | Spain/UK | France/UK | Update |
| $\begin{aligned} & \text { anb- } \\ & 78 \mathrm{ab} \end{aligned}$ | Anglerfish (Lophius budegassa) in Divisions VIIb-k and VIIIa,b | Spain/UK | Spain/UK | France/UK | Update |
| $\begin{aligned} & \text { anb- } \\ & 8 \mathrm{c} 9 \mathrm{a} \end{aligned}$ | Anglerfish (Lophius budegassa) in Divisions VIIIc and IXa | Portugal | Portugal | Portugal | Update |
| Anp- <br> 8c9a | Anglerfish (L. piscatorius) in Divisions VIIIc and IXa | Spain | Spain | Spain | Update |
| Bss-8ab | Sea bass in Divisions VIIIa,b | FR | FR |  | Update WGNEW* |
| $\begin{aligned} & \text { Bss- } \\ & 8 \mathrm{c} 9 \mathrm{a} \end{aligned}$ | Sea bass in Divisions VIIIc and IXa | FR | FR |  | Update WGNEW* |
| hke- <br> nrtn | Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock); | Spain | Spain | Spain | Update |
| hkesoth | Hake in Division VIIIc and IXa (Southern stock); | Spain | Spain | Portugal | Update |
| $\begin{aligned} & \text { mgb- } \\ & 8 \mathrm{c} 9 \mathrm{a} \end{aligned}$ | Megrim (Lepidorhombus boscii) in Divisions VIIIc and IXa | Spain | Spain |  | Update |
| $\begin{aligned} & \hline \text { mgw- } \\ & 8 \mathrm{c} 9 \mathrm{a} \\ & \hline \end{aligned}$ | Megrim (Lepidorhombus whiffiagonis) in Divisions VIIIc and IXa | Spain | Spain |  | Update |
| mgw-78 | Megrim (L. whiffiagonis) in Subarea VII \& Divisions VIIIa,b,d,e | Spain | Spain |  | Re-examine |
| sol-bisc | Sole in Divisions VIIIa,b,d (Bay of Biscay) | France | France |  | Update |
| sol-8c9a | Sole in Divisions VIIIc and IXa | Portugal | Portugal |  | Multiyear |
| ple-89a | Plaice in Subarea VIII and Division IXa | Ireland | Spain |  | Biennial $2^{\text {nd }}$ year |
| pol-89a | Pollack in Subarea VIII and Division IXa | Spain | Spain |  | Biennial <br> $2^{\text {nd }}$ year |
| whg- 89a | Whiting in Subarea VIII and Division IXa | Ireland | Spain |  | Biennial $2^{\text {nd }} \text { year }$ |
| gug-89a | Grey gurnard in Subarea VIII and Division IXa | Ireland | Spain |  | Biennial $2^{\text {nd }}$ year |
| Mut- <br> west | Striped red mullet in Subarea VI, VIII and Divisions VIIa-c, e-k and IXa (Western area) | Ireland | Spain |  | Biennial $2^{\text {nd }}$ year |
| nep- | Nephrops in Divisions VIIIa,b (Bay | France | France |  | Biennial |


| 2324 | of Biscay, FU 23, 24) |  |  |  | $2^{\text {nd }}$ year |
| :---: | :---: | :---: | :---: | :---: | :---: |
| NepVIIIc |  |  |  |  |  |
| nep-25 | Nephrops in North Galicia (FU 25) | Spain | Spain |  | Biennial 2nd year |
| nep-31 | Nephrops in the Cantabrian Sea (FU 31) | Spain | Spain |  | $\begin{gathered} \hline \text { Biennial 2 } 2^{\text {nd }} \\ \text { year } \\ \hline \end{gathered}$ |
| $\begin{aligned} & \text { Nep- } \\ & \text { IXa } \end{aligned}$ |  |  |  |  |  |
| $\begin{aligned} & \text { nep- } \\ & 2627 \end{aligned}$ | Nephrops in West Galicia and North Portugal (FU 26-27) | Spain/Portugal | Spain/ Portugal | Portugal/ Spai n | $\begin{gathered} \text { Biennial 2nd } \\ \text { year } \end{gathered}$ |
| $\begin{aligned} & \text { nep- } \\ & 2829 \end{aligned}$ | Nephrops in South-West and South Portugal (FU 28-29) | Spain/Portugal | Spain/ Portugal | Portugal/ Spai n | $\begin{gathered} \text { Biennial 2nd } \\ \text { year } \end{gathered}$ |
| nep-30 | Nephrops in Gulf of Cadiz (FU 30) | Spain/Portugal | Spain/ Portugal | Portugal/ Spai <br> n | $\begin{gathered} \text { Biennial 2nd } \\ \text { year } \end{gathered}$ |

* Finalise advice based on draft prepared by WGNEW


# Annex R - Stock Synthesis 3 (SS3) assessment progress Anglerfish in Divisions VIIb-k and VIIIa,b,d 

## A. SS3 assessment progress

The WKFLAT 2012 assessment required a modelling framework capable of handling length data as uncertainties in aging methodologies used continues, the Stock Synthesis assessment model (NOAA Fisheries Toolbox, 2011) was chosen for this purpose, it's a highly flexible statistical model framework which allows the building of simple to complex models using a mix of data compositions available. For the WKFLAT 2012 benchmark both anglerfish stock used a number of different model approaches as well as an SS3 length based model. The Stock Synthesis assessments were built using SS3 version 3.29 b. The recommendation from the benchmark was to explore and continue to develop this model for both species (ICES, 2012/ACOM:46). This annex explores the progress made with the Stock Synthesis model for both species.

## A.1. Lophius piscatorius

## Development of the model

Although a Stock Synthesis model was developed during the WKFLAT 2012 benchmark it was not present. This annex presents the results from the exploration and further development of the SS3 length based model.

For Lophius piscatorius model the following datasets were used:

- Quarterly landings and length frequency compositions from 1986 to 2012.
- Biomass index and length frequency compositions from the EVHOE-WIBTSQ4 from 1997 to 2012.
- Biomass index and length frequency compositions from the SPPGFS-WIBTSQ4 from 2001 to 2012.

The landings where aggregated into five fleet combinations; French trawl, French gillnet, Spanish trawl, beam trawl and other, the setting for the biological parameter have been set to those used in the Lophius piscatorius in area VIIIc and IXa SS3 assessment.

Assessment model results.
Stock trends for the SS3 model are presented in figure A.1.1. The model shows a declining trend in SSB over the time series with peaks in abundance at 1997 and to a lesser extent 2008. The SSB increases in 1997 and 2008 correspond to the 1992 and 2001 recruitments entering the fishery. The large peak in recruitment abundance in 2001 corresponds to the length distributions found in the EVHOE-IBTS-Q4 survey for 2001. Mean $F_{10-12}$ reached it maximum of 0.42 in 2004 followed by a declining trend.

The decreasing trend in SSB does not match the signals from the CPUE increases and Effort decreases for this stock (figure 4.2-1). The inclusion of commercial indices of abundance or biomass may help tune the model.

The model fit to the EVHOE-IBTS-Q4 and SPPGFS-WIBTS-Q4 surveys, shown in figure A.1.2, is slightly better for the EVHOE-IBTS-Q4 in the early years than that of the SPPGFS-WIBTS-Q4, the two most recent years for the EVHOE-IBTS-Q4 give a fit out-
side the confidence intervals of the survey and the two most recent years of the SPPGFS-WIBTS-Q4 shows a conflicting trend in abundance. Selectivity for all the fleets and the two survey indices give good fits to the length frequency distributions (figure A.1.3). However, the two trawl fleet combinations show an overestimation of the smaller length classes since 2005, this is probably due to the restriction on minimum landing weight of individuals $<500 \mathrm{~g}$, so they are no longer seen in the landings.

The retrospectives analysis given in figure A.1.4 shows an unbiased pattern until the time-series with most recent years data included. Here recruitment and SSB from the time period proceeding after 2007 has a revised increase and $\mathrm{F}_{10-12}$ shows a downward revision.

## A.2. Lophius budegassa

## Development of the model

The baseline model using data from 1986 to 2010, taken as the final model run from the WKFLAT 2012 benchmark assessment (ICES, 2012/ACOM:46), consists of six combined fisheries groupings; gillnets, French trawl, Spanish trawl, Nephrops trawl, Beam trawl and a category containing those not in the previous groupings. There was evidence in the length compositions for the French, Spanish and Nephrops trawls to suggest that a change in selectivity after 2005 was present. Smaller fish within these fleets were no longer seen in the landings due to a restriction on minimum landing weight imposed. For these three combinations a change in selectivity was introduced into the model. An extended time series of landing calculated from the average of the first ten year of landings data available to the assessment and a dummy index was also included in to the model to control the rate of biomass depletion prior 1986 as the model would estimate a stock collapse without recovery.

The baseline model was updated using data from 2011 and 2012. Taking into account the length distributions, the areas the fleets operate, landings and sampling levels the aggregation of fleets was also updated to five categories; French trawls, Spanish trawls in area VII, Spanish trawls in Area VIII, Beam trawls and other. Other changes applied to the model were the removal of the dummy index, the extended timeseries, selectivity adjustments to take account of the new fleet aggregations and the model estimating two growth parameters, K and t .

## Comparison of the baseline assessment model and the updated assessment model.

Stock trends for the two models are compared in figure A.2.1. The two assessment models although give very different results in spawning stock biomass the peaks in abundance occur during the same time periods. This is also true of recruitment and in the later part of the time-series for $\mathrm{F}_{10-12}$. The reduction in the scale of the SSB and increase in F is more in tune with the results seen in the last accepted assessment carried out by WGHMM during 2007 (ICES, 2007/ACFM:21).

The fit to the EVHOE-WIBTS-Q4 survey for the two models shown in figure A.2.2 give similar fits, however the fit of the model to the data is improved with the updated assessment and the recruitment seen in the EVHOE-WIBTS-Q4 is mirrored in the assessments with peaks in recruitment for the years 2004-08 and 2011 and 2012.

The fits to the length distributions shown in figure A.2.3, are good for both models and the fit to the EVHOE-WIBTS-Q4 are comparable with similar random patterns in the residuals (not shown). The years where very large peaks in recruitment exist are consistently underestimated by both models.

The retrospectives for the updated model given in figure A.2.4 show some bias with consistent underestimation of SSB and overestimation of $\mathrm{F}_{10-12}$ with the exception of the assessment estimate for 2012 where there is an overestimation of SSB and an underestimation of $\mathrm{F}_{10-12}$. The model is unable to fit the recruitment in the final years and calculates a geometric mean for the terminal year within the retrospective.

## A.3. Recommendations

Within the time frame of the planned benchmark assessment for the anglerfish stocks, combining efforts with all groups working on anglerfish will aid in the conclusion of providing an analytical assessment for all stocks, as all anglerfish stocks have similar data and biological deficiencies. In addition to the progress made on the models for the 2013 WGHMM meeting further work on fine tuning with better quality and aggregations of data will improving the level at which the stocks reside within the data limited approach to stocks (ICES, 2012/ACOM:68). Additional data on discards are required as discards of smaller anglerfish have increased for some stocks and are missing from the landings included in the models. Research and analysis will be required to produce appropriate tuning indices and CPUE's for both species and all stocks. The use of biological and length information already available from scientific surveys could provide a good estimation of both growth and maturity. To help validate growth as well as provide information on migration patterns international tagging studies should be initiated.

## A.4. References

ICES. 2007. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM), 8-17 May 2007, Vigo, Spain. ICES CM 2007/ACFM:21. 700 pp.
ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68. 42 pp.

ICES. 2012. Report of the Benchmark Workshop on Flatfish Species and Anglerfish (WKFLAT), 1-8 March 2012, Bilbao, Spain. ICES CM 2012/ACOM:46. 283 pp.

NOAA Fisheries Toolbox. 2011. Stock Synthesis 3, version 3.23b. [Internet address: http://nft.nefsc.noaa.gov]


Figure A.1.1. Lophius piscatorius model estimates for SSB, recruitment and $\mathrm{F}_{10-12}$.


Figure A.1.2. Model fits to the survey indices EVHOE-WIBTS-Q4 (left) and SPPGFS-WIBTS-Q4 (right).
length comps, sexes combined, retained, aggregated within season by fleet


Figure A.1.3. Model fits to the quarterly length distributions aggregated of the time-series for the combined fleets and survey indices.


Figure A.1.4. Retrospective analysis of SSB, recruits and $\mathrm{F}_{10-11}$ estimates for the updated assessment model, with four year peel.


Figure A.2.1. Comparison between the baseline assessment model (left) and the update assessment (right) for SSB, recruitment and $\mathrm{F}_{10-12 \text {. The red dotted line represents the extension to the }}$ time-series with the inclusion of the 2011 and 2012 data.


Figure A.2.2. Comparison between the EVHOE-WIBTS-Q4 survey index and modelled fit (blue line) for the baseline assessment model (left) and the update assessment (right).


Figure A.2.3. Comparison between the length distributions and modelled fit (red line) for the baseline assessment model (left) and the update assessment (right).


Figure A.2.4. Retrospective analysis of SSB, recruits and $F_{10-11}$ estimates for the updated assessment model, with four year peel.

## Annex S - Stock ~Annexes - New Stocks

## Stock Annex

## Grey gurnard in Subarea VIII and Division IXa

Stock specific documentation of standard assessment procedures used by ICES.

Stock Grey Gurnard in Subarea VIII and Division iXa<br>Working Group: Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM)<br>Date:<br>May 2013<br>Revised by<br>Eoghan Kelly WGHMM

## A. General

## A.1. Stock definition

Grey gurnard (Eutrigla gurnardus) occurs in the Eastern Atlantic from Iceland, Norway, southern Baltic and North Sea to southern Morocco and Madeira. It is also found in the Mediterranean and Black Seas. The species is more abundant in the North Sea and less so in the Channel, the Celtic Sea and in the Bay of Biscay. It can be found at depths ranging from 10 to 340 m though less often below 150 m . This species grows up to 60 cm though usually reaching 30 cm , with 19.3 cm as the length at first maturity (Fishbase).

No studies are known of the stock ID of grey gurnard and individual behaviour does not militate to maintain the population in a single stock. WGNEW concluded that in the absence of specific information on stock structure, the ICES ecoregions (North Sea including VIId, Celtic Seas and South European Atlantic) are to be used as minimum level of disaggregation for the definition of stock units (ICES, 2012). This is an interim solution until more information is available on the stock.

## A.2. Fishery

In the past, gurnards were often not sorted by species when landed and reported into one generic category of "gurnards". In recent years the official statistics seem to improve gradually, however, catch statistics are incomplete for several years. Grey gurnard is mainly taken as a by-catch in mixed demersal fisheries for flatfish and roundfish. However, the market is limited and the larger part of the catch appears to be discarded. Owing to the low commercial value of this species, landings data will usually not reflect the actual catches very well.

In South European Atlantic (VIII and IX), official landings have fluctuated at low level and were on average 63 t since 2000 (ICES, 2012). In North Portugal, Rocha (2007, 2008) determined the composition and proportion of Triglidae landings in artisanal fleet and Feijó et al. (2008) studied the mixture of Triglidae species in the trawl fleet. This work revealed that grey gurnard may represent as little as $0.5 \%$ of all gurnard landings and it is the tub gurnard (Chelidonichthys lucerna) that is the most valuable and frequently landed species of gurnard.

The Portuguese discard observer program in the period 2004-2011, recorded grey gurnard in less than $3 \%$ of the hauls sampled in the demersal fish bottom trawl fleet. For the crustacean bottom trawl fleet there was no occurrence of Grey gurnard in this period. Discarding of grey gurnard by Spanish trawl fleet has declined from 500 to 80 t in recent years.

## A.3. Ecosystem aspects

Grey gurnard is most common on sandy bottoms, but also on mud, shell and rocky bottoms. Juveniles feed on a variety of small crustaceans. The diet of older specimens consists mainly of larger crustaceans and small fish. Spawning takes place in spring and summer. There do not seem to be clear nursery areas.

## B. Data

## B.1. Commercial catch

Landings data are incomplete and issues with speciation makes commercial data difficult to interpret. Grey gurnard is taken as a by-catch in mixed demersal fisheries for flatfish and roundfish and it is thought that the larger part of the catch is discarded.

## B.2. Biological

Biological information was available from the Portuguese Ground Fish Survey. Length distribution ranged from 11 to 28 cm , with mean length close to the length at first maturity ( 19.3 cm ). Studies in the Baie de Douarnenez (Brittany) have shown that the length at which $50 \%$ of males and females were mature were 29.4 and 31.2 cm , respectively (Baron, 1985a, 1985b).

Biological sampling of gurnards was carried out on a fornightly basis in Northern Portugal during 2007. From 1965 Gurnards collected, 56 specimens of Eutrigla gurnardus ( $2.8 \%$ ) were randomly sampled from bottom trawler landings. Total length, total weight, eviscerated weight and gonad weight were recorded in addition to information on sex and maturity of each specimen. Length-based maturity ogives were generated. Otoliths wer also collected.

Between 2009 and 2012 the Portuguese port sampling program collected data from 947 fishing trips. Grey gurnards were observed in gill and trammel nets and in trawlers, normally mixed with other gurnards like tub, red, longfin, piper and streaked gurnards. The presence of grey gurnard occurred during all year, without remarkable seasonal variation. A bi-modal distribution ( 24 cm and 29 cm ) was observed and specimens smaller than 19 cm were not present. Although smaller individuals may be discarded at sea. Despite bibliography information indicating a maximum size of $\sim 60 \mathrm{~cm}$, individuals greater than 46 cm were not observed in these samples.

## B.3. Surveys

Biological data on grey gurnard were compiled from Portuguese Ground Fish Survey (PtGFS-WIBTS) for 2007 and 2008. This survey covered the whole Portuguese continental coast, within depths ranging from 20 to 500 m . Despite the low abundance the species was seen in the $20-100 \mathrm{~m}$ and the 101-200m depth range, mainly in North zone (Caminha to Lisbon). The species was not observed in the 2010 or 2011 survey. Biomass index was also available from EVHOE-WIBTS-Q4 in the Bay of Biscay but values were very low $(<0.4 \mathrm{Kg} / 30 \mathrm{~min})$.

## B.4. Commercial CPUE

Commercial indices were not available but exploration of logbook data may produce useful information.

## B.5. Other relevant data

No information.

## C. Assessment: data and method

For data-limited stocks where landings are negligible compared with discards (Category 6) ICES considers that a precautionary reduction of catches should be implemented, unless there is ancillary information clearly indicating that the current exploitation is appropriate for the stock. For this stock, ICES advises that catches should decrease by $20 \%$ in relation to the average catch of the last three years.
D. Short-Term Projection

## E. Medium-Term Projections

## F. Long-Term Projections

## G. Biological Reference Points

## H. Other Issues

## I. References

Baron, J. 1985. Les Triglides (Téléostéens, Scorpaeniformes) de la Baie de Douarnenez. I La croissance de: Eutrigla gurnardus, Trigla lucerna, Trigloprus lastoviza et Aspitrigla cuculus. Cybium 9(2): 127-144.

Baron, J. 1985. Les Triglides (Téléostéens, Scorpaeniformes) de la Baie de Douarnenez. II La reproduction de : Eutrigla gurnardus, Trigla lucerna, Trigloprus lastoviza et Aspitrigla cuculus. Cybium 9(3): 255-281.

ICES. 2012. Report of the Working Group on Assessment of New MoU Species (WGNEW), 5-9 March 2012, . ICES CM 2012/ACOM:20. 258 pp.

Feijó D, Rocha A, Santos P, Saborido-Rey F. 2008. Statistical Species characterization of Gurnard Landings in North of Portugal. Conference handbook (ICES CM 2008/K:15) ICES Annual Science Conference, Canada. pp. 10.

Fishbase Eutrigla gurnardus, Grey gurnard. http://www.fishbase.org/summary/Eutriglagurnardus.html (as seen on 7th February 2013).

Rocha A. 2007. Gestão de recursos pesqueiros com especial incidência no estudo de capturas de Ruivos e Cabras (Triglídeos). Relatório de Estágio da Licenciatura em Ciências e Tecnologia do Ambiente. pp. 41.

Rocha A, Feijó D, Santos P. 2008. An insight on gurnard Fisheries in North of Portugal Foro Ac. Rec. Mar. Rías Gal. 10: 609-615.

## Stock Annex Plaice in Subarea VIII and Division IXa

Stock specific documentation of standard assessment procedures used by ICES.

| Stock | Plaice in Subarea VIII and Divisiion IXa |
| :--- | :--- |
| Working Group: | Assessment of Southern Shelf Stocks of Hake, <br> Monk and Megrim (WGHMM) |
| Date: | May 2013 |
| Revised by | Eoghan Kelly WGHMM |

## A. General

## A.1. Stock definition

The stock unit definition of plaice (Pleuronectes platessa) in this area is not clear. WGNEW concluded that in the absence of specific information on stock structure, the ICES ecoregions (North Sea including VIId, Celtic Seas and South European Atlantic) are to be used as minimum level of disaggregation for the definition of stock units (ICES, 2012). This is an interim solution until more information is available on the stock.

## A.2. Fishery

Plaice is caught as a bycatch by various fleets and gear types covering small-scale artisanal and trawl fisheries. Portugal and France are the major participants in this fishery averaging 124 and 110 tons respectively between 2001 and 2011. French landings increased to 183 t in 2012. Average Spanish landings are around 22 tons but there were no data available in 2011.

## A.3. Ecosystem aspects

No information.

## B. Data

## B.1. Commercial catch

Fishery statistics are currently being compiled. At present, only official landings are available, which are considered to be preliminary for the purpose of stock assessment. There are concerns about the reliability of the 2008-2009 French data. There are speciation issues with flounder (Platichthys flesus) and they are often confounded at sales auction in Portugal. Landings statistics need to be quality-assured and confirmed for the region.

## B.2. Biological

No information.

## B.3. Surveys

Plaice was not present in the Spanish and Portuguese research surveys and not caught in sufficient quantities in the French survey in the Bay of Biscay to serve as an abundance index.

## B.4. Commercial CPUE

Commercial indices were not available but exploration of logbook data may produce useful information.

## B.5. Other relevant data

No information.

## C. Assessment: data and method

For data-limited stocks without information on abundance or exploitation (Category 5) ICES considers that a precautionary reduction of catches should be implemented, unless there is ancillary information clearly indicating that the current exploitation is appropriate for the stock. For this stock, ICES advises that catches should decrease by $20 \%$ in relation to the average catch of the last three years.

## D. Short-Term Projection

E. Medium-Term Projections

## F. Long-Term Projections

## G. Biological Reference Points

## H. Other Issues

## I. References

ICES. 2012. Report of the Working Group on Assessment of New MoU Species (WGNEW), 5-9 March 2012, . ICES CM 2012/ACOM:20. 258 pp.

Stock specific documentation of standard assessment procedures used by ICES.

| Stock | Pollack in Subarea VIII and Divisiion IXa |
| :--- | :--- |
| Working Group: | Assessment of Southern Shelf Stocks of Hake, <br> Monk and Megrim (WGHMM) |
| Date: | May 2013 |
| Revised by | José Castro |

## A. General

## A.1. Stock definition

There is little published information on pollack (Pollachius pollachius, Linnaeus, 1758) biology. The species 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.

Charrier et al. (2006) used genetic markers to assess the stock structure of pollack by comparing samples collected in the Atlantic French coast and off southern Norway; however, a limited genetic differentiation among samples was found. There are no morphological studies that allows to separate stocks for this species. Data from the fishery indicate three main areas of exploitation, so WGNEW proposed, based on a pragmatic approach, to distinguish three different stock units (ICES, 2012a): the southern European Atlantic shelf (ICES Subarea VIII and Division IXa), the Celtic Seas (ICES Subareas VI and VII), and the North Sea (ICES Subarea IV, including Divisions VIId and IIIa).

## A.2. Fishery

Pollack is mainly a bycatch in various fisheries in both VIII and IXa including small scale fisheries taking place in coastal waters. Catches are taken by the three countries with quota: France and Spain, followed distantly by Portugal. In France, pollack is mainly caught in nets, but also by lines, in Subarea VIII (the majority from division VIIIa). French observations also show that it is most available for fishing when it forms spawning aggregations. Otherwise its preference for wrecks and rocky bottom, makes it difficult to catch them with trawls. Spanish landings are taken mostly from Iberian waters (VIIIc and IXa), where they are basically caught by gillnet and longline (Rodriguez et al., 2011). The scarce Portuguese catches are made basically by the polyvalent fleet (Jardim et al., 2011).

However, there is a small scale target gillnet fishery that started in 2006 by the UK (Readdy and Robinson, 2011) which operates mainly in ICES Subarea VIIIa. In 2012 recorded landings from the UK for VIII and IXa combined have dropped to below 2 tonnes.

## A.3. Ecosystem aspects

Pollack is benthopelagic, found mostly close to the shore over hard bottom (Svetovidov, 1986). It usually occurs at 40-100 m depth but is found down to 200 m . In the Cantabrian Sea and off Galicia it mainly occurs between 50 and 150 m deep (Rodriguez et al., 2011). Feeding is mainly on fish, and incidentally on crustaceans and cephalopods. According to Fishbase spawning takes place from January to May, depending on the area, and mostly at 100 m depth. Cohen et al. (1990) report different spawning periods for Spain and Bay of Biscay, Februrary and March, respectively.

## B. Data

## B.1. Commercial catch

A TAC has been adopted for the subarea VIII and division IXa in 2000. Since then, the TAC has been decreasing and according to the regulation for 2012 the fishing opportunities were fixed in 1482 t for Divisions VIIIabde, 231 t for VIIIc and 282 t for IX-X (precautionary TAC). The national quotas are allocated between France (62.8\%) and Spain (36.7\%), followed distantly by Portugal (0.5\%).
A time series of landings has been obtainded from EUROSTAT, the statistical office of the European Union, since 1950; however, data show much more reliable from 1977 onwards. At the same time, the National laboratories of countries with pollack catches have provided more detailed data of landings, desaggregated by gear, since 2001. There is some mixing in Portuguese markets with whiting (Merlangius merlangus) due to use of common names; however, this problem should not have major impact in landing series due to the low level of Portuguesse landings for both species (Jardim et al., 2011).

Portuguese discard data of pollock can be assumed null (Fernandes and Prista, 2012). Llikewise, discard estimates from the coastal Spanish trawl fleets show negligible levels.

## B.2. Biological

Female length-at-maturity was considered as 35 cm (Cardinale et al, 2012), at the age of 3 years. Cohen et al. (1990) give a maximum length of 130 cm , maximum published weight of 18.1 kg and maximum reported age of 8 years. Life story (growth) parameters for Pollack 89a were estimated to be $L_{\max }=130 \mathrm{~cm}$, $L_{\text {inf }}=85.6 \mathrm{~cm}, \mathrm{~K}=0.19$ year $^{-1}$, and $M=0.55$ (ICES, 2012).
Since 2011, IEO (Spain) starts to collect information for pollack under the multiannual Community programme (DCF). Most samplings provide from the gillnet fleet because is compounded by a higher number of DCF métiers than longline.

UK took length samples during scientific surveys up until 2001. Currently, UK under the DCF is undertaking sampling from fixed net fishery although this mostly covers VIIe-h as most of area VIII landings are made into France.

## B.3. Surveys

Pollack abundance indices result neglegible in the groundfish surveys developed in the area (French, Spansih and Portuguese surveys). The bottoms preferred for this species (wrecks and rocky bottoms) makes that trawl surveys are probably not very well suited for monitoring this species.

However, despite the low abundance indices in the Spanish survey (SP_GFS), developed in Cantabrian Sea and off Galicia since 1983, it can be noted that pollack started to be detected since 2004 onwards. Biomass and abundance indicies were greatest in 2009 and bathymetric distribution ranged between $0-150 \mathrm{~m}$ with maximum abundance between 100-150 m .

## B.4. Commercial CPUE

CPUE data is not available.

## B.5. Other relevant data

No other relevant data were available.

## C. Assessment: data and method

No reliable assessment was presented for this species in the southern European Atlantic shelf ecoregion due to the lack of sufficient data. However, the existence of a landings time-series makes it feasible to apply DLS assessment methods in the future.
D. Short-Term Projection

No fishing possibilities can be projected.

## E. Medium-Term Projections

No Medium-Term Projections can be projected.

## F. Long-Term Projections

No Long-Term Projections can be projected.

## G. Biological Reference Points

No reference points have been defined. However, WGLIFE (ICES, 2012b) applied basic life history parameters to generate a proposal of reference points, assuming knife-edge recruitment at age 1 and also at age 2 .

## H. Other Issues

So far, no further management regulations have been defined for pollack in the Atlantic region, apart from a Minimum Landing Size of 30 cm in European Member States (Council Regulation (EU) 850/1998).

## I. References

Cardinale, M. Svedäng, H. Bartolino, V. Maiorano, L. Casini, M and Linderholm, H. 2012. Spatial and temporal depletion of haddock and pollack during the last century in the KattegatSkagerrak. J. Appl. Ichthyol. 28(2): 200-208.

Charrier, G., Durandc, J.D., Quinioub, L., Larocheb, J. 2006. An investigation of the population genetic structure of pollack (Pollachius pollachius) based on microsatellite markers. ICES Journal of Marine Science 63, 1705-1709.

Cohen, D.M.. Inada, T. Iwamoto, T. and Scialabba, N. 1990. FAO Species Catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10). 442p..

Fernandes, A.C. and Prista, N. 2012. Portuguese discard data on WGNEW 2012 species. Working document presented to the ICES WGNEW, Copenhagen, 5-9 March 2012.

ICES. 2012a. Report of the Working Group on Assessment of New MoU Species (WGNEW). ICES CM 2012/ACOM:20.

ICES, 2012b. Report of the Workshop on the Development of Assessments based on LIFE history traits and Exploitation Characteristics (WKLIFE). ICES CM 2012/ACOM:36.

Jardim, E., Alpoim, R., Silva, C., Fernandes, A.C., Chaves, C., Dias, M., Prista, N., Costa, A.M. 2011. Portuguese data of sole, plaice, whiting and pollock provided to WGHMM in 2011. Working document presented to the ICES WGHMM, Copenhagen, 5-11 May 2011.

Readdy, L. and Robinson, P. 2011. Data availability for the UK, England and Wales component, for Pleuronectes platessa in ICES area 89, Pollachius pollachius in ICES area 89, Solea solea in ICES area 8c9 and Merlangius murlangus in ICES area 89. Working document presented to the ICES WGHMM, Copenhagen, 5-11 May 2011.

Rodriguez, J., Fariña, A.C., Velasco, F., Pérez, N., Acosta, J.J. 2011. Spanish fishery data on plaice (Pleuronectes platessa), pollack (Pollachius pollachius), sole (Solea spp.) and whiting (Merlangius merlangus) in Iberian and Bay of Biscay waters. Working document presented to the ICES WGHMM, Copenhagen, 5-11 May 2011.

Svetovidov, A. N. 1986. Gadidae. In Fishes of the North-eastern Atlantic and the Mediterranean (Whitehead, P. J. P., Bauchot, M.-L., Hureau, J.-C., Nielsen, J. and Tortonese, E., eds), pp. 680-710. Paris: UNESCO.

Stock specific documentation of standard assessment procedures used by ICES.

| Stock | Whiting in Subarea VIII and Division IXa |
| :--- | :--- |
| Working Group: | Assessment of Southern Shelf Stocks of Hake, <br> Monk and Megrim (WGHMM) |
| Date: | May 2013 |
| Revised by | Eoghan Kelly WGHMM |

## A. General

## A.1. Stock definition

The stock unit definition of whiting (Merlangius merlangus) in this area is not clear and Atlantic Iberian waters (Division IXa) represent the southern limits of the distribution of the species. WGNEW concluded that in the absence of specific information on stock structure, the ICES ecoregions (North Sea including VIId, Celtic Seas and South European Atlantic) are to be used as minimum level of disaggregation for the definition of stock units (ICES, 2012). This is an interim solution until more information is available on the stock.

## A.2. Fishery

France and Spain are the main participants in this fishery although France has not recorded landings since 2008 and there were no Spanish data available for 2011. Landings are primarily made by trawlers although France recorded substantial landings by long lines prior to 2009.

## A.3. Ecosystem aspects

No information.

## B. Data

## B.1. Commercial catch

Fishery statistics are currently being compiled. At present, only official landings are available, which are considered to be preliminary for the purpose of stock assessment. There are concerns about the reliability of the 2008-2009 French data. There may be species identification issues in landings with Pollack (Pollachius pollachius). Landings statistics need to be quality-assured and confirmed for the region.

## B.2. Biological

Atlantic Iberian waters (Division IXa) represent the southern limits of the distribution of the species.

## B.3. Surveys

Whiting are present in the French EVHOE-WIBTS-Q4 survey for the Bay of Biscay area from 1987, with the exclusion of 1993 and 1996. Age information is available since 1997. Survey information could provide information on recruitment but catches of adult whiting are not in sufficient quantity to serve as an SSB indicator. Other approaches should be initiated to obtain fishery-independent information on total stock biomass.

## B.4. Commercial CPUE

AZTI have compiled whiting LPUE in Div. VIIIabd based on landings from the pair trawl fleet, which constitute $99 \%$ of the Spanish landings in that area. Landings and effort by this fleet have both declined from mid 2000s and LPUE has declined from 0.39 t /day in 2007 to 0.04 t /day in 2011.

## B.5. Other relevant data

No information.

## C. Assessment: data and method

For data-limited stocks without information on abundance or exploitation (Category 5) ICES considers that a precautionary reduction of catches should be implemented, unless there is ancillary information clearly indicating that the current exploitation is appropriate for the stock. For this stock, ICES advises that catches should decrease by $20 \%$ in relation to the average catch of the last three years.
D. Short-Term Projection

## E. Medium-Term Projections

## F. Long-Term Projections

## G. Biological Reference Points

## H. Other Issues

## I. References

ICES. 2012. Report of the Working Group on Assessment of New MoU Species (WGNEW), 5-9 March 2012, . ICES CM 2012/ACOM:20. 258 pp.

## Stock Annex European sea bass (Dicentrarchus labrax) in subarea VIIIa, VIIIb, VIIId (Bay of Biscay)

Stock specific documentation of standard assessment procedures used by ICES.

| Stock | European sea bass (Dicentrarchus labrax) in subarea <br> VIIIa,VIIIb, VIIId (Bay of Biscay) |
| :--- | :--- |
| Working Group: | Assessment of Southern Shelf Stocks of Hake, <br> Monk and Megrim (WGHMM) |
| Date: | May 2013 |
| Revised by | Mickael Drogou, May 2013 (stock annex developed <br> by IBPNEW 2012, retaining only information for |
|  | BSS-8ab and WGNEW 2013) |

## A. General

Seabass for the 8 ab area is considered in 2012 as data poor species, in category 5.2.0

## A.1. Stock definition

Bass 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.

Stock structure of sea bass in the Atlantic has been reviewed by WGNEW 2012 and IBP-NEW 2012 based on evidence from genetics studies, tagging studies, distribution of commercial catches and similarities in stock trends between areas, drawing also on extensive information contained in previous WGNEW and ICES SGBASS reports.

IBP-NEW considers that stock structure remains uncertain, and recommends further studies 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 bass shoals, to confirm and quantify the exchange rate of seabass between sea areas that could form management units for this stock. Such information is critical to support development of models to describe the spatial dynamic of the species under environmental drivers (eg. temperature and food). Such a modelling work is being carried out in France in the framework of a PhD study (R. Lopez).

The pragmatic view of IBP-NEW 2012 is to structure the baseline stock assessments into four units:

- Assessment area 1. Sea bass in ICES areas IVbc, VIId, VIIe,h and VIa,f\&g (lack of clear genetic evidence; concentration of area IV bass fisheries in the southern North Sea; seasonal movements of bass across ICES Divisions). Relatively data-rich area with data on fishery landings and length/age
composition; discards estimates and lengths; growth and maturity parameters; juvenile surveys, fishery LPUE trends.
- Assessment area 2. Sea bass in Biscay (ICES Sub area VIIIa,b). Available data are fishery landings, with length compositions from 2000; discards from 2009; some fishery LPUE.
- Assessment area 3. Sea bass in VIIIc and IXa (landings, effort)
- Assessment area 4. Sea bass in Irish coastal waters (VIa, VIIb, VIIj). Available data: Recreational fishery catch rates; no commercial fishery operating.

Fishery landings of sea bass are extremely small in Irish coastal waters of VIIa and VIIg and the stock assessment for assessment area 1will not reflect the sea bass populations around the Irish coast, which may be more strongly affiliated to the population in area 4 off southern, western and Northern Ireland.

## A.2. Fishery

## General description

Sea bass 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 and by pelagic trawlers, nets and in a mixed bottom trawl fisheries from November to April on pre spawning and spawning grounds when seabass is aggregated (Figure 1). In 2012 nets represent $31 \%$ of the landings of the area, lines (handlines+longlines) $29 \%$, bottom trawl $20 \%$, and pelagic trawl $9 \%$ (but It has to be note that pelagic trawlers were used from 2000 to 2008 to catch around $25 \%$ of the landings of the area decreasing to 9 (the pelagic fishery take place at present essentially in the Channel). In parallel a decrease of landings for liners is also observed from 2007.

In France, the market value seabass depends greatly on how its caught, giving added value to certain metiers as liners: according to auction, mean price of seabass sold by liners was $14.92 €$ per kg in 2009 compared with $€ 5.99$ per kg for pelagic trawl, $8.21 €$ per Kg for Bottom trawlers and $8.92 €$ per Kg for nets, reflecting differences in volume landed and fish condition.


Figure 1 : landings by french fleet in the Bay of Biscay from 2000

Spain is responsible for around $10 \%$ of the catches, mainly with bottom otter trawlers. Discarding is thought to be low because of the high value of the fish; some discards could occurred due to individual quota limitations but are not quantified.. Spanish bass landings from Division VIIIa,b,d have increased to around 20 tons in the 90 's to around 150 tons in the middle of the 2000's, then to 317 tons in 2011. Spanish commercial landings by gear type are shown in Figure 10.4. UK landings from this area are very low, usually inferior to 5 tons per year. Recreational fisheries are an important part of the total removals but these are not accurately quantified

Seabass are a popular target for recreational fishing in Europe, particularly for angling in the UK, Ireland and France, and increasingly in parts of southern Norway, the Netherlands and Belgium. Relatively little historical data are available on recreational fisheries although several European countries are now carrying out surveys to meet the requirements of the EU Data Collection Framework and for other purposes (ICES WKSMRF 2009, PGRFS 2010 \& 2011, WGRFS 2012; Herfault et al, 2010, Rocklin et al, 2012 in prep, Van der Hammen \& De Graaf, 2012).

## Fishery management regulations

Seabass are not subject to EU TACs and quotas. Commercial vessels catching bass within cod recovery zones are subject to days-at-sea limits according to gear, mesh and species composition. Under EU regulation, the MLS of bass in the Northeast Atlantic is 36 cm total length, and there is effectively a banned range for enmeshing nets of 70-89 mm stretched mesh in Regions 1 and 2 of Community waters ${ }^{1}$. A variety of national restrictions on commercial bass fishing are also in place. These include:

- a landings limit of $5 \mathrm{t} / \mathrm{boat} /$ week for all French trawlers landing bass;
- a licensing system from 2012 in France for commercial gears targeting sea bass.
- voluntary closed season from February to mid-March for long-line and hand-line bass fisheries in Brittany; France
- A minimum size landing of 42 cm for recreationnal fisheries since 2013 in France.

Depending on country, measures affecting recreational fisheries include minimum landing sizes, restrictions on sale of catch, gear restrictions.

## A.3. Ecosystem aspects

Temperature appears to be a major driver for bass production and distribution (Pawson, 1992). Reynolds et al. (2003) observed a positive relationship between annual seawater temperature during the development phases of eggs and larvae of sea bass and the timing and (possibly) abundance of post-larval recruitment to nursery areas. In addition, early growth is related to summer temperature and survival of 0-groups through the first winter is affected by body size (and fat reserves) and water temperature (Lancaster 1991; Pawson 1992). prolonged periods of temperatures below 5-6 ${ }^{\circ} \mathrm{C}$ may lead to high levels of mortality in 0-groups in estuaries during cold winters. As a

[^10]result, any SSB-recruit relationships may be obscured by temperature effects (Pawson et al., 2007a).

Recruitment of sea bass is highly variable, and the fisheries have often in the past been dominated by individual very strong year classes or have been negatively affected by periods of very poor recruitment. Expansion of sea bass populations in the North Sea in the 1990s coincided with a period of ocean warming as well as the growth of the very strong 1989 year class.

## B. Data

## B.1. Commercial catch

## B1.1 Landings data

## Data available

Landings series for use are available from three sources:
i) Official statistics recorded in the Fishstat database since around the mid 1980s.
ii) French landings for 2000-2012 from a separate analysis by Ifremer of logbook and auction data.
iii) Spanish landings for 2007-2011 from sale notes

French vessels take around $90 \%$ of the total annual landings in the area VIIIa and VIIIb with a a fishery including nets, bottom trawlers, pelagic trawlers (and also Danish seiners since 2010 in small proportion) who essentially operate during quarter 1 and 4 (prespawning and spawning season) and lines who operate essentially during quarter 3 and 4 . Declines are observed in landings from 1984 to 1999 but are certainly due to poor statistics, which are more reliable since 2000.

Spanish bass landings from Division VIIIa,b,d have increased to around 20 tons in the 90 's to around 150 tons in the middle of the 2000's, then to 317 tons in 2011. UK landings from this area are very low, usually inferior to 5 tons per year.

## Quality of official landings data

The official landings data for sea bass available to WGNEW 2013 are subject to several uncertainties that can affect the accuracy of assessments:

- Incomplete reporting of landings in the 1970s and early 1980s when the fisheries were developing;
- Poor reporting accuracy for small vessels that do not supply EU logbooks.

From 1999 onwards, French landings data from FishStat are replaced by more accurate figures from a separate analysis of logbook and auction data carried out by Ifremer, in which landings have been correctly allocated to fishing ground. The time series for each component fishing ground therefore has a step change around 2000

## B1.2 Discards estimates

## French Data

## Survey design and analysis

The French sampling schemes also utilise vessel-list sampling frames and random selection of vessels within strata defined by area and fleet sector. From the activity cal-
endars of French vessels for year $\mathrm{n}-1$, vessels are grouped by the métiers practiced. Thus, a vessel may belong to multiple groups if practicing several metiers in the period. If the metier has to be sampled in priority No. 1 , the vessel to be boarded is chosen randomly within this group of vessels. The observer then chooses to go onboard for a trip. During the trip, the fishing operations corresponding to metier No. 1 are sampled. Optionally, if the vessel practices several metier during the trip, fishing operation of the metier No 2 will also be sampled if the metier No. 2 is included in the annual sampling plan. If the metier is not part of the plan, it is requested to sample at least one fishing operation of this metier in the trip. (complete document on sampling protocol in French :http://sih.ifremer.fr/content/download/5587/40495/file/Manuel OBSMER V2 22012. pdf)

Data coverage and quality

## France

Discards data are only available for French fleets from 2009 onwards. Length frequencies are available. Discarding of sea bass by commercial fisheries can occur where fishing takes place in areas with bass smaller than the minimum landing size ( 36 cm in most European countries), and where mesh sizes $<100 \mathrm{~mm}$ are in use. For 2009, discard are estimated to 44 tons, for 201044 tons, for,2011 20 tons and 201237 tons. Precision is low at current sampling rates weighting and raising of France discards estimates was carried out using COST tools, which have limited flexibility to match raising procedures to the sampling stratification, including where vessels are stratified by LOA. There is therefore a large potential for bias in the discards estimates. However discard rates are low in general in the fishery.

## Spain

Observer data from Spanish vessels fishing in Areas VIII, have shown there was no seabass discard from 2003.

## B1.3 Recreational catches

Recreational marine fishery surveys in Europe are still at an early stage in development (ICES WKSMRF 2009; PGRFS 2010 \& 2011; WGRFS 2012). The following information was available to WGNEW 2012.

## France

A study targeting sea bass was conducted between 2009 and 2011 in VIIIa, VIIIb, VIIe, VIIh, VIId, Ivc. Estimates of sea bass catches were obtained from a panel of 121 recreational fishermen recruited during a random digit dialling screening survey of 15000 households in the targeted districts (Atlantic and Chanel). The estimated recreational catch of bass in the Bay of Biscay and in the Channel was 3,170 t of which $2,350 \mathrm{t}$ was kept and 830 t released. The precision of the the combined Biscay \& Channel estimate is relatively low (CV =-26\%; note that the figure of $51 \%$ given in IBP-NEW 2012 was incorrect). This makes the confidence interval at $95 \%$ of the average (3170t) to [1554t;4786t].

Increasing the panel from 121 to 210 fishermen would be expected to improve precision to $20 \%$ and increasing this panel to 500 would improve precision to $13 \%$.

Around $60 \%$ of the recreational catch estimate was from Bay of Biscay. The main gears used, in order of total catch, were fishing rod with artificial lure, fishing rod with bait, hand line, long line, net and spear fishing. Approximately $80 \%$ of the recreational catch was taken by sea angling (rod and line or handline).

## Spain

A recreational boat fishing survey was performed in the Basque Country to estimate the total catch of the target species of this fishery. Fishermen were asked about their catches in 2009, and 555 surveys were collected. Sea bass catch data were modeled with a two-step GLM, using type of boat and total boat length as covariables. The results were extrapolated to the total number of boats using an updated census. The estimated catch for seabass was in 2009 was 8183 Kg , with an associated standard error of 149 Kg . It is important to note that this estimation refers only to the fishing performed from boats. In order to estimate total recreational catches of sea bass, anglers fishing from coast and spear fishers need to be included in the survey. In 2012 a pilot study financed by the Data Collection Framework (DCF) was taking place in order to estimate total sea bass catches (taking into account all types of recreational fishing), and it is expected that the results if this study will increase significantly the estimated sea bass catch. Results were not available for WGNEW2013.

## Quality of recreational catch estimates

Recreational catch estimates from surveys (numbers or tonnes caught per year) are not yet available as time series. The estimates for France are characterised by relatively poor precision. The 2012 ICES Working Group on Recreational Fisheries initiated the development of data quality indicators for recreational fishery survey estimates, however sources and potential magnitude of bias in available estimates were not provided to WGNEW 2013.

## Scorecard on data quality

Data quality is evaluated in relation to precision (relative standard errors or proxies for effective sample size) and critical forms of bias (e.g. coverage of surveys; biases in fishery catch data, natural mortality rate). Where possible, sensitivity analyses are conducted to evaluate the effect of these biases on the assessment results. WGNEW 2012 (udated in WGNEW 2013, Figure 10.15, Figure 10.16, Figure 10.17, Figure 10.18) highlighted blocks of national data using traffic lights colours to indicate potential quality issues, but IBP-NEW 2012 and WGNEW 2013 did not have time to conduct the detailed evaluation of biases in data quality required by the ICES scorecard

## B.2. Biological sampling

B2.1 Length and age compositions of landed and discarded fish in commercial fisheries.

Length and age compositions of sea bass landings were available to WGNEW \& IBPNEW 2012.

## Length and age compositions of commercial landings

Length compositions of sea bass landings, are only available from sampling in France from 2000 in the Bay of Biscay, area VIIIa and VIIIb. Shorter time series of length compositions were supplied by Spain for Areas VIII for bottom trawlers in 2010 and 2011.

## Effective sample sizes for length and age compositions

The effective sample size for annual estimates of length or age composition lie between the number of trips sampled and the number of fish measured or aged, due to
cluster sampling effects. Effective sample sizes have not been computed yet for sampling data for seabass. In the meantime, numbers of fishing trips sampled for length or age could be used as an annual measure of relative precision of data sets

## Sampling methods and analysis

## France

The French sampling programme for length compositions of sea bass covers sampling at sea and on shore. Since 2009, both sampling types are first based on metiers composition and their relative importance per fishing harbours and month. Both are also designed to sample the whole catch following a concurrent sampling of species, potentially leading to low sea bass sample size. In order to complement this effort, specific sampling for sea bass at the market is added at times and harbours when higher landings are occurring, especially from metiers targeting sea bass. The sampling frame is based on the main harbours, gear types (or grouping of metiers) and month and is available to all samplers on a dedicated website. Real time follow-up of the plan, refusal rates and their reasons, time taken to sample, all this information is also available from the website, together with sampling protocol (in French :
http://sih.ifremer.fr/content/download/5587/40495/file/Manuel OBSMER V2 22012. pdf). Before 2009, only market specific sampling was in place, and the sampling plan was designed and followed by the stock coordinator. The French sampling programme for age compositions of sea bass is based on age-length keys with fixed allocation. For the VIIeh area, quarterly French landings at auctions are sampled in order to collect five scales (from 2000 to 2008) or three scales (from 2009) by length class (cm). For the VIIIab area the information is available only from 2010. For other areas the information is not available. All length samples are populated in a central data base (Harmonie) and regular extracts are available in the COST format. Raising the data to the population is done using COST tools and a special forum for discussing the outcomes of the analysis is held every year in March, in order to gather all stock coordinators and prepare the datasets for the assessment working groups.

## Data coverage and quality

Sampling has been very variable between areas and gears, with greatest consistency between years in the neighbouring stock unit in VIIIa,b. There has been a general increase in numbers of trips sampled for length since 2009 (see assessment report).

The statistical design of fishery sampling schemes has undergone change in recent years in France, following recommendations from ICES workshops on sampling survey design, with a move towards more representative sampling across trips within fleet segments. This can result in sampling more trips that have small catches of bass, and is one reason for the increase in numbers of sampled trips with bass since 2009 in France which does not imply an increase of the proportion in numbers of fish measured per trip.

## Length and age compositions

Length compositions are supplied by France since 2000 for VIIIab, disaggregated by seven gear types: bottom trawl, pelagic pair trawl, nets, handlines, longlines purseiners and danish seiners from 2012. French sampling rates for length compositions have been very variable between area, gear and year strata. Sampling has also been very variable between areas and gears, with greatest consistency between years in

VIIIa,b. There has been a general increase in numbers of trips sampled for length since 2009. An attempt of building a catch at age matrix is proposed in WGNEW 2013 but should be discussed and analysed to conclude that the use or not. If such is the case, because of age validation (see below) a 9 or 10+ group should be adopted. The matrix has been built on the assumption that stock delimitation for seabass is still uncertain, and with scales sampling from 2000 to 2005 from coastal fisheries of Audierne (boundary between VIIIa and VIIeh), with sampling from 2006 and 2007 from in shore and off shore fisheries in VIIeh, and with sampling from 2008 to 2011 from the all Bay of Biscay.

Spanish landings of Dicentrarchus labrax, which is not a target species for any Spanish fleet, were not sampled for length structure before the implementation of concurrent sampling in 2009. Length information is scarce for most part of the Spanish metiers. For this reason length structure is presented only for bottom trawl activity in the Bay of Biscay in 2010 and 2011 where enough individuals have been sampled to allow an adequate extrapolation..

## Accuracy and validation of age estimates

## Age-reading consistency

Consistency in age reading of sea bass between four operators in Cefas and Ifremer was examined during a limited exchange of otolith and scale images between laboratories in 2011, organised by the ICES Planning Group on Commercial Catches, Discards and Biological Sampling (Mahé et al. 2012). A total of 155 fish of $17-74 \mathrm{~cm}$ was sampled on board French research vessels during two international surveys. The precision of ageing was similar for scales and otoliths. The coefficient of variation of age readings for individual fish was around $12 \%$ implying a standard deviation of $+/-1$ year for a 10-year-old fish, with relatively few fish having identical readings by all four operators. However it was noted by the operators that photographic images were more difficult to evaluate than original age material, which was likely to have a negative effect on the consistency of ageing. These results provide no indication of the validity of ages, only the consistency between operators, and cannot indicate data quality in earlier years when different operators provided the age data. A more extensive age exchange is to be carried out in 2012.

Age validation
WGNEW was not aware of specific studies to validate absolute ages of seabass derived from otolith or scale readings. Strong and weak year classes can be followed clearly to over 20 years of age in UK sample data although it is not known to what extent the elevated numbers of sampled fish in immediately adjacent year classes is a true reflection of year class strength or a consequence of age errors discussed in the previous section. Year class tracking is less clear in the younger ages $3-5$ although this will be affected by gear selectivity and changes in fish behaviour.
Sea bass show relatively broad length-at-age distributions, and it has been noted in French data (Laurec et al. 2012 WD to IBP-NEW) that the length-at-age distributions can have unusual patterns including some multiple modes that could indicate age errors. This will result in some smoothing of age data across neighbouring year classes. In the UK data, unusual patterns in length-at-age distributions for some younger ages appear related more to effects of minimum landing size on data from the fishery.

## Inclusion of age error parameters in Stock Synthesis model

CV's for ageing error by age class can be input to Stock Synthesis. Based on the ICES sea bass scale exchange in 2002, the CVs of $\sim 12 \%$ can be specified as increasing values per age class to give a standard error of $\sim 1$ year per age class.

## Commercial discards

## France

Discarding of sea bass by commercial fisheries can occur where fishing takes place in areas with bass smaller than the minimum landing size ( 36 cm in most European countries), and where mesh sizes $<100 \mathrm{~mm}$ are in use. For 2009, .it's estimated to 44 tons, for 201044 tons, for, 201120 tons and 201237 tons.

## Spain

Observer data from Spanish vessels fishing in Areas VIII, have shown there was no seabass discard from 2003.

## Quality of discards estimates

Precision is low at current sampling rates weighting and raising of France discards estimates was carried out using COST tools, which have limited flexibility to match raising procedures to the sampling stratification, including where vessels are stratified by LOA. There is therefore a large potential for bias in the discards estimates. However discard rates are low in general in the fishery..

## B2.2 Growth parameters

For area VIIIa,b no specific growth curve is available yet, especially because af the lack of information on youngest age which are needed to calibrate the growth curve. IBPNew 2012 discussed this section but because of the difference in environmental condition between the Channel and Bay of Biscay, further studies are needed to present a robust growth curve in this area.

Growth is relatively slow and the species is long-lived (up to 30 years of age). In the Channel, maturity is attained at 4-7 years, which is around 35 cm for males and 42 cm for females (Pawson and Pickett 1996). Nevertheless, although bass is an eurythermic species (registered tolerance from 5-33o C) maximal somatic growth occurs around $22-24 \mathrm{oC}$ (Vinagre et al. 2012), thus contributing to pronounced latitudinal gradients in length at age and daily growth rates. Values from Pawson and Picket could thus be revised downwards to the North area in the Bay of Biscay (and in Iberic waters).

## B2.3 Maturity

Available data are from samples from all around the coast of England and Walesans are discussed in the IBPNew 2012 report. Nos specific data from The Bay of Biscay are available.

## B2.4 Larval dispersal, nursery grounds and recruitment

Bass larvae resulting from offshore spawning move steadily inshore towards the coast as they grow and, when they reach a specific developmental stage at around 11 - 15 mm in length (at 30-50 days old), it is thought that they respond to an environmental cue and actively swim into estuarine nursery habitats (Jennings and Pawson, 1992). From June onwards, 0-group bass in excess of 15 mm long are found almost
exclusively in creeks, estuaries, backwaters, and shallow bays all along the southeast, south, and west coasts of England and Wales, where they remain through their first and second years, after which they migrate to over-wintering areas in deeper water, returning to the larger estuaries in summer. Several studies indicate the existence of similar bass nursery areas in bays and estuaries on the French coasts of the Channel and Bay of Biscay and southern Ireland.
During the winter, juvenile bass move into deeper channels or into open water, and return in spring to the larger estuaries and shallow bays on the open coast, where they remain for the next 2-3 years.
On the south and west coasts of the UK, juvenile bass emigrate from these nursery areas at around 36 cm TL (age 3-6 years, depending on growth rate), often dispersing well outside the 'home' range, and not necessarily recruiting to their specific parent spawning stock (Pawson et al., 1987; Pickett and Pawson., 2004). It appears that there is substantial mixing of bass at this stage throughout large parts of the populations' distribution range. When they reach 4 or 5 years of age their movements become more wide-ranging and they eventually adopt the adult feeding/spawning migration patterns (Pawson et al., 1994).

## B2.5 Natural mortality M

A variety of methods are given in the literature relating natural mortality rate M to life history parameters such as von Bertalanffy growth parameters $k$ and Linf (asymptotic length), length or age at $50 \%$ maturity and apparent longevity particularly in an unexploited or very lightly exploited population. These methods were applied to the following sea bass life history parameters by Armstrong (2012):

There are no direct estimates of natural mortality available for Northeast Atlantic sea bass. Predation up to around age 4 will be in and near estuaries and bays. As with other fish species it is expected that M will be relatively high at the youngest ages, particularly given the slow growth rate in sea bass. For the benchmark assessment WGNEW 2012 proposes the compilation of life-history based inferences in the general value of $M$, based on maximum observed age, VB growth parameters, age at maturity and age of cohort biomass peak in relation to maturity. Age composition data from France since 2000 and the UK since 1985 indicate maximum recorded ages from 22 (French data) to 28 (UK data). The probability of encountering very old sea bass is partly a function of the interaction of year class strength and sampling rates, as well as mortality, however the occurrence of sea bass to almost 30 years of age suggests low rates of mortality.
The probability of encountering very old bass is partly a function of the interaction of year class strength and sampling rates, as well as mortality, however the occurrence of seabass to almost 30 years of age suggests low rates of mortality. The observed maximum age of 28 years in sea bass samples in the UK was recorded in the early 1980s, following a period of relatively low fishery landings. Age compositions of recreational fishery caught bass in southern Ireland, presented by stakeholders at IBPNEW 2012, also show ages up to 26 years. This stock has been subject to a commercial fishery ban for many years.

Inferences on natural mortality rates are given below:


The inferred values of M , with the exception of the Beverton method, are in the range $0.15-0.22$. The average of the Gislason estimates for ages $3-20$ is 0.19 .

A variety of methods are given in the literature relating natural mortality rate M to life history parameters such as von Bertalanffy growth parameters $k$ and Linf (asymptotic length), length or age at $50 \%$ maturity and apparent longevity particularly in an unexploited or very lightly exploited population. The probability of encountering very old bass is partly a function of the interaction of year class strength and sampling rates, as well as mortality, however the occurrence of seabass to almost 30 years of age suggests low rates of mortality. The observed maximum age of 28 years in sea bass samples in the UK was recorded in the early 1980s, following a period of relatively low fishery landings. Age compositions of recreational fishery caught bass in southern Ireland, presented by stakeholders at IBP-NEW 2012, also show ages up to 26 years (Fig. B2-3). This stock has been subject to a commercial fishery ban for many years.


Fig. B2-3. Age composition of bass from samples collected from recreational catches in southern Ireland (data courtesy Ed Fahy, IBP-NEW 2012 meeting).

Inferences on sea bass natural mortality based on some life history models in the literature are given in IBP-NEW 2012 benchmark assessment section. The inferred values of $M$, with the exception of the Beverton method, are in the range $0.15-0.22$ (Armstrong, 2012).

## Hooking mortality, and mortality of discarded bass from commercial vessels

The NMFS in the US has in the past used an average hooking mortality of $9 \%$ for striped bass, estimated by Diodati and Richards 1996. Striped bass are very similar to European sea bass in terms of morphology, habitats and angling methods. A literature review of hooking mortality for a range of species compiled by the Massachusetts Division of Marine Fisheries included a total of 40 different experiments by 16 different authors where striped bass hooking mortality was estimated over two or more days (Gary A. Nelson, Massachusetts Division of Marine Fisheries, pers. comm.) The mean hooking mortality rate was 0.19 (standard deviation 0.19). Direct experiments are needed on European seabass to estimate hooking mortality for conditions and angling methods typical of European fisheries.
A fraction of sea bass discarded from commercial line vessels and netters may survive depending on the extent of injury or stress. This will affect the calculation of fishing mortality reference points that are conditional on selectivity patterns. Trawlcaught undersized bass are less likely to survive. Unfortunately no estimates of survival rates of commercial bass discards is available.

## B.3. Surveys

## France : Evhoe survey

Seabass are caught in small numbers in the French Evhoe trawl survey, which extends to the shelf edge in Subareas VII and VIII but also extends into coastal areas of the Bay of Biscay and the Celtic Sea where bass may be caught (cf the station map). Less than $10 \%$ of the stations have bass catches in most years. A mean of 0.5 seabass per trawl has been recorded from 1987. Abundance indices are calculated as stratified means.

.Fig. B 3-2. Station positions for French Evhoe bottom-trawl survey.

## Spain

Information of Dicentrachus labrax catches in the series of research surveys conducted by the IEO since 1983 showed there are a very few seabass caught.

## B.4. Commercial LPUE

## France

IBP-NEW2012 evaluated a range of commercial fishery LPUE series for French and UK fleets operating in Areas IV and VII, including the LPUE trends for participants in the Cefas voluntary logbook scheme. A methodology on french bottom trawlers has been tested from auctions sales in area VII, IV and VIIIab : time series have been calculated for bottom trawlers $<18 \mathrm{~m}$, which don't target seabass. French and UK $(>10 \mathrm{~m})$ trawlers in areas IVb,c, VIId and VIIef could have been compared, and it shows very similar LPUE trends. With some exceptions (e.g. trawlers in VIId), UK $>10 \mathrm{~m}$ vessels tend to show different LPUE trends to 10 m and under vessels. For the VIIIa and VIIIb, there is unlikely no possible comparison for the french results with other countries or other data set, and so will not be used at present.

## Spain

LPUE data for Spanish fleets operating in ICES areas VI-VIII and landing into Basque Country ports were provided to WGNEW in 2005, and the best indicator of sea bass abundance trends (LPUE) in the period 1994-2004 was considered to be from vessels of the 'baka' otter trawl fleet working in Div. VIIIa,b,d and landing into the Basque
port of Ondarroa. Data for later years were not available to WGNEW. Landings and effort data were provided to WGNEW by Spain, though not in the form of LPUE indices.

## B.5. Other relevant data

None

## C. Assessment: data and method

This chapter refers to the work done during IBPNew2012 for the Bay of Biscay Area

## Length cohort analysis for Bay of Biscay

Little information on sea bass biology and data on exploitation are available for areas VIIIab: there are no growth parameter estimates, ALKs are only available for 20082010 and no abundance indices (either survey or commercial fishery based) are readily available. It is thus not possible to carry out an assessment comparable to the one developed for area IV and VII.
An exploratory analysis of the length frequency data was carried out using a length cohort analysis (Jones, 1984) applied to the pooled-gears length frequency distributions from French fleets fishing in the Bay of Biscay. The main difficulty with lengthcohort analysis is that its application requires estimates or assumptions about the underlying growth rates (Linf and K), and the choice of input growth parameters can critically influence the results obtained (Jones, 1990). As no growth parameters estimates are readily available for Bay of Biscay sea bass, two sets of values were used for comparison : i) a set of estimates obtained from area IV and VII and used in the stock assessment described above ( $\mathrm{Linf}=85 \mathrm{~cm}$ and $\mathrm{K}=0.09$ ) and ii) a set of parameters obtained during the IBP-NEW 2012 from fitting a VB growth model to length-age data collected in the Bay of Biscay in 2009 and 2010 ( $\mathrm{Linf}=95 \mathrm{~cm}$ and $\mathrm{K}=0.10$ ). The estimates of F at length and N at initial length were then used to calculate equilibrium yield under a series of fishing mortality levels using a length based Thompson and Bell model.

Results clearly show the strong impact of assumptions on growth parameters on equilibrium yields which makes the use of this method very problematic with the limited biological knowledge available. Furthermore, this method relies on strong assumptions which may not be met in the case of seabass, namely that length composition data are sampled from a stock at equilibrium, with no variation in exploitation over time and no variation in year-class strength. This underlines, for this area, the critical need for data (biological and fishery related) to be able to carry out an analytical assessment of the stock, either as a separate stock or in a joint assessment with the more northern areas.

## Inclusion of Bay of Biscay data in Stock Synthesis model

Runs 1A and 1B, the length only and age-length models for IVb,c and VIIa,d,e,f,g,h, were re-run to include a seventh fleet representing the French fleet in the Bay of Biscay. Length compositions for this fleet are provided for the years 2000 onwards. Tuning data for the Bay of Biscay are not included.
Inclusion of Bay of Biscay data scales up the SSB and recruitment compared with SS3 runs 1 A and 1 B . Although a trend of increasing F is shown, the rate of increase is lower than in IV\&VII and terminal $F$ is much lower.

A potential problem with this simple extension of the SS3 model is the possibility for different growth patterns in the warmer waters of the Bay of Biscay, affecting the fit of the length-based model. The absence of any age composition data precludes a direct evaluation of year class variations, and it is therefore not possible to evaluate how well the Solent and Thames recruit surveys match recruitment patterns in the Bay of Biscay population.

## Conclusions regarding Bay of Biscay area (IBP New 2012)

Further analysis of growth rates are needed to allow any interpretation of length composition data for this area. Inclusion of Bay of Biscay data in the SS3 model assumes that there is a single biological stock, a hypothesis which can neither be confirmed or disproved with current knowledge. Relative abundance indices for prerecruit and recruited sea bass are also needed for this area. IBP-NEW 2013 considers that no assessment can at present be performed for sea bass in the Bay of Biscay.

## Implications of missing recreational catches in assessment model

Recreational catch estimates for sea bass are currently available for only 2010, and only for France and the Netherlands. Data for surveys in the UK in 2012 are not yet available. For France and Netherlands, the combined estimates of recreational fishery removals for 2010, including an assumed hooking mortality of $20 \%$ for released fish, is $1,115 \mathrm{t}$ :

|  | All Areas IV - VIII |  |  | Areas IV \& VII only |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | kept | released | CV | Proportion in IV\&VII | kept | released | hooking mortality for releases | total removed |
| France 2010 | 2350 | 830 | 0.51 | 0.4 | 940 | 332 | 20\% | 1006 |
| Netherlands 2010 | 96 | 65 | 0.31 | 1 | 96 | 65 | 20\% | 109 |
| Total |  |  |  |  |  |  |  | 1115 |

These removals would represent $19 \%$ of a combined fishery removal of 5,850t in 2010 ( $1,115 \mathrm{t}$ recreational $+4,736 \mathrm{t}$ commercial), although this percentage will be imprecise due to the large CVs for the recreational catch estimates (for France, the CV for areas IV and VII will be larger than 0.51 as only $40 \%$ of the catch estimate is for this area). The addition of recreational catches from the UK, Belgium and other countries would increase this percentage, but addition of commercial discards weights for all international fleets would reduce the percentage. Estimates of discards weights of sea bass in areas IV\&VII in 2010 for UK trawls and nets, and French fleets, are around 200t. These figures exclude discards from other national fleets or UK fleets not sampled. Retained catches of sea bass by UK sea angers were estimated in the late 1980s and early 1990s to be around 400 t per year (Dunn et al 1989; Dunn and Potten 1994), although these estimates are of unknown accuracy. It is possible, therefore, that recreational fisheries could potentially account for around $20 \%$ of the fishing mortality in recent years. It is not possible to evaluate how the recreational fishing mortality rate may have altered over time, and how this would affect the fit of the model, including initial depletion rate. Further work is needed to consider how to handle recreational data (recent estimates and missing historical data) in assessments and advice for sea bass.

## Short term projections

Short term projections were not carried out, although the scenario of increasing F, declining SSB and very poor recruitment since 2008 would lead to an expectation of further SSB decline. Procedures for carrying out trends-only projections should be developed at WGNEW 2013.

## Appropriate Reference Points (MSY)

IBP-NEW 2012 was not in a position to develop MSY reference points for seabass based on the SS3 runs. Further work is needed at WGNEW 2013 to develop biological reference points.

Model used: Stock Synthesis 3 (SS3) (Methot, 2010)
Software used: Stock synthesis v3.23b (Methot, 2011)

The development of a seabass assessment model by IBP-NEW 2012 was built on experiences from application of the statistical, fleet-based separable model developed by Pawson et al (2007a) and updated by ICES WGNEW (Kupschus et al. 2008). The Pawson et al model was fitted only using UK age compositions for trawls, midwater trawls, nets and lines, separately for areas IVbc, VIId, VIIeh and VIIafg, and was intended mainly to estimate fleet selection patterns. Although it excluded any tuning data, the recruitment series for each sea area closely resembled the Solent survey indices and to an extent the shorter Thames series, and was able to provide coherent selection patterns by fleet.

The IBP-NEW 2012 assessment required a modelling framework capable of handling a mixture of age and length data for fisheries, including data for French fleets that had length composition data but no age composition data, and for which the length data were available only since the 2000s. The Stock Synthesis (SS) assessment model was chosen, primarily for its highly flexible statistical model framework allowing the building of simple to complex models using a mix of data compositions available. This model is written in ADMB (www.admb-project.org), is forward simulating and available at the NOAA toolbox: http://nft.nefsc.noaa.gov/SS3.html. For European sea bass a range of assessment models were built using Stock Synthesis 3 (SS3) version 3.29 b to integrate the mix of fisheries and survey data available (fleet-based landings; landings age or length compositions and discards length compositions for variable combinations of fleets and years; three surveys providing recruitment indices) and biological information from recent research on growth rates, maturity and mortality.

Two basic model structures were explored, with the same specifications where possible:

1. Age and length model - Including age compositions for the four UK fleets and combined length compositions for the French fleets.
2. Length only model - Including only the length compositon data for all fishery fleets.

## Input data

Years: 1985-2010
Model structure:

- Temporal unit: annual based data (landings, lpue, age-frequency and lengthfrequency)
- Spatial structure: One area
- Sex: Both sexes combined


## Fleet definition:

Six fleets were defined as the gear for UK vessles, France and Other:

- UK trawl
- UK midwater trawl
- UK nets
- UK lines
- French fleets (combined)
- Other (Other countries and Other UK fleets combined)


## Landed catches:

Annual landings in tonnes from 1985 to 2010 for the six fleets from ICES subdivisions IVb and c, VIIa, d-h were used in the assessment.

Abundance indices:
Ten abundance indices were defined for each age up to 4 years for different areas and time period.

- Spring Solent survey in ICES sub-division VIId covering ages 2 to 4 for years 1985 to 2009
- Autumn Solent survey in ICES sub-division VIId covering ages 2 to 4 for years 1986 to 2009
- Autumn/Winter Thames survey ICES sub-division IVc covering ages 0 to 3 for years 1997 to 2009

Age composition of data for age-length model:
The age bins were set at 0 to 11 with a plus group for ages 12 and over. Age compositions for four fishing fleets were used. The available age data and their disaggregated level differ among fleets:

- UK trawl - Annual total numbers and mean weight in kilograms for 1985 to 2010 were used in the age-length model.
- UK midwater trawl - Annual total number and mean weight in kilograms for 1985 to 2010 were used in the age-length model. Gaps in the time-series were present, for years 1986, 1990, 1993, 1997 and 2006.
- UK nets - Annual total numbers and mean weight in kilograms for 1985 to 2010 were used in the age-length model.
- UK lines - Annual total numbers and mean weight in kilograms for 1985 to 2010 were used in the age-length model.


## Length composition of data:

The length bin was set from 4 to 100 cm by 2 cm intervals. Length compositions for five fishing fleets were used. The available length data and their disaggregated level differ among fleets:

- UK trawl - Annual total numbers for 1985 to 2010 were used in the length only model.
- UK midwater trawl - Annual total numbers for 1985 to 2010 were used in the length only model.
- UK nets - Annual total numbers for 1985 to 2010 were used in the length only model.
- UK lines - Annual total numbers for 1985 to 2010 were used in the length only model.
- French all fleets combined - Annual total numbers for 2000 to 2010 were used in both the age-length and length only model.


## Model assumptions and parameters

| Characteristic | Settings |  |
| :--- | :--- | :---: |
| Starting year | 1985 |  |
| Ending year | 2010 |  |
| Equilibrium catch for starting year | Mean landings by fleet: 1980-1984 |  |
| Number of areas | 1 |  |
| Number of seasons | 1 |  |
| Number of fishing fleets | 6 |  |
| Number of surveys (recruit surveys) | 3 surveys, modelled as 10 single-age fleets at <br> ages $0-4$ |  |
| Individual growth | Von Bertalanffy, parameters fixed, combined <br> sex |  |
| Number of estimated parameters | 48 |  |
| Population characteristics |  |  |
| Maximum age | 30 |  |
| Genders | 1 |  |
| Population length bins | $4-100,2$ cm bins |  |
| Ages for summary total biomass | $0-12+$ |  |


| Data characteristics |  |
| :--- | :--- |
| Data length bins (for length structured fleets) | $14-94,2 \mathrm{~cm}$ bins |
| Data age bins (for age structured fleets) | $0-12+$ |
| Minimum age for growth model | 0 [age 2 for age-length model] |
| Maximum age for growth model | 30 |
| Maturity | Logistic 2-parameter - females; L50 $=40.65 \mathrm{~cm}$ |
| Fishery characteristics | -1 (whole year) |
| Fishery timing | Hybrid |
| Fishing mortality method | 2.9 |
| Maximum F | Asymptotic |
| Fleet 1: UK Trawl selectivity | Asymptotic |
| Fleet 2: UK Midwater trawl selectivity | Asymptotic (dome shaped forsensitivity run) |
| Fleet 3: UK Nets selectivity | Asymptotic |
| Fleet 4: UK Lines selectivity | Asymptotic |
| Fleet 5: Combined French fleet selectivity |  |


| Survey characteristics |  |
| :--- | :--- |
| Solent spring survey timing (yr) | 0.42 |
| Solent autumn survey timing (yr) | 0.83 |
| Thames survey timing (yr) | 0.75 |
| Catchabilities (all surveys) | Analytical solution |
| Survey selectivities | [all survey data entered as single ages; sel $=1]$ |
| Fixed biological characteristics | 0.2 |
| Natural mortality | 0.999 |
| Beverton-Holt steepness | 0.9 |
| Recruitment variability $\left(\sigma_{\mathrm{R}}\right)$ | 0.00001296 |
| Weight-length coefficient | 2.969 |
| Weight-length exponent | 40.649 cm |
| Maturity inflection (L50\%) | -0.33349 |
| Maturity slope | 5.78 cm |
| Length at age Amin | 80.26 cm |
| Length at Amax | 0.09699 |
| Von Bertalanffy k | 84.55 cm |
| Von Bertalanffy Linf | -0.730 yr |
| Von Bertalanffy t0 | $\mathrm{SD}=0.1166 *$ age +3.5609 |
| Std. Deviation length at age (cm) |  |

## D. Other Issues

## D.1. Historical overview of previous assessment methods <br> No previous methods for international data.

## E. References

Armstrong, M.J. 2012. Life history estimates of natural mortality of sea bass around the UK. Working Document: ICES IBP-NEW 2012; October 2012. 3pp

Armstrong, M.J. and Walmsley, S. 2012a. An evaluation of the bass fleet census and logbook system for estimating annual landings by gear for fishing vessels in England and Wales. Working Document: ICES IBP-NEW 2012; October 2012. 11pp.

Armstrong and Walmsley 2012b. Age and growth of sea bass sampled around the UK. Working Document: ICES IBP-NEW 2012; October 2012. 15pp.

Armstrong and Walmsley 2012c. Maturity of sea bass sampled around the UK. Working Document: ICES IBP-NEW 2012; October 2012. 14pp.

Armstrong, M.J. and Maxwell, D. 2012. Commercial fleet LPUE trends for seabass around the UK. Working Document: ICES IBP-NEW 2012; October 2012. 29 pp.

Cabral H, Costa MJ (2001) Abundance, feeding ecology and growth of 0-group sea bass, Dicentrarchus labrax, within the nursery areas of the Tagus estuary. J Mar Biol Ass UK 81: 679682.

Castilho R, MacAndrew BJ (1998) Population structure of sea bass in Portugal: evidence from allozymes. J Fish Biol 53: 1038-1049

Chavanne et al (2008) Review on breeding and reproduction of European aquaculture species; the European sea bass Dicentrarchus labrax. Aquabreeding FP6-2005-SSP-044424.
Child, A.R., 1992. Biochemical polymorphism in bass, Dicentrarchus labrax, in the waters around the British Isles. Journal of the Marine Biological Association of the U.K., 72, 357364.

Diodati, P. and R.A. Richards, 1996. Mortality of striped bass hooked and released in salt water. Transactions of the American Fisheries Society. 125: 300-307.
Drogou M et al., 2011. Synthèse des informations disponibles sur le Bar : flottilles, captures, marché. Reflexions autour de mesures de gestion.

Dunn, M.R. and Potten, S., 1994. National Survey of Bass Angling: Report to the Ministry of Agriculture, Fisheries and Food. University of Portsmouth, Centre for the Economics and Management of Aquatic Resources. $45 \mathrm{pp}+$ appendices.
Dunn, M., Potten, S., Radford, A. and Whitmarsh, D., 1989. An Economic Appraisal Of the Fishery for Bass in England and Wales. Report to the Ministry of Agriculture, Fisheries and Food. University of Portsmouth. 217 pp.

Durand J. D., F. Bonhomme et Y. Morizur, 2001. Travaux d'analyses génétiques de frayères chez le bar en Atlantique et en Manche. Contrat IFREMER-UMII n ${ }^{\circ} 002511263$, Rapport miparcours, mai 2001, 8 pp.
Fritsch, M., Morizur, Y., Lambert, E., Bonhomme, F. and Guinand, B., 2007 Assessment of sea bass (Dicentrarchus labrax, L.) stock delimitation in the Bay of Biscay and the English Channel based on mark-recapture and genetic data. Fisheries Research 83:123-132.

Gordo LS (1989) Age, growth and sexuality of sea bass, Dicentrarchus labrax, (Linnaeus, 1758) (Perciformes, Moronidae) from Aveiro lagoon, Portugal. Sci Mar 53: 121-126
Herfaut J., Levrel H., Drogou M. et Véron G., 2010. Monitoring of recreational fishing of seabass (Dicentrarchus labrax) in France: output from a dual methodology (telephone survey and diary) ICES CM 2010/R: 05

ICES. 2001. Report on the ICES Study Group on bass. CM 2001/ACFM:25, 18 pp .
ICES. 2002. Report on the ICES Study Group on bass. CM 2002/ACFM:11 ref.G, 59 pp.
ICES., 2004a. Report of the Study Group on Bass, Lowestoft, England, August 2003. ICES Document, CM 2004/ACFM: 04.73 pp.

ICES 2004b. Report of the Study Group on Bass, By Correspondence. ICES Document, CM 2004/ACFM: 31 Ref G. 56pp.
ICES 2008. Report of the Working Group on the Assessment of New MoU Species (WGNEW). By Correspondence, ICES CM 2008/ACOM:25. 77 pp. Kupschus, S., Smith, M. T., Walmsley, S. A. (2008)

ICES 2009 Report of the Workshop on Sampling Methods for Recreational Fisheries (WKSMRF). ICES CM 2009 / ACOM:41

ICES 2010 Report of the Planning Group on Recreational Fisheries Surveys (PGRFS). ICES CM 2010/ACOM: 34
ICES 2011 Report of the Planning Group on Recreational Fisheries Surveys (PGRFS). ICES CM 2011/ACOM: 23

ICES. 2012. Report of the Inter-Benchmark Protocol on New Species (Turbot and Sea bass; IBPNew 2012), 1-5 October 2012, Copenhagen, Denmark. ICES CM

2012/ACOM:45. 239 pp.Kennedy, M. and Fitzmaurice, P., 1968. Occurrence of eggs of bass, Dicentrarchus labrax, on the southern coasts of Ireland. Journal of the Marine Biological Association of the U.K., 48: 585-592.

Jennings, S., and Pawson, M. G., 1992. The origin and recruitment of bass, Dicentrarchus labrax, larvae to nursery areas. Journal of the Marine Biological Association of the United Kingdom, 72: 199.212.

Kennedy, M. and Fitzmaurice, P., 1968. Occurrence of eggs of bass, Dicentrarchus labrax, on the southern coasts of Ireland. Journal of the Marine Biological Association of the U.K., 48: 585-592.

Kennedy, M. and Fitzmaurice, P. 1972. The biology of the bass, Dicentrarchus labrax in Irish waters. Journal of the Marine Biological Association of the United Kingdom 52: 557-597.
Kupschus, S., Smith, M. T., Walmsley, S. A. (2008) Annex 2: Working Document. An update of the UK bass assessments 2007. Report of the Working Group on the Assessment of New MoU Species (WGNEW). By Correspondence, ICES CM 2008/ACOM:25. 77 pp.
Lam Hoai Thong., 1970. Contribution à l'étude des Bars de la région des Sables d'Olonne. Trav. Fac. Sci. Rennes, Ser. Océanogr. Biol., 3: 39-68.

Lancaster, J. E., 1991. The feeding ecology of juvenile bass Dicentrarchus labrax (L.). PhD thesis, University College of Swansea, 281 pp.

Laurec, A., Drogou M., Huet J., Martin S., 2012 Analysis of length distribution in sea bass for a given read age. WD to IBP-NEW 2012
Mahé, K., Holmes, A., Huet, J., Sévin, K., Elleboode, R., 2012. Report of the Seabass (Dicentrachus labrax) Otolith and Scale Exchange Scheme 2011, 16 pp.

Masski, H., 1998. Identification de Frayères et Etude des Structures de Population de Turbot (Psetta maxima L.) et du Bar (Dicentrarchus labrax L.) en Manche Ouest et dans les Zones Avoisinantes. Thèse présentée a la Faculte des Sciences de Brest. Universite de Bretagne Occdentale. 136pp + annexes.
Mayer, I., Shackley, S.E. and Witthames, P.R. 1990. Aspects of the reproductive biology of the bass, Dicentrarchus labrax L. II. Fecundity and pattern of oocyte development. J. Fish Biol. 36:141-148.

Methot, R.D. 2000. Technical Description of the Stock Synthesis Assessment Program. National Marine Fisheries Service, Seattle, WA. NOAA Tech Memo. NMFS-NWFSC-43: 46 pp.
Methot, R.D. 2011. User Manual for Stock Synthesis, Model Version 3.23b. NOAA Fisheries Service, Seattle. 167 pp.

Nijboer, 2011. Commercial line and net fishing on the european seabass (Dicentrarchus labrax). Report number 11.013, Institute for Marine Resourcesand Ecosystem Studies UR. 42p.
Pawson, M. G., 2008. The contribution of science to management of the North Sea cod (Gadus morhua) and UK sea bass (Dicentrarchus labrax) fisheries: can we do better? In: Advances in Fisheries Science: 50 years on from Beverton and Holt. Payne, A., Cotter, J. and Potter, T. (Eds.) Blackwell Publishing Ltd. pp 155-183.

Pawson, M. G., and Pickett, G. D. 1996. The annual pattern of condition and maturity in bass (Dicentrarchus labrax L) in waters around the UK. Journal of the Marine Biological Association of the United Kingdom, 76: 107.126.
Pawson, M. G., Kelley, D. F. and Pickett, G. D., 1987. The distribution and migrations of bass Dicentrarchus labrax L. in waters around England and Wales as shown by tagging. J. mar. biol. Ass. UK, 67: 183-217.

Pawson, M.G., G. D. Pickett and P. R. Witthames, 2000. The influence of temperature on the onset of first maturity in sea-bass (Dicentrarchus labrax L). Journal of Fish Biology, 56: 319.327.

Pawson MG et al (2007a) Migrations, fishery interactions and management units of sea bass (Dicentrarchus labrax) in northwest Europe. ICES J Mar Sci 64: 332-345

Pawson MG et al (2007b) The status of sea bass (Dicentrarchus labrax) stocks around England and Wales, derived using a separable catch-at-age model, and implications for fisheries management.. ICES J Mar Sci 64: 346-356
Pawson, M. G., Pickett, G. D., Leballeur, J., Brown, M. and Fritsch, M. 2007b. Migrations, fishery interactions, and management units of sea bass (Dicentrarchus labrax) in Northwest Europe. ICES Journal of Marine Science 64:332-345.

Pickett, G.D. 1990. Assessment of the UK bass fishery using a log-book-based catch recording system. Fish. Res. Tech. Rep. MAFF Direct. Fish. Res., Lowestoft (90): 33pp.
Pickett, G. D., and Pawson, M. G. 1994. Bass. Biology, Exploitation and Management. Chapman \& Hall, London, Fish and Fisheries Series, 12. 358 pp.

Quayle, V.A., Righton, D., Hetherington, S. and Pickett, G. 2009. Observations of the Behaviour of European SeaBass (Dicentrarchus labrax) in the North Sea.In: J.L. Nielsen et al. (eds.), Tagging and Tracking of Marine Animals with Electronic Devices,Reviews: Methods and Technologies in Fish Biology and Fisheries 9,DOI 10.1007/978-1-4020-9640-2 7, C _ UK Crown 2009

Quirijns, F. and Bierman, S. 2012. Growth and maturity of seabass sampled around the Netherlands. Working Document: ICES IBP-NEW 2012; October 2012. 9pp.
Ramos S et al (2012) Early life stages of fishes as ecological indicators of estuarine ecosystem health. Ecol Ind 19: 172-183

Rangel M, Erzini K (2007) An assessment of catches and harvest of recreational shore angling in the north of Portugal. Fish Manage Ecol 14: 343-352

Reynolds, W. J., Lancaster, J. E. and Pawson, M. G. 2003. Patterns of spawning and recruitment of bass to Bristol Channel nurseries in relation to the 1996 "Sea Empress" oil spill. J. Mar. Biol. Assoc. UK, 83: 1163-1170.
Rocklin et al, 2012 Assessment of the sea bass recreational catches using a large-scale network of volunteers, in prep.

Sobral MP et al (2000) Contribuição para o estudo da pescaria da majoeira na zona entre Espinho e Nazaré. Relatórios Científicos e Técnicos IPIMAR, 60, 21pp.
Stephens, A., and A. MacCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fish. Res. 70:299-310.

Stequert, B., 1972. Contribution à l'étude du bar Dicentrarchus labrax (L.) des reservoirs à poissons de la région d'Arcachon. Th. 3ème cyear classle: Faculté des Sciences.

Thompson, B. M., Harrop, R. T., 1987. The distribution and abundance of bass (Dicentrarchus labrax) eggs and larvae in the English Channel and Southern North Sea. Journal of the Marine Biological Association of the United Kingdom, 67, 263.274.
Van der Hammen, T and de Graaf, M 2012. Recreational fishery in the Netherlands: catch estimates of cod (Gadus morhua) and eel (Anguilla anguilla) in 2010. IMARES Wageningen UR, Report Number C014/12, 61 pp.

Vasconcelos et al (2008) Evidence of nursery origin otolith fingerprinting of five coastal fish species along the Portuguese coast through otolith elemental fingerprints. Est Coast Shelf Sci 79: 317-327

Veiga P et al (2010) Quantifying recreational shore angling catch and harvest in southern Portugal (north-east Atlantic Ocean): implications for conservation and integrated fisheries management. J Fish Biol 76: 2216-2237

Vinagre et al (2009) Latitudinal gradient in growth and spawning of sea bass, Dicentrarchus labrax, and their relationship with temperature and photoperiod. Est Coast Shelf Sci 81: 375-380

Vinagre et al (2012) Impact of climate change on coastal versus estuarine nursery areas: cellular versus whole animal indicators in juvenile sea bass. Mar Ecol Prog Ser 464: 237-243

Walmsley, S. and Armstrong, M. 2012. The UK commercial bass fishery in 2010. Working Document to ICES WGNEW 2012. August 2011.

## Stock Annex <br> European sea bass (Dicentrarchus labrax) in subarea VIIIc, IXa

Stock specific documentation of standard assessment procedures used by ICES.
Stock European sea bass (Dicentrarchus labrax) in subarea VIIIc, IXa
Working Group: Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM)

| Date: | May 2013 |
| :---: | :--- |
| Revised by | Mickael Drogou, May 2013 (stock annex developed <br> by IBPNEW 2012, retaining only information for |
|  | BSS-8c9a and WGNEW 2013) |

## General

Seabass for the 8 ab area is considered in 2012 as data poor species, in category 5.2.0

## A.1. Stock definition

Bass 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.

Stock structure of sea bass in the Atlantic has been reviewed by WGNEW 2012 and IBP-NEW 2012 based on evidence from genetics studies, tagging studies, distribution of commercial catches and similarities in stock trends between areas, drawing also on extensive information contained in previous WGNEW and ICES SGBASS reports.

IBP-NEW considers that stock structure remains uncertain, and recommends further studies 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 bass shoals, to confirm and quantify the exchange rate of seabass between sea areas that could form management units for this stock. Such information is critical to support development of models to describe the spatial dynamic of the species under environmental drivers (eg. temperature and food). Such a modelling work is being carried out in France in the framework of a PhD study ( R . Lopez).

The pragmatic view of IBP-NEW 2012 is to structure the baseline stock assessments into four units:

- Assessment area 1. Sea bass in ICES areas IVbc, VIId, VIIe,h and VIa,f\&g (lack of clear genetic evidence; concentration of area IV bass fisheries in the southern North Sea; seasonal movements of bass across ICES Divisions). Relatively data-rich area with data on fishery landings and length/age
composition; discards estimates and lengths; growth and maturity parameters; juvenile surveys, fishery LPUE trends.
- Assessment area 2. Sea bass in Biscay (ICES Sub area VIIIa,b). Available data are fishery landings, with length compositions from 2000; discards from 2009; some fishery LPUE.
- Assessment area 3. Sea bass in VIIIc and IXa (landings, effort,discards)
- Assessment area 4. Sea bass in Irish coastal waters (VIa, VIIb, VIIj). Available data: Recreational fishery catch rates; no commercial fishery operating.

Fishery landings of sea bass are extremely small in Irish coastal waters of VIIa and VIIg and the stock assessment for assessment area 1will not reflect the sea bass populations around the Irish coast, which may be more strongly affiliated to the population in area 4 off southern, western and Northern Ireland.

## A.2. Fishery

## General description

Spanish and Portugese vessels represent almost of the total annual landings in the area IXa and VIIIc. Commercial landings represent 772 tons in 2011. A peak of landings is observed in the early 90's reaching more than 1000 tons, and lowest landings (637 tons) have been observed in 2004. Artisanal fisheries are mainly observed in this area. Off Portugal, estimated total landings of sea bass (hereafter refers only to European sea bass) average 421 tons for the period 1986-2012. Landings had a maximum of 610 tons in 1989, followed by a slight decrease and another increase to a second maximum of 633 tons in 2006. Most landings come from the polyvalent mixed fishery (80-99\%) using mostly gill nets (GNS_DEF_80-99_0_0), trammel nets (GTR_DEF_>=100_0_0) and long-line or hand-line (LLS_DEF_0_0_0). The landings by purse seiners and trawlers represent a small amount.

Relatively little historical data are available on recreational fisheries although several European countries are now carrying out surveys to meet the requirements of the EU Data Collection Framework and for other purposes (ICES WKSMRF 2009, PGRFS 2010 \& 2011, WGRFS 2012; Herfault et al, 2010, Rocklin et al, 2012 in prep, Van der Hammen \& De Graaf, 2012).

## Fishery management regulations

Seabass are not subject to EU TACs and quotas. Under EU regulation, the MLS of sea bass in the Northeast Atlantic is 36 cm total length (EC regulation 850/98). A variety of national restrictions on commercial fishing for each metier also apply to sea bass. The measures affecting recreational fisheries in Portugal include gear restrictions, a minimum landing size equal to the commercial fishery MLS $(36 \mathrm{~cm})$, 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.

## A.3. Ecosystem aspects

This section comes from the IBPNew report and refers to UK studies.
Temperature appears to be a major driver for bass production and distribution (Pawson, 1992). Reynolds et al. (2003) observed a positive relationship between annual seawater temperature during the development phases of eggs and larvae of sea bass and the timing and (possibly) abundance of post-larval recruitment to nursery areas. In addition, early growth is related to summer temperature and survival of 0-groups
through the first winter is affected by body size (and fat reserves) and water temperature (Lancaster 1991; Pawson 1992). prolonged periods of temperatures below $5-6^{\circ} \mathrm{C}$ may lead to high levels of mortality in 0-groups in estuaries during cold winters. As a result, any SSB-recruit relationships may be obscured by temperature effects (Pawson et al., 2007a).

Recruitment of sea bass is highly variable, and the fisheries have often in the past been dominated by individual very strong year classes or have been negatively affected by periods of very poor recruitment. Expansion of sea bass populations in the North Sea in the 1990s coincided with a period of ocean warming as well as the growth of the very strong 1989 year class.

## B. Data

## B.1. Commercial catch

## B1.1 Landings data

## Data available

Landings series are derived from :
i) Official statistics recorded in the Fishstat database since around the mid 1970s.
ii) Spanish landings for 2007-2011 from sale notes
iii) Portugese estimated landings from 1986 to 2011 including distinction between Dicentrarchus labrax and punctatus.

Spanish and Portugese vessels represent almost of the total annual landings in the area IXa and VIIIc. Commercial landings represent 772 tons in 2011. A peak of landings is observed in the early 90's reaching more than 1000 tons, and lowest landings ( 637 tons) have been observed in 2004.. Artisanal fisheries are mainly observed in this area. Off Portugal, estimated total landings of sea bass (hereafter refers only to European sea bass) average 421 tons for the period 1986-2012. Landings had a maximum of 610 tons in 1989, followed by a slight decrease and another increase to a second maximum of 633 tons in 2006. Most landings come from the polyvalent mixed fishery ( $80-99 \%$ ) using mostly gill nets (GNS_DEF_80-99_0_0), trammel nets (GTR_DEF_>=100_0_0) and long-line or hand-line (LLS_DEF_0_0_0). The landings by purse seiners and trawlers represent a small amount.

## Quality of official landings data

The official landings data for sea bass available to WGNEW 2013 are subject to several uncertainties that can affect the accuracy of assessments:

- Incomplete reporting of landings in the 1970s and early 1980s when the fisheries were developing;
- Poor reporting accuracy for small vessels that do not supply EU logbooks.

Portugal: With the regulations introduced with the DCF, landings by species are now more accurate, especially since 2006. Additionally, market sampling enabled the estimation of the remaining misidentification and correction of total landings by species. Official landings underestimate total catch to an unknown degree. Landings series for use in the assessment are available from the Portuguese official statistics since 1986. Landings of sea bass from the ICES division IXa are reported in three cat-
egories: the European sea bass (Dicentrarchus labrax, FAO code BSS), the spotted sea bass (Dicentrarchus punctatus, FAO code PSU) and also a mix of the above two species under the category Dicentrarchus sp. (FAO code BSE). From DCF market sampling it was possible to estimate that the spotted sea bass represents only ca. $2.5 \%$ of sea bass species total landings, and produce a time series of corrected landings for Dicentrarchus labrax.

Spain : Landings from the sales notes are detailed for the 2007-2011 period. This source of information was chosen as the accuracy of the landings for D. labrax improves with respect to logbook data. Main reason seems to be the role of small scale fisheries that do not have to supply logbooks data.

## B1.2 Discards estimates

Portugal: Sea bass discards are recorded by the DCF on-board sampling programme. The Portuguese on-board sampling is not covering the Sea Bass fishing area.No discards are observed.

Spain: No bass discards were observed for any metier in the 2003-2011 periods.

## Quality of discards estimates

Portugal. As sampling is targeted at all species, annual coverage of the sea bass catches is relatively limited. The low numbers of sea bass in retained catches show that the Portuguese on-board sampling is not covering the sea bass fishing area. Nevertheless, the species is of high value and discards are probably negligible.

## B1.3 Recreational catches

Recreational marine fishery surveys in Europe are still at an early stage in development (ICES WGRFS 2012).

## Spain

A recreational boat fishing survey was performed in the Basque Country to estimate the total catch of the target species of this fishery. Fishermen were asked about their catches in 2009, and 555 surveys were collected. Sea bass catch data were modeled with a two-step GLM, using type of boat and total boat length as covariables. The results were extrapolated to the total number of boats using an updated census. The estimated catch for seabass was in 2009 was 8183 Kg , with an associated standard error of 149 Kg . It is important to note that this estimation refers only to the fishing performed from boats. In order to estimate total recreational catches of sea bass, anglers fishing from coast and spear fishers need to be included in the survey. In 2012 a pilot study financed by the Data Collection Framework (DCF) was taking place in order to estimate total sea bass catches (taking into account all types of recreational fishing), and it is expected that the results if this study will increase significantly the estimated sea bass catch. Results were not available for WGNEW2013.

## Portugal

It is recognized that a pilot study on recreational fishing of sea-bass should be carried out in order to determine the importance of this fishery in Portugal, whether it is necessary to monitor it regularly and if so how the monitoring could be carried out. Recreational fishery data have not been collected due to lack of resources and weak administrative information available. A pilot study addressed to the maritime touristic operators was implemented in 2010 in order to obtain the quantities of sea bass
catches. The results of this study revealed very low quantities of sea bass catches (DCF, 2012).

## Quality of recreational catch estimates

Recreational catch estimates from surveys (numbers or tonnes caught per year) are not yet available as time series. The estimates for France are characterised by relatively poor precision. The 2012 ICES Working Group on Recreational Fisheries initiated the development of data quality indicators for recreational fishery survey estimates, however sources and potential magnitude of bias in available estimates were not provided to WGNEW 2013.

## B.2. Biological

B2.1 Length and age compositions of landed and discarded fish in commercial fisheries.

Portugal : In Portugal, quarterly length compositions of sea bass landings from division IXa are available from DCF concurrent sampling since 2009 for the polyvalent fleet. The number of animals sampled is small, $\mathrm{N}=2229$ for the 4 years (2009 to 2012) and concerned only the area IXa. The sample rate (trips sampled per tonne landed) was around 0.2 in 2009, 2010 and 2011. Most specimens measured were landed from trammel nets (GTR_DEF_>=100_0_0), gill nets (GNS_DEF_80-99_0_0), and long-line (LLS_DEF_0_0_0). The quarterly length compositions show that recruitment to the fishery is seasonal starting during the second quarter of the year. Length compositions derived from fisheries with the two main gear types show that the fisheries with gill nets and trammel nets catch smaller animals (mean $=48 \mathrm{~cm}$ ) of a narrow length range, mainly animals between 40 and $55 \mathrm{~cm}(80 \%)$; whereas the line fishery catches animals bigger animals (mean $=51 \mathrm{~cm}$ ) and of a wider size range. There is no significant trend in the mean length of sea bass over the 4 years period analysed. No age sampling is available
Spain : No data available from Spain for the VIIIc, IXa area
B2.2 Biological parameters and other research in Iberian waters: weights, maturities, growth

This section provides biological parameters, discussed in a Portuguese Working Document for the ICES Working Group on Assessment of New MoU Species by Ana Moreno and Yorgos Stratoudakis (2013).

## Spawning season

Bass spawning is limited within the $9-17 \mathrm{o} \mathrm{C}$ water temperature range and has a latitudinal gradient in the Atlantic coast of Europe, with season placed progressively later in the year in more northerly latitudes (April-June off Ireland; February-May in the English Channel and eastern Celtic Sea; January-March in the Bay of Biscay and October-January in the Gulf of Cadiz). Based on back-calculated birthdates of juveniles caught in 4 Portuguese estuaries, Vinagre et al (2009) support the above latitudinal trend; successful spawning in SW Portugal seems to concentrate from December to February, becoming progressively later (January to April or February to April) as moving towards estuaries in NW Portugal, although temperature seasonality is not the trigger for this local pattern. An earlier study by Sobral et al (2000) identifies February as the main spawning month for bass off the Ria de Aveiro (NW Portugal), based on the macroscopic staging of gonads from fish caught by "ma-
joieiras" (small bits of old trammel nets fixed perpendicularly on the beach at low tide).

## Spawning grounds and seasonal migrations

Off western Portugal (where temperature is not a limiting factor for the definition of potential spawning habitat and continental shelf is narrow), there is no evidence of inshore-offshore migrations (sea bass is almost exclusively caught in the inner shelf and often at depths $<10 \mathrm{~m}$ ), and there is evidence of spawning at very shallow waters (Sobral et al 2000 and blog reports by recreational line fishers operating from land). Additionally, there is evidence of large pre-spawning and spawning aggregations found inshore, as verified by the occasional purse seine sets with up to 3-4 t of sea bass in the catch.

## Ontogenetic movements

Off Portugal, there is evidence that juvenile bass colonize transition waters during the summer and stay there for at least the first year (Gordo 1989; Cabral and Costa 2001). Although fish in the second year of life and even third have been found within such protected and semi-enclosed systems, no mature fish have ever been registered there, whereas there is little known on the movements of bass while at sea.

## Growth

Off Portugal, there are mean length at age data only for younger age groups (usually from studies with immature fish in estuaries and rias), appointing to intermediate sizes at age between the lower values in more northerly area and higher values in the Mediterranean and Atlantic Moroccan coast (Gordo 1989; Cabral and Costa 2001).

## Maturation

In the northern range of the species distribution area, maturity is attained at around 4 -7 years, which is around 35 cm for males and 42 cm for females. No information is available from Portugal. Nevertheless, Chavanne et al (2008) report from aquaculture experience that males complete maturation in the second year and females in the third (although recognize maturation as a problem for production only for fish reared for more than 3 years); it is thus likely that first maturation off Portugal occurs at intermediate ages between those reported from wild populations at the northern limit of the distribution and those from aquaculture.

## B.3. Surveys

## Portugal

No sea bass are caught in the Portuguese trawl survey cruises. Nevertheless, juvenile sea bass are regularly caught in surveys within estuaries (e.g. Gordo 1989; Cabral and Costa 2001). Monitoring efforts under the Water Framework Directive (e.g. Ramos et al 2012) could thus be used also to construct series of sea bass recruitment indices, at least in the main nurseries for the species in Portugal (Vasconcelos et al 2008), at no additional cost.

## Spain

Information of Dicentrachus labrax catches in the series of research surveys conducted by the IEO since 1983 is showed in Table 10.12. There are also a very few seabass caught.

## B.4. Commercial LPUE

## Spain

LPUE data for Spanish fleets operating in ICES areas VI-VIII and landing into Basque Country ports were provided to WGNEW in 2005, and the best indicator of sea bass abundance trends (LPUE) in the period 1994-2004 was considered to be from vessels of the 'baka' otter trawl fleet working in Div. VIIIa,b,d and landing into the Basque port of Ondarroa. Data for later years were not available to WGNEW. Landings and effort data were provided to WGNEW by Spain, though not in the form of LPUE indices.

## Portugal

Commercial catch-effort data was analysed for the Portuguese polyvalent fishery for the years 1995 to 2011 from auction daily landings data. The unit of effort is given as the number of trips that deliver sea bass. There is no apparent trend in the sea bass LPUE for the period analysed, but the unit of measure is probably not reflecting sea bass abundance (Figure 10.14)

Quality of data: Sea bass are a by-catch in most polyvalent fisheries and catchability may drift due to changes in species targeting, areas fished and vessel fishing power. On the other hand, the unit of effort given as the number of trips that deliver sea bass is probably meaningless to reveal abundance

## B.5. Other relevant data

None

## C. Assessment: data and method

Data do not allow to conduct an assessment.

## D. Short-Term Projection

None
E. Medium-Term Projections

None
F. Long-Term Projections

None

## G. Biological Reference Points

None

## H. Other Issues

None

## I. References

Cabral H, Costa MJ (2001) Abundance, feeding ecology and growth of 0-group sea bass, Dicentrarchus labrax, within the nursery areas of the Tagus estuary. J Mar Biol Ass UK 81: 679682.

Castilho R, MacAndrew BJ (1998) Population structure of sea bass in Portugal: evidence from allozymes. J Fish Biol 53: 1038-1049

Chavanne et al (2008) Review on breeding and reproduction of European aquaculture species; the European sea bass Dicentrarchus labrax. Aquabreeding FP6-2005-SSP-044424.

Child, A.R., 1992. Biochemical polymorphism in bass, Dicentrarchus labrax, in the waters around the British Isles. Journal of the Marine Biological Association of the U.K., 72, 357-364.

Dunn, M.R. and Potten, S., 1994. National Survey of Bass Angling: Report to the Ministry of Agriculture, Fisheries and Food. University of Portsmouth, Centre for the Economics and Management of Aquatic Resources. 45pp + appendices.

Dunn, M., Potten, S., Radford, A. and Whitmarsh, D., 1989. An Economic Appraisal Of the Fishery for Bass in England and Wales. Report to the Ministry of Agriculture, Fisheries and Food. University of Portsmouth. 217 pp.

Durand J. D., F. Bonhomme et Y. Morizur, 2001. Travaux d'analyses génétiques de frayères chez le bar en Atlantique et en Manche. Contrat IFREMER-UMII n ${ }^{\circ} 002511263$, Rapport miparcours, mai 2001, 8 pp .

Fritsch, M., Morizur, Y., Lambert, E., Bonhomme, F. and Guinand, B., 2007 Assessment of sea bass (Dicentrarchus labrax, L.) stock delimitation in the Bay of Biscay and the English Channel based on mark-recapture and genetic data. Fisheries Research 83:123-132.

Gordo LS (1989) Age, growth and sexuality of sea bass, Dicentrarchus labrax, (Linnaeus, 1758) (Perciformes, Moronidae) from Aveiro lagoon, Portugal. Sci Mar 53: 121-126
Herfaut J., Levrel H., Drogou M. et Véron G., 2010. Monitoring of recreational fishing of seabass (Dicentrarchus labrax) in France: output from a dual methodology (telephone survey and diary) ICES CM 2010/R: 05

ICES. 2001. Report on the ICES Study Group on bass. CM 2001/ACFM:25, 18 pp.
ICES. 2002. Report on the ICES Study Group on bass. CM 2002/ACFM:11 ref.G, 59 pp .
ICES., 2004a. Report of the Study Group on Bass, Lowestoft, England, August 2003. ICES Document, CM 2004/ACFM: 04. 73 pp.

ICES 2004b. Report of the Study Group on Bass, By Correspondence. ICES Document, CM 2004/ACFM: 31 Ref G. 56pp.

ICES 2008. Report of the Working Group on the Assessment of New MoU Species (WGNEW). By Correspondence, ICES CM 2008/ACOM:25. 77 pp. Kupschus, S., Smith, M. T., Walmsley, S. A. (2008)

ICES 2009 Report of the Workshop on Sampling Methods for Recreational Fisheries (WKSMRF). ICES CM 2009 / ACOM:41

ICES 2010 Report of the Planning Group on Recreational Fisheries Surveys (PGRFS). ICES CM 2010/ACOM: 34

ICES 2011 Report of the Planning Group on Recreational Fisheries Surveys (PGRFS). ICES CM 2011/ACOM: 23

ICES. 2012. Report of the Inter-Benchmark Protocol on New Species (Turbot and Sea bass; IBPNew 2012), 1-5 October 2012, Copenhagen, Denmark. ICES CM

2012/ACOM:45. 239 pp.Kennedy, M. and Fitzmaurice, P., 1968. Occurrence of eggs of bass, Dicentrarchus labrax, on the southern coasts of Ireland. Journal of the Marine Biological Association of the U.K., 48: 585-592.

Masski, H., 1998. Identification de Frayères et Etude des Structures de Population de Turbot (Psetta maxima L.) et du Bar (Dicentrarchus labrax L.) en Manche Ouest et dans les Zones Avoisinantes. Thèse présentée a la Faculte des Sciences de Brest. Universite de Bretagne Occdentale. 136pp + annexes.
Nijboer, 2011. Commercial line and net fishing on the european seabass (Dicentrarchus labrax). Report number 11.013, Institute for Marine Resourcesand Ecosystem Studies UR. 42p.

Pawson, M. G., 2008. The contribution of science to management of the North Sea cod (Gadus morhua) and UK sea bass (Dicentrarchus labrax) fisheries: can we do better? In: Advances in Fisheries Science: 50 years on from Beverton and Holt. Payne, A., Cotter, J. and Potter, T. (Eds.) Blackwell Publishing Ltd. pp 155-183.
Pawson, M. G., and Pickett, G. D. 1996. The annual pattern of condition and maturity in bass (Dicentrarchus labrax L) in waters around the UK. Journal of the Marine Biological Association of the United Kingdom, 76: 107.126.
Pawson, M. G., Kelley, D. F. and Pickett, G. D., 1987. The distribution and migrations of bass Dicentrarchus labrax L. in waters around England and Wales as shown by tagging. J. mar. biol. Ass. UK, 67: 183-217.

Pawson, M.G., G. D. Pickett and P. R. Witthames, 2000. The influence of temperature on the onset of first maturity in sea-bass (Dicentrarchus labrax L). Journal of Fish Biology, 56: 319.327.

Pawson MG et al (2007a) Migrations, fishery interactions and management units of sea bass (Dicentrarchus labrax) in northwest Europe. ICES J Mar Sci 64: 332-345
Pawson MG et al (2007b) The status of sea bass (Dicentrarchus labrax) stocks around England and Wales, derived using a separable catch-at-age model, and implications for fisheries management.. ICES J Mar Sci 64: 346-356
Pawson, M. G., Pickett, G. D., Leballeur, J., Brown, M. and Fritsch, M. 2007b. Migrations, fishery interactions, and management units of sea bass (Dicentrarchus labrax) in Northwest Europe. ICES Journal of Marine Science 64:332-345.
Pickett, G.D. 1990. Assessment of the UK bass fishery using a log-book-based catch recording system. Fish. Res. Tech. Rep. MAFF Direct. Fish. Res., Lowestoft (90): 33pp.
Pickett, G. D., and Pawson, M. G. 1994. Bass. Biology, Exploitation and Management. Chapman \& Hall, London, Fish and Fisheries Series, 12. 358 pp.

Quayle, V.A., Righton, D., Hetherington, S. and Pickett, G. 2009. Observations of the Behaviour of European SeaBass (Dicentrarchus labrax) in the North Sea.In: J.L. Nielsen et al. (eds.), Tagging and Tracking of Marine Animals with Electronic Devices,Reviews: Methods and Technologies in Fish Biology and Fisheries 9,DOI 10.1007/978-1-4020-9640-2 7, C _ UK Crown 2009
Ramos S et al (2012) Early life stages of fishes as ecological indicators of estuarine ecosystem health. Ecol Ind 19: 172-183
Rangel M, Erzini K (2007) An assessment of catches and harvest of recreational shore angling in the north of Portugal. Fish Manage Ecol 14: 343-352
Rocklin et al, 2012 Assessment of the sea bass recreational catches using a large-scale network of volunteers, in prep.

Sobral MP et al (2000) Contribuição para o estudo da pescaria da majoeira na zona entre Espinho e Nazaré. Relatórios Científicos e Técnicos IPIMAR, 60, 21pp.
Stephens, A., and A. MacCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fish. Res. 70:299-310.

Stequert, B., 1972. Contribution à l'étude du bar Dicentrarchus labrax (L.) des reservoirs à poissons de la région d'Arcachon. Th. 3ème cyear classle: Faculté des Sciences.

Vasconcelos et al (2008) Evidence of nursery origin otolith fingerprinting of five coastal fish species along the Portuguese coast through otolith elemental fingerprints. Est Coast Shelf Sci 79: 317-327

Veiga P et al (2010) Quantifying recreational shore angling catch and harvest in southern Portugal (north-east Atlantic Ocean): implications for conservation and integrated fisheries management. J Fish Biol 76: 2216-2237

Vinagre et al (2009) Latitudinal gradient in growth and spawning of sea bass, Dicentrarchus labrax, and their relationship with temperature and photoperiod. Est Coast Shelf Sci 81: 375-380

Vinagre et al (2012) Impact of climate change on coastal versus estuarine nursery areas: cellular versus whole animal indicators in juvenile sea bass. Mar Ecol Prog Ser 464: 237-243

## Stock Annex Striped red mullet in Subarea VI, VIII and Divisions VIIa-c, e-k and IXa (Western area)

Stock specific documentation of standard assessment procedures used by ICES.

| Stock | Striped red mullet in Subarea VI, VIII and Divisions <br> VIIa-c, e-k and IXa (Western area) |
| :---: | :--- |
| Working Group: | Assessment of Southern Shelf Stocks of Hake, <br> Monk and Megrim (WGHMM) |
| Date: | May 2013 |
| Revised by | Eoghan Kelly WGHMM |

## A. General

## A.1. Stock definition

The striped red mullet (Mullus surmuletus) is found along the European coasts from the South Norway and North Scotland including the Faroe Islands in the North, to the Strait of Gibraltar in the South. It is is considered occasional off Norway, around Ireland, at the north coasts of England and in the West of Scotland (Davis and Edward, 1988; Gibson and Robb, 1997). Physiological accommodation is to deep water and elevated temperatures (ICES, 2007), and toleration of both low and high salinity (corresponding respectively to juvenile and adult habitats). It is rarely found in the transitional zones of intermediate salinity. This species prefer sandy sediments (Carpentier et al., 2009).

Due to the presence of the striped red mullet in catches all year round, Dunn (1999) suggested that a single stock existed within the English Channel, although he could not determine whether this stock was distinct from other western stocks. In 2004 and 2005, a study using fish geometrical morphometry was carried out in the Eastern English Channel and the Bay of Biscay using samples from EVHOE and CGFS surveys (Mahé et al., 2007). It pointed out a morphological difference on striped red mullet between these areas.

A study based on the shape of the otoliths was conducted to differentiate stocks (Benzinou et al., 2012). This showed that populations of striped red mullet of Western English Channel and Eastern English Channel could be separated and that a continuum existed between the north and the south of the Bay of Biscay. Currently, there is insufficient data to separate the Bay of Biscay from the Celtic sea or the Eastern English Channel. Based on these findings WGNEW 2012 recommended two management areas: the north area (III, IV and VIId) and the south area (VI, VIIa,e,g,h,j-VIIIa,b and IXa).

## A.2. Fishery

According to ICES statistics, in the Atlantic Ocean, fishery of this species was only conducted by Spain and Portugal from 1950 to 1975 and was carried out nearby Spanish coasts and in the bay of Biscay. From 1990, catches strongly increased, essentially due to entry of France into the fishery, but also to England and Netherlands fisheries.

Striped red mullet are mostly exploitated in areas IV, VIId,e and VIIIa,b. French catches are the most important in the entire zone. The north of the Bay of Biscay (VIIIa,b) is exploited by France and Spain. The south (VIIIc) is only exploited by Spain. This species is discarded in negligible amounts by French or Spanish vessels. It was also rare in the discard samples of Portuguese bottom otter trawl fleet (IXa). Before 2002, a minimum landing size was set at 16 cm in France. Since then this minimal size requirement has been removed and this change has resulted in catches of immature individuals ( $<14 \mathrm{~cm}$ ), which have recently been targeted and landed.

## A.3. Ecosystem aspects

No information.

## B. Data

## B.1. Commercial catch

Spanish and Portuguese landings are available from mid 1960s while French and UK are available from around 1975 to present. The English Channel fishery is primarily carried out by the Netherlands and the UK.

## B.2. Biological

France started to collect age, length and maturity data for VIIIa,b at the end of 2007. Between 2007-2008, an otolith exchange program was instigated with the aim of optimising age estimation. Four age readers interpreted an image collection from the Bay of Biscay, the Spanish coasts and the Mediterranean coasts (Spain and Italy). Otoliths from the Bay of Biscay presented the highest percentage of agreement ( $82 \%$ ). Of 75 otoliths, 34 were read with $100 \%$ agreement (45\%) and thus a CV of $0 \%$. Modal age of these fishes was comprised between 0 and 3 years (Mahé et al., 2012).

## B.3. Surveys

Abundance indices at age are available from French EVHOE-WIBTS-Q4 survey and UK WCGFS survey, although this was discontinued in 2004. These surveys do not present any trends. There are few peaks in abundance of striped red mullet in Celtic sea and the Bay of Biscay and the Eastern English Channel. During EVHOE-WIBTSQ4 Survey, 2001, 2003, 2005 and 2009 peaks of abundance ranging from (from 16 to 23 per hour were present. Abundance indices per size class during EVHOE-WIBTS-Q4 show mainly fish between 8 to 17 cm total length and can therefore be used as a recruitment index.

Since 1979, the Portuguese Autumn Groundfish Survey (PtGFS-WIBTS-Q4) covers the whole Portuguese continental coast, within depths ranging from 20 to 500 m . The Portuguese Crustacean Trawl Survey (PtCTS-UWTV) covers the Southwestern and the South regions of the Portuguese continental coast, with depths ranging from 200 to 750 m . Data from these surveys shows that striped red mullet is distributed along the Portuguese coast, at depths ranging between 20 and 700 m . The potential distribution of this species in Bay of Biscay between Spanish and Portuguese coast should also be investigated.

## B.4. Commercial CPUE

Commercial indices were not available but exploration of logbook data may produce useful information.

## B.5. Other relevant data

No information.

## C. Assessment: data and method

For data-limited stocks without information on abundance or exploitation (Category 5) ICES considers that a precautionary reduction of catches should be implemented, unless there is ancillary information clearly indicating that the current exploitation is appropriate for the stock. For this stock, ICES advises that catches should decrease by $20 \%$ in relation to the average catch of the last three years.
D. Short-Term Projection
E. Medium-Term Projections

## F. Long-Term Projections

## G. Biological Reference Points

## H. Other Issues

## I. References

Benzinou, A. Carbini, S. Nasreddine, K. Elleboode, R. Mahé, K. 2012. Discriminating stocks of striped red mullet (Mullus surmuletus) in the Northwest European seas using three automatic shape classification methods, Fisheries Research, submitted.

Carpentier, A. Martin, CS. Vaz, S (Eds.) 2009. Channel Habitat Atlas for marine Resource Management, final report / Atlas des habitats des ressources marines de la Manche orientale, rapport final (CHARM phase II). INTERREG 3a Programme, IFREMER, Boulogne-surmer, France. 626 pp. and CD-rom

Davis, P.S. and Edward, A.J., 1988. New records of fishes from the northeast coast of England, with notes on the rediscovery of part of the type collection of marine fishes from the Dove Marine Laboratory, Cullercoats. Trans. Nat. Hist. Soc. Northumbria, 55 : 39-46.

Dunn, M.R., 1999. The exploitation of selected non-quota species in the English Channel. Lowestoft: 323pp.

Gibson, R.N. and Robb, L., 1997. Occurrence of juvenile red mullet (Mullus surmuletus) on the west coast of Scotland. Journal of the Marine Biological Association of the United Kingdom, 77(3): 911-912.

ICES, 2007. Report of the Working Group on Fish Ecology (WGFE), 5-9 March 2007, Nantes, France. ICES CM 2007/LRC:03. 217 pp.
Mahé, K., Elleboode, R., Charilaou, C., Ligas, A., Carbonara, P. and Intini, S, 2012. Red mullet (Mullus surmuletus) and striped red mullet (M. barbatus) otolith and scale exchange 2011, 30 pp .

ICES. 2012. Report of the Working Group on Assessment of New MoU Species (WGNEW), 5-9 March 2012, . ICES CM 2012/ACOM:20. 258 pp.
Mahé, K. Destombes, A. Coppin, F, Koubbi, P. Vaz, S. Leroy, D. and Carpentier, A. 2005. Le rouget barbet de roche Mullus surmuletus (L. 1758) en Manche orientale et mer du Nord, 186pp.

Quéro, J.C. and Vayne, J.J., 1997. Les poissons de mer des pêches françaises. IFREMER, Ed. Delachaux and Niestlé, 304pp.

## Annex T : Revision of MSY reference points for northern hake

WGHMM was asked to address the following Terms of Reference:
e ) With reference to the recommendation of WKMSYREF, reconsider MSY reference points for northern hake. If possible, also establish precautionary reference points. The application of updated reference points will, however, be contingent on the availability of up to date fishery data to calculate relevant values

## Context

In a special request advice from June 2010, ICES advised that a fishing mortality rate of 0.24 (average over lengths $15-80 \mathrm{~cm}$, which corresponds approximately to ages $1-$ 5) was consistent with MSY. This choice was based on a proposal from WGHMM (ICES, 2010) using the following rationale: "The time-series of spawning biomass and recruitment estimated in Stock Synthesis does not have sufficient contrast to allow direct estimation of $F_{\text {MSY. }} F_{\text {max }}(=0.29)$ would be a potential candidate for $F_{M S Y}$, as the yield-per-recruit curve has a well-defined maximum and discards are incorporated in the assessment and taken into account in the yield-per-recruit computation. Moreover, SSB during the historic period has been capable of increasing under high fishing pressure, suggesting a productive stock. However, an $F$ value of 0.29 corresponds approximately to $F_{24 \% S P R,}$ whereas the guidelines provided by ICES (ICES, 2010b) suggest that F values larger than F30\%SPR might lead to recruitment overfishing. ICES further indicated that values around $F_{35 \% \text { SPR }}$ should be robust $F_{M S Y}$ proxies against stock-recruitment functions and recruitment variability (ICES, 2010c). Taking all this into account and the specific aspects of the northern hake stock, a fishing mortality in the range $F_{35 \% S P R}-F_{\max }$ (i.e. $0.20-0.29$ ) should be selected as $F_{M S Y}$. If a single value is to be chosen within that range, $F_{30 \% S P R}=0.24$ could be a suitable candidate."

## Approach followed by WGHMM

In its recommendations for the estimation of MSY reference points, WKMSYREF considers that attempts should be made to integrate stock recruitment relationships into the analysis and that it should be carried out stochastically. WKMSYREF suggest to use the PlotMSY software (WKFRAME, 2010; WKMSYREF, 2013) which was developed by Cefas in 2010 in order to support the estimation of yield per recruit and MSY-based fishing mortality reference points, and was applied in ICES WGs for a number of stocks. This software programme has, however, been developed for an age-based population dynamics model with yearly time steps. Northern hake is assessed using SS3, with quarterly time steps and with 4 quarterly groups of hake by year (each group corresponding to a quarter of birth), which makes it impossible to use the above mentioned programme. A dedicated analysis has thus been developed for northern hake, similar in approach to PlotMSY, but with a stock dynamics structure based on SS3. Details of the approach are presented in WD 8.

The estimation of MSY reference points is carried out by combining the yield per recruit curve with a stock-recruitment relationship, using an approach based on the replacement line and its intersection with the stock recruitment curve. Three stock recruitment relationships (Ricker, Beverton-Holt and Smooth Hockey stick) are fitted to historical series of recruitment and SSB, estimated by SS3. Uncertainty is incorporated through the parameters of the stock-recruitment relationship only. Uncertainties around the estimates of the parameters are characterised using MCMC sampling. The data used for this analysis come from this year stock assessment ( R and SSB estimates from an assessment carried out over the period 1978 to 2012, Table 3.7.

## Results

The fits of the stock recruitment relationship are presented in Figure 1. Beverton- Holt and Hockey stick model give similar results in terms of expected recruitment levels at high SSB values ( R is around 360 million individuals). Breakpoint of the smooth Hockey-Stick model is estimated at an SSB of about 43000 tonnes. For the Beverton and Holt model, expected recruitment starts to decrease at a similar level. Among the three models, the best fit to the data is obtained with the Hockey stick model as shown by the log-likelihood values obtained for each stock recruitment relationship in Table 1.

Table 1. Results of fitting the model with three parameters. Rmax and S50 relates to the Beverton-Holt model (see WD 8 for details on models equations and parameters).

| S/R MODEL | $\begin{aligned} & \boldsymbol{\alpha} \\ & \mathbf{R}_{\text {MAX }} \end{aligned}$ | OR | $\beta$ OR $\mathrm{S}_{50}$ | LOG( $\sigma$ ) | Nb. PAR. | LOG- <br> LIKELIHOOD |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Smooth Hockey Stick | 4.05 |  | 43387 | -0.85 | 3 | 19.68 |
| Beverton-Holt | 368874 |  | 7644 | -0.82 | 3 | 20.78 |
| Ricker | 10.64 |  | 8.99 | -0.75 | 3 | 23.28 |

Equilibrium yield and SSB based on the three stock and recruitment models estimates are presented in Figures 2 to 4, together with box plots of $\mathrm{F}_{\mathrm{mSY}}$ and $\mathrm{F}_{\text {crash, }}$ and proxies for $F_{\text {msy }}$ based on the yield per recruit ( $\mathrm{F}_{\max }, \mathrm{F}_{0.1}$ ), and based on SSB per recruit ( $\mathrm{F}_{30 \%}$ and $\mathrm{F}_{35 \%} \mathrm{SPR}$ ). Values of F reference points estimated for the 3 stock recruitment relationships are presented in Table 2. Natural mortality (sometimes also considered as a potential $\mathrm{F}_{\mathrm{MSY}}$ proxy) for this stock is assumed to be $\mathrm{M}=0.4$.

For the three $\mathrm{S} / \mathrm{R}$ models, Fmsy is estimated with reasonably tight bounds (although it must be noted that only a rather limited amount of uncertainty has been incorporated in the analysis) and well below $\mathrm{F}_{\text {crash. }} \mathrm{F}_{\text {crash }}$ is estimated the lowest of all for the Hock-ey-stick model (0.95). Estimates of $\mathrm{F}_{\text {MSY }}$ for the Hockey-stick and the Beverton and Holt models are 0.30 and 0.28 , respectively, not "very far" from the current FMSY proxy $\mathrm{F}_{30 \%}$, which is estimated to be 0.24 . As expected, particularly given the shape of the Ricker SR fit in Figure 1, Fmsy for the Ricker model is higher, 0.53. \%SPR at Fmsy are similar for Hockey-Stick and Beverton-Holt ( $24 \%$ and $26 \%$ respectively). It is much lower for the Ricker model : $11 \%$.

Table 2. Estimates of $F$ reference points for 3 stock-recruitment relationship (for FMSY and Fcrash, the median values are presented together with the $5 \%$ and $95 \%$ quantiles)

|  |  | per recruit analysis | Hockey-Stick | Beverton-Holt | Ricker |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{F}_{2012}$ | 0.24 |  |  |  |  |
| Fcrash |  |  | 0.95 [0.87 ; 1.11] | 1.74 [1.33; 2.18] | 1.07 [0.97; 1.19] |
| FMSY |  |  | 0.30 [-;-] | 0.28 [0.26; 0.29] | 0.53 [0.48; 0.58] |
| \%SPR at FMSY |  |  | 24\% | 26\% | 11\% |
| $\mathrm{F}_{\text {max }}$ |  | 0.30 |  |  |  |
| $\mathrm{F}_{0.1}$ |  | 0.20 |  |  |  |
| $\mathrm{F}_{35}$ \% |  | 0.21 |  |  |  |
| $\mathrm{F}_{30}$ \% |  | 0.24 |  |  |  |

## Conclusions and recommendations

The historical development of the stock and the results of this analysis point towards a possible revision of the current $\mathrm{F}_{\text {MSY }}$ value (set at $\mathrm{F}_{30 \%}=0.24$ ). It is worth noting that when FMSY was set in 2010, only a time series for 1990-2009 was available. Since then, it has been possible to incorporate data starting from 1978 in the SS3 stock assessment. By extending the assessment to start in 1978, the current assessment displays
much more contrast, in terms of values of SSB and F estimated throughout the time series, than the assessment available in 2010. It is also worth noting that if the Fmsy value estimated assuming a Ricker stock recruitment relationship corresponds to $\mathrm{F}_{11 \%}$, a value higher that $\mathrm{F}_{20 \%}$ (equal to 0.35 ) which is generally considered by ICES to be the upper limit of potential $\mathrm{F}_{\mathrm{mSy}}$ proxies ( $\mathrm{F}_{40 \%}$ to $\mathrm{F}_{20 \%}$ ), $\mathrm{F}_{\text {MSY }}$ estimated assuming HockeyStick and Beverton-Holt are in the range of such potential proxies.

Once more, it is important to note that the only source of uncertainty which has been accounted for in the analysis is coming from the parameters of the stock-recruitment relationship. Incorporating more sources of uncertainty is needed in order to analyse the impact of fishing at a selected Fmsy on stock biomass (e.g. to obtain a realistic estimate of the probability that long-term SSB is below Blim, which should be very low, of the order of 0.05 or less). It must be ensured that the selected Fmsy is within precautionary limits. The analysis would include uncertainty on the biological parameters, such as natural mortality, maturity, mean weight at length, and fishery parameters such as selectivity at length by fleet.

The working group thus considers that it would be premature to give advice on a revised value of Fmsy until further analyses are carried out. WGHMM recommends that this issue be addressed during next benchmark which is plan for 2014.


Figure 1. Northern hake stock-recruit fits for Ricker (top), Beverton-Holt (middle) and smooth hockey stick (bottom). The left hand figures illustrate the 95th, 90th, median, 10th, and 5th percentiles from the MCMC samples, plotted with the assessment data points; the right hand figures provide 100 illustrative re-samples. The estimates derived from MCMC sampling are in red; the deterministic estimates in blue.

## Northern hake - Hockey stick



Figure 2. Northern hake yield and SSB based on the Hockey-stick stock and recruitment model estimates. Top: box plots of Fmsy and Fcrash with proxies for Fmsy based on the yield per recruit: Fmax, $\mathrm{F} 0.1, \mathrm{~F} 30 \%$ and $\mathrm{F} 35 \%$ SPR also F in the final year; middle: equilibrium landings versus fishing mortality; bottom: equilibrium SSB versus fishing mortality. The left hand figures illustrate the 95th, 90 th, median, 10 th, and 5 th percentiles from the successful MCMC samples, plotted with the assessment data points; the right hand figures provide 100 illustrative re-samples. The estimates derived from MCMC sampling are in red; the deterministic estimates in blue.

Northern hake - Beverton and Holt


Figure 3. Northern hake yield and SSB based on the Beverton and Holt stock and recruitment model estimates. Top: box plots of Fmsy and Fcrash with proxies for Fmsy based on the yield per recruit: Fmax, $\mathrm{F} 0.1, \mathrm{~F} 30 \%$ and $\mathrm{F} 35 \%$ SPR also F in the final year; middle: equilibrium landings versus fishing mortality; bottom: equilibrium SSB versus fishing mortality. The left hand figures illustrate the 95 th, 90 th, median, 10 th, and 5 th percentiles from the successful MCMC samples, plotted with the assessment data points; the right hand figures provide 100 illustrative resamples. The estimates derived from MCMC sampling are in red; the deterministic estimates in blue.

## Northern hake - Ricker



Figure 4. Northern hake yield and SSB based on the Ricker stock and recruitment model estimates. Top: box plots of Fmsy and Fcrash with proxies for Fmsy based on the yield per recruit: Fmax, $\mathrm{F} 0.1, \mathrm{~F} 30 \%$ and $\mathrm{F} 35 \%$ SPR also F in the final year; middle: equilibrium landings versus fishing mortality; bottom: equilibrium SSB versus fishing mortality. The left hand figures illustrate the 95th, 90 th, median, 10th, and 5th percentiles from the successful MCMC samples, plotted with the assessment data points; the right hand figures provide 100 illustrative re-samples. The estimates derived from MCMC sampling are in red; the deterministic estimates in blue.

## Annex U: Audit Reports

## Audit of Bay of Biscay Sole in Div VIIIa,b

Date: 16/5/2012
Reviewer: Santiago Cerviño

## General

- The assessment and projections follow the stock annex
- There is uncertainty in the estimated Fmax (Fmsy proxi) in recent year

For single stock summary sheet advice:

1) Assessment type: update
2) Assessment: analytical
3) Forecast: MFDP
4) Assessment model: XSA with 4 CPUEs
5) Data issues: survey, discards and maturity ogive
6) Consistency: Model accepted last year. No changes this year.
7) Stock status:
a. Fmsy $\rightarrow$ abobe targets
b. Fpa $\rightarrow$ increased risk
c. MSY B trigger $\rightarrow$ above B trigger
d. Bpa/Blim: full reproductive capacity
8) Man. Plan.: Recovery plan achieved in 2008. Long term management plan not already defined.

## General comments

This was a well documented, well ordered and considered section. It was easy to follow and interpret.

## Technical comments

DATA:
The paragraph in section "6.2.3 Abundance indices from surveys" starting with "The figures or tables starting with a...." Is a comment about XSA residuals and it should be better in the "Assessment" section.

A possible increase in 2012 catchability for ORHAGO survey, for ages 4-8 was identified. However in the CPUE section is commented that Survey (biomass) and CPUEs show similar trends than ORHAGO survey.

## ASESSMENT

The assessment follows stock annex.
This year, the inclusion of the Orhago survey CPUE (FR-ORHAGO) is explored to compare the assessment with and without this survey $y$. Two runs are presented in the report: with and without the survey

Exploratory runs and separable are saved in ICES files.
PROJECTIONS
Follows stock annex.
Section 6.3.4 "Catch options and prognosis", the paragraph about weight at age in landings is explained before in the report and also in the technical annex. Could be deleted here.

## REFERENCE POINTS

Fmax (Fmsy proxi) is 0.26 based on the WGHMM 2010. Fmax estimated this year is 0.38. The WG 2012 decided to not change the Fmsy outside a benchmark procedure.

## Conclusions

The assessment has been performed following the stock annex.
Additionally, an alternative run with a new survey (ORHAGO) with ages 2-7 and years 2007-12 was presented. The results show that this index may contribute to improve the quality of the model results, particularly for recruitments.

There is an important shift of Fmax in recent years. The reasons for this change are unclear and should be explored, e.g. recent changes in weight at age? Recent changes in selection pattern, why? The YPR curve seems to show a maximum in a relatively flat area, making their estimation more sensitive to changes weights or exploitation patterns. Alternatives proxis for Fmsy should also be explored if Fmax is not considered a stable proxi.

## Checklist for review process

## General aspects

- Has the EG answered those TORs relevant to providing advice? YES
- Is the assessment according to the stock annex description? YES
- Is general ecosystem information provided and is it used in the individual stock sections. THE ECOSYSTEM INFORMATION IS IN THE STOCK ANNEX
- If a management plan has been agreed, has the plan been evaluated? The recovery plan goals were achieved in 2008 however a long term management plan was not defined.


## For update assessments

- 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?


# Audit of Anglerfish (L. budegassa) in Divisions VIIb-k and VIIIa,b,d 

Date:
May 23th, 2013
Reviewer: Ricardo Alpoim

## General

There are good signs from surveys indices (e.g. recruitment), LPUEs and landings, which supports that continuing fishing at present level should not harm the stock. Preliminary information on discards reveals that some measures should be taken in account to preserve the recent recruitment. Data issues constitute a major constraint to the implementation of a more complex assessment.

For single stock summary sheet advice:

1) Assessment type: update
2) Assessment: LPUE and survey trends
3) Forecast: not presented
4) Assessment model: DLS, Category 3.2.0
5) Data issues: The data used in the assessment was consistent with the description in the stock annex. The following data issues were highlighted to be examined in near future (prior or at next benchmark):
a. Standardized LPUE
b. Growth pattern validated
c. Maturity ogives
d. Length distributions of landings and discards
e. Species split in the landings
6) Consistency: Both survey indices, LPUE and landings show a consistent increase in recent years coupled with a decrease in fishing effort.
7) Stock status: Survey indices well above the average. Evidence of good recruitments in recent years.
8) Man. Plan.: None

## General comments

This WG report was well written, concise and documented the assessment well. The input data were clearly described as were various data issues and their possible effects. Ecosystem aspects were included in the stock annex.

## Technical comments

The input data and assessment have been used as specified in the stock annex.

## Conclusions

Data constraints do not allow a better assessment. Data issues were identified and proposed to be tackled in the near future or at the next benchmark. A tentative date for the benchmark was agreed for 2016.

The assessment has been performed correctly and the update assessment gives a valid basis for advice.

## Checklist for review process

## General aspects

- Has the EG answered those TORs relevant to providing advice?
- Is the assessment according to the stock annex description?
- Is general ecosystem information provided and is it used in the individual stock sections.
- If a management plan has been agreed, has the plan been evaluated?

For update assessments

- 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?


# Audit of Lophius budegassa in Divisions VIIIc and IXa 

Date 23/5/2013
Reviewer: Ane Iriondo/Esther Abad

## General

- General WGHMM ToRs have been answered. ToR(c) was discussed during the WG, considering a benchmark in 2016 to resolve this issue.
- The assessment and projections follow the stock annex. There is a general problem with the stability of the ASPIC model.
- 2014 advice is provided.


## For single stock summary sheet advice:

1 ) Assessment type: update
2 ) Assessment: analytical
3 ) Forecast: presented
4 ) Assessment model: ASPIC (v. 5.34.9)- two Portuguese LPUE Series: PTTRC9a (1989-2012) and PT-TRF9a (1989-2012) and one Spanish: SPCORTR8c (1982-2012)

5 ) Data issues: Use of 2011 and 2012 official Spanish data. The data used in the assessment were consistent with the description in the stock annex.

6 ) Consistency: Last year assessment accepted. This year assessment accepted.

7 ) Stock status: Biomass at the beginning of 2013 is estimated to be below BMSY but above MSY $B_{\text {trigger. }}$. Fishing mortality is estimated to be below FMSY.

8 ) Man. Plan.: As part of the Recovery Plan for the Southern hake and Iberian Nephrops stocks (Council Regulation (EC) No.2166/2005), fishing effort regulations are affecting the Spanish and Portuguese mixed trawl fisheries. As anglerfish are taken in these mixed trawl fisheries, these stocks are also affected by the recovery plan effort limitation. No particular management plan for anglerfish is defined..

## General comments

This section is well explained and the data and results are well presented.

## Technical comments

The input data and assessment have been used as specified in the stock annex.

The assessment results are considered uncertain, due to the large confidence intervals and the large uncertainties around Bmsy and Fmsy. However, the inclusion of the Spanish Commercial LPUE SP-CORTR8c tuning fleet must be considered an improvement in the assessment model, covering an extended part of the stock distribution.

Tables 8.2.6 and 8.2.10 - it is very difficult to read these tables because of the characters are very small.

## Conclusions

The assessment is well presented and correctly performed, following the stock annex.
The instability of the model requires more effort in trying to use the SS3 model which seems appropriate for this stock as it was demonstrated during the benchmark (WKFLAT 2012).

## Checklist for review process

## General aspects

- Has the EG answered those TORs relevant to providing advice? YES
- Is the assessment according to the stock annex description? YES
- Is general ecosystem information provided and is it used in the individual stock sections. THE ECOSYSTEM INFORMATION IS IN THE STOCK ANNEX
- If a management plan has been agreed, has the plan been evaluated?

For update assessments

- 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?


# Audit of Megrim (Lepidorhombus whiffiagonis) in Divisions VIIb-k and VIIIa,b,d 

Date 05/27/213
Reviewer: Iñaki Quincoces

## General

No estimates of the stock population structure and SSB are available. An analysis of surveys trends and age abundances has been used.

Data issues constitute a major constraint to the implementation of a more complex assessment.

## For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM!

1) Assessment type: SALY
2) Assessment: trends based on surveys and age composition of catches
3) Forecast: not presented
4) Assessment model: DLS, Category 3.2.0
5) Data issues: The data used in the assessment was consistent with the description in the stock annex. Data for 2011 and 2012 has been updated
6) Consistency: Last year was accepted but with concerns about Spanish data availability, this year the problem has been solved. This year computational problems made impossible to run the Bayesian model for trends that is in the stock annex.
7) Stock status: Catch, landing and discard data and survey indices do not appear to indicate the presence of important change in trends of recruitment or the overall biomass. In the context of the current trend analysis and in view of available data the stock appears stable at the present level of fishing.
8) Man. Plan.: None

## General comments

This WG report was well written, concise and documented the assessment well. The input data were clearly described as were various data issues and their possible effects. Ecosystem aspects were included in the stock annex.

## Technical comments

The use of a model that needs a lot of time or computational power with the time restrictions of a working group and the narrow time lapse between data reception and the meeting could be a problem as seen this year. It could be advisable to explore faster kinds of approaches to perform the analysis.

## Conclusions

Data constraints do not allow a better assessment. Data and operational issues were identified and proposed to be tackled in the near future or at the next benchmark.

The assessment has been performed correctly and the update assessment gives a valid basis for advice.

# Audit of Megrims in Divisions VIIIc and IXa (Lepidorhombus whiffiagonis) 

Date: May 2013
Reviewer: Muriel Lissardy

Audience to write for: advice drafting group, ACOM, benchmark groups and EG.

## 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!

1) Assessment type:update
2) Assessment: analytical
3) Forecast: presented
4) Assessment model: XSA- tuning by 2 commercial + 1 survey
5) Data issues: Data are available as describe in the stock annex. It is recommended to continue with the collection of discards data.
6) Consistency: assessment carried out according to stock annex. The Spanish landings and unallocated landings have been added for 2011.
7) Stock status: Fmsy at 0.17 ( $\mathrm{F} 40 \%$ ) was proposed in 2010. F is estimated to have been below this value since 2009. This year F is slightly above Fmsy (0.19 in 2012).
8) Man. Plan.: As part of the Recovery Plan for the Southern hake and Iberian Nephrops stocks (Council Regulation (EC) No.2166/2005), in force since January of 2006, the fishing effort regulations are affecting the Spanish and Portuguese mixed trawl fisheries. As megrims are taken in these mixed trawl fisheries, these stocks are also affected by the recovery plan effort limitation. No particular management plan for megrims. No specific management objectives are known to ICES

## General comments

This was generally easy to follow and clearly described.
Discards estimates are available for Spain. Discards in number represent between 10$45 \%$ of the total catch. Discards data are not yet used in this assessment due to the lack of data in some years of the series. It is therefore recommended to continue with the collection of discards data to provide annual estimates with a view to incorporate them in the assessment soon.

Comparison of this assessment with the one performed in 2011 shows different trends for final years F and recruitment and similar for SSB, but with high increases.

There was a strong declining trend in the fishing mortality between 2006 and 2010. The projections have been based on the Fsq (3y mean) which therefore overestimates the real F for the intermediate year.

In the short-term forecast the recruitment value for 2012 was derived from a geometric mean

## Technical comments

Well made standard XSA assessment according to the stock annex.
The errors contains in the report was corrected during the WGHMM with the stock assessor.

## Conclusions

The assessment has been performed correctly.
The two megrim species (L. whiffiagonis and L. boscii) are managed under a common TAC. They are caught and recorded together in the landings statistics. 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. The two stock have the same increased in the SSB in recent years.

## Checklist for review process

## General aspects

- Has the EG answered those TORs relevant to providing advice?
- Is the assessment according to the stock annex description?
- Is general ecosystem information provided and is it used in the individual stock sections.
- If a management plan has been agreed, has the plan been evaluated?

For update assessments

- 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?


## Audit of Four-spot megrim in VIIIc and IXa [mgb89a]

Date: 16/05/2013
Reviewer: José Castro

## General

WGHMM TORs have been answered. Advice was given (ToR a), and the approaches proposed to be implemented on the benchmark next year (ToR b) can improve the current assessment.

The inclusion of discards in the assessment requires filling out its time series, currently incomplete. This can be achieved by inter-seasonal work in the National laboratories, or by applying statistical models, as a Bayesian approach, able to estimates missing values. The standardization of the commercial LPUE requires splitting the SP-CORUTR8c tuning series into the two métiers in which is compounded.

The assessment is according to the stock annex description, except for minor changes (extension of taper time).

Assessment, recruitment and forecast model applied as specified in the stock annex. The results permit to update the advice for 2014. Last year the projections for catch options and management advice had to be based on the assessment conducted in 2011.

## For single stock summary sheet advice:

1) Assessment type: update
2) Assessment: analytical
3) Forecast: presented
4) Assessment model: XSA - tuning by 1 comm +1 surveys
5) Data issues: use of 2011 and 2012 official Spanish data. The differences with the scientific estimates, traditionally used in the rest of the time series, were added as unallocated catches in order to follow the data description in stock annex. The only change in the setting was the extension of the taper time from 20 years to 23 years.
6) Consistency: Last yr assessment accepted - this yr also accepted.
7) Stock status: $\mathrm{F}<\mathrm{Fmsy}$, $\mathrm{Bmsy}_{\text {mo }}$ no defined, R increasing in recent years
8) Man. Plan.: there is no management plan for this stock. Indirectly, it could be affected by the southern hake MP, which establish a $10 \%$ annual effort reduction since 2005.

## Technical comments

The increase of 2012 effort of the commercial tuning fleet, contrary to the recent trend observed, needs to be better explained in the report.

## Conclusions

The assessment has been performed correctly.

# Audit of Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa, b, d (northern stock) 

Date: 10-16 May 2013
Reviewer: Lisa Readdy

## General

WGHMM2013's assessment deviated from the stock annex due to model convergence and a strong retrospective pattern; these deviations were explained fully in the report and accepted by the group.

Discards from countries which have recorded zero discards historically are now estimated to be discarding large quantities in the most recent years and these are not included in the model.

## For single stock summary sheet advice:

1) Assessment type: update
2) Assessment: analytical
3) Forecast: presented
4) Assessment model: Stock Synthesis 3 (SS3) length based assessment - tuning by four surveys
5) Data issues: Data have been supplied for landings from all countries and discards from some countries. Missing raised discards from countries which have recorded zero discards historically are now estimated to be discarding large quantities in the most recent years and these are not included in the assessment. Where both official and scientific landings are presented to the working group the scientific landings where used in the assessment.
6) Consistency: WGHMM2013's assessment deviated from the assessment carried out according to the benchmark assessment in 2011 and the WGHMM2011's accepted assessment. The only differences were to the growth parameters which were fixed to those estimated from the WGHMM2011 assessment.
7) Stock status: Blim, Flim and Fpa have not been defined for this stock.
8) Man. Plan.: Agreed in 2004 but is no longer appropriate: SSB above 140000 t by reducing fishing mortality to 0.25 , with a maximum TAC change between years of $15 \%$. Technical measures for the Northern Hake stock recovery plan include mesh size restrictions, minimum landings sizes and area closures.

## General comments

Only the draft report was available at the time of this review and it was a well documented, well ordered and considered stock annex and section. It was easy to follow and interpret. Where deviations from the stock annex occurred a sensitivity analysis was carried out, presented to the working group and included in the main report at section three.

## Technical comments

WGHMM2013 assessment of Northern Hake does not follow the stock annex because of the issues discussed in section three of the main report. With the exception of the deviation outlined in the main report the assessment was carried out in accordance with the stock annex.

The assessment model according to the annex continues to estimate growth at a higher rate with each additional year's data; this estimate is then applied across the full time-series.

Discard data remains a problem as countries newly recording discards are not included in the assessment.

## Conclusions

Where possible the assessment has been performed correctly and in accordance with the stock annex. Changes that were made have been described in the main report at section three.

This stock is scheduled to be benchmarked in 2014 and some of the suggestions made during the working group are listed below.

- Sensitivity to different values and methods applied to the growth and natural mortality parameters.
- Analysis to obtain biological reference points such as Fmsy.
- Re-look at the data, fleet combinations and length distributions
- Inclusion of new discard levels from countries which have historically recorded zero.


## Checklist for review process

## General aspects

- Has the EG answered those TORs relevant to providing advice? Yes
- Is the assessment according to the stock annex description? No, minor changes to growth parameters within the assessment was necessary.
- Is general ecosystem information provided and is it used in the individual stock sections? Yes, The ecosystem information is in the stock annex.
- If a management plan has been agreed, has the plan been evaluated? The management plan was agreed in 2004 but is no longer appropriate.


## For update assessments

- 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? No, minor changes to growth parameters within the assessment was necessary.
- Is there any major reason to deviate from the standard procedure for this stock? Yes, non-convergence of the model and retrospective patterns.

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes.

## Audit of (Southern Hake)

Date 15/5/2013
Reviewer: Eoghan Kelly

## General

- Gadget model was updated with 2012 data
- Assessment is valid for providing 2013 advice
- Data issues should be resolved for next year


## For single stock summary sheet advice:

1 ) Assessment type: update
2 ) Assessment: analytical
3 ) Forecast: presented
4 ) Assessment model: gadget model - tuning by 2 commercial +3 surveys (inclusive discards)
5 ) Data issues: unallocated landings; landings length distribution in 2009 and 2010 corrected; Portuguese survey in 2012 not performed; Portuguese CPUE in 2011 and 2012 not available.

6 ) Consistency: Last year's (2012) assessment accepted. F decreased in 2012 (0.57) but is still well above Fmax (0.24), the suggested Fmsy proxy. SSB continues increasing trend. Recruitment estimates for the last year in the assessment highly uncertain and replaced by the geometric mean. Retrospective pattern has a tendency to overestimate SSB and underestimate F.

7 ) Stock status: No biomass reference points are defined for this stock, but F has been above the proposed Fmsy proxy (Fmax) for the entire time series ( $\mathrm{Fmax}=0.24$ ). R uncertain, higher than average in recent years.
8 ) Man. Plan.: A recovery plan agreed by EU in 2005, and enforced since 2006. SSB above 35000 t by 2016 and to reduce fishing mortality to 0.27 . The main elements in the plan are a $10 \%$ annual reduction in F and a $15 \%$ constraint on TAC change between years. Plan is not evaluated by ICES.

## General comments

Only draft report was available for review but this section was well structured and easy to follow.

Use of unallocated designation for dealing with discrepancy between official and scientific estimates of landings was well explained.

## Technical comments

Unallocated landings were included in this year's catch data to deal with difference between official landings and scientific estimates of landings.

The Portuguese bottom trawl survey was not carried out in 2012 and Portuguese CPUE data were not available for 2011 and 2012.

Length frequency distributions from Cadiz fleet was included in main fleet from 2005-12.

Mean length at maturity has decreased in recent years and 2012 value of 31.5 cm is the lowest in the time series.

The 2012 recruitment has been substituted with a GM from 1989-2011. Given the drop in F (2012), the assumption of Fsq, using a three year mean, may not be appropriate.

## Conclusions

The assessment and the forecast have been performed correctly, and can be used as a basis to provide the advice. However, it should be noted that the forecasted yield and stock size for 2014 are dependent on the GM assumption made for recruitments and on the Fsq assumption.

The absence of 2012 Portuguese survey and Portuguese commercial index are the only contradictions with the stock annex.

## Checklist for review process

## General aspects

- Has the EG answered those TORs relevant to providing advice? Yes.
- Is the assessment according to the stock annex description? Yes, apart from the absence of 2012 Portuguese survey and Portuguese commercial index.
- Is general ecosystem information provided and is it used in the individual stock sections? Yes, although not included quantitatively.
- If a management plan has been agreed, has the plan been evaluated? No.

For update assessments

- Have the data been used as specified in the stock annex? Yes, but two Portuguese indices (PtGFS-WIBTS-Q4 and P-TR) were not updated in 2012.
- 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.


## Audit of Anglerfish (L. piscatorius) in Divisions VIIb-k and VIIIa,b,d

Date: May 23, 2013
Reviewer: Cristina Silva

## General

- Assessment based on analysis of trends. WKFLAT 2012 did not find an acceptable method for providing analytical assessment.
- LPUEs and survey data indicate increase in biomass and evidence of good recruitments in recent years, supporting that continuing fishing at present levels should not harm the stock.
- Preliminary information on discards reveals that some measures should be taken in account to preserve the recent recruitment.
- Data issues constitute a major constraint to the implementation of a more complex assessment.


## For single stock summary sheet advice:

1) Assessment type: update
2) Assessment: LPUE and survey trends
3) Forecast: not presented
4) Assessment model: DLS, Category 3.2.0
5) Data issues: The data used in the assessment were consistent with the description in the stock annex. The following data issues were highlighted to be examined in near future (prior or at next benchmark):
a. Standardized LPUE
b. Growth pattern validated
c. Maturity ogives
d. Length distributions of landings and discards
e. Species split in the landings
6) Consistency: Both survey indices, LPUE and landings show a consistent increase in recent years coupled with a decrease in fishing effort.
7) Stock status: Survey indices well above the average. Evidence of good recruitments in recent years.
8) Man. Plan.: None

## General comments

This WG report was well written, concise and the assessment well documented. The input data were clearly described as were various data issues and their possible effects. Ecosystem aspects were included in the stock annex.

## Technical comments

The input data and assessment have been used as specified in the stock annex.

## Conclusions

Data constraints do not allow a better assessment. Data issues were identified and proposed to be tackled in the near future or at the next benchmark. A tentative date for the benchmark was agreed for 2016.

The assessment has been performed correctly and the update assessment gives a valid basis for advice.

## Checklist for review process

## General aspects

- Has the EG answered those TORs relevant to providing advice?
- Is the assessment according to the stock annex description?
- Is general ecosystem information provided and is it used in the individual stock sections.
- If a management plan has been agreed, has the plan been evaluated?

For update assessments

- 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?


## Audit of Anglerfish (Lophius piscatorius) in Div VIIIc and IXa

Date: 23/5/2012
Reviewer: Yolanda Vila

## General

- The assessment and projections follow the stock annex (benchmarked in 2012)
- The model seems to be sensitive to changes in the initial values of parameters.


## For single stock summary sheet advice:

9) Assessment type: update
10) Assessment: analytical
11) Forecast: Presented
12) Assessment model: SS3 with 2 CPUEs and 1 survey
13) Data issues: Use of 2011 and 2012 official Spanish data. Cedeira CPUE in 2012 is not available.
14) Consistency: Updated assessment changes the low bound of the parameter 2 relative to selectivity of the abundance index and from retrospective analysis, recruitment seems to be sensitive to the recent year's exclusion.
15) Stock status: $\mathrm{F}<\mathrm{F}_{\text {MSY, }}$ MSY-Btrigger no defined, R remains stable in recent years.
16) Man. Plan.: There is no management plan for this stock. Indirectly, it could be affected by the southern hake MP, which establish a $10 \%$ annual effort reduction since 2005.

## General comments

This was a well documented, well ordered and considered section. It was easy to follow and interpret

## Technical comments

Retrospective analysis performed indicates that the model was sensitive to remove one year of data and the convergence was not possible. Assessment model seems to be sensitive to changes in the initial parameters.

Despite the Fmsy proxy accepted is Fo.1, which value is higher than FSQ, there is no comment about the other F values as $\mathrm{F}_{40 \%}$, $\mathrm{F}_{35 \%}$ and $\mathrm{F}_{30} \%$.

## Conclusions

The assessment has been performed following the stock annex.

## Checklist for review process

## General aspects

- Has the EG answered those TORs relevant to providing advice? YES
- Is the assessment according to the stock annex description? YES
- Is general ecosystem information provided and is it used in the individual stock sections. THE ECOSYSTEM INFORMATION IS IN THE STOCK ANNEX
- If a management plan has been agreed, has the plan been evaluated?


## For update assessments

- 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?


## Annex V: Stock Data Problems Relevant to Data Collection - WGHMM

| Stock | Data Problem | How to be addressed in | By who ${ }^{1}$ |
| :---: | :---: | :---: | :---: |
| Stock name | Data problem identification | Description of data problem and recommend solution | Who should take care of the recommended solution and who should be notified on this data issue. |
|  <br> 8abd | Discards availability | Lack of discard data from the French fleets. | Ask the DPMA to supply these data as soon as possible (at least one month before WG( May) |
|  <br> 8abd | Discards quality | Revision of UK discard data series | CEFAS to review data series, specially 2011 \& 2012 |
| $\text { Meg } 7 \text { \& }$ <br> 8abd | Tuning fleets | Scrutinising FU04 for further segmentation (level 6 DCF (metier level)) | IFREMER to provide FU LPUE data series reviewed |
| Ang-78ab | Discards availability | Asking all MS to give the discard estimations and associated LDs | Stock coordinators will send a letter asking MS to provide data |
| Ang-78ab | Maturity data | Maturity data from all the DCF years is needed for construct a new maturity give | Stock coordinators will send a letter asking MS to provide data |
| Ang-78ab | Length distributions quality | The length range of the species make too difficult to obtain LDs of good quality specially for larger individuals that usually show a scattered pattern | Ask MS for an intensification of the sampling effort |
| Ang-78ab | Ageing or growth pattern unknown | In order to use length based models it's necessary to have a good ageing of the species or unless a good knowledge of the growth pattern | Ask MS for a research program in order to address the problem |
| Nep-30 | Length distributions coverage | Although concurrent sampling onboard is carried out in all months, there is a poor coverage of Nephrops catches outside of the fishing season. Sampling onboard must be complemented with Nephrops direct sampling in the harbours | Ask MS for an intensification of the sampling effort |
| Bss 8ab | Time-series of relative abundance indices on pre-recruit | Refer to UK survey used in seabass assessment in in Divisions IVbc, VIIa and VIId-h | Ask the DPMA to support the fundings of such surveys over the long term (refer to the French BARGIP project for next years) |

[^11]| Stock | Data Problem | How to be addressed in | By who $^{1}$ |
| :--- | :--- | :--- | :--- |
| Bss 8ab | Further studies <br> using tagging, <br> genetics, and other <br> stock and <br> individual markers <br> are needed to more <br> accurately define <br> stock boundaries <br> suitable for <br> assessment and <br> management <br> purposes. | Refer to French pilot tagging <br> program done between 2010 and <br> 2012. | Ask the DPMA to <br> support the fundings <br> of such surveys over <br> the long term (refer to <br> the French BARGIP <br> project for next years) |
| Bss 8ab | representative <br> sampling coverage <br> recreational fishery <br> catches | Refer to French surveys done from <br> 2006 onwards | DCF |
| Bss 8c9a | Time-series of <br> relative abundance <br> indices on pre- <br> recruit | Refer to UK survey used in seabass <br> assessment in in Divisions IVbc, VIIa <br> and VIId-h |  |
| Bss 8c9a | Further studies <br> using tagging, <br> genetics, and other <br> stock and <br> individual markers <br> are needed to more <br> accurately define <br> stock boundaries <br> suitable for <br> assessment and <br> management <br> purposes. |  | representative <br> sampling coverage <br> recreational fishery <br> catches |
| Bss 8c9a |  |  |  |

# Annex W - Interim Benchmark for Bay of Biscay sole 

Bay of Biscay Interim Benchmark, May 2013 (by correspondence)

| Experts: | Steve Flatman, CEFAS |
| :--- | :--- |
| Willy Vanhee, ILVO |  |
|  | Brian Harley, CEFAS |

Secretariat: Barbara Schoute, ICES

Since the stop of the Ressgasc survey in 2003, the assessment of the Bay of Biscay sole has been carried out without any survey index. A new survey (named ORHAGO) has started in 2007 to overcome this lack which has been regretted by numerous review groups and in ICES advises since many years. During the last benchmark (WKFLAT2011), the survey was too short to be included in the assessment, but WKFLAT (2011) recommended to consider the inclusion of the survey as soon the series is 5 years long. Despite the survey being carried out for the 5th time in 2011, the survey data had not been worked out by the time of the 2012 WGHMM and the inclusion of the 2011 survey index in the assessment could not be explored.

This survey is coordinated by the ICES WGBEAM which have approved the calculation method to implement for the Bay of Biscay sole stock abundance index at its 2013 meeting (daylight hauls for a set of reference stations). The quality of this index was analysed by comparing the trends of the log mean standardised CPUE at different ages of each cohort. This analysis shows a good ability of the ORHAGO survey index to track the strongest cohorts.

The following document has been corrected on the basis of the feedback of the three consulted experts. Their detailed comments are in the end of this document.

All of them have agreed on the interest to add the Orhago survey in the 2013 assessment.

# Addition of the French ORHAGO Survey in the XSA tuning fleets of Bay of Biscay sole stock ${ }^{1}$ 

Gérard Biais and Muriel Lissardy, Ifremer, Unité Halieutique Gascogne Sud

## Background

The beam trawl ORHAGO survey was launched in 2007 to fulfil the need of a fishery independent abundance index for the Bay of Biscay sole stock which has been pointed out since many years by successive ICES WG and their review groups and as well as in ICES advises.

The sampling plan was designed to have a full coverage of the sole habitat in the Bay of Biscay and in a period (November-December) during which the fish behaviour and distribution should be in favour of obtaining an unbiased abundance index (young fish moving offshore when coastal waters become colder and before the concentrations of the spawning season). The strategy is a systematic sampling with 49 reference stations. It was validated in 2007 by the WGBEAM which coordinate this survey and to which the results of the survey are reported since its beginning.

Furthermore, the survey was designed to investigate the daylight effect on sole CPUE by towing systematically the beam trawl at night and during the daylight on the same haul positions and the same day. This choice was because the sole catches are known to be higher at night. Consequently, it seemed necessary to check if CPUE during that period might provide a more reliable abundance index than during daylight. This was often underlined by the fishermen who were interviewed when preparing the survey. In a context of an EU multiannual plan for restoring the state of the Bay of Biscay sole stock, it was considered important to get the agreement of the industry on the survey protocol and then the future acceptance of assessments in which the survey will take part.

Five years was estimated to be a minimum range of years for this investigation which was presented at the 2012 WGBEAM. It showed that the night/day CPUE ratio is on average 1.1 but with large year to year variations from 1.0 to 1.4. The improvement in accuracy of the stock assessment due to the use of a night CPUE series to tune it appeared then to be confirmed by comparative assessments which were planned for 2013.

This analysis was presented at the April 2013 WGBEAM and included investigations on the effect of missing values for some stations in some years ( 0 to $20 \%$, depending on the year and the day fishing period). It showed that XSA outputs are slightly sensitive to the choice of night or daylight CPUE series as well as to the number of years that a station might have been hauled. According to these results, the CPUE series based on all the reference stations and carried out by daylight was estimated to be the abundance index to retain for the Bay of Biscay sole. As a consequence, the ORHAGO survey hauls should be carried out only during daylight from 2013 onwards.

[^12]The ORHAGO series has also been presented to the WKFLAT which carried out the first benchmark assessment of the Bay of Biscay stock in 2011. This working group considered that this series should be used to tune the assessment in the near future but that its length was still too short to be inserted in the tuning process in 2011.

## Consistency of the ORHAGO CPUE series regarding year class strength in following years

The quality of the ORHAGO time-series (Table 1) was analysed by comparing the trends of the log mean standardised CPUE at different ages of each cohort (Figure 1). The ability of the ORHAGO survey to track the strongest cohorts is shown by the agreement between age indices of the 2001 and 2007 cohorts, which are the highest in recent years as also estimated by the 2012 WGHMM assessment. It demonstrates that the ORHAGO indices can pick up abundance signals up to ages 7 and $8+$. However, a year effect is noticeable in 2012, year for which an increase of 4 to 8 age group strengths is observed. It let suspect a higher catchability of older age groups in 2012 for which there is no explanation. Nevertheless, the overall ability of the ORHAGO survey to identify year-class strengths consistently across all ages may be estimated at least as good as than the two other commercial tuning fleets which have been added to the tuning fleets by the WKFLAT in 2011 (Figure 2).

## Data screening with XSA

An XSA tuning run (low F shrinkage s.e. $=2.5$, other settings as in 2012 WGHMM tuning) was carried out on data from ORHAGO time series individually. For this run, data files up to 2012 were used to have the same series than the 2013 WGHMM.

No trend was noticed in XSA Log catchability residuals which are small except at age 1 in 2007, and at age 6 in 2008 and in 2010 (Figure 3).

## Sensitivity of the assessment to the addition of ORHAGO time-series to the tuning fleets

The 2007-2011 ORHAGO time-series was added to the 4 tuning series used by the WGHMM to run an XSA in 2012, applying the same settings, to show the sensitivity of the last agreed assessment to the addition of the ORHAGO series. Outputs are only slightly changed (Figure 4) for the fishing mortality (unchanged) and SSB (increased by $6 \%$ in last year) but the recruitment estimate in the last year is increased to a value more in line with recent values. Despite this limited changes, the weight of the ORHAGO survey in age estimate is major, far above the weight of other fleets from age 2 to 6 (Table 2).
The quality of the ORHAGO survey to serve as a tuning index is then confirmed but also that the two commercial tuning fleets added in 2011 by the WKFLAT give a relevant abundance signal. Regarding this issue, it might be particularly useful to have a survey in the tuning file for the 2013 WGHMM because the new use of electronic logbooks has some caused obvious wrong recordings of effort which limit available commercial tuning data in 2012. Consequently, the addition of the ORHAGO survey to the tuning fleets appears to have potential advantage for improving or validating the quality of the Bay of Biscay sole assessment and the use of this survey for this assessment should not be delayed.

Table 1: ORHAGO CPUE (in number/100 km)

|  | Age |  |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Year | $1^{* *}$ | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 2007 | 59.8 | 140.5 | 79.2 | 27.5 | 11.3 | 8.9 | 1.5 | 1 |
| 2008 | 340.3 | 126.7 | 69.8 | 22.1 | 4.1 | 2.4 | 2.8 | 1.2 |
| 2009 | 80.9 | 441 | 87.7 | 17.5 | 4.2 | 1.7 | 0.4 | 2 |
| 2010 | 167.8 | 184.5 | 152.1 | 19.6 | 2.4 | 0.1 | 0.9 | 0.6 |
| 2011 | 93.9 | 175.8 | 60.2 | 23.3 | 3 | 1.5 | 1.7 | 2.9 |
| 2012 | 62.4 | 86.4 | 99.6 | 53.8 | 21.9 | 5.3 | 3.2 | 5.6 |

**: the age 1 is not used in the assessment (range used in tuning: 2-8)

Table 2: Fleet contributions to XSA survivor estimates

|  | Age |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Fleet | 2 | 3 | 4 | 5 | 6 | 7 |
| FR-SABLES | 0.00 | 0.00 | 0.07 | 0.16 | 0.22 | 0.25 |
| FR-ROCHELLE | 0.00 | 0.00 | 0.06 | 0.10 | 0.15 | 0.23 |
| FR-BB-IN-Q4 | 0.00 | 0.17 | 0.13 | 0.19 | 0.19 | 0.18 |
| FR-BB-OFF-Q2 | 0.06 | 0.18 | 0.16 | 0.14 | 0.12 | 0.10 |
| FR-ORHAGO | $\mathbf{0 . 9 1}$ | 0.64 | 0.57 | 0.41 | 0.31 | 0.23 |
| F shrinkage <br> mean | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |



Figure 1: ORHAGO $\log$ mean standardized and $\log$ CPUE trends


Figure 2: Commercial fleet log mean standardized CPUE trends


Figure 3: ORHAGO XSA Log catchability residual plots (individual run, no Taper, mean q, s.e. shrink $=2.5$, s.e. $\min =.2$ )




Figure 4: Comparison of XSA outputs of the 2012 WGHMM XSA outputs to a run with the same settings but with the addition of the ORHAGO survey

## Comments of experts:

Steve Flatman email correspondence:
The survey might be very influential in XSA due to the short time series, but the results with and without the survey are similar, so I don't think that there is a problem.

Do you have any age 1 estimates from the survey? If so these could be used with RCT3 (or XSA if you have time to add in age 1 to all data files!) to give some additional year-class strength information.
With this reply: "A run during the WGBEAM using the age 1 catches and the survey estimate. The age 2 estimate which are very close to the recruitment series. For that reason and also because a change in the recruitment age is a too large change for an interim benchmark, we do not thing that it was not necessary to write something about that trial" and S. Flatman answer: "I think that the document and XSA results look OK."

Final comment: The addition of the survey tuning fleet appears to be useful to the assessment, as it provides a fishery-independent source of data, and possibly more robust estimates of year-class size from younger ages.

Willy Vanhee email correspondence:
I can agree with the inclusion of the new survey index as tuning file in the sole VIIIab assessment.

The observation that it is a short time series is still relevant but as there is an urgent need for an independent tuning index, I think it could be accepted at the moment. The short time series is also inherent to a lower SE compared to a longer times series and therefore account for a possible higher weighting in the final survivor estimates than could be expected from a longer time series. Nevertheless, the short times series appears to be able to track year class strength rather well. The fact that it also appears to be able to track cohorts at older ages looks very promising.

You quite rightly have run a single fleet XSA with the survey and show the residuals plot where all available ages are plotted. However, you do not provide the values for age 1 in the table. I realize that the assessment does not include age 1 , but the age 1 survey index could be used with RCT3 to estimate the incoming recruitment, or give guidance for the value to be used in the forecast. Indeed, that has to be discussed in the Working group to what extend the RCT3 estimate are reliable enough or not. The use of a GM recruitment or RCT3 estimates for the incoming recruitment have to be therefore investigated every year. Can I ask you to provide the survey index for age 1 in the table.

The noisy residuals of age 6 are facts that do happen ... we are not living in a perfect world.

Brian Harley email correspondence:
I have made only 2 comments: "Should this be 'Sensitivity' rather than 'sensibility"" in the text, the rest seems a very good analysis and comment on the survey.


[^0]:    * revised
    ** preliminar

[^1]:    Input units are thousands and kg - output in tonnes

[^2]:    Input units are thousands and kg - output in tonnes

[^3]:    * Spanish Official landings

[^4]:    *Spanish Oficial landings

[^5]:    *Landings, LPUE and fishing effort from fishing trips with at least 10\% Nephrops.
    ** Ayamonte landings are included since 2002

[^6]:    Abstract
    In light of recent revisions to the ICES' guidelines for MSY reference points, WKMSYREF agreed on the need to reconsider MSY reference points for northern hake. WKMSYREF considers that attempts should be made to integrate stock recruitment

[^7]:    ${ }^{1}$ The log-likelihood for the fit to length composition observations from fishery or survey source, is defined according to a multinomial error structure. The absolute value of the sample size (which may be many thousands of fish measured) should not be interpreted literally. The input sample size scales the variance of the data. The recommended maximum level for the sample size was 400 in Fournier and Archibald (1982). In many recent synthesis applications, a value of 200 has been used (which produces an expected coefficient of variation (CV) of approximately $20 \%$ (Methot, 2000)

[^8]:    ${ }^{2}$ The choice of selection pattern was carried out during the 2010 Benchmark (WKROUND 2010) following the following procedure: A preliminary set of model runs indicated that results were sensitive to the degree of flexibility allowed in the shape of the fishery selectivity-at-length patterns. If all fleets are allowed to be dome-shaped, the model cannot unambiguously determine the degree to which large fish exist but are never caught, vs. a result in which these large fish have reduced abundance but remain catchable. Three approaches were used to resolve this issue. First, examination of size composition data from the 1980s indicated that the percentage of large fish in the catch was much higher during the early 1980s and declined to a much lower level by 1990. This indicated that the old fish are catchable when they exist. Second, model runs were conducted with a profile on fixed levels for the degree of domed selectivity for selected fleets. These runs confirmed that the best fit to the size composition data occurred with the maximum domed pattern but the biomass increased to unrealistically high levels when the pattern was fully domed. Third, the overall average size composition of each contemporary fleet was examined and it was found that two fleets, "other trawls in VII and VIII" and "others", had the lowest slope of the right hand side of the length composition. These two fleets were assigned an asymptotic selectivity pattern (two parameter logistic function) and all other fleets were modelled with the flexible double normal pattern. This change stabilized model performance.

[^9]:    ${ }^{1}$ A fraction of Le Guilvinec trawlers (mainly located at the harbour of Loctudy) correspond to a different profile of exploitation from that of traditional vessels which can be used to tune XSA. The typical daily trip for this category consists on longer fishing time than the traditional one. The daily catchability for Nephrops is maximised around dawn and dusk. Then, this fraction of trawlers was removed from the tuning fleet.

[^10]:    ${ }^{1}$ Region 1: All waters which lie to the north and west of a line running from a point at latitude $48{ }^{\circ} \mathrm{N}$, longitude $18^{\circ} \mathrm{W}$; thence due north to latitude $60^{\circ} \mathrm{N}$; thence due east to longitude $5^{\circ} \mathrm{W}$; thence due north to latitude $60^{\circ} 30^{\prime} \mathrm{N}$; thence due east to longitude $4^{\circ} \mathrm{W}$; thence due north to latitude $64{ }^{\circ} \mathrm{N}$; thence due east to the coast of Norway.

    Region 2: All waters situated north of latitude $48^{\circ} \mathrm{N}$, but excluding the waters in Region 1 and ICES Divisions IIIb, IIIc and IIId.

[^11]:    ${ }^{1}$ Recommendations on surveys for be addressed by the SCICOM Steering Group on Ecosystem Surveys, Science and Technology (SSGESST)

[^12]:    ${ }^{1}$ Revised draft, 16 may 2013

