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REPORT OF THE SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES ON

Assessment of Mediterranean Sea stocks – part 1

(STECF 12-19)

Edited by Massimiliano Cardinale, Giacomo-Chato Osio & Aymen Charef

This report was reviewed by the STECF during its 41st plenary meeting held from 5 to 9 November, 2012 in Brussels, Belgium

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TABLE OF CONTENTS

SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

Assessment of Mediterranean Sea stocks - part 1 (STECF-12-19)

THIS REPORT WAS ADOPTED DURING THE PLENARY MEETINGHELD IN BRUSSELS 5 – 9 November 2012

Request to the STECF

STECF is requested to review the report of the **EWG 12-10** held from 16 – 20 July Sète, France, to evaluate the findings and make any appropriate comments and recommendations.

Introduction

The report of the Expert Working Group on Assessment of Mediterranean Sea stocks - part 1 (STECF EWG 12-10) was reviewed by the STECF during the plenary meeting held from 5 to 9 November, 2012 in Brussels, Belgium. The following observations, conclusions and recommendations represent the outcomes of that review.

STECF observations

STECF notes that all ToRs were addressed, with the exception of ToR f. The major ToRs (a-d) were addressed through the assessments of 25 demersal stocks and their fisheries, which resulted in an estimate of the current exploitation rate compared to FMSY. All stock assessed were classified as being exploited unsustainably. The assessment of 2 stocks did not result in a conclusion regarding their exploitation status due to data deficiencies.

STECF also notes that EWG 12-10 devoted considerable time at the meeting to evaluate the quality of the data submitted by Member States in response to the DCF Mediterranean data call in 2012 (ToR e).

The EWG 12-10 undertook revised assessments of the stocks of hake and red mullet in the Aegean and Ionian seas, but rejected the results because of unsatisfactory model fit. Most likely due mainly to the shortness of the time series, the lack of contrasting periods of over- and under- exploitation and the lack of a stock biomass estimate at low level of exploitation. Furthermore, the models were generally found to explain a very small part of the variance observed in the dataset.

STECF noted that its recent assessments of Mediterranean fisheries and stocks of demersal and small pelagic species have delivered very useful information on their past and recent status.

STECF conclusions

STECF endorses the findings and conclusions of the Report of the STECF-EWG 12-10 and wishes to draw particular attention to the following:

23 of the stocks assessed by the EWG 12-10 are being exploited at a rate that exceeds the rate that will deliver maximum sustainable yield (MSY). The assessment of two stocks was inconclusive due to data deficiencies.

In summary:

- **two** stocks in GSA 5, Norway lobster (*Nephrops norgevicus*) and Common octopus (*Octopus vulgaris*)
- **three** stocks in GSA 6, Blue whiting (*Micromestius poutassou*), Red shrimp (*Aristeus antennatus*) and Black-bellied anglerfish (*Lophius budegassa*)
- **three** stocks in GSA 7, European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*) and Black-bellied anglerfish
- **three** stocks in GSA 9, Blue whiting, Sardine (*Sardina pilchardus*) and Poor cod (*Trisopterus minutus*)
- **one** stock of Spottail mantis shrimp (*Squilla mantis*) in GSA 10
- **two** stocks of Hake and Pink shrimp (*Parapaeneus longirostris*) in GSA 11
- **two** stocks of red mullet and Spottail mantis shrimp in GSA 17
- **four** stocks of Norway lobster, Pink shrimp, Red mullet and Spottail mantis shrimp in GSA 18
- **three** stocks of Common Pandora (*Pagellus erythrinus*), Black-bellied anglerfish and Red mullet in GSA 15&16
- stocks of and Spottail mantis shrimp in GSA 6 and 7 could not be assessed due to data limitations

STECF concludes that in order to achieve MSY, effort and/or catches of the fleets' exploiting the above stocks needs to be reduced to levels that will deliver fishing mortality rates at or below their respective F_{MSY} reference values.

STECF recommendations

As a result of its review of the Report of the STECF-EWG 12-10 on assessment of Mediterranean stocks, the STECF has drawn the following recommendations:

1. In an attempt to ensure future data quality and completeness, STECF recommends that DG MARE communicate the detailed comments on data quality and completeness contained in section ** of the EWG 12-10 report to Member States' DCF program national correspondents.

2. Noting that the time and resources required to undertake stock assessments of resources in the Mediterranean are finite and that there is little point in undertaking annual assessments for many of the resources, STECF proposes that the annual requests for stock assessments and advice be focused on a smaller number of stocks. STECF considers that as a rule of thumb, the Committee is unable to adequately deal with more than about 30 assessments per year and proposes that this could be achieved if revised assessments were undertaken biennially. Adopting such an approach would enable better coordination and planning including the appointment of stock co-ordinators and securing availability of appropriate expertise. STECF recommends that DG MARE devise a prioritized biennial schedule for assessments and discuss how such a programme can be incorporated into the annual STECF work programme at the forthcoming STECF Bureau meetings.

REPORT TO THE STECF

EXPERT WORKING GROUP ON Assessment of Mediterranean Sea stocks - part 1 (STECF EWG 12-10)

Sète, France 16-20 July 2012

This report does not necessarily reflect the view of the STECF and the European Commission and in no way anticipates the Commission's future policy in this area

1 EXECUTIVE SUMMARY

The STECF Expert Working Group 12-10 (EWG 12-10) met in Sète (France) from 16 to 20 July 2012 to continue STECF efforts regarding its mandate for the assessments of Mediterranean stock and fisheries. The meeting was chaired by Massimiliano Cardinale and attended by 19 experts in total, including 3 STECF members and 2 JRC experts.

The major ToRs (a-d), the assessment of 25 Mediterranean exploited stocks and fisheries, was addressed by using the data provided through DCF data call for the Mediterranean issued to Member States on 12 April 2012 with deadlines on 18 June 2012.

The assessments of recent and historic stock parameters and fisheries as well as management advice provided in the present report is constrained for the Geographical Subareas (GSA) of France, Greece, Cyprus, Italy, Malta and Spain. Other stocks have been subject to assessment during previous meetings (EWG 11-05 and EWG 11-12). The assessment of exploited stocks and fisheries estimated the stocks' exploitation status, which was evaluated against the proposed F_{MSY} limit.

The EWG 12-10 performed an extensive cross-check of the quality, completeness and accurateness of the data obtained during the DCF Mediterranean data call in 2012 (ToR e). Comments on DCF data quality and availability are outlined under each stock assessment section. A specific effort was devoted to assess the performance of the MEDITS trawl survey gear and the estimation of the swept area parameters.

ToR f was not covered by EWG 12-10 due to lack of experts with specific background as well as time constraints.

Under ToR g (Other Business) EWG 12-10 revised the stock assessments of hake (*Merluccius merluccius*) and red mullet (*Mullus barbatus*) in the Aegean and Ionian seas.

The EWG 12-10 discussed also relevant topics for the following-up EWG meetings within the STECF framework in 2012.

More detailed responses regarding specific conclusions and recommendations are provided in the following two sections of the present report.

2 CONCLUSIONS OF THE WORKING GROUP

ToR a-d) update and assess historic and recent stock parameters: The EWG 12-10 assessed the status of 25 demersal stocks and their fisheries, which resulted in an estimate of the current exploitation rate compared to F_{MSY}. All stock assessed were classified as being exploited unsustainably (Annex II and Figure 1). The assessment of 2 stocks did not result in a conclusion regarding their exploitation status due to data deficiencies.

The EWG 12-10 could provide for the assessed stocks detailed summary sheets informing about the stocks' status and their state of exploitation in relation to proposed management reference points consistent with high long term yields (F_{MSY}).

The STECF EWG 12-10 concludes that the:

- **two** stocks in GSA 5, Norway lobster (*Nephrops norgevicus*) and Common octopus (*Octopus vulgaris*) are subject to overfishing
- **three** stocks in GSA 6, Blue whiting (*Micromestius poutassou*), Red shrimp (*Aristeus antennatus*) and Black-bellied anglerfish (*Lophius budegassa*) are subject to overfishing
- **three** stocks in GSA 7, European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*) and Black-bellied anglerfish are subject to overfishing
- **three** stocks in GSA 9, Blue whiting, Sardine (*Sardina pilchardus*) and Poor cod (*Trisopterus minutus*) are subject to overfishing
- **one** stock of Spottail mantis shrimp (*Squilla mantis*) in GSA 10 is subject to overfishing
- **two** stocks of Hake and Pink shrimp (*Parapaeneus longirostris*) in GSA 11 are subject to overfishing
- **two** stocks of red mullet and Spottail mantis shrimp in GSA 17 are subject to overfishing
- **four** stocks of Norway lobster, Pink shrimp, Red mullet and Spottail mantis shrimp in GSA 18 are subject to overfishing
- **three** stocks of Common Pandora (*Pagellus erythrinus*), Black-bellied anglerfish and Red mullet in GSA 15&16 are subject to overfishing
- stocks of and Spottail mantis shrimp in GSA 6 and 7 could not be assessed due to data limitations

A summary of the assessments from EWG 12-10 and all preceding assessments EWGs have been plotted in Figure 1. The plot is constructed by GSA (each panel) and it includes all species for which an assessment with accepted F_{curr} and F_{msy} has been finalized or attempted since 2009. The ratio F_{curr}/F_{msy} has been calculated and status is classified as overexploited if $F_{curr}/F_{msy}>1$ and as sustainable if $<=1$. The F values are referred to the year in which the assessment was performed (thus it generally refers to the actual F of one year before), assessments pre-2009 were considered outdated.

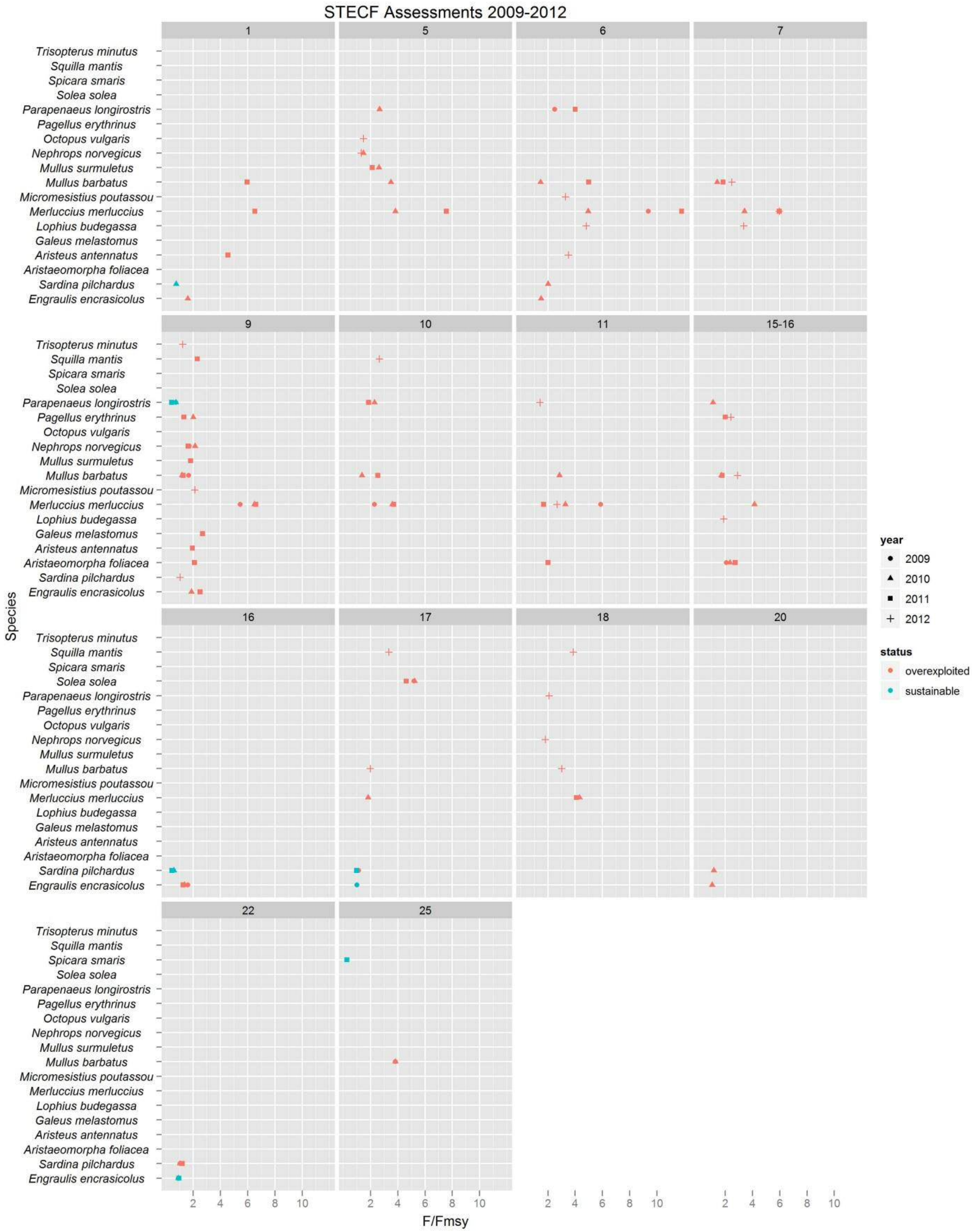


Figure 1. Overview of Mediterranean stock assessments from EWG 12-10 and all preceding assessments EWGs since 2009. Each panel is a GSA and $F/F_{msy}>1$ indicates that a stock is overexploited.

ToR e, DCF data call and data quality: A review of the quality, completeness and accurateness of data resulting from the official Mediterranean DCR/DCF data call issued on April 2012 was performed by the experts for eachassessed stock/GSAs combination. Additionally, MEDITS gear performance was checked against prior submissions. Several data gaps and inconsistencies were identified and are highlighted in the text. Specific recommendations on MEDITS swept area calculation were issued to improve the quality of the data estimated from the survey.

ToR f, mixed fisheries: due to lack of expertise this ToR was not addressed during EWG 12-10.

ToR g (Other Business): The revision of the assessments of the stocks of hake and red mullet in the Aegean and Ionian seas showed consistent results with what has been presented by the Greek authorities within the "Assessments carried out in the context of developing management plan for demersal trawl fisheries in Greece". However, the fit of the models was not satisfactory (likely due mainly to the shortness of the time series, the lack of contrasting periods of over- and under-exploitation and the lack of a stock biomass estimate at low level of exploitation), and the models were generally found to explain a very small part of the variance observed in the dataset. A comparative run carried out using ASPIC was performed for the Aegean hake stock using the same dataset.The results were consistent with these of the R surplus function for B/B_{MSY}, F/F_{MSY} and MSY. However, rather large differences were observed for F, F_{MSY} and *k*. Moreover, ASPIC provided a better fit to the MEDITS survey CPUE time series than the R surplus function. These results generally underline the need of systematic comparisons between alternative and well-established methodologies as those included in the NOAA toolbox (e.g. ASPIC). As in previous STECF reports, the revised assessments were considered only indicative of trends.

Future planning of Mediterranean expert group meetings: The venue of the second meeting, EWG 12-19, will be held in Ancona (Italy)from 10 to 14 December 2012.

3 RECOMMENDATIONS OF THE WORKING GROUP

ToR a-d update and assess historic and recent stock parameters: The EWG 12-10 recommends the reduction of the effort and/or the catches of the relevant fleets' exploiting the following stocks until fishing mortality is below or at the proposed level F_{MSY}, in order to avoid future loss in stock productivity and landings: European hake (*Merluccius merluccius*), in GSA 07 and GSA 11, red mullet (*Mullus barbatus*) in GSA 07, GSA 15&16, GSA 17 and GSA 18, Blue whiting (*Micromestius poutassou*) in GSA 06 and GSA 09, Pink shrimp (*Parapaeneus longirostris*) in GSA 11 and GSA 18, Norway lobster (*Nephrops norgevicus*) in GSA 05 and GSA 18, Black-bellied anglerfish (*Lophius budegassa*) in GSA 06, GSA 07 and GSA 15&16, Spottail mantis shrimp (*Squilla mantis*) in GSA 10, GSA 17 and GSA 18, Common octopus (*Octopus vulgaris*) in GSA 05, Red shrimp (*Aristeus antennatus*) in GSA 06, Sardine (*Sardina pichardus*) in GSA 09 and Common pandora (*Pagellus erythrinus*) in GSA 15&16. TheF_{MSY}target should be reached by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches and effort consistent with F_{MSY} should be estimated.

ToR e data quality and MEDITS survey swept area estimation:

EWG 12-10 reiterates its previous recommendation that obvious errors in wing opening (WO) estimate need to be corrected in the MEDITS database and that corrections should follow a common procedure.

EWG 12-10 recommend a revision of the procedures to monitor trawl gear during MEDITS and the regression formulae used in Italy, Greece, Malta and Cyprus in order to assess if such regression are appropriate and truly reflecting the average gear performance in each year. EWG 12-10 recommends that a statistical analysis should be performed to investigate and quantify the bias in mean CPUE and variance that is introduced by using measured WO vs model derived constant WOs.

EWG 12-10 recommends that the technical features and the performance of the gears used in the MEDITS trawl surveys have to be checked according to a protocol to be defined inside the MEDITS group. For each GSA, gear/boat combination and year, a statistically adequate number of hauls covering the entire depth range must be mandatorily monitored by means of Scanmar/Simrad or similar devices. A report showing the results of the gear performance monitoring per year and GSA should be produced.

ToR f, mixed fisheries: In the absence of appropriate expertise, EWG 12-10 was unable to address the task to further develop mixed fisheries approaches, and EWG 12-10 recommends deferring the task to future meetings.

Other ToR: Assessment in Greek waters: As a general remark, EWG 12-10 notes that the fit of production models are very sensitive to initial parameter, especially b_0/k. Furthermore, the reliability and interpretation of the results is strongly dependent on the length of the time series, the presence of periods with contrasting level of exploitation and fishing effort and the stock being at reasonably unexploited levels at the beginning of the time series.

EWG 12-10 notes also that most of the time series of the Mediterranean stocks are short (rarely more than 20 years of data are available) and likely characterized by an initial state of overexploitation (i.e. low biomass compared to B_{MSY} and high fishing mortality compared to F_{MSY}) as showed by the fact that more than 90% of the stocks recently assessed by STECF is considered largely overexploited compared to MSY. This stresses the crucial need for gathering and incorporating data going as further back as possible in order to capture the earlier stages of the development of the Mediterranean fisheries. This would provide key information to establish the baseline levels needed for a robust assessment of the Mediterranean stocks status.

Although EWG 12-10 recognize the merits of the attempt of the Greek authorities of updating the status of some demersal species in Greek waters, EWG 12-10 consider the present stock assessments for hake and red mullet in Aegean and Ionian Sea as valid only for exploration of trends. In addition, EWG 12-10 consider that assessments based on biological data older than 4 years, as it is the case for hake and red mullet assessment in the Aegean and Ionian Sea, are not reliable for assessing the current status of the stocks and therefore for scientific advice and management.

Previous attempts of assessing the hake stock in the Aegean Sea gave similarly unreliable results that lead to no scientific advice by STEFC. Thus, EWG 12-10 can only reiterate previous SGMED and STECF conclusions on the validity of the stock assessment of hake stock in the Aegean Sea.

Future planning of Mediterranean expert group meetings: The next STECF expert meeting (EWG 12-19: Assessment of Mediterranean Sea stocks - part 2) will be convened on 10-14 December 2012 in Ancona, Italy.

4 INTRODUCTION

The expert working group on Mediterranean stock and fisheries assessment STECF EWG 12-10 held its second out of three meetings planned in 2012in Sete (France), 16-20July 2012.

The chairman opened the meeting at 9.00 am on Monday, 16 July 2012, and adjourned the meeting by 4.00 pm on Friday, 20 July2012. The meeting was attended by 19 experts in total, including 3 STECF members and 2 JRC experts.

The structure of the present report is in accordance with the terms of reference to STECF, as defined in the following chapter.

4.1 Terms of Reference for the STECF EWG 12-10

The STECF is requested to

a) update and assess, by all relevant individual GSAs or combined GSAs where appropriate, historic and recent stock parameters for the longest time series possible of the priority 9 species listed below as well as of other species listed under Annex 7 of the DCF data call issued on April 2012 and relevant for the different fisheries; due account shall be given to technical interactions and description of the concerned fisheries also in terms of fishing effort deployed.

To the extent possible, the assessment shall provide the target (biological, bio-economic), the precautionary (threshold) and conservation (limit) reference points, either model based or empirical. The reference points shall be related to high yields and low risk of stock/fishery collapse and ensure that the exploitation levels maintain or restore marine biological resources at least at levels which can produce the maximum sustainable yield.

Assessment data and methods are to be fully documented with particular reference to the completeness and quality of the data submitted by Member States as response to the official Mediterranean DCF data call issued on April and reminded in June 2012.

Data collected outside the DCR/DCF and/or delivered to the meeting by non-EU scientists, provided they have been duly documented and validated, shall be used as well and merged with DCR/DCF data whenever considered necessary.

Due account shall also be given to data used and assessments carried out by the FAO-regional projects co-funded by the European Commission and EU-Member States in particular when using data collected through the DCF/DCR, EU funded research projects, studies and other types of EU funding.

- Sardine (*Sardina pilchardus*)

•Anchovy (*Engraulis encrasicolus*)

•European hake (*Merluccius merluccius*)

•Common sole (*Solea solea*)

•Red mullet (*Mullus barbatus*)

•Deep-water rose shrimp (*Parapenaeus longirostris*)

•Red shrimp (*Aristeus antennatus*)

•Giant red shrimp (*Aristaeomorpha foliacea*)

•Norway lobster (*Nephrops norvegicus*)

The table below summarizes particular stocks assessed in 2011 and should deserve much lower priority in 2012. Assessment priorityshall be given on stocks/GSAs not yet assessed either analytically or through data-shortage methods; special attention shall be given to demersal stocks in GSA 6, 7, 10, 11, 17, 18, 19, 22/23 and 25.

However, in case the GFCM-SAC has carried out and/or endorsed an assessment for a stock not listed below there is no need to redo the analyses unless new scientific and fishery elements have emerged that calls for a revised assessment.

GSA	Common name	Need to UPDATE since no assessment in 2011
1	Hake	N
1	Pink shrimp	N
1	Red mullet	N
1	Blue and red shrimp	N
5	Hake	N
5	Striped red mullet	N
6	Hake	N
6	Pink shrimp	N
6	Red mullet	N
7	Hake	N
7	Red mullet	N
9	Anchovy	N
9	Common Pandora	N
9	Hake	N
9	Norway lobster	N
9	Pink shrimp	N
9	Red mullet	N
9	Blue and red shrimp	N
9	Spottail mantis shrimp	N
9	Striped red mullet	N
9	Blackmouth catshark	N
9	Giant red shrimp	N
10	Hake	N
10	Pink shrimp	N
10	Red mullet	N
11	Giant red shrimp	
11	Hake	N
15-16	Giant red shrimp	N
15-16	Red mullet	N
15-16	Common Pandora	N
16	Anchovy	N
16	Sardine	N
17	Common sole	N
17	Sardine	N
18	Hake	N
22	Anchovy	N
22	Sardine	N
25	Picarel	N

b) The DCR/DCF data call of April 2012 includes the entire list of the common reference species for the MEDITS surveys. Test the consistency of the data, assess whether there is sufficient data and resolution to carry out adequate assessments, including data-shortage methods (e.g. biomass dynamic models; demographic models; SURBA; AIM; SEINE etc.).

Moreover, during SGMED 10-02 via inspection of MEDITS trends it was assessed which species could be used for trend estimation (Table 3.4.2). If adequate corresponding data is available in the Landings and Discard data from DCR/DCF, potentially new assessments should be conducted during the current and/or next meeting(s) for: *Lophius spp, Pagellus erythrinus, Trigla lucerna, Trachurus spp, Eutrigla gurnardus, Micomestius poutassou and Boops boops*.

Table 3.4.2 List of priority species by Medits code and GSA. Enough data is available for trend estimation (YES), not enough data for trend estimation (NO), status of the data unclear due to errors in database (na, ?) or occasional occurrence of the species in the surveys.

GSA	LOPH PIS	LOPH BUD	PAGE ERY	TRIG LUC	TRAC MED	TRAC TRA	EUTR GUR	MICM POU	SQUI MAN	BOOP BOO	SOLE VUL	SPAR AUR
6	YES	YES	YES	?	YES	YES	YES	YES	NO	YES	?	na
7	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	na
8	YES	YES	YES	na	YES	YES	no	YES	na	YES	?	na
9	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	no
10	YES	YES	YES	YES	YES	YES	NO*	YES	YES	YES	NO*	NO*
11	na	YES	na	na	YES	na	YES	YES	na	na	?	na
16	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	?	NO
17	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	?	NO
18	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	?	NO
20	?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO
22+23	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	
0 Infl.				yes							YES	

*rare presence or absence of the species during the surveys

c) assess, review and propose biological fisheries management reference points, either model based or empirical, of exploitation and stock size related to high yields and low risk of stock/fishery collapse in long term of each of the stocks listed under a), b) and assessed by STECF or other scientific frameworks. This work shall provide, to the extent possible, the target (biological, bio-economic) for sustainable fishing at MSY or proxy, the precautionary (threshold) and conservation (limit) reference points. Assessment data and methods are to be fully documented with particular reference to the completeness and quality of the data submitted by Member States as response to the official Mediterranean DCR/DCF data calls.

d) provide a synoptic overview on the recent status of exploitation level and stock size of the species listed under a), b) in relation to the biological fisheries management reference points as identified under c).

e) review the quality and completeness of all data resulting from the official Mediterranean DCR/DCF data call issued on April 2012. STECF is requested to summarize and concisely describe in detail all data quality deficiencies of relevance for the assessment of stocks and fisheries. Such review and description are to be based on the data format of the official DCR/DCF data call. During the EWG 11-14 meeting (Cyprus, 26- 30 September 2011) several inconsistencies and errors emerged in trawl gear performance parameters in MEDITS survey. Particular attentions should be devoted to assessing the quality change and correction of errors in the April 2012 Data Call by means of a graphical comparison with prior years data and evaluation of potential impact on trawl survey standardized index of abundance.

f) review and evaluate existing scientific frameworks for the elaboration of mixed fisheries management advice, and develop a framework to deliver management advice for multi-species/stocks fisheries in the

Mediterranean. Such framework shall consider and be consistent with the management advice for fisheries of single species/stocks provided by STECF so far and provide medium term scenarios constrained by one or all species/stock specific management points to be achieved by 2015 or 2020, respectively. The framework shall be age-structured, to the extent possible, and be based on ecological data and concepts as a first step; considerations shall be given to accommodate within this framework, whenever necessary, empirical indicators. Theinput data required and model processes to deliver management advice for multi-species/stocks fisheries shall be described in detail.

The management advice shall consider quantitative annual effort changes and consistent catch possibilities.

g) Any Other Business: Which are the species for which assessments on the status of the stocks in GSA 9 and/or 11 can be considered as representative also of the stocks in GSA 8? Adequate scientific justifications both on the distribution of species and main oceanographic conditions should be used to address this matter.

Time series of landingsdata reported by the Greek Statistical Service and the abundance indexes obtained from the"MEDITS" surveys that have been used to assess several species in the Aegean and Ionian seas (i.e. GSA 22 and 23). Theassessments were carried out by Greek scientistsin 2012 and using data up to 2009 by applying the same methodology (i.e. production models) used during SGMED 10-12. The STECF is requested to review the methods and results presented by the Greek authorities for the stocks of hake and red mullet.

4.2 Participants

The full list of participants at EWG 12-10 is presented in Annex I to this report.

5 ToR A-D UPDATE AND ASSESS HISTORIC AND RECENT STOCK PARAMETERS (SUMMARY SHEETS)

The following section of the present report does provide short stock specific assessments in the format of summary sheets. Such summary sheets are only provided in cases when the analyses resulted in an analytical assessment of the exploitation rate. Unlike earlier years, the assessments are presented in geographic order by GSA, and not any longer by species. The format of the summary sheet has been agreed by the experts in 2008. Detailed versions of the assessments of stocks and fisheries are provided in the following section 6 of the report.

5.1 Summary sheet of Norway lobster (*Nephrops norvegicus*) in GSA 05

Species common name:	Norway lobster
Species scientific name:	*Nephrops norvegicus*
Geographical Sub-area(s) GSA(s):	GSA 05

Most recent state of the stock

- State of the adult abundance and biomass:

SSB shows an increasing trend since 2006. Since no biomass reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of the juvenile (recruits):

Recruitment showed oscillations, with the highest values of the time series in the intermediate years (2005-2008). Since no recruitment reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of exploitation:

The currentF (0.55) is larger than F_{MSY} (0.42), which indicates that Norway lobster in GSA 05 is exploited unsustainably.

- Source of data and methods:

Landings time series are from 2002 to 2011. Length frequency distributions are from on board monthly samplings. The biological parameters used for the assessment were those used during SGMED-09-02 for Norway lobster in GSA 09 and, in some cases (e.g. maturity) from the Spanish National Data Collection (GSA 05). Natural mortality at age was calculated using PROBIOM (Abella et al., 1997).

Outlook and management advice

EWG 12-10 proposed $F_{0.1}$ = 0.42 as proxy of F_{MSY} and as the exploitation reference point. Taking into account the results obtained by the XSA analysis (current F is around 0.55), the stock is considered exploited unsustainably.

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

- Short, medium and long term scenarios

To be conducted in future meetings.

Fisheries

Norway lobster catches from the Balearic fleet are generated exclusively by the bottom trawlers. The species is mostly caught in the upper slope (350-600 m). The mean annual number of days in which the fleet works in this fishing tactic (alone or in combination with other fishing tactics) is around 1050 days. Other species caught on the upper slope are *Merluccius merluccius*, *Lepidorhombus* spp., *Lophius* spp. and *Micromesistius poutassou* (Guijarro and Massutí, 2006). Discards on the upper slope have been estimated to be up to 18% (autumn) and 45% (spring) of captured biomass and they are composed by a large number of elasmobranchs, teleosts, crustaceans and cephalopods, among others.

Precautionary and target management reference points or levels

$F_{0.1}$ (3-7) = 0.42	(SGMED-10-02)
F_{MSY} (3-7) = 0.42	
F_{mean} (age range)=	
Z_{msy} (age range)=	
Z_{mean} (age range)=	
B_{pa} (spawning stock)	
B_{lim} (spawning stock)	

Table of **agreed** precautionary and target management reference points or levels

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on assessment

5.2 Summary sheet of Common octopus (*Octopus vulgaris*) in GSA 05

Species common name:	Common octopus
Species scientific name:	*Octopus vulgaris*
Geographical Sub-area(s) GSA(s):	GSA 05

Most recent state of the stock

- State of the adult abundance and biomass:

Data on the spawning stock size are not available from production model outputs (see below) owing to the inherent characteristics of the model (catch data is used as a whole, not split by sizes or ages). The analysis of the time series from 1977 to 2011 showed that octopus total biomass was larger than B_{MSY} before the 1980s ($B>B_{MSY}$),but has remained lower than B_{MSY} since then.The main output parameters in 2011 for determining the stock status in terms of biomass were: 1) MSY=197 tons; 2) B_{MSY}=614 tons; 3) B/B_{MSY}=0.506.

- State of the juvenile (recruits):

Data on the spawning stock size and the recruits are not available from production model outputs (see below) owing to the inherent characteristics of the model (catch data is used as a whole, not split by sizes or ages).

- State of exploitation:

Relative fishing mortality (F/F_{MSY}) has oscillated between 1 and 2.3 throughout the time series. In 2011, F was 1.48 times F_{MSY}. The main output parameters in 2011 for determining the stock status in terms of exploitation were: 1) $F_{MSY=}$0.320; 2) F/F_{MSY}=1.481.

EWG 12-10 proposes F_{MSY}=0.32 as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the ASPIC analysis (current F is around 0.47), the stock is considered exploited unsustainably.

- Source of data and methods:

Data used in the assessment were CPUEs and landings from Mallorca (GSA 05) during the time series 1977-2011. The analysis was performed using the ASPIC 5.3 software (A Stock-Production model Incorporating Covariates) (Prager, 1994, 2005) assuming a Schaefer (1954) model. This program implements a non-equilibrium, continuous-time, observation-error estimator for the dynamic production model (Schnute, 1977; Prager, 1994).

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} and B_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

The common octopus is caught both by the trawl and artisanal fishery in GSA 05. However, the main catches are from trawlers, and represent between 80 and 95% of the total octopus landings. Thisspecies is mainly taken by trawlers operating on the shallow continental shelf, accounting for between 20 and 37% of total catches from these trawling grounds.

Precautionary and target management reference points or levels

$F_{0.1}$ (mean)=	
F_{MSY} (all ages)= 0.32	
F_{mean} (age range)=	
Z_{MSY} (age range)=	
Z_{mean} (age range)=	
B_{pa} (spawning stock)	
B_{lim} (spawning stock)	

Table of **agreed** precautionary and target management reference points or levels

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on assessment

This is the first assessment of a cephalopod species from GSA05 and, to our knowledge, the first in the Mediterranean Sea. Owing to differences in life-history traits of cephalopods compared to fishes, the standard assessment methods used for fishes are not useful for cephalopods. Surplus production models are therefore appropriate tools to determine the exploitation status of cephalopods.

5.3 Summary sheet of blue whiting (*Micromesistius poutassou*) in GSA 06

Species common name:	Blue whiting
Species scientific name	*Micromesistius poutassou*
Geographical Sub-area(s) GSA(s):	GSA 06

Most recent state of the stock

- State of the adult abundance and biomass:

A Length Cohort Analysis (VIT software) was carried out during EWG 12-10 using DCF data of landings at age (2009-2011). MEDITS survey indices and landings data showed a variable pattern without a clear trend. However, since no biomass reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of the juvenile (recruits):

VIT recruits estimates were as follows: 62.4 x10^6 in 2009, 65.7 x10^6 in 2010 and 93.8 x10^6 in 2011. However, since no recruitment reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1}$ = 0.32 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 1.05), the stock is considered exploited unsustainably.

- Source of data and methods:

Length cohort analysis VIT was computed using as input DCF data on landings (2009-2011) and size structure of the bottom otter trawl catches.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be carried out during the follow-up EWG 12-19 meeting (10-14 December 2012) in accordance with data availability.

Fisheries

No particular description is provided. Landings data were reported to EWG 12-10 through the DCF. The majority of landings are reported by otter trawlers. Landings fluctuated during the period 2002-2011 with a maximum value of 4,723t in 2006 and a minimum value of 1,276t in 2003. Discards are reported as negligible (<0.05t).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG

$F_{0.1}$ (ages 2-5) = 0.32	
F_{max} (age range)=	
F_{MSY} (ages 2-5) = 0.32	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

5.4 Summary sheet of blue and red shrimp (*Aristeus antennatus*) in GSA 06

Species common name:	Blue and red shrimp
Species scientific name:	*Aristeus antennatus*
Geographical Sub-area(s) GSA(s):	GSA 06

Most recent state of the stock

- State of the adult abundance and biomass:

The XSA analyses show an increase in SSB in the last years, from 311 t in 2005 to 925 t in 2011, the highest value over the whole period 2002-2011.Landings fluctuated between 308 t in 2005 and 743 t in 2009, with an average of about 600 t. In 2010 and 2011, landings decreased to around 650 t. MEDITS survey indices fluctuated without any particular trend. However, since no biomass reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of the juvenile (recruits):

XSA estimates ranged between 61.7 x 10^6 individuals in 2004 and 136.8 x 10^6 recruits in 2008. Since 2009, recruits (age 0) steadily decreased reaching 75.4 x 10^6 individuals in 2011. However, since no recruitment reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1}$ = 0.30 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the XSA analysis (current F is around 1.05), the stock is considered exploited unsustainably.

- Source of data and methods:

The state of exploitation was assessed for the period 2002-2011 applying the Extended Survivor Analysis (XSA) tuned with fishery independent abundance indices (MEDITS survey). In addition, Yield per Recruit (YPR) analysis was carried out. Both methods were performed from the size composition of bottom trawl landings, transforming length data to ages using knife edge slicing.

Input fishery data were taken from DCF and from other sources. Discards, are very low or nil and were thus not included in the assessment.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

Blue and red shrimp (*Aristeus antennatus*) is one of the most important crustacean species for the trawl fisheries in GSA 06 (Northern Spain). This resource is an important component of the commercial landings in some ports of GSA 06, and it is the target species of a specific trawl fleet. The blue and red shrimp has a wide bathymetric distribution, between 80 and 3300 m depth, and some areas may constitute a refuge for the resource, located distantly from the main fishing ports and below 1000 m depth. Females dominate in the landings, representing nearly 80% of the total. Discards of the blue and red shrimp are very low. The number of harbors with vessels targeting blue and red shrimp is 14 for the whole GSA 06. Exploitation is based on very young age classes, mainly 1 and 0 year old individuals.

Limit and precautionary management reference points

Table of limit and target management reference points or levels **proposed by STECF EWG**

$F_{0.1}$ (ages 0-3) = 0.30	
F_{max} (age range)=	
F_{MSY} (ages 0-3) = 0.30	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and target management reference points or levels **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

5.5 Summary sheet of black-bellied anglerfish (*Lophius budegassa*) in GSA 06

Species common name:	Black-bellied anglerfish
Species scientific name:	*Lophius budegassa*
Geographical Sub-area(s) GSA(s):	GSA 06

Most recent state of the stock

- State of the adult abundance and biomass:

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend, with recent values in the higher range since 1994. However, in the absence of proposed biomass management reference points, EWG 12-02 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

- State of the juvenile (recruits):

Recruitment increased over the last 3 years (2009-2011). However, in the absence of proposed management reference points, EWG 12-02 is unable to fully evaluate the status of the recruitment in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1} = 0.15$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 0.72), the stock is considered exploited unsustainably.

- Source of data and methods:

The data used in the analyses were DCF length frequencies from the 2012 data call, for the years 2009 to 2011. The pseudo-cohort VPA approximation in the VIT4win software was used for this analysis, separately for each year. Natural mortality vector was obtained applying the PRODBIOM method.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

The anglerfish is a by catch species of commercial importance, caught in bottom trawl fisheries (~90% of catch in numbers) and by trammel nets (~10% of catch in numbers). Discards are negligible because this species has high commercial value in the entire size range.

Limit and precautionary management reference points

Table of limit and precautionary management reference points **proposed by** EWG 12-10

$F_{0.1}$(age 1-4)= 0.15	
F_{max}(age 1-4)=	
F_{MSY}(age 1-4)= 0.15	
F_{pa}(F_{lim}) (age 1-4)	
B_{MSY}(spawning stock)=	
B_{pa}(B_{lim}, spawning stock)	

Table of limit and precautionary management reference points **agreed by fisheries managers**

$F_{0.1}$(age 1-4)=	
F_{max}(age 1-4)=	
F_{MSY}(age 1-4)=	
F_{pa}(F_{lim}) (age 1-4)	
B_{MSY}(spawning stock)=	
B_{pa}(B_{lim}, spawning stock)=	

5.6 Summary sheet of Hake (*Merluccius merluccius*) in GSA 07

Species common name:	European Hake
Species scientific name:	*Merluccius merluccius*
Geographical Sub-area(s) GSA(s):	GSA 07

Most recent state of the stock

- State of the adult abundance and biomass:

The stock spawning biomass (SSB) displays a decreasing trend over the analysed period. However, in the absence of any biomass reference point, EWG 12-10 is unable to fully evaluate the stock size status respect to these.

- State of the juvenile (recruits):

The highest recruitment observed over the period were in 1997, 2002-2003 and 2007. Since 2007, the recruitment follows a decreasing trend and is currently at the lowest observed level. However, in the absence of any recruitment reference point, EWG 12-10 is unable to fully evaluate the stock size status respect to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1} = 0.24$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the XSA analysis (current F is around 1.43), the stock is considered exploited unsustainably.

- Source of data and methods:

Data from DCF (catch at age from the French and Spanish trawlers, French gillnetters and Spanish longliners) for the period 1998-2011 were used to run an Extended Survivor Analysis (XSA), tuned with MEDITS abundance indices for 1998-2010.

Discards were not included in the catches before 2008 because they were considered negligible. However, in 2008 some discards appear (173 t) due to controls and an exceptionally high recruitment and they were thus included in the catch at age matrix. In 2009, the level of discards decreased again (9 t) but discards were still included in the catches. In 2010 and 2011, no discards data was available, but the amount of discards was considered negligible and thus discards were included in the catch at age matrix.

Growth parameters were derived from tagging experiments (Mellon et al, 2010) conducted in GSA 07 and the Data Collection Framework (DCF) while natural mortality was estimated using PROBIOM.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

Mediterranan hake (*Merluccius merluccius*) is one of the most important demersal target species of the commercial fisheries in the Gulf of Lions (GSA07). In this area, hake is exploited by French trawlers, French gillnetters, Spanish trawlers and Spanish long-liners. Around 220 boats are involved in this fishery and, according to official statistics, total annual landings for the period 1998-2011 have oscillated around an average value of 2230 tons (1362 tons in 2011). In the past 10 years, the fishing capacity of the French trawlers in GSA 07 has progressively declined. Their number decreased by nearly 30% over the period. Because of the decline of small pelagic fish in the area, since 2009 trawlers fishing small pelagic fish have diverted their effort to demersal resources.

The French fleet of trawler is the largest in number of boats and catch (44 and 72%, respectively). The length of the catches from the trawlers ranges between 3 and 92 cm total length (TL), with an average size of 21 cm TL. The second largest fleet is the French gillnetters (~39 and 14% respectively, range 13-86 cm TL and average size 39 cm TL), followed by the Spanish trawlers (~11 and 8%, respectively, range 5-87 cm TL, and average size 24 cm TL), and the Spanish long-liners (~6 and 6%, respectively, range 22-96 cm TL and average size 52 cm TL). The hake trawlers fishery exploits a highly diversified species assemblage composed by: Striped mullet (*Mullus surmuletus*), Red mullet (*Mullus barbatus*), Anglerfish (*Lophius piscatorius*), Black-bellied anglerfish (*Lophius budegassa*), European conger (*Conger conger*), Poor-cod (*Trisopterus minutus capelanus*), Fourspotted megrim (*Lepidorhombus boscii*), Soles (*Solea* spp.), horned octopus (*Eledone cirrhosa*), squids (*Illex coindetii*), Gilthead seabream (*Sparus aurata*), European seabass (*Dicentrarchus labrax*), Seabreams (*Pagellus* spp.), Blue whiting (*Micromesistius poutassou*) and Tub gurnard (*Chelidonichtys lucerna*).

Limit and precautionary management reference points

Table of limit and precautionary management reference points **proposed by** EWG 11-20

$F_{0.1}$ (0-3) = 0.24	(STECF EWG 11-20)
F_{msy} (0-3)= 0.24	
F_{mean} (age range)=	
Z_{msy} (age range)=	
Z_{mean} (age range)=	
B_{pa} (spawning stock)	
B_{lim} (spawning stock)	

Table of **agreed** precautionary and target management reference points or levels

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

5.7 Summary sheet of red mullet (*Mullus barbatus*) in GSA 07

Species common name:	Red mullet
Species scientific name:	*Mullus barbatus*
Geographical Sub-area(s) GSA(s):	GSA 07

Most recent state of the stock

- State of the adult abundance and biomass:

Stock spawning biomass has increased during the period analysed (2004-2011), with the highest values of the data series observed in the last two years (2010-2011). However, since no precautionary biomass reference point level for this stock was has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of the juvenile (recruits):

Recruitment showed strong inter-annual variations, with two peaks in 2006 and 2010, the latter being the highest observed in the times series.However, in the absence of any recruitment reference point, EWG 12-10 is unable to fully evaluate the stock size status respect to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1}$ = 0.51 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the XSA analysis (current F is around 1.26), the stock is considered exploited unsustainably.

- Source of data and methods:

The stock status was assessed for the period 2004-2011 applying an Extended Survivor Analysis (XSA) tuned with fishery independent survey abundance indices (MEDITS). The size composition derived from French and Spanish trawlers and from the French gillnets were used, transforming number at length into number at age by knife edge slicing.

In the absence of stock specific parameters, growth parameterswere taken from GSA 09 (Ligurian and North Tyrrhenian Sea) and data derived from DCF. Natural mortality was estimated using PROBIOM.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort and/or cacthes to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries

considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

In the Gulf of Lions (GFCM-GSA 07), red mullet (*Mullus barbatus*) is exploited by both French and Spanish trawlers. Information on French gillnetters is available from 2011. The French gillnetters are suspected to have fished red mullet in the past, but no data is available to quantify their catches in the past.

Around 200 boats are involved in this fishery. According to official statistics, the total annual landings for the period 2004-2011 have oscillated around an average value of 190 tons. The French gillnets represent nearly half of the boats (45%), followed by the French (41%) and Spanish trawlers (14%). In terms of landings, most catches came from the French trawlers (74%), followed by the French gillnets (13%) and the Spanish trawlers (13%). The mean modal lengths in the catches of the French trawlers and gillnets, and Spanish trawlers were 13.8, 17.5 and 14.8 cm, respectively.

In GSA 07, the trawl fishery is multi-specific. In addition to *M. barbatus*, the following species can be considered as important by-catches: *Merluccius merluccius, Lophius sp., Pagellus sp., Trachurus sp., Mullus surmuletus, Octopus vulgaris, Eledone sp., Scyliorhinus canicula, Trachinus sp., Triglidae*and*Scorpaena sp*.

Length atfirst capture is about 7 cm. The catch is mainly composed by individuals of age 0 and 1, whereas the oldest age class (5+ group) is poorly represented.

Limit and precautionary management reference points

Table of limit and precautionary management reference points **proposed by** EWG 12-10

$F_{0.1}$ (0-3) = 0.51	(STECF EWG 11-20)
F_{msy} (age range)= 0.51	
F_{mean} (age range)=	
Z_{msy} (age range)=	
Z_{mean} (age range)=	
B_{pa} (spawning stock)	
B_{lim} (spawning stock)	

Table of **agreed** precautionary and target management reference points or levels

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (Flim) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (Blim, spawning stock)=	

5.8 **Summary sheet of black-bellied anglerfish (*Lophius budegassa*) in GSA 07**

Species common name:	Black-bellied anglerfish
Species scientific name	*Lophius budegassa*
Geographical Sub-area(s) GSA(s):	GSA 07

Most recent state of the stock

- State of the adult abundance and biomass:

Stock assessment has been computed by Length Cohort Analysis (LCA; VIT software) using DCF data of landings at age (2009-2011). Results obtained did not show a particular trend in stock size. However, in the absence of proposed biomass management reference points, EWG 12-02 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

- State of the juvenile (recruits):

Results showed little variation of the estimates of recruitment for the three years analysed. However, in the absence of proposed management reference points, EWG 12-02 is unable to fully evaluate the status of the recruitment in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1}$ = 0.29 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 0.97), the stock is considered exploited unsustainably.

- Source of data and methods:

Length cohort analysis (LCA) analysis was performed using VIT program (Lleonart and Salat, 1992) for the years 2009, 2010 and 2011 to provide an overview of the current state of exploitation for black-bellied anglerfish in GSA 07. This method was used as the results from a preliminary XSA run were not considered to be reliable. Eight age classes were considered, the last one being a plus group. LCA was computed using DCF data of commercial landings (2009-2011).In the absence of stock specific parameters, the growth and maturity parameters used for the assessment of *Lophius budegassa* in GSA 07 are from GSA 06.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries

considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

In this area, *Lophius budegassa* is exploited by French and Spanish trawlers. Around 127 boats are involved in this fishery and, according to the official statistics, total annual landings for the period 2005-2011 have oscillated around an average value of 252 tons (324 tons in 2011). The French trawlers fleet is the largest (77% of the boats) and makes most of the catches (87%). The length of *Lophius budegassa*in the French trawler catches ranges between 18 and 80 cm total length (TL), with an average size of 32 cm TL. The length in the catch from Spanish trawlers is smaller (23% of the boats and 13% of the catch), ranging from 14-77 cm TL, with an average size of 30 cm TL. The trawl fishery exploits a highly diversified species assemblage: Hake (*Merluccius merluccius*), Striped mullet (*Mullus surmuletus*), Red mullet (*Mullus barbatus*), Black-bellied angler (*Lophius budegassa*), European conger (*Conger conger*), Poor-cod (*Trisopterus minutus capelanus*), Fourspotted megrim (*Lepidorhombus boscii*), Soles (*Solea* spp.), horned octopus (*Eledone cirrhosa*), squids (*Illex coindetii*), Gilthead seabream (*Sparus aurata*), European seabass (*Dicentrarchus labrax*), Seabreams (*Pagellus* spp.), Blue whiting (*Micromesistius poutassou*) and Tub gurnard (*Chelidonichtys lucerna*).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by the EWG

$F_{0.1}$ (2-4) = 0.29	
F_{max} (age range)=	
F_{msy} (2-4) = 0.29	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

Since they were not available in the data call, the discards were not included in the catches. This data will be possibly included at the next meeting. For France, data on fishing effort was provided on a yearly basis for OTB and OTM, over the period 2003-2008. No data was provided for 2009-2011. For Spain, fishing effort was provided for OTB and LLS over 2002-2010 but no data was provided in 2011.

5.9 Summary sheet of blue whiting (*Micromesistius poutassou*)in GSA 09

Species common name:	Blue whiting
Species scientific name	*Micromesistius poutassou*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

Stock assessment has been computed by Length Cohort Analysis (LCA; VIT software) using DCF data of landings at age (2009-2011) and by SURBA using data collected during MEDITS surveys (1994-2011). Results obtained did not show a particular trend instock size. MEDITS survey indices also indicate a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. Since no biomass reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of the juvenile (recruits):

Length frequency distributions (LFD) collected during MEDITS showed the occasional presence of recruits (0+) in some of the years analysed but without any particular trend.However, in the absence of proposed management reference points, EWG 12-02 is unable to fully evaluate the status of the recruitment in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1}$ = 0.53 as proxy of F_{MSY} and as the exploitation reference point. Taking into account the results obtained by the VIT analysis (current Fis around 1.12), the stock was considered exploited unsustainably.

- Source of data and methods:

LCA was computed using DCF data of commercial landings (2009-2011). Catch at age were obtained splitting the LFDs of commercial catches and natural mortality was estimated using PRODBIOM.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

Blue whiting represent an important resource for the otter trawling fleet operating on the slope over muddy bottoms and the highest biomass is found on epibathyal fishing grounds, which are often called "Norway lobster and blue whiting fishing grounds". Annual landings from 2009 to 2011 were rather stable.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by EWG

$F_{0.1}$ (all ages) = 0.53	
F_{max} (age range)=	
F_{msy} (all ages) = 0.53	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

5.10 Summary sheet of Sardine (*Sardina pilchardus*) in GSA 09

Species common name:	Sardine
Species scientific name:	*Sardina pilchardus*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

An XSA (Extended Survivor Analysis) assessment was carried out during EWG 12-10 using the catch data collected under DCF from 2006 to 2011. The analyses provide a SSB decreasing trend, from about 25,000 tons in 2006 to about 20,000 tons in 2011. Landings fluctuate without any particular trend, while MEDITS survey indices showed a decreasing trend.However, in the absence of proposed biomass management reference points, EWG 12-02 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

- State of the juvenile (recruits):

XSA estimates ranged between 1.7 x 10^9 in 2008 and 1.3 x 10^9 recruits in 2010 but without any particular trend. However, in the absence of proposed management reference points, EWG 12-02 is unable to fully evaluate the status of the recruitment in relation to these.

- State of exploitation:

STECF EWG 10-02 proposed E = 0.4 as limit management reference point for small pelagics in the Mediterranean consistent with high long term yields and as a proxy of F_{MSY}. The exploitation rates showed in some years values higher than the E = 0.4 reference point. In 2011, E is very close to 0.4. On the basis of these results, this stock could be considered as exploited nearly sustainably. As a consequence, F needs only a slight reduction from the current value towards the candidate reference points to achieve long term sustainability.

- Source of data and methods:

Data coming from DCF (age distribution of the catches obtained from purse seines) for the period 2006-2011 were used to run an XSA, tuned with fishery independent data (i.e. MEDITS abundance indices for 2010-2011). It was assumed a mean value computed from 2010-2011 data per age class for the years 2006-2009.

Data coming from DCF provided at the EWG 12-10 contained, for GSA 09, information on sardine landings and the size structure of the purse seines catches for the years 2006-2011. Data coming from the landings of other fisheries, and discards (available only for the year 2011) were included in the analyses as well, even though they could be considered negligible compared to the high landings from purse seine.

Outlook and management advice

EWG 12-10 recommends the exploitation rate to be reduced below or at the proposed level, in order to avoid future loss in stock productivity and landings. Catches consistent with such reductions in exploitation rate should be estimated. EWG 12-10 notes that effort management of these fisheries targeting small pelagics implies a high risk due to their schooling behavior and the multi-species character of their fisheries (changing target species as available and depending on the market). EWG 12-10 instead recommends landing restrictions as a more effective management tool for small pelagics. EWG 12-10 also recommends a multi-annual management plan being implemented taking into account mixed-fisheries effects, in particular the technical relation with anchovy (*Engraulis encrasicolus*) fisheries.

The purse seine fleet operating in the GSA 09 at the same time exploit anchovy and sardine. Therefore, any future management options need to take into account also the effects on anchovy, the other important resource exploited by this fishery.

Fisheries

In the GSA 09, sardine is mainly exploited by purse seiners that use light for attracting fish. Due to the low economic value, sardine does not represent the main target for this fleet in the GSA 09, while anchovy is the most important species exploited by this fishery. The fishing season starts in spring (March) and ends in autumn (October). Favorable weather conditions and high catches can extend the fishing activity to the end of November. However, the maximum activity of the fleet is normally observed during the summer. Some vessels coming from the south of Italy (mainly from GSA 10) join the local fleet in the exploitation of these resources. Studies carried out in the GSA 09 in 2011 within the framework of the DCF, as well as those in the Adriatic Sea in 2005, demonstrated that discards of sardine can be considered as negligible.

Sardine is also caught a by-catch in the bottom trawl fisheries. However, the landings done by these *metiers* are very low (about 1%) in comparison to that of purse seines. No information is available on discard for those gears. Pelagic trawling for small pelagics is not carried out in the GSA 09.

Limit and precautionary management reference points

Table of limit and target management reference points or levels **proposed by STECF EWG**

E_{msy} (F/Z, F age range 1-2) = 0.4	
$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and target management reference points or levels **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

5.11 **Summary sheet of poor cod (*Trisopterus minutus capelanus*) in GSA 09**

Species common name:	Poor cod
Species scientific name	*Trisopterus minutus capelanus*
Geographical Sub-area(s) GSA(s):	GSA09

Most recent state of the stock

- <u>State of the adult abundance and biomass:</u>

The VIT analysis performed give SSB estimations of 163 tons in 2011. The MEDITS survey data show fluctuations in stock abundance without a clear trend. However, since no biomass reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- <u>State of the juvenile (recruits):</u>

The VIT analysis performed give estimations of $3x10^6$ recruits in 2011. The SURBA analysis of MEDITS data for the period 1994-2011shows a high fluctuation in the recruitment index with a negative trend in the last five years. However, since no recruitment reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- <u>State of exploitation:</u>

EWG 12-10 proposed $F_{0.1}$ = 0.74 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 0.90), the stock is considered exploited unsustainably.

- <u>Source of data and methods:</u>

Data used derive from MEDITS trawl survey and from commercial catches (landings and discards) by size and age. The survey-based stock assessment approach SURBAwas used on MEDITS (1994-2011) data to estimate trends in F, SSB and recruitment. A cohort analysis using VIT software on commercial catches for 2011 was performed to estimate F, $F_{0.1}$, numbers at age and other stock parameters.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

However, these are the first assessments for poor cod in GSA 09, and it is necessary to conduct further analysis on other years to confirm the results obtained from the 2011 data.

Fisheries

Poor cod is a by-catch demersal species in the GSA09, usually landed together with other small-sized species. Almost all the landings of poor cod are from bottom trawl vessels.The remaining fraction is caught by artisanal vessels using set nets, in particular gillnets. Poor cod is one of the species exploited by the demersal trawl fishery targeting a highly diversified species assemblageon deep shelf, including hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*) and horned octopus (*Eledone cirrhosa*).

In the last 8 years the total landings of poor cod in the GSA09 fluctuated between 90 to 230 tons. An evident decline was observed in 2006but then the landings remained quite constant. The contribution of gillnet and trammel net is negligible.

In the last 8 years,fishing effort by the gears exploiting poor cod in GSA09 has shown different patterns; for bottom trawl demersal fishery, the main fleet targeting poor cod, an increasing trend is observed, from a minimum of 252,970 GT*fishing days in 2004 to 1,270,144 in 2011; on the contrary, fishing effort for bottom trawl mixed fishery, which exploits poor codto a lesser extent, shows an evident decreasing trend in fishing effort in the period considered. However, it is not possible to exactly quantify the specific effort exerted by the demersal fishery fleet on this stock. Fishing effort of set nets (GNS and GTR) has remained largely stable.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 12-10

$F_{0.1}$ (1-2) = 0.74	
F_{max} (age range)=	
F_{msy} (1-2)= 0.74	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

5.12 Summary sheet of Spottail mantis shrimp (*Squilla mantis*) in GSA 10

Species common name:	Spottail mantis shrimp
Species scientific name:	*Squilla mantis*
Geographical Sub-area(s) GSA(s):	GSA 10

Most recent state of the stock

- State of the adult abundance and biomass:

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. However, recent values are in the lower range when compared to the middle of the 1990s. However, in the absence of proposed biomass management reference points, EWG 12-10is unable to fully evaluate the status of the stock spawning biomass in relation to these.

- State of the juvenile (recruits):

Not assessed.

- State of exploitation:

EWG 12-10 proposed $F_{0.1} = 0.41$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 1.08), the stock is considered exploited unsustainably.

- Source of data and methods:

  The data used in the analyses were DCF length frequencies and age frequencies from the 2012 data call, for the year 2011 (data for earlier years - 2008 and 2009 -were available only for trawlers). The pseudo-cohort VPA approximation in the VIT software was used for the analysis. Natural mortality vector was obtained applying the PRODBIOM method.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

The mantis shrimp is a by catch species of commercial importance, caught by a variety of static fishing gear (trammel nets, gillnets and baited traps) and towed nets. In GSA10 the bulk of catches are produced by otter trawl and trammelnets, with a low contribution of gillnets. Trammelnet catches and gillnet catches are combined for the present assessment as “set nets”.

Landings of mantis shrimp were 145 t in 2008 and 128 t in 2009 for otter trawl (no data for set nets). No data on landings was available for 2010. For 2011, landings data by fishing gear (at annual level) is available and given in the table below. Total discards are 12% of the catches, but for age 0 caught by otter trawl, discards represent around 50% of the catch in numbers. Low levels of discards (<10% of the catch) from trammelnets correspond to damaged or otherwise unmarketable individuals.

Limit and precautionary management reference points

Table of limit and precautionary management reference points **proposed by** EWG 12-10

$F_{0.1}$(age 1-3) = 0.41	
F_{max}(age 1-3)=	
F_{MSY}(age 1-3) = 0.41	
F_{pa}(Flim) (age 1-3)	
B_{MSY}(spawning stock)=	
B_{pa}(B_{lim}, spawning stock)	

Table of limit and precautionary management reference points **agreed by fisheries managers**

$F_{0.1}$(age 1-3)=	
F_{max}(age 1-3)=	
F_{MSY}(age 1-3)=	
F_{pa}(F_{lim}) (age 1-3)	
B_{MSY}(spawning stock)=	
B_{pa}(B_{lim}, spawning stock)=	

5.13 Summary sheet of Hake (*Merluccius merluccius*) in GSA 11

Species common name:	European hake
Species scientific name:	*Merluccius merluccius* (L., 1758)
Geographical Sub-area(s) GSA(s):	GSA 11

Most recent state of the stock

- State of the adult abundance and biomass:

MEDITS abundance (n/km²) and biomass (kg/km²) indices do not indicate a significant trend in the period 1994-2011. The stock spawning biomass (SSB) calculated using SURBA oscillated during the period but has decreased in the last 6 years, reaching the lowest observed values in 2011. However, in the absence of proposed biomass management reference points, EWG 12-02 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

- State of the juvenile (recruits):

Relative indices of recruitment estimated by SURBA indicated high fluctuations in the period 1994-2011. However, in the absence of proposed management reference points, EWG 12-10 is unable to fully evaluate the status of the recruitment in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1}$ = 0.30 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 1.16), the stock is considered exploited unsustainably.

- Source of data and methods:

SURBA was used to analyse the MEDITS time series (1994-2011) and to estimate trend in relative SSB, R and F. Data coming from DCF (age distribution of landings and discards for OTB and GTR) for the period 2009-2011 were used to run the VIT.However, because of the incosistencies on 2011 discard data noted above, EWG 12-10 decide to scale it using the information of the previous years.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

Hake is exploited in all trawlable areas around Sardinia and is one of the most important target species showing the highest landings.

According to the scientist's knowledge of the GSA 11 landings of hake comes almost entirely from bottom trawl vessels whereas catches from trammel nets or longlines are negligible and do not belong to a target fishery. Small hakes are commonly caught from shallow waters about 50 m to 300 m depth, whereas adults reach the maximum depths exploited by the fleet (800 m). Both juvenile and adult catches come from a mixed fishery, as in the GSA 11 there is not a specific fishery for hake. The most important by catch species are horned octopus (*Eledone cirrhosa*), squids (*Illex coindetii*), poor cod (*Trisopterus minutus capelanus*) at depths less than 350 m and *Chlorophtalmus agassizii*, greater forkbeard (*Phycis blennoides*) and deep-water pink shrimp (*Parapenaeus longirostris*) caught at greater depth.

At the end of 2006 the trawl fleet of GSA 11 was composed by 157 vessels (11.7% of the overall Sardinian fishing fleet) and has shown in these last 15 years remarkable changes. From 1994 to 2004 a general increase in the number of vessels was observed and the replacement of the old, low tonnage wooden boats by larger steel boats.

Using data available to EGW-12-10, the trends in fishing show a major drop of total fishing effort in 2008, when both the trawlers and the small scale fishery effort decreased (of 25 and 31 % respectively). In the last three years effort was almost stable.
The total landings of hake of GSA 11 in the last 7 years decreased from 866 t (2005) to 268 t in 2009 and slightly increased in 2011 (389 t). The major drop occurred in 2007, and continued in the following 3 years.

Limit and target management reference points or levels

Table of limit and target management reference points or levels **proposed by EWG**

$F_{0.1}$ (0-4-3) = 0.30	
F_{max}=	
F_{MSY} (0-4) = 030	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and target management reference points or levels **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

It is important to clearify if GTR is belonging to a real fishery for hake in GSA 11. Quality checked landing and discard data are essential to run catch-based assessment approach such as LCA or XSA. A specific check of discard data (particularly for 2011) is also needed.

Data Quality check

EGW 12-10 noted that landing and discard seems to be misreported in some years for GTR. In particular landings at length for GTR are not reported in 2007, while for LLS are only reported in 2009. Even if the contribution to total landings of these fisheries (GTR and LLS) is not high in the GSA 11, it is not clear to EGW 12-10 if they are or not belonging to a real fishery for hake.

Furthermore, GTR discards are reported in 2005, 2010 and 2011, but data seems to be not reliable neither because the length distribution (discards' lengths range from 27 to 48 cm), nor because is the only GSA in the region where have been reported for those gear.

Finally the very high increase of total discards (mainly due to OTB) in 2011, which is more then 10 times larger than previous yearsand about 4,5 times of OTB landings, is not reliable..

Discard data strongly influences the assessment thus must be checked for inconsistencies.

Considering the importance of the discards for the assessment of hake and because of the incosistences noted above, EWG 12-10 decided to use only 3 years for the VIT analysis (i.e. when discard were constantly reported for OTB), and for 2011, using the proportion of the previous year (2010) as a reference to scale discards quantities and their related distribution at lenghts.

5.14 **Summary sheet of pink shrimp (*Parapenaeus longirostris*) in GSA 11**

Species common name:	Deepwater pink shrimp
Species scientific name:	*Parapenaeus longirostris*
Geographical Sub-area(s) GSA(s):	GSA 11

Most recent state of the stock

- State of the adult abundance and biomass:

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h) without an increasing trend from 2009 onwards. Pseudocohort analysis show an increasing of SSB in 2010 and a sharp decrease in 2011.However, in the absence of proposed biomass management reference points, EWG 12-10 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

- State of the juveniles (recruits):

Relative recruitment indices estimated from MEDITS show an increasing in the last 3 years. However should be consider that because of the season young of the year (0+) are poorly sampled by the MEDITS survey. An increasing trend of recruitment was also showed by the VIT analysis. However, in the absence of proposed management reference points, EWG 12-02 is unable to fully evaluate the status of the recruitment in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1}$ = 0.49 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained withVIT analysis (current F is around 0.69), the stock is considered exploited unsustainably.

- Source of data and methods:

Both indirect (fisheries monitoring) and direct (scientific surveys) data sources were utilized. The analyses were conducted using VIT and SURBA software. Sex combined growth parameters were used to split the length frequency distribution for the VIT SURBA analysis.In the absence of stock specific parameters, the growth parameters are the same of those used in the neighbouring GSA (GS9).

The vector for natural mortality estimated using PROBIOM was used. Management reference points were estimated by an YPR analysis based on VIT software

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

The species is only exploited by trawlers, which operate in all seas surrounding the island. Fishing grounds are typical muddy bottoms from 150 to 570 m depth, but the occurrence of the species is mainly between 200 and 450 meter of depth.

P. longirostris is generally caught together with other important commercial species such as *Nephrops norvegicus*, *Merluccius merluccius*, *Eledonecirrhosa*, *Illex coindetii*, *Todaropsis eblanae*, *Helicolenus dactylopterus,Phycis blennoides, Micromesistius poutassou*, *Lophius* sp. and some other minor species such us *Glossanodon leioglossus, Capros aper, Galeus melastomus* and *Raja* spp..

The landings show an increasing trend, from 43 t in 2009 to 71 t in 2011.

Limit and precautionary management reference points

Table of limit and precautionary management reference points **proposed by EWG 12-10**

$F_{0.1}$ (all classes)= 0.49	
F_{max} (age range)=	
F_{MSY} (all classes)= 0.49	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

5.15 **Summary sheet of red mullet (*Mullus barbatus*) in GSAs 15-16**

Species common name:	Red mullet
Species scientific name:	*Mullus barbatus*
Geographical Sub-area(s) GSA(s):	GSAs15-16

Most recent state of the stock

- State of the adult abundance and biomass:

An XSA (Extended Survivor Analysis) assessment was carried out during EWG 12-10 using the catch data collected under DCF from 2006 to 2011. The analyses show a SSB decreasing trend, from 2,389 t in 2007 to 1,147 t in 2011. MEDITS survey indices, analysed using SURBA, showed an increasing of relative SSB from 1994 to 2008 followed by a decline in 2009-2011. However, since no biomass reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of the juvenile (recruits):

The recruitment showed a reduction from 134.6 million in 2006 to 64.9 million in 2011. A decreasing trend in recruitment at age 1 from 2009 to 2011 was observed also in the SURBA analysis on the MEDITS survey. However, since no recruitment reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1}$ = 0.45 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the XSA analysis (current F is around 1.3), the stock is considered exploited unsustainably.

- Source of data and methods:

Data coming from DCF (age distribution of landings and discards) obtained from bottom trawlers and trammel nets for the period 2006-2011 were used to run an XSA, tuned with fishery independent data (i.e. MEDITS abundance indices for 2006-2011). Single survey exploratory SURBA 2.2 model run was carried out fitting constant catchability (1.0 for all ages) at age over the MEDITS data 2002-2011.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries

considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

Landings data for GSAs 15 & 16 collected within the Data Collection Framework (DCF) showed a decrease of the annual landings from 1,409 t in 2005 to 608.5 t in 2011. More than 95% of the landings is due to bottom otter trawlers. The contribution of the Maltese fleet was less than 5% in 2005-2011.

Limit and precautionary management reference points

Table of limit and target management reference points or levels **proposed by STECF EWG 12-10**

$F_{0.1}$ (2-5) = 0.45	
F_{max} (age range)=	
F_{msy} (2-5)= 0.45	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and target management reference points or levels **agreed by fisheries managers**

F0.1 (age range)=	
Fmax (age range)=	
Fmsy (age range)=	
Fpa (Flim) (age range)=	
Bmsy (spawning stock)=	
Bpa (Blim, spawning stock)=	

5.16 Summary sheet of Common Pandora (*Pagellus erythrinus*) in GSA 15-16

Species common name:	Common Pandora
Species scientific name:	*Pagellus erythrinus*
Geographical Sub-area(s) GSA(s):	GSA 15-16

Most recent state of the stock

- State of the adult abundance and biomass:

An XSA (Extended Survivor Analysis) assessment was carried out during EWG 12-10 using catch data and data collected under the DCR / DCF from 2006 to 2011. According to the XSA analysis, SSB has shown a consistent decline between 2006 and 2011, from 1,500 to 550 tons. However, in the absence of proposed biomass management reference points, EWG 12-02 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

- State of the juvenile (recruits):

The XSA estimates of recruitment showed a decreasing trend from 11 million to 1 million between 2006 and 2010 with an increase to 5 million in 2011. However, in the absence of proposed management reference points, EWG 12-02 is unable to fully evaluate the status of the recruitment in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1} = 0.30$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the XSA analysis (current F is around 0.72), the stock is considered exploited unsustainably.

- Source of data and methods:

Data coming from DCF for the period 2006-2011 were used to run an XSA, tuned with fishery independent data (i.e. MEDITS abundance indices for 2006-2011). Total landings from bottom otter trawlers (OTB) and artisanal fleet segments (trammel nets, GTR and set bottom longlines, LLS) were available for both GSA 15 and 16. Landings at length information for GSA 16 was used to estimate length frequency distributions of the landings in GSA 15 since landings at length from GSA 15 were available only for 2011 and only for trammel nets (GTR) and set bottom longlines (LLS). Discards at length data was only available for 2010 and 2011 for OTB in GSA 16, and this information was used to reconstruct discards data for GSA 16 in 2006-2009 as well as for GSA 15.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

Common Pandora is an important demersal fishery resource in the Mediterranean, including the Strait of Sicily. Trawling is carried out on the continental shelf of the Central Mediterranean throughout the year, and catches include also pink shrimp (*Parapenaeus longirostris*), Norway lobster (*Nephrops norvegicus*), giant red shrimp (*Aristaeomorpha foliacea*), hake (*Merluccius merluccius*), violet shrimp (*Aristeus antennatus*), scorpionfish (*Helicolenus dactylopterus*), grater forkbeard (*Phicys blennioides*), blackspot seabream (*Pagellus bogaraveo)* and monkfish (*Lophius spp.*). In addition to trawling, common Pandora is targeted by several artisanal gears, including set gillnets, trammel nets, pots and traps and set longlines.

Considering data from both GSAs combined, catches by the OTB fleet have declined in 2006-2011, whilst catches from the artisanal fleet have remained stable since 2008. Trawlers were responsible for 80% of common Pandora landings in 2011. On average the Maltese fleet was responsible only for 3% of total landings in GSAs 15 and 16 in 2006-2011.

Limit and precautionary management reference points

Table of limit and target management reference points or levels **proposed by STECF EWG 12-10**

$F_{0.1}$ (2-7)= 0.30	
F_{max} (age range)=	
F_{MSY} (2-7)= 0.30	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and target management reference points or levels **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

5.17 Summary sheet of Black bellied anglerfish (*Lophius budegassa*) in GSA 15-16

Species common name:	Black Bellied Anglerfish
Species scientific name:	*Lophius budegassa*
Geographical Sub-area(s) GSA(s):	GSA 15-16

Most recent state of the stock

- State of the adult abundance and biomass:

According to SURBA estimates, SSB clearly increased from 2002 to 2006, showing thereafter a slight decrease. The first estimates of absolute values of SSB obtained by VIT, ranged between 540 tons (2010) and 980 tons (2009). However, in the absence of proposed biomass management reference points, EWG 12-02 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

- State of the juvenile (recruits):

According to SURBA estimates, recruitment remained quite stable from 2002 to 2008, followed by an increase in 2009 and 2010, and a large decrease in 2011. Absolute values of recruits at age 1 obtained by VIT in 2009 and 2010 were around 1 million of recruits per year. However, in the absence of proposed management reference points, EWG 12-10 is unable to fully evaluate the status of the recruitment in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1}$ = 0.16 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F_{1-7} is around 0.30), the stock is considered exploited unsustainably.The same result was supported also by the Beverton and Holt total mortality estimator calculated on trawl survey data.

- Source of data and methods:

Data coming from DCF for the period 2002-2011 were used to run a SURBA (i.e. MEDITS abundance indices by age for 2002-2011). Age structure of the landings in 2009 to 2010 was used to assess stock status through a pseudocohort analysis using the VIT software.

Outlook and management advice

Based on VIT results,EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

In the Strait of Sicily (central Mediterranean Sea) black-bellied anglerfish is a high value commercial species. It is fished almost exclusively by trawlers operating mainly on the outer shelf-upper slope, together with other important species, such as *Mullus spp., Pagellus spp., Merluccius merluccius, Zeus faber, Raja spp, Eledone spp., Illex coindetii, Todaropsis eblanae, Parapenaeus longirostris* and *Nephrops norvegicus*.

In the last three years the landings of both the Italian and Maltese trawlers ranged between 250 and 285 tons, the Italian landings amounting to more than 98% of the totals.

Limit and precautionary management reference points

Table of limit and target management reference points or levels **proposed by STECF EWG 11-12**

$F_{0.1}$ (1-7) = 0.16	
F_{max} (age range)=	
F_{MSY} (1-7)= 0.16	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and target management reference points or levels **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

5.18 **Summary sheet of red mullet (*Mullus barbatus*) in GSA 17**

Species common name:	Red Mullet
Species scientific name:	*Mullus barbatus*
Geographical Sub-area(s) GSA(s):	GSA 17

Most recent state of the stock

- <u>State of the adult abundance and biomass:</u>

An XSA (Extended Survivor Analysis) assessment was carried out during EWG 12-10 using DCF data of landings and discard at age from Italian OTB, GNS and TBB data (2006-2011). The analyses showed a decreasing trend in SSB from 5,600 to 3,747 tons. MEDITS survey indices show a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. However, in the absence of proposed biomass management reference points, EWG 12-02 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

- <u>State of the juvenile (recruits):</u>

After 3 years of stable recruitment, the abundance dropped at low levels in 2009. In 2010 the trend increased again reaching, in 2011, around the same values of the first years of the time series. However, in the absence of proposed management reference points, EWG 12-02 is unable to fully evaluate the status of the recruitment in relation to these.

- <u>State of exploitation:</u>

EWG 12-10 proposed $F_{0.1}$ = 0.36 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the XSA analysis (current F is around 0.71), the stock is considered exploited unsustainably.

- <u>Source of data and methods:</u>

XSA analysis was computed on DCF data of commercial landings (2006-2011), calibrated with fishery independent survey abundance indices (MEDITS). Landings and discard at age data were obtained from the Italian fleet within the DCF. The discard is high and it represents an important percentage on the overall catches. MEDITS abundance indices in number at length were transformed in number at age using age length keys (ALK) obtained fromotolith reading ofcommercial samples.

Outlook and management advice

EWG 12-10recommends the relevant fleets catches and/or effort to be reduced below or at the proposed level F_{MSY}, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches and effort consistent with F_{MSY}should be estimated.

Fisheries

Landings data were reported to EWG 12-10 through the DCF(OTB, TBB and GNS). Otter trawl landings represent around 96% of the catches. Total landings remained above 3,500 tons between 2006-2008, than decreased to 2,000 tons in 2010 and then in 2011 increased again to 2,692 tons. Discard is high, about 20% of the total catches.

Limit and precautionary management reference points

Table of limit and precautionary management reference points **proposed by STECF EWG 12-10**

E_{msy} (age range) =	
$F_{0.1}$ (1-3) = 0.36	
F_{max} (age range)=	
F_{msy} (1- 3) = 0.36	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and target management reference points or levels **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

This is the first assessment of red mullet in GSA 17 using XSA. Thus, results of this analysis are not directly comparable to those of the previous assessment based on pseudocohort analysis (VIT).

5.19 **Summary sheet of spottail mantis shrimp (*Squilla mantis*) in GSA 17**

Species common name:	Spottail mantis shrimp
Species scientific name	*Squilla mantis*
Geographical Sub-area(s) GSA(s):	GSA 17

Most recent state of the stock

- State of the adult abundance and biomass:

The analyses performed give a SSB estimation of 2,610 tons in 2011. The MEDITS and SoleMon surveys indicate a general decreasing trend in stock biomass. However, since no biomass reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of the juvenile (recruits):

The analyses performed give an estimation of $527x10^6$ recruits in 2011.However, since no recruitment reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1} = 0.30$ as proxy of F_{MSY} and as the exploitation reference pointconsistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 1.00), the stock is considered exploited unsustainably.

- Source of data and methods:

This is the first assessment of mantis shrimp in GSA 17. The assessment is based only on Italian data, because fishery data from the Croatian fleets are missing and for Slovenian data size distribution of the catches was not available. However the contribution of Slovenian catches is negligible, considering that it represents less the 0.1% of the total catches. Considering the absence of specimens collected during SoleMon survey carried out inside the Croatian waters and the low abundance observed in the MEDITS data available from the eastern side of the basin (2002 and 2005), is possible to assume that the assessment carried out during the EWG 12-10covers almost completely the stock exploited in GSA 17.
Data used derive from DCF commercial catches (landing and discard) by size. A steady state VPA analysis was performed with VIT using commercial catches for the year 2011 in order to estimate F of the three fleets exploiting mantis shrimp (OTB, GNS and TBB),$F_{0.1}$, the numbers at age and other stock parameters.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries

considerations. Catches and effort consistent with F_{MSY} should be estimated. EWG 12-10also emphasizes that this is the first attempt to evaluate the exploitation state of the species and, therefore, it is necessary to analyze a longer data series in order to confirm the results obtained for 2011.

Fisheries

Although in the Italian landings of GSA 17, *S. mantis* ranks first among the crustacean landed in the Adriatic ports, mantis shrimp is not the target of a specialised fishery, but it is only an important component of local multispecies trawl and gill net fishery. Only in the Gulf of Trieste it is the target of a small artisanal fishery with creels. In the Italian side of the GSA 17, the species is exploited by different types of gears, the majority of the landing comes from trawling. The Italian annual landing for 2011 was due for 63% to bottom trawl (2,399 tons), for 30% to gillnet (1,136 tons) and for 7% to rapido trawl (251 tons).

The species is absent from the landings statistic of Croatia (FAO-FISHSTAT J – GFCM Database) and it accounted for 3.5 tons in the Slovenian landings of 2011 (2012 DCF data; not used in the assessment). Moreover *S. mantis* it is not present in the list of shared stock of GFCM.

About 400 bottom trawlers exploit this resource all year round in the coastal areas. Mantis shrimp is caught as a part of a species mix that constitutes the target of the trawlers operating on the continental shelf. The main species caught in GSA 17 associated with mantis shrimp are *Sepia officinalis*, *Trigla lucerna*, *Merluccius merluccius*, *Mullus barbatus*, *Eledone* spp. Trawl catch is mainly composed by age 1 and 2 individuals while the older age classes are poorly represented in the catch. *S. mantis* is also a by catch (only in few cases also target) of gillnetters targeting *Solea solea*, especially during spring-summer seasons in the coastal area.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 12-10

$F_{0.1}$ (0-5) = 0.30	
F_{max} (age range)=	
F_{msy} (0-5)= 0.30	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

5.20 **Summary sheet of pink shrimp (*Parapenaeus longirostris*) in GSA 18**

Species common name:	Pink shrimp
Species scientific name:	*Parapenaeus longirostris*
Geographical Sub-area(s) GSA(s):	GSA 18

Most recent state of the stock

- State of the adult abundance and biomass:

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h). MEDITS indices indicate a remarkable peak of abundance and biomass in 2005, followed by a sharp decrease in 2007 and an increase in 2008. After this year, abundance slightly increasedin 2009 and successively decreased to 2011. However, in the absence of proposed biomass management reference points, EWG 12-10is unable to fully evaluate the status of the stock spawning biomass in relation to these.

- State of the juveniles (recruits):

Recruitment estimates from MEDITS peaked in 2005 then sharply decreased in 2007. After this year there was a slow rising from 2008 to 2009 and a slight reduction in the following years. The pseudocohort analysis by yearshows the same pattern. However, in the absence of proposed management reference points, EWG 12-10 is unable to fully evaluate the status of the recruitment in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1}$ = 0.70 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the pseudocohort analysis (current F is around 1.45), the stock is considered exploited unsustainably.

- Source of data and methods:

The analysis was carried out for the western side of the GSA 18, given the availability of fishery data only for this side. The analyses were conducted using VIT software. Growth parameters were used to split the LFD for the VIT age-class analyses. A natural mortality vector M was estimated using PRODBIOM (Abella et al., 1997). Management reference points were estimated by YPR analysis.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

Pink shrimp is targeted only by trawlers, and fishing grounds are located along the coasts of the whole GSA. Catches from trawlers are from a depth range between 50and 500 m and the species co-occurs with other important commercial species as *M. merluccius*, *Illex coindetii*, *Eledonecirrhosa*, *Lophius* spp., *Lepidorhombus boscii*, *N. norvegicus*. In 2008 a management plan was adopted, that foresaw the reduction of fleet capacity associated with a reduction of the time at sea.

Landings are rather stable in the observed years with a slight increase in 2009 and a small decrease in 2011, while fishing effort of trawlers is decreasing.

Limit and precautionary management reference points

Table of limit and precautionary management reference points **proposed by EWG 12-10**

$F_{0.1}$ (0-2) = 0.70	
F_{max} (age range)=	
F_{MSY} (0-2) = 0.70	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

5.21 **Summary sheet of red mullet (*Mullus barbatus*) in GSA 18**

Species common name:	Red mullet
Species scientific name:	*Mullus barbatus*
Geographical Sub-area(s) GSA(s):	GSA 18

Most recent state of the stock

- <u>State of the adult abundance and biomass:</u>

MEDITS survey indices indicate an increasing pattern of the biomass (kg/km^2). However, in the absence of proposed biomass management reference points, EWG 12-10 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

- <u>State of the juvenile (recruits):</u>

Abundance indices from MEDITS trawl-survey show a variable pattern also because recruits are caught during the MEDITS survey only in some years. The abundance showed an increasing trend along the time series with peaks in 1999 and 2005; in 2011 another peak is present in the survey series and it is also detected by XSA. However, in the absence of proposed management reference points, EWG 12-10 is unable to fully evaluate the status of the recruitment in relation to these.

- <u>State of exploitation:</u>

EWG 12-10 proposed $F_{0.1}$ = 0.50 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the XSA analysis (current F is around 1.50), the stock is considered exploited unsustainably.

- <u>Source of data and methods:</u>

The data used in the analyses were from trawl surveys (time series of MEDITS survey from 1996 to 2011) and from commercial catches. The analysis was carried out for the western side of the GSA 18, given the availability of fishery data only for this side. The stock is assessed by XSA method for the time series 2007-2011. A sex combined analysis was carried out. A vector of natural mortality M was estimated using PROBIOM (Abella et al., 1997). Management reference points were estimated by Y/R analysis using Yield software.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries

considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

Red mullet is mainly targeted by trawlers and at much lesser extent by small scale fisheries using gillnets and trammel nets. Fishing grounds are located along the coasts of the whole GSA. Red mullet co-occurs with other important commercial species as *Pagellus* sp., *Eledone* sp., *Octopus* sp., *M. merluccius*. In 2008 a management plan was adopted, which included the reduction of the fleet capacity associated with a reduction of the time at sea. Available landing data collected under the DCF ranged from 1,680 tons in 2007 to 532 tons in 2011, the latter being the lowest value registered. The landings of red mullet are almost completely from trawlers with small scale fishery representing about 7% of total production. The fishing effort of trawlers, that is the major component of fishing in the area, is also decreasing.

Limit and precautionarymanagement reference points

Table of limit and precautionary management reference points **proposed by EWG 12-10**

$F_{0.1}$ (0-2) = 0.50	
F_{max} (age range) =	
F_{MSY} (0-2) = 0.50	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points **agreed by fisheries managers**

F0.1 (age range)=	
FMSY (age range)=	
Fmsy (age range)=	
Fpa (Flim) (age range)=	
BMSY (spawning stock)=	
Bpa (Blim, spawning stock)=	

5.22 **Summary sheet of spottail mantis shrimp (*Squilla mantis*) in GSA 18**

Species common name:	Spottail mantis shrimp
Species scientific name	*Squilla mantis*
Geographical Sub-area(s) GSA(s):	GSA 18

Most recent state of the stock

- State of the adult abundance and biomass:

The VIT analysis performed give an SSB estimate in 2011of 190 tons. However, since no biomass reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of the juvenile (recruits):

The VIT analysis performed give an estimation of $47x10^6$ recruits in 2011. However, since no recruitment reference point for this stock has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1}$ = 0.27 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 1.04), the stock is considered exploited unsustainably.

- Source of data and methods:

This is the first assessment of mantis shrimp in the GSA 18. Because fishery data from the eastern side of the basin are missing, the assessment is based only on Italian catch data of 2011, assuming that the Italian fleets exploit only the stock inhabiting the western side of GSA 18, which can be considered separated from the stock present in the eastern side of the basin.

Data used derive from commercial catches (landing and discard) by age. A steady state VPA analysis was performed with VIT using commercial catches for the year 2011 in order to estimate F of the four fleets exploiting mantis shrimp (OTB_DEMSP, OTB_MDDWSP, GNS and GTR),$F_{0.1}$, the numbers at age and other stock parameters.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

EWG 12-10 emphasizes that this is the first attempt to evaluate the exploitation state of the species and, therefore, it is necessary to analyze a longer data series in order to confirm the results obtained for 2011.

Fisheries

Squilla mantis does not represent a target species in the fisheries carried out in the GSA 18 but it is part of the mixed species representing the by-catch of otter trawlers and set netters using gill net and trammel net. The species is absent from the landings statistic of Montenegro and Albania (FAO-FISHSTAT J – GFCM Database) and it is not present in the list of shared stocks of GFCM.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 12-10

$F_{0.1}$ (0-5) = 0.27	
F_{max} (age range)=	
F_{msy} (0-5)=0.27	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

5.23 Summary sheet of Norway lobster (*Nephrops norvegicus*) in GSA 18

Species common name:	Norway lobster
Species scientific name:	*Nephrops norvegicus*
Geographical Sub-area(s) GSA(s):	GSA 18

Most recent state of the stock

- State of the adult abundance and biomass:

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h). Abundance and biomass are rather stable from 1997 to 2006; then there is a slight decrease in 2007 followed by a large increase in 2009. After this year the abundance indices are decreasing toa level similar to the average of the time series. However, in the absence of proposed biomass management reference points, EWG 12-10is unable to fully evaluate the status of the stock spawning biomass in relation to these.

- State of the juvenile (recruits):

Recruitment estimates from MEDITS surveys (individuals smaller than size at first maturity were considered as recruits) in the GSA 18 showed an increase from 2007 and 2009 and then a decrease until 2011. The initial numbers reconstructed by VIT are consistent with this pattern for recent years (2010-2011). However, in the absence of proposed management reference points, EWG 12-10is unable to fully evaluate the status of the recruitment in relation to these.

- State of exploitation:

EWG 12-10 proposed $F_{0.1}$ = 0.30 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 0.54), the stock is considered exploited unsustainably.

- Source of data and methods:

The data used in the analyses were from trawl surveys (time series of MEDITS survey from 1996 to 2011) and from commercial catches. The stock is assessed by VIT method in 2010 and 2011. This analysis was carried out for the western side of the GSA 18, given the availability of fishery data only for this side. A sex combined analysis was carried out. A constant value of natural mortality M equal to 0.47 was estimated using Beverton & Holt Invariant method and terminal fishing mortality F_{term}= 0.5 was assumed. The F current has been calculated on the age range between 1 and 7, being these the age classes more represented in the catches. Management reference points were estimated by Yield per recruit (YPR) using VIT software.

Outlook and management advice

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

Norway lobster is only targeted by trawlers on offshore fishing grounds. Norway lobster may co-occurs with other important commercial species as *M. merluccius*, *Illex coindetii*, *Eledonecirrhosa*, *Lophius* spp., *Lepidorhombus boscii*, *P. longirostris*.

In 2008 a management plan was adopted, which included the reduction of the fleet capacity associated with a reduction of the time at sea Available landing data are from DCF. EWG 12-10 received Italian landings data for GSA 18 by fisheries.

In general, demersal trawlers account for the majority of the landings. Landings decreased from 2007 and 2011. The fishing effort of trawlers, that is the major component of fishing in the area, is also decreasing.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 12-10

$F_{0.1}$ (1-7) = 0.30	
F_{max} (age range)=	
F_{msy} (1-7)=0.30	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

6 ToR A-D UPDATE AND ASSESS HISTORIC AND RECENT STOCK PARAMETERS (DETAILED ASSESSEMENTS)

The following section of the present report does provide detailed stock specific assessments and all relevant data of such stocks and their fisheries. Unlike earlier years, the assessments are presented in geographic order byGSA, and not any longer by species. The format of the assessments has been agreed by the experts in 2008. Short versions of the assessments of stocks and fisheries in the format of summary sheets are provided in the preceding section 5.1 in cases when the analyses resulted in an analytical assessment of the stock status.

6.1 Stock assessment of Norway lobster in GSA 5

6.1.1 *Stock identification and biological features*

6.1.1.1 Stock Identification

Due to the lack of information about the structure of Norway lobster (*Nephrops norvegicus*) population in the western Mediterranean, this stock was assumed to be confined within the GSA 05 boundaries.

N. norvegicus is a mud-burrowing species that prefers sediments with mud mixed with silt and clay in variable proportions. The emergence of individuals from burrows may vary depending on biological features and environmental factors (moult or reproduction cycles, light intensity, etc).

6.1.1.2 Growth

Maximum observed size in GSA 05 was 80 mm CL for males and 65 mm CL for females. As there is not an estimation of growth parameters in the area, the used ones where those estimated for the GSA 09:

L_∞ =72.1

K = 0.169

Length-weight relationships: a = 0.000373, b = 3.1576

6.1.1.3 Maturity

Maturity curve was computed with information obtained from GSA 05.

0	1	2	3	4	5	6	7	8	9+
0.02	0.05	0.14	0.32	0.58	0.80	0.92	0.97	0.99	1.00

6.1.2 *Fisheries*

6.1.2.1 General description of fisheries

Norway lobster catches from the Balearic fleet comes exclusively from bottom trawl. The species is mostly caught in the upper slope (350-600 m). The mean annual number of days in which the fleet works in this fishing tactic (alone or in combination with other fishing tactics) is around 1050 days. Other species caught on the upper slope are *Merluccius merluccius*, *Lepidorhombus* spp., *Lophius* spp. and *Micromesistius poutassou* (Guijarro and Massutí, 2006). Discards of other species on the upper slopehave been estimated to be up to 18% (autumn) and 45% (spring) in terms of biomass and they are composed by a large number of elasmobranchs, teleosts, crustaceans and cephalopods, among others.

6.1.2.2 Management regulations

- Fishing license: number of licenses observed
- Engine power limited to 316 KW or 500 HP: partial compliance (in some cases real HP isat least the double)
- Mesh size in the codend (before June 1st 2010: 40 mm diamond: after June 1st 2010: 40 mm square or 50 mm diamond -by derogation-): full compliance
- Time at sea (12 hours per day and 5 days per week): full compliance
- Minimum landing size (EC regulation 1967/2006, 20 mm CL): mostly full compliance

6.1.2.3 Catches

6.1.2.3.1 *Landings*

Landings of Norway lobster in GSA 05 come exclusively from trawling. In the last 8 years the total landings of *N. norvegicus* in GSA 05 oscillated around 20 tons (Fig. 6.1.2.3.1.1).

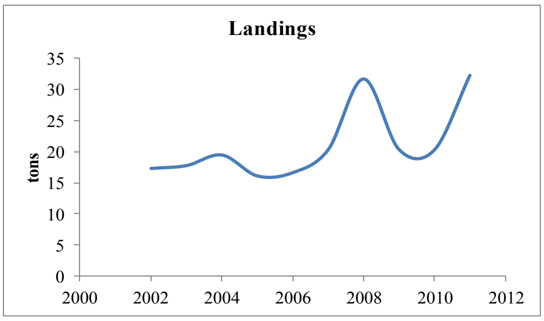


Fig. 6.1.2.3.1.1Landings of Norway lobster (trawling) in the GSA 05, from 2002 to 2011.

Landings are mostly composed by specimens from 25 to 45 mm CL (80% of the catches, Fig.6.1.2.3.2.1).

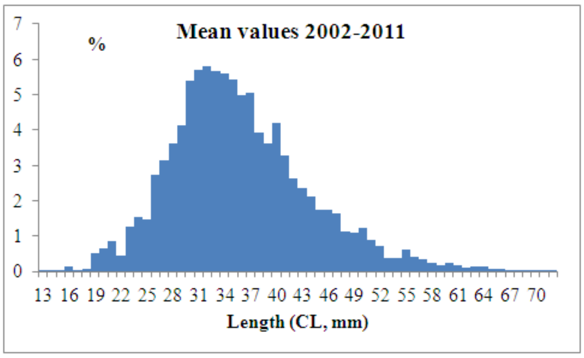


Fig. 6.1.2.3.1.2Size structure of the landings of *N. norvegicus* in 2002-2011 (mean value) caught by otter trawling in the GSA 05.

6.1.2.3.2 *Discards*

Discards of Norway lobster in GSA 05 can be considered as negligible. At the same time, the presence of specimens under the MLS (20 mm CL) in the landings is very scarce.

6.1.2.4 Fishing effort

The number of fishing trips has oscillated between 1,900 and 2,800 between 2002 and 2011, with a slight decreasing trend (Fig.6.1.2.4.1).

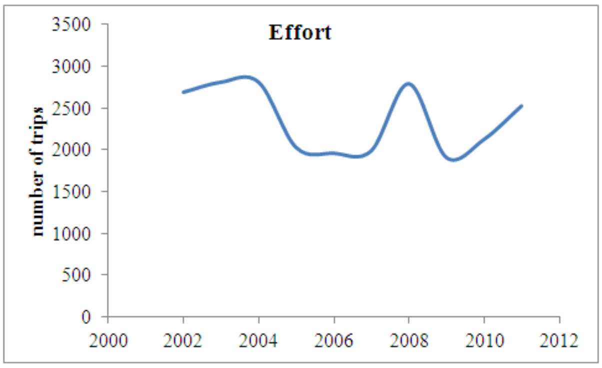


Fig. 6.1.2.4.1Number of fishing trips in Mallorca during 2000-2011.

6.1.3 *Scientific surveys*

6.1.3.1 BALAR and MEDITS surveys

6.1.3.1.1 *Methods*

From 2001, the Spanish Institute of Oceanography has performed annual bottom trawl surveys following the same methodology and sampling gear described in the MEDITS protocol.

6.1.3.1.2 *Geographical distribution patterns*

N. norvegicus is mostly distributed in the north of Mallorca and Menorca and in the south of Mallorca, where the main fishing grounds are located.

6.1.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of the *N. norvegicus* in GSA 05 was derived from the BALAR (2001-2006) and MEDITS (2007-2011) surveys. Fig.6.1.3.1.3.1 displays the biomass trends in GSA 05. Biomass does not show any clear trend, with maximum values observed in 2002 and 2008.

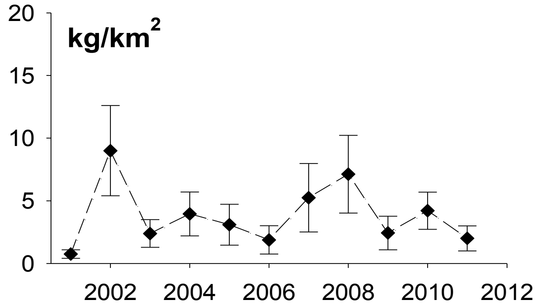


Fig. 6.1.3.1.3.1. Biomass indices of *Nephrops norvegicus* in GSA 05 from BALAR and MEDITS surveys.

6.1.3.1.4 *Trends in abundance by length or age*

No analyses were conducted during EWG 12-10 meeting.

6.1.3.1.5 *Trends in growth*

No analyses were conducted during EWG 12-10.

6.1.3.1.6 *Trends in maturity*

No analysis were conducted during EWG 12-10.

6.1.4 *Assessment of historic stock parameters*

The assessment of Norway lobster from GSA05 was performed in the EWG 12-10, but using a length cohort analysis. The assessment has been updated now, using an Extended Survivor Analysis (XSA). The main results are presented in the following paragraphs.

6.1.4.1 Method 1: XSA

6.1.4.1.1 *Justification*

This method was used as the number of available years is now considered long enough (8 years, 2004-2011) for this type of modelling.

6.1.4.1.2 *Input parameters*

Number of individuals caught by age (thousands, mean 2002-2011)									
0	1	2	3	4	5	6	7	8	9+
0	7.21	83.99	212.94	150.78	69.08	33.95	17.69	8.03	12.25

Landings time series 2002-2011 from GSA 05.

Age distributions obtained from slicing of length distributions 2002-2011.

Biological parameters used correspond to those available from GSA 05 and GSA 09.

BALAR-MEDITS survey used as tuning fleet

There are no catches for age 0.

Mean weight in catch									
0	1	2	3	4	5	6	7	8	9+
0.001	0.004	0.012	0.022	0.037	0.055	0.075	0.095	0.117	0.159

Growth parameters		
L∞	k	t0
72.1	0.169 y-1	-

Length-weight relationship	
a	b
0.000373	3.1576

Maturity oogive										
Age	0	1	2	3	4	5	6	7	8	9+
Prop. Matures	0.02	0.05	0.14	0.32	0.58	0.80	0.92	0.97	0.99	1.00

Natural mortality (PROBIOM; Abella et al., 1997)										
Age	0	1	2	3	4	5	6	7	8	9+
M	0.95	0.47	0.37	0.29	0.26	0.24	0.23	0.22	0.21	0.21

Different sensitivity analysis were performed before running the final XSA, considering different ages for shrinkage. For F, results were very similar during the last years for all the trials, although there were some changes in the first half of the data series when considering ages 7, 8 and 9. In the case of SSB, results were very different if we considered ages 1-6 (similar results for all these trials) or ages 7-9 (similar results for all the trials).

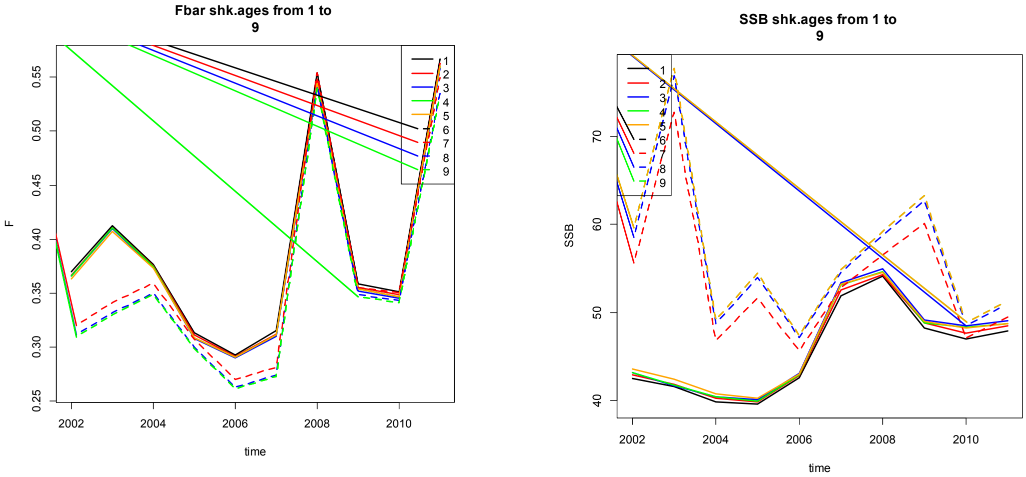


Fig.6.1.4.1.2.1 Sensitivity analysis considering different ages for shrinkage, both for F_{3-7} and for SSB.

Thus, for the final XSA run, the following settings were used:

fse	rage	qage	shk.n	shk.f	shk.yrs	shk.ages
1.5	3	7	TRUE	TRUE	3	2

6.1.4.1.3 *Results*

Results obtained using XSA showed a fluctuacting recruitment, with the highest values of the series in the intermediate years. SSB shows an increasing trend since 2006.

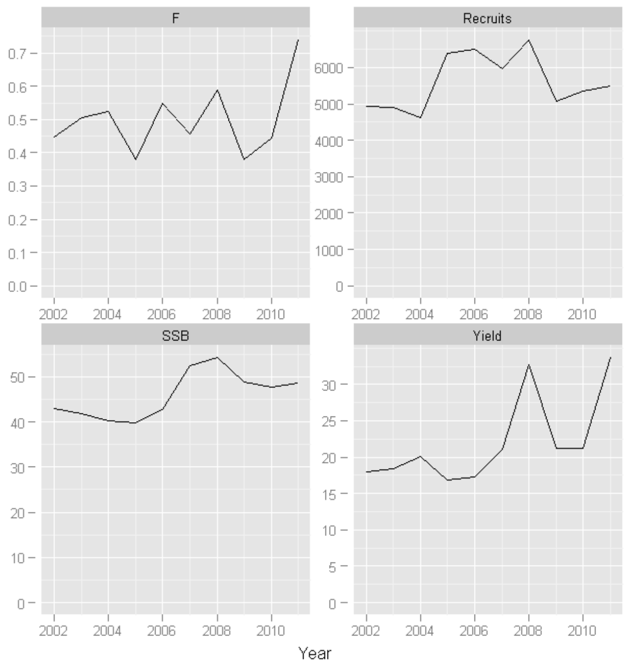


Fig. 6.1.4.1.3.1 XSA results for *Nephrops norvegicus* in GSA 05.

Residuals from the BALAR-MEDITS tuning fleet did not show any particular trend in the residuals. However, there are large residuals observed for the oldest age classes (age 4 to 8) for 2002-2006 (Fig. 6.1.4.1.3.1). The stock summary of the final XSA model is shown in Table 6.1.4.1.3.1.

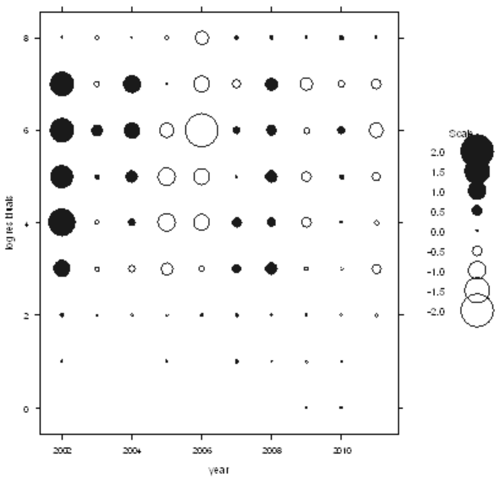


Fig. 6.1.4.1.3.2Log catchability residual plots (XSA) for BALAR -MEDITS surveys.

```
The XSA dignostics are reported below:

FLR XSA Diagnostics
CPUE data from indices
Catch data for 10 years 2002 to 2011 Ages 0 to 9
       fleet first age last age first year last year alpha beta
1 Surveys (n/km2) 0 8 2002 2011 <NA><NA>

Time series weights :
       Tapered time weighting not applied

Catchability analysis :
       Catchability independent of size for ages > 3
       Catchability independent of age for ages > 7

Terminal population estimation :
       Survivor estimates shrunk towards the mean F        of the final 3 years or the 2
oldest ages.
       S.E. of the mean to which the estimates are shrunk = 1.5
       Minimum standard error for population estimates derived from each fleet = 0.3
prior weighting not applied

Regression weights
```

```
       year
age 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
 all 1 1 1 1 1 1 1 1 1 1

 Fishing mortalities
      year
age 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
 0 0 0 0 0 0 0 0 0 0 0
 1 0 0 0.007 0.027 0.001 0 0.008 0.001 0.003 0.001
 2 0.018 0.021 0.117 0.204 0.01 0.006 0.161 0.076 0.069 0.13
 3 0.332 0.144 0.323 0.283 0.205 0.132 0.571 0.414 0.378 0.617
 4 0.412 0.524 0.408 0.46 0.38 0.505 0.666 0.524 0.378 0.861
 5 0.552 0.689 0.494 0.208 0.512 0.425 0.701 0.454 0.416 0.581
 6 0.521 0.674 0.533 0.4 0.351 0.492 0.641 0.309 0.501 0.625
 7 0.576 0.649 0.739 0.617 0.322 0.638 0.421 0.314 0.613 0.791
 8 0.285 0.349 0.641 0.302 1.516 0.539 0.524 0.265 0.374 0.953
 9 0.285 0.349 0.641 0.302 1.516 0.539 0.524 0.265 0.374 0.953

 XSA population number (Thousand)
 age
year 0 1 2 3 4 5 6 7 8 9
 2002 4923 1884 1053 724 353 176 102 36 36 39
 2003 4908 1904 1177 714 389 180 80 48 16 36
 2004 4615 1898 1190 797 463 177 71 32 20 30
 2005 6392 1785 1179 731 431 237 85 33 12 20
 2006 6510 2472 1086 664 412 210 152 45 14 10
 2007 5964 2518 1544 742 405 217 99 85 26 50
 2008 6747 2307 1574 1060 487 188 112 48 36 59
 2009 5062 2609 1431 925 448 193 73 47 25 58
 2010 5353 1958 1629 915 458 205 96 43 27 37
 2011 5485 2070 1220 1049 469 242 106 46 19 28

 Estimated population abundance at 1st Jan 2012
 age
year 0 1 2 3 4 5 6 7 8 9
 2012 106 2121 1292 740 424 153 106 45 17 6

 Fleet: Surveys (n/km2)
 Log catchability residuals.
  year
age 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
 0 0 0 0 0 0 0 0 0 0 0
 1 0.021 0 0 0 0 0.042 -0.018 -0.024 -0.021 0
 2 0.093 -0.067 -0.026 -0.064 0.055 0.06 0.01 0.011 -0.013 -0.059
```

```
 3 0.832 -0.103 -0.289 -0.563 -0.17 0.347 0.536 -0.114 -0.064 -0.411
 4 1.408 -0.069 0.297 -0.901 -0.773 0.389 0.333 -0.482 -0.006 -0.195
 5 1.164 0.128 0.559 -0.857 -0.803 0.076 0.5 -0.486 0.099 -0.38
 6 1.251 0.481 0.693 -0.65 -1.742 0.259 0.524 -0.239 0.208 -0.784
 7 1.163 -0.186 0.791 -0.102 -0.699 -0.262 0.603 -0.461 -0.307 -0.54
 8 0.115 -0.238 -0.058 -0.237 -1.176 0.242 0.202 0.03 0.344 0

 Regression statistics
 Ages with q dependent on year class strength
[1] 6.96E-308 0.252530243 0.223689715 0.744036149 0.000178591 7.753213311
[7] 6.679419137 4.173322317

  Terminal year survivor and F summaries:

 ,Age 0 Year class 2011
 source
 scaledWts survivors yrcls
nshk 1 2121 2011

 ,Age 1 Year class 2010
 source
 scaledWts survivors yrcls
fshk 1 462 2010

 ,Age 2 Year class 2009
 source
 scaledWts survivors yrcls
Surveys (n/km2) 0.956 568 2009
fshk 0.044 945 2009

 ,Age 3 Year class 2008
 source
 scaledWts survivors yrcls
Surveys (n/km2) 0.734 244 2008
fshk 0.266 620 2008

 ,Age 4 Year class 2007
 source
 scaledWts survivors yrcls
Surveys (n/km2) 0.659 126 2007
fshk 0.341 300 2007

 ,Age 5 Year class 2006
 source
```

```
 scaledWts survivors yrcls
Surveys (n/km2) 0.735 73 2006
fshk 0.265 120 2006

 ,Age 6 Year class 2005
 source
 scaledWts survivors yrcls
Surveys (n/km2) 0.592 21 2005
fshk 0.408 62 2005

 ,Age 7 Year class 2004
 source
 scaledWts survivors yrcls
Surveys (n/km2) 0.702 10 2004
fshk 0.298 35 2004

 ,Age 8 Year class 2003
 source
 scaledWts survivors yrcls
fshk 1 9 2003
```

Table. 6.1.4.1.3.1. XSA results.

	Population in number	Population in weight	Recruitment number	SSB	F_{3-7}
2002	9418.2	87.2	5008.9	43.0	0.50
2003	9439.1	86.4	4864.4	40.5	0.55
2004	9237.7	86.1	4553.7	39.8	0.52
2005	10813.5	85.4	6319.9	39.5	0.40
2006	11468.6	89.3	6440.7	42.9	0.35
2007	11458.0	106.0	5814.4	53.9	0.43
2008	12503.4	110.4	6720.3	55.2	0.60
2009	10801.4	100.6	5065.2	48.2	0.41
2010	10689.8	100.0	5365.9	47.8	0.48
2011	10665.6	98.2	5454.7	46.3	0.74

Retrospective analysis (Fig. 6.1.4.1.3.3) was performed and, in general, R and SSB seem to be underestimated for some years, while the opposite is true for F. These results can be a consequence of the short data series available for such a long-living species. Longer data series will probablyreturn more robust results.

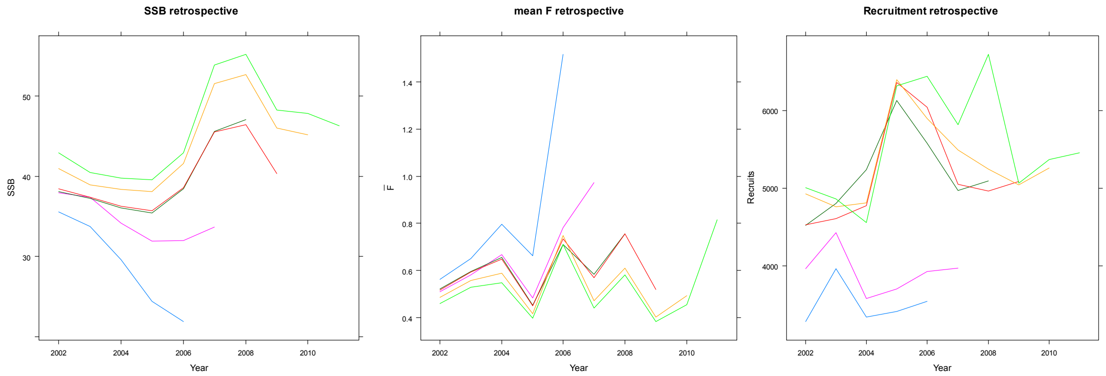


Fig. 6.1.4.1.3.3 XSA retrospective analysis.

6.1.5 *Long term prediction*

6.1.5.1 Justification

6.1.5.1.1 *Input parameters*

Reference F for the Yield per recruit (YPR) analysis was estimated using 3 to 7 years age classes. Stock weight at age and catch weight at age were estimated as the mean values of the last three years (2009-2011).

6.1.5.1.2 *Results*

The estimated fishing mortality (F_{curr}) is displayed in the following table, along with the reference points $F_{0.1}$computed during EWG 12-10. $F_{0.1}$ = 0.42 is considered as proxy of F_{MSY}.

$F_{0.1}$ as proxy of F_{MSY}	0.421
F_{ref} (2009-2011; ages 3-7)	0.55

6.1.6 *Data quality*

Only part of the Spanish data was submitted in time before the meeting; catch data was only available by age, not by size. However, during the meeting, the remaining data was submitted, so it could be used for performing the assessment.

6.1.7 *Scientific advice*

The estimation of stock specific biological parameters (e.g. growth) from GSA 05 will likely improve the data input for the assessment of *Nephrops norvegicus* in GSA 05.

6.1.7.1 Short term considerations

6.1.7.1.1 *State of the spawning stock size*

SSB shows an increasing trend since 2006.

6.1.7.1.2 *State of recruitment*

Recruitment showed oscillations, with the highest values of the series in the intermediate years, 2005-2008.

6.1.7.1.3 *State of exploitation*

The current F(0.55) is larger than F_{MSY} (0.42), which indicates that Norway lobster in GSA 05 is fished unsustainably.

6.2 Stock assessment of common octopus (*Octopus vulgaris*) in GSA 05

6.2.1 *Stock identification and biological features*

6.2.1.1 Stock Identification

No analyses were conducted during STECF EWG 12-10. Due to a lack of information about the structure of the octopus population in the western Mediterranean, this stock was assumed to be confined within the boundaries of the GSA 05.

6.2.1.2 Growth

No analyses were conducted during STECF EWG 12-10 meeting.

6.2.1.3 Maturity

No analyses were conducted during STECF EWG 12-10.

6.2.2 *Fisheries*

6.2.2.1 General description of fisheries

In the Balearic Islands (GSA 05), commercial trawlers use up to four different fishing tactics (Palmer et al. 2009), which are associated with the shallow and deep continental shelf, and the upper and middle continental slope (Guijarro and Massutí 2006; Ordines et al. 2006). Vessels mainly target striped mullet (*Mullus sumuletus*) and European hake (*Merluccius merluccius*) on the shallow and deep shelf respectively. However, these two target species are caught along with a large variety of fish and cephalopod species. Norway lobster (*Nephrops norvegicus*) and the red shrimp (*Aristeus antennatus*) are the main target species on the upper and middle slope respectively. Norway lobster is caught at the same time as a large number of other fish and crustacean species, but the red shrimp fishery is the only Mediterranean fishery that could be considered monospecific.

Common octopus is caught both by the trawl and artisanal fishery. However, the main catches come from trawlers, which represent between 80 and 95% of the total landings (Figure 6.2.2.1.1). The species is mainly taken by trawlers working on the shallow continental shelf, accounting for between 20 and 37% of total catches from those trawling grounds (Figure 6.2.2.1.2).

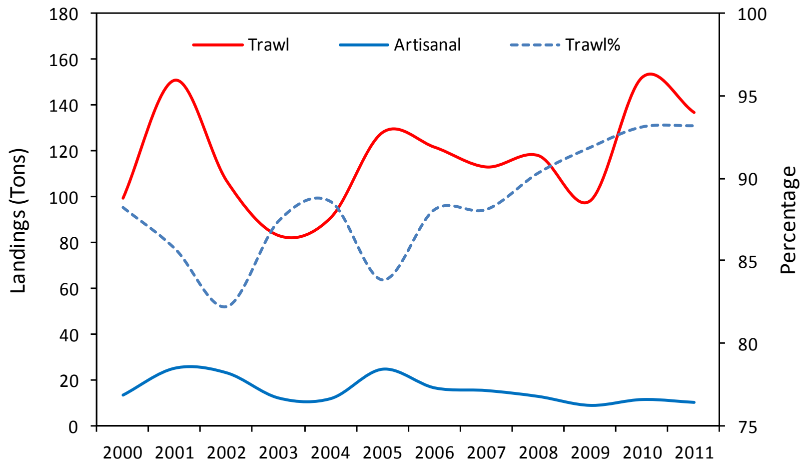


Fig.6.2.2.1.1 Trawl (red line) and artisanal (blue line) fishery landings of common octopus from Mallorca (Balearic Islands) during 2000-2011. The percentage of trawl landings compared to total landings is also shown (dotted line).

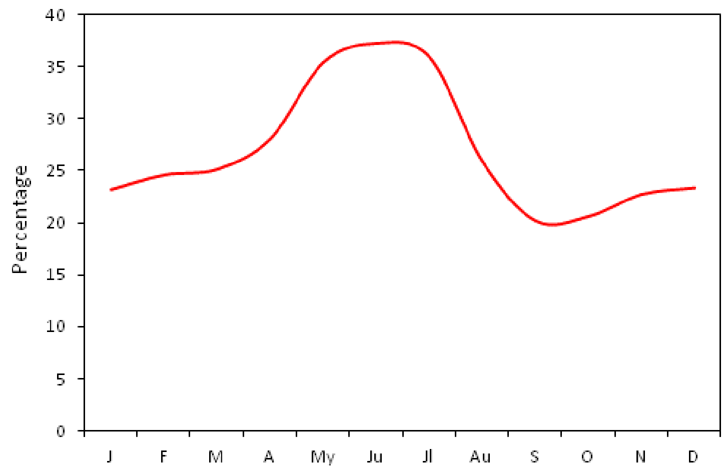


Fig.6.2.2.1.2 Monthly percentages of common octopus landings compared to total landings of bottom trawlers from GSA 05 on the shallow continental shelf.

6.2.2.2 Management regulations applicable in 2011 and 2012

Fishing license: full compliance.
Engine power limited to 316 KW or 500 CV: no compliance.
Mesh size in the cod-end (40 mm stretched): full compliance.
Fishing forbidden upper 50 m depth: partial compliance.
Time at sea (12 hours per day and 5 days per week): full compliance.

6.2.2.3 Catches

6.2.2.3.1 *Landings*

Octopus landings showed a large decrease from the beginning of the series in 1977 (364 tons) to mid-1980s

(129 tons) followed by a peak in 1992 (262 tons). Since then, landings have oscillated between 96 and 179 tons (Figure 6.2.2.3.1.1).

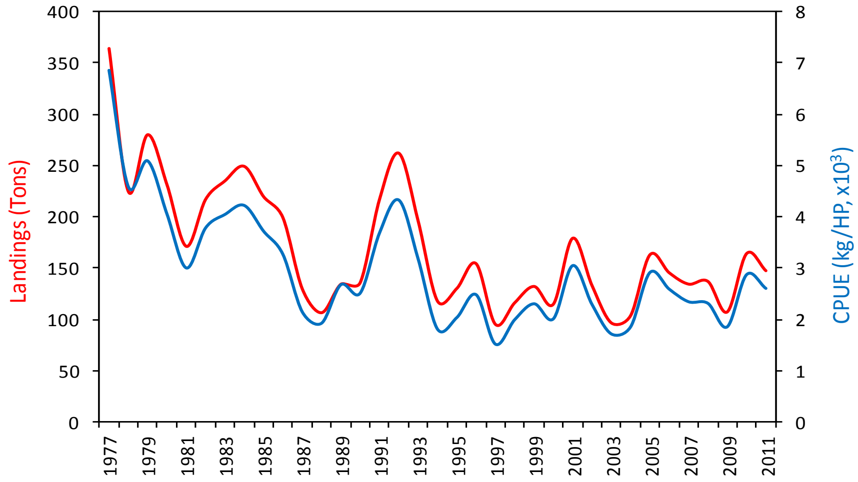


Fig.6.2.2.3.1.1 Landings (t) (red line) and CPUE (kg/HP) (blue line) of common octopus from GSA 05 between 1977 and 2011.

6.2.2.3.2 *Discards*

Octopuses are rarely discarded and when discarded they are still alive and returned to sea in good condition.

6.2.2.4 Fishing effort

During the period from 1965 to 2011, the bottom trawl fishery off Mallorca has showed large variations in the number of vessels, mean engine power and the fishing time at sea (Figure 6.2.2.4.1 A). The number of trawlers doubled during the first twelve years and reached its maximum of 70 units in 1977, but this number has decreased progressively since then and is now similar to the initial number of vessels. Through different time steps, the number of fishing hours has also decreased from 126 $h \cdot w^{-1}$ in 1965 to 60 $h \cdot w^{-1}$ in 2011. Mean engine power, however, has increased considerably with time, and currently vessels have more than six times the power they had in 1965. The fishing effort index used in this assessment ($HP \cdot y^{-1}$), which incorporates this data (number of vessels, engine power and time at sea), also increased with time, but at different growth rates throughout the series (Figure 6.2.2.4.1 B). This general increasing trend, however, was punctuated by episodes of rapid decreases in the fishing effort related to the decrease in time at sea due to different fishing regulations coming into force. Three main phases can be distinguished in the evolution of the fishing effort over time: 1) from 1965 to the mid 1970s it increased by a factor of 2.5; 2) from the mid 1970s to 1994 it continued to grow but at a slower rate; and 3) from 1994 to the present it has gradually decreased. However, the improvement in fishing power with time owing to technological advances was not accounted for and thus the decline in CPUE should in fact be steeper.

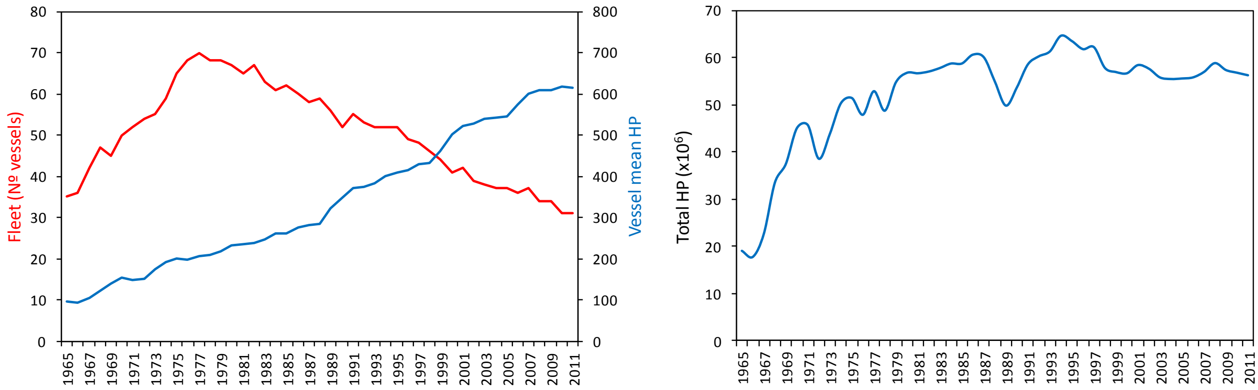


Fig.6.2.2.4.1 (A) Total number of vessels (red line) along with mean vessel HP (blue line) during 1965-2011. (B) Annual horse power (HP) of the entire bottom trawl fleet of Mallorca (Balearic Islands, western Mediterranean) during the same period.

6.2.3 *Scientific surveys*

The model fit using abundance indexes from surveys (MEDITS) was worst than the fit using exclusively fishery data. Consequently, it was decided to present as a final assessment this last one with a better model fit and without the surveys data.

6.2.4 *Assessments of historic stock parameters*

The species has not been assessed previously in GSA05 and, to our knowledge, neither in other Mediterranean areas.

6.2.4.1 Method 1: Surplus Production Model

6.2.4.1.1 *Justification*

The analysis was performed using the ASPIC.5.3 software (A Stock-Production model IncorporatingCovariates) (Prager, 1994, 2005) assuming a Schaefer (1954) model. This program implements a nonequilibrium, continuous-time, observation-error estimator for the dynamic production model (Schnute, 1977; Prager, 1994). ASPIC requires starting guesses of the following estimated parameters: 1) K, the stock's maximum biomass or carrying capacity; 2) MSY, the maximum sustainable yield; 3) B_1/K, the ratio of the biomass at the beginning of the first year to K; and 4) q, the catchability coefficient.

6.2.4.1.2 *Input parameters*

Input data are CPUEs and landings of common octopus from Mallorca (GSA05) from 1977 to 2011. CPUEs were obtained using the landings and the fishing effort in horse power (HP) as explained above. In the first ASPIC runs, we followed the recommendations of Prager (2004) to set the starting guesses for the parameters K, MSY, B1/K and q, which were then interactively adjusted depending on the program outputs. The initial guesses for the MSY and K were half and ten times respectively the largest catch observed during the period from 1977 to 2011 (Prager 2004). The ASPIC input file is attached below.

```
BOT           ## Run type (FIT, BOT, or IRF)
"Octopus GSA05"
LOGISTIC YLD WTDSSE   ## Model type, conditioning type, objective function
102                        ## Verbosity
1000                      ## Number of bootstrap trials, <= 1000
0 50000                 ## 0=no MC search, 1=search, 2=repeated srch; N trials
1.00000d-08           ## Convergence crit. for simplex
3.00000d-08   6      ## Convergence crit. for restarts, N restarts
1.00000d-04   0      ## Convergence crit. for estimating effort; N steps/yr
8.00000d00            ## Maximum F allowed in estimating effort
0d0                        ## Weighting for B1 > K as residual (usually 0 or 1)
1                            ## Number of fisheries (data series)
1.00000d00            ## Statistical weights for data series
7.500d-01               ## B1/K (starting guess, usually 0 to 1)
1.81919d02            ## MSY (starting guess)
3.63838d03            ## K (carrying capacity) (starting guess)
1.00000d-06           ## q (starting guesses -- 1 per data series)
1 1 1 1                   ## Estimate flags (0 or 1) (B1/K,MSY,K,q1...qn)
9.09590d01  3.63838d02           ## Min and max constraints -- MSY
7.27675d02  7.27680d03           ## Min and max constraints -- K
4590456                 ## Random number seed
35                          ## Number of years of data in each series
" Octopus GSA05"
CC

   1977   6.87000d-03   3.63838d02     1
   1978   4.59300d-03   2.24256d02     1
   1979   5.10000d-03   2.79701d02     1
   1980   4.06000d-03   2.30851d02     1
   1981   3.00800d-03   1.70766d02     1
   1982   3.79200d-03   2.16645d02     1
   1983   4.05400d-03   2.34662d02     1
   1984   4.22900d-03   2.48799d02     1
   1985   3.72700d-03   2.19284d02     1
   1986   3.27400d-03   1.98762d02     1
   1987   2.15100d-03   1.29379d02     1
   1988   1.92900d-03   1.06024d02     1
   1989   2.68100d-03   1.33802d02     1
   1990   2.51600d-03   1.35303d02     1
   1991   3.69200d-03   2.16530d02     1
   1992   4.33500d-03   2.61665d02     1
   1993   3.18400d-03   1.95507d02     1
   1994   1.81400d-03   1.17393d02     1
   1995   2.03900d-03   1.29648d02     1
   1996   2.48600d-03   1.53888d02     1
   1997   1.51900d-03   9.46650d01     1
   1998   1.99900d-03   1.15747d02     1
   1999   2.30900d-03   1.31650d02     1
   2000   2.01500d-03   1.14377d02     1
   2001   3.05400d-03   1.78698d02     1
   2002   2.29600d-03   1.32526d02     1
   2003   1.71900d-03   9.60780d01     1
   2004   1.85900d-03   1.03268d02     1
   2005   2.92100d-03   1.62580d02     1
   2006   2.59300d-03   1.44927d02     1
   2007   2.34800d-03   1.33935d02     1
   2008   2.31700d-03   1.36534d02     1
   2009   1.85900d-03   1.06784d021
   2010   2.87700d-03   1.63656d02     1
   2011   2.60900d-03   1.47001d02     1
```

6.2.4.1.3 *Results*

The model was successfully fitted since all input parameters (B1/K, MSY, K, q) were estimated by the program and there was no need to fix any of them. The relationship between observed and estimated CPUE was rather high (r^2=0.720). Trial replacements for out-of-bounds estimates were only needed for the parameter K in 4 out of the 1000 bootstraps. Residuals of the CPUE fit did not show any trend (Figure 6.2.4.1.3.1).

CONTROL PARAMETERS (FROM INPUT FILE) Input file: d:\...tos\reunions\stecf ewg 12 10\pop\pop wtd\pop_ss075.inp

----

Operation of ASPIC: Fit logistic (Schaefer) model by direct optimization with bootstrap.

Number of years analyzed:	35	Number of bootstrap trials:	1000	
Number of data series:	1	Bounds on MSY (min, max):	9.096E+01	3.638E+02
Objective function:	Least squares	Bounds on K (min, max):	7.277E+02	7.277E+03
Relative conv. criterion (simplex):	1.000E-08	Monte Carlo search mode, trials:	0	50000
Relative conv. criterion (restart):	3.000E-08	Random number seed:	4590456	
Relative conv. criterion (effort):	1.000E-04	Identical convergences required in fitting:	6	
Maximum F allowed in fitting:	8.000			

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) error code 0

Normal convergence

GOODNESS-OF-FIT AND WEIGHTING (NON-BOOTSTRAPPED ANALYSIS)

Loss component number and title	Weighted SSE	N	Weighted MSE	Current weight	Inv. var. weight	R-squared in CPUE
Loss(-1) SSE in yield	0.000E+00					
Loss(0) Penalty for B1 > K	0.000E+00	1	N/A	0.000E+00	N/A	
Loss(1) Pop	1.434E+00	35	4.346E-02	1.000E+00	1.000E+00	0.720

....

TOTAL OBJECTIVE FUNCTION, MSE, RMSE: 1.43416468E+00 4.626E-02 2.151E-01

Estimated contrast index (ideal = 1.0): 0.5048 C* = (Bmax-Bmin)/K

Estimated nearness index (ideal = 1.0): 1.0000 N* = 1 - |min(B-Bmsy)|/K

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	User/pgm guess	2nd guess	Estimated	User guess
B1/K	Starting relative biomass (in 1977)	6.858E-01	7.500E-01	9.000E-01	1	1
MSY	Maximum sustainable yield	1.968E+02	1.819E+02	1.440E+02	1	1
K	Maximum population size	1.228E+03	3.638E+03	8.640E+02	1	1
phi	Shape of production curve (Bmsy/K)	0.5000	0.5000	----	0	1
--------- Catchability Coefficients by Data Series ---------------						
q(1)	Pop	8.178E-06	1.000E-06	9.500E-05	1	1

MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Logistic formula	General formula
MSY	Maximum sustainable yield	1.968E+02	----	----
Bmsy	Stock biomass giving MSY	6.141E+02	K/2	K*n**(1/(1-n))
Fmsy	Fishing mortality rate at MSY	3.205E-01	MSY/Bmsy	MSY/Bmsy
n	Exponent in production function	2.0000	----	----
g	Fletcher's gamma	4.000E+00	----	[n**(n/(n-1))]/[n-1]
B./Bmsy	Ratio: B(2012)/Bmsy	5.057E-01	----	----
F./Fmsy	Ratio: F(2011)/Fmsy	1.481E+00	----	----
Fmsy/F.	Ratio: Fmsy/F(2011)	6.754E-01	----	----
Y.(Fmsy)	Approx. yield available at Fmsy in 2012	9.952E+01	MSY*B./Bmsy	MSY*B./Bmsy
	...as proportion of MSY	5.057E-01	----	----
Ye.	Equilibrium yield available in 2012	1.487E+02	4*MSY*(B/K-(B/K)**2)	g*MSY*(B/K-(B/K)**n)
	...as proportion of MSY	7.557E-01	----	----
--------- Fishing effort rate at MSY in units of each CE or CC series ---------				
fmsy(1)	Pop	3.919E+04	Fmsy/q(1)	Fmsy/q(1)

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1977	0.489	8.422E+02	7.444E+02	3.638E+02	3.638E+02	1.866E+02	1.525E+00	1.372E+00
2	1978	0.345	6.650E+02	6.500E+02	2.243E+02	2.243E+02	1.961E+02	1.077E+00	1.083E+00
3	1979	0.472	6.368E+02	5.920E+02	2.797E+02	2.797E+02	1.962E+02	1.474E+00	1.037E+00
4	1980	0.433	5.533E+02	5.335E+02	2.309E+02	2.309E+02	1.933E+02	1.350E+00	9.011E-01
5	1981	0.324	5.158E+02	5.273E+02	1.708E+02	1.708E+02	1.928E+02	1.011E+00	8.400E-01
6	1982	0.412	5.379E+02	5.253E+02	2.166E+02	2.166E+02	1.926E+02	1.287E+00	8.759E-01
7	1983	0.479	5.139E+02	4.895E+02	2.347E+02	2.347E+02	1.886E+02	1.496E+00	8.368E-01
8	1984	0.578	4.678E+02	4.307E+02	2.488E+02	2.488E+02	1.790E+02	1.803E+00	7.618E-01
9	1985	0.593	3.981E+02	3.697E+02	2.193E+02	2.193E+02	1.655E+02	1.851E+00	6.482E-01
10	1986	0.622	3.443E+02	3.193E+02	1.988E+02	1.988E+02	1.514E+02	1.942E+00	5.606E-01
11	1987	0.423	2.969E+02	3.060E+02	1.294E+02	1.294E+02	1.472E+02	1.320E+00	4.835E-01
12	1988	0.311	3.147E+02	3.407E+02	1.060E+02	1.060E+02	1.577E+02	9.712E-01	5.125E-01
13	1989	0.348	3.664E+02	3.844E+02	1.338E+02	1.338E+02	1.692E+02	1.086E+00	5.966E-01
14	1990	0.320	4.018E+02	4.234E+02	1.353E+02	1.353E+02	1.777E+02	9.972E-01	6.542E-01
15	1991	0.511	4.442E+02	4.238E+02	2.165E+02	2.165E+02	1.778E+02	1.594E+00	7.233E-01
16	1992	0.746	4.055E+02	3.508E+02	2.617E+02	2.617E+02	1.602E+02	2.328E+00	6.603E-01
17	1993	0.718	3.040E+02	2.723E+02	1.955E+02	1.955E+02	1.357E+02	2.240E+00	4.951E-01
18	1994	0.471	2.442E+02	2.492E+02	1.174E+02	1.174E+02	1.273E+02	1.470E+00	3.976E-01
19	1995	0.511	2.541E+02	2.538E+02	1.296E+02	1.296E+02	1.290E+02	1.594E+00	4.138E-01
20	1996	0.649	2.535E+02	2.372E+02	1.539E+02	1.539E+02	1.226E+02	2.024E+00	4.128E-01
21	1997	0.401	2.222E+02	2.360E+02	9.467E+01	9.467E+01	1.222E+02	1.252E+00	3.619E-01
22	1998	0.450	2.497E+02	2.571E+02	1.157E+02	1.157E+02	1.303E+02	1.405E+00	4.067E-01
23	1999	0.497	2.643E+02	2.651E+02	1.317E+02	1.317E+02	1.332E+02	1.550E+00	4.303E-01
24	2000	0.412	2.658E+02	2.776E+02	1.144E+02	1.144E+02	1.377E+02	1.286E+00	4.329E-01
25	2001	0.674	2.891E+02	2.652E+02	1.787E+02	1.787E+02	1.332E+02	2.103E+00	4.708E-01
26	2002	0.555	2.436E+02	2.389E+02	1.325E+02	1.325E+02	1.233E+02	1.731E+00	3.967E-01
27	2003	0.384	2.344E+02	2.502E+02	9.608E+01	9.608E+01	1.276E+02	1.198E+00	3.817E-01
28	2004	0.363	2.660E+02	2.844E+02	1.033E+02	1.033E+02	1.400E+02	1.133E+00	4.331E-01
29	2005	0.556	3.027E+02	2.924E+02	1.626E+02	1.626E+02	1.428E+02	1.735E+00	4.929E-01
30	2006	0.518	2.829E+02	2.796E+02	1.449E+02	1.449E+02	1.384E+02	1.618E+00	4.607E-01
31	2007	0.481	2.764E+02	2.785E+02	1.339E+02	1.339E+02	1.380E+02	1.501E+00	4.501E-01
32	2008	0.485	2.804E+02	2.818E+02	1.365E+02	1.365E+02	1.392E+02	1.512E+00	4.567E-01
33	2009	0.353	2.831E+02	3.029E+02	1.068E+02	1.068E+02	1.462E+02	1.100E+00	4.610E-01
34	2010	0.519	3.225E+02	3.155E+02	1.637E+02	1.637E+02	1.503E+02	1.618E+00	5.251E-01
35	2011	0.474	3.091E+02	3.098E+02	1.470E+02	1.470E+02	1.485E+02	1.481E+00	5.033E-01
36	2012		3.106E+02				5.057E-01		

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) Pop

Data type CC: CPUE-catch series Series weight: 1.000

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Statist weight
1	1977	6.870E-03	6.088E-03	0.4888	3.638E+02	3.638E+02	-0.12086	1.000E+00
2	1978	4.593E-03	5.316E-03	0.3450	2.243E+02	2.243E+02	0.14612	1.000E+00
3	1979	5.100E-03	4.841E-03	0.4725	2.797E+02	2.797E+02	-0.05209	1.000E+00
4	1980	4.060E-03	4.363E-03	0.4327	2.309E+02	2.309E+02	0.07195	1.000E+00
5	1981	3.008E-03	4.312E-03	0.3239	1.708E+02	1.708E+02	0.36017	1.000E+00
6	1982	3.792E-03	4.296E-03	0.4125	2.166E+02	2.166E+02	0.12469	1.000E+00
7	1983	4.054E-03	4.003E-03	0.4794	2.347E+02	2.347E+02	-0.01255	1.000E+00
8	1984	4.229E-03	3.522E-03	0.5776	2.488E+02	2.488E+02	-0.18281	1.000E+00
9	1985	3.727E-03	3.023E-03	0.5932	2.193E+02	2.193E+02	-0.20929	1.000E+00
10	1986	3.274E-03	2.612E-03	0.6224	1.988E+02	1.988E+02	-0.22603	1.000E+00
11	1987	2.151E-03	2.502E-03	0.4229	1.294E+02	1.294E+02	0.15120	1.000E+00
12	1988	1.929E-03	2.786E-03	0.3112	1.060E+02	1.060E+02	0.36757	1.000E+00
13	1989	2.681E-03	3.143E-03	0.3481	1.338E+02	1.338E+02	0.15914	1.000E+00
14	1990	2.516E-03	3.463E-03	0.3196	1.353E+02	1.353E+02	0.31935	1.000E+00
15	1991	3.692E-03	3.466E-03	0.5109	2.165E+02	2.165E+02	-0.06310	1.000E+00
16	1992	4.335E-03	2.869E-03	0.7459	2.617E+02	2.617E+02	-0.41283	1.000E+00
17	1993	3.184E-03	2.227E-03	0.7180	1.955E+02	1.955E+02	-0.35751	1.000E+00
18	1994	1.814E-03	2.038E-03	0.4710	1.174E+02	1.174E+02	0.11648	1.000E+00
19	1995	2.039E-03	2.076E-03	0.5108	1.296E+02	1.296E+02	0.01776	1.000E+00
20	1996	2.486E-03	1.940E-03	0.6487	1.539E+02	1.539E+02	-0.24804	1.000E+00
21	1997	1.519E-03	1.930E-03	0.4011	9.467E+01	9.467E+01	0.23947	1.000E+00
22	1998	1.999E-03	2.102E-03	0.4502	1.157E+02	1.157E+02	0.05045	1.000E+00
23	1999	2.309E-03	2.168E-03	0.4967	1.317E+02	1.317E+02	-0.06316	1.000E+00
24	2000	2.015E-03	2.270E-03	0.4120	1.144E+02	1.144E+02	0.11923	1.000E+00
25	2001	3.054E-03	2.169E-03	0.6738	1.787E+02	1.787E+02	-0.34229	1.000E+00
26	2002	2.296E-03	1.954E-03	0.5548	1.325E+02	1.325E+02	-0.16151	1.000E+00
27	2003	1.719E-03	2.046E-03	0.3840	9.608E+01	9.608E+01	0.17419	1.000E+00
28	2004	1.859E-03	2.326E-03	0.3631	1.033E+02	1.033E+02	0.22401	1.000E+00
29	2005	2.921E-03	2.392E-03	0.5559	1.626E+02	1.626E+02	-0.19994	1.000E+00
30	2006	2.593E-03	2.286E-03	0.5184	1.449E+02	1.449E+02	-0.12592	1.000E+00
31	2007	2.348E-03	2.277E-03	0.4810	1.339E+02	1.339E+02	-0.03062	1.000E+00
32	2008	2.317E-03	2.304E-03	0.4845	1.365E+02	1.365E+02	-0.00542	1.000E+00
33	2009	1.859E-03	2.477E-03	0.3526	1.068E+02	1.068E+02	0.28691	1.000E+00
34	2010	2.877E-03	2.581E-03	0.5187	1.637E+02	1.637E+02	-0.10876	1.000E+00
35	2011	2.609E-03	2.534E-03	0.4744	1.470E+02	1.470E+02	-0.02922	1.000E+00

ESTIMATES FROM BOOTSTRAPPED ANALYSIS

Param name	Point estimate	Estimated bias in pt estimate	Estimated relative bias	80% lower	80% upper	50% lower	50% upper	Inter-quartile range	Relative IQ range
				Bias-corrected approximate confidence limits					
B1/K	6.858E-01	5.358E-02	7.81%	4.985E-01	7.404E-01	6.105E-01	6.960E-01	8.549E-02	0.125
K	1.228E+03	1.047E+02	8.52%	1.108E+03	1.670E+03	1.169E+03	1.403E+03	2.346E+02	0.191
q(1)	8.178E-06	-6.215E-07	-7.60%	5.361E-06	9.171E-06	6.946E-06	8.764E-06	1.818E-06	0.222
MSY	1.968E+02	-4.140E+00	-2.10%	1.649E+02	2.030E+02	1.862E+02	1.991E+02	1.291E+01	0.066
Ye(2012)	1.487E+02	-1.343E+00	-0.90%	1.285E+02	1.721E+02	1.395E+02	1.622E+02	2.266E+01	0.152
Y.@Fmsy	9.952E+01	3.024E+00	3.04%	7.548E+01	1.243E+02	8.636E+01	1.120E+02	2.562E+01	0.257
Bmsy	6.141E+02	5.234E+01	8.52%	5.541E+02	8.352E+02	5.844E+02	7.016E+02	1.173E+02	0.191
Fmsy	3.205E-01	-2.166E-02	-6.76%	2.194E-01	3.605E-01	2.702E-01	3.391E-01	6.881E-02	0.215
fmsy(1)	3.919E+04	7.909E+02	2.02%	3.661E+04	4.291E+04	3.784E+04	4.066E+04	2.822E+03	0.072
B./Bmsy	5.057E-01	3.422E-02	6.77%	3.612E-01	6.570E-01	4.214E-01	5.659E-01	1.446E-01	0.286
F./Fmsy	1.481E+00	-1.476E-03	-0.10%	1.207E+00	1.874E+00	1.336E+00	1.679E+00	3.427E-01	0.231
Ye./MSY	7.557E-01	1.526E-02	2.02%	5.919E-01	8.823E-01	6.652E-01	8.116E-01	1.464E-01	0.194

INFORMATION FOR REPAST (Prager, Porch, Shertzer, & Caddy. 2003. NAJFM 23: 349-361)

Unitless limit reference point in F (Fmsy/F.): 0.6754
CV of above (from bootstrap distribution): 0.1776

NOTES ON BOOTSTRAPPED ESTIMATES:

- Bootstrap results were computed from 1000 trials.
- Results are conditional on bounds set on MSY and K in the input file.
- All bootstrapped intervals are approximate. The statistical literature recommends using at least 1000 trials for accurate 95% intervals. The default 80% intervals used by ASPIC should require fewer trials for equivalent accuracy. Using at least 500 trials is recommended.
- Bias estimates are typically of high variance and therefore may be misleading.

Trials replaced for lack of convergence: 0
Trials replaced for MSY out of bounds: 0
Trials replaced for q out-of-bounds: 0
Trials replaced for K out-of-bounds: 4
Residual-adjustment factor: 1.0626

Elapsed time: 0 hours, 12 minutes, 46 seconds.

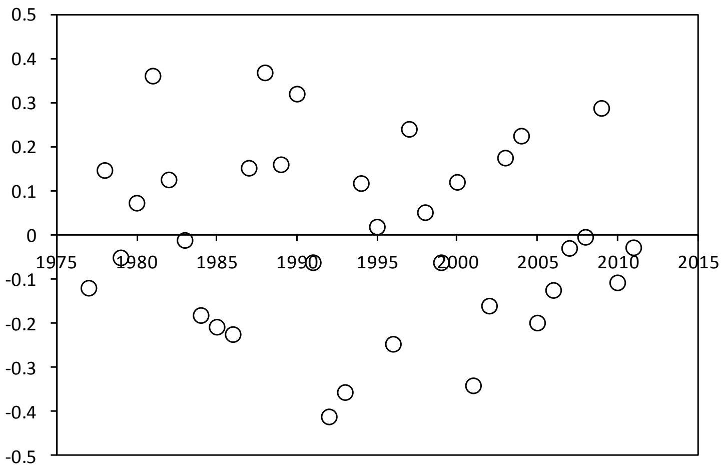


Fig. 6.2.4.1.3.1 Residuals in log scale of the CPUE fit.

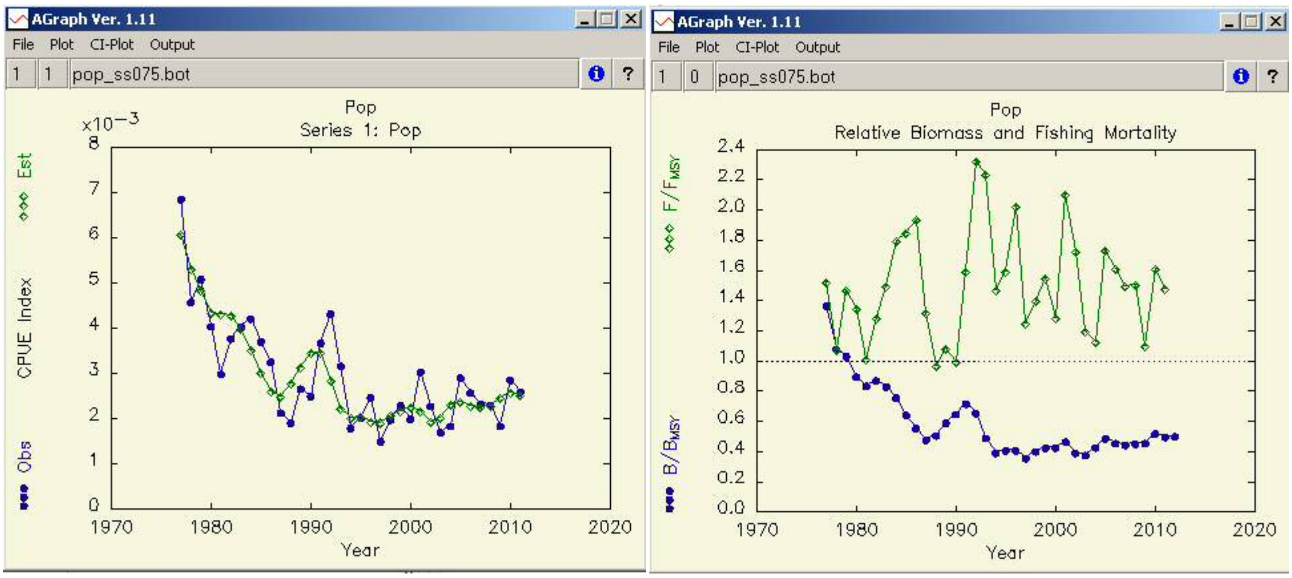


Figure 6.2.4.1.3.2Time trajectories of the relative fishing mortality rate (F/F_{MSY}) (A) and relative population biomass (B/B_{MSY}) (B).

As it can be seen in Figure 6.2.4.1.3.2 A the fit of the model is rather good along the entire data series. The evolution of relative F and B (Fig. 6.2.4.1.3.2B) showed that the species was underexploited before 1980 when $B>B_{MSY}$ but has remained overexploited since then with F and B values higher than F_{MSY} and B_{MSY} respectively. There was a sudden improvement during 1989-1991 when the F/F_{MSY} decreased to 1, but raised also suddenly up to 2.2-2.3 the next two years. According to model outputs, the stock biomass at the beginning of the time series compared to K was near 70% (B1/K=0.686). The estimated fishing mortality (F) oscillated between 0.32 and 0.75 during the time series (Fig. 6.2.4.1.3.3). The main output parameters for determining the stock status exploitation were: 1) MSY=197 tons; 2) B_{MSY}=614 tons; 3)$F_{MSY=}$0.320; 4)B/B_{MSY}=0.506; and 5) F/F_{MSY}=1.481.

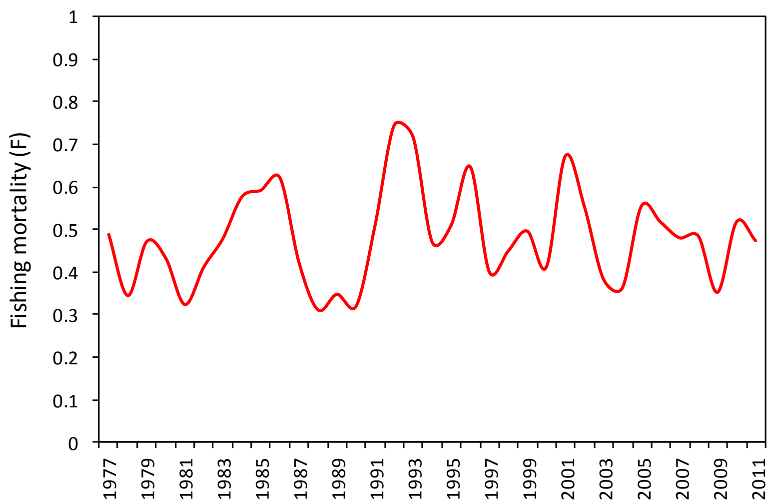


Fig. 6.2.4.1.3.3 Estimated fishing mortality (F) during the time series 1977-2012.

6.2.5 *Medium term prediction*

No analyses were conducted during STECF EWG 12-10.

6.2.6 *Long term prediction*

No analyses were conducted during STECF EWG 12-10.

6.2.6.1 Justification

No analyses were conducted during STECF EWG 12-10.

6.2.7 *Data quality*

The data series used in this assessment is the best time series of catches and effort available in the GSA05. It comes from a scientific project focussed specifically to collect the best data series available in Mallorca. All ports and other putative data sources of fishery statistics from the island were consulted and a reliable dataset of monthly landings and fishing effort from late 1960s was obtained. In spite of this, it is also true that an improvement in the results could be attained if the time series of fishing effort was standardized somehow to account for the increase in fishing power. This is needed owing to the important technical improvements (e.g. radar, GPS, gear) suffered by the fishery from the 1960s.

A further step could be the use of abundance indexes from surveys (MEDITS), although the time series available in GSA05 (2001-2012) is much shorter compared to the time series available from fishery statistics (1977-2011).

Owing to differences in life-history traits of cephalopods compared to fishes, the standard assessments methods used for fishes are not useful for cephalopods. Cephalopod growth does not follow the von Bertalanffy function, preventing the use of such standard methods (e.g. VPA). Surplus production models are therefore useful tools to determine the status exploitation of cephalopods such as octopus.

6.2.8 *Scientific advice*

6.2.8.1 Short term considerations

Data on the spawning stock size and the recruits are not available from production model outputs owing to the inherent characteristics of the model (catch data is used as a whole, not split by sizes or ages).

6.2.8.1.1 *State of the spawning stock size*

ASPIC outputs showed that octopus in GSA05 was underexploited before the 1980s ($B>B_{MSY}$)but has remained overexploited since then. From early 1980s the B/B_{MSY} decreased down to 0.4 and this value has remained rather constant up to 2011. However, there was a slight improvement during the late 1980s and early 1990s when it raised up to 0.65.

6.2.8.1.2 *State of exploitation*

Relative fishing mortality (F/F_{MSY}) has oscillated between 1.0 and 2.3 throughout the time series. In 2011, F was 1.48 times F_{MSY}.STECF EWG proposes F_{MSY}=0.320 as a limit management reference point. The estimate of the current fishing mortality F_{2011}=0.474.Taking into account the results obtained by the ASPIC analysis (current F is around 1.43 times F_{MSY}), the stock is considered exploited unsustainably.

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

6.3 Stock assessment of blue whiting in GSA 06

STECF EWG 12-10 assessed this stock for the first time in 2012 and used as input data the Data Collection Framework (DCF)information on sizeswhile the biological parameters derivedfor this species were from the Spanish National Data Collection for the GSA 06.

6.3.1 *Stock identification and biological features*

6.3.1.1 Stock Identification

Due to insufficient information about the stock structure of blue whiting in the western Mediterranean Sea, this stock was assumed to be confined within the boundariesof the GSA 06.

6.3.1.2 Growth

The growth parameters are the following: L_{inf}=48.4, K=0.19, t_0=0. Length-weight relationships: a=0.0007, b=3.69 (data source: Spanish National Data Collection).

6.3.1.3 Maturity

No information was available atSTECF EWG 12-10. Thus, the size at first maturity (i.e. 18 cm) was derived from FishBase (www.fishbase.org). Age at maturity was obtained through size to age transformation. The estimated age at first maturity is around two years.

6.3.2 *Fisheries*

6.3.2.1 General description of fisheries

No updated information was available to STECF EWG 12-10. Blue whiting is a demersal species important locally, especially in the northern part of GSA 06 and it is mainly exploited by the otter trawlers.

Landings data were reported to STECF EWG 12-10 through the DCF. The majority of the landings corresponded to bottom otter trawlers; landings reported for purse seine represented <0.15 % of the landings.

Table 6.3.2.1.1. Annual landings (t) by gear in GSA 06 from the DCF data.

FT_LVL4	FT_LVL5	FT_LVL6	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OTB	DEMSP	40D50	2409	1276	2591	2222	4723	4448	2194	1528	1321	1936
PS		14D16	0.4		1.3	1.2	4.3	6.1				

6.3.2.2 Management regulations applicable in 2010 and 2011

The management regulations applicable are to the same of the bottom trawling (Regulation (EC) No 1967/2006). Bottom trawling is allowed forfive days a week, for a maximum of 12 hours at sea per day. No specific regulations are enforcedfor this species (i.e. no minimum landing size established).

6.3.2.3 Catches

6.3.2.3.1 *Landings*

The time series of landings data (tons) and MEDITS trawl survey biomass indices (Kg/h) for the period 2002-2011 were shown in Figure 6.3.2.3.1.1. During this period both series showed a fluctuating trend without a good correlation between landings and MEDITS from 2005 to 2011. Maximum landing values were observed in 2006 and 2007 while maximum trawl survey index of biomass was estimated in 2005.

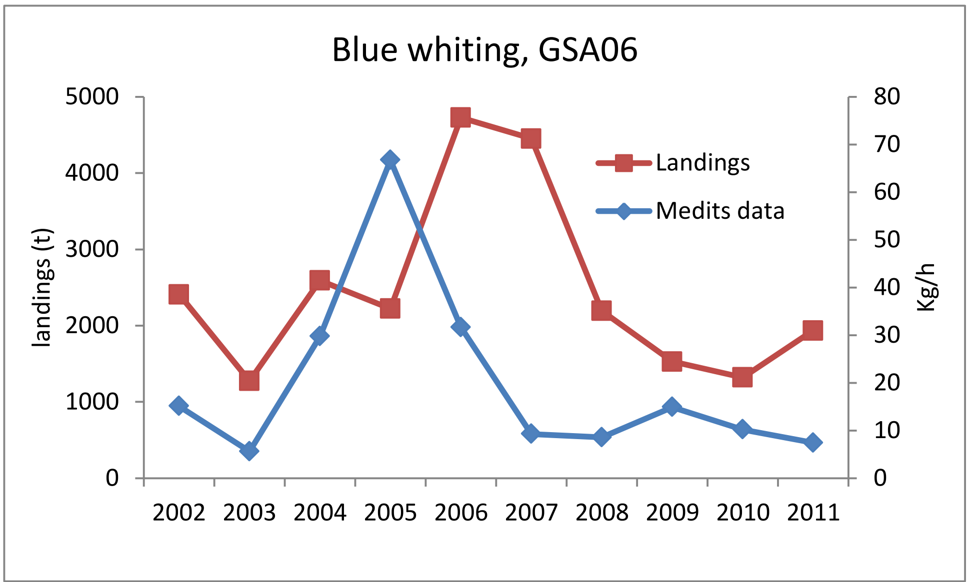


Fig. 6.3.2.3.1.1 Blue whiting in GSA 06: comparison between total annual landings (t) and the MEDITS biomass indices for the period 2002-2011.

DCF data on age structure of otter trawl blue whiting landings in GSA 06 were available for the period 2009-2011, and are shown in Figure 6.3.2.3.1.2.This species is commercialised mainly from age 1, in adult or pre-adult phase. Recruitment is usually discarded.

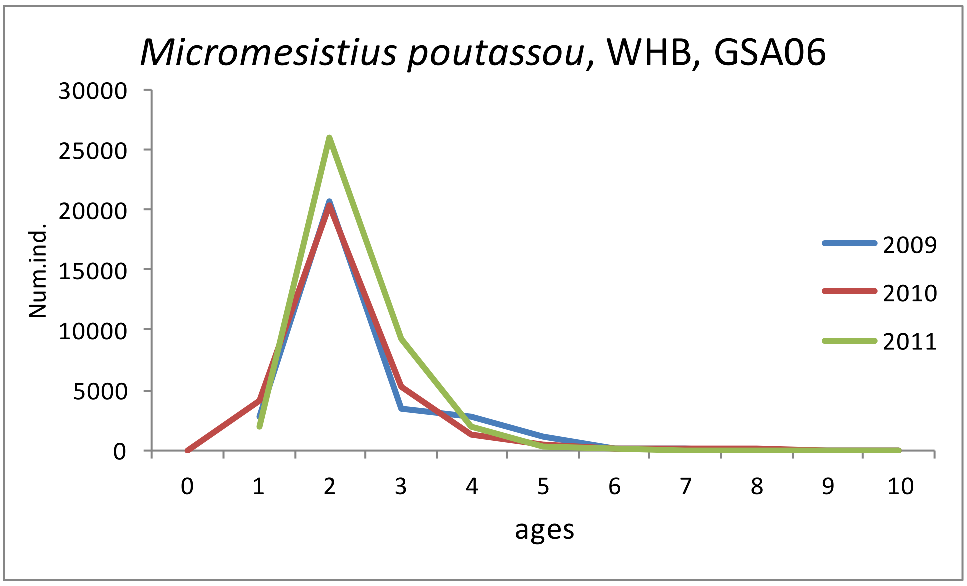


Fig.6.3.2.3.1.2 Age frequency distribution of *M. poutassou* landed in the GSA 06 from 2009 to 2011as obtained from the DCF.

6.3.2.3.2 *Discards*

Information on discards was available for 2009, 2010 and 2011. The amount of discards reported is very low (<0.05 t per year). No data on the lengths or agesof discards are available.

6.3.2.4 Fishing effort

The number of vessels and GT days at sea of OTB fleet in GSA 06 in the period 2002-2010 by fleet segment is presented in Table 6.3.2.4.1 and Figure 6.3.2.4.1. There was a decreasing trend in both number of vessels and GT days at sea in the fleet segment corresponding to small and medium vessels (VL0012 and VL1224) from 2006 until 2010. The number of the largest vessels (>24 m) have increased until 2008 and declined thereafter. There was no information about specific effort targeting blue whiting in GSA 06.

Table 6.3.2.4.1Number of vessels of OTB by fleet segment in GSA 06.

Num.ves.	2002	2003	2004	2005	2006	2007	2008	2009	2010
VL0012	30	28	30	28	28	26	27	22	21
VL1224	468	507	521	523	493	474	477	429	421
VL2440	106	114	122	125	127	134	135	129	125
ALL	604	649	673	676	648	634	639	580	567

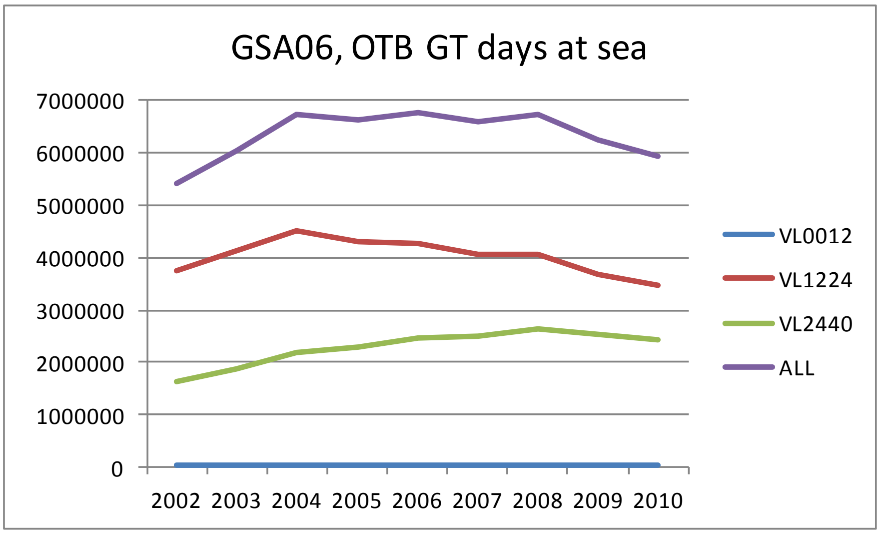


Fig.6.3.2.4.1 OTB GT days at sea by fleet segment in GSA 06 from 2002 to 2010.

6.3.3 *Scientific surveys*

6.3.3.1 MEDITS

6.3.3.1.1 *Methods*

Since 1994, MEDITS trawl surveys has been regularly carried out each year during spring. Based on the DCR data call, abundance and biomass indices were recalculated. In GSA06 the following number of hauls was reported per depth stratum (Table 6.3.3.1.1.1).

Table 6.3.3.1.1.1 Number of hauls per year and depth stratum in GSA06, 1994-2011.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GSA06_010-050	7	8	7	7	7	8	9	7	10	8	8	11	10	5	7	6	5	7
GSA06_050-100	19	25	26	25	27	27	29	29	34	36	30	31	33	26	29	28	19	28
GSA06_100-200	10	16	16	14	12	16	17	18	19	20	16	17	17	14	20	20	12	20
GSA06_200-500	9	14	9	10	6	12	11	15	16	17	15	14	17	10	13	14	10	15
GSA06_500-800	7	11	10	8	4	10	7	8	7	11	11	8	12	9	8	7	7	8

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean
The variation of the stratified mean is then expressed as the 95 % confidence interval:
Confidence interval = Yst ± t(student distribution) * V(Yst) / n

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.3.3.1.2 *Geographical distribution patterns*

No information was documented during STECF EWG 12-10.

6.3.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of blue whiting in GSA 06 was derived from the international survey MEDITS.

Figure6.3.3.1.3.1displays the estimated trend in blue whiting abundance and biomass in GSA 06.The estimated abundance and biomass indices did not reveal any significant trends since 1994.

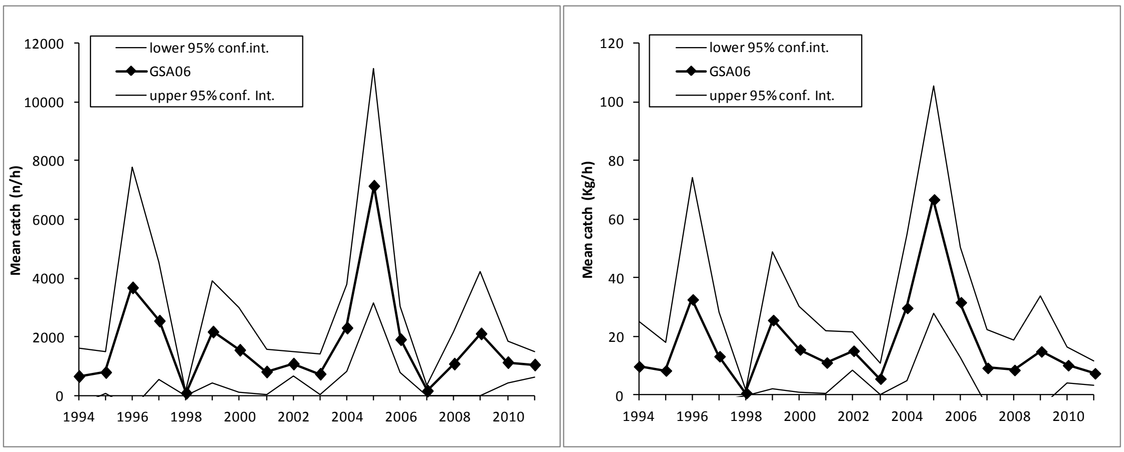


Fig. 6.3.3.1.3.1 Abundance and biomass indices of blue whiting in GSA 06.

6.3.3.1.4 *Trends in abundance by length or age*

The following Figures. 1.1.3.1.4.1- 3show the stratified abundance indices of blue whiting in GSA 06 in 1994-2011.

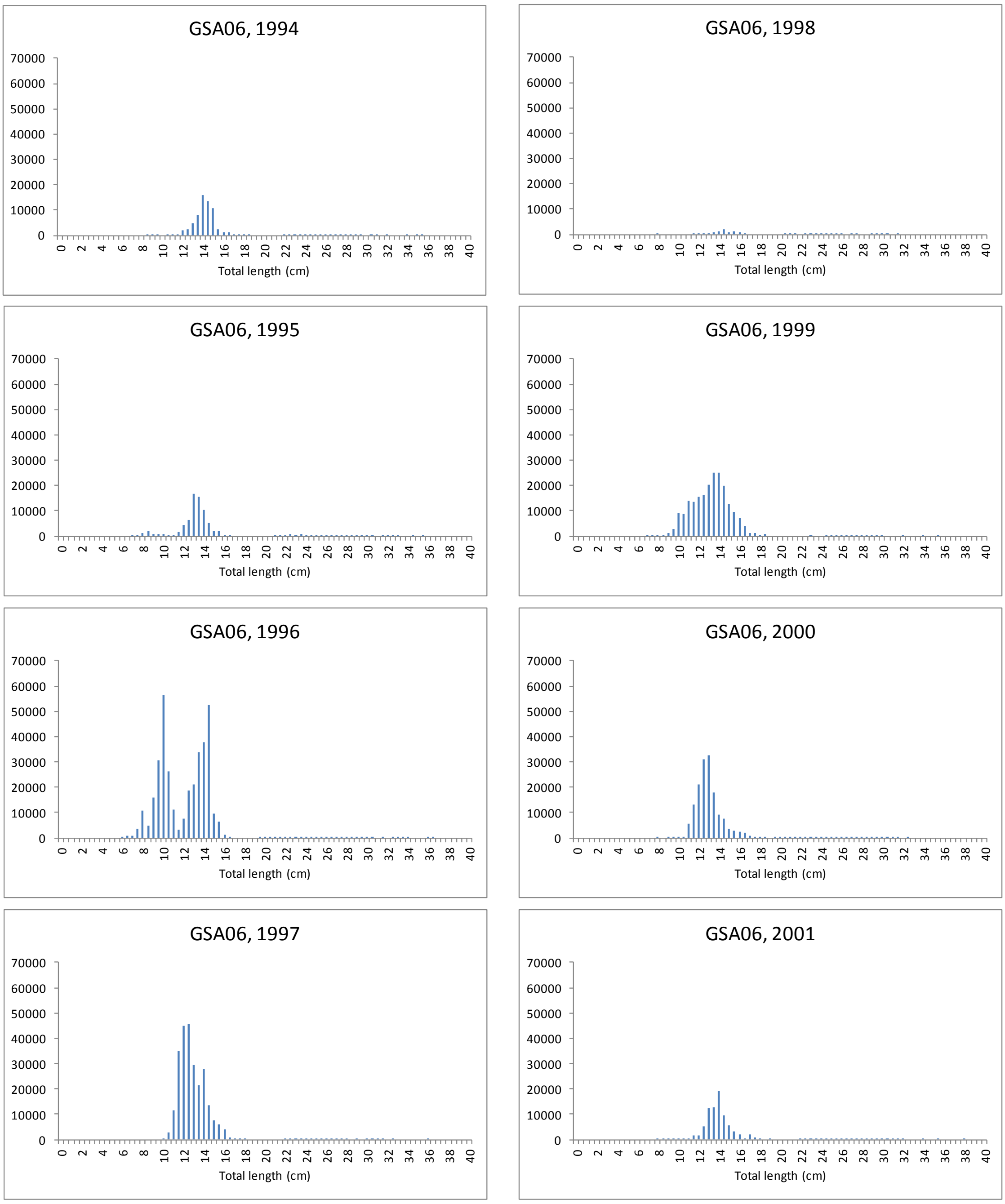


Fig. 6.3.3.1.4.1 Stratified abundance indices by size, 1994-2001.

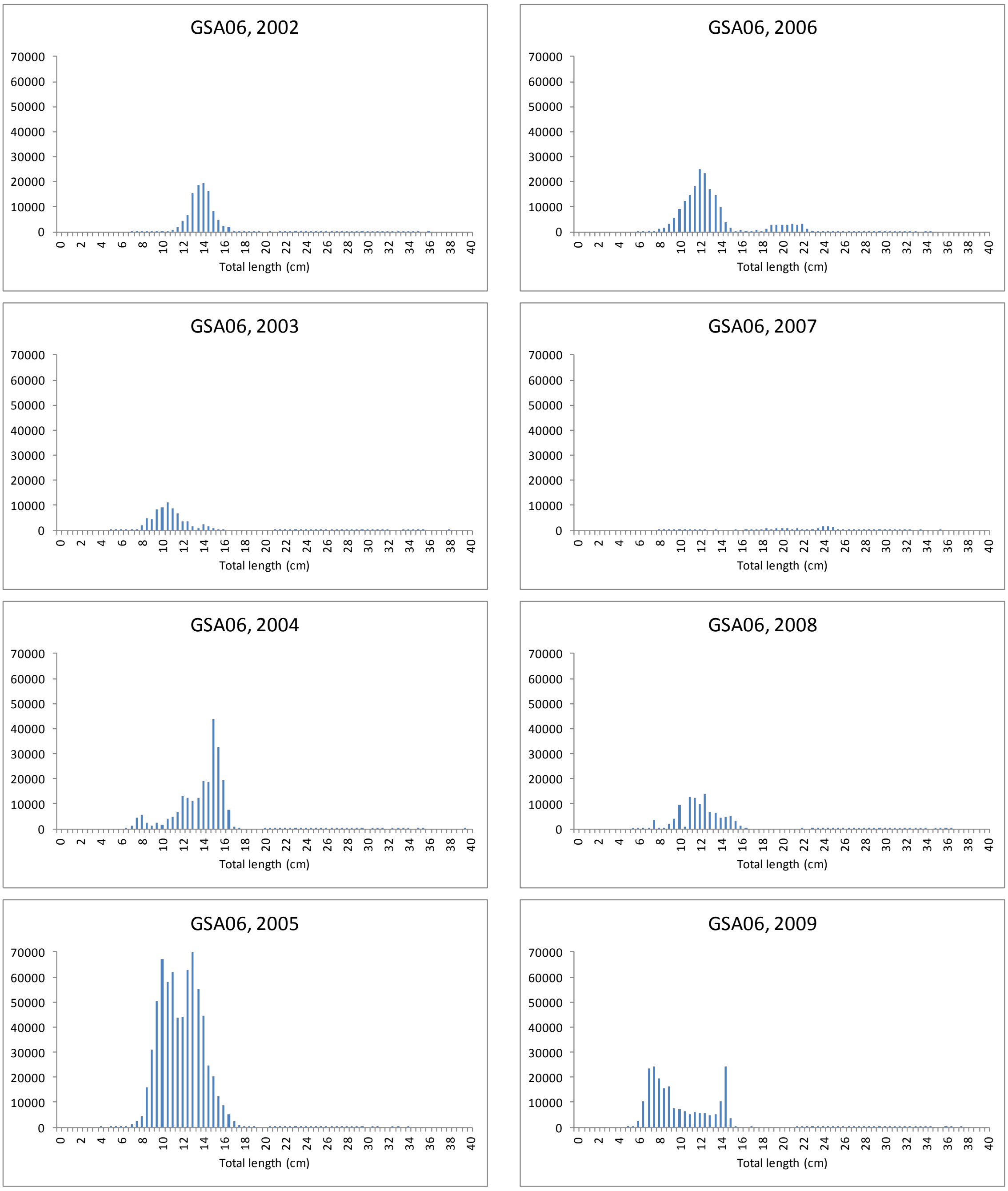


Fig.6.3.3.1.4.2Stratified abundance indices by size, 2002-2009.

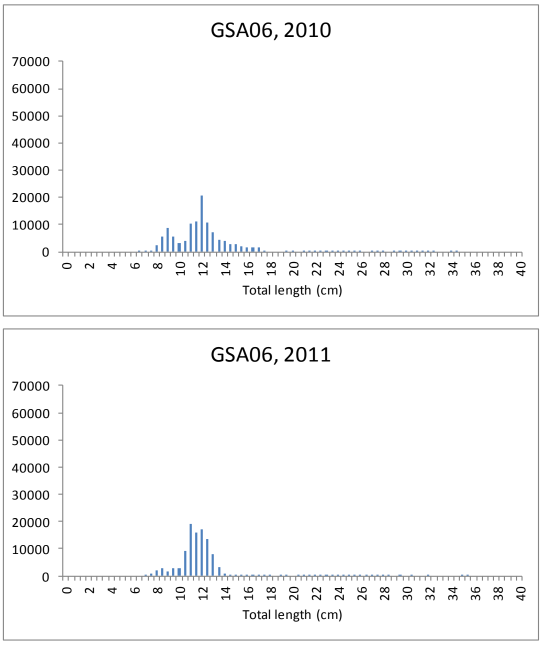


Fig.6.3.3.1.4.2Stratified abundance indices by size, 2010-2011.

6.3.3.1.5 *Trends in growth*

No information has been documented.

6.3.3.1.6 *Trends in maturity*

No information has been documented.

6.3.4 *Assessments of historic stock parameters*

6.3.4.1 Method: LCA

6.3.4.1.1 *Justification*

Three pseudo-cohort analyses, for 2009, 2010 and 2011 separately, were performed, using VIT software (Lleonart and Salat 1992).

6.3.4.1.2 *Input parameters*

Analyses were performed using number at age obtained from length frequencies distribution separated using knife-edge slicing method and using VIT software.

The set of growth parameters used for the assessment of blue whiting in GSA06 were those used in the Spanish National Data Collection for GSA 06: L_{inf}=48.4 cm, K=0.19, t_0=0. Length-weight relationships: a=0.007, b=3.69. These set of growth parameters are different from the biological parameters used in other areas (e,g. blue whiting assessment in GSA 09 in this report: L_{inf}=45.25, is below to the maximum length reported in the GSA 06 catches, 46 cm).

Natural mortality by age, calculated using PROBIOM (Abella *et al*, 1997), was:

Age	0	1	2	3	4	5	6	7	8	9	10	Mean
M	1.12	0.55	0.48	0.4	0.37	0.35	0.33	0.32	0.32	0.31	0.3	0.44

A terminal fishing mortality F_{term}=0.15 was assumed.

The maturity ogive used was obtained from the size at first maturity reported for blue whiting in FishBase (www.fishbase.org).

Age	0	1	2	3	4	5	6	7	8	9	10
Maturity	0	0.013	0.61	1	1	1	1	1	1	1	1

The length frequency distributions used for the present assessment (Table 6.3.4.1.2.1 and Figure6.3.4.1.2.1) showed a similar size range but slight differences in the modal size. Data from 2010 and 2011 showed a mode around 15-20 cm while 2009 data showed a second mode at 27 cm. Minimum and maximum lengths also presented some differences between years (2009: 11cm and 38cm; 2010: 8 cm and 44 cm; 2011: 11cm and 46 cm).

Table 6.3.4.1.2.1 Input data for LCA. Catch at length in 2009-2011.

Total length (cm)	2009	2010	2011
8	0	10.0401963	0
9	0	15.885437	0
10	0	5.61443161	0
11	11.974084	8.34374934	1.266
12	52.2078872	24.6185569	0
13	698.160447	388.812122	94.925
14	1113.60359	2442.2415	1016.176
15	3152.38488	4982.18663	2847.342
16	4882.578	7085.86969	4702.589
17	3724.51319	6772.22184	5431.582
18	3308.71081	7902.41418	5526.138
19	3912.60392	9286.52829	4173.434
20	3804.86524	7574.78665	4218.242
21	2227.19524	5374.52532	3321.827
22	1285.89138	3373.63879	2277.341
23	652.733874	1546.28835	1855.893
24	578.171081	1136.5926	1338.159

25	1182.53871	796.393579	889.975
26	1578.81208	782.626552	705.952
27	1984.57233	605.373083	523.72
28	1998.60122	490.040645	397.903
29	1215.58702	324.952978	180.124
30	730.253709	227.684781	83.202
31	230.077193	232.419775	63.244
32	259.995756	143.326076	82.103
33	113.545016	95.5113732	32.319
34	48.1697286	69.8576112	16.743
35	3.69278592	54.0639013	20.895
36	15.0822728	16.1007742	10.148
37	4.00637518	23.5807843	7.405
38	2.36568759	9.485103	2.299
39	0.725	2.47151248	0.276
40	0	2.88511388	0.763
41	0	1.578	0.68
42	0	1.44255694	0
43	0	4.17187467	0
44	0	4.03915943	0
45	0	0	0
46	0	0	0.313

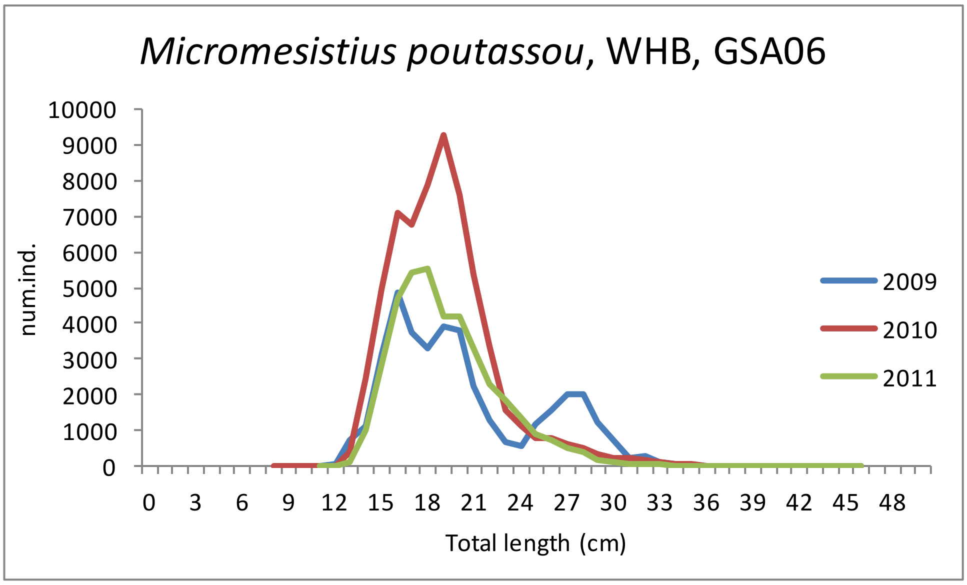


Fig. 6.3.4.1.2.1 Input data for LCA. Length frequencies of blue whiting in GSA 06 for the period 2009-2011.

6.3.4.1.3 *Results*

Table 6.3.4.1.3.1 shows the summary results from the pseudo-cohort analysis in 2009, 2010 and 2011. Ages and lengths in the catches and in the stock were quite similarin 2010 and 2011, but higher in 2009, this reflecting the presence of the second mode observed in the catches. Results on biomass showed large interannual variations in these 3 years, and recruitment was notably higher in 2011 than in previous years.

Table 6.3.4.1.3.1Summary results of stock parameters derived from the VIT model for the 2009 - 2011.

	2009	2010	2011
Catch mean age	2.988	2.647	2.709
Catch mean length	20.441	18.821	19.197
Mean F	0.813	0.358	0.343
Total catch (Tons)	1472.22	1249.01	1842.11
Catch/D%	59.87	61.84	64.56
Catch/B%	61.23	66.85	77.42
Current Stock Mean Age	2.088	1.944	1.908
Current Stock Critical Age	4	2	2
Virgin Stock Critical Age	6	6	6
Current Stock Mean Length	15.386	14.512	14.37
Current Stock Critical Length	25.765	15.301	15.301
Virgin Stock Critical Length	32.921	32.921	32.921
Number of recruits, R	62,429,165	65,707,881	93,819,766
Mean Biomass, Bmean (Tons)	2404.45	1868.41	2379.29
Spawning Stock Biomass, SSB (Tons)	1804.40	1287.13	1526.76
Biomass Balance, D (Tons)	2459.03	2019.59	2853.24
Bmax/Bmean	30.58	33.88	38.44
Turnover, D/Bmean	102.27	108.09	119.92

Age frequencies of the catches showed a mode on age 2. In 2009 there was a second mode around age 4. Maximum ages were 8 years in 2009 and 10 years in 2010 and 2011 (Fig. 6.3.4.1.3.1)

Fig. 6.3.4.1.3.1Catch at age calculated by slicing method with VIT software.

Figure6.3.4.1.3.2 shows the LCA results of the initial numbers of stock. Recruitment is similar in 2009 and 2010, and it reaches a higher value on 2011. For age classes 6-10, stock numbers are very low.

Fig. 6.3.4.1.3.2 LCA output. Stock numbers at age of *M. poutassou* in the GSA 06.

Figure6.3.4.1.3.3 shows the vector of fishing mortality by age resulting from the pseudo-cohort analysis. Fishing mortality vectors were similar in 2010 and 2011, the highest mortalities reported in age classes 3 and 4. In 2009, there was a higher mortality in older age classes 5 and 6. F_{bar} (ages 2-5, which represents the majority of the catches) is shown in Fig.6.3.4.1.3.4. $F_{bar}$was 0.96 (2009), 0.84 (2010) and 1.05 (2011).

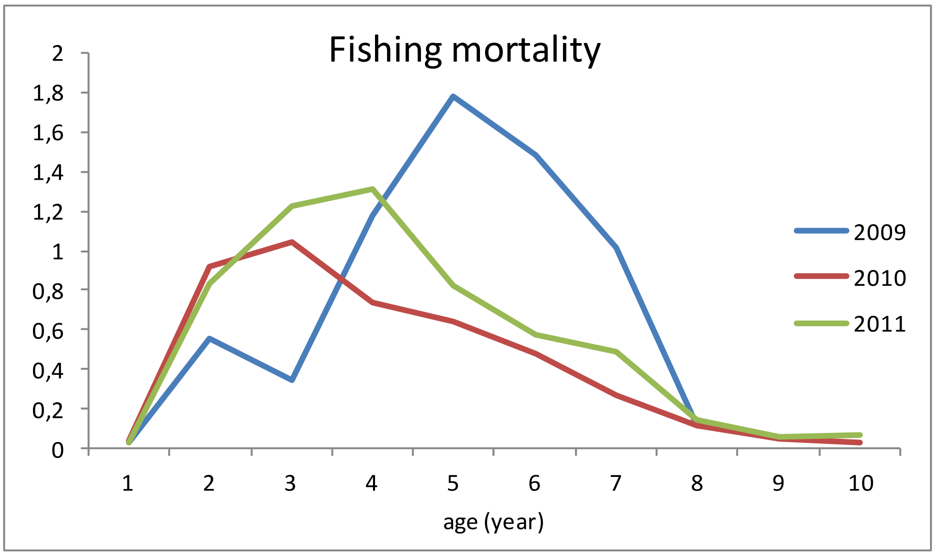


Fig.6.3.4.1.3.3LCA output. Fishing mortality by age of *M. poutassou* in the GSA 06.

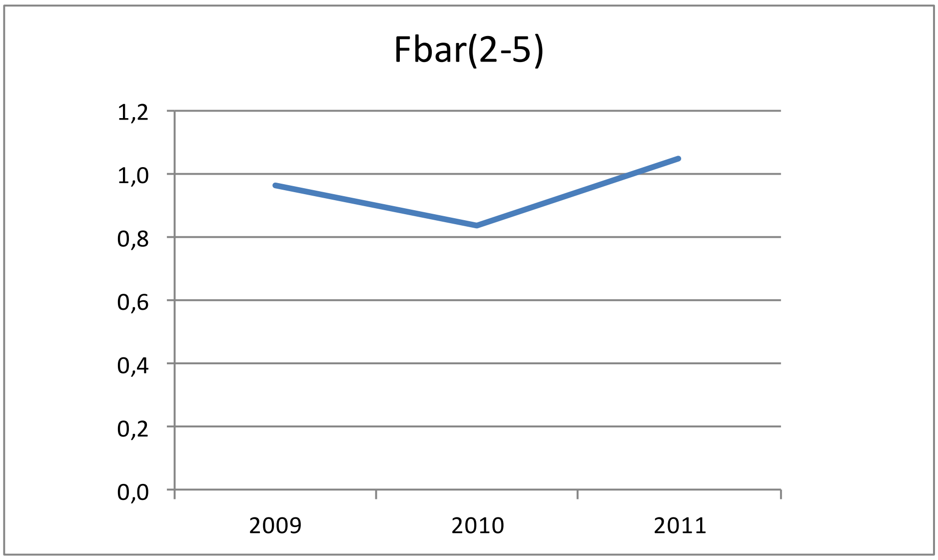


Fig.6.3.4.1.3.4 LCA output. F_{bar} calculated from the estimated fishing mortality vector.

6.3.5 *Long term prediction*

6.3.5.1 Justification

A YPR analysis for years 2009, 2010 and 2011 was conducted using VIT software andis based on results obtained on previous pseudocohorts analyses.

6.3.5.2 Input parameters

The age frequency data of 2009, 2010 and 2011 and the biological parameters used are given in Table 6.3.5.2.1.

Table 6.3.5.2.1 Input parameters to the YPR analysis for 2009, 2010 and 2011.

2009	age group	stock weight (g)	catch weight (g)	maturity	F	M
	1	6.896	6.896	0.013085	0.034	0.497
	2	29.905	29.905	0.610822	0.554	0.443
	3	77.643	77.643	1	0.342	0.388
	4	140.593	140.593	1	1.176	0.36
	5	218.916	218.916	1	1.781	0.344
	6	311.36	311.36	1	1.488	0.328
	7	408.003	408.003	1	1.013	0.32
	8	505.709	505.709	1	0.117	0.312

2010	age group	stock weight (g)	catch weight (g)	maturity	F	M
	1	6.89	6.89	0.013085	0.039	0.497
	2	28.877	28.877	0.610822	0.923	0.443
	3	74.398	74.398	1	1.045	0.388
	4	143.171	143.171	1	0.737	0.36
	5	226.34	226.34	1	0.641	0.344
	6	318.546	318.546	1	0.478	0.328
	7	413.524	413.524	1	0.265	0.32
	8	505.691	505.691	1	0.12	0.311
	9	591.848	591.848	1	0.046	0.309
	10	670.417	670.417	1	0.031	0.3

2011	age group	stock weight (g)	catch weight (g)	maturity	F	M
	1	6.903	6.903	0.013085	0.027	0.497
	2	29.116	29.116	0.610822	0.836	0.443
	3	73.614	73.614	1	1.225	0.388
	4	139.822	139.822	1	1.313	0.359
	5	225.104	225.104	1	0.819	0.344
	6	317.84	317.84	1	0.573	0.328
	7	411.834	411.834	1	0.489	0.32
	8	505.494	505.494	1	0.147	0.311
	9	591.782	591.782	1	0.056	0.309
	10	670.211	670.211	1	0.065	0.3

6.3.5.3 Results

Table 6.3.5.3.1 shows the results from the YPR analysis and Figure6.3.5.3.1 shows the YPR curve. Value of YPR at the current exploitation level is between 20-25 g/recruit. The analysis indicates overexploitation in all years.

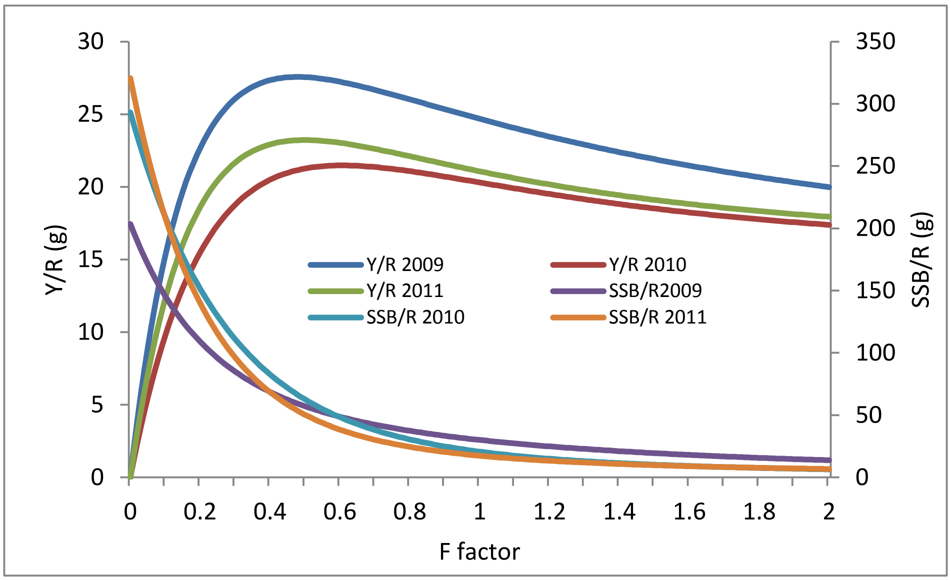


Fig. 6.3.5.3.1 YPR outputs. YPR and SSB per recruit curves for blue whiting in GSA 06.

Table6.3.5.3.1 Results of the YPR analysis.

2009	Factor	Y/R	B/R	SSB
F(0)	0	0	215.02	203.598
F(0.1)	0.3	26.076	95.745	84.845
Fmax	0.49	27.56	68.702	58.104
Fcurrent	1	24.679	39.917	30.04

2010	Factor	Y/R	B/R	SSB
F(0)	0	0	304.613	293.191
F(0.1)	0.39	20.369	95.388	84.98
Fmax	0.62	21.471	55.9	45.992
Fcurrent	1	20.3	29.856	20.645

2011	Factor	Y/R	B/R	SSB
F(0)	0	0	332.062	320.64
F(0.1)	0.32	22.037	100.125	89.458
Fmax	0.51	23.219	59.167	48.891
Fcurrent	1	21.068	26.813	17.388

$F_{0.1}$ calculated from $F_{0.1}$ factor considering an $F_{bar\ 2\text{-}5}$ are:

	2009	2010	2011
$F_{bar2\text{-}5}$	0.96	0.84	1.05
F(0.1) factor	0.30	0.39	0.32
$F_{0.1}$	0.29	0.33	0.34

An F_{01} mean of 0.32 is proposed as proxy of F_{MSY} for this stock.

6.3.6 *Data quality and availability*

There is a scarcity of discards data in GSA06 both in terms of absolute quantity and in length or age frequencies, which could be important for the assessment of this species as age class 0 is almost absent in landings because mainly discarded. However, in GSA 06 there is no information on discards length or age distributions.

Annual data of landings by age class were obtained from the DCF and used in the pseudo-cohort analysis (for more details on data quality see ToR e).

6.3.7 *Scientific advice*

6.3.7.1 Short term considerations

6.3.7.1.1 *State of the stock size*

Stock assessment has been computed by Length Cohort Analysis (VIT software) using as input DCF data of the annual length distributions in 2009-2011. Results obtained didn't show a clear trend in stock size. MEDITS survey indices showed also a variable pattern of abundance and biomass without a clear trend.Since no biomass reference levels for the stock of blue whiting in GSA06were proposed, STECF EWG 12-10cannot evaluate the stock status in relation to these.

6.3.7.1.2 *State of recruitment*

STECF EWG 12-10 is unable to provide any scientific advice of the state of the recruitment as only three years of data are available.

6.3.7.1.3 *State of exploitation*

STECF EWG 12-10 proposes $F_{0.1} \leq 0.32$ as proxy of F_{MSY}. According to the F estimates derived from the Length Cohort Analyses, F in 2011 (1.05) was larger than F_{MSY}. Based on this assessment, EWG 12-10 considers the stock of blue whiting in the GSA 06 is exploited unsustainably.

6.4 Stock assessment of the blue and red shrimp in GSA 06

This stock was assessed in October 2011, at the SAC GFCM Sub-Committee on Stock Assessment-Demersal Species meeting. The present analysis is an update of the assessment conducted at GFCM including 2011 data.The Assessment Forms are available at:
http://151.1.154.86/GfcmWebSite/SAC/SCSA/13/SAFs/Demersal/2011_ARA_GSA06_IEO.pdf

6.4.1 *Stock identification and biological features*

6.4.1.1 Stock Identification

Due to insufficient information about the stock structure of blue and red shrimp (*Aristeus antennatus*) in the western Mediterranenan Sea, this stock was assumed to be confined within the boundaries of the GSA 06.

6.4.1.2 Growth

The growth parameters used were taken from Garcia-Rodriguez (2003) and estimated from length frequency distributions analysis (L_{inf} = 77.0; K = 0.38; t_0= -0.065).The parameters of the length-weight relationship were taken from Data Collection Framework(DCF) official data call (a= 0.00237; b= 2.49607).

6.4.1.3 Maturity

Maturity ogive was taken from García Rodriguez (2003), with size at first maturity (50 %) estimated at 23.5 mm CL.

Age class	0	1	2	3	4+
Proportio of mature	0.07863	0.7669	0.998	1	1

6.4.2 *Fisheries*

6.4.2.1 General description of fisheries

Blue and red shrimp is one of the most important crustacean species for the trawl fisheries in GSA 06 (Northern Spain). The blue and red shrimp has a wide bathymetric distribution, between 80 and 3300 m depth (Sardà *et al*., 2004).However, some areas may act as a refugefor the stock, as they are located distantly from the main fishing ports and below 1000 m of depth where the trawlers rarely operate. Females predominate in the landings, representing nearly 80% of the total. Discards of the blue and red shrimp are very low. In GSA 06, The number of harbours with vessels fishing blue and red shrimp is 14. Exploitation is based on young age classes, mainly 1 and 0 year old individuals.

6.4.2.2 Management regulations applicable

The management regulations applicable are the same as for bottom trawling (Regulation (EC) No

1967/2006). Bottom trawling is practiced five days a week and for a maximum of 12 hours at sea per each day. No specific regulations are enforcedfor this resource (i.e. no minimum landing size established). In some fishing ports (e.g. Palamós, in the northern part of the GSA 06), by agreement between the fishermen' associations, the trawlers targeting blue and red shrimp fish this species only four days a week, thus shifting their activity towards other species the remaining day of the week.

6.4.2.3 Catches

6.4.2.3.1 *Landings*

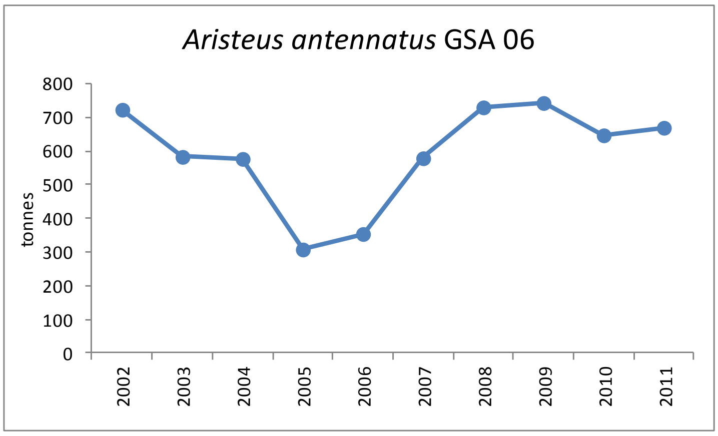


Fig. 6.4.2.3.1.1 Total annual landings (t) od Aristeus antennatus in GSA 6 for the period 2002-2011.

Landings in GSA06 over 2002- 2011 fluctuated between 308 t in 2005 and 743 t in 2009, with an average of about 600 tonnes. Blue and red shrimp landings decreased during 2002- 2005 but in 2006 this trend changed, and reached its maximum in 2009 (743 t). Landings in 2010 and 2011 were lower, around 650 t (data sources: statistics of the Autonomous Governments of Valence and Catalonia 2002-2010 and DCF for 2011; for details see ToR e).

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
annual landings (t)	723.0	583.0	577.0	308.0	354.0	579.0	730.0	743.0	647.0	669.5

6.4.2.3.2 *Discards*

Data on discards were available for 2010 and 2011 (<0.9 % of the total catch). No data on discarded sizes were available.

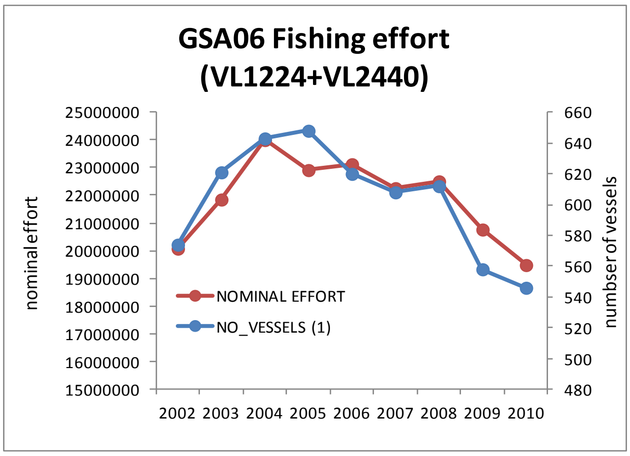
6.4.2.4 Fishing effort

Fleet segments in the categories 12-24 m and 24-40 m (fleet segments VL1224 and VL2440)generally obtain most of the catches of blue and red shrimp (small trawlers do not go fishing into the blue and red shrimp fishing grounds)and the trend in fishing effort between 2002 and 2010 (no data are available for 2011) is shown below:

	2002	2003	2004	2005	2006	2007
Number of_Vessels (1)	574	621	643	648	620	608
Nominal effort	20079145	21850961	23997878	22914118	23124939	22261086
GT_days at sea	5397429	6006369	6695698	6596284	6736987	6556329

	2008	2009	2010
Number of_vessels (1)	612	558	546
Nominal effort	22506554	20768173	19487159
GT_Days at sea	6705133	6221781	5895468

(1) number of vessels at the beginning of the year, quarter1.



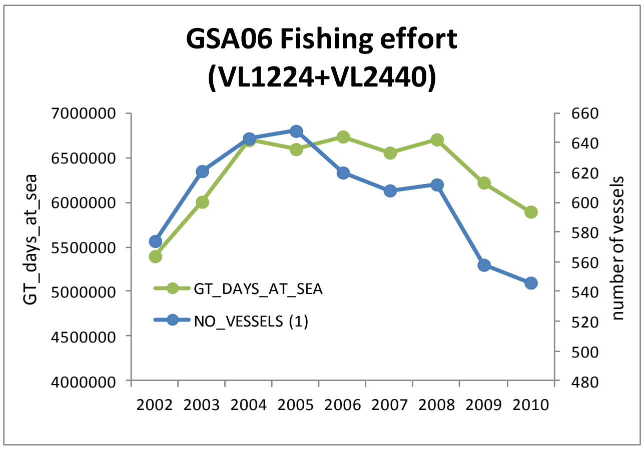


Fig. 6.4.2.4.1 Trend of number of vessels (only vessels VL1224 and VL2440), nominal effort and GT_days_at_sea over 2002- 2010 in GSA06.

Over the period 2002-2010, the number of vessels increased from 2002 to 2005, and since then, it decreased from a peak in 2005 of 648 vessels to 546 vessels in 2011. The trend of nominal effort was quite similar to that of the number of vessels, while GT_days_at_sea declined only from 2009 and onwards.

6.4.3 *Scientific surveys:*

6.4.3.1 MEDITS

6.4.3.1.1 *Methods*

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 06 the following number of hauls were reported per depth stratum (Table 6.4.3.1.1.1).

Table 6.4.3.1.1.1 Number of hauls per year and depth stratum in GSA 06, 1994-2011.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GSA06_010-050	7	8	7	7	7	8	9	7	10	8	8	11	10	5	7	6	5	7
GSA06_050-100	19	25	26	25	27	27	29	29	34	36	30	31	33	26	29	28	19	28
GSA06_100-200	10	16	16	14	12	16	17	18	19	20	16	17	17	14	20	20	12	20
GSA06_200-500	9	14	9	10	6	12	11	15	16	17	15	14	17	10	13	14	10	15
GSA06_500-800	7	11	10	8	4	10	7	8	7	11	11	8	12	9	8	7	7	8

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

Confidence interval = Yst ± t(student distribution) * V(Yst) / n

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.4.3.1.2 *Geographical distribution patterns*

No information was documented during STECF EWG12-10.

6.4.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of the blue and red shrimp in GSA 06 was derived from the international survey MEDITS. Figure 6.4.3.1.3.1displays the estimated trend in blue and red shrimp abundance and biomass in GSA 06. No clear trend is identified from these indices.

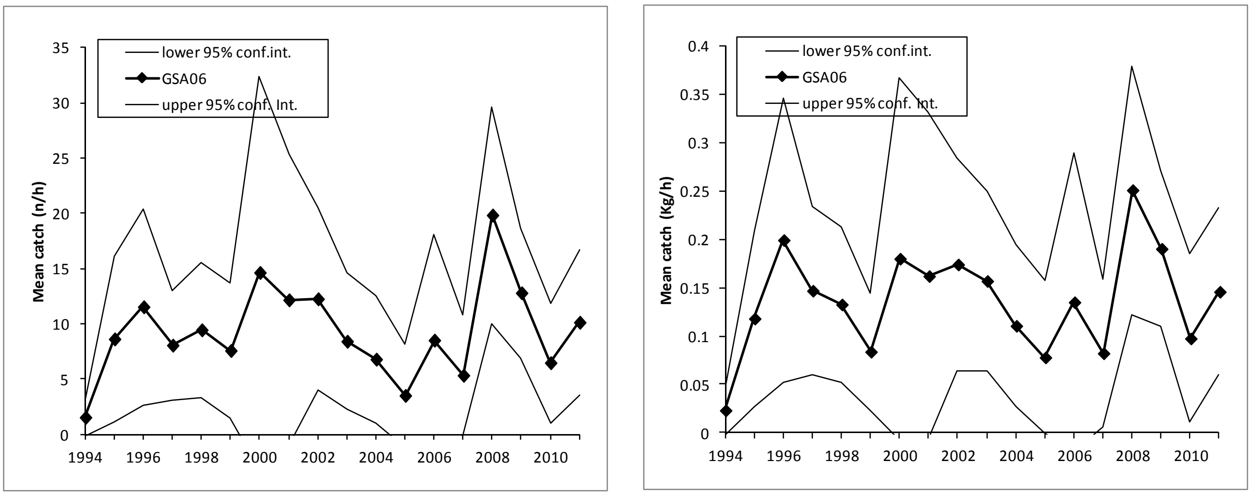
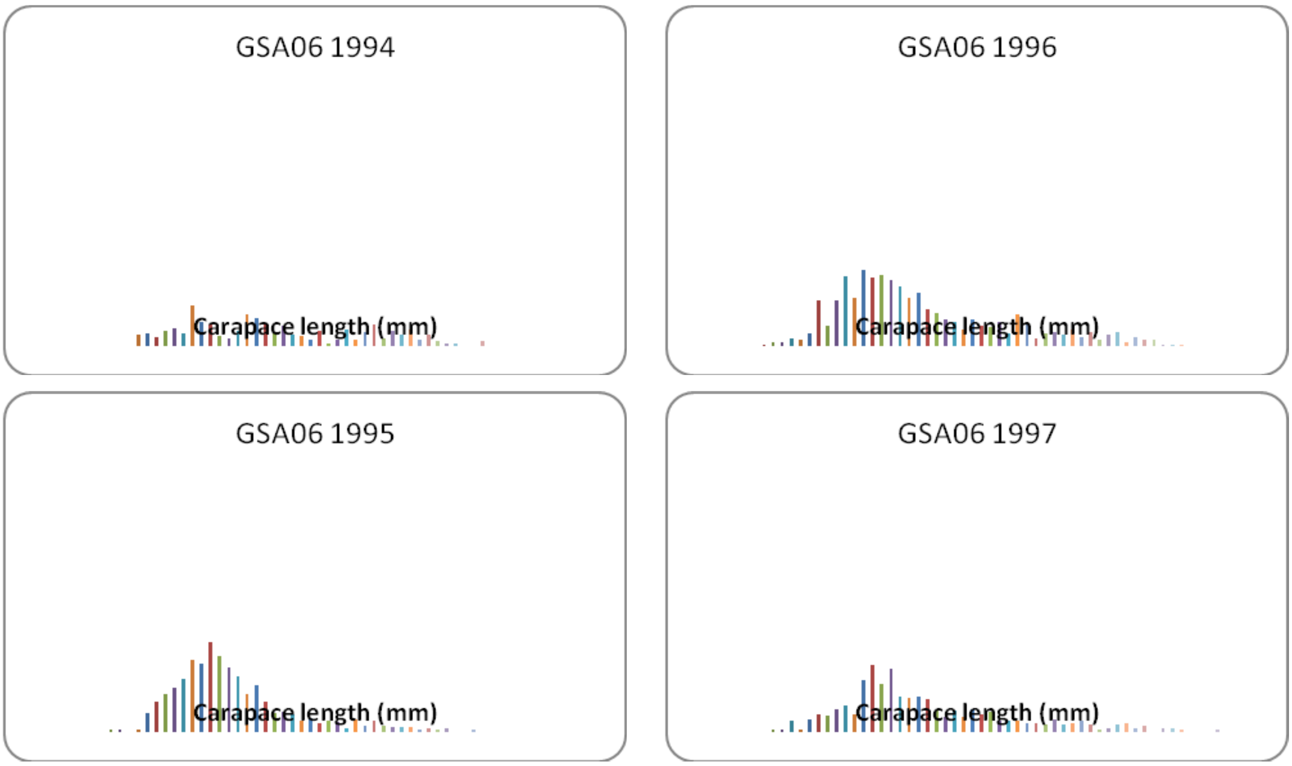
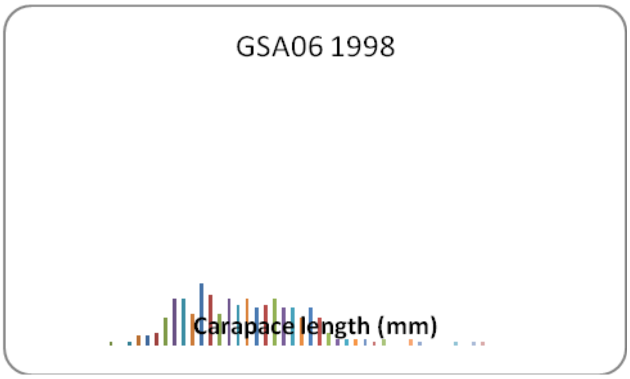


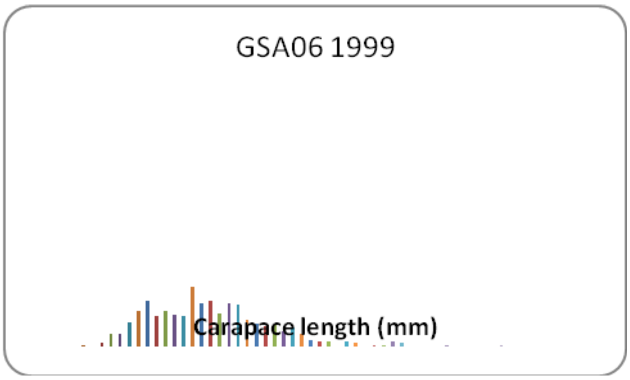
Fig. 6.4.3.1.3.1 *A. antennatus*: trends in density and biomass indices from 1994 to 2011 in GSA06.

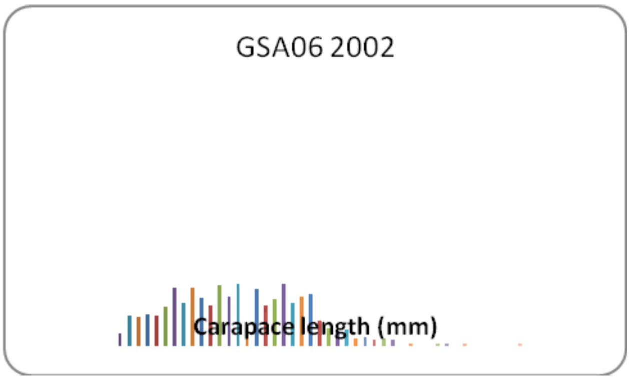
6.4.3.1.4 *Trends in abundance by length or age*

The following figure 6.4.3.1.4.1 displays the stratified abundance indices by size in GSA 06, 1994-2011 (size distributions 1994- 2009 taken from SGMED 10-02 report; 2010 and 2011 size distributions updated from the access database, and expressed in percentage because the values are much lower than in the previous years).

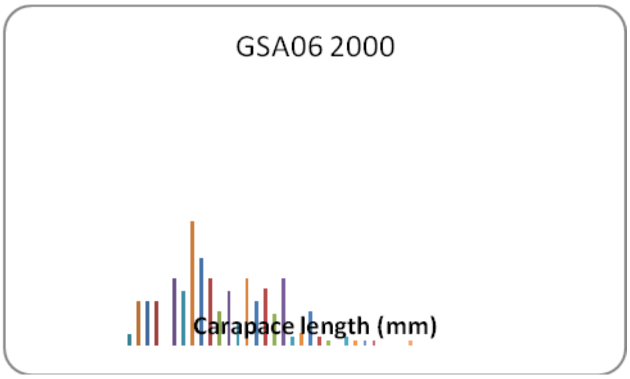


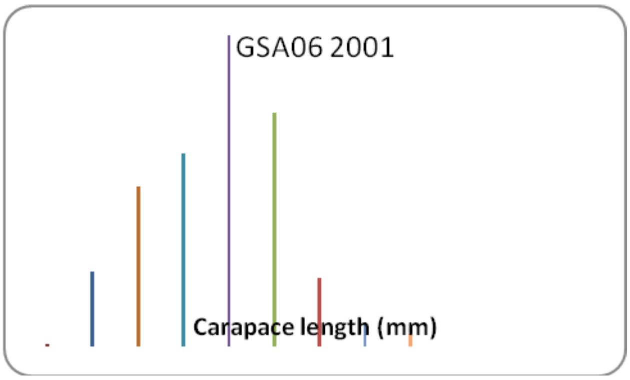

GSA06 1998
Carapace length (mm)

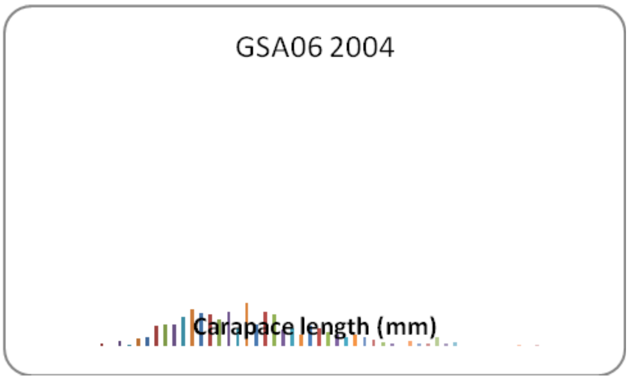

GSA06 1999
Carapace length (mm)

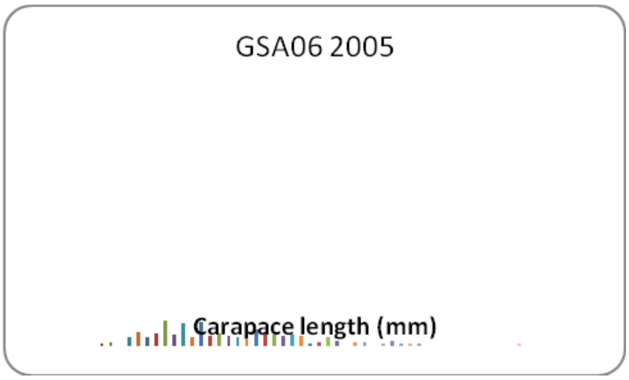

GSA06 2002
Carapace length (mm)

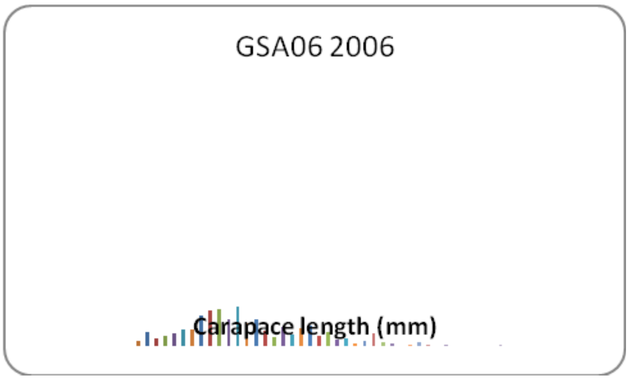

GSA06 2003
Carapace length (mm)

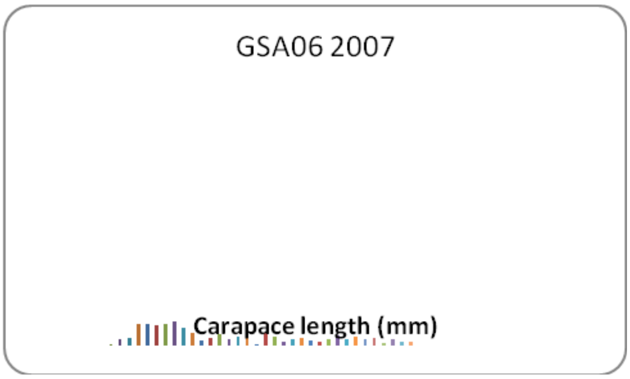

GSA06 2000
Carapace length (mm)

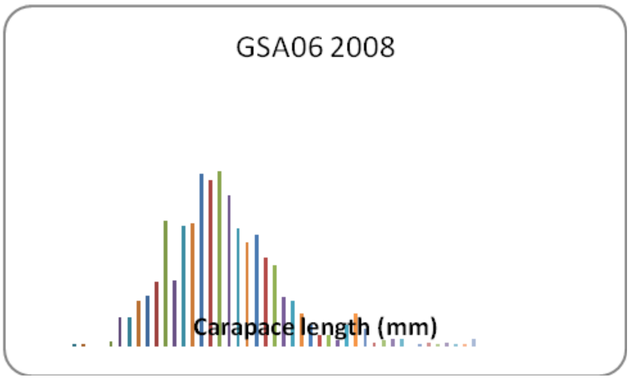

GSA06 2001
Carapace length (mm)

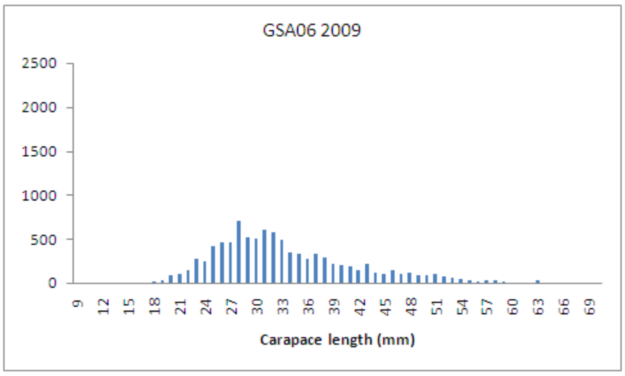

GSA06 2004
Carapace length (mm)


GSA06 2005
Carapace length (mm)


GSA06 2006
Carapace length (mm)


GSA06 2007
Carapace length (mm)


GSA06 2008
Carapace length (mm)


GSA06 2009
2500
2000
1500
1000
500
0
9
12
15
18
21
24
27
30
33
36
39
42
45
48
51
54
57
60
63
66
69
Carapace length (mm)

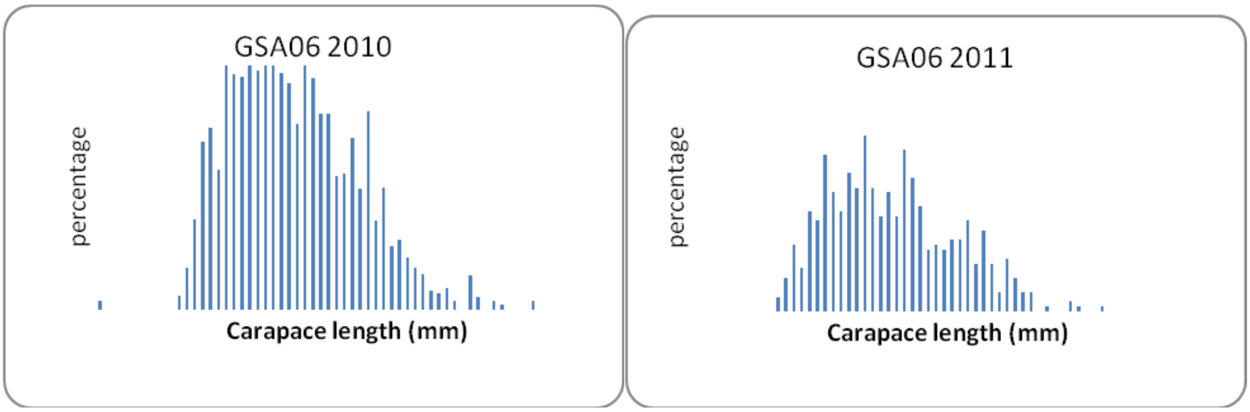


Fig. 6.4.3.1.4.1Stratified abundance indices by size, 1994-2011.

6.4.3.1.5 *Trends in growth*

No analyses were conducted during STECF EWG 12-10.

6.4.3.1.6 *Trends in maturity*

No analyses were conducted during STECF EWG 12-10.

6.4.4 *Assessment of historic stock parameters*

6.4.4.1 Method 1: XSA

6.4.4.1.1 *Justification*

This stock was assessed in the framework of SGMED 10-02andin October 2011, at the SAC GFCM Sub-Committee on Stock Assessment- Demersal Species meeting. The present analysis is an update, including the 2011 data.Available DCF data (2002- 2011) allow to carry out an Extended Survivor Analysis, tuned with fishery independent data (i.e. MEDITS abundance indices by age 2002- 2011). Data on discard was not available, but discards of blue and red shrimp are considered to be very low and thus they were not included in the assessment.

6.4.4.1.2 *Input parameters*

Table 6.4.4.1.2.1 Input data used in the XSA assessment.

GSA06 Aristeus antennatus

Catch numbers at age
Numbers 10^3

Age class	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	14867	17186	18763	11308	11377	16435	36942	22312	16690	9139
1	35940	26627	31431	16656	20145	31522	32769	37516	30436	31085
2	3618	3077	1885	1056	876	2293	3206	2821	3941	4797
3	565	629	518	211	72	246	826	657	459	410
4+	13	33	24	19	0	11	56	134	68	28

Catch weights at age (kg)

Age class	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	0.006	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
1	0.014	0.014	0.013	0.012	0.013	0.013	0.012	0.013	0.014	0.015
2	0.034	0.034	0.034	0.034	0.033	0.033	0.033	0.034	0.033	0.034
3	0.052	0.053	0.054	0.055	0.053	0.053	0.054	0.055	0.055	0.054
4+	0.066	0.066	0.069	0.07	0	0.066	0.072	0.072	0.074	0.071

Age class	Maturityat age	Age class	**M** (1)
0	0.07863	0	0.46
1	0.7669	1	0.46
2	0.998	2	0.46
3	1	3	0.46
4+	1	4+	0.46

Tuning index (MEDITS)

Age class	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	216.5	48.7	77.4	87.9	44.5	121.1	296.2	123.6	107.5	194.7
1	901.2	576.4	462.6	209.5	528.2	281.5	1377.7	856	444.3	636.4
2	94.3	121.2	79.1	32.3	215.4	108.5	141.3	211.4	76.9	148.2
3	6	35.4	15.9	0	4.5	0	25.4	35	11.3	6.8
4+	2	4.4	2.4	1.7	2.8	0	0	0	2	0

(1) M as used in GFCM assessment.

Catch numbers at age were derived from the DCF annual size distributions (Fig. 6.4.4.1.2.1). The set of parameters used for age knife-edge slicing.

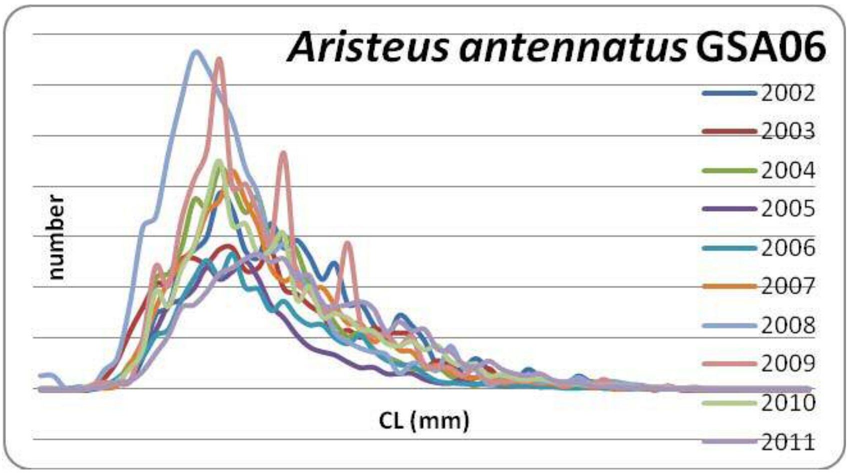


Fig. 6.4.4.1.2.1 Blue and red shrimp annual size distributions, 2002- 2011.

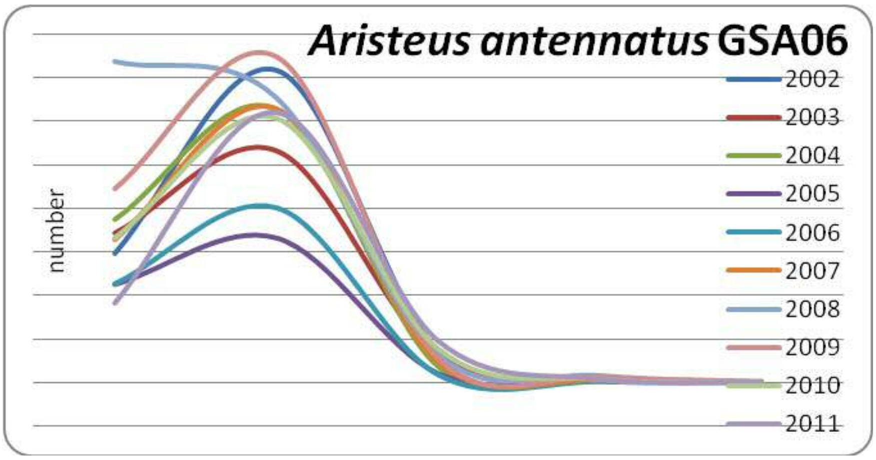


Fig. 6.4.4.1.2.2 Blue and red shrimp landings by age class, 2002- 2011.

XSA final run

Period: 2002-2011

Age 4+ group was used as input.

Catchability analysis:

Catchability dependent on stock size for ages < 1

Catchability independent of age for ages >= 1

Tuning converged after 13 iterations

Blue and red shrimp XSA model diagnostics are shown in figure 6.4.4.1.2.3 and Table 6.4.4.1.2.2.

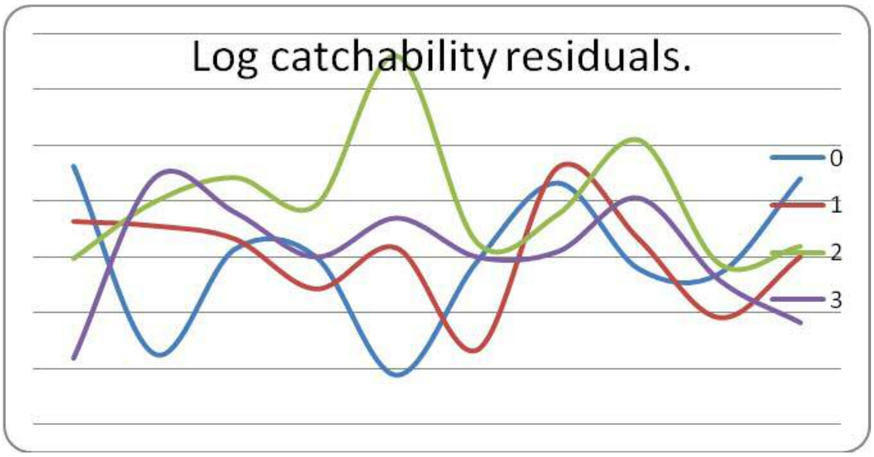


Fig. 6.4.4.1.2.3 Trends in log catchability residuals by age.

Table 6.4.4.1.2.2Blue and red shrimp XSA model diagnostics.

Log catchability residuals.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	0.81	-0.87	0.07	0	-1.06	-0.04	0.66	-0.11	-0.15	0.7
1	0.32	0.28	0.16	-0.29	0.08	-0.84	0.81	0.16	-0.55	0
2	-0.02	0.49	0.71	0.46	1.81	0.12	0.38	1.05	-0.07	0.09
3	-0.91	0.71	0.4	99.99	0.35	99.99	0.05	0.53	-0.21	-0.59

Regression weights

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

6.4.4.1.3 *Results*

Table 6.4.4.1.3.1 Results of the blue and red shrimp XSA assessment. Estimated fishing mortality at age , in recruitment at age 0, total and spawning stock biomass, landings, ratio between yield and SSB and the mean fishing mortality over ages 0-3 (F_{bar}).

Fishing mortality (F) at age

Age class	2002	2003	2004	2005	2006	2007	2008
0	0.2697	0.2809	0.482	0.236	0.1686	0.2361	0.4154
1	1.8791	2.1056	2.8088	2.0479	1.3905	1.6392	1.8391
2	1.2669	1.3956	1.6544	1.7697	0.8266	0.785	1.1053
3	1.2704	1.2123	1.6578	1.3847	0.7495	0.8472	1.141
4+	1.2704	1.2123	1.6578	1.3847	0.7495	0.8472	1.141

Age class	2009	2010	2011	F_{bar}			
0	0.2929	0.2423	0.1654	0.2336			
1	1.7628	1.3297	1.6557	1.5827			

2	1.2785	1.6269	1.1843	1.3632			
3	1.0649	1.1008	1.1201	1.0953			
4+	1.0649	1.1008	1.1201				

Summary

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 0- 3
	Age 0					
2002	79159	1491	871	723	0.485	1.1715
2003	88314	1214	670	583	0.4801	1.2486
2004	61740	1063	587	577	0.5427	1.6507
2005	67708	771	311	308	0.3994	1.3595
2006	92304	1067	430	354	0.3319	0.7838
2007	98365	1435	723	579	0.4034	0.8769
2008	136780	1698	768	730	0.43	1.1252
2009	110589	1659	854	743	0.4479	1.0998
2010	97608	1575	850	647	0.4108	1.0749
2011	75451	1519	925	670	0.4408	1.0314
Arith.						
Mean	90802	1349	698.9	591	0.4372	1.1422
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

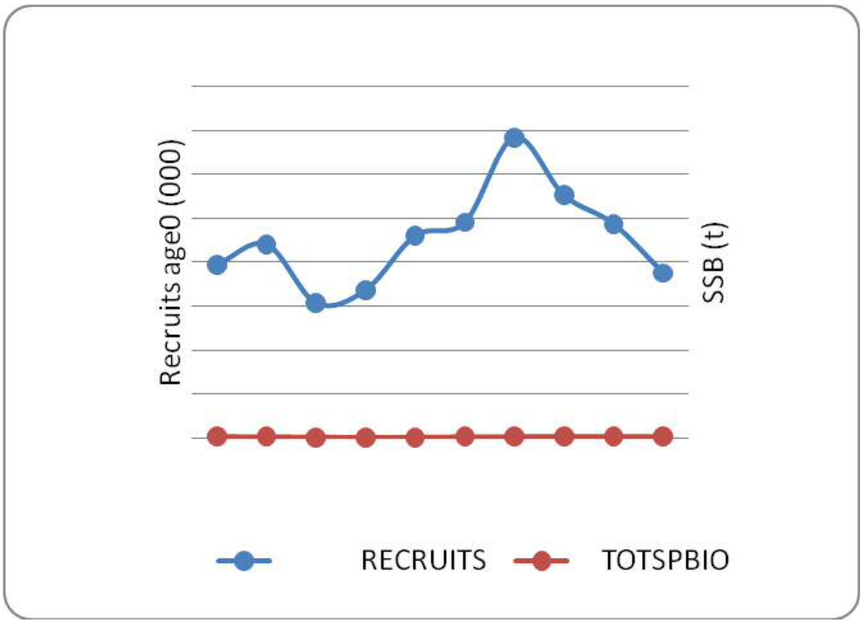


Fig.6.4.4.1.3.1 Trends in recruitment (age 0) and spawning stock biomass (SSB) as estimated by the XSA.

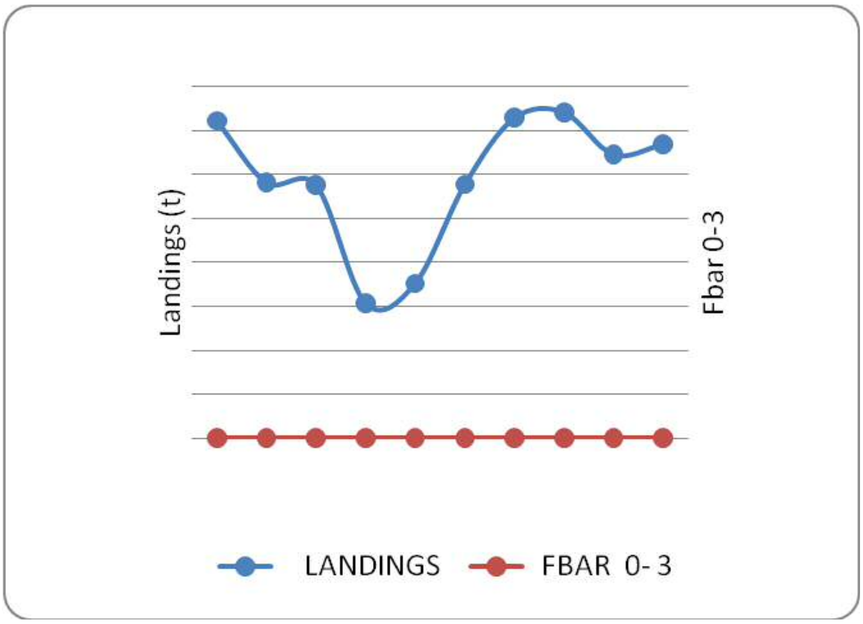


Fig. 6.4.4.1.3.2 Trends in landings and fishing mortality (F_{bar} ages 0-3) as estimated by the XSA.

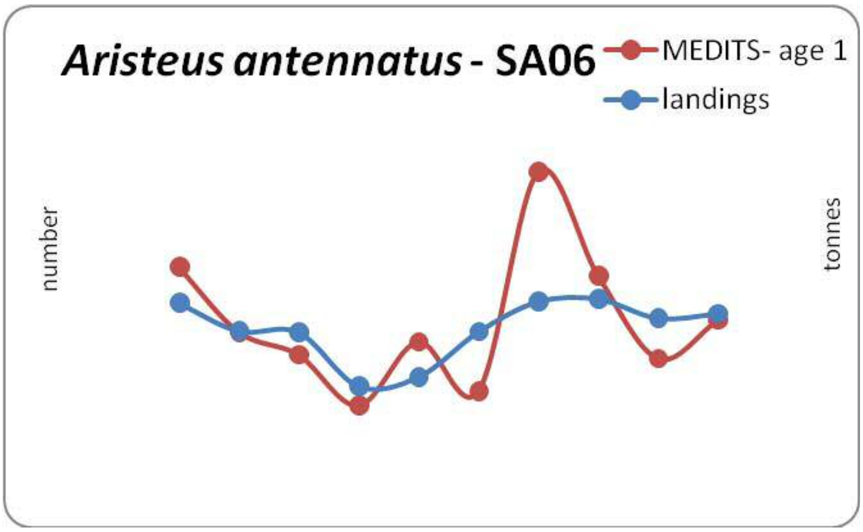


Fig. 6.4.4.1.3.3 Trends in landings (t) and number of age 1individuals as estimated by the MEDITS survey.

6.4.5 *Long term prediction*

6.4.5.1 Justification

Yield per recruit analysis (YPR) was conducted assuming equilibrium conditions, based on the exploitation pattern resulting from the XSA analysis. YPR was used for the estimation of $F_{0.1}$(i.e. proxy of F_{MSY}) and F_{max}.

Table 6.4.5.1.1 Input parameters used in the YPR analysis.

age group	stock weight	catch weight	maturity	F (2011)	M
0	0.0059	0.0059	0.08	0.1654	0.46
1	0.0133	0.0133	0.8	1.6557	0.46
2	0.0336	0.0336	0.9	1.1843	0.46
3	0.0538	0.0538	1	1.1201	0.46
4+	0.0626	0.0626	1	1.1201	0.46

YPR analysis was performed, using as $F_{ref}= F_{bar0\text{-}3(2002\text{-}2011)}= 1.14$

6.4.5.2 Results

By comparing $F_{curr(2011)}=1.049$ against $F_{0.1}$,STECF EWG 12-10 concludes that the stock is subject to overfishing. Fig.6.4.5.2.1shows the YPR results.

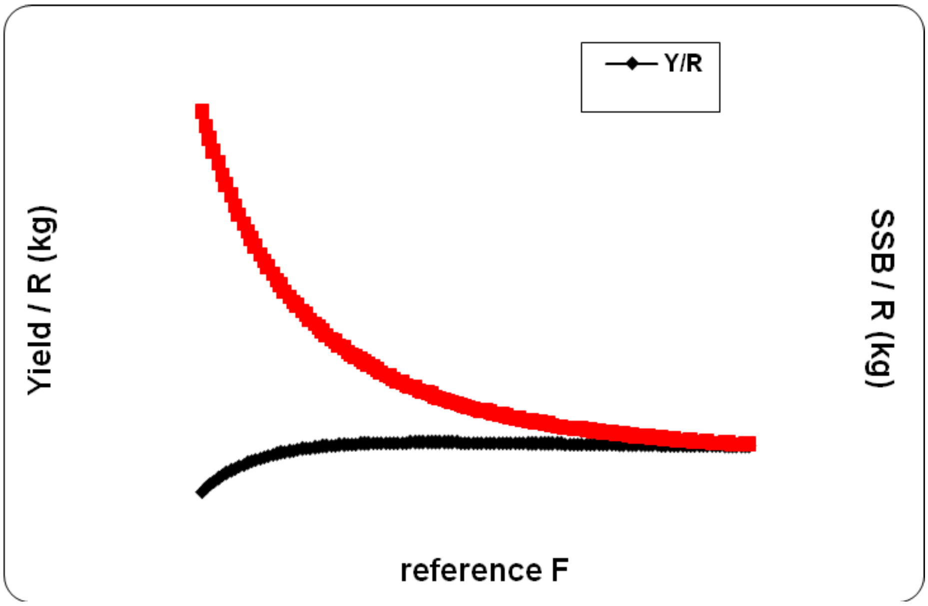


Fig. 6.4.5.2.1Yield per Recruit results, taking as F_{ref}, $F_{bar0\text{-}3}$ over 2002-2011.

Table6.4.5.2.1YPR results.

$F_{ref}= F_{bar03}$ (2002-2011)= 1.14		
Ffactor	Fmax	Y/Rmax
0.55	0.63	0.0077
Ffactor	F(0.1)	Y/R(0.1)
0.29	0.33	0.0071

6.4.6 *Data quality*

DCF landings data seems incosistent as landings displayed an increasing trend over the period 2002-2011. Regarding MEDITS data (distributions of sizes and abundance and biomass indices), the current values in the DCF database are much lower than those shown in the SGMED10-02 report, although the shape of the distributions and the trends of the indices are similar (see ToR e for details on the data quality).

6.4.7 *Scientific advice*

6.4.7.1 Short term considerations

The exploitation of blue and red shrimp in GSA06 is based in age classes 0 and 1, with class 1 that constitutes the main component of the catches. In this regard, a close link between landings and age class 1 from MEDITS data has been observed (Fig. 6.4.4.1.3.3).

6.4.7.2 State of the spawning stock size

In the absence of proposed or agreed management reference points, STECF EWG 12-10 is unable to fully evaluate the state of the spawning stock in comparison to these.

SSB decreased by almost 30% during 2002-2005, from 871 t to 311 t. Since 2006 SSB has steadily increased, reaching 925 t in 2011, the highest value over the whole period 2002-2011. No baseline for comparison of the current values against historic SSB is available. This increase in the SSB size coincided with the decrease in the number of vessels that started also in 2006.

6.4.7.3 State of recruitment

In the absence of proposed or agreed management reference points, STECF EWG 12-10 is unable to fully evaluate the state of recruitment in comparison to these.

The number of recruits increased from 2004 to 2008, when the maximum value was reached. Since then, recruits have decreased, and values in 2010 and 2011 were below the mean recruitment over 2002- 2011.

6.4.7.4 State of exploitation

Fishing mortality ($F_{bar\ 0\text{-}3}$) increased from 2002 to 2005 (highest value during 2002-2001), then gradually decreased until 2006 (minimum value of the time series), and in the last years (2008-2011) was estimated to be around 1.

No management reference points have been proposed for this stock in the framework of SGMED. From YPR analysis (Table 6.4.5.1.1), STECF EWG 12-10 proposes $F_{0.1} \leq 0.3$ as limit management reference point (F_{MSY} proxy) consistent with high long term yields. This reference point is similar to that proposed by SAC GFCM Sub-Committee on Stock Assessment ($F_{0.1} \leq 0.28$) in 2011.

6.5 **Stock assessment of black-bellied anglerfish in GSA 06**

6.5.1 *Stock identification and biological features*

6.5.1.1 Stock identification

Due to a lack of information about the structure of black-bellied anglerfishpopulation in the western Mediterranean, this stock was assumed to be confined within the boundaries of the GSA 06. The species is of secondary commercial importance in GSA 06, but regularly caught by bottom trawlers and to, a lesser extent, set nets (mainly trammelnets). The bulk of catches correspond to individuals between 10 and 50 cm TL which are often sold together with *L. piscatorius*. In the DCF 2012 data, the two species are reported separately, but are collected as a unique group and then commercial landings are allocated to *L. piscatorius* or *L. budegassa*usingthe proportion in the experimental trawl survey information (Spanish Data Collection Programme).

6.5.1.2 Growth

Growth parameters of *L. budegassa* were determined by modal progression analysis based on the analysis of length frequency distributions merged for several years from the data collection samples (Spanish Data Collection Programme) because of the difficulty of obtaining representative annual size frequencies. The values of the von Bertalanffy growth function for GSA 06 (combining males and females) were: L_∞ = 102 cm TL, k = 0.15 yr^{-1}, t = -0.05 yr, while the length-weight relationship parameters were: a = 0.0232 g cm^{-3} and b = 2.8455.

6.5.1.3 Maturity

The proportion of mature individuals by age class (both sexes combined) was determined from the length-based maturity ogive with parameters b_0 = 2.3454, b_1 = 0.4987, $L_{50\%}$ = 4.7025 yr, transformed to ages, based on pooled samples over several years (Spanish Data Collection Programme).

6.5.2 *Fisheries*

6.5.2.1 General description of fisheries

Black-belliedangler fish are by catch of commercial importance of bottom trawl fisheries. They are also caught by a variety of static fishing gear (trammel nets, gillnets and baited traps). In GSA 06 the bulk of catches (90% in weight) are from otter trawl, while trammel nets amounts less than 10% of the catches. The largest individuals are caught by trammel nets, but these are not sampled. In all fisheries, discards of anglerfish are negligible.

6.5.2.2 Management regulations applicable in 2010 and 2011

The management regulations applicable are the general for bottom trawling (Regulation (EC) No 1967/2006). Bottom trawling is practiced five days a week and for a maximum of 12 hours at sea per eachday. Minimum landing size is 30 cm TL (local regulation not included in 1967/2006).

6.5.2.3 Catches

6.5.2.3.1 *Landings*

The landings of black-belliedanglerfish have increased over the 2002-2012 period, although there is some uncertainty as to whether the reported landings in the data call represent only *Lophius budegassa* or a mix of the two species of *Lophius*.

Table 6.5.2.3.1.1 Landings of *Lophius budegassa* by fishing gear in GSA06 from the DCF2012 data call.

YEAR	GTR	OTB
2002	2.84	350.17
2003	7.97	434.15
2004	6.73	415.20
2005	5.03	520.15
2006	6.95	640.62
2007	8.09	609.74
2008	10.16	513.02
2009		562.50
2010		747.42
2011	18.19	1193.80

6.5.2.3.2 *Discards*

Discards of black-belliedanglerfish in GSA06 are negligible and none is reported in the DCF2012 data call.

6.5.2.4 Fishing effort

Catches are produced by demersal otter trawlers in the categories 12-24 m and 24-40 m (fleet segments VL1224 and VL2440)and the trend in fishing effort between 2002 and 2010 (no data are available for 2011) is shown below:

	2002	**2003**	**2004**	**2005**	**2006**	**2007**
Number of_Vessels (1)	574	621	643	648	620	608
Nominal effort	20079145	21850961	23997878	22914118	23124939	22261086
GT_days at sea	5397429	6006369	6695698	6596284	6736987	6556329

	2008	**2009**	**2010**
Number of_vessels (1)	612	558	546
Nominal effort	22506554	20768173	19487159
GT_Days at sea	6705133	6221781	5895468

(1) number of vessels at the beginning of the year, quarter1.

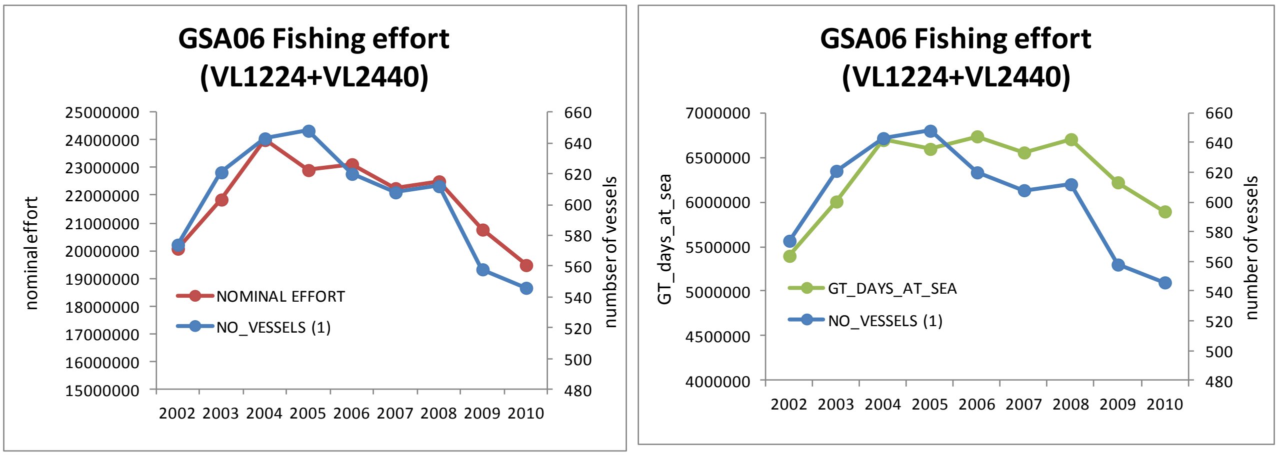


Fig. 6.5.2.4.1 Trend of number of vessels (only vessels VL1224 and VL2440), nominal effort and GT_days_at_sea over 2002- 2010 in GSA06.

Over the period 2002-2010, the number of vessels increased from 2002 to 2005, and since then, it decreased from a peak in 2005 of 648 vessels to 546 vessels in 2011. The trend of nominal effort was quite similar to that of the number of vessels, while GT_days_at_sea declined only from 2009 and onwards.

6.5.3 *Scientific surveys*

6.5.3.1 MEDITS

The average biomass index of black-belliedanglerfish from experimental trawl surveys MEDITS is shown in the figure 6.5.3.1.1(the biomass index for *L. piscatorius* was added for comparison). The biomass index shows interannual fluctuations with no significant trend, although density of black-belliedanglefish has increased over the last 2 years (i.e. similar to the pattern seen in the commercial catches).

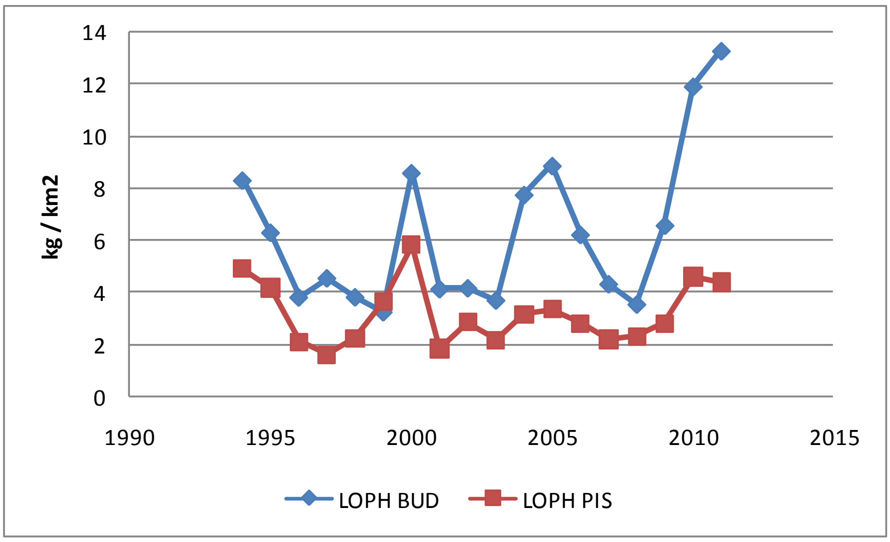


Fig. 6.5.3.1.1 Evolution of *L.budegassa* and *piscatorius*. biomass (kg/km2) in GSA 06 from MEDITS trawl surveys.

6.5.3.1.1 *Methods*

6.5.3.1.2 *Geographical distribution patterns*

No information was documented during STECF EWG12-10.

6.5.3.1.3 *Trends in abundance and biomass*

The average biomass index of black-bellied anglerfish from experimental trawl surveys MEDITS is shown in the figure 6.5.3.1.3.1 (the biomass index for *L. piscatorius* was added for comparison). The biomass index shows interannual fluctuations with no significant trend, although density of black-belliedanglefish has increased over the last 2 years (i.e. similar to the pattern seen in the commercial catches).

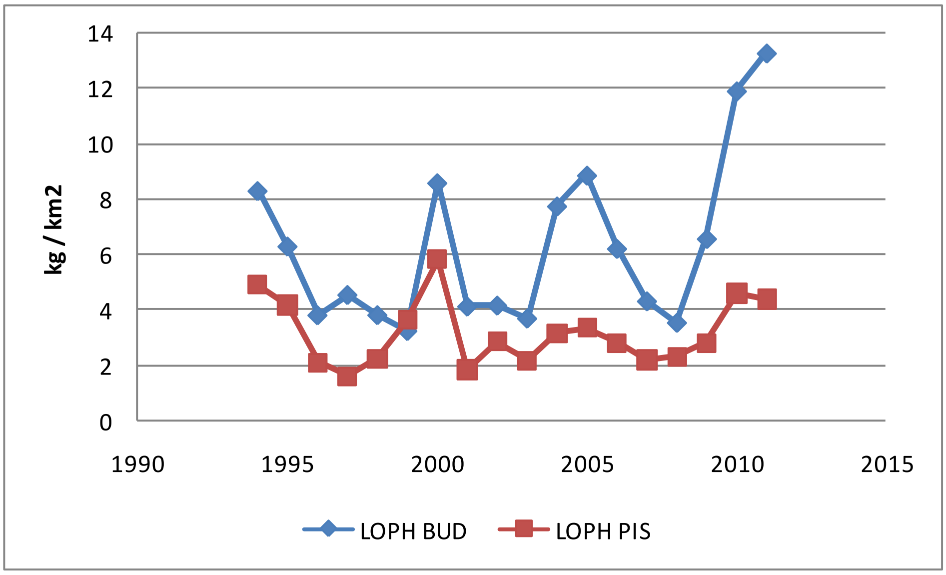


Fig. 6.5.3.1.3.1 Evolution of *L.budegassa* and *piscatorius*. biomass (kg/km2) in GSA 06 from MEDITS trawl surveys.

6.5.3.1.4 *Trends in abundance by length or age*

No information was documented during STECF EWG 12-10.

6.5.3.1.5 *Trends in growth*

No analyses were conducted during STECF EWG 12-10.

6.5.3.1.6 *Trends in maturity*

No analyses were conducted during STECF EWG 12-10.

6.5.4 *Assessment of historic stock parameters*

6.5.4.1 Method 1: VIT

6.5.4.1.1 *Justification*

Length frequency distributions of landings were available for the years 2009-2011. The data were analyzed separately for each year under steady state assumption, using age classes as pseudocohorts. A VPA based on pseudocohorts and Yield per recruit (YPR)was applied using the VIT4win software (Lleonart and Salat, 1997). Data of number at age were obtained from the slicing (knife-edge slicing) procedure in VIT4win.

6.5.4.1.2 *Input parameters*

The VPA analysis on pseudocohorts was carried out combining sexes, because black-belliedanglerfish does not show sexual dimorphism. The von Bertalanffy growth parameters were L_∞ = 102 cm TL, k = 0.15 yr^{-1}, t_0 = -0.05 yr, while the length-weight relationship parameters were: a = 0.0232 g cm^{-3} and b = 2.8455. A vector of natural mortality was computed using PRODBIOM (Abella et al., 1997).

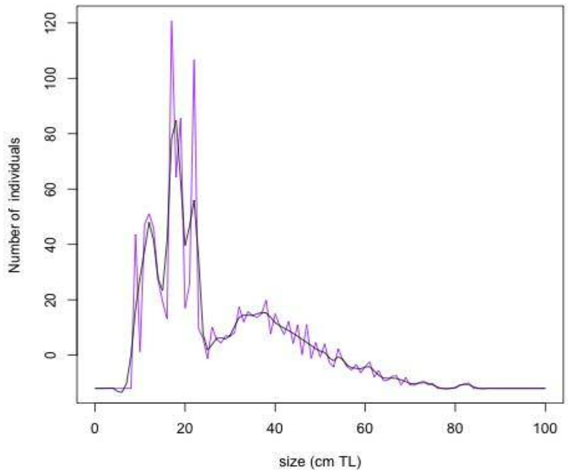
Table 6.5.4.1.2.1 Vector of natural mortality obtained by PRODBIOM for *Lophius budegassa* in GSA 06.

Age	M
0	0.767
1	0.428
2	0.298
3	0.244
4	0.214
5	0.196
6	0.182
7+	0.174

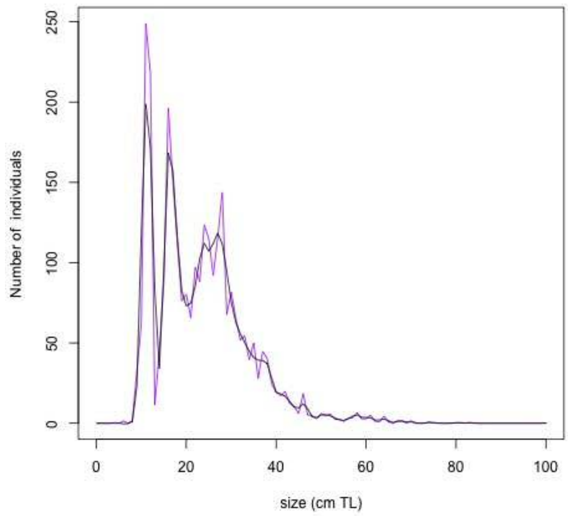
The terminal fishing mortality was set at 0.5 (after performing sensitivity analysis over a wide range of values: 0.05 – 1). The proportion of mature individuals by age class was derived as explained above in the section 6.5.1.3.

The size frequency distributions of the trawl catches showed important differences from year to year. In 2009 the catches were dominated by small specimens from 10 cm TL, with a secondary mode at 35 cm TL. In 2010 there were 3 modes in the 10 to 35 cm TL range, while in 2011 the catches were dominated by a strong mode of 30 cm TL. Large individuals (over 50-60 cm TL) are rarely observed in the trawl catches, but present in set net gears. Set gears are not sampled although its catches are about 1% of the landings.

2009



2010



2011

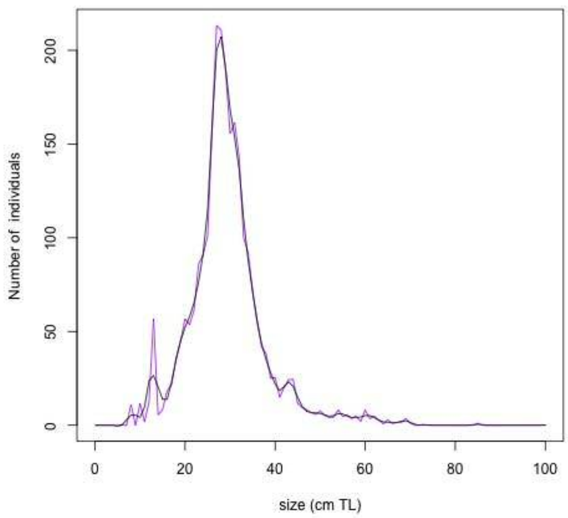


Fig. 6.5.4.1.2.1 Size frequency distribution of *Lophius budegassa* caught by OTB in GSA06 (2009-2011) with smoothed size frequency distribution (black) used in the GSA 06 stock assessment.

6.5.4.1.3 *Results*

Three independent annual VIT assessments were carried out in 2009, 2010 and 2011. Due to the structure of the size frequencies, different age class compositions were obtained in each year: 4 years in 2009, 6 in 2010 and 7 in 2011, with a plus class in all cases (note that the maximum reported age in the literature for black-bellied anglerfish is 21 yr).

The catches of *Lophius budegassa* were dominated by individuals of age classes 1, 2 and 3 in 2009 and 2010.

However, the bulk of catches in 2011 are in age classes 2 and 3. The low abundance of age 1 anglerfish in the catches may be due to the effect of the adoption of more selective mesh in trawls in GSA06. The following figure shows the numbers at age in the total catches:

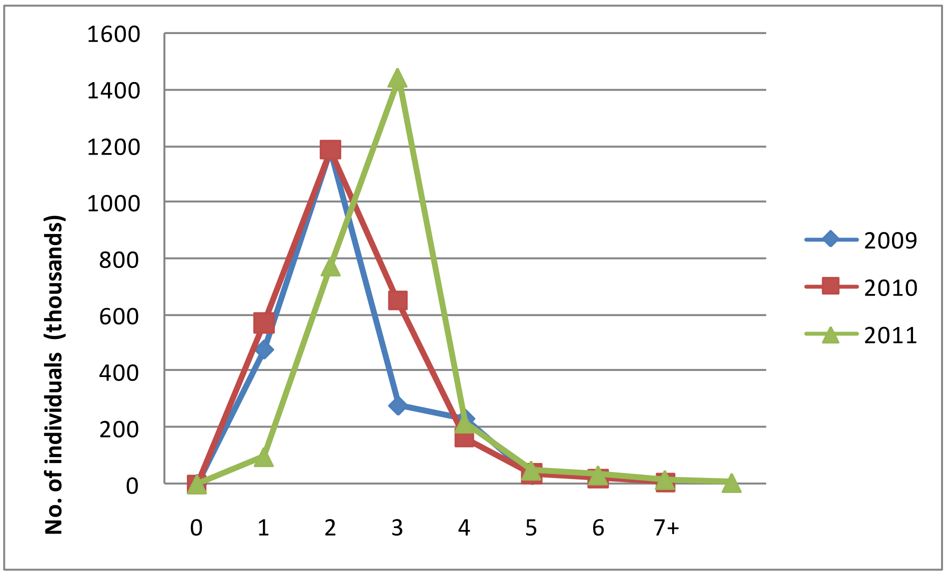


Fig. 6.5.4.1.3.1 Numbers at age of *L. budegassa* in the total catches of OTB for 2009-2011 (GSA 06).

The catches in weight are dominated by age 1 to age 3 classes in all three years, with high catches of age 2 in 2011, as shown in figure6.5.4.1.3.2.

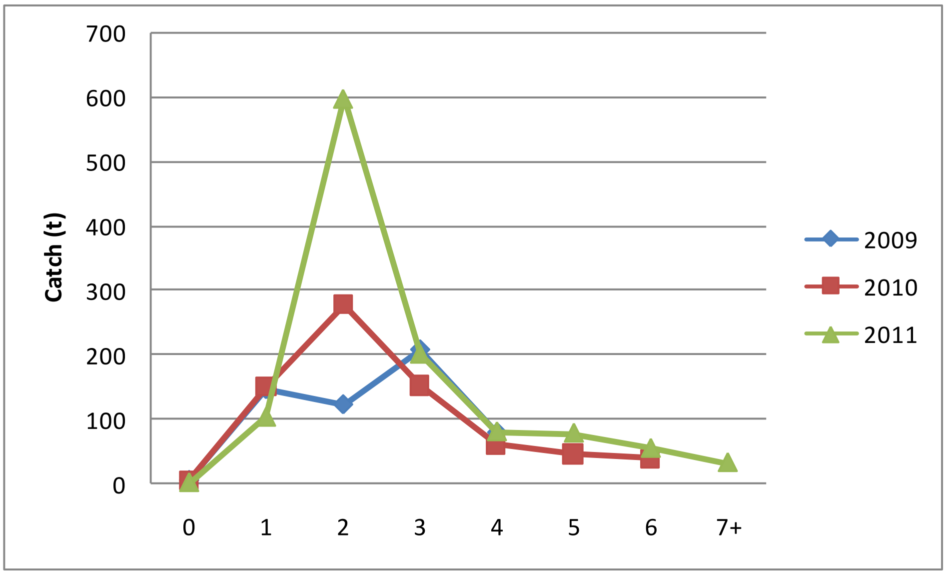


Fig. 6.5.4.1.3.2Catch at age of *L. budegassa* in the total catches of OTB for 2009-2011 (GSA06).

The population of anglerfish in GSA 06 has increased steadily over the last three years, in agreement with the increase in density observed in MEDITS survey data series, as shown in the following figure:

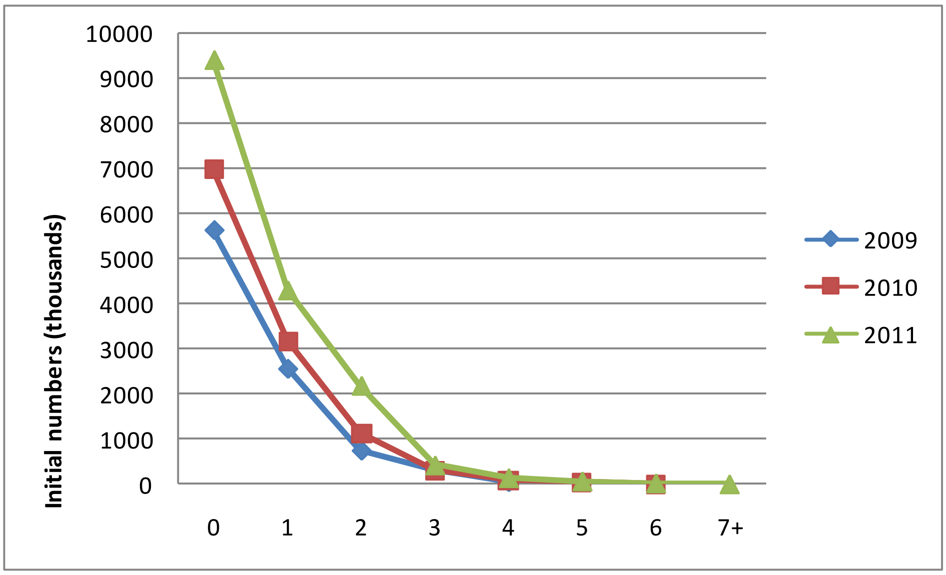


Fig. 6.5.4.1.3.3Initial number of *L. budegassa* in GSA 06 for 2009-2011.

Fishing mortality was similar for age classes 1 to 7+ in each year, with a reduction of fishing mortality on age 1 in 2011, as shown in the figure6.5.4.1.3.4.

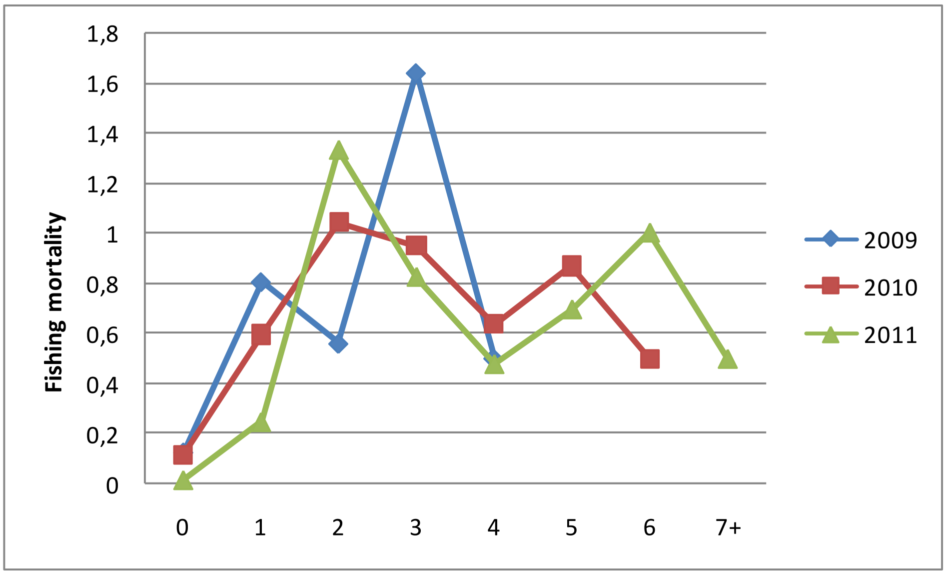


Fig. 6.5.4.1.3.4Fishing mortality of *L. budegassa* by OTB for 2009-2011 (GSA06).

6.5.5 *Long term prediction*

6.5.5.1 Justification

A yield per recruit (Y/R) analysis was carried out using the VIT4win program.

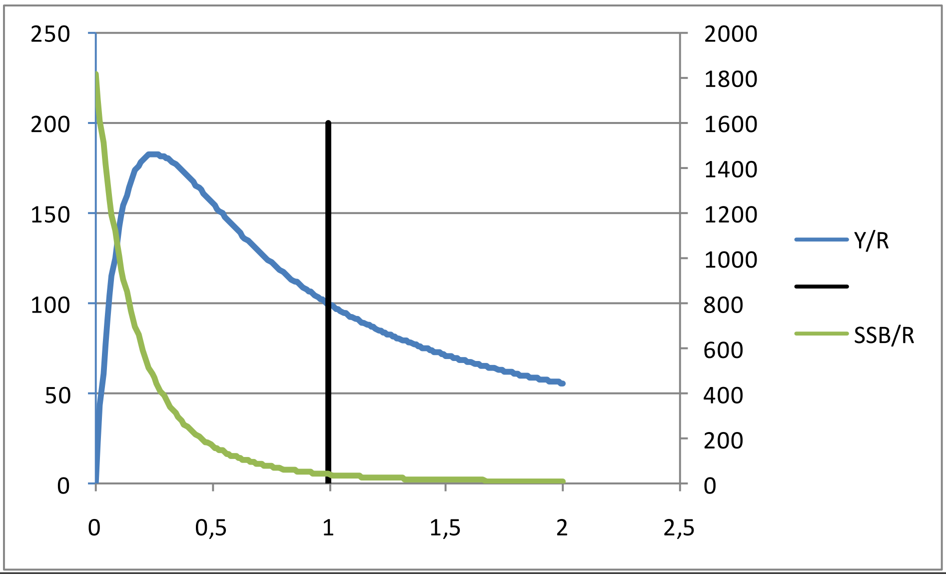
6.5.5.2 Input parameters

The same input parameters used for VIT were used in the YPR analysis.

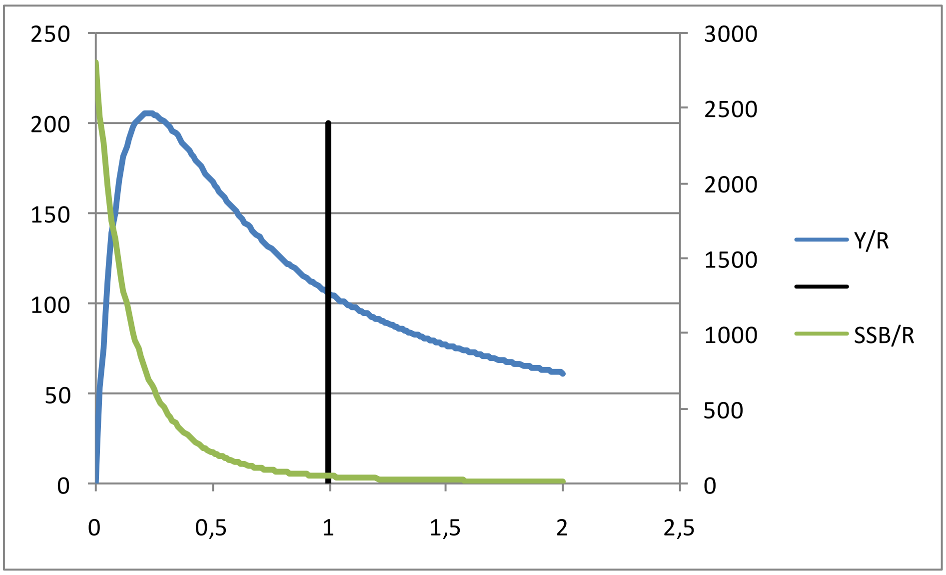
6.5.5.3 Results

The yield curves were dome shaped for all three years, with maximum yield found at considerably lower F than current F. Maximum production (ca. 200 g / recruit) would be obtained at 25% of current F, as shown in the following figure:

- 2009



- 2010



- 2011

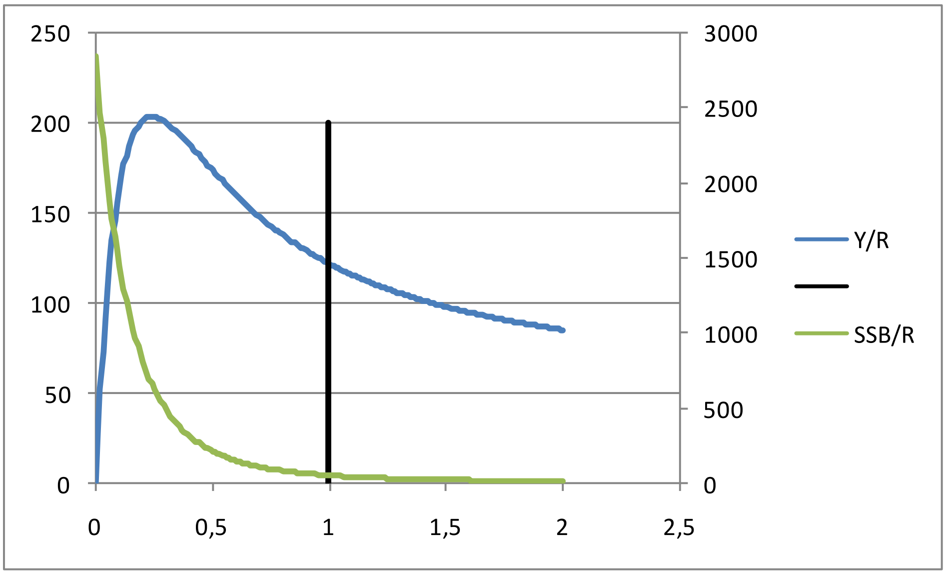


Fig. 6.5.5.3.1 Annual YPR and SSBPR of anglerfish over the period 2009-2011 in GSA06, with current F (factor = 1) shown for comparison.

Table 6.5.5.3.1shows the summary results of the YPR analysis. Note that fishing mortality decreased over the 3 years, but the value for 2011 (F=0.72) is still far from the F_{MSY}. Fishing mortality should be reduced by 80% to reach F_{MSY}.

Table6.5.5.3.1 Results summarising the YPR analysis performed on 2009 - 2011 assessments of black-bellied anglerfish in GSA06.

		Factor	Absolute F	Y/R	B/R	SSB/R
2009	Virgin	0.00	0.00	0.00	4324.23	1822.29
	F(0.1)	0.20	0.18	180.27	1460.34	598.22
	Fcurr	1.00	0.88	99.85	129.88	41.78
	F(Max)	0.26	0.23	183.38	1159.54	470.45
2010	Virgin	0.00	0.00	0.00	5398.79	2803.06
	F(0.1)	0.17	0.14	199.88	1922.72	952.93
	Fcurr	1.00	0.81	105.41	137.89	46.49
	F(Max)	0.24	0.19	205.30	1416.13	687.40
2011	Virgin	0.00	0.00	0.00	5152.65	2853.10
	F(0.1)	0.17	0.12	196.73	1856.28	968.12
	Fcurr	1.00	0.72	122.19	168.09	57.30
	F(Max)	0.25	0.18	203.93	1319.11	667.28
Average	F(0.1)	0.18	0.15	192.29	1746.45	839.76
	Fcurr	1.00	0.80	109.15	145.28	48.53
	F(Max)	0.25	0.20	197.54	1298.26	608.38

6.5.6 *Data quality and availability*

Data from DCF 2012 were used. The data available are of sufficient quality to perform a VPA on pseudocohorts at annual scale, but note that the biological parameters used are a pool of biological samples obtained over time due to the difficulty in obtaining representative length frequency data. Black-bellied anglerfish in the range 50 – 100 cm TL are very rare from trawl sampling; complementary specimens from trammel nets would be desirable to obtain more representative size frequencies, although in 2011 landings from set nets were less than 2% of the total.

6.5.7 *Scientific advice*

6.5.7.1 Short term considerations

6.5.7.1.1 *State of the stock size*

Survey indices and commercial catches indicate increased abundance over 2010-2011 and the VPA assessment based on pseudocohorts showed an increase in SSB from 2009 to 2011. However, in the absence of proposed biomass management reference points, EWG 12-10 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

Table 6.5.7.1.1.1 Spawning stock biomass assessment of black-bellied anglerfish in GSA 06.

	SSB (t)
2009	235
2010	324
2011	540

6.5.7.1.2 *State of recruitment*

Recruitment of anglerfish has steadily increased in the assessed period 2009-2011, as shown in the following table. However, in the absence of proposed management reference points, EWG 12-10 is unable to fully evaluate the status of the recruitment in relation to these.

Table 6.5.7.1.2.1 Recruitment of black-bellied anglerfish in GSA 06 (age 0 abundance).

Age 0	Million indiv.
2009	3.89
2010	4.83
2011	3.89

6.5.7.1.3 *State of exploitation*

EWG 12-10 proposed $F_{0.1}$ = 0.15 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 0.72), the stock is considered exploited unsustainably.

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

6.6 Stock assessment of hake in GSA 07

6.6.1 *Stock identification and biological features*

6.6.1.1 Stock Identification

Hake (*Merluccius merluccius*) in the Gulf of Lions (GSA 7) is a shared stock exploited by both Spanish and French fishing fleets (trawlers, longliners and gillnetters).

6.6.1.2 Growth

The growth of European Hake (*Merluccius merluccius*) in the Gulf of Lions was recently re-estimated from tagging experiments developed by IFREMER in the area (Mellon-Duval et al., 2010). The new parameters have not been yet compared to a new analysis of the otoliths. Therefore, the data sent within the data call are in length and have been converted to age using the L2Age program (i.e. knife edge slicing). The growth parameters used during the EWG 12-10 were:

Growth parameters

	Males	Females
L_{inf}	72.8	100.7
K	0.233	0.236
t_0	0	0

6.6.1.3 Maturity

PERIOD	Age	0	1	2	3	4	5	6+
1998-2010	Prop. matures	0	0.11	0.63	0.91	0.98	0.99	1

Natural mortality

PERIOD	Age	0	1	2	3	4	5	6+
1998-2010	M	0.88	0.43	0.33	0.25	0.22	0.20	0.19

6.6.2 *Fisheries*

6.6.2.1 General description of the fisheries

Hake (*Merluccius merluccius*) is one of the most important demersal target species for the commercial fisheries in the Gulf of Lions (GFCM-GSA07). In this area, hake is exploited by French trawlers, French gillnetters, Spanish trawlers and Spanish long-liners. Around 220 boats are involved in this fishery and, according to official statistics, the total annual landings for the period 1998-2011 have oscillated around an average value of 2,230 tons (1,362 tons in 2011). In the past 10 years, the fishing capacity of the French trawlers in GSA 07 has progressively declined. Their number decreased by nearly 30% over the period. Because of the large decline of small pelagic fish species in the area, in 2009 the trawlers fishing small pelagic have diverted their effort on demersal species.

The French trawler fleet is the largest in number of boats and catch (44 and 72%, respectively). The length of hake in the trawler catches ranges between 3 and 92 cm total length (TL), with an average size of 21 cm TL. The second largest fleet is the French gillnetters (~39 and 14% respectively, range 13-86 cm TL and average size 39 cm TL), followed by the Spanish trawlers (~11 and 8%, respectively, range 5-87 cm TL, and average size 24 cm TL), and the Spanish long-liners (~6 and 6%, respectively, range 22-96 cm TL and average size 52 cm TL). The hake trawlers exploits a highly diversified species assemblage: Striped mullet (*Mullus surmuletus*), Red mullet (*Mullus barbatus*), Anglerfish (*Lophius piscatorius*), Black-bellied anglerfish (*Lophius budegassa*), European conger (*Conger conger*), Poor-cod (*Trisopterus minutus capelanus*), Fourspotted megrim (*Lepidorhombus boscii*), Soles (*Solea* spp.), horned octopus (*Eledone cirrhosa*), squids (*Illex coindetii*), Gilthead seabream (*Sparus aurata*), European seabass (*Dicentrarchus labrax*), Seabreams (*Pagellus* spp.), Blue whiting (*Micromesistius poutassou*) and Tub gurnard (*Chelidonichtys lucerna*).

6.6.2.2 Management regulations applicable in 2010 and 2011

French Trawlers:

- Fishing license: full compliance
- Engine power limited to 316 KW or 500 CV: partial compliance
- Cod-end mesh size (bottom trawl: square 40 mm; pelagic trawl: diamond 20 mm): partial compliance
- Fishing forbidden within 3 miles (France): partial compliance
- Time at sea: full compliance

French gillnetters:

- Fishing license: full compliance
- Maximum length of net: partial compliance

Spanish trawlers:

- Fishing license: full compliance
- Engine power limited to 316 KW or 500 CV: no compliance
- Mesh size in the codend (40 mm diamond): full compliance
- Fishing forbidden <50 m depth: full compliance
- Time at sea: full compliance

Spanish longliners:

- Fishing license: full compliance
- Number of hook per boat: partial compliance

6.6.2.3 Catches

6.6.2.3.1 *Landings*

The following table shows the annual landings (t) by gear (DCF data):

COUNTRY	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
French trawlers	1688	1525	1347	1835	2168	2024	1023	1002	1014	1282	2071	1642	1527	970
Spanish trawlers	140	279	166	196	231	206	101	125	116	107	192	258	156	1
French gillnetters	500	500	500	500	182	248	99	255	299	168	111	286	247	250
Spanish longliners	101	109	285	163	146	112	78	101	170	143	97	83	53	40

6.6.2.3.2 *Discards*

Discards were not included in the catches before 2008 because landings were almost equal to catches as very few fishes were discarded. In 2008 some discards appear (173 t) due to controls and exceptionally high recruitment and were thus included in the catches. In 2009, the level of discards decreased (9 t) but discards were still included in the catches. However, in 2010 and 2011, no discards data was available, but the amount of discards was considered negligible and thus discards were not included in the catch at age matrix.

6.6.2.3.3 *Fishing effort*

For France, fishing effort data was provided on a yearly basis for OTB, OTM, over the period 2003-2008. No data was available over 2009-2011. For Spain, fishing effort was provided for OTB and LLS over 2002-2010, no data was provided for 2011.

Table 6.6.2.3.3.1 Fishing effort (kW·days) by gear for France, 2003-2008.

	2003	2004	2005	2006	2007	2008
OTB	12970505	8450443	5870844	6219184	5938674	5277458
OTM	3766550	1330992	1864890	2193060	1144433	931468

Table 6.6.2.3.3.2 Fishing effort (kW·days) by gear for Spain, 2002-2010.

	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
LLS	195074	197896	202306	171414	177074	198536	236340	270382	255079
OTB	1493537	1355499	1243124	1223685	1379150	1535408	1601404	1598654	1382555

6.6.3 *Scientific surveys*

6.6.3.1 MEDITS

6.6.3.1.1 *Methods*

Fishery independent information regarding the state of the hake in GSA 07 was derived from the international survey MEDITS.

The data was assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This involves weighting the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

Confidence interval = $Yst \pm t(\text{student distribution}) * V(Yst) / n$

Length distributions were obtained by the sum of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the GSA strata.

6.6.3.1.2 *Geographical distribution patterns*

No information was documented during EWG12-10.

6.6.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of the hake in GSA 07 was derived from the international survey MEDITS. Figure 6.6.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 07. The estimated abundance and biomass indices do not reveal a clear trend.

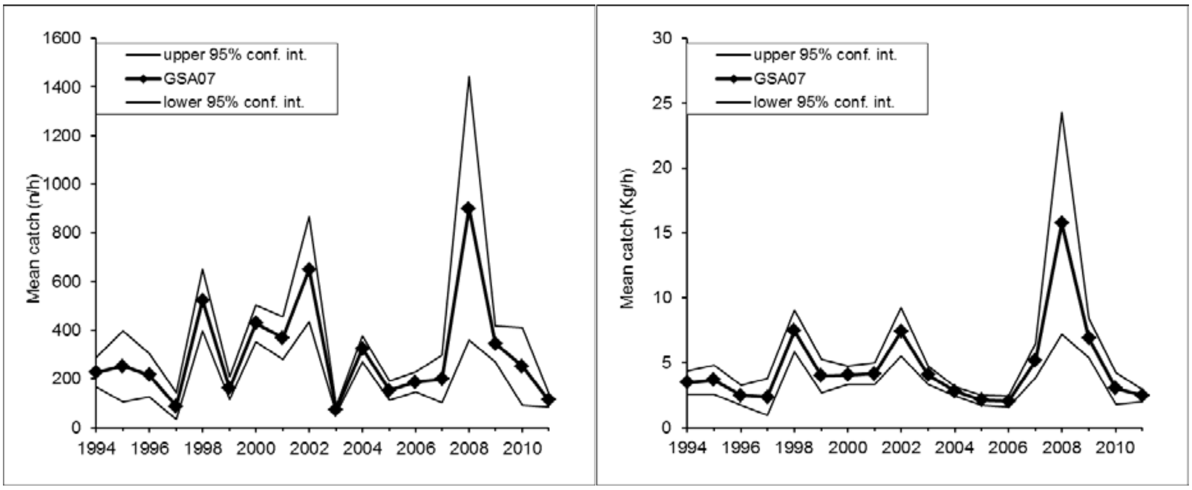
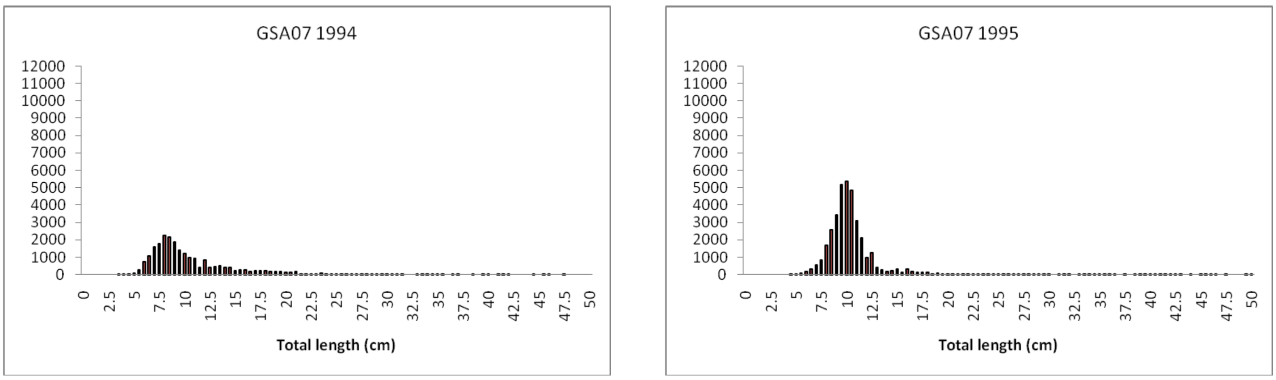
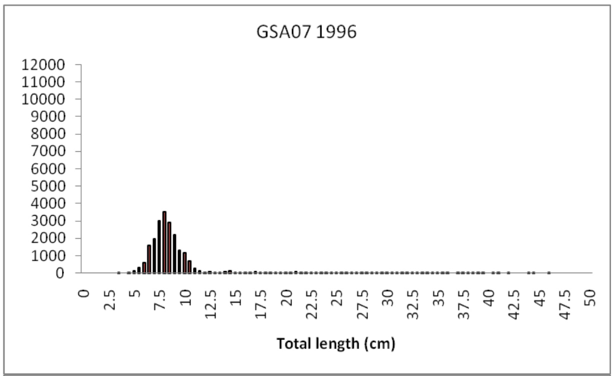


Fig. 6.6.3.1.3.1 Abundance and biomass indices of hake in GSA 07.

6.6.3.1.4 *Trends in abundance by length or age*

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12000
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9000
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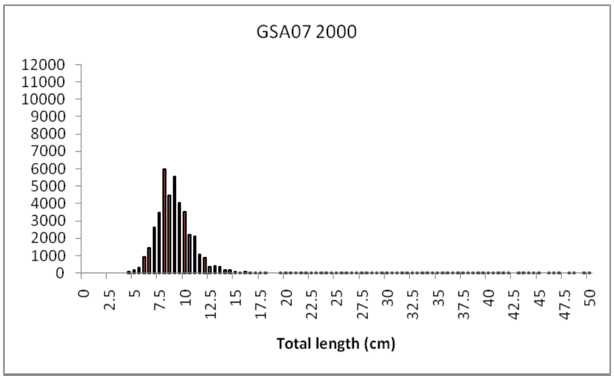
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50
Total length (cm)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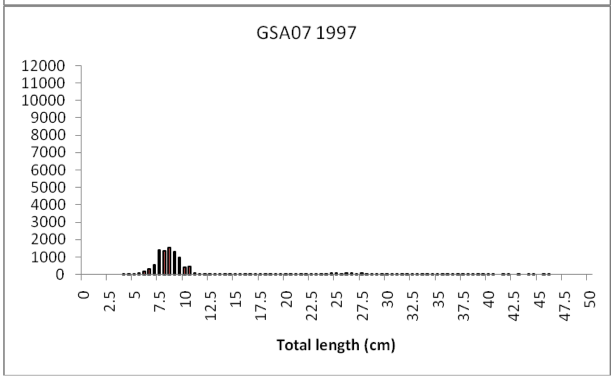
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50
Total length (cm)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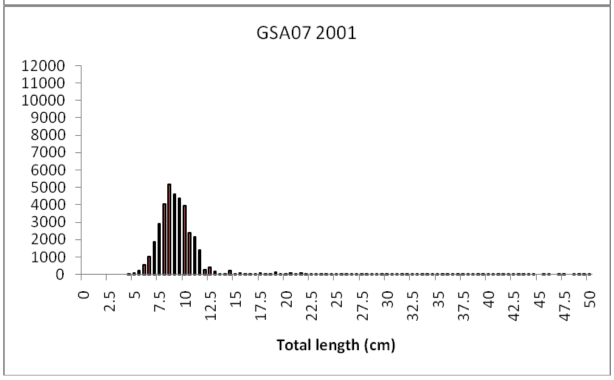
Total length (cm)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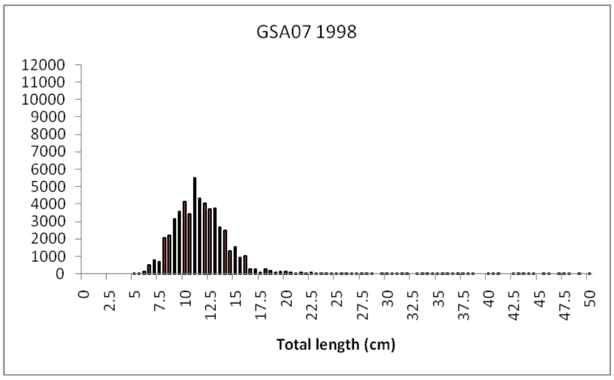
Total length (cm)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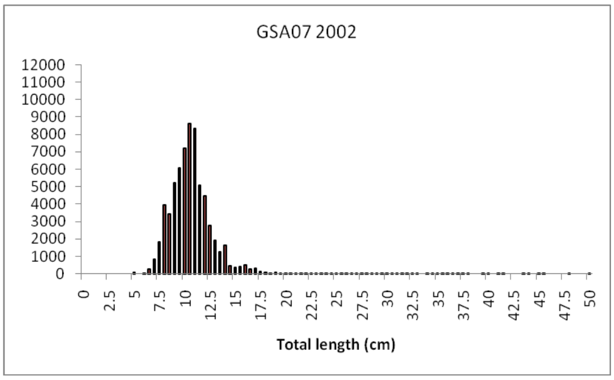
Total length (cm)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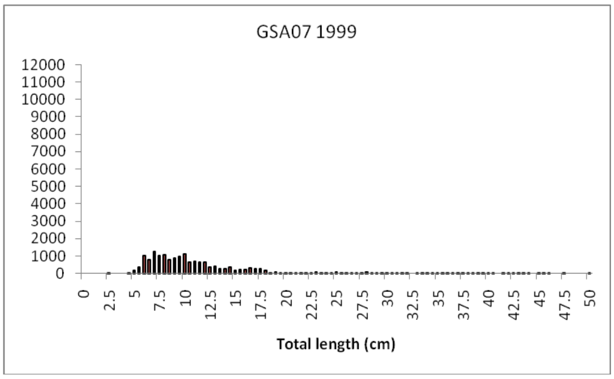
Total length (cm)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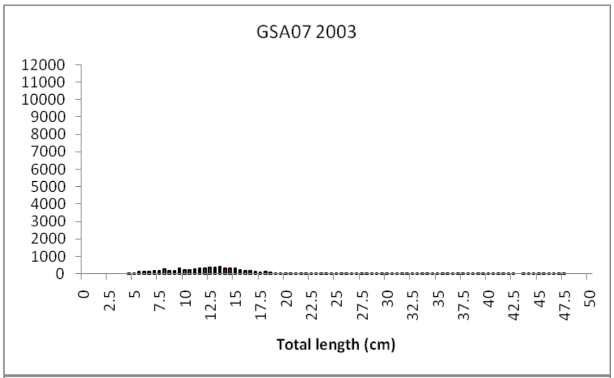
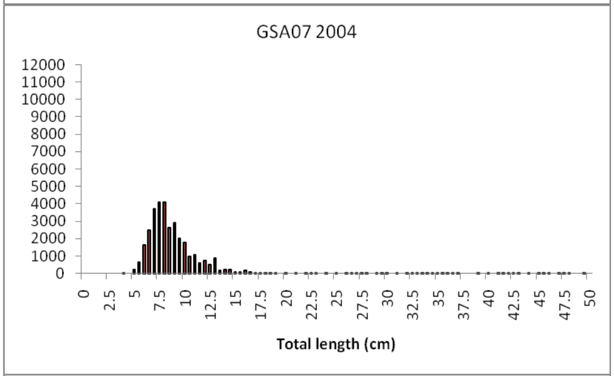
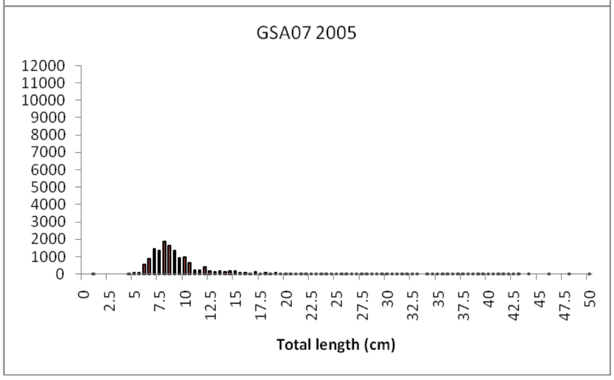
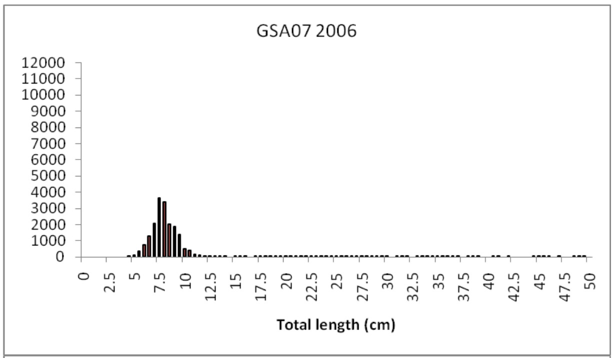
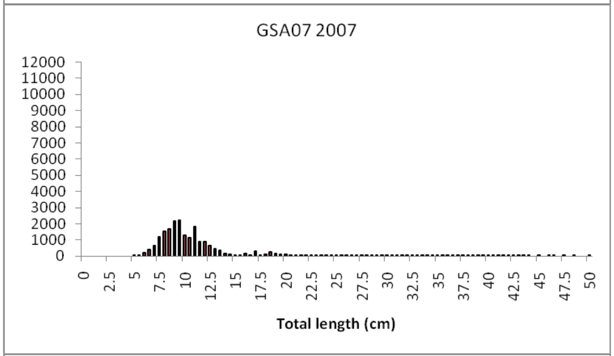
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50
Total length (cm)

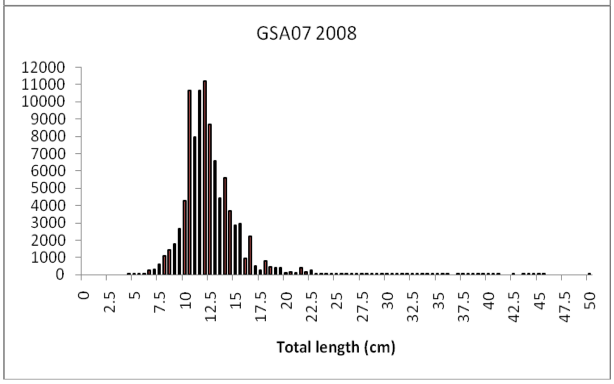

GSA07 2003
Total length (cm)

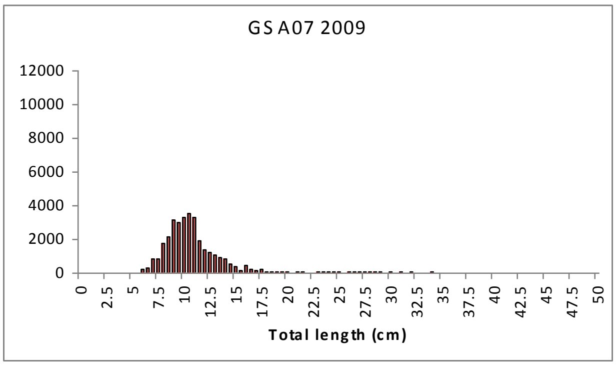

GSA07 2004
Total length (cm)


GSA07 2005
Total length (cm)


GSA07 2006
Total length (cm)


GSA07 2007
Total length (cm)


GSA07 2008
Total length (cm)


GS A07 2009
Total length (cm)

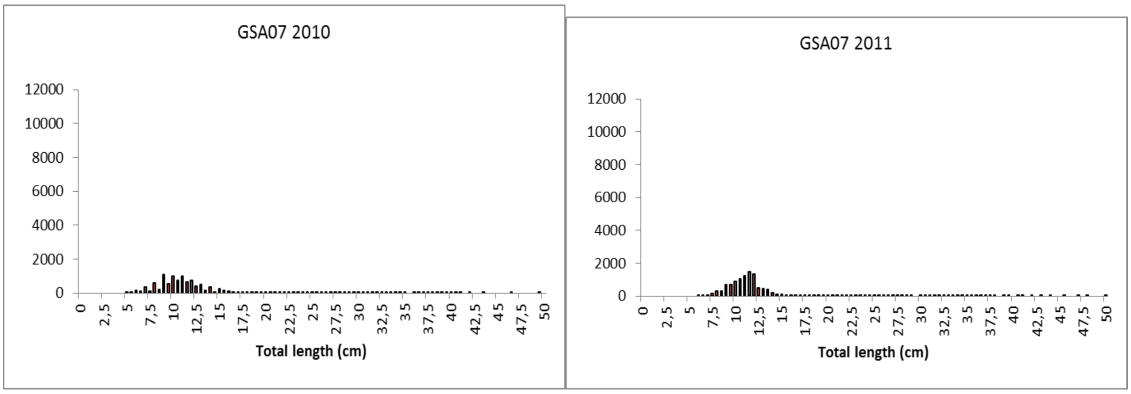


Fig. 6.6.3.1.4.1 Length frequency distribution of hake in GSA 07 obtained from MEDITS survey.

6.6.3.1.5 *Trends in growth*

No information has been documented.

6.6.3.1.6 *Trends in maturity*

No information has been documented.

6.6.4 *Assessments of historic stock parameters*

6.6.4.1 Method 1: XSA

6.6.4.1.1 *Justification*

During EWG12-10 meeting an assessment was made (using XSA tuned using MEDITS survey data) over the period 1998-2011. XSA was run considering age classes from 0 to 6+.

6.6.4.1.2 *Input parameters*

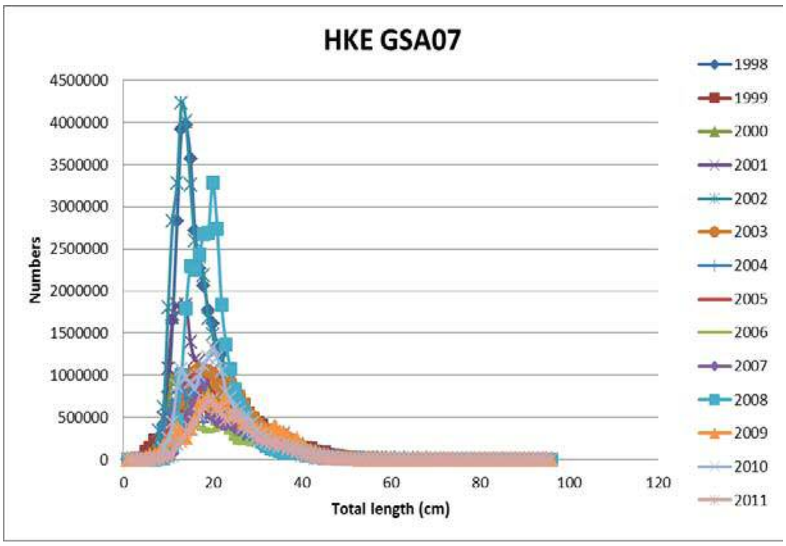


Fig. 6.6.4.1.2.1 Length distributions of total landings 1998-2011 (all gears combined).

Hake GSA 07 Catch at Age (thousands)

AGE	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	20751	6379	7366	12266	23919	5902	6098	5744	2690	3074	11172	3621	6884	2471
1	13300	8954	6958	9822	14416	10309	5261	5613	4379	6067	17723	7643	9825	6242
2	1721	2882	2321	2867	2207	2877	1425	1728	1800	1969	1692	2794	2145	1583
3	207	269	313	318	238	321	153	170	247	243	152	327	186	136
4	45	37	66	38	29	32	15	19	34	27	18	20	15	6
5	15	10	25	18	12	9	2	3	6	6	5	3	1	1
6+	7	4	14	12	6	11	1	1	2	3	2	2	1	0

Hake GSA 07 Weight at Age (kg)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	0,0245	0,024	0,02	0,023	0,023	0,028	0,02	0,03	0,03	0,03	0,032	0,03	0,03	0,03
1	0,104	0,128	0,13	0,131	0,113	0,131	0,12	0,13	0,14	0,13	0,1	0,14	0,12	0,13
2	0,406	0,409	0,42	0,409	0,408	0,393	0,4	0,41	0,43	0,42	0,397	0,39	0,39	0,38
3	0,892	0,871	0,88	0,846	0,842	0,848	0,87	0,85	0,85	0,86	0,864	0,85	0,87	0,84
4	1,4185	1,437	1,43	1,441	1,417	1,405	1,4	1,38	1,38	1,38	1,379	1,34	1,4	1,41
5	1,9605	1,964	1,99	2,014	1,993	1,972	1,95	1,96	1,95	1,96	2,003	1,98	1,96	1,93
6+	2,4955	2,488	2,46	2,446	2,581	2,909	2,8	2,59	2,68	2,53	2,387	2,46	2,51	2,58

Natural Mortality (M) at age (PROBIOM)

Age	0	1	2	3	4	5	6+
	0.88	0.43	0.33	0.25	0.22	0.20	0.19

MEDITS index (1998-2011)

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	46392	13757	40130	34419	61553	4944	30999	13668	17858	17108	76973	30477	22335	10230
1	4606	1703	549	858	2523	1698	660	792	453	1583	11196	2803	1655	824
2	121	327	224	214	218	432	142	126	151	304	292	602	329	195
3	22	41	37	27	46	50	35	26	12	55	49	46	20	14
4	7	2	8	5	2	6	2	1	1	9	8	4	0	1
5	0	0	1	2	1	0	0	1	3	1	1	0	0	0
6+	0	0	0	2	3	0	0	0	0	10	0	0	0	0

6.6.4.1.3 *Results*

Two sensitivity analyses were conducted before performing the assessment, in order to assess the effect of different XSA settings on the outcome of the method.

First, 5 different shrinkage assumptions (i.e. fse) were tested: 0.5, 1, 1.5, 2 and 2.5 (Figure 6.6.4.1.3.1). The results showed a very high robustness to this parameter as almost no difference was observed between the runs.

The second sensitivity analysis was conducted to assess the effect of the age after which catchability is no longer estimated (i.e. qage assigning values ranging from 0 to 6 (Figure 6.6.4.1.3.2). The results were found to be robust to this parameter as the runs showed very similar results.

The parameters finally retained for the final run are in Table 6.6.4.1.3.1. The results of the final run are in Figure 6.6.4.1.3.3. A retrospective analysis was conducted on mean F, recruitment and SSB (Figure 6.6.4.1.3.5).

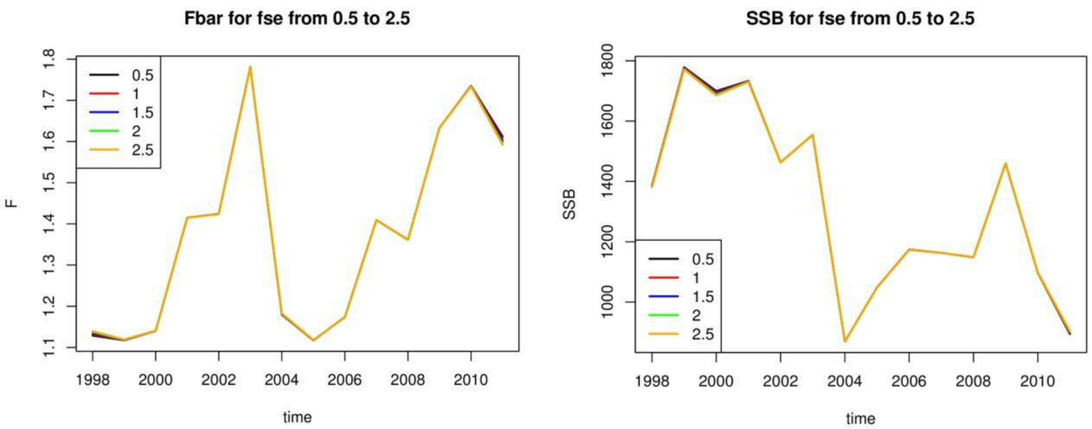


Fig. 6.6.4.1.3.1 Sensitivity analysis on shrinkage. The shrinkage parameter (fse) was set from 0.5 to 2.5. The resulting time series of fishing mortality (left panel, $F_{0\text{-}3}$) and spawning stock biomass (right panel, SSB) were plotted.

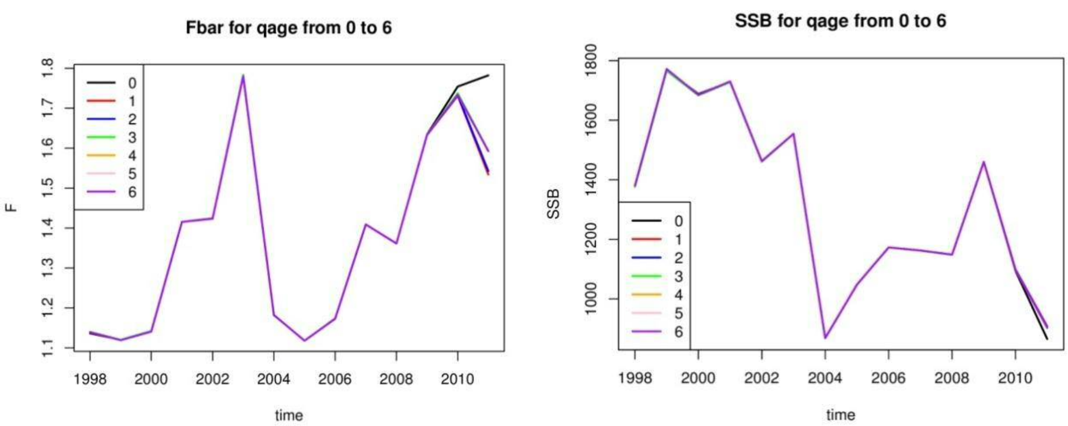


Fig. 6.6.4.1.3.2 Sensitivity analysis on catchability. The age after which catchability is no longer estimated (qage) was set from 0 to 6. The resulting time series of fishing mortality (left panel, F_{bar}) and spawning stock

biomass (right panel, SSB) were plotted.

Table 6.6.4.1.3.1 Parameters used to perform the SSB.

Fse	shk.yrs	shk.ages	rage	qage
2.5	3	2	-1	6

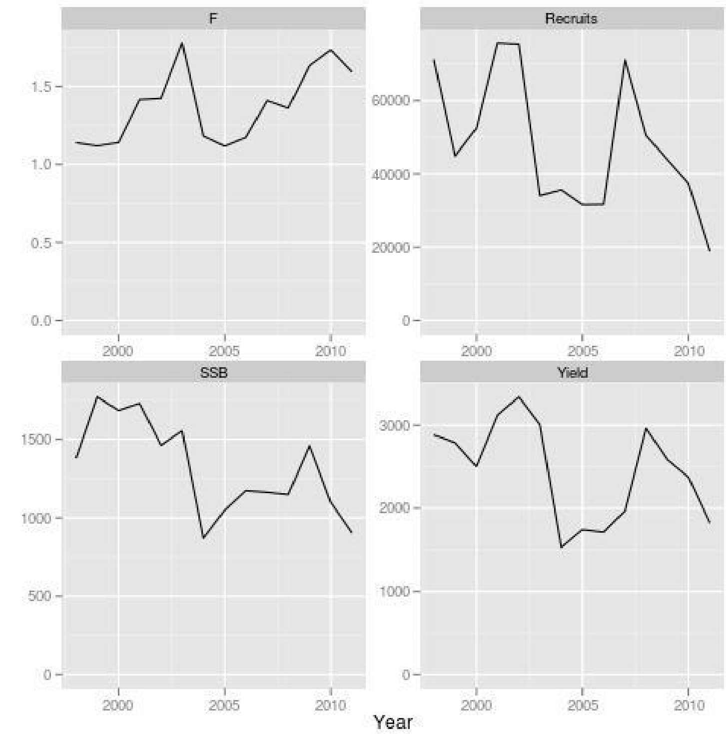


Fig. 6.6.4.1.3.3 Assessement results: F, Recruitment, SSB and Yield.

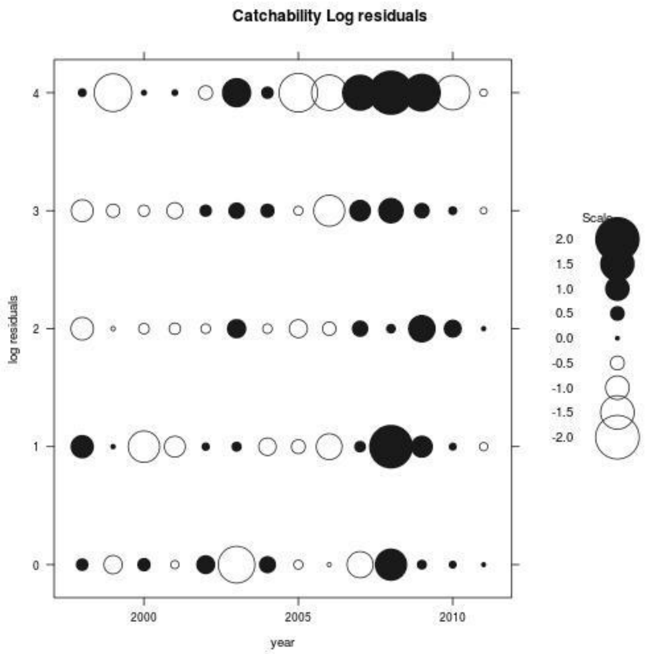


Fig. 6.6.4.1.3.4 Log catchability residual plots (XSA) for the tuning fleet, MEDITS

Because of the large decline of small pelagic species in the area, trawlers fishing those species have diverted their effort on demersal species in 2009. This can explain the divergence of the mean F trajectories obtained from the retrospective analysis after 2008. Furthermore, the very high recruitment in 2007 and 2008 can explain the overestimation of the recruitment in 2007 and then of the SSB in 2009 (age 2, 0.67% of matures).

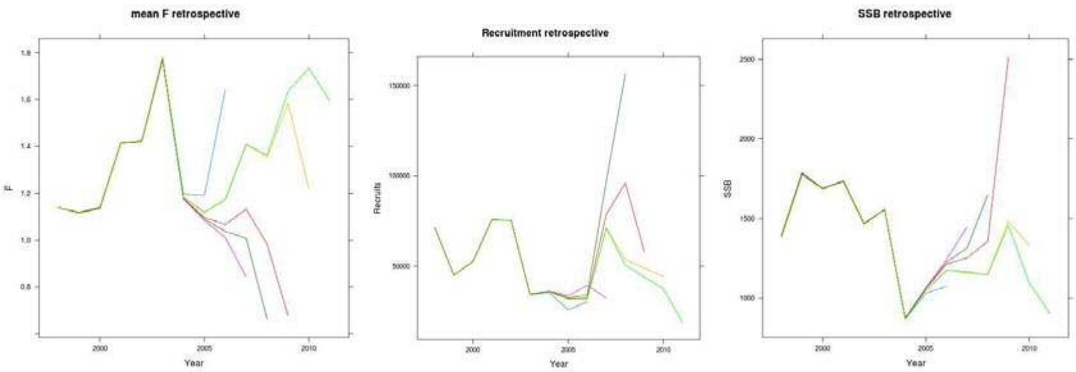


Fig. 6.6.4.1.3.5 Retrospective analysis (mean F, Recruitement, SSB).

6.6.5 *Long term prediction*

6.6.5.1 Justification

Yield per recruit analysis was not performed because the reference points were already calculated in the last year assessment.Forecast analyses will be conducted and delivered during EWG 12-19 meeting.

6.6.5.2 Input parameters

Forecast analyses will be conducted and delivered by EWG 12-19 (December 2012).

6.6.5.3 Results

Forecast analyses will be conducted and delivered by EWG 12-19 (December 2012).

6.6.6 *Data quality*

No fishing effort data for the French OTB and OTM was provided for the period 2009-2011. For Spain, no fishing effort data was provided in 2011.

6.6.7 *Scientific advice*

6.6.7.1 Short term considerations

6.6.7.1.1 *State of the spawning stock size*

The SSB shows a decreasing trend over the analyzed period. In the absence of a precautionary reference point the STECF EWG 11-20 is unable to fully evaluate the stock size status.

6.6.7.1.2 *State of recruitment*

The highest recruitment values observed over the period are in 1997, 2002-2003 and 2007. Since 2007, the recruitment follows a decreasing trend and is currently at the lowest observed level.

6.6.7.1.3 *State of exploitation*

EWG 12-10 proposed $F_{0.1} = 0.24$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the XSA analysis (current F is around 1.43), the stock is considered exploited unsustainably.The exploitation is mainly concentrated on age classes 0 and 1.

6.7 Stock assessment of red mullet in GSA 07

6.7.1 *Stock identification and biological features*

6.7.1.1 Stock identification

In GSA 07, red mullet (*Mullus barbatus*) is a shared stock, which is exploited by French and Spanish vessels.

6.7.1.2 Growth

In the absence of stock specific parameters, the growth parameters used in the analysis of *M. barbatus* (GSA 07) were obtained from GSA 09 (Ligurian and North Tyrrhenian Sea). Length-weight parameters were instead those computed in the Data Collection Framework in GSA 07:

Growth	L∞	29.0
	K	0.6
	t0	-0.1
Length-weigth	a	0.0077
	b	3.1315

6.7.1.3 Maturity

Red mullet spawning period in GSA 07 extends from May to August with a peak in June-July. The maturity ogives used was obtained from GSA 09 (Ligurian and North Tyrrhenian Sea).

0	1	2	3	4	5+
0.00	1.00	1.00	1.00	1.00	1.00

6.7.2 *Fisheries*

6.7.2.1 General description of fisheries

In the Gulf of Lions (GSA 07), red mullet is exploited by both French and Spanish trawlers. Information on French gillnets is available from 2011. The French gillnets is suspected to have fished red mullet in the past, but no data is available to quantify their catches.

Around 200 boats are involved in this fishery. According to official statistics, total annual landings for the period 2004-2011 have oscillated around an average value of 190 tons. The French gillnets represent nearly half of the boats (45%), followed by the French (41%) and Spanish trawlers (14%). In terms of landings, most catches were done by the French trawlers (74%), followed by the French gillnets (13%) and the Spanish trawlers (13%). The mean modal lengths in the catches of the French trawlers and gillnets and Spanish trawlers were 13.8, 17.5 and 14.8 cm, respectively.

In GSA 07, the trawl fishery is multi-specific. In addition to *M. barbatus*, the following species can be considered as important by-catches: *Merluccius merluccius, Lophius sp., Pagellus sp., Trachurus sp., Mullus surmuletus, Octopus vulgaris, Eledone sp., Scyliorhinus canicula, Trachinus sp., Triglidae,* *Scorpaena sp.*

Length at the first capture is about 7 cm. The catch is mainly composed by individuals of age 0 and 1, whereas the oldest age class (5+ group) is poorly represented.

6.7.2.2 Management regulations applicable in 2010 and 2011

French trawlers:
- Fishing license: full compliance
- Engine power limited to 316 KW or 500 CV: no compliance
- Cod-end mesh size (bottom trawl: square 40 mm or diamond 50 mm with derogation; pelagic trawl: diamond 20 mm): partial compliance
- Fishing forbidden within 3 miles (France): partial compliance
- Time at sea: full compliance
- Freezing of the effort in the Fishery Restricted Area: no compliance

French gillnetters:
- Fishing license: full compliance
- Maximum length of net: partial compliance
- Freezing of the effort in the Fishery Restricted Area: no compliance

Spanish trawlers:
- Fishing license: full compliance
- Engine power limited to 316 KW or 500 CV: no compliance
- Mesh size in the codend (square 40 mm or 50 mm diamond with derogation): fully observed
- Fishing forbidden <50 m depth: full compliance
- Time at sea: full compliance
- Freezing of the effort in the Fishery Restricted Area: no compliance

6.7.2.3 Catches

6.7.2.3.1 *Landings*

The following table shows the annual landings (in tons) of otter trawlers (OTB) and gillnets (GNS) in GSA 07 by Member State (MS), for the French (FRA) and Spanish (ESP) fleet.

The gillnetters were firstly sampled in 2011, no data was provided before that period (landings and size distribution), because no size sampling was done on small scale fishery and especially on red mullet before that period. There is no information about the importance of GNS in the past. During EWG-12-10 two assessments where performed, one including GNS data and one excluding it. As there were not changes in the results, we considered that the impact of this gear was low, so we kept this gear in the analysis. However for future assessments it would be ideal to estimate the proportion of the catches taken by the gillnet fisheries in order to update the catch matrix accordingly.

MS	Gear	2004	2005	2006	2007	2008	2009	2010	2011
FRA	OTB	151.0	148.1	183.5	171.5	111.4	119.7	219.0	170.0
FRA	GNS								30.1
ESP	OTB	25.9	27.6	32.7	37.2	21.2	26.1	25.1	28.3

6.7.2.3.2 *Discards*

Discards are considered to be very low and thus are not included in the assessment.

6.7.2.3.3 *Fishing effort*

Data on fishing effort was to be provided over the period 2002-2011, on a quarterly basis. However, no data was available for Spain in 2011 and no data was available for France in 2009 and 2010. For 2011, French data only consists in number of boats for OTB, but the value is not considered realistic and need to be cross-checked.

6.7.3 *Scientific surveys*

6.7.3.1 MEDITS

6.7.3.1.1 *Methods*

In GSA 07 the following number of hauls per depth stratum was reported in the Data Call.

Number of hauls per year and depth stratum in GSA07, 1994-2011.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
010-050	12	12	12	14	12	12	12	12	12	13	12	12	12	14	11	11	12	12
050-100	32	32	32	35	39	32	32	32	31	38	31	30	33	31	24	29	28	31
100-200	12	10	10	10	10	10	11	10	10	11	14	12	11	11	8	11	10	11
200-500	6	7	6	7	6	6	6	7	5	6	6	6	6	6	5	6	3	6
500-800	8	7	4	5	4	4	6	5	4	5	5	5	5	5	5	5	5	5

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices were calculated using stratified means (Cochran, 1953; Saville, 1977). This involves weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

This approach is standard, but it was noted that the calculation may be biased due to the assumptions made on zero catch stations, and hence on the data distribution. Even though normal distribution is often assumed, the data may be better described by a delta-distribution, quasi-poisson. Indeed, the data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions were obtained by the sum of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the GSA strata.

6.7.3.1.2 *Geographical distribution patterns*

No analyses were conducted during EWG12-10 meeting.

6.7.3.1.3 *Trends in abundance and biomass*

Fishery independent data of the red mullet in GSA 07 was derived from the MEDITSsurvey. Figure displays the estimated trend in red mullet abundance and biomass in GSA 07.

The time series of the estimated abundance and biomass indices displayed variations over the whole time period, with an increasing trend during the last 5 years.

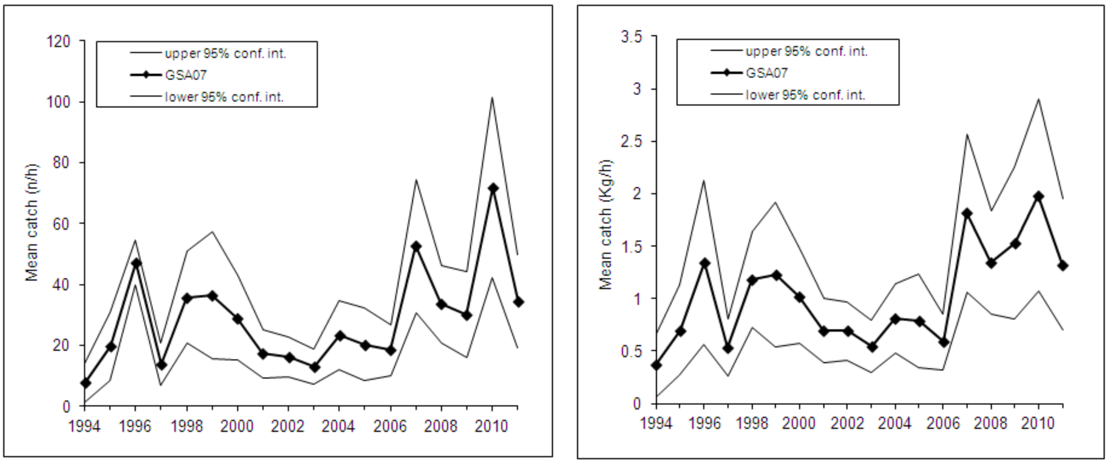
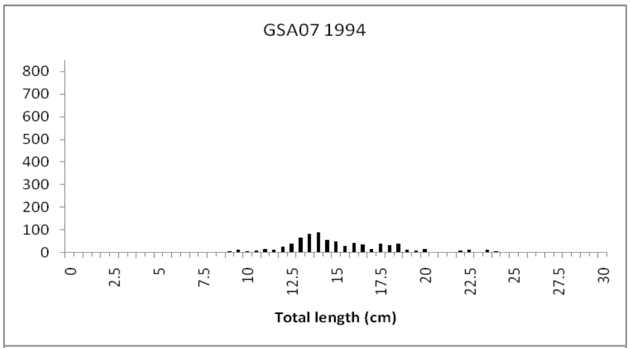
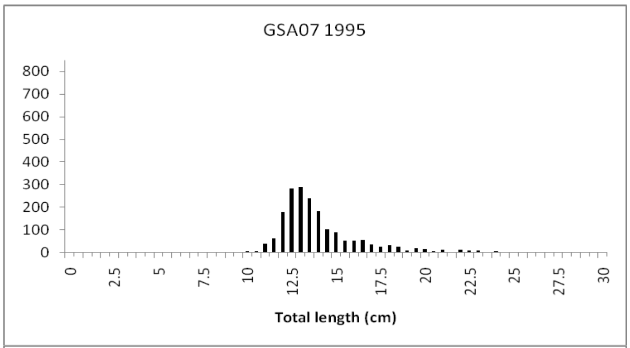


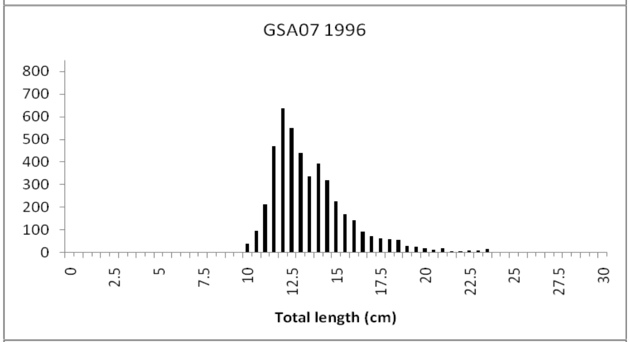
Fig. 6.7.3.1.3.1 Abundance and biomass indices of red mullet in GSA 07.

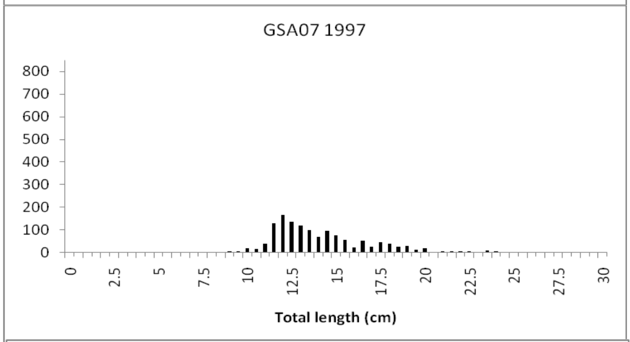
6.7.3.1.4 *Trends in abundance by length or age*

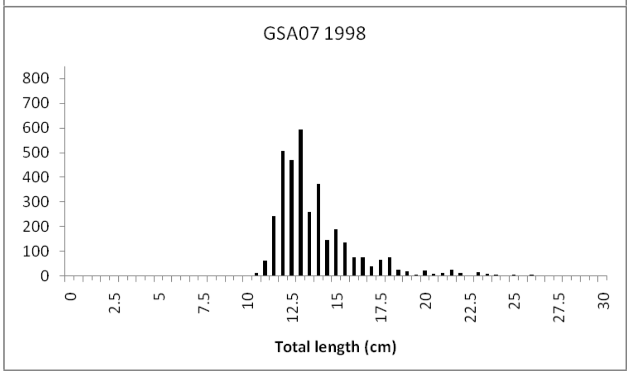
The following figures display the MEDITS stratified abundance indices of GSA 07 in 1994-2011.

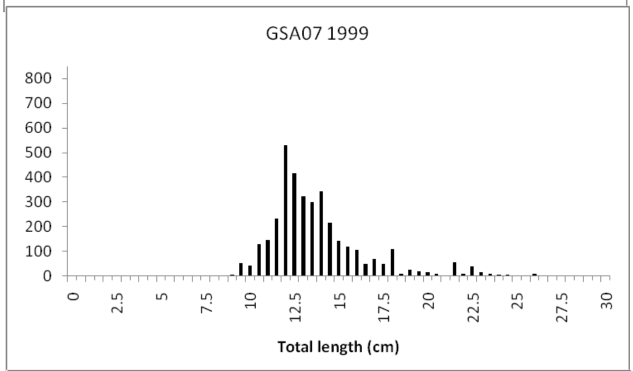

GSA07 1994
Total length (cm)

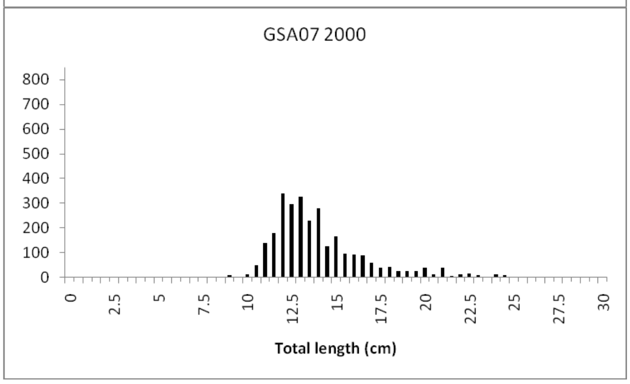

GSA07 1995
Total length (cm)

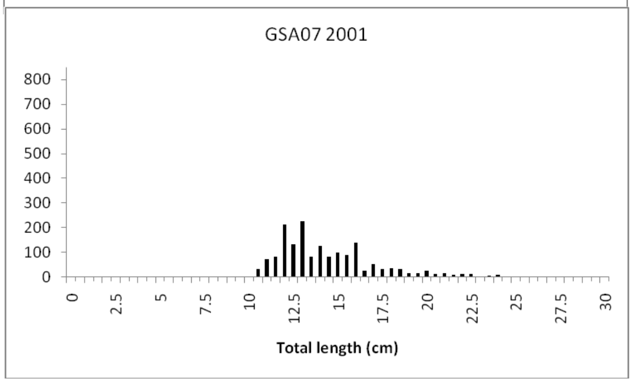

GSA07 1996
Total length (cm)

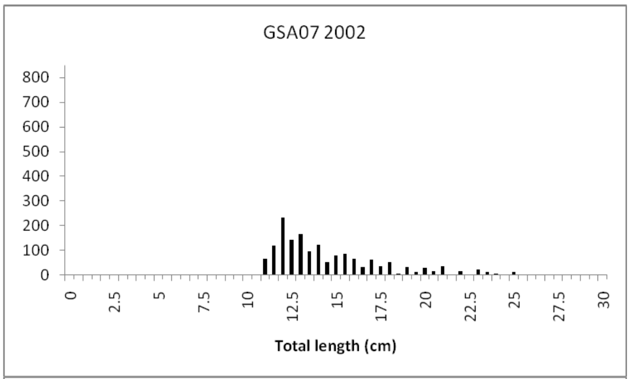

GSA07 1997
Total length (cm)

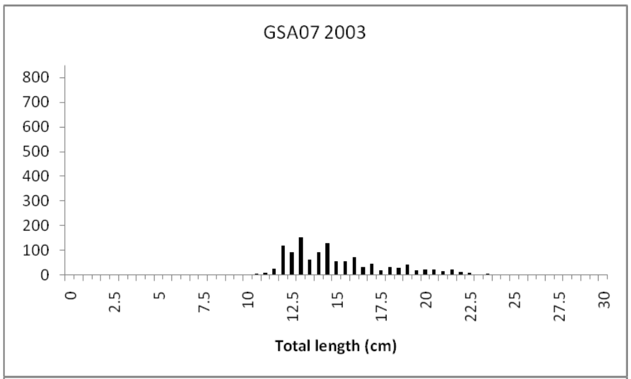

GSA07 1998
Total length (cm)

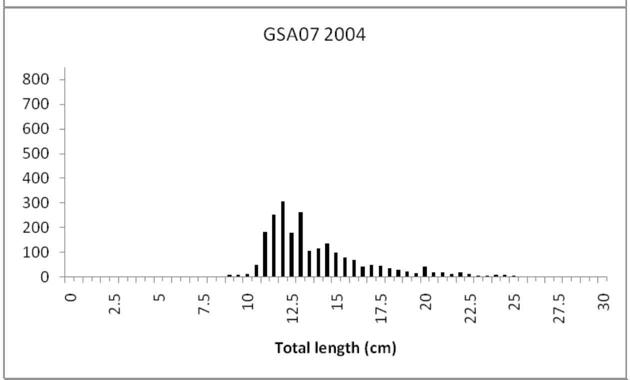

GSA07 1999
Total length (cm)

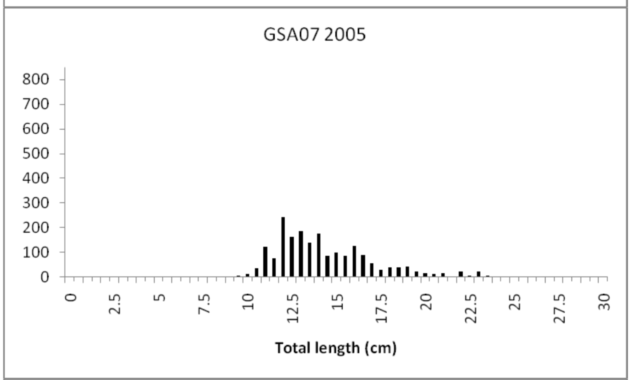

GSA07 2000
Total length (cm)

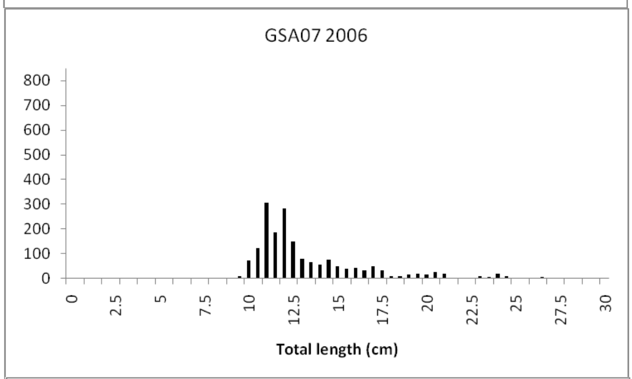

GSA07 2001
Total length (cm)

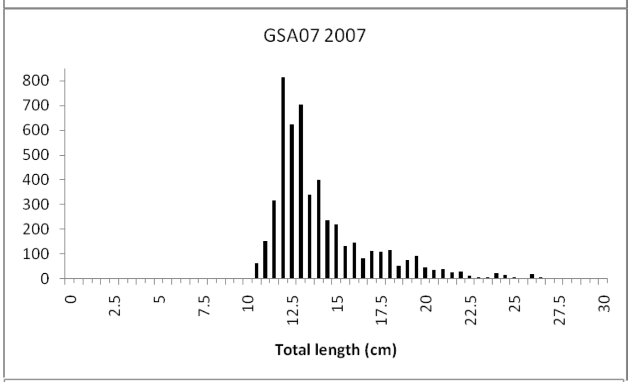

GSA07 2002
Total length (cm)

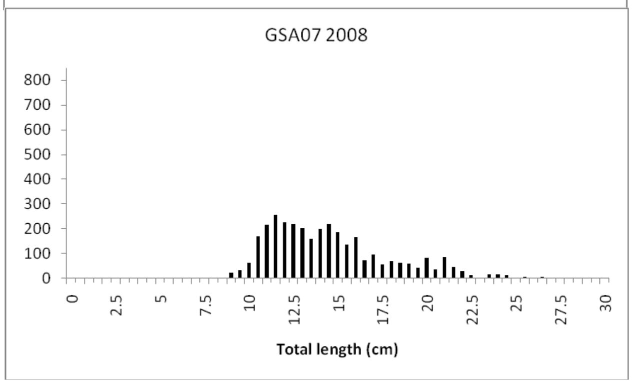

GSA07 2003
Total length (cm)

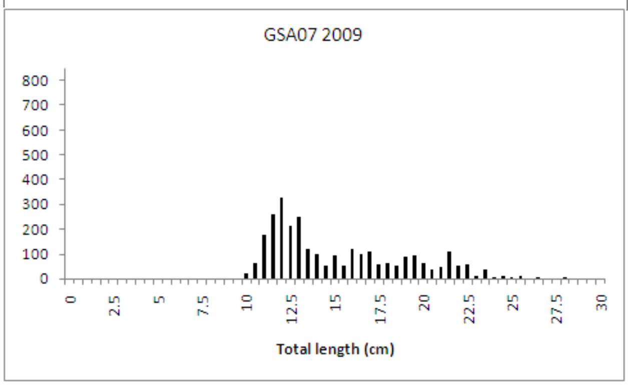

GSA07 2004
Total length (cm)


GSA07 2005
Total length (cm)


GSA07 2006
Total length (cm)


GSA07 2007
Total length (cm)


GSA07 2008
Total length (cm)


GSA07 2009
Total length (cm)

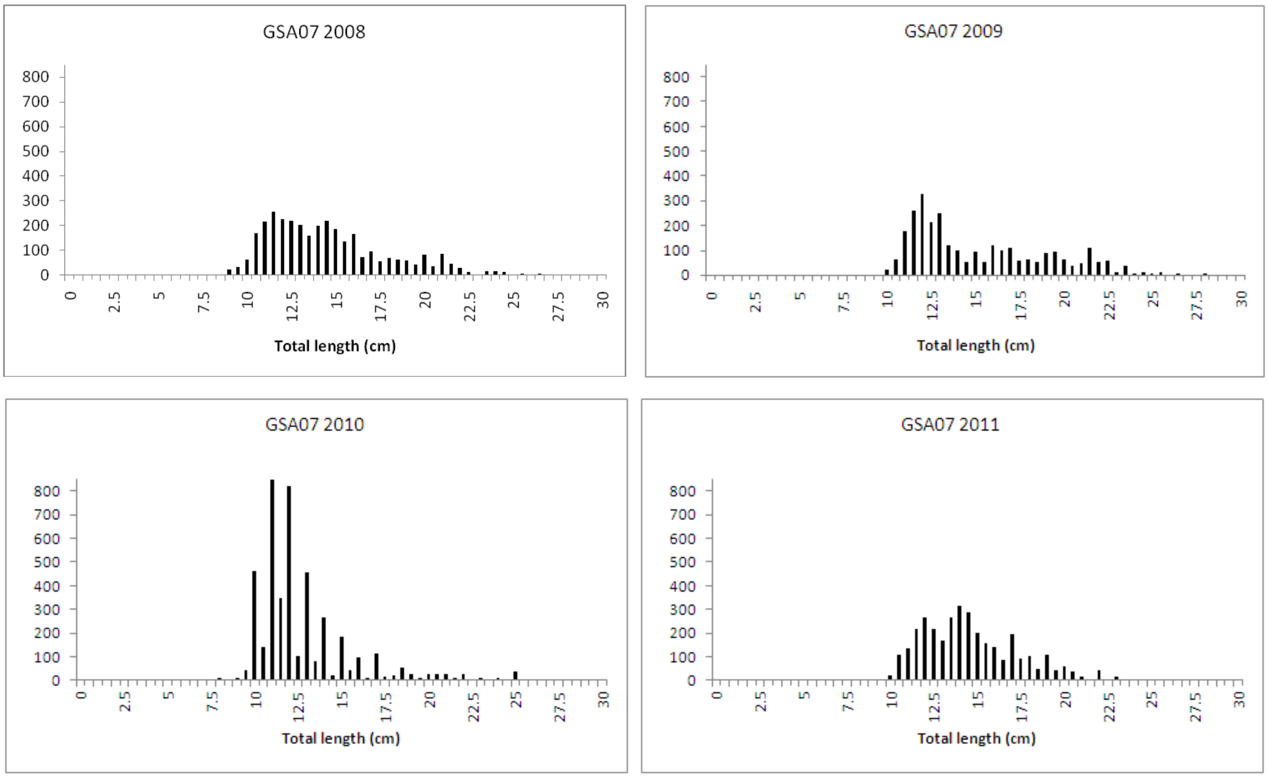


Fig. 6.7.3.1.4.1 Stratified LFD by year for red mullet in GSA 07 from MEDITS survey

6.7.3.1.5 *Trends in growth*

No analyses were conducted during EWG-12-10.

6.7.3.1.6 *Trends in maturity*

No analyses were conducted during EWG-12-10.

6.7.4 *Assessments of historic stock parameters*

6.7.4.1 Method 1: XSA

6.7.4.1.1 *Justification*

XSA was run considering six age classes, the last one being a plus group.

6.7.4.1.2 *Input parameters*

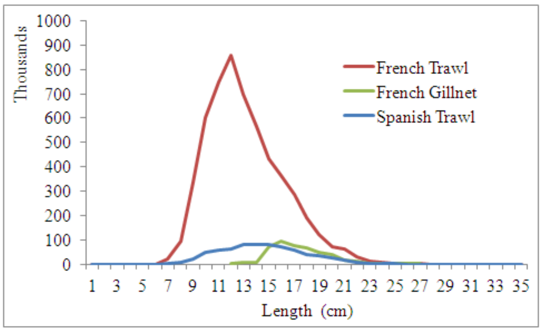


Fig. 6.7.4.1.2.1 Catch in numbers per length for the French and Spanish trawlers and the French gillnets (mean values 2004-2011).

Table6.7.4.1.2.1Total catch in numbers per age and year and mean weigth by age and year.

	0	1	2	3	4	5
2004	4295.7	2166.9	82.8	8.6	0.1	0
2005	2833	2379.7	133.8	17.7	4.1	11.4
2006	4877.2	2450.2	134.8	6.7	0.4	0.8
2007	3389	2973.8	202.1	3.2	0.3	0.2
2008	1168.4	1881.4	166.5	4.6	0.4	0.4
2009	2558	1756.9	174.7	6.5	0.1	0
2010	6080.8	2966.4	210	14.6	2.8	0.2
2011	4077.5	2983.5	204.7	14.8	4.9	2.3

	0	1	2	3	4	5
2004	0.019	0.049	0.125	0.183	0.22	0.271
2005	0.017	0.051	0.122	0.184	0.248	0.288
2006	0.021	0.05	0.123	0.185	0.22	0.308
2007	0.021	0.046	0.122	0.174	0.248	0.248
2008	0.019	0.055	0.119	0.187	0.22	0.277
2009	0.016	0.057	0.12	0.182	0.22	0.271
2010	0.015	0.051	0.122	0.19	0.223	0.248
2011	0.016	0.054	0.122	0.189	0.233	0.259

The parameters used are described in the tables below.

Natural mortality obtained using PROBIOM (Abella et al., 1997).

0	1	2	3	4	5+
1.30	0.79	0.62	0.54	0.54	0.54

Maturity ogive.

0	1	2	3	4	5+
0.37	0.85	0.95	0.97	0.98	1.00

Two sensitivity analyses were performed before selecting the settingsof the final XSA. First, 5 different shrinkage weights were considered: 0.5, 1, 1.5, 2 and 2.5 (Figure 6.7.4.1.2.2). Results were found to be very similar although the value 2.5 led to a lower F_{bar} (ages 0-3) and a higher SSB.

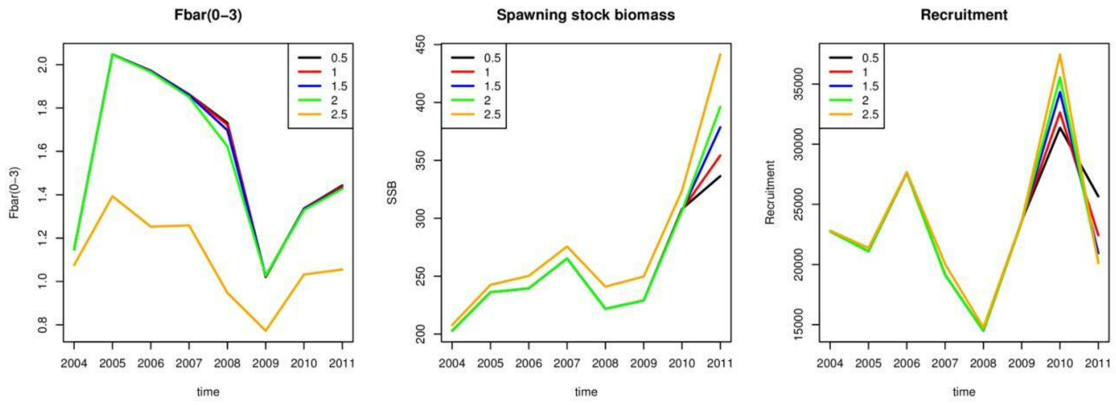


Fig. 6.7.4.1.2.2 Sensitivity analysis on shrinkage. The shrinkage parameter (fse) was set to 5 values from 0.5 to 2.5. The resulting time series of fishing mortality (Fbar), Spawning stock biomass (SSB) and recruitment are plotted on the same graph.

The second sensitivity analysis was conducted to assess the effect of the selected ages for the shrinkage. The shrinkage weight parameter was set at 1.5 and the parameter controlling the ages for shrinkage (shk.ages) was assigned to values ranging from 1 to 5 (Figure 6.7.4.1.2.3). The results were found to be similar and in the final run, the parameter was set to age 2.

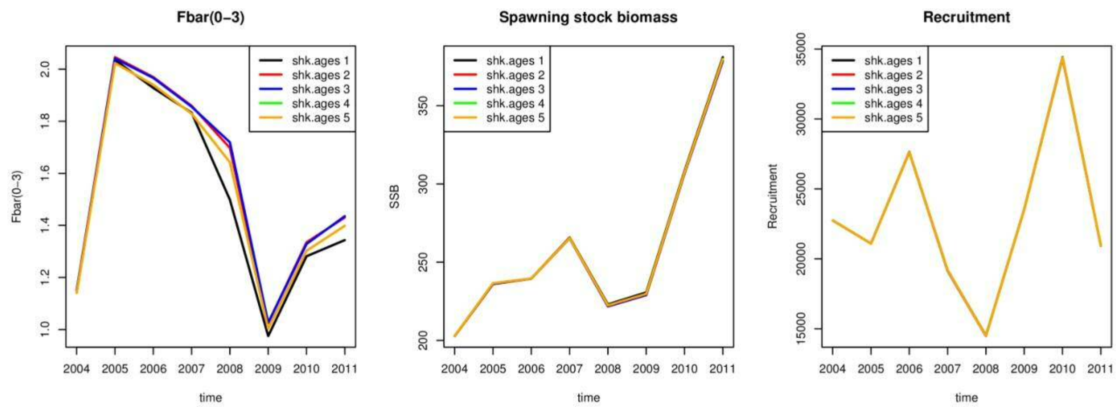


Fig. 6.7.4.1.2.3 Sensitivity analysis on shrinkage. The shrinkage parameter (shk.ages) was set to 5 values from 1 to 5. The resulting time series of fishing mortality (Fbar), Spawning stock biomass (SSB) and recruitment are plotted on the same graph.

Thus, for the final XSA run, the following settings were used:

fse	rage	qage	shk.n	shk.f	shk.yrs	shk.ages
1	-1	5	TRUE	TRUE	3	2

6.7.4.1.3 *Results*

The results obtained using XSA showed two peaks of recruitment in 2006 and in 2010, the latter being the highest in the time series. The SSB showed an increase in 2010 and 2011. F oscillated around 1.5 during the period.

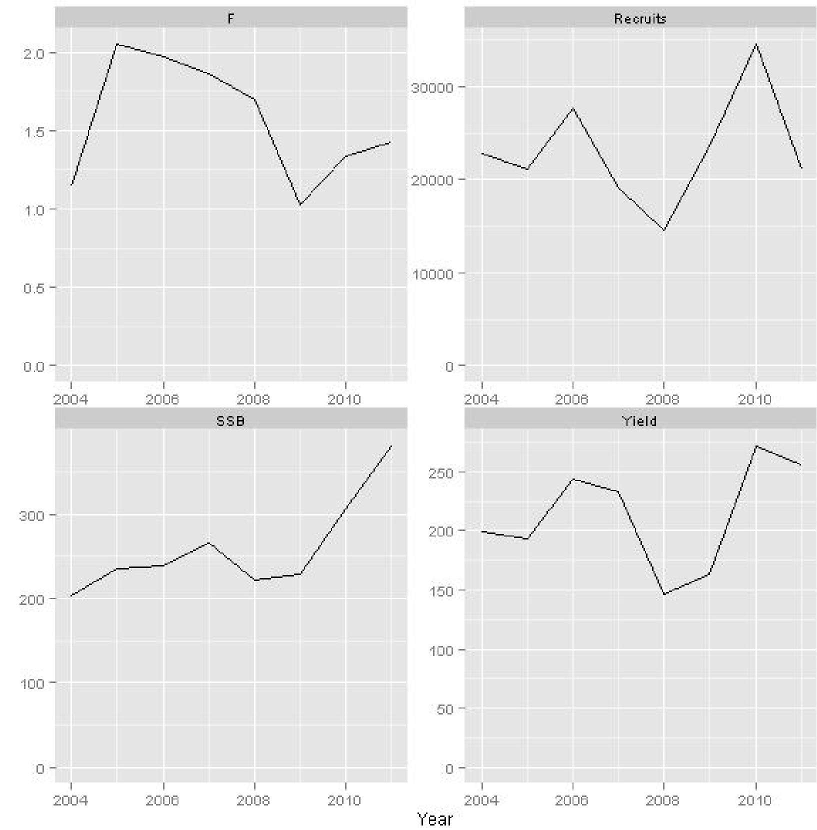


Fig. 6.7.4.1.3.1 XSA results for red mullet in GSA 07.

Residuals from the tuning fleet did not show any clear trend although the residuals were large for the oldest age classes. This possibly means that there an inconsistency between catch and survey information for age 3 and 4. As survey catch very few of the oldest fish, a solution in the future would be to eliminate these from the tuning fleet as they are not sampled consistenyl by the survey.The assessement was run again with tuning data for the ages 0-2 (without age 3 and 4). The XSA results were exactly the same than using the tuning data with ages 0-4, for that reason the tuning fleet was kept with ages 0-4.

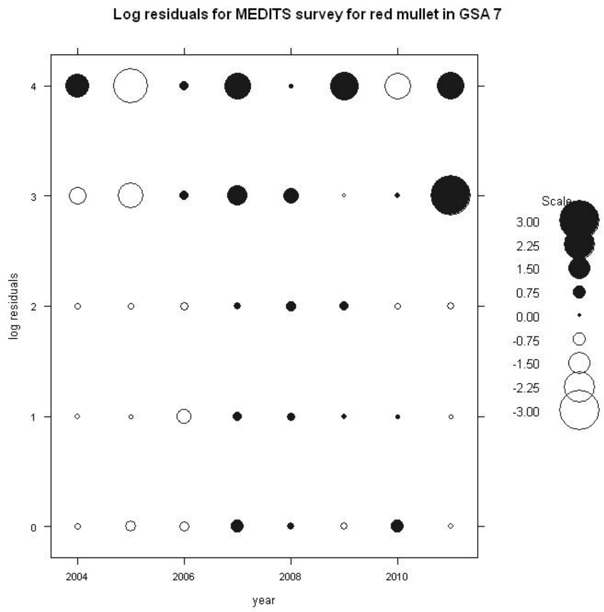


Fig.6.7.4.1.3.2 Log catchability residual plots (XSA) for the MEDITS survey.

Retrospective analysis were also performed. In Figure6.7.4.1.3.3, F and SSB don't show any particularity, but R seems to be overestimated certainly due to the high values of recruitment in 2006 and 2010

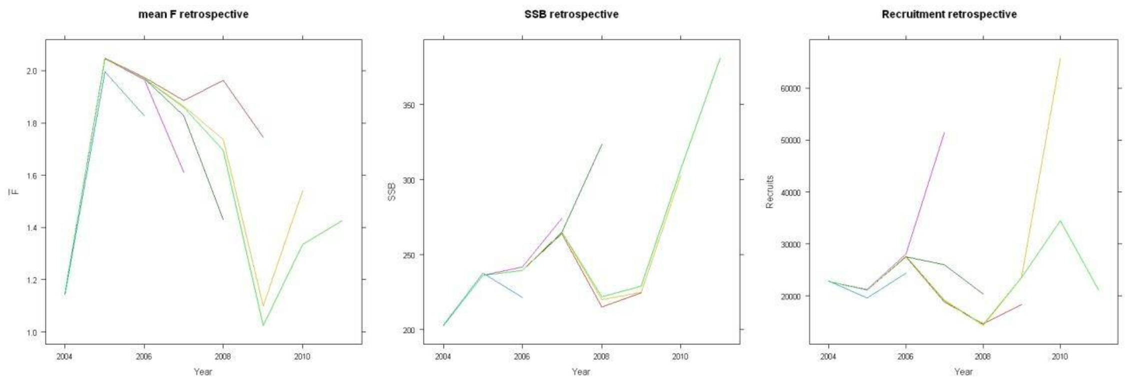


Fig. 6.7.4.1.3.3.Retrospective analysis (mean F, Recruitement, SSB).

6.7.5 *Long term prediction*

6.7.5.1 Justification

Yield per recruit analysis was not performed as the reference point $F_{0.1}$ as a proxy of F_{MSY} was already calculated in 2011.

6.7.5.2 Input parameters

6.7.5.3 Results

6.7.6 *Data quality*

No effort data for the French OTB and OTM was provided for 2009-2011. For Spain, no fishing effort was provided for 2011.

6.7.7 *Scientific advice*

6.7.7.1 Short term considerations

6.7.7.1.1 *State of the spawning stock size*

The highest SSB values were observed in 2010 and 2011. In order to assess whether this increasing trend in SSB is due to the high recruitments in 2009 and 2010, this assement has to be updated on a yearly basis.

6.7.7.1.2 *State of recruitment*

Two peaks of recruitment were observed in 2006 and in 2010, the latter being the highest in the time series.

6.7.7.1.3 *State of exploitation*

EWG 12-10 proposed $F_{0.1} = 0.51$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the Xsa analysis (current F is around 1.26), the stock is considered exploited unsustainably.

6.8 Stock assessment of Black-bellied anglerfish in GSA 07

6.8.1 *Stock identification and biological features*

6.8.1.1 Stock Identification

Black-bellied anglerfish(*Lophius budegassa*) in the Gulf of Lions (GSA07) is a shared stock exploited by both Spanish and French trawlers fleets.

6.8.1.2 Growth

In the absence of stock specific parameters, the growth parameters used for the assessment of *Lophius budegassa* in the GSA 07 are from GSA 06.

The parameters used during the EWG 12-10 were:

L_{inf}	103
K	0.15
t_0	-0.05
a	0.0244
b	2.8457

6.8.1.3 Maturity

In the absence of stock specific parameters, maturity ogive was taken from GSA 06, (DCF 2003-2007).

Period	Age	0	1	2	3	4	5	6	7+
1998-2010	Prop. Matures	0.09	0.14	0.21	0.30	0.41	0.54	0.66	0,91

6.8.2 *Fisheries*

6.8.2.1 General description of fisheries

In this area, *Lophius budegassa* is exploited by French and Spanish trawlers. Around 127 boats are involved in this fishery and, according to official statistics, total annual landings for the period 2005-2011 have oscillated around an average value of 252 tons (324 tons in 2011). The French trawlers fleet is the largest (77% of the boats) and makes most of the catches (87%). The length in the french trawler catches ranges between 18 and 80 cm total length (TL), with an average size of 32 cm TL. The Spanish trawlers is smaller (23% of the boats and 13% of the catch), the length in the catch is in the range 14-77 cm TL, with an average size of 30 cm TL. The trawlers fishery exploits a highly diversified species assemblage: Hake (*Merluccius merluccius*), Striped mullet (*Mullus surmuletus*), Red mullet (*Mullus barbatus*), Black-bellied angler (*Lophius budegassa*), European conger (*Conger conger*), Poor-cod (*Trisopterus minutus capelanus*), Fourspotted megrim (*Lepidorhombus boscii*), Soles (*Solea* spp.), horned octopus (*Eledone cirrhosa*), squids (*Illex coindetii*), Gilthead seabream (*Sparus aurata*), European seabass (*Dicentrarchus labrax*), Seabreams

(*Pagellus* spp.), Blue whiting (*Micromesistius poutassou*) and Tub gurnard (*Chelidonichtys lucerna*).

6.8.2.2 Management regulations applicable in 2010 and 2011

French Trawlers :

- Fishing license: full compliance
- Engine power limited to 316 KW or 500 CV: partial compliance
- Cod-end mesh size (bottom trawl: square 40 mm; pelagic trawl: diamond 20 mm): partial compliance
- Fishing forbidden within 3 miles (France): partial compliance
- Time at sea: full compliance

Spanish trawlers :

- Fishing license: full compliance
- Engine power limited to 316 KW or 500 CV: nocompliance
- Mesh size in the codend (40 mm diamond): full compliance
- Fishing forbidden <50 m depth: full compliance
- Time at sea: full compliance

6.8.2.2.1 *Landings*

Table6.8.2.2.1.1Annual landings (t) by gear (DCF data).

COUNTRY	2005	2006	2007	2008	2009	2010	2011
French trawlers	130	226	159	133	323	467	324
Spanish trawlers	39	40	33	49	32	30	31

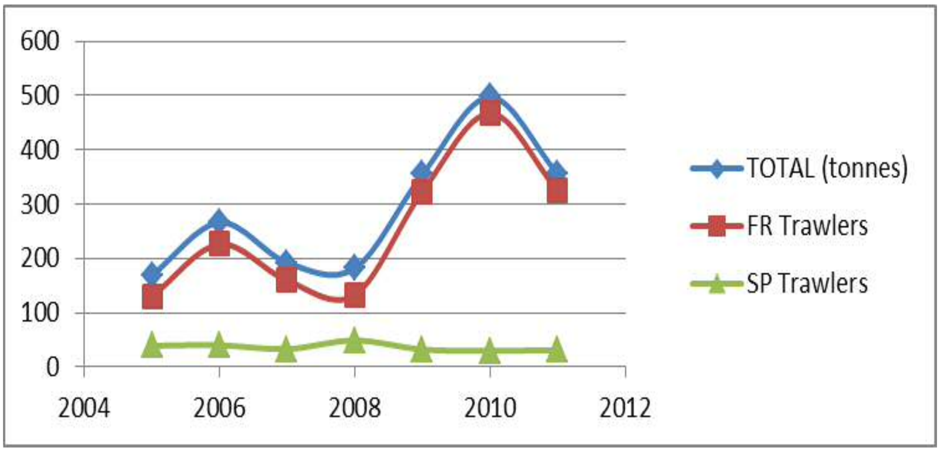


Fig. 6.8.2.2.1.1Total annual landings (t) and landings by country, by year (DCF data).

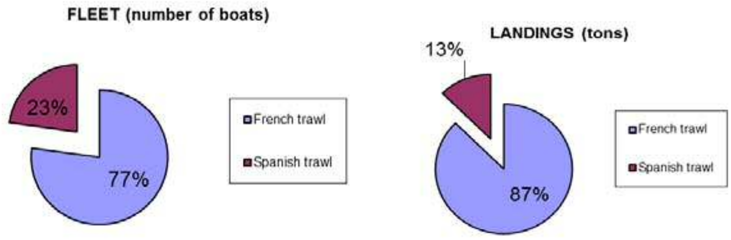


Fig. 6.8.2.2.1.2 Percentage of fleet (as number of boats) and landings (as tons) by country.

6.8.2.2.2 *Discards*

Discards were not included in the catches, since they were not available in the data call. These data will be checked for the update of this assessed stock.

6.8.2.3 Fishing effort

For France, data on fishing effort was provided on a yearly basis for OTB and OTM, over the period 2003-2008. No data was provided for 2009-2011.

For Spain, fishing effort was provided for OTB and LLS over 2002-2010 while no data was provided in 2011.

Table 6.8.2.3.1 Fishing effort (kW*days) by gear for France, 2003-2008.

	2003	2004	2005	2006	2007	2008
OTB	12970505	8450443	5870844	6219184	5938674	5277458
OTM	3766550	1330992	1864890	2193060	1144433	931468

Table 6.8.2.3.2 Fishing effort (kW*days) by gear for Spain, 2002-2010.

	2002	2003	2004	2005	2006	2007	2008	2009	2010
OTB	1493537	1355499	1243124	1223685	1379150	1535408	1601404	1598654	1382555

6.8.3 *Assessments of historic stock parameters*

6.8.3.1 Method: LCA

6.8.3.1.1 *Justification*

Length cohort analysis (LCA) analysis was performed using VIT program (Lleonart and Salat, 1992) for the years 2009, 2010 and 2011 to provide an overview of the current state of exploitation for Black-bellied anglerfish in GSA 07. This method was used as the results from a preliminary XSA run were not considered to be reliable. Eight age classes were considered, the last one being a plus group.

6.8.3.1.2 *Input parameters*

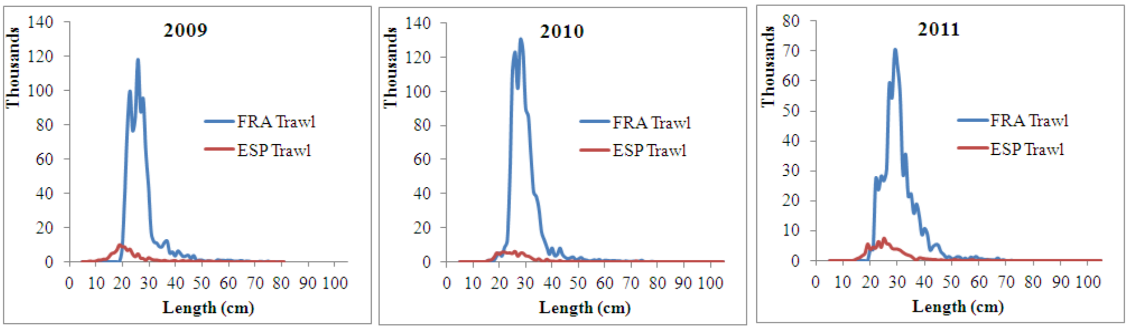


Fig. 6.8.3.1.2.1 Catch in numbers per length for French and Spanish trawlers by year.

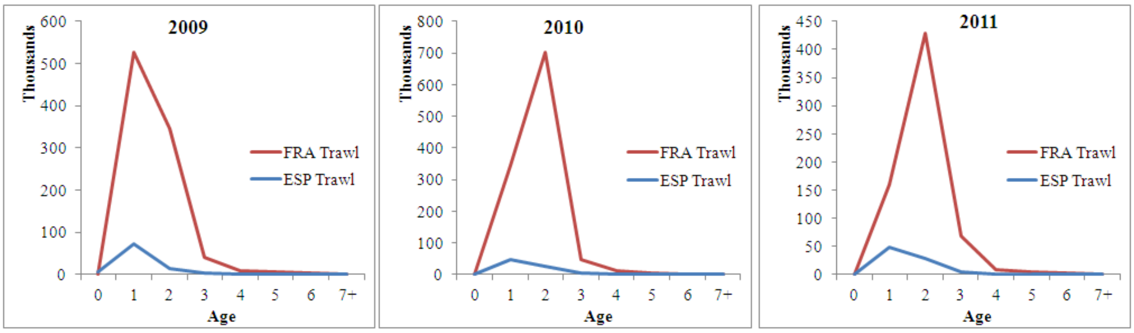


Fig. 6.8.3.1.2.2 Catch in numbers atage for total catches.

The parameters used are described in the tables below.

Natural mortality obtained using PROBIOM (Abella et al., 1997).

0	1	2	3	4	5	6	7+
0.960	0.477	0.375	0.293	0.260	0.241	0.230	0.222

Maturity ogive (from the Spanish Data Collection Program, GSA 06 Northern Spain, 2003-2007).

0	1	2	3	4	5	6	7
0.087	0.136	0.206	0.300	0.413	0.537	0.656	0.759

6.8.3.1.3 *Results*

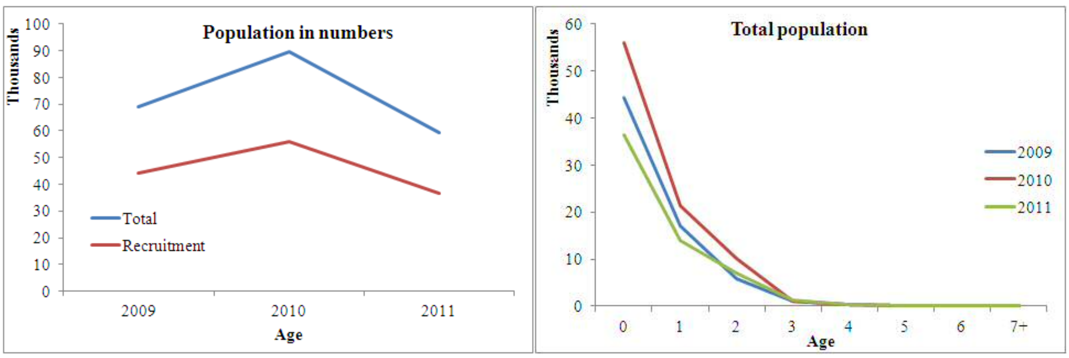


Fig 6.8.3.1.3.1 LCA results for anglerfish for the three years analysed.

The general results of LCA show similar values for the three years analysed, both for the population and for the F values.

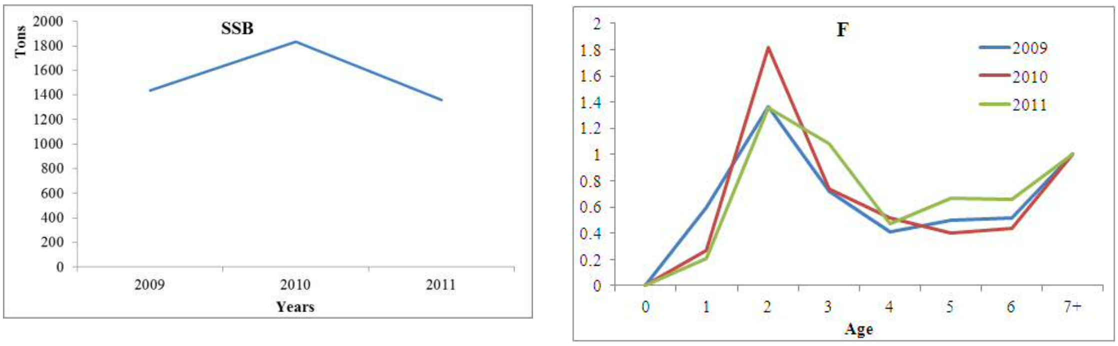


Fig 6.8.3.1.3.2 VIT results for anglerfish for the three years analysed.

6.8.3.2 Method 2: XSA

6.8.3.2.1 *Justification*

As a first attempt to assess this stock, an XSA was used for comparative purposes with the VIT runs.

6.8.3.2.2 *Input parameters*

Besides the catch at age matrix (Table 6.8.3.2.2.1), input the data used were the same as those used in the VIT analysis

Table 6.8.3.2.2.1 Catch at age matrix for *Lophius budegassa* in GSA 07.

Age	2005	2006	2007	2008	2009	2010	2011
0	0	0	0	1,8	0,8	0	0
1	20,8	7,6	2,7	163,9	119,8	37,6	35,5
2	215,2	128,4	65,6	108,7	787,5	931,5	507
3	96	169,5	71,9	80,2	80	184,6	172
4	12,6	52,5	52,5	34,3	26,3	28,5	29,1
5	4,3	14,4	20,2	5,5	5,3	8,7	6,9
6	1,1	1	9,9	5,6	6,1	4,7	5,9
7+	2,4	1,3	6,8	3,7	4,8	5,4	3,5

6.8.3.2.3 *Results including sensitivity analysis*

XSA were run using ages 0 to 7 with age 7 set as a plus group. Since no tuning data was available for this species in GSA 07, a dummy tuning file was constructed setting the index value at one for each year and age. The tuning options were then adjusted to not account for it. F_{bar} was calculated set as the average fishing mortality estimated over the ages 2 to 4.

F terminal

Terminal F was set using VIT results.

Table 6.8.3.2.3.1 Vector of terminal F values used for *Lophius Budegassa* in GSA7.

Age	0	1	2	3	4	5	6	7
F	0.015	0.247	1.336	0.828	0.479	0.698	1.005	0.5

F of the oldest age class

Terminal F was set at 1.005 for the period 2005-2011

Set of options to run XSA using FLR

Option	fse	rage	qage	shk.n	shk.f	shk.yrs	shk.ages
Value	3	-1	6	FALSE	FALSE	0	0

Diagnostics from FLR

FLR XSA Diagnostics 2012-07-20 11:53:29

CPUE data from indices

Catch data for 7 years 2005 to 2011. Ages 0 to 7.

fleet first age last age first year last year alpha

1 MEDITS-SURVEY (pas milliers) 0 6 2005 2011 <NA> beta 1 <NA>

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of size for all ages

Catchability independent of age for ages > 6

Terminal population estimation:

Final estimates not shrunk towards mean F

Minimum standard error for population

estimates derived from each fleet = 0.3

prior weighting not applied

Sensitivity analysis

A sensitivity analysis was performed to assess the effect of varying the values for the qage parameters. XSA was run with options set to the default values and qage set to values ranging from 0 to 7. F_{bar}(1-6) and SSB were computed for each run and summarized in Figure6.8.3.2.3.1.

The results displayed very high values for SSB and low values of F_{bar} when qage ranged from 0 to 5 (Figure 6.8.3.2.3.2). For both parameter values 6 and 7 similar results were obtained and reached realistic levels. On the basis of this test the parameter qage was kept at 6.

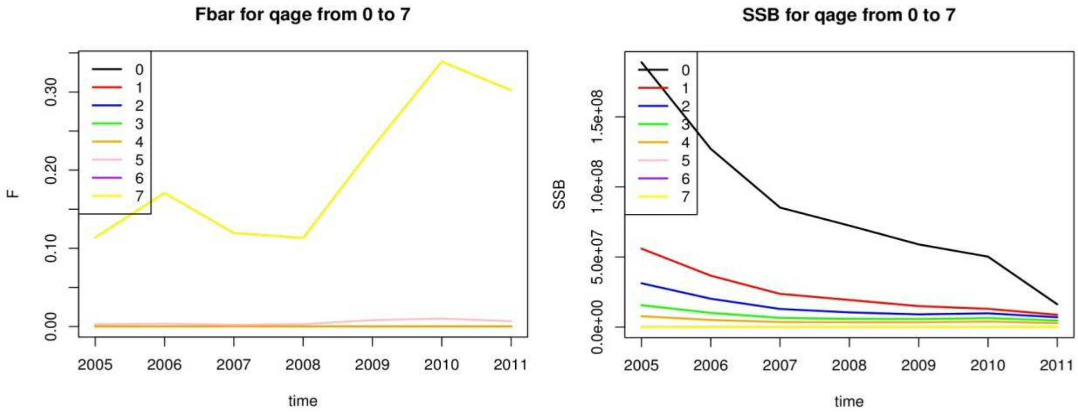


Fig. 6.8.3.2.3.1 Sensitivity analysis of the estimates of F_{bar} and SSB to the parameter qage. The parameter was set to values ranging from 0 to 7.

XSA final run

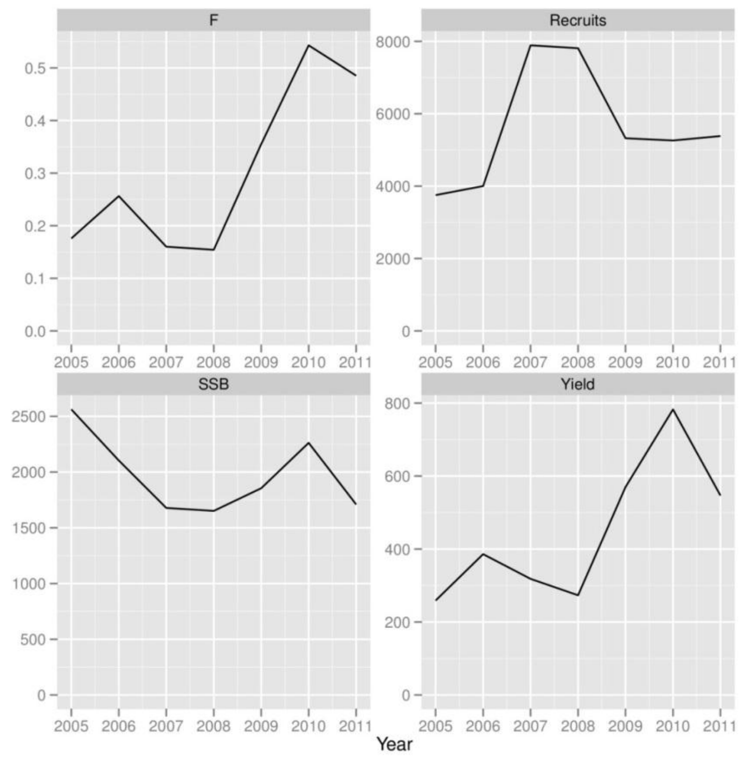


Fig.6.8.3.2.3.2 Black-bellied anglerfish in GSA 07. F, Recruits, SSB and Yield as estimated by the XSA run.

Run diagnosis

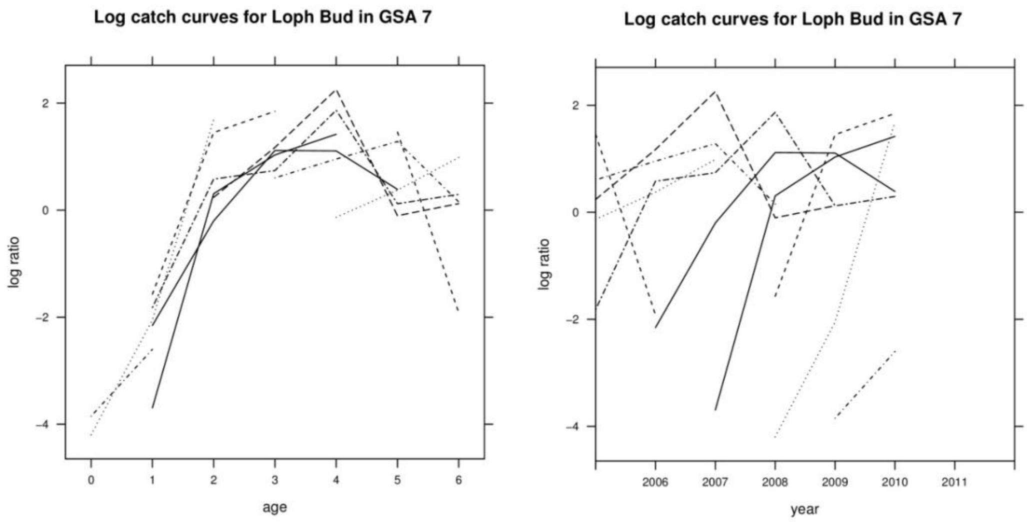


Fig.6.8.3.2.3.3Black-bellied anglerfish in GSA 07. Log catch curves per age and per year.

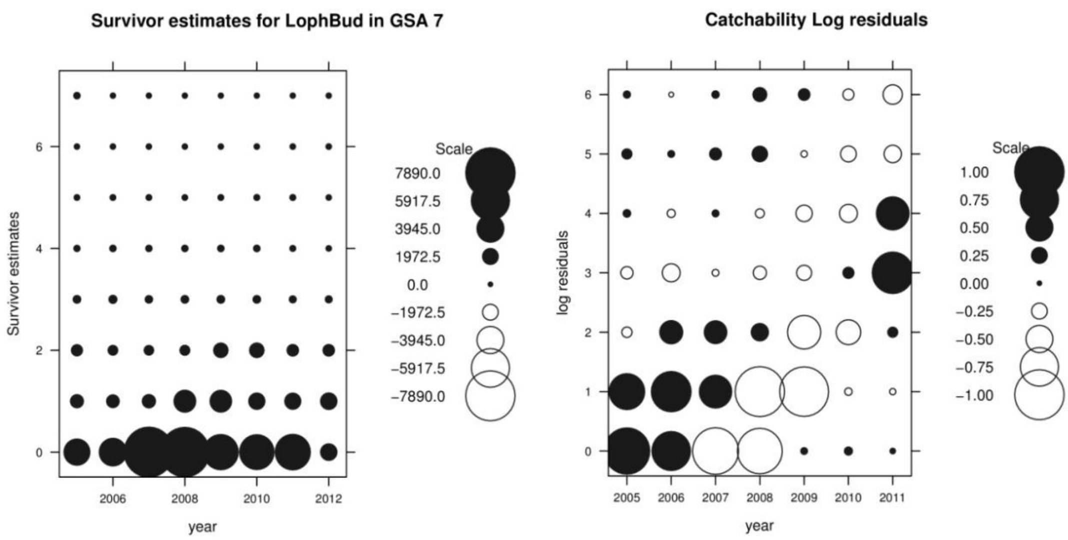


Fig. 6.8.3.2.3.4Black-bellied anglerfish in GSA 07. Survivor estimates and catchability log-residuals.

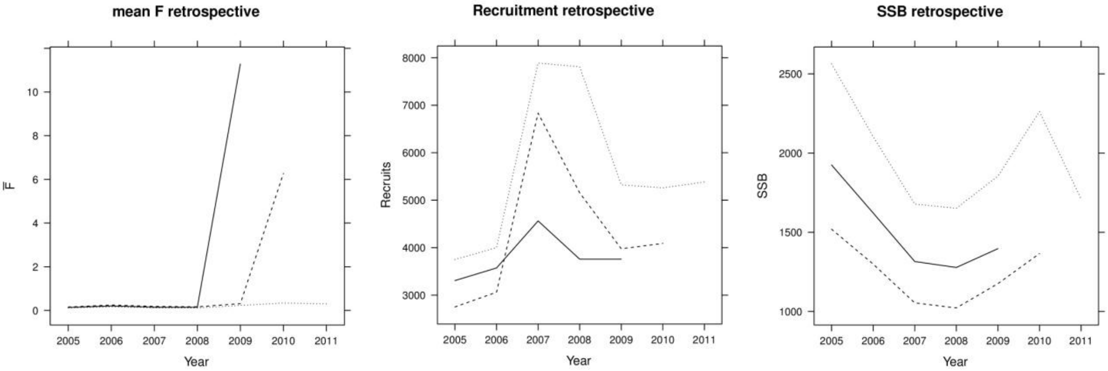


Fig. 6.8.3.2.3.4Black-bellied anglerfish in GSA 07. Retrospective analysis.

Reference points

$F_{current}$=0.461

$F_{0.1}$=0.30

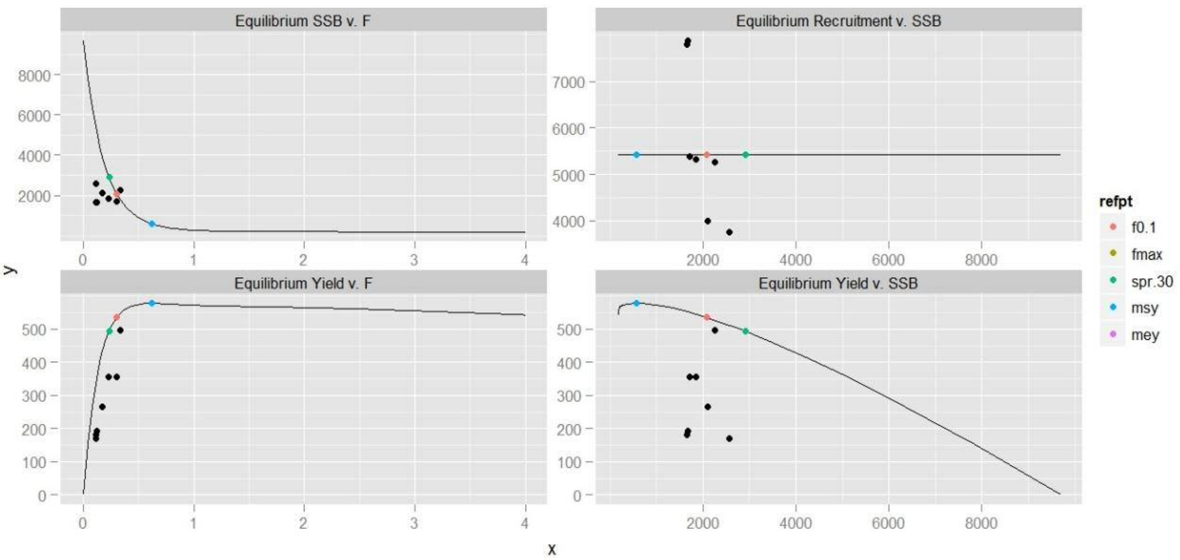


Fig. 6.8.3.2.3.5 Yield per recruitment analysis

Table 6.8.3.2.3.2 Values of Fishing mortality at age as estimated by the XSA, spawning-stock biomass, total biomass and abundance.

Age	2005	2006	2007	2008	2009	2010	2011
0	0.0000	0.0000	0.0000	0.0004	0.0002	0.0000	0.0000
1	0.0178	0.0067	0.0022	0.0715	0.0523	0.0237	0.0227
2	0.2537	0.1869	0.0941	0.1496	0.7923	1.0264	0.6890
3	0.2240	0.3826	0.1754	0.1848	0.1816	0.5042	0.6204
4	0.0500	0.1994	0.2108	0.1283	0.0917	0.0980	0.1463
5	0.0239	0.0782	0.1154	0.0321	0.0275	0.0416	0.0325
6	0.0081	0.0071	0.0733	0.0439	0.0468	0.0318	0.0372
7	0.0081	0.0071	0.0733	0.0439	0.0468	0.0318	0.0372

Spawning-stock biomass

Age	2005	2006	2007	2008	2009	2010	2011
0	14.18	15.13	29.82	29.52	20.12	19.88	20.35
1	49.72	54.1	56.2	68.51	102.95	68.46	70.5
2	129.04	109.22	103.27	95.35	166.28	194.27	136.52
3	161.25	193.97	164.94	176.73	167.44	149.05	125.94
4	202.51	226.59	214.62	216.57	235.31	237.86	166.55

5	284.83	288.43	281.81	264.9	295.65	319.96	330.4
6	361.14	347.11	350.89	328.96	334.26	376.9	406.08
7	1359.43	869.18	476.66	470.97	532.9	895.62	453.25

Total biomass

Age	2005	2006	2007	2008	2009	2010	2011
0	157.57	168.07	331.35	328	223.56	220.94	226.08
1	355.15	386.42	401.44	489.36	735.32	489.03	503.56
2	614.45	520.12	491.78	454.07	791.82	925.09	650.11
3	537.51	646.57	549.81	589.1	558.14	496.84	419.8
4	493.93	552.67	523.47	528.22	573.92	580.15	406.21
5	527.47	534.13	521.87	490.56	547.51	592.51	611.86
6	547.17	525.92	531.65	498.43	506.46	571.06	615.27
7	1493.88	955.15	523.81	517.55	585.61	984.19	498.08

Abundance

Age	2005	2006	2007	2008	2009	2010	2011
0	3751.69	4001.65	7889.29	7809.59	5322.93	5260.57	5382.78
1	1498.5	1436.5	1532.2	3020.75	2989.12	2037.62	2014.24
2	1161.54	910.89	882.9	945.98	1740.26	1755.38	1231.27
3	552.99	616.37	516.74	549.53	557.03	538.87	430.13
4	294.35	330.74	314.58	324.46	341.82	347.6	243.53
5	205.32	215.9	208.92	196.46	220.06	240.47	242.99
6	153.57	157.7	157.06	146.42	149.66	168.4	181.44
7	334.28	204.53	107.49	96.45	117.4	192.94	107.32

6.8.4 *Long term prediction*

6.8.4.1 Justification

Yield per recruit analysis was performed for 2009, 2010 and 2011 separately.

6.8.4.2 Input parameters

Input data were the same as for these used in the VIT analysis.

6.8.4.3 Results

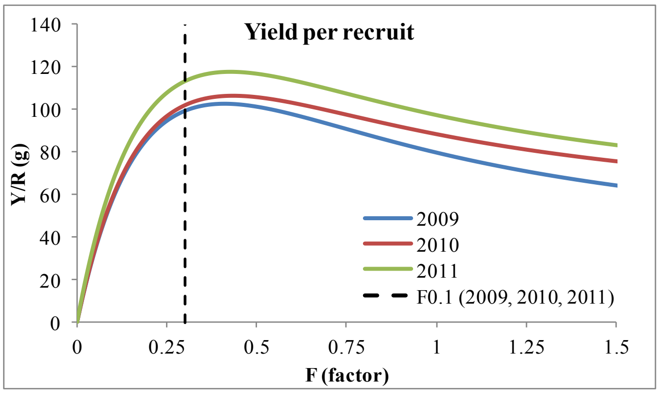


Fig. 6.8.4.3.1 Yield per recruitment analysis for the different runs by year

Table 6.8.4.3.1 Results for the yield per recruitment analysis for the different runs by year

Y/R	2009	2010	2011
F0.1 (absolute)	0.250	0.306	0.292
F2-4	0.832	1.021	0.972

6.8.5 *Scientific advice*

6.8.5.1 Short term considerations

6.8.5.1.1 *State of the spawning stock size*

Results obtained did not show a particular trend in stock size. However, in the absence of proposed biomass management reference points, EWG 12-10 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

6.8.5.1.2 *State of recruitment*

Results showed little variation of the estimates of recruitment for the three years analysed. However, in the absence of proposed management reference points, EWG 12-10 is unable to fully evaluate the status of the recruitment in relation to these.

6.8.5.1.3 *State of exploitation*

EWG 12-10 proposed F0.1 = 0.29 as proxy of FMSY and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 0.97), the stock is considered exploited unsustainably.

6.8.6 *Comments on the assessment*

The angler fish stock has been assessed for the first time duringthe EWG 12-10. The XSA runs yielded F estimates that were lower than for the VIT run, whereas the SSB estimates were higher than for the VIT runs. The results of the XSA were furthermore found quite unstable due to the lack of tuning data to calibrate XSA. It was generally found that this preliminary run was not robust enough to be reliable and trusted and therefore VIT results were considered for defining the status of the stock. However, the estimation of a tuning survey index and the addition of few years, could lead to the use of XSA for the assessment of this stock in the future.

From the results of the yearly pseudocohortanalysis performed for the period 2009-2011 (VIT) and the YPRanalyses, this stock appears to be in an overexploitation status (F_{curr}=0.972 and F_{msy}=0.292).

6.9 Stock assessment of the blue whiting in GSA 09

6.9.1 *Stock identification and biological features*

6.9.1.1 Stock Identification

Due to insufficient information about the stock structure of blue whiting in the western Mediterranean Sea, this stock was assumed to be confined within the boundaries of the GSA 09.

Blue whiting is widely distributed throughout the Mediterranean and thus in all the Italian seas. In the GSA 09, the highest biomasses are found on ephibathyal fishing grounds (200-500m depth) and, generally, it is fished together with Norway lobster.

The maximum size of the species as observed in the length frequency distributions collected during MEDITS trawl surveys was 41 cm of total length (TL). Trawl fishery mostly lands specimens ranging from 10 cm to 30 cm. In some areas larger specimens are caught using fixed gear, such as bottom long-lines and nets.

The range of length distributions obtained from trawl catches depends on depth; generally young specimens (9-10 cm TL) are almost exclusively found between 100 m and 200 m. Larger specimens (two or more years old TL>23cm) are instead caught at depths below 200 m (Orsi Relini and Peirano, 1983,1985).

Blue whiting is a carnivorous species, prey mostly upon pelagic crustaceans (Brian, 1931), but juveniles of pelagic fish species can also be part of its food spectrum (Bini, 1970).

6.9.1.2 Growth

The growth of blue whiting was analysed by means of different methods (otolith readings; Orsi Relini and Peirano, 1983 and 1985; modal progression analysis (MPA); GSA09 GRUND National Trawl Survey Report). The parameters of the Von Bertalanffy growth curve estimated with different methods are listed in table 1.1.1.2.1.

References	Method	Sex	L_∞	k	t_0
Orsi Relini and Peirano (1985)	Otoliths	M	40.48	0.231	-1.27
Orsi Relini and Peirano (1985)	Otoliths	F	48.37	0.189	-1.23
GSA09 (2003)	MPA	M+F	45.25	0.350	0.00

Length-weight relationship parameters are listed in the table 1.1.1.2.2.

References	Sex	a	b
Orsi Relini and Peirano (1985)	M	0.009	2.880
Orsi Relini and Peirano (1985)	F	0.006	3.012
Orsi Relini and Peirano (1985)	I	0.009	2.912
GSA09 (2003)	M+F	0.004	3.154

6.9.1.3 Maturity

The spawning season of blue whiting is restricted to the winter months (January to April). In the Ligurian Sea, the age of first maturity is two years (around 22 cm) (Orsi Relini and Peirano, 1983 and 1985) In the Northern Tyrrhenian Sea, the maximum value of the gonodosomatic index (G.S.I; gonad weight*100/gutted weight) calculated for spawning female was 6.06 (± 3.59) (Chiericoni *et al.*, 1996).

6.9.2 *Fisheries*

6.9.2.1 General description of fisheries

In GSA09, the blue whiting is one of the most important target species of the fishery carried out on the muddy bottoms of the upper slope and it is typically caught together with Norway lobster. The species is exploited mainly with otter bottom trawling (OTB).

The age structure of the landings, according to the EU Data Collection Framework (DCF) data, is shown in Figure 6.9.2.1.1.

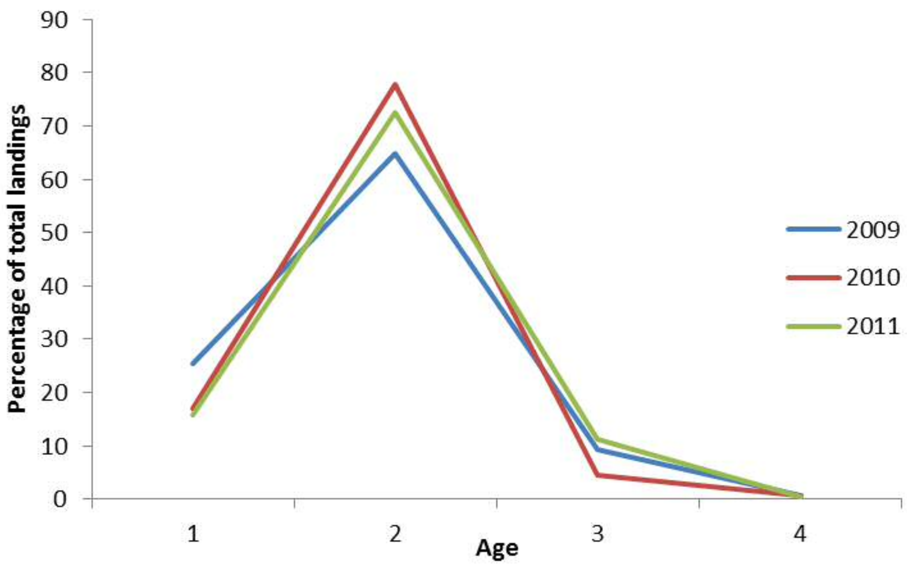


Fig. 6.9.2.1.1.Age frequency distribution (in percentage) of *M. poutassou* landed in the GSA 09 from 2009 to 2011.

6.9.2.2 Management regulations applicable in 2009-2011

EC regulation 1967/2006 does not provide for a minimum landing size for this species.

6.9.2.3 Catches

6.9.2.3.1 *Landings*

The landings are entirely taken by the OTB fleet. Total landings of blue whiting based on DCF remainedrather stable in the last three years with a mean value of about 116 t (Figure1.1.2.3.1.1; Table1.1.2.3.1.1) despite this, seasonal fluctuations are a proper characteristic of the landings of this species, as shown by the landings per unit of effort (LPUE: in kg/boat/day) estimated for the fleet of Santa Margherita Ligure in the period 1987-1996 and in more recently years (2009-2010 and 2011-2012) (Figure1.1.2.3.2 and Figure1.1.2.3.3) (Mannini 2010, and pers.comm.).

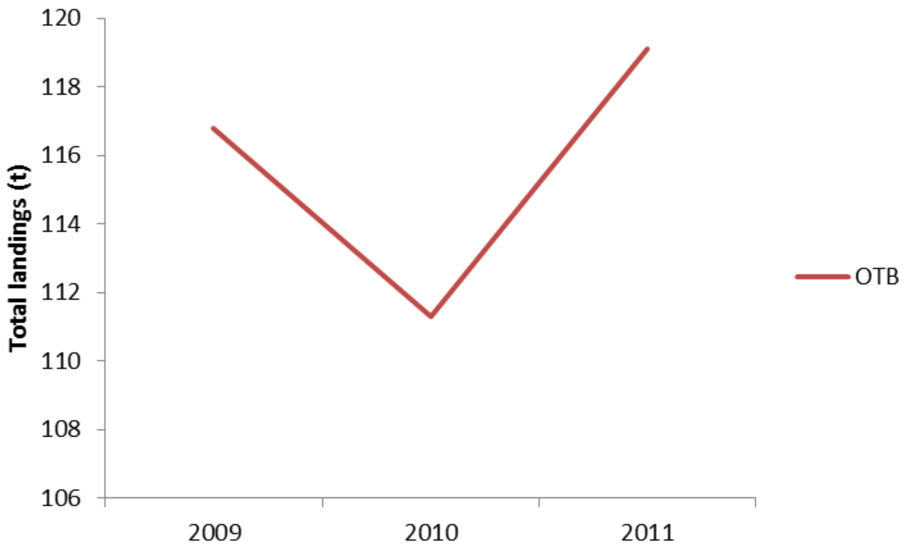


Fig. 6.9.2.3.1.1. Total landings by OTB in GSA 09.

Table6.9.2.3.1.1. Annual landings (t) by fishing technique in GSA 09 as provided through the official DCF data call in 2012.

Country	Area	Year	Gear	Species	Landings (t)
ITA	SA9	2009	OTB	WHB	116.8
ITA	SA9	2010	OTB	WHB	111.3
ITA	SA9	2011	OTB	WHB	119.1

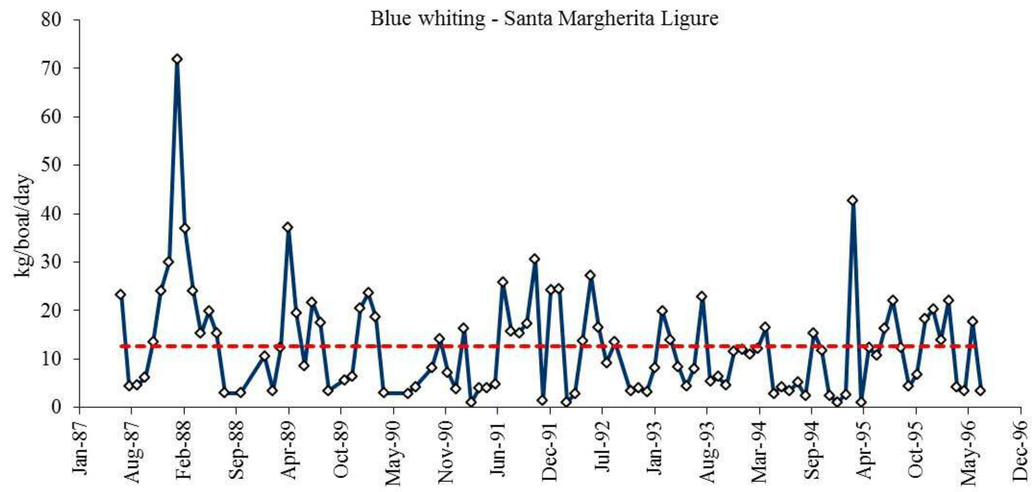
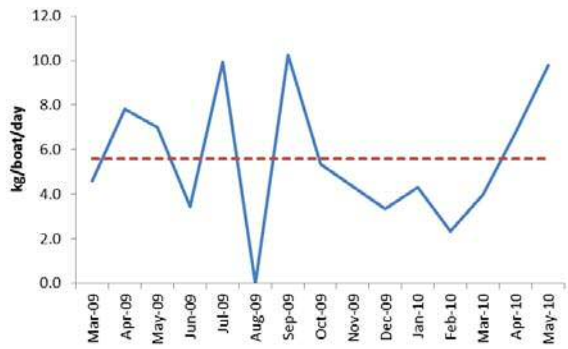


Fig. 6.9.2.3.1.2. Time series of blue whiting LPUE (kg/boat/day) from Santa Margherita Ligure from July 1987 to October 1996 (red dashed line is the mean of the period).



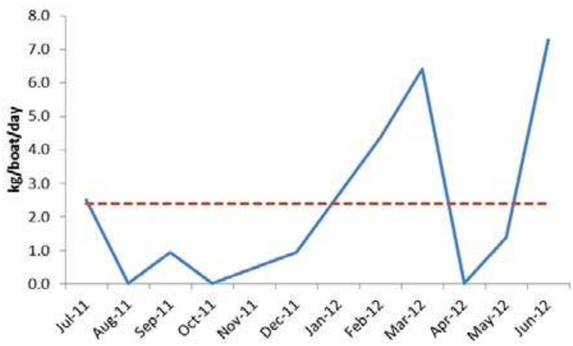


Fig. 6.9.2.3.1.3. Time series of blue whiting LPUE (kg/boat/day) from Santa Margherita Ligure from March 2009 to May 2010and from July 2011 and June 2012 (red dashed line is the mean of the period).

6.9.2.3.2 *Discards*

Discardsis mainly represented by young specimens but, depending on the market request, in some cases also bigger ones are discarded. In the following table are reported discards values and percentage respect to the total catches.

Country	Area	Year	Gear	Species	Landings (t)	Discards (t)	% Discards on total catches
ITA	SA9	2009	OTB	WHB	116.8	10.4	8.2
ITA	SA9	2010	OTB	WHB	111.3	5.8	5.0
ITA	SA9	2011	OTB	WHB	119.1	26.3	18.1

6.9.2.4 Fishing effort

The fishing effort by fishing technique is listed in Table 6.9.2.4.1. A decreasing trend is recognizable from 2004 until now (Figure 6.9.2.4.1).

Table 6.9.2.4.1 Trends in annual fishing effort expressed as nominal effort (kW·days) and GT·days at sea deployed in GSA 09 from 2004 to 2010.

Country	Area	Year	Gear	Nominal effort	GT days at sea
ITA	SA9	2004	OTB	15625026	2560791
ITA	SA9	2005	OTB	14609930	2411430
ITA	SA9	2006	OTB	12288869	2213795
ITA	SA9	2007	OTB	12891442	2178393
ITA	SA9	2008	OTB	10567382	1849826
ITA	SA9	2009	OTB	11668537	1939715
ITA	SA9	2010	OTB	10515499	1788242
ITA	SA9	2011	OTB	10069537	1734356

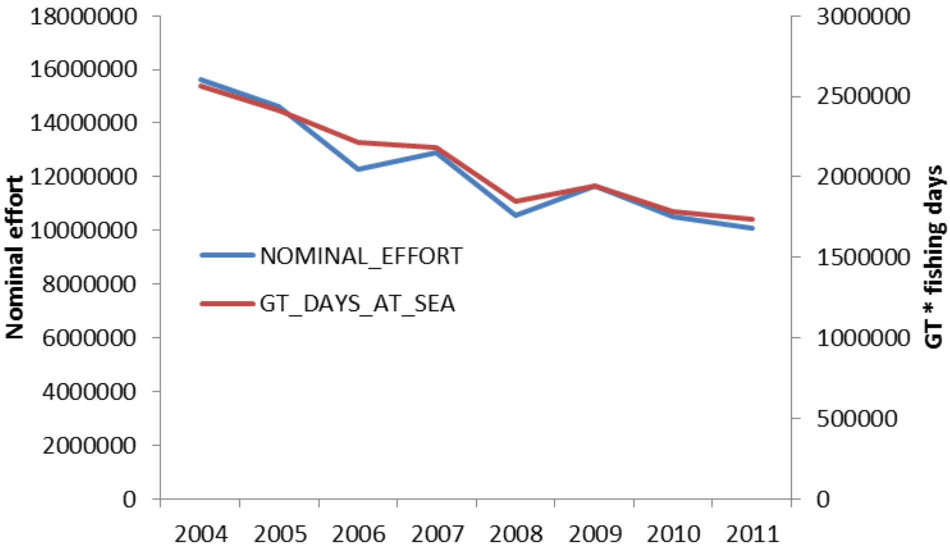


Fig. 6.9.2.4.1 Trends in annual fishing effort expressed as nominal effort (kw·days) and GT·days at seadeployed in GSA 09 from 2004 to 2011.

6.9.3 *Scientific surveys*

6.9.3.1 MEDITS

6.9.3.1.1 *Methods*

Since 1994 MEDITS trawl surveys has been regularly carried out each year during the spring season. Blue whiting density and biomass indexes showed large fluctuations, and peaks were detected in 1999,2003 and 2005 (Fig. 6.9.3.1.1.1).

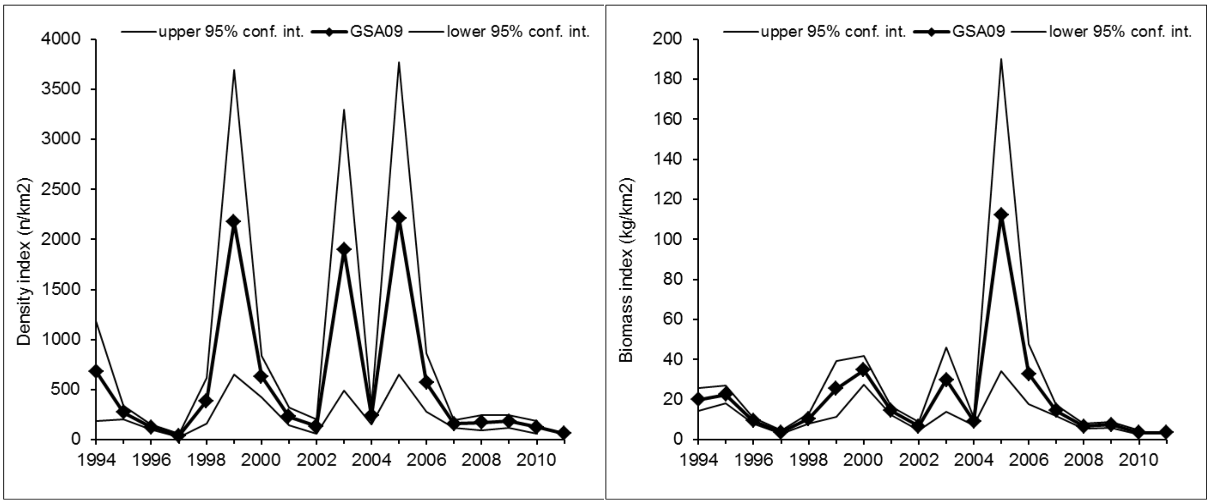


Fig. 6.9.3.1.1.1*M. poutassou*: MEDITS trends in density and biomass indexes from 1994 to 2011 in GSA 09.

Based on the DCF data, abundance and biomass indices were recalculated. In GSA09 the following number of hauls was reported per depth stratum (Table 6.9.3.1.1.1).

Table 6.9.3.1.1.1. Number of hauls per year and depth stratum in GSA09, 1994-2011.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GSA09_010-050	*21*	*20*	*20*	*20*	*21*	*20*	*20*	*19*	*15*	*14*	*15*	*16*	*15*	*15*	*16*	*16*	*15*	*15*
GSA09_050-100	*21*	*21*	*20*	*20*	*20*	*21*	*22*	*23*	*17*	*18*	*17*	*16*	*18*	*18*	*16*	*16*	*19*	*19*
GSA09_100-200	*38*	*40*	*40*	*40*	*39*	*39*	*38*	*38*	*30*	*30*	*30*	*31*	*29*	*30*	*31*	*31*	*29*	*29*
GSA09_200-500	*40*	*40*	*42*	*42*	*41*	*41*	*42*	*41*	*32*	*33*	*36*	*35*	*36*	*37*	*34*	*34*	*35*	*35*
GSA09_500-800	*33*	*32*	*31*	*31*	*32*	*32*	*31*	*32*	*26*	*25*	*22*	*22*	*22*	*20*	*23*	*23*	*22*	*22*
Total	153	153	153	153	153	153	153	153	120	120	120	120	120	120	120	120	120	120

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean
The variation of the stratified mean is then expressed as the 95 % confidence interval:
Confidence interval = Yst ± t(student distribution) * V(Yst) / n

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations in each stratum. Aggregated length frequencies were then raised to stratum abundance · 100 (because of the low numbers in most strata) and finally aggregated (sum) over the strata of the entire GSA.

6.9.3.1.2 *Geographical distribution patterns*

The stock is present in the whole area but is more abundant in the northern part of the GSA 09 (Ligurian Sea) as showed in Figures6.9.3.1.2.1-4 (from Ardizzone *et al*., Eds. CD-ROM Version).

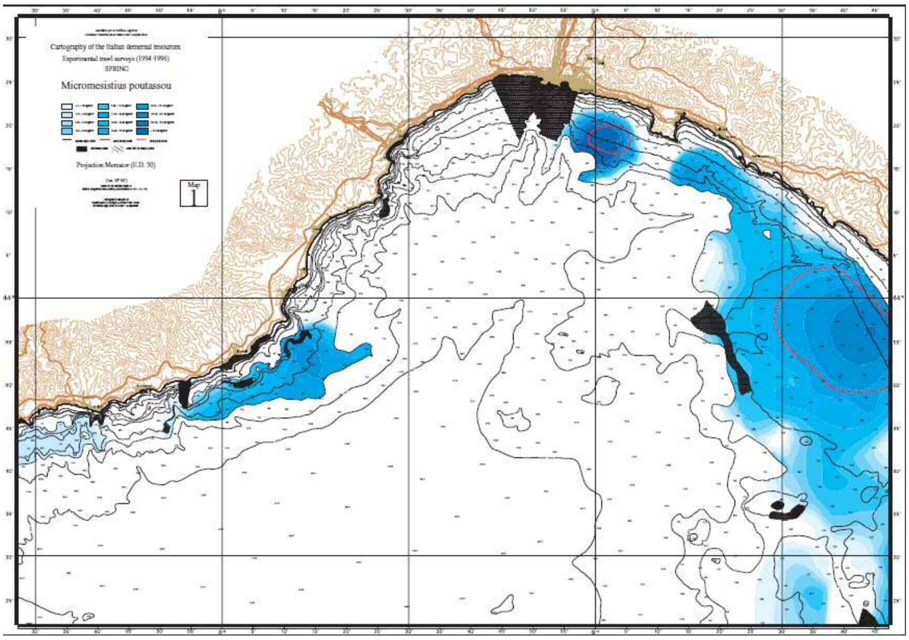


Fig. 6.9.3.1.2.1 Spring biomass index of *M. poutassou*from 1994-1996 in GSA09 (Northern Ligurian Sea).

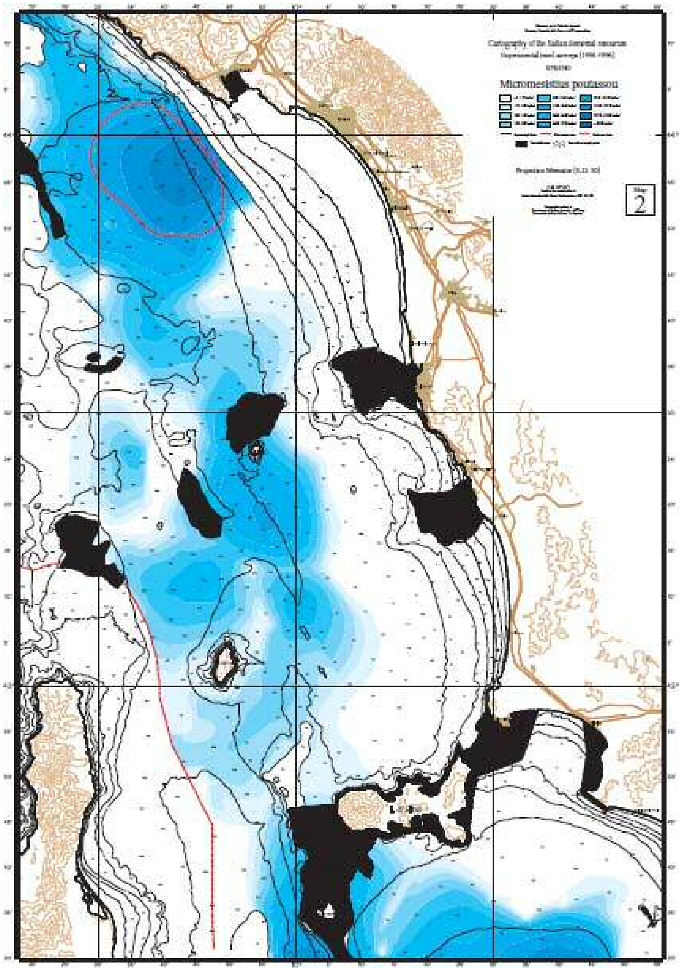


Fig. 6.9.3.1.2.2 Spring biomass index 1994-1996, GSA09 (Southern Ligurian Sea).

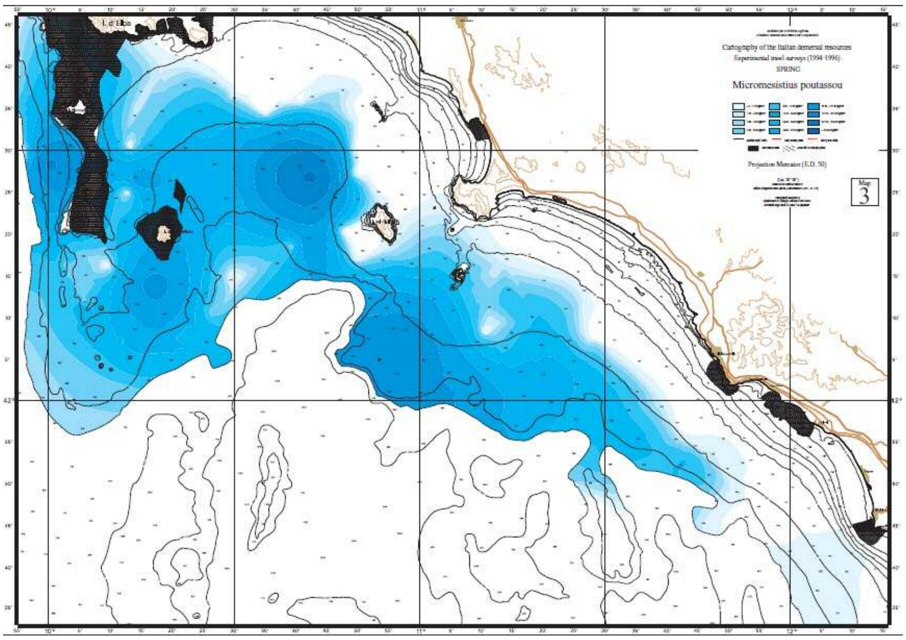


Fig. 6.9.3.1.2.3 Spring biomass index 1994-1996, GSA09 (Northern Tyrrhenian Sea).

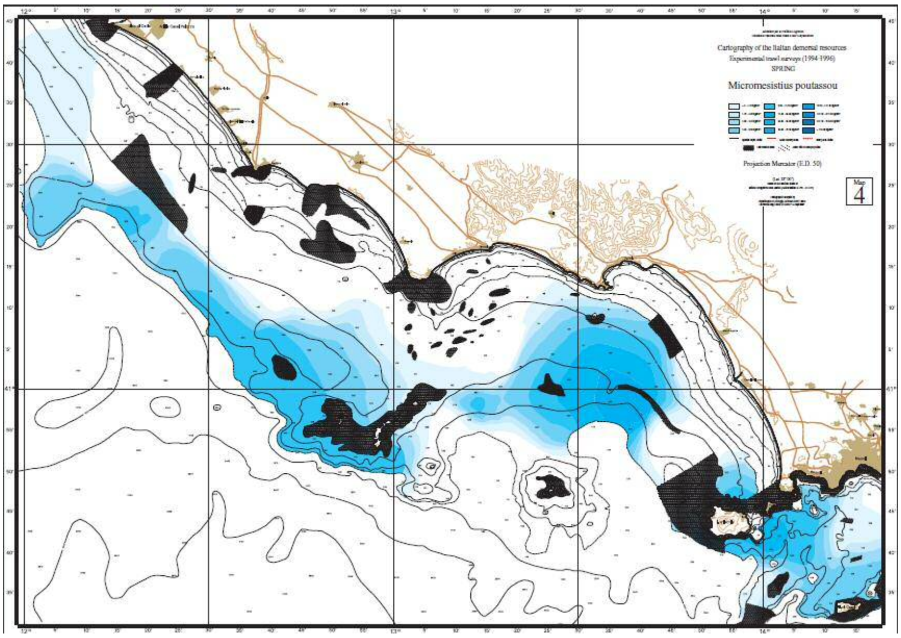


Fig. 6.9.3.1.2.4 *M. poutassou*.Spring biomass index 1994-1996, GSA09 (Central TyrrhenianSea).

6.9.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of blue whiting in GSA09 was derived from the international survey MEDITS. Figure 6.9.3.1.3.1 displays the estimated trend in *M. poutassou* abundance and biomass in GSA 09. The estimated abundance and biomass indices do not reveal a clear trend but a series of peaks followed by quite stable situations.

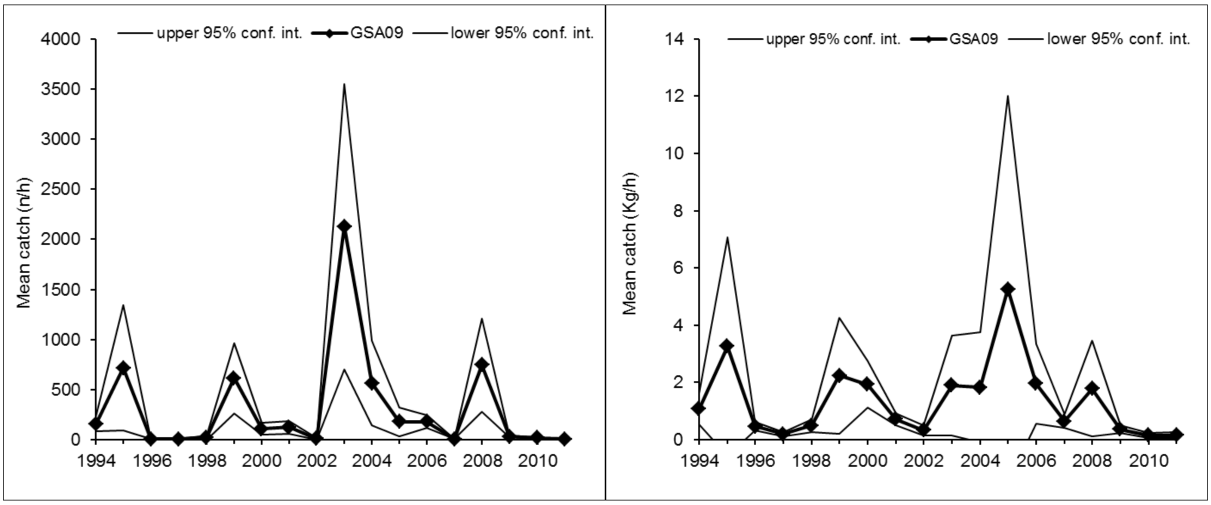


Fig. 6.9.3.1.3.1 Abundance and biomass indices of blue whiting in GSA09.

6.9.3.1.4 *Trends in abundance by length or age*

The following figures 6.9.3.1.4.1-3 display the stratified abundance indices of GSA 09 in 1994-2011.

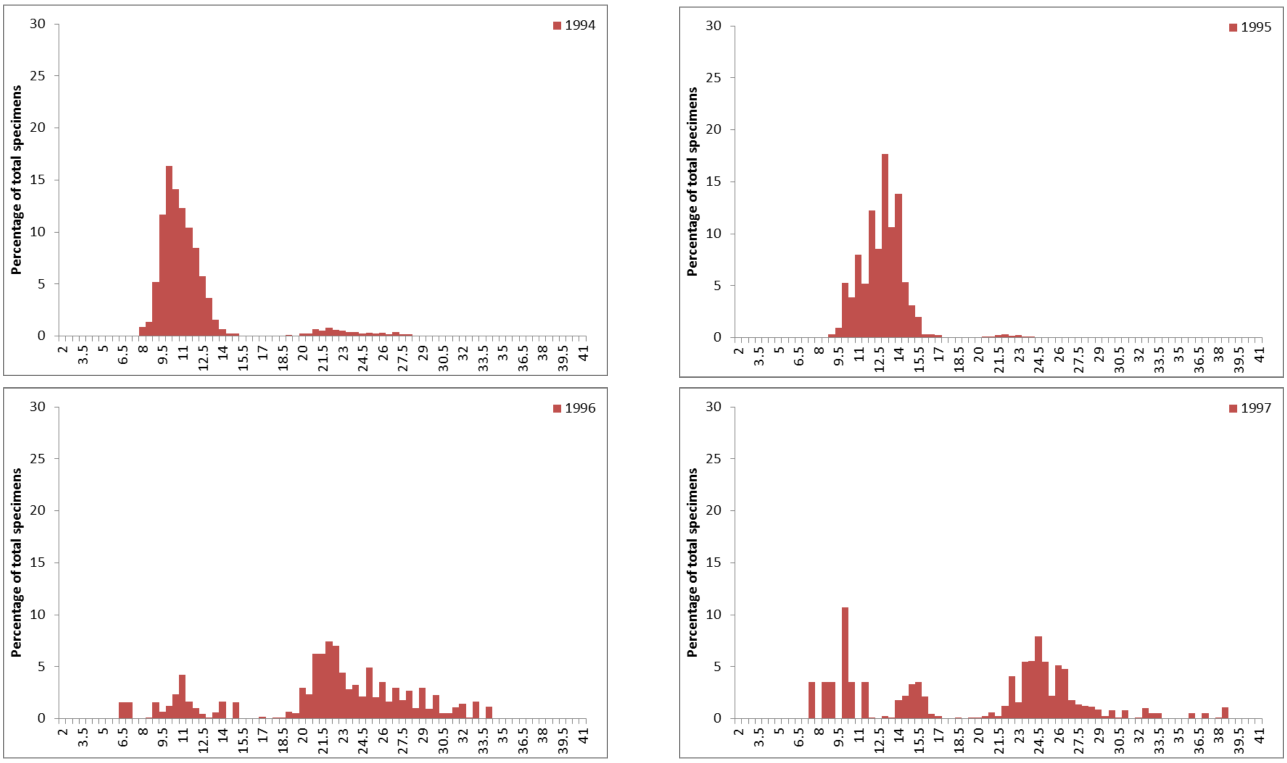
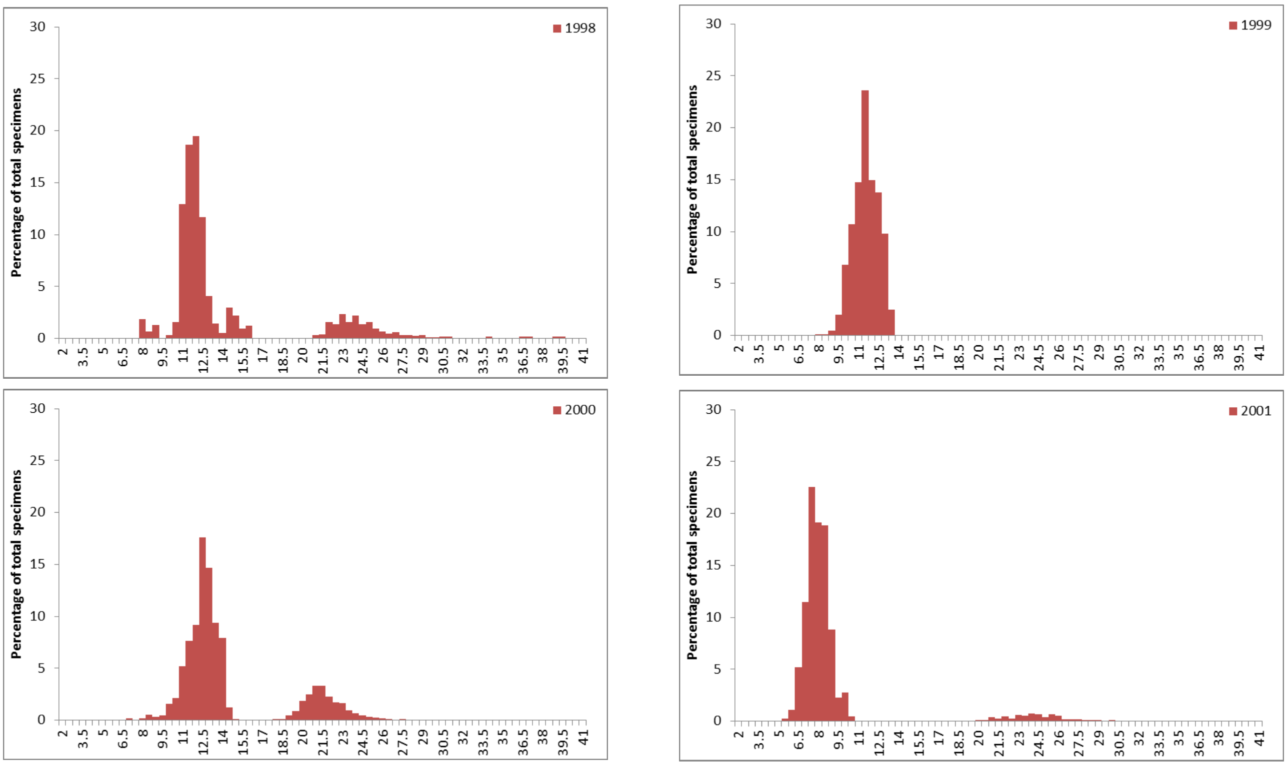


Fig. 6.9.3.1.4.1 Stratified abundance indices blue whiting in GSA09by size in percentage, 1994-1997.



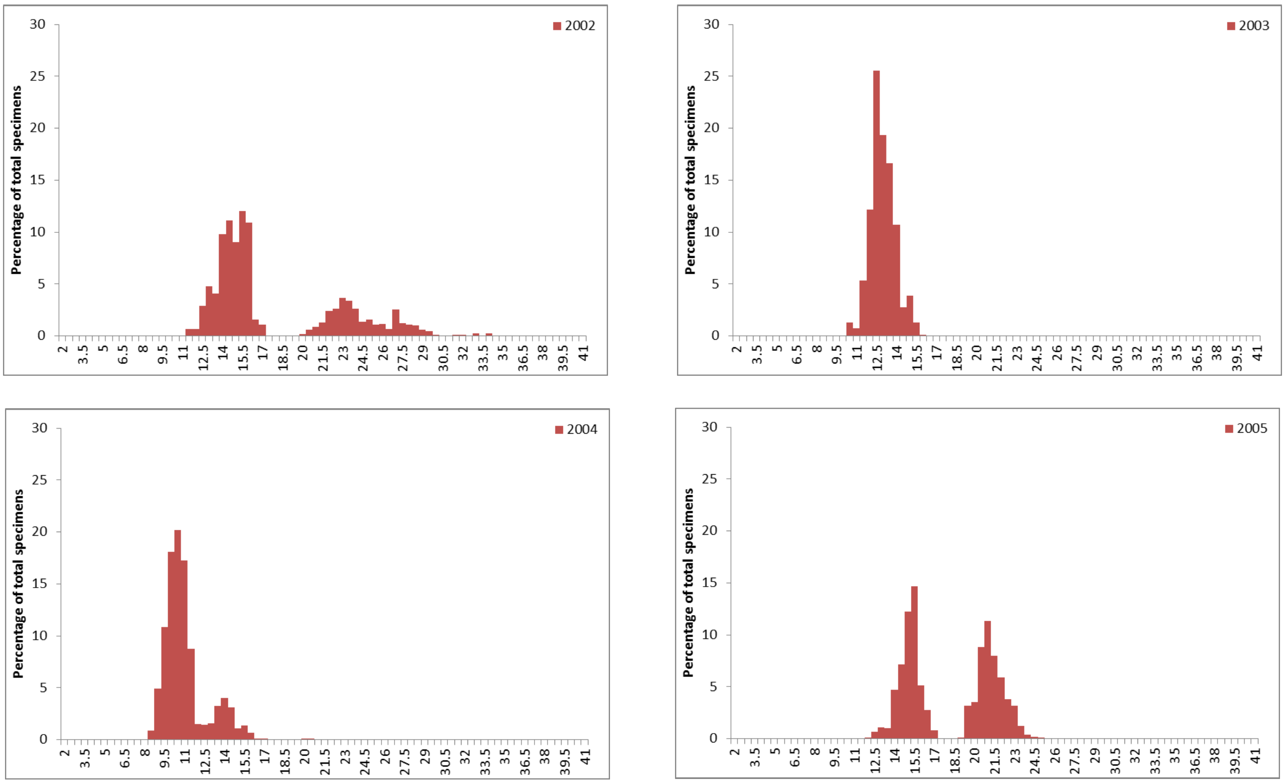
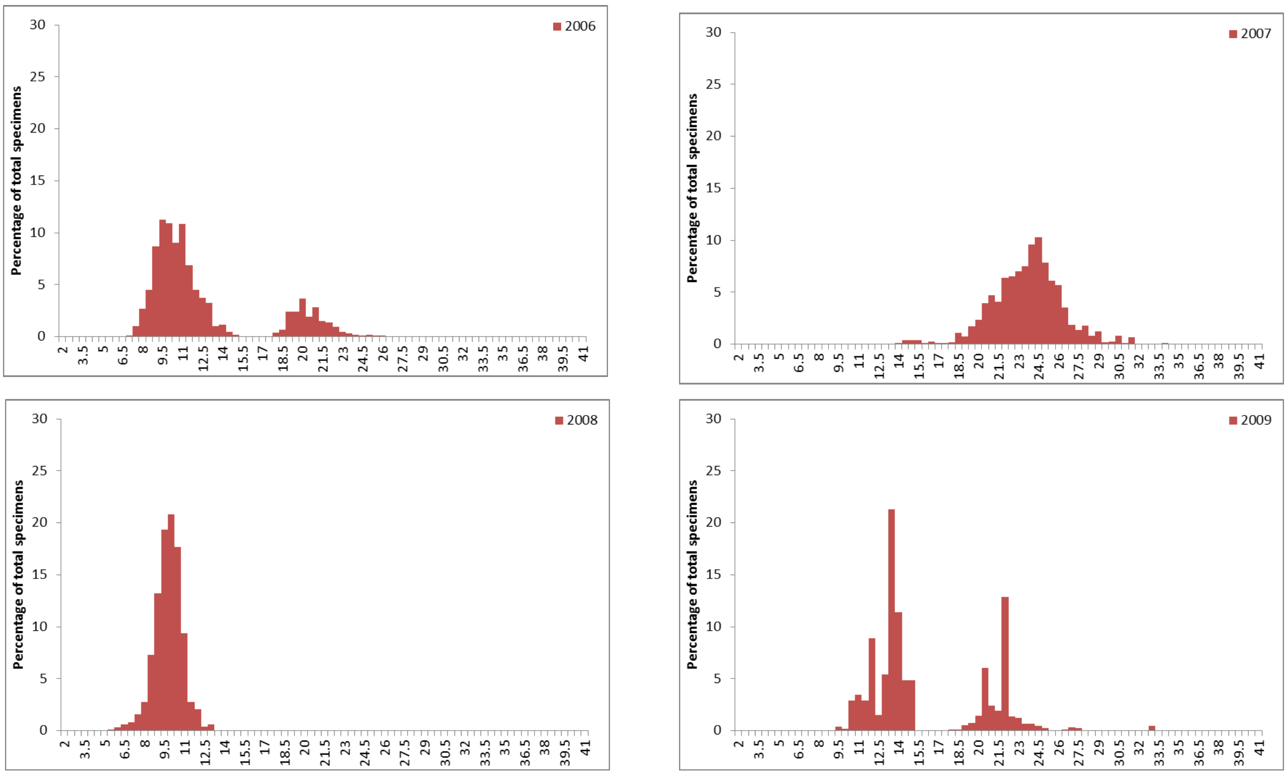


Fig. 6.9.3.1.4.2 Stratified abundance indices blue whiting in GSA09by size, 1998-2005.



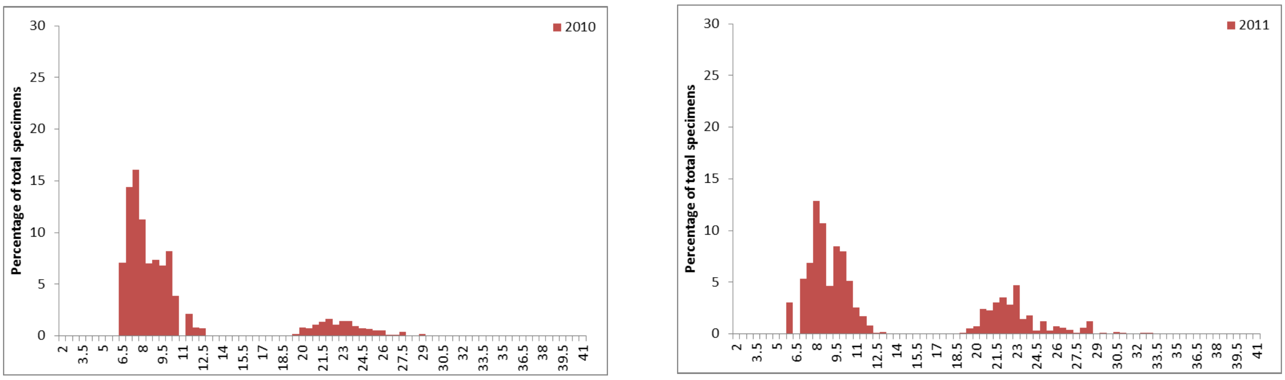


Fig. 6.9.3.1.4.3 Stratified abundance indices blue whiting in GSA09by size, 2006-2011.

The boxplot of the MEDITS length frequencies distributions (LFD)is shown in Figure 6.9.3.1.4.4. It is evident a high variability in the LFD and in some years (e.g. 2010 and 2011) it is also evident the presence of recruits.

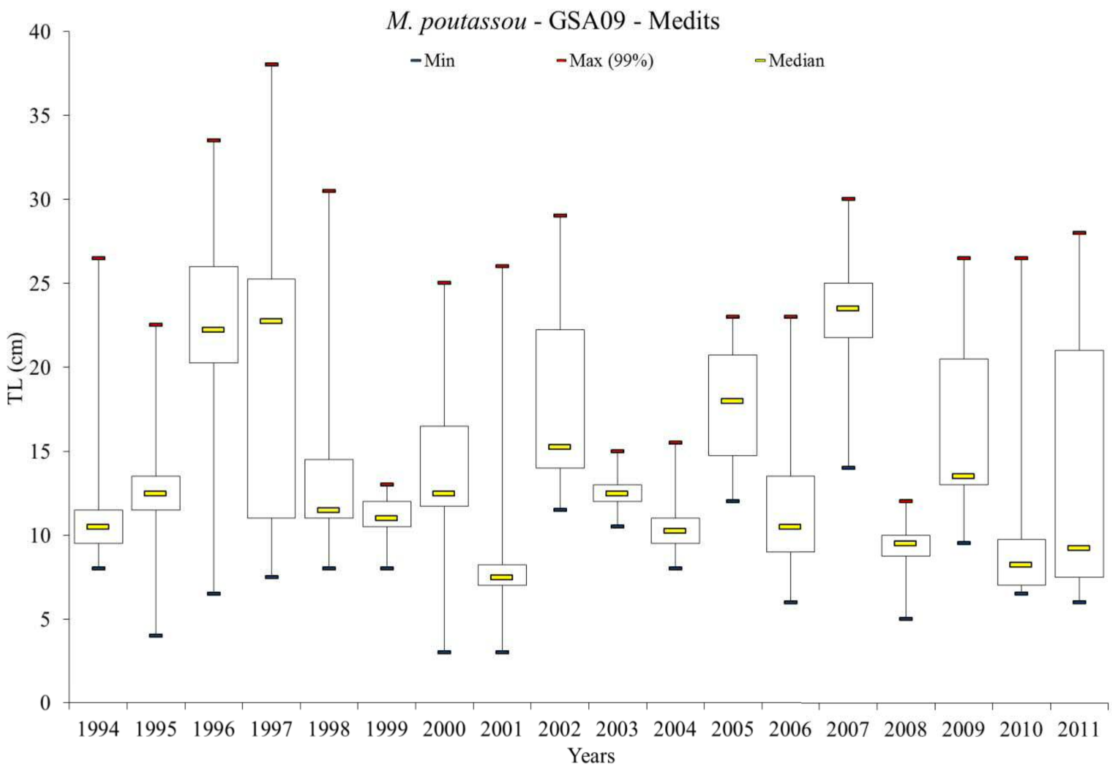


Fig. 6.9.3.1.4.4 Boxplot of the length frequency distributions of blue whiting in GSA09 obtained in the MEDITS surveys.

6.9.3.1.5 *Trends in growth*

No analyses were conducted during EWG12-10 meeting.

6.9.3.1.6 *Trends in maturity*

No analyses were conducted during EWG-12-10.

6.9.4 *Assessment of historic stock parameters*

6.9.4.1 Method 1: LCA

6.9.4.1.1 *Justification*

The pseudo-cohort analysis VIT was applied using data from 2009 to 2011.

6.9.4.1.2 *Input parameters*

DCF data provided at EWG12-10 contained information on blue whiting landings and the respective size structure for 2009-2011. A VPA analysis was performed using a Length Cohort Analysis (LCA) and applying the routine included in the VIT package designed by Lleonart and Salat (1992) for each year separately. Biological parametersare listed in Table6.9.4.1.2.1 and data used are reported in Table 6.9.4.1.2.2. A natural mortality vector computed using ProdBiom (Abella, 1998) was used and a terminal fishing mortality F_{term} = 0.3, corresponding to the mean of natural mortality values of the older age class,was assumed. Length frequency distributions were splitted in age classes by statistical slicing (assuming the normal distribution of the cohorts) developed by Scott et alduring EWG 11-12 (Figure 6.9.4.1.2.1). The 0+ age class was not considered in the analysis and the LFD were splitted up to the age class 4+. Analysis was performed by sex combined.

Table 6.9.4.1.2.1 Input parameters for the LCA of blue whiting in GSA 09.

	Growth (GSA9)	**Length-Weight relationships (GSA9)**	**Natural mortality vector (ProdBiom)**	**Proportion of matures (GSA9)**
Sex combined	$L\infty$ = 45.25 cm TL k = 0.35 t_0 = 0	a = 0.004 b = 3.154	0.61 (age 1) 0.44 (age 2) 0.37 (age 3) 0.34 (age 4+)	age(1) = 0.4 age(2) = 0.8 age(3) = 1.0 age(4+) = 1.0

Table6.9.4.1.2.2 Input data for the LCA of blue whiting in GSA 09 in 2009-2011.

Total length (cm)	2009	2010	2011
10	0.000	0.000	2.338
11	0.000	0.000	0.000
12	0.000	0.000	2.806
13	0.000	0.000	10.288
14	0.000	0.000	26.987
15	0.000	2.616	27.207
16	0.000	9.636	41.903
17	2.554	22.982	25.580
18	0.000	24.418	48.314
19	32.249	40.722	105.021
20	72.600	10.439	90.092
21	85.345	56.347	120.514
22	116.425	85.800	99.597
23	156.896	134.663	71.141
24	70.596	185.184	129.581
25	65.276	112.577	144.859
26	98.473	125.198	139.629
27	85.219	96.966	150.948
28	103.726	52.621	87.978
29	55.952	25.085	49.359
30	31.477	13.075	49.959
31	3.962	7.541	19.570
32	11.490	4.021	8.362
33	6.835	2.772	4.085
34	5.745	0.942	0.000
35	0.000	1.495	0.000
36	0.000	2.824	1.012
37	0.000	0.000	4.144

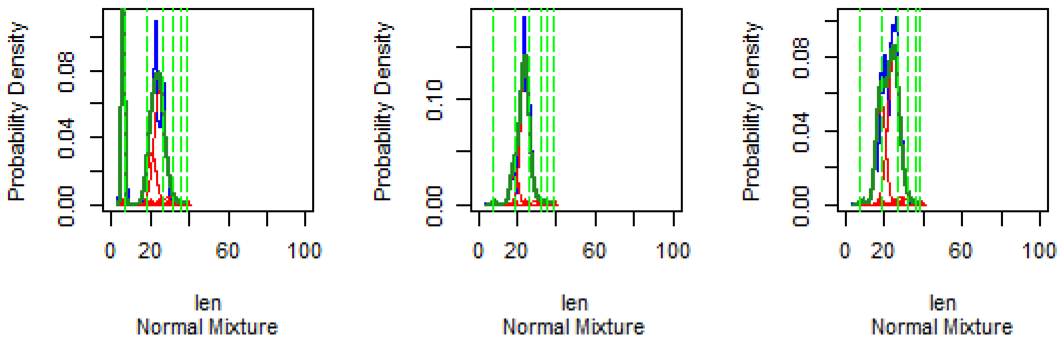


Fig. 6.9.4.1.2.1 Statistical age slicing of the commercial length frequency distribution of *M. poutassou* (2009-2010).

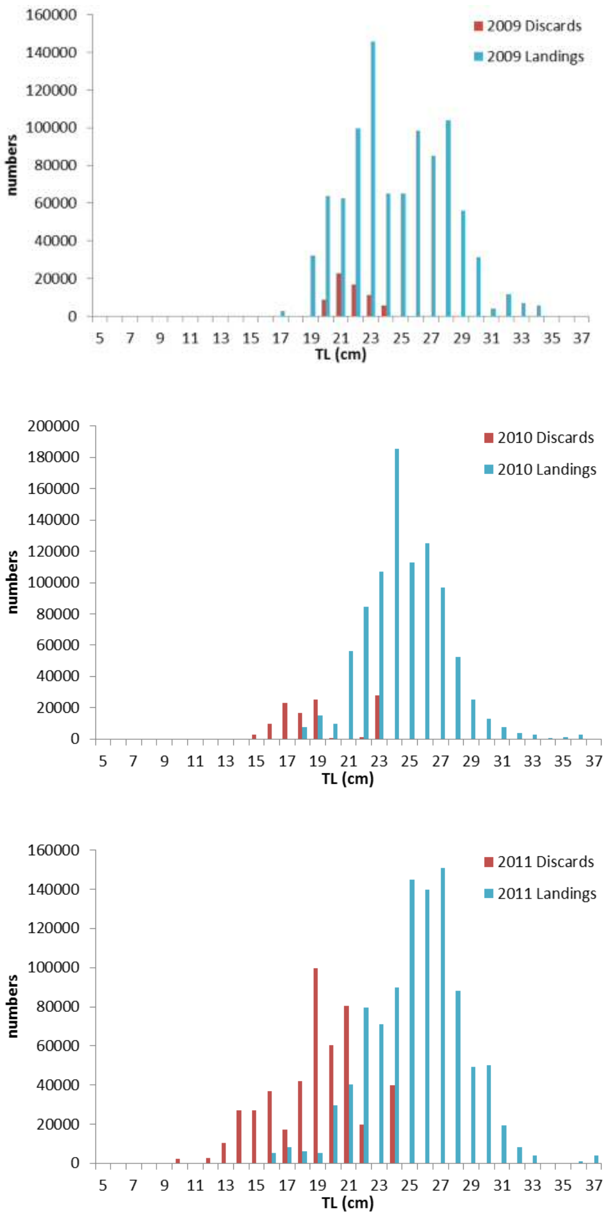
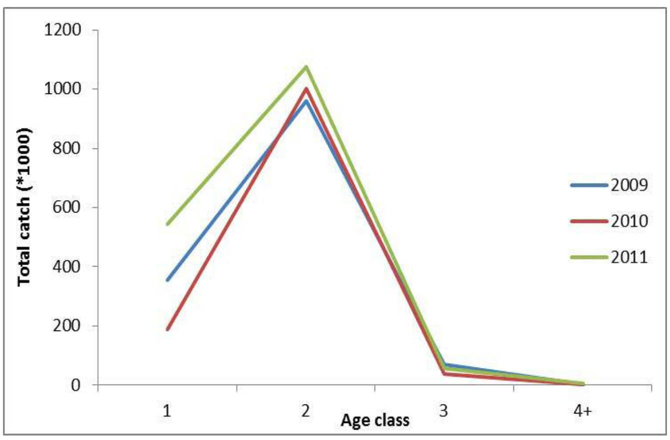
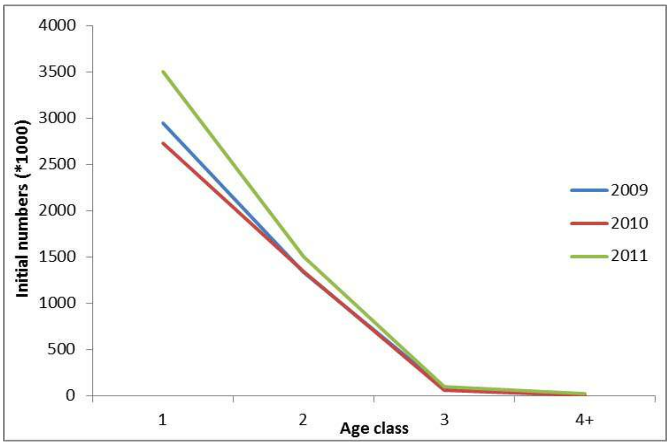


Fig. 6.9.4.1.2.2 Input data for the LCA; landings and discards at length (2009-2011).

6.9.4.1.3 *Results*

Fishing mortality is mainly concentrated on specimens belonging to the age classes 2 and 3 (Fig. 6.9.4.1.3.1).





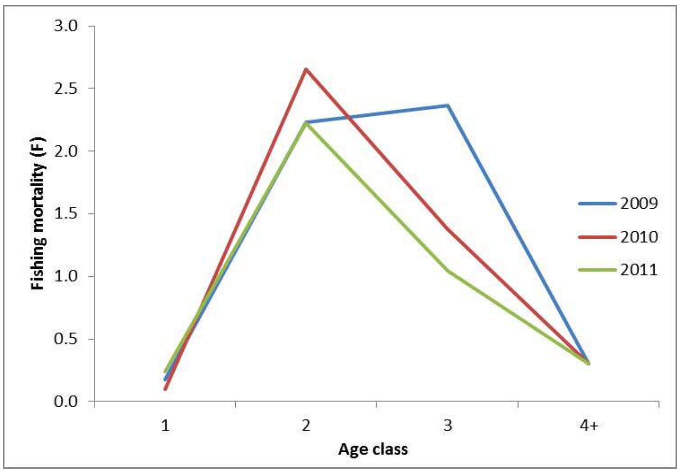


Fig.6.9.4.1.3.1 LCA outputs: catch numbers, numbers-at-age in the stock and fishing mortality at age of *M. poutassou*in the GSA09.

6.9.4.2 Method 2: SURBA

6.9.4.2.1 *Justification*

The MEDITS survey provided the longer standardized time-series data on abundance and population structure of *M. poutassou* in the GSA 09.

6.9.4.2.2 *Input parameters*

The survey-based stock assessment model SURBA (Needle, 2003) was used to reconstruct trend in the population size and fishing mortality. The parameters used are the same as for the LCA (Table 6.9.4.1.2.2) while in the figure 6.9.4.2.2.1 the set of input data are reported. LFD were splitted in age classes by

LFDA package using a knife edge slicing approach. This preliminary attempt to use SURBA was made excluding the 0+ specimens from the dataset due to their high variability in the LFDs.

---Title------------------------------------						---Maturity at age ------			
Micmpou MDTS9411						0.2	0.8	1	1
---Number of ages ---------						0.2	0.8	1	1
4						0.2	0.8	1	1
---Number of years ------						0.2	0.8	1	1
18						0.2	0.8	1	1
---First Age ------						0.2	0.8	1	1
1						0.2	0.8	1	1
---First year ------						0.2	0.8	1	1
1994						0.2	0.8	1	1
---plus group flag 1=plus group ------						0.2	0.8	1	1
1						0.2	0.8	1	1
---Start and end period of survey ------						0.2	0.8	1	1
0.5	0.6					0.2	0.8	1	1
--- Index ------						0.2	0.8	1	1
1031.499	552.788	33.397	8.5			0.2	0.8	1	1
29733.3	643.812	154.72	24.482			0.2	0.8	1	1
283.092	317.418	75.757	8.225			0.2	0.8	1	1
134.586	331.569	30.684	16.2			0.2	0.8	1	1
299.194	301.869	15.491	18.013			---Stock weights at age ------			
3164.234	209.057	20.047	8.871			30.64721	105.8087	187.8534	380.1711
4029.55	590.734	16.321	12.978			16.78053	99.01848	198.2343	286.527
190.848	611.523	39.523	5.206			58.53309	108.7647	195.8464	284.4137
613.503	209.155	10.603	2.261			36.71535	105.8473	207.558	372.1039
86272.14	231.457	15.635	0.919			28.69487	99.44724	183.4287	360.2436
8239.787	140.566	3.856	1.6			13.54848	111.227	187.714	320.3777
16300.38	1213.173	8.406	0.4			29.61781	91.57412	193.0926	342.5125
3855.297	366.776	10.589	5			62.36136	102.3572	192.8074	319.8156
239.266	529.091	17.671	0.872			25.27683	105.5349	189.0885	310.9306
129.722	219.603	25.382	0.4			15.37337	92.56643	191.3956	366.571
2302.006	152.494	14.552	0.4			18.73629	95.34243	184.5441	367.5125
116.054	133.087	6.059	0.4			39.62609	83.07119	182.8559	372.7548
122.978	127.716	5.4	0.4			44.09839	94.53711	187.2333	337.4825
---Default age weights ------						59.67922	101.4143	185.1186	343.5707
1	1	1	1			14.71134	115.8987	181.4207	372.7548
---Default catchabilities ------						32.87371	95.31335	239.8742	372.7548
1	1	1	1			61.61494	96.3486	187.7092	372.7548
---Mean F range ------						62.30712	100.5255	206.8472	372.7548
1	3								
--- Number of years for mean F, M,W, Mat, Rec, Forecasts ---									
3	3	3	3	11					
---Nat. mortality at age ------									
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						
0.61	0.44	0.37	0.31						

Fig. 6.9.4.2.2.1 Input data for SURBA model of *M. poutassou*.

6.9.4.2.3 *Results*

Fishing mortalityestimated over age classes 1 to 4 showed an increasing trend from the end of 1990s until 2007 and then a declne until 2010. In the last three years (2008-2010 fishing mortality is consistent with the values estimated by LCA method with a mean value of about 1.5. SSB in the last years is stable but at the lowest observed level in the time series.

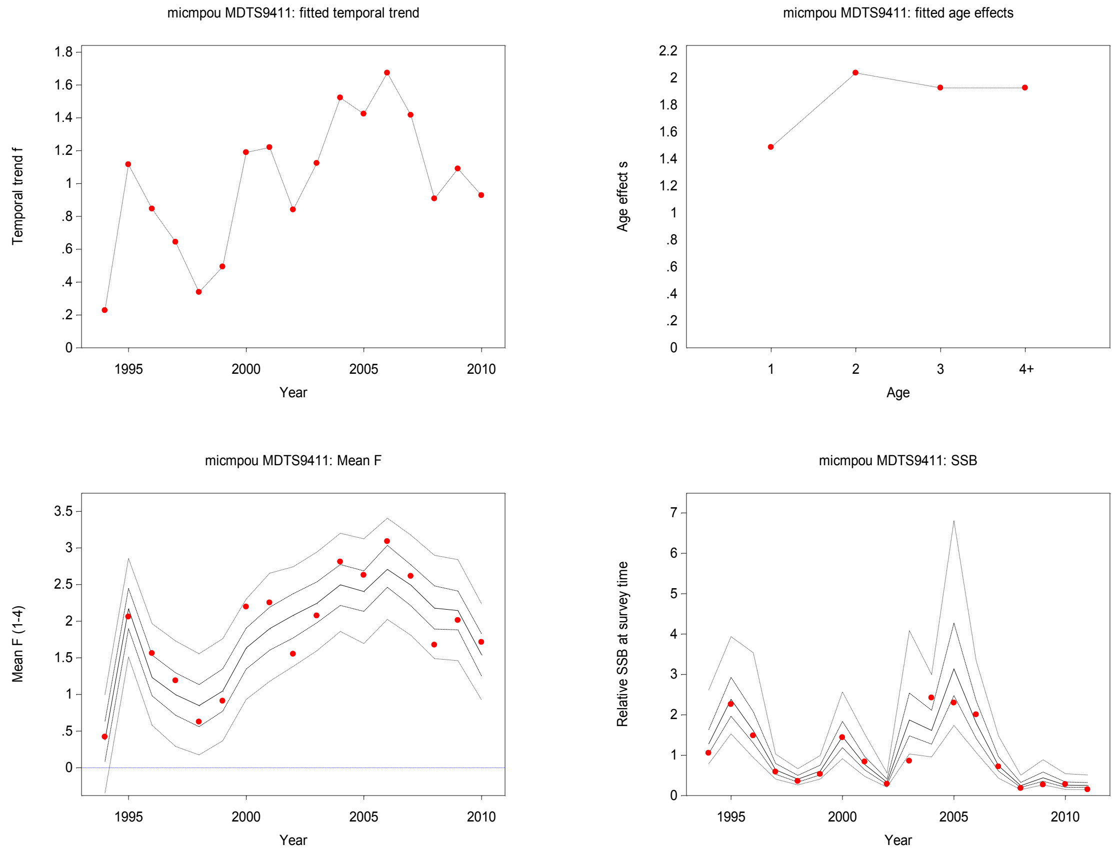
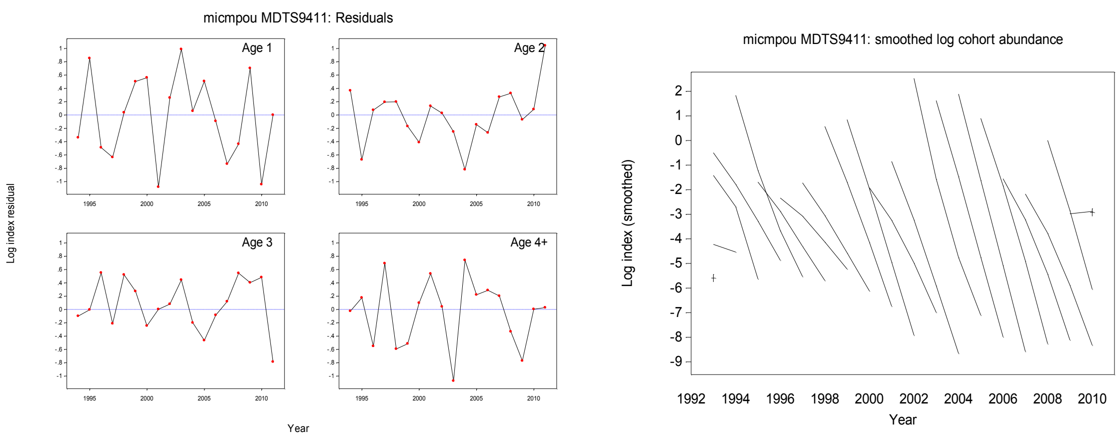


Fig. 6.9.4.2.3.1 MEDITS survey. Mean F and relative SSB at survey time estimated by SURBA.

Model diagnostics

The SURBA model for *M. poutassou* fits quite well on MEDITS survey data as showed in Figure 6.9.4.2.3.2.



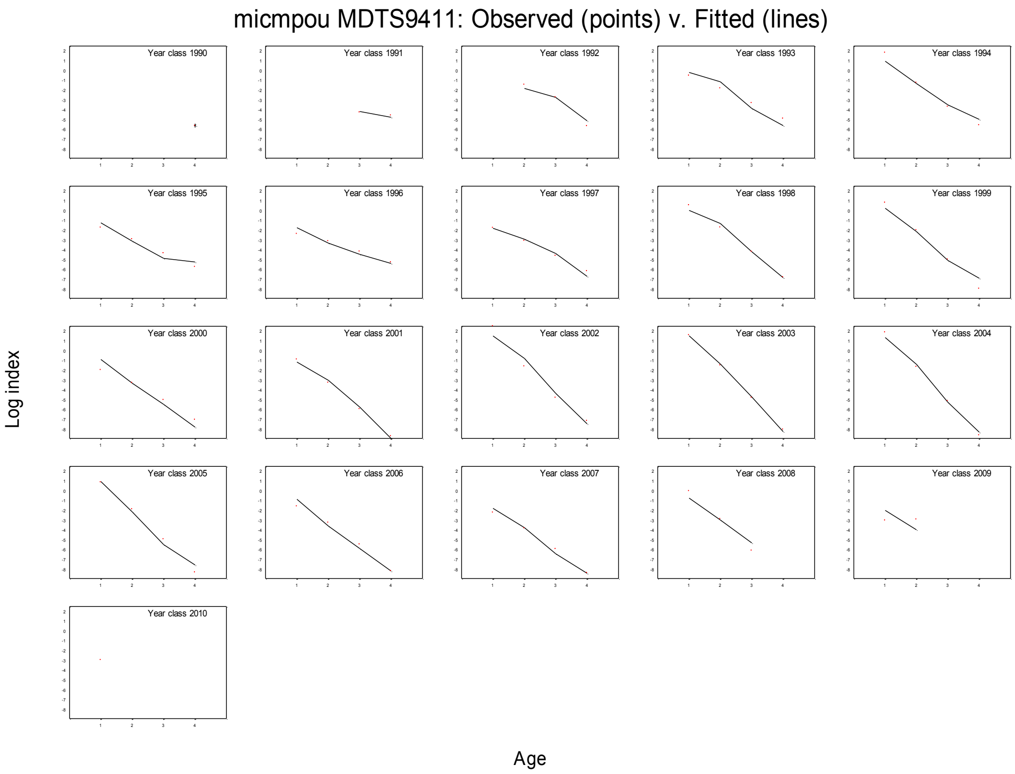


Fig. 6.9.4.2.3.2 Model diagnostic for SURBA of *M. poutassou* in the GSA 09; 1) Residual by age, 2) Log survey abundance indices by cohort. Each line represents the log index abundance of a particular cohort throughout its life and 3) Comparison between observed (points) and fitted (lines) MEDITS survey abundance indices, for each year.

6.9.5 *Long term prediction*

6.9.5.1 Justification

The yield per recruit (YPR) analysis was run using the results of the LCA using VIT.

6.9.5.2 Input parameters

Length frequency data (2009 – 2011) and the biological parameters used were the same used for the LCA.

6.9.5.3 Results

YPR and Spawning Stock Biomass per recruit (SSBPR) output curves are illustrated in the Figure 6.9.5.3.1 while in Table 6.9.5.3.1 are reported the main results of the LCA analysis.

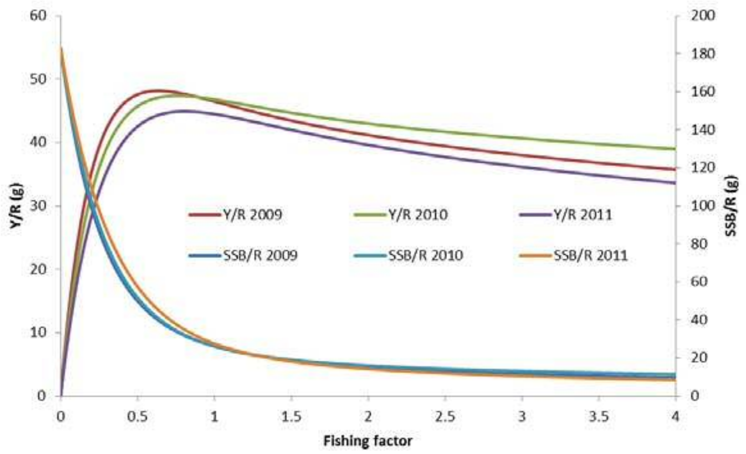


Fig. 6.9.5.3.1 LCA outputs: YPR and SSBPR curves of *M. poutassou* in the GSA09.

Table 6.9.5.3.1 Main outputs of the LCA.

		Factor	Absolute F	Y/R	SSB/R	B/R
2009	F_{virgin}	0.00	0.00	0.00	182.85	210.55
	$F_{0.1}$	0.41	0.52	46.13	59.69	82.41
	F_{max}	0.64	0.81	48.16	40.20	61.17
	F_{curr}	1.01	1.28	46.48	26.14	44.97
	F_{2-3}		2.30			
2010	F_{virgin}	0.00	0.00	0.00	182.85	210.55
	$F_{0.1}$	0.49	0.54	45.52	52.67	74.79
	F_{max}	0.77	0.85	47.36	34.10	54.53
	F_{curr}	1.01	1.12	46.78	26.24	45.59
	F_{2-3}		2.02			
2011	F_{virgin}	0.00	0.00	0.00	182.85	210.55
	$F_{0.1}$	0.54	0.51	43.22	53.39	74.58
	F_{max}	0.82	0.78	44.90	34.75	53.99
	F_{curr}	1.01	0.96	44.47	27.53	45.69
	F_{2-3}		1.64			
Mean		$F_{0.1}$	0.53			
		F_{max}	0.81			
		F_{curr}	1.12			
		F_{2-3}	1.98			

6.9.6 *Data quality*

MEDITS survey data were available from 1994 to 2011 as mean abundance and biomass per hour.Some minimal differences in the development of the time trend between hour indexes and those for square kilometers estimated for blue whiting in GSA 09 were recognized and a check on swept area values needs to be done.

6.9.7 *Scientific advice*

6.9.7.1 Short term considerations

6.9.7.1.1 *State of the stock size*

Stock assessment has been computed using a Length Cohort Analysis (VIT software) run with DCF data of landings at age (2009-2011). Results obtained did not show a clear trend in stock size. MEDITS survey indices show a variable pattern of abundance (in n/h) and biomass (in kg/h) without a clear trend. Spawning Stock Biomass trend obtained by SURBA show many variations in time with phase of high values followed by period of lower ones. In the last three years (2008-2010) SSB is in a lower level condition. Since no stock size reference level for blue whiting in GSA09 has been proposed, EWG 12-10 cannot evaluate the stock status in relation to these.

6.9.7.1.2 *State of recruitment*

MEDITSlength frequency distributions showed an high variability concerning the presence of recruits.Moreover it is important to highlight that the gregarious nature of the species imply the presence of high concentrations of young specimens in some areas and season.

6.9.7.1.3 *State of exploitation*

EWG 12-10 proposed $F_{0.1}$ = 0.53 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 1.12), the stock is considered exploited unsustainably.

6.10 **Stock assessment of sardine in GSA 09**

6.10.1 *Stock identification and biological features*

6.10.1.1 Stock identification

Due to a lack of information about the stock structure of the sardine population in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries. Studies are needed on the biological stock identification of this species in the Mediterranean Sea. The spawning season of the species in the area is mainly during winter.

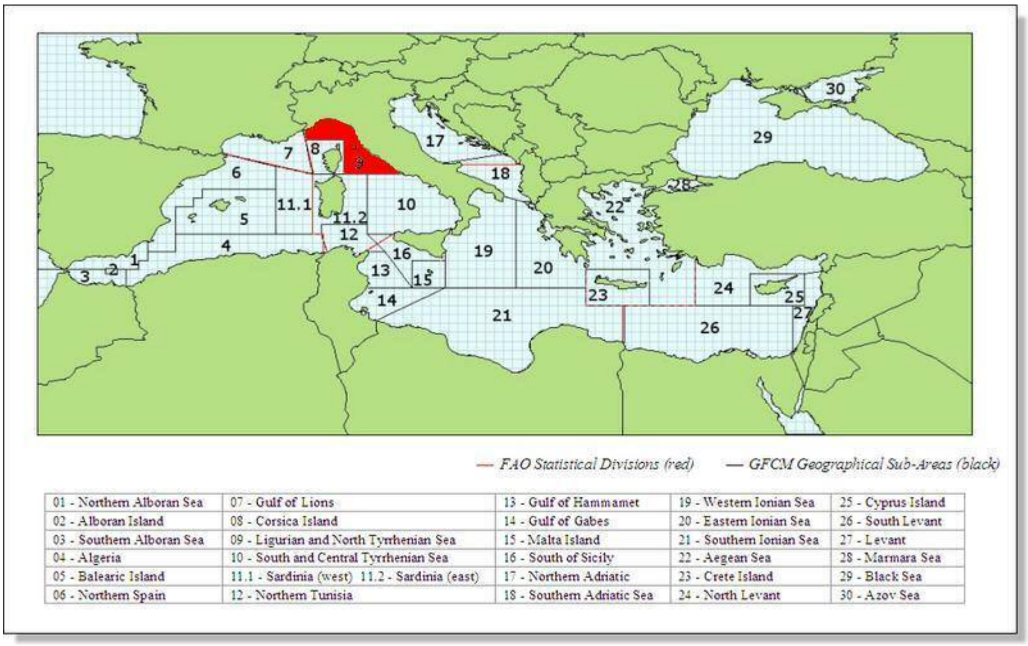


Fig. 6.10.1.1.1Assumed stock distribution map of sardine in GSA 09.

6.10.1.2 Growth

Growth parameters were estimated using data collected within the Data CollectionFramework (DCF). The method applied was the von Bertalanffy equation fit to the age (otolith readings) and growth data using non-linear estimation with minimum least squares.

6.10.2 *Fisheries*

6.10.2.1 General description of the fisheries

In the GSA 09, sardine is mainly exploited by purse seiners. Due to its low economic value, however, sardine does not represent the main target species for this fleet in the GSA 09, while anchovy (*Engraulis encrasicolus*) is the most important species exploited by this fishery. The fishing season starts in spring (March) and ends in autumn (October). Favorable weather conditions and abundance in the catches can extend the fishing activity to the end of November. However, the maximum activity of the fleet is normally observed in the summer. Some vessels coming from the south of Italy (mainly from GSA 10) join the local fleet. Sardine is also a by-catch in the bottom trawl fisheries. However, the landings yielded by these *metiers* are very low (about 1%) in comparison to those by purse seiners. Pelagic trawling is not carried out in the GSA 09.

Table 6.10.2.1.1 Sardine landings (in tons) by gear in GSA 09 from DCF data.

Gear	2006	2007	2008	2009	2010	2011
Otter trawl	44	41	38	52	31	31
Purse seine	4344	5112	2288	5674	4476	2543

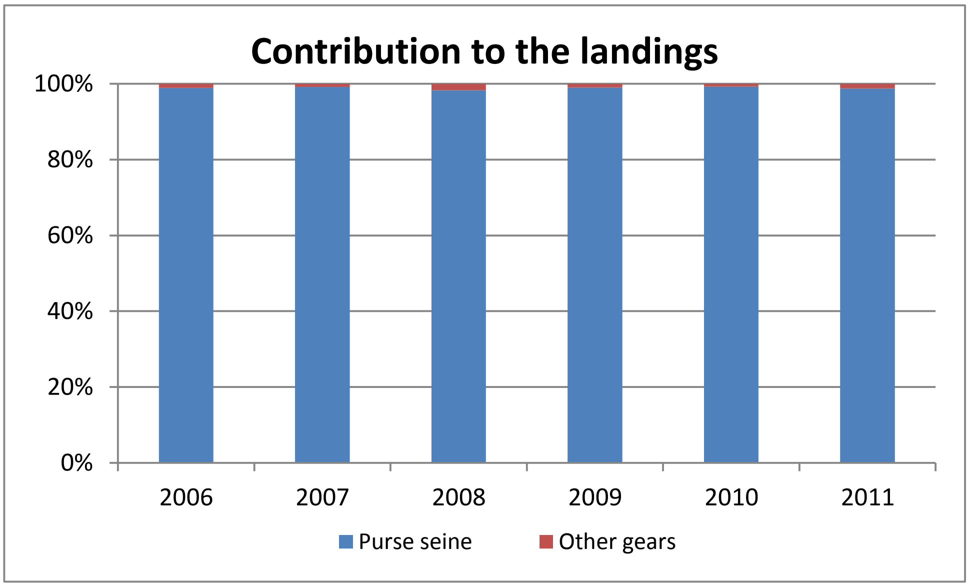


Fig. 6.10.2.1.1 Sardine in GSA 09. Contribution of the different fleets to the total landing in the period 2006-2011.

6.10.2.2 Management regulations applicable in 2009-2011

In Italy, the legal minimum size for sardine is 11 cm (Reg. (CE) 1967/2006), while 14 mm is the minimum mesh size allowed for purse seine and 40 mm squared or 50 mm diamond cod end mesh size for bottom trawl.

6.10.2.3 Catches

6.10.2.3.1 *Landings*

The time series of the landings data and the MEDITS trawl survey biomass indices (kg·km^{-2}) for the period 1994-2011 are shown in figure 6.10.2.3.1. The patterns of experimental and commercial data do not show a good match. Landing statistics and trawl survey biomass estimations showed a good correlation only for the period 1994-1999. In the case of the MEDITS trawl survey data, the trend is characterized by a large decrease, over the time series, while landings do not show any particular trend during the same period.

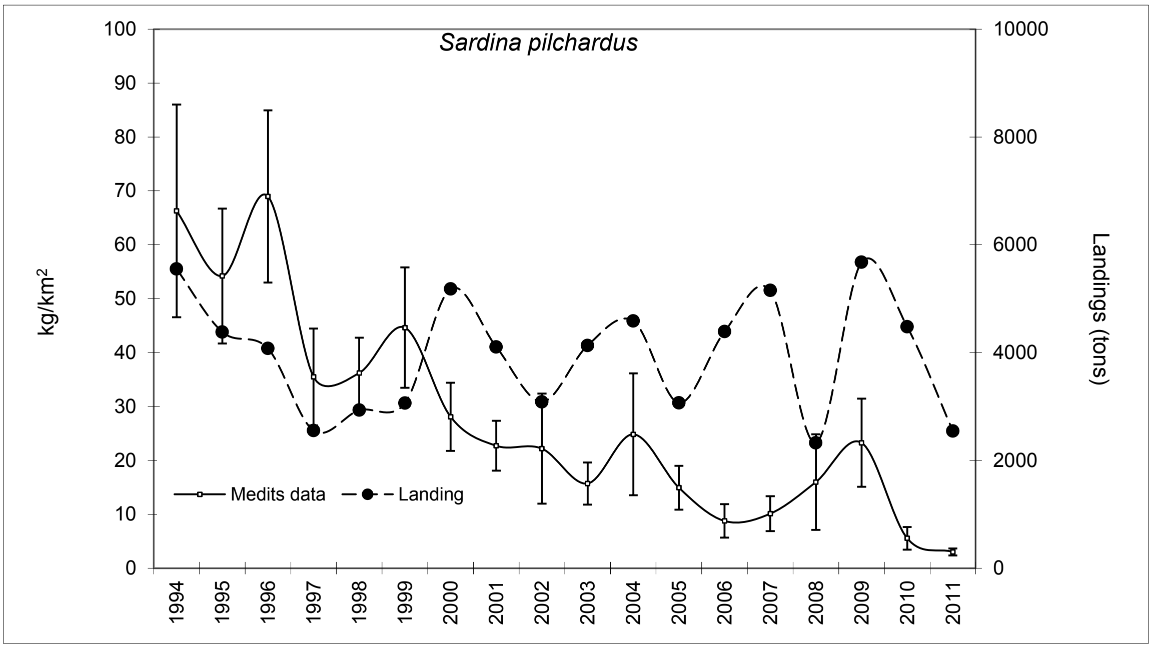


Fig. 6.10.2.3.1.1 Sardine in GSA 09: comparison between the total landings and the MEDITS biomass indices for the period 1994-2011.

Data on age composition of sardine landings in GSA 09 are available for the period 2006-2011. The age frequency distribution of purse seine landings is shown in Figure6.10.2.3.1.2, while the catch in weight (tons) by age class is shown inFigure6.10.2.3.1.3. In both cases, it emerges that the purse seine fisheries exploit mainly the age class 1. However, in 2007 and 2009 the contribution to the catch by age class 3 was high.

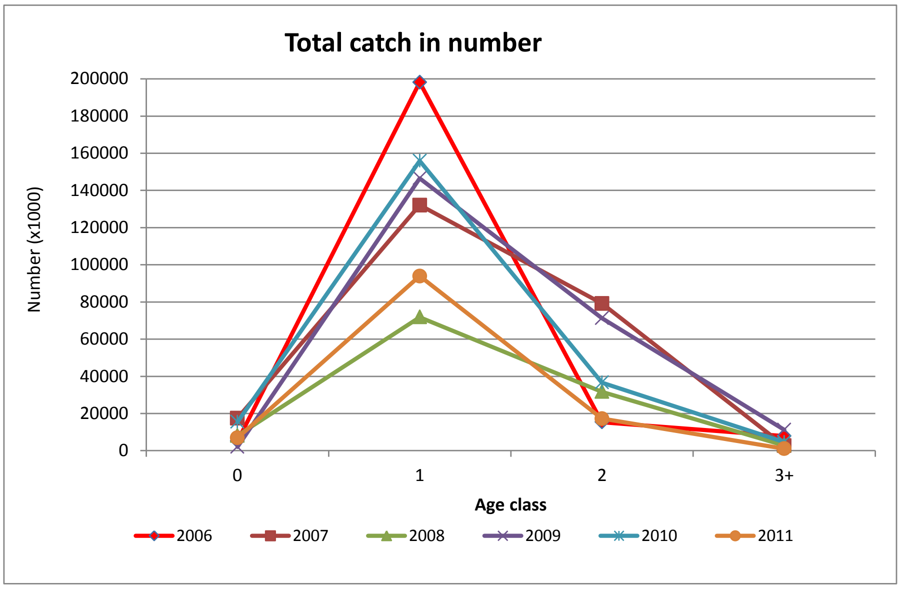


Fig. 6.10.2.3.1.2 Sardine in GSA 09: annual catch in number by age class.

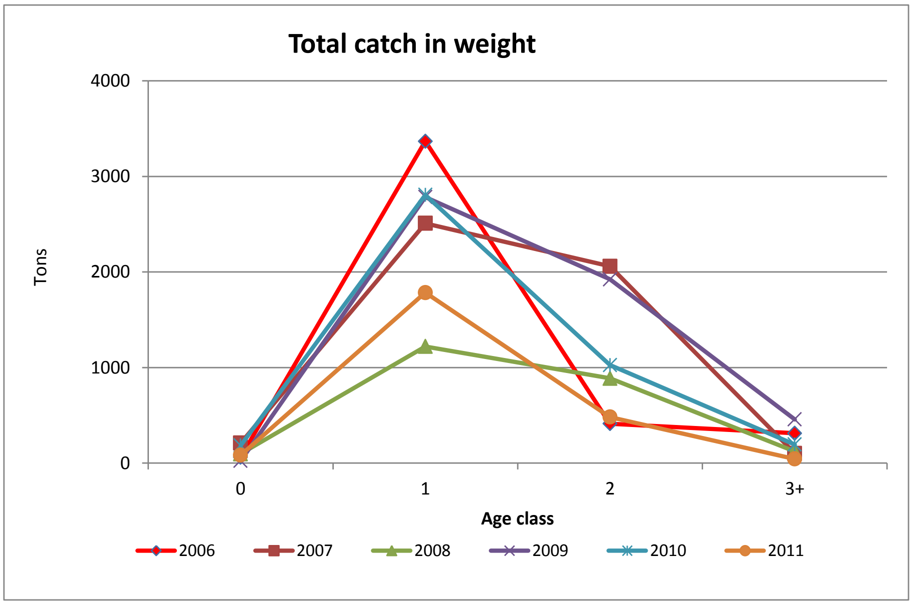


Fig. 6.10.2.3.1.3 Sardine in GSA 09: annual catch in weight by age class.

6.10.2.3.2 *Discards*

Studies carried out in the framework of the DCF in 2011 showed that discards of sardine by the commercial fleet in GSA 09 can be considered as negligible. According to the DCF investigation, in 2011 the discards at sea of sardine in the GSA 09 were estimated around 3 tons by purse seine fishery and 123 tons by demersal otter trawl fishery.

6.10.2.4 Fishing effort

The fishing effort, expressed as GT · fishing days, remained quite constant during the investigated period (2006-2011). However, it is worth to recognize that this estimate of fishing effort is relative to the entire purse seine fleet in the GSA 09, without any information about the specific targeting effort for sardine.

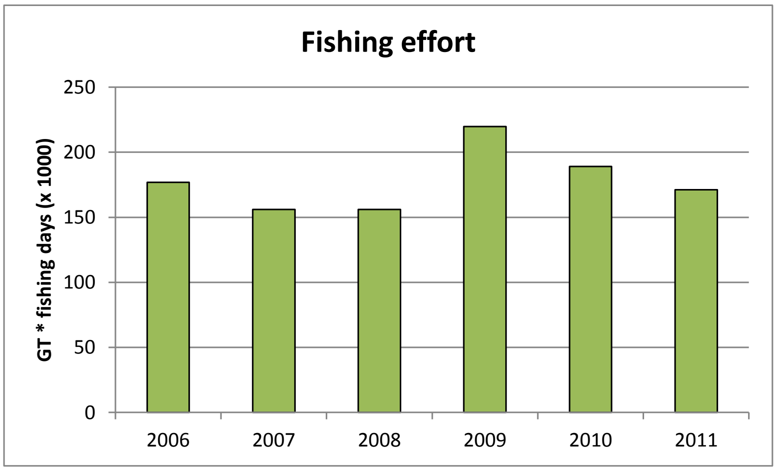


Fig. 6.10.2.4.1 Sardine in GSA 09: total fishing effort (GT · fishing days) of purse seine vessels.

6.10.3 *Scientific surveys*

As mentioned above, in GSA 09 acoustic survey started in 2009, and they have been carried out for 3 years, until 2011. Thus, due to the shortness of the time series the acoustic survey is not used in the assessment of sardine in GSA 09.

6.10.4 *Assessment of historic stock parameters*

6.10.4.1 Method: XSA on DCF data

6.10.4.1.1 *Justification*

Data coming from DCF for the period 2006-2011 were used to perform an Extended Survivor Analysis (XSA) using FLR (http://flr-project.org) calibrated with fishery independent data (i.e. MEDITS abundance indices by age class for 2010-2011). For each age class an average was computed from 2010-2011 data and used as tuning information for the period 2006-2009 for which no data on size structure are available from MEDITS survey in the GSA 09.

Data coming from DCF provided at the EWG 12-10 included information on total landings and catch at age of sardine in GSA 09 for the years 2006-2011. Discard data (available only for the year 2011) were also included in the analyses, adding the same discard amount in each year of the time series of data.

6.10.4.1.2 *Input parameters*

Landings of sardine collected within the DCF in GSA 09 are available since 2006. Catch at age information was obtained from otolith readings carried out in the framework of DCF from 2006 to 2011. Discard data (i.e. annual amount of discards and their age structure) were available for 2011 only. It was assumed a constant discard rate during the investigated period, therefore discards data were spread in each year of the time series of data. Catch at age, weight at age, mortality at age and maturity at age data for the 2006-2011 period were compiled for age classes 1 to 4+ and used as input data for the XSA (Table 6.10.4.1.2.1).

Table 6.10.4.1.2.1 Sardine in GSA 09: input parameters of the XSA, i.e. catch at age, weight at age, maturity at age and natural mortality at age.

	Catch-at-age (thousands)					
Age class	2006	2007	2008	2009	2010	2011
0	5154	198133	15309	7829	5154	198133
1	17498	132067	79215	2679	17498	132067
2	8069	71791	31679	2827	8069	71791
3+	1998	146551	71226	11172	1998	146551
	Total Yields (in tons)					
	2006	2007	2008	2009	2010	2011
Tons	4514	5279	2452	5852	4633	2700
	Weight-at-age (kg)					

Age class	2006	2007	2008	2009	2010	2011
0	0.012	0.012	0.012	0.012	0.012	0.012
1	0.017	0.019	0.017	0.019	0.018	0.019
2	0.027	0.026	0.028	0.027	0.028	0.028
3+	0.040	0.038	0.043	0.041	0.042	0.040
	Maturity-at-age					
Age class	2006	2007	2008	2009	2010	2011
0	0.5	0.5	0.5	0.5	0.5	0.5
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3+	1	1	1	1	1	1
	Natural Mortality-at-age					
Age class	2006	2007	2008	2009	2010	2011
0	1.38	1.38	1.38	1.38	1.38	1.38
1	0.36	0.36	0.36	0.36	0.36	0.36
2	0.25	0.25	0.25	0.25	0.25	0.25
3+	0.20	0.20	0.20	0.20	0.20	0.20
	Proportion of F before spawning					
Age class	2006	2007	2008	2009	2010	2011
0	1.38	1.38	1.38	1.38	1.38	1.38
1	0.36	0.36	0.36	0.36	0.36	0.36
2	0.25	0.25	0.25	0.25	0.25	0.25
3+	0.20	0.20	0.20	0.20	0.20	0.20
	Proportion of M before spawning					
Age class	2006	2007	2008	2009	2010	2011
0	1.38	1.38	1.38	1.38	1.38	1.38
1	0.36	0.36	0.36	0.36	0.36	0.36
2	0.25	0.25	0.25	0.25	0.25	0.25
3+	0.20	0.20	0.20	0.20	0.20	0.20

The vector of natural mortality M was estimated using Prodbiom (Abella *et al.*, 1997).

The following set of parameters was used for age slicing of the MEDITS trawl survey data (2010-2011), used as tuning information in the XSA:

Growth parameters (von Bertalanffy)
L_∞ = 20.0 (cm, total length); k = 0.39; $t_{0=}$ -0.48
L*W: a = 0.007; b=3.046

For each age class an average was computed from 2010-2011 data and used as tuning information:

Year	Age class 0	Age class 1	Age class 2	Age class 3+
2006	1396	1091	402	14
2007	1396	1091	402	14
2008	1396	1091	402	14
2009	1396	1091	402	14
2010	2777	1663	435	13
2011	14	518	369	14

The diagnostic file from XSA is also shown:

```
CPUE data from indices
Catch data for 6 years 2006 to 2011. Ages 0 to 3.
   fleet first age last age first year last year alpha beta
1 Medits         0        2       2006      2011  <NA><NA>

 Time series weights :
    Tapered time weighting applied
   Power =   3 over  20 years

 Catchability analysis :
     Catchability independent of size for ages >   1
     Catchability independent of age for ages >   2

 Terminal population estimation:
     Survivor estimates shrunk towards the mean F of the final   2 years or the  2 oldest
ages.
    S.E. of the mean to which the estimates are shrunk =   1
    Minimum standard error for population estimates derived from each fleet =  0.3 prior
weighting not applied

Regression weights
     year
age    2006  2007 2008  2009 2010 2011
  all 0.954 0.976 0.99 0.997    1    1

 Fishing mortalities
   year
age  2006  2007  2008  2009  2010  2011
  0 0.007 0.023 0.010 0.003 0.023 0.008
  1 0.581 0.509 0.259 0.557 0.649 0.406
  2 0.140 0.557 0.244 0.508 0.291 0.147
  3 0.140 0.557 0.244 0.508 0.291 0.147

 XSA population number (Thousand)
      age
year         0      1      2     3
  2006 1585033 538507 132930 67607
  2007 1530617 396175 210209  7010
  2008 1650080 376294 166090 14709
  2009 1558144 411077 202566 31360
  2010 1370630 390994 164389 20584
  2011 1662612 337073 142578  8943

 Estimated population abundance at 1st Jan  2012
      age
year   0      1      2     3
  2012 0 417083 158317 97261
```

```
 Fleet:  Medits
 Log catchability residuals.
   year
age   2006   2007   2008   2009   2010   2011
  0  0.004  0.002  0.006  0.003 -0.003 -0.011
  1 -0.150  0.050 -0.014  0.042  0.352 -0.286
  2  0.103 -0.047 -0.042 -0.046  0.082 -0.047

 Regression statistics
 Ages with q dependent on year class strength
[1] "-0.0622399077958652" "0.746145138854778"   "14.7309738166786"
[4] "7.25720262756727"

 Terminal year survivor and F summaries:

 ,Age 0 Year class =2011

source
       scaledWts survivors yrcls
Medits     0.206    496261  2011
fshk       0.019    250989  2011
nshk       0.776    403194  2011

 ,Age 1 Year class =2010
source
       scaledWts survivors yrcls
Medits     0.781    106803  2010
fshk       0.219     92693  2010

 ,Age 2 Year class =2009
source
       scaledWts survivors yrcls
Medits     0.906     91456  2009
fshk       0.094     65632  2009
Warning message:
sd(<matrix>) is deprecated.
 Use apply(*, 2, sd) instead.
```

6.10.4.1.3 *Results*

Different XSA runs were performed using shrinkage of 0.5, 1.0 and 2.0. As shown in figure 6.10.4.1.3.1,the three different settings produced quite dissimilar estimates of recruitment and SSB. However, the three different values of shrinkage showed similar patterns, with a decreasing trend in SSB and a fluctuating recruitment.

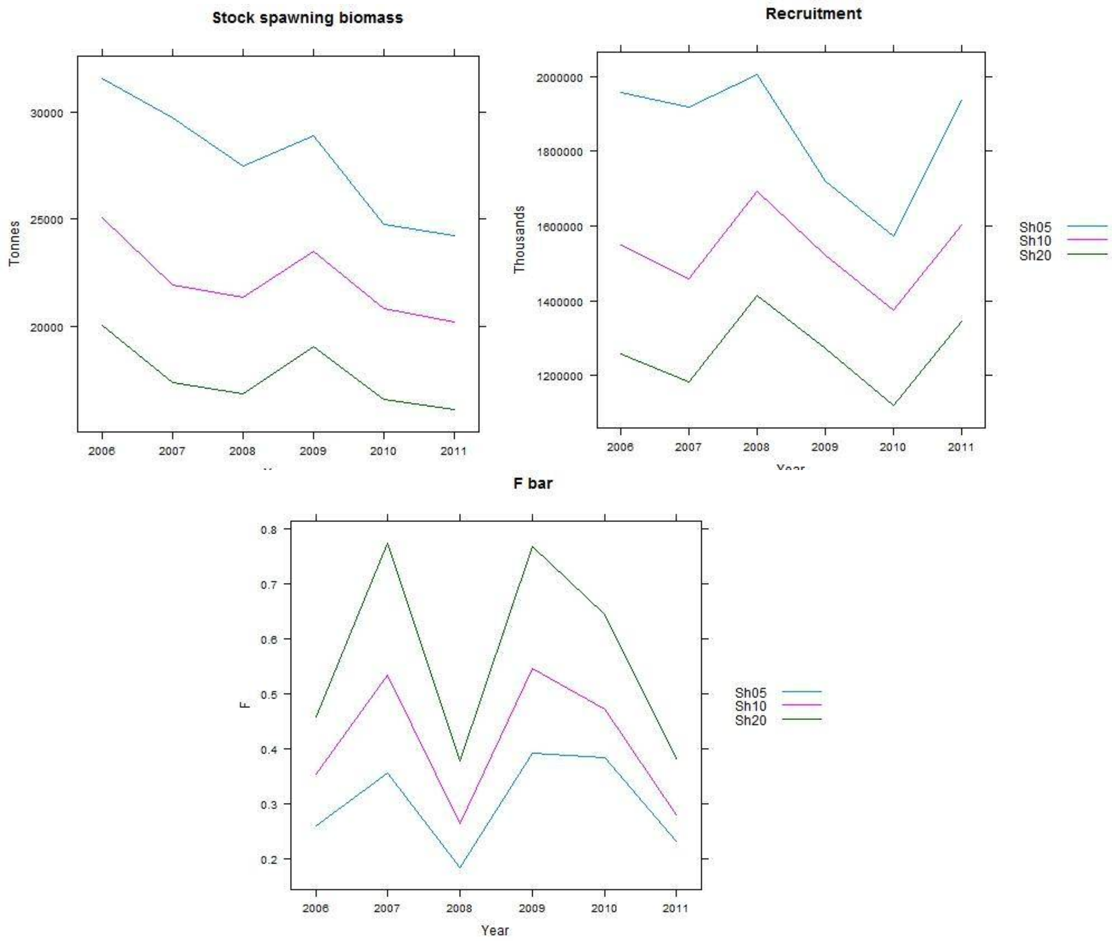


Fig. 6.10.4.1.3.1 Estimates of recruitment, SSB and F_{bar} (mean F for ages 1 and 2) using different values of shrinkage.

Even though the three XSA run with different shrinkage values produced relatively small residuals, with no trend in their distribution (Fig. 6.10.4.1.3.2), the XSA with shrinkage 1.0 was adopted as the final model since it was considered as the best compromise in terms of smoothing of the data.

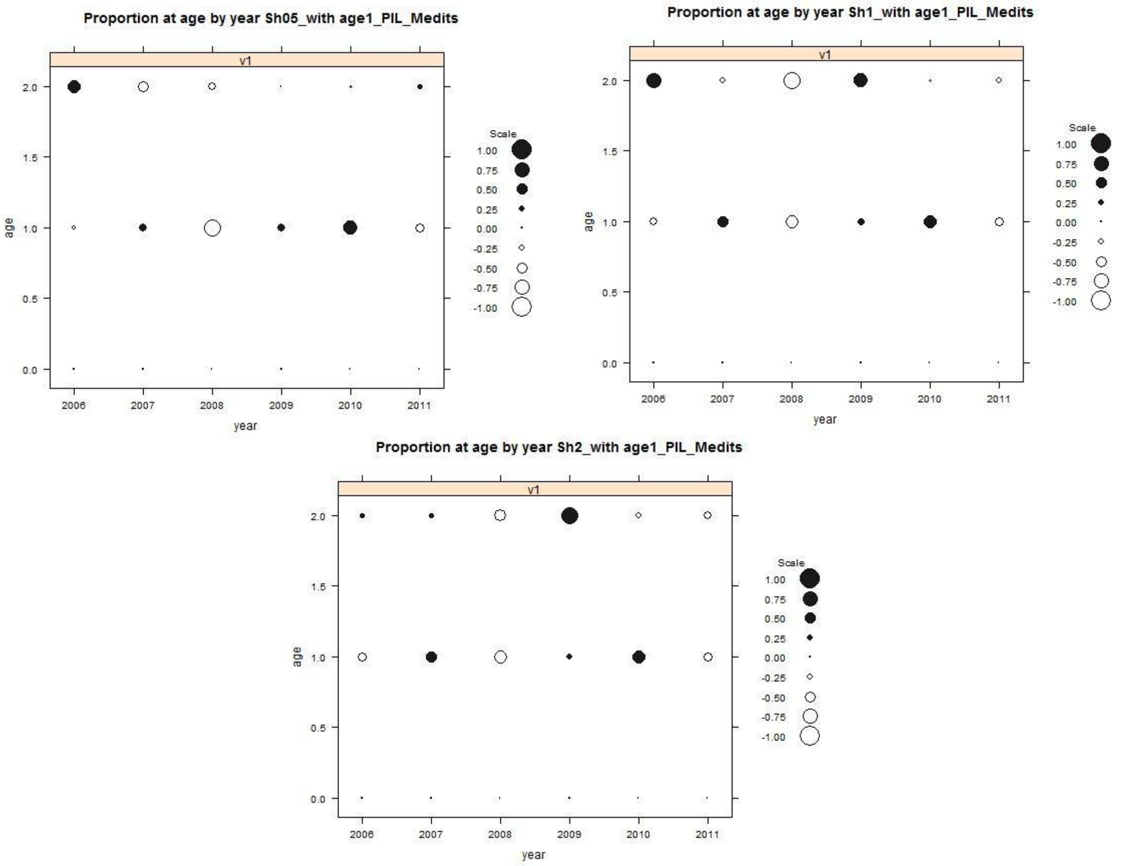


Fig. 6.10.4.1.3.2Residuals at age obtained with shrinkage set at 0.5, 1.0, and 2.0.

Table 6.10.4.1.3.1 shows the estimates for spawning stock biomass (SSB), total biomass (TB) and recruitment from 2006 to 2011 as derived from the XSA. The annual catches, including discards, are also shown.

Even though a fluctuation pattern could be observed, SSB seems to follow a general but slight decreasing trend, from 25061 tons in 2006 to 20204 tons in 2011. Similar considerations can be applied to the trend in total biomass, which decreased from 34349 tons in 2006 to 29828 tons in 2011. An oscillating pattern is evident for the recruitment, with a peak in 2008 and a minimum in 2010, followed by a new rather sharp increase in 2011.

Table 6.10.4.1.3.1 Spawning stock biomass (SSB), total biomass (TB) and recruitment estimates for sardine in GSA 09 from 2006 to 2011derived by the XSA. Total yields (landings and discards) are also shown.

	2006	2007	2008	2009	2010	2011
SSB (tons)	25061	21936	21326	23489	20841	20204
TB (tons)	34349	30686	31487	32629	29080	29828
Recruitment (thousands)	1548079	1458448	1693499	1523272	1373255	1603989

Yield (tons)	4514	5279	2452	5852	4633	2700

XSA estimates of F_{bar} (estimates on ages1 and 2) are shown in Table 6.10.4.1.3.2 and Figure6.10.4.1.3.3. F_{bar} shows a fluctuating pattern, with a minimum in 2008 (F_{bar} = 0.27), and two peaks in 2007 and 2009 (F_{bar} = 0.54 and 0.55, respectively).

Table 6.10.4.1.3.2 Fishing mortality and numbers at age as estimated by XSA.

F-at-age

Age	2006	2007	2008	2009	2010	2011
0	0.007	0.024	0.009	0.003	0.023	0.009
1	0.573	0.525	0.274	0.537	0.670	0.405
2	0.135	0.544	0.255	0.553	0.276	0.154
3+	0.135	0.544	0.255	0.553	0.276	0.154
F_{bar}	0.354	0.535	0.265	0.545	0.473	0.280

Numbers-at-age (thousands)

Age	2006	2007	2008	2009	2010	2011
0	1548079	1458448	1693499	1523272	1373255	1603989
1	543887	386879	358138	422001	382221	337733
2	137839	213962	159604	189899	172010	136457
3+	70111	7137	14131	29371	21545	8558
Total	2299916	2066426	2225372	2164543	1949031	2086737

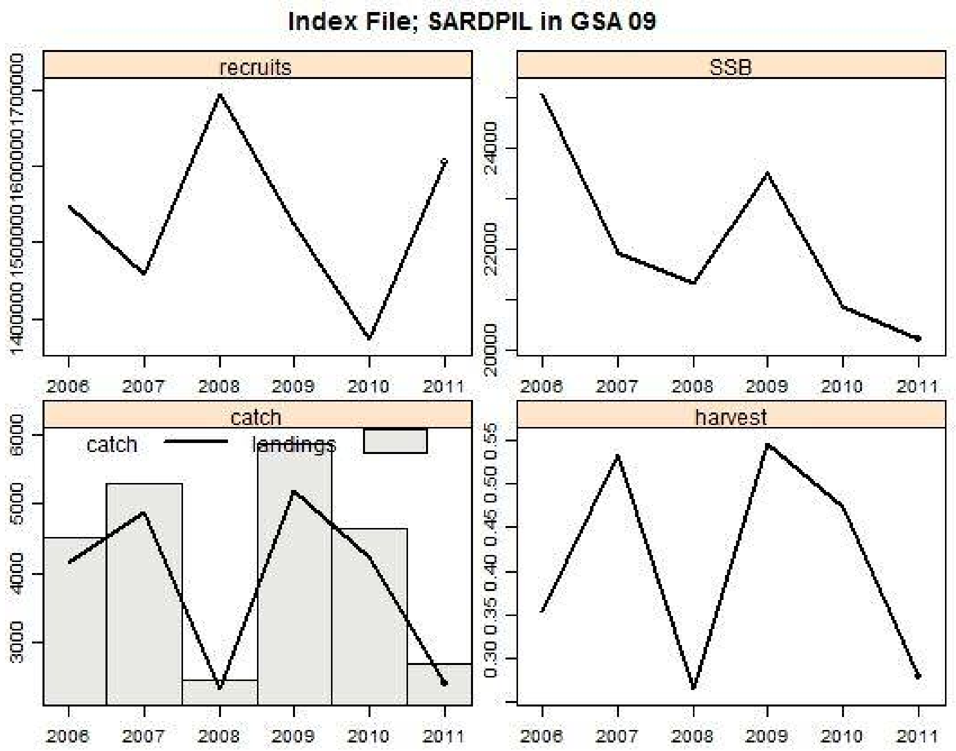


Fig. 6.10.4.1.3.3 Summary of stock parameters (recruitment, SSB, catch and landing, F mean for ages 1-2) as estimated by XSA.

The current exploitation rate (E) computed as F_{bar} on Z is just slightly higher than the reference point suggested by Patterson (1992) (E = 0.4) as proxy of F_{MSY} for small pelagic; in 2006, 2008 and 2011 the exploitation rate resulted equal or slightly lower than the reference point.

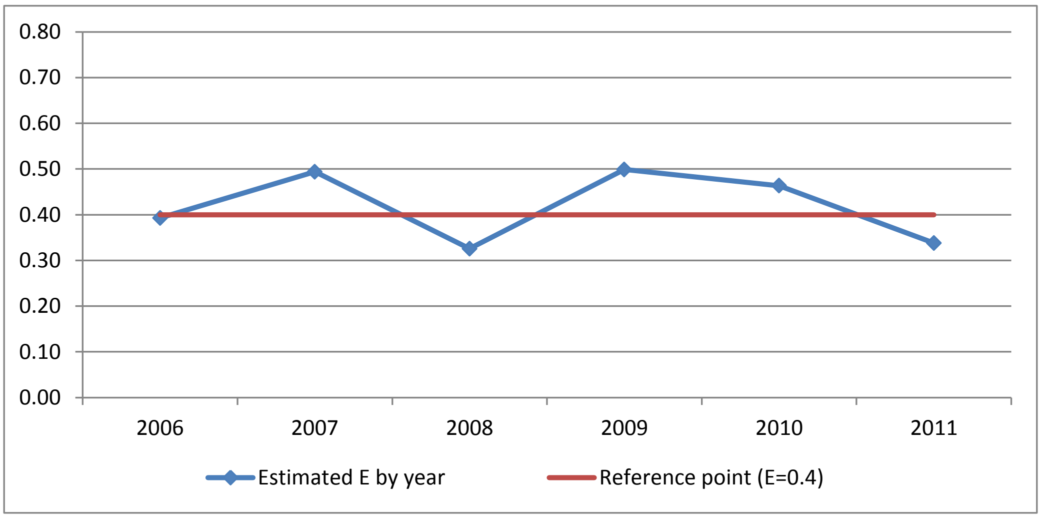


Fig. 6.10.4.1.3.4 Sardine in GSA 09: exploitation rate estimated using XSA results and compared to the reference point (E = 0.4).

6.10.5 *Long term prediction*

6.10.5.1 Justification

Yield per recruit analysis (YPR) was conducted assuming equilibrium conditions and using the software Yield Per Recruit (version 3.1) provided by NOAA's National Marine Fisheries Service.

6.10.5.2 Input parameters

Yield per recruit analysis was conducted based on the exploitation pattern resulting from the final XSA model and population parameters as defined in Table 6.10.4.1.2.1. Minimum and maximum ages for the analysis were considered to be age class 0 and 3+. Stock weights at age, catch weight at age and maturity at age were estimated as mean values from 2006 to 2011.

6.10.5.3 Results

YPR (Fig. 6.10.5.3.1) were not considered reliable due to flat-topped shape of the curve. Therefore, $F_{0,1}$ ($F_{0,1}$ = 1.12; F_{max} = 1.80) should not be used as a reference point for this stock. Also, the use of YPR for estimating targets for long-term management of pelagic fisheries has been discouraged (Patterson, 1992) and the exploitation rate (E=0.4) computed as F_{bar} on Z is used as reference point as suggested by Patterson (1992) and adopted by STECF for small pelagic stock in the Mediterranean Sea.

Fig. 6.10.5.3.1 YPR analysis for sardine in GSA 09.

6.10.6 *Data quality and availability*

Total landings and catch at age data for sardine in GSA 09 from 2006 to 2011 were available at the EWG 12-10. Although the landing of sardine coming from other gears (i.e. mainly otter trawler) is about 1% of the total landing, information is available for the other gears only in the last two years. Data concerning fishing activity and fishing effort of the purse seine fleet for GSA 09 have been regularly submitted by the Italian

Authorities. However it is not possible to break down the effort information according to the targeted species (i.e. anchovy and sardine).

6.10.7 *Scientific advice*

6.10.7.1 Short term considerations

6.10.7.1.1 *State of the spawning stock size*

In the absence of proposed or agreed biomass management reference points, STECF EWG 12-10 is unable to fully evaluate the state of sardine biomass in comparison to these. The analyses carried out on for the period 2006-2011, resulted in an SSB ranging from around 25,000 to 20,000 tons. Both landings and the survey indices indicate that the stock is currently at a low level.

6.10.7.1.2 *State of recruitment*

In the absence of proposed or agreed management reference points, STECF EWG 12-10 is unable to fully evaluate the state of recruitment in comparison to these. The analyses carried out for the period 2006-2011 show a fluctuating pattern in recruitment, with a decrease until 2010, followed by a new increase in 2011.

6.10.7.1.3 *State of exploitation*

STECF EWG 10-02 proposed E=0.4 as limit management reference point consistent with high long term yields for small pelagic species. The current exploitation rate for sardine in GSA 09 in 2011 is slightly higher than the reference point but showing E values lower than the reference point in 2006, 2008 and 2011. Applying E=0.4 as a reference point, the stock is considered only slightly overexploited. Therefore, F needs to be reduced from the current value towards the candidate reference points to achieve long term sustainability of the sardine stock in GSA 09.

Any future management options need to take into account the effect on anchovy as well, as purse seine fleet operating in the GSA 09 contemporary exploits anchovy and sardine.

6.11 **Stock assessment of poor cod in GSA 09**

6.11.1 *Stock identification and biological features*

6.11.1.1 Stock Identification

The poor cod (*Trisopterus minutus capelanus*), a subspecies of the Atlantic species *Trisopterus minutus* (Linnaeus, 1758) is one of the most common gadids in the Mediterranean, found in small schools on muddy and sandy bottoms from 20 m to over 250 m depth, with greater abundances between the depths of 40 and 120 m. Studies carried out in the northern Tyrrhenian Sea have shown a significant correlation between decreasing average size of the population and increasing depth (Biagi *et al*., 1996).

Genetic analysis using minisatellite loci and allozima (Mattiangeli *et al.*, 2003) has demonstrated a clear genetic differentiation between individuals of the western Mediterranean (Gulf of Lion, Tuscan Archipelago) and those of the eastern (Aegean Sea). However, due to the scarce information about the stock identification of poor cod population in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries(Fig. 6.11.1.1.1). As a matter of fact, there is no available definition of unit stocks neither based on genetics, bio-chemistry, fishery, behavioral nor any alternative method based on somatic features of the species. Under a management point of view, in the frame of SGMED and GFCM, it has been decided that, lacking any evidence to suggest alternative hypothesis, inside each GSA inhabits a single, homogeneous stock that behaves as a single well-mixed and self-perpetuating population.

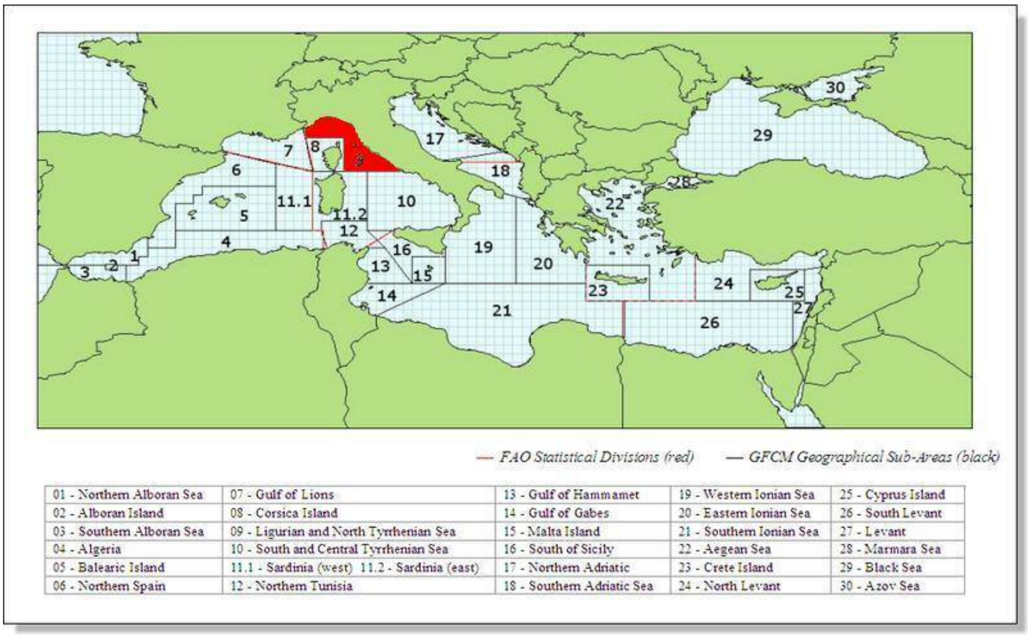


Fig. 6.11.1.1.1Assumed stock distribution map.

6.11.1.2 Growth

The maximum size reached by the species is 28 cm TL, but more commonly specimens between 10 and 20 cm TL are found.

The following parameters of the Von Bertalanffy's growth curve have been estimated using length frequency distribution analysis for both sexes combined (Abella *et al*., 2011):

L_∞ = 27.0 cm, K=0.45, t_o=0

Poor cod is a demersal predator with a diet composed mainly of benthic organisms and to a certain degree of nektobenthic species. Studies on the feeding behaviour of the species in the Tyrrhenian (Sartor, 1993) confirm that its diet is composed prevalently of mysid crustaceans, benthic decapods and Gobidae; other taxa have a secondary importance. Mysidacea, with *Lophogastertypicus*, constitute the main prey for specimens with TL<10 cm; decapods, present in a large number of species, most importantly *Alpheus glaber* and *Chlorotocuscrassicornis*, are a very important food items for specimens larger than 10 cmTL.

6.11.1.3 Maturity

The rather long reproductive period (around 4-5 months) extends from the end of winter to late summer, probably with more than one spawning event during the reproductive season(Biagi *et al*., 1990). Spawners tend to concentrate between the depths of 50 and 120 m. In the northern Tyrrhenian Sea the prevalence of large females has been observed at the start of the reproductive season, followed by the progressive maturation of smaller specimens(Biagi *et al*., 1992). From MEDITS survey data, the size at first sexual maturity for the two sexes combined ranges between 10.5 and 15 cm TL (Fig. 6.11.1.3.1). In the northern Tyrhenian Sea, Biagi *et al*. (1992) found mature females from 10 cm TL; the size at first maturity was 12.4 cm TL and 13.8 cm for males and females respectively, corresponding to specimens at the beginning of the second year of life.

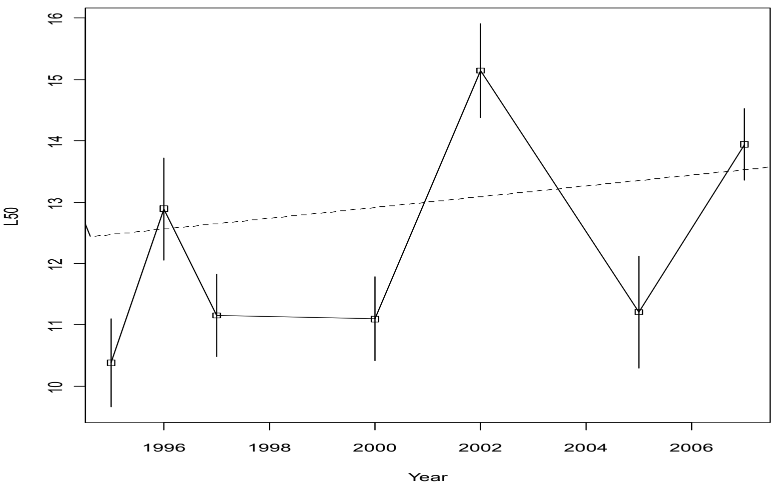


Fig. 6.11.1.3.1Length at first maturity (L_{50}) of poor cod in GSA 09 estimated using data collected during the MEDITS survey (1995-2007).

In the northern Tyrrhenian, Biagi *et al.* (1992) identify recruitment during spring-summer with higher abundance of specimens of the age group 0 in summer on bottoms between 100 and 200 m depth, especially in areas where the crinoid *Leptometra phalangium* is abundant.

6.11.2 *Fisheries*

6.11.2.1 General description of fisheries

Poor cod is a by-catch demersal species in GSA09, usually landed together with other small-sized species. Almost all the landings of poor cod are from bottom trawl vessels; the remaining fraction is caught by artisanal vessels using set nets, in particular gillnets. Poor cod is one of the species exploited by the demersal trawl fishery targeting a highly diversified species assemblage, including hake, red mullet and horned octopus (*Eledonecirrhosa*) on deep shelf (Biagi *et al*., 2002). The main trawl fleets of GSA09 are present in the following continental harbours: Viareggio, Livorno and Porto Santo Stefano (Tuscany), Fiumicino, Terracina, Anzio and Gaeta (Latium). In the last eight years, the total landings of poor cod of GSA09 fluctuated between a minimum of 91in 2010 to a maximum of 226 tons in 2004. In 2011 the landing was about 105 tons.

As concerns the fishing activity, the majority of bottom trawlers in GSA09 operate daily with only some vessels staying out for two-three days, mostly in summer.

Although poor cod is an important by-catch for many fleets, there are no recent comprehensive assessments on the state of exploitation of this resource in the GSA 09 and, in general, in the Mediterranean Sea. In the Strait of Sicily Ragonese and Bianchini (1998) have applied the yield per recruit model of Thompson and Bell to assess the state of exploitation of the stock and to estimate the effects of changing the pattern of exploitation. The results indicate that the resource was overexploited and that the yield per recruit could be increased by moving the age of first catch from 0.5 to 1 year.

6.11.2.2 Management regulations applicable in 2010 and 2011

- Fishing closure for trawling: 45 days in late summer (not enforced every year)
- Cod end mesh size of trawl nets: 40 mm (stretched, diamond meshes) till 30/05/2010. From 1/6/2010 the existing nets have beenmodified with a cod end with 40 mm square meshes or a cod end with 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.
- Two small No Take Zones (“Zone di TutelaBiologica”, ZTB) are present inside the GSA09; one off the Giglio Island (50 km^2, northern Tyrrhenian Sea) another off Gaeta, (125 km^2, central Tyrrhenian Sea). Bottom fishing was not allowed in the two ZTB. A recent regulation of the Italian Ministry of Agricultural, Food and Forestry Policies has established that fishing activity can be carried out in these two areas from July 1st to December 31st.

6.11.2.3 Catches

6.11.2.3.1 *Landings*

In the last eight years, the total landings of poor cod in the GSA 09 fluctuated between 230 to about 90 tons

(Figure6.11.2.3.1.1 and Table 6.11.2.3.1.1).An evident decline was observed in 2005 and 2006, and then the landings remained quite constant around 100 tons per year. The contribution by gillnet and trammel net is negligible.

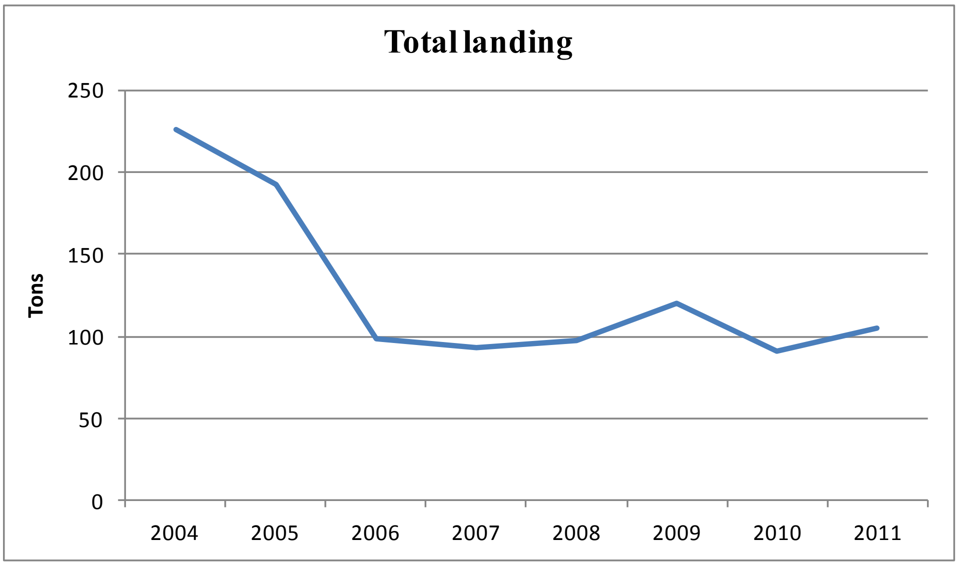


Fig. 6.11.2.3.1.1 Landings of poor cod in GSA09, from 2004 to 2011 (DCF official data).

Table 6.11.2.3.1.1Landings (t) poor cod in GSA09by year and major gear types, 2004-2011 as reported by DCF for GSA 09.

Gear	2004	2005	2006	2007	2008	2009	2010	2011
GNS		3.26		4.20	0.52	0.45	0.72	0.23
GTR				0.59	0.42	0.04	0.02	
OTB	225.81	189.72	98.76	88.29	96.00	119.98	90.21	104.47
Total	225.81	192.98	98.76	93.09	96.95	120.48	90.95	104.70

6.11.2.3.2 *Discards*

Juveniles of poor cod are usually completely discarded at sea due to their low commercial value. In 2011, 37.4 tons have been discarded, corresponding to 26.4% of the total catch in GSA 09.

6.11.2.4 Fishing effort

In the last 8 years, the fishing effortby the gears exploiting poor cod in the GSA09 has shown different patterns; for bottom trawl demersal fishery, the main fleet targeting poor cod, an increasing trend is observed, from a minimum of 252,970 GT*fishing days to 1,270,144 in 2011; on the contrary, fishing effort of the bottom trawl mixed fishery, which exploits poor codin a less extent, shows an evident decreasing trend in fishing effort in the period considered. However, it is not possible to exactly quantify the specificeffort exerted by the demersal fishery fleet on this stock. Fishing effort of set nets (GNS and GTR) remained substantially stable (Figure6.11.2.4.1 and Table 6.11.2.4.2.1).

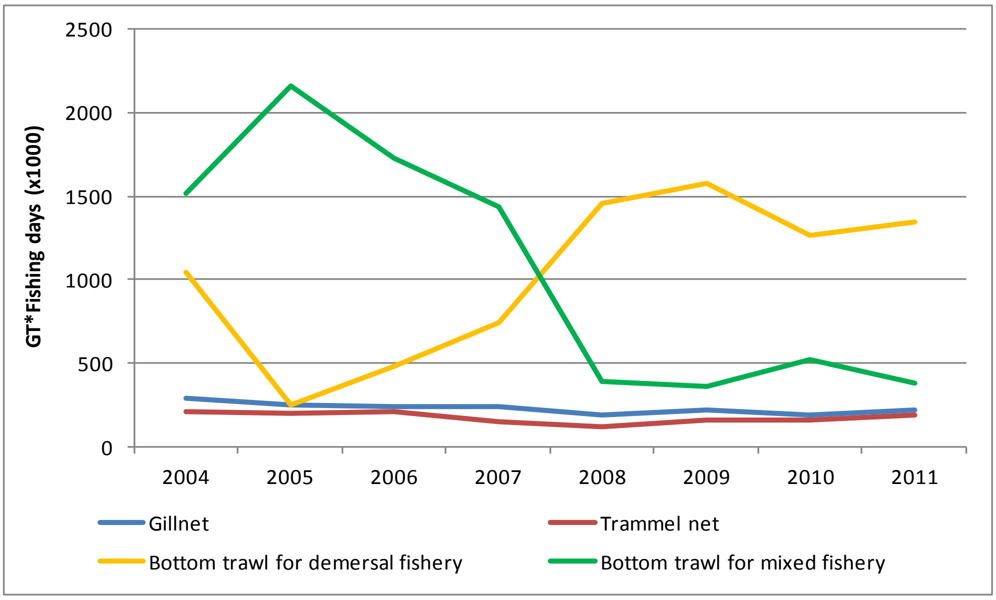


Fig. 6.11.2.4.1 Effort trends (GT*fishing days) by the major fleets in GSA 09, 2004-2011.

Table 6.11.2.4.2.1 Trends in annual effort (GT*fishing days) by trammel nets (GTR), gillnets(GNS) and bottom trawlers (OTB) deployed in GSA09, 2004-2011.

Gear	2004	2005	2006	2007	2008	2009	2010	2011
Gillnet	287202	251526	238944	244466	186122	216121	192228	216010
Trammel net	209842	197003	208753	147389	122717	154838	162608	191624
Bottom trawl demersal fishery	1042307	252970	480436	744769	1461445	1579446	1270144	1349679
Bottom trawl mixed fishery	1518484	2158460	1733359	1433624	388381	360269	518098	384677
Total	3059839	2861964	2663498	2572255	2160673	2312683	2145088	2144001

6.11.3 *Scientific surveys*

6.11.3.1 MEDITS

6.11.3.1.1 *Methods*

Based on the DCF official data, abundance and biomass indices were calculated. In GSA09 the following number of hauls was reported per depth stratum (Table 6.11.3.1.1.1).

Table 6.11.3.1.1.1 Number of hauls per year and depth stratum in GSA09, 1994-2011.

Stratum	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
010-050	21	20	20	20	21	20	20	19	15	14	15	16	15	15	16	16	15	15
050-100	21	21	20	20	20	21	22	23	17	18	17	16	18	18	16	16	19	19
100-200	38	40	40	40	39	39	38	38	30	30	30	31	30	30	31	31	29	29
200-500	40	40	42	42	41	41	42	41	32	33	36	35	37	37	34	34	35	35
500-800	33	32	31	31	32	32	31	32	26	25	22	22	20	20	23	23	22	22
Total	153	153	153	153	153	153	153	153	120	120	120	120	120	120	120	120	120	120

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 1 km^2.
The abundance and biomass indices were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modeled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al*., 2004).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.11.3.1.2 *Geographical distribution patterns*

No information was documented during EWG-12-10.

6.11.3.1.3 *Trends in abundance and biomass*

Figure 6.11.3.1.3.1 shows the MEDITS abundance index of poor cod obtained from 1994 to 2011.A fluctuating trend is evident, with very low values in the last two years (2010-2011).

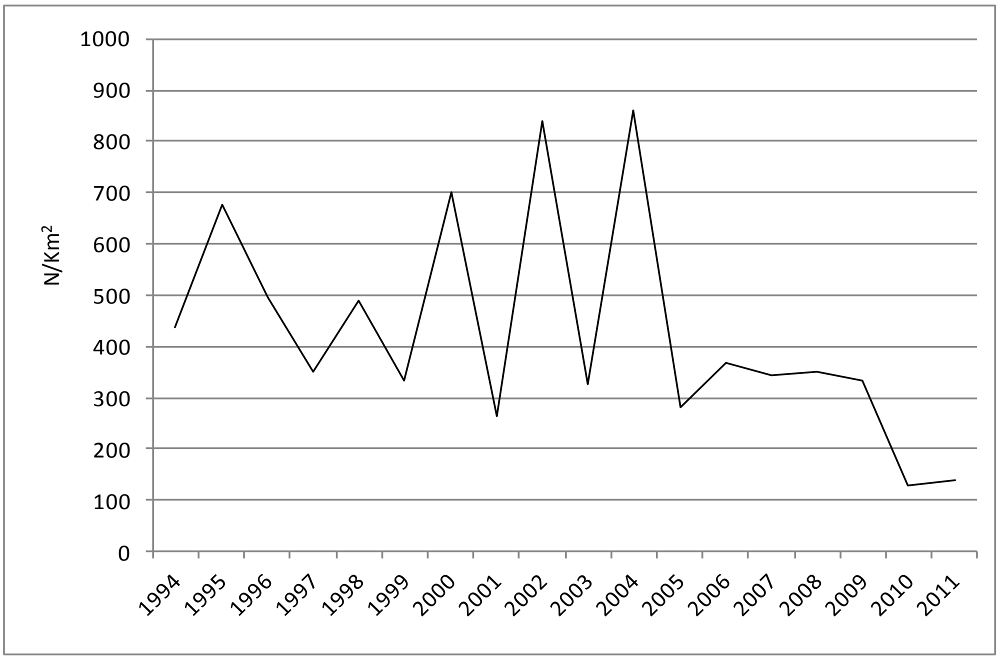


Fig. 6.11.3.1.3.1 Density MEDITS index of poor cod in GSA 09.

6.11.3.1.4 *Trends in abundance by length or age*

The following figure 6.11.3.1.4 displays the stratified abundance indices of GSA09 in 1994-2011. The size distributions are, in most of the years, characterized by two evident modes, the first one at 5-7 cm TL and the second one at 13-15 cm TL.

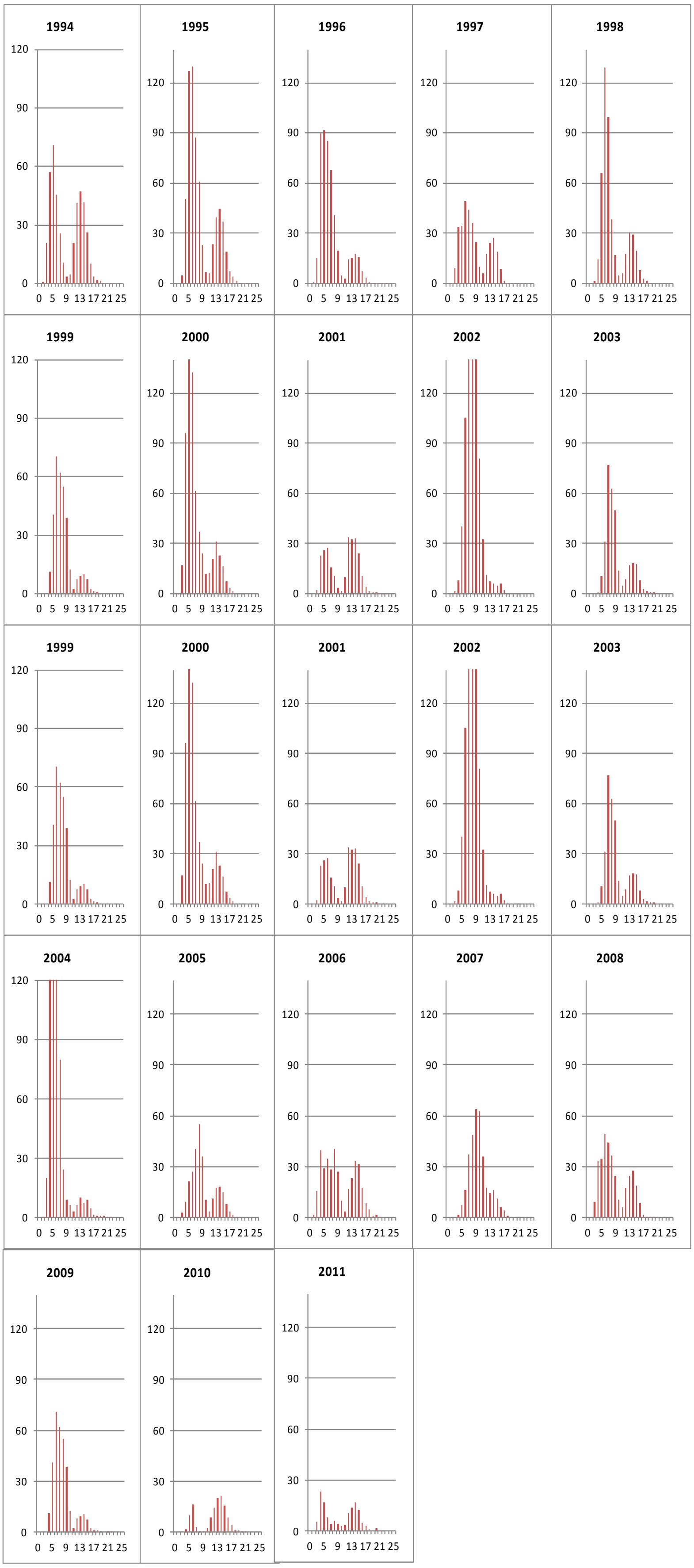


Fig. 6.11.3.1.4 Stratified abundance indices by length (n·km^{-2}), 1994-2011.

6.11.3.1.5 *Trends in growth*

No information was documented in EWG 12-10.

6.11.3.1.6 *Trends in maturity*

No information was documented.

6.11.4 *Assessments of historic stock parameters*

6.11.4.1 Method 1: SURBA

6.11.4.1.1 *Justification*

The relatively long time series of data (1994-2011) available from the MEDITS surveys provided the most useful data sets for analysis. The survey-based stock assessment approach SURBA (Needle, 2003) was used on MEDITS data of poor codinthe GSA09.

6.11.4.1.2 *Results*

Fitted year effect, that is the model proxy for the combination of fishing effort and mean natural mortality in the underlying population, shows fluctuations that are particular wide in the last years. Fitted age effect shows an increasing from age 0 to age 3+, while fitted cohort effect showsa decreasing trend (Fig.6.11.4.1.2.1).

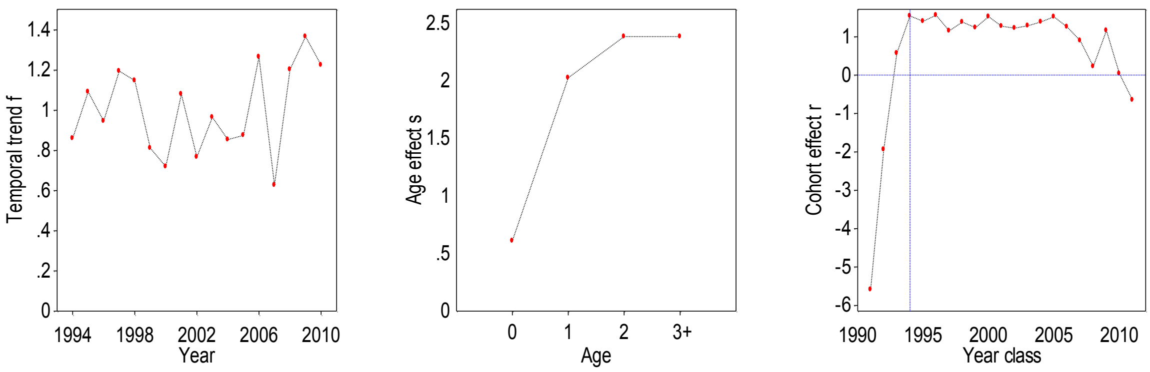


Fig. 6.11.4.1.2.1MEDITS survey. Fitted year, age and cohort effects estimated by SURBA.

Figure6.11.4.1.2.2 shows estimated trend in F, relative recruitment and SSB by SURBA.$F_{0\text{-}3+}$estimated from MEDITS indices showed a decreasing between 1994 and 2005, followed by large fluctuations in the following 3 years. Very high F values, over 2.5, have been observed in 2010 and 2011.

Recruitment index showed high variability from year to year, without a temporal pattern in the period 1994-2005; since 2006, an evident decreasing trend is shown with very low values in the last two years.

Relative SSB was higher during 1994-95, fluctuating without any trend in the following years.

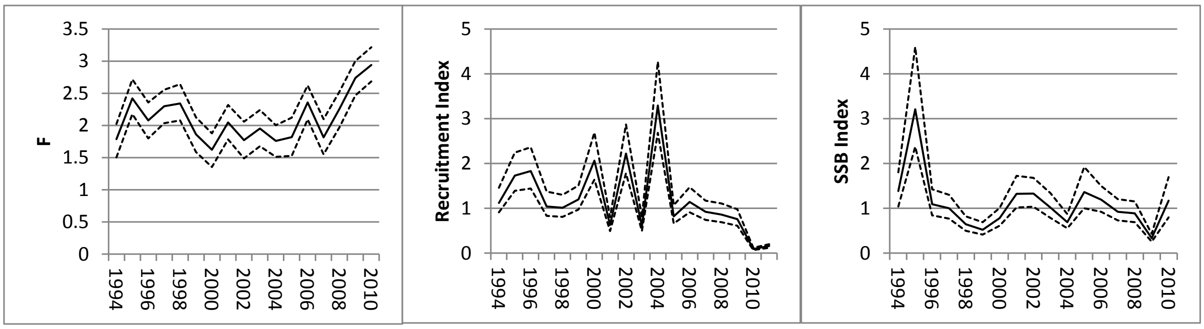


Fig. 6.11.4.1.2.2 MEDITS survey. Estimated trend in F, relative recruitment and SSB from SURBA. 50th percentile of bootstrapped runs (solid line) and 5% and 95% percentiles of bootsrapped runs (dashed lines).

Model diagnostics are shown in the followingFigures6.11.4.1.2.3 and 6.11.4.1.2.4.

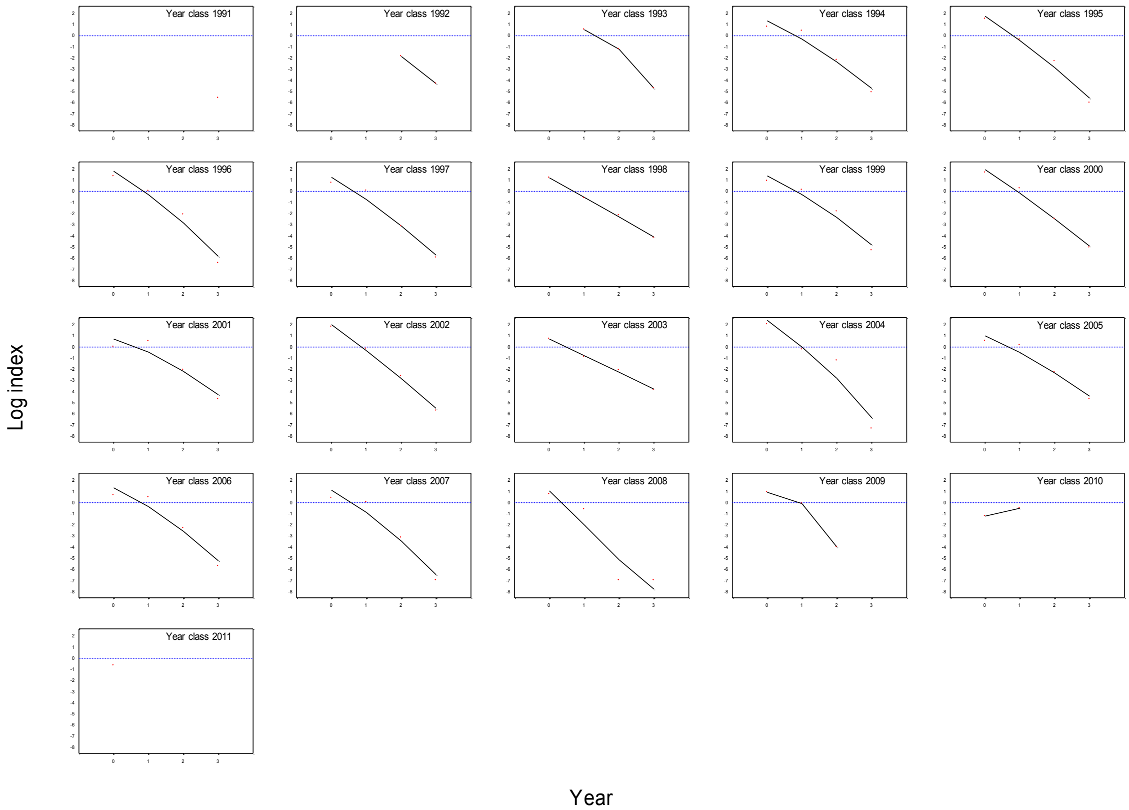


Fig. 6.11.4.1.2.3 Model diagnostic for poor cod SURBA model in the GSA09 (MEDITS data). Comparison between observed (points) and fitted (lines) survey abundance indices, for each year.

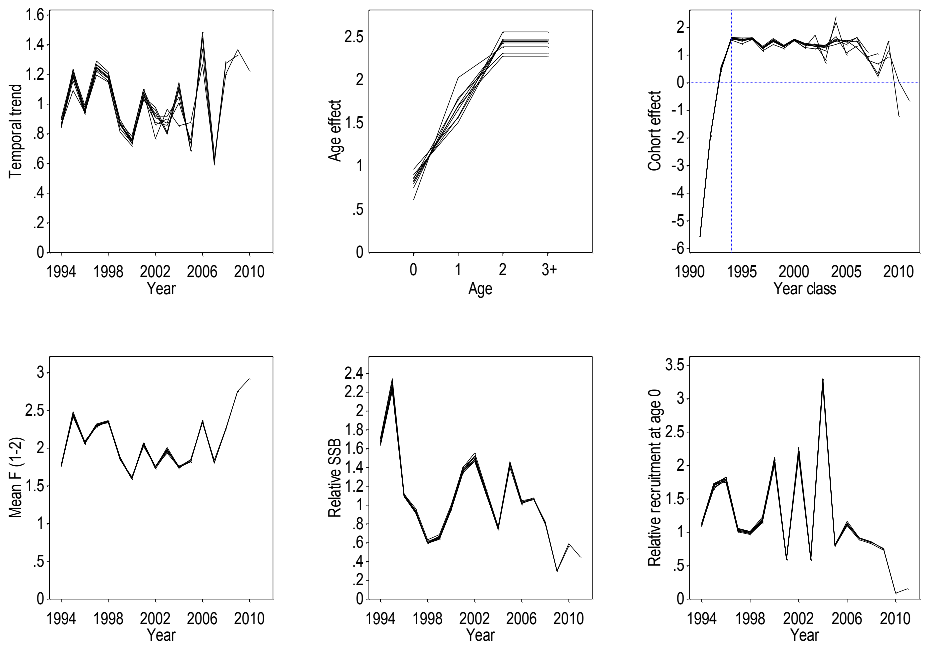


Fig. 6.11.4.1.2.4 Model diagnostic for poor cod SURBA model in the GSA09 (MEDITS data).

6.11.4.2 Method 2: LCA

6.11.4.2.1 *Justification*

EWG 12-10 performed the first assessment of poor cod in GSA09 applying an LCA on 2011 DCF landings dataand catch atage.The software used to carry out the analyses was VIT (Lleonart & Salat, 1992).
Data used in the analysis cover set nets (trammel net + gillnet) and trawling (including discard). Considering that only data for one year were available, it was not possible to perform a formal VPA.

6.11.4.2.2 *Input parameters*

Data derived from commercial catches (i.e. landing and discard) by size/age for sexes combined were used in the analyses. LFDA was used in order to convert the size frequency distributions in age classes.

The length and the age frequency distributionsof the catches are shown in Figures 6.11.4.2.2.1 and 6.11.4.2.2.2, respectively.

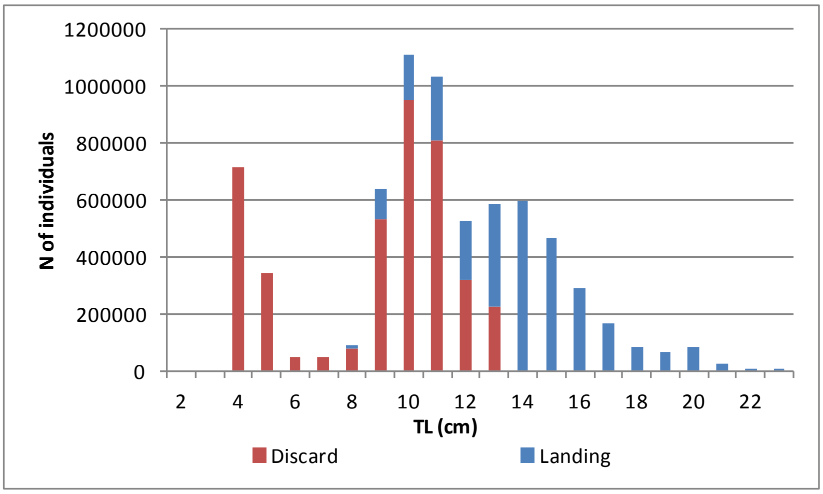


Fig. 6.11.4.2.2.1 Size frequency distributions of the total catch of poor cod in GSA 09 in 2011.

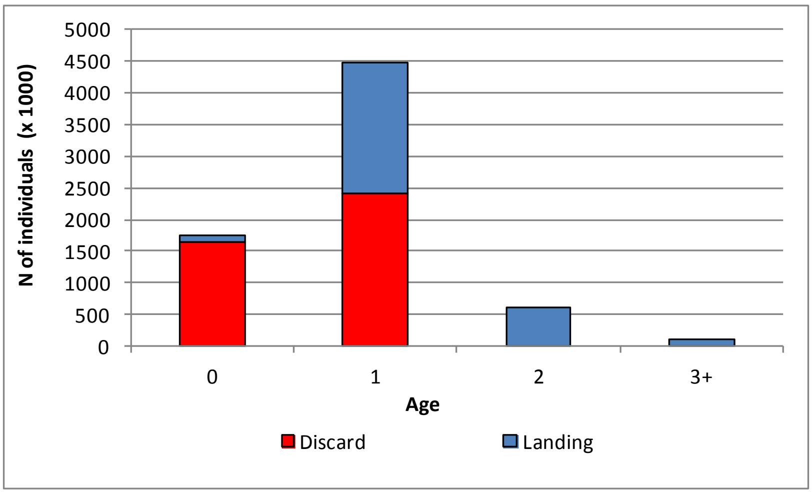


Fig. 6.11.4.2.2.2Numbers at age of the total catch of poor cod in GSA 09 for 2011.

The range of the exploited sizes is between 4 and 23 cm total length (TL), corresponding to specimens between 0+ and 4 years of age. The discarded specimens show a size range between 4 and 13 cm TL, the majority of them with a size comprised between 4 and 11 cm TL (i.e. 0+ and 1 year age classes). The landingsare composed by specimens between 9 and 23 cm TL, with high abundance of the size classes between 13 and 16 cm TL (1 and 2 year age classes). The total catches (landings + discards) were mainly composed by 0+ and 1 age classes.

The number of specimens at age used in the VIT analysis is reportedin Table 6.11.4.2.2.1.

Table 6.11.4.2.2.1 Numbers at age (in thousands) of the total catches for 2011.

Age	Landing	Discard	Total
0	95291	1653283	1748574
1	2045271	2419982	4465253
2	603405	0	603405
3+	120161	0	120161
Total	2864128	4073265	6937393

The following set of parameters was used to perform the LCA:

Growth parameters (Von Bertalanffy)
$L\infty$ = 27 (cm, total length)
K = 0.45
$t_0 = 0$
L*W
a = 0.03
b=2.622
Natural mortality (M) vector Age 0 = 1.29, Age 1 = 0.53, Age 2 = 0.37, Age 3 = 0.31
Length at maturity (L_{50})
L_{50} = 13 cm TL

The vector of natural mortality M was estimated using Prodbiom.

6.11.4.2.3 *Results*

VIT results of catch and biomass at age, the initial number by age in the stock and the total fishing mortality by age are showed in figure6.11.4.2.3.1.

The total catch in number is almost composed by fish of the 0 and 1 age classes, while 1 and 2 age classes dominates in terms of biomass. Fishing mortality is the highest for 1 and 2 age classes.

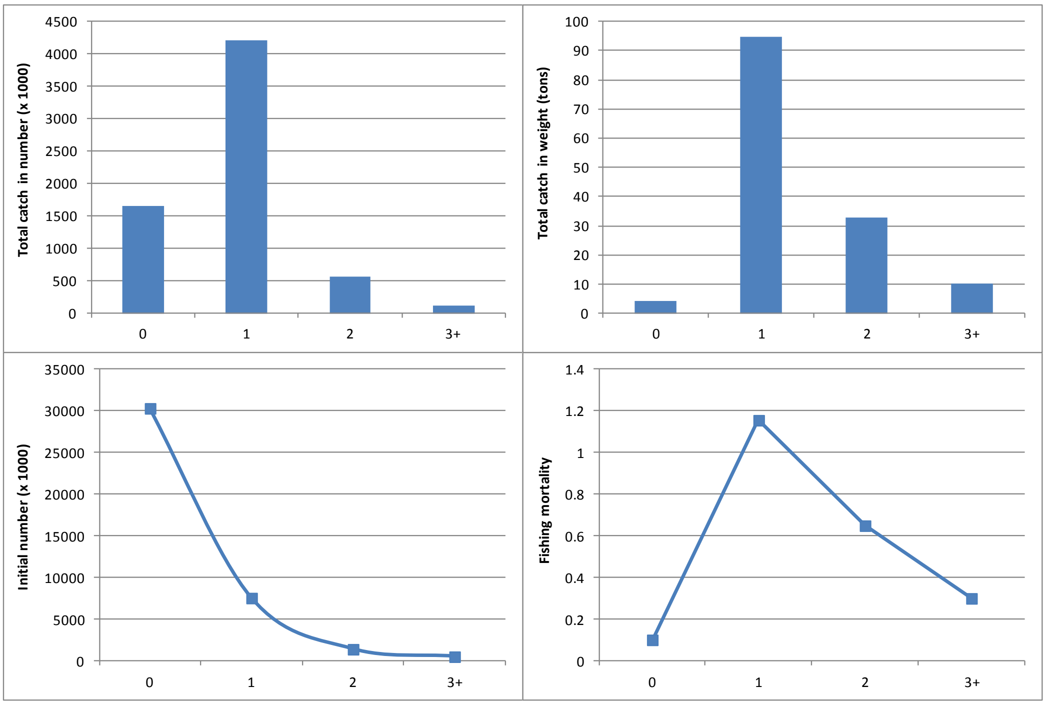


Fig. 6.11.4.2.2.1 LCA outputs: catch in number, biomass, initial number and fishing mortality at age of poor cod in the GSA09.

6.11.5 *Long term prediction*

6.11.5.1 Justification

Yield per recruit analysis (YPR) was conducted based on the exploitation pattern resulting from the VIT model and population parameters.

The YPR analysis allowed the estimate of $F_{0.1}$, which is considered as a proxy of F_{MSY}.

6.11.5.2 Imput parameters

Length frequency data (2011) and the biological parameters used were the same used for the LCA.

6.11.5.3 Results

Figure6.11.5.3.1 shows the results of the YPR analysis and the SSB/R and Table 6.11.5.3.1shows the reference fishing mortality (F_{ref}), along with the reference points $F_{0.1}$ and the F_{max}. The F current is the mean of the F values obtained from the LCA analysis for the 1-2 age classes excluding the first (0) and the last (3+) age class.

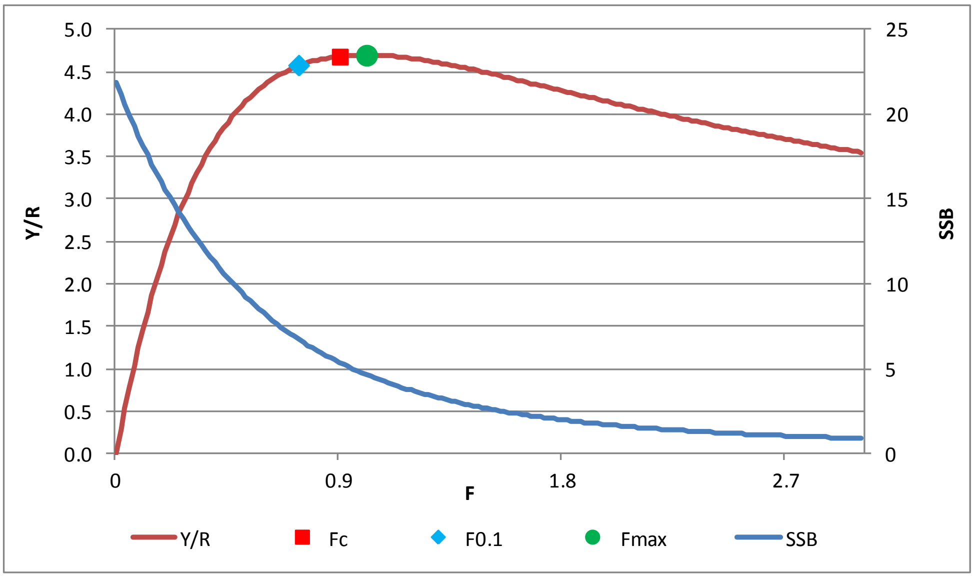


Fig. 6.11.5.3.1 Results of the Y/R analysis.

Table. 6.11.5.3.1 Results summarising the yield per recruit analysis performed on 2011 data.

	F	Y/R	B/R	SSB
Virgin	0.00	0.00	23.69	21.87
$F_{0.1}$	0.74	4.57	8.23	6.72
Fcurrent	0.90	4.68	6.83	5.37
F_{max}	1.01	4.70	6.09	4.66

6.11.6 *Data quality*

No specific comments were raised.

6.11.7 *Scientific advice*

6.11.7.1 Short term considerations

6.11.7.1.1 *State of the stock size*

The MEDITS survey data (1994-2011) indicate a fluctuating stock with a decreasing trend in stock abundance for the last years. The LCA analyses give a SSB estimation of 163 tons in 2011.

6.11.7.1.2 *State of recruitment*

The analyses performed on commercial data give an estimation of $3x10^6$ recruits in 2011. The analysis of MEDITS data for the period 1994-2011 shows high fluctuations in the recruitment index with a negative trend in the last five years.

6.11.7.1.3 *State of exploitation*

EWG 12-10 proposes $F_{0.1} \leq 0.74$ as limit management reference point consistent with high long term yields (F_{MSY} proxy).

The current F=0.90is above the F_{MSY} reference point (0.74), which indicates that poor cod in GSA09 is exploited unsustainably.

The analysis of MEDITS data shows high values of F with a peak in correspondence of the last two years of the data series (2009 and 2010). The higher F values estimated for MEDITS data in respect to that coming from commercial fishery is probably due to the fact that the survey is carried out in May-June when poor cod shows the peak in recruitment.

EWG 12-10 emphasizes that this is the first attempt to evaluate the exploitation state of the species and, therefore, it is necessary to analyse a longer data series in order to confirm the results obtained for 2011.

6.12 **Stock assessment of spottail mantis shrimp in GSA10**

6.12.1 *Stock identification and biological features*

6.12.1.1 Stock identification

The stock of the spottail mantis shrimp (*Squilla mantis*) was assumed to cover the geographical boundaries of GSA, for want of specific information on stock status. The species is of secondary commercial importance in GSA10, but regularly caught by set nets (mainly trammelnets, with a small contribution from gillnets). Its area of distribution is coastal (5-80 m depth, with occasional catches down to 120 m depth) and is found in high densities in the vicinity of large rivers, mainly in the Western Mediterranean and the Adriatic sea (Maynou et al., 2005).

6.12.1.2 Growth

Growth parameters of *S. mantis* were determined by modal progression analysis based on the analysis of length frequency distributions (M. T. Spedicato, pers. comm..). The values of the von Bertalanffy growth function for GSA10 (combining males and females) were: L_∞ =42.0 mm CL, k=0.49 yr^{-1}, t=0 yr, while the length-weight relationship parameters were: a=0.002018 g mm^{-3} and b = 2.948 (all parameters correspond to measurements in mm CL). The value of these parameters is very close to the values reported for the Ebro Delta or the Adriatic sea in Maynou et al. (2005).

6.12.1.3 Maturity

The proportion of mature individuals by age class was determined as: Age0 = 0.04, Age1= 0.9, Age2 and older = 1, for males and females combined (M. Sbrana, pers. comm.), taking a length at 50% maturity of 20 mm CL (comparable to other Mediterranean mantis shrimp populations).

6.12.2 *Fisheries*

6.12.2.1 General description of fisheries

The mantis shrimp is a by catch species of commercial importance, caught by a variety of static fishing gear (trammel nets, gillnets and baited traps) and towed nets. In GSA10 the bulk of catches are produced by otter trawl and trammelnets, with a low contribution of gillnets. Trammelnet catches and gillnet catches are combined for the present assessment as “set nets”.

6.12.2.2 Catches

6.12.2.2.1 *Landings*

Landings of mantis shrimp were 145 t in 2008 and 128 t in 2009 for otter trawl (no data for set nets). No data on landings was available for 2010. For 2011, landings data by fishing gear (at annual level) is available and given in the table below.

Table 6.12.2.2.1.1 Landings and discard (in tons) of mantis shrimp for 2011 reported in the 2012 DCF data call (GSA10).

	Landings	Discards	Total
Otter trawl OTB	276.20	21.14	297.34
Gillnet GNS	0.19	0.00	0.19
Trammel net GTR	110.79	3.43	114.21
Total	387.18	24.57	411.74
% Discard			12%

6.12.2.2.2 *Discards*

Total discards are 12% of the catches, but for Age 0 caught by otter trawl, discards represent around 50% of the catch in numbers. Low levels of discards (<10% of the catch) from trammelnets correspond to damaged or otherwise unmarketable individuals.

6.12.3 *Scientific surveys*

6.12.3.1 MEDITS

The average biomass index of mantis shrimp in the 50 and 100 depth strata is shown in Figure6.12.3.1.1.

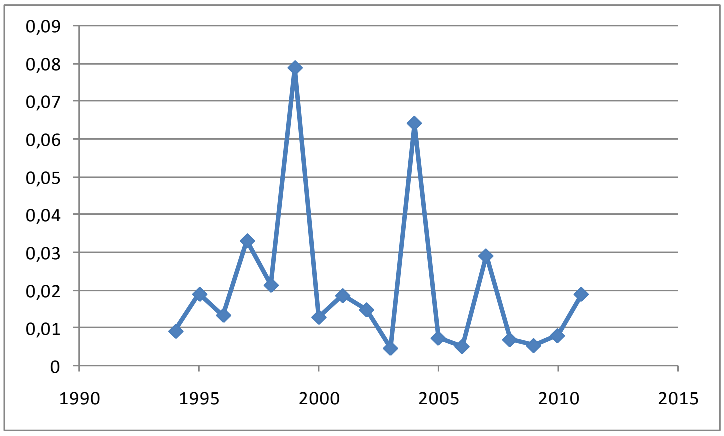


Fig. 6.12.3.1.1 Evolution of mantis shrimp biomass (kg/km2) in GSA10 from MEDITS trawl surveys.

The MEDITS data series shows high interannual variability in the average biomass of mantis shrimp, with no significant temporal trend.

6.12.4 *Assessment of historic stock parameters*

6.12.4.1 Method 1: VIT

6.12.4.1.1 *Justification*

Only one year of length frequency distributions of landings was available: 2011. The data were analyzed under steady state assumption, using age classes as pseudocohorts. A VPA based on pseudocohorts and Y/R analysis was applied using the VIT4win software package (Lleonart and Salat, 1997). Data of number at age were taken from the DCF official 2012 data call. Due to the low and sparse frequency of individuals in ages classes 4 to 7 (maximum reported), the analysis was carried out using a class plus for age 3.

6.12.4.1.2 *Input parameters*

The VPA analysis on pseudocohorts was carried out combining sexes, because the mantis shrimp does not show sexual dimorphism. The von Bertalanffy growth parameters were $L_\infty = 42.0$ mm CL, $k = 0.49$ yr^{-1}, $t = 0$ yr, while the length-weight relationship parameters were: $a = 0.002018$ g mm^{-3} and $b = 2.948$ (all parameters correspond to measurements in mm CL). A vector of natural mortality was computed using Probiom (Abella et al., 1997): Age 0 = 1.42, Age 1 = 0.63, Age 2 = 0.48, Age 3+ = 0.38. The terminal fishing mortality was set at 0.5 (after performing sensitivity analysis over a wide range of values: 0.05 – 1). The proportion of mature individuals by age class was determined as: Age0 = 0.04, Age1= 0.9, Age2 and older = 1, for males and females combined (M. Sbrana, pers. comm.), taking a length at 50% maturity of 20 mm CL.

6.12.4.1.3 *Results*

Figure 6.12.4.1.3.1 and Table 6.12.4.1.3.1 show the numbers at age in the total catches. Most individuals caught belong to ages 0 and 1, with the catch of 0-age individuals due mainly to bottom trawl.

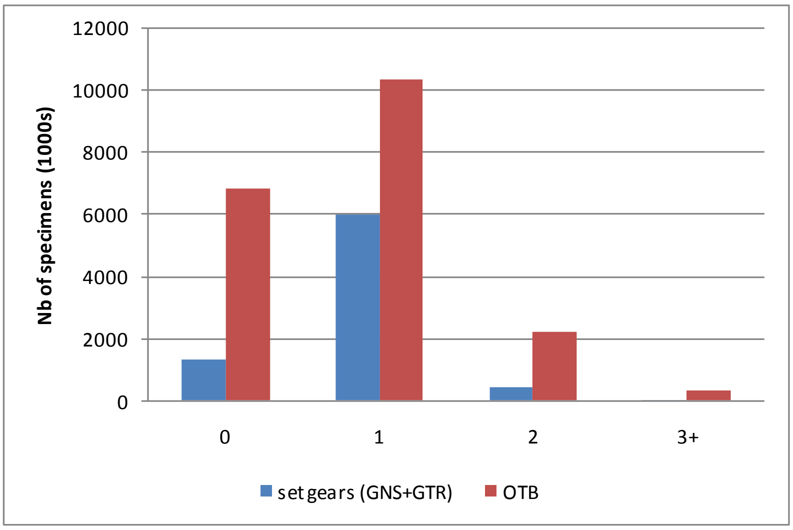


Fig. 6.12.4.1.3.1 Numbers at age in the total catches for 2011 (GSA10).

Table 6.12.4.1.3.1 Numbers at age in the total catches for 2011 (GSA10).

Age	Total catch	set gears (GNS+GTR)	OTB
0	8,149,662	1,318,957	6,830,705
1	16,405,765	6,024,292	10,381,473
2	2,650,695	451,591	2,199,105
3+	342,645	22,989	319,656
Total	27,548,768	7,817,829	19,730,939

The catches in weight are dominated by Age 1, contributing to *ca.* 2/3 of the catches, as shown in the Figure 6.12.4.1.3.2.

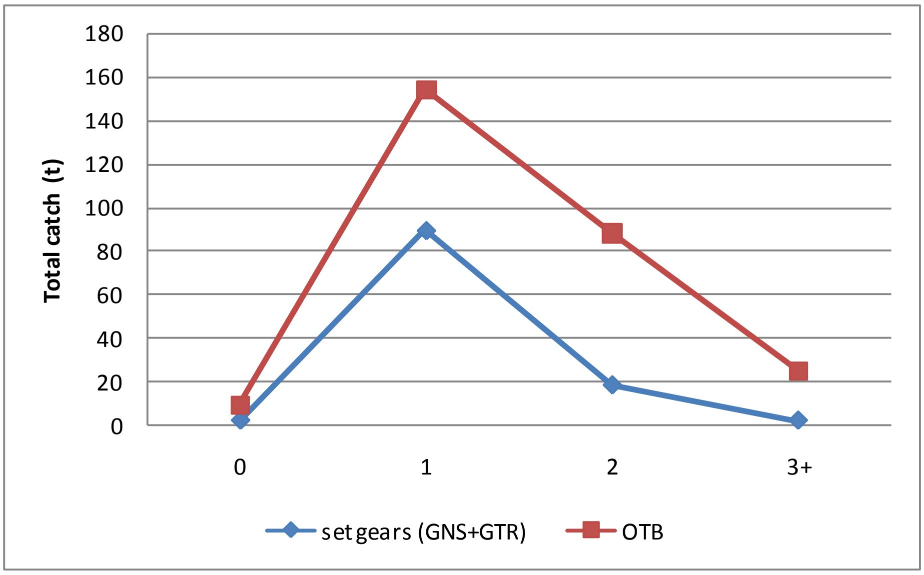


Fig. 6.12.4.1.3.2 Distribution of catches (t) by age class in GSA10 in 2011.

The initial number of individuals was estimated at *ca.* 140 million individuals, as shown in Figure 6.12.4.1.3.3.

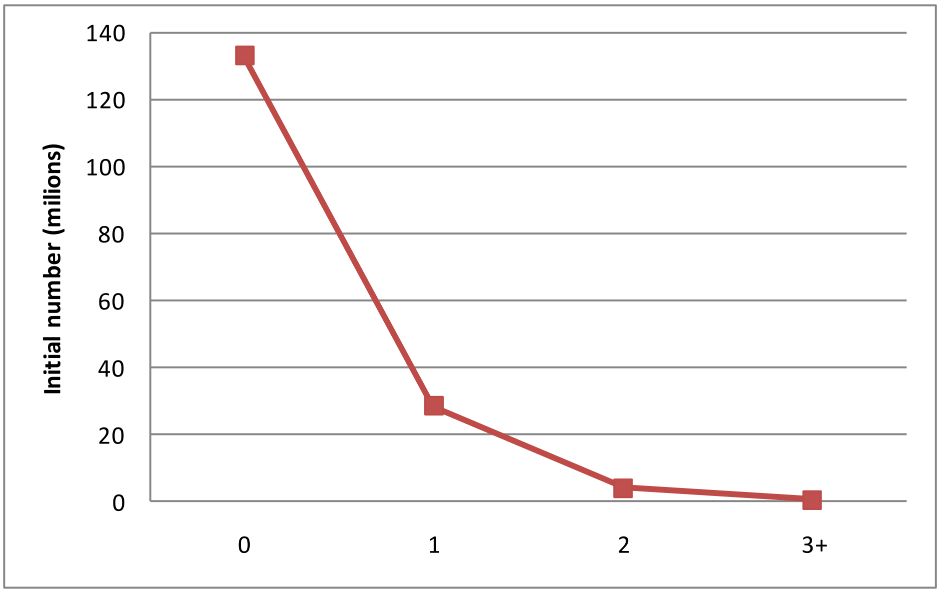


Fig. 6.12.4.1.3.3Initial number of individuals in GSA10 in 2011.

Fishing mortality is higher for ages 1 and 2, due particularly to otter trawl, as shown in Figure 6.12.4.1.3.4.

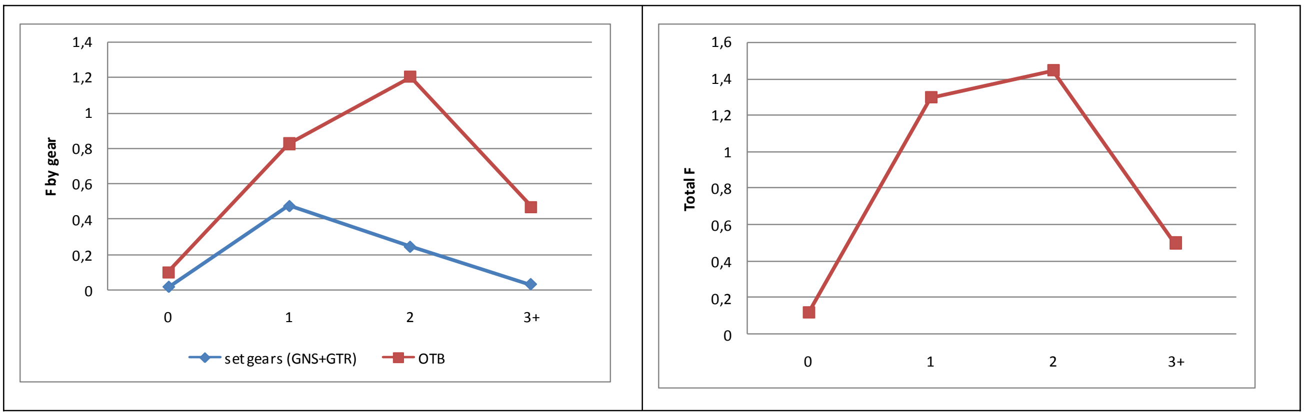


Fig. 6.12.4.1.3.4Fishing mortality by age class and gear (left panel) and total fishing mortality (right panel) in 2011 in GSA10.

The average fishing mortality for age classes 1-3 was F = 1.08 yr^{-1}.

6.12.5 *Long term prediction*

6.12.5.1 Justification

A yield per recruit (Y/R) analysis was carried out using the VIT4win program.

6.12.5.2 Input parameters

The same input parameters used for VPA were used in the Y/R analysis

6.12.5.3 Results

The yield curves were dome shaped for both fishing gears. The yield produced by set nets was close to the maximum, while the yield produced by OTB was lower than the maximum, which would be found at 58% of current fishing mortality.

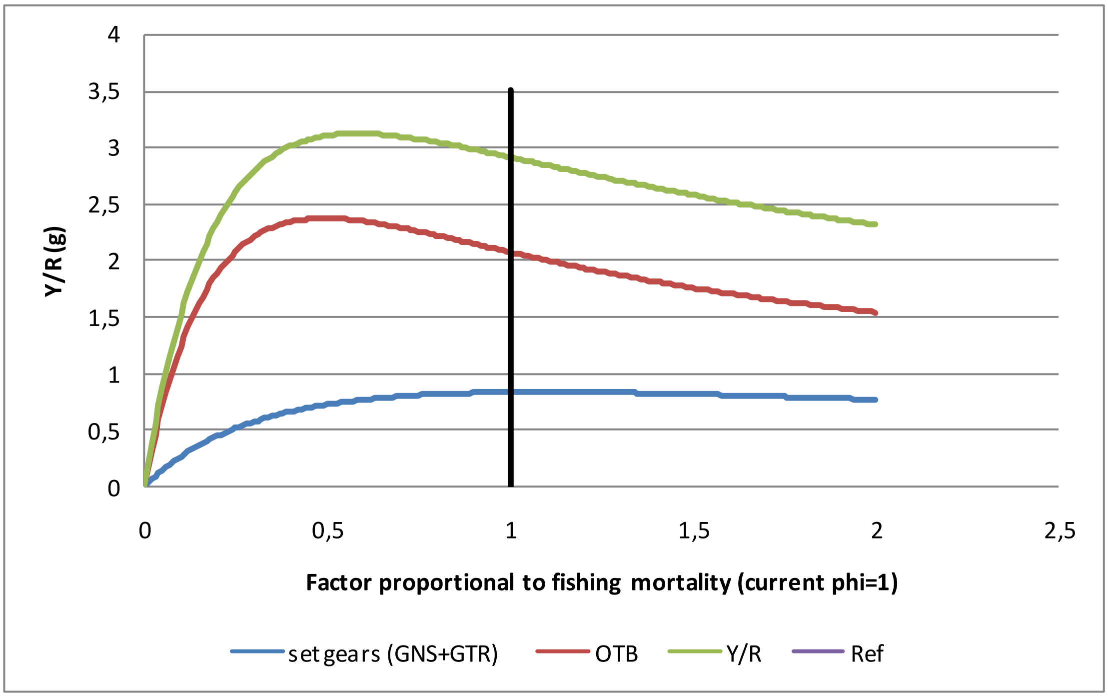


Fig. 6.12.5.3.1Yield per recruit of mantis shrimp by fishing gear and total in 2011 (GSA10).

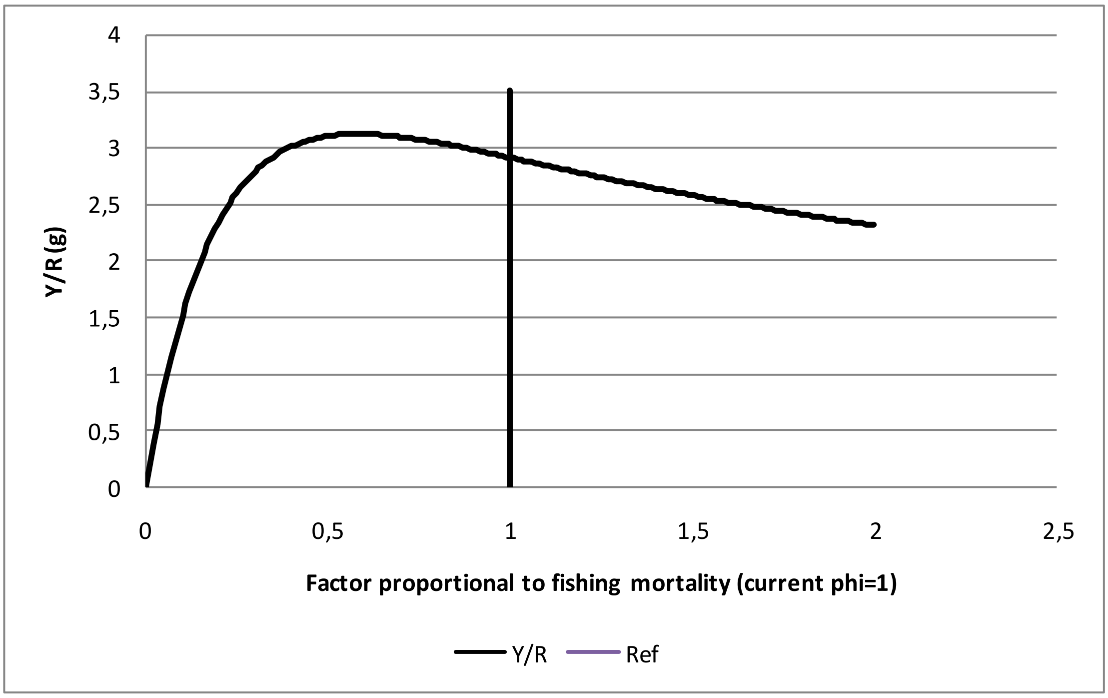


Fig. 6.12.5.3.2Yield per recruit of mantis shrimp in 2011 (GSA10), both gears combined.

Spawning stock biomass at current fishing mortality is less than 10% of virgin biomass, as shown in Figure 6.12.5.3.3.

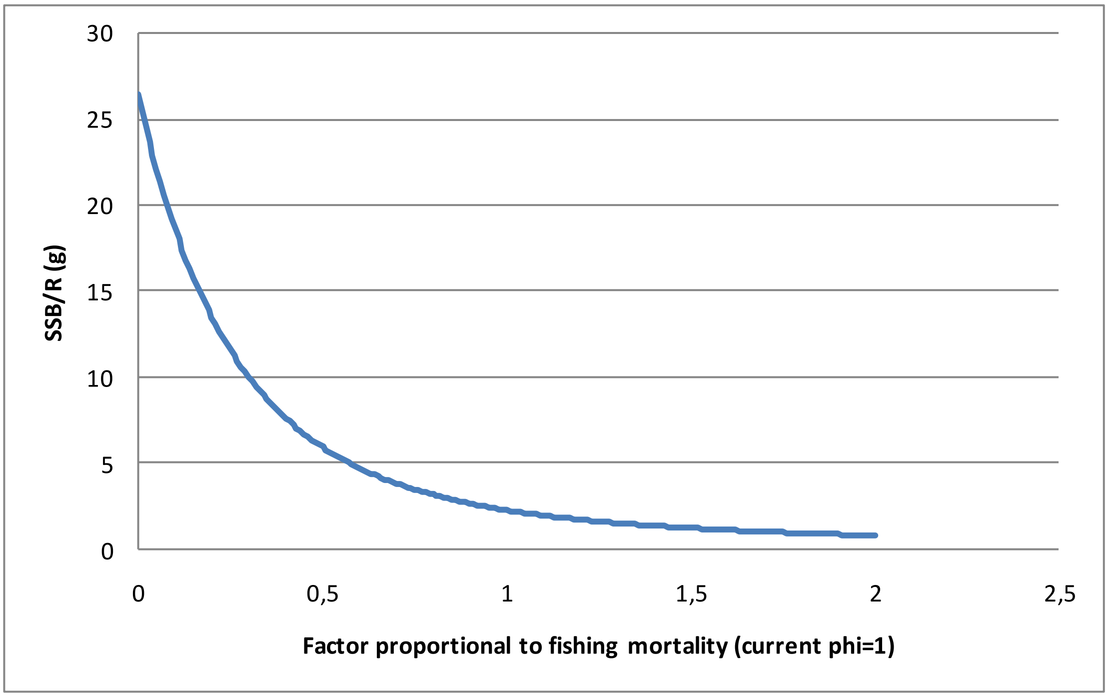


Fig. 6.12.5.3.3 Spawning stock biomass per recruit in GSA10 in 2011.

The yield per recruit analysis shows that a substantial reduction in fishing mortality would be necessary to reach F_{msy} (from current F of 1.08 to $F_{0.1}$ of 0.41), Table 6.12.5.3.1.

Table 6.12.5.3.1 Results summarizing the yield per recruit analysis performed on 2011 data (GSA10).

	TOTAL FISHERY					set nets (GNS+GTR)	OTB
	Factor	Absolute F	Y/R	B/R	SSB/R	Y/R	Y/R
Virgin	0	0	0	27.421	26.393	0	0
F01	0.38	0.41	2.994	8.709	7.788	0.655	2.339
Fcurr	1	1.08	2.913	3.051	2.249	0.835	2.078
Fmax	0.58	0.63	3.121	5.782	4.904	0.761	2.360

6.12.6 *Data quality and availability*

Data from DCF 2012 were used. The data available are of sufficient quality to perform a VPA on pseudocohorts, although longer data series would be desirable in order to investigate the robustness of these results to the strong interannual variability in the abundance of the mantis shrimp, suggested from the evolution of the trawl survey index of abundance.

6.12.7 *Scientific advice*

6.12.7.1 Short term considerations

6.12.7.1.1 *State of the spawning stock size*

EWG 12-10 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points. However, survey indices indicate a variable pattern of abundance, with the values in the last 3 years among the lowest observed in the 1994-2011 data series.

6.12.7.1.2 *State of recruitment*

EWG 12-10 is unable to fully evaluate the state of mantis shrimp recruitment.

6.12.7.1.3 *State of exploitation*

EWG 12-10 proposed $F_{0.1}$ = 0.41 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 1.08), the stock is considered exploited unsustainably.

6.13 **Stock assessment of hake in GSA 11**

6.13.1 *Stock identification and biological features*

6.13.1.1 Stock Identification

This stock is assumed to be confined within the GSA 11 boundaries, where it is distributed between 30 and 650 m of depth, with a peak in abundance (due to high number of recruits) over the continental shelf-break (between 150 and 250 m depth). The stock is mainly exploited by the local fishing fleet, although seasonally and occasionally some other Italian fleet use to fish in some areas of the GSA 11. Spawning is taking place almost all year round, with a peak during winter–spring.

Juveniles showed a patchy distribution with some main density hot spots (nurseries) showing a high spatio-temporal persistence (Murenu *et al.*, 2007) in western areas.

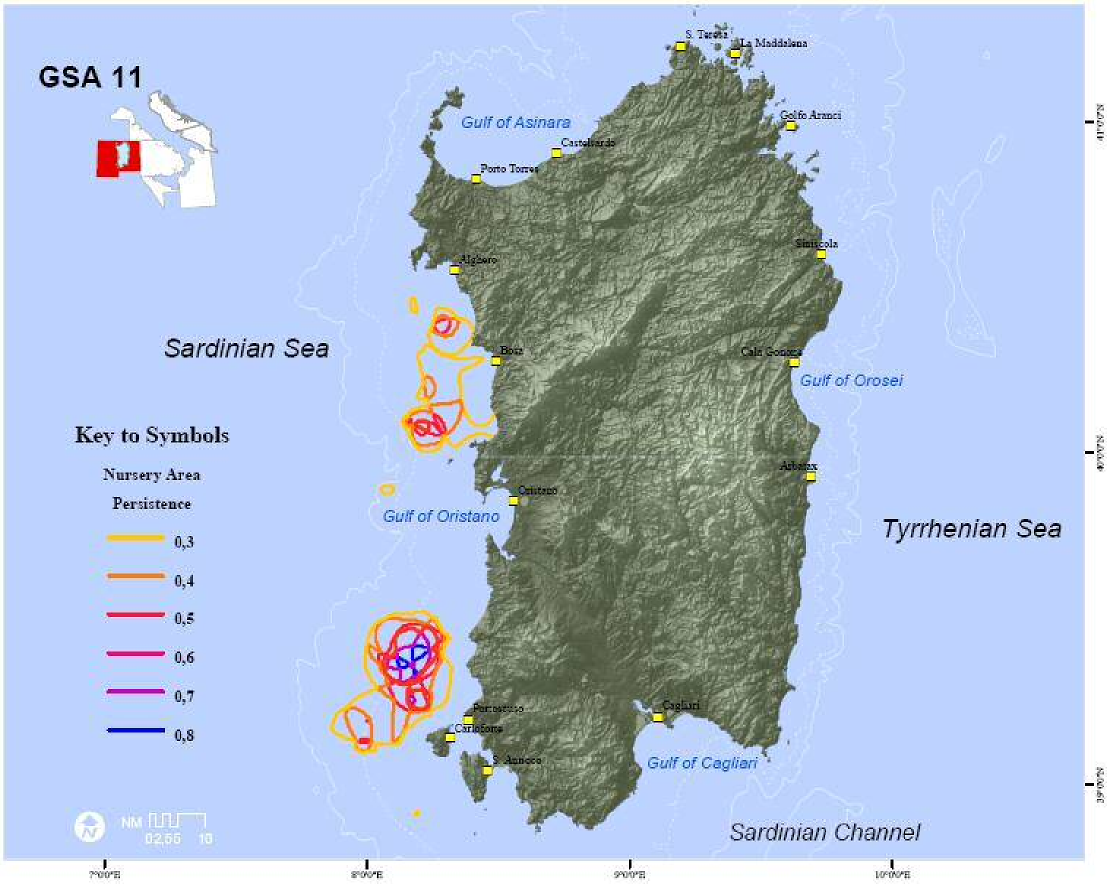


Fig. 6.13.1.1.1 Temporal persistence of hake nurseries calculated from data survey time-series density maps (1994-2006) of juveniles.

6.13.1.2 Growth

The same fast growth of last SGMED have been used in this assessment (L_∞=100,7 cm, K=0.248, t_0= -0.01).

6.13.1.3 Maturity

Due to the low catchability of large hake in trawl, the catch rate of mature specimens during the MEDITS trawl survey is usually very low, influencing the identification of gonad development and growth rate for large individuals. Female length at first maturity is estimated at around 36 cm. Although spawning around Sardinian coasts (GSA 11) occurs nearly all over the year (January to September), a maturity peak is usually observed in winter and spring (February-May).

6.13.2 *Fisheries*

6.13.2.1 General description of fisheries

Hake is one of the most important commercial species in the Sardinian seas. In this area, the biology and population dynamics have been studied intensively in the past fifteen years. Although hake is not a target of a specific fishery, such as for example red shrimp, it is the third species in terms of biomass landed in GSA 11 (Murenu M., pers. com.). In the GSA 11 hake is caught exclusively by a mixed bottom trawl fishery at depth between 50 and 600 m. No gillnet or longline fleets target this species. Although different nets are used in shallow, mid and deep water ("terra" mainly targeting *Mullus* spp., "mezzo fondo" targeting fish and "fondale" net targeting deep shrimp) the main trawl used is an "Italian trawl net" type with a low vertical opening (max up to 1.5 m). The dimensions of the trawl change in relation to the trawlers engine power. Important by catch species are *Eledone cirrhosa, Loligo spp., Trisopterus minutus, Chlorophthalmus agassizi,Phycis blennoides and Parapaeneus longirostris.*Detailed maps of the fishing-grounds are reported in Murenu *et al*. (2006).Most of the effort is concentrated within a relative short distance around the major fishing ports (Cagliari, Alghero, Porto Torres, La Caletta, Sant'antioco, Oristano, Alghero). Moreover, some large trawlers move seasonally in different fishing grounds far from the usual ports.

From 1994 to 2004, the trawl fleet showed remarkable changes in GSA 11. Those mostly consisted of a general increase in the number of vessels and by the replacement of the old, low tonnage wooden boats by larger steel boats. For the entire GSA an increase of 85% for boats >70 tons class occurred. A decrease of 20% for the smaller boats (<30 GRT) was also observed.

6.13.2.2 Management regulations applicable in 2010 and 2011

As in other areas of the Mediterranean, management is based on the control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area closures), and minimum landing sizes (EC 1967/06). Two small closed areas were also established along the mainland (west and east coast respectively) although these are defined to mainly protect Norway lobster. Since 1991, a fishing closure for 45 trawling days has been enforcedalmost every year.

Towed gears are not allowed within the three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

6.13.2.3 Catches

6.13.2.3.1 *Landings*

Landings available for GSA 11 by major fishing gears are listed in Table6.13.2.3.1.1.

Landings decreased from 866 t (2005) to 389 t in 2011 (Figure6.13.2.3.1.1).Landings of hake are mostly taken by the demersal trawl fisheries (OTB),which in average account for about the 86% of the total. From available data, landings from other gears are mainly from GTR although they seem to be misreported in 2007 and 2009. It is not clear to EGW 12-10 if they are belonging to a real fishery for hake.

Table6.13.2.3.1.1 Landings (t) by year and major gear types, 2005-2011 as reported through DCF in 2012.

GEAR	2005	2006	2007	2008	2009	2010	2011
GTR (LLS 2009)	101	206		28,6	7,02	87,9	102
OTB	765	594	442	279	261	330	287
Total landings	866	800	442	307	268	418	389

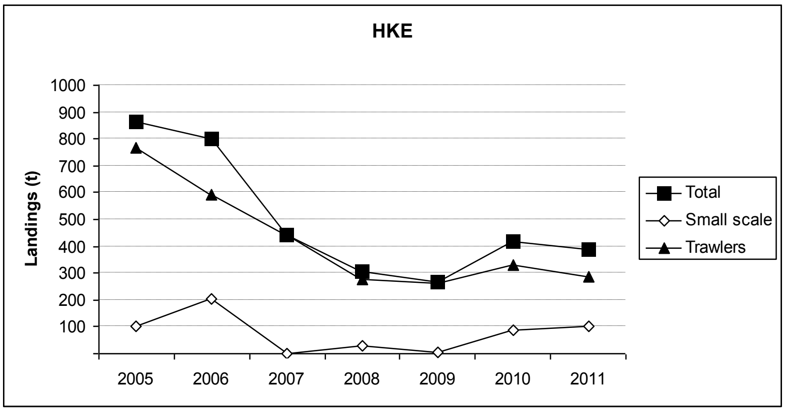


Fig. 6.13.2.3.1.1 Landings (t) by year and major gear types, 2005-2011 as reported through DCF.

Looking to landing at length, data distribution differs particularly in 2008 when a peak of recruits was shown in Figure6.13.2.3.1.2.

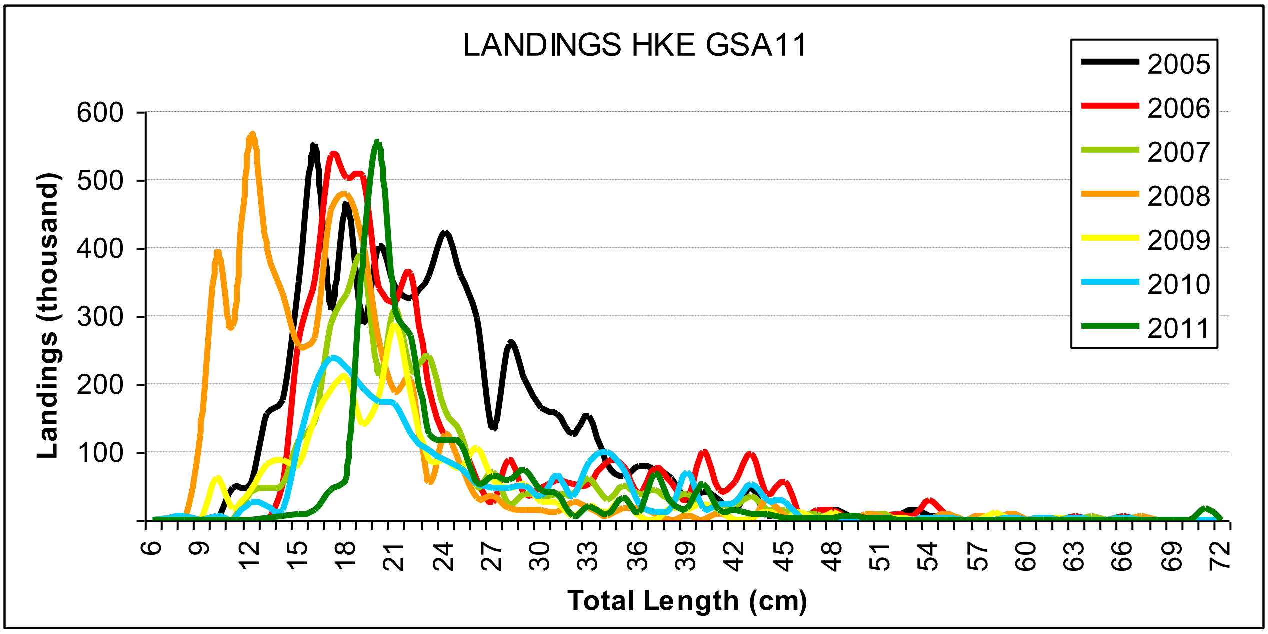


Fig. 6.13.2.3.1.2 Landings by length and year (2005-2011) as reported through DCF.

6.13.2.3.2 *Discards*

Discards reported to STECF EGW12-10 were null for 2007 and 2008 as shown in Table6.13.2.3.2.1. The discard decrease observed in 2010 reflect the drop observed in the same period for the total landings, while the very high increase in 2011 (more then 10 times greater of previous years) seems to be not realistic even because the MEDITS suvey does not show a peak in recruitment nor in abundances for this year. Moreover seem to be not reliable that in 2011 OTB discards are 90% and OTB landings account for 10% only.

Table6.13.2.3.2.1 Discards (t) by year, 2005-2010, as reported through DCF in 2011.

	2005	2006	2007	2008	2009	2010	2011
total discards	387	234	0	0	168	125	1946

Looking to discard at length, data were neither continuous by gear nor by year. Moreover the discard from GTR belongs only to large size specimens, that usually are not discarded by commercial fleets as shown by trawlers' discards data (Figure6.13.2.3.2.1).

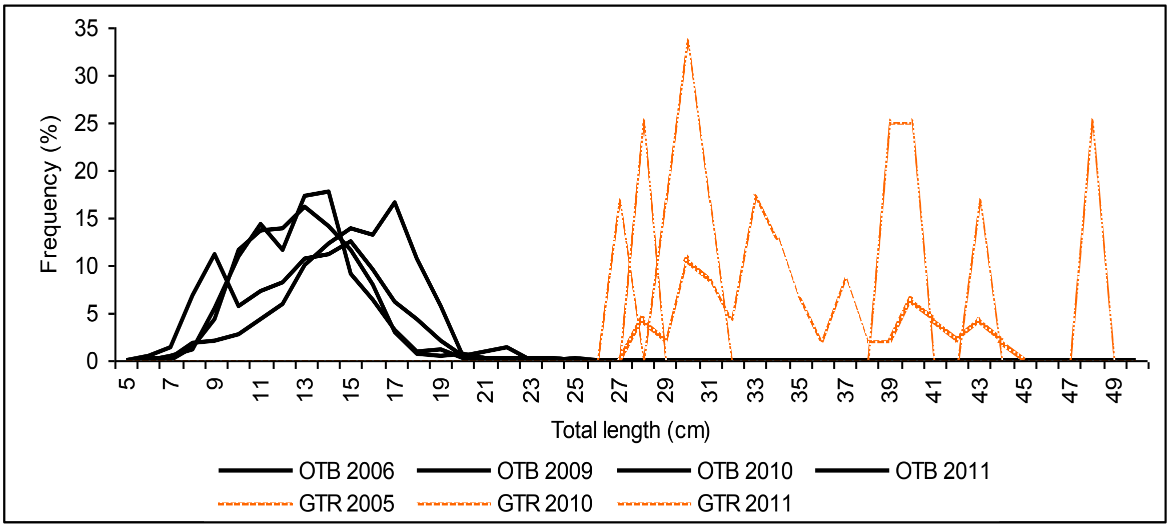


Fig. 6.13.2.3.2.1. Discards (t) by length, year and major gear types, 2005-2011 as reported through DCF.

6.13.2.4 Fishing effort

The reported fishing effort values through the DCF data call weremodified and updated for 2011.

Using data available to EWG 12-10, the trends in fishing effort by year and major gear type is listed in Table6.13.2.4.1 and shown in Figure6.13.2.4.1 in terms of kW*days. The trend analysis show a major drop of total fishing effort in 2008, when both the trawlers and the small scale fishery effort decrease (of 25 and 31 % respectively). In the last three years the total effort was almost stable, even if a minor increase in small scale fishery occur.

Trend in fishing effort (kW*days) for GSA 11 by gear type, for 2004 to 2011 as reported through the DCF official data call is shown in Table6.13.2.4.1.

Table6.13.2.4.1. Trend in nominal effort (kW*days) for GSA 11 by major gear types, 2004-2011. Data submitted through the DCF data call in 2012.

AREA	**GEAR**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
SA 11	FPO	48666	77107	976288	1514990	946792	1061601	1060063	1776625
SA 11	FYK				4611				720
SA 11	GNS	1378699	1068693	215992	785702	469361	1003413	604642	320583
SA 11	GTR	8013778	7204105	7361556	5058262	3765417	4110927	4478336	4425145
SA 11	LLD	169657	280487	490653	1469465	1027107	560887	695218	1125271
SA 11	LLS	1282251	946753	1364505	1172901	661573	673775	542250	442194
SA 11	LTL			7099	2914	589	566		
SA 11	none	21421	798	70267	154312	65247	44038	9259	17027
SA 11	OTB	7834441	7284509	5627750	5660565	4326313	4370758	4036734	3788057
SA 11	PS	38988							

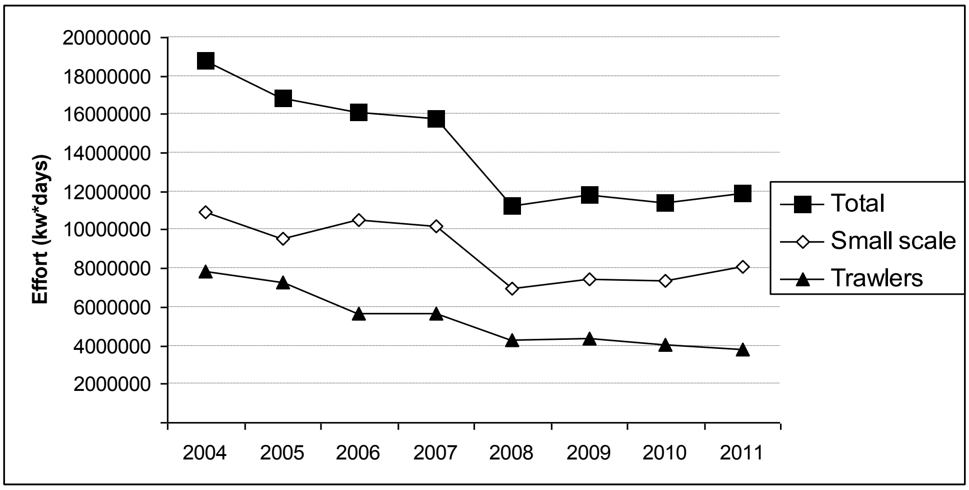


Fig. 6.13.2.4.1. Trend in fishing effort (kW*days) for the Italian fleet in GSA 11 for the major gear types in 2004-2011.

6.13.3 *Scientific surveys*

6.13.3.1 MEDITS

6.13.3.1.1 *Methods*

Since 1994 the MEDITS trawl surveys have been yearly carried out between May and July (except in 2007).

According to the MEDITS protocol (Relini, 2000; Bertand *et al.*, 2002) a stratified random sampling design with allocation of hauls proportional to depth strata extension (depth strata: 10–50 m, 51–100 m, 101–200 m, 201–500 m, 501–800 m) was adopted. A specific gear (GOC 73, with a 20 mm stretched mesh size in the cod-end) was always used following the instruction stated and reported in Dremière and Fiorentini (1996).

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 11 the following number of hauls was reported per depth stratum (Table6.13.3.1.1.1).

Table 6.13.3.1.1.1 Number of hauls per year and depth stratum in GSA 11, 1994-2011.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GSA11_010-050	17	19	21	21	21	21	19	18	20	18	17	17	19	19	17	18	19	20
GSA11_050-100	28	21	23	23	21	22	22	24	19	19	18	22	19	20	19	20	19	19
GSA11_100-200	22	23	30	31	31	30	31	30	24	24	24	24	24	24	22	24	24	24
GSA11_200-500	35	29	29	26	25	27	24	25	20	24	21	20	20	20	21	19	20	21
GSA11_500-800	23	16	22	25	25	24	27	26	16	14	15	14	16	17	16	16	17	17

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution or quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.13.3.1.2 *Geographical distribution patterns*

The spatial distribution of European hake has been described by modeling the spatial correlation structure of the abundance indices using geostatistical techniques (i.e. kriging). In different studies either total abundance index or abundances of recruits and adults were analysed (Murenu *et al.*, 2007).

On average, considering the analyzed yearly distributions (1994-2005), the recruits were considered individuals smaller than 12.3 cm (±1.41). These individual are belonging to the age 0 group. Persistence of the nursery areas along the years was studied by applying indicator kriging technique (Journel 1983, Goovaerts, 1997) to abundance estimations of recruits (Murenu *et al.*, 2008).

Main results and maps are reported in the "nursery section" of the SGMED 09-02 report.

6.13.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of hake in GSA 11 was derived from the international survey MEDITS. Figure 6.13.3.1.3.1displays the estimated trend in hake abundance and biomass in GSA 11. As shown below both for biomass and abundance in some years a high level of uncertainty is evident.

The estimated abundance and biomass indices since 1999 show high variation without any trend.

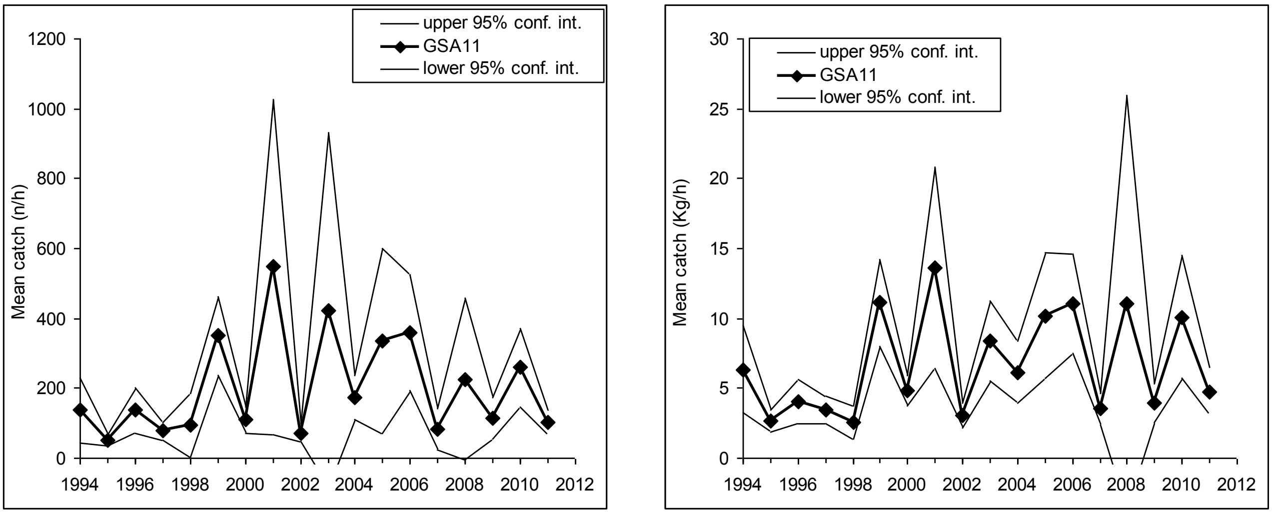
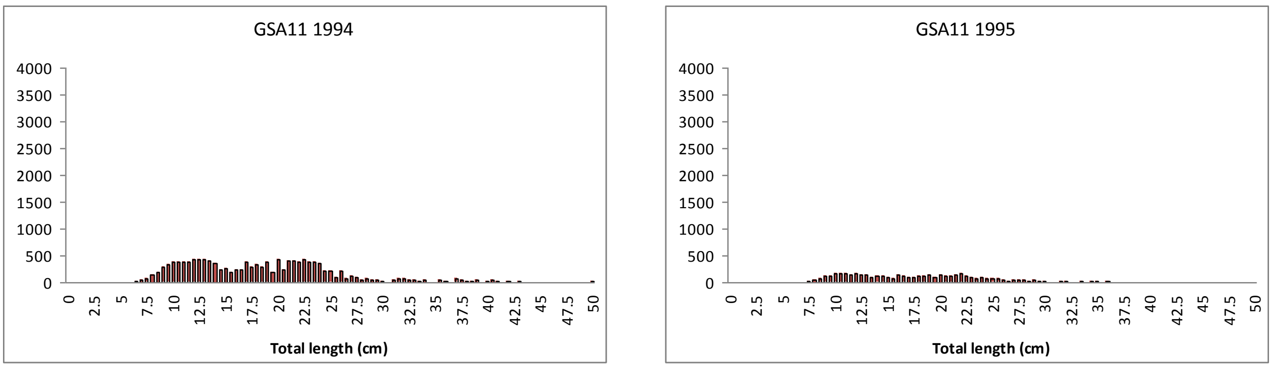


Fig. 6.13.3.1.3.1. Abundance and biomass indices of hake in GSA 11.

6.13.3.1.4 *Trends in abundance by length or age*

The following Figure 6.13.3.1.4.1 and 6.13.3.1.4.2 display the stratified abundance indices of GSA 11 in 1994-2001 and 2002-2011 respectively.



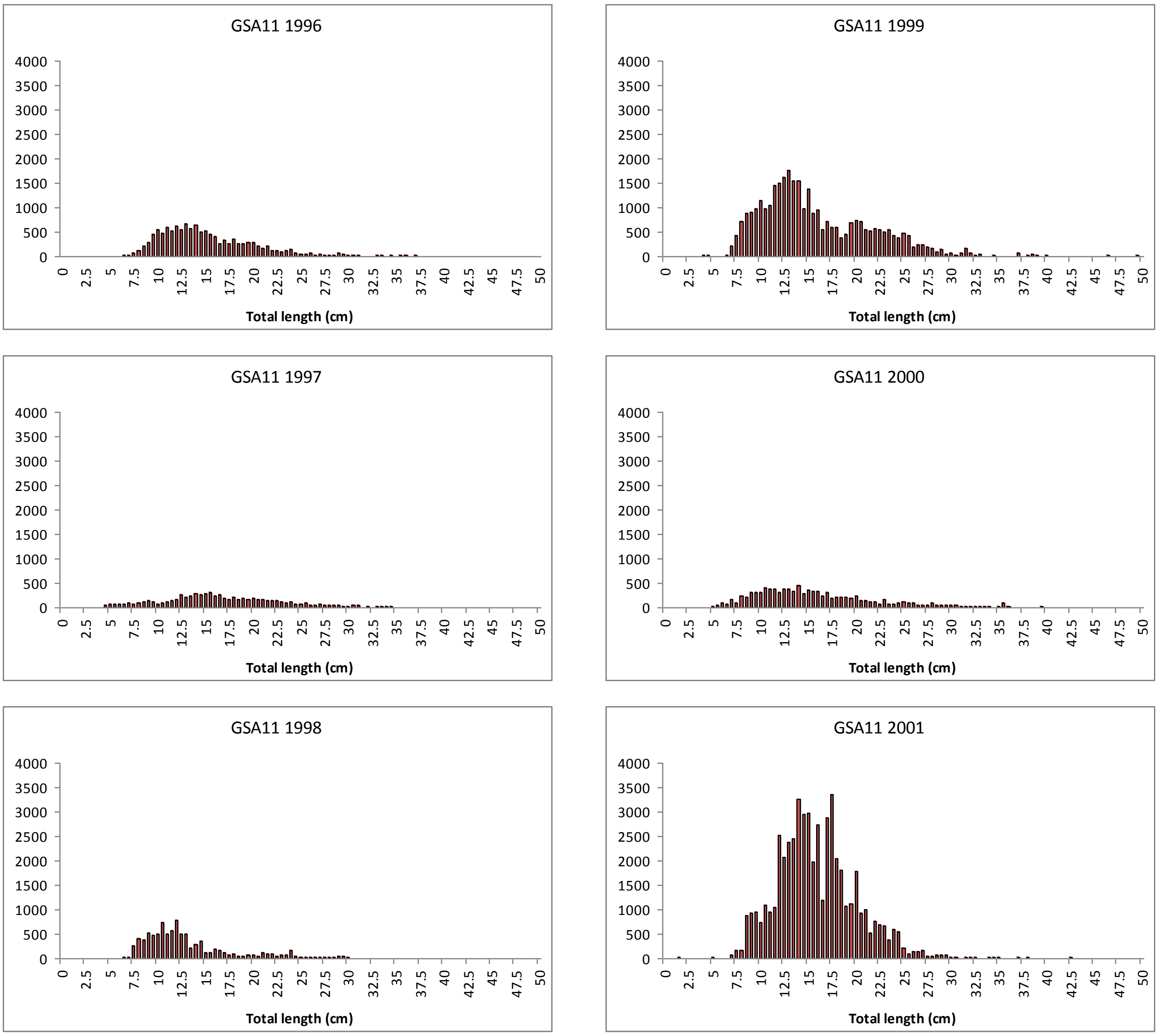
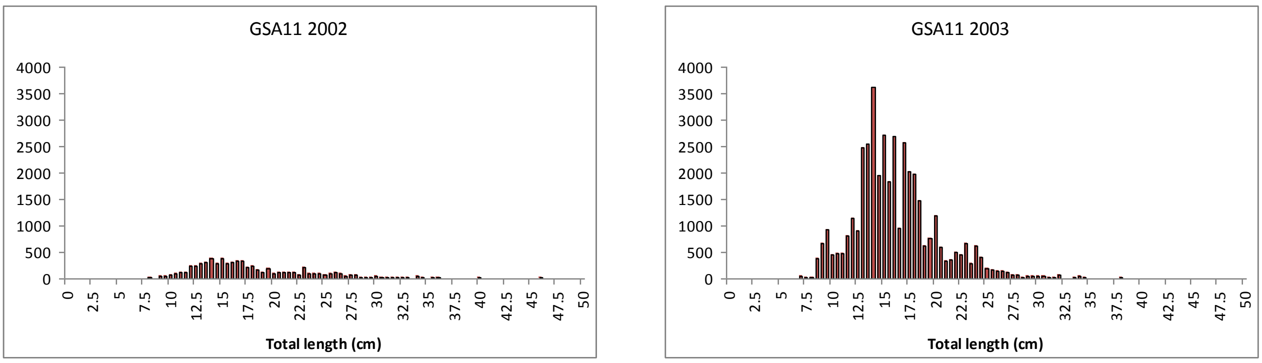


Fig. 6.13.3.1.4.1 Stratified abundance indices by size, 1994-2001.



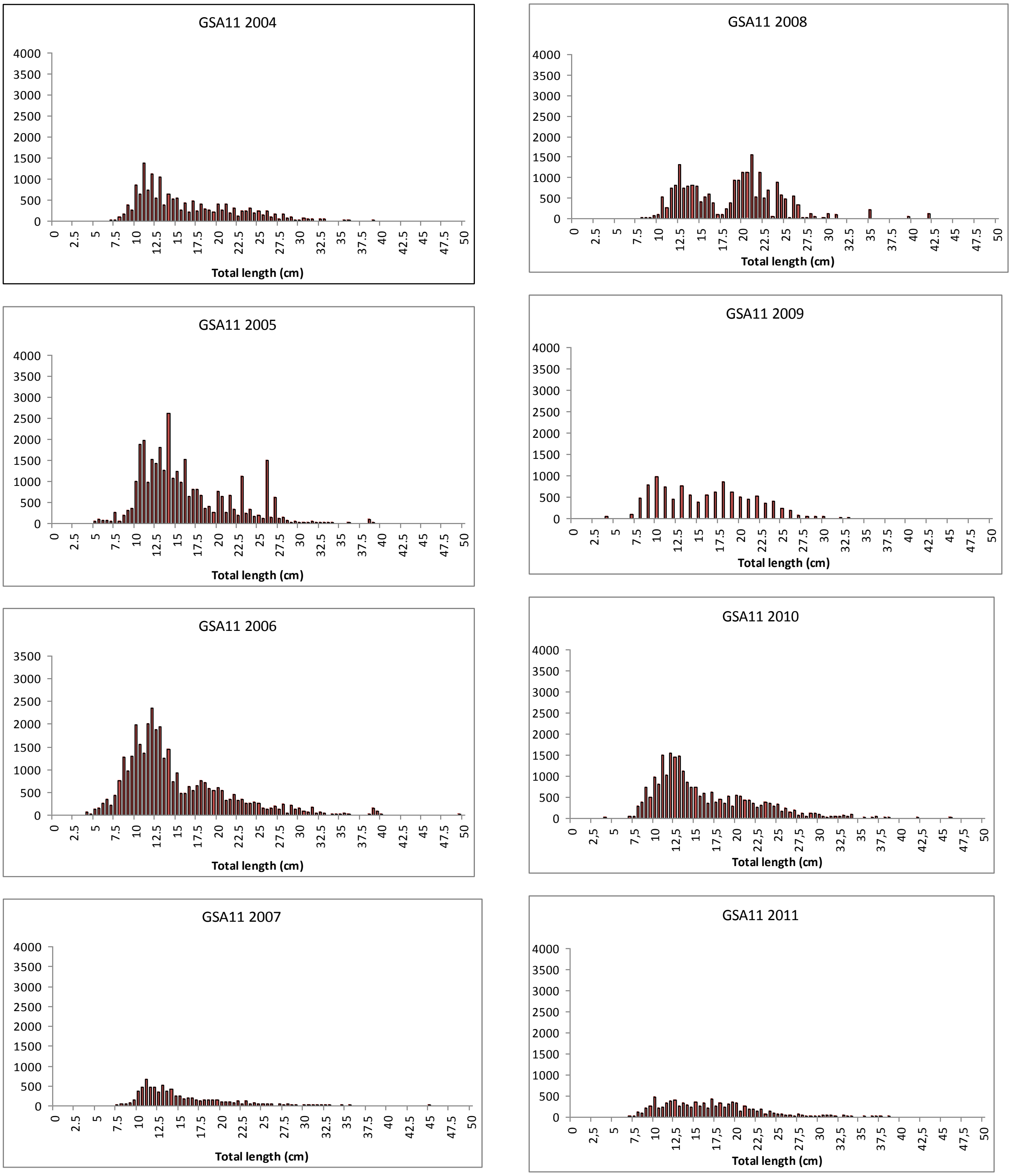


Fig. 6.13.3.1.4.2 Stratified abundance indices by size, 2002-2011.

6.13.3.1.5 *Trends in growth*

No analyses were conducted in EWG 12-10.

6.13.3.1.6 *Trends in maturity*

No analyses were conducted.

6.13.4 *Assessment of historic stock parameters*

6.13.4.1 Method 1: SURBA

6.13.4.1.1 *Justification*

The MEDITS survey provided the longer standardized time-series on abundance, biomass and population structure of *M. merluccius* in the GSA11 which allows utilizing the SURBA software for the assessment. The SURBA assessment tool reconstructs the trend in F from length frequency distribution (LFD).The SURBA was applied to the MEDITS survey data.

6.13.4.1.2 *Input parameters*

Data from trawl surveys (time series of MEDITS from 1994 to 2010) from DCF have been used for the analysis. The SURBA software package (Needle, 2003) use trawl surveys data available from MEDITS to reconstruct trend in population structure and fishing mortality of hake in GSA 11.

The LFDs were converted in numbers at age using the “age slicing” (i.e. statistical slicing) subroutine as implemented in the R program introduced by the working group last year (Scott et al., 2011).

Table6.13.4.1.2.1 Input data used in the SURBA model.

	Age					
Year	0	1	2	3	4	5+
1994	6104	6625	371	20	0	0
1995	2403	2274	49	2	3	0
1996	9504	2823	68	24	3	0
1997	4354	2803	9	4	1	0
1998	7690	1576	34	48	1	0
1999	22338	11042	131	4	1	0
2000	7174	3007	45	5	1	0
2001	41332	11837	111	6	1	0
2002	4633	2274	146	10	2	0
2003	33446	7792	69	2	2	0
2004	10996	5609	84	6	1	0
2005	23243	9604	51	3	1	0
2006	26533	8215	211	94	4	0
2007	5975	1792	173	0	2	1
2008	8902	12812	372	1	4	0

2009	6417	4588	19	9	1	0
2010	16587	7857	84	0	0	2
2011	5949	3675	69	3	0	0

Age	0	1	2	3	4	5+
Proportion mature	0	0,1	0,9	1,0	1,0	1,0
Mean weights	0,01	0,01	0,07	0,20	0,39	0,63

The VBGF parameters used to split the LFD has not been changed from those used in the previous SGMED meeting and correspond to a fast growth scenario, L_∞=100,7 cm, K=0.248, t_0= -0.01.

According to the PRODBIOM approach developed by Caddy and Abella (1999), a vectorial natural mortality at age was estimated (Table6.13.4.1.2.2). Guess-estimates of catchability by age are also given in Table6.13.4.1.2.2.

Table6.13.4.1.2.2 Input parameters used in the SURBA analysis (sex combined) in GSA11.

Growth parameters		
Linf	100.7	cm total length
K	0.248	
t_0	-0.01	
Natural mortality		
M vector		Age_0=1.11,Age_1=0.51,Age_2=0.39,Age_3=0.33,Age_4=0.31,Age_{5+}=0.29
Length at maturity		
L50	36	cm total length (sex combined)
Catchability (q)		q_0=0.8,q_{1-3}=1.0,q_4=0.75,q_{5+}=0.6

6.13.4.1.3 *Results*

The fitted year effect show high fluctuations in the whole time series (fig. 6.13.4.1.3.1). The age effect show a decreasing trend with high values for age 1 and 2. The Fitted cohort effects are slight increasing from 1998.

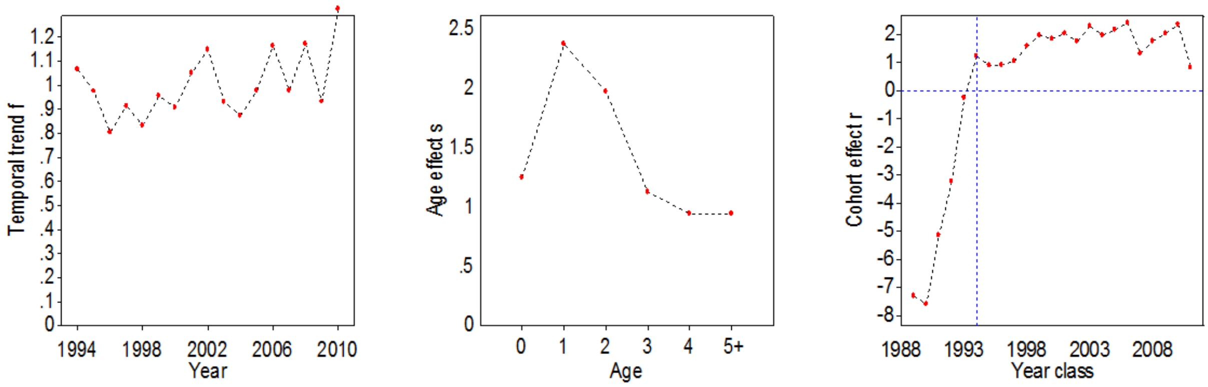


Fig. 6.13.4.1.3.1.MEDITS survey. Fitted year, age and cohort effects estimated by SURBA.

As shown in Figure6.13.4.1.3.2. relative indices of spawning stock biomass (SSB) showed a peak in 1994 and 2005. Relative indices estimated by SURBA indicated very high fluctuations of recruitment in the period 1994-2011, with large recruitment observed in 2001, 2003 and 2005 and a decreasing trend in the last years.

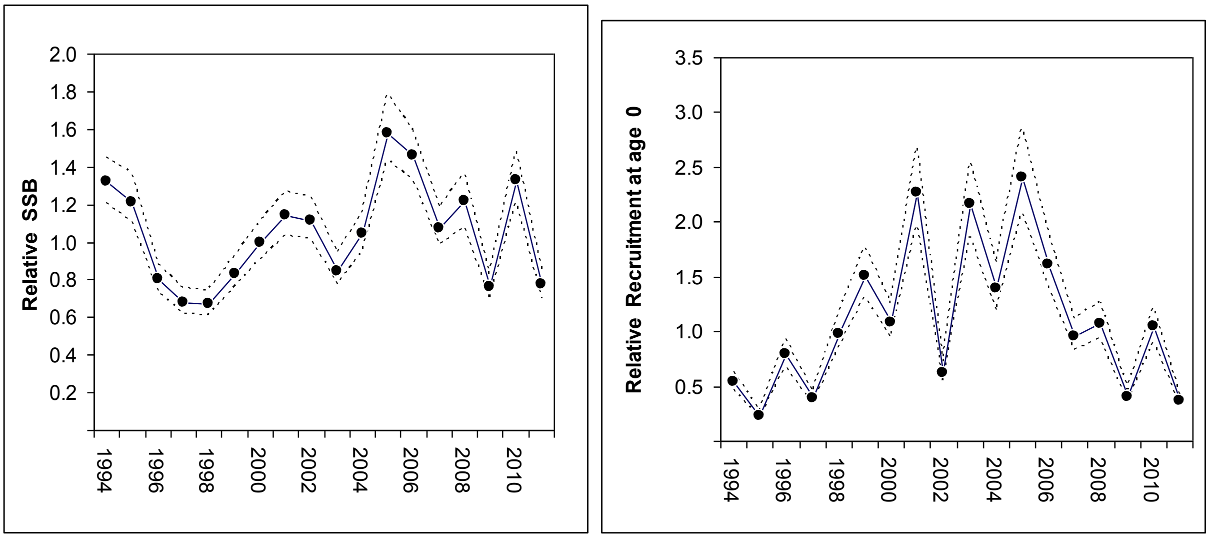


Fig. 6.13.4.1.3.2. Relative SSB, relative recruitment index at age 1 and estimated trend in $F_{1\text{-}3}$ of *M. merluccius* in the GSA11. Dotted lines are 2.5% and 97.5% confidence intervals.

Average fishing mortality ($F_{1\text{-}3}$) estimated from trawl survey data (MEDITS) range between 1.5 and 2.8with a mean value of 1.8 (Figure6.13.4.1.3.3). These SURBA results also show that the mean F for ages 1-3 was high and increasing up to the maximum value in the last year.

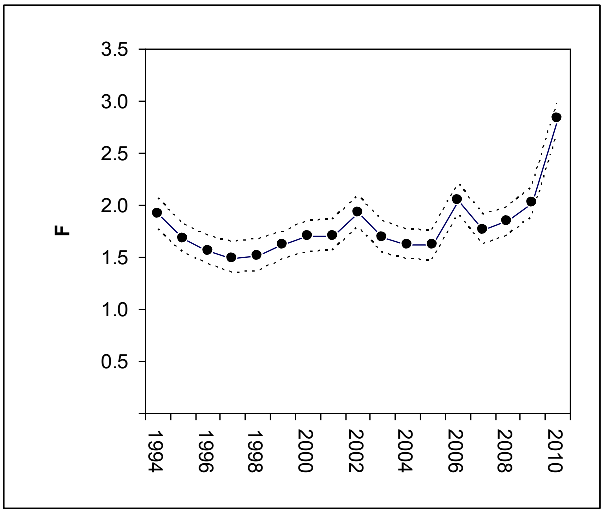
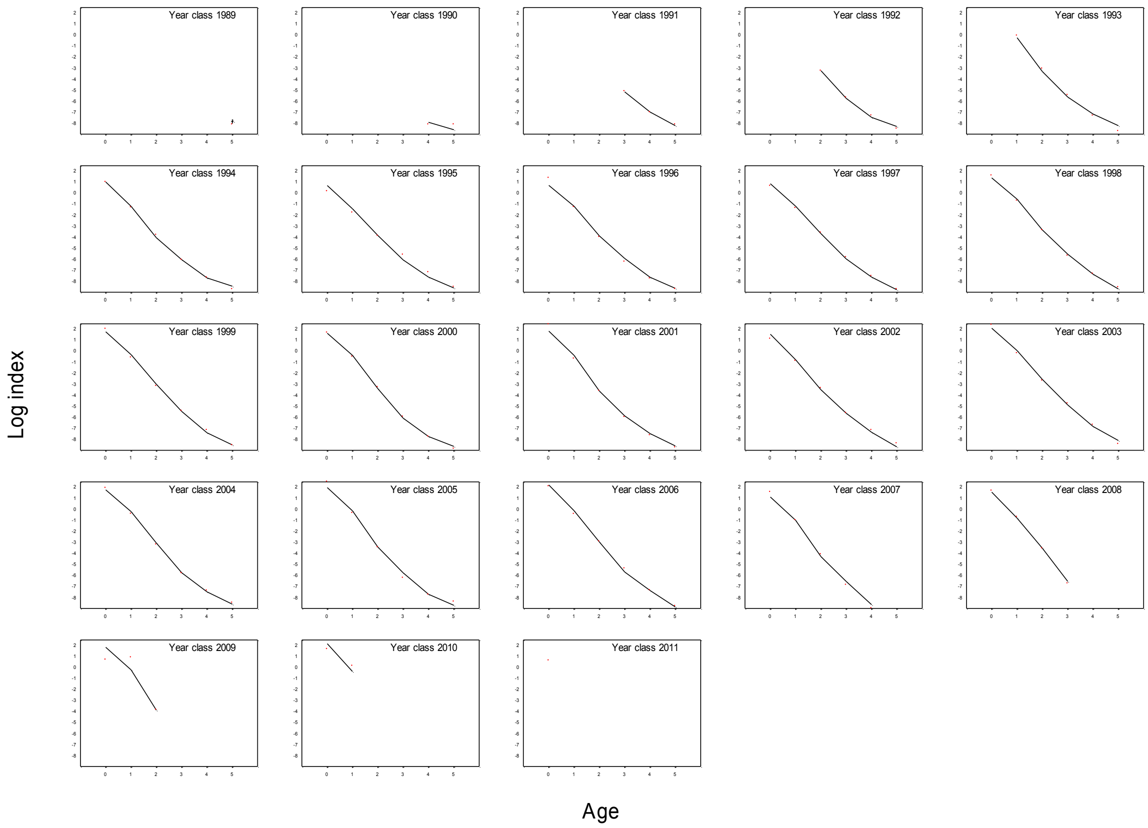


Fig. 6.13.4.1.3.3. Estimated trend in F_{1-3} of *M. merluccius* in the GSA11. Dotted lines are 2.5% and 97.5% confidence intervals.

Model diagnostics

The SURBA model for *M. merluccius* fits well on survey data. The diagnostic do not highlight trends in the residuals as showed by comparison between observed and fittedabundance indices per year, comparative scatterplot at age, catch curves and residual of the log index abundance (Figure6.13.4.1.3.4).



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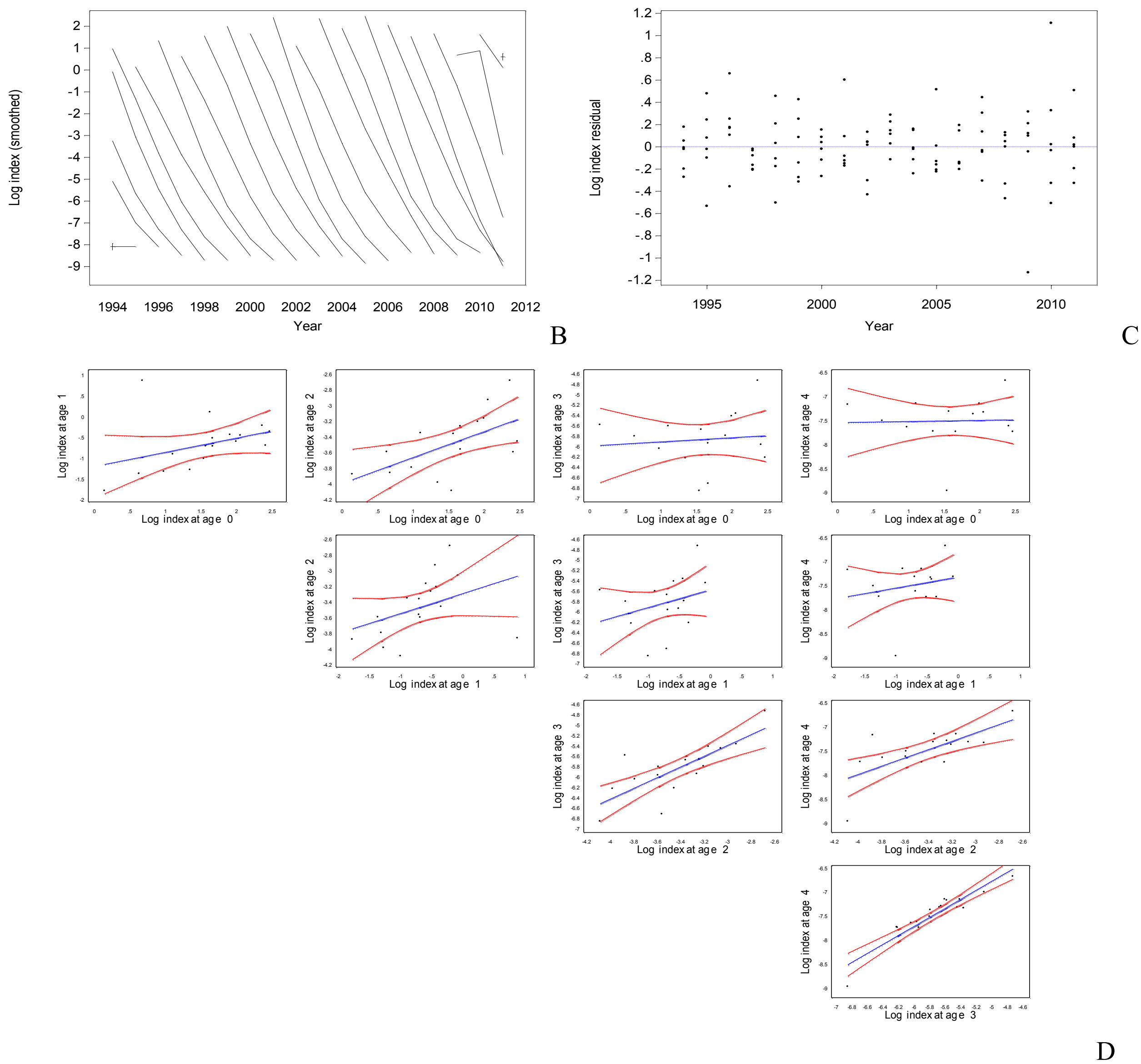


Fig. 6.13.4.1.3.4Model diagnostic for SURBA model in the GSA 11 (MEDITS survey). A) Comparison between observed (points) and fitted (lines) survey abundance indices, for each year; B) Log survey abundance indices by cohort. Each line represents the log index abundance of a particular cohort throughout its life; C) Log index residuals over time and D) Comparative scatterplots at age.

6.13.4.2 Method 2: LCA

6.13.4.2.1 *Justification*

This LCA assessment of hake in the GSA 11 was performed aimed at the estimation of a vector of F at size, using official data on total annual catches by size.

Because of constrains of the data quality, a pseudo-cohort analysis was preferred to a formal VPA. VIT was carried out on years when both landing data and discard information were available (2009-2011).

6.13.4.2.2 *Input parameters*

Data coming from DCF provided at the EWG 12-10 contained information on hake landings and discard by gear and the respective size structure.

From this data set the last 3 years were used to run an LCA analysis using the VIT software. Length data were sliced by gear using the R procedure. The resulting age slicing table6.13.4.2.2.1 was used as catch input file for the LCA analysis. The same M vector used for SURBA, was utilized.

Table6.13.4.2.2.1. Input data for the LCA analysis of hake in GSA11 (discard included, sex combined, years 2009-2011)

	OTB			GTR		
Age	2009	2010	2011*	2009	2010	2011*
0	3067	1691	347	0	0	0
1	8307	5510	5015	13	130	104
2	200	398	244	14	327	223
3	28	15	18	1	1	66
4	8	12	1	1	1	1

*rescaled to 2010

6.13.4.2.3 *Results*

Hake landings in the time series considered were concentrated on age classes 0-2 and the estimated fishing mortality peaked for specimens of age class 1 (Table6.13.4.2.3.1 and Figure6.13.4.2.3.1).

Table6.13.4.2.3.1. $F_{1\text{-}3}$ by age and years of *M. merluccius* in the GSA11.

age	Total F09	Total F10	Total F11	mean 09-11
0	0,15	0,10	0,02	0,09
1	2,62	1,49	1,64	1,92
2	1,04	2,01	1,43	1,50
3	0,44	0,21	2,33	0,99
4	0,30	0,30	0,30	0,30
Mean F	0,91	0,82	1,14	0,96

	2009	2010	2011	mean 09-11
$F_{(1\text{-}3)}$	1,37	1,24	1,80	1.47
$F_{0.1}$	0,25	0,31	0,32	0.30

Fig. 6.13.4.2.3.1. LCA output: fishing mortality by ages of *M. merluccius* in the GSA11.

Assuming no variation in the exploitation pattern, the main results of the YPR analysis are reported in Table6.13.4.2.3.2.

Table 6.13.4.2.3.2. Main results of the VIT analysis.

year	yield (t)	rec	F	Z
2009	436	10,7	0,92	1,45
2010	543	10,2	0,83	1,36
2011	596	10,4	1,16	1,69

6.13.5 *Long term prediction*

For the long term predictions the VIT software was used.

6.13.5.1 Method 1: VIT

6.13.5.1.1 *Justification*

Yield per recruit (YPR)analyses as implemented in the package VIT4win (Lleonart and Salat 2000) were used to estimate biological reference points (BRP) under equilibrium conditions.

6.13.5.1.2 *Input parameters*

Input parameters are given in section 6.13.4.4.2 on the VIT assessment above. Landing and discards data from DCF call for GSA 11 were used. However, because of the incosistencies on 2011 discard data noted above, EWG 12-10 decide to scale it using the information of the previous years.

6.13.5.1.3 *Results*

The VIT results regarding the long term prediction are presented below (Figure6.13.5.1.3.1).

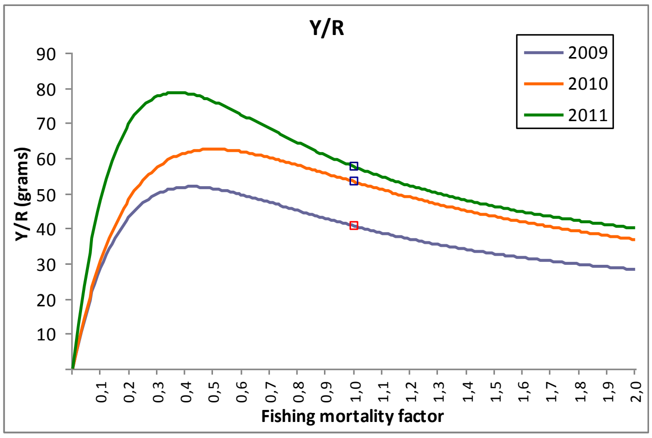


Fig.6.13.5.1.3.1 Yield per recruit by different level of F factor (year 2009-2011).

According to these calculations, F_{curr} (0.97 from VIT) was above the estimated $F_{0.1}$ value(average = 0.30, 2011=0.32).

EWG 12-10 proposed $F_{0.1}$ = 0.30 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 0.97), the stock is considered exploited unsustainably.

6.13.6 *Data quality*

MEDITS survey data were available from 1994 to 2011. Landing and discard from 2005.

EGW 11-20 noted that landing and discard seems to be misreported in some years for GTR. In particular landings at length for GTR are not reported in 2007, while for LLS are only reported in 2009. Even if the contribution to total landings of these fisheries (GTR and LLS) is not high in the GSA11, it is not clear to EGW 11-20 if they are belonging to a real fishery for hake.

Furthermore, GTR discards are reported in 2005, 2010 and 2011, but data seems to be not reliable in terms of length distribution (lengths range from 27 to 48 cm), nor because GSA 11 is the only SA in the region where discard have been reported for this gear.

Finally the very high increase of total discards (mainly due to OTB) in 2011, which is more then 10 times largerthan previous years and about 4,5 times of OTB landings, is not reliable.

Discard data strongly influences the assessment thus must be checked for inconsistencies.

Since the significance of the discards component for the assessment of hake and because of the incosistencies noted above, EWG 12-10 decide to use only 3 years for the analysis (i.e. when discard were constantly reported for OTB), and for 2011, using the proportion of the previous year (2010) as a reference to scale discards quantities and their related distribution at lenghts.

6.13.7 *Scientific advice*

6.13.7.1 Short term considerations

6.13.7.1.1 *State of the spawning stock size*

The estimates of SSB index from VIT showed an increase in 2010 and a sharp decrease in 2011.However, in the absence of proposed biomass management reference points, EWG 12-02 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

6.13.7.1.2 *State of recruitment*

Relative indices estimated by SURBA indicated very high fluctuations of recruitment in the period 1994-2011, with a clear decreasing trend in the last 6 years.However, in the absence of proposed management reference points, EWG 12-10 is unable to fully evaluate the status of the recruitment in relation to these.

6.13.7.1.3 *State of exploitation*

EWG 12-10 proposed $F_{0.1}$ = 0.30 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 1.16), the stock is considered exploited unsustainably.

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

6.14 **Stock assessment of pink shrimp in GSA 11**

6.14.1 *Stock identification and biological features*

6.14.1.1 Stock Identification

Due to a lack of information about the structure of pink shrimp population in the western Mediterranean, this stock was assumed to be confined within the GSA11 boundaries.

The species is epibenthic and inhabits muddy and sandy muddy bottoms from 150 to 570 m of depth, with a main occurrence between 200 and 450 meter of depth.
High abundance of small specimens generally occurs in the shelf break and in some areas in the upper slope, while greater specimens are distributed at depths greater than 200 m.

The main important patch of juveniles is localized on the shelf break of the central-west coast but other small patches have been identified on deeper water in the north-western and south-western coast.

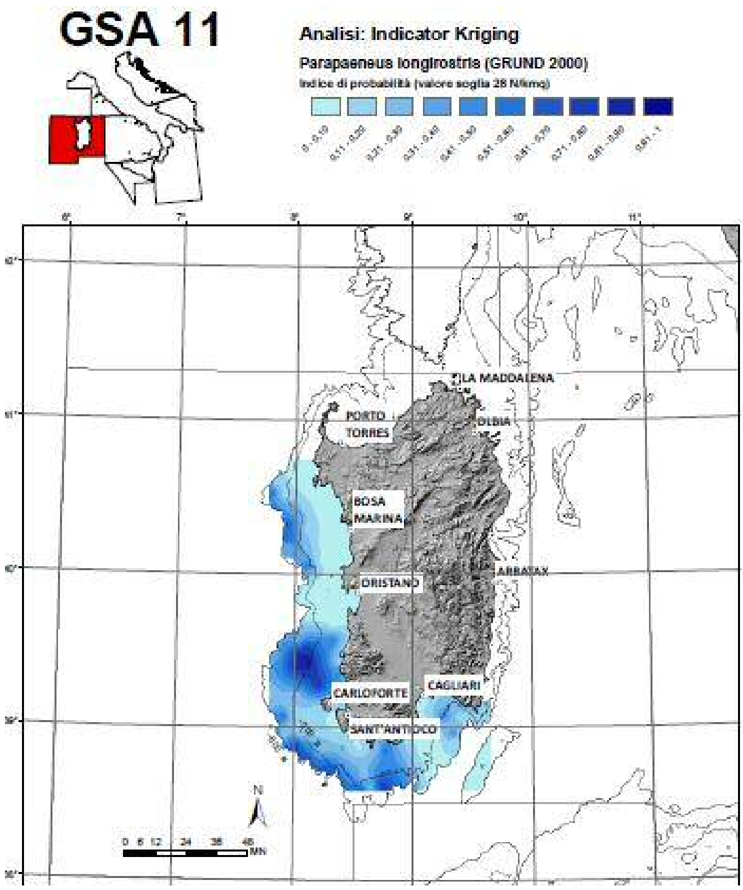


Fig. 6.14.1.1.1 Indicator kriging of *P. longirostris* in the GSA11.

The structure of the populations is characterised by a sex ratio of about 0.5 and a different growth pattern between males and females. The females are the bigger ones. As regards the life span, the pink shrimp is a short-living species with a life span of about 4 years.

6.14.1.2 Growth

Since the DCR do not provide growth parameters for the GSA 11, those estimated from GSA 09, central

Tyrrhenian Sea, where used($L\infty$ = 43.5, K=0.6 t_0=0).

6.14.1.3 Maturity

The reproductive areas of *P. longirostris* are located in the upper slope where mature females are present all year round, with a main peak in spring.The size at onset of sexual maturity is about 24 mm CL.

6.14.2 *Fisheries*

6.14.2.1 General description of fisheries

The species is one of the most important target species of the fishery carried out on bottoms of the upper slope and it is part of an important fishing assemblage targeted exclusively by trawlers of which as *Nephrops norvegicus*, *Merluccius merluccius*, *Eledonecirrhosa*, *Illex coindetii*, *Todaropsis eblanae*, *Helicolenus dactylopterus,Phycis blennoides, Micromesistius poutassou*, *Lophius* sp. are the most priceless species.

The discard fraction is composed of species such us *Glossanodon leioglossus, Capros aper, Galeus melastomus* and *Raja* sp.

The large trawlers of GSA11 operate all the week from Monday to Saturday, generally coming back daily to the closest port at the coast for few hours early in the morning in order to send all the fish to the market. The mid-sized and small trawlers perform daily fishing trips, before the sunrise until the early morning, staying sometimes two days at sea.

Moreover, due to the distance of the fishing grounds (Murenu et al., 2010) to the main harbors of the western cost and the dominant weather conditions, the fleet targeting *P. longirostris* shows some seasonal variations, with more time spent at sea from mid spring to mid autumn. Some large trawlers move seasonally to different fishing grounds far from the usual ports.

Most of the effort in the GSA 11 is concentrated around the major fishing ports (Cagliari, Alghero, Porto Torres, La Caletta, Sant'antioco, Oristano, Alghero).

The trawl fleet showed remarkable changes from 1994 to 2004, with a general increase in the number of vessels and the replacement of the older ones, low tonnage wooden boats by larger steel boats. Since 2004 for the entire GSA an increase of 85% for boats >70 tons class occurred. A decrease of 20% for the smaller boats (<30 GRT) was also observed.

6.14.2.2 Management regulations applicable in 2010 and 2011

The minimum legal landing size is 20 mm carapace length (EC regulation 1967/2006). The other management regulations are the same described for hake in the GSA11.

6.14.2.3 Catches

6.14.2.3.1 *Landings*

Available landing data are from DCF regulations. EWG 12-10 received Italian landings data for GSA 11 by fishing gears which are listed in Table6.14.2.3.1.1. All landings are from trawlers. The production clearly show an increasing trend, from 43 t in 2009 up to 71 t in 2011.

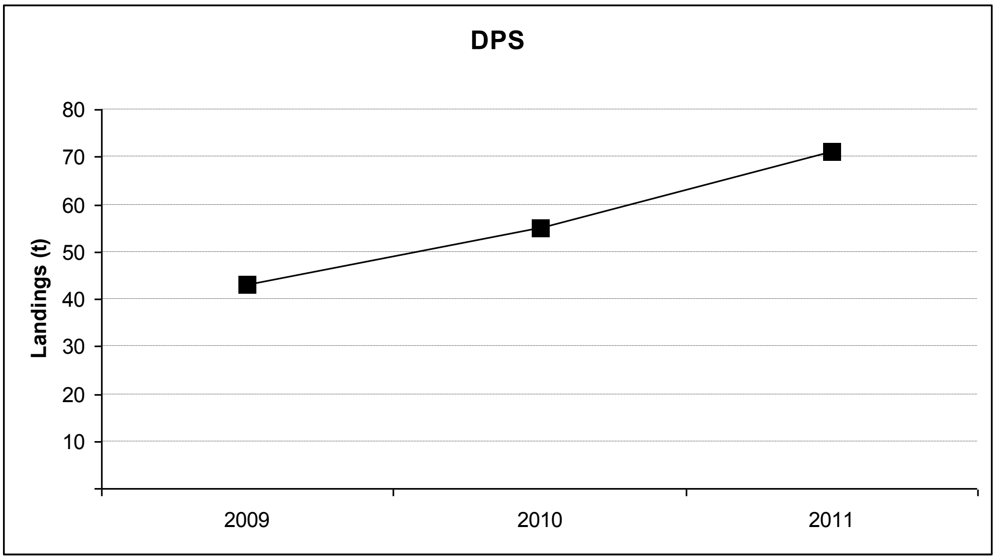


Fig. 6.14.2.3.1.1 Trend of annual landings (in tons, 2009-2011).

Table6.14.2.3.1.1. Annual landings (in tons) by gear type, 2009-2011.

AREA	COUNTRY	SPECIES	GEAR	2009	2010	2011
SA 11	ITA	DPS	OTB	43	55	71

The landings at length show a different pattern between 2009 and the last two years.

In 2009 the length at first capture is about 22 mm carapax length but decrease to 15 mm in the last years (Fig. 6.14.2.3.1.2)

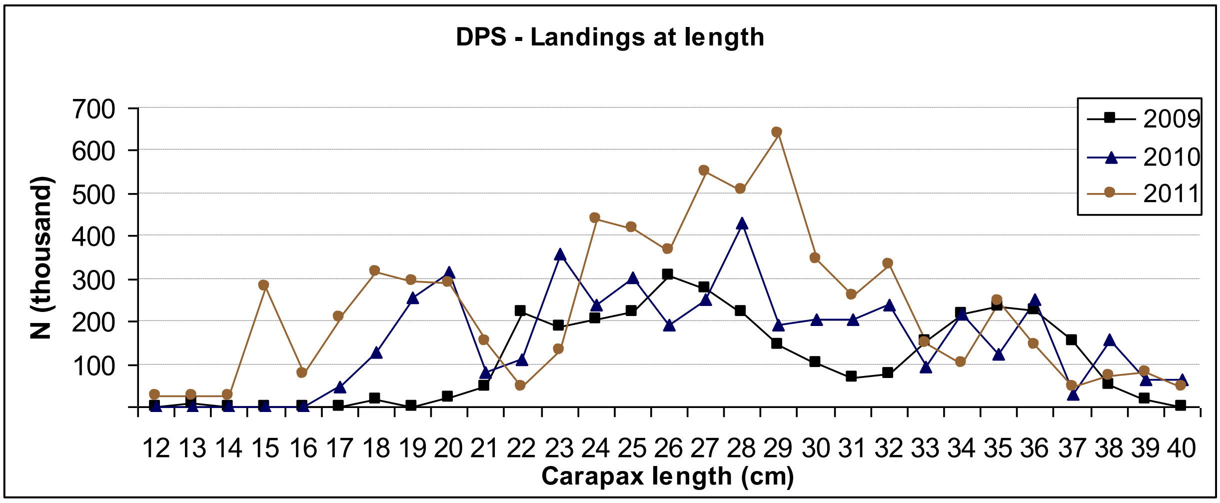


Fig. 6.14.2.3.1.2 Landings at length of *P. longirostris* in the GSA11 by DCF information.

6.14.2.3.2 *Discards*

No discards was reported to EWG 12-10 through the DCR data call.

6.14.2.4 Fishing effort

Trend in fishing effort (kW*days) for GSA 11 by gear type, for 2004 to 2011 as reported through the DCF official data call is in the Tab. 6.14.2.4.1.

Table6.14.2.4.1 Trend in nominal effort (kW*days) for GSA 11 by major gear types, 2004-2011. Data submitted through the DCF data call in 2012.

AREA	GEAR	2004	2005	2006	2007	2008	2009	2010	2011
SA 11	FPO	48666	77107	976288	1514990	946792	1061601	1060063	1776625
SA 11	FYK				4611				720
SA 11	GNS	1378699	1068693	215992	785702	469361	1003413	604642	320583
SA 11	GTR	8013778	7204105	7361556	5058262	3765417	4110927	4478336	4425145
SA 11	LLD	169657	280487	490653	1469465	1027107	560887	695218	1125271
SA 11	LLS	1282251	946753	1364505	1172901	661573	673775	542250	442194
SA 11	LTL			7099	2914	589	566		
SA 11	none	21421	798	70267	154312	65247	44038	9259	17027
SA 11	OTB	7834441	7284509	5627750	5660565	4326313	4370758	4036734	3788057
SA 11	PS	38988							

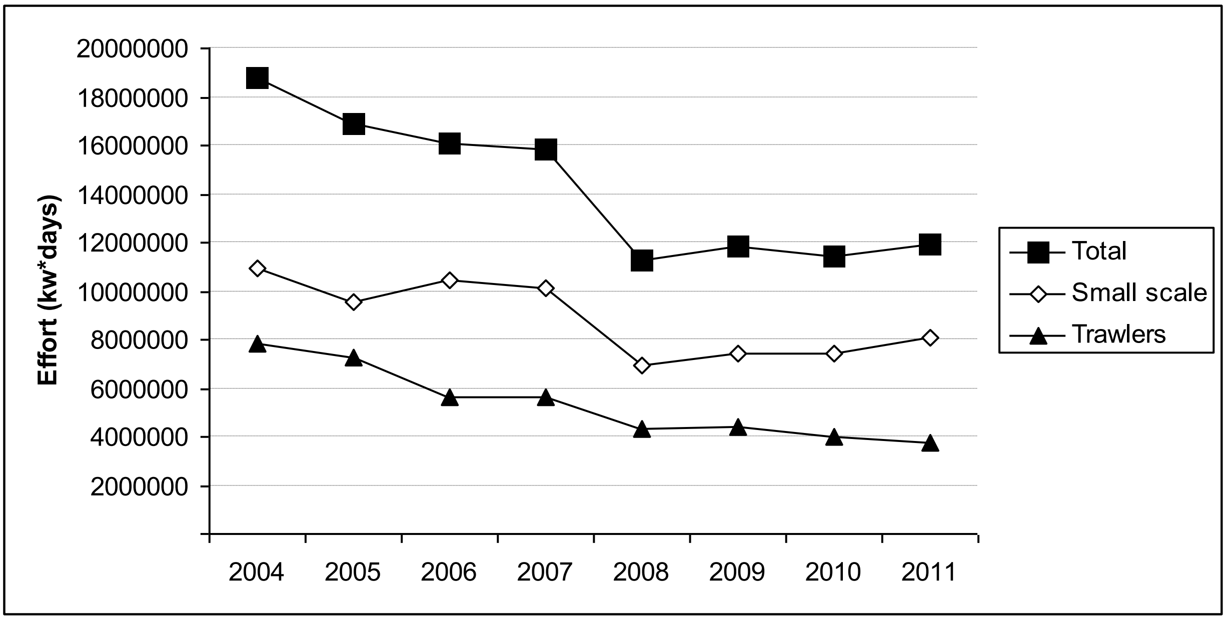


Fig. 6.14.2.4.1Trend of nominal effort over 2004- 2011 in GSA 11.

6.14.3 *Scientific surveys*

6.14.3.1 MEDITS

6.14.3.1.1 *Methods*

According to the MEDITS protocol (Bertrand et al., 2002), trawl surveys were yearly (May-July) carried out, applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish and weight per surface unit) were standardised to square kilometre, using the swept area method.

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 11 the following number of hauls was reported per depth stratum (Table 6.14.3.1.1.1).

Table6.14.3.1.1.1Number of hauls per year and depth stratum in GSA 11, 1994-2011.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GSA11_010-050	17	19	21	21	21	21	19	18	20	18	17	17	19	19	17	18	19	20
GSA11_050-100	28	21	23	23	21	22	22	24	19	19	18	22	19	20	19	20	19	19
GSA11_100-200	22	23	30	31	31	30	31	30	24	24	24	24	24	24	22	24	24	24
GSA11_200-500	35	29	29	26	25	27	24	25	20	24	21	20	20	20	21	19	20	21
GSA11_500-800	23	16	22	25	25	24	27	26	16	14	15	14	16	17	16	16	17	17

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Only hauls noted as valid were used, including stations with no catches (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$

$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval =

Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution or quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

6.14.3.1.2 *Geographical distribution patterns*

The spatial distribution of *Parapaeneus longirostris* has been described by modeling the spatial correlation structure of the abundance indices using geostatistical techniques.

The stock is more abundant in the south-western part of the GSA 11 as shown in Figure (Figure6.14.3.1.2.1).

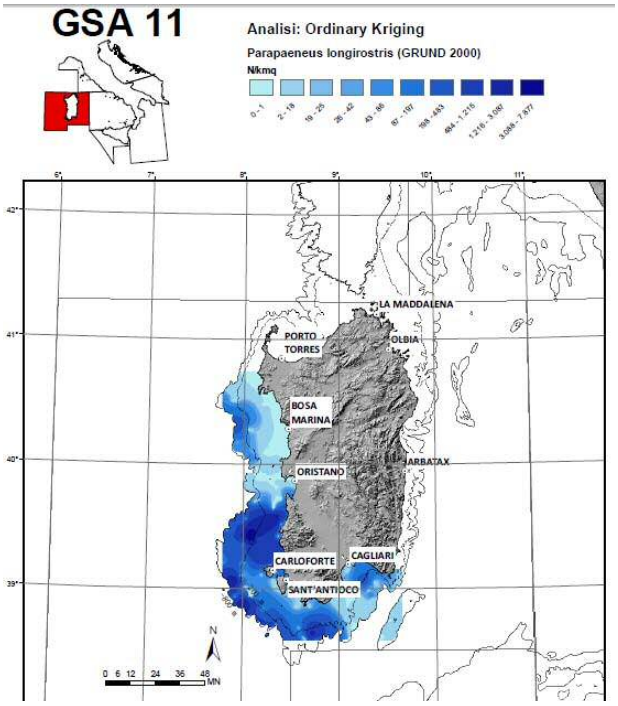


Fig. 6.14.3.1.2.1. Map of pink shrimpnursery area.

6.14.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of pink shrimp in GSA 11 was derived from the international survey MEDITS. Figure 6.14.3.1.3.1 displays the estimated trend of *P. longirostris* abundance and biomass standardized to hour in GSA 11. Indices from MEDITS trawl-surveys show two peaks, one in 1999 and one in 2004, but without showing any significant trend.

From 2009 onwards the indices are increasing and commercial catches follow a similar pattern.

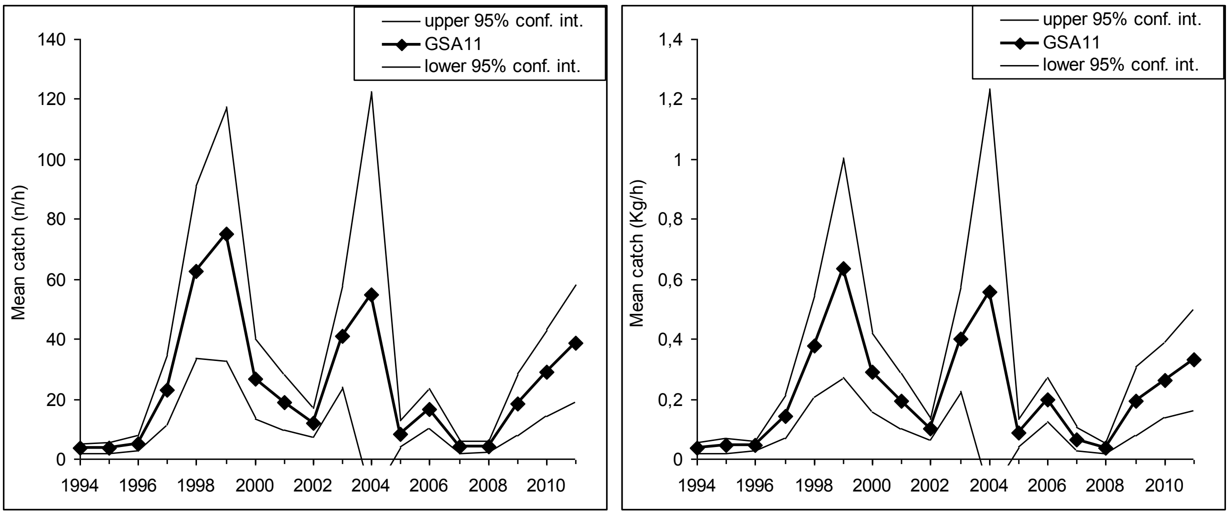
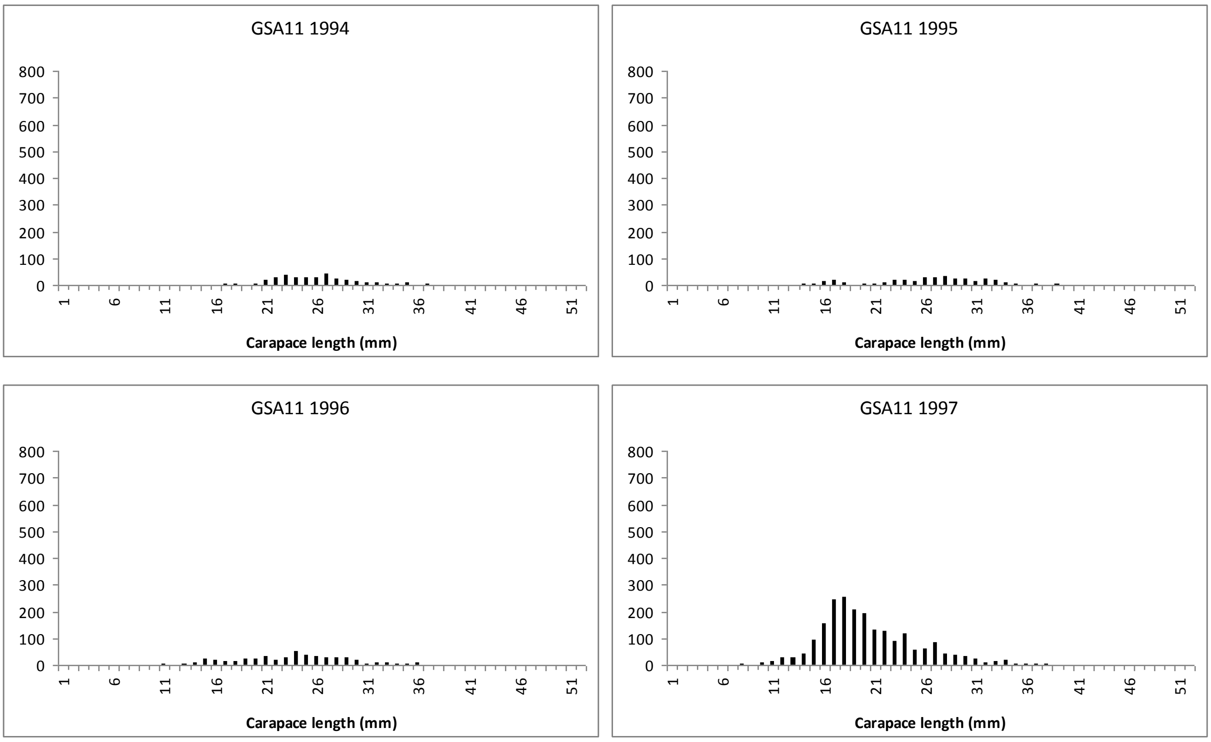


Fig. 6.14.3.1.3.1 Trends in survey abundance and biomass indices (MEDITS) of pink shrimp in GSA 11.

6.14.3.1.4 *Trends in abundance by length or age*

The following figures6.14.3.1.4.1, 6.14.3.1.4.2, 6.14.3.1.4.3 display the stratified abundance indices by length of GSA 11 in 1994-2001, 2002-2009 and 2010-2011.



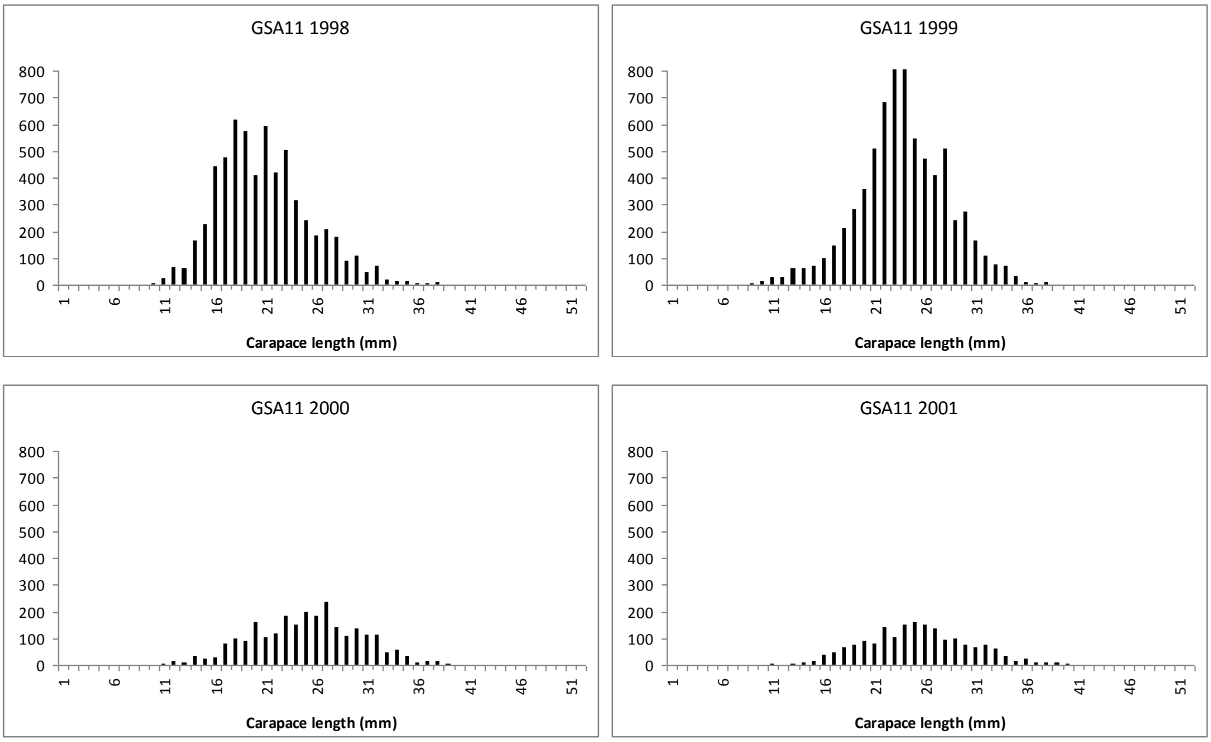


Fig. 6.14.3.1.4.1Stratified abundance indices by size, 1994-2001.

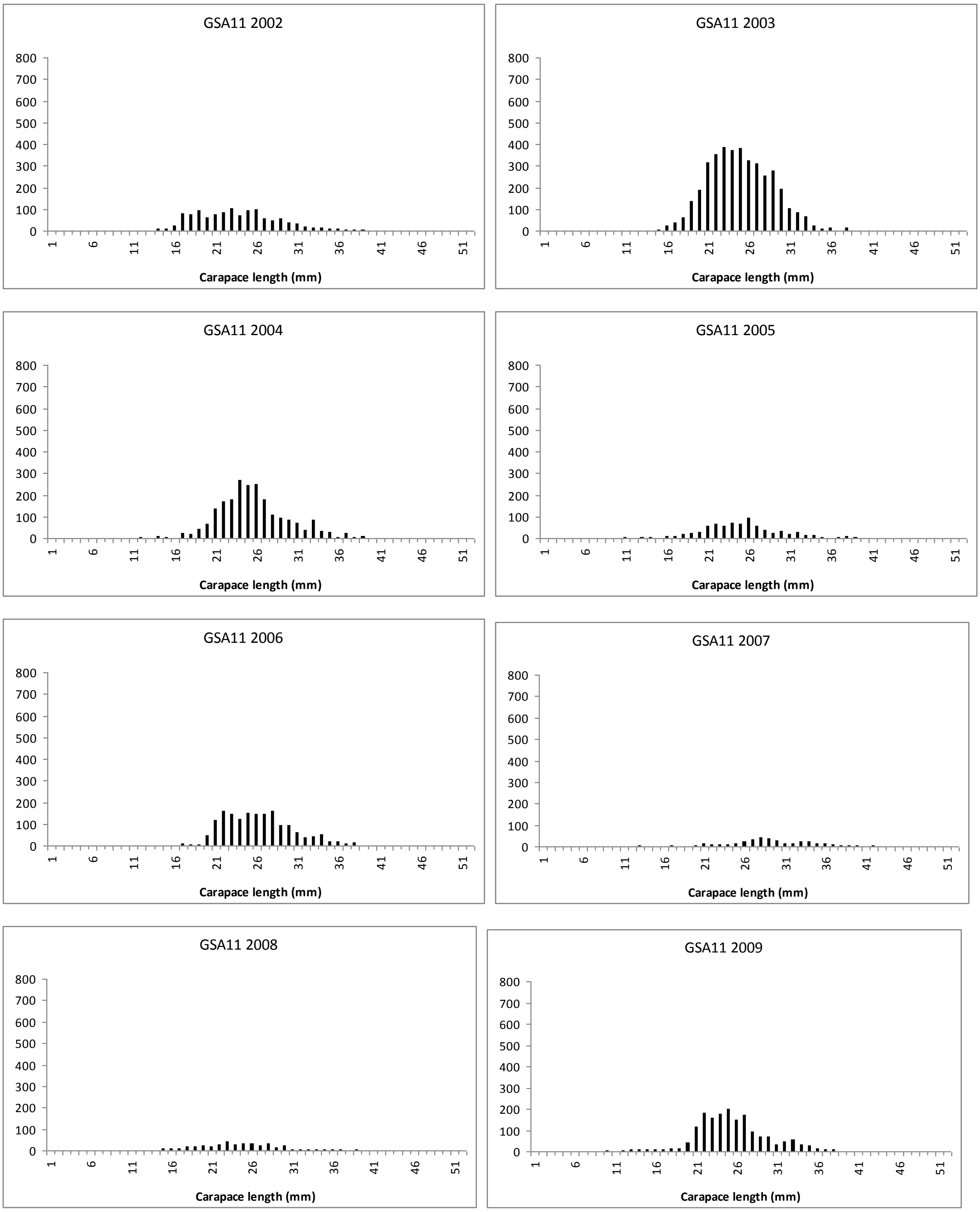
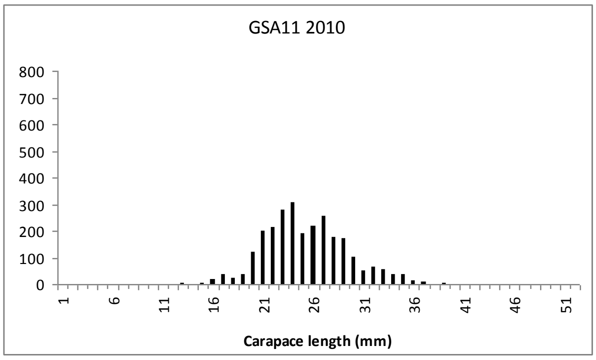


Fig. 6.14.3.1.4.2 Stratified abundance indices by size, 2002-2009.



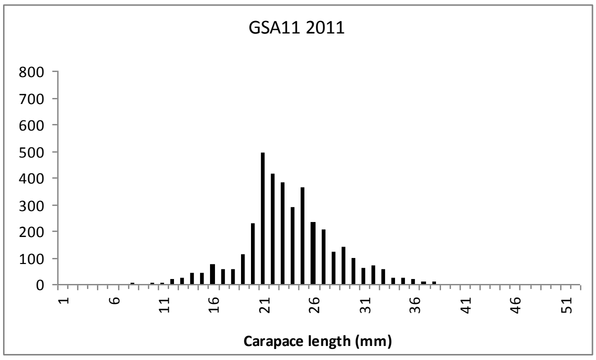


Fig. 6.14.3.1.4.3 Stratified abundance indices by size in 2010 and 2011.

6.14.3.1.5 *Trends in growth*

No information was been documented.

6.14.3.1.6 *Trends in maturity*

No information was been documented.

6.14.4 *Assessment of historic stock parameters*

EWG 12-10 applied the VIT model to commercial landings and SURBA model to survey data.

6.14.4.1 Method 1: SURBA

6.14.4.1.1 *Justification*

The MEDITS survey provided the longer standardized time-series data on abundance and population structure of *P. longirostris* in the GSA11 which allows to utilize the SURBA software for the assessment. The SURBA assessment tool estimates the trend in F from length frequency distribution (LFD).

6.14.4.1.2 *Input parameters*

The survey-based stock assessment model SURBA (Needle, 2003) was used to estimate the trend in population structure and fishing mortality.

The following set of input data and parameters were used (Table 6.14.4.1.2.1 and 2).

Table 6.14.4.1.2.1 Input data used in the SURBA model.

	Survey index data (CPUE)				Proportion mature				Mean weights			
	Age				Age				Age			
Year	1	2	3	4+	1	2	3	4+	1	2	3	4+
1994	159	154	15	1	0.8	1	1	1	16.5	18.4	24.3	29
1995	124	190	24	6	0.8	1	1	1	16.5	18.4	24.3	29
1996	312	159	20	6	0.8	1	1	1	16.5	18.4	24.3	29
1997	1789	311	30	6	0.8	1	1	1	16.5	18.4	24.3	29
1998	5129	905	37	11	0.8	1	1	1	16.5	18.4	24.3	29
1999	4696	2253	119	11	0.8	1	1	1	16.5	18.4	24.3	29
2000	1294	1084	114	25	0.8	1	1	1	16.5	18.4	24.3	29
2001	984	769	75	25	0.8	1	1	1	16.5	18.4	24.3	29
2002	779	355	40	12	0.8	1	1	1	16.5	18.4	24.3	29
2003	2256	1614	50	13	0.8	1	1	1	16.5	18.4	24.3	29
2004	2727	2324	93	15	0.8	1	1	1	16.5	18.4	24.3	29
2005	415	317	24	13	0.8	1	1	1	16.5	18.4	24.3	29
2006	764	779	97	20	0.8	1	1	1	16.5	18.4	24.3	29
2007	71	212	62	21	0.8	1	1	1	16.5	18.4	24.3	29
2008	241	136	15	9	0.8	1	1	1	16.5	18.4	24.3	29
2009	963	696	80	16	0.8	1	1	1	16.5	18.4	24.3	29
2010	1445	1094	98	6	0.8	1	1	1	16.5	18.4	24.3	29
2011	2602	980	75	11	0.8	1	1	1	16.5	18.4	24.3	29

Table 6.14.4.1.2.2Input parameters used in the SURBA model.

Growth parameters	
Linf	43,5 mm carapace length
K	0,6
t_0	0
Length-weight relationships	
a	0,00727
b	2,2101
Natural mortality	
M=0,79	
Length at maturity	
L50	24 mm carapace length
Lc100	22 mm carapace length

Standardized time series of MEDITS length-frequency-distributions were sliced into different age-groups by the rage slicing procedure (Scott et al., 2011). The same growth parameters for the whole time series were used.

6.14.4.1.3 *Results*

The fitted year effect show high fluctuations in the whole time series. Moreover a decreasing trend could be observed from 2000 to 2010(Figure 6.14.4.1.3.1). The age effect shows a flat patter with high values for stock mortality from age 2. The fitted cohort effects are increasing from 2007.

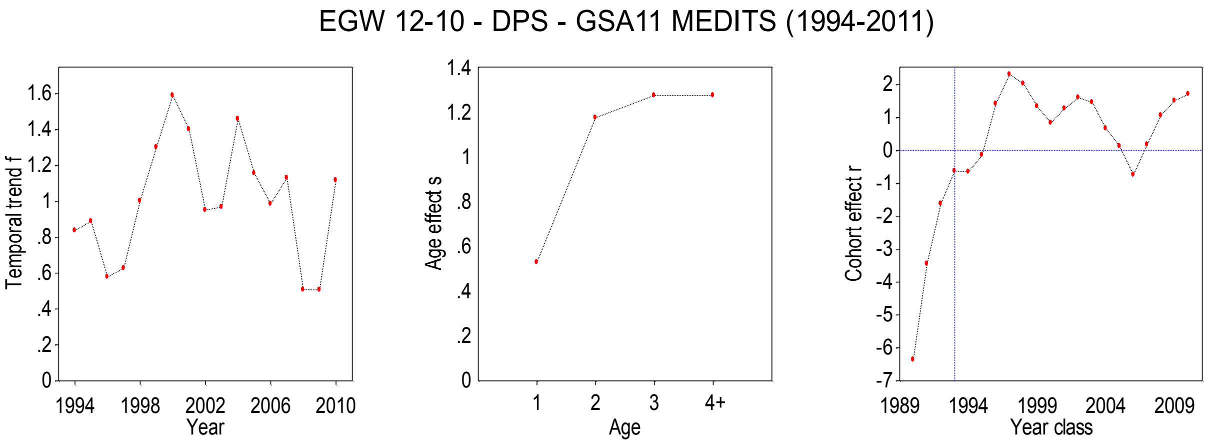


Fig. 6.14.4.1.3.1 MEDITS survey. Fitted year, age and cohort effects estimated by SURBA.

Average fishing mortality (F_{1-3}) estimated from trawl survey data (MEDITS) ranges between 0.3 and 1.39 with a mean value of 0.92 (Fig. 6.14.4.1.3.2). Relative indices of spawning stock biomass (SSB) showed a peak in 1998-99 and 2003 with a decreasing trend until the 2007. In the last 4 years an increasing trend is clear. A same pattern for the relative recruitment estimated from the MEDITS survey was observed. It is necessary to consider that, due to the season when MEDITS surveys are conducted, young of the year (0+) are poorly sampled.

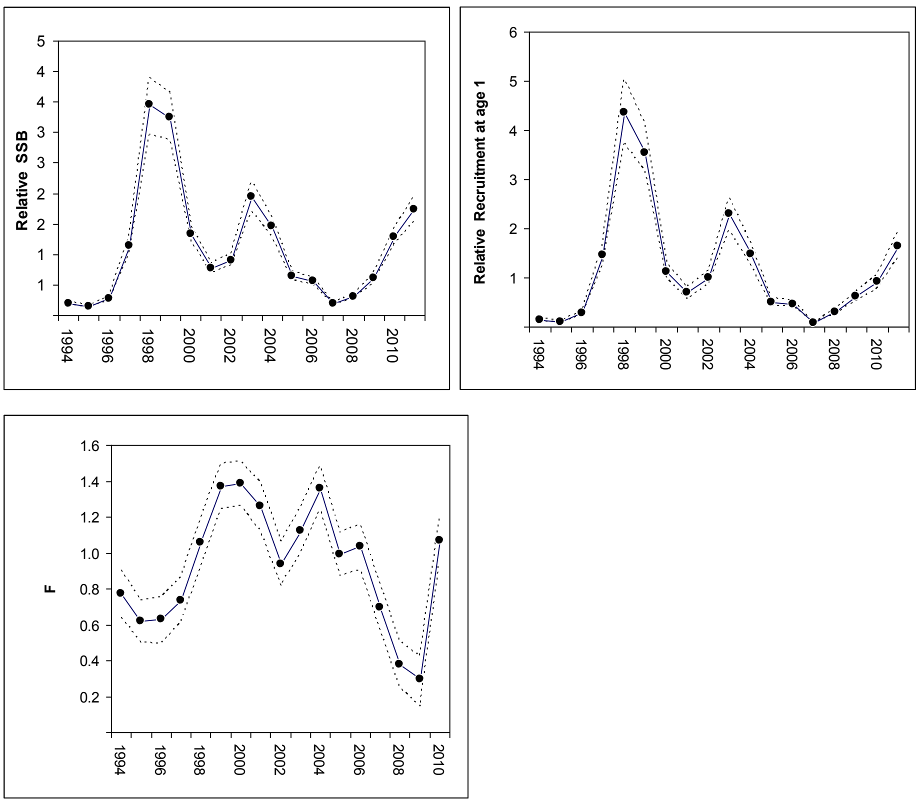
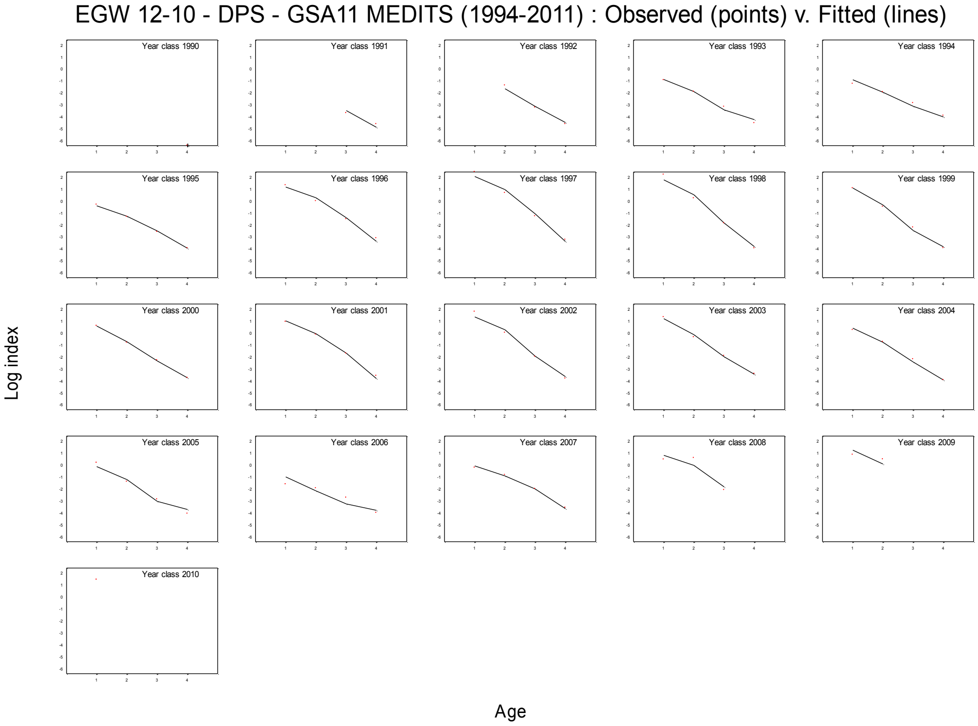
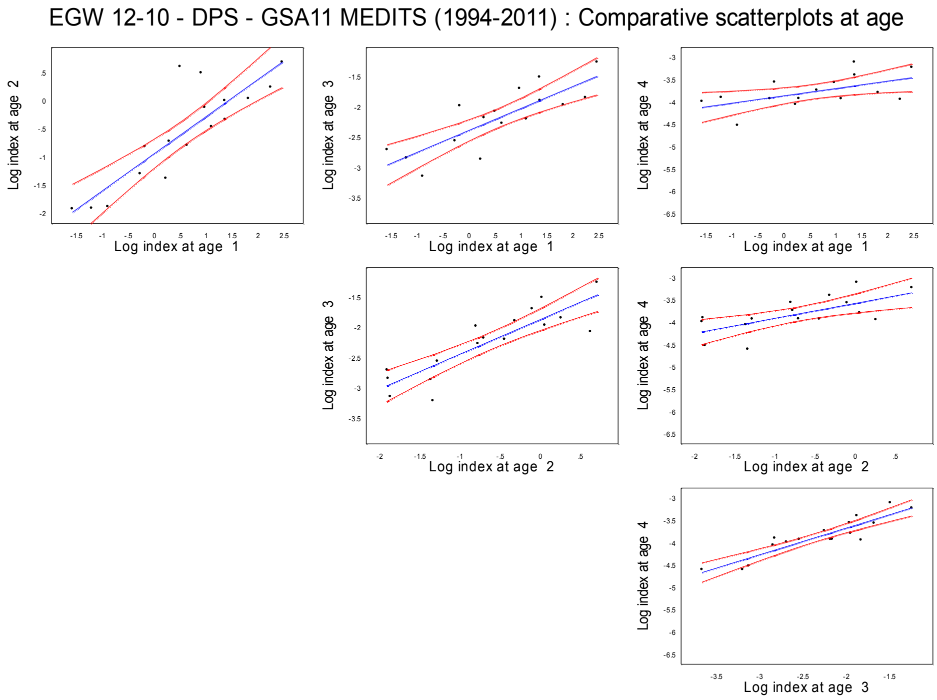


Fig. 6.14.4.1.3.2 Estimated trend in F_{1-3}, relative SSB and relative recruitment index at age 1+ of *P. longirostris* in the GSA11, dotted lines are 2.5% and 97.5% confidence intervals.

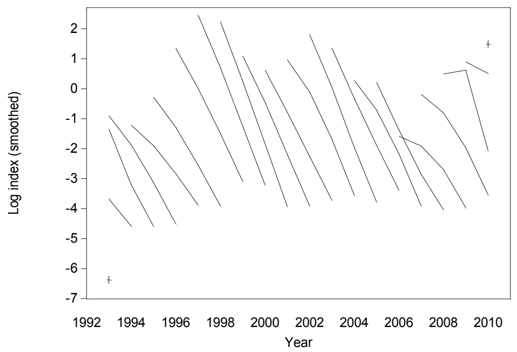
The SURBA model for *P. longirostris* fits very well on survey data and do not highlight trends in the residuals as showed by the comparisons made between observed and fittedabundance indices per year, comparative scatterplot at age, catch curves and residuals of the log index abundance (Fig. 6.X.4.1.3.3).



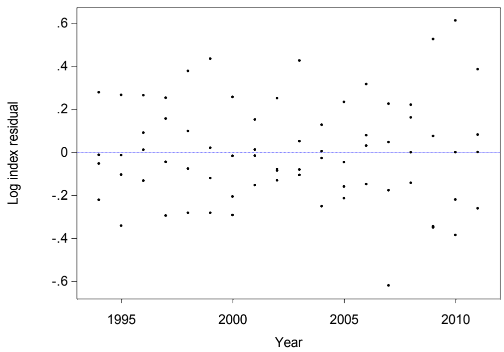
A



B



C



D

Fig. 6.14.4.1.3.3Model diagnostic for SURBA model of in the GSA 11. A) Comparison between observed (points) and fitted (lines) MEDITS survey abundance indices, for each year; B) comparative scatterplot at age; C) Log survey abundance indices by cohort (catch curves); D) residual of the log index abundance.

6.14.4.2 Method 2: VIT

6.14.4.2.1 *Justification*

VIT software was applied using the landing number at age of 2009, 2010 and 2011 from DCF. Analyses were performed separately for each year.

6.14.4.2.2 *Input parameters*

A sex combined analysis was carried out using the following growth parameters (same of those used in 2011):

Growth parameters: CL_∞= 4,35 cm, K= 0.6, t_0= 0;

Length-weight relationship: a =0.00727, b =2.2101.

Natural mortality: M=0.79

Length at maturity: L_{50}=2.4 cm

The vector of natural mortality M was estimated using PRODBIOM (Abella *et al.*, 1998) and terminal fishing mortality F_{term}= 1 was assumed. A sensitivity analysis was performed for 2011 with terminal F equal to 0.9, 1.0 and 1.1. The number of individuals in landing, natural mortality and maturity used as used in VIT are showed below.

Table 6.14.4.2.2.1 Natural mortality and maturity vectors used in 2009-2011.

age	Maturity	Natural mortality
1	0,8	0,79
2	1,0	0,49
3	1,0	0,39

4	1,0	0,34

Table 6.14.4.2.2.2 Landings in numbers at age in 2009, 2010 and 2011.

age	2009	2010	2011
1	937000	1841000	2736000
2	1352000	1808000	3156000
3	837000	625000	545000
4	68000	282000	204000

6.14.4.2.3 *Results*

Estimates fishing mortality at age for sex combined by VIT are plotted in the figure6.14.4.2.3.1.

The mortality acting on the age groups shows values changing from 0.91 in 2009 to 0.64 in 2010 and 0.78 in 2011, with an average over the last three years of 0.78.

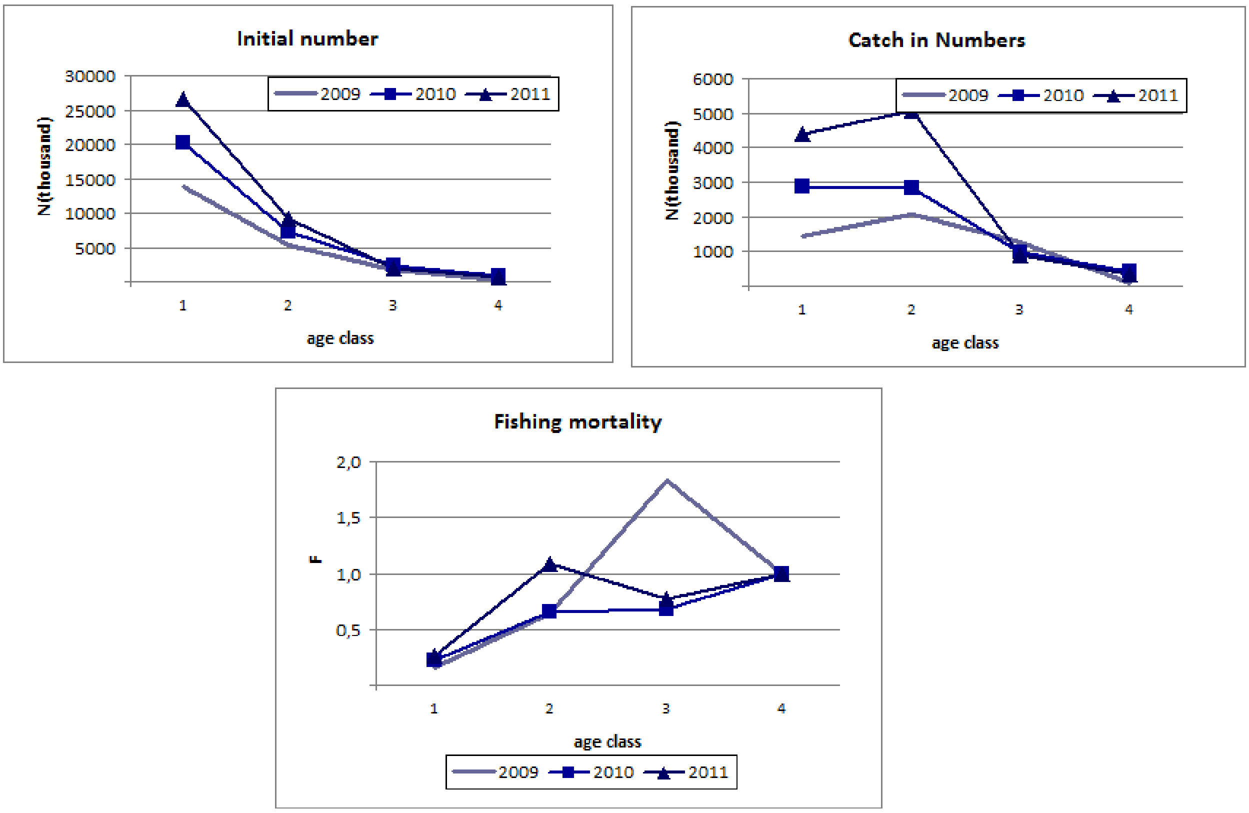


Fig. 6.14.4.2.3.1 LCA output by ages: initial numbers, catch numbers and fishing mortality of *P. longirostris* in the GSA11.

Deep water pink shrimp landings were concentrated on age classes 1-2 and the estimated fishing mortality rates show a peak for specimens of age class 3in 2009 and of age class 2 in 2010 and 2011 (Fig. 6.14.4.2.3.1). The mean fishing mortality ($F_{1\text{-}3}$) was 0.70. $F_{0.1}$ was 0.49.

Assuming no variation in the exploitation pattern, the main results of the Y/R analysis are reported in Table6.14.4.2.3.2.

Table6.14.4.2.3.2Main results of the VIT analysis.

year	yield (t)	rec	F	Z
2009	43	13,9	0,92	1,41
2010	55	20,2	0,65	1,14
2011	71	26,6	0,69	1,29

6.14.5 *Long term prediction*

Two assessment approaches were applied for long term predictions, the VIT and secondly the YIELD software.

6.14.5.1 Method 1: Yield per recruit from VIT

6.14.5.1.1 *Justification*

The yield per recruit from the VIT was applied.

The cohort analysis and the Yield per recruit (YPR) approach as implemented in the VIT software under equilibrium conditions were used, then VIT and YIELD results were compared.

6.14.5.1.2 *Input parameters*

Input parameters are given in section 6.14.4.2.2.

6.14.5.1.3 *Results*

Results of the YPR analysis from the VIT are shown in the table 6.14.5.1.3.1 and in the figure 6.14.5.1.3.1. The YPR analyses indicate that the reference point $F_{0.1}$ is on average 0.49 (three years).

Table6.14.5.1.3.1Overall results of YPR analysis for 2009-2011.

2009	Factor	F	Y/R	B/R	SSB
F(0)	0	0,00	0	11,902	11,688
F(0.1)	0,57	0,52	2,965	5,663	5,462
phi=1	1	0,92	3	4	3,774
phi=2	2	1,81	2,713	2,368	2,196
2010	Factor	F	Y/R	B/R	SSB
F(0)	0	0,00	0	11,902	11,688
F(0.1)	0,75	0,48	2,627	5,504	5,314
phi=1	1	1	3	4,473	4,291
phi=2	2	1,28	2,454	2,341	2,185
2011	Factor	F	Y/R	B/R	SSB
F(0)	0	0,00	0	11,902	11,688
F(0.1)	0,61	0,48	2,583	5,061	4,87
phi=1	1,01	0,69	2,667	3,342	3,165
phi=2	2	1,57	2,227	1,619	1,471

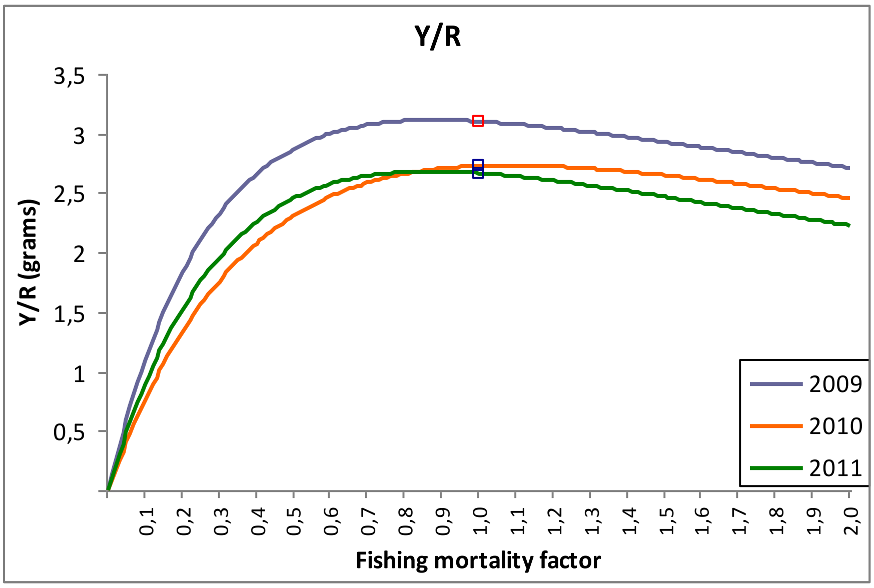


Fig. 6.14.5.1.3.1Y/R curves from VIT in 2009-2011.

According to these calculations, F_{curr} (0.75 from VIT) was above the average (0.49) estimated $F_{0.1}$ values.

6.14.6 *Data quality*

Data from DCF 2011 were used. Assessments were performed for the new submitted time series.

6.14.7 *Scientific advice*

6.14.7.1 Short term considerations

6.14.7.1.1 *State of the stock size*

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h) that was increasing in the last years.Pseudo cohort analysis also shows an increase of SSB in the last years. However, in the absence of proposed biomass management reference points, EWG 12-10 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

6.14.7.1.2 *State of recruitment*

Recruitment indices show an increasing in the last 3 years. However, in the absence of proposed management reference points, EWG 12-10 is unable to fully evaluate the status of the recruitment in relation to these.

6.14.7.1.3 *State of exploitation*

EWG 12-10 proposed $F_{0.1}$ = 0.49 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 0.69), the stock is considered exploited unsustainably.

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

6.15 **Stock assessment of red mullet in GSAs 15 and 16**

6.15.1 *Stock identification and biological features*

6.15.1.1 Stock identification

Levi et al., (1992), comparing growth curves of *M. barbatus* in the Mediterranean, found significant differences between red mullet growth in Sicilian side of Strait of Sicily (GSA 15 and 16) and Gulf of Gabes (GSA 14).

Other evidences supporting the existence of separate stocks of red mullets in Central Mediterranean comes from parasitological observations. A large infestation by a trematode of the genus *Stephanostomum* seriously affected the red mullet fishery in the Tunisian waters for several months in 1990. No such occurrence was noted in the fish landed at the Sicilian base-ports of the strait of Sicily (Levi et al., 1993).

Other hypothesis on separation of stocks units in the strait of Sicily was proposed by Levi et al. (1995), on the basis of independence of water masses and circulation system in the Sicilian and African border of the Strait of Sicily.

Since the red mullet is a typical coastal resources, the peculiarity of the Strait of Sicily (two shelves - the European and the African ones-separated by narrow deep bottoms) supports the hypothesis of the existence of different subpopulations in the area and thus the stock was assumed to be confined in GSAs 15 and 16.

6.15.1.2 Growth

The Von Bertalanffy Growth Function (VBGF) parameters by sex available for different areas of the Strait of Sicily are reported in Table 6.15.1.2.1.

Table 6.15.1.2.1. Summary of the Von Bertalanffy growth function parameters of *M. barbatus* in the Strait of Sicily (n.a. not available).

Author	Area	Females			Males			Combined sexes			Remarks
		L_∞	K	t_0	L_∞	K	t_0	L_∞	K	t0	
Gharbi & Ktari 1981	14	20.46	0.50	-0.04	18.09	0.50	-0.18	-	-	-	Scales readings
Andaloro & Prestipino G., 1985	16	24.55	0.23	-2.01	23.29	0.16	-2.84	-	-	-	Otoliths readings
Levi et al., 1992	15 & 16	-	-	-	-	-	-	27.62	0.15	2.68	Otoliths readings
Djabali et al., 1990	4	-	-	-	-	-	-	29.65	0.21	n.a.	n.a.
Ben Meriem et al., 1995	n.a.	-	-	-	-	-	-	26.70	0.51	n.a.	n.a..
IRMA-CNR, 1999	15 & 16	23.20	0.64	-0.55	19.91	0.67	-0.66	-	-	-	LFD analysis
SAMED, 2002	15 & 16	26.00	0.62	-0.20	20.20	0.64	-0.20	-	-	-	Otoliths readings
CNR-IAMC, 2007	16	26.50	0.26	-1.24	20.67	0.49	-0.62	-	-	-	Otoliths readings
CNR – IAMC, 2010	15 & 16	23.61	0.45	-0.80	20.16	0.57	-0.80	-	-	-	Otoliths readings

6.15.1.3 Maturity

According to Levi (1991), spawning in GSA 15 and 16 takes place in May. The estimates of length at first maturity for the Strait of Sicily (Table 6.15.1.2.2) resulted in the same range on the estimates available for other areas of the Central Mediterranean (Voliani, 1999).

Table 6.15.1.3.1 Length at 50% maturity ($L_{50\%}$) by sex of *M. barbatus* in the Strait of Sicily (n.a.not available).

Author	GSA	Females		Males	
		L50%	g	L50%	g
Gharbi & Ktari, 1981	13	15-16	n.a.	14	n.a.
SAMED, 2002	15&16	15.5	n.a.	n.a.	n.a.
Gangitano S. (pers. comm.)	15&16	14.9	1.18	n.a.	n.a.
Cherif et al., 2007	12	13.9	n.a.	13.9	n.a.

6.15.2 *Fisheries*

6.15.2.1 General description of fisheries

Red mullet (*M. barbatus*) is one of the main demersal resources of the coastal areas in the Mediterranean, fished by otter trawl and, in minor quantities, by trammel-nets, together with other several species (Voliani, 1999) such as *Mullus surmuletus, Merluccius merluccius, Pagellus sp., Uranoscopus scaber, Raja sp., Trachinus sp., Octopus vulgaris, Sepia officinalis, Eledone sp.* and *Lophius sp.*.

In GSAs 15 and 16 red mullet is caught almost exclusively by inshore trawlers operating on shelf fishing-grounds of GSA 15 and 16.

6.15.2.2 Management regulations applicable in 2010 and 2011

At present there are no formal management objectives for red mullet fisheries in the Strait of Sicily. As in other areas of the Mediterranean, the stock management is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area closures), and fish size limits.

Since 1989 no new fishing licenses were assigned in Italy and a progressive reduction of fleet capacity is occurring. The Italian government has adopted a management plan in which a reduction of trawler capacity of 20% is planned within 2013.

The adoption of the fishing closure of 30-45 days per year since late eighties should have contributed to reduce the fishing effort on demersal resources off the Sicilian coast. However this measure for many years had low efficacy in Sicily because the period of trawling ban was not chosen to reduce fishing mortality on juveniles (late summer-early autumn).

On the other hand, coupling the trawling ban in autumn, when the young red mullet move deeper, with the existing prohibition of trawling within three nautical miles from the coast, where the fish recruit in summer (Voliani, 1999), has proved to produce a remarkable increase of the stock size (Relini et al., 1996; Pipitone et al., 2000). Since 2008, the seasonal trawling ban for Sicilian trawlers was done in September–October contributing to improve the stock status of red mullet.

The European Commission regulation 1967/2006 fixed a minimum mesh size of 40 mm square or 50 mm diamond for bottom trawling of EU fishing vessels after July 2008, however derogations were possible until 2010. The regulation CE 27 June 1994 n°1626 of the European Union fixed the minimum marketable size of *Mullus* sp. at 11 cm total length. This minimum length, confirmed by the new regulation CE 1967 of 21 December 2006, is valid for both Italian and Maltese fishing boats operating in the area.

It is important to notice the existence in the Strait of Sicily of the Maltese Management Fishing Zone (MMFZ). This zone extends up to 25 nautical miles from baselines around the Maltese islands, in which fisheries are specifically managed on the basis of the control of the fleet capacity.

The access of Community vessels to the waters and resources in the MMFZ is regulated as follows:

(a) fishing within the management zone is limited to fishing vessels smaller than 12 metres overall length using other than towed gears and ;

(b) the total fishing effort of those vessels, expressed in terms of the overall fishing capacity, does not exceed the average level observed in 2000-2001 that corresponds to 1 950 vessels with an overall engine power and tonnage of 83 000 kW and 4 035 GT respectively.

Trawlers not exceeding an overall length of 24 metres are authorised to fish in certain areas within the management zone (see Fig. 12). The overall fishing capacity of the trawlers allowed to operate in the management zone must not exceed the ceiling of 4 800 kW and the fishing capacity of any trawler authorised to operate at a depth of less than 200 metres must not exceed 185 kW.

Trawlers fishing in the management zone hold a special fishing permit in accordance with Article 7 of Regulation (EC) No 1627/94 and are included in a list containing their external marking and vessel's Community fleet register number (CFR) to be provided to the Commission annually by the Member States concerned.

6.15.2.3 Catches

6.15.2.3.1 *Landings*

According to Andreoli *et al*., (1995), the estimated yield of *Mullus* spp. (i.e. *Mullus barbatus* and *M. surmuletus*) between April 1985 and March 1986 was about 1100 tons and 630 tons in 1986-87.

Landings data for GSAs 15 and 16 collected within the Data Collection Framework (DCF) showed a decrease from 1,409 t in 2005 to 608.5 t in 2011. More than 95% of the annual landing is due to bottom otter trawlers. The contribution of the Maltese fleet was less than 5% in 2005-2011 (Table6.15.2.3.1.1).

Table 6.15.2.3.1.1Annual landings (t) by fishing technique as reported to STECF EWG 12-10 through the DCF data call.

Species	Area	Country	FT_LVL4	2005	2006	2007	2008	2009	2010	2011
MUT	16	ITA	GTR	29	39	37	20	13	0.37	0.51
MUT	16	ITA	OTB	1377	1084	1343	1157	787	757.4	586.1
MUT	16	Total ITA	n/a	1406	1123	1380	1177	801	757	586.6
MUT	15	MLT	GTR	1.01	0.75	0.50	0.42	0.35	1.02	
MUT	15	MLT	OTB	1.9	7.0	0.5	13.8	8.9	12.3	21.86
MUT	15	Total MLT	n/a	3	8	1	14	9	13	
MUT	15&16	ITA&MLT	Total	1409	1131	1381	1191	810	770	608.5

6.15.2.3.2 *Discards*

Recent studies on trawl discards in the GSA 16 during 2006 gave a length at 50% discard ranging between 11.3 (autumn) and 12.0 (spring) cm TL (Gancitano V., pers. comm.). This data was confirmed by data for

2009, which showed that size at 50% discard of red mullet was between 11-12 cm TL for trawlers below 24 m LOA (Fig. 6.15.2.3.2.1).

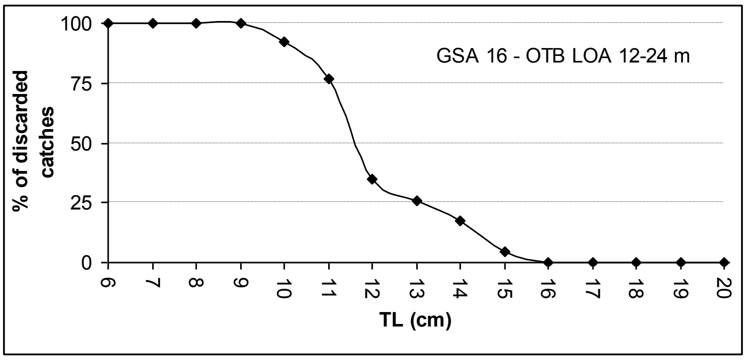


Fig. 6.15.2.3.2.1Length at discard expressed as % of discarded on catch of *Mullus barbatus* of trawlers 12-24 m LOA in 2009 in GSA 16,. The length at 50% discard was around 11-12 cm TL.

The annual amount of discards, estimated within the DCF for trawlers smaller than 24 m LOA, ranged between 32 and 117 tons in the period 2006-2011 in GSA 16 (Table6.15.2.3.2.1). Discard data for GSA 15 were not available during EWG 12-10.

Table6.15.2.3.2.1 Discards data by fishing technique in GSA 16.

Species	Area	FT_LVL4	2006	2007	2008	2009	2010	2011
MUT	16	OTB	94	117	101	186	32	17.5

From 2006 to 2011 the catch was dominated by the age groups 3 and 4 (Fig. 6.15.2.3.2.2)

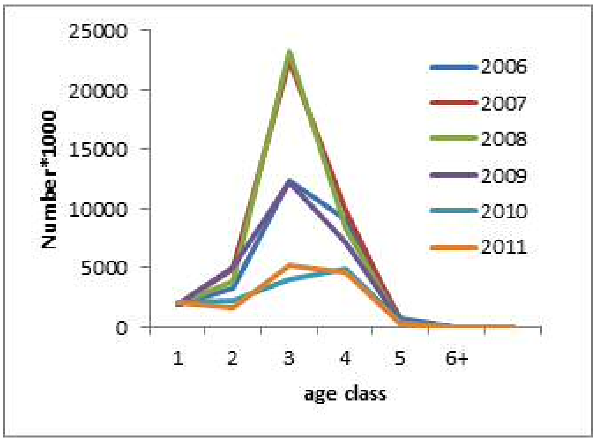


Fig. 6.15.2.3.2.2 Catch composition of red mullet in GSAs 15-16.

6.15.2.4 Fishing effort

The effort of the main fisheries and segment deployed in GSA 15 and 16 by the Italian and Maltese fleet is showed in figure6.15.2.4.1 The effort Italian otter trawl >24 m LOA decreased of 32% since 2004, while the effort of the smallest trawlers (12-24 m LOA) remained quite constant. The effort of Maltese trawlers of LOA>24 m showed an increasing trend. A decreasing pattern was also evident for both Italian and Maltese small scale vessels (6-12 m) equipped with trammel nets (Figure6.15.2.4.2).

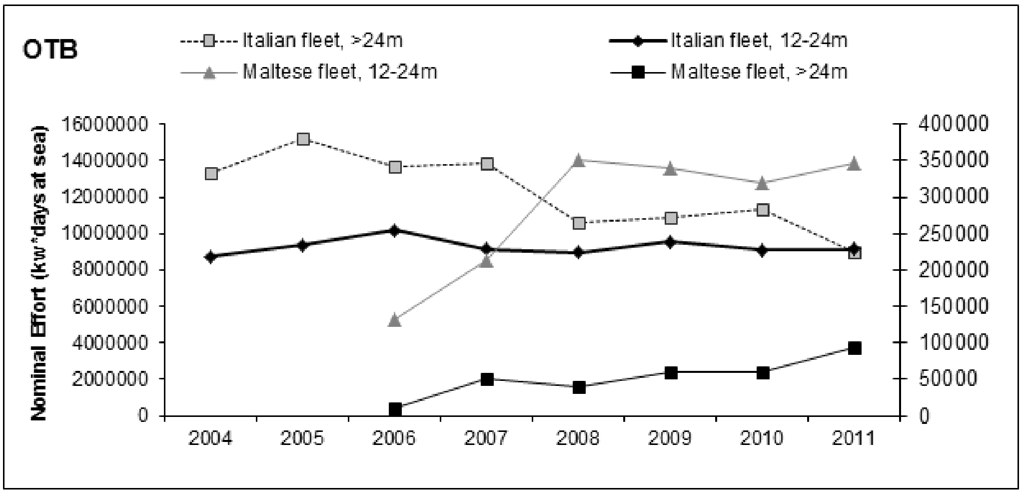


Fig. 6.15.2.4.1Nominal effort (kW*days at sea) trends of trawlers (OTB) by segments of Maltese (right) & Italian fleet (left), 2004-2011.

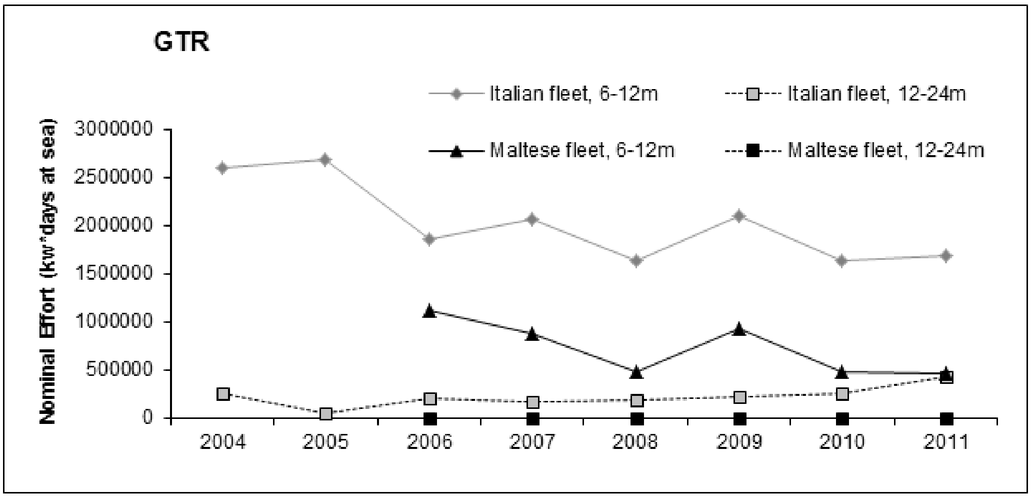


Fig. 6.15.2.4.2Nominal effort (kW*days at sea) trends of artisanal fisheries (GRT- trammel nets) segments in GSA 15 and 16, 2004-2010.

6.15.3 *Scientific surveys*

6.15.3.1 MEDITS

6.15.3.1.1 *Methods*

The total number of trawl stations by depth strata in GSA 16 and 15 is showed in Tables6.15.3.1.1.1and 6.15.3.1.1.2.In GSA 16 the total number of hauls increased from 1994 to the current 120 hauls.

Table6.15.3.1.1.1 Number of hauls per year and depth stratum in GSA 16, 1994-2010.

Depth (m)	1994	1995	1996	1997	1998	1999	2000	2001	2002
10-50	4	4	4	4	4	4	4	4	7
50-100	8	8	8	8	8	8	7	8	11
100-200	4	4	4	4	5	5	6	5	10
200-500	10	11	11	12	11	11	11	11	19
500-800	10	14	14	13	14	14	14	14	19
Depth (m)	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
10-50	7	7	10	10	11	11	11	11	11
50-100	12	12	20	22	23	23	23	23	23
100-200	8	9	18	19	21	21	21	21	21
200-500	18	19	28	31	27	27	27	27	27
500-800	20	19	32	33	38	38	38	38	38

Table6.15.1.2.7. Number of hauls per year and depth stratum in GSA 15, 2002-2010.

Depth (m)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
10-50	1	1	2	1	1	0	0	0	0	0
50-100	5	5	4	5	5	12	6	6	6	6
100-200	13	13	13	13	13	12	13	14	14	14
200-500	10	10	10	9	10	4	9	10	10	10
500-800	16	16	15	17	16	17	17	15	15	15

The data collected through MEDITS were used to calculate density and biomass indices. Catches by haul were standardized to 60 minutes hauling duration and calculated as through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.15.3.1.2 *Geographical distribution patterns*

As indicated by Garofalo *et al*. (2004), two major and clearly separate spawning areas exist in the Northern side of the Strait of Sicily (GSA 15 & 16). They are located over the Adventure Bank, off the South–Western coast of Sicily (GSA 16) and over the Malta Bank, between Sicily and the Maltese Island (GSA 15), respectively, in the outer shelf (100-150m) (Fig. 6.19.2.3.6).

Recent researches on the Marine Protected Area of Castellammare del Golfo (north-western coasts of Sicily – GSA 10), where trawling has been forbidden since 1990, have shown that the oldest spawners are distributed on the deep shelf (100-200 m), while the young ones are found in shallower areas (<50m) (Fiorentino *et al*., 2008).

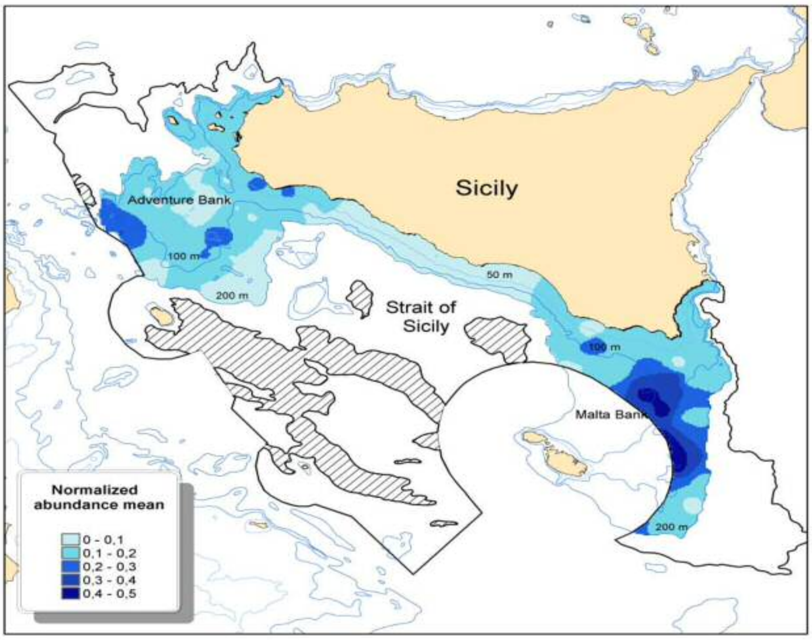


Fig. 6.15.2.3.6.Map of the average distribution pattern of *M. barbatus* spawners based on scientific survey data. The contour of the overall study area and the water depth of more than 800 m (black shaded) are also shown (GSA 15 and 16) (from Garofalo et al., 2004).

6.15.3.1.3 *Trends in abundance and biomass*

Temporal trends of MEDITS abundance and biomass indices of red mullet in GSAs 16 and 15 are showed in Figs. 6.15.3.1.3.1 and 6.15.3.1.3.2. In GSA 16, the estimated abundance and biomass indices reveal a significant increasing trend in the period 1994-2008 followed by a decline in the last 3 years. No trend was observed in the GSA 15.

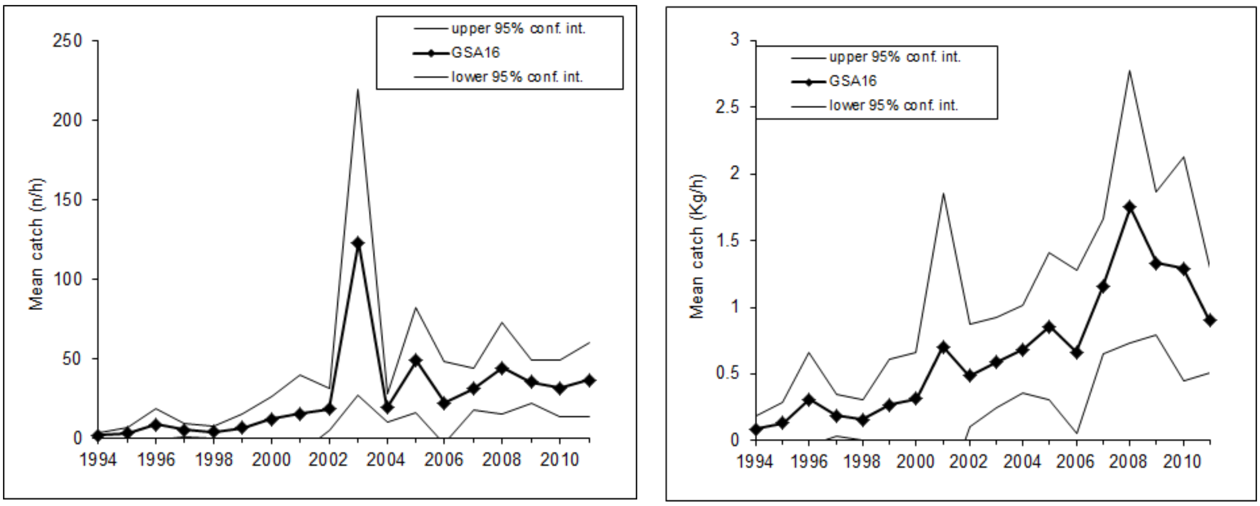


Fig. 6.15.3.1.3.1 Abundance and biomass indices of red mullet in GSA 16.

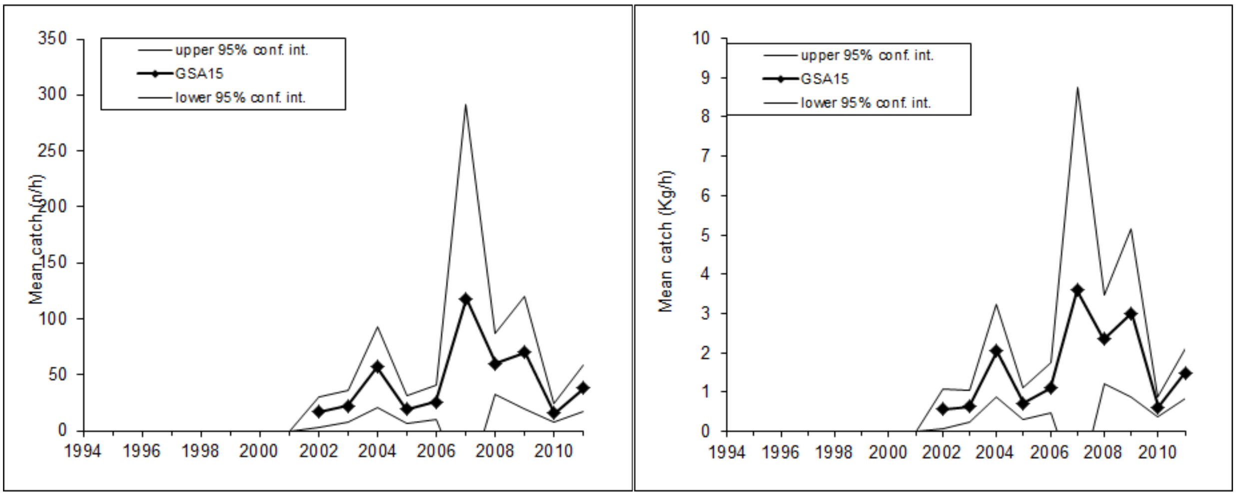


Fig. 6.15.3.1.3.2 Abundance and biomass indices of red mullet in GSA 15.

The time series of recruitment index from trawl surveys in autumn (GRUND surveys) carried out in GSA 16 (individuals smaller than 11 mm CL) showed an increasing trend of recruitment from 2000 to 2008. The XSA estimates (see section 1.1.4.1) indicated a decreasing in recruitment from 2006 to 2011. Higher recruitment occurred in 2003-2004 and 2007-2008 when strong positive anomalies of the seawater surface temperature were observed in the Strain of Sicily (B. Patti personal communication).

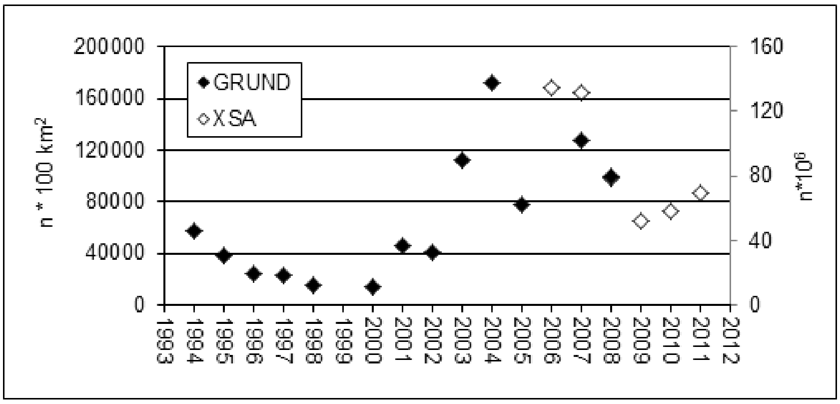
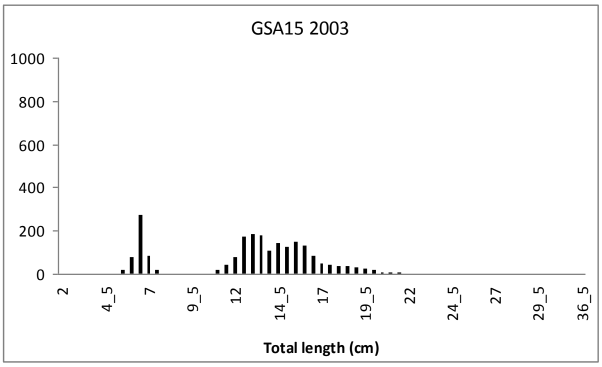
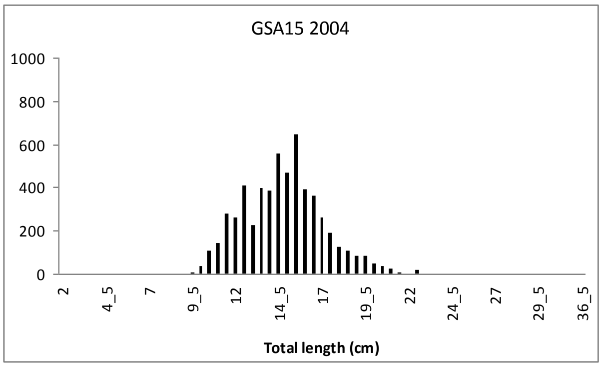


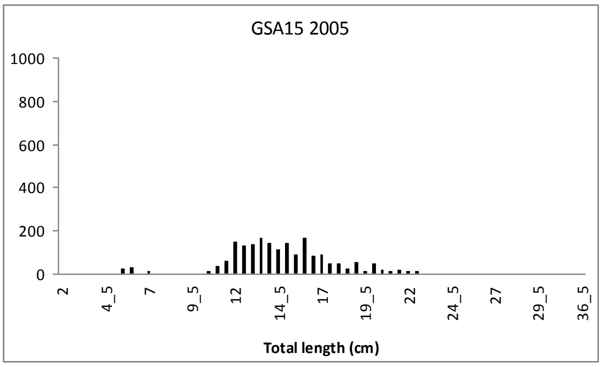
Fig. 6.15.3.1.3.3 Recruitment of red mullet in the GSAs 15 and 16. Grund survey index and XSA estimates of annual recruitment.

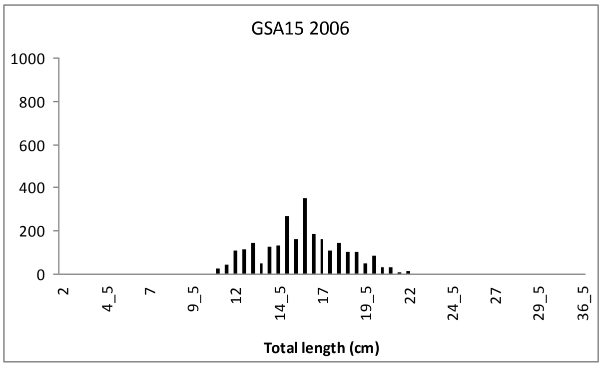
6.15.3.1.4 *Trends in abundance by length or age*

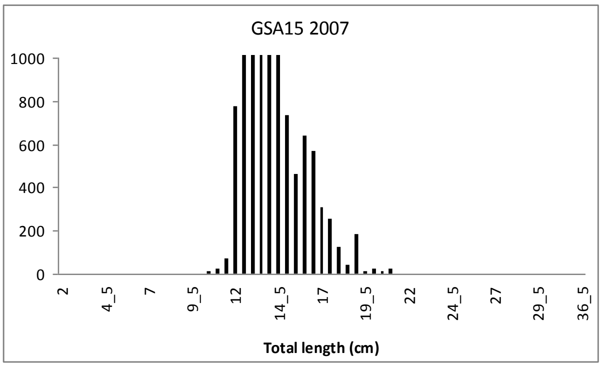
Figures6.15.3.1.4.1 - 3display the size structures of red mullet obtained during the MEDITS survey carried out in GSAs 15 and 16 in 2003-2011 and 1994-2011 respectively.

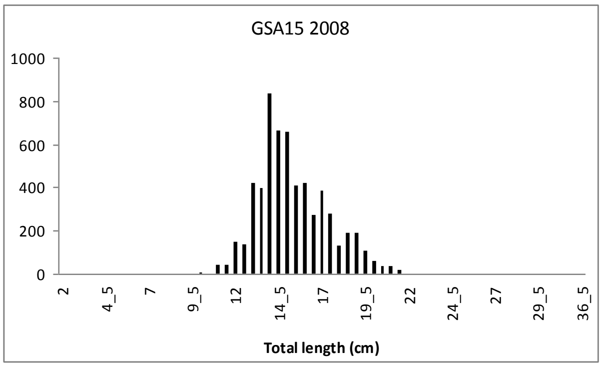

GSA15 2003
1000
800
600
400
200
0
2
4_5
7
9_5
12
14_5
17
19_5
22
24_5
27
29_5
36_5
Total length (cm)

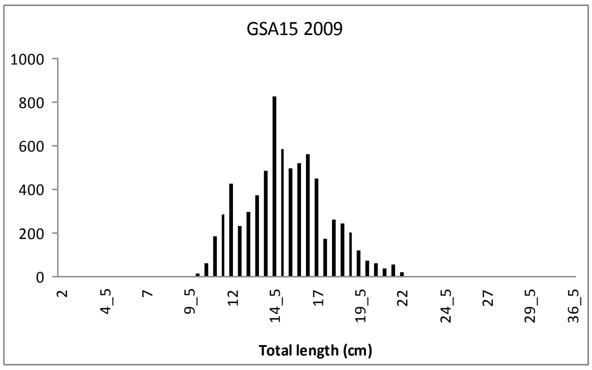

GSA15 2004
1000
800
600
400
200
0
2
4_5
7
9_5
12
14_5
17
19_5
22
24_5
27
29_5
36_5
Total length (cm)

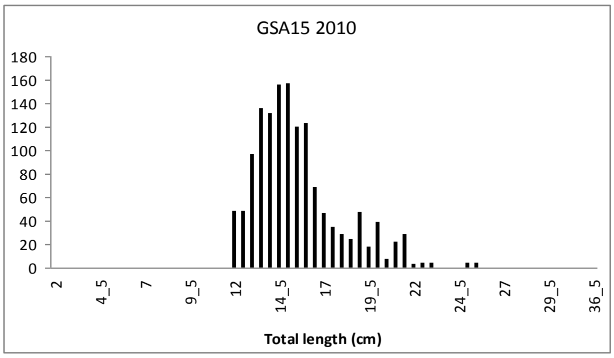

GSA15 2005
1000
800
600
400
200
0
2
4_5
7
9_5
12
14_5
17
19_5
22
24_5
27
29_5
36_5
Total length (cm)


GSA15 2006
1000
800
600
400
200
0
2
4_5
7
9_5
12
14_5
17
19_5
22
24_5
27
29_5
36_5
Total length (cm)


GSA15 2007
1000
800
600
400
200
0
2
4_5
7
9_5
12
14_5
17
19_5
22
24_5
27
29_5
36_5
Total length (cm)


GSA15 2008
1000
800
600
400
200
0
2
4_5
7
9_5
12
14_5
17
19_5
22
24_5
27
29_5
36_5
Total length (cm)


GSA15 2009
1000
800
600
400
200
0
2
4_5
7
9_5
12
14_5
17
19_5
22
24_5
27
29_5
36_5
Total length (cm)


GSA15 2010
180
160
140
120
100
80
60
40
20
0
2
4_5
7
9_5
12
14_5
17
19_5
22
24_5
27
29_5
36_5
Total length (cm)

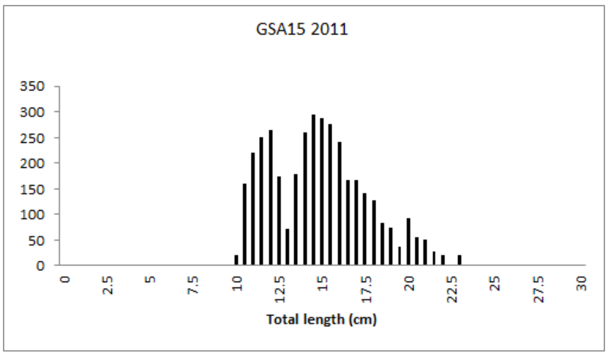

GSA15 2011
350
300
250
200
150
100
50
0
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
27.5
30
Total length (cm)

Fig. 6.15.3.1.4.1 Stratified abundance indices by size in GSA 15, 2003-2011.

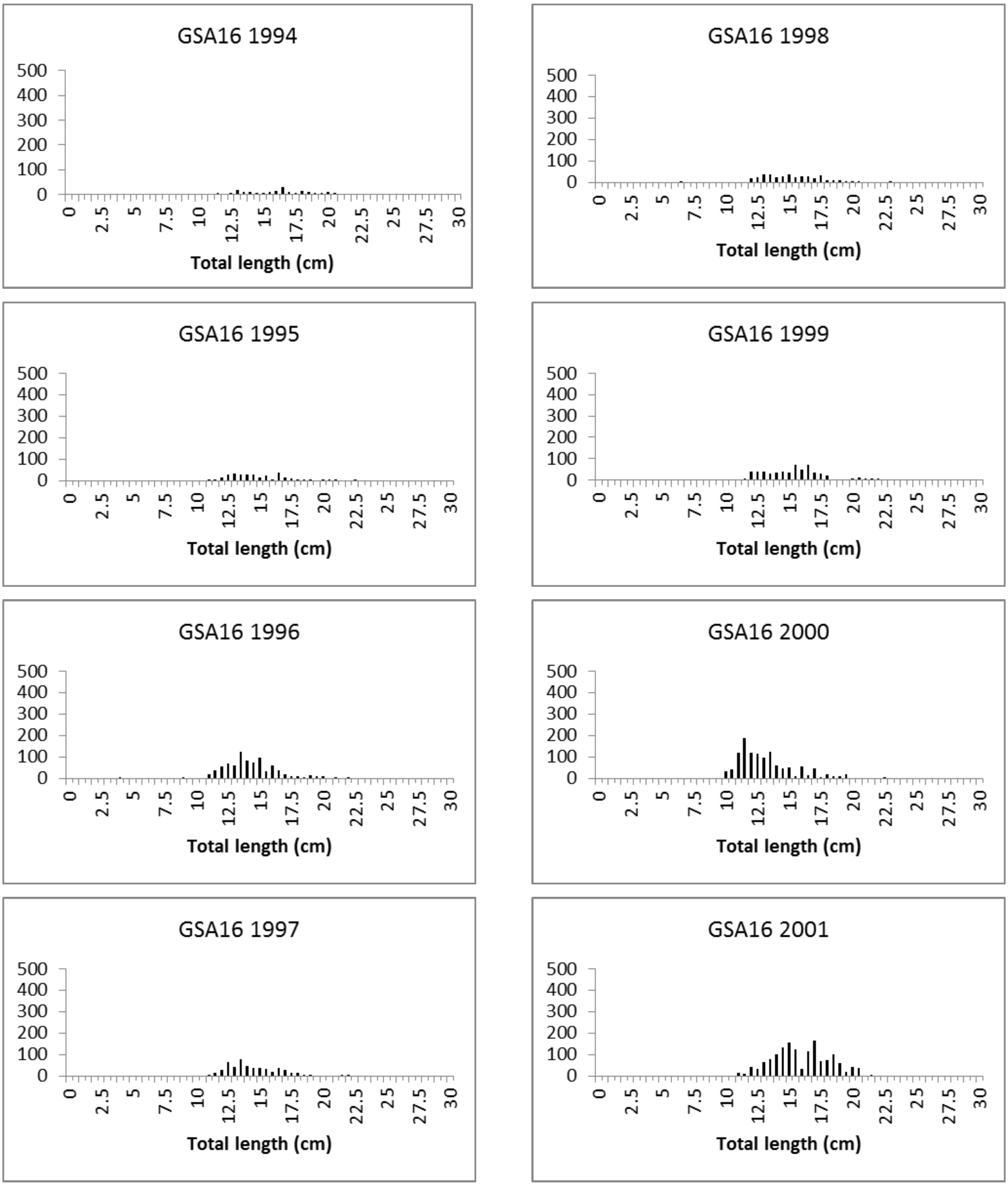


Fig. 6.15.3.1.4.2 Stratified abundance indices by size in GSA 16, 1994-2001.

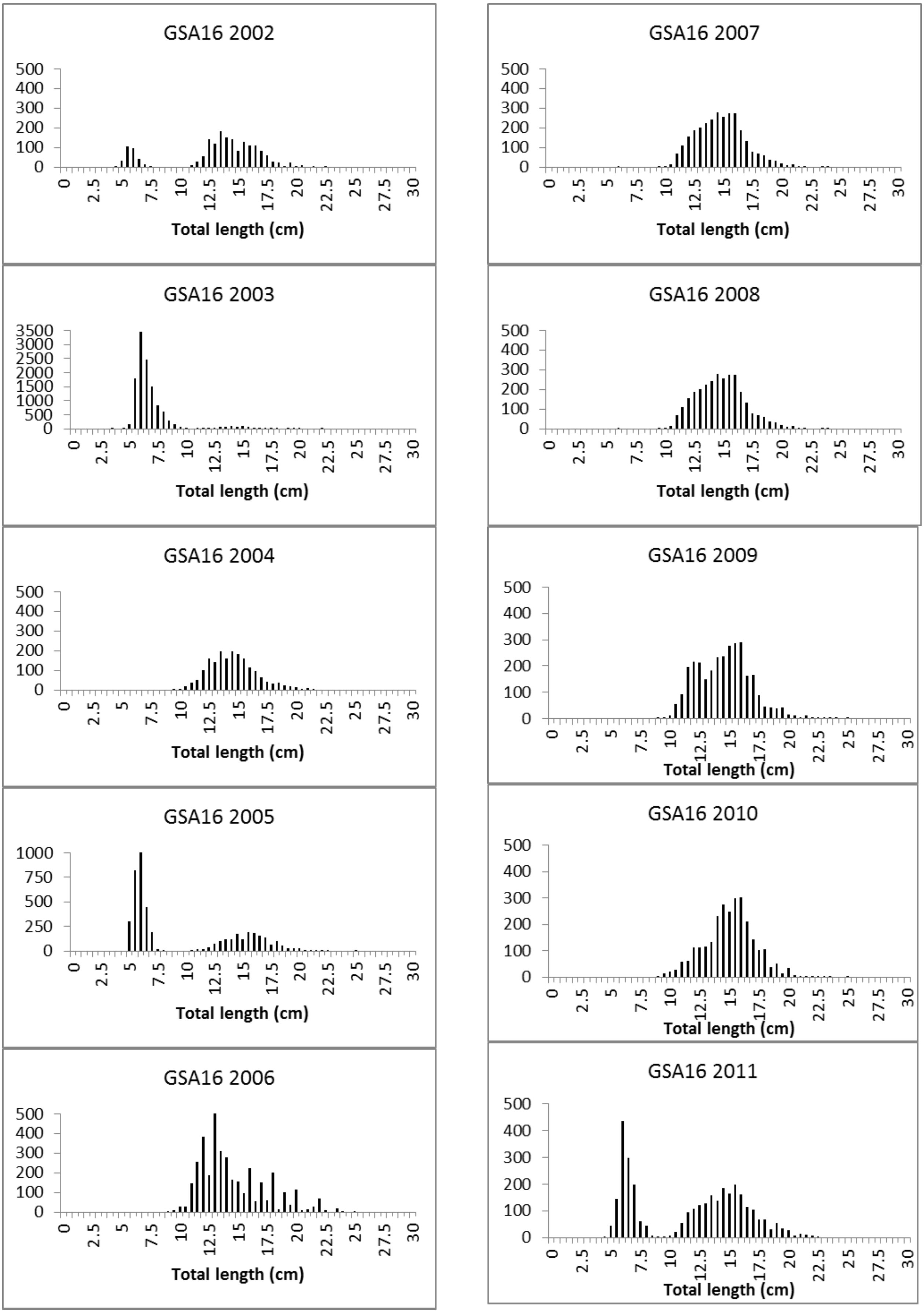


Fig. 6.15.3.1.4.3 Stratified abundance indices by size in GSA 16, 2002-2011.

6.15.3.1.5 *Trends in growth*

No analyses were conducted during STECF EWG 12-10.

6.15.3.1.6 *Trends in maturity*

No analyses were conducted during STECF EWG 12-10.

6.15.4 *Assessment of historic stock parameters*

Levi et al. (1993) assessed exploitation state of *M. barbatus* of Sicilian side of Strait of Sicily (GSA 15 and 16), by using analytical monospecific model based on trawl surveys data. According to the Beverton and Holt relative yield per recruit model, in 1985/87 the exploitation rate (E=F/Z) ranged between 0.66 and 0.73 whereas the estimated $E_{0.1}$ was 0.56 (Figure6.15.4.1).

The stock simulation according to a Thompson and Bell model, with fishing mortality (F) from 0.5 to 2 times the current value and keeping gear selectivity constant, showed that the long term yield does not change significantly varying fishing effort (Figure. 6.15.4.2).

However the picture is different in terms of economic gain since the potential income doubled if fishing mortality was reduced to a 40% of current value. Further increase of yield and economic value in long-term scenario could derive by changing from 32 to 40 mm.

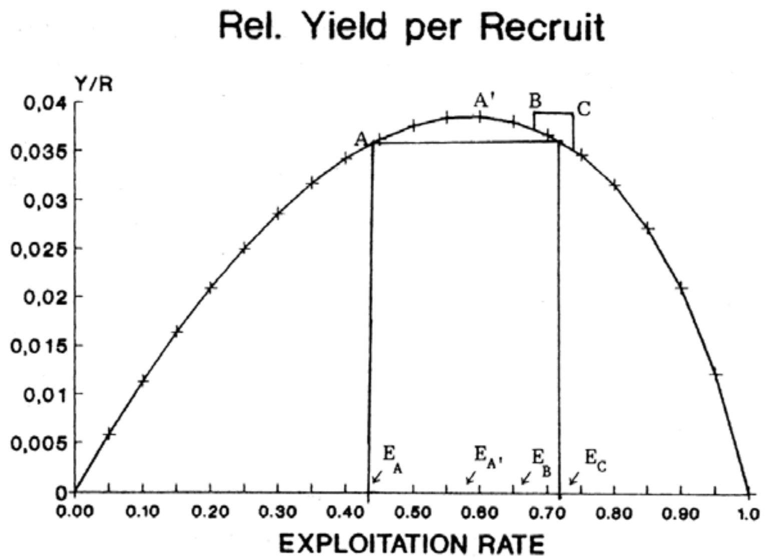


Fig. 6.15.4.1 Beverton and Holt relative yield per recruit. *Mullus barbatus.* L∞ = 27.62 cm; M/K= 1.61. B-C 1985/86 situation; A maximum yield per recruit; Optima: $E_{max.}$= 0.59; $E_{0.1}$= 0.56; $E_{0.5}$=0.31 (from Levi et al., 1993).

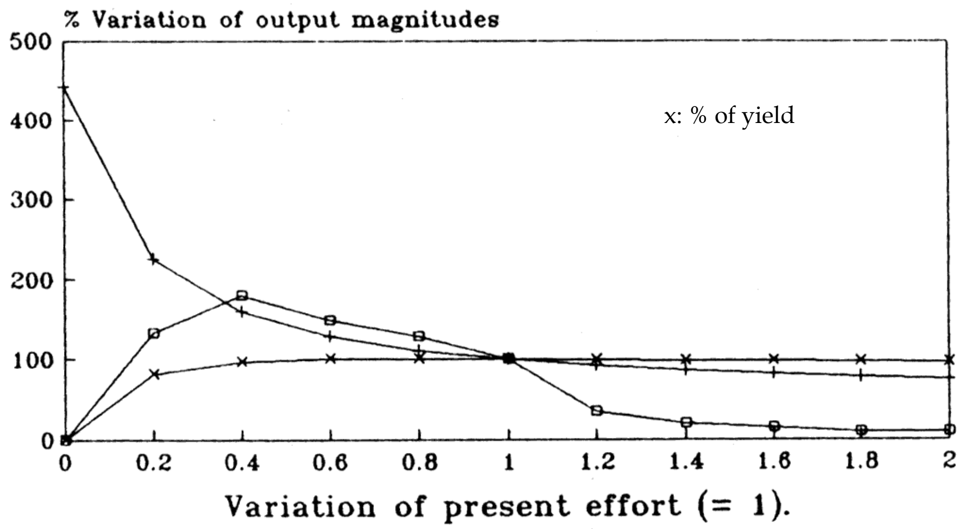


Fig. 6.15.4.2 Thompson and Bell analysis for 1985/86 fishing pattern. *Y*, %variation of output magnitudes; *X*, variations of present effort (=1) (from Levi et al., 1993).

Comparable results were obtained by stock assessments carried out in the framework of the GRUND (Italian group on evaluation of demersal resources) trawl surveys in the late 1990s. (Table 6.15.4.1, IRMA-CNR, 1999).

Table 6.15.4.1Simulation of long - term variation in yield per recruit (YPR) and income per recruit (£/R) of red mullet in GSA 15 & 16 changing current mesh size from 30 to 40 mm opening according to Thompson and Bell model (from IRMA-CNR, 1999).

Fishing mortality (F)	YPR(g) "30"	YPR(g) "40"	Δ%	£/R "30"	£/R "40"	Δ%
0.5	5.8	5.9	+1.9	29	31	+5.5

Levi et al. (2003) investigated the stock-recruitment relationship for Red mullet in the Strait of Sicily including environmental information in terms of sea surface temperature (SST) anomaly as a proxy for oceanographic processes affecting recruitment. The study showed that, for a given level of spawning stock, higher level of recruitment occurred in years of higher SST (fig. 6.15.4.3).

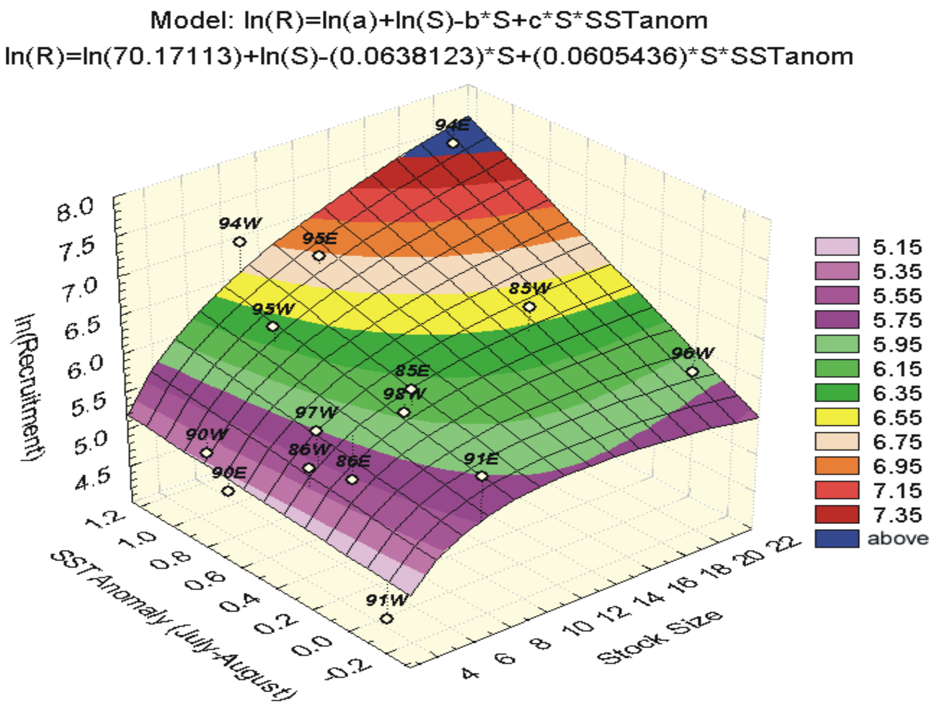


Fig. 6.15.4.3Stock-recruitment relationship including sea surface temperature anomalies of *M. barbatus* in the Strait of Sicily (GSA 16 and 15, excluding the MMFZ) (from Levi et al., 2003).

6.15.4.1 Method 1: SURBA

6.15.4.1.1 *Justification*

The relatively long time series of data available from the MEDITS surveys provided the most useful data set to analyse the trend of red mullet stock. The survey-based stock assessment approach SURBA (Needle, 2003) was used on MEDITS (1994-2011) data of red mullet of GSAs 15-16. The annual size distributions for males and females from MEDITS were converted in age distributions using the statistical slicing method approach developed during STECF EWG 11-14 (Scott et al, 2011). In each year a single age distribution for the two sexes combined was obtained pooling together the age distributions of the two sexes.

6.15.4.1.2 *Input parameters*

Table 6.15.4.1.1.1 shows the input parameters using to run SURBA. The age group 0 was removed from the dataset because they are not caught during Medits. The survey is generally carried out just before the recruitment period and therefore the survey catch does not include the 0 group.

Single survey exploratory SURBA 2.2 model runs were carried out fitting constant catchability (1.0 for all ages) catchability at age.

The model settings are given below:

Year range: 1994-2011

Age range: 1-5+ as Age groups

Catchability: 1.0 at all ages

Age weighting 1.0 at ages 1-4 , and 0.75 for age 5+

Smoothing Index Rho: 2.0

Cohort weighting: not applied

Results as relative values

Table 6.15.4.1.1.1Input parameters of SURBA.

Growth parameters

Sex	L∞	k	t0	A	b
F	23.61	0.45	-0.80	0.0134	2.9419
M	20.16	0.57	-0.80	0.0176	2.8226

Proportion of mature

Age				
1	2	3	4	5+
0.1	0.9	1	1	1

Natural mortality

Age				
1	2	3	4	5+
1	0.6	0.42	0.36	0.33

6.15.4.1.3 *Results*

Comparative scatterplots at age indicated a good internal consistency of the MEDITS data, except for age 4 against age 5 the year after (Fig. 6.15.4.1.2.1)

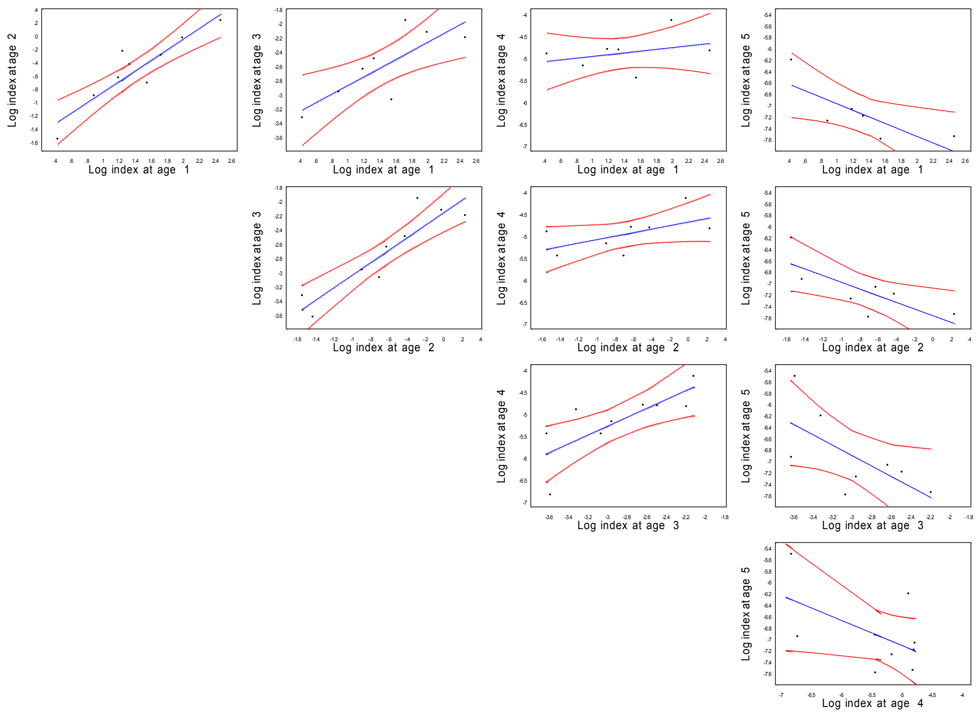


Fig. 6.15.4.1.2.1 Red mullet in GSAs 15-16: Output from SURBA (ver. 2.2) plots for MEDITS survey (ages 1-5), showing age scatter plots.

The trends in $F_{1\text{-}4}$, SSB and recruitment at age 1 from SURBA run, and the model residuals are given in Figures 6.15.4.1.2.2 and 6.15.4.1.2.3. The retrospectives for the MEDITS survey data are given in Figure 6.19.2.3.16. The model estimates an increased temporal trend in the year effect and a dome shaped age effect increasing from age 1 to age 3 and decreasing for ages 4 and 5. Both SSB and recruitment indices peaked in 2007 to decrease steadily in the last 4 years, while F was increasing. $F_{1\text{-}4}$ increased from 1.4 in 2004 to 1.7 in 2009 and 1.5 in 2010.

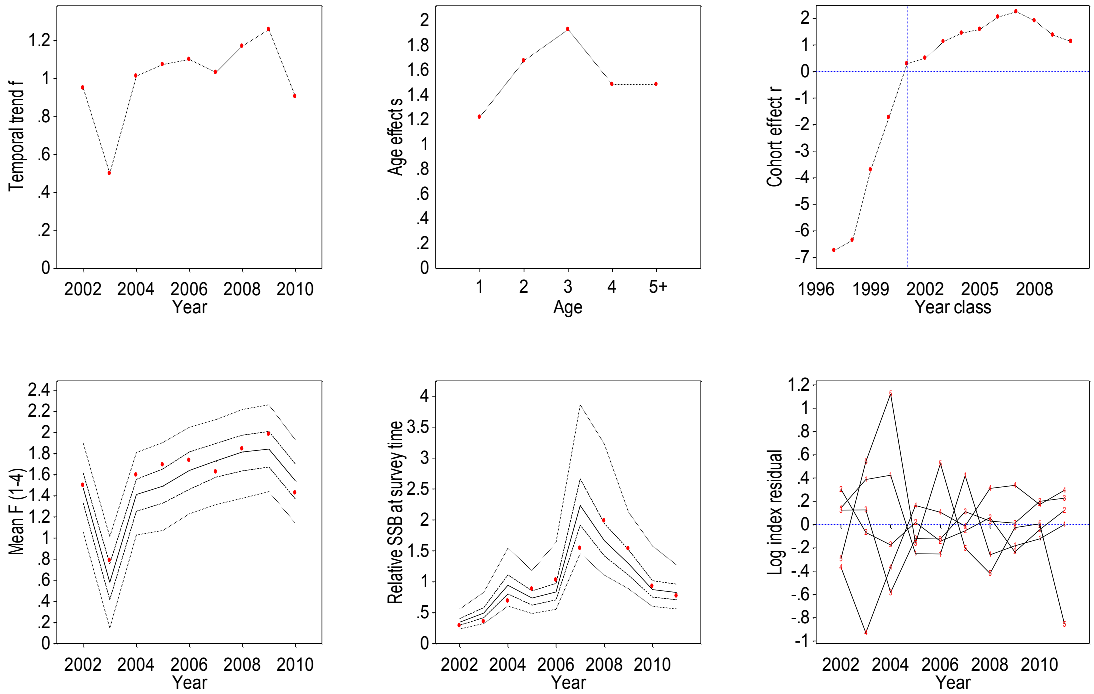


Fig. 6.15.4.1.2.2 Red mullet in GSAs 15&16. SURBA model parameters and estimates of F, SSB, recruitment and overall residuals.

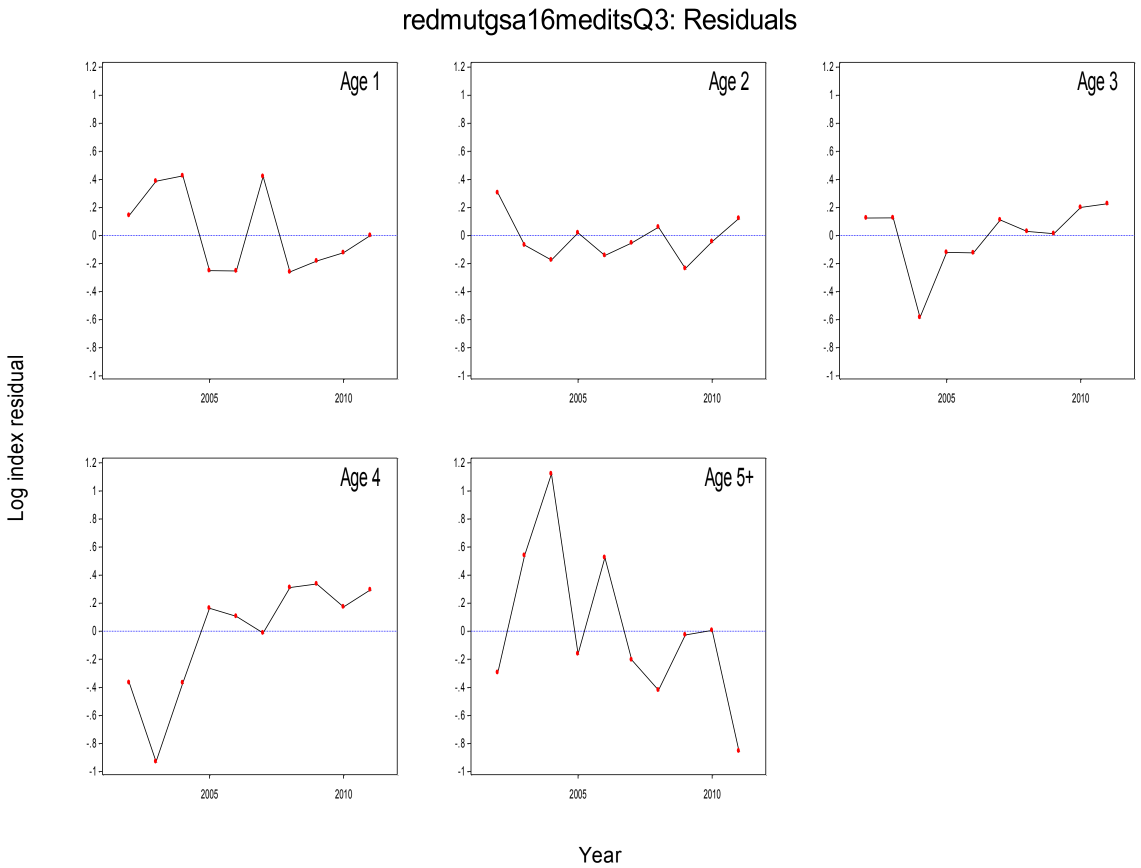


Fig. 6.15.4.1.2.3 Red mullet in GSAs 15&16. Temporal trend in residuals by age of the SURBA model.

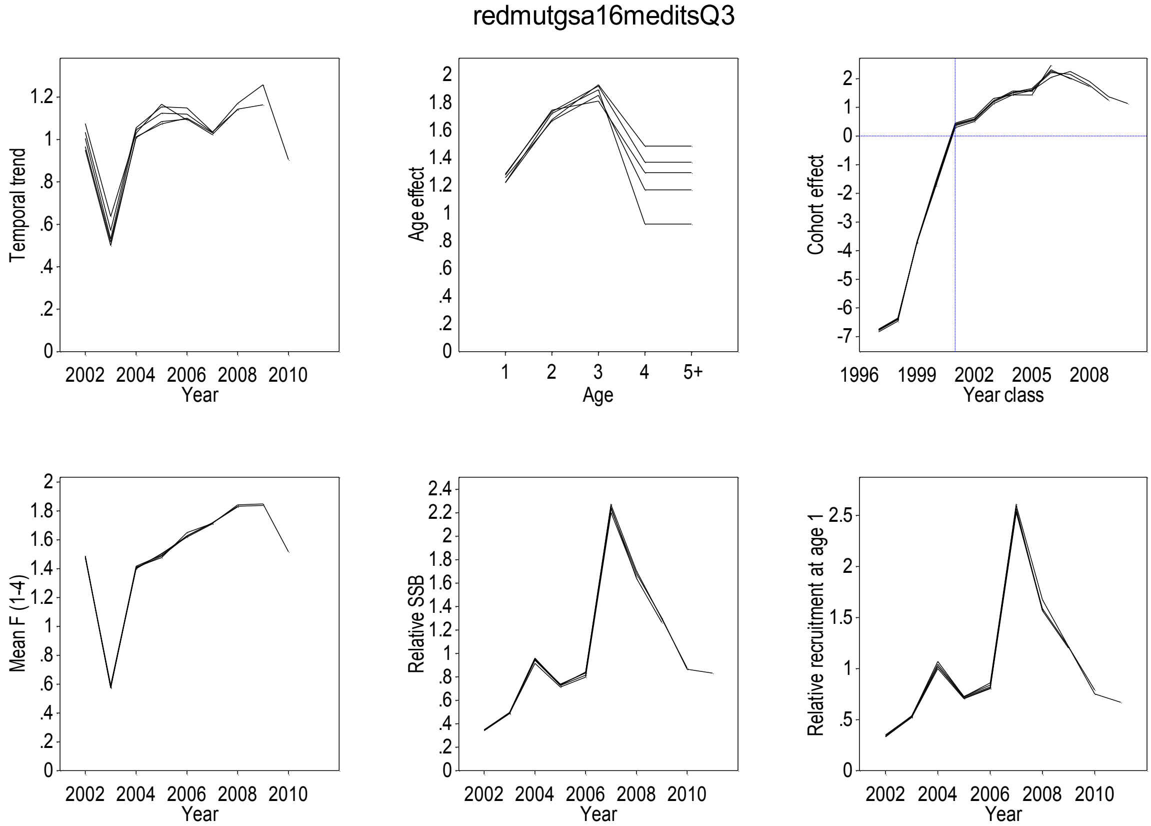


Fig. 6.15.4.1.2.4 Red mullet in GSAs 15&16. SURBA model: retrospective analysis.

6.15.4.2 Method 2: XSA

6.15.4.2.1 *Justification*

Red mullet was previously assessed using a pseudocohort approach (length cohort analysis with VIT) in STECF EWG 11-12. An XSA assessment was carried out during EWG 12-10 using the catch data (landings and discards) collected under DCF from 2006 to 2011 and calibrated with survey data (MEDITS 2006-2011).

6.15.4.2.2 *Input parameters*

Reliable DCF catch data for red mullet are available for trammel nets and bottom trawlers since 2006. The annual size distributions of the catch as well as of the surveys (MEDITS) were converted in numbers at ages classes 1-6+ using the slicing statistical approach developed during approach developed during STECF-EWG 11-12 (Scott et al., 2011) and using the same growth parameters adopted to slice the MEDITS size distributions. The mortality and maturity at age data are listed in Table 6.15.4.2.2.1.

The XSA settings are given below:

Fse: 0.5, 1.0, 2.0

Rage: 1

Qage: 2

shk.yrs: 3

shk.ages: 3

Table 6.15.4.2.2.1 *Mullus barbatus* in GSAs 15 and 16. XSA input data (i.e. catch at age, weight at age, maturity at age and natural mortality at age)

	Catch-at-age (thousands)					
Age class	2006	2007	2008	2009	2010	2011
1	3341.40	4910.60	3802.40	5038.00	2259.70	1694.70
2	12424.30	22450.20	23198.00	12214.20	4095.70	5262.40
3	9114.20	9817.60	8351.40	7186.50	4849.10	4656.30
4	765.86	482.89	353.26	506.52	379.20	285.98
5	44.20	17.37	16.79	30.43	33.35	15.46
6+	0.05	0.26	0.23	0.04	0.02	0.01
	Weight-at-age					
Age class	2006	2007	2008	2009	2010	2011
1	0.010	0.012	0.011	0.010	0.005	0.005
2	0.040	0.037	0.036	0.038	0.041	0.041
3	0.056	0.051	0.050	0.053	0.059	0.058
4	0.062	0.057	0.058	0.061	0.083	0.085
5	0.106	0.106	0.106	0.106	0.106	0.106
6+	0.117	0.117	0.117	0.117	0.117	0.117
	Maturity-at-age					
Age class	2006	2007	2008	2009	2010	2011
1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.9	0.9	0.9	0.9	0.9	0.9
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6+	1	1	1	1	1	1
	Mortality-at-age					
Age class	2006	2007	2008	2009	2010	2011
1	1	1	1	1	1	1
2	0.6	0.6	0.6	0.6	0.6	0.6
3	0.42	0.42	0.42	0.42	0.42	0.42
4	0.36	0.36	0.36	0.36	0.36	0.36
5	0.33	0.33	0.33	0.33	0.33	0.33
6+	0.31	0.31	0.31	0.31	0.31	0.31

6.15.4.2.3 *Results including sensitivity analyses*

XSA was run setting shrinkage at 0.5, 1.0, 2.0. As showed in Figure 6.15.4.2.3.1, the three different settings produced quite similar estimates of recruitment and SSB except for the 2010 and 2011 when model with shrinkage 0.5 diverged from models with 1.0 and 2.0 shrinkage. The XSA model with 2.0 shrinkage produced significant lower estimates of $F_{1\text{-}5}$.

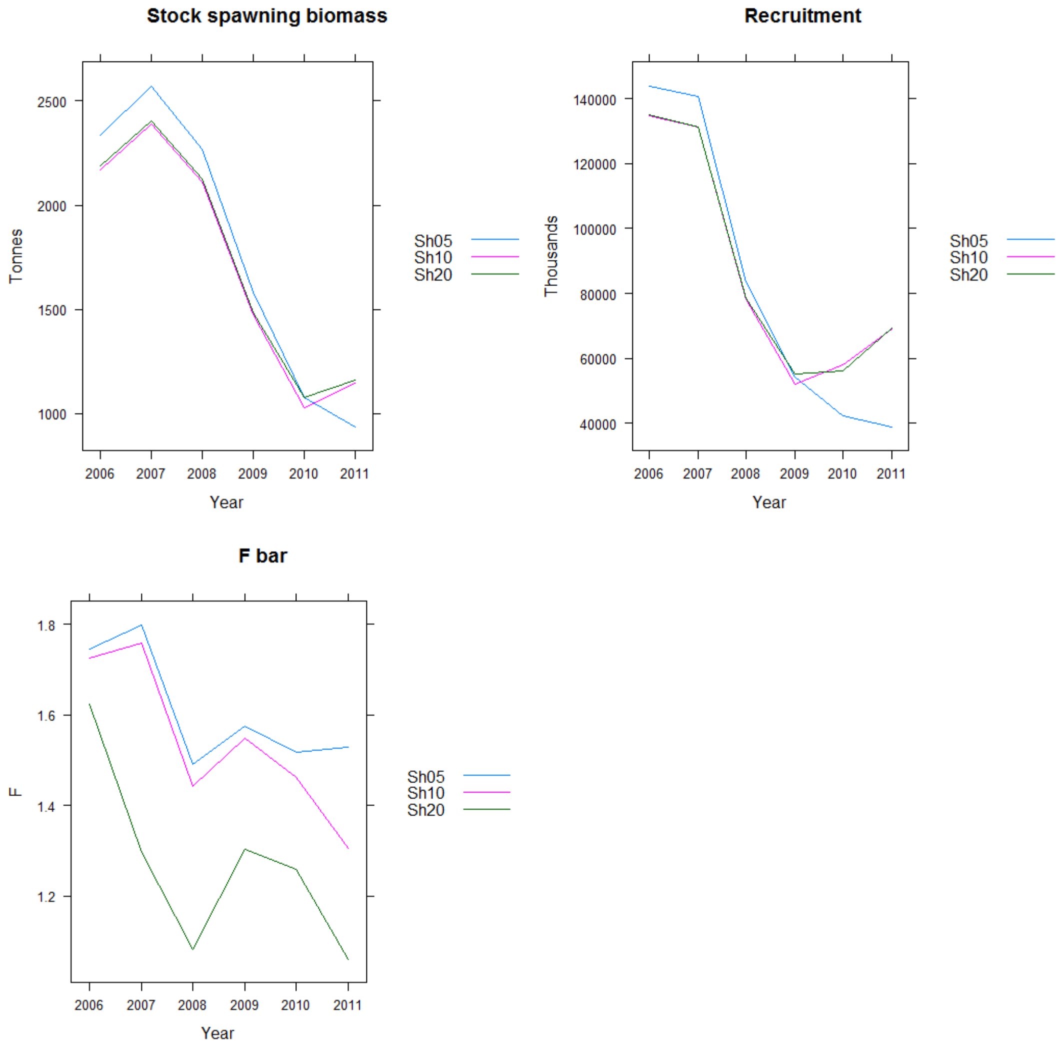


Fig.6.15.4.2.3.1 Estimates of recruitment, SSB and F using different values of shrinkage.

Model with 1.0 shrinkage was adopted as final model since it produced relatively small residuals, with no clear trend in their distribution (Fig. 6.15.4.2.3.2) and a more consistent pattern as also showed by the retrospective analysis (Fig. 6.15.4.2.3.3).

Shrinkage=1.0 Shrinkage=2.0 Shrinkage=0.5

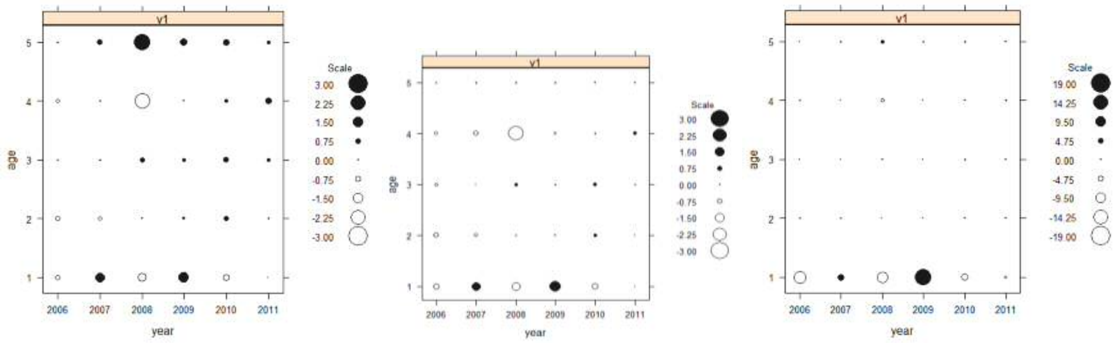
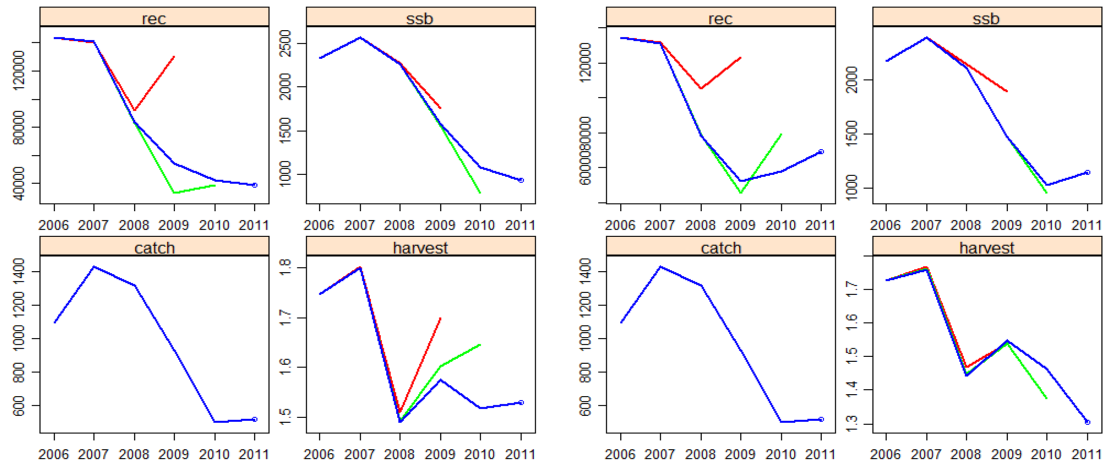


Fig. 6.15.4.2.3.2Residuals at age obtained with XSA models with different level of shrinkage.

Shrinkage=0.5 Shrinkage=1.0



Shrinkage=2.0

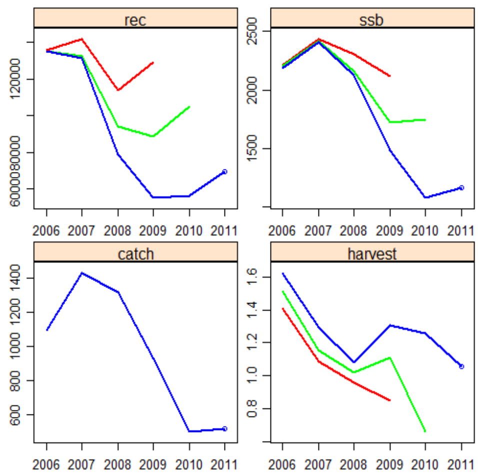


Fig. 6.15.4.2.3.3Retrospective analysis for XSA models different level of shrinkage.

In 2006-2011, the SSB declined from 2,167 to 1,147 t in 2011. The recruitment also showed a decreasing trend from 134.6 million in 2006 to 64.9 million in 2011. The total biomass consequently declined in the same period from about 3,500 t to 1,510 t (Table 6.15.4.2.3.1). XSA estimates of $Fbar_{2\text{-}5}$ and $Fbar_{1\text{-}5}$ showed a reduction since 2006 (Table 6.15.4.2.3.2) with the lowest values estimated in 2011. Figure6.15.4.2.3.4 shows the stock summary (recruitment, SSB, Catch and landing, F mean for ages 1-5) as estimated by XSA.

Table 6.15.4.2.3.1Spawning stock biomass (SSB), total biomass (TB) and recruitment estimates by XSA for red mullet in GSA 15 & 16 from 2006 to 2011.

	2006	2007	2008	2009	2010	2011
SSB (tons)	2167.4	2389.4	2108.2	1472.3	1028.6	1146.9
TB (tons)	3498.8	3966.4	3034.3	2032.7	1331.3	1510.8
Recruitment (millions)	134.678	131.194	78.262	51.944	58.061	68.931

Table 6.15.4.2.3.2Fishing mortality and numbers at age at age as estimated by XSA.

F-at-age

age	2006	2007	2008	2009	2010	2011
1	0.0	0.1	0.1	0.2	0.1	0.0
2	0.6	0.9	1.0	0.9	0.4	0.4
3	2.6	2.8	2.4	2.6	2.4	2.2
4	3.3	2.8	2.1	2.3	2.7	2.3
5	2.1	2.2	1.6	1.9	1.8	1.6
6+	2.1	2.2	1.6	1.9	1.8	1.6
Fbar2-5	2.1	2.2	1.8	1.9	1.8	1.6
Fbar1-5	1.7	1.8	1.4	1.5	1.5	1.3

Numbers-at-age (thousands)

age	2006	2007	2008	2009	2010	2011
1	134680	131190	78262	51944	58061	68931
2	37447	47607	45420	26592	16216	20051
3	11177	11730	10453	8822	6052	5969
4	871	568	455	632	452	358
5	56	22	23	40	45	22
6+	0	0	0	0	0	0

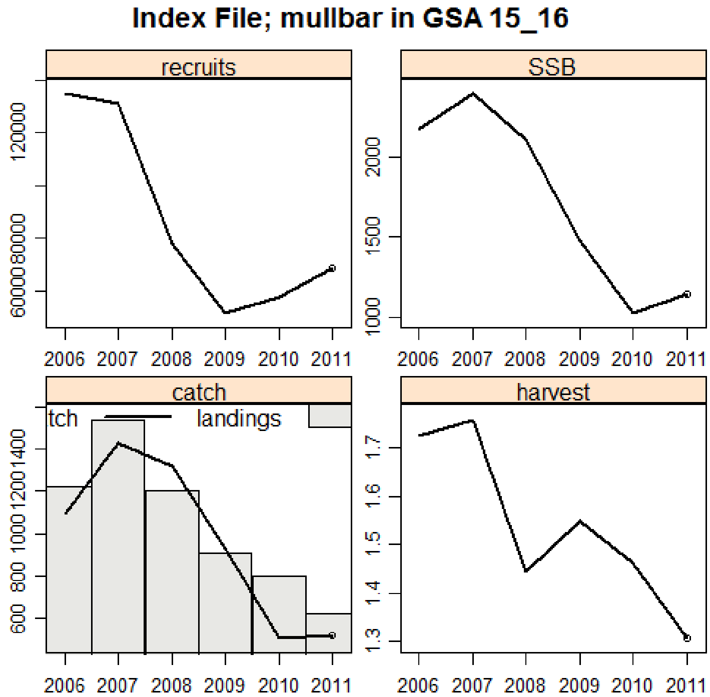


Fig. 6.15.4.2.3.4 Stock summary of red mullet (recruitment, SSB, Catch and landing, F mean for ages 1-5) in GSA 15&16 as estimated by XSA.

6.15.5 *Long term prediction*

6.15.5.1.1 *Justification*

F_{01} as proxy of F_{MSY} is equal to 0.45 and it was derived by a YPR analysis conducted during the EWG 11-12 meeting.

6.15.6 *Data quality and availability*

STECF EWG 12-10 notes that there was no discards information for GSA 15.

6.15.7 *Scientific advice*

6.15.7.1 Short term considerations

6.15.7.1.1 *State of the spawning stock size*

In the absence of proposed or agreed biomass management reference points, STECF EWG 12-10 is unable to fully evaluate the state of red mullet biomass in comparison to these. The analyses carried out for the period 2006-2011, resulted in a SSB ranging from around 1,020 to 2,389 tons. Both landings and the survey indices likely indicate that the stock is currently at a low level.

6.15.7.1.2 *State of recruitment*

In the absence of proposed or agreed management reference points, STECF EWG 12-10 is unable to fully evaluate the state of recruitment in comparison to these. The analyses carried out for the period 2006-2011 show a decreasing pattern in recruitment from 2006 to 2009 followed by an increase in 2010-11.

6.15.7.1.3 *State of exploitation*

The estimated current fishing mortality was 1.3 and thus higher than F_{MSY}. Therefore,EWG 12-10 considers that the stock of red mullet in the GSA 15&16 is exploited unsustainably. EWG 12-10 considers also that F needs to be reduced towards the candidate F_{MSY} reference points (0.45) to achieve long term sustainability.

6.16 **Stock assessment of common Pandora in GSAs 15 and 16**

6.16.1 *Stock identification and biological features*

6.16.1.1 Stock identification

Common Pandora (*Pagellus erythrinus*) is a widely distributed species in the Sparidae family, which is found in the north-eastern and central-eastern Atlantic Ocean, from Norway (Bauchot and Hureau, 1986) to Guinea-Bissau (Sanches, 1991 in Coelho et al. 2010) and the Mediterranean Sea (Spedicato et al. 2002).In the Mediterranean it occurs on continental shelf bottoms throughout all Mediterranean basins, including the Black Sea. Although several aspects of common Pandora population biology and fisheries have been the subject of several studies (e.g. Santos et al. 1995, Pajuelo and Lorenzo 1998, Hossucu 2003, Klaoudatos 2004, Metin et al. 2011), no detailed information on stock structure is available from the Central Mediterranean. Cannizzaro et al. (1994) identified nursery areas on the Adventure Bank of the Strait of Sicily, but similar information is lacking from Malta and Tunisia.

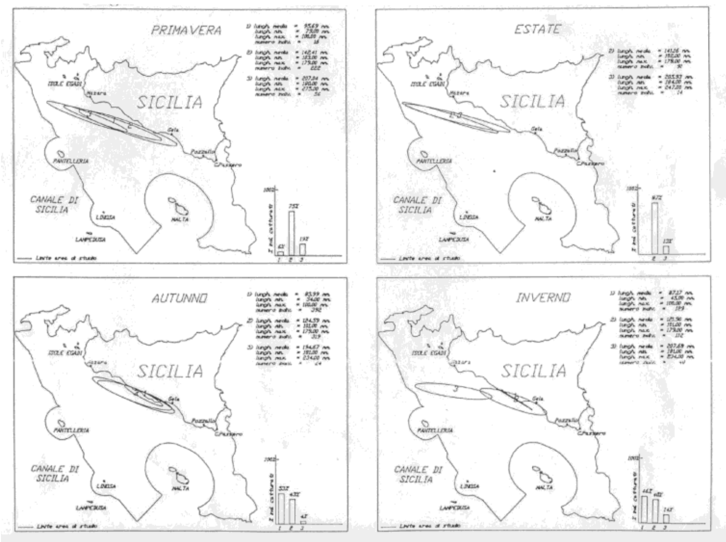


Fig. 6.16.1.1.1*P. erythrinus* nursery areas with individuals smaller than 10cm in the Strait of Sicily based on 1985-87 data (Cannizzaro et al., 1994).

Due to a lack of information about the structure of common Pandora population in the western Mediterranean, this stock was assumed to be confined within the boundaries of the GSA 15 and 16.

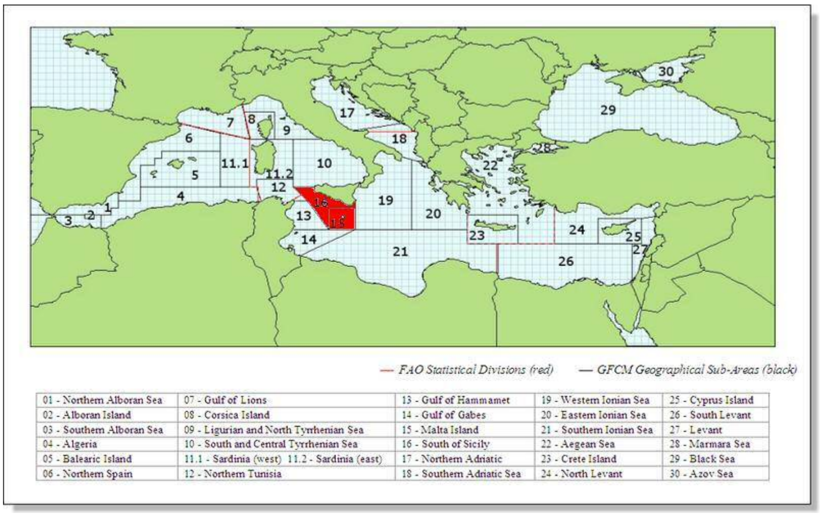


Fig. 6.16.1.1.2 Assumed stock distribution map of *P. erythrinus* in GSA 15 & 16.

6.16.1.1 Growth

Andaloro and Giarritta (1985) described the growth of the species in the area on the basis of commercial catches from trawlers. Orsi-Relini and Romeo (1985) reported difference in growth patterns between specimens caught by trawling and those caught by long lines. Gancitano et al. (2010a) studied the existence of differences in growth of *P.erythrinus* in GSA 16 based on data from commercial trawling and artisanal fisheries (trammel net and long lines). In this study a total of 2647 otoliths ($945_{trawling}$; $563_{artisanal}$ from females and $758_{trawling}$; $381_{artisanal}$ from males) were sampled and age was estimated by reading whole sagitta under transmitted light. Since this species is a protogynous hermaphroditic species, the von Bertalanffy growth curves (VBGF) parameters were estimated by combined sex and keeping the metiers separate using the "Length at Age" routine as implemented in FISAT II. The results showed that differences in VBGF parameters by metier were significant (p<0.05; F=54.94). Moreover, specimens caught by artisanal gears were larger at a given age than those caught by trawling. The difference in exploitation pattern of trawling and artisanal fisheries suggests that growth parameters have to be obtained by integrating information coming by different sources.

The VBGF parameters by sex available in the scientific literature as well as length weight relationship parameters are reported below.

Table 6.16.1.1.1 VBGF parameters of *P. erythrinus*. Length refers to total length in mm.

			Females & Males		
Author	Area	Data Source	L_{inf}	k	t_0
Ragonese et al., 2004	Strait of Sicily	MEDITS Trawl survey data	380	0.18	-0.71
Gancitano et al., 2010a	Strait of Sicily	Commercial trawl / trammel / longline data	465	0.09	-2.99
Gancitano et al., 2010a	Strait of Sicily	Commercial trawl data	240	0.51	-0.84
Gancitano et al., 2010a	Strait of Sicily	Trammel / longline data	489	0.09	-3.06
STECF EWG 11-12	Strait of Sicily	Trawl / artisanal data	400	0.16	-1.0

Table 6.16.1.1.2 *P. erythrinus* length-weight relationship parameters. Parameters given by Ragonese et al. (2004) are in mm; parameters given by Gancitano et al. (2010b) are in cm.

		Females		Males		Combined	
Author	Area	a	b	a	b	a	b
Ragonese et al., 2004	Strait of Sicily	0.000043 - 0.000029	2.78 - 2.85	0.000035 - 0.000022	2.81 - 2.91		
Gancitano et al., 2010b	Strait of Sicily					0.0216	2.8299
CNR-IAMC (average 2006-2010)	Strait of Sicily					0.02252	2.82138

6.16.1.2 Maturity

P. erythrinus is a protogynous hermaphroditic species; the majority of large fish change sex from females to males (Fiorentino et al. 2005).

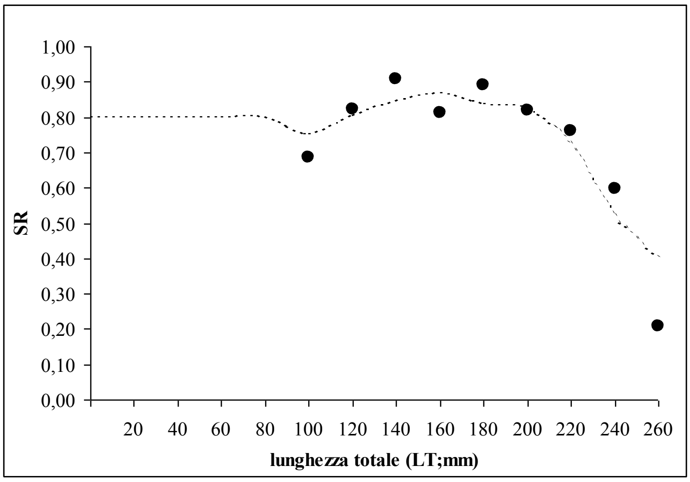


Fig. 6.16.1.2.1 Percentage of female *P. erythrinus* by length class (total length) in GSA 16; when reaching a length of 180-200 mm total length, individuals start changing sex.

Several authors have reported that the sex ratio of *P. erythrinus* in the Mediterranean is skewed in favour of females due to a lack of large individuals (Pajuelo and Lorenzo 1998; Vassilopoulo et al. 1986; Hashem and Gassim, 1981; Unsal, 1984; Mytilineou, 1989; Ozaydın 1997 in Hossucu 2003; Hoşsucu and Cakır, 2003), a situation which has important management implications.

The length at 50% maturity has been reported at 120-130 mm for females and 160-170 mm for males by Ragonese et al. (2004). Fiorentino et al. (2005) estimated the maturity oogive for females in GSA 16, and estimated an L_m of 160 mm.

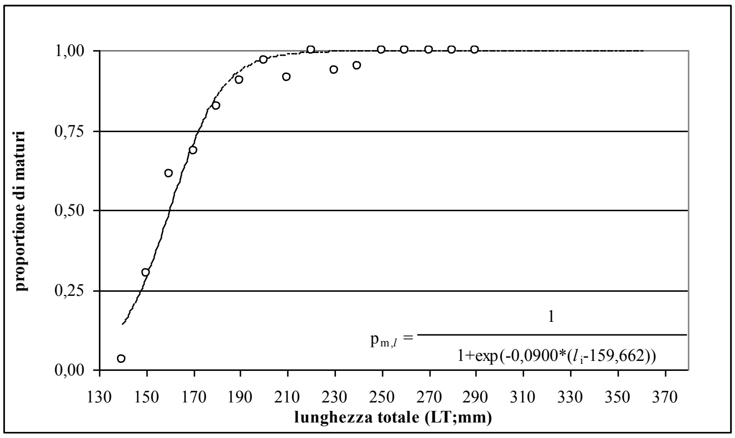


Fig. 6.16.1.2.2 Maturity ogive of female *P. erythrinus* in GSA 16; L_m= 160 mm TL (after Fiorentino et al. 2005).

With regards the timing of the reproductive season, Giudicelli (1982, in Fiorentino et al. 2005) found a reproductive peak for *P. erythriuns* in the Gulf of Tunis is between May and August. Similarly Ragonese et al. (2004) reported the spawning season for *P. erythrinus* to occur in spring-summer. Fiorentino et al. (2005) found a peak in the reproductive period in the second week of May and the first week of June based on 1995-2001 MEDITS data.

6.16.1.3 Fisheries

6.16.1.3.1 *General description of fisheries*

Common Pandora is an important demersal fishery resource through the Mediterranean, including the Strait of Sicily (Gancitano et al. 2010b). Trawling is carried out on the continental shelf of the Central Mediterranean throughout the year, and catches include pink shrimp (*Parapenaeus longirostris*), Norway lobster (*Nephrops norvegicus*), giant red shrimp (*Aristaeomorpha foliacea*), hake (*Merluccius merluccius*), violet shrimp (*Aristeus antennatus*), scorpionfish (*Helicolenus dactylopterus*), grater forkbeard (*Phicys blennioides*), blackspot seabream (*Pagellus bogaraveo)* and monkfish (*Lophius budegassa*). In addition to trawling, common Pandora is targeted by several artisanal gears, including set gillnets, trammel nets and set longlines.

6.16.1.3.2 *Management regulations applicable in 2010 and 2011*

At present there are no formal management objectives for common Pandora in the Strait of Sicily fisheries. As in other areas of the Mediterranean, management is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area/season closures). A compulsive annual fishing ban for 30 days was recently adopted by Sicilian Government (August –September).

In order to limit the over-capacity of fishing fleet, no new fishing licenses have been assigned in Italy since 1989, and a progressive reduction of the trawl fleet capacity is occurring. Maltese fishing licenses had been fixed at a total of 16 trawlers since 2000. Eight new licences were however issued in 2008, which was made possible under EU law by the reduction of the capacities of other Maltese fishing fleets.

In terms of technical measures, the 'Mediterranean Regulation' (EC 1967/2006; EC 1343/2011) fixed a minimum mesh size of 40 mm for bottom trawling of EU fishing vessels (Italian and Maltese trawlers). Mesh size had to be modified to square 40 mm or diamond 50 mm in July 2008, and derogations were only possible up to 2010.

The minimum marketable size of *P. erythrinus* is fixed at 15 cm by the Mediterranean Regulation (EC 1967/2006).

The Maltese Islands are surrounded by a 25 nautical miles (nm) fisheries management zone, where fishing effort and capacity are being managed by limiting vessel sizes, as well as total vessel engine powers (EC 813/04; EC 1967/06). Trawling is allowed within this designated conservation area, however only by vessels not exceeding an overall length of 24 m and only within designated areas. Such vessels fishing in the management zone hold a special fishing permit in accordance with Article 7 of Regulation (EC) No 1627/94, and are included in a list containing their external marking and vessel's Community Fleet Register number (CFR) to be provided to the Commission annually by the Member States concerned. Moreover, the overall capacity of the trawlers allowed to fish in the 25 nm zone cannot exceed 4 800 kW, and the total fishing effort of all vessels is not allowed to exceed an overall engine power and tonnage of 83 000 kW and 4 035 GT respectively. The fishing capacity of any single vessel with a license to operate at less than 200m depth can not exceed 185 kW. In addition, the use of all trawl nets within 1.5 nm of the coast is prohibited according to the 'Mediterranean Regulation' (EC 1967/2006).

6.16.1.4 Catches

6.16.1.4.1 *Landings*

Table 6.16.1.4.1.1Annual *P. erythrinus* landings (t) by fishing technique in GSAs 15 & 16 as reported to EWG 12-10 through the Data Collection Framework (DCF) data call.

COUNTRY	GEAR	2006	2007	2008	2009	2010	2011
ITA	GNS		16.10			0.27	
	GTR	135.10		19.32	32.25	15.49	26.90
	LLS			21.39	29.53	9.27	20.93
	OTB	777.26	465.35	361.50	223.27	273.94	211.82
ITA Total		912.32	481.42	402.21	285.04	298.97	259.65
MLT	GNS	0.00			0.04		
	GTR	1.55	0.94	1.01	0.94	2.38	0.91
	LLS	2.66	2.49	4.38	1.25	10.63	5.54
	OTB	0.98	2.89	3.93	8.52	7.11	6.54
MLT Total		5.19	6.31	9.32	10.74	20.11	12.99
Grand Total		917.51	487.73	411.53	295.79	319.08	272.64

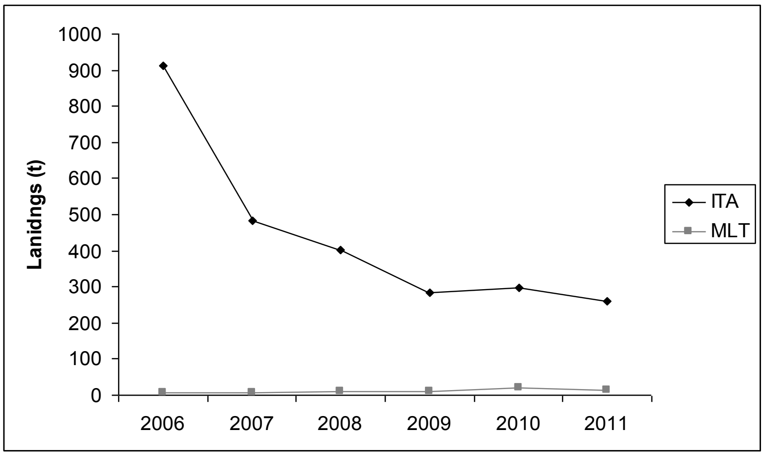


Fig. 6.16.1.4.1.1 Total landings of *P. erythrinus* by Maltese and Italian fleets in GSA 15 & 16; ITA = Italy, MLT = Malta.

On average the Maltese fleet was responsible for 3% of the total landings in GSAs 15 & 16 in 2006-2011. The percentage of catches taken by Maltese fishermen increased steadily from and average of 1% in

2006/2007 to an average of 6% in 2010 and 2011.

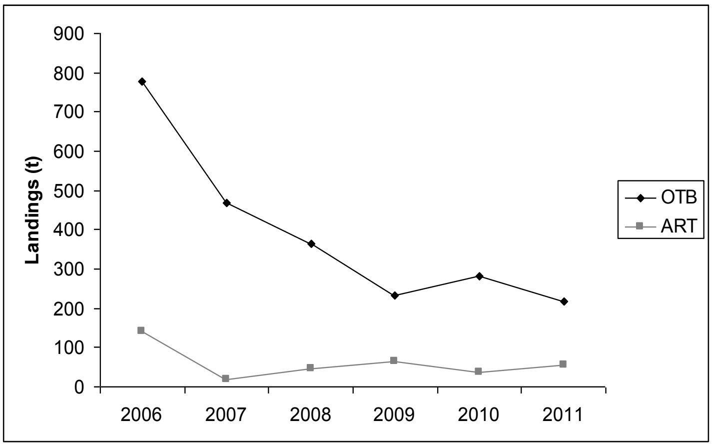


Fig. 6.16.1.4.1.2 Total landings of Maltese and Italian fleets combined; OTB = bottom otter trawlers, ART = artisanal gears (GNS, GTR, LLS, LHP, FPO).

Considering data from both GSAs combined, catches by the OTB fleet have declined in 2006-2011, whilst catches from the artisanal fleet have remained stable since 2008. Trawlers were responsible for 80% of common Pandora landings in 2011.

6.16.1.4.2 *Discards*

Information on common Pandora discards were available for bottom trawlers from GSA 16 for 2010 and 2011. Total reported discards for bottom otter trawlers (OTB) in GSA 16 were 39.1 t in 2010, and 8.8 t in 2011. Discards at length data showed that individuals as small as 6 cm are caught by commercial trawl nets. The 77% decrease of discards from 2010 to 2011 may be related to the improved trawl net selectivity following the implementation of larger minimum mesh sizes as per EC 1967/2006. For the purpose of the current analysis average discard parameters for 2010 and 2011 were used to extrapolate both total discard landings and discards at length data for OTB to 2006-2009 data.

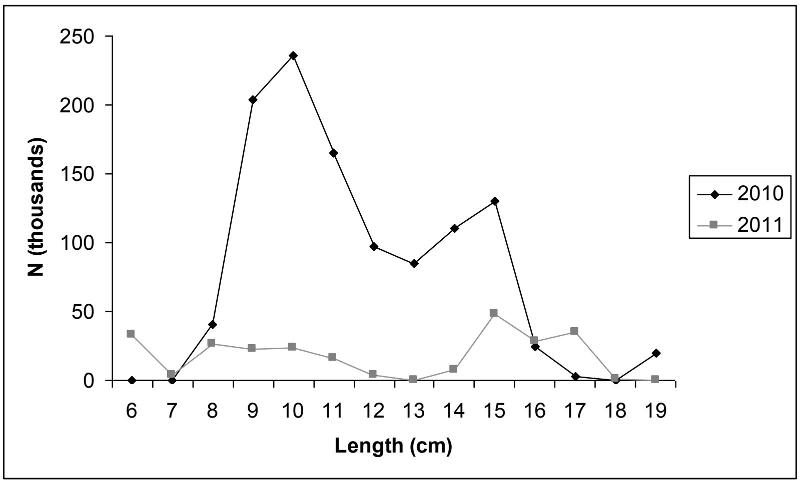


Fig. 6.16.1.4.2.1GSA 16 OTB discards at length data of common Pandora.

Catch at age information revealed that on average 89% of catches were individuals aged 1-4 years, and 9% were aged 5-7 years. Overall, the 3 year age class contributed the most to catches (average of 33%). Very few individuals were aged 7 years or above (1.4%). There was a small shift in catch composition in 2011, with the percentage of individuals aged 1-4 years in catches decreasing to 80% and the percentage of individuals aged 5-7 years increasing to 16%.

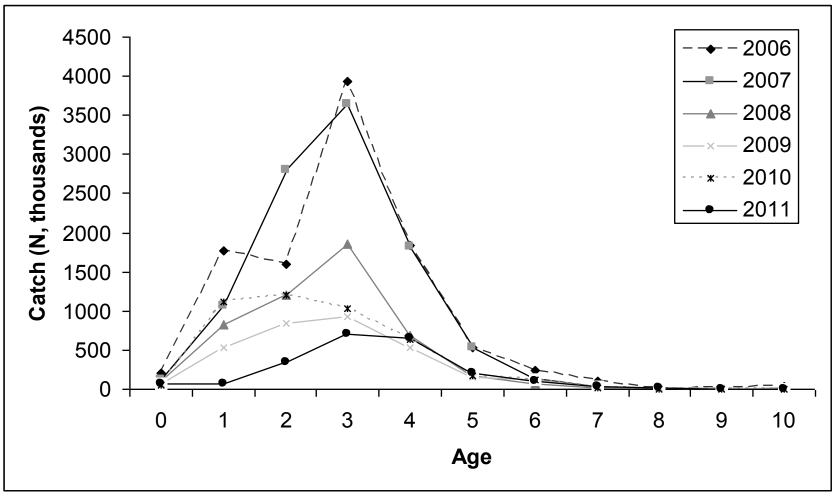


Fig. 6.16.1.4.2.2Catch composition of *P. erythrinus* in GSA 15 and 16.

6.16.1.5 Fishing effort

The effort by main fishing technique and segment deployed in GSA 15 and 16, keeping separate the Italian and Maltese fleet, as reported to EWG 12-10 through the DCF data call is showed in Figure 6.16.1.6.1.

The segment of the Italian demersal otter trawl reveals a 32% decrease for vessels larger than 24 m in the period 2004-2011. The Maltese OTB fleet was responsible for only 1.6% of total trawling effort in GSAs 15 & 16 in 2006-2011; however the nominal effort of Maltese trawlers has increased by 67% in 2006-2011.

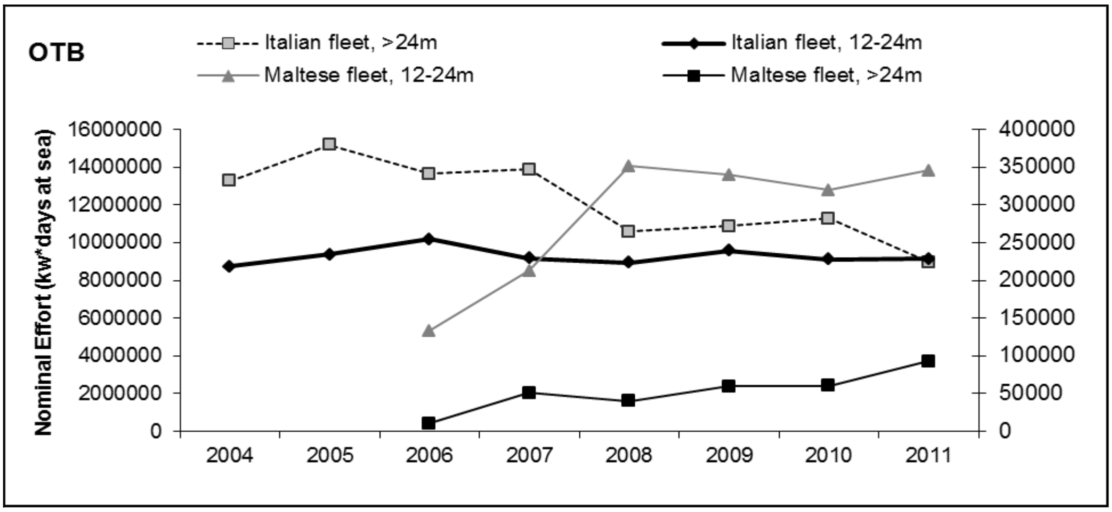


Fig. 6.16.1.5.1. Nominal effort (kW*days at sea) trends of trawlers (OTB) operating in GSA 15 & 16. Italian and Maltese fleets are represented on different axis (left and right respectively) due to the low nominal effort of the Maltese fleet.

A decreasing pattern was clear for both Italian and Maltese artisanal vessels equipped with trammel-nets and set bottom longlines.

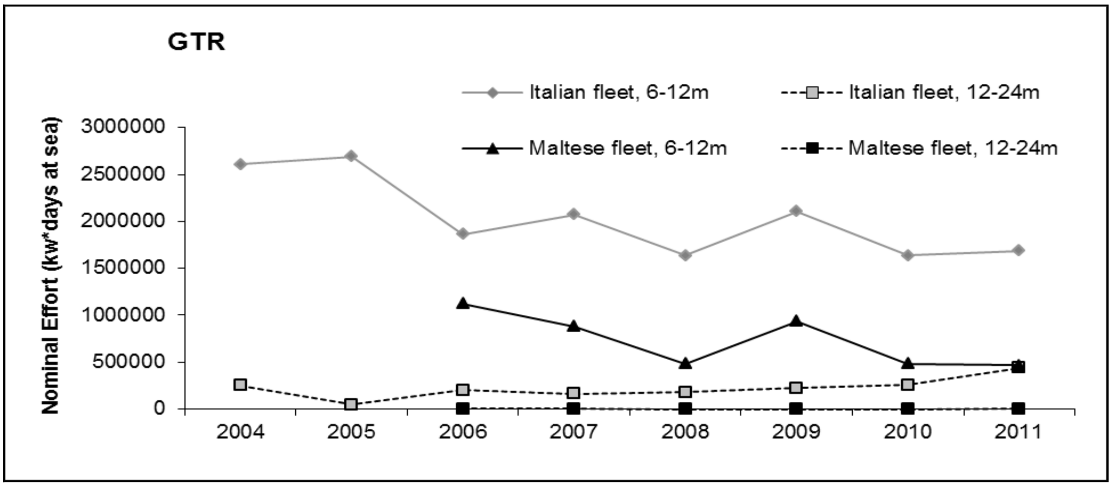


Fig. 6.16.1.5.2Nominal effort (kW*days at sea) trends of the artisanal set trammel net (GTR) fleet segment in GSAs 15 and 16.

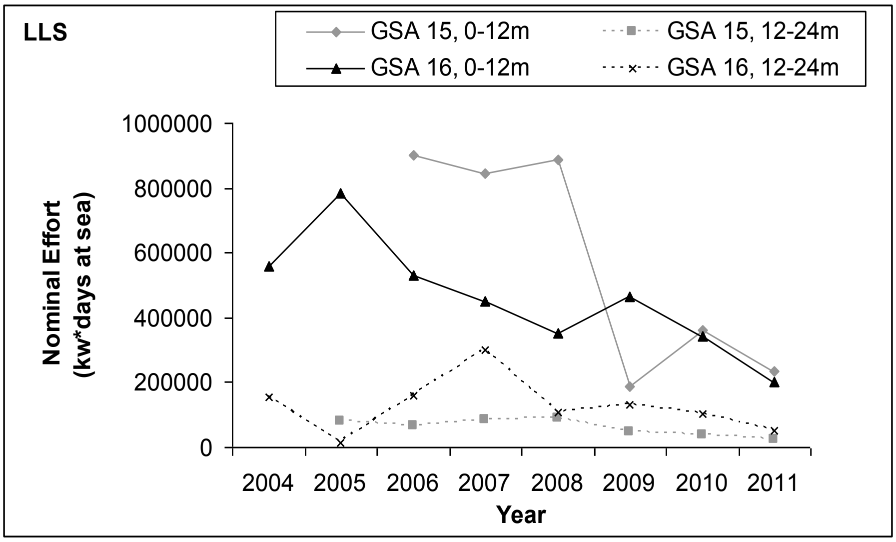


Fig. 6.16.1.5.3 Nominal effort (kW*days at sea) trends of the artisanal set longline (LLS) fleet segment in GSAs 15 and 16.

6.16.2 *Scientific surveys*

6.16.2.1 Medits

6.16.2.1.1 *Methods*

Based on the DCF data call, abundance and biomass indices were recalculated and presented in section 6.16.2.1.3 of this report.

In order to collect fisheries independent data, which is a requirement of the EU DCF (Council Regulation 199/2008, Commission Regulation 665/2008, Commission Decision EC 949/2008 and Commission Decision 93/2010); the MEDITS international trawl survey is carried out in GSAs 15 & 16 on an annual basis. The number of hauls was reported per depth stratum in 1994-2011 (GSA 16) and 2002-2011 (GSA 15) is reported below.

Table 6.16.2.1.1.1 Number of hauls per year and depth stratum in GSA 16, 1994-2011.

Depth (m)	1994	1995	1996	1997	1998	1999	2000	2001	2002
10-50	4	4	4	4	4	4	4	4	7
50-100	8	8	8	8	8	8	7	8	11
100-200	4	4	4	4	5	5	6	5	10
200-500	10	11	11	12	11	11	11	11	19
500-800	10	14	14	13	14	14	14	14	19
Depth (m)	2003	2004	2005	2006	2007	2008	2009	2010	2011
10-50	7	7	10	10	11	11	11	11	11
50-100	12	12	20	22	23	23	23	23	23
100-200	8	9	18	19	21	21	21	21	21
200-500	18	19	28	31	27	27	27	27	27
500-800	20	19	32	33	38	38	38	38	38

Table 6.16.2.1.1.2 Number of hauls per year and depth stratum in GSA 15, 2002-2011.

Depth (m)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
10-50	1	1	2	1	1	0	0	0	0	0
50-100	5	5	4	5	5	12	6	6	6	6
100-200	13	13	13	13	13	12	13	14	14	14
200-500	10	10	10	9	10	4	9	10	10	10
500-800	16	16	15	17	16	17	17	15	15	15

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). A limited number of obvious data errors were corrected and catches by haul were standardized to 60 minutes haul duration. Only hauls noted as valid were used, including stations with no catches of hake, red mullet or pink shrimp (i.e. zero catches were included).

The abundance and biomass indices were subsequently calculated by stratified means (Cochran, 1953; Saville, 1977). This implies weighing average values of the individual standardized catches as well as the variation of each stratum by the respective stratum area:

$Yst = \Sigma (Yi*Ai) / A$ $V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A = total survey area

Ai = area of the i-th stratum

si = standard deviation of the i-th stratum

ni = number of valid hauls of the i-th stratum

n = number of hauls in the GSA

Yi = mean of the i-th stratum

Yst = stratified mean abundance

V(Yst) = variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t (student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions about the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution or quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al.* 2004).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.16.2.1.2 *Geographical distribution patterns*

P. erythrinus inhabits the continental shelf bottoms of the Strait of Sicily. Whilst common Pandora can be found at depths of up to 300 m, they are most common at depths from 20-100 m (Santos et al., 1995). No maps of the geographic distribution patterns other than those presented in the stock identification section above are at present available for GSAs 15 & 16.

6.16.2.1.3 *Trends in abundance and biomass*

Figure 6.16.2.1.3.1 displays the estimated trend in *P. erythrinus* MEDITS abundance and biomass in GSA 15, Figure 6.16.2.1.3.2 displays the estimated trend in MEDITS abundance and biomass in GSA 16. The patterns in both density and biomass indices recorded in GSAs 15 & 16 are similar. Considering the longer time series from GSA 16, density as well as biomass indices fluctuate without any clear discernable trend from 1994 to 2011.

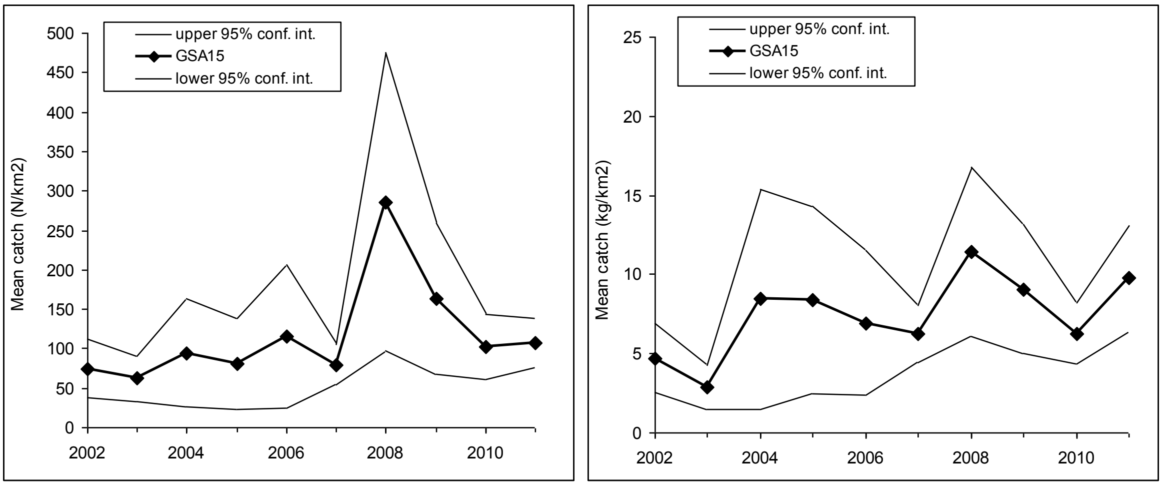


Fig. 6.16.2.1.3.1 MEDITS abundance and biomass indices of *P. erythrinus* in GSA 15.

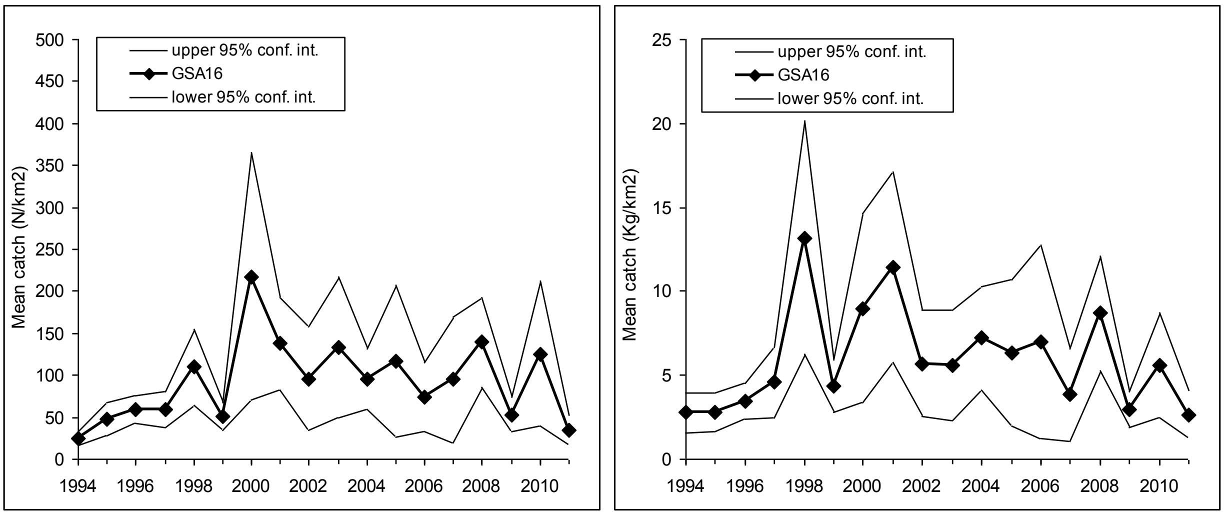
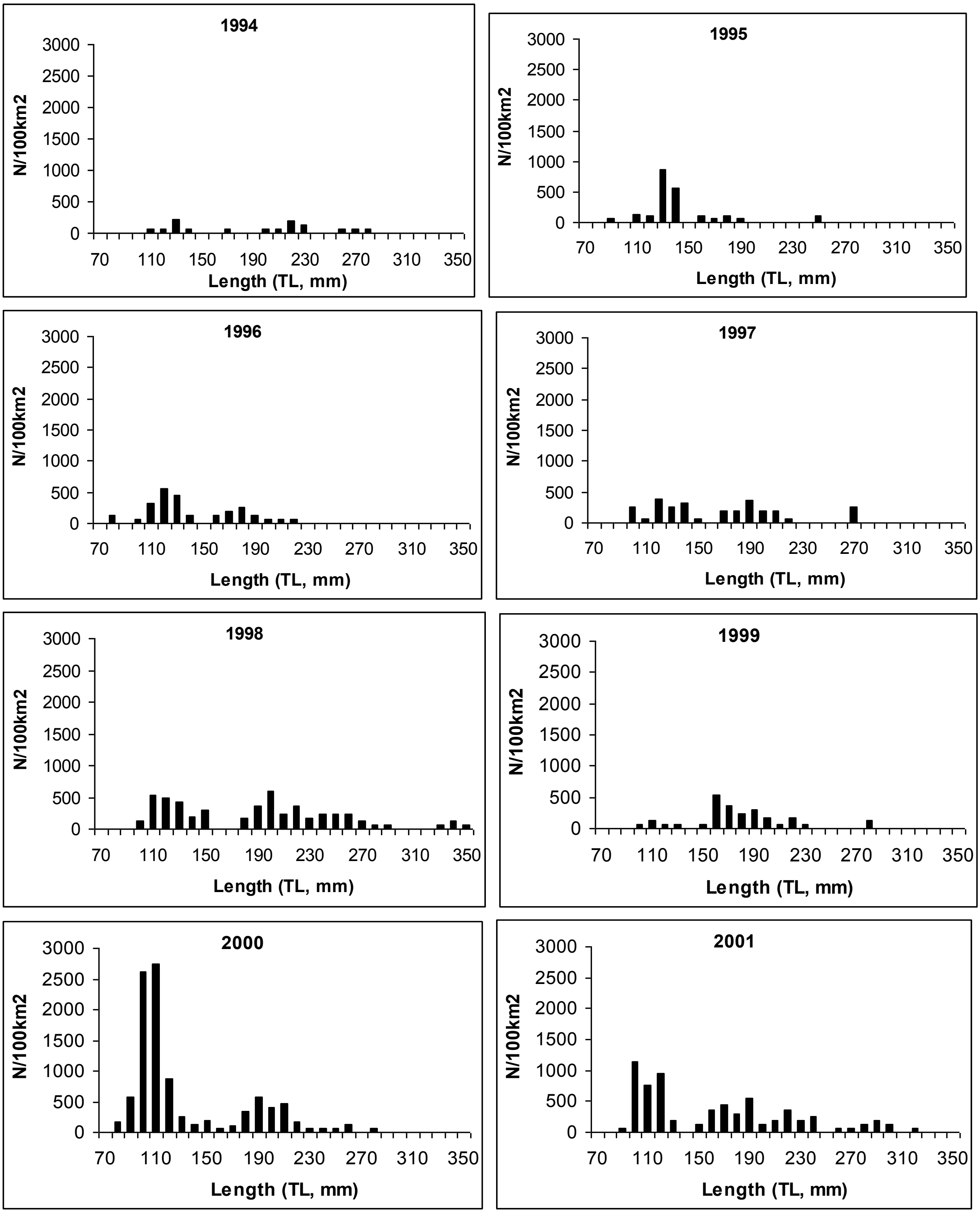
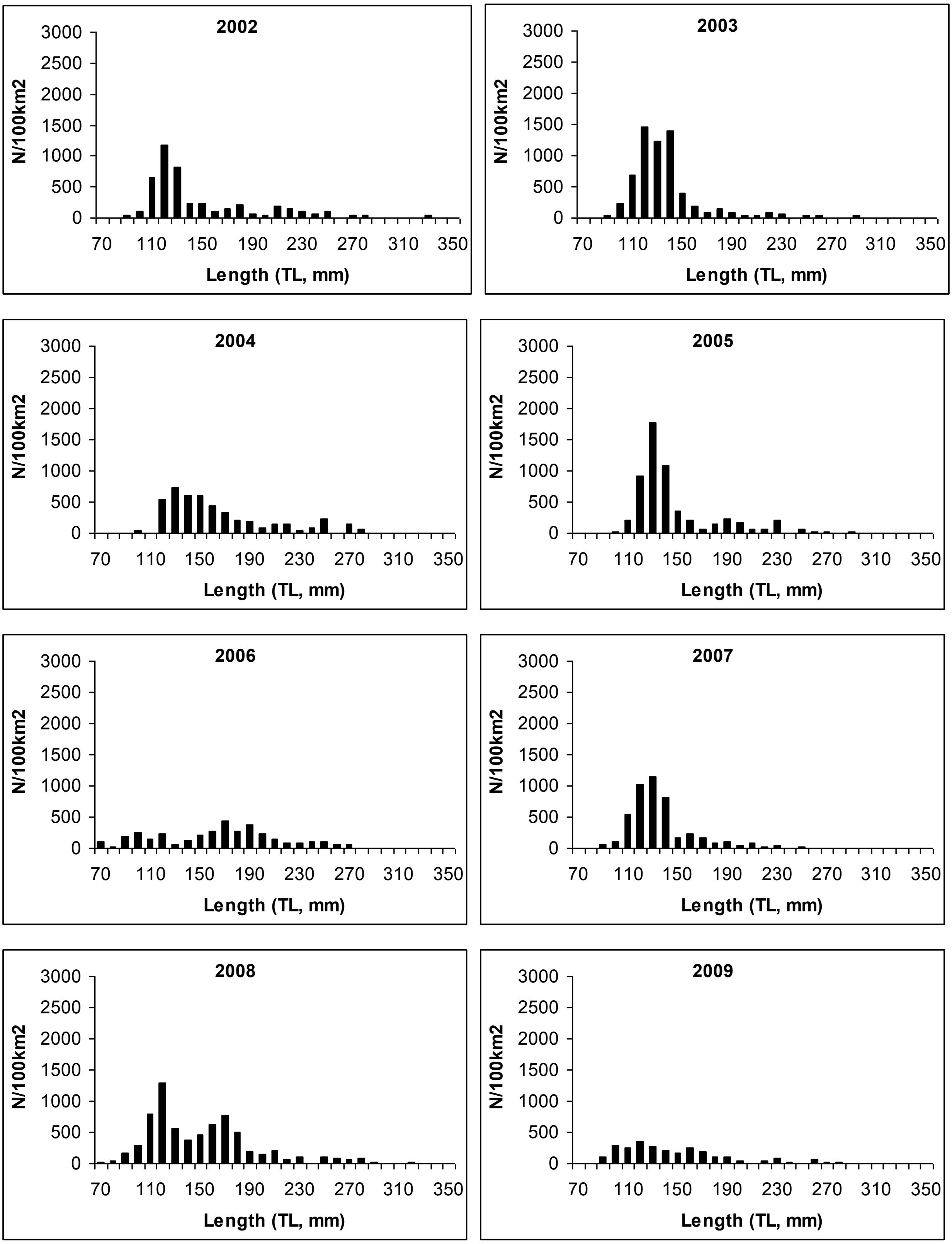


Fig. 6.16.2.1.3.2 MEDITS abundance and biomass indices of *P. erythrinus* in GSA 16.

6.16.2.1.4 *Trends in abundance by length or age*

Figure 6.16.2.1.4.1 displays the *P. erythrinus* MEDITS abundance indices by size in 1994-2011 for GSA 16 and figure 6.16.2.1.4.2 the MEDITS abundance indices by size in 2002-2011 for GSA 15.




2002
2003
2004
2005
2006
2007
2008
2009
N/100km2
3000
2500
2000
1500
1000
500
0
70
110
150
190
230
270
310
350
Length (TL, mm)

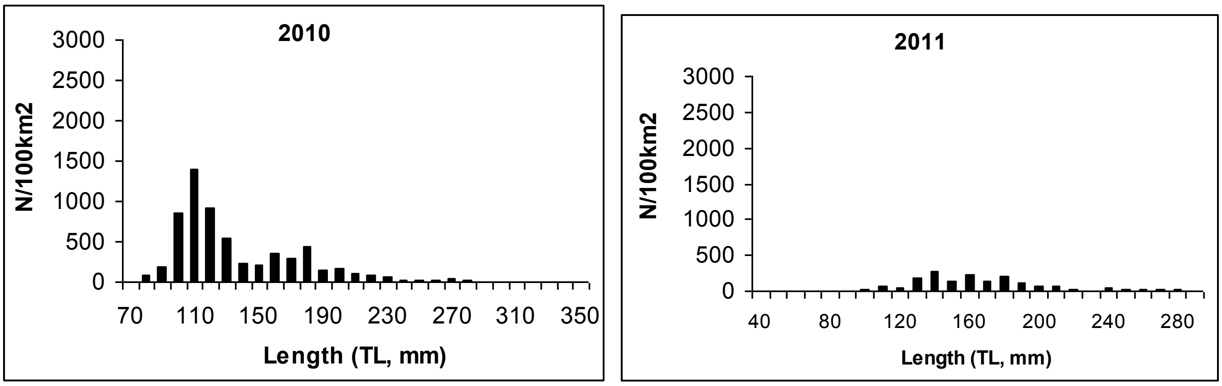
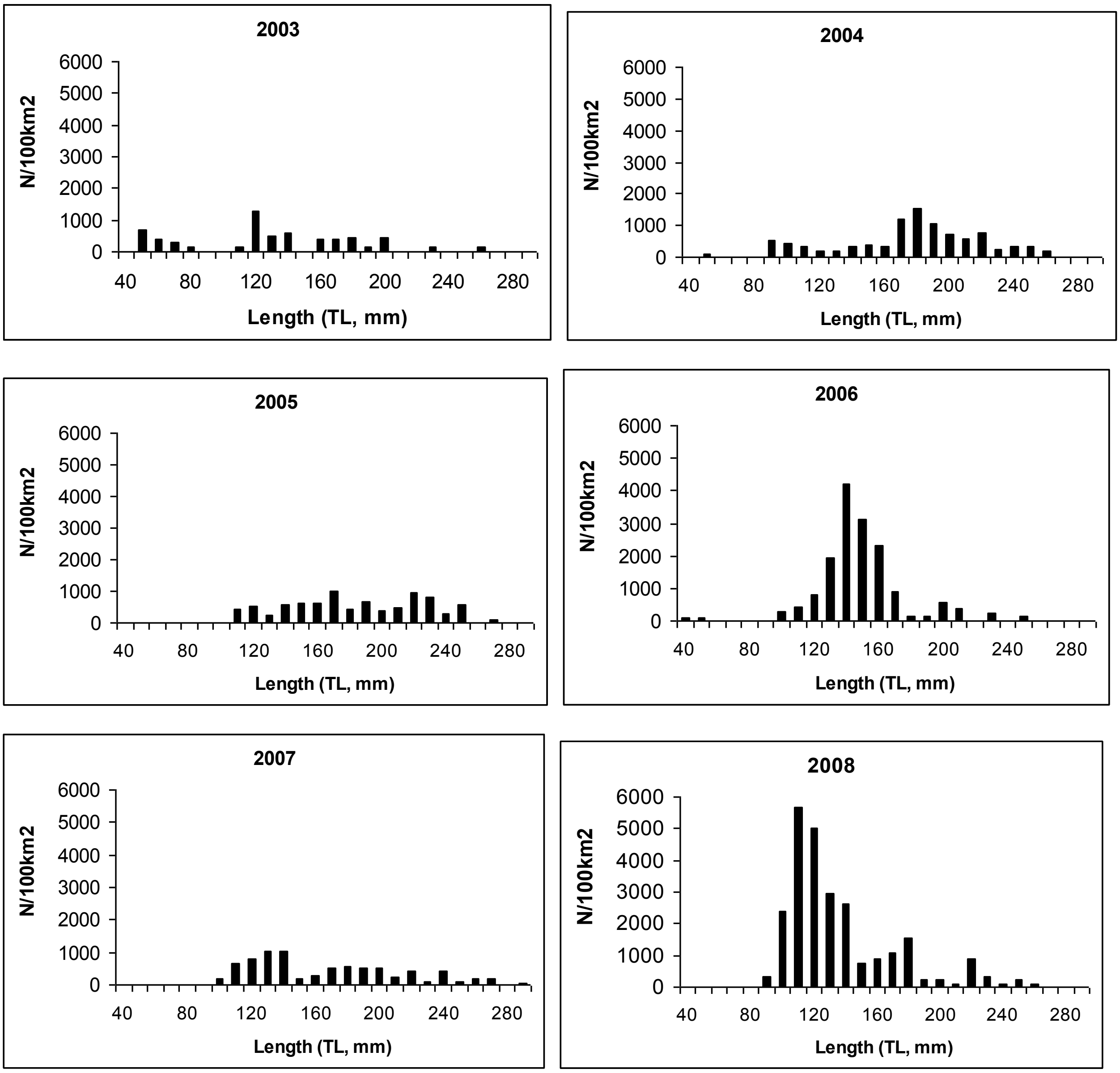


Fig. 6.16.2.1.4.1 Standardised MEDITS length frequency distributions of *P. erythrinus* recorded in GSA 16 in 1994-2011.



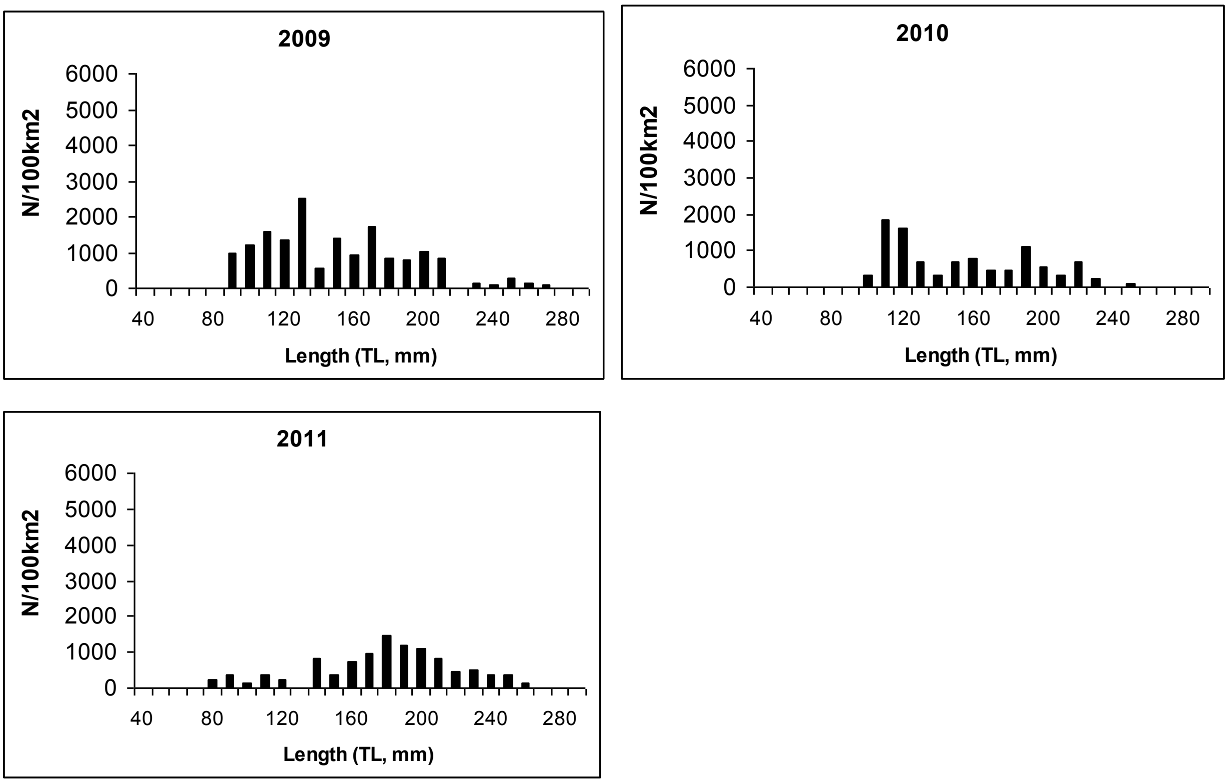


Fig. 6.16.2.1.4.2 Standardised MEDITS length frequency distributions of *P. erythrinus* recorded in GSA 15 in 2002-2011.

6.16.2.1.5 *Trends in growth*

No analyses were conducted during STECF EWG 12-10.

6.16.2.1.6 *Trends in maturity*

No analyses were conducted during STECF EWG 12-10.

6.16.3 *Assessment of historic parameters*

6.16.3.1 Method 1: XSA

6.16.3.1.1 *Justification*

Common Pandora was assessed using a pseudocohort approach (length cohort analysis with VIT) in STECF-EWG 11-12. An XSA assessment was carried out during STECFEWG 12-10 using the 2006-2011 catch data (landings and discards) collected within the Data Collection Regulation (DCR; 2006-2008) and the subsequent Data Collection Framework (DCF; 2009-2011) and calibrated with trawl survey data (MEDITS 2006-2011).

6.16.3.1.2 *Input parameters*

DCR/DCF landings data for common Pandora were available for bottom trawlers as well as artisanal gears since 2006. Discards data were available for bottom trawlers for GSA 16 since 2010. The average discard proportion for bottom trawlers in 2010 and 2011 was added to total landings data for trawlers in 2006-2009 to estimate total catches.

The annual size distributions of the catches as well as of surveys (MEDITS) were converted in numbers at ages using the statistical slicing method approach developed during STECF EWG 11-12 (Scott et al, 2011). Natural mortality rates by age group but constant for all years were calculated based on PRODBIOM (Abella *et al.*, 1997).

Table 6.16.3.1.2.1*P. erythrinus* VBGF and length-weight parameters

Sex	L_∞ (cm, TL)	k	t_0	a	b
Combined	40	0.176	-1	0.02252	2.82138

Table 6.16.3.1.2.2 Catch at Age

	2006	2007	2008	2009	2010	2011
0	212.92	128.23	100.14	63.63	56.02	69.72
1	1763.94	1064.16	828.54	525.72	1112.49	74.28
2	1590.28	2805.44	1209.30	843.11	1194.23	339.90
3	3924.79	3644.71	1855.23	923.44	1030.80	711.24
4	1834.67	1818.17	686.55	530.07	640.98	646.03
5	535.22	525.47	168.66	161.96	178.29	206.19
6	239.93	138.02	68.05	118.05	114.80	97.79
7+	142.65	40.22	58.51	75.41	26.93	60.67

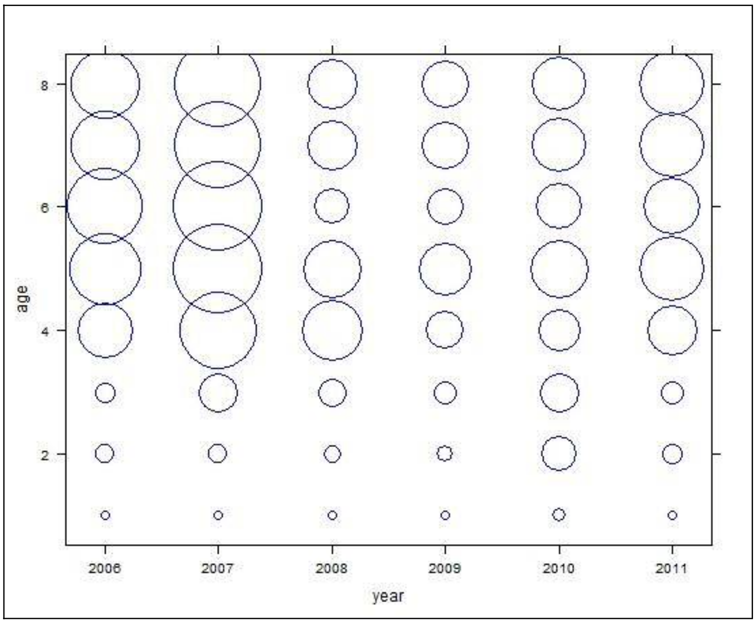


Fig. 6.16.3.1.2.1 Catch matrix for *P. erythrinus* in GSA 15 & 16.

Table 6.16.3.1.2.3 Catch and stock weight at age (kg)

Age	0	1	2	3	4	5	6	7+
Weight (g)	0.012	0.040	0.083	0.136	0.194	0.253	0.310	0.433

Table 6.16.3.1.2.4 Maturity at Age

Age	0	1	2	3	4	5	6	7+
Maturity	0	0	1	1	1	1	1	1

Table 6.16.3.1.2.5 Mortality at Age

Age	0	1	2	3	4	5	6	7+
Mortality	0.59	0.22	0.14	0.11	0.09	0.08	0.07	0.07

Table 6.16.3.1.2.6 MEDITS Tuning Data

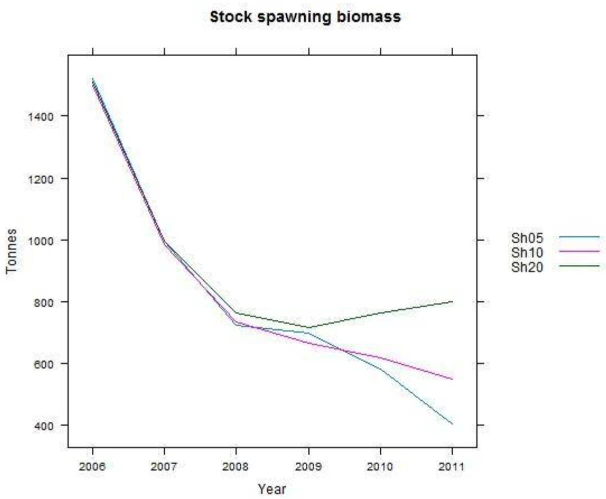
	2006	2007	2008	2009	2010	2011
1	1544.84	2807.80	7372.00	2963.04	4043.41	506.79
2	3372.58	1553.05	3257.14	1840.40	1406.42	1361.15
3	1272.35	723.78	1342.67	1121.46	1298.81	1599.85
4	289.25	295.63	500.10	154.63	354.25	401.53
5	184.55	92.02	233.69	152.80	55.41	159.05
6	89.34	47.38	96.69	54.55	40.88	27.32
7+	0.90	16.45	27.87	0.63	0.63	32.61

Table 6.16.3.1.2.7 Settings used for the XSA runs

Settings		
fse	Shrinkage	0.5, 1.0, 2.0
rage	The oldest age for which the two parameter model is used for determining catchability at age	1
qage	The age after which catchability is no longer estimated. Catchability at older ages will be set to the value of catchability at this age.	3
shk.yrs	The number of years to be used for shrinkage to the mean F.	5
shk.ages	The ages over which shrinkage to the mean F should be applied.	3

6.16.3.1.3 *Results including sensitivity analyses*

XSA was run setting shrinkage at 0.5, 1.0, and 2.0. Results were similar with all three settings; the model with shrinkage of 1.0 was adopted as final model since it produced the smallest residuals, with no major trend in their distribution.



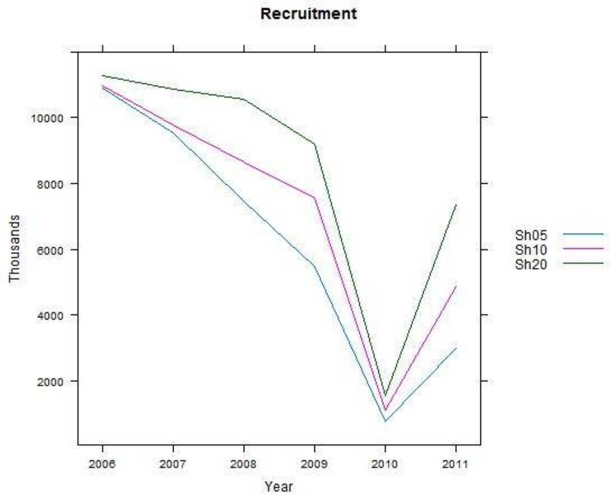


Fig.6.16.3.1.3.1 Estimates of recruitment and SSB under different shrinkage settings.

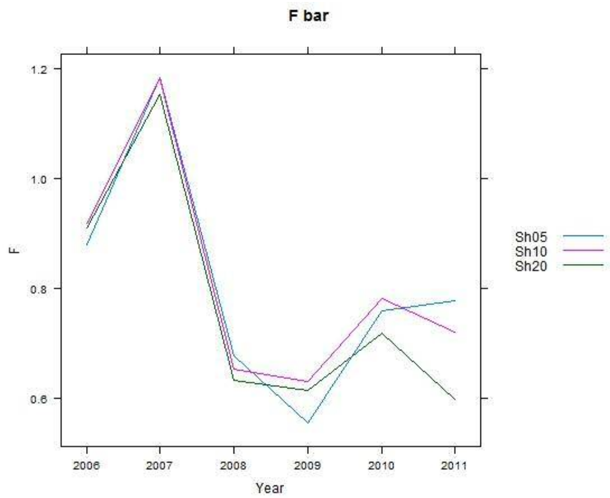


Fig. 6.16.3.1.3.2 Estimates of F_{bar} (ages 2-7) under different shrinkage settings.

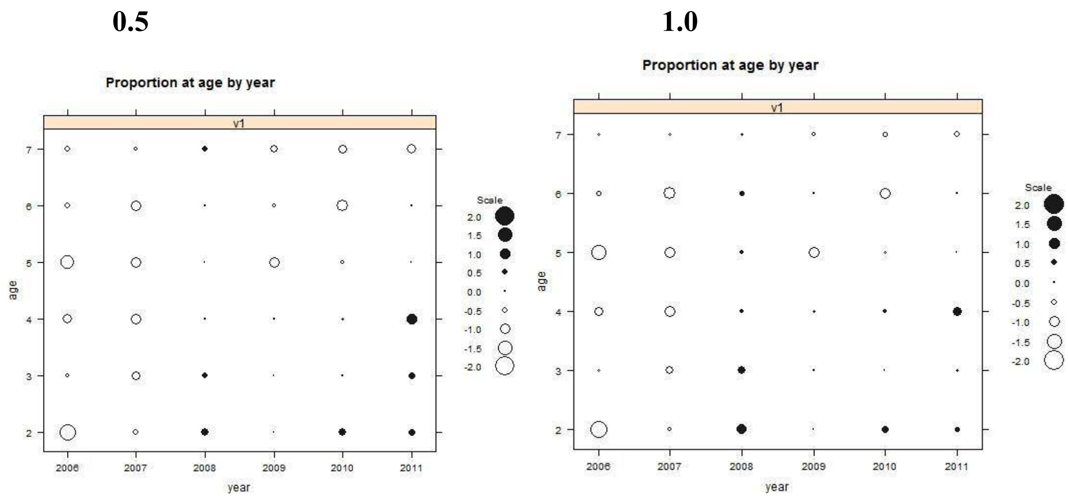


Fig. 6.16.3.1.3.3 Residuals at age obtained with shrinkage settings 0.5 and 1.0.

2.0

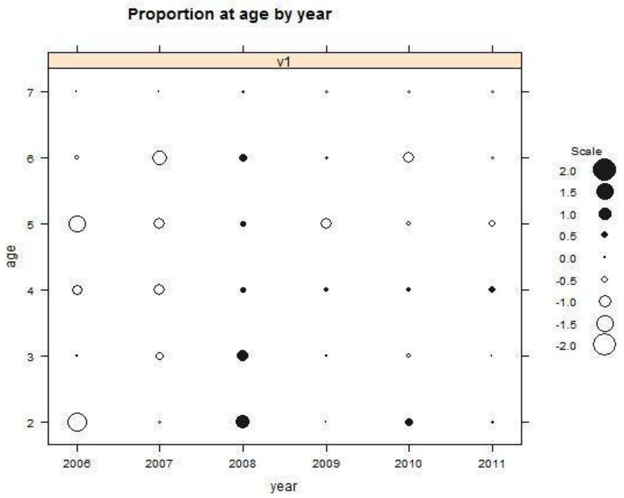


Fig. 6.16.3.1.3.4 Residuals at age obtained with the shrinkage setting 2.0.

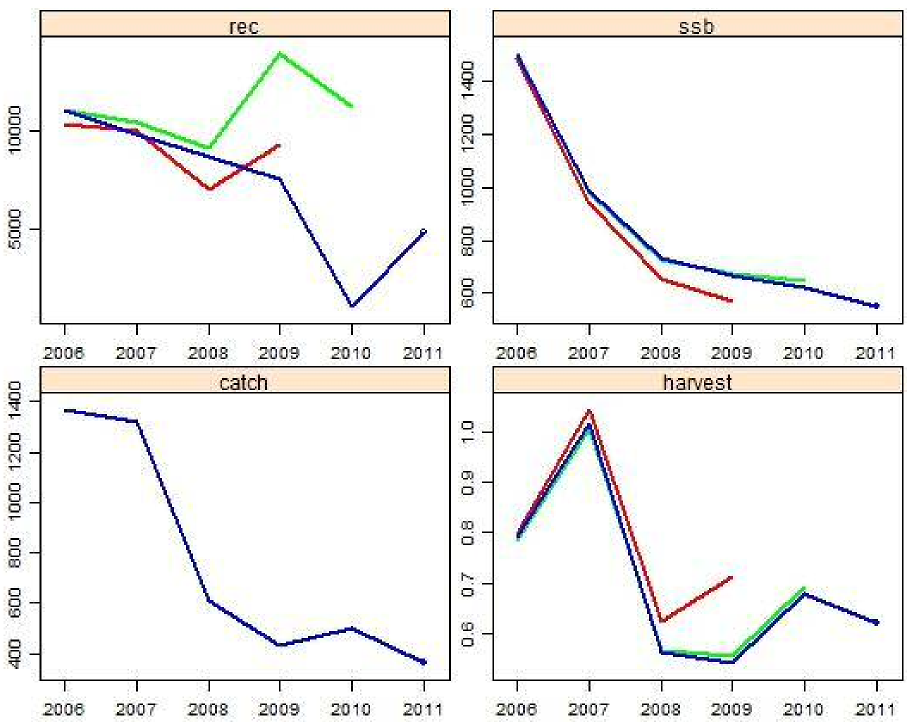


Fig. 6.16.3.1.3.5 Retrospective analysis for model with shrinkage set at 1.0

The following table lists F (age 2-7), SSB and recruitment XSA estimates by from 2006 to 2011.

Table 6.16.3.1.3.1 F, SSB and recruitment estimates by XSA for *P. erythrinus* in GSA 15 &

16 in 2006 to 2011.

F_{2-7}					
2006	**2007**	**2008**	**2009**	**2010**	**2011**
0.92	1.18	0.65	0.63	0.78	0.72
SSB (tons)					
2006	**2007**	**2008**	**2009**	**2010**	**2011**
1499.60	984.85	734.76	655.93	619.52	548.59
Recruitment (millions)					
2006	**2007**	**2008**	**2009**	**2010**	**2011**
10.9733	9.7929	8.6470	7.5470	1.1078	4.8475

XSA estimates of F_{2-7} varied between 0.63 (2009) and 1.18 (2007). In 2011 the fishing mortality estimate was 0.72.

During 2006-2011 spawning stock biomass (SSB) declined steadily from 1,500 to 550 tons, while recruitment declined from 11 million to 1 million in 2006-2010. In 2011 there was an increase in recruitment to 5 million. However based on the retrospective analysis estimates of recruitment were the least reliable of the model outputs.

Table 6.16.3.1.3.2 Fishing mortality and numbers at age as estimated by XSA.

F-at-age

	2006	**2007**	**2008**	**2009**	**2010**	**2011**
1	0.026	0.018	0.016	0.011	0.070	0.020
2	0.220	0.224	0.191	0.133	0.357	0.156
3	0.256	0.631	0.417	0.296	0.488	0.171
4	0.959	1.425	1.076	0.594	0.651	0.553
5	1.221	1.738	1.072	0.942	0.975	1.007
6	1.372	1.367	0.643	0.680	0.849	0.861
7	1.481	1.706	0.524	1.136	1.368	1.579

Numbers-at-age (thousands)

	2006	**2007**	**2008**	**2009**	**2010**	**2011**
1	10973	9763	8647	7547	1108	4847
2	9981	5924	5317	4719	4136	572
3	7538	6430	3801	3524	3316	2323
4	6723	5071	2974	2177	2278	1769
5	2722	2308	1093	909	1077	1065
6	746	733	371	342	324	371
7	322	175	173	180	160	128

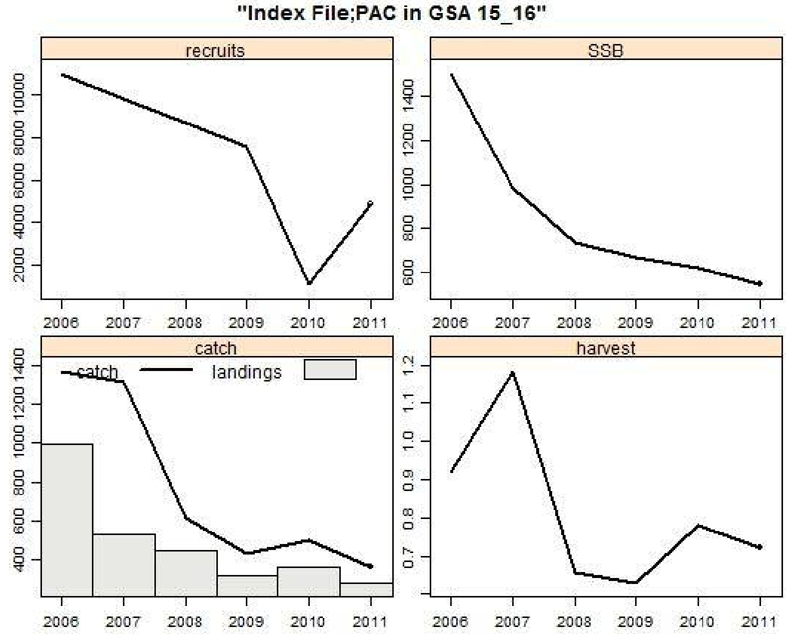


Fig. 6.16.3.1.3.6 Summary of stock parameters (recruitment, SSB, catch and landings, F mean for ages 2-7) as estimated by XSA for *P. erythrinus* in GSA 15 and 16.

6.16.4 *Short term prediction 2010-2012*

No short term predictions were performed in STECF EWG 12-10.

6.16.5 *Data quality*

STECF EWG 12-10 notes that the discrepancies in the estimation of MEDITS swept area in GSA 15 and GSA 16 were not corrected in response to the official data call for the Mediterranean and Black Sea sent to Member States on the 12th April 2012. Information on total landings by fleet segment for *P. erythrinus* in GSA 15 & 16 was missing for 2010 in GSA 15 although this information had been available at STECF EWG 11-12. There were considerable annual differences between the length frequency data available for larger individuals targeted by the artisanal fleet in GSA 16, and such data was only available for 2011 for two fleet segments (GTR and LLS) in GSA 15. There was no discards information for GSA 15 and discards data for GSA 16 was limited to bottom otter trawlers in 2010 and 2011.

6.16.6 *Scientific advice*

6.16.6.1 Short term considerations

6.16.6.1.1 *State of the spawning stock size*

According to the XSA analysis SSB (combined sex) has shown a consistent decline in 2006-2011 from 1,500 to 550 tons. However, in the absence of proposed biomass management reference points, EWG 12-10 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

6.16.6.1.2 *State of recruitment*

The XSA estimates of recruitment showed a decreasing trend from 11 million to 1 million in 2006-2010; in 2011 there was an increase in recruitment to 5 million. However, in the absence of proposed management reference points, EWG 12-10 is unable to fully evaluate the status of the recruitment in relation to these.

6.16.6.1.3 *State of exploitation*

EWG 12-10 proposed $F_{0.1} = 0.30$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the XSA analysis (current F is around 0.72) the stock is considered exploited unsustainably.

EWG 12-10 recommends the relevant fleets' effort or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations and the effects of the different gears targeting different life stages of common Pandora. Catches and effort consistent with F_{MSY} should be estimated.

6.17 **Stock assessment of black bellied angler fish in GSAs 15 and 16**

6.17.1 *Stock identification and biological features*

6.17.1.1 Stock Identification

No information is available to the WG on the structure of this stock in the area. Due to a lack of information about the structure of black bellied anglerfish population in the western Mediterranean, this stock was assumed to be confined within the boundaries of the GSA 15 and 16.

6.17.1.1 Growth and natural mortality

Considering the northern sector of the Strait of Sicily (GSA 15 and 16) the observed maximum length was 90 cm TL. The observed maximum age in the catches was 16 years (estimated by illicia reading).

No published parameters are available for the area. Two set of parameters were considered: those proposed for GSA 6 and 7 ($L\infty$=102 cm; K=0.15 and t_0=-0.05, “fast” set) and a set of parameters estimated for the GSA 16 ($L\infty$=72.5; K=0.17; t_0=-0.41, “low” set).
In order to identify the most appropriate set of parameters, the expected mean at age of the two curves were compared with the cumulative length frequency distributions observed during the MEDITS surveys (1994-2010). Due to its better fitting on the observed modal lengths, the “low” set parameters were used in further analyses.

	fast	low
	102	72.5
	0.15	0.17
age	-0.05	-0.41
0	0.76	4.88
1	14.86	15.45
2	27.00	24.37
3	37.45	31.90
4	46.44	38.24
5	54.18	43.60
6	60.84	48.12
7	66.57	51.93
8	71.51	55.14
9	75.76	57.86
10	79.41	60.15
11	82.56	62.08
12	85.27	63.71
13	87.60	65.08
14	89.60	66.24
15	91.33	67.22

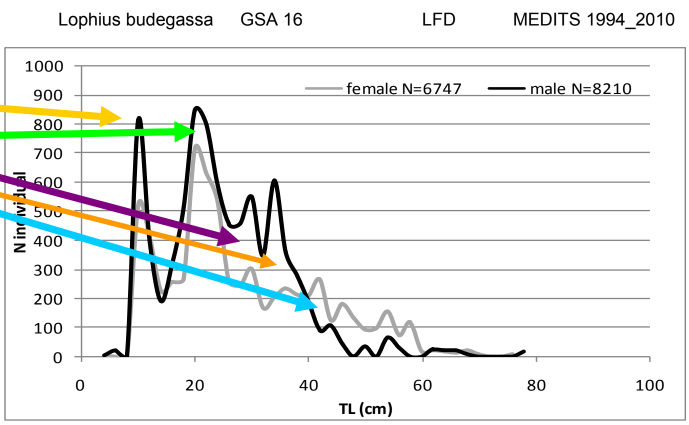


Fig. 6.17.1.2.1 Comparison of the mean length at age by two set of growth curve with the observed LFD from MEDITS surveys in GSA 16.

Table 6.17.1.2.1Von Bertalanffy growth function and length-weight relationship parameters used for the assessment of black bellied anglerfishin the Strait of Sicily (GSA 15 and 16). L_∞as TL in cm and weight in g.

Reference	L∞	K	t_0	a	b
IAMC CNR (not published)	72.5	0.17	-0.41	0.0174	2.9376

6.17.1.2 Maturity

According to preliminary estimates the length at 50% maturity (L_m) of the species is 35 and 40 cm TL, for males and females respectively (IAMC CNR, unpublished).

6.17.2 *Fisheries*

6.17.2.1 General description of the fisheries

In the Strait of Sicily black-bellied anglerfish is a high value commercial species. It is fished almost exclusively by trawlers operating mainly on the outer shelf-upper slope, together with other important species, such as *Mullus spp., Pagellus spp., Merluccius merluccius, Zeus faber, Raja spp, Eledone spp., Illex coindetii, Todaropsis eblanae, Parapenaeus longirostris* and *Nephrops norvegicus*.

6.17.2.2 Management regulations applicable in 2011 and 2012

As in other areas of the Mediterranean Sea, management is based on the control of fishing capacity (licenses), fishing effort (fishing activity) and technical measures (mesh size and area/season closures). No minimum landing sizes is established for this species under the ‘Mediterranean Regulation’ (EC 1967/06).

The adoption of a 30-45 day annual trawling by the Sicilian Government since late 1980s have should contributed to a reduction in fishing effort on demersal resources off the Sicilian coast.

In order to limit the over-capacity of fishing fleet, no new fishing licenses have been assigned in Italy since 1989 and a progressive reduction of the trawl fleet capacity is occurring. Maltese fishing licenses had been fixed at a total of 16 trawlers since 2000. Eight new licences were however issued in 2008, a move made possible under EU law by the reduction of the capacities of other Maltese fishing fleets.

In terms of technical measures, the ‘Mediterranean Regulation’ (EC 1967/2006; EC 1343/2011) fixed a minimum mesh size of 40 mm for bottom trawling of EU fishing vessels (Italian and Maltese trawlers). Mesh size had to be modified to square 40 mm or diamond 50 mm in July 2008, and derogations were only possible up to 2010.

The Maltese Islands are surrounded by a 25 nautical miles (nm) fisheries management zone, where fishing effort and capacity are being managed by limiting vessel sizes, as well as total vessel engine powers (EC 813/04; EC 1967/06). Trawling is allowed within this designated conservation area, however only by vessels not exceeding an overall length of 24m and only within designated areas. Such vessels fishing in the management zone hold a special fishing permit in accordance with Article 7 of Regulation (EC) No 1627/94, and are included in a list containing their external marking and vessel's Community Fleet Register number (CFR) to be provided to the Commission annually by the Member States concerned. Moreover, the overall capacity of the trawlers allowed to fish in the 25nm zone can not exceed 4 800 kW, and the total fishing effort of all vessels is not allowed to exceed an overall engine power and tonnage of 83 000 kW and 4 035 GT respectively. The fishing capacity of any single vessel with a license to operate at less than 200 m depth can not exceed 185 kW. In addition, the use of all trawl nets within 1.5 nm of the coast is prohibited according to the 'Mediterranean Regulation' (EC 1967/2006).

6.17.2.3 Catches

6.17.2.3.1 *Landings*

In the last three years, the landings of the Italian and Maltese trawl fleets combined ranged between 250 and 285 tons. Catch due to artisanal fisheries could be considered as negligible. The Italian fleet was responsible for more than 98% of the total landings.

Table 17.2.3.1.1Landings (t) by year and fisheries, 2006-2011. Maltese and Italian data derive from DCF (OTB= bottom trawlers; Artisanal includes nets and longlines).

GSA	Country	gear	2006	2007	2008	2009	2010	2011
15	Malta	OTB	0.32	0.98	1.93	4.02	2.83	4.34
15	Malta	Artisanal	0.50	0.35	0.33	0.25	0.01	0.02
15	Malta	Total	0.81	1.33	2.26	4.27	2.84	4.35
16	Italy	OTB	306.4	403.0	302.7	245.69	282.95	274.55
16	Italy	Artisanal	0.00	0.00	0.00	0.00	0.00	0.04
16	Italy	Total	306.41	403.06	302.70	245.69	282.95	274.59
15&16	Italy&Malta	Total	307.22	404.39	304.96	249.96	285.79	278.98

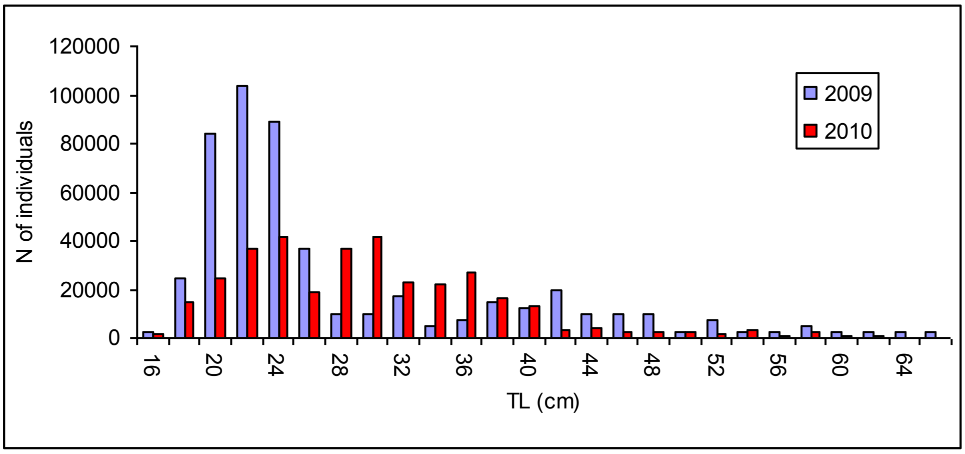


Fig. 17.2.3.1.1Length structure by year of black bellied anglerfish landings of Sicilian trawlers fishing in the Strait of Sicily.

6.17.2.3.2 *Discards*

No information on discards was available to the WG.

6.17.2.4 Fishing effort

The effort of trawlers deployed in GSA 15 & 16, keeping separate the Italian and Maltese fleet, as reported to STECF EWG 12-10 through the DCF data call is showed in figure 6.17.2.4.1.

The segment of the Italian demersal OTB reveals a 32% decrease in effort for vessels larger than 24 m in the period 2004-2011. The Maltese OTB fleet was responsible for only 1.6% of total trawling effort in GSAs 15 & 16 in 2006-2011, however the nominal effort of Maltese trawlers has increased by 67% in 2006-2011.

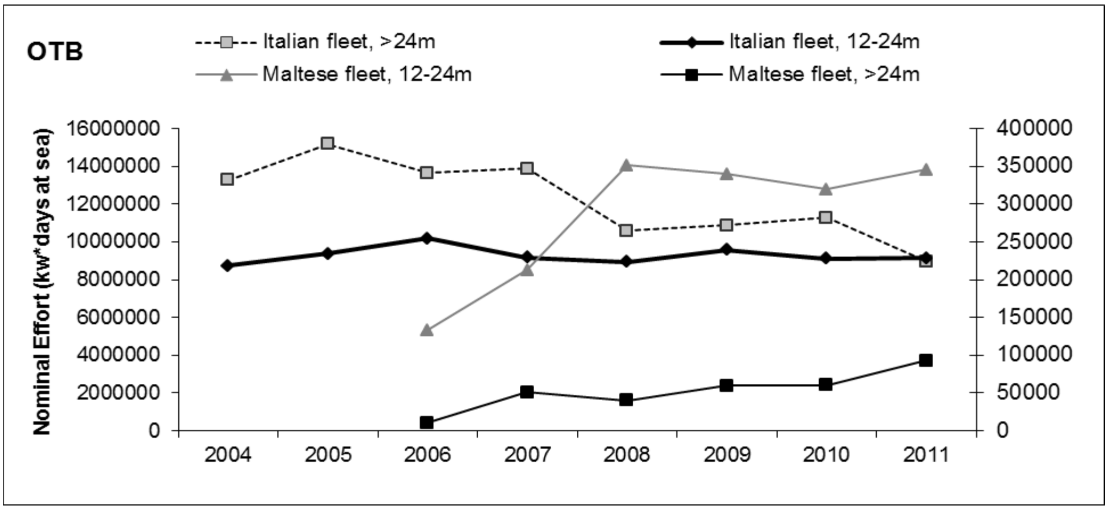


Fig.6.17.2.4.1Nominal effort (kW*days at sea) trends of trawlers (OTB) by segments of Italian (left) and Maltese (right) fleets, 2004-2011.

6.17.3 *Scientific surveys*

6.17.3.1 Medits

6.17.3.1.1 *Methods*

Based on the DCR/DCF data call, abundance and biomass indices were recalculated and presented in section 6.17.3.1.3 of this report.

In GSA 15 & 16 the following number of hauls was reported per depth stratum (Table 6.17.3.1.1.1-2).

Table 6.17.3.1.1.1 Number of hauls per year and depth stratum in GSA 16, 1994-2011.

Depth (m)	1994	1995	1996	1997	1998	1999	2000	2001	2002
10-50	4	4	4	4	4	4	4	4	7
50-100	8	8	8	8	8	8	7	8	11
100-200	4	4	4	4	5	5	6	5	10
200-500	10	11	11	12	11	11	11	11	19
500-800	10	14	14	13	14	14	14	14	19
Depth (m)	2003	2004	2005	2006	2007	2008	2009	2010	2011
10-50	7	7	10	10	11	11	11	11	11
50-100	12	12	20	22	23	23	23	23	23
100-200	8	9	18	19	21	21	21	21	21
200-500	18	19	28	31	27	27	27	27	27
500-800	20	19	32	33	38	38	38	38	38

Table 6.17.3.1.1.2 Number of hauls per year and depth stratum in GSA 15, 2002-2011.

Depth (m)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
10-50	1	1	2	1	1	0	0	0	0	0
50-100	5	5	4	5	5	12	6	6	6	6
100-200	13	13	13	13	13	12	13	14	14	14
200-500	10	10	10	9	10	4	9	10	10	10
500-800	16	16	15	17	16	17	17	15	15	15

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution or quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.17.3.1.2 *Geographical distribution patterns*

No analyses were conducted during STECF EWG 12-10.

6.17.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of the black bellied angler in GSAs 15 and 16 was derived from the international surveys MEDITS. In the GSA 16, the stock increased progressively from 1999 and onward (Figure 6.17.3.1.3.1).

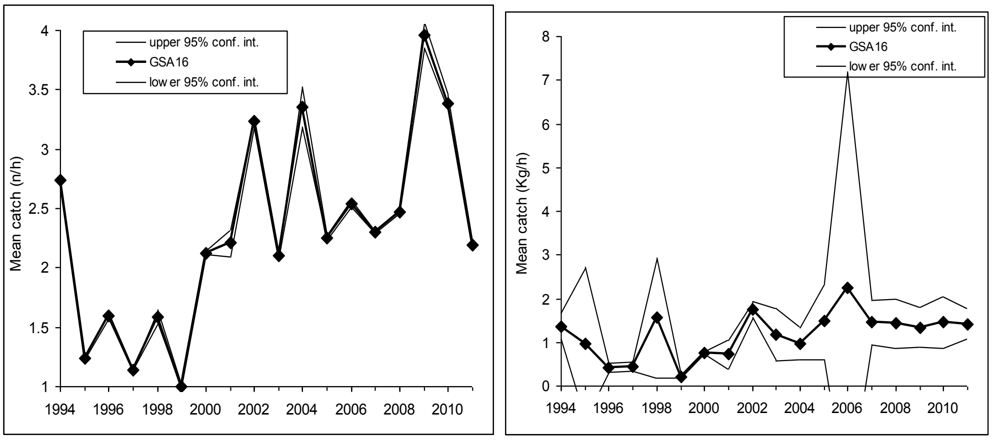


Fig. 6.17.3.1.3.1 Abundance (n/h) and biomass (kg/h) indices of black bellied anglerfish in GSA 16 (MEDITS surveys).

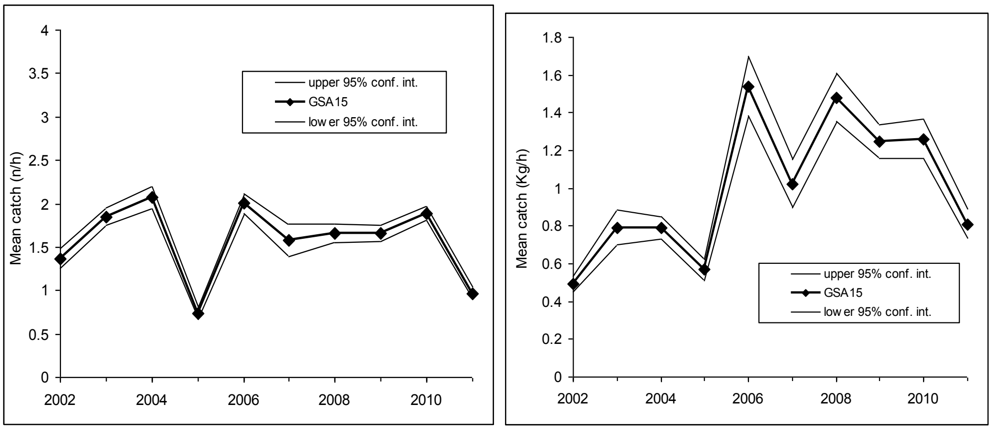
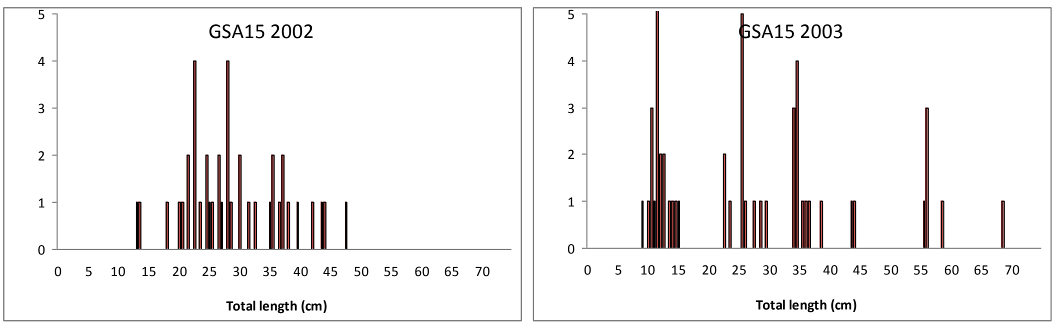


Fig. 6.17.3.1.3.2 Abundance and biomass indices of black bellied anglerfish in GSA 15.

6.17.3.1.4 *Trends in abundance by length or age*

Figures 6.17.3.1.4.1 - 3 display the stratified abundance indices of black bellied angler, as number per 1 hour haul, obtained during the MEDITS survey carried out in GSAs 15 and 16 in 2003-2011 and 1994-2011 respectively.



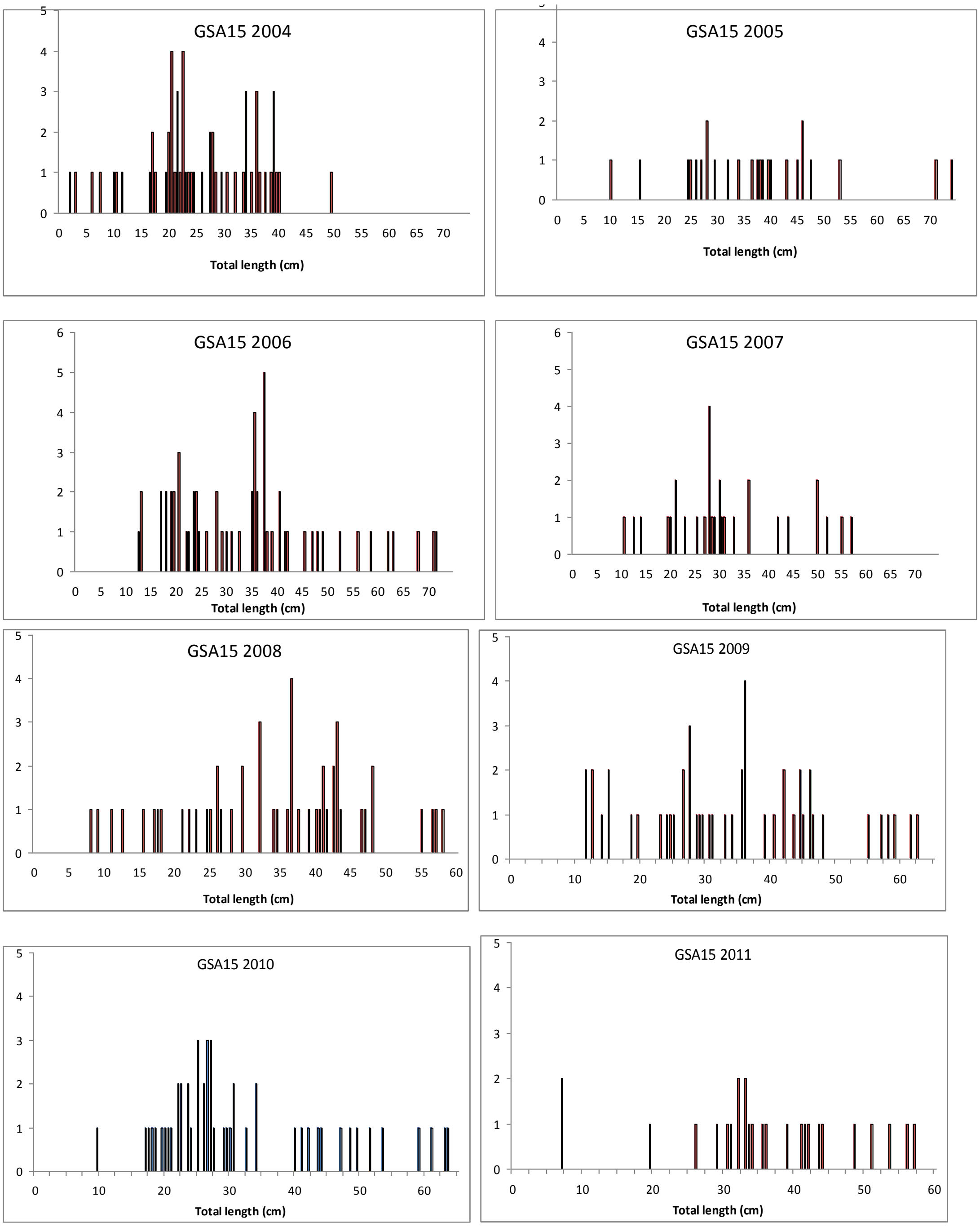


Fig. 6.17.3.1.4.1 Stratified abundance indices (n/h) by size in GSA 15, 2002-2011.

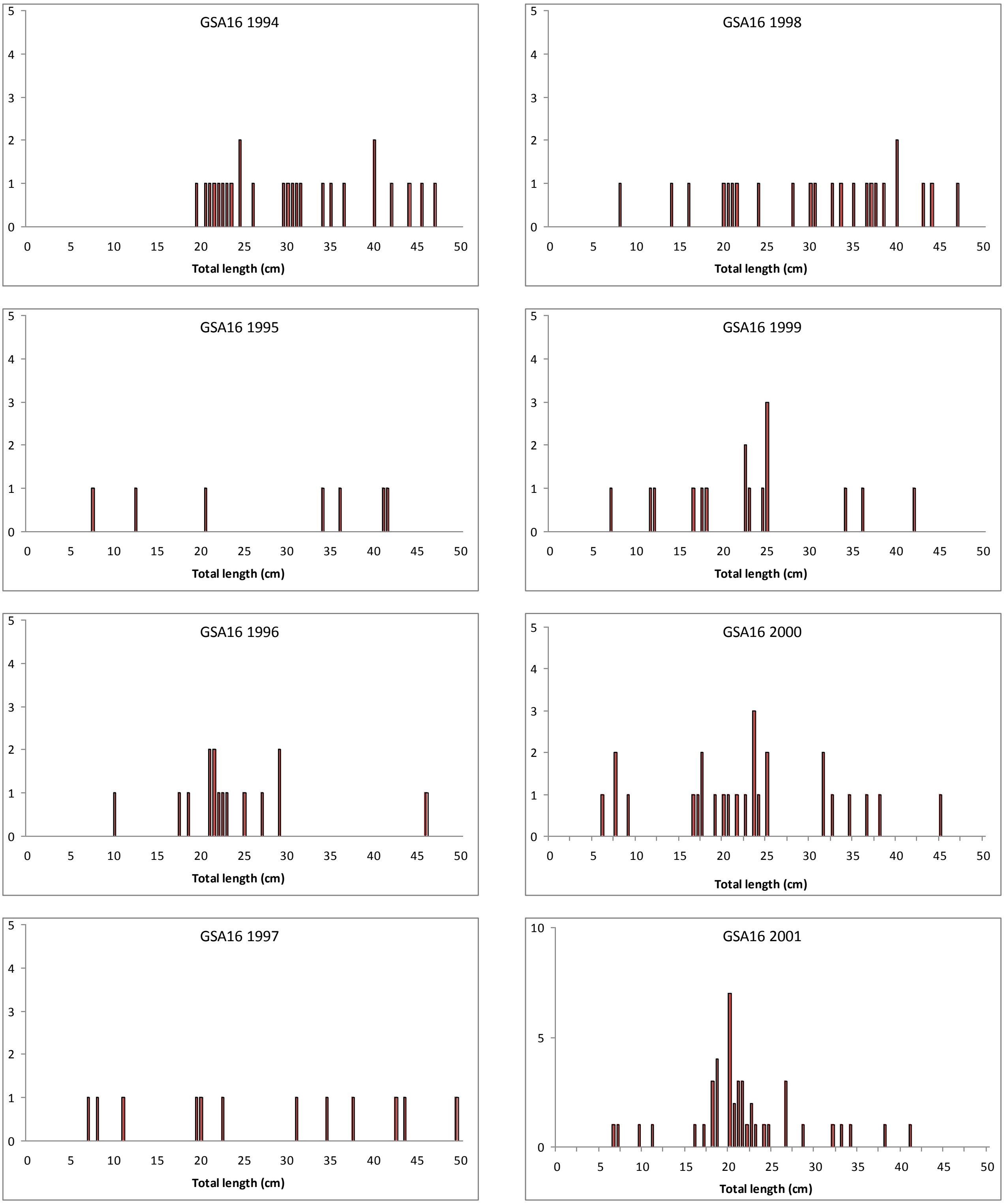
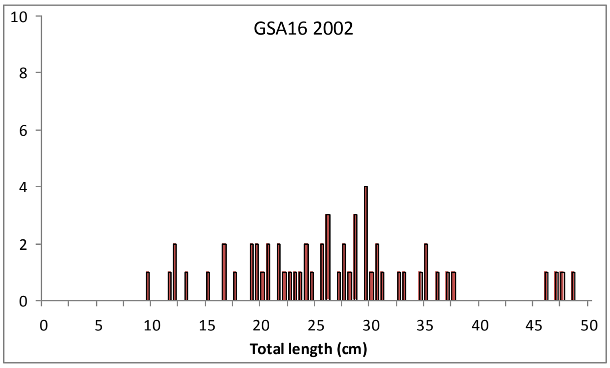
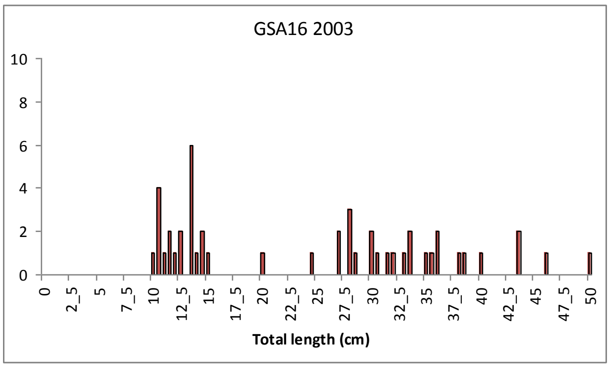
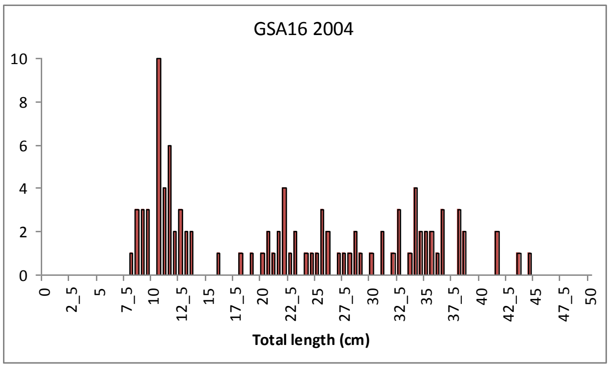
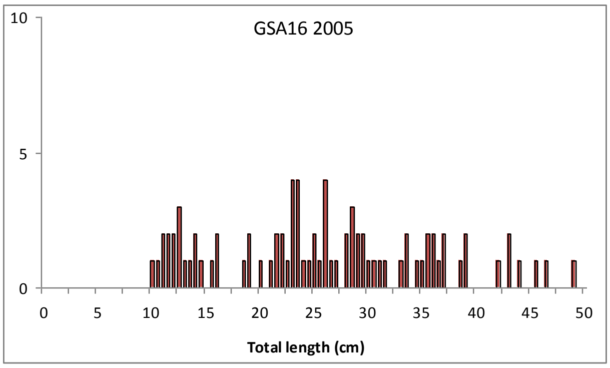


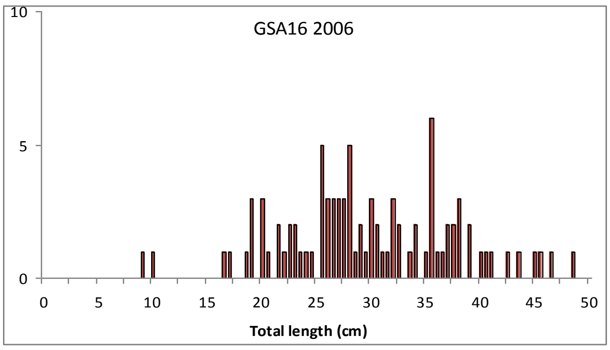
Fig. 6.17.3.1.4.2 Stratified abundance indices by size (n/h) in GSA 16, 1994-2001.

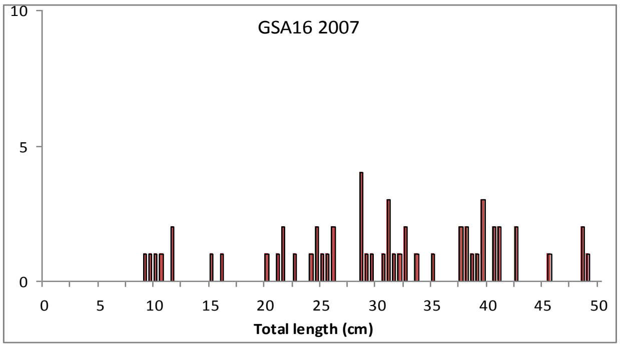

GSA16 2002
Total length (cm)

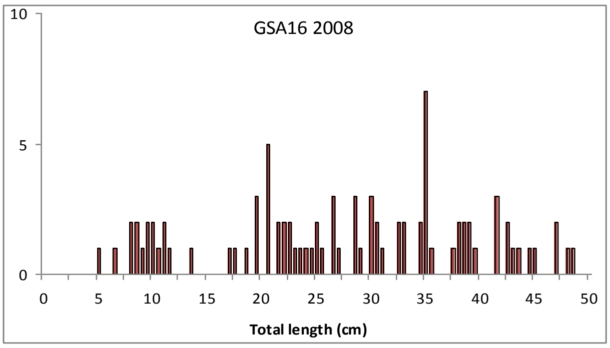

GSA16 2003
Total length (cm)

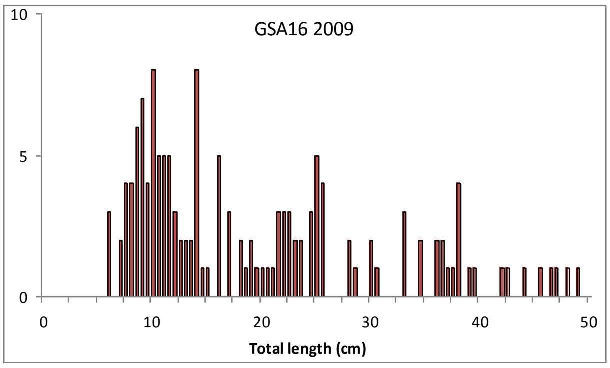

GSA16 2004
Total length (cm)

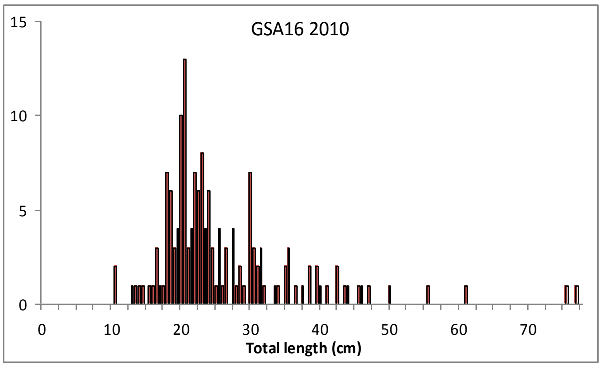

GSA16 2005
Total length (cm)


GSA16 2006
Total length (cm)


GSA16 2007
Total length (cm)


GSA16 2008
Total length (cm)


GSA16 2009
Total length (cm)


GSA16 2010
Total length (cm)

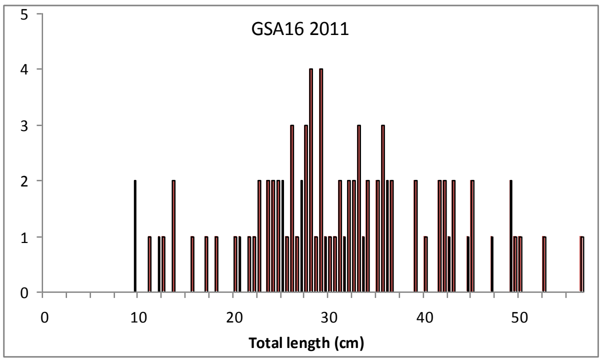

GSA16 2011
Total length (cm)

Fig. 6.17.3.1.4.3 Stratified abundance indices by size (n/h) in GSA 16, 2002-2011.

Figure 6.17.3.1.4.4 displays the stratified abundance indices of black bellied anglerfish, as number by 100 km2, in GSA 15 and GSA 16 in 2002-2011.

In order to allow a more reliable use of the survey data, a re-estimation of the horizontal opening of the GOA 73 reported in the GSA 15 data base was done. Since the same gear, the same vessel (Sant Anna), the same captain and the same haul protocol were used in GSA 15, the relationship and parameters proposed by Fiorentini et al. (1999) for GSA 16 were adopted.

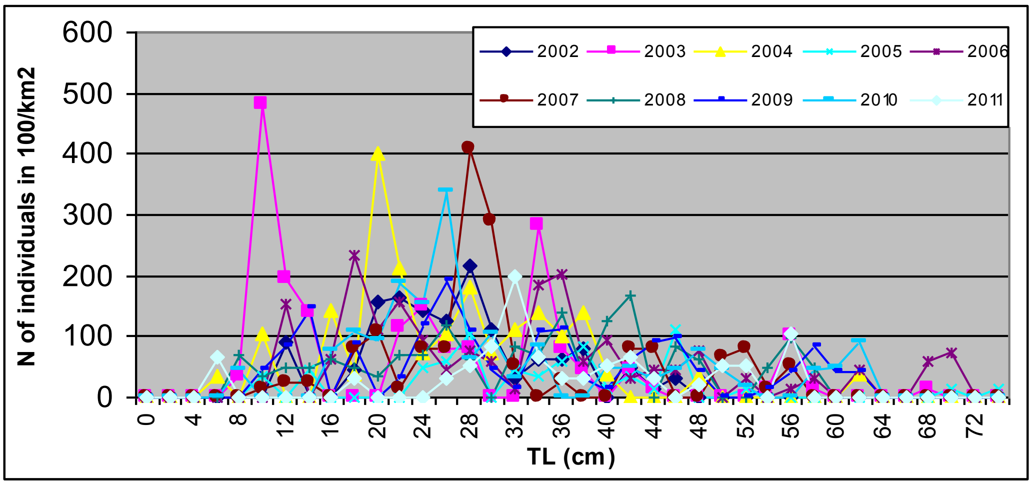


Fig. 6.17.3.1.4.4 Stratified abundance indices by size class in GSA 15, 2002-2011

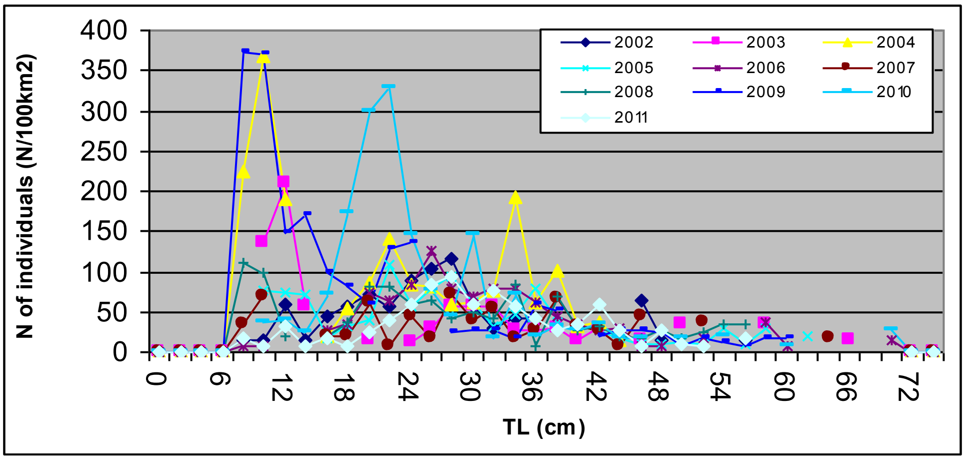


Fig. 6.17.3.1.4.5 Stratified abundance indices by size class in GSA 16, 2002-2011

6.17.3.1.5 *Trends in growth*

No analyses were conducted during STECF EWG 12-10.

6.17.3.1.6 *Trends in maturity*

No analyses were conducted during STECF EWG 12-10.

6.17.4 *Assessment of historic stock parameters*

6.17.4.1 Method 1: SURBA

6.17.4.1.1 *Justification*

The availability of a 10 year time series (2002-2011 for GSA 15 and 16) of length frequency distribution (LFD) data from trawl surveys allows to reconstruct the dynamic of the main stock parameters (recruitment and spawning stock biomass indices as well as fishing mortality rates) of black bellied anglerfish in GSA 15 and 16 by using SURBA software package.

Firstly the LFDs by sex combined from the MEDITS trawl surveys, standardized as number per 100 km^2, were converted in numbers by age group using the subroutine "age slicing" (i.e. knife edge slicing) as implemented in the software package LFDA (Kirkwood *et al*., 2001) and using the parameters given below.

Table 6.17.4.1.1.1 Black bellied angler parameters used for age slicing

Linf	K	t0	Age at fully maturity	a	b
72.5	0.17	-0.41	3	0.0174	2.9376

Successively, the mean weight and maturity at age were estimated using the Von Bertalanffy Growth Function (VBGF) and a vectorial natural mortality at age estimated suing PRODBIOM (Abella et al. 1997) was calculated to run the SURBA analysis. Subsequently the numbers at age were used to estimate a time series of fishing mortality rates, recruitment and SSB indices. A constant catchability-at-age was assumed when running the model.

6.17.4.1.2 *Input parameters*

The number at age from the MEDITS survey data is reported in Table 6.17.4.1.2.1. The age slicing produced more than 15 age groups. Due to the limited number of individuals aged older than 7 years, a plus group was created (7+).

Table 6.17.4.1.2.1 Number at age used in the SURBA analysis

	1	2	3	4	5	6	7+
2002	285	404	131	28	63	9	10
2003	72	185	184	65	21	23	75
2004	448	308	352	150	16	8	10
2005	168	255	160	70	58	13	79
2006	312	315	275	117	59	25	124
2007	143	341	102	98	66	17	79
2008	231	210	185	162	63	45	119
2009	368	236	143	68	97	33	109
2010	792	442	117	83	53	44	91
2011	81	248	215	111	47	42	61

Table 6.17.4.1.2.2 Natural mortality, proportion of mature and mean weight at age for black bellied anglerfish in GSA 15 & 16.

Age	1	2	3	4	5	6	7+
Natural mortality at age	0.78	0.34	0.25	0.21	0.19	0.17	0.16
Maturity at age	0	0	1	1	1	1	1
Weight at age	117.2	319.9	607.9	953.5	1329.8	1714.3	2090.6

The model settings are given below:

Year range: 2002-2011

Age range: 1-7+ as Age groups

Catchability: 1.0 at all ages

Age weighting 1.0 at ages 1-4, 0.75 for age 5 and 6, and 0.5 for age 7+

Smoothing Index Rho: 2.0

Cohort weighting: not applied

Results as relative values

6.17.4.1.3 *Results*

The comparative scatter plot of smoothed indices by age appear consistent (Fig. 6.17.4.1.3.1).

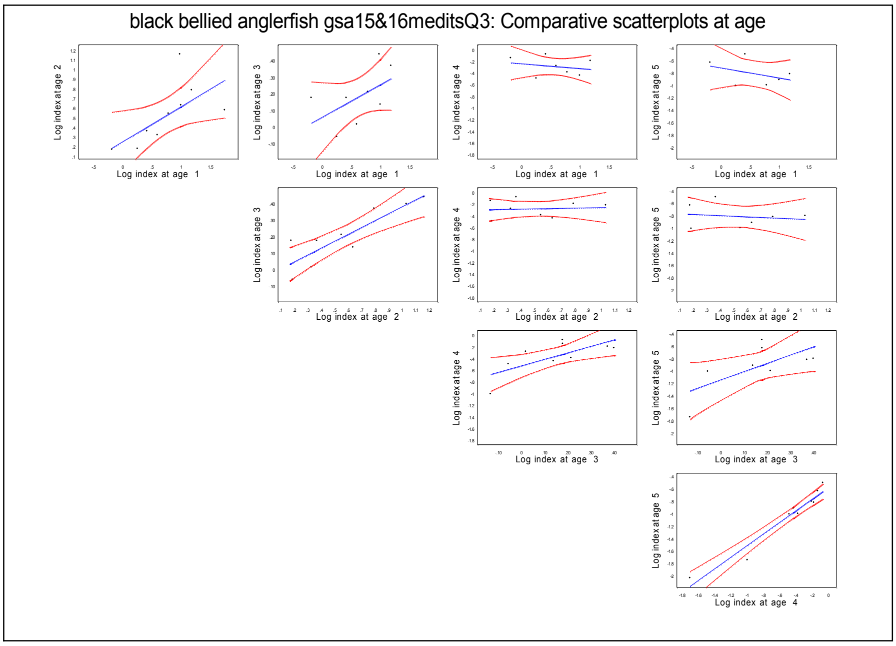


Fig. 6.17.4.1.3.1 Black bellied anglerfish in GSAs 15 & 16: Output from SURBA (ver. 2.2) plots for MEDITS survey (ages 1-5), showing age scatter plots.

The model output shows high uncertainty of the $F_{2\text{-}5}$ estimates, following the high variability in the estimated temporal trend *f* . The median of bootstrapped values was 0.25 in 2010.

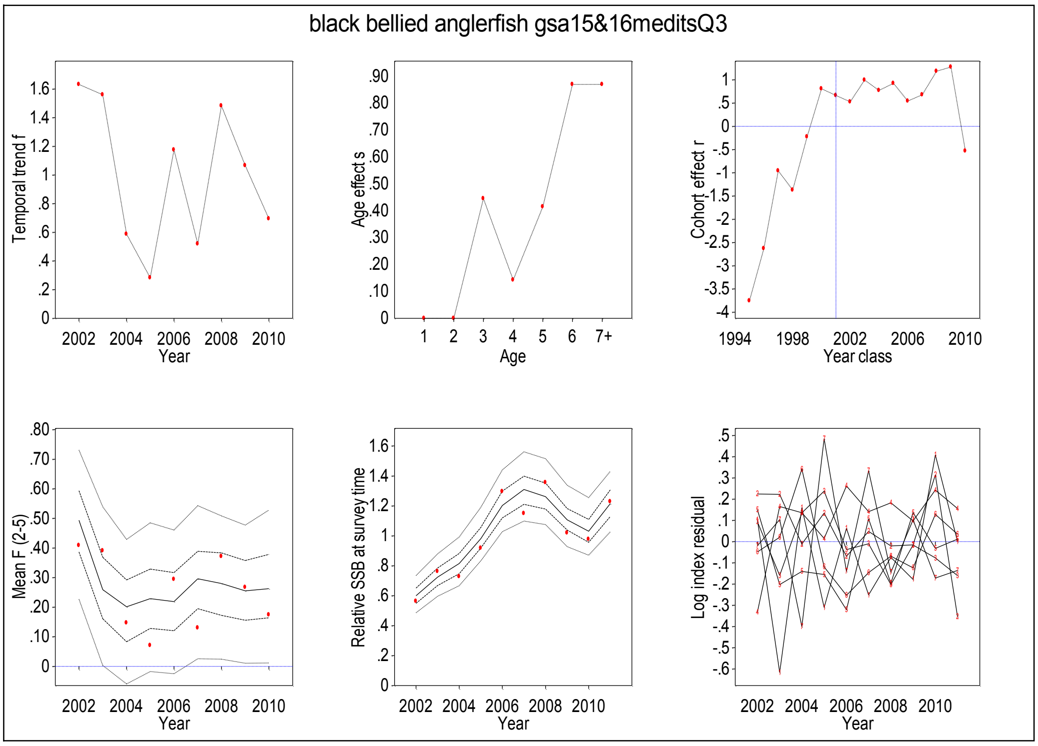


Fig. 6.17.4.1.3.2 Black bellied anglerfish in GSAs 15-16. SURBA model parameters and estimates of $F_{2\text{-}5}$, SSB, recruitment and overall residuals.

The residuals by age were fairly small, with no evident trend in all age classes.

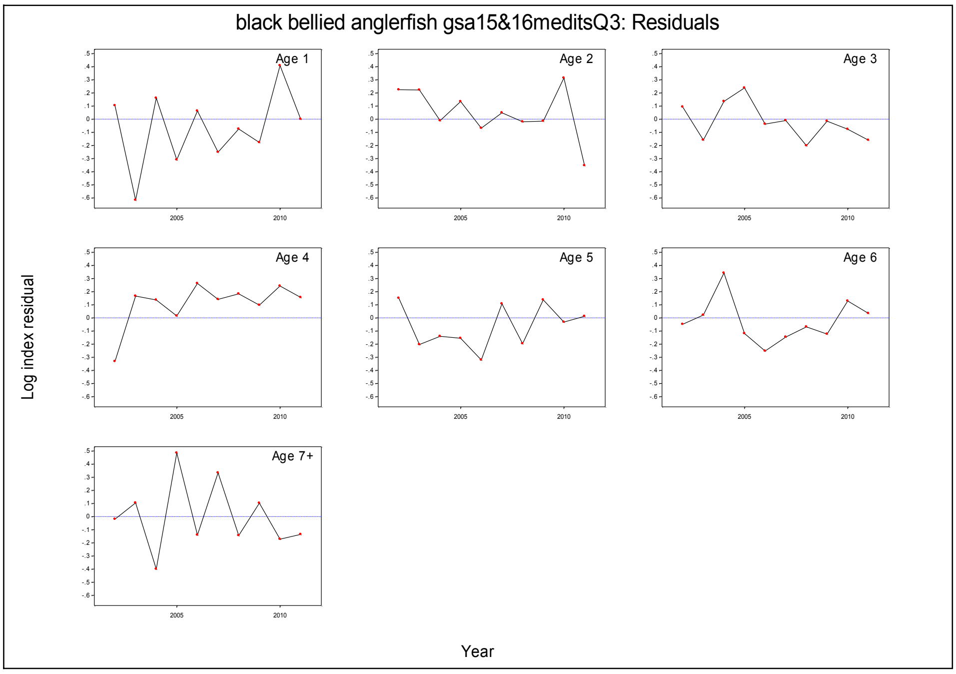


Fig. 6.17.4.1.3.3 Black bellied anglerfish in GSAs 15 & 16. Residuals by age and year of the SURBA model.

The observed versus fitted number at age are shown in figure 6.17.4.1.3.4.

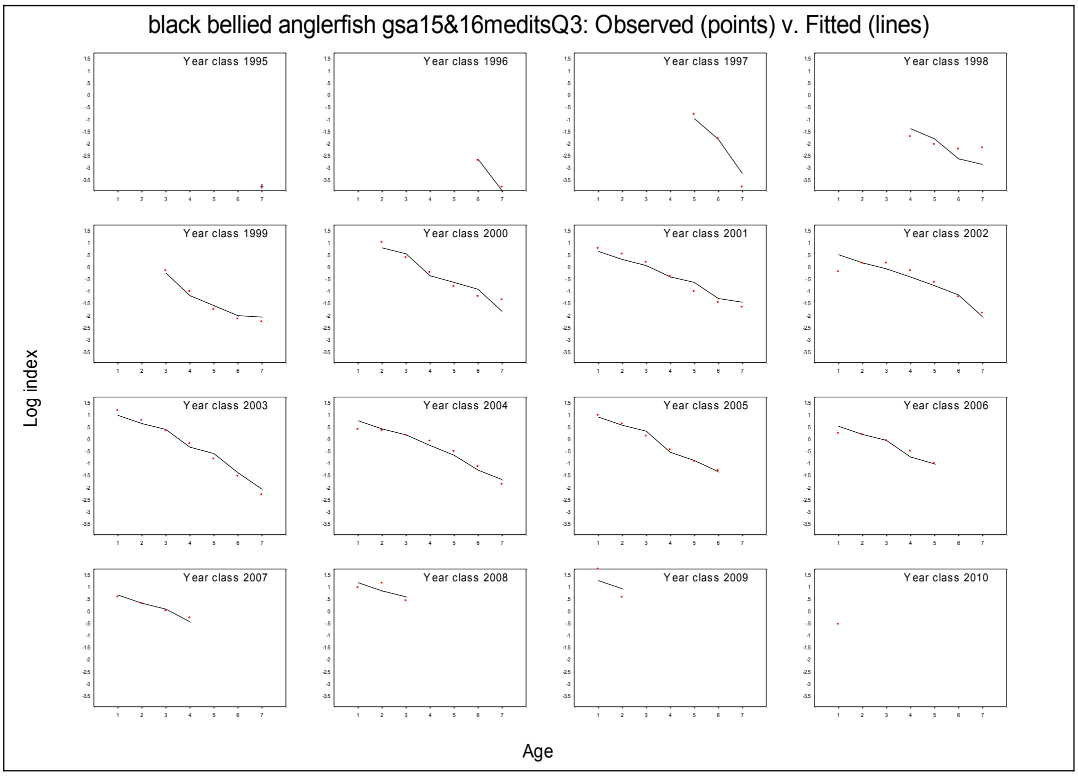


Fig. 6.17.4.1.3.4 Model diagnostic for SURBA model in the GSA 15 & 16 (MEDITS data). Comparison between observed (points) and fitted (lines) survey abundance indices, for each year class.

The retrospective analysis show a low precision in the estimation of the temporal and age effects of the model (Fig. 6.17.4.1.3.5).

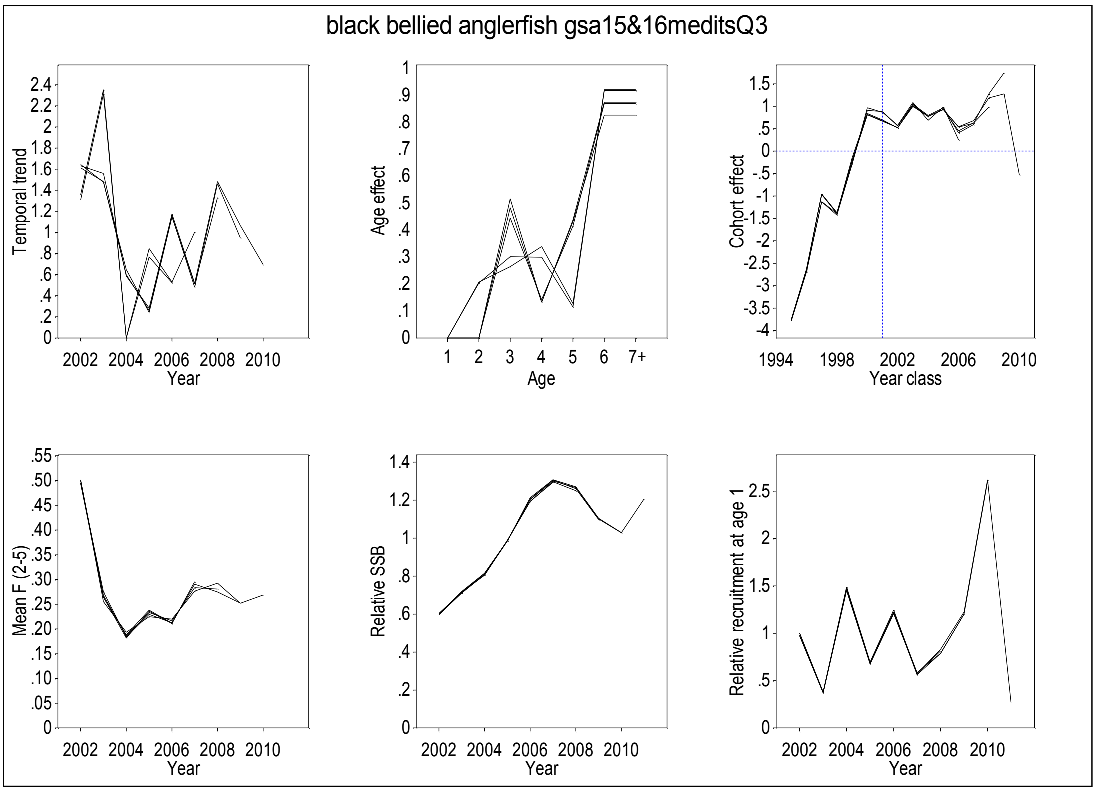


Fig. 6.17.4.1.3.5 Black bellied anglerfish in GSAs 15-16. SURBA model: retrospective analysis.

Due to the uncertainty in mortality estimates from SURBA, another estimate of total mortality rates was carried out according to the Beverton and Holt estimator as implemented in the LFDA package with the growth parameters reported in Table 6.17.4.1.1.1. The results using different values of length at full capture are reported below.

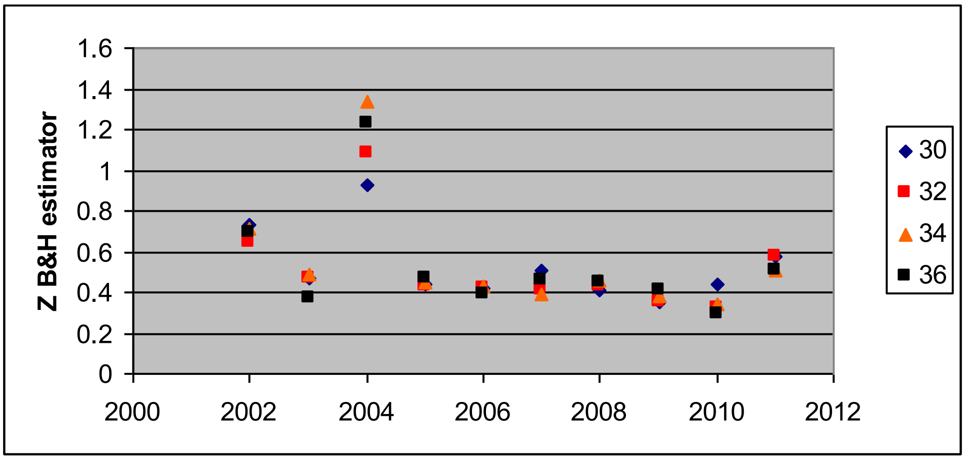


Fig. 6.17.4.1.3.5 Z values by Beverton & Holt estimator with different length at fully capture (cm, TL).

Using the Beverton and Holt estimator and length frequency distributions from trawl surveys, the mean Z in the last three years was 0.41. Assuming an M value of 0.2, the estimation of current F is around 0.2, which is comparable with those obtained by SURBA.

6.17.4.2 Method 2: VIT

6.17.4.2.1 *Justification*

An approach under steady state (i.e. pseudocohort analysis) was used, keeping separate the available years (2009-2010). Cohort (VPA equation) and yield per recruit analysis as implemented in the package VIT4win were carried out (Lleonart and Salat, 2000).

6.17.4.2.2 *Input parameters*

The 2009 and 2010 catch data collected within the EU Data Collection Framework (DCF) used in the analysis are reported in Table 6.17.4.2.2.1. Italian catch data of 2011 was submitted in response to the 2012 official DCF data call and was thus not available to the WG. Analyses were carried out on the landings (combined sex) of Italian and Maltese trawlers operating in GSA 15 & 16. Length frequency distributions were sliced into age group using the same approach used for trawl survey data (age slicing routine of LFDA package).

Table 6.17.4.2.2.1. Absolute number by age class of black bellied anglerfish landed by year in the Strait of Sicily (GSA 15 and 16 combined).

Age	2009	2010	mean
0	0	0	0
1	231537.2	85126.38	158331.8
2	128808.6	128150.3	128479.5
3	31981.08	75410.52	53695.8
4	41190.61	29932.69	35561.65
5	24318.77	7703.939	16011.35
6	11692.8	4717.461	8205.131
7	8917.957	3401.333	6159.645
8	3353.534	1992.404	2672.969
9	5300.253	2236.674	3768.464
10	2386.947	904.063	1645.505
11	2013.781	536.845	1275.313
12	1698.953	96.883	897.918
13	1433.35	0.58	716.965
14	1209.266	0.489	604.8775
15	963.824	0.39	482.107

6.17.4.2.3 *Results*

Fishing mortality rates (F) at age of black-bellied anglerfish in GSA 15 and 16 are shown in Figure 6.17.4.2.3.1.

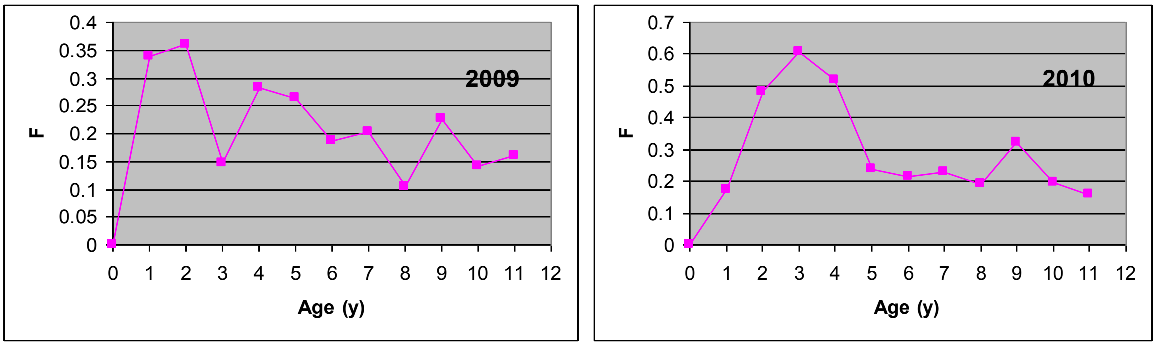


Fig. 6.17.4.2.3.1 Fishing mortality by age of black-bellied anglerfish in GSAs 15 & 16.

The reconstructed yields obtained by the VIT package are virtually equal to the observed ones. Absolute recruitment estimation and other main results of VIT, including the current mortality rates, are listed in Table 6.17.4.2.3.1.

Table 6.17.4.2.3.1 Overview of the VIT analysis results of black-bellied anglerfish in GSAs 15 & 16.

Year	2009	2010
Official total yield (t)	274,6	283,0
Estimated SSB (t)	977.9	536.1
Recruitment (n) at age 1	1119679	1095984
Mean Z over all age	0.406	0.490
Mean F over all age	0.219	0.303
Mean F (1-7 age groups)	0.254	0.351

6.17.5 *Long term prediction*

6.17.5.1 Justification

The VIT approach to biomass and yield per recruit analysis was applied in order to analyse the stock production with increasing exploitation under equilibrium conditions.

A yield (Y), biomass (B) and spawning stock biomass (SSB) per recruit analysis of females of black-bellied anglerfish was in addition carried out using the Yield package (Branch et al., 2001). Availability of biological parameters and length at first capture data allows for a quantitative simulation of the likely changes in Y, B and SSB per recruit as a function of fishing mortality (F) using the Yield package. Yield was also used to estimate a probability estimation of Biological Reference Points (BRP) (F_{max} and $F_{0.1}$).

6.17.5.2 Input parameters

The input parameters were the same as those adopted for the VIT analysis and are show in Table 6.17.5.2.1 below.

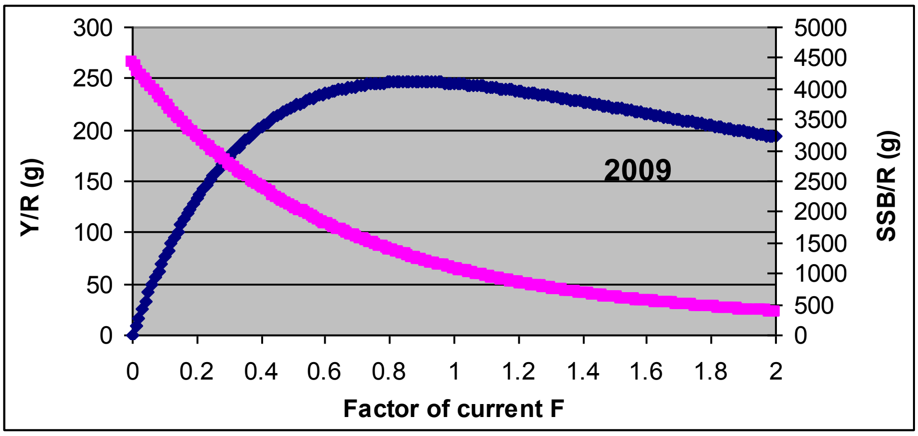
Table 6.17.5.2.1Parameters used for stock assessment using Yield software. Length is in cm and weight in g.

L∞	72.5 (0.1)	Lm	40 (0.1)
K	0.17 (0.1)	Lc	30 (0.1)
t0	-0.4 (0.1)	M	0.20 (0.1)
a	0.0174	Recruitment	Constant with CV=0.4
b	2.9376		

6.17.5.3 Results

6.17.5.3.1 *VIT package*

Estimation of Biomass and Yield per recruit (YPR) varying current fishing mortality (F_{curr}) by a multiplicative factor is reported in Figure 6.17.5.3.1.1.



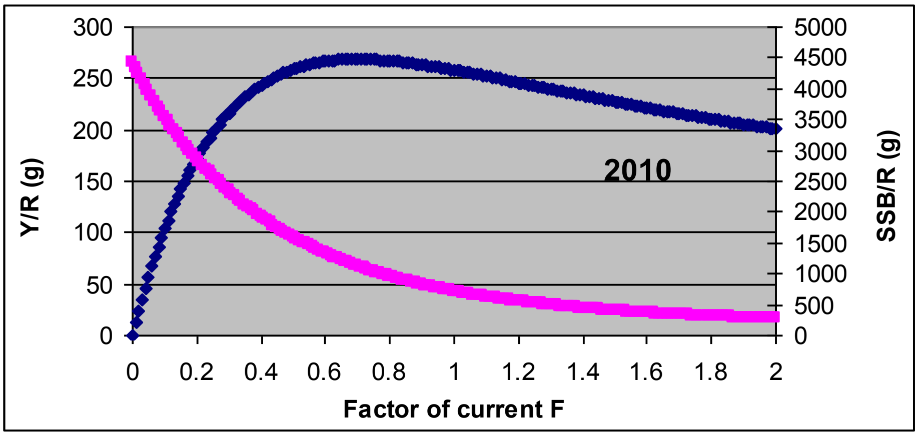


Fig. 6.17.5.3.1.1 YPR and Spawning Stock Biomass (SSBPR) per recruit varying current fishing mortality (Fc) by a multiplicative factor of current F.

Assuming no variation in the exploitation pattern, the main result of the YPR analysis in terms of current F and optimal ones are reported in Table 6.17.5.3.1.1.

Table 6.17.5.3.1.1Estimation of current F, as Fmean (1-7), and reference points Fmax and F0.1, and corresponding Y, B and SSB per recruits.

		Factor	F	Y/R	B/R	SSB
2009	F(0)	0	0	0	4414.8	4114.9
	F(0.1)	0.63	0.16	238.1	1739.3	1507.7
	Fmax	0.88	0.22	246.9	1264.8	1054.1
	Fc	1	0.25	245.2	1073.7	873.3
2010	F(0)	0	0	0	4414.8	4114.9
	F(0.1)	0.49	0.17	258.1	1622.4	1365.3
	Fmax	0.71	0.25	268.6	1122.2	880.8
	Fc	1.01	0.35	258.1	710.3	489.1

The current F over age groups 1-7 (median value 2009-2010 being 0.30) is higher than both F_{max} (median value 2009-2010 being 0.16) and $F_{0.1}$ (median value 2009-2010 being 0.24).

6.17.5.3.2 *YIELD package*

Estimation of Y and SSB per recruit according to Yield package are shown in Fig. 6.17.5.3.2.1.

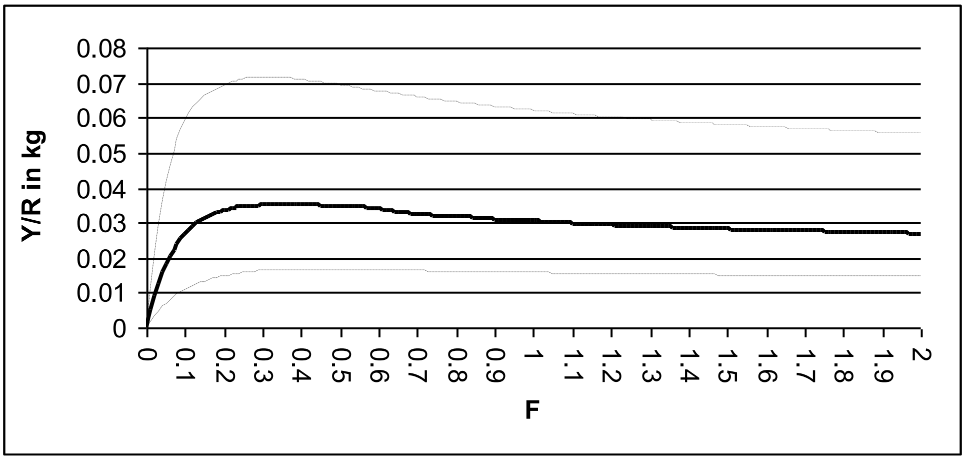


Fig. 6.17.5.3.2.1Median of YPR and corresponding uncertainty for black bellied anglerfish in the GSA 15 & 16 according to the Yield Package (YPR in kg).

Searching for BRP through 500 simulations produced the probability distribution of F_{max} and $F_{0.1}$ showed in Figure6.17.5.3.2.2. The median value of F_{max} was 0.26, whereas the median value of $F_{0.1}$ was 0.16. EWG 12-10 proposed $F_{0.1}$ = 0.16 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 0.35 in 2010), the stock is considered exploited unsustainably.

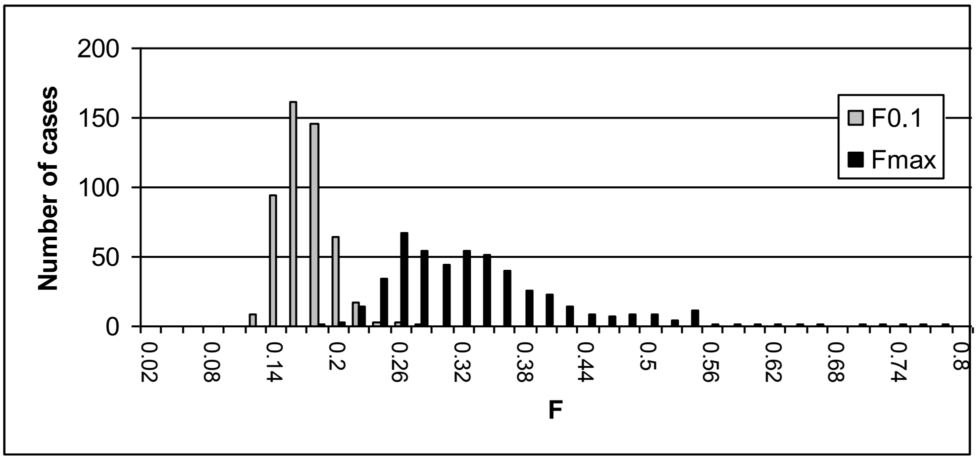


Fig. 6.17.5.3.2.2 Probability distribution of F_{max} and $F_{0.1}$ according to Yield package.

6.17.6 *Data quality and availability*

Italian landings data for 2011 as well as Italian / Maltese discards data for black bellied angler were not submitted during the latest DCF data call and thus not available to EWG 12-10. Given the low abundance of the stock in the GSAs 15 & 16, the number of specimens caught during MEDITS surveys did not always allow to clearly identify cohorts. A similar situation can be found in the landing size structures. An improved sampling approach, including discards, should be adopted to achieve a better reconstruction of the size and age structure of this stock.

6.17.7 *Scientific advice*

6.17.7.1 Short term considerations

6.17.7.1.1 *State of the spawning stock size*

According to SURBA estimates, SSB showed clear signs of an increasing trend from 2002 to 2006, after a decreasing during previous years. The first estimates of absolute values obtained by VIT ranged between 540 (2010) and 980 (2009) tons. However, in the absence of proposed biomass management reference points, EWG 12-10 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

6.17.7.1.2 *State of recruitment*

According to SURBA estimates, recruitment remained quite stable from 2002 to 2008, followed by an increase in 2009 and 2010, and a large decrease in 2011. Absolute values obtained by VIT were around 1 million of recruits at age 1 per year. However, in the absence of proposed management reference points, EWG 12-10 is unable to fully evaluate the status of the recruitment in relation to these.

6.17.7.1.3 *State of exploitation*

EWG 12-10 proposed $F_{0.1}$ = 0.16 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 0.35), the stock is considered exploited unsustainably.

6.18 **Stock assessment of red mullet in GSA 17**

6.18.1 *Stock identification and biological features*

6.18.1.1 Stock identification

Red mullet (*Mullus barbatus*) is uniformly distributed in the whole Adriatic and the isolation of the Adriatic population was assessed by molecular and Bayesian analysis (Maggio *et al.*, 2009). This study proved a limited gene flow attributable to really low adult migration and a reduced passive drift of pelagic larvae from and to the Adriatic Sea.

A previous study from Garoia *et al.* (2004) developed a set of dinucleotide microsatellite markers and revealed a significant overall heterogeneity within the red mullet Adriatic stock: this result indicate that this species may constitute local subpopulations that remain partly isolated from each other. However, the randomness of genetic differences among samples indicated that red mullet in the Adriatic likely belongs to a single population. Besides, no correlation between geographic distance and genetic differentiation has been detected.

The observed genetic fragmentation could be explained by a passive dispersion of larvae due to marine currents, from random changes in allele frequencies or from fishing pressure.

Although the red mullet is distributed in the entire Adriatic, the density of the population is not the same in space. For example, Arneri and Jukić (1986) found that the biomass index between Italian and Croatian waters is about 1:4.

The present stock assessment takes in consideration the population within the boundaries of the GSA 17 (figure 6.18.1.1.1, darker area), only along the Italian coast.

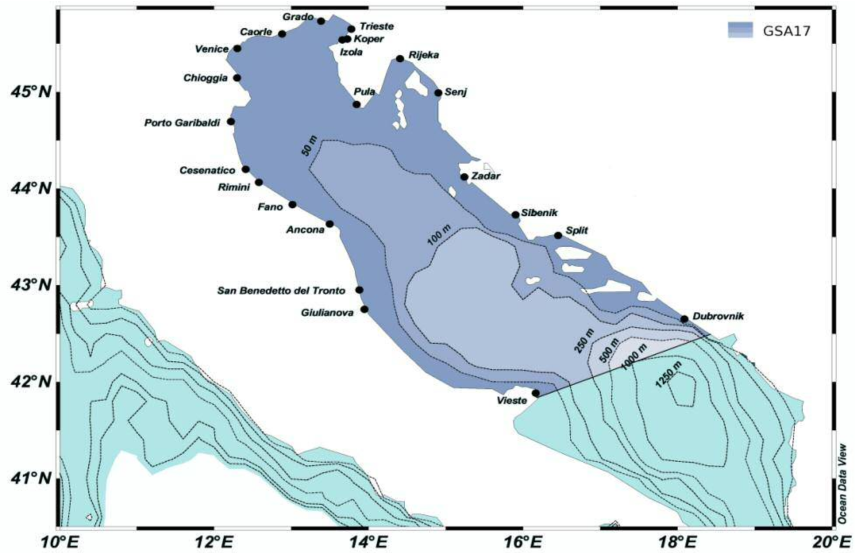


Fig. 6.18.1.1.1 GSA 17 boundaries in the Adriatic Sea.

6.18.1.2 Growth

According to Jardas (1996), red mullet grow up to 30 cm, with females growing faster and bigger than males.

The Von Bertalanffy Growth Function parameters available for this species are presented in Table 6.18.1.2.1.

Table 6.18.1.2.1 Summary of the Von Bertalanffy growth function parameters of *M. barbatus* the Adriatic Sea (from Vrgoc*et al.*,2004)

Author	**Sex**	**L_∞ (cm)**	**K (yr^{-1})**	**t_0 (yr)**	**Φ'**
Scaccini (in Levi *et al.*, 1994)	M+F	27.49	0.5	-0.25	5.93
Jukić and Piccinetti, 1988	M+F	27.0	1.8		7.18
Marano, 1994; Ungaro *et al.*, 1994	M+F	19.70	0.360	-1.18	4.94
Vrgoč, 1995 ("Hvar")	M+F	27.75	0.274	-0.616	5.35
Marano, 1996; Marano *et al.*, 1998b, c	M	27	0.184	-1.92	4.90
	F	34.5	0.156	-1.53	5.22
	M+F	31.5	0.182	-1.45	5.19
	M+F (Bhatt)	26.3	0.45		5.74
Ardizzone, 1998	M+F	27.50	0.50		5.93
Marano, 1998b, c	M	22.5	0.24	-1.29	4.80
	F	26.2	0.23	-1.41	5.06
	M+F	22.5	0.38	-0.63	5.26
	M+F (Bhatt)	25.4	0.25		5.08
	M+F (Surf.)	23	0.52		5.62
Vrgoč, 2000	M+F	26.86	0.295		5.36
EC XIV/298/96-EN, Ionian and Southern Adriatic	M+F	21.72	0.31		4.99
EC XIV/298/96-EN, Adriatic Sea	M+F	27.5	0.50		5.94

6.18.1.3 Maturity

Red mullet reproduction in GSA 17 occurs in late spring and summer. Specimens reach sexual maturity during the first year of life, at length between 10 and 14 cm (Županović, 1963; Haidar, 1970; Jukić and Piccinetti, 1981; Marano *et al.*, 1998; Vrgoč, 2000).

6.18.2 *Fisheries*

6.18.2.1 General description of the fisheries

In the Adriatic, red mullet is mainly fished by bottom trawl nets. Smaller quantities are also caught with trammel-nets and gill nets.

6.18.2.2 Management regulations applicable in 2011 and 2012

Fishing closure for trawling: 45 days in late summer have been enforced in 2011-2012 for the Italian fleet.

Minimum landing sizes: EC regulation 1967/2006 defined 11 cm TL as minimum legal landing size for red mullet.

6.18.2.3 Catches

6.18.2.3.1 *Landings*

Mannini and Massa (2000) analyzed trends of the red mullet landings in the Adriatic from 1972 to 1997. In that period, the landings showed an overall increase. This positive trend was constant in the Western Adriatic, while in the Eastern Adriatic landings decreased during the second half of the 1990s. No data of Croatian landings are available from 2000 and onwards.

Landings data for the Italian fleet were reported to STECF EWG 12-10 through the Data Collection Framework. The catches remained above the 3,000 t from 2006 to 2009 and then started to decrease, reaching the minimum in 2010 with less than 2,000 t. In 2011 the landings increased again (see table 6.18.2.3.1.1).

Table 6.18.2.3.1.1Annual landings (t) by fishing gear as reported to STECF EWG 11-12 through the DCF data call.

Species	**Area**	**Country**	**Gear**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
MUT	17	ITA	OTB	3100.570	3298.478	3158.313	2433.403	1796.154	2618.797
MUT	17	ITA	GNS	n/a	n/a	n/a	n/a	n/a	31.225
MUT	17	ITA	TBB	n/a	n/a	n/a	n/a	n/a	43.588

Slovenian catches are low: the highest catches between 2006 and 2011 were 2 t reported in 2007. Besides, since no Croatian data are available to the STECF EWG 12-10, for the present assessment we considered only data from the Italian fleet.

6.18.2.3.2 *Discards*

Discard data for the Italian fleet are available for 2010 and 2011.

Table6.18.2.3.2.1Discard data (t) by fishing gear as reported to STECF EWG 12-10 through the DCF data call.

Species	**Area**	**Country**	**Gear**	**2010**	**2011**
MUT	17	ITA	OTB	183	795.95
MUT	17	ITA	TBB	n/a	7.39

While in 2010 the discard represented about 9% of the total catches, in 2011 for the only otter trawl the discard amounted to 30% of the total catches. The TL of the discards in 2011 ranged between 4 and 16 cm.

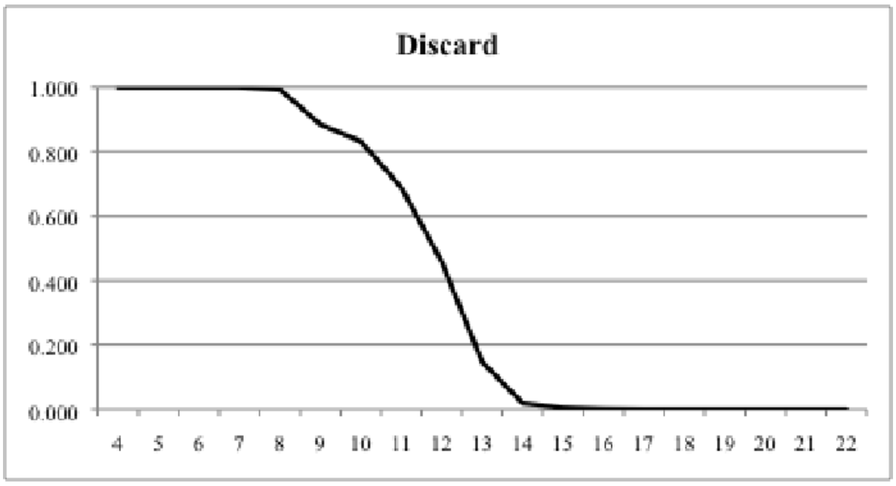


Fig. 6.18.2.3.2.1 Length of the discards of *M. barbatus* for Italian OTB in 2011, expressed as % of the total catch. The length at 50% discard is between 11-12 cm TL.

6.18.2.4 Fishing effort

The trend in fishing effort by year and major gear type is listed in Table 6.18.2.4.1. The total fishing effort in kWdays from 2006 to 2011 is decreasing (figure Table 6.18.2.4.1).

Table 6.18.2.4.1Trend in nominal effort (kW*days) for GSA 17 by gear type, 2006-2011 as reported through the DCF official data call.

Area	Gear	Fishery	2006	2007	2008	2009	2010	2011	Total
SA 17	DRB	MOL	6269118	6609979	5981163	4214396	4324692	5407947	45383023
	FPO	DEMSP	2259253	1885243	2012117	2044266	1855252	1611908	14303755
	FYK	CATSP			7253	11626	8903	2558	37123
		DEMSP	1263716	1467137	774992	978492	1224764	921329	8096239
	GND	SPF	2090	1727	3538	2731	450	2711	42939
	GNS	DEMSP	4973097	3101318	3551683	4469092	4965672	5859451	36165441
		SLPF	11055		5044	10672	1581	1061	31142
	GTR	DEMSP	1821930	2922357	2788971	3392336	3475548	4576602	22783912
	LHP	CEP			26	41	4483	4625	9175
		FINF		11	138	127	4903	8178	13392
	LLD	LPF	75655	179410	69897	68436	43012		647560
	LLS	DEMF	6660	1428	81	851	442	322	11454
	none	-1	4019057	2690424	2655737	2943287	2811114	3135985	31819320
		DEMF						12	12
	OTB	DEMSP	20224032	19641564	21684187	20691455	19812706	18097702	161006135

		DWSP MDDWSP	 1239512	 1100893	191741 4910	101430	159412	131412 6047	593230 11162408
	OTM	MDPSP	23022		376	2694			44759
	PS	LPF SPF	 1383666	 1549344	 890058	6190 1198676	287 665404	4047 653817	43658 7608907
	PTM	SPF	4696448	4190687	5277496	5789325	5917072	4225935	39431223
	TBB	DEMSP	5266768	6625945	4136346	4386154	3817491	2584717	34945400

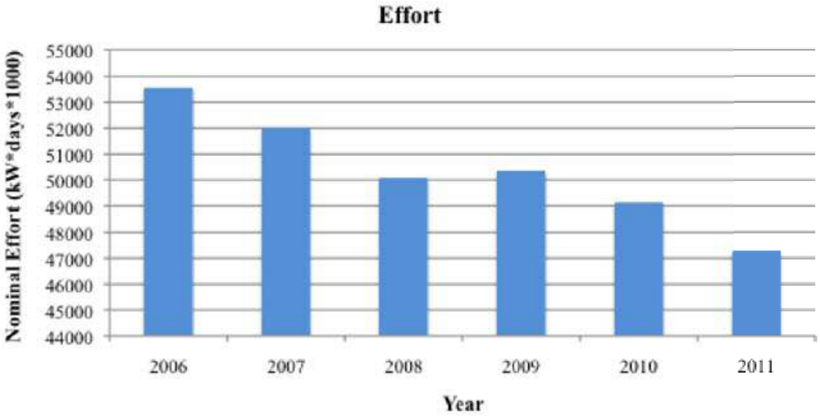


Fig. 6.18.2.4.1 Nominal effort in kW*days for the Italian fleet (GSA 17)

6.18.3 *Scientific surveys*

6.18.3.1 MEDITS

6.18.3.1.1 *Methods*

Based on the DCF data call, abundance and biomass indices were calculated. In GSA 17 the following number of hauls was reported per depth stratum (see table 6.18.3.1.1.1).

Table 6.18.3.1.1.1 Number of hauls per year and depth stratum in GSA 17 from 2006 to 2011.

Depth (m)	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
10-50	62	67	65	63	65	62
50-100	65	61	64	66	59	64
100-200	43	45	43	43	50	49
200-500	11	10	10	11	9	10

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval =

$Yst \pm t(\text{student distribution}) * V(Yst) / n$

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modeled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.18.3.1.2 *Geographical distribution patterns*

No information was documented during EWG 12-10.

6.18.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of the red mullet in GSA 17 was derived from the international survey MEDITS. Figure 6.18.3.1.3.1 show the estimated trend in red mullet abundance and biomass in GSA 17. The stock seems stable with some fluctuations. The lowest values of the last 10 years were reached in 2007, but since then the indices are increasing.

The data presented are for the entire GSA 17, since it wasn't possible to discriminate between Italian and

Slovenian hauls.

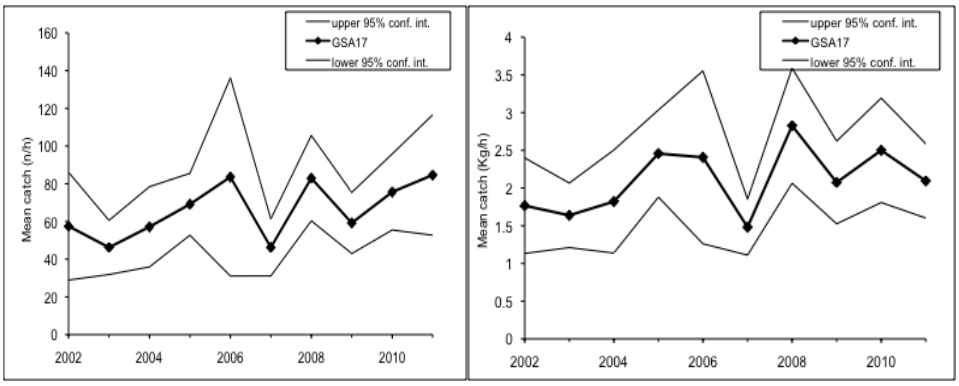


Fig. 6.18.3.1.3.1 Abundance and biomass indices of red mullet in GSA 17.

6.18.3.1.4 *Trends in abundance by length or age*

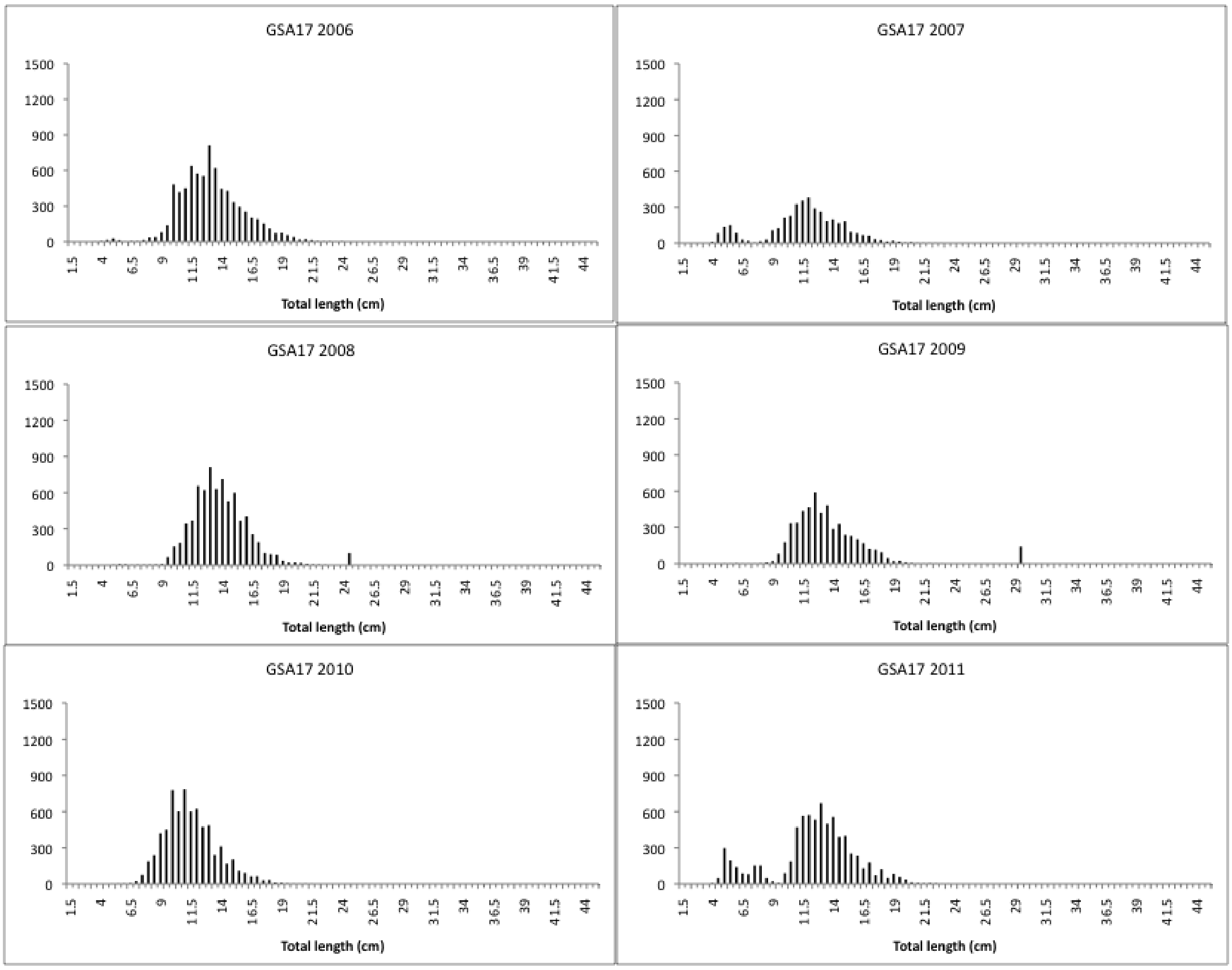


Fig. 6.18.3.1.4.1Stratified abundance indices by size, 2006-2011

6.18.3.1.5 *Trends in growth*

No analyses were conducted during STECF EWG 12-10.

6.18.3.1.6 *Trends in maturity*

No analyses were conducted during STECF EWG 12-10.

6.18.4 *Assessment of historic stock parameters*

6.18.4.1 Method 1: Length cohort analysis (LCA)

6.18.4.1.1 *Justification*

An approach under steady state (i.e. pseudocohort) assumptions has been used for 2011 length frequency distributions for GSA 17 (Italian fleet) commercial catches (landings and discard). Cohort (VPA equation) and Yield per recruit (YPR) analysis as implemented in the package VIT4win were used (Lleonart and Salat, 2000). Data were derived from the DCF data call.

6.18.4.1.2 *Input parameters*

Only data coming from the Italian catch and survey have been used. The growth parameters used were obtained independently for males and females during the SAMED project (SAMED, 2002), and have been combined assuming a sex ratio 1:1 (Ttable 6.18.4.1.2.1).

An attempt to estimate growth parameters from length at age data derived from otolith reading has been done.The resulting biomass and the F values obtained using these estimates weren't satisfactory, thus those results have not been included in the present report.

The parameters of the length-weight relationship used for the present assessment are the ones suggested by Marano (1994) and Ungaro (1994) and reported in Table 6.18.4.1.2.1.

Table 6.18.4.1.2.1 *M. barbatus* growth parameter for GSA 17.

Time series: 2006-2011

Parameters	L_∞	K	t_0	a	b
	25 cm	0.415 y^{-1}	0.37	0.009	3.076

Table 6.18.4.1.2.2 *M. barbatus* maturity vector for GSA 17.

Time series: 2006-2011

LT (cm)	4-9	10-11	12-14	15-25
Maturity	0	0.5	0.75	1

Two different natural mortality scenarios have been tested: a fixed value (M = 0.7) and an M vector estimated using PRODBIOM (Abella *et al*., 1997) (Table 6.18.4.1.2.3).

Table 6.18.4.1.2.3 M vector from PRODBIOM for *M. barbatus* in GSA 17.

Time series: 2006-2011

LT (cm)	4-9	10-14	15-18	19- 20	21	22-25
M	1.60	0.84	0.37	0.29	0.26	0.25

The two scenarios gave almost the same results, being the confidence intervals completely overlapping: for this reason in this report we are presenting only the results obtained with the M vector.

Terminal F was fixed at 0.5. Sensitivity analysis demonstrated that the results are not influenced by this choice.

Catch at length information for both landings and discard was obtained within the framework of DCF for 2011 (Table 6.18.4.1.2.4).

Table6.18.4.1.2.4 LFD of total catches for GSA 17 by fleet segment.

LT (cm)	2011		
	GNS	OTB	TBB
4	0	124434	0
5	0	3018878	0
6	0	1130727	0
7	0	515316	0
8	0	5859139	0
9	0	5676974	739904
10	0	12700315	0
11	18239	18440080	0
12	36478	17371844	0
13	55279	13690890	0
14	72957	12164679	49574
15	456259	7862798	247868
16	255909	6976373	198294
17	18520	2751246	297441
18	0	492743	0
19	0	234514	0
20	0	55220	0
21	0	9158	0
22	0	753	0

6.18.4.1.3 *Results*

The stock biomass at the beginning of year 2011 is 15344 t, while the average biomass at sea is 2613 t.

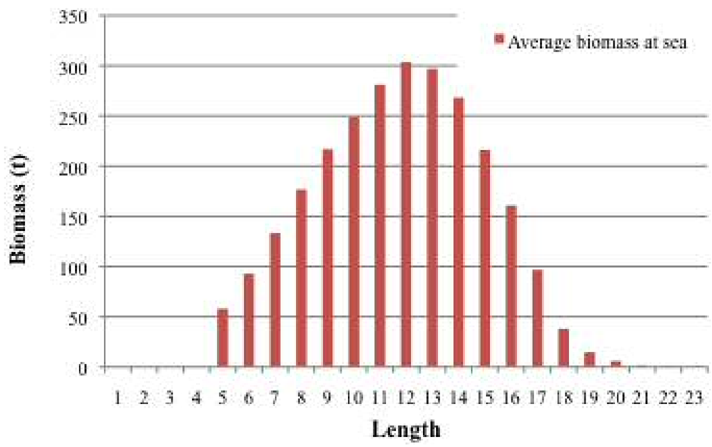


Fig. 6.18.4.1.3.1 Average biomass at sea estimated by VIT for *M. barbatus* in 2011 in GSA 17.

The estimated F for red mullet in 2011 reaches very high value for specimens between 15 and 19 cm (figure 6.18.4.1.3.2).

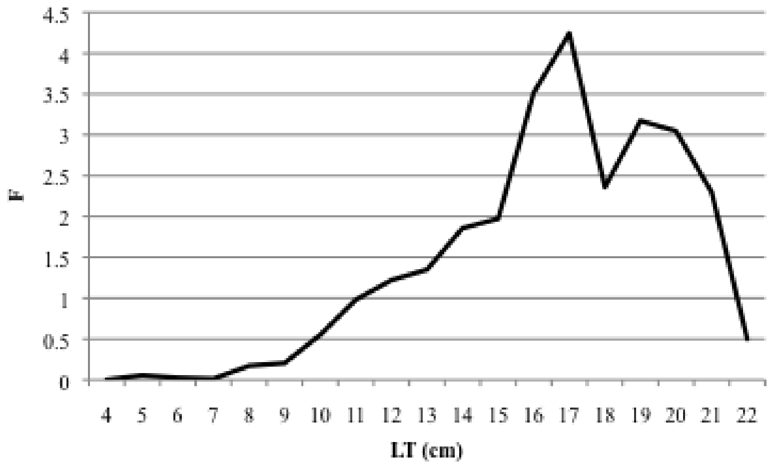


Fig. 6.18.4.1.3.2F estimate by length resulting from LCA for *M. barbatus* in GSA 17.

6.18.5 *Long term prediction*

6.18.5.1 Justification

The YPR analysis provided by the VIT software has been applied. $F_{0.1}$ has been used as a proxy for F_{msy}.

6.18.5.2 Input parameters

The input parameters for the YPR analysis are those used in the LCA for 2011 data described above.

6.18.5.3 Results

The YPR results from the VIT analysis are illustrated in Figure 1.1.6.3.1 and in Table 1.1.6.3.1.

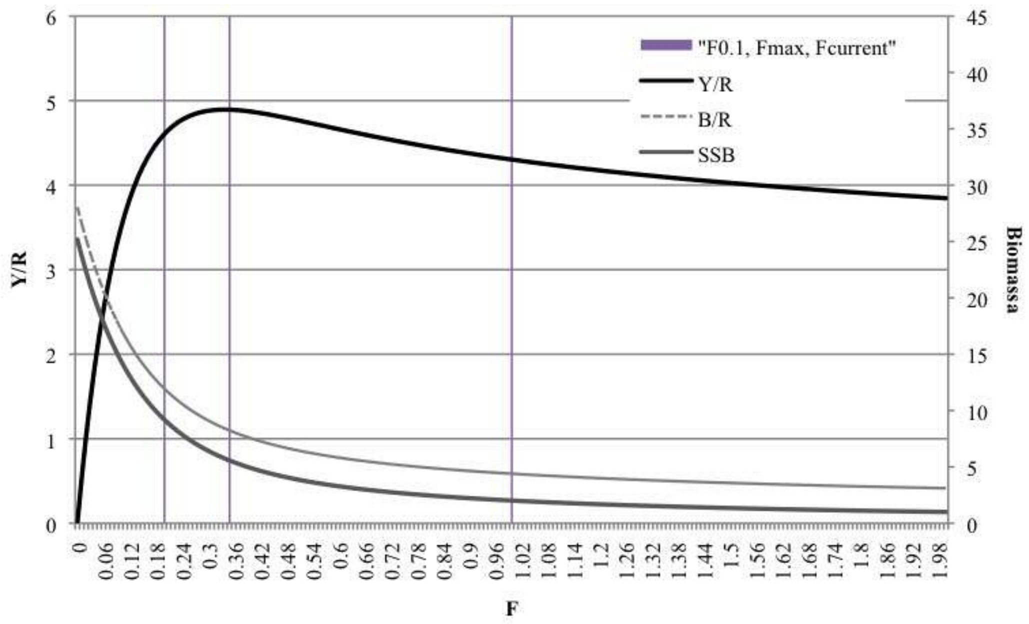


Fig. 6.18.5.3.1 Yield per recruit analysis for *M. barbatus* in GSA 17 for 2011.

Table 6.18.5.3.1Reference points resulting from YPR for *M. barbatus* in GSA 17.

	F	YPR	SSB	TSB/R
F_{zero}	0.00	0.00	25.18	28.06
F_{msy}	0.36	4.60	9.20	11.95

6.18.5.4 Method 2: Extended Survivor Analysis (XSA)

6.18.5.4.1 *Justification*

Data coming from DCF for the period 2006-2011 were used to perform an Extended Survivor Analysis (XSA) calibrated with fishery independent data (i.e. MEDITS abundance indices by age class for 2006-2011) and using FLR (www.flr-project.org). Data included information on total landings and catch at age of *M. barbatus* in GSA 17 for the Italian fleet. Discard data (available for 2010 and 2011) were also included in the analyses.

6.18.5.4.2 *Input parameters*

Catch at age data were obtained from otolith reading carried out in the framework of DCF from 2006 to 2011.

Annual amount of discard data was available for both 2010 and 2011, while the discard age structured was available only for the 2011.

XSA has been performed using commercial catch at age data derived from the DCF data call for GSA 17.

MEDITS abundance indices have been used to tune the analysis. The numbers at age were obtained slicing (i.e. knife edge slicing) the numbers at length in the survey with ALKs from commercial data. (fig 6.18.5.4.2.1. and table 6.18.5.4.2.1). Since the ALK for 2006-2007 and 2008 showed a complete lack of age 4, the length distribution for those years was sliced using the ALK from 2009 samples.

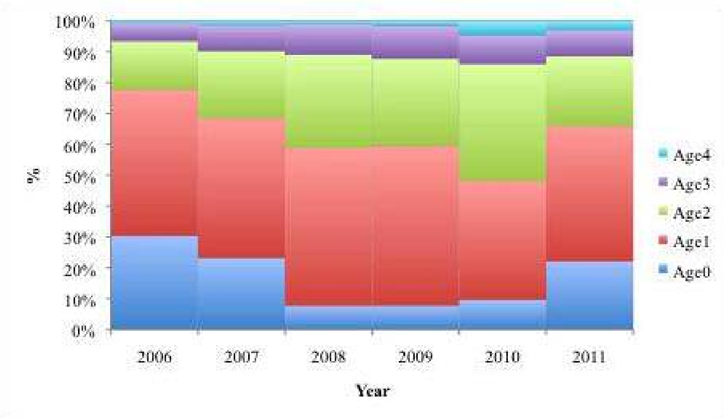


Fig. 6.18.5.4.2.1 Slicing of MEDITS abundance data using ALK from commercial data.

Table6.18.5.4.2.1MEDITS survey data disaggregated by age using ALK from commercial data.

	Age0	Age1	Age2	Age3	Age4
2006	4652	7267	2412	888	130
2007	1956	3831	1841	704	119
2008	1151	7691	4541	1481	178
2009	833	5617	3056	1150	179
2010	1261	5105	4980	1221	622
2011	3418	6824	3503	1326	472

Discard data for 2010 and 2011 were used. The proportion of discard for each age class in 2011 has been applied to the previous years, to include a discard estimate in the catch at age matrix. Besides, the average between the percentage of discard on the overall catches in 2010 and 2011 has been added up to the total landings in the previous years, to include a complete time series of discards in the analysis (Table 6.18.5.4.2.2).

Table 6.18.5.4.2.2 Discard proportion applied to the overall catches and to the catch at age distribution from 2006 to 2009 for *M. barbatus* in GSA 17.

Overall Catch	Age0	Age1	Age2	Age3	Age4
0.20	0.62	0.32	0.02	0.00	0.00

In Table 6.18.5.4.2.3 and Table 6.18.5.4.2.4, the catch numbers at age (landings + discard) and the weight at age used in the analysis are presented.

Table 6.18.5.4.2.3 Catch numbers at age by year including discard proportion, used in the XSA analysis for *M. barbatus* in GSA 17.

	Age0	Age1	Age2	Age3	Age4
2006	11563	59652	25237	4866	327
2007	9783	75678	25167	4467	418
2008	8403	76106	21493	3983	253
2009	14966	65536	16068	3261	289
2010	12713	31835	19429	3162	660
2011	30936	49629	23553	6615	790

Table 6.18.5.4.2.4 Weight at age by year used in the XSA analysis for *M. barbatus* in GSA 17.

	Age0	Age1	Age2	Age3	Age4
2006	0.020	0.033	0.053	0.062	0.072
2007	0.020	0.033	0.053	0.062	0.072
2008	0.020	0.033	0.053	0.062	0.072
2009	0.019	0.030	0.048	0.062	0.072
2010	0.015	0.024	0.044	0.062	0.072
2011	0.010	0.021	0.038	0.059	0.067

The proportion of mature specimens and the M vector are the same used in the LCA and are presented in Table 6.18.5.4.2.5by age class.

Table 6.18.5.4.2.5 Maturity at age and Natural mortality at age for *M. barbatus* in GSA 17.

	Maturity	M
Age0	0.1	1.60
Age1	0.9	0.84
Age2	1	0.37
Age3	1	0.29
Age4	1	0.26

Trends in landings and in numbers at age by year are presented in Figures6.18.5.4.2.2 and 6.18.5.4.2.3 respectively.

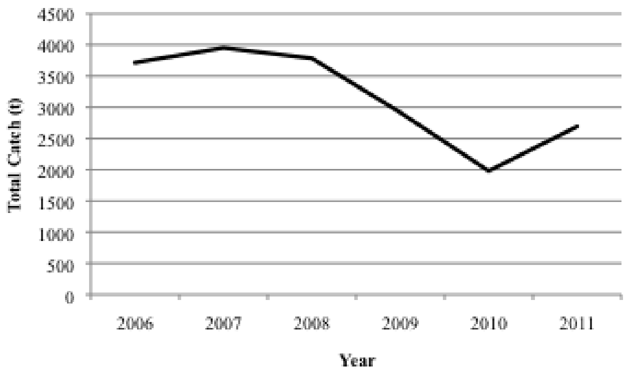


Fig. 6.18.5.4.2.2 Trend in total catch by year of *M. barbatus* in GSA 17 (Italian fleet).

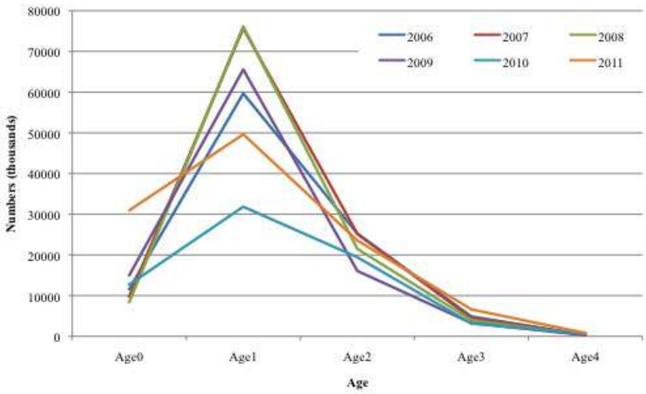


Fig. 6.18.5.4.2.3 Trend in numbers at age of the total catches of *M. barbatus* in GSA 17 (Italian fleet only).

Then XSA runs were made using the following settings:

- Catchability dependent on stock size for ages < 2
- Catchability independent of age for ages >= 3
- S.E. of the mean to which the estimates are shrunk = 0.50
- Minimum standard error for population estimates derived from each fleet = 0.300
- F_{bar}: 1-3

6.18.5.4.3 *Results*

XSA Diagnostics in the form of residuals by survey data are shown in Figure 6.18.5.4.3.1.

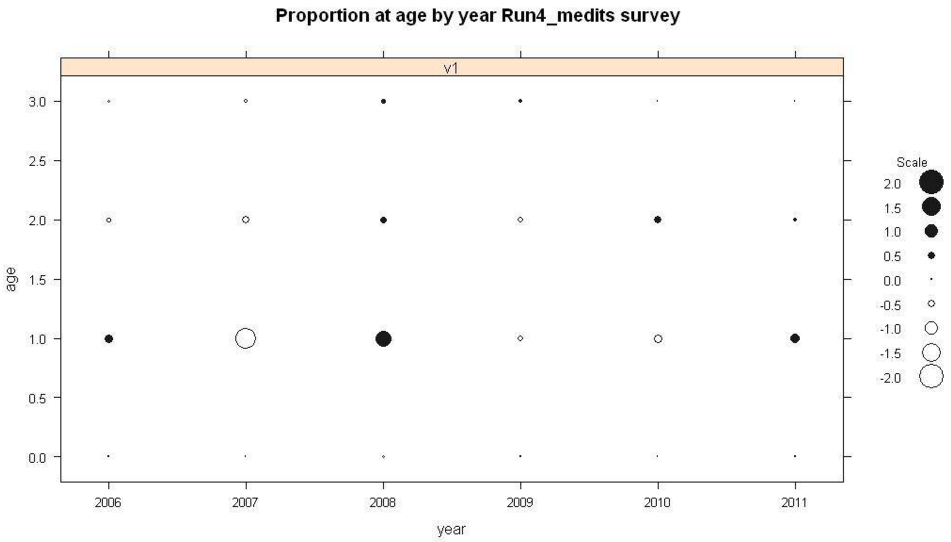


Fig. 6.18.5.4.3.1 Log transformed catchability residuals by age.

Table 6.18.5.4.3.1shows the estimates for spawning stock biomass (SSB), total biomass (TB) and recruitment from 2006 to 2011 as derived from the XSA.

Table 6.18.5.4.3.1 Spawning stock biomass (SSB), total biomass (TB) and recruitment estimates for red mullet in GSA 17 from 2006 to 2011 derived by the XSA .

	2006	2007	2008	2009	2010	2011
SSB (tons)	5600	5515	5321	4942	4395	3747
TB (tons)	14508	14083	14017	11284	10020	8144
Recruitment (thousands)	1075574	1034224	1051040	805582	910275	1079000

SSB follow an evident decreasing trend, from 5600 tons in 2006 to 3747 tons in 2011. Similar considerations can be applied to the trend in total biomass, which decreased from 14508 tons in 2006 to 8144 tons in 2011. The recruitment remain quite stable from 2006 to 2008, drop to the lowest value of 805582 thousandsin 2009, and then increasedagain reaching the highest observed level in 2011 (Figure 6.18.5.4.3.2).

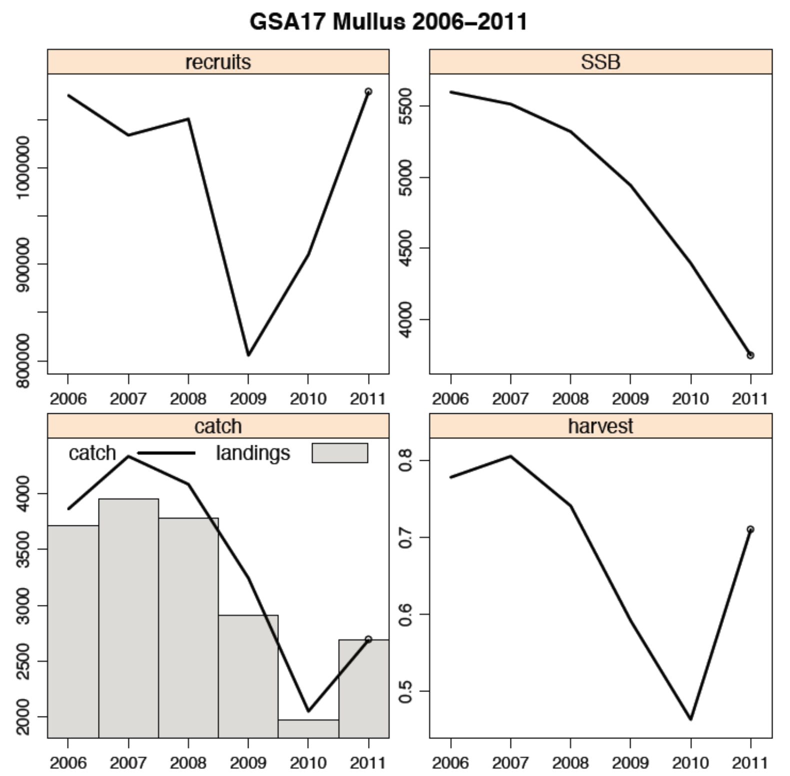


Fig. 6.18.5.4.3.2 Summary of stock parameters (recruitment, SSB, catch and landings, F mean for ages 1-3) as estimated by XSA.

XSA estimates of F_{bar} (estimates on ages1 to 3) and F at age are shown in Table 6.18.5.4.3.2. F_{bar} shows a fluctuating pattern, with a minimum in 2010 (F_{bar} = 0.463), and a maximum in 2007 (F_{bar} = 0.806).

Table 6.18.5.4.3.2 Numbers at age (thousands) estimated by XSA for *M. barbatus* in GSA 17.

	2006	2007	2008	2009	2010	2011
Age0	1075574	1034224	1051040	805582	910275	1079000
Age1	205756	211959	204410	208425	155920	178069
Age2	45352	49633	41781	38241	46919	46395
Age3	11828	10351	13366	10997	13060	16261
Age4	780	950	837	941	2694	1906

Table 6.18.5.4.3.3 Fishing mortality and F_{bar} (1-3) estimated by XSA for *M. barbatus* in GSA 17.

	2006	2007	2008	2009	2010	2011
Age0	0.024	0.021	0.018	0.042	0.032	0.066
Age1	0.582	0.784	0.836	0.651	0.372	0.552
Age2	1.107	0.942	0.965	0.704	0.690	0.944
Age3	0.645	0.691	0.422	0.420	0.328	0.635
Age4	0.645	0.691	0.422	0.420	0.328	0.635
F_{bar} (1-3)	0.778	0.806	0.741	0.592	0.463	0.710

6.18.6 *Long term prediction*

6.18.6.1 Justification

Equilibrium YPR reference points for this stock were estimated using the YPR software Version 3.1 (NOAA-NMFS, April 2012).The YPR routine, included in the stock assessment toolbox of NOAA, it is based on the Thompson-Bell model for estimating the expected lifetime yield and biomass from a cohort subjected to varying levels of fishing mortality. $F_{0.1}$has been used as a proxy for F_{msy}.

6.18.6.2 Input parameters

The input data are presented in table 6.18.6.2.1. Selectivity at age has been calculated as the ratio between each F at age and the highest F at age (F at age 2) obtained by the XSA model, averaged along the years.

Table 6.18.6.2.1 Input parameters for the YPR analysis for *M. barbatus* in GSA 17.

Age	Mean Weight (2006-2011)	M	Maturity	Selectivity
0	17.33	1.60	0.10	0.04
1	29.00	0.84	0.90	0.70
2	48.17	0.37	1.00	1.00
3	61.50	0.29	1.00	0.58
4	71.17	0.26	1.00	0.58

6.18.6.3 Results

The Yield per Recruit (gr) and the SSB per recruit (gr) resulting from the YPR analysis are illustrated in Fig. 6.18.6.3.1 and table 6.18.6.3.1. YPR were not considered reliable due to the impossibility of the model to find F_{max} in the range between 0 and 2. Besides, F_{msy} is estimated at the really high value of 1.06 and should not be used as a reference point for this stock.

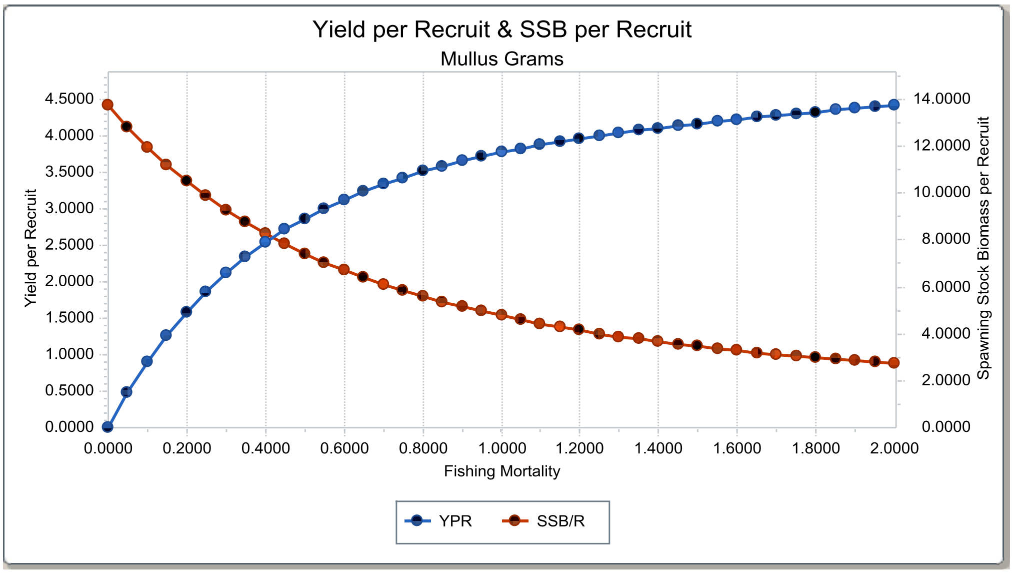


Fig. 6.18.6.3.1 Resulting Yield per Recruit and SSB per Recruit for *M. barbatus* in GSA 17.

Table6.18.6.3.1 Reference points resulting from the YpR analysis for *M. barbatus* in GSA 17. F_{max} is highlighted because was not found in the range between 0 and 2.

	F	YpR	SSB/R	TSB/R	Mean Age
F_{zero}	0.00	0.00	13.74	33.97	0.53
$F_{0.1}$	1.06	3.83	4.56	25.47	0.26
F_{max}	2.00	4.41	2.73	23.63	0.20
F at 30% of MSY	1.20	3.95	4.14	25.05	0.24

6.18.7 *Data quality and availability*

Total landings and catch at age data for red mullet in GSA 17 from 2006 to 2011 were available at the EWG 12-10. Data concerning fishing activity and fishing effort for GSA 17 have been regularly submitted by the Italian Authorities. Discards data have been collected in the last two years, and for 2011 are available disaggregated by age as well. MEDITS data for *M. barbatus* in GSA 17 are missing prior to 2002, even though the survey started in 1996; besides, there is a lack of data of *M. barbatus* catches from the Eastern side of the GSA 17: since the stock is considered 'shared' by both the Adriatic coasts, the total catches should also include the Croatian catches.

6.18.8 *Scientific advice*

6.18.8.1 Short term considerations

6.18.8.1.1 *State of spawning stock biomass*

In the absence of proposed or agreed biomass management reference points, STECF EWG 12-10 is unable to fully evaluate the state of red mullet biomass in comparison to these.The analyses carried out on for the period 2006-2011 show that the SSB decrease constantly from 2006 to 2011 from a value of 5600 t in 2006 to the value of 3747 t in 2011.

6.18.8.1.2 *State of recruitment*

In the absence of proposed or agreed management reference points, STECF EWG 12-10 is unable to fully evaluate the state of recruitment in comparison to these. The analyses carried out on for the period 2006-2011 show that recruitment fluctuates around a mean value of 1042631 from 2006 to 2008. In 2009 recruitment declined, reaching the minimum value of 805582. After that, the recruitment increases constantly with a value in 2011 of 1079000 thousands.

6.18.8.1.3 *State of exploitation*

EWG 12-10 proposed $F_{0.1} = 0.36$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the XSA analysis (current F is around 0.71), the stock is considered exploited unsustainably.

6.19 **Stock assessment of spottail mantis shrimp in GSA 17**

6.19.1 *Stock identification and biological features*

6.19.1.1 Stock Identification

The mantis shrimp, *Squilla mantis*, occurs in the Eastern Atlantic, from the Iberian peninsula to Angola and in the whole Mediterranean, except the Black Sea. It digs burrows on soft bottoms of the continental shelf down to a depth a 100 m, the maximum recorded depth is 247 m (Manning, 1997).

In the Adriatic Sea the highest densities of *S. mantis* are commonly found on grounds characterised by fine sands or sandy mud at depths of less than 50 m. The species is very common in the western side of the basin, while is quite rare in the eastern side, because the sediment features are not suitable for their borrowing behaviour (Scarcella, pers. comm.; Fig. 6.19.1.1.1). Atkinson et al., (1997) investigated the biology and the borrowing behaviour of mantis shrimp from the northern Adriatic Sea, providing a good description of the U-shape burrows, using resin casts.
S. mantis, being rather common and easy to find on the Mediterranean nearshore grounds, has been also the subject for anatomical and physiological studies since the past century. Only as an example we can quote the anatomical studies on the nervous system by Bellonci (1878), Police (1908), and Ferrero and Burgni (1989). Moreover, Giesbrecth (1910) with his classical monograph on the Stomatopoda of the Gulf of Napoli greatly contributed to the knowledge of the biology, the larval development and the ecology. Anyhow genetic study to support the stock segregation of the species in GSA 17 are missing, but, considering its territorial behaviour, is possible to assume that the species inhabiting the area is constituted by sub-populations characterized by a low rate of mixing with sub-populations of GSA 18.

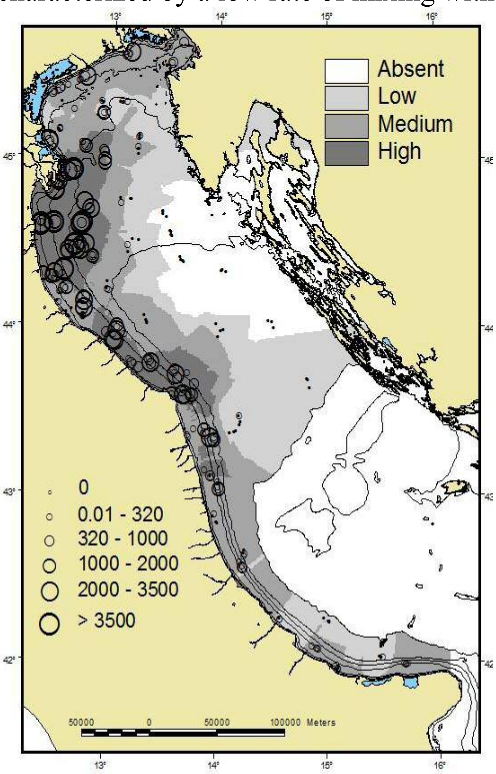


Fig. 6.19.1.1.1 Spatial distribution of *Squilla mantis* from SoleMon surveys (2007-2010). Bubble plot: N.

ind/km^2.

6.19.1.2 Growth

The growth has been studied in GSA 17, by Froglia et al. (1996) using indirect method. The length frequency distributions for males and females recorded during experimental trawls carried in the central area of the GSA 17 in 1994 and 1995 (Froglia et al., 1996) showed similar size ranges for both sexes. The largest specimens (39 mm Carapace Length both for males and females) were collected in September 1994, and the smallest specimens were observed in the November 1994 (5 mm CL for males and females) and probably represent the new generation whose larvae settled on the bottom in late summer and early autumn. The results of the analyses indicate that the growth is quite similar for males and females. Both sexes reach around 18 mm CL at the end of the first year of life and around 32 mm CL at the end of the third of life. Species life span seems not to exceed five or six years. The Von Bertalannfy (VBGF) parameters were computed on the above data and are presented in Table 6.19.1.2.1.

Table 6.19.1.2.1 VBGF parameters of *Squilla mantis* in GSA 17.

Sex	CL_{inf} (mm)	k	t_0	CL max (mm)
Males	41.18 (± 2.99)	0.532 (± 0.102)	0.038 (± 0.110)	39
Females	41.88 (± 4.78)	0.448 (± 0.122)	-0.059 (± 0.154)	39
Both	41.53	0.490	-0.0105	

6.19.1.3 Maturity

In the GSA 17 females reach maturity in their second year of life. Females with mature ovaries and active (white) cement glands are observed in late winter in the Central Adriatic (Piccinetti and Piccinetti Manfrin, 1970; Froglia et al., 1996). Spent females, with still whitish glan, are usually observed from April to September, when the sex ratio (M/F) is strongly in favour of males (Piccinetti and Piccinetti Manfrin, 1971; Froglia et al., 1996). The mean size of mature females was around 29 mm CL.

6.19.2 *Fisheries*

6.19.2.1 General description of fisheries

S. mantis is an important commercial species in the Adriatic,being caught in trammel nets, otter trawls and beam trawls (Froglia and Giannini, 1989). According to GFCM statistics, Adriatic landings account for 66% of Mediterranean landings of this species (FISHSTAT J – GFCM, 2008).

Although in the Italian landings of GSA 17 *S. mantis* ranks first among the crustacean landed in the Adriatic ports, it is not the target of a specialised fishery, but is only an important component of local multispecies trawl and gill net fishery. Only in the Gulf of Trieste it is the target of a small artisanal fishery with creels (Ferrero et al., 1988). The Italian annual landing for 2011was for 63% from the bottom otter trawls (2,399 tons), 30% from thegillnett (1,136 tons) and for 7% from*rapido* trawl (251 tons).

The species is absent from the landings statistic of Croatia (FAO-FISHSTAT J – GFCM Database) and it accounted only for 3.5 tons in the Slovenian landings of 2011 (2012 DCF data). The species is not present in the list of shared stock of GFCM.

About 400bottom ottertrawlers exploit this resource all year round. Mantis shrimp is caught as a part of a species mix that constitutes the target of the trawlers operating on the continental shelf. The main species caught in GSA 17 associated with mantis shrimp are *Sepia officinalis, Trigla lucerna, Merluccius merluccius, Mullus barbatus*and *Eledone* spp. Trawl catch is mainly composed by age 1 and 2 individuals while the older age classes are poorly represented in the catch. As concerns artisanal fisheries, *S. mantis* is a by catch (only in few cases it isalso targeted) of gillnetters targeting *Solea solea*, especially during spring-summer seasons in the coastal area.

Catches show marked dielperiodicity with significantly more animals caught at night (Froglia and Giannini, 1989; Froglia and Gramitto, 1989). The burrowing behaviour of *S. mantis* makes it vulnerable only when individuals are out of their burrows and this occurs mainly at night, between sunset and sunrise. Seasonal variations in catchability result from reduced out-of-burrow activity, because females rarely exit their burrow when they are incubating their egg mass in spring and early summer. Conversely, catches increases in winter, when mating takes place. Catches increase further in late autumn with the arrival of new recruits. The reproductive behaviour of the species also influences the relative proportion of males and females in the catches by season: females outnumber males only in winter (mating season), while the sex-ratio is biased towards males in spring and summer. Additionally, weather and sea conditions represent an important influence on the catchability of this species as catches increase after prolonged bad weather conditions probably because of disturbance of the burrow systems as a result of the high turbidity (Froglia et al., 1996).

6.19.2.2 Management regulations applicable in 2010 and 2011

- Minimum landing sizes: none.
- Fishing closure for trawling: 30-45 days in late summer (not every year have been enforced).
- Cod end mesh size of trawl nets: 40 mm (stretched, diamond meshes) till 30/05/2010. From 1/6/2010 the existing nets have been replaced with a cod end with 40 mm (stretched) square meshes or a cod end with 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast. However, towed gears are always forbidden inside 1.5 miles from the coastwith the exception of some areas of the GSA 17 that have benefited from the derogation according by the EC Regulation 1967/2006 for the Mediterranean Sea.

6.19.2.3 Catches

6.19.2.3.1 Landings

The total landing showed a stable trend in the period 2007-2011 (Figure6.19.2.3.1.1), with a maximum value in 2010 (4,564 tons) and a minimum in 2011 (3,786 tons). The species is mainly landed by the trawl fleet (OTB) fishing on the continental shelf. Similarly,a stable trend in the landing of OTB is observed, with the lowest value in 2011. This tendency is also observed for the LPUE, remained quite constant during the period analysed (Figure 6.19.2.3.1.1.2). The stable trend in the landing is evident also for artisanal gears. In 2011 the landing of gillnet (GNS) were 1,136 tons, representing the 30% of the total landing of the species. The LPUE for GNS showed a reduction from 2006 to 2011. Also TBB landings of *S. mantis* shows a stable trend (250 tons in 2011 and 489 in 2009) representing in 2011 the 6% of the total landings.

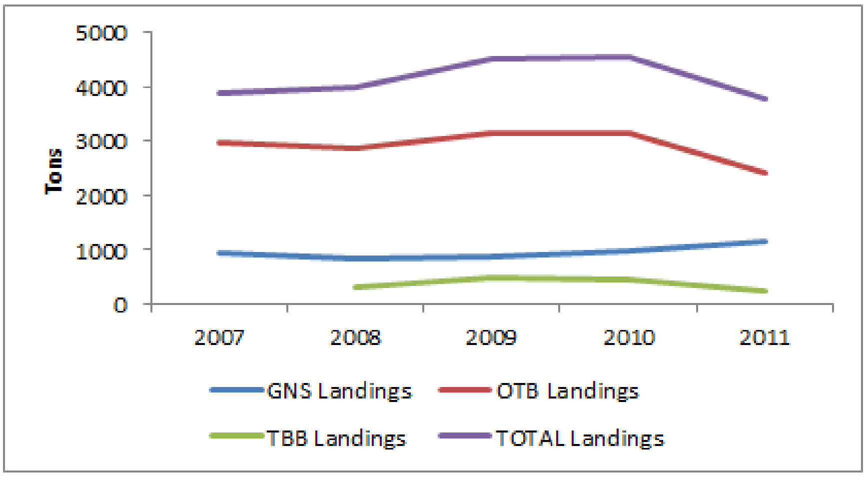


Fig. 6.19.2.3.1.1Landings (in tons) from the trawls and small-scale fleet in the GSA 17 in the period 2007-2011 (official 2012 DCF data call). GNS: gillnets; TBB: beam trawl (*rapido* trawl); OTB: demersal trawling.

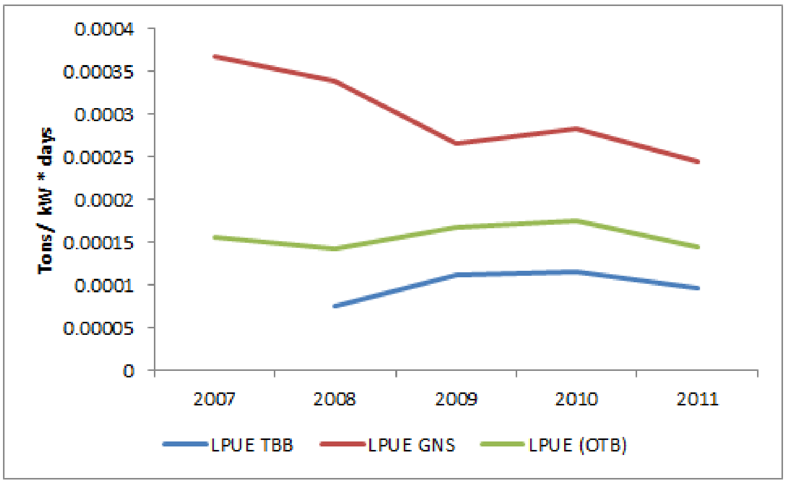


Fig. 6.19.2.3.1.2 Landing per Unit of Effort (LPUE) in GSA 17 in the period 2007-2011 (official 2012 DCF data call). GNS: gillnets; TBB: beam trawl (*rapido* trawl); OTB: demersal trawling.

6.19.2.3.2 Discards

According to the data collected in 2011 in the framework of DCF, discard represented 16% (721 tons)of the total catch. This fraction is mainly observed in OTB catches and is composed by non-marketable small specimens and damaged individuals.

6.19.2.4 Fishing effort

The fishing capacity of the GSA 17OTB has shown in these last 8 years a progressive decrease. Fishing effort (kW*fishing days) performed by the GSA 17 trawlers fishing for demersal species decreased from about 2,500,000 in 2004 to about 1,657,000 in 2011. Stable trends have been detected for GNS and TBB(Figure6.19.2.4.1).

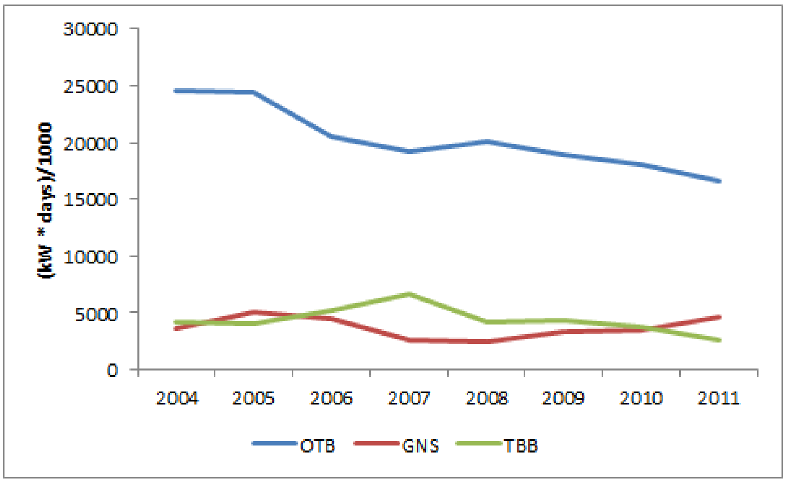


Fig. 6.19.2.4.1 Fishing effort (kW* fishing days) for the different type of gears in the GSA 17 during 2004-2011.). GNS: gillnets; TBB: beam trawl (*rapido* trawl); OTB: demersal trawling.

6.19.3 *Scientific surveys*

6.19.3.1 MEDITS

6.19.3.1.1 *Methods*

Based on the DCFdata call, abundance and biomass indices were recalculated. In GSA 17 the following number of hauls was reported per depth stratum (Table6.19.3.1.1.1).

Table 6.19.3.1.1.1 Number of hauls per year and depth stratum in GSA17, 2002-2011.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
GSA17_010-050	76	62	65	77	61	71	67	65	67	63	686
GSA17_050-100	73	57	67	90	65	60	64	66	59	62	663
GSA17_100-200	76	50	38	63	42	45	43	43	49	49	498
GSA17_200-500	14	13	12	13	11	10	10	11	9	10	113
GSA17_500-800	1	1	1								3

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

Confidence interval = $Yst \pm t(\text{student distribution}) * V(Yst) / n$

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.19.3.1.2 *Geographical distribution patterns*

No information was documented during EWG 12-10.

6.19.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of the spottail mantis shrimp in GSA 17 was derived from the international survey MEDITS. Figure 6.19.3.1.3.1displays the estimated trend in abundance and biomass.

Although mantis shrimp is not a target species in the MEDITS survey, data collected allowed to estimate the density of the population. In Figure6.6.1.3.1 the trends of the number of specimens and biomass indices estimated for the depth stratum 0-200 m are reported. The two trends, very similar to each other, show a high values in 2004-2006 followed by a general decrease in the remaining period.

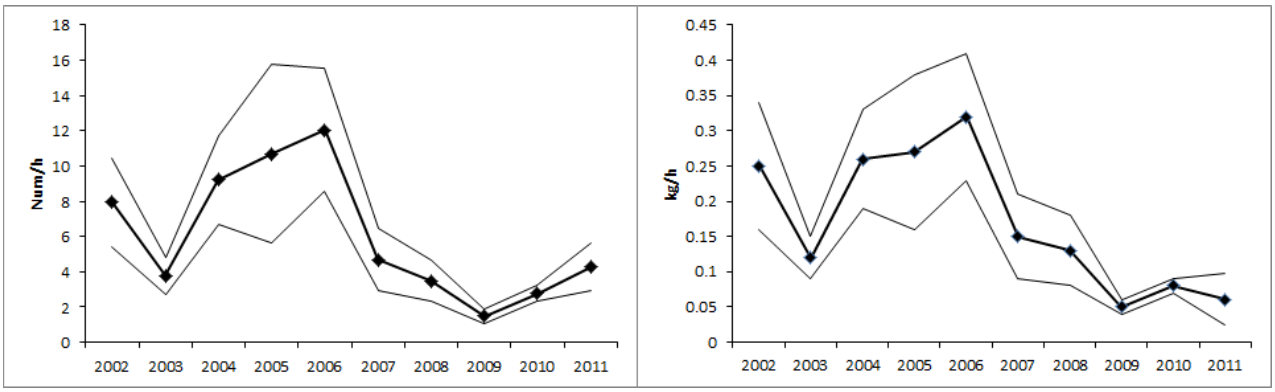


Fig. 6.19.3.1.3.1Trends of the number of specimens and biomass indices estimated for the depth stratum 0-200 m (excluding Croatian hauls).

Data from hauls carried out in the Croatian waters are available only for 2002 and 2005. In both years the index of abundance and biomass were quite low as well as the frequency of occurrences.

6.19.3.1.4 *Trends in abundance by length or age*

No information was been documented.

6.19.3.1.5 *Trends in growth*

No information was been documented.

6.19.3.1.6 *Trends in maturity*

No information was been documented.

6.19.3.2 SoleMon

6.19.3.2.1 *Methods*

Nine *rapido* trawl fishing surveys were carried out in GSA 17 from 2005 to 2011: two systematic "pre-suveys" (spring and fall 2005) and four random surveys (spring and fall 2006, fall 2007-2008) stratified on the basis of depth (0-30 m, 30-50 m, 50-100m). Hauls were carried out by day using 2-4 *rapido* trawls simultaneously (stretched codend mesh size = 40.2 ± 0.83). The following number of hauls was reported per depth stratum (Table 6.19.3.2.1.1).

Table 6.19.3.2.1.1Number of hauls per year and depth stratum in GSA 17, 2005-2011.

Depth strata	**Spring 2005**	**Fall 2005**	**Spring 2006**	**Fall 2006**	**Fall 2007**	**Fall 2008-2011**
0-30	30	30	20	35	32	39
30-50	14	12	10	20	19	17
50-100	24	15	8	8	11	11
HR islands	0	5	4	4	0	0
TOTAL	68	62	42	67	62	67

Abundance and biomass indexes from *rapido* trawl surveys were computed using ATrIS software (Gramolini *et al*., 2005) which also allowed drawing GIS maps of the spatial distribution of the stock.

The abundance and biomass indices by GSA 17 were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum area in the GSA 17:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as ± standard deviation.

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution or by a quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al.*, 2004).

Length distributions represented an aggregation (sum) of all standardized length frequencies over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.19.3.2.2 *Geographical distribution patterns*

According to data collected during SoleMon surveys *S. mantis* aggregates inshore along the Italian coast, especially in the area close to the Po river mouth (Fig. 6.19.1.1.1).

6.19.3.2.3 *Trends in abundance and biomass*

The SoleMon trawl surveys provided data either on mantis shrimp total abundance and biomass.

Figure6.19.3.2.3.1 shows the abundance and biomass indices of mantis shrimp obtained from 2005 to 2011; a clear decreasing trend from 2005 to 2007 has been observed, followed by an increasing trends until fall 2010.

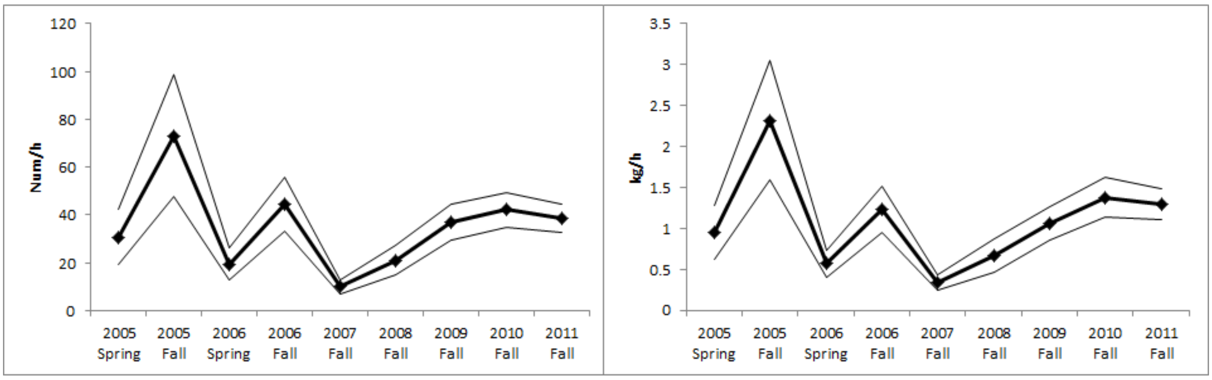


Fig. 6.19.3.2.3.1 Abundance and biomass indices of *S. mantis* obtained from SoleMon surveys (excluding Croatian hauls).

In the surveys carried out inside the 12 nm of Croatian waters in fall 2005 and 2006 and in spring 2006, mantis shrimp were not collected.

6.19.3.2.4 *Trends in abundance by length or age*

Figure6.19.3.2.4.1 displays the stratified abundance indices obtained in the GSA 17 in the 2011.

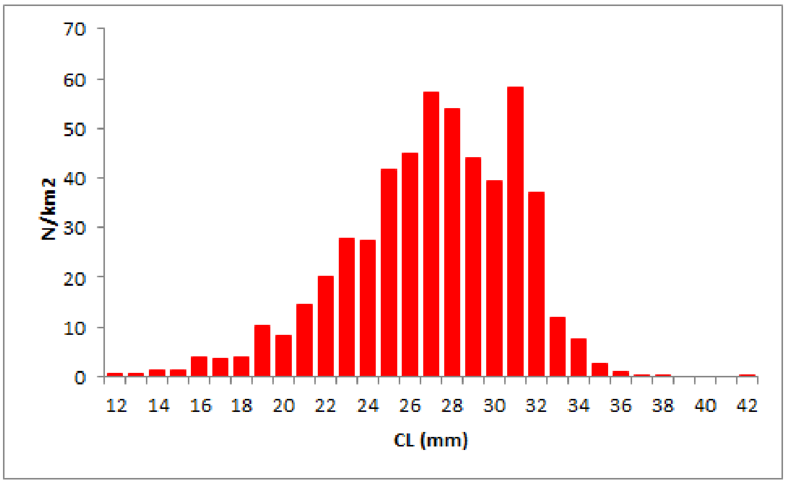


Fig. 6.19.3.2.4.1 Stratified abundance indices by size, 2011.

6.19.4 *Assessments of historic stock parameters*

This is the first assessment of mantis shrimp in GSA 17. The assessment is based only on Italian data, because fishery data from the Croatian fleets are missing and Slovenian data on size distribution of the catches was not available. However the contribution of the Slovenian catches is marginal, considering that they represent less the 0.1% of the GSA 17 catches. Considering the absence of specimens collected during the SoleMon survey and the low abundance observed in the MEDITS data available from the eastern side of the basin (2002 and 2005) inside the Croatian waters, is possible to assume that the assessment carried out during the EWG 12-10 covers almost completely the stock exploited in the GSA 17.

6.19.4.1 Method 1: Steady state VPA (VIT)

6.19.4.1.1 *Justification*

A VPA was performed to estimate a vector of *F* at age using the VIT software. Data on total annual catches by size have been converted in age using knife edge slicing (LFDA 5.0) based on the VBGF parameters showed in Table 6.19.1.2.1. Data used in the analysis were the OTB, GNS and TBB catch at age distribution (including discard) of 2011. Considering that only discard data for 2011 were available for the three fleets, it was not possible to perform the analysis also for the previous years.

6.19.4.1.2 *Input parameters*

Data derived from commercial catches (landing and discard) for sexes combined were used to estimate F, the value of the $F_{0.1}$, the numbers at age and other population parameters.

The length frequency distribution (landing and discard) and the age frequency distribution are shown in Figures6.19.4.1.2.1 and 6.19.4.1.2.2, respectively.

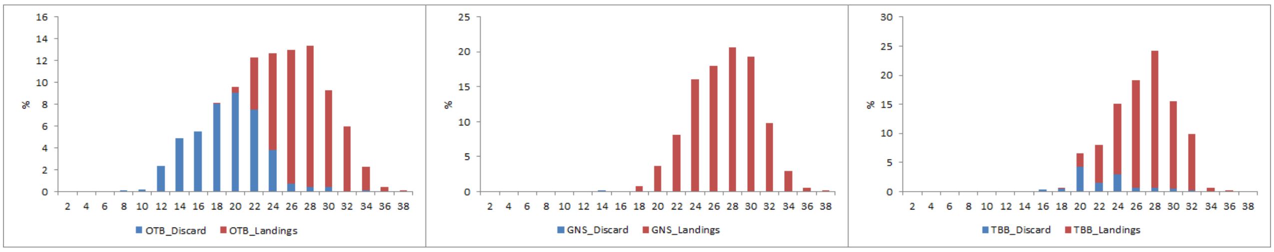


Fig. 6.19.4.1.2.1 Size frequency distributions of otter-trawl fleet (OTB), gillnet (GNS) and *rapido*trawl fleet (TBB) for the year 2011.

Overall, the exploited size range is comprised between 8 and 38 mm carapace length (CL), corresponding to specimens between 0+ and 5 age classes. The discarded specimens show a size range between 8 and 34 mm CL, the majority of them with a size comprised between 12 and 22 mm CL (0+ and 1 age classes). The otter trawl landing is composed by specimens between 8 and 38 mm CL, with higher abundances of the size classes comprised between 26 and 34 cm CL (1 and 2 age classes).

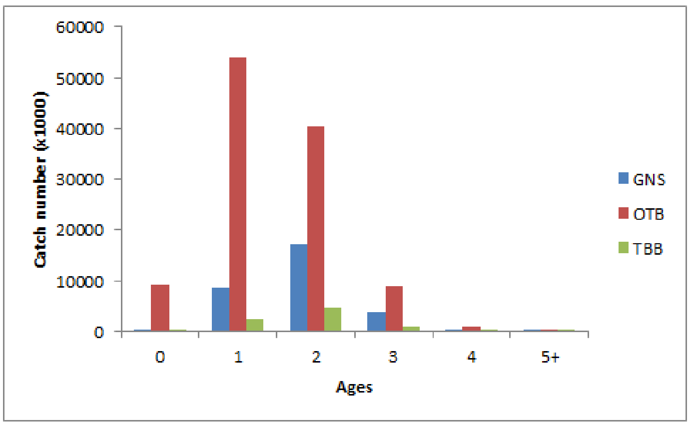


Fig. 6.19.4.1.2.2 Catches numbers at age for 2011.

Table 6.19.4.1.2.1 Catches numbers at age (in thousands), 2011.

Age class	GNS	OTB	TBB
0	8.44	9171.129	3.109
1	8587.222	54073.61	2443.376
2	17184.36	40405.13	4670.864
3	3642.321	8872.732	811.379
4	282.697	827.892	13.345
5+	8.987	136.681	0.112
Total	29714.027	113487.174	7942.185

The following set of parameters was used to perform the VPA:

Growth parameters (Von Bertalanffy)
L_∞ = 41.53 (mm, carapace length)
k = 0.49
t_0 = -0.0105
L*W
a = 0.0014
b = 3.045
$F_{terminal}$ = 0.8
Natural mortality
M vector Age_0=1.28 , Age_1=0.58, Age_2=0.44, Age_3=0.38, Age_4=0.35, Age_{5+}=0.33
Length at maturity (L_{50})
L_{50}= 29.0 mm CL
Proportion of matures
Age_0=0.04, Age_1=0.90, Age_2=1.00, Age_3=1.00, Age_4=1.00, Age_{5+}=1.00

The vector of natural mortality M was estimated using Prodbiom. The F-terminal has been estimated using the length frequency distribution observed during the SoleMon survey in 2011. A catch curve has been used to calculate the total mortality (Z = 1.13; M_{old}= 0.33; F = 1.13 – 0.33 = 0.8; Figure 6.6.4.1.2.3).

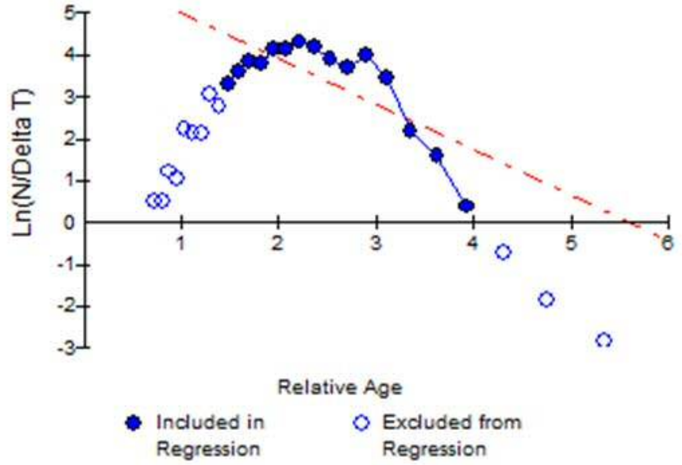


Fig. 6.19.4.1.2.3.Catch curve from SoleMon survey LFD data for *Squilla mantis*.

A sensitivity analysis showed that the choice of the F terminal does not affect the results of the analyses more than the changes in VBGF parameters.

6.19.4.1.3 *Results*

VIT results regarding thepattern of catch at age in biomass, the initial number by age and the total and fishing mortality by age are showed in Figure6.19.4.1.3.1. The total catch in biomass is almost due to 1 and 2 age classes. Fishing mortality significantly affects the stock from 1 age class and onward, with the highest values observed for 2 and 3 age classes.

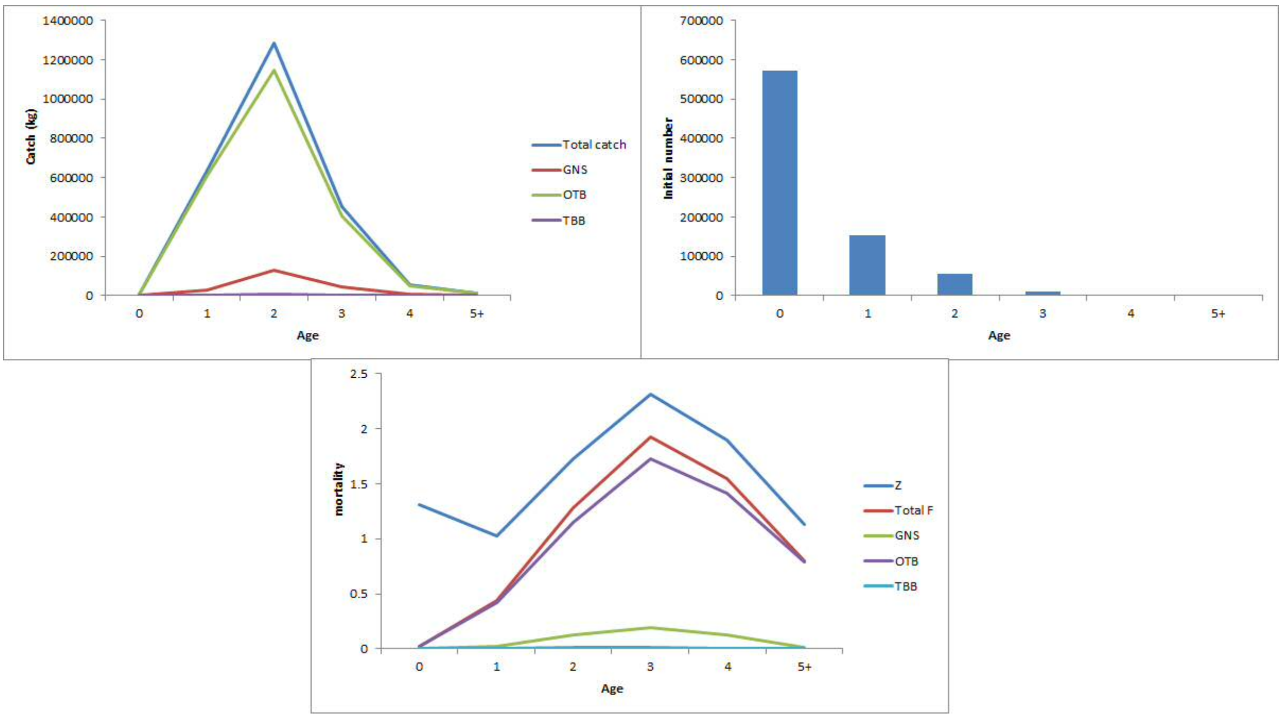


Fig. 6.19.4.1.3.1 VPA outputs: catch in biomass, initial number and fishing mortality at age of *S. mantis* in the GSA 17.

6.19.5 *Long term prediction*

6.19.5.1 Justification

Yield per recruit (YPR) analysis was conducted based on the exploitation pattern resulting from the VIT model and population parameters.

The YPRanalysis allowed to estimate the relative yields and surviving fraction of the parental biomass and to produce an estimate of $F_{0.1}$, which can be considered a proxy of F_{MSY}.

6.19.5.2 Input parameters

The parameters were used to estimate RFPs were the same used in the VIT model.

6.19.5.3 Results

Table 6.19.5.3.1 shows the reference fishing mortality, along with the reference points $F_{0.1}$ and F_{max}. Figure 6.19.5.3.1 shows the results of the yield per recruit analysis.

Table 6.19.5.3.1 Reference fishing mortality ($F_{0.1}$) and the referent points $F_{0.1}$ and F_{max}.

	Y/R	SSB/R
$F_{0.1}$ = 0.30	4.2	11.8
F_{max} = 0.57	4.5	7.3
$F_{current}$ = 1.00	4.3	4.6

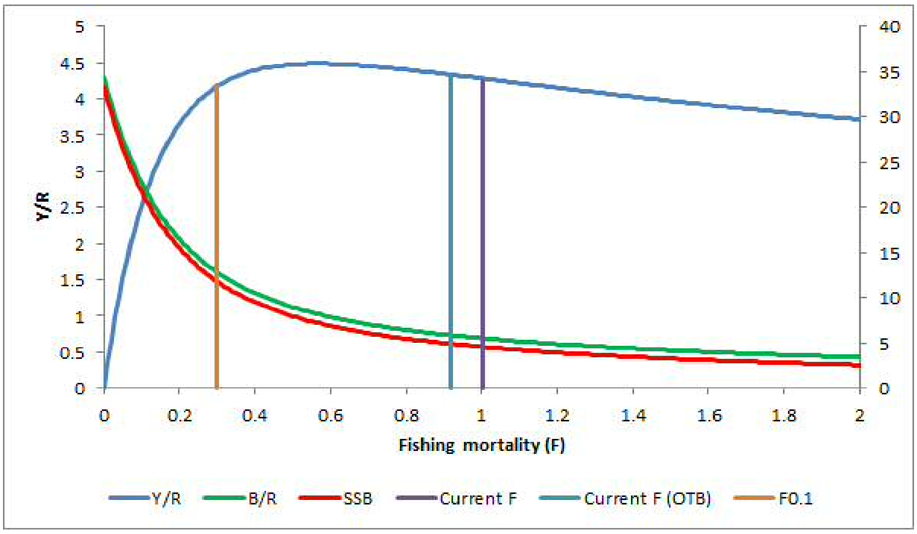


Fig. 6.19.5.3.1 Results of the YPR analysis.

6.19.6 *Data quality*

The data available for the assessment were submitted in the 2012 DCF official data call by Slovenia and Italy. Because of the absence of information regarding the number of trips and length sampled, both related to the landed and discarded portions, was not possible to check the quality of the data. Anyway, no major shortcomings have been evidenced in terms of data completeness for 2011 in comparison with the previous years, when Italian data on GNS and TBB were absent. Finally, the length frequency distribution of CL of the catches is provided with a precision of 2 mm. In other GSA the measurements are collected at 1 mm, so the EWG 12-10 suggests to use the same approach with a precision level of 1 mm also in GSA 17. Finally MEDITS survey data prior 2002 were not available during the EWG 12-10.

6.19.7 *Scientific advice*

6.19.7.1 Short term considerations

6.19.7.1.1 *State of the stock size*

EWG 12-10 is unable to fully evaluate the status of the stock size as no biomass reference point is defined. The analyses performed give a SSB estimate of 2,610 tons in 2011. The MEDITS and SoleMon surveys indicate a general decreasing trend in stock biomass.

6.19.7.1.2 *State of recruitment*

Given the quality of data and results, EWG 12-10 is unable to fully evaluate the state of recruitment. The analyses performed give an estimation of $527x10^6$ recruits in 2011.

6.19.7.1.3 *State of exploitation*

EWG 12-10 proposes $F_{0.1} \leq 0.30$ as limit management reference point consistent with high long term yields (F_{MSY} proxy).

The current F=1.00 estimated for 2011 is above the F_{MSY}reference point (0.30), which indicates that mantis shrimp in GSA 17 is exploited unsustainably.

EWG 12-10recommends reducing fishing mortality towards the proposed reference point F_{MSY}. This can be done by reducing fishing effort or/and catches of the relevant fleets taking into account mixed-fisheries effects. Catch forecasts consistent with the adopted measures shall be estimated.

EWG 12-10 emphasizes that this is the first attempt carried out using a steady state approach to evaluate the exploitation state of the species and, therefore, it is necessary to analyse a longer data series in order to confirm the results obtained for 2011. Moreover different approaches in the age slicing (implemented during EWG 11-12) can be carried out as an exploratory analysis in order to confirm the robustness of the slicing method employed in the present report.

6.20 **Stock assessment of pink shrimp in GSA 18**

6.20.1 *Stock identification and biological features*

6.20.1.1 Stock Identification

Due to a lack of information about the structure of pink shrimp population in the Adriatic Sea, this stock was assumed to be confined within the boundaries of the GSA 18 as also agreed upon by SGMED 01-09.

The deep-water rose shrimp inhabits preferably muddy sediments (Karlovac, 1949). In the southern Adriatic it is distributed mostly between 30 and 600 m depth although it is more abundant between 200 and 400 m depth (Pastorelli *et al*., 1996). According to previous studies (Abellò *et al*., 2002; Mannini *et al*., 2004), the eastern part the south Adriatic is characterised by high occurrence and abundance of the species, given the charateristics of the water masses (warmer and saltier) and the lower fishing pressure; in particular an higher abundance of the juveniles was reported (Ungaro *et al*., 2006). However according to MEDITS time series the abundance of the species was growing even on the western side since 2002.

Spawning time is considered extended almost all the year round, as for other Mediterranean areas (Relini, 1999) and sex ratio as estimated from trawl-survey data is approximately 0.45. The abundance of this shrimp has increased from 1996 to 2005 (Ungaro *et al*., 2006) and pink shrimp is one of the target species of the central and southern Adriatic multispecies trawl catches.

6.20.1.2 Growth

According to historical information , *P. longirostris* in the Adriatic area can grow up to 16 cm (males) and 19 cm (females) total length. However, males are usually from 8 to 14 cm and females from 12 to 16 cm total length. Larger specimens are caught mainly in deeper waters. During the expedition “Hvar”, the largest specimen caught was a female 17 cm length (Karlovac, 1949). The growth rate differs between the sexes. Size distribution and growth parameters indicate a life cycle of 3-4 years (Froglia, 1982). Historical parameters of the length-weight relationship reported in literature for carapace length expressed in mm and sex combined (Marano *et al*., 1998) are a=0.0034, b=2.4364.

Estimates of growth parameters achieved using DCF data through the analysis of length frequency distributions and von Bertalanffy model gave the following parameters by sex: females CL_∞=46.0 mm; K=0.6; t_0= -0.20; males: CL_∞=39 mm; K=0.69; t_0= -0.20.

The parameters of the length-weight relationship estimated within the DCF for sex combined and carapace length expressed in cm were: a=0.926, b=2.434.

6.20.1.3 Maturity

In the Mediterranean Sea, both sexes of *P. longirostris* reach maturity in the first year of life (Froglia, 1982). According to the data obtained in the DCF, the maturity ogive (mature females were specimens belonging to the maturity stage 2 onwards) estimated by a maximum likelihood procedure indicates a $L_{m50\%}$ of about 18.3

mm (±0.1 mm) and a maturity range (MR) equal to 2.4 mm ($L_{m75\%}$-$L_{m25\%}$ ±0.13 cm) of carapace length (figure 6.20.1.3.1).

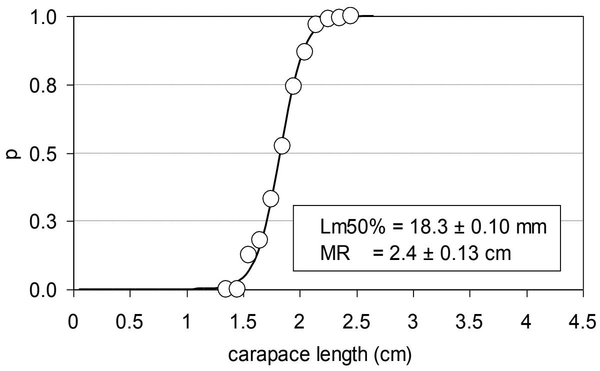


Fig. 6.20.1.3.1 Maturity ogive and proportions of mature female of pink shrimp in the GSA 18 (MR indicates the difference $L_{m75\%}$-$L_{m25\%}$).

The sex ratio evidenced the prevalence of males in the size class from 16 to 18 mm and from 23 to 25 mm, while from 27 mm onwards females dominate.

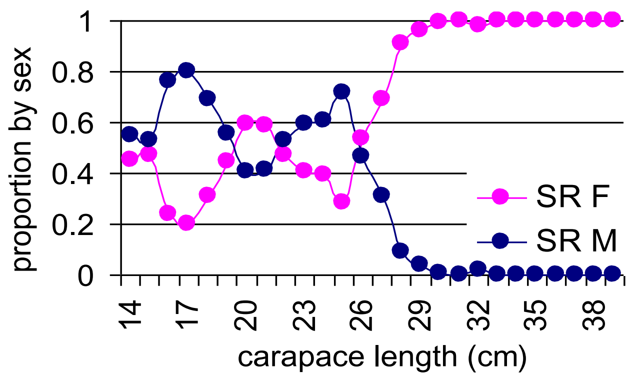


Fig. 6.20.1.3.2 Sex ratio at length of pink shrimp in the GSA 18.

6.20.2 *Fisheries*

6.20.2.1 General description of fisheries

Pink shrimp is only targeted by trawlers and fishing grounds located along the coasts of the whole GSA. Catches from trawlers are from a depth range between 50-60 and 500 m and the species may co-occurs with other important commercial species as *M. merluccius*, *Illex coindetii*, *Eledonecirrhosa*, *Lophius* spp., *Lepidorhombus boscii*, *N. norvegicus*.

6.20.2.2 Management regulations applicable in 2011 and 2012

Management regulations on the western side of the GSA are based on technical measures, closed number of fishing licenses for the fleet and area limitation (distance from the coast and depth). In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late 1980s and the fishing capacity has been gradually reduced. Other management measures are technical measures (mesh size), minimum landing sizes (EC 1967/06) and seasonal fishing ban, which in southern Adriatic has been mandatory since the late 1980s. In 2008 a management plan was adopted, which stipulated the reduction of the fleet capacity associated with a reduction of the time at sea. Two biological conservation zone (ZTB) were permanently established in 2009 (Decree of Ministry of Agriculture, Food and Forestry Policy of 22.01.2009; GU n. 37 of 14.02.2009) along the mainland, offshore Bari (180 km^2, between about 100 and 180 m depth), and in the vicinity of Tremiti Islands (115 km^2 along the bathymetry of 100 m) on the northern border of the GSA where a marine protected area (MPA) had been established in 1989. In the former only the professional small scale fishery using fixed nets and long-lines is allowed, from January 1st to June 30, while in the latter the trawling fishery is allowed from November 1st to March 31 and the small scale fishery all year round. Recreational fishery using no more than 5 hooks is allowed in both areas. Since June 2010 the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coasts are enforced.

6.20.2.3 Catches

6.20.2.3.1 *Landings*

Available landing data are from DCF. EWG 12-10 received Italian landings data for GSA 18 by fisheries which are listed in Table 6.20.2.3.1.1 (in 2008 the species was not a target for biological sampling in this GSA, thus the data of landings of 2008 were provided by the team in charge of DCF data collection in the western area). No data from FISHSTAT FAO were available for this species for the east side of GSA 18 in the period 2007-2011.

In general, demersal trawlers account for the majority of the landings. Landings are rather stable in the observed years with a slight increase in 2009 and a small decrease to 2011.

Table6.20.2.3.1.1 Annual landings (tons) by fishery, from 2007 to 2011.

YEAR	GEAR	FISHERY	LANDINGS
2007	OTB		863
2008	OTB		766
2009	OTB	DEMSP	690
2009	OTB	MDDWSP	243
2010	OTB	DEMSP	551
2010	OTB	MDDWSP	330
2011	OTB	DEMSP	621
2011	OTB	MDDWSP	241

6.20.2.3.2 *Discards*

The proportion of the discards of pink shrimp in the GSA 18 was generally low (less than 4% and generally around 1-2%). Discards data of 2009, 2010 and 2011 were available. Considering the amount of discard and the fact that the collection of discard data was not foreseen in DCF in 2007 and 2008 these data were not used in the analyses.

6.20.2.4 Fishing effort

The trends in fishing effort by year and major gear type in terms of kW*days are listed in Table 6.20.2.4.1 and in figure 6.20.2.4.1.

Table 6.20.2.4.1 Effort (kW*days) for GSA 18 by gear type, 2004-2011 as reported through the DCF official data call.

YEAR	GNS	GTR	LLS	OTB		
				DEMSP	DWSP	MDDWSP
2004	67828	29235	60741	147850		2388604
2005	94644	69435	80581	56423		2309466
2006	120055	32007	76098	598799		2054616
2007	70224	45292	74171	519085		1759397
2008	50376	83968	107911	1890398	29701	119323
2009	78139	80946	64941	2101567	18235	266753
2010	57056	79765	87474	1608697	21524	437823
2011	44943	79593	76512	1607442	10809	281989

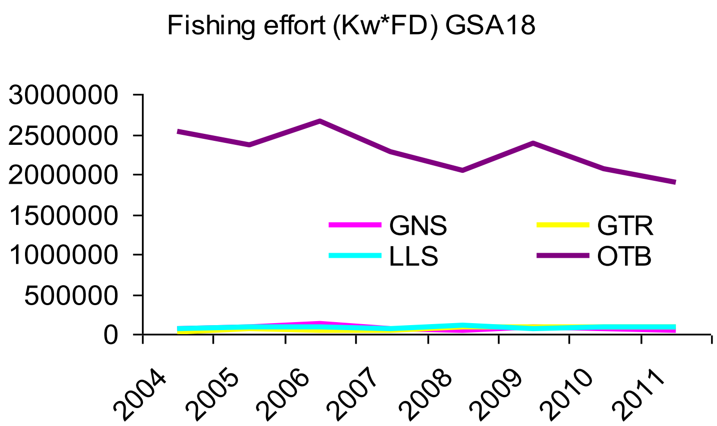


Fig6.20.2.4.1.Effort (kW*days) for GSA 18 by gear type, 2004-2011.

The fishing effort of the trawlers, which is the major component of the fishing activity in the area, is decreasing.

6.20.3 *Scientific surveys*

6.20.3.1 MEDITS

6.20.3.1.1 *Methods*

According to the MEDITS protocol (Bertrand et al., 2002), trawl surveys were yearly (May-July) carried out, applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish and weight per surface unit) were standardised to square kilometre, using the swept area method.

Based on the DCF data call, abundance and biomass indices were recalculated with a standardization to the hour. In GSA 18 the following number of hauls was reported per depth stratum (Table 6.20.3.1.1.1).

Table 6.20.3.1.1.1 Number of hauls per year and depth stratum in GSA 18, 1994-2011.

Stratum	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
10-50 m	14	14	18	17	17	17	17	18	12	12	11	10	11	10	13	12	12	12
50-100 m	14	15	24	25	25	26	25	24	20	19	21	20	21	22	21	20	20	20
100-200 m	24	23	33	33	33	32	33	33	31	32	31	33	31	31	33	30	31	31
200-500 m	10	10	18	18	18	19	18	18	13	13	13	13	13	13	12	14	13	13
500-800 m	10	10	19	19	19	18	19	19	14	14	14	14	14	14	11	14	14	14
Total	72	72	112	112	112	112	112	112	90	90	90	90	90	90	90	90	90	90

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. Only hauls noted as valid were used, including stations with no catches (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution or quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)). Length distributions represent the number of individual per km^2 (Cochran, 1977).

6.20.3.1.2 *Geographical distribution patterns*

The geographical distribution pattern of pink shrimp in the GSA 18 has been studied using trawl-survey data and geostatistical methods. In these studies the abundance indices of recruits were analysed. Results highlighted that areas located in the Gulf of Manfredonia and between Monopoli and Brindisi coasts within 200 m depth are characterised by high concentration of pink shrimp recruits reaching 2000 individuals/km^2 in 2000-2001. A peak of 5000 individuals/km^2 was observed in the southernmost location (border between GSA 18 and 19) off Capo S. Maria di Leuca (e.g. Carlucci *et al.*, 2009).

Pink shrimp nursery areas obtained applying the indicator kriging techniques are reported below (Fig. 6.20.3.1.2.1).

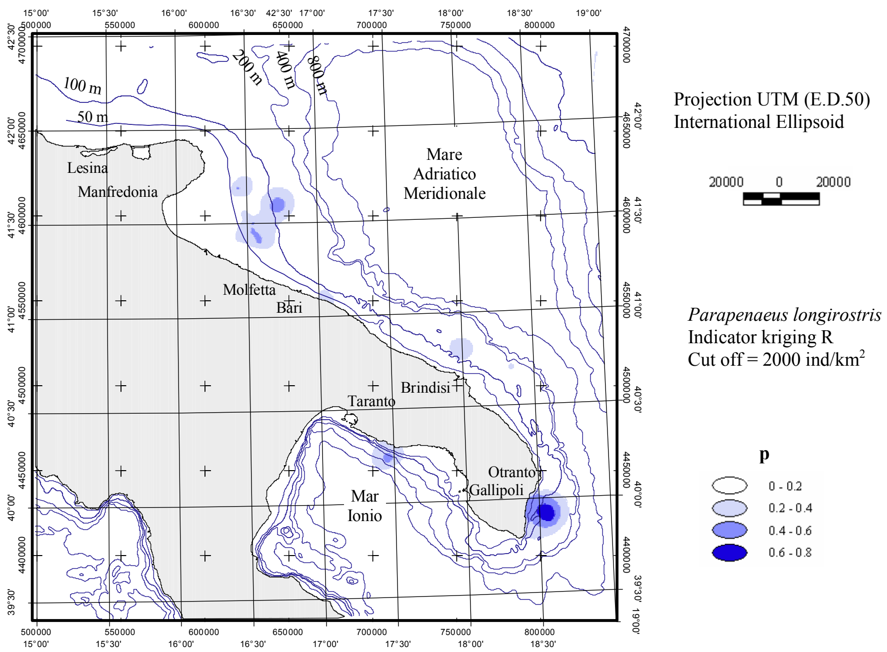


Fig. 6.20.3.1.2.1 Geographical distribution patters of pink shrimp nursery areas as estimated from MEDITS.

6.20.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of pink shrimp in GSA18 was obtained from the international survey MEDITS.

Figure 6.20.3.1.3.1 displays the estimated trend of *P. longirostris* abundance and biomass standardized to the square km in the GSA 18. Indices from MEDITS trawl-surveys show three main peaks in 1996, 2005, and 2009 with a significant increasing trend. However, the values of abundance of the last two years are decreasing.

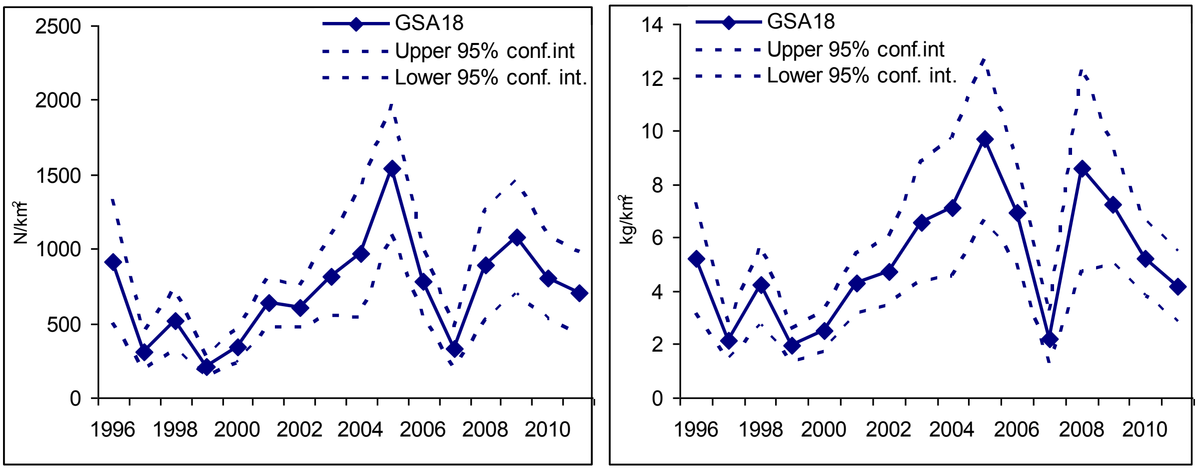
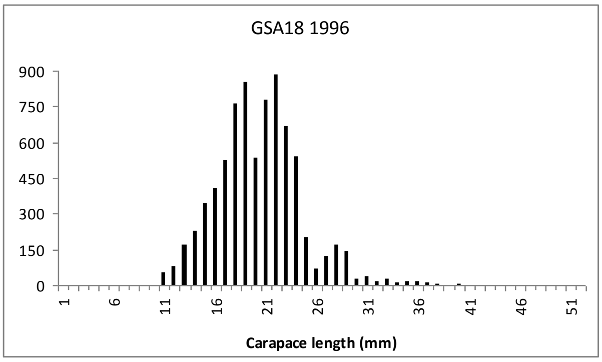
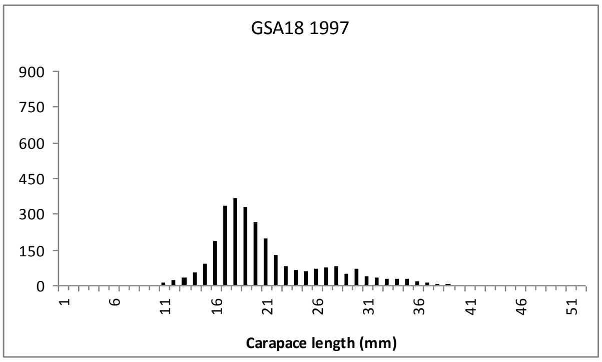


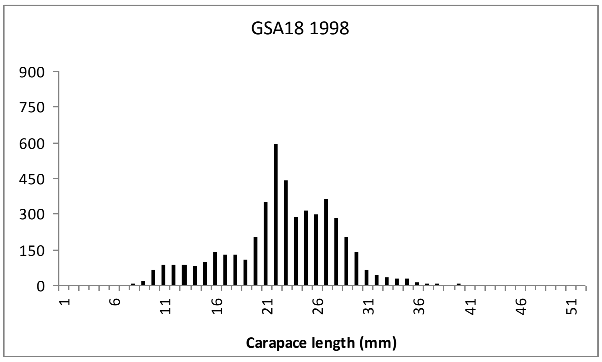
Fig. 6.20.3.1.3.1Abundance and biomass indices with confidence interval (95%) of red mullet in GSA 18 estimated from MEDITS in the whole GSA18 and standardized to the km^2.

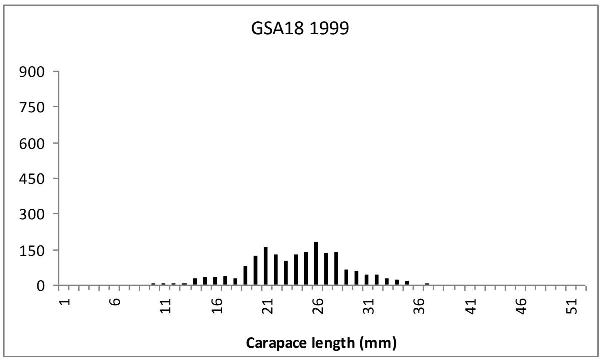
6.20.3.1.4 *Trends in abundance by length or age*

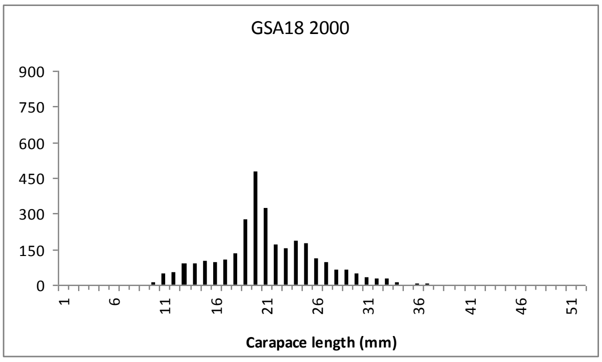
Figure6.20.3.1.4.1displays the stratified abundance indices by length in 1996-2011.

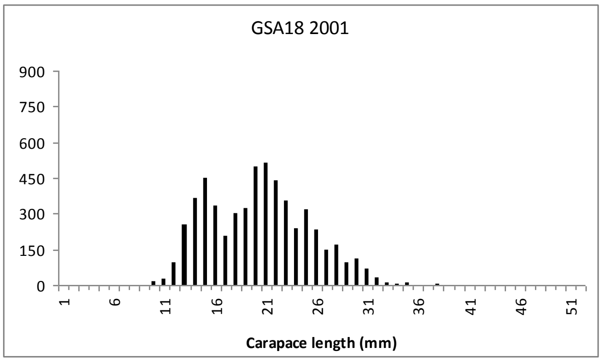

GSA18 1996
0 150 300 450 600 750 900
1 6 11 16 21 26 31 36 41 46 51
Carapace length (mm)

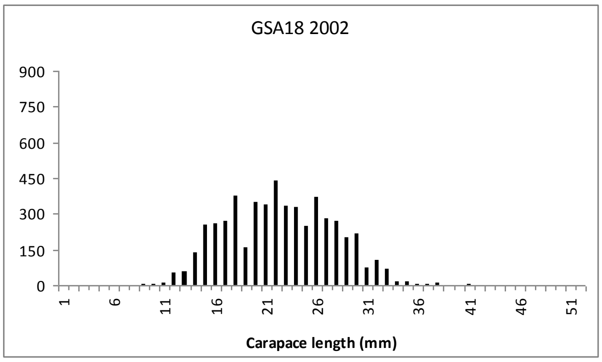

GSA18 1997
0 150 300 450 600 750 900
1 6 11 16 21 26 31 36 41 46 51
Carapace length (mm)

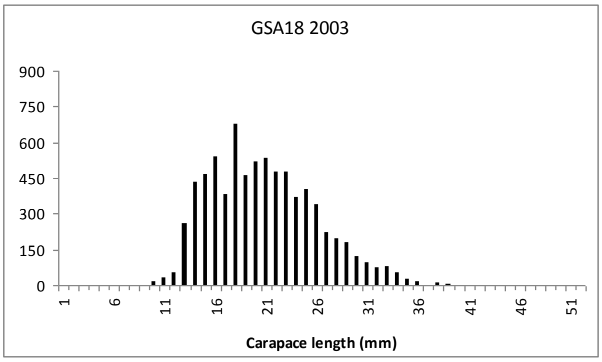

GSA18 1998
0 150 300 450 600 750 900
1 6 11 16 21 26 31 36 41 46 51
Carapace length (mm)

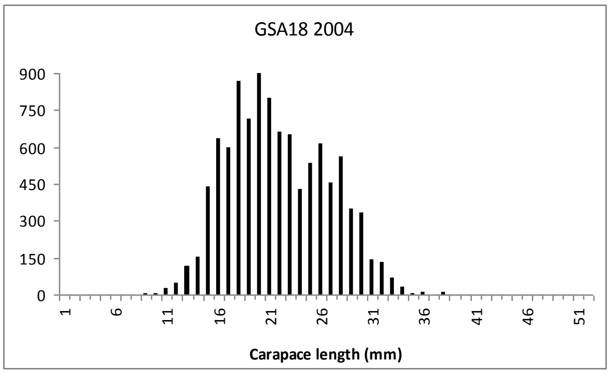

GSA18 1999
0 150 300 450 600 750 900
1 6 11 16 21 26 31 36 41 46 51
Carapace length (mm)

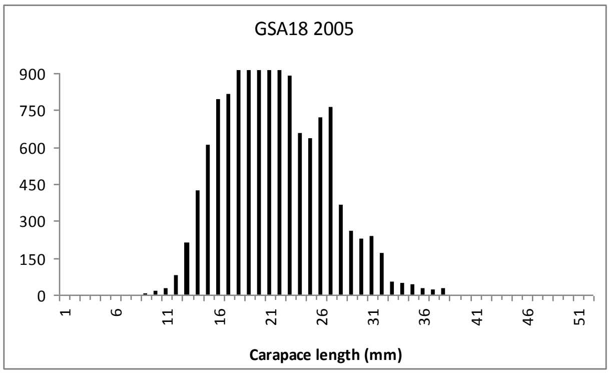

GSA18 2000
0 150 300 450 600 750 900
1 6 11 16 21 26 31 36 41 46 51
Carapace length (mm)


GSA18 2001
0 150 300 450 600 750 900
1 6 11 16 21 26 31 36 41 46 51
Carapace length (mm)


GSA18 2002
0 150 300 450 600 750 900
1 6 11 16 21 26 31 36 41 46 51
Carapace length (mm)


GSA18 2003
0 150 300 450 600 750 900
1 6 11 16 21 26 31 36 41 46 51
Carapace length (mm)


GSA18 2004
0 150 300 450 600 750 900
1 6 11 16 21 26 31 36 41 46 51
Carapace length (mm)


GSA18 2005
0 150 300 450 600 750 900
1 6 11 16 21 26 31 36 41 46 51
Carapace length (mm)

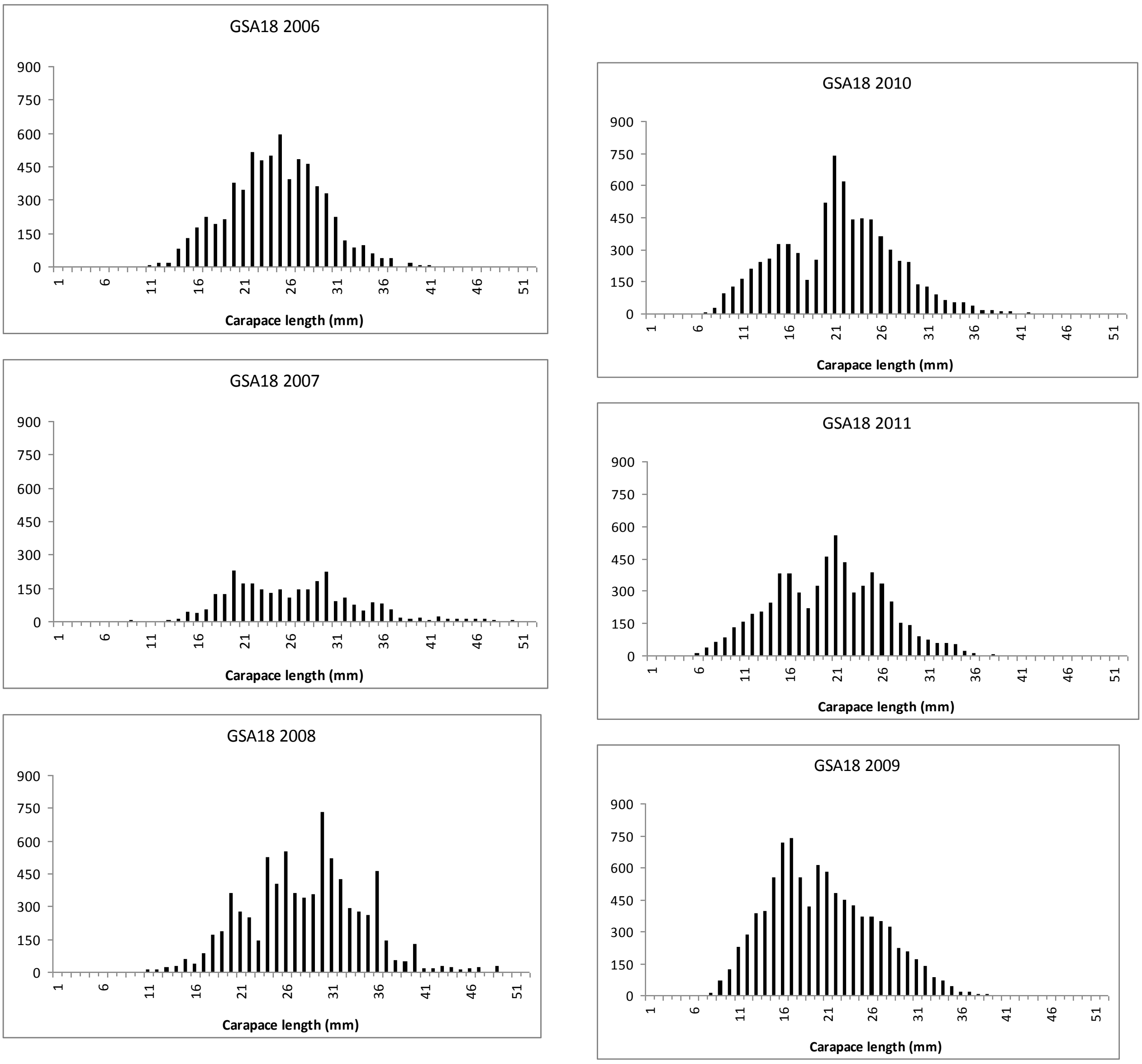


Fig. 6.20.3.1.4.1Stratified abundance indices by size, 1996-2011.

No trends in the length indicators was observed in MEDITS survey.

6.20.4 *Assessment of historic stock parameters*

The assessment was performed on data from the western side of the GSA 18, lacking, for the time being, the landing data from the whole GSA18. The VIT model was applied.

6.20.4.1 Method 1: VIT

6.20.4.1.1 *Justification*

Pseudocohort analysis was carried out using VIT software for and fitting landing number at age of 2007, 2009, 2010 and 2011 from DCF. Four analyses were performed (one for each year).

6.20.4.1.2 *Input parameters*

A sex combined analysis was carried out using the following growth parameters:

CL_{∞}=46.0 mm; K=0.6; t_0= -0.20 ;length-weight relationship: a =0.926, b =2.434.

The vector of natural mortality M was estimated using PRODBIOM (Abella *et al.*, 1998). Natural mortality, maturity and number of individuals in the landings used as input in VIT are showed below.

Table 6.20.4.1.2.1Natural mortality and maturity vectors used in the analysis.

Age	M	Maturity
0	1.42	0.47
1	0.82	0.98
2	0.70	1
3+	0.65	1

Table 6.20.4.1.2.1Landings in numbers at age in 2007, 2009, 2010 and 2011.

	Year			
Age	2007	2009	2010	2011
0	44,373,665	49,726,684	33,031,391	24,282,722
1	60,210,210	63,538,523	67,284,792	63,964,980
2	3,861,590	2,783,480	3,791,438	3,390,175
3	129,286	84,235	158,304	182,168

A sensitivity analysis performed for 2011 with terminal F equal to 0.9, 1.0 and 1.1 indicates slight variations of F estimates in response to changes of this parameter. Estimates of current F were respectively 1.43, 1.45 and 1.46 and $F_{0.1}$ were respectively 0.7, 0.68 and 0.67. A terminal fishing mortality F_{term}= 1 was assumed.

6.20.4.1.3 *Results*

Estimates of total and fishing mortality at age for sex combined by VIT are plotted in the Figure 6.20.4.1.3.1. The fishing mortality shows values changing from 1.45 in 2011 to 1.72 in 2009, with an average over the last three years of 1.56. The lowest value was estimated in 2011.

The number at ages of the catches by year estimated by VIT are reported in figure 6.20.4.1.3.2.

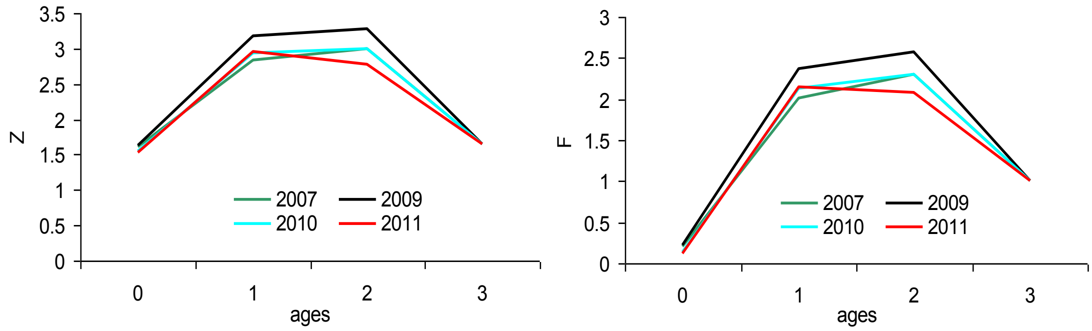


Fig. 6.20.4.1.3.1 Total and fishing mortality by age and year as estimated by VIT (2007; 2009-2011).

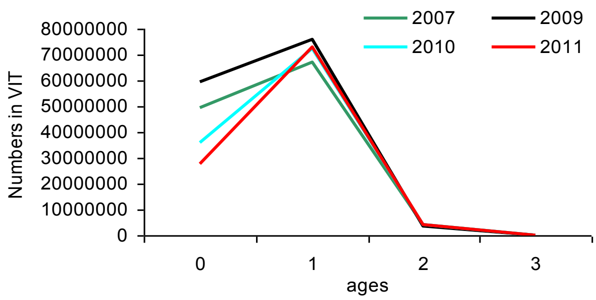


Fig. 6.20.4.1.3.2 Number at ages of the catches by year as estimated by VIT, (2007; 2009-2011).

6.20.5 *Long term prediction*

The Yield per recruit (YPR) was performed only on the western side of the GSA18, lacking, for the time being, the landing data from the whole GSA18.

6.20.5.1 Method 1: VIT

6.20.5.1.1 *Justification*

The pseudo-cohort analysis and the YPR approach as implemented in the VIT software under equilibrium conditions were used.

6.20.5.1.2 *Input parameters*

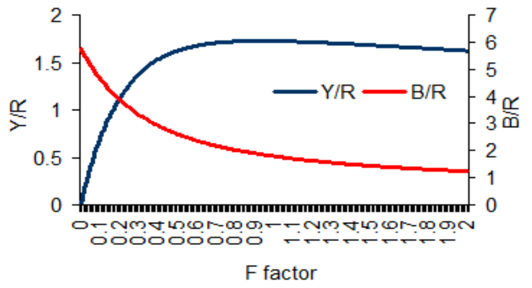
Input parameters are on the same as used for the VIT assessment above.

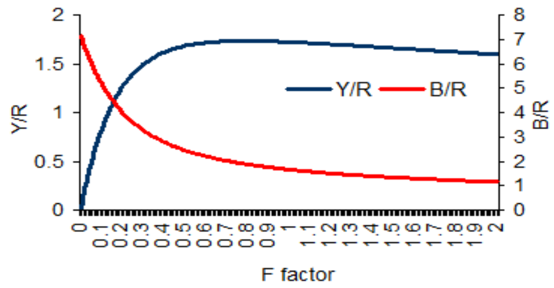
6.20.5.1.3 *Results*

Results of the YPR analysis from VIT are shown in the figure 6.20.5.1.3.1. The YPR analyses indicate that the reference point $F_{0.1}$ (used as proxy of F_{msy}) is on average 0.68 (last three years).

2007	Factor	F	Y/R	B/R	SSB/R
F(0)	0	0	0	5.756	5.081
F0.1	0.5	0.75	1.622	2.606	1.99
Fmax	0.94	1.42	1.727	1.862	1.285
Fcurr	1.01	1.51	1.726	1.789	1.218
Fdouble	2	3.01	1.622	1.236	0.735

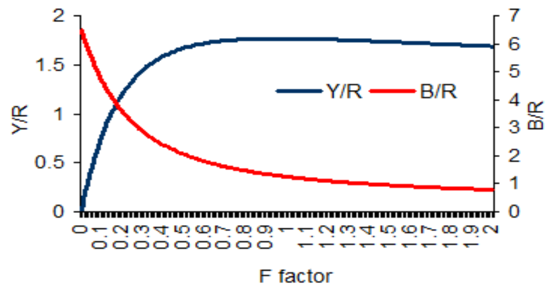
2009	Factor	F	Y/R	B/R	SSB
F(0)	0	0	0	7.164	6.489
F0.1	0.4	0.69	1.616	2.789	2.168
Fmax	0.8	1.38	1.733	1.886	1.305
Fcurr	1.01	1.72	1.722	1.657	1.096
Fdouble	2	3.45	1.594	1.152	0.666





2010	Factor	F	Y/R	B/R	SSB
F(0)	0	0	0	7.164	6.489
F0.1	0.45	0.68	1.635	2.833	2.202
Fmax	0.97	1.47	1.766	1.879	1.285
Fcurr	1.01	1.52	1.766	1.84	1.248
Fdouble	2	3.04	1.687	1.324	0.787

2011	Factor	F	Y/R	B/R	SSB
F(0)	0		0	7.16	6.49
F0.1	0.47	0.68	1.65	2.82	2.19
Fmax	1.04	1.50	1.78	1.86	1.26
Fcurr	1.01	1.45	1.78	1.88	1.28
Fdouble	2	2.89	1.72	1.38	0.82



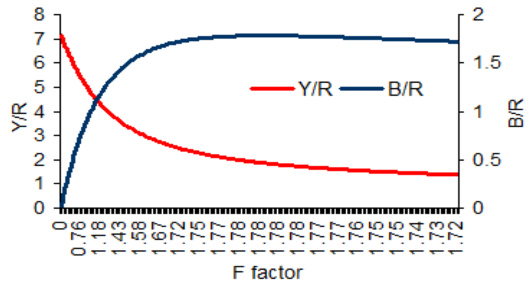


Fig. 6.20.5.1.3.1 Overall results of the YPR analysis for 2007, 2009-2011.

6.20.6 *Data quality and availability*

Data from DCF data call of April 2012 were used. Assessments were performed for the new submitted time series (2007-2011). A consistent sum of products compared to landings was observed (differences less than 10% for age data and lesser than 5% for length data).

For 2008, landingslength structures of pink shrimp were not available, given that the species was not a target of the biological samplings for length. Landing data for 2008 were not present in the JRC database, because, given the requirements of the current data call.According to the current specifications of the data call landing data have to be provided only when age and length structures are available. Thus, if the species has been not a target, landing data are not submitted, though overall landings are always collected. The data of landings of 2008 were provided by the team in charge of DCF data collection in the western area of GSA 18. Discards data of 2009, 2010 and 2011 were available. In 2009, 2010 and 2011 data were provided by year and metier, in 2007 only by fleet segment. Information on number of samples for landings, discards and catches, as well as the number of measurements by length for landings, discards and catches were also available.

6.20.7 *Scientific advice*

6.20.7.1 Short term considerations

6.20.7.1.1 *State of the spawning stock size*

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h). MEDITS indices indicate a remarkable peak of abundance and biomass in 2005, followed by a sharp decrease in 2007 and an increase in 2008. After this year, abundance slightly increases in 2009 and decreased in 2011. However, in the absence of proposed biomass management reference points, EWG 12-02 is unable to fully evaluate the status of the SSB in relation to these.

6.20.7.1.2 *State of recruitment*

Recruitment estimates from MEDITS peaked in 2005 and then sharply decreased in 2007. After 2007, there was a slow rising, from 2008 to 2009, and a slight reduction in the following years. A similar trend was obtained from the pseudocohort analysis by year (fig. 6.20.7.1.2.1).

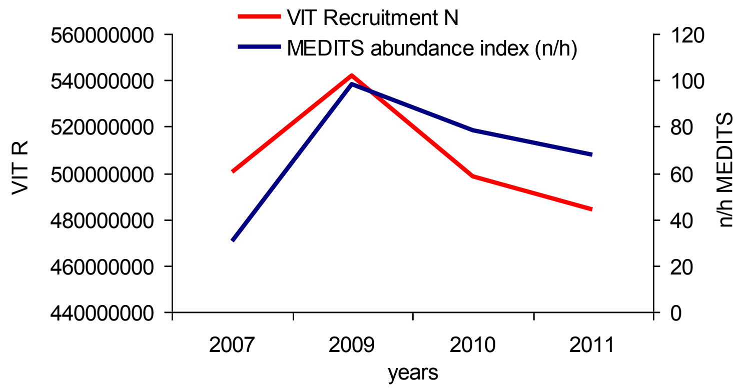


Fig. 6.20.7.1.2.1 Estimates of recruitment from VIT analysis by year and abundance indices from MEDITS survey.

6.20.7.1.3 *State of exploitation*

EWG 12-10 proposed $F_{0.1}$ = 0.45 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 0.70), the stock is considered exploited unsustainably.

EWG 12-10 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

6.21 **Stock assessment of red mullet in GSA 18**

6.21.1 *Stock identification and biological features*

6.21.1.1 Stock Identification

Due to a lack of information about the structure of red mullet populations in the Adriatic Sea, this stock was assumed to be confined within the boundaries of GSA 18. Genetic studies conducted in the Adriatic (Garoia *et al*., 2004) evidenceda high genetic diversity, but that such spatial genetic heterogeneity was not related to a geographic cline. However, the randomness of genetic differences among samples indicated that the Adriatic red mullet stock probably belongs to a single population unit. Nevertheless, individuals may group into local, genetically differentiated sub-populations. The observed genetic fragmentation in the Adriatic stock might be due to reproductive success, survival rates or fishing pressure.In addition to the genetic considerations, indications presented by SGMED/ECA/RST-09-01 and based on correlation matrices of trawl-survey data in adjacent areas suggested that the spatial structure of red mullet population can be characterized by local differences.

In the Adriatic Sea,red mullet spawns in late spring and summer, and according to Haidar (1970) the most intensive spawning occurs at depths of 60 to 70 m. After spawning, post larvae move towards shallower water (30-40 m) and then towards sandy coastal areas to become demersal at 4 cm TL. Later, they start their dispersion in deeper waters towards sandy, muddy and gravel grounds (Relini *et al.*, 1999). Regarding the sex ratio males are generally prevailing up to 14-15 cm, while females are more frequent over 15-16 cm TL. The relative index of the population abundance is observed to decrease with depth. According to Haidar (1970) the main fish predators of juvenile and adult red mullet are *Lophius piscatorius*, *Raja clavata*, *Zeus faber* and *Merluccius merluccius*.

6.21.1.2 Growth

Literature data on the growth of red mullet in the Adriatic Sea show a high variability in growth between areas and time. According to the data reported in the AdriaMed website, asymptotic length for sex combined varies from 19.7 to 31.5 cm (range for females and males respectively: 26.2-34.5 cm and 17.8-27 cm), while the curvature parameter varies from 0.118 to 0.8 for sex combined (range for females and males respectively: 0.122-0.23; 0.184-0.282). Red mullet grows up to about 30 cm (around 0.5 kg), although the usual total length in catches is from 10 to 20 cm. On average, females reach larger size than males and grow faster, which can be already noticed in the first year of their life (Haidar, 1970). Therefore, almost all largest specimens are females. According to Scaccini (1947) the life cycle is 8 years with a faster growth rate in the firsts three years for both sexes. After the first three years, a reduction in growth is evident (age1=12.6-12.7 cm for males and females respectively, age2=17.5-20.3; age3=20.4-23.9; age8=25.5-29.3 cm). The estimated von Bertalanffy growth curve (VBGF)parametersfor sex combined from Scaccini (1947) were: L_∞=27.5 cm; K=0.5; t_0= -0.25. The growth parameters estimated by sex using the analysis of length frequency distributions of MEDITS data collected in the central-northern Adriatic area during the SAMED project (AAVV, 2002), , were: females: L_∞=27 cm; K=0.396; t_0= -0.78; males: L_∞=23 cm; K=0.43; t_0= -

0.80.Parameters of the length-weight relationship reported in literature for sex combined are: a=0.008-0.0125, b=3.09-2.97 (Marano et al., 1998).

Estimates of growth parameters were achieved using otolith data collected within the Data collection framework (DCF)and analyzing length frequency distributions. The following VBGF parameters were estimated for sex combined: L_{∞}=30 cm; K=0.4; t_0= -0.3. The parameters of the length-weight relationship estimated within the DCFfor sex combined were: a=0.008, b=3.11.

6.21.1.3 Maturity

According to Haidar (1970) females always have an annual reproduction cycle and reach sexual maturity in the first year of life at lengths around 12 cm. According to other literature sources, the size at first maturity for females is in the range 10-14 cm (AdriaMed website).

Using the data obtained in the DCF, the proportion of mature females (specimens belonging to the maturity stage 2 onwards) by length class is reported in the table below together with the maturity ogive estimated by a maximum likelihood procedure, which indicates a $L_{m50\%}$ of about 12.3 cm (±0.072 cm) and a maturity range ($MR=L_{m75\%}-L_{m25\%}$) of 1.14±0.1 cm (Figure 6.21.1.3.1).

CL (cm)	Proportion of mature females
9	0
10	0.032
11	0.141
12	0.642
13	0.906
14	0.976
15	0.996
16	0.995
17	1
18	1
19	1
20	1

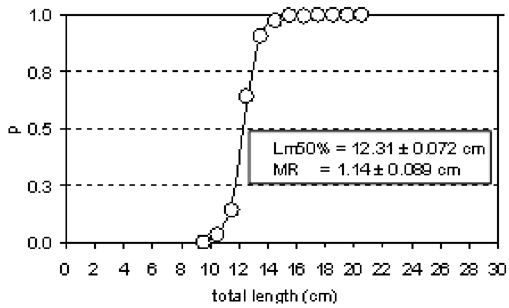


Fig. 6.21.1.3.1 Female maturity ogive (MR indicates the difference Lm75%-Lm25%).

The sex ratio from DCF evidenced the prevalence of males in the size class from 9 to 15 cm while from 16 cm onwards the proportion of females was dominant (Figure 6.21.1.3.2).

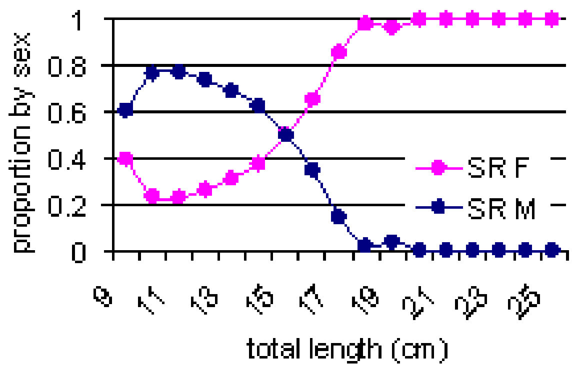


Fig. 6.21.1.3.2 Sex ratio at length for red mullet in GSA 18.

6.21.2 *Fisheries*

6.21.2.1 General description of the fisheries

Red mullet is mainly targeted by trawlers and at much lesser extent by small scale fisheries using gillnets and trammel nets. Fishing grounds are located along the coasts of the whole GSA.

Red mullet co-occurs with other important commercial species as *Pagellus* sp., *Eledone* sp., *Octopus* sp., *M. merluccius*.

6.21.2.2 Management regulations applicable in 2011 and 2012

Management regulations are based on technical measures, closed number of fishing licenses for the fleet and area limitation (distance from the coast and depth). In order to limit the over-capacity of the fishing fleet, the Italian fishing licenses have been fixed since the late eighties and the fishing capacity has been gradually reduced. Other management measures are technical measures (mesh size), minimum landing sizes (EC 1967/06) and seasonal fishing ban, which in southern Adriatic has been mandatory since the late eighties. In 2008 a management plan was adopted, that foresaw the reduction of fleet capacity associated with a reduction of the time at sea. Two biological conservation zone (ZTB) were permanently established in 2009 (Decree of Ministry of Agriculture, Food and Forestry Policy of 22.01.2009; GU n. 37 of 14.02.2009) along the mainland, offshore Bari (180 km^2, between about 100 and 180 m depth), and in the vicinity of Tremiti Islands (115 km^2 along the bathymetry of 100 m) on the northern border of the GSA where a marine protected area (MPA) had been established in 1989. In the former only the professional small scale fishery using fixed nets and long-lines is allowed, from January 1st to June 30, while in the latter trawling fishery is allowed from November 1st to March 31 and the small scale fishery all year round. Recreational fishery using no more than 5 hooks is allowed in both areas. Since June 2010 the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coasts are enforced.

6.21.2.3 Catches

6.21.2.3.1 *Landings*

Available landing data collected under the DCF are referred only to the western side of the GSA 18 and ranged from 1,680 tons in 2007 to 532 tons in 2011, the latter being the lowest value observed (Table6.21.2.3.1.1 and Figure6.21.2.3.1.1). The reported landings of red mullet were mainly from trawlers in all the years (Table 6.21.2.3.1.1). In 2011, gillnet and trammel net represent about 7% of total catches. Data from the eastern side of the GSA for the same period were not available from FAO-Fishstat. Since 2008, the total catches are decreasing.

Table 6.21.2.3.1.1 Annual landings (in tons) by major fishing techniques for red mullet in the GSA 18 (2007-2010).

YEAR	GEAR	FISHERY	LANDINGS
2007	OTB		1680
2008	OTB		914
2009	OTB	DEMSP	921
2009	OTB	MDDWSP	34
2009	Total		954
2010	OTB	DEMSP	525
2010	OTB	MDDWSP	76
2010	Total		601
2011	GNS	DEMF	37
2011	GTR	DEMSP	0.40
2011	OTB	DEMSP	472
2011	OTB	MDDWSP	22
2011	Total		532

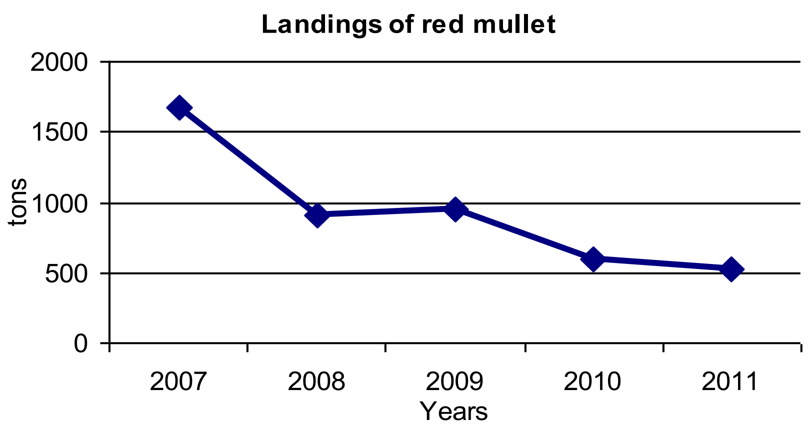


Fig. 6.21.2.3.1.1 Total annual landings in tons for red mullet in GSA 18 (2007-2011).

6.21.2.3.2 *Discards*

The proportion of discards of red mullet in the GSA 18 was generally low (less than 6%). Discards data of 2009, 2010 and 2011 were available. Considering the amount of discard and the fact that the collection of discard data was not foreseen in DCF in 2007 and 2008,discard data were notused in the analyses.

6.21.2.4 Fishing effort

The trends in fishing effort by year and major gear type in terms of kW*days are listed in Table6.21.2.4.1 and in Fig.6.21.2.4.1.

Table6.21.2.4.1 Effort (kW*days) for GSA18 by gear type and years 2004-2011, as reported through the DCF official data call.

YEAR	GNS	GTR	LLS	OTB		
				DEMSP	DWSP	MDDWSP
2004	67828	29235	60741	147850		2388604
2005	94644	69435	80581	56423		2309466
2006	120055	32007	76098	598799		2054616
2007	70224	45292	74171	519085		1759397
2008	50376	83968	107911	1890398	29701	119323
2009	78139	80946	64941	2101567	18235	266753
2010	57056	79765	87474	1608697	21524	437823
2011	44943	79593	76512	1607442	10809	281989

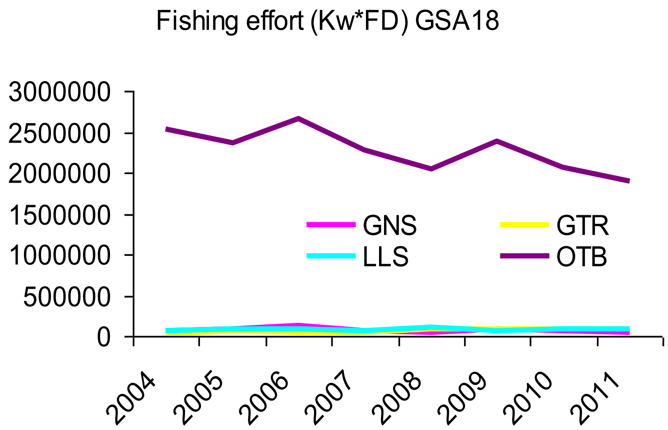


Fig. 6.21.2.4.1 Effort (kW*days) for the GSA18 by gear type and years 2004-2011

Fishing effort of trawlers,which is the major component of fishing in the area, is decreasing.

6.21.3 *Scientific surveys*

6.21.3.1 MEDITS

6.21.3.1.1 *Methods*

According to the MEDITS protocol (Bertrand et al., 2002), trawl surveys were carried out yearly (May-July), applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. Abundance data (number of fish per surface unit) were standardised to square kilometre, using the swept area method.

Based on the DCF data call, abundance and biomass indices were calculated. In the GSA18 the following number of hauls was reported per depth stratum (Table6.21.3.1.1.1).

Table 6.21.3.1.1.1 Number of hauls per year and depth stratum in GSA 18, 1994-2011.

Stratum	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
10-50 m	14	14	18	17	17	17	17	18	12	12	11	10	11	10	13	12	12	12
50-100 m	14	15	24	25	25	26	25	24	20	19	21	20	21	22	21	20	20	20
100-200 m	24	23	33	33	33	32	33	33	31	32	31	33	31	31	33	30	31	31
200-500 m	10	10	18	18	18	19	18	18	13	13	13	13	13	13	12	14	13	13
500-800 m	10	10	19	19	19	18	19	19	14	14	14	14	14	14	11	14	14	14
Total	72	72	112	112	112	112	112	112	90	90	90	90	90	90	90	90	90	90

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. Only Hauls noted as valid were used, including stations with no catches of red mullet (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$

$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n.

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al*. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.21.3.1.2 *Geographical distribution patterns*

The geographical distribution pattern of red mullet in the GSA18 has been studied using trawl-survey data and geostatistical methods. In these studies the abundance indices of recruits were analysed. Results highlighted a patchy distribution of juveniles of red mullet mostly concentrated along the coast of the South Adriatic Sea within 50 m of depth. The areas showing the highest probability and persistency were detected from 1997 to 2002 using cut-offs of 5000 and 10000 n/km^2. In particular, the nursery areas were mainly distributed (probability of 0.8) along the Gargano peninsula and along the coasts off the area between Molfetta and Brindisi, within 50 m of depth. Mapping of the red mullet nursery areas obtained applying the median indicator kriging technique is reported below in fFigure 6.21.3.1.2.1.

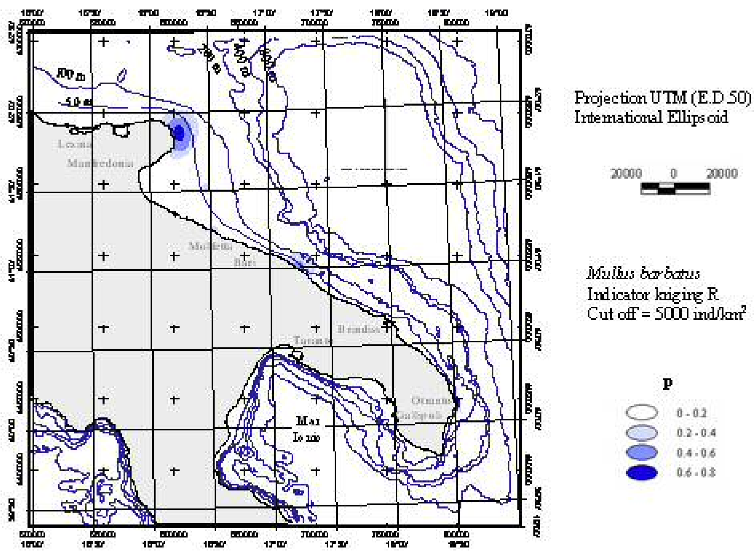


Fig. 6.21.3.1.2.1 Geographical distribution patterns of nursery areas of red mullet along the western side of the GSA18.

6.21.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of the red mullet in GSA 18 was obtained from the international survey MEDITS. Figure 6.21.3.1.3.1 displays the estimated trend of red mullet abundance and biomass per square km in GSA 18. Abundance indices from MEDITS trawl-survey show a very variable pattern also due to the presence of recruits only in some years. However, the abundance and biomass showed a very variable pattern with an increasing trend (Spearman rho respectively 0.512 and 0.706) along the time series,and with 2 major peaks, in 1999 and 2005.

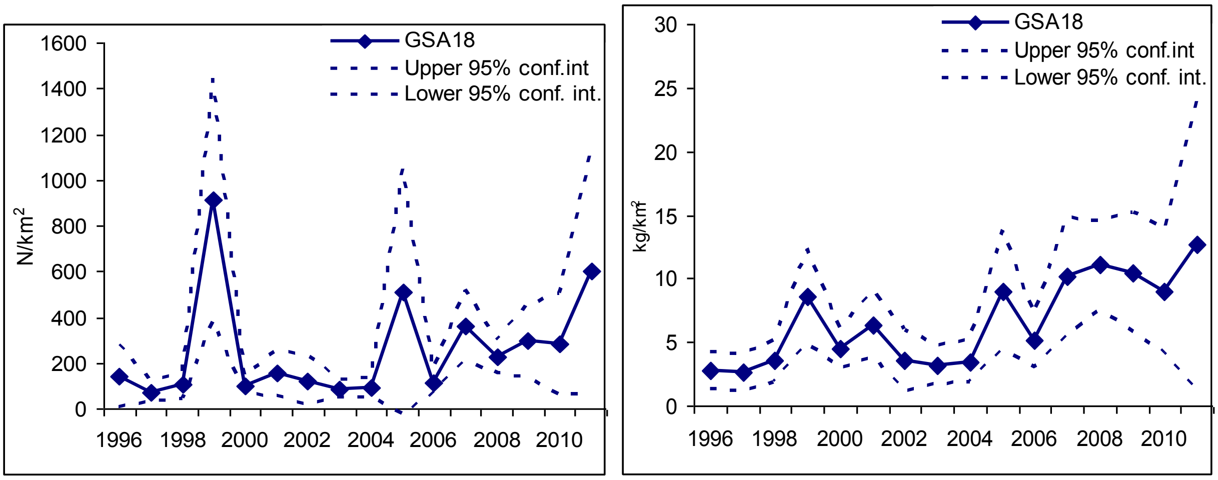


Fig. 6.21.3.1.3.1 Abundance and biomass indices with confidence interval (95%) of red mullet in GSA18 estimated from MEDITS in whole GSA18 and standardized to the km^2.

6.21.3.1.4 *Trends in abundance by length or age*

An increasing trend in mean length was observed in the MEDITS survey.

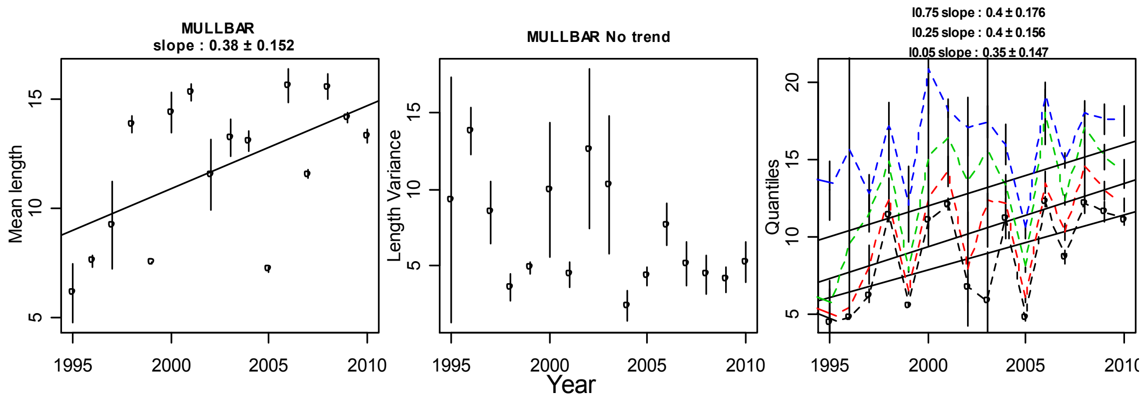
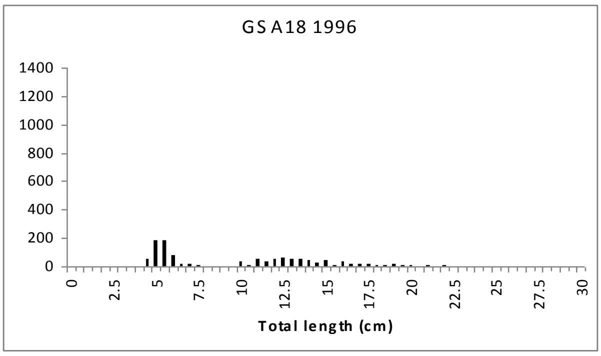
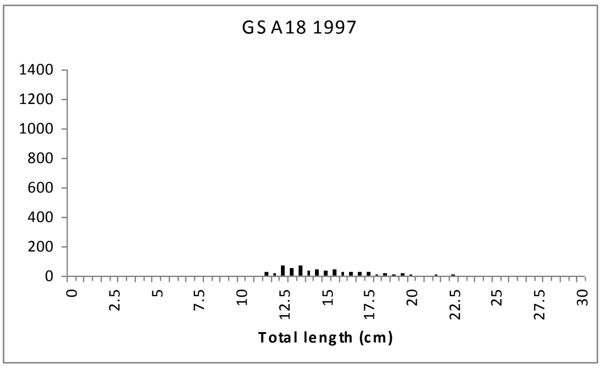
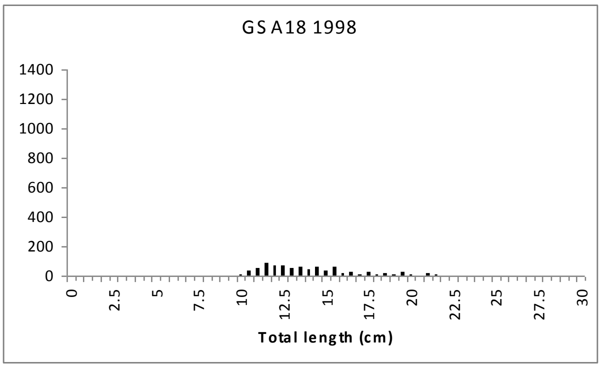


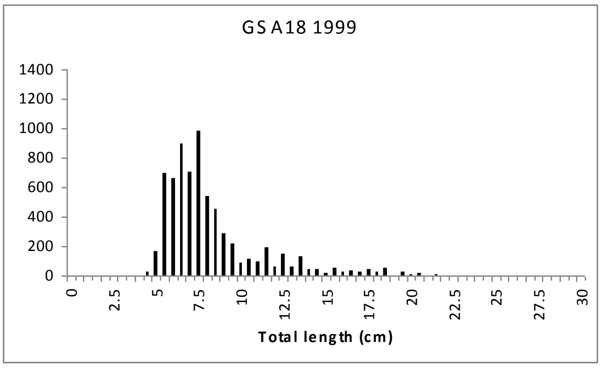
Fig. 6.21.3.1.4.1 Mean length, variance and quantiles derived from the MEDITS length compositions.

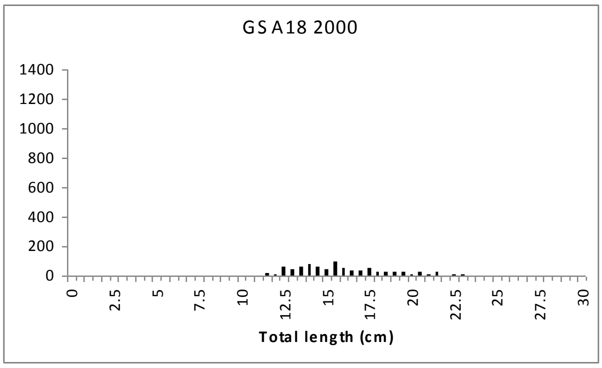
Figure6.21.3.1.4.2 displays the stratified abundance indices by length of red mullet in the GSA 18 in 1996-2011.

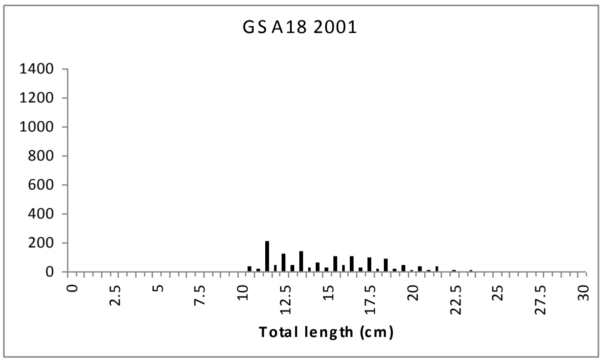

GS A18 1996
Total length (cm)

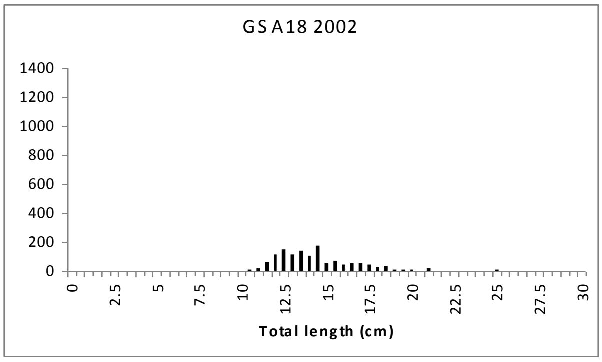

GS A18 1997
Total length (cm)

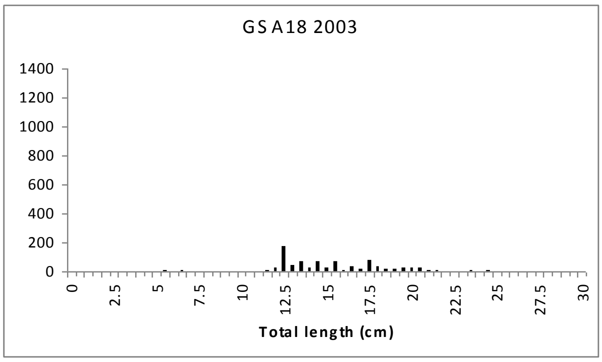

GS A18 1998
Total length (cm)


GS A18 1999
Total length (cm)


GS A18 2000
Total length (cm)


GS A18 2001
Total length (cm)


GS A18 2002
Total length (cm)


GS A18 2003
Total length (cm)

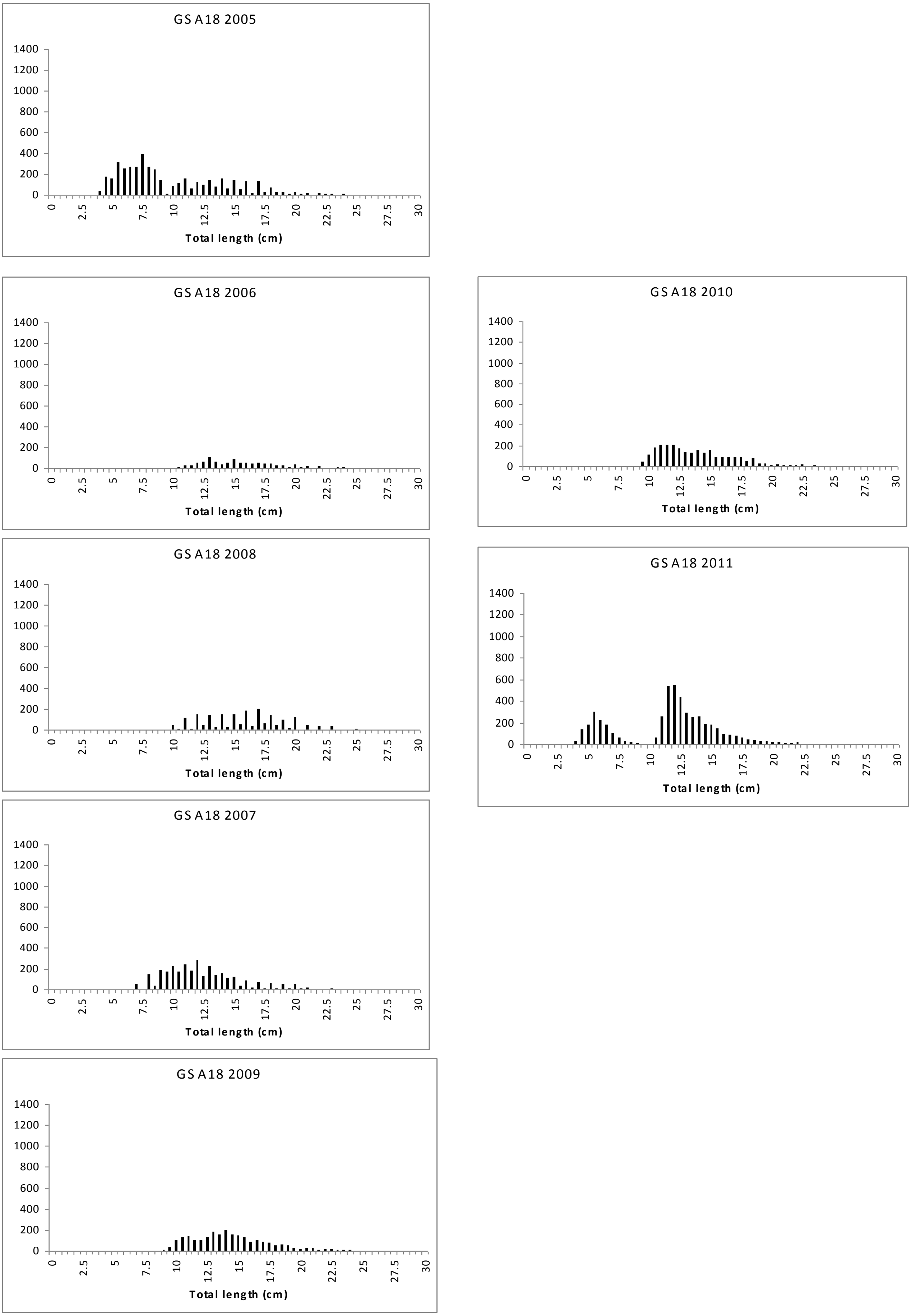


Fig. 6.21.3.1.4.2 Stratified abundance indices by size, 1996-2011.

6.21.3.1.5 *Trends in growth*

The occurrence of growth change along time was not fully explored during EWG 12-10.

6.21.3.1.6 *Trends in maturity*

No analyses were conducted during EWG 12-10.

6.21.4 *Assessment of historic stock parameters*

6.21.4.1 Method 1:XSA

6.21.4.1.1 *Justification*

The assessment of red mullet in GSA18 has been performed during this EWG for the first time. In the last 2012 data call the data from 2007 to 2011 have been provided; the time series from 2007 to 2011 has been considered covering the mean life span of the species, allowing to assess the stock using XSA method. The assessment was performed using the data from the west side only, both for landings and tuning procedures.

6.21.4.1.2 *Input parameters*

For the assessment of red mullet stock in GSA18 the DCF official data on the age structure and landing of commercial catch have been used. A sex combined analysis was carried out. The maturity at age has been estimatedusing the maturity at length transformed to agesby slicing procedure. The natural mortality has been calculated using PRODBIOM (Abella,1998). The survey indices from MEDITS data from 2007 to 2011 have been used for the tuning.

The age distribution is showed in the Figure 6.21.4.1.2.1and in the Tables6.21.4.1.2.1-6.21.4.1.2.6:

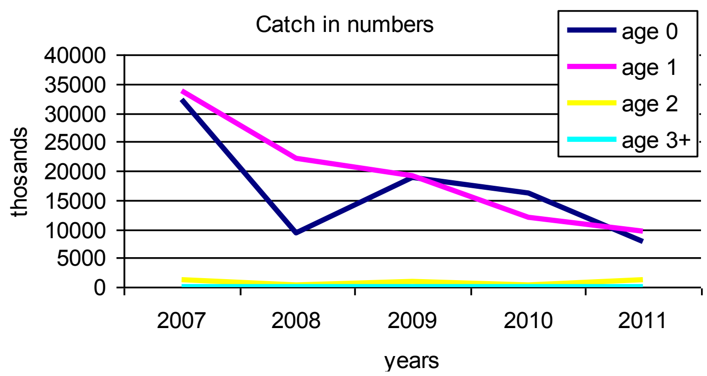


Fig. 6.21.4.1.2.1Catch in numbers by age and year used in the XSA.

The other inputs are reported in the tables below:

Table 6.21.4.1.2.1 Catch in numbers by age and year used in the XSA.

Catch in numbers (thousands)	age 0	age 1	age 2	age 3+
2007	32139	33643	1321	51
2008	9232	22085	393	30
2009	18901	19173	951	21
2010	16208	11962	260	25
2011	7664	9621	1135	25

Table 6.21.4.1.2.2 Weights at age used in the XSA (used for the stock and the catch).

Weight at age (kg)	age 0	age 1	age 2	age 3+
2007	0.005	0.031	0.085	0.148
2008	0.006	0.030	0.085	0.192
2009	0.005	0.037	0.091	0.172
2010	0.005	0.030	0.085	0.168
2011	0.005	0.034	0.082	0.170

Table 6.21.4.1.2.3 Indices from Medits survey used in the XSA.

Survey indices (n/km2)	age 0	age 1	age 2	age 3
2007	192.0	185.1	14.3	0.4
2008	9.3	63.3	23.2	5.4
2009	2.0	70.1	20.1	6.6
2010	2.5	50.5	16.3	2.8
2011	219.9	347.1	27.4	3.8

Table 6.21.4.1.2.4 Proportion of mature at age used in the XSA.

Maturity			
Age 0	age 1	age 2	age 3+
0.16	0.92	1	1

Table 6.21.4.1.2.5Natural mortality at age used in the XSA.

Natural mortality			
age 0	age 1	age 2	Age 3+
1.03	0.71	0.65	0.62

Table 6.21.4.1.2.6Growth parameters and length-weight relationship coefficient used in PRODBIOM.

Growth parameters	
Linf	30
K	0.4
t_0	-0.3
A	0.0083
B	3.1134

6.21.4.1.3 *Results*

A separable VPA as exploratory analysis has been performed not using the tuning data in order to detect the presence of conflicts among the ages under the assumption that the exploitation pattern is constant. The log-catchability residuals in Table 6.21.4.1.3.1and Figure6.21.4.1.3.1do not show particular conflicts.

Table 6.21.4.1.3.1 Log-catchability residuals of the separable VPA.

Log-catchability residuals	2007	2008	2009	2010
0/1	-0.098	-0.329	0.067	0.458
1/2	0.206	0.693	0.164	-0.964

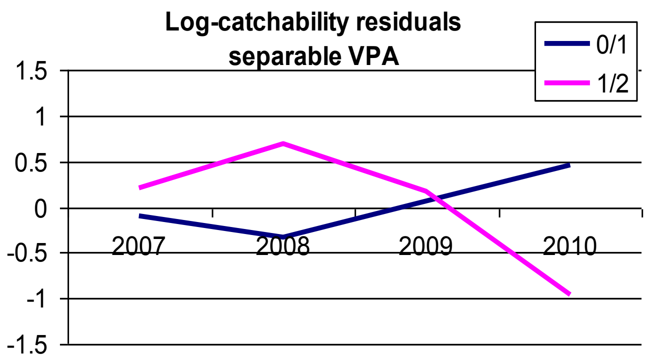


Fig. 6.21.4.1.3.1 Log-catchability residuals of the separable VPA.

The XSA run with the following settings has been performed:

- Catchability dependent on stock size for ages < 1;
- Catchability independent of age for ages >= 1;
- S.E. of the mean to which the estimates are shrunk = 1;
- Minimum standard error for population estimates derived from each fleet = 0.300.

The log-catchability residuals are listed in the table below:

Table 6.21.4.1.3.2 Log-catchability residuals of XSA.

Age	2007	2008	2009	2010	2011
0	-0.06	-0.08	-0.23	0.09	0.27
1	0.83	-0.51	0.26	-0.68	0.11
2	0.52	1.43	1.05	1.27	0.21

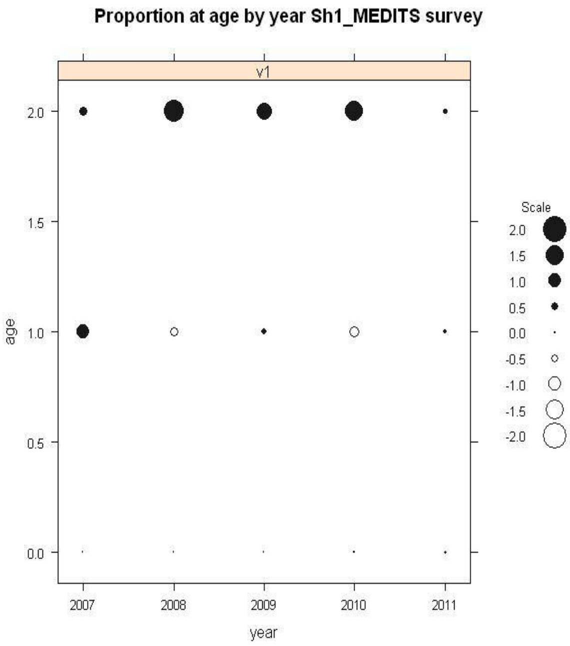


Fig. 6.21.4.1.3.2 Log-catchability residuals of the XSA.

The residuals do not show any particular trend. The other results produced by XSA are:

Table 6.21.4.1.3.3 Fishing mortality by year estimated with XSA.

Fishing mortality	2007	2008	2009	2010	2011
0	0.44	0.18	0.43	0.51	0.12
1	3.41	2.38	3.16	1.66	2.74
2	1.98	1.11	1.81	0.92	1.58
3+	1.98	1.11	1.81	0.92	1.58
Fbar(0-2)	1.94	1.22	1.80	1.03	1.48

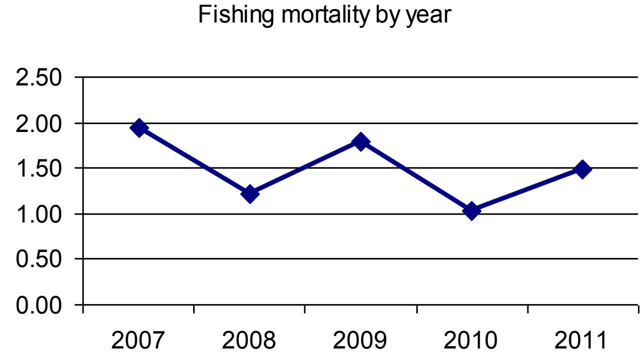


Fig. 6.21.4.1.3.3Estimated fishing mortality by year (F_{bar}(0-2)).

Table6.21.4.1.3.4 Stock in numbers (thousands) estimated by age and year.

Stock numbers (thousands)	2007	2008	2009	2010	2011	2012
0	150989	95451	90702	68208	113221	0
1	49629	34701	28561	21088	14666	35841
2	2121	810	1575	598	1980	464
3+	72	57	31	54	40	218
TOTAL	202810	131019	120869	89947	129907	36523

Table 6.21.4.1.3.5Recruits (thousands), Total biomass (tons), SSB, Landings(tons), Y/SSB.

YEAR	RECRUITS (age 0)	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	F_{bar}(0-2)
2007	150989	3183	732	1680	2.2955	1.94
2008	95451	2009	589	914	1.551	1.22
2009	90702	1757	451	954	2.1164	1.80
2010	68208	1337	461	601	1.3043	1.03
2011	113221	1469	365	532	1.4574	1.48

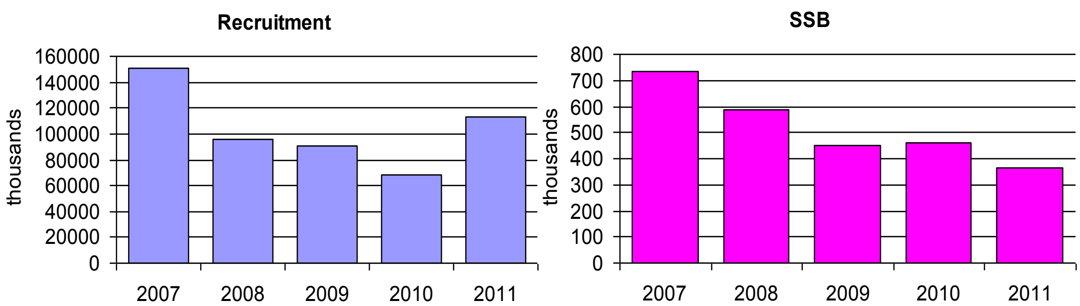


Fig. 6.21.4.1.3.4Estimated recruitment and SSB by year.

The retrospective analysis shows a decreasing signal for SSB also truncating one or 2 years.Moreover, the same shape for F is reconstructed in all the three cases. More variability there is in the recruitment estimates, though the same increasing signal in the last year characterizes the three cases.

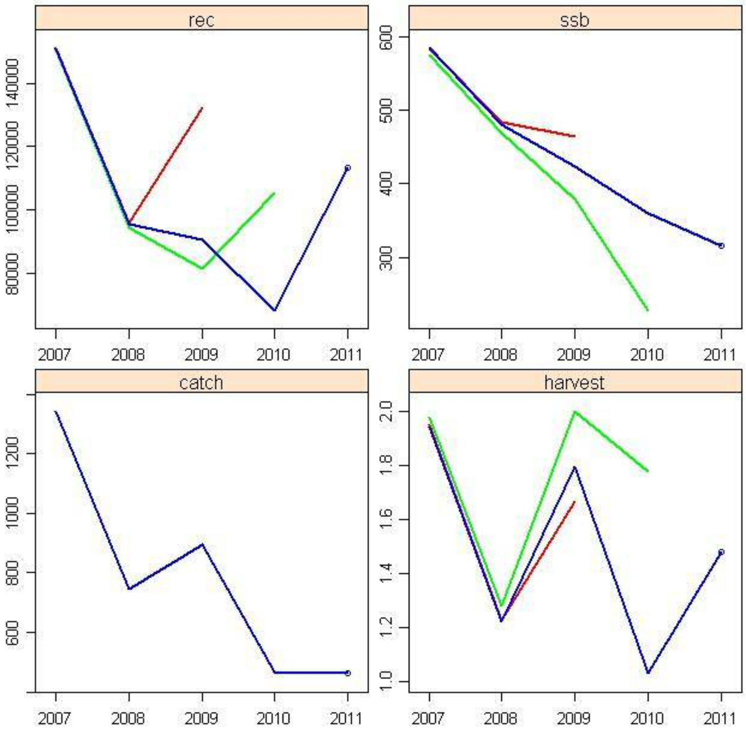


Fig. 6.21.4.1.3.5Retrospective analysis of the XSA.

The results obtained with XSA method showed a decreasing pattern in SSB(from 732 in 2007 to 365 tons in 2011). Recruitment shows a decrease until 2010 and an increase in 2011. The fishing mortality shows a decrease in time from 1.94 in 2007 to 1.48 in 2011.

6.21.5 *Long term prediction*

6.21.5.1 Justification

Yield per recruit (YPR) analysis has been conducted using the Yield software.

6.21.5.2 Input parameters

The same input parameters used for XSA have been used in Yield to perform the YPR analysis, running 1000 simulations. The additional parameters set for YPRare:

- Recruitment constant (104 millions= average of recruitment estimated by XSA from 2007-2011) with CV=0.1;
- Length at first capture: 11 cm;
- CV=0.05 on natural mortality (constant = 0.75 as average of vector M).

6.21.5.3 Results

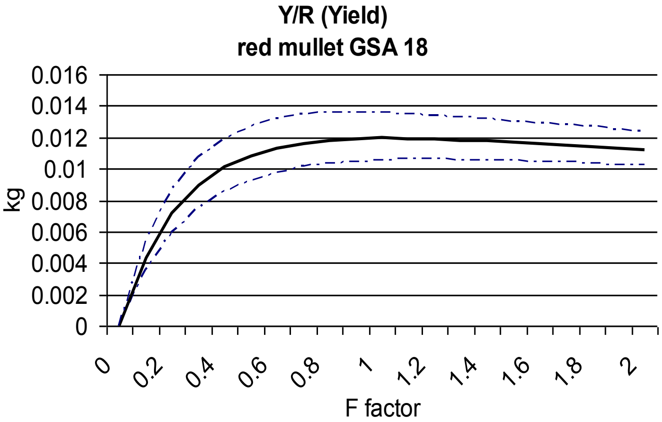


Fig. 6.21.5.3.1YPR curve estimated using Yield.

The $F_{0.1}$ and F_{max} are respectively 0.5 and 1. Moreover, the reference F, corresponding to SSB_{30SPR} calculated by Yield is 0.7.$F_{0.1}$ is used in the advice as proxy of F_{MSY}.

6.21.6 *Data quality and availability*

Data from DCF data call of April 2012 were used. Assessments were performed for the new submitted time series (2007-2011). A consistent sum of products compared with landing and discard was observed (difference less than 10%).Discards data from 2009, 2010 and 2011 were available. In 2009, 2010 and 2011 data were provided by year and metier, in 2007 and 2008 only at fleet segment level. Information on number of samples for landings, discards and catches, as well as the number of measurements by length for landings, discards and catches were also available.

6.21.7 *Scientific advice*

6.21.7.1 Short term considerations

6.21.7.1.1 *State of the spawning stock size*

EWG 12-10 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points. However, survey indices indicate an increasing biomass in recent years

6.21.7.1.2 *State of recruitment*

In 1999 and 2005 the MEDITS surveys indicated peaks in recruitment; in 2011 another peak is present in the survey series and it is also estimated by the XSA.

6.21.7.1.3 *State of exploitation*

EWG 12-10 proposed $F_{0.1}$ = 0.50 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the XSA analysis (current F is around

1.50), the stock is considered exploited unsustainably.

EWG 12-10 recommends the relevant fleets' effort and/or cacthes to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

6.22 **Stock assessment of spottail mantis shrimp in GSA 18**

6.22.1 *Stock identification and biological features*

6.22.1.1 Stock identification

The mantis shrimp, *Squilla mantis*, occurs in the Eastern Atlantic, from the Iberian peninsula to Angola and in the whole Mediterranean, except the Black Sea. It digs burrows on soft bottoms of the continental shelf down to a depth a 100 m, the maximum recorded depth is 247 m (Manning, 1997).

In the Adriatic Sea, the highest densities of *S. mantis* are in northern sector of the basin (GSA 17) commonly found on grounds characterised by fine sands or sandy mud at depths of less than 50 m. In the GSA 18, the species is common both in the western and in the eastern side of the basin (MEDITS data).

Genetic studies to support the stock segregation of the species in GSA 18 are missing, but, considering its territorial behaviour, is possible to assume that the species inhabiting the area is constituted by several sub-populations characterized by a low rate of mixing with sub-populations of GSA 17. Moreover, it is possible to assume that sub-populations inhabiting the western side of the basin are physically separated from the ones present in the eastern side.

However, due to insufficient information about the stock structure of mantis shrimp in the Adriatic Sea, this stock was assumed to be confined within the boundariesof the GSA 18.

6.22.1.2 Growth

The growth has been studied in GSA 18 using indirect method. The length frequency distributions were recorded for males and females using the DCF data and the parameters estimated are presented in Table 6.22.1.2.1.

Table 6.22.1.2.1 VBGF parameters of *Squilla mantis* in GSA 18.

Sex	CL_{inf} (mm)	k	t_0
Both	42	0.5	-0.2

6.22.1.3 Maturity

The mean size of mature females was around 29 mm CL. The proportion of mature are presented in Table 6.22.1.3.1.

Table 6.22.1.3.1 VBGF parameters of *Squilla mantis* in GSA 18.

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5+
Maturity	0.04	0.9	1	1	1	1

6.22.2 *Fisheries*

6.22.2.1 General description of fisheries

S. mantis is an important commercial species in the Adriatic Sea, being caught in trammel nets, otter trawls and beam trawls (Froglia and Giannini, 1989). According to GFCM statistics, Adriatic landings account for 66 % of the Mediterranean landings of this species (FISHSTAT J – GFCM, 2008).

Mantis shrimp does not represent a target species in the fisheries carried out in the GSA 18 but it is part of the mixed species representing the by-catch of demersal otter trawler and set netters using gill nets and trammel nets.

The species is absent from the landings statistic of Montenegro and Albania (FISHSTAT J – GFCM, 2008) and it is not present in the list of shared stock of GFCM. Anyway considering the fishery indipentdent data provided in the framework of MEDITS survey from the eastern side, it is possible to suppose that also in Montenegro and Albania the species is exploited by the artisanal fleets and trawlers.

6.22.2.2 Management regulations applicable in 2011 and 2012

- Minimum landing sizes: none.
- Fishing closure for trawling: 30-45 days in late summer (not every year have been enforced).
- Cod end mesh size of trawl nets: 40 mm (stretched, diamond meshes) till 30/05/2010. From 1/6/2010 the existing nets have been replaced with a cod end with 40 mm (stretched) square meshes or a cod end with 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast. However, towed gears are always forbidden inside 1.5 miles from the coastwith the exception of some areas of the GSA 18 that have benefited from the derogation according by the EC Regulation 1967/2006 for the Mediterranean Sea.

6.22.2.3 Catches

6.22.2.3.1 *Landings*

The Italian landings of mantis shrimp in GSA 18 showed a clear decrasing trend from 2007 to 2011 (Fig. 6.22.2.3.1.1), from 1,157 tons in 2007 to 415 tons in 2011. Similarly to GSA 17, the majority of the catches come from the otter trawl fleet targeting demersal species. In 2011, the 18% of the total landing were from artisanal fishery, mainly using gill nets. A small amount of the landings (less than 2%) are from otter trawlers exploiting mixed demersal and deep water species. Data regarding artisanal fishery using set net are missing from 2007 to 2010. The LPUEs showed the same patterns of the landings (Figure 6.22.2.3.1.2).

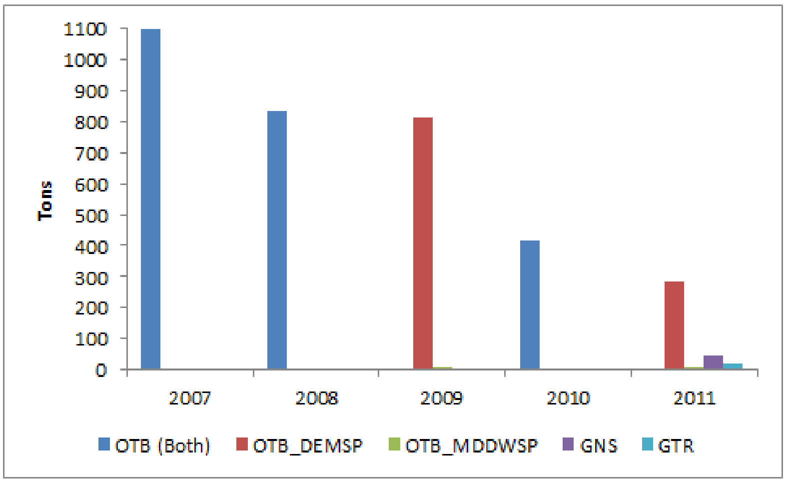


Fig. 6.22.2.3.1.1Landings (in tons) from the trawls and small-scale fleet in the GSA 18 in the period 2007-2011 (official 2012 DCF data call). OTB (Both): otter trawl; GNS: gillnets;GTR: trammel nets;OTB_DEMSP: otter-trawl fleet targeting demersal species; OTB_MDDWSP: otter trawl fleet targeting mixed demersal and deep water species.

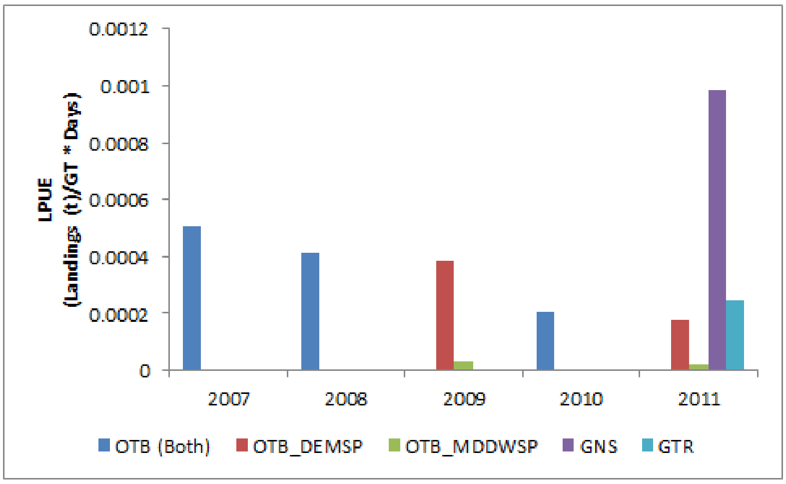


Fig. 6.22.2.3.1.2 Landing per Unit of Effort (LPUE) in GSA 18 in the period 2007-2011 (official 2012 DCF data call). OTB (Both): otter trawl; GNS: gillnets;GTR: trammel nets;OTB_DEMSP: otter-trawl fleet targeting demersal species; OTB_MDDWSP: otter trawl fleet targeting mixed demersal and deep water species.

6.22.2.3.2 *Discards*

According to the data collected in 2011under the DCF, discard represented 15% of the total catch (62 tons). This fraction is mainly observed in the OTB catches and it is composed by non-marketable small specimens and damaged individuals.

6.22.2.4 Fishing effort

The total fishing capacity of the GSA 18 has shown a progressive decrease in these last 8 years. Fishing effort (GT*fishing days) performed by the GSA 18 trawlers fishing for demersal species increased, while the trawlers targeting a pool of mixed demersal and deep water species showed an inverse trend. The GNS and GTR showed general stable trends (Fig. 6.22.2.4.1).

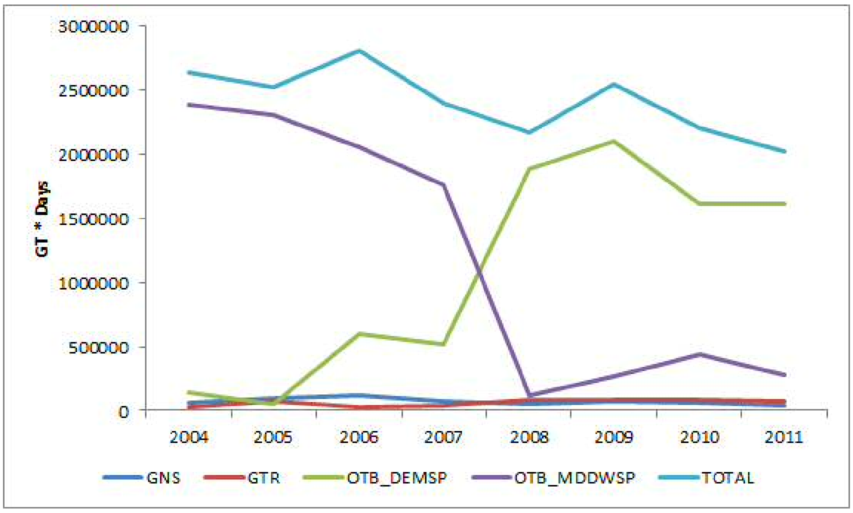


Fig. 6.22.2.4.1Fishing effort (GT* fishing days) for the different type of gears in the GSA 18 during 2004-2011. OTB (Both): otter trawl; GNS: gillnets;GTR: trammel nets;OTB_DEMSP: otter-trawl fleet targeting demersal species; OTB_MDDWSP: otter trawl fleet targeting mixed demersal and deep water species.

6.22.3 *Scientific surveys*

6.22.3.1 MEDITS

6.22.3.1.1 *Methods*

Based on the DCFdata call, abundance and biomass indices were recalculated. In GSA 18 the following number of hauls was reported per depth stratum (Table 6.22.3.1.1.1).

Table 6.22.3.1.1.1 Number of hauls per year and depth stratum in GSA 18, 2002-2011.

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
GSA18_010-050	14	15	18	17	17	17	17	18	14	14	13	11	11	11	12	12	12	12	255
GSA18_050-100	14	14	24	25	25	26	25	24	28	28	29	20	21	20	23	20	20	20	406
GSA18_100-200	24	23	32	33	33	32	33	33	40	39	39	32	31	32	32	30	31	31	580
GSA18_200-500	10	10	19	18	18	19	18	18	20	20	22	13	13	13	12	14	13	13	283
GSA18_500-800	10	10	19	19	19	18	19	19	21	21	19	14	14	14	11	14	14	14	289
TOTAL	72	72	112	112	112	112	112	112	123	122	122	90	90	90	90	90	90	90	1813

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

Confidence interval = $Yst \pm t(\text{student distribution}) * V(Yst) / n$

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.22.3.1.2 *Geographical distribution patterns*

No information was documented during EWG12-10.

6.22.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of the spottail mantis shrimp in GSA 18 was derived from the international survey MEDITS. Figure 6.22.3.1.3.1 displays the estimated trend in abundance and biomass. The estimated abundance and biomass indices do not reveal a clear trend.

Although mantis shrimp is not a target species in the MEDITS survey, data collected allowed to estimate the relative density of the population. In Figure 6.22.3.1.3.1 the trends of the indices of the number of specimens and biomass estimated for the depth stratum 0-200 m are reported.

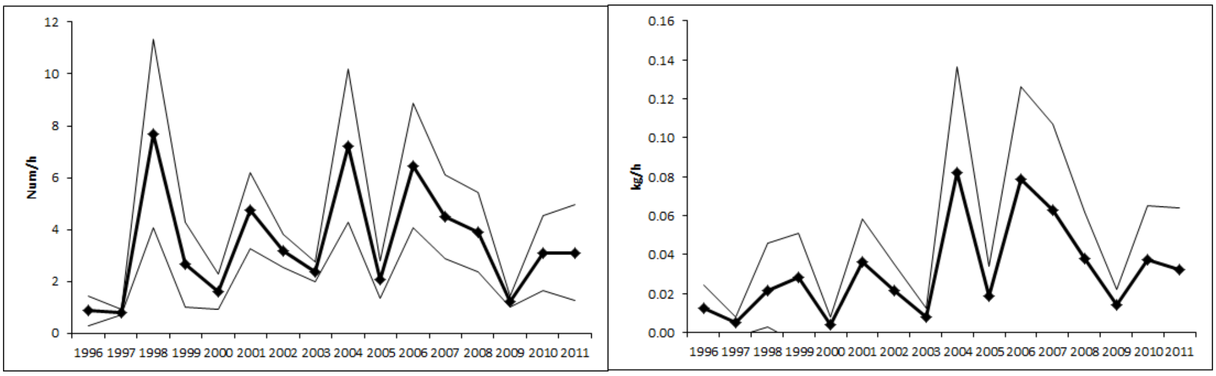


Fig. 6.22.3.1.3.1Trends of the indices of the number of specimens and biomass estimated for the depth stratum 0-200 m (eastern and western side of the basin).

In Figure 6.22.3.1.3.2 the MEDITS data are presented separately for the western and eastern side of the haul carried out in GSA 18. The MEDITS data show that the species is present also in the eastern side and in both cases is not possible to define a trend.

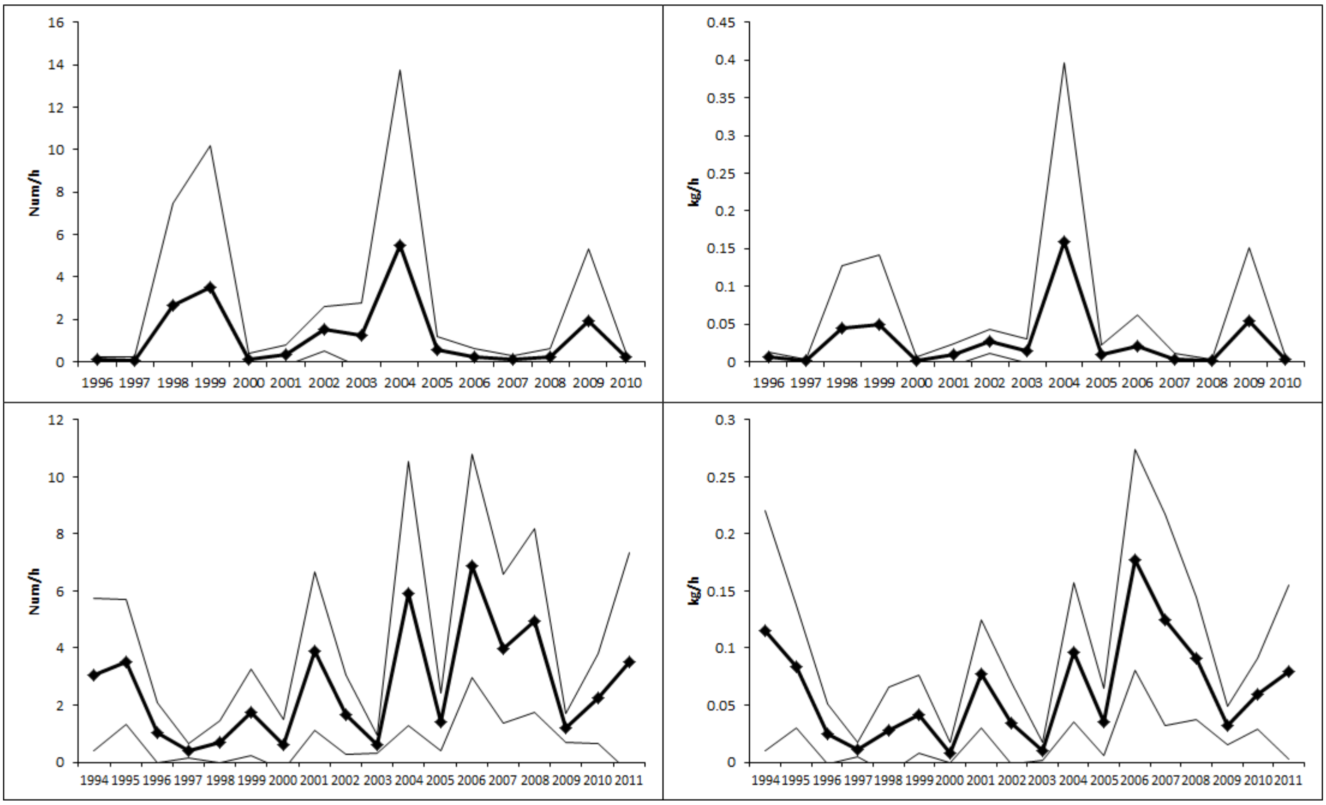


Fig. 6.22.3.1.3.2 Trends of the indices of the number of specimens and biomass estimated for the depth stratum 0-200 m from the eastern side (upper graphs) and western side (lower graphs).

6.22.3.1.4 *Trends in abundance by length or age*

No information was been documented.

6.22.3.1.5 *Trends in growth*

No information was been documented.

6.22.3.1.6 *Trends in maturity*

No information was been documented.

6.22.4 *Assessments of historic stock parameters*

This is the first assessment of mantis shrimp in the GSA 18. Because fishery data from the eastern side of the basin are missing, the assessment is based only on Italian catch data of 2011, assuming that the Italian fleets exploit the stock inhabiting the western side of GSA 18, which can be considered separate from the stock present in the eastern side of the basin.

6.22.4.1 Method 1: Steady state VPA (VIT)

6.22.4.1.1 *Justification*

A VPA was performed aimed at the estimation of a vector of *F* at age using the VIT software. Data on total annual catches by size have been converted in age using knife-edge slicing (LFDA 5.0) based on the VBGF parameters showed in Table 6.22.4.1.2.2. Data used in the analysis were the OTB-DEMSP, OTB-MDDWSP, GNS and GTR catch at age distribution (including discard) of 2011. Considering that only discard data for 2011 were available for the four fleets, it was not possible to perform the analysis also for the previous years.

6.22.4.1.2 *Input parameters*

Data derived from commercial catches (landing and discard) for sexes combined were used to estimate F, the value of the $F_{0.1}$, the numbers at age and other features.

The length frequency distribution (landing and discard) and the age frequency distribution are shown in Fig. 6.22.4.1.2.1and in Fig. 6.22.4.1.2.2, respectively.

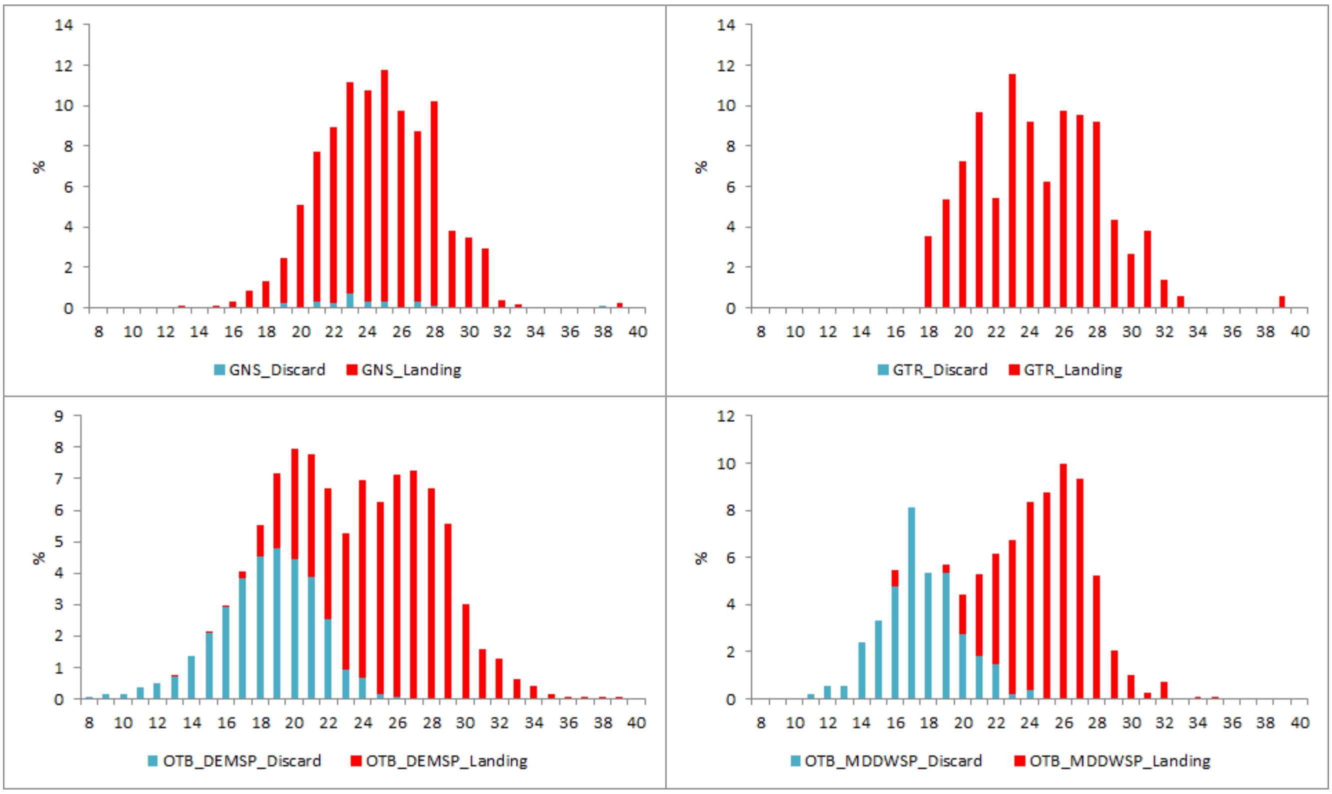


Fig. 6.22.4.1.2.1Size frequency distributions of gillnet (GNS), trammel net (GTR), otter-trawl fleet targeting demersal species (OTB_DEMSP), and otter trawl fleet targeting mixed demersaland deep water species (OTT_MDDWSP) for the year 2011.

Overall, the exploited size range is comprised between 8 and 39 mm carapace length (CL), corresponding to specimens between 0+ and 5 years of age. The discarded specimens show a size range between 8 and 26 mm CL, the majority of them with a size comprised between 16 and 22 mm CL (0+ and 1 age classes). The otter trawl catches,both exploiting demersal species (DEMSP) and mixed demersal and deep water species (MDDWSP), are characterized by a bi-modal size frequency distribution, with the left side composed by an high percentage of discarded specimens and the right side composed by landed individuals (2 and 3 age classes).

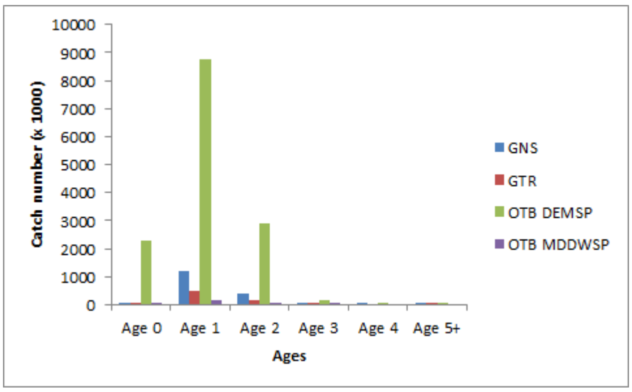


Fig. 6.22.4.1.2.2 Catches numbers at age for 2011.GNS: gillnets;GTR: trammel nets;OTB_DEMSP: otter-

trawl fleet targeting demersal species; OTB_MDDWSP: otter trawl fleet targeting mixed demersal and deep water species.

Table 6.22.4.1.2.1Landings numbers at age (in thousands) for 2011.GNS: gillnets;GTR: trammel nets;OTB_DEMSP: otter-trawl fleet targeting demersal species; OTB_MDDWSP: otter trawl fleet targeting mixed demersal and deep water species.

Age class	GNS	GTR	OTB DEMSP	OTB MDDWSP
0	34.573	16.723	2269.535	67.248
1	1209.605	504.561	8765.185	177.446
2	380.375	169.169	2883.577	33.633
3	1.843	3.135	150.638	0.348
4	0.651	0	16.118	0
5+	3.698	4.149	11.86	0
Total	1630.745	697.737	14096.913	278.675

Table 6.22.4.1.2.2. Set of parameters was used to perform the VPA:

Growth parameters (Von Bertalanffy)
L_∞ = 42 (mm, carapace length)
k = 0.5
t_0 = -0.2
L*W
a = 0.002
b = 2.94
$F_{terminal}$ = 0.84
Natural mortality
M vector Age_0=1.07, Age_1=0.50, Age_2=0.38, Age_3=0.33, Age_4=0.30, Age_{5+}=0.29
Length at maturity (L_{50})
L_{50}= 22.0 mm CL
Proportion of matures
Age_0=0.04, Age_1=0.90, Age_2=1.00, Age_3=1.00, Age_4=1.00, Age_{5+}=1.00

The vector of natural mortality M was estimated using the software Prodbiom.

The F-terminal has been estimated using the length frequency distribution observed during the SoleMon survey in 2011. A catch curve has been used to calculate the total mortality (Z = 1.13; M_{old}= 0.29; F = 1.13 – 0.29 = 0.84; Figure 6.22.4.1.2.3).

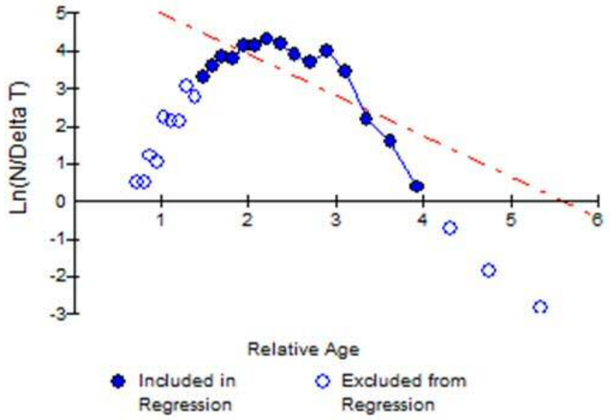


Fig. 6.22.4.1.2.3Catch curve from SoleMon survey LFD data for *Squilla mantis*.

A sensitivity analysis showed that the choice of the F terminal does not affect the results of the analyses more than the changes in the VBGF parameters.

6.22.4.1.3 *Results*

VIT results regarding thepattern of catch in biomass at age, the initial number, the total number and the fishing mortality at age are showed in Figure6.22.4.1.3.1. The total catch in biomass is almost due to the 1 and 2 years old age classes. Fishing mortality significantly affects the stock from 1 year old age class and onwards, with the highest values estimated for 2 and 3 years old age class.

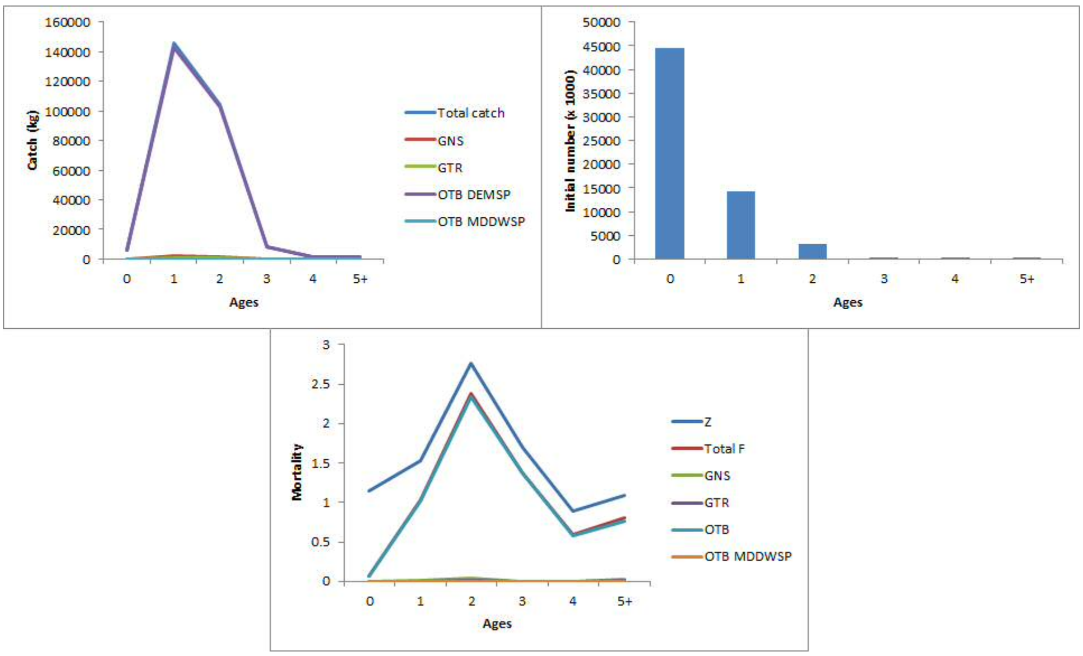


Fig. 6.22.4.1.3.1VPA outputs: catch in biomass, initial number and fishing mortality at age of *S. mantis* in the GSA 18.GNS: gillnets;GTR: trammel nets;OTB_DEMSP: otter-trawl fleet targeting demersal species; OTB_MDDWSP: otter trawl fleet targeting mixed demersal and deep water species.

6.22.5 *Long term prediction*

6.22.5.1 Justification

Yield per recruit (YPR) analysis was conducted based on the exploitation pattern resulting from the VIT model and population parameters.

The YPR analysis allowed to estimate the relative yields and surviving fraction of the parental biomass and to produce an estimate of $F_{0.1}$ which can be considered a proxy of F_{MSY}.

6.22.5.2 Input parameters

The parameters were the same as these used in the VIT model.

6.22.5.3 Results

Table 6.22.5.3.1 shows the reference fishing mortality (F_{ref}), along with the reference points $F_{0.1}$ and the F_{max}. Figure 6.22.5.3.1 shows the results of the YPR analysis.

Table 6.22.5.3.1 Reference fishing mortality (F_{ref}) and the referent points $F_{0.1}$ and the F_{max}.

	Y/R	SSB/R
$F_{0.1}$ = 0.27	6.2	17.5
F_{max} = 0.48	6.6	7.3
$F_{current}$ = 1.04	5.9	1.9

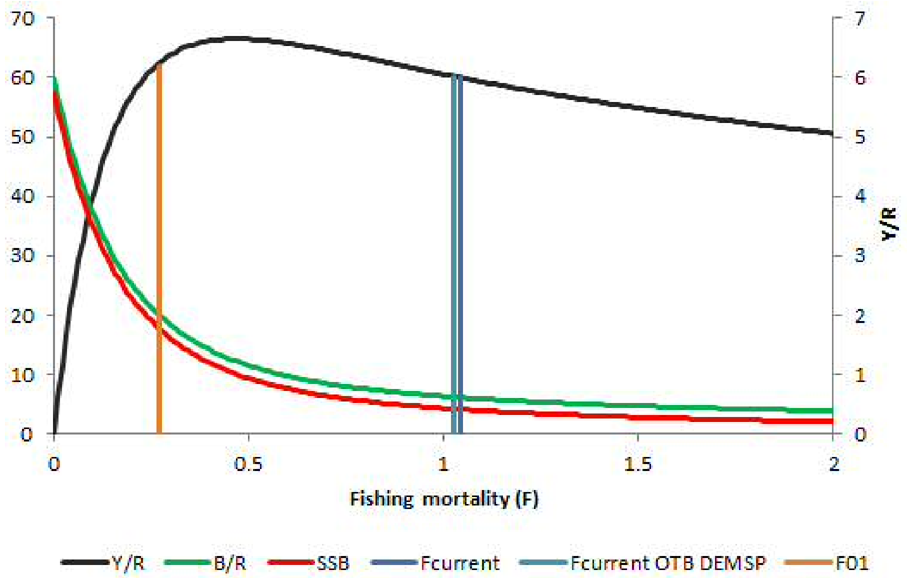


Fig.6.22.5.3.1 Results of the YPR analysis.

6.22.6 *Data quality*

The data available for the assessment were submitted by Italy for the 2012 DCF official data call. In 2011, a lower number of trips and size classeshas been sampled from OTB catches in comparison of the 2008-2010 period. Anyway, no major shortcomings have been evidenced in terms of data completeness for 2011 in comparison with the previous years, when Italian landing and discard data on GNS and GTR were absent.

6.22.7 *Scientific advice*

6.22.7.1 Short term considerations

6.22.7.1.1 *State of the stock size*

EWG 12-10 is unable to fully evaluate the status of the stock size as no biomass reference point is defined. The analyses performed give a SSB estimation of 190 tons in 2011.

6.22.7.1.2 *State of recruitment*

Given the quality of data and results, EWG 12-10 is unable to fully evaluate the state of recruitment. The analyses performed give an estimation of $47x10^6$ recruits in 2011.

6.22.7.1.3 *State of exploitation*

EWG 12-10 proposes $F_{0.1}$≤0.27 as limit management reference point consistent with high long term yields (F_{MSY} proxy).

The current F=1.04 estimated for 2011 is above F_{MSY}(0.27), which indicates that mantis shrimp in GSA 18 is exploited unstainably.

EWG 12-10recommends to reduce fishing mortality towards the proposed reference point F_{MSY}. This can be done by reducing effort or/and catches of the relevant fleets fleet taking into account mixed-fisheries effects. Catch forecasts consistent with the adopted measures shall be estimated.

EWG 12-10 emphasizes that this is the first attempt carried out using a steady state approach to evaluate the exploitation state of the species and, therefore, it is necessary to analyse a longer data series in order to confirm the results obtained for 2011. Moreover different approaches in the age slicing (statistical slicing as implemented during EWG 11-12) can be carried out as an exploratory analysis in order to test the robustness of the employed estimates presented in this report.

6.23 **Stock assessment of Norway lobster in GSA 18**

6.23.1 *Stock identification and biological features*

6.23.1.1 Stock Identification

Lacking specific information on the stock identification of Norway lobster (*N. norvegicus*)in the Adriatic Sea,the stock was assumed in the boundaries of the whole GSA 18,. *N. norvegicus* is a sedentary long-living, slow growing lobster which inhabits burrows constructed in muddy substrates of the upper slope and its presence appears to be related with heterogeneity in the characteristics of the sediment as well as with variations in fishing effort. The species was recorded at depths from about 30 meters in the northern Adriatic Sea to 400 meters in the southern part of the Adriatic Sea (Marano *et al.*, 1998). In the southern Adriatic, along the western (Italian) and eastern (Albanian) coasts, the settlements are not as dense as in northern part(Karlovac, 1953; Marano *et al.*, 1998).

Total mortality has been found negatively correlated with the mean size obtained in different Mediterranean GSAs, although also environmental influences at geographical scale could play an important role (Abellò *et al.*, 2002). Indeed, differences in growth have been highlighted for *N. norvegicus* from different habitats in the same geographical area (Central Adriatic) (Froglia and Gramitto, 1987).

In the Adriatic, *N. norvegicus* spawns once a year (Froglia and Gramitto, 1981). The proportion of females with mature ovaries peaks in spring or at the beginning of summer. Berried females were found in October and November (Orsi Relini *et al.*, 1998), but some specimens can be present up to late spring. According to Karlovac (1953), Norway lobster larvae are present in the Adriatic plankton in late winter, from January to April.

The sex ratio in the catches changes through the year. The proportion of females is lower when they carry external eggs because they are less active and are more often hidden in burrows. On the other hand, this proportion increases and is higher in the mating period (Jukić, 1971; Froglia and Gramitto, 1981; Ungaro *et al.*, 1999).

Data about the length at first sexual maturity highlight that at the first maturity, the individuals are two (Froglia and Gramitto, 1981; 1987) or three years old (Orsi Relini *et al.*, 1998).

In the southern Adriatic commercial catches of Norway lobster are taken on the same fishing grounds as pink shrimp and European hake (AA.VV. 2000; EU project 97/0066 –Medland).

6.23.1.2 Growth

In the DCF framework parameters were estimated from the analysis of LFDs and the following values were obtained: females CL_{∞}=62 mm; K=0.19; t_0= -0.5; males CL_{∞}=80 mm; K=0.17; t_0= -0.5. These estimates are comparable with the values obtained in the SAMED project (2002) in the same area. Parameters of the length-weight relationship were a=0.5749, b=3.1626 for sex combined (length in cm).

These parameters are comparable with the estimates from Marano et al., 1998.

6.23.1.3 Maturity

Studies on maturity cycle of Norway lobster evidenced that maturity process is completed from late-spring summer through autumn and the smallest ovigerous female had 23.5 mm carapace length. Records from literature report a length at first maturity (Lm_{50}) between 30.6 and 34.8 mm, depending on the year. These differences were probably due to the seasonal variations and diverse availability of the species to the gear.

The maturity ogive for females estimated within DCF was 24.2 mm CL and maturity range 2.1 mm as reported in Figure 6.23.1.3.1. In this case females from stage 2b (i.e. MEDITS maturity scale) onwards were considered mature.

The sex ratio evidenced the prevalence of males in the higher size classes.

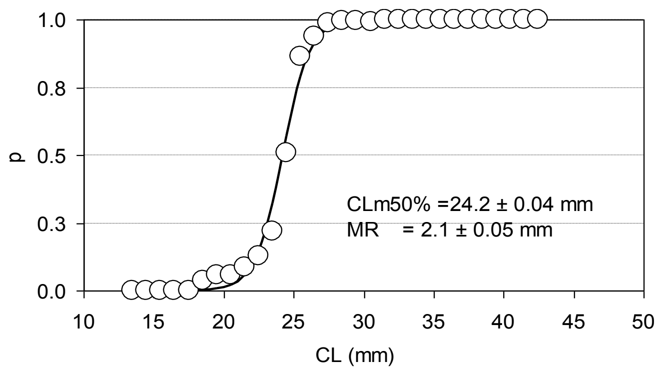


Fig. 6.25.1.3.1 Maturity ogives of females.

6.23.2 *Fisheries*

6.23.2.1 General description of the fisheries

Norway lobster is only targeted by trawlers on offshore fishing grounds and usually occurs with other important commercial species as *M. merluccius*, *Illex coindetii*, *Eledonecirrhosa*, *Lophius* spp., *Lepidorhombus boscii* and *P. longirostris*.

6.23.2.2 Management regulations applicable in 2011 and 2012

Management regulations are based on technical measures, closed number of fishing licenses for the fleet and area limitation (distance from the coast and depth). In order to limit over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late 1980s and fishing capacity has been gradually reduced. Other management regulations are based ontechnical measures (mesh size), minimum landing sizes (EC 1967/06) and seasonal fishing ban, whichin southern Adriatic has been mandatory since the late 1980s. In 2008 a management plan was adopted and foresaw the reduction of fleet capacity associated with a reduction of the time at sea. Two biological conservation zone (ZTB) were permanently established in 2009 (Decree of

Ministry of Agriculture, Food and Forestry Policy of 22.01.2009; GU n. 37 of 14.02.2009) along the mainland, offshore Bari (180 km^2, between about 100 and 180 m depth), and in the vicinity of Tremiti Islands (115 km^2 along the bathymetry of 100 m) on the northern border of the GSA where a marine protected area (MPA) had been established in 1989. In the former, only the professional small scale fishery using fixed nets and long-lines is allowed, from January 1st to June 30, while in the latter the trawling fishery is allowed from November 1st to March 31 and the small scale fishery is allowed all year round. Recreational fishery using no more than 5 hooks is allowed in both areas. Since June 2010, the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coast are also enforced.

6.23.2.3 Catches

6.23.2.3.1 *Landings*

Available landing data are from DCF regulations. EWG 12-10 received Italian landings data for GSA 18 by fisheries which are listed in Table 6.23.2.3.1.1 No data from FISHSTAT FAO were available for the east side of GSA18 for this species in the period 2007-2011.

In general, demersal trawlers account for the majority of the landings. Landings declined from 2007 to 2011.

Table 6.23.2.3.1.1 Annual landings (tons) by fishery, from 2007 to 2011.

YEAR	GEAR	FISHERY	GSA	LANDINGS
2007	OTB	-1	18	1300
2008	OTB	-1	18	1003
2009	OTB	DEMSP	18	984
2009	OTB	MDDWSP	18	103
2010	OTB	DEMSP	18	812
2010	OTB	MDDWSP	18	206
2011	OTB	DEMSP	18	658
2011	OTB	MDDWSP	18	101
2011	OTB	-1	18	106

6.23.2.3.2 *Discards*

The proportion of the discards of Norway lobster in the GSA 18 is generally low (about 3%). Discards data of 2009, 2010 and 2011 were available. Considering the amount of discard and that the collection of discard data was not foreseen in DCF in 2007 and 2008 discard data were not used in the assessment.

6.23.2.4 Fishing effort

The trends in fishing effort by year and major gear type in terms of kW*days are listed in Table 6.23.2.4.1 and shown in Figure 6.23.2.4.1. The fishing effort of trawlers that is the major component of fishing in the area is decreasing.

Table 6.23.2.4.1Effort (kW*days) for GSA 18 by gear type, 2004-2011 as reported through the DCF official data call.

YEAR	GNS	GTR	LLS	OTB		
				DEMSP	DWSP	MDDWSP
2004	67828	29235	60741	147850		2388604
2005	94644	69435	80581	56423		2309466
2006	120055	32007	76098	598799		2054616
2007	70224	45292	74171	519085		1759397
2008	50376	83968	107911	1890398	29701	119323
2009	78139	80946	64941	2101567	18235	266753
2010	57056	79765	87474	1608697	21524	437823
2011	44943	79593	76512	1607442	10809	281989

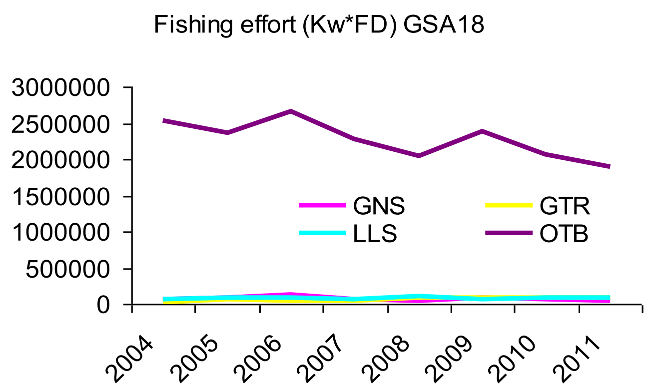


Fig. 6.23.2.4.1Effort (kW*days) for GSA 18 by gear type, 2004-2011.

6.23.3 *Scientific surveys*

6.23.3.1 MEDITS

6.23.3.1.1 *Methods*

According to the MEDITS protocol (Bertrand et al., 2002), trawl surveys were carried out yearly (May-July), applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was used throughout the time series. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish and weight per surface unit) were standardised to square kilometre, using the swept area method.

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 18 the following number of hauls was reported per depth stratum (Table6.23.3.1.1.1).

Table 6.23.3.1.1.1 Number of hauls per year and depth stratum in GSA 18, 1994-2011.

Stratum	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
10-50 m	14	14	18	17	17	17	17	18	12	12	11	10	11	10	13	12	12	12
50-100 m	14	15	24	25	25	26	25	24	20	19	21	20	21	22	21	20	20	20
100-200 m	24	23	33	33	33	32	33	33	31	32	31	33	31	31	33	30	31	31
200-500 m	10	10	18	18	18	19	18	18	13	13	13	13	13	13	12	14	13	13
500-800 m	10	10	19	19	19	18	19	19	14	14	14	14	14	14	11	14	14	14
Total	72	72	112	112	112	112	112	112	90	90	90	90	90	90	90	90	90	90

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution or a quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.23.3.1.2 *Geographical distribution patterns*

Using GRUND survey data two main nursery areas were localized in the GSA offshore Gargano promontory and in the southernmost part of the area using weighted inverse distance method.

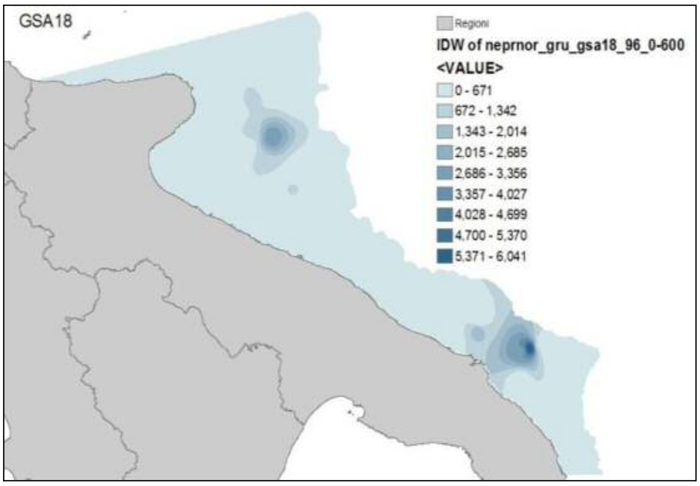


Fig. 6.23.3.2.1 Geographical distribution patterns of nursery of Norway lobster as estimated from GRUND data.

6.23.3.1.3 *Trends in abundance and biomass*

Fishery independent information regarding the state of Norway lobster in the whole GSA18 was obtained from the international survey MEDITS.

Figure 6.23.3.3.1 displays the estimated trend of *N. norvegicus* abundance and biomass standardized to the hour square km in the GSA 18. The pattern is rather stable since 1997 to 2006; then there is a slight decrease in 2007 followed by a remarkable increase in 2009. After 2009, the abundance indices are decreasing at a level similar to those of the whole time series.

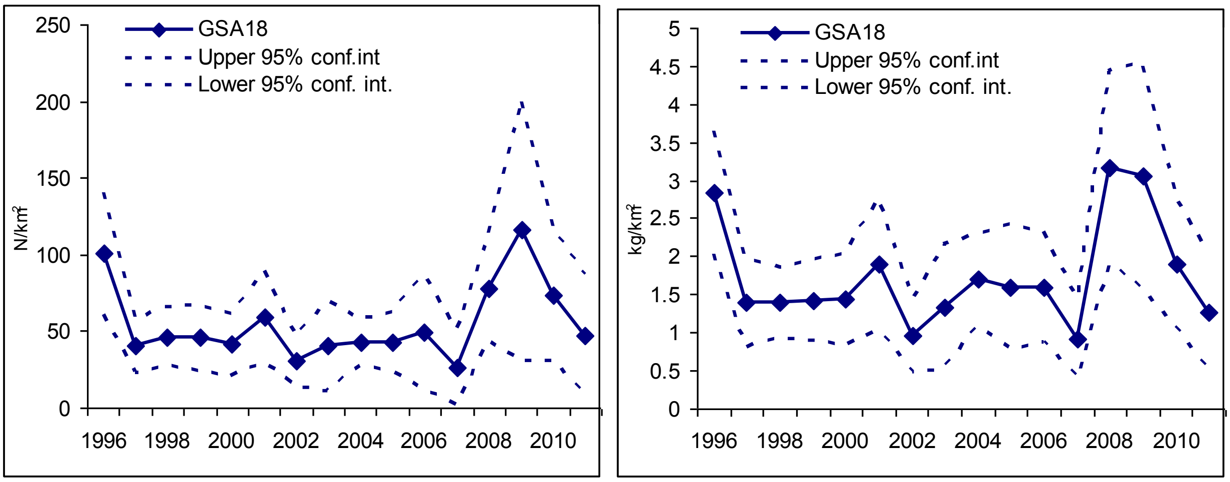
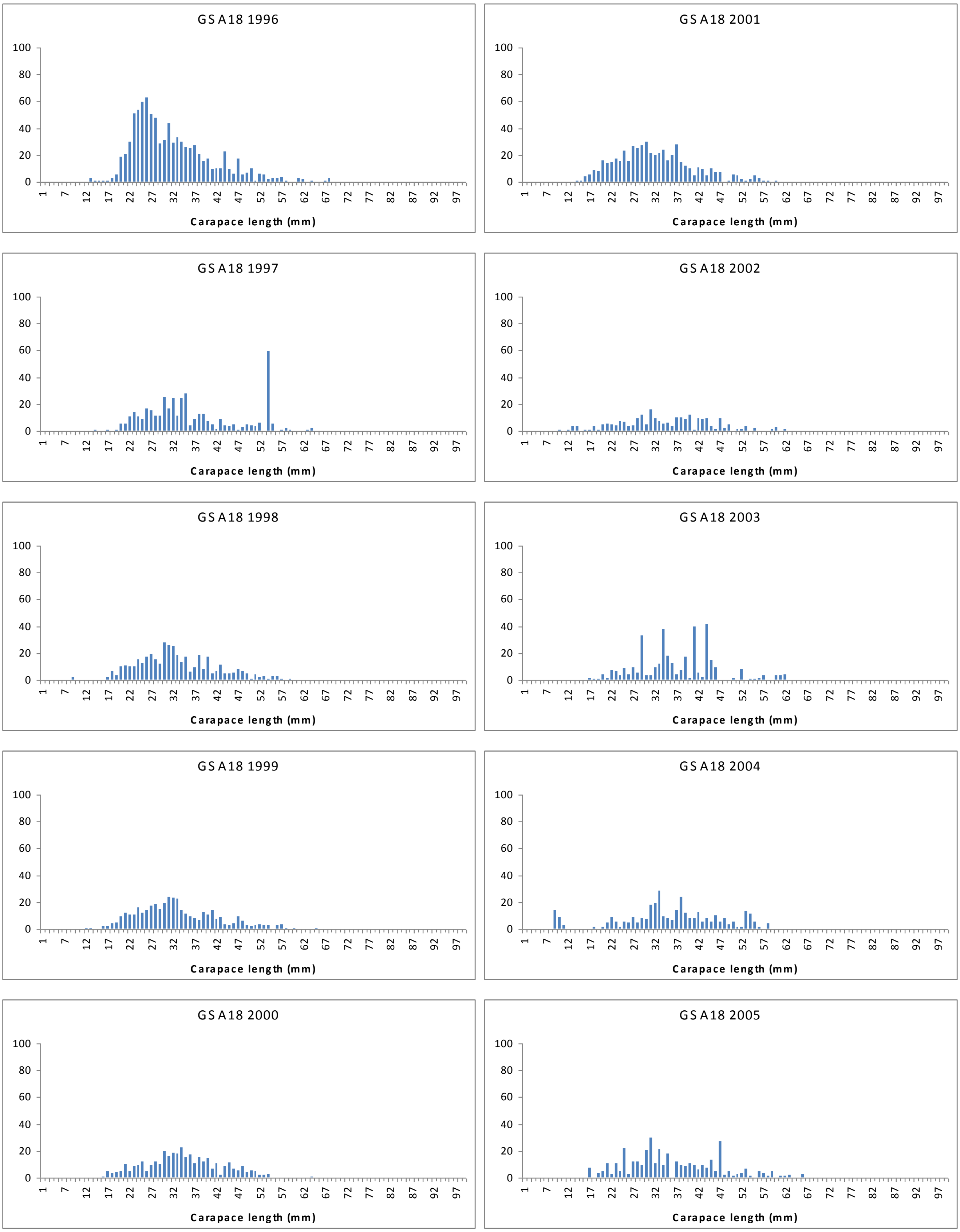


Fig. 6.23.3.3.1 Abundance and biomass indices with confidence interval (95%) of Norway lobster in the GSA18 estimated from MEDITS in whole GSA18 and standardized to the km^2.

6.23.3.1.4 *Trends in abundance by length or age*

The following Figure6.23.3.4.1 displays the stratified abundance indices of GSA18 in 1996-2011.



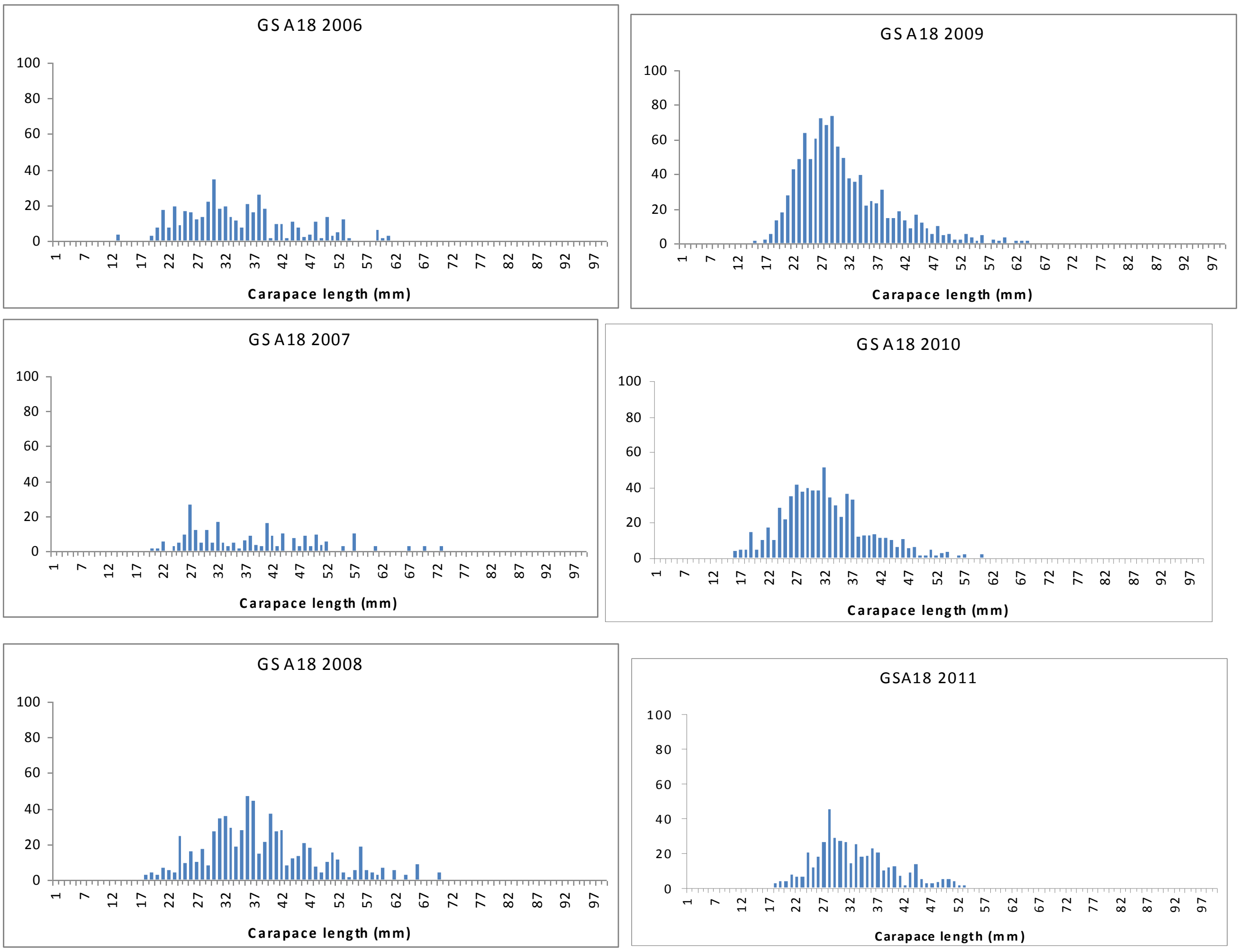


Fig. 6.23.3.4.1 Stratified abundance indices by size, 1996-2011

6.23.3.1.5 *Trends in abundance by length or age*

No information has been documented.

6.23.3.1.6 *Trends in growth*

No information has been documented.

6.23.3.1.7 *Trends in maturity*

No information has been documented.

6.23.4 *Assessment of historic stock parameters*

The assessment was performed only for the western side of the GSA 18, lacking the landing data from the whole GSA 18. The VIT model was applied.

6.23.4.1 Method 1: VIT

6.23.4.1.1 *Justification*

VIT software was applied using the landing structures at age of 2010 and 2011 from DCF. Only the last 2 years of the time series has been used, with an age structure more homogeneous than previous years. Two analyses were performed (one per year).

6.23.4.1.2 *Input parameters*

A sex combined analysis was carried out using the following growth parameters:

CL_{∞}= 71 cm, K= 0.18, t_0= -0.5; length-weight relationship: a =0.574, b = 3.15.

Considering the slow growth pattern, combined with the species behavior and its availability to the gears at early life stages, Norway lobster has been assumed fully recruited to the fishery between the first and the second year of life. Given these considerations, aconstant value of natural mortality M = 0.47 was estimated using Beverton & Holt Invariant method (Ragonese et *al*. 2006). This M value is quite close to the constant natural mortality used for the same species in GSA 9 during STECF EWG 11-12. Catch at age was used as input in the VIT and isshowed in Table 6.23.4.12.1. Proportion of matures (0 at age 0, 0.058 at age 1, 0.827 at age 2 and for older ages 1) has also been used.

Following a sensitivity analysis performed for both years with terminal F equal to 0.4, 0.5 and 0.6, a terminal fishing mortality F_{term}= 0.5 was assumed.

The F for the last 2 years has been calculated for the age classes between 1 and 7, being these the age classes more represented in the catches.

Table 6.23.4.1.2.1 Landings in numbers at age in 2010 and 2011.

Age	**2010**	**2011**
0	36457	14912
1	8782857	6895022
2	20786440	15695300
3	9258378	8288052
4	2747913	2511560
5	862771	648862
6	254600	217108
7	94207	69098
8	33260	26777
9	9764	7150
10	4349	4632
11	1951	378
12	4031	183
13	439	33
14	363	182
15+	300	57

6.23.4.1.3 *Results*

Estimates of fishing mortality at age for sex combined and reconstructed catch in weight by age as estimated by the cohort analysis using VIT are plotted in the Figure 6.23.4.1.3.

F was equal to 0.47 in 2010 and 0.54 in 2011, with an average of 0.5.

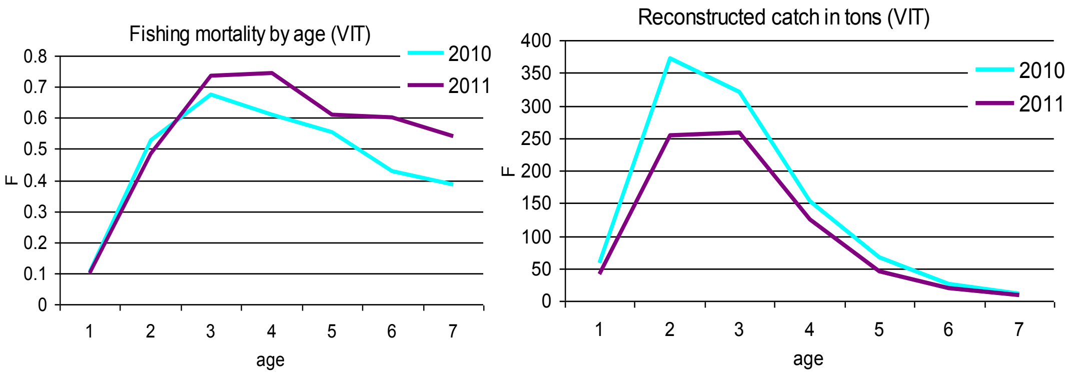


Fig. 6.23.4.1.3 Fishing mortality by age as estimated by the cohort analysis using VIT, by year (2010-2011).

6.23.5 *Long term prediction*

Yield per recruit (YPR) analysis has been applied for long term predictions using VIT software.

6.23.5.1 Method 1: VIT

6.23.5.1.1 *Justification*

The cohort analysis and YPR, implemented under equilibrium conditions in the VIT software, were used to calculate limit and target reference points for the stock.

6.23.5.1.2 *Input parameters*

Input parameters are given in section 6.23.4.1.2.

6.23.5.1.3 *Results*

Results of the YPR analysis from the VIT are shown in the Figure 6.23.5.1.3.1. The analyses indicate that the reference point $F_{0.1}$ (proxy of F_{MSY}) is on average 0.30 .

The sensitivity analysis performed for both years with terminal F equal to 0.4, 0.5 and 0.6 indicates that this parameter is stable and producesvery similar results.

2010	Factor	F(1-7)	Y/R	B/R	SSB	2011	Factor	F(1-7)	Y/R	B/R	SSB
F(0)	0.00	0.00	0.00	43.60	38.89	**F(0)**	0.00	0.00	0.00	43.60	38.89
F0.1	0.66	0.31	5.02	16.92	12.53	**F0.1**	0.56	0.30	5.08	18.01	13.56
Fmax	1.18	0.55	5.36	11.21	7.02	**Fmax**	1.07	0.58	5.47	11.82	7.57
Fcurr	1.01	0.47	5.33	12.59	8.34	**Fcurr**	1.01	0.54	5.47	12.30	8.03
Fdouble	2.00	0.94	5.13	7.62	3.71	**Fdouble**	2.00	1.09	5.19	7.72	3.78

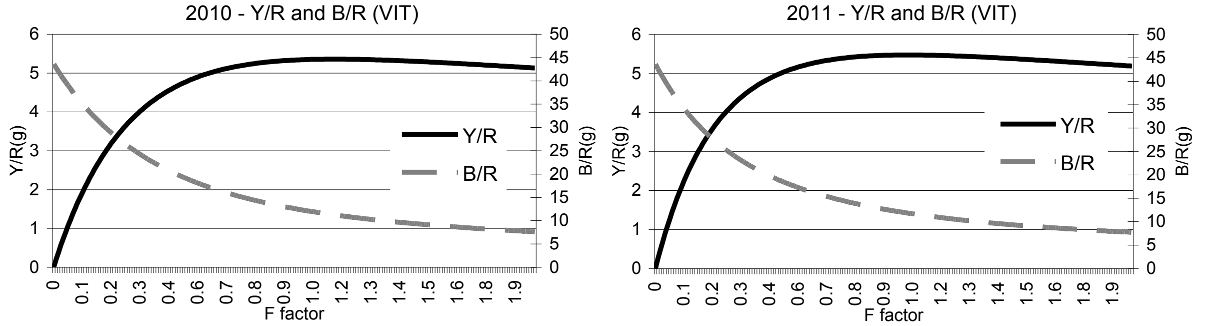


Fig. 6.23.5.1.3.1 Norway lobster in GSA18. Overall results and graphs of YPR analysis using VIT software, years 2010-2011.

6.23.6 *Data quality and availability*

Data from DCF data call issued in 2012 were used. A consistent sum of products compared to landings was observed (differences less than 10% for age data and lesser than 5% for length data). In 2009, 2010 and 2011 data were provided by year and metier, in 2007 for fleet segment.

Discards data of 2009, 2010 and 2011 were available. The proportion of the discards of Norway lobster in the GSA 18 is generally low (less then 3%) and thus they were not used in the analysis.

Information on number of samples for landings, discards and catches, as well as the number of measurements by length for landings, discards and catches were also available.

6.23.7 *Scientific advice*

6.23.7.1 Short term considerations

6.23.7.1.1 *State of the spawning stock size*

MEDITS Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h). The pattern is rather stable between 1997 and 2006, followed by a slight decrease in 2007 and a large increase in 2009. After 2009, the abundance indices are decreasing at a level similar to the average of the time series.

6.23.7.1.2 *State of recruitment*

Recruitment estimates from MEDITS surveys (individuals smaller than size at first maturity were considered as recruits) in the GSA 18 showed an increase from 2007 and 2009 and then a decrease until 2011 (Figure6.23.7.1.2.1). The initial numbers reconstructed by VIT (2010-2011) are consistent with this pattern.

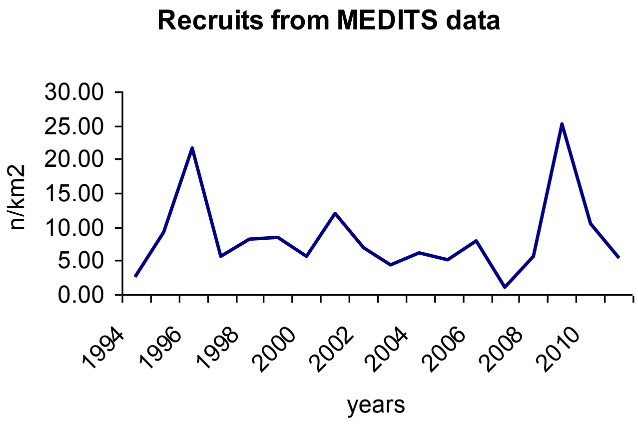


Fig. 6.23.7.1.2.1 Recruits (individuals with size less than the size at the first maturity = 24 mm) from MEDITS data.

6.23.7.1.3 *State of exploitation*

EWG 12-10 proposed $F_{0.1}$ = 0.30 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 0.54), the stock is considered exploited unsustainably.

EWG 12-10 recommends the relevant fleets' effort and/or cacthes to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

7 ToRE Quality and completeness of the official Mediterranean DCF data call

STECF EWG 12-10 undertook a scrutiny of the DCF data. Data omissions, inconsistencies and errors were detected by the experts and will be reported to STECF, DG Mare and the national DCF correspondents.

The STECF EWG 12-10 working group recognized that the actual DCF data call as defined and conducted in 2012 to support its analysis, in accordance with the ToRs from DG MARE, has been significantly improved when compared with previous calls. However, current data call had a partial success with regard to scientific requirements as some assessments could not be carried out due to lack of data. Several data submissions continued to be generally late (i.e. after the submission deadline) and contained data errors or did not included all the data necessary for the assessment. EWG 12-10 identified significant issues and in the following section of the present report, comments of data quality are presented by country, GSA and species. Data quality, with a particular focus on MEDITS trawl gear performance is assessed in the next sections (7.2).

7.1 Quality of Mediterranean DCF Data Call

Spain

GSA 05

Norway lobster, only part of the Spanish data was submitted in time before the meeting; catch data was only available by age but not by size. However, during the meeting, the remaining data was submitted, so it could be used for performing the assessment.

GSA 06

Blue Whiting, data on the lengths or ages of discards was not available. There is a scarcity of discards data in GSA 06 both in terms of absolute quantity and in length or age information, which could be important for the assessment of this species as age class 0 is mainly discarded.

Black-bellied anglerfish, the landings have increased over the 2002-2012 period, although there is some uncertainty as to whether the reported landings in the data call represent only *Lophius budegassa* or a mix of the two species of *Lophius* (i.e. *Lophius piscatorius*).

France

GSA 07

Mediterranean hake, discards were not included in the catches before 2008 because they were considered negligible. However, in 2008 some discards appear (173 t) due to more stringent controls and an exceptionally high recruitment, and they were thus included in the catch at age matrix. In 2009, the level of discards decreased again (9 t) but discards were still included in the catches. In 2010 and 2011, no discards data was available.

Red mullet, information on French gillnetters is available from 2011 only. The French gillnetters are suspected to have fished red mullet in the past, but no data is available to quantify their catches in the past. Data on fishing effort was to be provided over the period 2002-2011, on a quarterly basis. However, no data was available for Spain in 2011 and no data was available for France in 2009 and 2010. For 2011, French data only consists in number of boats for OTB, but the value is not considered realistic and need to be cross-checked.

Black-bellied anglerfish, since they were not available in the data call, the discards were not included in the catches. This data will be possibly included at the next meeting. For France, data on fishing effort was provided on a yearly basis for OTB and OTM, over the period 2003-2008. No data was provided for 2009-2011. For Spain, fishing effort was provided for OTB and LLS over 2002-2010 but no data was provided in 2011.

Italy

GSA 09

Blue whiting, for MEDITS survey, some minimal differences in the development of the time trend between hour indexes and those for square kilometers were recognized and a check on swept area values needs to be done.

Sardine, the landing of sardine coming from other gears (i.e. mainly otter trawler) is about 1% of the total landings, although information is available for the other gears only in the last two years. Data concerning fishing activity and fishing effort of the purse seine fleet for GSA 09 have been regularly submitted by the Italian Authorities.

GSA 10

Mantis shrimp, the data used in the analyses were DCF length frequencies and age frequencies from the 2012 data call, for the year 2011. Landings of mantis shrimp for 2008 and 2009 were reported for otter trawl, while trammel net and gillnet catches were not reported in these years No data on landings was available for 2010.

GSA 11

Mediterranean hake, landing and discard seems to be misreported in some years for GTR. In particular landings at length for GTR are not reported in 2007, while for LLS are only reported in 2009. Even if the contribution to total landings of these fisheries (GTR and LLS) is not high in the GSA 11, it is not clear to EGW 12-10 if they are or not belonging to a real fishery for hake. Furthermore, GTR discards are reported in 2005, 2010 and 2011.However, data seems to be not reliable in terms of the estimated length distribution (i.e. lengths range from 27 to 48 cm), but also because this is the only GSA in the region where discards have been reported for this gear. Finally the large increase of total discards (mainly due to OTB) in 2011, which is more than 10 fold greater of previous years, must be checked.

GSA 17

Red mullet, no Croatian data are available to the STECF EWG 12-10, discards data have been collected in the last two years, but only for 2011 are available disaggregated by age as well.

Mantis shrimp, the data available for the assessment were submitted in the 2012 DCF official data call by Slovenia and Italy. Because of the absence of information regarding the number of trips and length sampled, both related to the landed and discarded portions, was not possible to check the quality of the data. Anyway, no major shortcomings have been evidenced in terms of data completeness for 2011 in comparison with the previous years, when Italian data on GNS and TBB were absent. Finally, the length frequency distribution of the catches is provided at 2 mm size class. In other GSA the measurements are collected at 1 mm, so the EWG 12-10 suggests to use the same approach (i.e. 1 mm size class) also in GSA 17.

GSA 18

Pink shrimp, in 2008, length structures of the landings were not available, given that the species was not a target of the biological samplings for length.

Red mullet, discards data from 2009, 2010 and 2011 were available. In 2009, 2010 and 2011 data were provided by year and metier, in 2007 and 2008 only at fleet segment level, according to the DCR framework.

Mantis shrimp, in 2011, a lower number of trips and size classes has been sampled from OTB catches in comparison of the 2008-2010 period. Anyway, no major shortcomings have been evidenced in terms of data completeness for 2011 in comparison with the previous years, when Italian landing and discard data on GNS and GTR were absent.

Italy&Malta

GSA 15-16

Common Pandora, STECF EWG 12-10 notes that the discrepancies in the estimation of MEDITS swept area in GSA 15 and GSA 16 were not corrected in response to the official data call for the Mediterranean and Black Sea sent to Member States on the 12th April 2012. Information on total landings by fleet segment for *P. erythrinus* in GSA 15 & 16 was missing for 2010 in GSA 15, although this information had been available at STECF EWG 11-12. There were considerable annual differences between the length frequency data available for larger individuals targeted by the artisanal fleet in GSA 16, and such data was only available for 2011 for two fleet segments (GTR and LLS) in GSA 15. There was no discards information for GSA 15 and discards data for GSA 16 was limited to bottom otter trawlers in 2010 and 2011.

Red mullet, STECF EWG 12-10 notes that there was no discards information for GSA 15.

Black-bellied anglerfish, Italian landings data as well as Italian and Maltese discards data for black bellied anglerfish were not submitted during the latest DCF data call and thus was not available to EWG 12-10.

7.2 MEDITS trawl survey performance

During STECF EWG 11-12 meeting, an overview of the MEDITS trawl survey gear performance based on the data available in the JRC database was carried out and several inconsistencies were identified. Subsequently, in the data call of the 12th April 2012 a request for revised Wing Opening (WO) data was made.

To investigate suspicious patterns or clearly erroneous gear performances a series of plots was generated to explicitly explore problems in WO at different depths. Valid hauls only where selected including both measured and estimated wing opening. This in theory should indicate the difference between tows monitored with Scanmar/Simrad and tows not monitored directly but using some form of regression formulae, like those derived by Souplet or Fiorentini, to derive WO at different depth. From visual inspection (Fig.7.1) it appears that only Spanish vessels (Corinde) and French vessels (L'Europe) report WO data from Scanmar/Simrad measurements and not the results from a model based on Scanmar/Simrad data or regression formulae as from Souplet or Fiorentini. The parameter GEOMETRICAL_PRECISION should indicate if WO was measured with Scanmar (M) or estimated (E), however it appears to be used inconsistently by different countries (
Table 7.1).

Table 7.1.1 Summary table indicating the number of MEDITS tows for which trawl gear performance was monitored with Scanmar/Simrad (Geometrical Precision "M") or derived from models (Geometrical Precision "E") by country and year.

Country	CYP	CYP	ESP	ESP	FRA	FRA	GRC	GRC
GEOM_PRECISION	E	M	E	M	E	M	E	M
1994	0	0	0	83	0	94	25	85
1995	0	0	0	111	16	74	120	0
1996	0	0	0	107	10	77	56	101
1997	0	0	0	102	15	74	70	94
1998	0	0	0	94	2	93	61	117
1999	0	0	0	117	3	88	61	117
2000	0	0	0	114	2	90	55	118
2001	0	0	0	125	8	81	54	116
2002	0	0	0	136	3	61	0	0
2003	0	0	0	140	1	95	123	51
2004	0	0	0	128	91	1	98	19
2005	25	0	0	123	2	88	60	55
2006	0	25	0	147	4	88	60	118
2007	0	25	0	164	5	86	0	0
2008	0	27	0	176	13	68	61	120
2009	0	27	0	169	2	86	0	0
2010	0	27	0	131	21	62	0	0
2011	0	26	0	169	16	80	0	0

Country	HRV	HRV	ITA	ITA	MLT	MLT	SVN	SVN
GEOM_PRECISION	E	M	E	M	E	M	E	M
1994	0	0	470	0	0	0	0	0
1995	0	0	418	41	0	0	0	0
1996	0	0	590	0	0	0	2	0
1997	0	0	591	0	0	0	2	0
1998	0	0	589	0	0	0	2	0
1999	0	0	589	0	0	0	2	0
2000	0	0	589	0	0	0	2	0
2001	0	0	589	0	0	0	2	0
2002	60	0	696	0	45	0	2	0
2003	0	0	695	0	45	0	2	0
2004	0	0	691	0	44	0	2	0
2005	59	0	520	217	45	0	2	0
2006	0	0	623	120	45	0	0	0
2007	0	0	753	0	46	0	4	0
2008	0	0	747	0	45	0	2	0
2009	0	0	750	0	45	0	2	0
2010	0	0	752	0	45	0	2	0
2011	0	0	756	0	44	0	2	0

By fitting a Generalized Additive Model (GAM) to the WO and Haul Depth (HD) the relationship between these variables by country is explored. Considering that Spain and France mostly report measures of gear performance while the rest report estimates obtained on Scanmar/Simrad data by regression formulae or formulae as from Souplet or Fiorentini, a major difference emerges in how WO is estimated from one country to another. Coorinde and L'Europe are large survey vessels while the other vessels are mainly small trawler, but the way the net opens with increasing depth appears substantially different between the two groups. In tows where WO is estimated (E) (ITA, MLT, GRE, CYP) by regression after depths of 200 m the WO goes asymptotic while this does not happen in tows that are measured with Scanmar (ES and FRA) (Fig.7.1.1). The variability in WO is large when gear is monitored and very stable when derived from models.

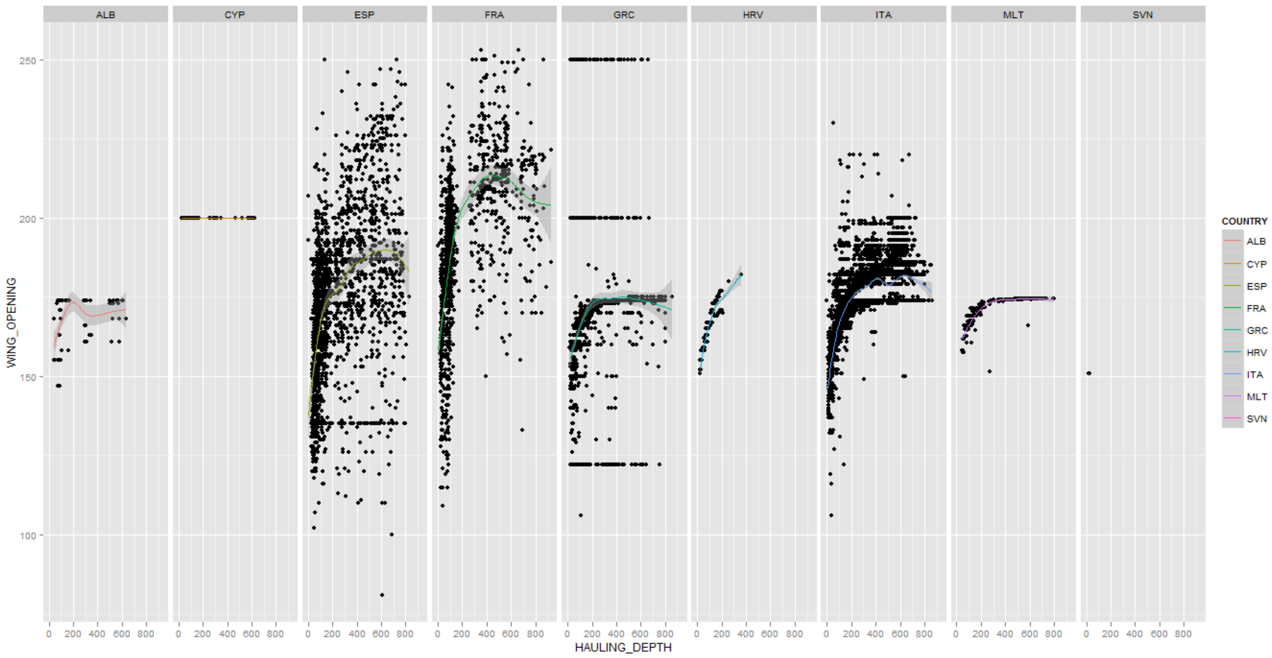


Fig.7.1.1 Wing Horizontal Opening (in dm)(WO) against Hauling Depth (in m) from MEDITS fitted for each country with a GAM regression between WO and HD. The Wing Opening at similar depths is very different from one country to the other and the variability is much higher when gear performance is monitored rather than modeled.

More detailed plots explores the relationship between WO and HD by year and GSA to identify discrepancies between countries and years and verify the corrections made to WO from previous submissions.

In Italy MEDITS gear performance is mainly derived from models and WO at depth is plotted by GSA in Fig. 7.1.2. There is a change in the slope between WO and depth from 2004-2005 and onwards in GSA 9 while in GSA 10 there is less variation in the early series and an increase in wing opening in recent years. In GSA 11 some major change happened in 2011 with much larger and variable openings while in GSA 16 17, 18 and 19 the estimates of WO is rather constant over the years. Clearly no variation in WO is allowed for by the regression models returning estimated of WO at depth.

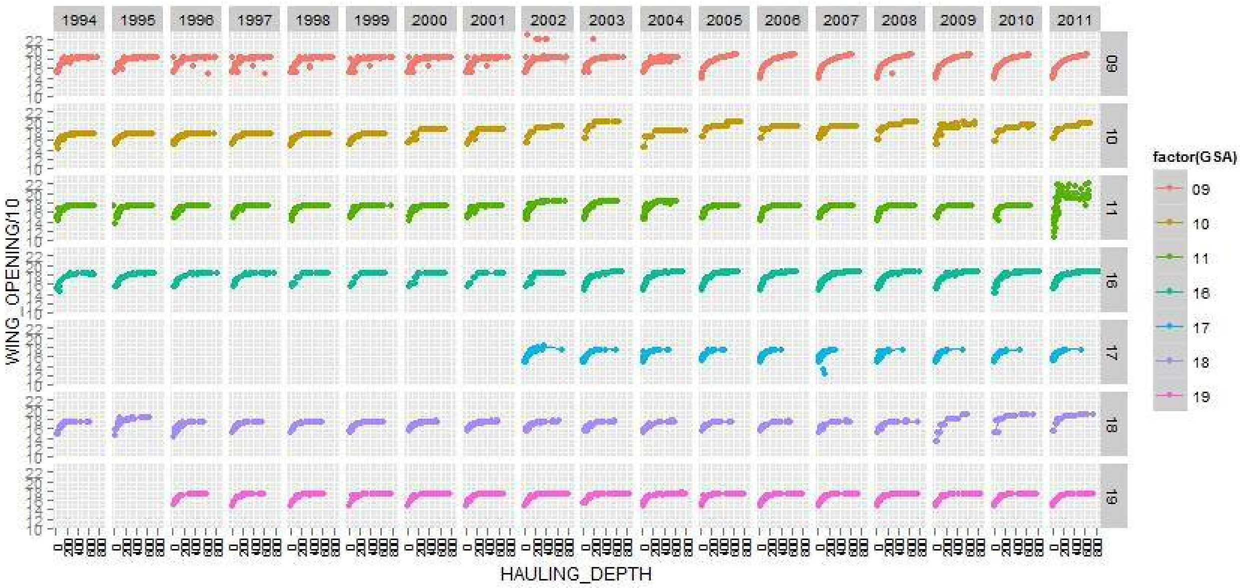


Fig. 7.1.2 MEDITS trawl WO at depth by GSA in ITALY from 1994 to 2011.

An overview of the Spanish MEDTS WO at depth is plotted in Fig. 7.1.3. There is a year to year variability in the overall WO with some years of higher opening than others. Clear data inconsistencies emerge for 1994, 1998 and 2008 and need to be resolved since swept areas derived from such WO would be severely biased. Strange patterns emerge also from data in 1995 and 1996 in GSA 01 (Fig. 7.1.3Fig.7.1.4).

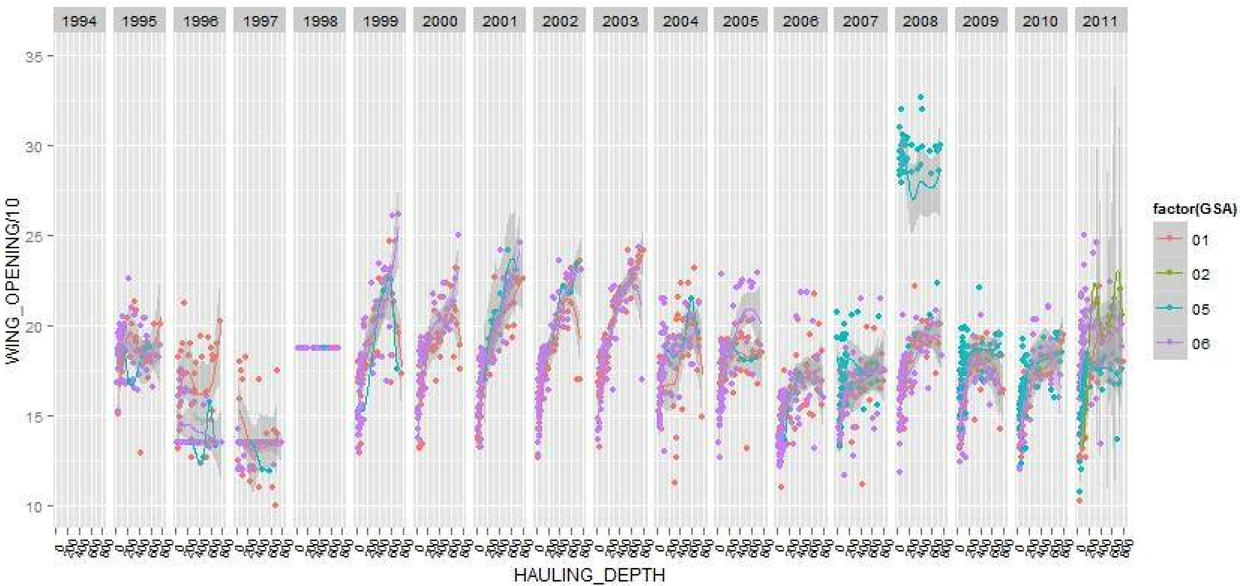


Fig. 7.1.3. MEDITS trawl WO at different depth in Spain from 1994 to 2011.

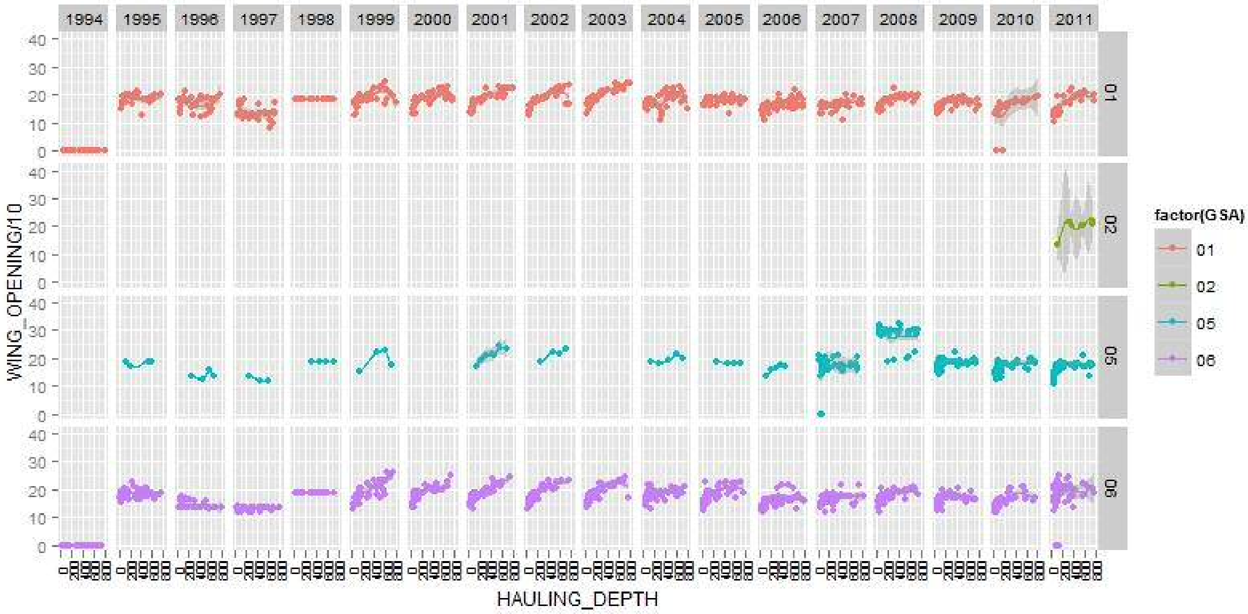


Fig.7.1.4 MEDITS trawl WO at different depth in SPAIN by individual GSA and year.

MEDITS trawl WO at depth in the French survey is plotted in Fig.7.1.5 and similarly to Spanish data display a significant inter-annual variation as well as some differences between GSA 07 and 08. WO also shows some relevant haul to haul variation at the same depth.

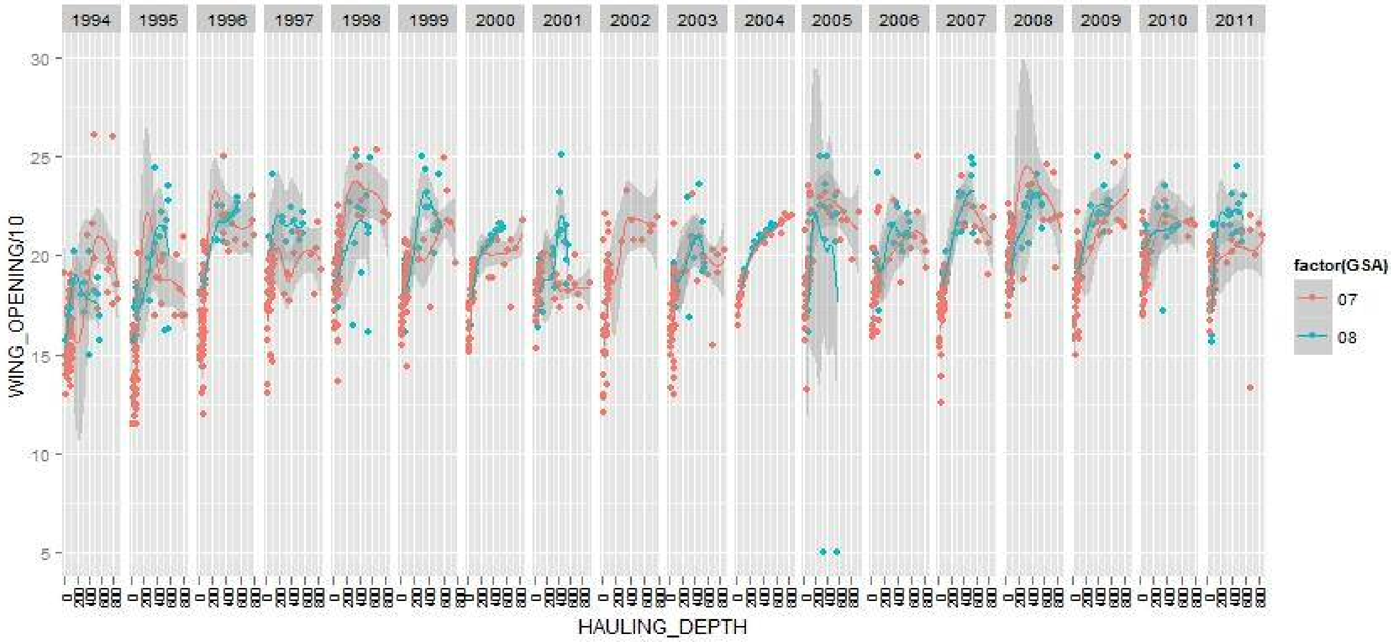


Fig.7.1.5 MEDITS trawl WO at depth in France by GSA.

Greek MEDITS survey (Fig. 7.1.6), ends in 2008 and displays several problems in WO in GSA 22&23 that need to be corrected. In GSA 22&23 the variability in WO in 1994 would suggest the use of a monitoring device while in the following years a model estimate or a fixed value was used. Inter-annual and intra-annual variation is mostly absent and it is assumed that in average the gear always performs in the same way.

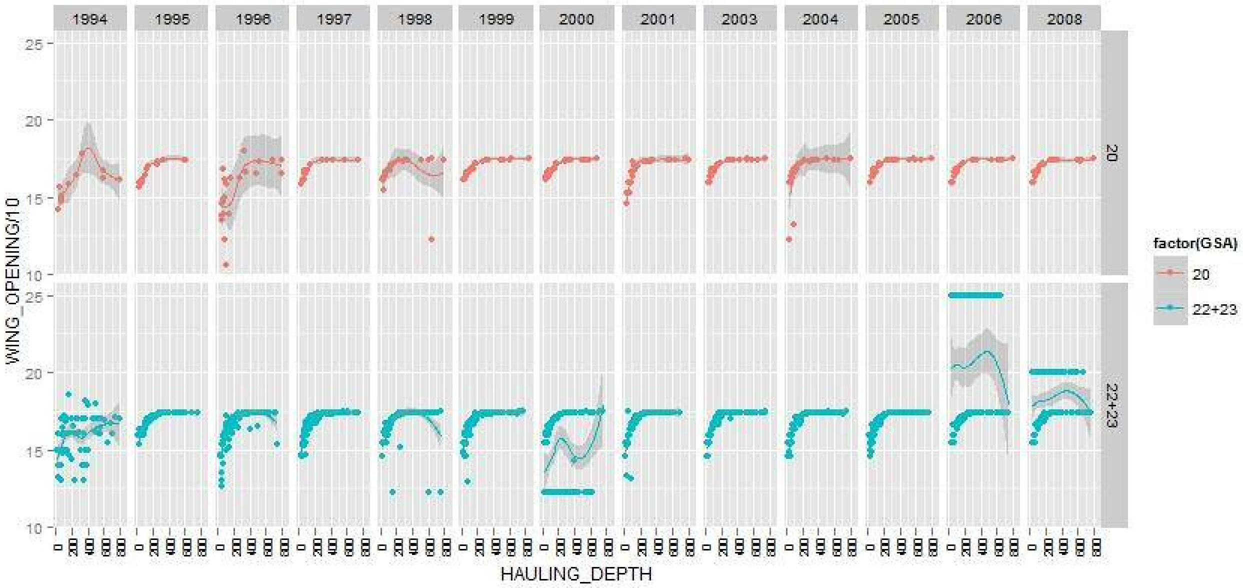


Fig. 7.1.6 MEDITS trawl WO at depth by GSA in Greece for GSA 20 and 22&23 combined fitted with a smoother.

In the case of MEDITS survey in Cyprus (Fig.7.1.7) a fixed WO of 20 m is used irrespectively of year and depth. This is obviously wrong and needs to be corrected.

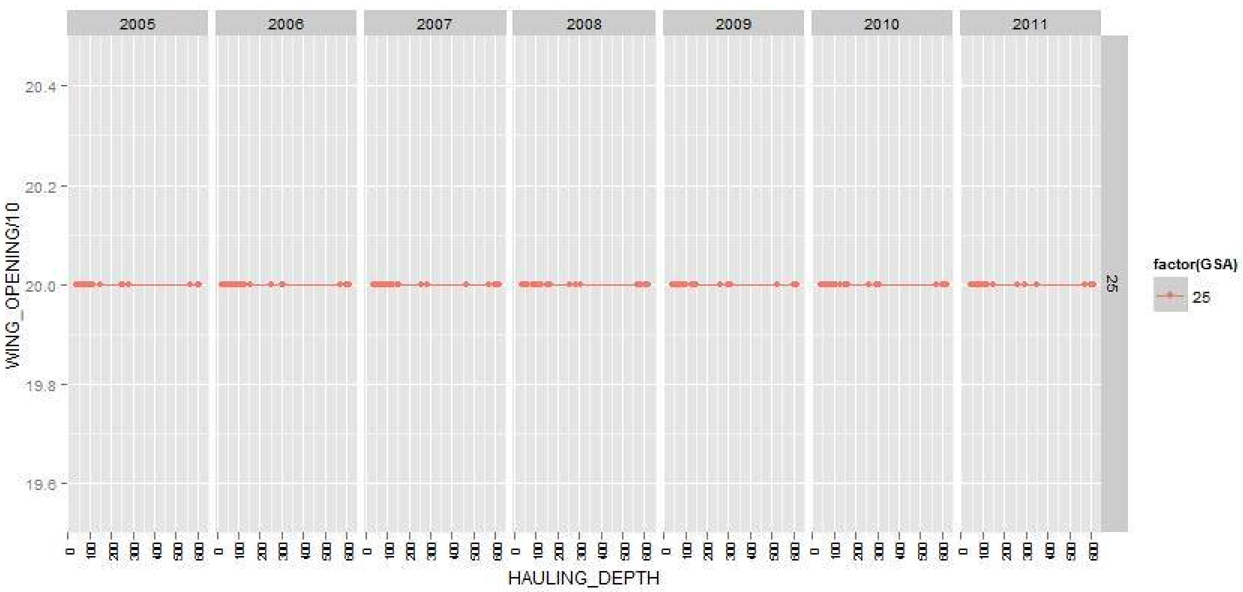


Fig.7.1.7 MEDITS trawl WO at depth in Cyprus (GSA 25) fitted with a smoother.

MEDITS survey in Malta shows revised WO parameters from previous data call and gear performance is derived from models and thus does not present any type of variation (Figure 7.1.8).

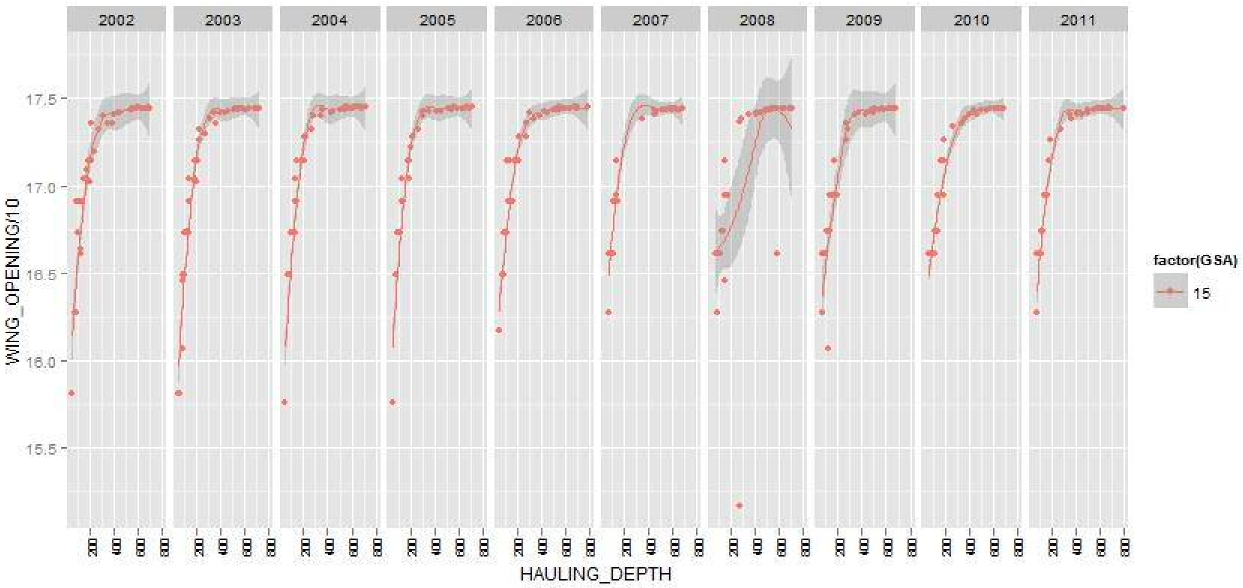


Figure 7.1.8 MEDITS trawl WO at depth in Malta (GSA 15). Regression formulae are used to derive WO and data appears more consistent than the previous submission in 2011.

7.2.1 *Data quality*

In spite of a clear request in the last DCF data call of the 12th April 2012 for a revision of the WO very few corrections and changes have been made by Member States. In particular:

1. Spain needs to provide actual WO data, instead of a fixed value, for 1994 and 1998, plus a revision of WO in 2008 in GSA 05 as current values are likely to be unrealistic. In GSA 06 some fixed wing spreads were used in 1996 and 1997 and need to be corrected with realistic WO at depths.
2. Fixed WO is reported for multiple hauls in GSA 22&23 in Greece in 2000, 2006 and 2008 and thus need to be corrected.
3. All WO data reported by Cyprus are wrong since a unique value is used for all depths and all years. Realistic values need to be provided.
4. In Italy in GSA 11 there is a major shift in the WO from 2010 to 2011. This could be due to the use of Scanmar in 2011, but the difference is major and should be taken into consideration. Overall the lack of any variability in WO due to model derived estimates should be seriously taken into consideration when MEDITS CPUEs are derived.

7.2.2 *Haul to haul variability*

By comparing Spanish and French WO data with Italian, Greek, Maltese and Cypriot a major difference between countries in how the WO is generated is evident. Spain and France measures the mean WO on most hauls, while the other countries use a regression equation to estimate a mean WO at depth, which is thus always the same within GSA and year or always the same as can be seen in the cases of Italy and Malta (Fig. **7.1.2**,

Figure 7.1.8). The major difference is that for France and Spain the haul to haul WO variation is high and correctly accounted for, while in the other cases the use of a constant mean value of WO relies on the assumption that gear performs always in the same way within a year or across years. However, available data from French and Spanish MEDITS clearly show that this assumption is invalid for WO. Most critically WO is artificially stabilized by the use of a formula, when in reality it shows varies large variability between hauls. Thus, when a CPUE is estimated and a fixed WO enters the CPUE equation, the bias can be substantial. The risk of not monitoring trawl performance on a haul to haul basis is that of generating a biased CPUE index used then for assessment.

7.3 **EWG 12-10 Recommendations**

Currently, two substantially different methods for deriving net wing opening are used and this is not the best practice for a standardized trawl survey. Based on the differences in net wing opening at depth between gears monitored using Scanmar/Simrad from those not monitored, EWG 12-10 recommend a revision on the procedures to monitor trawl gear during MEDITS. EWG 12-10 recommends a revision, with Scanmar data, of the regression formulae used in Italy, Greece, Malta and Cyprus to assess if they have been appropriate and truly reflecting the average gear performance in each year. EWG 12-10 also reiterates its previous recommendation that obvious errors in WO estimate need to be corrected in the MEDITS database.

EWG 12-10 recommends that a statistical analysis should be performed to investigate and quantify the bias in mean CPUE and variance that is introduced by using measured WO vs model derived, constant WOs. Such analysis would provide useful indication on how to best correct and model historical MEDITS data since reconstructing past gear performance would be impossible.

The risk of not accounting for inter-annual variability as well as tow to tow difference in WO is that of introducing large variations in the CPUE, which reflects unaccounted changes in swept area rather than change in stock abundance. EWG 12-10 recommends that the technical features and the performance of the gears used in the MEDITS trawl surveys have to be checked according to a protocol to be defined inside the MEDITS group. For each GSA, gear/boat combination and year, a statistically adequate number of "safe" hauls covering the entire depth range must be mandatorily monitored by means of Scanmar/Simrad or similar devices. A report showing the results of gear performance monitoring per year and GSA should be produced. This will make the survey CPUE more accurate and reliable, allow a control of performance of the same gear from year to year and across a range of depths, and render the CPUEs from different GSAs more comparable. Such recommendations are also in line with Bertrand et al., (2002) and are current practice in many world wide scientific trawl surveys.

The intiative taken by the MEDITS Coordination meeting is explicitly tackling the issue of wing opening measurement and the importance of a coordinated action in fixing gear performance issues can only be supported.

7.4 **Summary of MEDITS Coordination Meeting held in Ljubljana**

EWG 12-10 was informed that during the last MEDITS Coordination Meeting held in Ljubljana during March 2012 the main results from EWG 11-14 meeting (Cyprus, 26- 30 September 2011), regarding the checks of the trawl gear performance parameters in MEDITS survey, were presented to the MEDITS groupMEDITS . In addition, the following issue in the agenda was discussed:

- the estimate of the gear geometry/performance, the quality check of the gear setting, equipment for the estimation of gear performance, data acquisition, data processing and analyses.

Antonello Sala from ISMAR-CNR was invited as an expert and he presented to the MEDITS group the results of some analyses and issues related to a) check-up of MEDITS gear; b) standardization of data-processing; c) MEDITS gear performance.

The establishment of a multidisciplinary Working Group to further progress in the harmonization of the MEDITS samplings in the Mediterranean Sea was agreed by the MEDITS coordination meeting. This WG should include technologists and other researchers with different expertise to tackle some relevant and multifaceted aspects related to the gear geometry and the estimates of gear parameters derived using, for example, acoustic technology. The tasks of the WG can be summarised as follows:

1) preparing a (e.g. using photos, sketches, etc..) checklist for the quality control of the technical characteristics of the MEDITS gear, in order to avoid the use of a gear that has not exactly the same characteristics from year to year;

2) preparing a standard procedure, easily to apply in the field also for non technologists, to monitor and collect the data on the gear performance, including the monitoring of gear horizontal and vertical opening, the duration of trawling and the measurement of the distance covered, and others. This would allow that comparable data are gathered between GSAs and that the consistency in the time series is maintained;

3) evaluate and make available tools that enable, using the same methodological approach, the estimate of the parameters of the gear performance, which affect the estimates of the swept area, and thus influence the abundance indices. This was conceived as the way forward to apply, where necessary, appropriate corrections according to a standardized methodological protocol followed in a coordinated and consistent manner by the group.

8 TOR FMIXED FISHERIES MANAGEMENT ADVICE

The great majority of Mediterranean fish stocks is subject to overfishing and simultaneously exploited by mixed fisheries, in particular demersal species. The exploited stocks in mixed fisheries requires specific conservation needs as defined by the European Common Fisheries Policy and the Marine Strategy Framework Directive.

The ToR f has been partially addressed in previous meetings. During the STECF EWG 11-14, H-J Ratz introduced a multi-species and multi-fisheries (mixed fisheries) approach to the Maximum Sustainable Yield (MSY) concept. A stochastic medium term forecast model for mixed fisheries was developed, which provides age specific parameter estimations for a maximum of ten stocks and ten fisheries for a projected period of ten years. The model is designed as an evaluation tool of diverse management scenarios to guide managers towards the complex problems related to multi-annual management plans.

The model was implemented using recent stock specific parameters of seven stocks and four fisheries from GSA 09. The model generated quantitative conclusions on future biomass and catch trends under different management scenarios over the medium term. The implementation of the F_{MSY} as biological management limit for all stocks would provide strong incentives to decouple specific fisheries strategies to optimize the stock specific exploitation consistent with the F_{MSY}criterion. In general, the mixed fisheries require complex a priori decisions regarding their specific selection strategies in order to achieve and maintain sustainable fisheries.

Given the poor status of exploited stocks and their fisheries in GSA 9, the realization of the political goal towards sustainable fisheries would require stringent or even brutal management actions. For obvious reasons, multi-annual management plans accompanied by impact assessments offer preferable solutions. The stakeholders and management commitment in the design of such plans is essential, also to allow concerted advice being provided.

The EWG 12-10 advised that the ToR should be further addressed when having much accurate expertise on board, plausibly during the forthcoming meeting EWG 12-20 (10-14 December 2012).

9 TOR G OTHER BUSINESS

Review of the stock assessments of the hake (*Merluccius merluccius*) and red mullet (*Mullus barbatus*) in the Aegean and Ionian seas

9.1 General method

EWG 12-10 has been requested through correspondence by DGMARE to review the assessment of hake and red mullet stocks in the Aegean and Ionian seas (GSA 22&23 and GSA 20, respectively). The assessments have been presented to DGMARE by the Greek authorities within the "Assessments carried out in the context of developing management plan for demersal trawl fisheries in Greece". The assessments were based on a logistic surplus production model (Schaefer 1954) within a non-equilibrium approach. The model, which run using an ad hoc R script (for convenience called R surplus function thereafter), fit a time series of MEDITS survey CPUE and fisheries landings data (Tserpes 2008) to estimate *k* (unfished equilibrium stock size) *r* (intrinsic rate of population growth) and the relative status of the stock in terms of B/B_{MSY} and $F/F_{MSY.}$ Moreover, for the stock of hake in the Aegean Sea, the review also included a comparison with the results obtained using the ASPIC software (i.e. NOAA toolbox; http://nft.nefsc.noaa.gov/) fitted on the same dataset.

For each stock, the initial settings and the estimated parameters are listed in Tables 1 to 8. For the implementation of the Schaefer's model used here, the starting parameters are *F* (fishing mortality), *M* (natural mortality) and *a*, but b_0/k (b_0 is the starting biomass) and *k* were also derived for interpretation purposes. Time series of standardized residuals were plotted, as well as time series of B/B_{MSY} and F/F_{MSY}. Plots of the estimated and observed MEDITS survey CPUE time series were also produced. Finally, Kobe plots were also reproduced for a complete comparison with the assessments provided by the Greek authorities.

Procedure for obtaining starting values in the R implementation of the Schaefer's model

Both ASPIC and the R surplus function require information on the initial biomass fraction b_0/k. In the case of the R surplus function, estimates of the initial biomass fraction are based on independent information about the harvest rate at the beginning of the period, whereas a starting guess has to be provided to ASPIC. Therefore, in the R surplus function, the first year is deleted from the dataset and used to provide the starting guesses according to the following steps:

Start with an initial value for *r* and increase it:

```
r<- r + 0.01
```

Use *F* and *Z* to estimate the harvest rate

```
Z<-F+M
```

```
hr<- (F/Z)*(1-exp(-Z))
```

Get an approximation for b_0/k (here defined as $B_{fraction}$):

```
Bfraction<- 1-hr/r
```

Initial estimate for k, using a:

```
kin<- a*(Cav*4/r)
```

with $C_{av}$the catch of the first year of data (successively droppped from the dataset)

Estimate for b_0:

```
b0<- Bfraction * kin
```

9.2 HAKE IN THE AEGEAN SEA

Table 9.2.1 Starting model parameters for Hake stock in the Aegean Sea.

	F	M	a	b_0/k	k
Original	0.3	0.2	0.95	0.42	29974 t
	MSY	b_0/k	k		
ASPIC	1621 t	0.7	3638 t		

Table 9.2.2 Model derived estimates for Hake stock in the Aegean Sea.

	B/B_{MSY}	F/F_{MSY}	MSY (t)	Catch (t)	F	F_{MSY}	r	k	R^2
Original	1.1	1.09	3373	4042	0.299	0.275			
Check	1.1	1.07	3372	4041.7	0.295	0.275	0.58	24688 t	0.25
ASPIC	1.07	0.989	3862	3844	0.523	0.528		14620 t	0.48

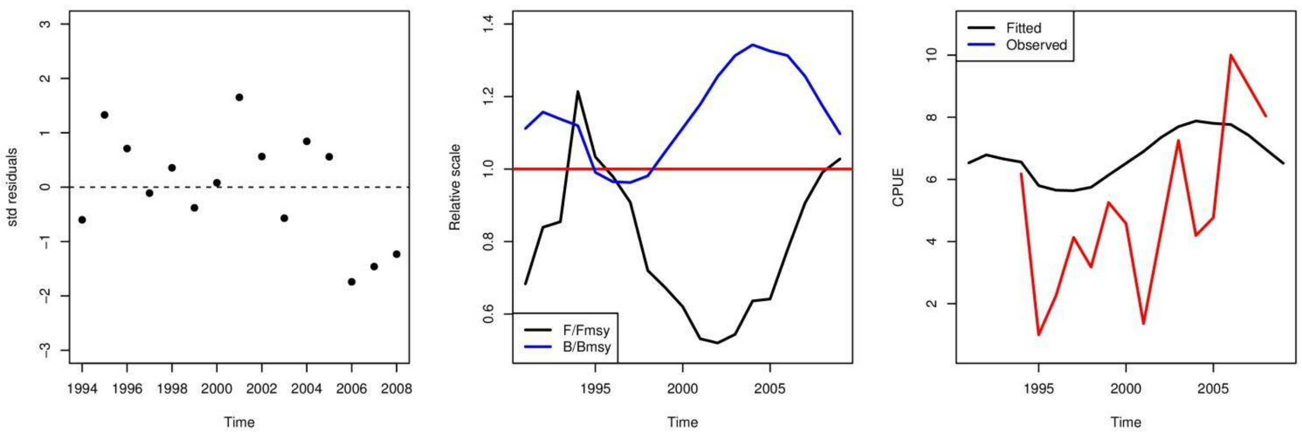


Fig. 9.2.1a. Hake stock in the Aegean Sea. From left to right, standardized residuals, F/F_{MSY} and B/B_{MSY} time series and fitted and observed MEDITS survey CPUE.

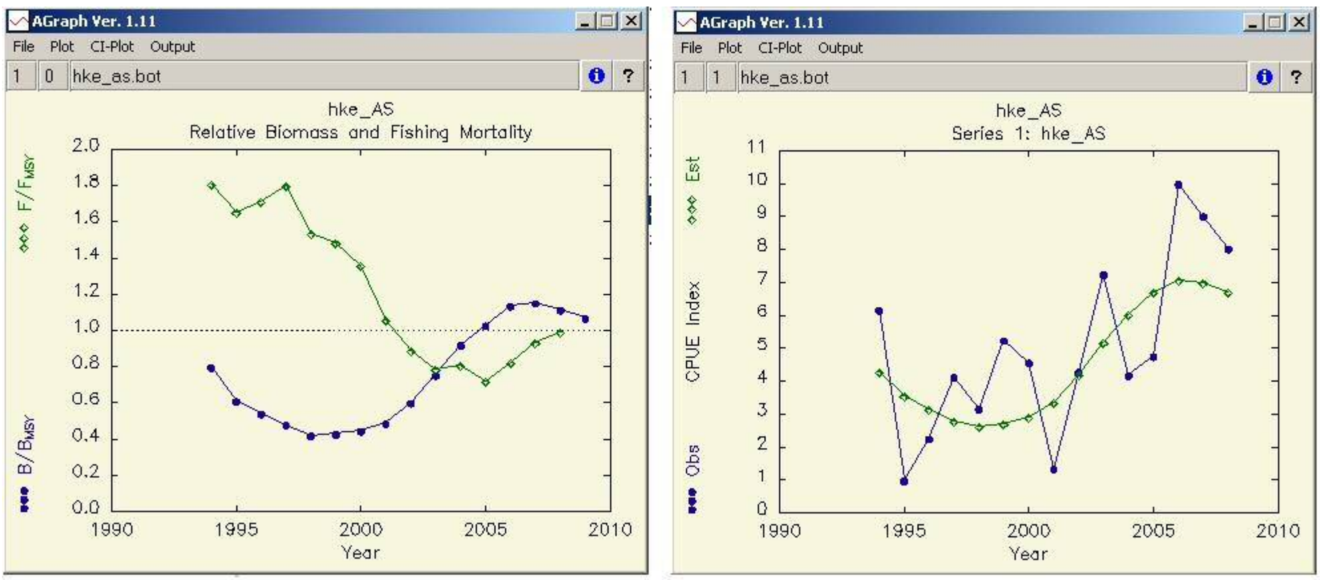


Fig. 9.2.1b. Hake stock in the Aegean Sea. Output of the ASPIC run. From left to right, F/F_{MSY} and B/B_{MSY} time series and fitted and observed MEDITS survey CPUE.

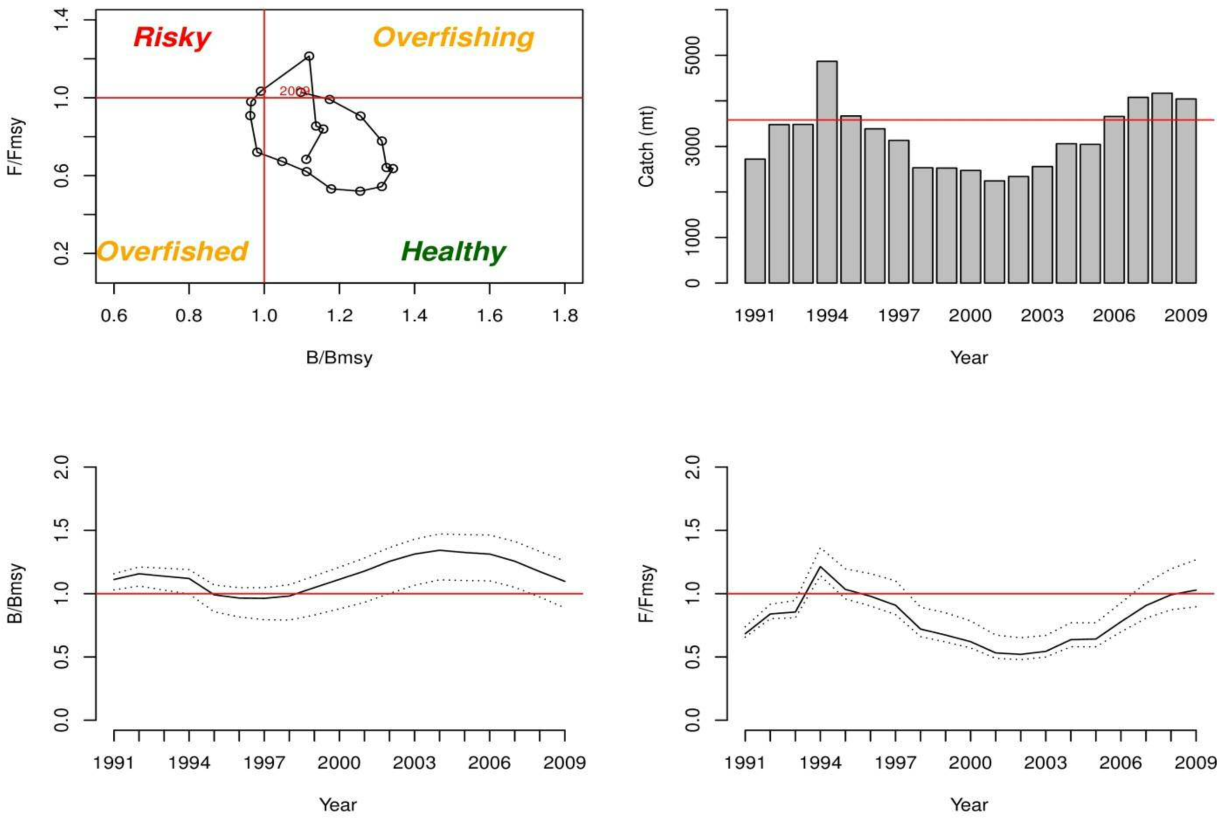


Fig. 9.2.2 Hake stock in the Aegean Sea, Kobe plot.

Hake stock in the Aegean Sea, ASPIC input file:

```
BOT             ## Run type (FIT, BOT, or IRF)

"Pop"
LOGISTIC YLD WTDSSE    ## Model type, conditioning type, objective function
102                    ## Verbosity
1000                   ## Number of bootstrap trials, <= 1000
0 50000                ## 0=no MC search, 1=search, 2=repeated srch; N trials
1.00000d-08            ## Convergence crit. for simplex
3.00000d-08    6       ## Convergence crit. for restarts, N restarts
1.00000d-04    0       ## Convergence crit. for estimating effort; N steps/yr
8.00000d00             ## Maximum F allowed in estimating effort
0d0                   ## Weighting for B1 > K as residual (usually 0 or 1)
1                      ## Number of fisheries (data series)
1.00000d00             ## Statistical weights for data series
7.00000d-01            ## B1/K (starting guess, usually 0 to 1)
1621            ## MSY (starting guess)
3.63838d03             ## K (carrying capacity) (starting guess)
1.00000d-06            ## q (starting guesses -- 1 per data series)
0 1 1 1                ## Estimate flags (0 or 1) (B1/K,MSY,K,q1...qn)
810  3242             ## Min and max constraints -- MSY
7.27675d02  7.27680d03             ## Min and max constraints -- K
1234567             ## Random number seed
20                       ## Number of years of data in each series

"Pop"
CC
1994    6.1794639088   4866.8  1
1995    1       3667.7  1
1996    2.2701681461   3384.7  1
1997    4.1336211265   3131.6  1
1998    3.1770946657   2530.6  1
1999    5.2559369966   2524.5  1
```

```
2000    4.5800806111   2472.6  1
2001    1.359568563    2243.5  1
2002    4.3052054874   2338.5  1
2003    7.2508424119   2557.7  1
2004    4.1932442978   3058.7  1
2005    4.7703287629   3044.6  1
2006    10      3657.1  1
2007    9.0184595482   4076.9  1
2008    8.0369190965   4167.5  1
## Output Options for .INI
sfile=T
sumfile=F
sumfileloc=
ci=50
```

Results

The fit of the model to the observed MEDITS survey CPUEs is not satisfactory and the residual pattern of the last 3 years of data is particularly poor. Also, the *k* starting value, and the MSY level are suspiciously high for this stock. Moreover, it has not been specified whether the Turkish landings data has been included and whether the MEDITS survey index did cover the entire GSAs or only the western (i.e. Greek part) side of these.

The ASPIC run generally yielded results consistent with these of the R surplus function for B/B_{MSY}, F/F_{MSY}, MSY. However, rather large differences were observed for F, F_{MSY} and k.

9.3 HAKE IN THE IONIAN SEA

Table 9.3.1 Starting model parameters for Hake stock in the Ionian Sea

	F	M	*a*	b_0/k	*k*
Original	0.3	0.2	1	0.42	9093 t

Table 9.3.2Derived model estimates for Hake stock in the Ionian Sea

	B/B_{MSY}	F/F_{MSY}	MSY (t)	Catch (t)	F	F_{MSY}	*r*	*k*	R^2
Original	1.1	1.09	995	1189	0.283	0.260			
Check	1.098	1.09	992	1188.6	0.283	0.260	0.52	7622	0.32

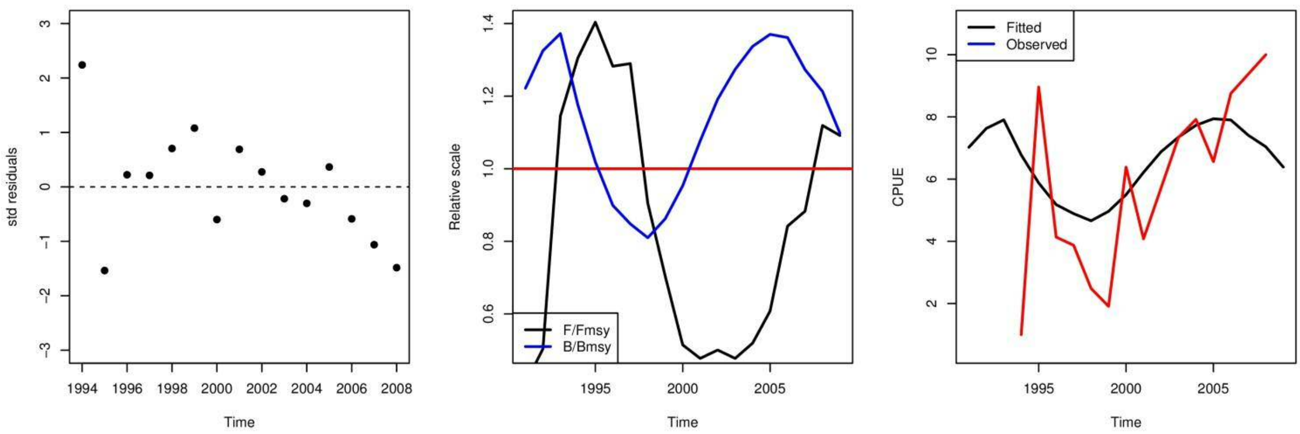


Fig. 9.3.1 Hake stock in the Ionian Sea. From left to right, standardized residuals, F/F_{MSY} and B/B_{MSY} time series and fitted and observed MEDITS survey CPUE.

Results

The model for hake in the Ionian Sea displays residual patterns with a clear temporal trend and with some years (i.e. 1994 and 1995) displaying extreme values (Figure 9.3.1). Overall, the model fit is not satisfactory.

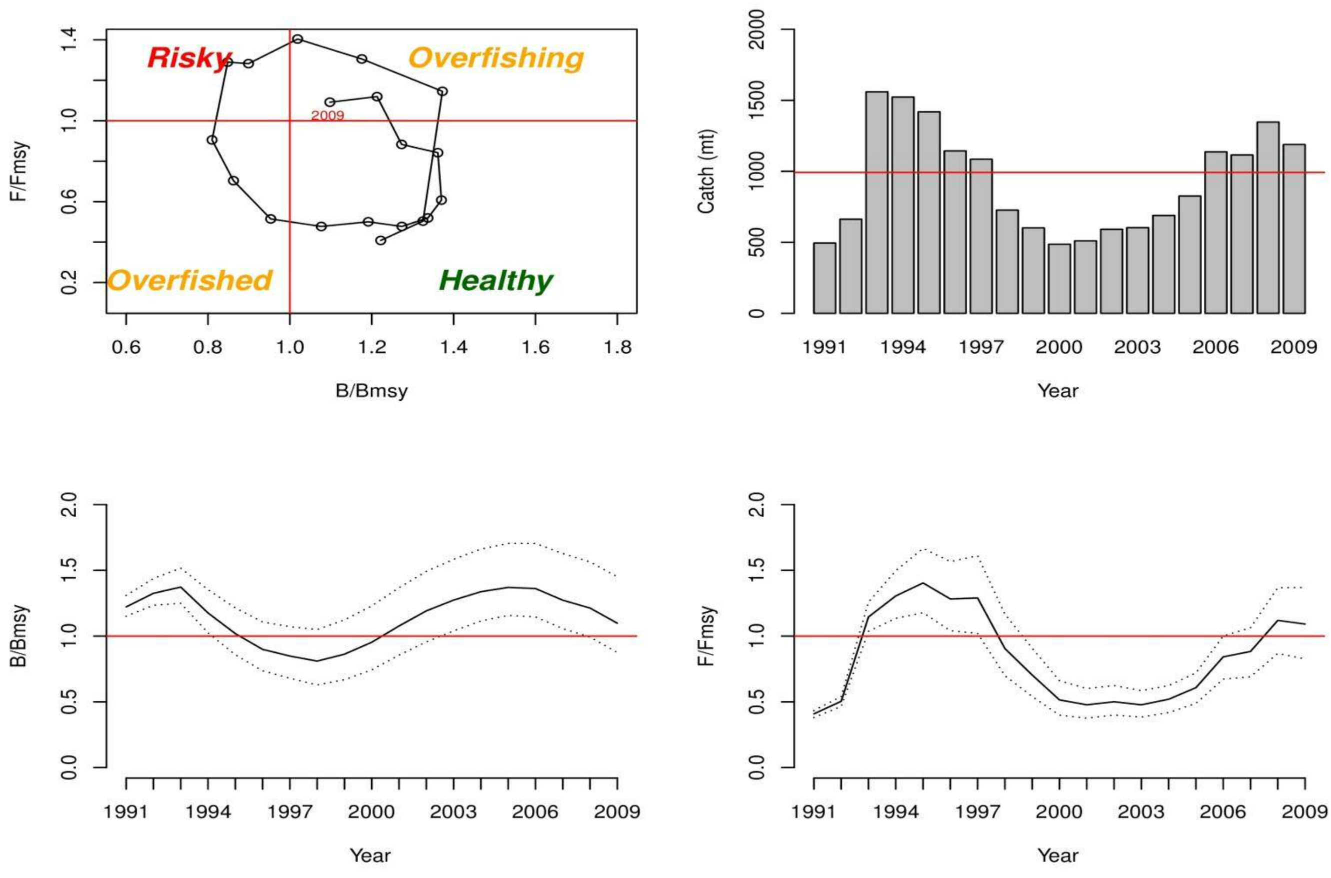


Fig. 9.3.2 Hake in the Ionian Sea. Kobe plot.

9.4 RED MULLET IN THE AEGEAN

Table 9.4.1 Starting model parameters for Red mullet stock in the Aegean Sea.

	F	M	*a*	b_0/k	*k*
Original	0.70	0.48	1.32	~0	23623

Table 9.4.2Model derived estimates for Red mullet stock in the Aegean Sea.

	B/B_{MSY}	F/F_{MSY}	MSY (t)	Catch (t)	F	F_{MSY}	*R*	*k*	R^2
Original	1.55	0.42	2453	1591	0.175	0.416			
Check	1.545	0.423	2431	1591.1	0.176	0.415	0.830	11711	~0

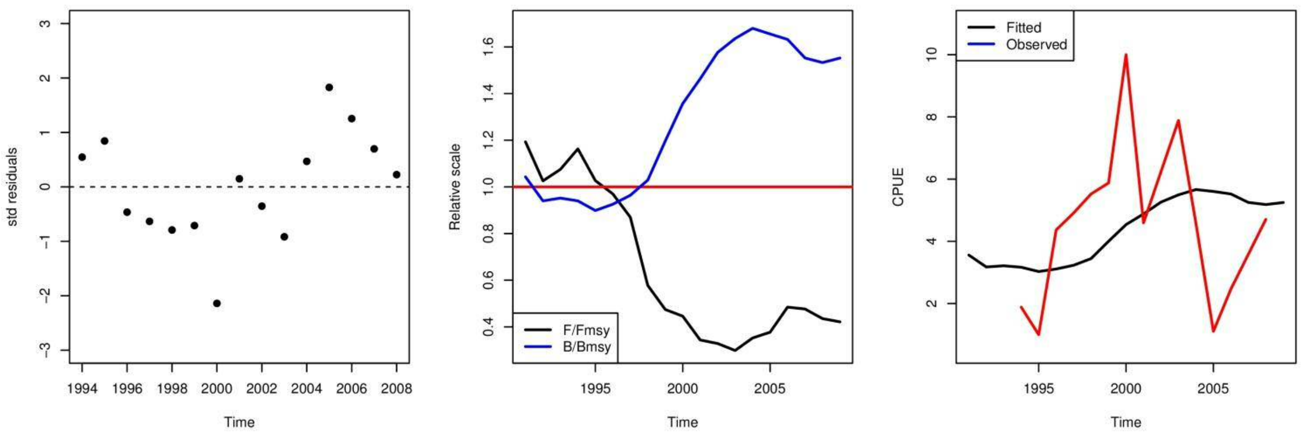


Fig. 9.4.1 Red mullet stock in the Aegean Sea. From left to right, standardized residuals, F/F_{MSY} and B/B_{MSY} time series and fitted and observed MEDITS survey CPUE.

Results

The model for red mullet in the Aegean Sea displays residual patterns with a clear temporal trend (Figure 9.4.1). Overall, the model fit is not satisfactory.

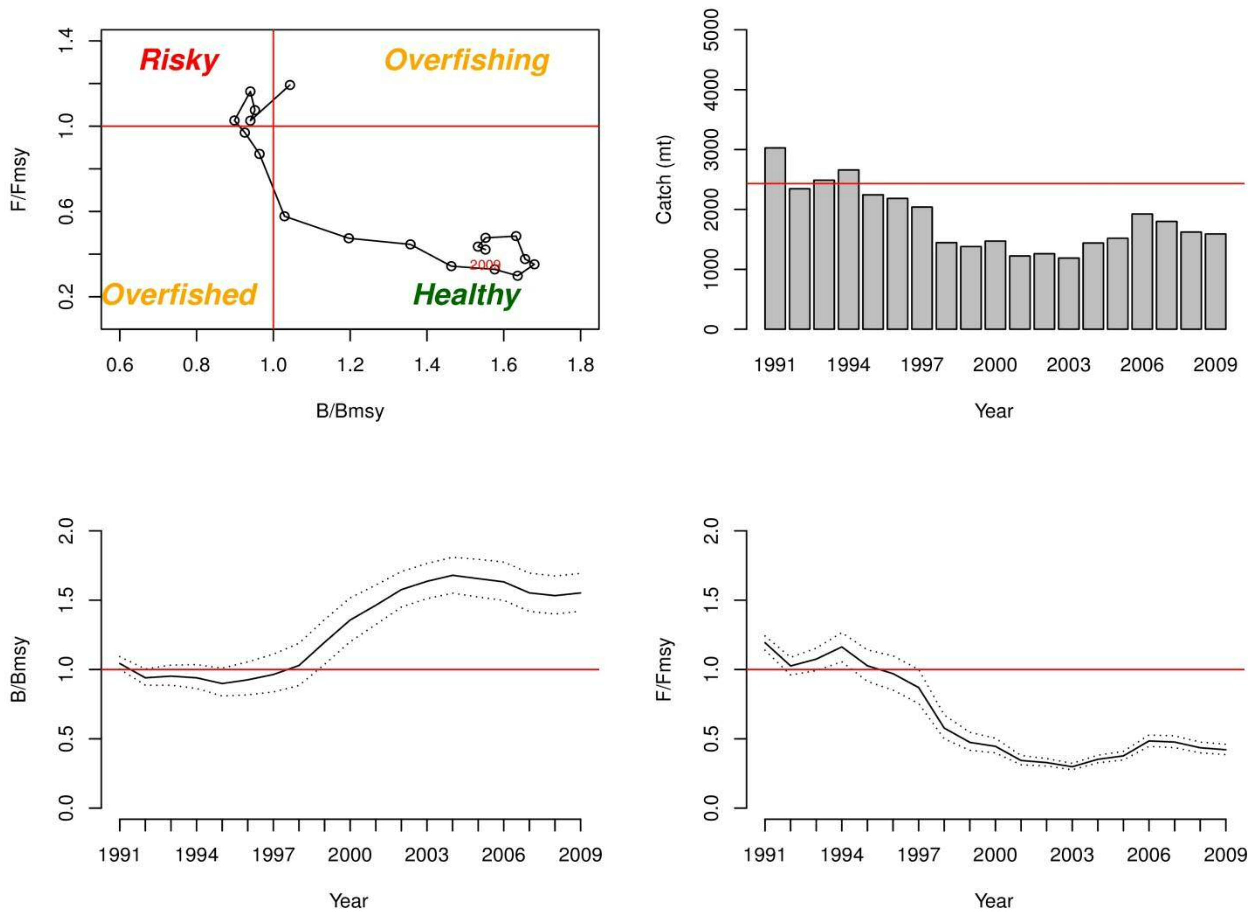


Fig. 9.4.2 Red mullet stock in the Aegean Sea. Kobe plot.

9.5 RED MULLET IN THE IONIAN

Table 9.5.1 Starting model parameters for Red mullet stock in the Ionian Sea.

	F	M	*a*	b_0/k	*k*
Original	0.70	0.48	1.20	~0	3747 t

Table 9.5.2Model derived estimates for Red mullet stock in the Ionian Sea.

	B/B_{MSY}	F/F_{MSY}	MSY (t)	Catch (t)	F	F_{MSY}	*r*	*k*	R^2
Original	1.43	0.49	391	276	0.189	0.386			
Check	1.429	0.490	390	276	0.19	0.385	0.77	2032	0.26

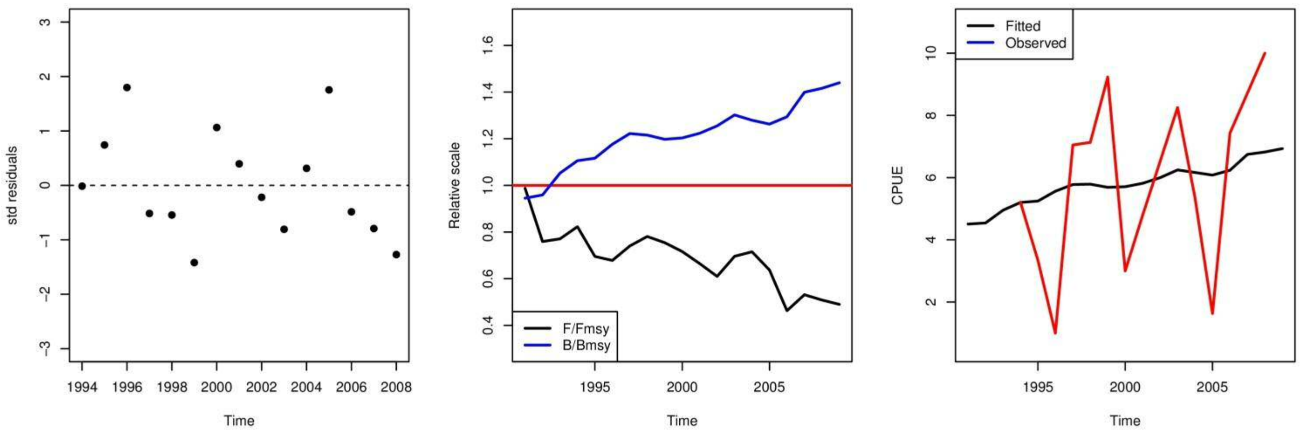


Fig.9.5.1 Red mullet stock in the Ionian Sea. From left to right, standardized residuals, F/F_{MSY} and B/B_{MSY} time series and fitted and observed MEDITS survey.

Results

The model for red mullet in the Ionian Sea displays a reasonable residual pattern but the observed against the fitted MEDITS survey CPUE and the overall model fit is not satisfactory (Figure 9.5.2).

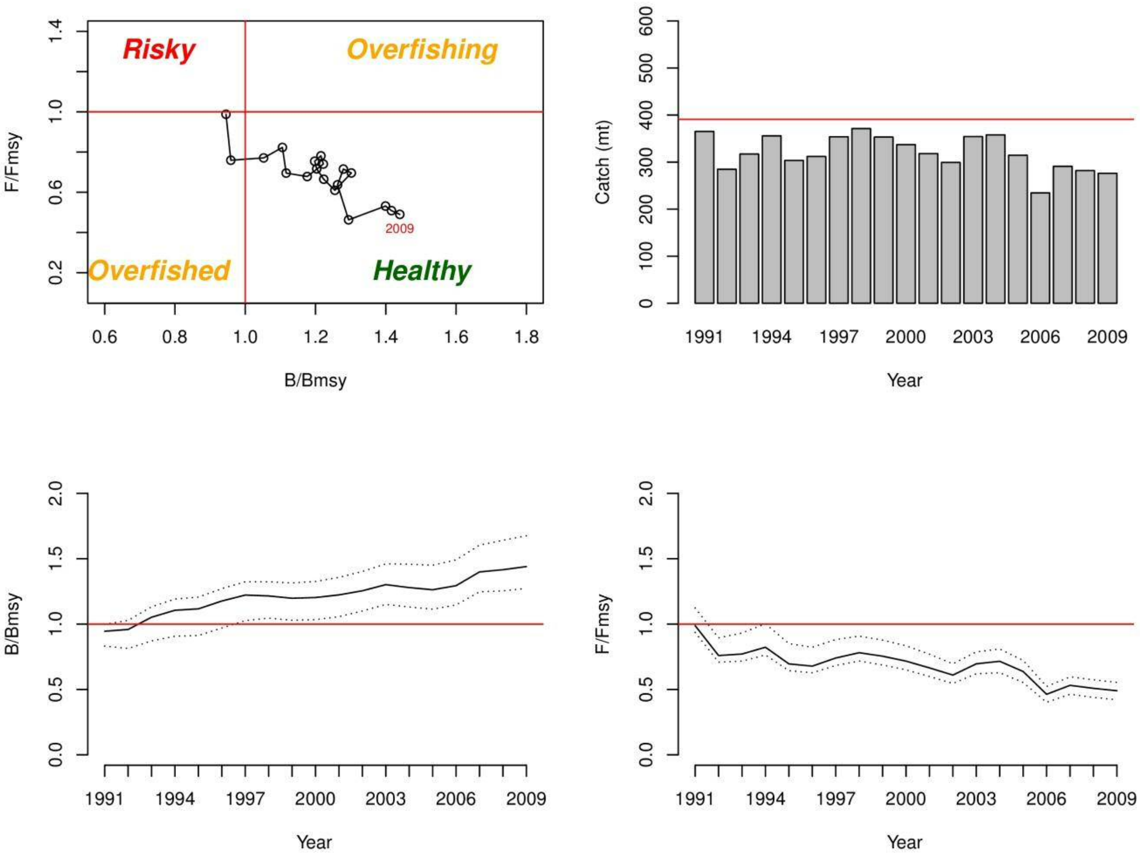


Fig. 9.5.2 Red mullet stock in the Ionian Sea. Kobe plots.

9.6 Conclusions

The revision of the assessments of the stocks of hake and red mullet in the Aegean and Ionian seas showed consistent results with what has been presented by the Greek authorities within the "Assessments carried out in the context of developing management plan for demersal trawl fisheries in Greece". However, the fit of the models was not satisfactory (likely due mainly to the shortness of the time series, to the lack of contrasting periods of over- and under-exploitation and to the lack of a stock biomass estimate at low level of exploitation), and the models were generally found to explain a very small part of the variance observed in the dataset. A comparative run performed for of the Aegean hake stock using the same dataset and carried out using ASPIC showed results consistent with these of the R surplus function for B/B_{MSY}, F/F_{MSY}, MSY. However, rather large differences were observed for F, F_{MSY} and *k*. Moreover, ASPIC provided a better fit to the MEDITS survey CPUE time series than the R surplus function.

Finally, it has not been specified whether the Turkish landings data has been included in the assessment and if the MEDITS survey index did cover the entire GSAs or only the western side of these. Further, the MEDITS survey CPUE has been standardized using GAMs but the details are not known and in particular it is unclear how a standardized value was derived for years when MEDITS was not carried out as in 2002 and 2007.

These results generally underline the need of systematic comparisons between alternative and well-established methodologies as those included in the NOAA toolbox (e.g. ASPIC). This is particularly important when an official manual of the alternative method is not available and thus some of the model key parameters are not sufficiently well explained as it is the case of the R surplus function.

As a general remark, EWG 12-10 notes that the fit of production models are very sensitive to initial parameter, especially b_0/k. Furthermore, the reliability and interpretation of the results is strongly dependent on the length of the time series, the presence of periods with contrasting level of exploitation and fishing effort and the stock being at reasonably unexploited levels at the beginning of the time series (Hilborn & Walters 1992).

EWG 12-10 notes also that most of the time series of the Mediterranean stocks are short (rarely more than 20 years of data are available) and likely characterized by an initial state of overexploitation (i.e. low biomass compared to B_{MSY} and high fishing mortality compared to F_{MSY}) as showed by the fact that more than 90% of the stocks recently assessed by STECF is considered largely overexploited compared to MSY. This stresses out the crucial need for gathering and incorporating data going as further back as possible in order to capture the earlier stages of the development of the Mediterranean fisheries. This would provide key information to establish the baseline levels needed for a sound assessment of the Mediterranean stocks status.

Generally, EWG 12-10 also consider that the age-structure of a given population contains information on future harvest possibilities. The surplus production model neglects this information and may lead to major deviations between the expected and actual outcomes especially under multiple steady states and nonlinearities (Tahvonen 2008). Thus, age based assessment models are generally used, especially when results are also used for forecasting future fishing opportunities. Although EWG 12-10 recognize the merits of the attempt of the Greek authorities of updating the status of some demersal species in Greek waters, EWG 12-10 consider the present stock assessments for hake and red mullet in Aegean and Ionian Sea as valid only for exploration of trends. In addition EWG 12-10 consider that assessments based on biological data older than 4 years, as it is the case for hake and red mullet assessment in the Aegean and Ionian Sea, are not reliable for assessing the current status of the stocks and therefore for scientific advice and management.

Previous attempts of assessing the hake stock in the Aegean Sea gave similarly unreliable results that lead to no scientific advice by STEFC. SGMED 10-02 in 2010 and then STECF concluded the following: “The lack of catch-at-age data did not allow the use of an age-based assessment that would provide a more detailed and robust information about the stock status. Fisheries data from the eastern Aegean coast would have been useful but no hake landings appear in the GFCM dataset from Turkey, with only a few exceptions of reporting very low landings (1993, 1997, 1998). SGMED 10-02 notes that due to lack of recent data, the assessment relies on data up to 2006. SGMED-10-02 considers all analyses presented to assess the status of hake in GSAs 22 and 23 as preliminary and not suitable to provide sound scientific advice.”

Thus, EWG 12-10 can only reiterate previous SGMED and STECF conclusions on the validity of the stock assessment of hake stock in the Aegean Sea.

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12 ANNEX II STOCK SUMMARY TABLE

Common name	GSA	Assessment	Comments	Short term	Stock status (F_{msy}) in 2011
Norway lobster	5	XSA			Overexploited
Common octopus	5	ASPIC			Overexploited
Blue whiting	6	VIT			Overexploited
Red shirmp	6	XSA			Overexploited
Black bellied Anglerfish	6	VIT			Overexploited
Spottail mantis shrimp	6		Lack of data		Overexploited
Red mullet	7	XSA			Overexploited
Hake	7	XSA			Overexploited
Black bellied Anglerfish	7	VIT			Overexploited
Spottail mantis shrimp	7		Lack of data		Overexploited
Blue whiting	9	SURBA, VIT			Overexploited
Sardine	9	XSA			Overexploited
Poor cod	9	SURBA, VIT			Overexploited
Spottail mantis shrimp	10	VIT			Overexploited
Hake	11	VIT			Overexploited
Pink shirmp	11	VIT			Overexploited
Red mullet	17	VIT, XSA			Overexploited
Spottail mantis shrimp	17	VIT			Overexploited
Norway lobster	18	VIT			Overexploited
Pink shirmp	18	VIT			Overexploited
Red mullet	18	XSA			Overexploited
Spottail mantis shrimp	18	VIT			Overexploited
Common pandora	15&16	XSA			Overexploited
Black bellied Anglerfish	15&16	SURBA, VIT			Overexploited
Red mullet	15&16	SURBA, XSA			Overexploited

13 LIST OF BACKGROUND DOCUMENTS

Background documents are published on the EWG 12-10 meeting's web page on:

http://stecf.jrc.ec.europa.eu/web/stecf/ewg10

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Abstract

The Expert Working Group meeting of the Scientific, Technical and Economic Committee for Fisheries EWG 12-10 was held from 16 – 20 July in Sete, France, to assess the status of demersal and small pelagic stocks in the Mediterranean Sea against the proposed FMSY reference point. The report was reviewed and endorsed by the STECF during its 41st plenary held from 5 to 9 November 2012 in Brussels (Belgium).

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The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

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