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REPORT OF THE SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

2013 Assessment of Mediterranean Sea stocks part I (STECF 13-22)

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This report was reviewed by the STECF during its 44th plenary meeting

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

2013 Assessment of Mediterranean Sea stocks - part 1 (STECF-13-22)

THIS REPORT WAS REVIEWED DURING THE PLENARY MEETING HELD IN BRUSSELS 4 – 8 November 2013

Request to the STECF

STECF is requested to review the report of the EWG 13-09 held from 15–19 July 2013 in Ispra, Italy, 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 13-09) was reviewed by the STECF during the plenary meeting held from 4 to 8 November, 2013 in Brussels. The following observations, conclusions and recommendations represent the outcomes of that review.

STECF observations

The meeting was the first of two STECF expert meetings, within STECF's 2013 work programme, planned to assess demersal stocks from the Mediterranean Sea. The meeting was organized by the STECF Secretariat (JRC) in Ispra (Italy) from 15-19 July, 2013. The meeting was chaired by Massimiliano Cardinale and a total of 25 experts participated, including 4 STECF members plus 4 JRC experts.

Historic fishery-dependent and scientific survey data were obtained from the official Mediterranean DCF data call issued to Member States on April 9th 2013 with deadlines on 3rd June and 29th November 2013. The latter deadline was specifically set to call for in-year (2013) MEDITS survey data to improve the precision of short term forecasts of stock size and catches under various management scenarios.

In relation to each of the Terms of Reference (ToRs), STECF notes the following:

ToRs (a-c): The EWG 13-09 performed assessments and short-term catch forecasts for 15 demersal stocks. Medium-term forecast were carried out for only those stocks for which a meaningful stock recruitment relationship supported such analyses.

ToR (d): Stock-specific evaluations of data quality were conducted for all stocks addressed under ToRs (a-c). Data coverage and quality for the fisheries and survey data submitted under the data call was undertaken by JRC experts prior to the meeting using data exploration tools and the MEDITS SQL quality checks developed specifically for this purpose.

ToR (e): JRC experts distributed the latest releases of Fisheries Libraries in R (FLR) and supported the EWG participants in running assessments and solving specific R issues. JRC distributed a revised and cleaned version of the short and medium term forecast R scripts and initiated the redesign and development of the scripts for fisheries and survey data.

ToR (f): An evaluation of the current Beta version of the BEMTOOL software (developed in the MAREA framework) which is a bioeconomic model designed to carry out simulations for different management scenarios for Mediterranean fisheries was carried out. Based on the results obtained through four case studies investigated during the meeting, the EWG considered that the model is a good starting point for the evaluation of different management scenarios for Mediterranean fisheries. However, in order to better encourage the integration of BEMTOOL into the scientific advisory process for the Mediterranean the EWG 13-09 noted the following:

a) BEMTOOL would benefit from an simpler software installation procedure;

b) Simulation testing with economic and biological data of known underlying properties is needed;

c) In order to assess the risks associated with alternative management scenarios, BEMTOOL should be able to provide estimates of uncertainty associated with simulation results.

ToR (g1): The stocks to be assessed in the future meetings were identified under the assumption that annual assessments will continue to be required. It was suggested that for the expert group (EWG 13-19) planned for later this year, priority should be given to sardine, anchovy, red mullet and striped red mullet stocks. The expert group noted that mixed-fisheries assessments would need a minimum number of key stocks per GSA (e.g. 5 or 6 stocks per GSA) to provide meaningful results and suggested that results of stock assessments conducted in the most recent 2 to 3 years (i.e. 2010-2012) could be used to satisfy the criteria of a minimum number of stocks per GSA. The EWG 13-09 also considered that it would be desirable to develop a framework for mixed fisheries assessments and advice in a dedicated expert group rather than the regular expert group dealing with single-stock assessments.

ToR (g2): An analysis of compliance of Mediterranean trawl fisheries with the current minimum catch sizes enforced by EU reg 1967/2006 for a selected set of demersal stocks was also undertaken.

The EWG 13-09 report contains a proposal to convene a methodological EWG early in 2014 to set up and test different assumption of selectivity for a set of stocks, and about discard data and slicing methodologies to be used for future stock assessments. Specifically there is a need to undertake the following: collate and assemble the necessary input data by fleet for stocks of hake and Norway lobster in selected GSAs; run statistical catch at age assessment models with different assumptions on selectivity (i.e. dome shaped, logistic, etc); discuss and compare the results with previous assessment conducted by XSA or other models; set up a common methodology to reconstruct times series of discard data to be used in future stock assessment; decide upon a common slicing methodology to reconstruct times series of catch at age data to be used in future stock assessment.

STECF conclusions

Based on the findings in the EWG 13-09 report, STECF concludes the following:

Of the 15 demersal stocks assessed by the EWG 13-09, only one, Norway lobster in GSA 15-16 is currently being exploited at a sustainable rate. Of the remaining 14 stocks, 13 are currently being exploited at rates that are not consistent with achieving MSY and one stock could not be assessed. A summary of stock status is given in Table 5.1.1.

Table 5.1.1. Summary of stock status for the 15 stocks assessed by the EWG 13-09

GSA	Common name	Species	Presentation	Assessment	Comment	Status	F/F_{MSY}
1	Hake	*Merluccius merluccius*	Yes	XSA	Accepted	Overexploited	7.32
1	Pink shrimp	*Parapenaeus longirostris*	Yes	XSA	Accepted	Overexploited	1.65
5	Pink shrimp	*Parapenaeus longirostris*	Yes	XSA	Accepted	Overexploited	1.24
6	Pink shrimp	*Parapenaeus longirostris*	Yes	XSA	Accepted	Overexploited	5.48
7	Hake	*Merluccius merluccius*	Yes	XSA	Accepted	Overexploited	16.64
9	Giant red shrimp	*Aristaeomorpha foliacea*	Yes	XSA	Accepted	Overexploited	1.72
10	Hake	*Merluccius merluccius*	Yes	XSA	Accepted	Overexploited	7.14
10	Pink shrimp	*Parapenaeus longirostris*	Yes	XSA	Accepted	Overexploited	1.33
11	Hake	*Merluccius merluccius*	Yes	XSA	Not accepted	Unknown	NA
15-16	Norway lobster	*Nephrops norvegicus*	Yes	a4a	Accepted	Exploited sustainably	0.75
15-16	Blue and red shrimp	*Aristeus antennatus*	Yes	VIT	Accepted	Overexploited	3.12
17	Common sole	*Solea solea*	Yes	SS3 by fleet	Accepted	Overexploited	3.00
18	Hake	*Merluccius merluccius*	Yes	XSA	Accepted	Overexploited	5.26
19	Pink shrimp	*Parapenaeus longirostris*	Yes	XSA	Accepted	Overexploited	1.96
19	Hake	*Merluccius merluccius*	Yes	XSA	Accepted	Overexploited	5.50

STECF supports the Expert group’s proposal to convene a methodological EWG early in 2014 but notes that because of budgetary constraints such a meeting is unlikely to take place. Nevertheless, in order to address the methodological issues outlined in the EWG 13-09 report with a view to providing the best scientific advice in the future, STECF considers that it is highly desirable that such a meeting is convened at the earliest opportunity.

STECF concludes that the EWG 13-09 adequately address all of the Terms of Reference and endorses the findings presented in the report.

REPORT TO THE STECF

EXPERT WORKING GROUP ON Assessment of Mediterranean Sea stocks - part 1 (STECF EWG 13-09)

Ispra, Italy 15 - 19 July 2013

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 meeting was the first of two STECF expert meetings, within STECF's 2013 work programme, planned to undertake stock assessments of demersal species in the Mediterranean Sea. The meeting was organized by JRC in Ispra (Italy) from 15-19 of July 2013. The meeting was chaired by Massimiliano Cardinale and attended by 25 experts in total, including 4 STECF members plus 4 JRC experts (Annex I).

Historic fisheries and scientific survey data were obtained from the official Mediterranean DCF data call issued to Member States on April 9th 2013 with deadlines on 3rd June and 29th November 2013. The latter deadline had been specifically set to call for in-year (2013) MEDITS survey data to improve the precision of short term forecasts of stock size and catches under various management scenarios. Greece, and Cyprus did not provide any data for the June 2013 deadline.

In fulfillment of TORs (a-c), the EWG 13-09 undertook the stock assessment of 15 demersal stocks species. Around 93% of assessed stocks were classified as exploited unsustainably (Annex II).

Following TOR (c), the EWG 13-09 also conducted short term forecasts of stock size and catches for 15 stocks and medium term forecast only for these stocks where a meaningful stock recruitment relationship supported such analyses.

In fulfilment of TOR (d), stock specific evaluation of the data quality were conducted for all stocks requested under ToR (a-c) by the EWG 13-09 experts. Moreover, JRC team examined the data coverage and quality for the fisheries and survey data. This was performed by means of data exploration and the MEDITS SQL quality checks developed by JRC. Results of the evaluations are reported under ToR (d) and at the end of the assessment section of each stock. Data coverage was not always complete in the latest data call: fishing effort data (Table D) for all Italian GSA in 2010 was missing from the files provided. France did not provide any fisheries data (Tables A-D) for GSA 08 (Corsica). The latter is a recurrent omission and with no apparent justification and it undermines the possibility of EWG 13-09 to perform any assessment in GSA 08. Also no data on effort for GSA 7 (Table D) was uploaded. French MEDITS TC data did not cover the time series before 1997. Greece and Cyprus did not submit any data. Other issues in the data where identified in the stock assessment sections, but of particular concern to the EWG 13-09 is the quality of the fisheries data from GSA 11 (Italy), which as in previous meeting has impeded the EWG to conduct an assessments of hake in GSA 11.

To addres TOR (e), the JRC team distributed the latest releases of Fisheries Libraries in R (FLR) and supported the experts in running assessments and solving specific R issues. JRC distributed a revised and cleaned version of the short and medium term forecast R scripts and initiated the redesign and development of the scripts for fisheries and MEDITS data.

In particular, EWG 13-09 consider that the existing MEDITS routines need to be expanded to incorporate a standardized calculation of the stratified numbers (n/km^2) at length that reflects the survey stratification to replace the functions previously available in the JRC ACCESS MEDITS database. The transition from the ACCESS routines to R will give more flexibility and will facilitate their use, allowing experts to have more control of the MEDITS data preparation steps. A new slicing function from the FLa4a package will be added to the slicing tools and the sliced data will be generated as an R FLIndex (i.e. the FLR standard format for trawl survey data) to be used for stock assessment. Data will also be generated as a csv files so that any assessment method can be used, before or after slicing. Development of the described routines is in progress and should be completed for the next EWG 13-19

To addres TOR (f), EWG 13-09 conducted an evaluation of the current Beta version of the BEMTOOL software (developed in the MAREA framework) in order to identify possible problems in its installation, running and compatibility with the outcomes of stock assessment tools regularly used by the STECF EWG. Additionall the EWG made recommendations to better integrate Bemtool forecasts and evaluation of management scenarios in regular scientific advice. EWG 1309 recognise the effort made by developers of BEMTOOL to generate a comprehensive bio-economic model for simulating management scenarios of the Mediterranean fisheries. The EWG, within the limited time available, and with the support of the developers of BEMTOOL, was able to install and address all items of this TOR. The installation procedure is detailed in Annex 1 of the TOR f. During EWG 13-09, a case study has been carried out for the four main species (*M. barbatus, P. longirostris, N. norvegicus and M. merluccius*) and fleets operating in GSA 18. The case study of GSA 18 has been also updated using the results of the last hake assessment (i.e. EWG 13-09). The knowledge of the operational modules and components of BEMTOOL and their interactions would have required a deep analysis of the available documentation, which was not possible during EWG 1309. Notwithstanding the limited amount of time and human resources available, the EWG 13-09 consider that the model is a good starting point for the evaluation of different management scenarios in the Mediterranean fisheries. However, in order to better integrate BEMTOOL forecasts and evaluation of management scenarios in future scientific advice, EWG 13-09 consider that:

d) BEMTOOL would benefit from an easier procedure of installation of the software;

e) Simulation testing with economic and biological data of known underlying properties would be necessary;

f) If managers wish to carry out a risk analysis between alternative management scenarios, BEMTOOL should account for uncertainty in the simulations.

To addres TOR (g1), EWG 13-09 identify a list of stocks to be assessed in the forthcoming meetings for each GSA (see Table 11.1). EWG 13-09 noted that, due to the restricted number of stocks to be assessed during each EWG, the current established priority list would not support the development of a mixed fisheries framework advice. Evaluation of mixed fisheries would need a minimum number of stocks per GSA (e.g. 5 or 6 stocks per GSA). However, EWG 13-09 consider that the number of stocks to be assessed by GSA in the forthcomings meetings (i.e. Table 11.1) should not be modified and therefore EWG 1309 advises to conserve the current list of stocks. Therefore, EWG 13-09 also advises that if managers are wishing to develop mixed fisheries framework advice, results of stock assessments conducted in the previous 2 or 3 years (i.e. 2010-2012) could be combined in order to satisfy the criteria of a minimum number of stocks per GSA. EWG 13-09 moreover advises that it would be optimal to develop mixed fisheries framework advice in ad-hoc working groups and not within the regular stock assessment meetings.

To addres TOR (g2), EWG 13-09 analised the current compliance of Mediterranean trawl fisheries with the current minimum catch sizes enforced by EU reg 1967/2006 for a set of demersal stocks. Results showed a very reduced compliance for hake stocks in GSAs 10, 11 and 19 with a percentage of specimens below the minimum legal size (20 cm) between 60% and 72%. Also for the deepsea pink shrimp there was a high catch of undersized specimens (43-44%) in GSAs 10 and 19. It is however important to notice that for several stocks the minimum legal size is smaller than the length at first maturity and always much smaller than the L_{opt}. Thus, EWG 13-09 consider that the current minimum legal size is inadequate to achieve MSY and to maximise the revenue from the fleets.

The EWG's report will be presented and reviewed during the STECF autumn plenary meeting PLEN 13-03, 4-8 November 2013.

2. CONCLUSIONS OF THE WORKING GROUP

ToR (a-c), Update and assess historic and recent stock parameters: EWG 13-09 did assess historic and recent parameters and conducted short term forecast for all stocks requested under ToR (a-c). Medium term forecasts were not conducted for any of the stocks requested under ToR (a-c) as no meanifgul stock and recruitment relationships were estimated. EWG 13-09 concludes that all stocks except *N. novegicus* in GSA 15&16 are exploited unsustainably and require large reduction in F to achieve F_{MSY}. Due to data decifiency, the assessment of hake in GSA 11 was not accepted.

ToR (d), Evaluation of DCF data quality by EWG experts: As in previous meetings, the quality of the fisheries data from GSA 11 (Italy) has impeded the EWG to conduct an assessments of hake in GSA 11. Also, lack of catch data for GSA 8 did not allow the EWG to conduct an assessment for any of the species in the area. Thus, EWG 13-09 reiterates that the situation with fisheries data in GSA 8 and 11 is of concerns. While for GSA 8 data should be provided, for GSA 11 a thorough review of the data and the data collection process is deemed necessary to be able to perform proper stock assessments. Since it is unclear the sampling level in GSA 11 and how the raising are performed, the EWG 13-09 considers necessary to access the raw sampling data to verify the raising procedures to evaluate properly the fisheries data.

ToR (e), Review of R scripts used for stock assessment, short and medium term forecast and estimation of reference points: All R scripts used in the different analysis were reviewed and delivered prior the meeting by the JRC team. No major issues were found. Development of new R routines for the standardisation of the MEDITS data is in progress and should be completed for the next EWG 13-19.

ToR (f), Evaluation of BEMTOOL software: In order to better integrate BEMTOOL forecasts and evaluation of management scenarios in future scientific advice, EWG 13-09 concluded that:

a) BEMTOOL would benefit from an easier procedure of installation of the software;

b) Simulation testing with economic and biological data of known underlying properties would be necessary;

c) If managers wish to carry out a risk analysis between alternative management scenarios, BEMTOOL should account for uncertainty in the simulations.

ToR (g1), Stock priority list: EWG 13-09 identified the stocks to be assessed for each GSA in the forthcomings meetings. The complete list of the stocks is available in Table 11.1 of this report.

ToR (g2) Mismatch between the legal minimum catching size of a stock and the actual exploitation pattern of the various fisheries exploiting it: EWG 13-09 concluded that for several stocks the minimum legal size is smaller than the MLS and the length at first maturity, and always much smaller than the L_{opt}. Thus, EWG 13-09 consider that the current minimum legal size is inadequate to achieve MSY and to maximise the revenue from the fleets.

Others: None

3. RECOMMENDATIONS OF THE WORKING GROUP

ToR (a-c), Update and assess historic and recent stock parameters: The EWG 13-09 recommends the reduction of the effort and/or the catches of the relevant fleets' exploiting all stocks listed in Annex II, with the exception of *N. norvegicus* in GSA 15 and 16, until fishing mortality is below or at the proposed level F_{MSY}. This is necessary to achieve MSY and to avoid future loss in stock productivity and landings. The F_{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} in the short term were estimated.

ToR (d), Evaluation of DCF data quality by EWG Experts: None

ToR (e), Review of R scripts used for stock assessment, short and medium term forecast and estimation of reference points: None

ToR (f), Evaluation of BEMTOOL software: None

ToR (g1), Stock priority list: None

ToR (g2), Mismatch between the legal minimum catching size of a stock and the actual exploitation pattern of the various fisheries exploiting it: None

Others

EWG 13-09 recommends that an ad-hoc methodological EWG should be held in the beginning of 2014 to set up and test different assumption of selectivity for a set of stocks and about the use of discard data and slicing methodologies in the future stock assessments. The EWG should:

- Collate and assemble the necessary input data by fleet for stocks of hake and Norway lobster in selected GSAs
- Run statistical catch at age assessment models with different assumptions on selectivity (i.e. dome shaped, logistic, etc)
- Discuss and compare the results with previous assessment conducted by XSA or other models
- Set up a common methodology to reconstruct times series of discard data to be used in future stock assessment
- Decide upon a common slicing methodology to reconstruct times series of catch at age data to be used in future stock assessment

Future planning of Mediterranean expert group meetings: The next STECF expert meeting (EWG 13-19: Assessment of Mediterranean Sea stocks - part 2) will be convened in Brussels the week 9-13 of December 2013.

4. INTRODUCTION

The expert working group on Mediterranean stock and fisheries assessment STECF EWG 13-09 held its first meeting planned for 2013 in Ispra (Italy), 15-19 July 2013.

The chairman opened the meeting at 14.00 on Monday, 15 July 2013, and adjourned the meeting by 13.00 on Friday, 19 July 2013. The meeting was attended by 25 experts in total, including 4 STECF members and 4 JRC experts.

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

Terms of Reference for the STECF EWG 13-09

GENERAL GUIDELINE: unless the data used and information provided comes from the official data calls, the experts are requested to indicate the data source from where certain information has been taken (e.g. L-W relationships, prices, etc.) or if it is an experts' reasoned guess

The STECF 13-09 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 15 stocks (Table 1).

Stocks highlighted with an asterisk may be shared with non-EU countries; taking into account the repartition of catches among countries (GFCM capture database; DCF, etc) and including also their likely exploitation patterns (STECF analyses, GFCM-SAC assessment forms; FAO regional projects, scientific papers, etc), indicate whether an assessment carried out with only EU catch data can still be considered scientifically sound.

Due account shall be given to technical interactions and description of the multispecies and multiple-gears fisheries concerned in terms of exploitation pattern, deployed fishing effort (trends over time) and allocation of stock catches among different métiers.

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 long-term 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 2013.

Assessment priority shall be given to stocks/GSAs following the yearly planning recommended by STECF, in the case that updated data has not been provided by relevant Member States, other stocks (crustaceans or demersal fish) in the priority list for 2013 or 2014 should be assessed by giving however priority to the **red mullet and striped mullet**.

Table 1 Priority stocks.

GSA	CODE	Common name	Species
1	HKE	Hake	*Merluccius merluccius*
1*	DPS	Pink shrimp	*Parapenaeus longirostris*
5	DPS	Pink shrimp	*Parapenaeus longirostris*
6	DPS	Pink shrimp	*Parapenaeus longirostris*
7	HKE	Hake	*Merluccius merluccius*
9	ARS	Giant red shrimp	*Aristaeomorpha foliacea*
10	HKE	Hake	*Merluccius merluccius*
10	DPS	Pink shrimp	*Parapenaeus longirostris*
11	HKE	Hake	*Merluccius merluccius*
12-16*	NEP	Norway lobster	*Nephrops norvegicus*
15-16*	ARA	Blue and red shrimp	*Aristeus antennatus*
17*	SOL	Common sole	*Solea solea*
18*	HKE	Hake	*Merluccius merluccius*
19	DPS	Pink shrimp	*Parapenaeus longirostris*
19	HKE	Hake	*Merluccius merluccius*

Data collected outside the DCF and/or delivered to the meeting by non-EU scientists shall be used as well and merged with DCF data whenever necessary and following quality check. Due account shall also be given to data used and assessments carried out within the FAO regional projects co-funded by the European Commission and EU-Member States in particular when using data collected through the DCF/DCR and EU funded research projects, studies and other types of EU funding.

Raw data used to generate the input data, assessment scripts as well as input files need to be made available for reproducibility of the assessments and documentation.

However, in case that an assessment with the most recent data has been already carried out and/or endorsed by the GFCM-SAC for the same stock(s) and fisheries, there is no need to redo the analyses unless new scientific and fishery elements have emerged that call for a revised assessment. A revision of a GFCM-SAC assessment has to be conducted only if raw data to generate the input data for the assessment are made available to the STECF-EWG the first day of the meeting at latest.

b) Provide a synoptic overview on the recent status of exploitation level and stock size of the stocks listed under a) including information on the fisheries minimum sizes at first capture corresponding, where possible, to 0%; 25% and 50 %.

c) provide for each stock a short term forecast and medium term forecasts (only when an acceptable Stock/Recruitment empirical/model based relationship is identifiable) of stock biomass and yield for the demersal stocks assessed in this meeting (Tor a) including, where advisable, assessments carried out in scientific frameworks other than STECF. The forecast scenarios shall include, inter alia:

the status quo

and

target to F_{msy} or other appropriate proxy for 2015 and 2020 respectively.

Whenever the quality of the data series allow it, please produce catch forecasts to get high yield under different recruitment scenarios while avoiding with high probability the risk that SSB fall under B_{lim}. In particular:

1) Estimate the biomass reference points (i.e. $SSB_{trigger}$ both as SSB_{lim} and SSB_{pa}) defined as the levels of SSB below which recruitment is considered likely to become increasingly impaired and thus actions should be taken (i.e. reducing fishing mortality below F_{MSY}) when the SSB approaches such stock sizes.

2) Using the framework developed at ICES-WKFRAME 2010 and adopted in the STECF EWG 12-13, estimate the levels of F which minimize the risk of SSB falling below $SSB_{trigger}$ or crashing the stock and provide MSY or maximize the total yield from the stock in the long term.

3) Estimate on the basis of commercial average catch rates by métier, the level of fishing effort by métier which is commensurate to the sustainable short-term and medium-term forecasts.

Implications of the proposed changes in fishing mortality on the fishing effort exerted by the relevant fisheries/métier concerned should be identified or roughly addressed. The identification and description of fisheries/métier (DCF codification) to be considered are left to the experts on the basis of their knowledge of fisheries in each GFCM-GSA.

The simulation by fishery for the abovementioned targets shall be driven either by the most relevant stock(s) (either in quantity and/or economic value), or the most vulnerable stock or a scientifically weighed mix of MSY targets for the main species involved in the fishery.

Raw data used to generate the input data for the assessment shall be made available to allow for testing different settings and data scenarios.

d) review the quality and completeness of all data resulting from the official Mediterranean DCF data call issued on April 2013. 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 the data format of the official DCF data calls for the Mediterranean issued on April 2013.

e) Review, update and consolidate the R scripts developed by SGMED and JRC over the period 2008-2012 to:

- perform deterministic and statistical age slicing on DCF catch at length and MEDITS data
- extract and standardize MEDITS indexes of biomass and abundance
- R plotting functions to produce standard plots for STECF reports

f) BEMTOOL[1]**:** - test the current Beta version of the software and identify possible problems in its installation, running and compatibility with the outcomes of stock assessment tools regularly used by the STECF EWG.

- run at least one case study in relation to the management scenarios indicated in point c) above while taking into account whether advisable improvements in the exploitation pattern of the fisheries concerned are needed (see also ToRs b) and g.2)).

- integrate, where necessary, with latest updated data/parameters the case studies currently uploaded in the Beta version

- Initiate extending the number of case studies currently implemented in the Beta version; this is a process that should steadily progress also in the future EWG meetings with a view to have a complete set of relevant fisheries in all GSAs

- discuss the consistency and results of the different fleet, stock and socio-economic projections obtained with BEMTOOL.

Make recommendations to better integrate Bemtool forecasts and evaluation of management scenarios in regular scientific advice.

- indicate whether BEMTOOL is adequate to evaluate the effects on fisheries and stocks of area based management approaches (i.e. marine protected areas, fisheries restricted areas, fishing protected areas etc.) and/or seasonal closures. Provide information on format, data needed and time/spatial scale to these ends and comment as adequate whether data submitted following the data calls carried out so far are suitable to this scope.

[1] DG-MARE is being supporting the elaboration of an integrated bio-economic modeling tool aimed to develop and support multi-objective approaches for the evaluation of different harvesting strategies and fisheries management scenarios in the Mediterranean. STECF EWGs are expected to be one of the end-users.

g) Any Other Business:

1. With a view to establish a rolling program to address the formulation of scientific advice for the management of mixed fisheries, in line with the Mediterranean-EWG advice, identify the relevant stocks (higher catches and/or economic value) whose assessment needs to be regularly carried out (yearly, biennial, triennial etc) in each GSA and/or merged GSAs in the forthcoming EWG meetings. Indicate whether the current list of stocks to be assessed in the forthcoming EWG session needs to be amended with a view to develop a framework for the provision of mixed fishery scientific advice.

2. the specific target fishing mortality to restore and maintains populations of harvested species above levels which can produce the maximum sustainable yields is also related to the specific exploitation pattern of the fisheries concerned. The Council Regulation (EC) N° 1967/2006 stipulates the **minimum catching size**, which is the conservation size that shall not be caught by the fishing gears, for several species (see Annex).

    2.1. Identify and comment as adequate possible mismatching between the legal minimum catching size of a stock and the actual exploitation pattern of the various fisheries exploiting it. Due account shall be given to the data submitted through the official data call and/or additional expert knowledge.

ANNEX: Minimum conservation size established by Article 15 and Annex III of the Council Regulation (EC) N° 1967/2006.

(Extract of Article 15: 1. A marine organism which is smaller than the minimum size specified in Annex III (hereinafter undersized marine organisms) shall not be caught, etc…..)

ANNEX III

Minimum sizes of marine organisms

Scientific name	Common name	Minimum size
1. Fishes		
Dicentrarchus labrax	Sea bass	25 cm
Diplodus annularis	Annular sea bream	12 cm
Diplodus puntazzo	Sharpsnout sea bream	18 cm
Diplodus sargus	White sea bream	23 cm
Diplodus vulgaris	Two-banded sea bream	18 cm
Engraulis encrasicolus (*)	European anchovy	9 cm
Epinephelus spp.	Groupers	45 cm
Lithognathus mormyrus	Stripped sea bream	20 cm
Merluccius merluccius (***)	Hake	20 cm
Mullus spp.	Red mullet	11 cm
Pagellus acarne	Spanish sea bream	17 cm
Pagellus bogaraveo	Red sea bream	33 cm
Pagellus erythrinus	Common pandora	15 cm
Pagrus pagrus	Common sea bream	18 cm
Polyprion americanus	Wreckfish	45 cm
Sardina pilchardus (**)	European sardine	11 cm
Scomber spp.	Mackerel	18 cm
Solea vulgaris	Common sole	20 cm
Sparus aurata	Gilt-head sea bream	20 cm
Trachurus spp.	Horse mackerel, scad	15 cm
2. Crustaceans		
Homarus gammarus	Lobster	300 mm TL105 mm CL
Nephrops norvegicus	Norway lobster	20 mm CL70 mm TL
Palinuridae	Crawfish	90 mm CL
Parapenaeus longirostris	Deep-water rose shrimp	20 mm CL
3. Mollusc bivalves		
Pecten jacobeus	Scallop	10 cm
Venerupis spp.	Carpet clams	25 mm
Venus spp.	Venus shells	25 mm

TL = total length; CL = carapace length.
(*) Anchovy: Member States may convert the minimum size into 110 specimens per kg;
(**) Sardine: Member States may convert the minimum size into 55 specimens per kg;
(***) Hake: Nevertheless, until 31 December 2008 a margin of tolerance of 15 % of weight will be permitted for hake between 15 and 20 cm. This tolerance limit shall be complied with by both individual vessels, at sea or at the place of landing, and at the markets of first sale after landing. This limit shall also be complied with in any subsequent commercial transaction at national and international level.

Participants

The full list of participants at EWG 13-09 is presented in Annex I of this report.

5. TOR A-C 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. The assessments are presented in geographical order (i.e. by GSA) and not any longer by species. Detailed versions of the assessments of stocks and fisheries are provided in the following section 6 of the report.

5.1. SUMMARY SHEET OF HAKE IN GSA 1

Species common name:	European hake
Species scientific name	*Merluccius merluccius* (L., 1758)
Geographical Sub-area(s) GSA(s):	GSA 1

Most recent state of the stock

State of the adult abundance and biomass

SSB fluctuated around 300 t over 2003- 2012, with a minimum in 2007 (229 t) and a peak in 2010 (366 t). No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits)

Recruitment fluctuated markedly over 2003- 2012, with highest values in 2003, 2008 and 2010 (around 17-18000 thousand recruits) and a minimum in 2005 (5400 thousand recruits). Recruitment markedly decreased from 2010 to 2012 (7100 thousand recruits in 2012).

State of exploitation

Exploitation is based on age classes 1 and 2, with age 1 as the youngest age fully recruited to the fisheries. By comparing F_{01} and F_{max} against current F, it can be concluded that the stock is exploited unsustainably. Results were the following: F_{curr} = 1.61, F_{01} = 0.22, F_{max} = 0.37.

Source of data and methods

The state of exploitation was assessed for the period 2003-2012 applying an Extended Survivor Analysis (XSA) method calibrated with fishery independent survey abundance indices (MEDITS). In addition, a yield-per-recruit (Y/R) analysis was carried out. Both methods were performed from the size composition of trawl landings, transforming length data to ages by knife-edge slicing (L2AGE program).

Input data were taken from DCF. Natural mortality (vector) was estimated using PROBIOM. M at the mid-point of the year was selected as M representative for that annual class.

Outlook and management advice

EWG 13-09 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed level F_{01}, 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.

Fisheries

European hake is one of most important demersal target species of the Mediterranean fishing fleets, exploited in GSA 01 mainly by trawlers (95% landings) on the shelf and slope, and by small-scale fisheries using gillnets (3%) and long lines (2%) on the shelf (average 2009-2012). Over the period 2003-2012 annual landings oscillated between around 300 and 600 tonnes. Trawl discards in weight are very low or nil.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by EWG 13-09.

F_{01} (ages 1-2) =	0.22
F_{max} (age range)=	
F_{MSY} (ages 1-2) =	0.22
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_{01} (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

The detailed assessment of European hake in GSA 1 can be found in section 6.1 of this report report and the short term forecast in section 7.1.

5.2. SUMMARY SHEET OF DEEPWATER PINK SHRIMP IN GSA 1

Species common name:	Deepwater pink shrimp
Species scientific name:	*Parapenaeus longirostris*
Geographical Sub-area(s) GSA(s):	GSA 1

Most recent state of the stock

State of the adult abundance and biomass

The SSB showed a marked incrising trend along the time series, increasing from about 100 tons in 2007 to about 400 tons in 2012. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits)

There was a slight increase of recruits during the time series analysed caractherised by a marked peak in 2011.

State of exploitation

The current F (0.43) is larger than F_{01} (0.26), which indicates that *Parapenaeus longirostris* in GSA 1 is exploited unsustainably.

Source of data and methods

Landings, tuning fleet (MEDITS) and size-frequency distributions: 2003-2012. Growth and maturity parameters: García-Rodríguez et al. (2009). Lenght-weight relationship: Spanish DCF 2011-2012. Natural mortality: PRODBIOM. XSA, Y/R and projections: R scripts developed by the JRC team for STECF EWG 13-09.

Outlook and management advice

STECF EWG 13-09 also recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{01} 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.

Fisheries

In GSA 1, deepwater pink shrimp is a target species for around 170 trawling vessels (in 2011) operating on the upper slope and it is one of the most important crustaceans species for the trawl fisheries. The species is caught almost exclusively as a by-catch by trawlers working in the deep continental shelf and the upper slope (100–400 m). No artisanal boats target this species.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by EWG 13-09.

F_{01} (1-3)	0.26
F_{max} (1-3)	
F_{msy} (1-3) =	0.26
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_{01} (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

The detailed assessment of deepwater pink shrimp in GSA 1 can be found in section 6.2 of this report and the short term forecast in section 7.2.

5.3. SUMMARY SHEET OF DEEPWATER PINK SHRIMP IN GSA 5

Species common name:	Deepwater pink shrimp
Species scientific name:	*Parapenaeus longirostris*
Geographical Sub-area(s) GSA(s):	GSA 5

Most recent state of the stock

State of the adult abundance and biomass:

SSB showed the maximum values at the beginning of the period (2002), with minimum values in 2005-2006 and a slightly increasing trend since then. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits):

Recruitment showed a similar trend than the SSB, with the maximum values at the beginning of the period (2002), with minimum values in 2005-2006 and a slightly increasing trend since then.

State of exploitation:

EWG 12-10 proposed F_{01} as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account that the current F_{0-2}= 0.77 is slightly larger than F_{01}= 0.62, the pink shrimp in GSA 05 is considered exploited unsustainably.

Source of data and methods:

An Extended Survivor Analysis (XSA) was performed using as input data bottom trawl landings and age distributions (from sliced length frequency distributions) from 2002-2012 (from the Official DCF Data Call). Biological parameters used correspond to those computed by Guijarro *et al.* (2009) in the study area. Standardized indices from bottom trawl surveys (BALAR and MEDITS) were used as tuning fleets.

Outlook and management advice

STECF EWG 13-09 also recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{01} 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.

Although the stock is fished unsustainably, it is important to remark than the CPUEs (both from surveys and commercial fleet) oscillations found for this species are also found in other areas of the Mediterranean and probably caused not only by the fishing effort but also by environmental changes. For this reason, it is important to follow the evolution of this stock, especially because it seems that it has started to recover during the last years.

Fisheries

In the Balearic Islands (western Mediterranean), commercial trawlers develop up to four different fishing tactics, which are associated with the shallow shelf, deep shelf, upper slope and middle slope (Guijarro and Massutí 2006; Ordines et al. 2006), mainly targeted to: (i) *Spicara smaris, Mullus surmuletus, Octopus vulgaris* and a mixed fish category on the shallow shelf (50-80 m); (ii) *Merluccius merluccius, Mullus* spp., *Zeus faber* and a mixed fish category on the deep shelf (80-250 m); (iii) *Nephrops norvegicus*, but with an important by-catch of big *M. merluccius*, *Lepidorhombus* spp., *Lophius* spp. and *Micromesistius poutassou* on the upper slope (350-600 m) and (iv) *Aristeus antennatus* on the middle slope (600-750 m). The pink shrimp, *P. longirostris*, is an important by-catch species in the upper slope.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 13-09.

F_{01} (ages 0-2) =	0.62
F_{max} (age range)=	
F_{MSY} (ages 0-2) =	0.62
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_{01} (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

The detailed assessment of pink shrimp in GSA 05 can be found in section 6.3 of this report and the short term forecast in section 7.3.

5.4. SUMMARY SHEET OF DEEPWATER PINK SHRIMP IN GSA 6

Species common name:	Deepwater pink shrimp
Species scientific name:	*Parapenaeus longirostris*
Geographical Sub-area(s) GSA(s):	GSA 6

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, abundance and biomass in the last three years have increased considerably, reaching the levels of the previous peaks observed in 2000-2001. SSB declined largely duing the first year of the time series and fluctuates with no trend thereafter. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits)

Recruitment as estimate by the XSA fluctuates with no trend over the analysed period (2001-2012).

State of exploitation

EWG 13-09 proposes $F \leq 0.27$ as limit management reference point (basis F_{01} as a proxy of F_{MSY}) consistent with high long term yields. A considerable reduction (around 81%) is necessary to reach the F_{MSY} reference point This stock had been previously assessed in 2011 (EWG 11-14).

Source of data and methods

The data used in the analyses were DCF length frequencies from the 2012 data call, corresponding to the years 2001 to 2012. The FLR implementation of XSA was used for this analysis. The following growth parameters were used (males and females combined): L_∞ = 45.0 mm CL, k = 0.39 yr^{-1}, t = 0.1109 yr, while the length-weight relationship parameters were: a= 0.0030 and b= 2.49. Natural mortality vector was obtained applying the PRODBIOM method.

Outlook and management advice

EWG 13-09 recommends the relevant fleets cacthes and/or effort to be reduced until fishing mortality is below or at 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.

Fisheries

The deepwater pink shrimp is a target species of the mixed continental shelf and upper continental slope trawl fishery. Landings (t) of pink shrimp in the period 2001 – 2012 are shown in the table below. Discards are negligible because this species has high commercial value in the entire size range. Undersized individuals (< 20 mm CL) are virtually absent from the catches.

2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
331	165	116	76	102	123	107	104	116	141	92	120

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by EWG 13-09.

$F_{0.1}$ (ages 2-4) =	0.27
F_{max} (age range)=	
F_{MSY} (ages 2-4) =	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)=	

Comments on the assessment

The detailed assessment of pink shrimp in GSA 6 can be found in section 6.4 of this report and the short term forecast in section 7.4.

5.5. SUMMARY SHEET OF HAKE IN GSA 7

Species common name:	Hake
Species scientific name	*Merluccius merluccius* (L., 1758)
Geographical Sub-area(s) GSA(s):	GSA 7

Most recent state of the stock

State of the adult abundance and biomass

The stock spawning biomass (SSB) as estimated by the XSA shows a decreasing trend over the analyzed period. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits)

The highest recruitment values were observed in 1998, 2002-2003 and 2007. Since 2007, the recruitment follows a decreasing trend and it is currently at the lowest level observed.

State of exploitation

The exploitation level is currently above the level estimated to produce sustainable high long term yield. The current fishing mortality $F_{curr} = 1.83$ is higher than F_{01} ($F_{01} = 0.11$). The exploitation is mainly concentrated on age classes 0 and 1. Therefore, STECF EWG 13-09 considered the stock exploited unsustainably and recommends fishing mortality to be reduced to the proposed reference point in order to achieve long term sustainability.

Source of data and methods

Data coming from DCF (catch at age from the French and Spanish trawlers, French gillnetters and Spanish longliners) for the period 1998-2012 were used to run an Extended Survivor Analysis (XSA), tuned with MEDITS abundance indices for 1998-2012. Discards were included in the catches.

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

Outlook and management advice

EWG 13-09 recommend the relevant fleets catches and/or effort to be reduced until fishing mortality is below or at the proposed level F_{msy} (0.11), 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.

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 240 boats are involved in this fishery and, according to official statistics, the total annual landings for the period 1998-2012 have oscillated around an average value of 2030 tons (1123 tons in 2012). In 2009, because of the large decline of small pelagic fish species in the area, the trawlers fishing small pelagic have diverted their effort on demersal species. Since 2011, the fishing capacity of French trawlers in GSA 07 has decreased by nearly 30%.

The French trawler fleet is the largest in number of boats and catch (42 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 (~41 and 14% respectively, range 13-86 cm TL and average size 39 cm TL), followed by the Spanish trawlers (~11 and 8%, respectively, range 5-88 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*).

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

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
French trawlers	1688	1525	1347	1835	2168	2024	1023	1002	1014	1282	1898	1633	1527	970	759
Spanish trawlers	140	279	166	196	231	206	101	125	116	107	192	258	156	113	162
French gillnetters	500	500	500	500	182	248	99	255	299	168	111	286	247	250	175
Spanish longliners	101	109	285	163	146	112	78	101	170	143	97	83	53	29	18

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

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
French trawlers	-	-	-	-	-	-	-	-	-	-	173	9	-	-	9
Spanish trawlers	-	-	-	-	-	-	-								

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by EWG 13-09.

$F_{0.1}$ (ages 0-3) =	0.11
F_{max} (ages 0-3) =	
F_{MSY} (ages 0-3) =	0.11
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

The detailed assessment of hake in GSA 7 can be found in section 6.5 of this report and the short term forecast in section 7.5.

5.6. SUMMARY SHEET GIANT RED SHRIMP IN GSA 9

Species common name:	Giant red shrimp
Species scientific name	*Aristaeomorpha foliacea*
Geographical Sub-area(s) GSA(s):	GSA 9

Most recent state of the stock

State of the adult abundance and biomass:

Stock assessment has been computed by Extended Survivors Analysis (XSA) using DCF data of landings (2006-2012). Results obtained did not show a clear trend in the stock size. MEDITS survey indices indicate a variable pattern of abundance (n/km^2) and biomass (kg/km^2) without a clear trend. In the period analyzed indices showed a remarkable increase in 2010 both in terms of biomass and abundance. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits):

To evalutate the state of recruitment, the XSA output and index of recruitment estimated with MEDITS surveys were compared. Both approach indicate that in the 2008-2011 period an important recruitment took place with a main peak in 2010.

State of exploitation:

EWG 13-09 proposed an $F_{01} \leq 0.36$ as limit reference point and taking into account results coming from the XSA ($F_{(1\text{-}3)} = 0.62$), the stock was considered to be exploited unsustainably.

Source of data and methods:

XSA was computed on DCF data of commercial landings (2006-2012). Landings per age were obtained splitting LFD respects on the following growth parameters. As natural mortality was used a vector estimated by PRODBIOM.

Outlook and management advice

EWG 13-05 recommends the relevant fleets catches and/or effort to be reduced until fishing mortality is 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.

Fisheries

Annual landings (t) by fisheries in GSA 09 (2006-2010).

YEAR	GEAR	FISHERY	LANDINGS
2006	OTB	MDDWSP	62.61
2007	OTB	MDDWSP	36.65
2008	OTB	MDDWSP	24.39
2009	OTB	MDDWSP	34.29
2010	OTB	MDDWSP	36.85
2011	OTB	DWSP	17.62
2011	OTB	MDDWSP	50.81
2012	OTB	MDDWSP	52.38

Annual fishing effort by fishing technique in GSA 09 (2006-2010).

COUNTRY	AREA	GEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012
ITA	GSA 9	DRB	271634	264317	219582	230204	381592	277250	229384	219990	136966
ITA	GSA 9	FPO			1664		27551	9493	9919		
ITA	GSA 9	GND	15372	4992	62253			4431	14908	5877	
ITA	GSA 9	GNS	3758570	3903858	3261681	3761065	3048710	3251684	2817577	3711453	2061794
ITA	GSA 9	GTR	3279499	3814735	3861839	2761471	2415273	3047433	2981409	3231880	2854501
ITA	GSA 9	LLD	453740	821542	930859	523364	602955	365199	554045	429722	399733
ITA	GSA 9	LLS	424132	495263	383146	118928	31420	31260	20773	26691	23739
ITA	GSA 9	LTL			6987	2494		2603		13785	4765
ITA	GSA 9	NA	1497515	1583872	939417	637514	547250	615676	320480	422085	167761
ITA	GSA 9	OTB	14820339	14700599	12404787	12782144	10693694	12176447	11228001	10696166	9997907
ITA	GSA 9	PS	1393298	1412031	1147523	1116579	1032017	1318198	990104	1162692	1105419
ITA	GSA 9	PTM			4599				100		

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by EWG 13-09.

$F_{0.1}$ (ages 1-3) =	0.36
F_{max} (age range)=	
F_{msy} (age 1-3)=	0.36
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

The detailed assessment of giant red shrimp in GSA 09 can be found in section 6.6 of this report and the short term forecast in section 7.6.

5.7. SUMMARY SHEET OF HAKE IN GSA 10

Species common name:	Hake
Species scientific name	*Merluccius merluccius* (L., 1758)
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/km^2) and biomass (kg/km^2) with an increasing up to 2010 and a decreasing in the last two years. The recent values are at the same level of those observed at the beginning of the time series. SSB fluctuates without any trend over the analysed time series. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits):

MEDITS data showed a sharp increase of recruitment in 2005 and thereafter a level similar or higher than in the past years. From 2007 onward recruitment decreased again until 2011. In 2012 a new increase was observed. From the XSA assessment no particular trends are observed, with the recruitment fluctuating around the average of the time series.

State of exploitation:

EWG 13-09 proposes $F \leq 0.14$ as proxy of F_{MSY}. Given the results of the present analysis (current F is around 1), the stock is exploited unsustainably.

Source of data and methods:

The data used in the analyses were from trawl surveys (time series of MEDITS from 2006 to 2012) and from fisheries up to 2012.

The analyses on the population were conducted using XSA. Fast growth scenario has been used: L_∞=104 cm, K=0.2, t_0= -0.01; length-weight relationship: a=0.00355, b=3.22 for sex combined. Natural mortality vector was obtained applying the Prodbiom method. Size at first maturity was varying around 32 cm (maturity range 2 cm).

Outlook and management advice

EWG 13-09 recommends the 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.

Fisheries

M. merluccius is with red mullet and deep-water pink shrimp a key species of fishing assemblages in the central-southern Tyrrhenian Sea. Fishing grounds are located on the soft bottoms of continental shelves and the upper part of continental slope along the coasts of the whole GSA. Catches from trawlers are from a depth range between 50-60 and 500 m and hake occurs with other important commercial species as *Illex coindetii*, *M. barbatus*, *P. longirostris*, *Eledone* spp., *Todaropsis eblanae*, *Lophius* spp., *Pagellus* spp., *P. blennoides*, *N. norvegicus*. The landings fluctuates around 1,100 and 1,600 tons with the maximum in 2006 and the minimum in 2012.

Most part of the landings of hake is from trawlers and nets (GNS and GTR), but the catches of the demersal long-line fishery are also important.

Annual landings (tons) by major gear type, 2004-2012.

Species	GEAR	FISHERY	2004	2005	2006	2007	2008	2009	2010	2011	2012
HKE	GND	SPF	7								
HKE	GNS	DEMF	177	294	326	213	311	282	431	287	311
HKE	GTR	DEMSP	202	124	148	157	68	107	202	153	138
HKE	LLS	DEMF	266	269	288	240	232	247	184	318	214
HKE	OTB	DWSP									7
HKE	OTB	DEMSP	186								307
HKE	OTB	MDDWSP	300	612							105
HKE	OTB	Aggregate			759	641	501	441	475	443	
		Total	1138	1299	1522	1251	1112	1077	1292	1200	1082

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by EWG 13-09.

$F_{0.1}$ (all classes)	0.14
F_{max} (age range)	
F_{msy} (all classes) =	0.14
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

The detailed assessment of hake in GSA 10 can be found in section 6.7 of this report and the short term forecasts in the section 7.7.

5.8. SUMMARY SHEET OF DEEPWATER PINK SHRIMP IN GSA 10

Species common name:	Deepwater pink shrimp
Species scientific name:	*Parapenaeus longirostris*
Geographical Sub-area(s) GSA(s):	GSA 10

Most recent state of the stock

State of the adult abundance and biomass

Survey MEDITS indices indicate a sharp decrease of abundance (n/h) and biomass (kg/h) from 2006 to 2007 and increase until 2012, which corresponds to the higher value of the abundance and biomass of the time series. GRUND data showed a decrease of abundance and biomass from 2005 to 2006 which followed an increasing phase. SSB does not show any particular trend over the time series. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits)

Recruitment estimates from GRUND surveys showed a decrease in abundance from 2005 to 2006 after a rising phase from 2002 to 2005, whilst recruitment indices from MEDITS show peaks in 1999, 2003, 2005 and 2012. Recruitment as estimated by the XSA shows a decline between 2006 and 2011, with a large increase in the last years of assessment (i.e. 2012).

State of exploitation

EWG 13-09 proposes $F \leq 0.93$ as limit management reference point (basis F_{01} as proxy of F_{MSY}) of exploitation consistent with high long term yield. Given the results of the present analysis ($F_{curr} = 1.24$), the stock is considered to be exploited unsustainably.

Source of data and methods

During EWG 13-09 the assessment of deepwater pink shrimp has been performed for the first time with XSA method. The data provided in the last data call 2013 from 2006 to 2012 have been used; the time series from 2006 to 2012 has been considered covering more than the mean life span of the species, allowing to make an attempt of stock assessment with XSA method. XSA was applied using the landing structures at age and MEDITS survey data from 2006 to 2012.

Outlook and management advice

EWG 13-09 recommends the 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.

Fisheries

The deepwater pink shrimp is only targeted by trawlers and fishing grounds are located on the soft bottoms of continental shelves and the continental slope along the coasts of the whole GSA. The pink shrimp occurs mainly with *M. merluccius*, *M. barbatus*, *Eledone cirrhosa*, *Illex coindetii* and *Todaropsis eblanae*, *N. norvegicus*, *P. blennoides*, depending on depth and area.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 13-09.

$F_{0.1}$ (ages 0-2) =	0.93
F_{max} (age range)=	
F_{MSY} (ages 0-2) =	0.93
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

The detailed assessment of deepwater pink shrimp in GSA 10 can be found in section 6.8 of this report and the short term forecast in section 7.8.

5.9. SUMMARY SHEET OF HAKE IN GSA 11

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

Most recent state of the stock

Due to data limitation, the assessment of hake in GSA 11 has not been accepted.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 13-09.

$F_{0.1}$ (ages range) =	
F_{max} (age range)=	
F_{MSY} (ages range) =	
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

The detailed assessment of hake in GSA 11 can be found in section 6.9 of this report.

5.10. SUMMARY SHEET OF NORWAY LOBSTER IN GSA 15 AND 16

Species common name:	Norway lobster
Species scientific name:	*Nephrops norvegicus*
Geographical Sub-area(s) GSA(s):	GSA 15 and 16

Most recent state of the stock

State of the adult abundance and biomass:

In 2002-2012, the SSB ranged between about 860 and 1892 t with a large increases in 2012. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits):

Recruitment at age 1 showed large fluctuations from about 230 and 22 million. Since no recruitment reference point for this stock has been proposed, EWG 13-09 cannot evaluate the stock status in relation to these.

State of exploitation:

F was generally lower than 0.5 with a declining trend from 0.65 in 2003 to 0.15 in 2012. Based on the adopted proxy for F_{MSY} (F_{01}=0.20) the stock was exploited unsustainably in the period 2002-2011. The estimated F was however below F_{MSY} in 2012 indicating that in the this year the stock was exploited sustainably.

Source of data and methods:

An a4a statistical catch at age assessment (Millar et al., 2012) was carried out using the Italian and Maltese annual landings data of the GSAs 15-16 for the period 2002 to 2012 and calibrated with MEDITS survey data for the same period 2002-2012. The Maltese landings (GSA 15), corresponding to a proportion generally less than 0.25% of the Italian landings, were available for the period 2006-2012. An average proportion of 0.25% was added to the Italian landings for the period 2002-2006. The annual size distributions of the catch as well as of the surveys (MEDITS) were converted in numbers at ages classes 1-8+ using the slicing statistical approach developed by Scott et al. (2011) and using the same growth parameters adopted to slice the MEDITS size distributions. The growth parameters used for the assessment were those used during SGMED-09-02 for Norway lobster in GSA 09 combined with maturity at age data from DCF in GSA 16. Natural mortality at age was calculated using PRODBIOM (Abella et al., 1997).

Outlook and management advice

EWG 13-09 proposed F_{01} = 0.20 as proxy of F_{MSY} and as the exploitation reference point. Based on the F_{cur} estimated by the statistical catch at age (a4a assessment), the stock was exploited unsustainably in the period 2002-2011. The estimated F_{cur} was however below F_{MSY} in 2012 indicating that the stock was exploited sustainably in 2012. EWG 13-09 recommends that the relevant fleets' effort and/or catches are not increased to maintain fishing mortality below 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.

Fisheries

Norway lobster catches in the Strait of Sicily is caught almost exclusively by the bottom trawlers. It is one of the main commercial species for trawlers exploiting fishing grounds on the upper slope to target mainly the deepsea pink shrimp (*Parapenaeus longirostris*) and the giant red shrimp (*Aristaeomorpha foliacea*). Other accompanying species of commercial relevance are *Merluccius merluccius*, *Lepidorhombus* spp., *Lophius* spp.

Table of limit and precautionary management reference points proposed by STECF EWG 13-09.

$F_{0.1}$ (1-7)	0.20
F_{max} (age range)	
F_{MSY} (1-7)	0.20
Z_{msy} (age range)=	
Z_{mean} (age range)=	
B_{pa} (spawning stock)	
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)=	

Comments on assessment

Two different assessments (XSA and SCA – a4a) were carried out during EWG 13-09. The advice was based on the results of the statistical catch at age (SCA) because it was assumed to be more suitable in assessing F in the more recent years than the XSA, also considering its flexible parameterization of the selectivity at age.

The detailed assessment of Norway lobster in GSAs 15 and 16 can be found in section 6.10 of this report and the short term forecast in section 7.10.

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5.11. SUMMARY SHEET OF BLUE AND RED SHRIMP IN GSA 15 AND 16

Species common name:	Blue and red shrimp
Species scientific name:	*Aristeus antennatus*
Geographical Sub-area(s) GSA(s):	GSA 15 and 16

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), with the current estimates being at the low level of the time series (1994-2012; mean catch of 0.38 kg/h in 2012 compared to an average biomass index of 0.74 kg/h). No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits)

Recruitment estimates based on GSA 15 and GSA 16 MEDITS data (individuals with 16-28 mm carapace length, i.e. individuals aged 1 year) show large inter-annual variations. Values estimated in 2012 were above the average of the time series (3.8 juveniles per km^2, compared to an average of 2.4). Similarly in GSA 15 the highest number of juveniles time series was recorded in 2012.

State of exploitation

STECF EWG 13-09 proposes $F_{0.1} \leq 0.26$ as a limit management reference point consistent with high long term yields (F_{MSY} proxy). Given the results of the present analysis (F_{cur} 2012 = 0.81), the stock is exploited unsustainably.

Source of data and methods

Cohort (VPA equation) and Y/R analysis as implemented in the package VIT4win were implemented based on DCF data of commercial landings (2009-2012). Catch length frequency distributions were converted in numbers at ages using the statistical slicing method; a vector of natural mortality by age was calculated using the PRODBIOM approach.

Outlook and management advice

EWG 13-09 recommends the relevant fleets' effort and/or catches to be reduced to reach the proposed $F_{MSY,}$ in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan.

Fisheries

The key target species for the Sicilian and Maltese bottom otter trawl fleets operating on the slope of the continental shelf in the Strait of the Sicily is the giant red shrimp, *Aristaeomorpha foliacea*. However whilst *A. foliacea* is fished mainly in the central – eastern side of the Strait of Sicily, it is substituted by the blue and red shrimp *A. antennatus* on the western side of the channel. Other commercial species frequently caught together with blue and red shrimp are the deep water rose shrimp (*Parapenaeus longirostris*), Norway lobster (*Nephrops norvegicus*), greater forkbeard (*Phycis blennoides*) and hake (*Merluccius merluccius*).

With regards to fishing effort, data submitted by Italy and Malta in response to the annual EU fisheries Data Collection Framework (DCF) data-call in 2013 revealed a 40% decrease in fishing effort for Italian bottom otter trawl vessels larger than 24 m in the period 2004-2012. Maltese vessels were only responsible for 3.5%

of total trawling effort in GSAs 15 and 16 in 2012, however the total nominal effort of Maltese trawlers increased by 78% in 2005-2012 and fishing effort exerted by Maltese trawlers increased by 27% in 2011-2012.

Yield for Italian and Maltese trawlers combined in the period 2009-2012 peaked in 2012, at 94 tonnes. The lowest landings were reported in 2009, at 42.18 tonnes. The average of blue and red shrimp landings was 61 tonnes from Sicilian trawlers and 2 tonnes from Maltese trawlers in 2009-2012; the average annual contribution of Maltese catches to the total catch in this period was 3.6%.

Area	Country	2009	2010	2011	2012
15	Malta	2.1	1.7	2.3	2.3
16	Italy	40.0	54.2	59.8	91.7
15 and 16	Italy & Malta	42.2	55.9	62.1	94.0

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 13-09.

$F_{0.1}$ (ages 1-7) ≤	0.26
F_{max} (age range)=	
F_{MSY} (ages 1-7) =	0.26
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

The detailed assessment of blue and red shrimp in GSAs 15 and 16 can be found in section 6.11 of this report and the short term forecast in section 7.11.

5.12. SUMMARY SHEET OF COMMON SOLE IN GSA 17

Species common name:	Common sole
Species scientific name	*Solea solea*
Geographical Sub-area(s) GSA(s):	GSA 17

Most recent state of the stock

State of the adult abundance and biomass:

An XSA (Extended Survivor analysis) and SCAA (Statistical Catch at Age; SS3) assessment were performed using DCF catch data from Italy and Slovenia together with catch information for the Croatian fishery provided by a Croatian ad-hoc project. According to the XSA and SS3 outputs, the SSB was practically constant in the period 2006-2012, but the estimates made by the SS3 model show that the SSB is less than 20% of the biomass observed in the 90s and with a clear decreasing abundance of the older ages. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits):

According both to the XSA and SS3 analyses the recruitment of sole in GSA 17 fluctuated without a clear pattern since 2006. The SoleMon survey data show higher values in the last two years.

State of exploitation:

EWG 13-09 consider that the more accurate methodology to assess the stock is the SCAA carried out with SS3, thus EWG 13-09 proposes $F \leq 0.31$ as proxy for F_{MSY}. Given the results of the present analysis (current F is around 0.93), the stock is exploited unsustainably.

Source of data and methods:

An XSA was performed using 2006-2012 DCF data (landings and age composition of the catches), by gear (otter bottom trawl, gillnet, and *rapido* trawl), tuned with fishery independent abundance indices (SoleMon survey) for the period 2006-2012. An SCAA was performed using 2006-2012 DCF data (landings and age composition of the catches), by gear (otter bottom trawl, gillnet, and *rapido* trawl) and reconstructed catches by age for the period 2000-2005, tuned with fishery independent abundance indices (SoleMon survey) for the period 2005-2012. Total landings by gear and country (1970-2012) were reconstructed based on data available in the FAO-FishstaJ database. A vector of natural mortality was obtained applying PRODBIOM. In addition, Yield per Recruit (YPR) analysis was also performed for the estimation of F_{01} (i.e. proxy of F_{MSY}).

Outlook and management advice

EWG 13-09 recommends the 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 common sole is a very important commercial species in the central and northern Adriatic Sea. Italian *rapido* trawlers exploit the resource usually providing 40% of landings. Sole is also a target species of the Italian and Croatian set netters, and it represents an accessory species for otter trawlers. The main fisheries operating with *rapido* trawl in GSA 17 are from Ancona, Chioggia and Rimini. Over 2006-2012, annual landings ranged between 1400 t in 2008 and 2000 t in 2006.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 13-09.

$F_{0.1}$ (ages 0-4) =	0.31
F_{max} (age 0-4)=	0.60
F_{MSY} (ages 0-4) =	0.31
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

Two different assessments (XSA and SCAA – SS3) were carried out during EWG 13-09. The advice was based on the results of the statistical catch at age (SS3) because it was assumed to be more suitable in assessing F in the more recent years than the XSA, also considering its flexible parameterization of the selectivity at age.

The detailed assessment of common sole in GSA 17 can be found in section 6.12 of this report and the short term forecast in section 7.12.

5.13. SUMMARY SHEET OF HAKE IN GSA 18

Species common name:	Hake
Species scientific name	*Merluccius merluccius* (L., 1758)
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) without a temporal trend. However, recent values are higher or similar to those observed since 1996. SSB increased up to 2011 and but declined in the last year of assessment (i.e. 2012), reaching the lowest observed value in the time series. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits):

MEDITS data showed a sharp increase of recruitment in 2005 and thereafter a level similar or higher than in the past years. In 2008 a new, though lower peak, was observed and a new one in 2012. Recruitment as estimated by the XSA shows a decline until 2011 but a large increase in 2012.

State of exploitation:

WG Demersals of GFCM and EWG 13-09 proposes $F \leq 0.19$ as proxy of F_{MSY}. Given the results of the present analysis (current F is around 1), the stock appeared to be exploited unsustainably. A considerable reduction in F is necessary to approach the reference point.

Source of data and methods:

The data used in the analyses were from trawl surveys (MEDITS 1996-2012) and from commercial fisheries from the Italian side for the GSA18 (2007-2012), while for Montenegro and Albania catches similar as in 2011 was assumed. Fast growth parameters were used for sex combined (L_{∞}= 104 cm; K= 0.2; t_0 = -0.01) to split the LFDs. A natural mortality vector M was estimated using PRODBIOM.

Outlook and management advice

EWG 13-09 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 one of the most important species in the GSA 18 representing in some years about 20% of landings from trawlers. Trawling is the most important fishery activity on the whole area with an effort of about 75% (average among the years 2004-2012) of the total effort. Hake is also caught by off-shore bottom long-lines, but these gears are utilised by a low number of boats (less than 5% of the whole South-western Adriatic fleet). Long-line landings account for about 10-12% of the total hake production.

Fishing grounds are located on the soft bottoms of continental shelves and the upper part of continental slope. Catches from trawlers are from a depth range between 50-60 and 500 m and hake occurs with other commercial species as *Illex coindetii*, *M. barbatus*, *P. longirostris*, *Eledone spp.*, *Todaropsis eblanae*, *Lophius spp*., *Pagellus spp*., *P. blennoides*, *N. norvegicus*.

In 2012 the landings of hake in the whole GSA 18 were about 3525 tons, assuming the production for Montenegro and Albania in 2012 was the same as in 2011.

Annual landings (t) 2007-2012 by fleet and total.

Year	Italy-LLS	Italy-OTB	Montenegro	Albania	Total Landings
2008	550	3640	59	390	4639
2009	532	3540	52	456	4580
2010	597	3372	46	375	4390

2011	534	3285	37	402	4258
2012	566	2520	37*	402*	3525

*to be verified in the next Adriamed (FAO) WG on demersals

Year	Landings (tons)
2007	4566
2008	4639
2009	4580
2010	4390
2011	4258
2012	3525*

*to be verified in the next Adriamed (FAO) WG on demersals

The fishing effort of the western side, that is the major component of fishing effort in the area, is decreasing. Fishing effort in the following table is from the west side only.

Sum of NOMINAL_EFFORT		GEAR					
AREA	YEAR	GNS	GTR	LLS	OTB	PTM	Total
SA 18	2004	1457047	396599	556022	14685616	224372	17319656
	2005	2035861	515167	1082879	13563127	1046113	18243147
	2006	1833287	70950	754338	14684386	1433668	18776629
	2007	1280477	324507	688853	12729135	1968559	16991531
	2008	894323	1021626	1260704	11463435	2085703	16725791
	2009	1205076	837252	884150	13878367	2027392	18832237
	2010	570405	885271	1263867	11856268	2121029	16696840
	2011	450946	777735	922942	11329443	2104853	15585919
	2012	395458	541056	967941	9821959	1267443	12993857

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by EWG 13-09.

$F_{0.1}$ (0-4)	0.19
F_{max} (0-4)	0.25
F_{msy} (0-4)=	0.19
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)=	

Comments on the assessment

The detailed assessment of hake in GSA 18 can be found in section 6.13 of this report and the short term forecast in section 7.13. This assessment will be reviewed under the Adriamed and GFCM WG to update catch data from the eastern side of the GSA18.

5.14. SUMMARY SHEET OF DEEPWATER PINK SHRIMP IN GSA 19

Species common name:	Deepwater pink shrimp
Species scientific name:	*Parapenaeus longirostris*
Geographical Sub-area(s) GSA(s):	GSA 19

Most recent state of the stock

State of the adult abundance and biomass

A variable pattern is observed both in abundance and biomass in MEDITS indices. A Extended Survivors Analysis (XSA) was carried out during EWG 13-09 using DCF data of landings at age (2006-2012). A decrease of both SSB and fishing mortality was observed in the last years. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits)

XSA estimates a general decrease in recruitment during the analysed period.

State of exploitation

EWG 13-09 proposes $F_{0.1} \leq 0.67$ as limit management reference point (basis $F_{0.1}$ as proxy of F_{MSY}) of exploitation consistent with high long term yield. Given the results of the present analysis ($F_{curr} = 1.31$), the stock is considered to be exploited unsustainably.

Source of data and methods

For the assessment of deepwater pink shrimp stock in GSA 19 the DCF official data on the age structure and landing of commercial catch have been used. XSA has been performed.

A sex combined analysis was carried out using the following growth parameters: $CL_{\infty} = 4.6$ cm, K= 0.575, t_0= -0.2; length-weight relationship (cm-g): a = 0.935, b = 2.4523.

Catch in numbers at age were derived form the DCF annual size distributions using the LFDA (FAO package) algorithm to slice the LFDs. For older individuals, a 3+ group has been used.

The maturity at age has been derived by the maturity at length by age slicing procedure (Age 0=0.47, Age 1=0.98, Age 2=1, Age 3+=1)

The natural mortality has been calculated using PRODBIOM method (Age 0=1.41, Age 1=0.81, Age 2=0.7, Age 3+=0.7)

Outlook and management advice

EWG 13-09 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

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 13-09.

$F_{0.1}$ (ages 0-2) =	0.67
F_{max} (age range)=	
F_{MSY} (ages 0-2) =	0.67
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

The detailed assessment of deepwater pink shrimp in GSA 19 can be found in section 6.14 of this report and the short term forecast in section 7.14.

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5.15. SUMMARY SHEET OF HAKE IN GSA 19

Species common name:	Hake
Species scientific name	*Merluccius merluccius* (L., 1758)
Geographical Sub-area(s) GSA(s):	GSA 19

Most recent state of the stock

State of the adult abundance and biomass:

An XSA (Extended Survivor analysis) assessment was performed using DCF catch data and MEDITS surveys. Even though the survey indices of abundance increased in the last couple of years, the indices of biomass from both the survey and the assessment indicate a strong decrease in the stock size which started in 2008-2009. The recent values are lower than those observed at the beginning of the time series. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 13-09 is unable to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

State of the juvenile (recruits):

The estimated recruitment, even if it is following a slightly decreasing trend, it is on an average level respect to the whole time series. The MEDITS data shows an increase in the abundance index, which, might be due to an increasing of smaller individuals in the population.

State of exploitation:

EWG 13-09 proposes $F \leq 0.22$ as proxy for F_{MSY}. Given the results of the present analysis (current F is around 1.21), the stock appeared to be exploited unsustainably. A considerable reduction is necessary to approach the reference point.

Source of data and methods:

An XSA was performed using DCF data over 2006-2012 (landings and length composition of the catches), by gear (otter bottom trawl, gillnet, trammel net and longline), tuned with fishery independent abundance indices (MEDITS survey). Natural mortality vector was obtained applying PRODBIOM. In addition, Yield per Recruit (YPR) analysis was performed for the estimation of F_{01} (i.e. proxy of F_{MSY}).

Outlook and management advice

The catches of hake in GSA 19 is mainly due to otter trawler, with an important contribution from longlines. EWG 13-09 recommends the 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

European hake is fished with bottom trawl (OTB) and different small-scale gears (long-line (LLS), gillnet (GNS) and trammel net (GTR)). The main fisheries operating in GSA 19 are from Gallipoli, Taranto, Schiavonea and Crotone. The fishing pressure varies between fisheries and fishing grounds. Over 2006-2012, annual landings ranged between 1565 t in 2006 and 657 t in 2012.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 13-09.

$F_{0.1}$ (ages 0-4) =	0.22
F_{max} (age 0-4)=	0.34
F_{MSY} (ages 0-4) =	0.22
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

The detailed assessment of European hake in GSA 19 can be found in section 6.15 of this report and the short term forecast in section 7.15.

6. ToR a-b 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. The assessments are presented in geographic order by GSA. Short versions of the assessments of stocks and fisheries in the format of summary sheets are provided in the preceding section in cases when the analyses resulted in an analytical assessment of the stock status.

6.1. Stock assessment of hake in GSA 01

6.1.1.1. Stock Identification

The delimitation of the hake stock in GSA 01 is considered largely unknown. Likely connections with hake in GSA 06 may exist, because of the continuity of shelf. Large exchanges with the south Alboran Sea (GSA 03) are believed insignificant. No analyses were conducted during STECF EWG 13-09. Due to a lack of information about the structure of the hake population in the western Mediterranean, this stock was assumed to be confined within the boundaries of the GSA 01 (Figure 6.1.1).

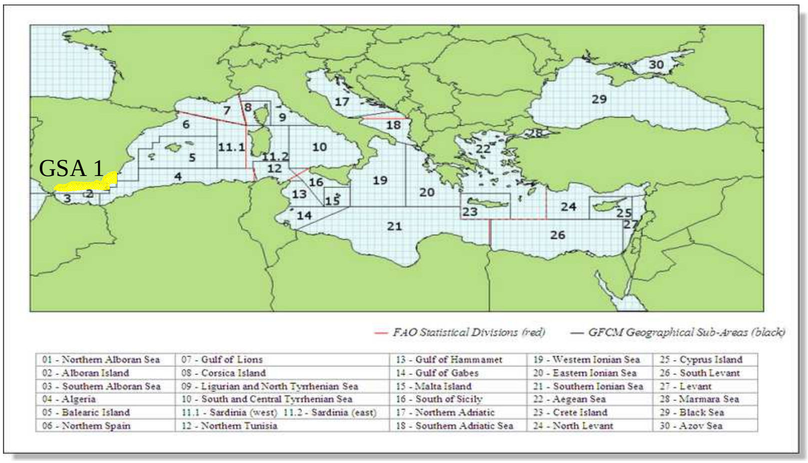


Figure 6.1.1. Geographical location of GSA 01.

6.1.1.2. Growth

At present, there is no international agreement regarding the reading of hake otoliths (WKAEH, 2009). Therefore, the growth parameters to be used are those estimated from tagging or modal progression analysis.

Growth parameters (Linf= 110; k= 0.178; to= 0; males and females combined) were taken from Mellon-Duval *et al.* (2010). These growth parameters were estimated through tagging in the Gulf of Lions and correspond to fast growth for the species. The length- weight relationship parameters used are a=0.0067 and b=3.035 (DCF 2011).

6.1.1.3. Maturity

Maturity ogive was taken from García- Rodríguez and Esteban (1995), with size at first maturity (50 %) at 33 cm TL.

ages	0	1	2	3	4	5+

% mature	0	0.15	0.82	0.98	1	1

6.1.2. *Fisheries*

6.1.2.1. General description of fisheries

European hake is one of most important demersal target species of the Mediterranean fishing fleets, exploited in GSA01 mainly by trawlers (95% landings) on the shelf and slope, and by small-scale fisheries using gillnets (3%) and long lines (2%) on the shelf (average 2009-2012).

6.1.2.2. Management regulations applicable in 2010 and 2011

In addition to the regulations specified in (CE) regulation nº 1967/2006, trawl fisheries in GSA01 are regulated by “Orden AAA/2808/2012” published in the Spanish Official Bulletin (BOE nº 313 29 December 2012), that establishes an Integral Management Plan for Mediterranean fishery resources. Regulations include trawling fishing license linked fishing area, engine power limited to 316 KW or 500 HP, codend mesh size (40 mm square or 50 mm rhomboidal), fishing forbidden within upper 50 m depth, time at sea (12 hours per day and 5 days per week) and minimum legal size (20 cm TL).

This Management Plan proposes a reduction of fishing effort by at least 20% over the period 2013-2017, based on the number of vessels active on 1 January 2013. Fishing effort reduction will be measured in terms of number of vessels, engine power and tonnage.

6.1.2.3. Catches

6.1.2.3.1. Landings

Table 6.1.2.3.1.1. Hake annual landings (t) of European hake by gear (data source: DCR and DCF).

	GNS	GTR	LLS	OTB
2002	40.498		44.387	451.088
2003	37.015		13.548	415.798
2004	30.840		2.308	515.819
2005	35.265		6.110	295.813
2006	48.481		12.361	282.940
2007	39.379		5.673	274.939
2008	37.300		6.671	282.299
2009	17.179	32.770	5.541	563.709
2010	9.75	16.03	20.602	571.147
2011	5.58	13.638	15.991	647.802
2012	2.63	11.498	8.948	437.210

6.1.2.3.2. Discards

OTB data on discards are available for 2005 and 2008 to 2012. Discards represent around ≤5% of the OTB catch in weight. No data was provided on the discards sizes and thus discard data were not used in the assessment.

6.1.2.4. Fishing effort

Data on fishing effort in GSA 1 are available on a quarterly basis.

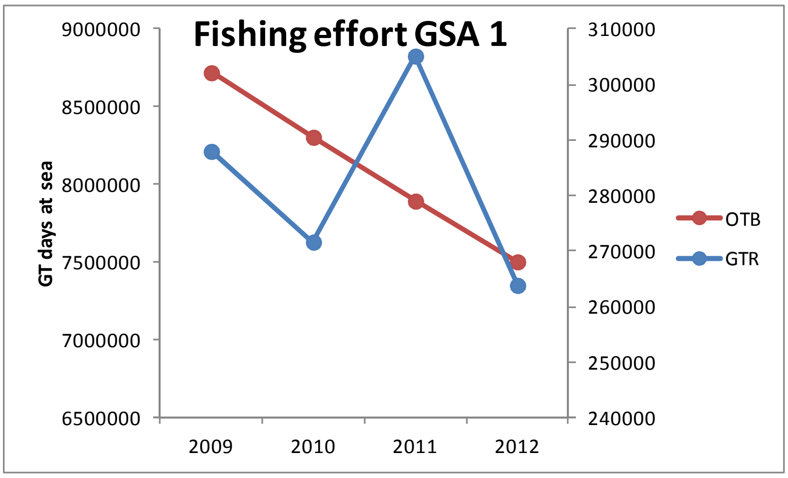


Fig. 6.1.2.4.1. Annual fishing effort (GT*days at sea) for OTB (left axis) and GTR (right axis) in GSA 1 over 2009- 2012.

Table 6.1.2.4.1. Annual fishing effort (GT*days at sea) in GSA 1 over 2009- 2012.

	GT_DAYS_AT_SEA			
	2009	2010	2011	2012
GTR	287966	271639	305124	263850
OTB	8718779	8303920	7893339	7503031
Total	9006745	8575559	8198463	7766881

6.1.3. *Scientific surveys*

6.1.3.1. MEDITS

6.1.3.1.1. Methods

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 01 the following number of hauls was reported per depth stratum (Tab. 6.1.3.1.1.1).

Tab. 6.1.3.1.1.1. Number of hauls per year and depth stratum in GSA 01, 1994-2012.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
GSA01_010-050	2	1	2	2	2	2	2	4	4	4	4	2	4	4	4	2	3	3	3
GSA01_050-100	5	5	5	6	6	9	6	6	8	12	8	8	8	8	7	8	6	6	8
GSA01_100-200	3	3	3	5	5	5	5	5	8	6	5	6	6	7	7	7	4	4	4
GSA01_200-500	8	9	11	10	7	11	13	10	11	11	13	11	13	13	13	13	6	8	8
GSA01_500-800	8	9	12	10	12	12	12	13	13	14	13	11	19	13	9	9	6	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:

$Y_{st} = \Sigma (Y_i * A_i) / A$
$V(Y_{st}) = \Sigma (A_i^2 * s_i^2 / n_i) / A^2$
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 = $Y_{st} \pm$ t(student distribution) * $V(Y_{st}) / n$

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per km^2) 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.

6.1.3.1.2. Geographical distribution patterns

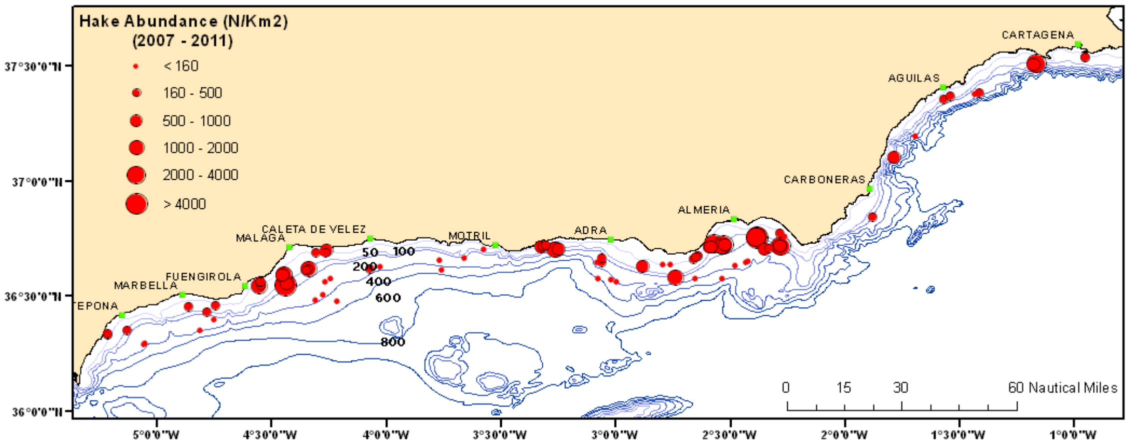


Fig. 6.1.3.1.2.1. *Merluccius merluccius* spatial distribution of estimated abundances indices (n/Km^2) for the period 2007-2011. MEDITS trawl surveys. (GSA 01, Northern Alboran Sea).

6.1.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the European hake in GSA 1 was derived from the international survey MEDITS. Figure 6.1.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 01 over 1995- 2012.

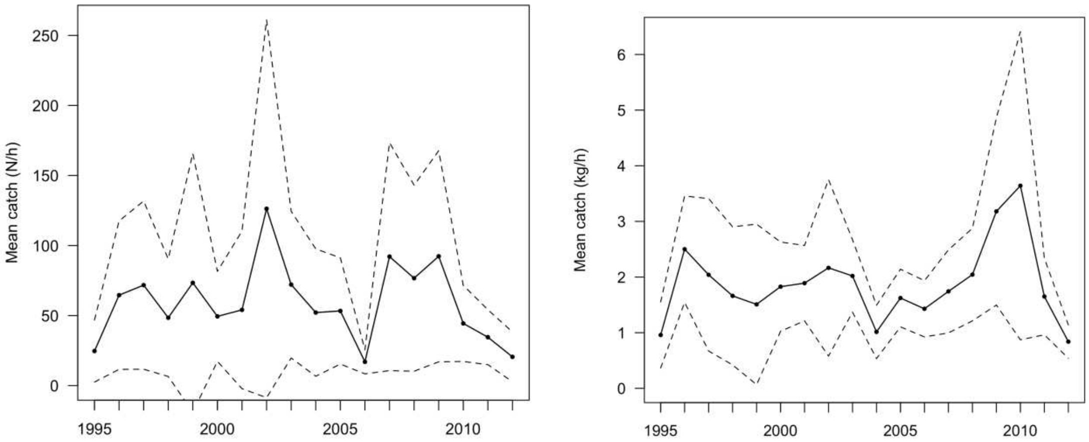
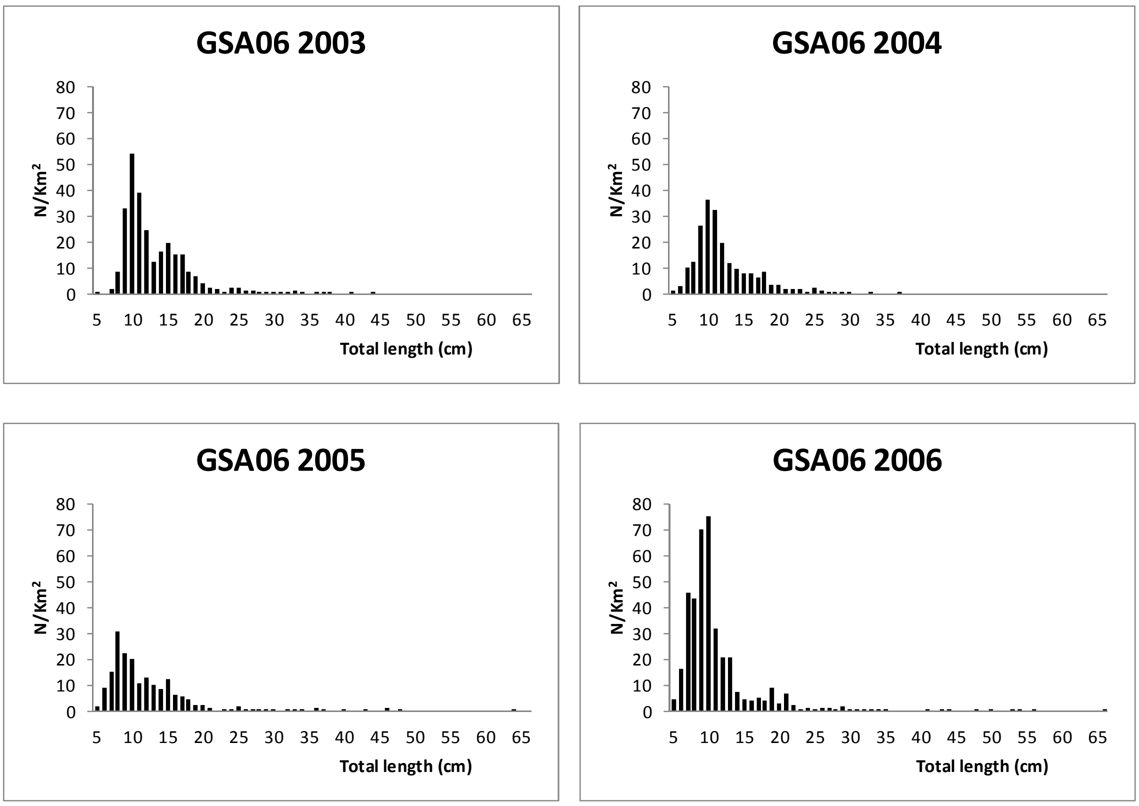


Fig. 6.1.3.1.3.1. European hake abundance and biomass trend in GSA 1 over 1995- 2012 as estimated from the MEDITS survey data provided during the meeting.

6.1.3.1.4. Trends in abundance by length or age



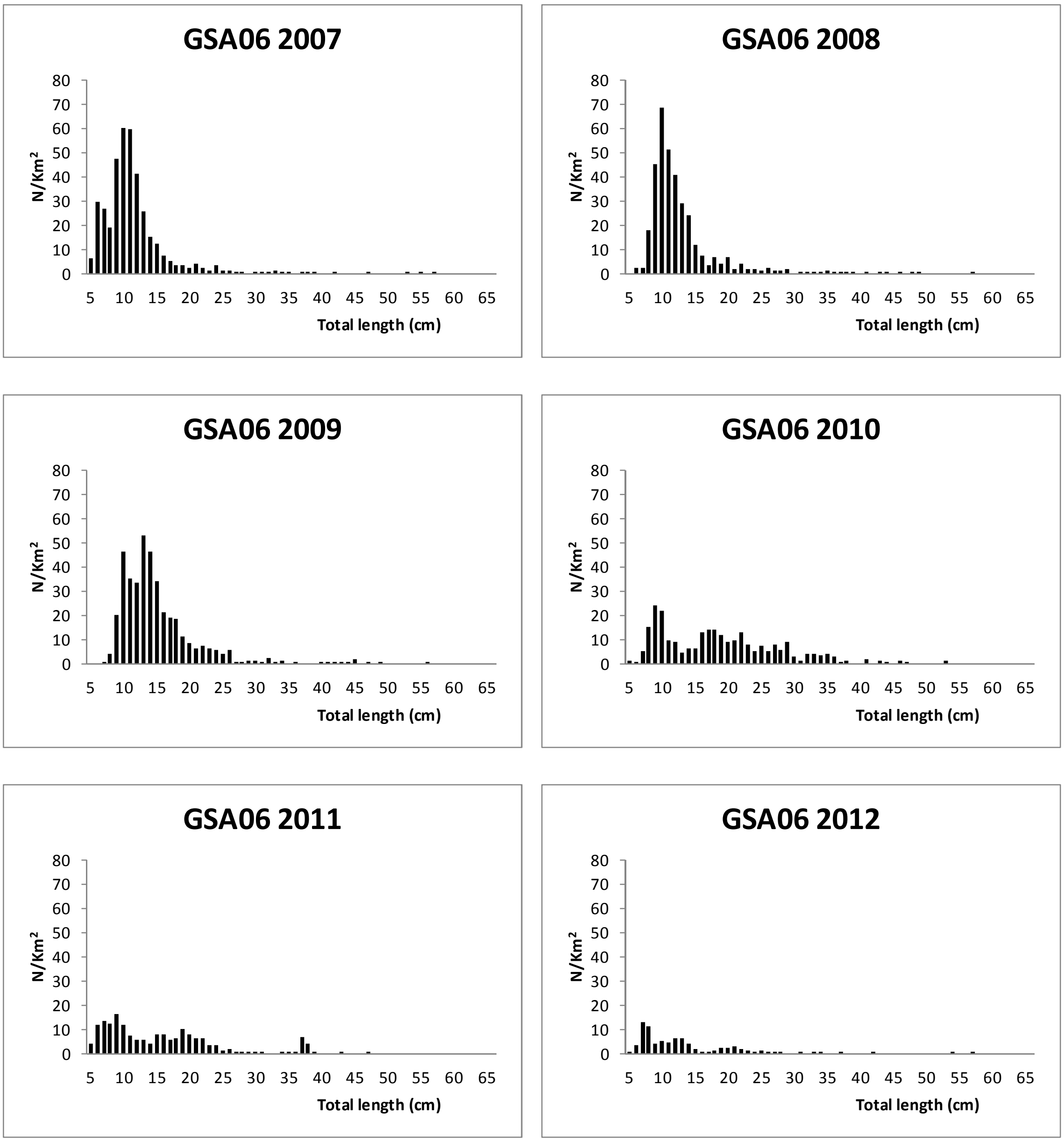


Fig. 6.1.3.1.4.1. Trends in abundance (n/km^2) of European hake in GSA 1 over 2003- 2012 (data source: MEDITS survey).

6.1.3.1.5. Trends in growth

No information was been documented.

6.1.3.1.6. Trends in maturity

No information was been documented.

6.1.4. *Assessments of historic stock parameters*

6.1.4.1. Method 1: XSA

6.1.4.1.1. Justification

This stock was assessed by EWG 13-09 using XSA, run with an *ad hoc* R-script developed during the meeting. SOP correction was made before running the analysis. XSA was run considering age classes 0 to 5+, the same as in the earlier assessment.

Input parameters

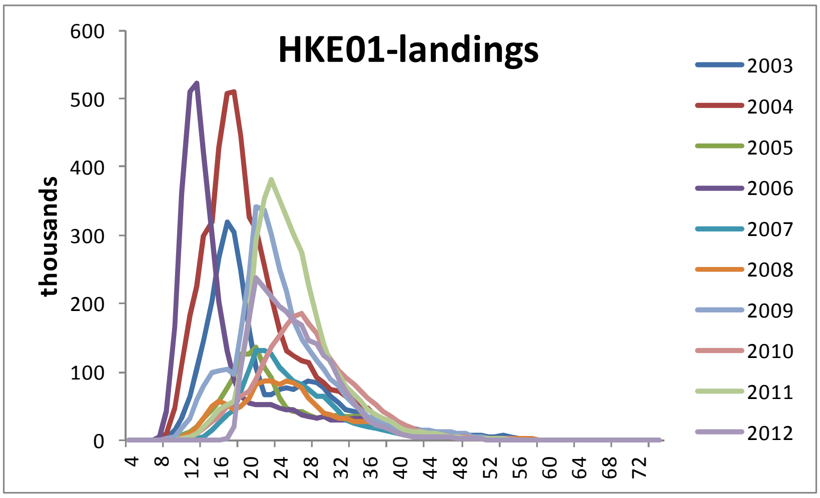


Fig. 6.1.4.1.1.1. OTB landings size distributions over 2003- 2012.

Table 6.1.4.1.1.1. XSA input parameters: catch numbers at age; weight at age; natural mortality at age; and tuning parameters (MEDITS survey 2003- 2012). Input landings data correspond to métier OTB demersal species.

	Catch numbers at age				Numbers*10**-3					
AGE	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	1135	2096	249	2654	86	222	491	142	163	4
1	1644	3053	1050	706	1277	964	2792	1901	3376	2322
2	322	353	300	273	187	246	360	534	428	294
3	73	38	53	39	38	40	68	34	35	23
4	7	6	4	2	6	8	5	4	3	2
+gp	2	2	2	3	2	4	2	1	1	1

	Catch weights at age (kg)									
AGE	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.029	0.027	0.03	0.02	0.033	0.029	0.028	0.031	0.031	0.03
1	0.109	0.098	0.106	0.117	0.124	0.126	0.117	0.146	0.128	0.131
2	0.425	0.387	0.434	0.425	0.41	0.429	0.412	0.396	0.395	0.373
3	1.002	0.979	0.937	0.966	0.924	0.954	0.907	0.913	0.901	0.91
4	1.545	1.603	1.566	1.671	1.709	1.6	1.667	1.676	1.626	1.676
+gp	2.61	2.981	2.82	2.67	2.483	2.603	2.643	2.72	2.725	2.701

Natural mortality was estimated using PROBIOM. M at the mid-point of the year was selected as M representative for that annual class.

Natural Mortality (M) at age

AGE	0	1	2	3	4	+gp
	1,24	0,58	0,45	0,40	0,37	0,35

MEDITS tuning parameters (2003-2012)

	0	1	2	3	4	5+
2003	238.5	35.8	4.1	0	0	0
2004	184.7	27.6	0.8	0	0	0
2005	166.3	18.6	3.8	1.9	0.5	0.1
2006	348.7	34.7	2.8	2	0.3	0.3
2007	355.2	26.8	4.1	1.5	0.3	0
2008	303.9	36.6	6.2	1.2	0.3	0
2009	311.7	81.4	5.4	1.6	0.2	0
2010	130.2	113.9	19.7	3	0	0
2011	113.9	49.7	13	0.7	0	0
2012	62.3	17.4	1.6	0.5	0.5	0

Different sensitivity analyses were performed before running the final XSA, considering different ages for shrinkage (Fig. 6.1.4.1.1.2).

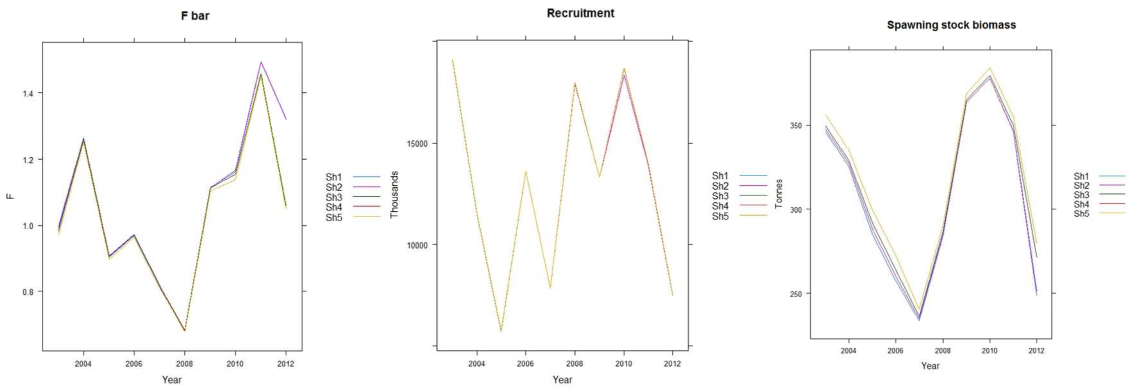


Fig. 6.1.4.1.1.2. Sensitivity analysis

The following settings were used for the final XSA final run:

fse	Rage	qage	shk.n	shk.f	shk.yrs	shk.ages
1.5	2	4	TRUE	TRUE	3	4

6.1.4.1.2.Results

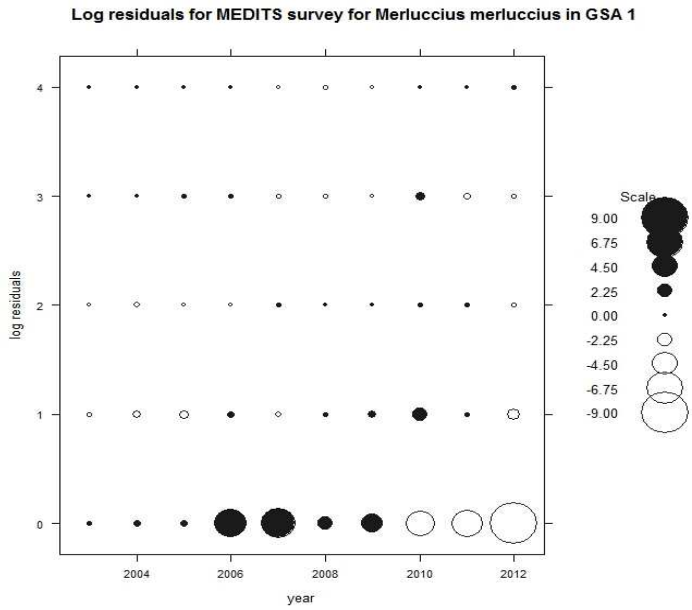


Fig 6.1.4.1.2.1. Log catchability residual residual plots (XSA) for MEDITS survey.

Residuals from the MEDITS tuning did not show any particular trend but they are very large for the age class 0 and increased since 2006 (Fig 6.1.4.1.2.1.). This might indicate that age 0 is not consistently represented in the catches and cold be excluded.

Table 6.1.4.1.2.1. Hake XSA model diagnosis.

log catchability residuals.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.297	0.563	0.708	5.318	5.75	2.153	3.352	-4.834	-5.078	-8.229
1	-0.154	-0.839	-1.013	0.673	-0.405	0.172	0.917	1.991	0.274	-1.616
2	-0.015	-0.381	-0.005	-0.046	0.149	0.077	0.035	0.147	0.197	-0.158
3	0	0	0.227	0.224	-0.19	-0.135	-0.092	0.954	-0.71	-0.279
4	0	0	0.073	0.079	-0.086	-0.191	-0.044	0	0	0.169

Regresion weights

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Table 6.1.4.1.2.2. XSA results

Fishing mortality at age estimated by XSA

AGE	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.117	0.413	0.084	0.447	0.020	0.023	0.071	0.014	0.022	0.001
1	1.167	1.761	1.023	0.958	1.135	0.864	1.323	1.233	1.874	1.518
2	1.629	1.569	1.592	1.468	1.269	1.151	1.907	2.172	2.458	1.616
3	1.912	1.364	2.127	1.475	1.274	1.758	2.315	1.803	1.491	2.117
4	1.236	1.308	0.681	0.454	1.269	1.690	1.603	1.340	1.192	0.245
gp+	1.236	1.308	0.681	0.454	1.269	1.690	1.603	1.340	1.192	0.245

Summary of stock parameters as estimated by XSA

	RECRUITS	TOTALBIO	SSB	LANDINGS	YIELD/SSB	F_1-2	F_0-3
	age 0						
2003	18095.6	1182.0	338.1	416	1.23	1.40	1.21
2004	10888.6	1037.1	317.3	516	1.63	1.66	1.28
2005	5435.8	672.5	285.2	296	1.04	1.31	1.21
2006	12929.5	693.7	258.1	283	1.10	1.21	1.09
2007	7502.1	753.0	229.1	275	1.20	1.20	0.92
2008	17076.5	1034.6	277.2	282	1.02	1.01	0.95
2009	12675.5	1223.9	350.1	535	1.53	1.62	1.40
2010	17749.9	1392.5	366.0	509	1.39	1.70	1.31
2011	13314.6	1341.9	337.6	614	1.82	2.17	1.46
2012	7112.1	928.7	265.8	418	1.57	1.57	1.31
	(thousands)	(tonnes)	(tonnes)	(tonnes)			

Results obtained using XSA showed a fluctuating recruitment, markedly decreasing in the last two years, 2011 and 2012. SSB fluctuated around 300 t over 2003- 2012 (Fig 6.1.4.1.2.2.). The SSB/R did not display a clear pattern (Fig 6.1.4.1.2.3.).

Fig 6.1.4.1.2.2. XSA results for *Merluccius merluccius* in GSA 1.

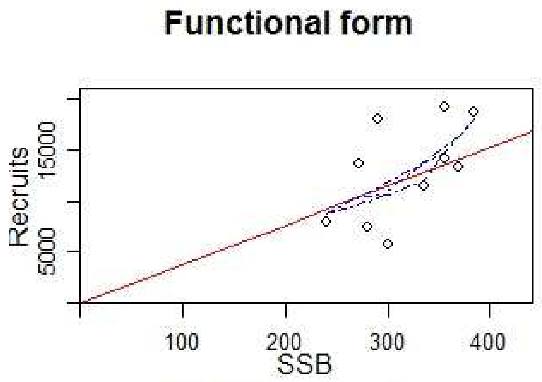


Fig 6.1.4.1.2.3. Hake in GSA 1: SSB/R relationship.

Retrospective analysis results (Fig 6.1.4.1.2.4) showed no particular retrospective bias in fishing mortality (F) or spawning biomass (SSB). Recruitment instead appears to be underestimated in recent years.

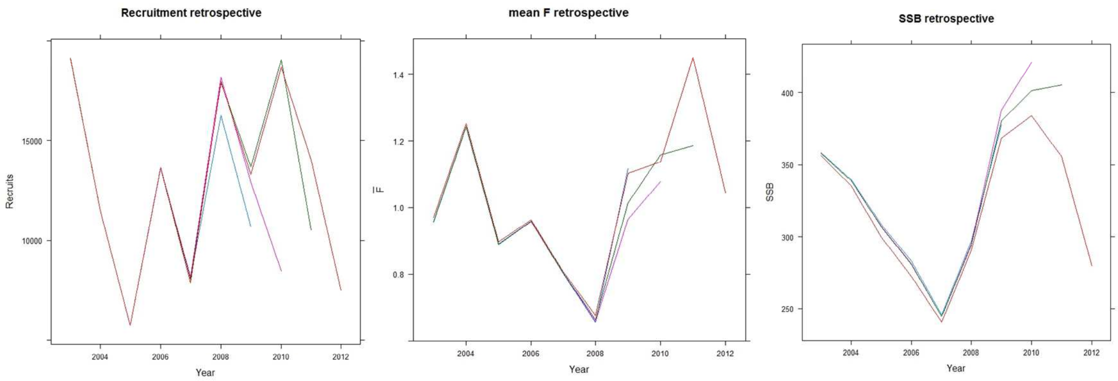


Fig 6.1.4.1.2.4. XSA retrospective analysis for R, mean F and SSB (left to right).

6.1.5. *Long term prediction*

6.1.5.1. Justification

Y/R was used for the estimation of $F_{0.1}$ and F_{max}.

6.1.5.1.1. Input parameters

age group	stock weight	catch weight	maturity	F	M
0	0.029	0.029	0	0.03	1.24
1	0.120	0.120	0.15	1.36	0.58
2	0.409	0.409	0.82	1.86	0.45
3	0.939	0.939	0.98	1.90	0.40
4	1.634	1.634	1	1.21	0.37
5	2.696	2.696	1	1.21	0.35

6.1.5.1.2. Results

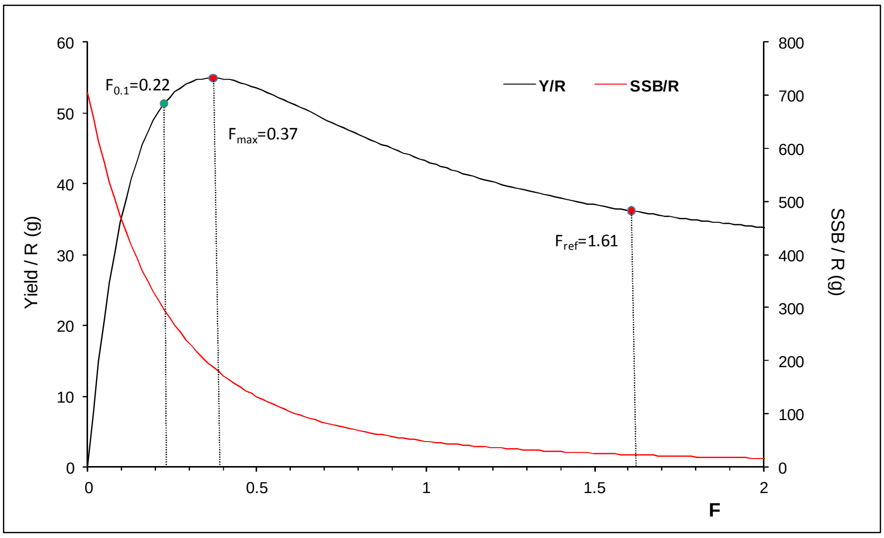


Fig. 6.1.5.1.2. Results of the Y/R analysis, Y/R and SSB/R are shown.

The F_{ref} used is $Fbar_{1\text{-}2}$ over 2008-2012 (F_{ref}= 1.61). $Fbar_{1\text{-}2}$ was chosen because most of the landings correspond to age classes 1 and 2. Results were the following: F_{ref} = 1.61; $F_{0.1}$ = 0.22; F_{max} = 0.37.

Hake in GSA 1 was assessed in the last GFCM-SCSA-WG demersals (Split, November 2012), using data over 2003-2011. Resuls of that assessement were the following: $F_{0.1}$ = 0.28, F_{max} = 0.39, F_{curr} = $Fbar(_{1\text{-}3})$= 1.5.

6.1.6. *Data quality*

No major issue witht the data were found regarding catch, sizes, and effort data (only a minor mistake in 2012: PS landings, 1.8 t).

Hake in GSA 1 is mostly fished by OTB, although other small-scale fishing types (i.e. GNS, LLS and GTR) catch a small amount of the total catch (around 5-10% over 2003-2012, according to the submitted DCR and DCF landings data). In the most recent years, 2010-2012, OTB landings represent 95% of the total catch.

In the GSA 01, for sampling purposes only the major métiers are to be considered. In order to identify the métiers to be sampled, the DCF proposed the use of a Ranking System, based on four criteria of selection (landings, economical value, effort and métier with special importance). With this methodology the métiers GNS_DEF (Gillnets) and LLS_DEF (Long lines) were not selected in the GSA1, and consequently no information is available on the sizes exploited by these small- scale métiers, with the exception of GTR in 2009. This might affect the results of the assessment as large individuals, which are generally caught by this fleets, are not included in the catch ate age matrix.

OTB data on discards are available for 2005 and 2008 to 2012. Discards represent around ≤5% of the OTB catch, in weight. Data on discarded sizes are not available.

Data on fishing effort were provided differently for the period 2002- 2010 (DCR, all fishing types) and 2009-2012 (DCF, fishing effort corresponding to the métiers sampled in the frame of the DCF). In the report of this EWG 13- 09 meeting, fishing effort data are shown for the period 2009- 2011.

MEDITS data were available only as raw data. Data on abundance and biomass were estimated by the experts at the meeting (Fig. 6.1.3.1.3.1 European hake abundance and biomass trend in GSA 1 over 1995-2012) and provided by experts attending the meeting (Fig. 6.1.3.1.4.1. Trends in abundance (n/km^2) of European hake in GSA 1 over 2003- 2012).

6.1.7. *Scientific advice*

6.1.7.1. Short term considerations

6.1.7.1.1. State of the stock size

Over 2003- 2012 SSB displayed no clear trend and fluctuated around 300 t.

6.1.7.1.2. State of recruitment

Exploitation of hake in GSA 01 is based on age 1 and, hence, this fishery is highly dependent on recruitment. According to MEDITS data, over the period 1995- 2012 recruitment displayed marked inter-annual variations, with no apparent either increasing or decreasing trend, although in the most recent years, since 2009, recruitment is decreasing and it was very low in 2011 and 2012 (Fig. 6.1.3.1.4.1).

6.1.7.1.3. State of exploitation

By comparing $F_{0.1}$ and F_{max} against F_{ref}, taking as reference $Fbar_{1\text{-}2}$ over 2008-2012 it can be concluded that the stock is exploited unsustainably. The continued low abundance of adult fish in the surveyed population and landings indicate a very high exploitation pattern far in excess of those achieving high yields and low risk of fisheries collapse.

6.1.7.2. Management recommendations

From a precautionary approach and taking into account the estimated reference point F_{MSY} proxy ($F_{0.1}$), a reduction of the current fishing mortality is recommended to achieve $F_{0.1}$.

6.2. STOCK ASSESSMENT OF DEEPWATER PINK SHRIMP IN GSA 1

6.2.1. *Stock identification and biological features*

6.2.1.1. Stock Identification

No analyses were conducted during STECF EWG 13-09. Due to a lack of information about the structure of the deepwater pink shrimp population in the western Mediterranean, this stock was assumed to be confined within the boundaries of the GSA 1 (Figure 6.2.1).

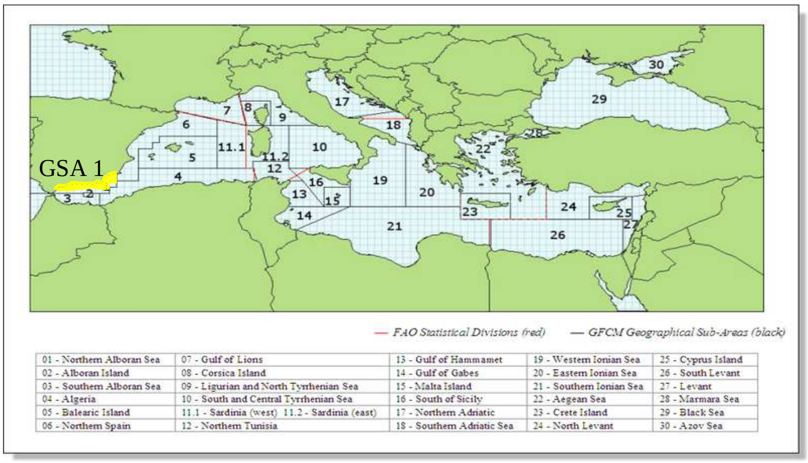


Figure 6.2.1. Geographical location of GSA 01.

6.2.1.2. Growth

Since there is not an estimation of growth parameters in the area, those estimated for the GSA 6 by García-Rodríguez et al. (2009) were used: 1) L_{inf}=45 mm; 2) K=0.3903; 3) t_0=0.1019. Length-weight parameters were taken from the Spanish DCF 2011-2012: 1) a=0.003055; 2) b=2.490608.

6.2.1.3. Maturity

The maturity curve was also obtained from García-Rodríguez et al. (2009): 1) Age 0: 0.000; 2) Age 1: 0.134; 3) Age 2: 0.504: 4) Age 3: 0.878; 5) Age 4+: 0.986.

6.2.2. *Fisheries*

6.2.2.1. General description of the fisheries

Deepwater pink shrimp is a target species for around 170 trawling vessels (2011) operating on the upper slope and it is one of the most important crustaceans species for the trawl fisheries of GSA 1. In GSA 1, *P. longirostris* is caught almost exclusively by trawl as a by-catch in the deep continental shelf and the upper slope (100–400 m). No artisanal boats target this species.

6.2.2.2. Management regulations applicable in 2010 and 2011

- Fishing license: number of licenses observed
- Engine power limited to 316 KW or 500 HP: partial compliance (in some cases real HP is at 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

6.2.2.3. Catches

6.2.2.3.1.Landings

Landings of deepwater pink shrimp in GSA 1 come exclusively from trawling. During the last 10 years the total landings showed important oscillations, ranging between a minimum of 66 tons in 2006 and a maximum of 250 tons in 2009; carapace length of the individuals landed ranged between 14 and 40 mm with a modal size at 22-24 mm (Fig. 6.2.2.3.1.1).

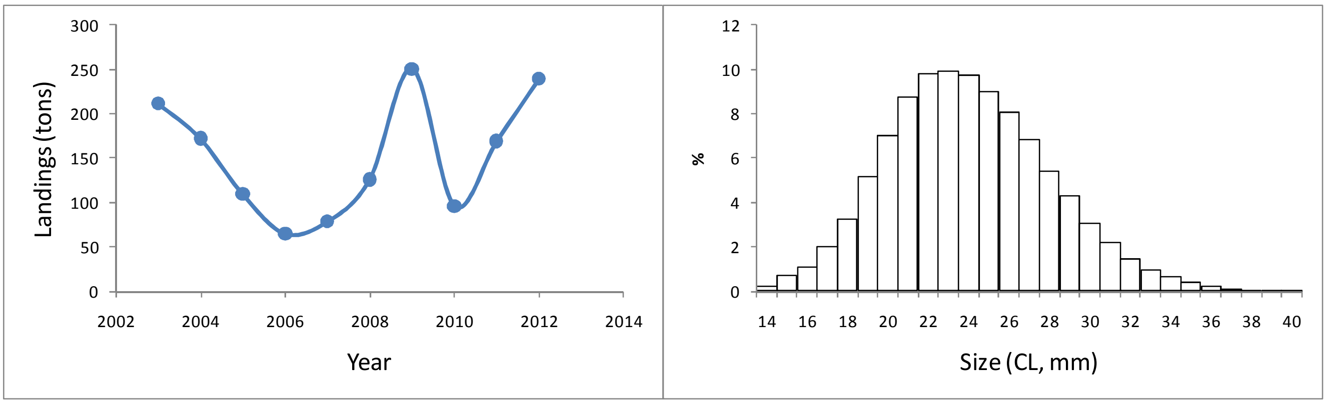


Fig. 6.2.2.3.1.1. Annual landings (left) and size distribution (right) of deepwater pink shrimp from GSA 1 during 2003-2012.

6.2.2.3.2.Discards

Discards of deepsea pink shrimp in GSA 1 can be considered as negligible.

6.2.2.4. Fishing effort

The fishing effort (in days) decreased during 2004-2007 but increased steadily afterwards up to 2012; catch-effort data from the time series used showed a significant positive relationship (Fig. 6.2.2.4.1).

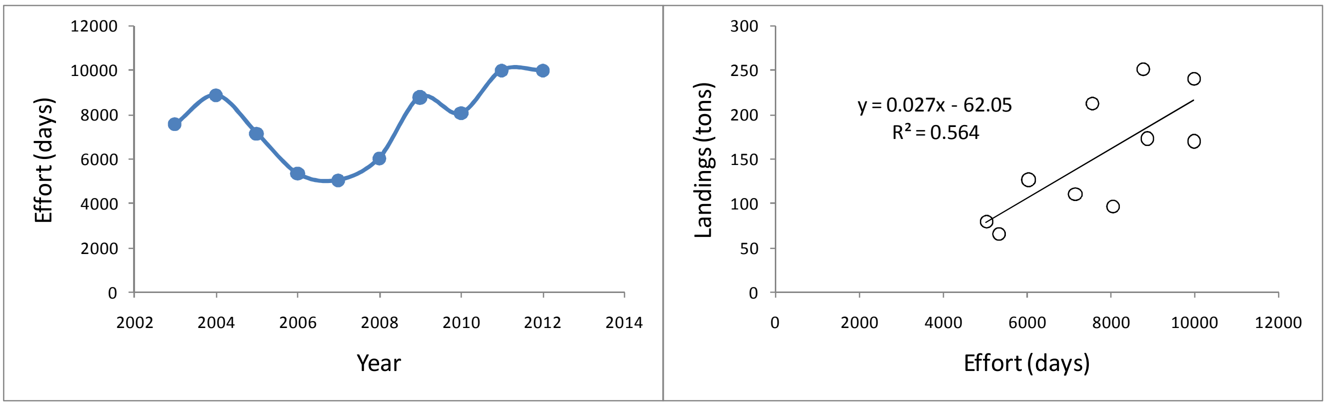


Fig. 6.2.2.4.1. Fishing effort in days (left) and catch-effort relationship (right) of deepsea pink shrimp from GSA 1 during 2003-2012.

6.2.3. *Scientific surveys*

6.2.3.1. MEDITS

6.2.3.1.1. Methods

The GSA 1 has been included in the annual MEDITS surveys developed by Spain from 1994 using the methodology adopted in the framework of this project.

6.2.3.1.2. Geographical distribution patterns

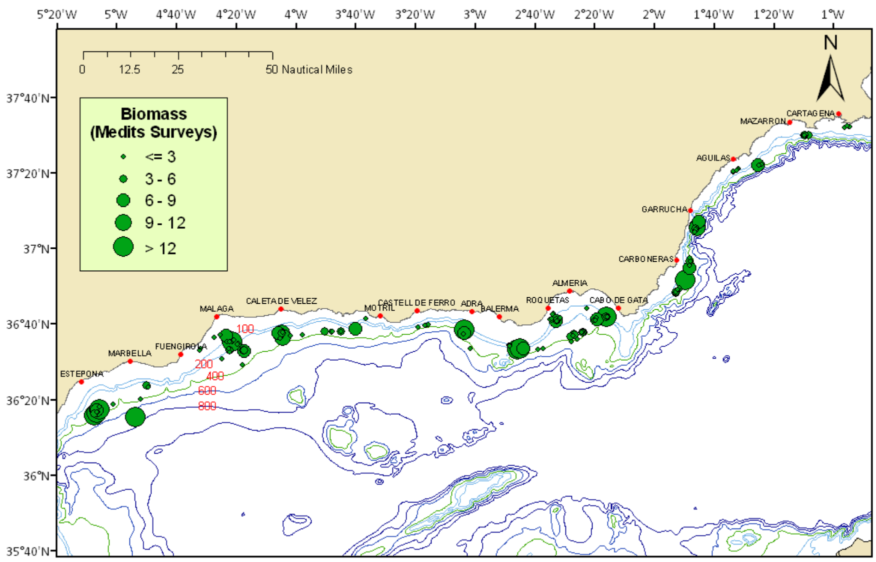


Fig. 6.2.3.1.2.1. *Parapenaeus longirostris* abundance (kg/Km^2, 2003-2011 average) in GSA 1 based on MEDITS survey data.

6.2.3.1.3. Trends in abundance and biomass

CPUE from fisheries and MEDITS biomass indexes only showed a similar pattern during 2009-2012. In the previous years, however, both series differed: whereas CPUE showed important variations, MEDITS indexes remained rather constant.

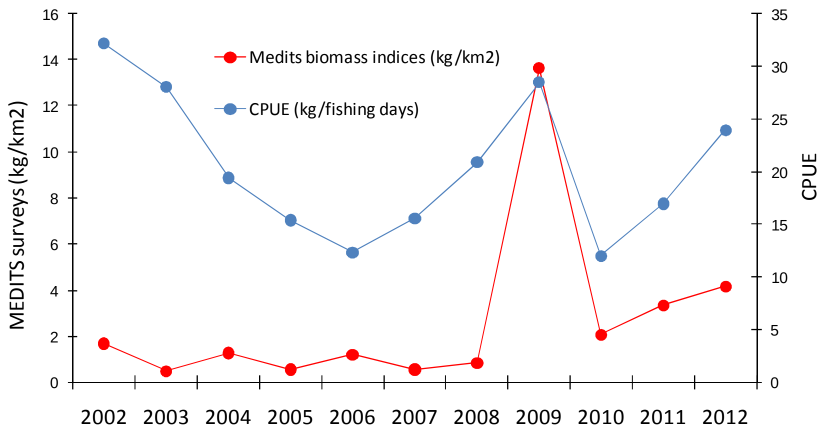


Fig. 6.2.3.1.3.1. Abundance indices from the fishery (CPUE) and the MEDITS surveys during 2002-2012.

6.2.3.1.4. Trends in abundance by length or age

No analyses were conducted during STECF EWG 13-09 meeting.

6.2.3.1.5. Trends in growth

No analyses were conducted during STECF EWG 13-09 meeting.

6.2.3.1.6. Trends in maturity

No analyses were conducted during STECF EWG 13-09 meeting.

6.2.4. *Assessments of historic stock parameters*

A first preliminary assessment of this stock was done during the SGMED-08-03 using VIT, pseudocorhort analysis and Y/R under two differet scenarios, fast and slow growth. However, SGMED-08-03 was unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

6.2.4.1. Method 1: XSA

6.2.4.1.1. Justification

The availability of a rather long time series (10 years) of landings and abundance indexes from MEDITS surveys allowed the application of an XSA.

6.2.4.1.2. Input parameters

Landings time series: 2003-2012.

Age distributions obtained from slicing of length distributions 2003-2012 using L2AGE4.
MEDITS surveys from 2003 to 2012 were used as tuning fleet.
There were no catches for age 0; group plus was set at age 4.

The number of individuals by age was SOP corrected [SOP = Landings / Σ_a (total catch numbers at age *a* x catch weight-at-age *a*)]

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
SOP	1.05	1.04	1.07	1.04	1.10	1.01	1.07	1.04	1.05	1.06

Maturity				
0	1	2	3	4+
0.00	0.13	0.50	0.88	0.99

Natural mortality (from PROBIOM)				
0	1	2	3	4+
1.25	0.82	0.39	0.28	0.22

Growth parameters (from García et al., 2009)		
L_{inf}	K	t_0
45	0.3903	0.1019

LWR (from DCF 2011-2012)

a	b
0.003055	2.490608

The input parameters for the XSA are summarized in the following table:

CATCH	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	211.6	172.3	110.1	65.6	78.9	126.3	250.2	96.5	169.3	239.1

CATNUM	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0	0	0	0	0	0	0	0	0	0
1	15920.7	13568.9	7263.1	2505.9	6069.9	7238.5	6761	2512.6	2790.5	10042.7
2	9842.7	7569.4	6176.4	3869.7	3613	7134.7	15653	5338.7	10891.7	14721
3	1681	1020.5	307.7	534.5	479.2	735.2	2030	1362.1	2069.2	1731.6
4+	206.8	166.6	19.4	72.6	77.2	23.9	499.9	109.1	122.1	81.4

CATWT	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
1	0.005	0.006	0.007	0.006	0.006	0.006	0.007	0.006	0.007	0.006
2	0.011	0.01	0.01	0.011	0.011	0.01	0.011	0.011	0.011	0.011
3	0.017	0.018	0.017	0.017	0.017	0.017	0.018	0.018	0.017	0.017
4+	0.024	0.024	0.023	0.025	0.028	0.027	0.024	0.023	0.024	0.024

TUNEFF	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.4	5.6	0	1.3	3.7	0	1.2	1.7	4.7	34.9
1	15.2	62.2	27.1	34.4	32.7	21.6	115.4	284.6	110.4	347.7
2	27.1	58.6	31.2	77.6	33.2	59.1	349.1	44.3	196.1	219.9
3	5.4	12	1.9	8.3	2.3	4.7	22.3	13.4	25.5	19.7
4+	0.7	6.1	1.2	1.3	0.1	0.3	5.4	7.1	6.8	2

Different sensitivity analyses were performed before running the final XSA. The first sensitivity analysis tested different shrinkage (0.5, 1.0, 1.5, 2.0 and 2.5); the results of this analysis did not show important differences among the different weights used, except for F with a shrinkage of 0.5 (Fig.6.2.4.1.2.1A). Based on these results, the option of shrinkage weight of 1.5 was chosen. The second sensitivity analysis tested different shrinkage ages (1, 2 and 3); according to this simulation, the second scenario (2 ages shrinkage) was selected (Fig. 6.2.4.1.2.1B).

Based on these simulation analyses, the following inputs were selected to run the final XSA:

fse	rage	Qage	shk.n	shk.f	shk.yrs	shk.ages
1.5	0	3	TRUE	TRUE	3	2

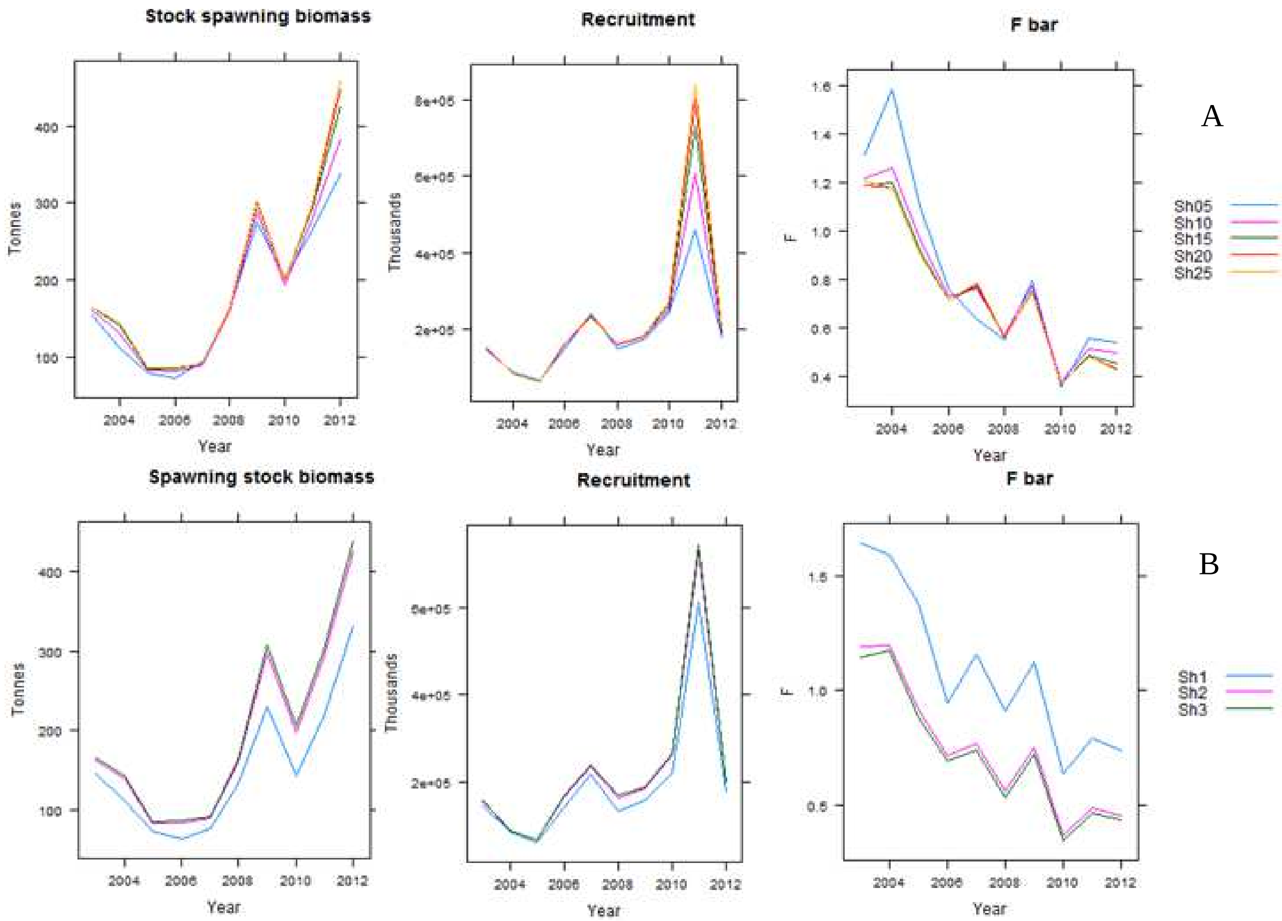


Fig.6.2.4.1.2.1. Sensitivity analyses using different shrinkage (A) and shrinkage ages (B). Shrinkage modeled were 0.5, 1.0, 1.5, 2.0 and 2.5 (Sh05 to Sh25) and shrinkage ages were 1, 2 and 3 (Sh1, Sh2 and Sh3).

6.2.4.1.3.Results

Since a first run showed very high residuals for age 0 in most years (Fig. 6.2.4.1.3.1A), age 0 was removed from the tuning fleet. A second running without age 0 gave consistent residual results with no trends and most values having residual values lower than 1.5 (Fig. 6.2.4.1.3.1B). Consequently, the final XSA was running without age 0 in the tunning fleet.

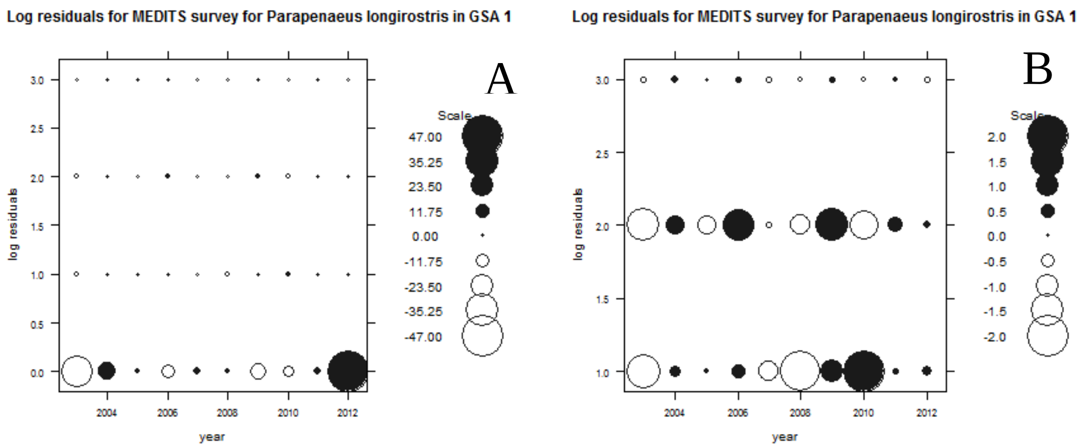


Fig. 6.2.4.1.3.1. Log residuals for MEDITS surveys using all available ages (A) and without age 0 (B).

Results of XSA (Fig. 6.2.4.1.3.1) showed an slightly increase of recruits during the time series analysed with a marked peak in 2011. The SSB increased from about 100 tons in 2007 to about 400 tons in 2012. The fishing mortality displayed a marked decreasing trend along the time series from F values of 1.2 in 2003 to 0.4 in 2012.

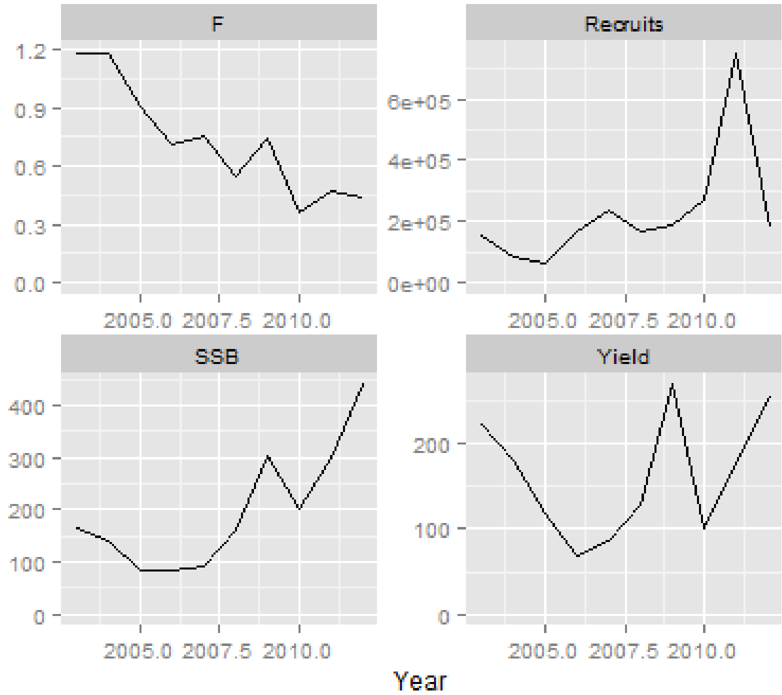


Fig. 6.2.4.1.3.1. XSA results of *Parapenaeus longirostris* in GSA 1.

The XSA dignostics are reported below:

CPUE data from indices

Catch data for 10 years 2003 to 2012. Ages 0 to 4.

	fleet	first age	last age	first year	last year	alpha	beta
1	FLEET 1	1	3	2003	2012	<NA>	<NA>

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of size for ages > 0

Catchability independent of age for ages > 3

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

age \ year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age \ year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.714	0.630	0.580	0.227	0.201	0.185	0.237	0.074	0.056	0.072
2	1.330	2.431	1.235	1.558	1.024	0.730	1.430	0.506	0.934	0.807
3	1.498	0.519	0.847	0.362	0.964	0.796	0.518	0.505	0.439	0.415
4	1.498	0.519	0.847	0.362	0.964	0.796	0.518	0.505	0.439	0.415

XSA population number (Thousand)

year \ age	0	1	2	3	4
2003	146588	44912	15544	2380	282
2004	80760	41998	9683	2784	448
2005	62178	23138	9852	577	36
2006	160072	17814	5704	1940	260
2007	222546	45861	6253	813	128
2008	157164	63760	16523	1521	48
2009	177508	45028	23339	5391	1307
2010	255493	50857	15644	3780	298
2011	712370	73200	20803	6387	372
2012	170589	204097	30473	5534	257

Estimated population abundance at 1st Jan 2013

year \ age	0	1	2	3	4
2013	0	48875	83608	9211	2763

Fleet: FLEET 1

Log catchability residuals.

age \ year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	-1.156	0.289	0.035	0.400	-0.606	-1.357	0.687	1.405	0.087	0.215
2	-1.096	0.561	-0.535	1.045	-0.099	-0.606	1.091	-0.926	0.441	0.125

3 -0.115 0.154 0.011 0.086 -0.096 -0.073 0.112 -0.047 0.046 -0.078

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

```
              1       2       3
Mean_Logq -6.2449 -4.5944 -5.2909
S.E_Logq   0.6406  0.6406  0.6406
```

Terminal year survivor and F summaries:

,Age 0 Year class =2012

```
source
    scaledWts survivors yrcls
nshk        1     48875  2012
```

,Age 1 Year class =2011

```
source
       scaledWts survivors yrcls
FLEET 1     0.731    103701  2011
fshk        0.269     46512  2011
```

,Age 2 Year class =2010

```
source
       scaledWts survivors yrcls
FLEET 1     0.598     10436  2010
fshk        0.402      6868  2010
```

Age 3 Year class =2009

```
source
       scaledWts survivors yrcls
FLEET 1     0.943      2556  2009
fshk        0.057      2538  2009
```

Year	Population numbers	Population weight	Recruitment numbers	SSB	F_{1-3}
2003	209706.10	589.37	146588.02	157.00	1.18
2004	135672.94	490.44	80759.99	135.91	1.19
2005	95780.74	333.29	62178.22	79.75	0.89
2006	185790.41	369.19	160071.53	80.74	0.72
2007	275600.91	583.89	222545.70	85.87	0.73
2008	239017.44	732.13	157164.17	156.40	0.57
2009	252573.32	877.85	177507.57	285.80	0.73
2010	326071.06	807.61	255492.64	192.37	0.36

2011	813132.37	1571.11	712370.21	285.42	0.48
2012	410949.99	1830.62	170588.67	415.69	0.43

Finally, retrospective analyses showed consistent XSA results in SSB and mean F, but there were mismatchings in recruitment during the last years, specially in 2011 (Fig. 6.2.4.1.3.2).

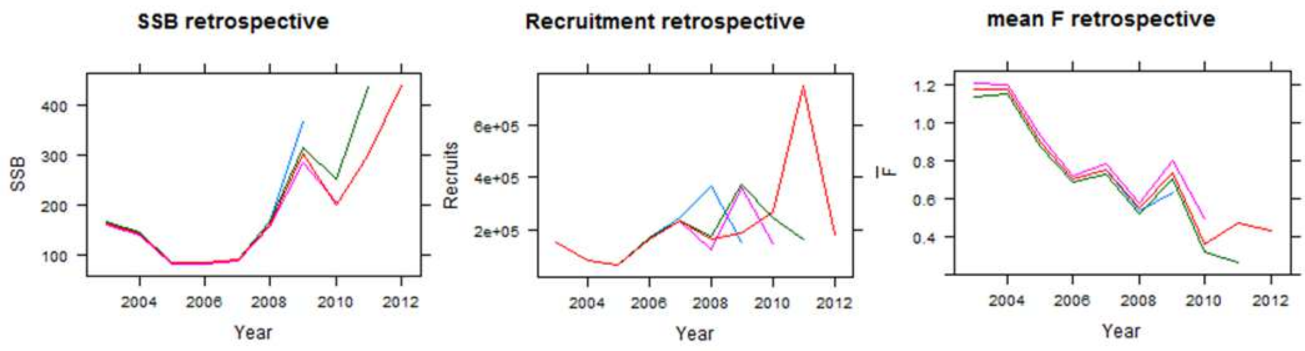


Fig. 6.2.4.1.3.2. XSA retrospective analyses of *Parapenaeus longirostris* in GSA 1.

6.2.5. *Long term prediction*

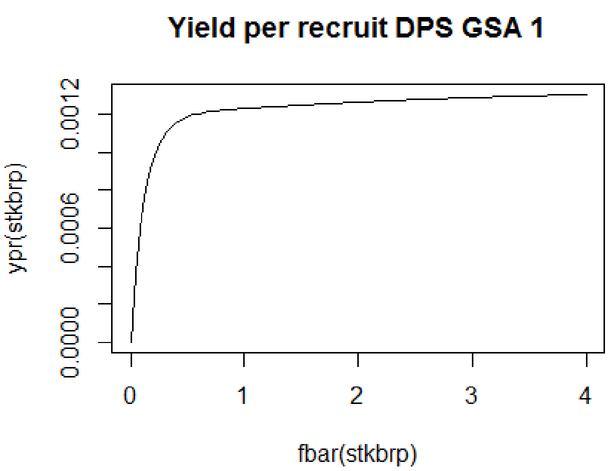
6.2.5.1. Justification

6.2.5.1.1.Input parameters

Yield per recruit analysis was used to calculate the reference point $F_{01.}$ Current F was estimated using the R script provided by STECF EWG 13-09, which used the default assumptions agreed in the meeting, e.g., weights are means of the last 3 years and future recruitment are obtained as the geometric mean of the last 3 years.

6.2.5.1.2. Results

The following figure shows the yield per recruit for *P. longirostris* in GSA 1.



The reference point $F_{0.1}$ and the estimated reference fishing mortality (F_{ref}) obtained were:

$F_{0.1}$	0.26

F_{ref} (2010-2012; ages 1-3)	0.42

6.2.6. *Data quality*

Data from DCF 2012 were used. The data available are of sufficient quality to perform XSA. The data submitted to the EWG 13-09 are in general of good quality. Reported discards are neglegible.

6.2.7. *Scientific advice*

6.2.7.1. Short term considerations

6.2.7.1.1. State of the spawning stock size

The SSB showed a marked increasing trend along the time series, increasing from about 100 tons in 2007 to about 400 tons in 2012

6.2.7.1.2. State of recruitment

There was a slight increase of recruits during the time series analysed with a marked peak in 2011.

6.2.7.1.3. State of exploitation

The current F_{1-3} (0.43) is larger than $F_{0.1}$ (0.26), which indicates that *Parapenaeus longirostris* in GSA 1 is exploited unsustainably.

6.2.7.2. Management recommendations

EWG 13-09 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{01} 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.

6.3. STOCK ASSESSMENT OF DEEPWATER PINK SHRIMP IN GSA 5

6.3.1. *Stock identification and biological features*

6.3.1.1. Stock Identification

GSA05 has been pointed as an individualized area for assessment and management purposes in the western Mediterranean (Quetglas *et al.*, 2012) due to its main specificities (Figure 6.3.1). These include: 1) Geomorphologically, the Balearic Islands (GSA 05) are clearly separated from the Iberian Peninsula (GSA 06) by depths between 800 and 2000 m, which would constitute a natural barrier to the interchange of adult stages of demersal resources; 2) Physical geographically-related characteristics, such as the lack of terrigenous inputs from rivers and submarine canyons in GSA 05 compared to GSA 06, give rise to differences in the structure and composition of the trawling grounds and hence in the benthic assemblages; 3) Owing to these physical differences, the faunistic assemblages exploited by trawl fisheries differ between GSA 05 and GSA 06, resulting in large differences in the relative importance of the main commercial species; 4) There are no important or general interactions between the demersal fishing fleets in the two areas, with only local cases of vessels targeting red shrimp in GSA 05 but landing their catches in GSA 06; 5) Trawl fishing exploitation in GSA 05 is much lower than in GSA 06; the density of trawlers around the Balearic Islands is one order of magnitude lower than in adjacent waters; and 6) Due to this lower fishing exploitation, the demersal resources and ecosystems in GSA 05 are in a healthier state than in GSA 06, which is reflected in the population structure of the main commercial species (populations from the Balearic

Islands have larger modal sizes and lower percentages of small-sized individuals), and in the higher abundance and diversity of elasmobranch assemblages.

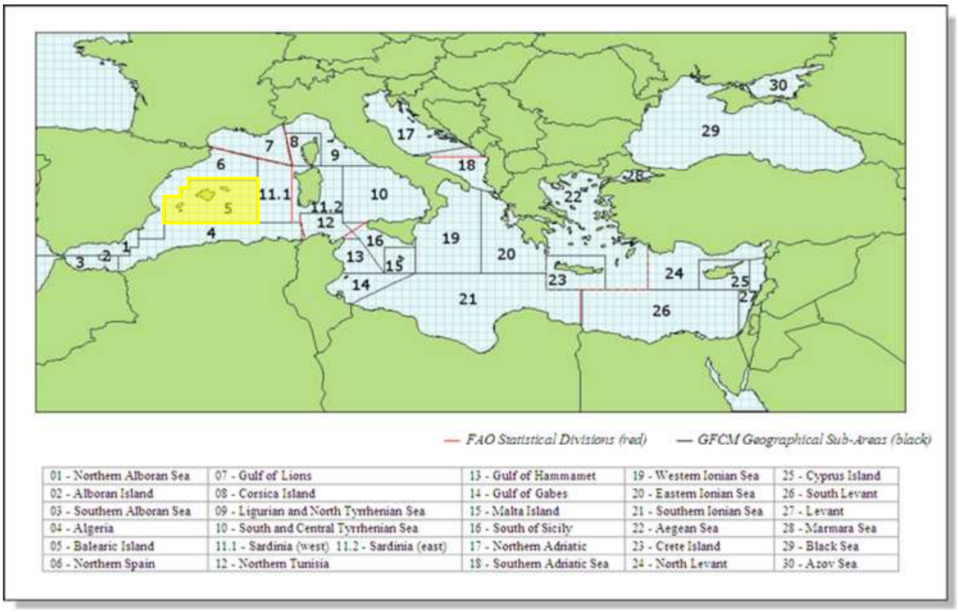


Figure 6.3.1. Geographical location of GSA 05.

6.3.1.2. Growth

The growth parameters used during the EWG 13-09 were those computed by Guijarro *et al.* (2009) for GSA 5. The length data from the data call have been converted to age using the L2Age program (i.e. knife edge slicing).

L_{inf} (mm)	44
k	0.67
t_0	-0.21
a	0.0022
b	2.5626

6.3.1.3. Maturity

The maturity ogive used was the following (Guijarro *et al*., 2009):

Age	0	1	2	3+
Prop. matures	0.11	0.62	0.96	1.00

6.3.2. *Fisheries*

6.3.2.1. General description of the fisheries

In the Balearic Islands (western Mediterranean), commercial trawlers develop up to four different fishing tactics, which are associated with the shallow shelf, deep shelf, upper slope and middle slope (Guijarro and Massutí 2006; Ordines et al. 2006), mainly targeted to: (i) *Spicara smaris*, *Mullus surmuletus*, *Octopus vulgaris* and a mixed fish category on the shallow shelf (50-80 m); (ii) *Merluccius merluccius*, *Mullus* spp., *Zeus faber* and a mixed fish category on the deep shelf (80-250 m); (iii) *Nephrops norvegicus*, but with an important by-catch of big *M. merluccius*, *Lepidorhombus* spp., *Lophius* spp. and *Micromesistius poutassou* on the upper slope (350-600 m) and (iv) *Aristeus antennatus* on the middle slope (600-750 m). The deepwater pink shrimp, *P. longirostris*, is an important by-catch species in the upper slope.

6.3.2.2. Management regulations applicable in 2010 and 2011

- Fishing license: number of licenses observed
- Engine power limited to 316 KW or 500 HP: not fully observed (in occasions, at least doubled)
- Mesh size in the codend (before Jun 1st 2010: 40 mm diamond: after Jun 1st 2010: 40 mm square or 50 mm diamond -by derogation-): fully observed
- Time at sea (12 hours per day and 5 days per week): fully observed
- Minimum landing size (EC regulation 1967/2006, 20 mm CL): mostly fully observed

6.3.2.3. Catches

6.3.2.3.1. Landings

Pink shrimp landings came exclusively from bottom trawlers (OTB) in GSA 5. The following table shows the annual landings (t, DCF data, 2002-2011):

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
36.189	22.128	6.372	1.645	0.911	0.728	2.718	5.11	6.253	4.544	4.17

Historical data landings showed important oscillations with maximum landings around 30-50 t in 2000-2002 and values lower than 20 t for the rest of the years (Fig. 6.3.2.3.1.).

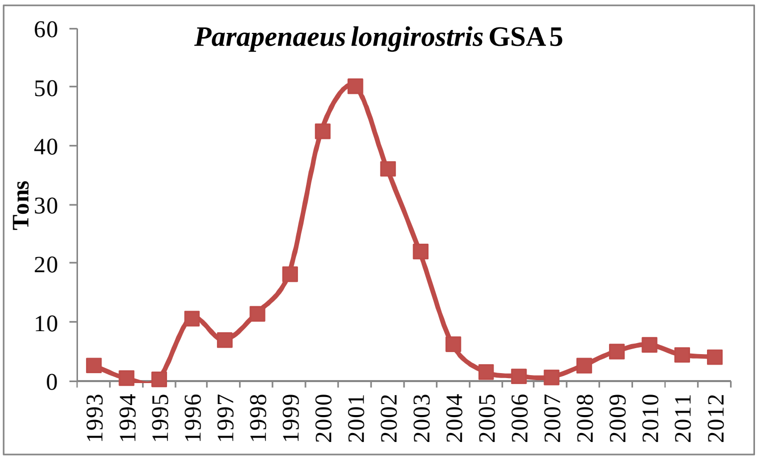


Fig. 6.3.2.3.1. Historical data landings of pink shrimp in GSA 5.

6.3.2.3.2. Discards

Discard of pink shrimp in GSA 05 can be considered as negligible.

6.3.2.3.3. Fishing effort

Fishing effort available from the Data Call included years 2010-2012. Table 6.3.2.3.3.1. summarizes these values.

Table 6.3.2.3.3.1. Effort data for OTB according to the DCF Data Call.

	2009	2010	2011	2012
Nominal effort	2784175	2927650	2694399	2675591
GT days at sea	648574	672068	616595	630595

6.3.3. *Scientific surveys*

6.3.3.1. BALAR and MEDITS surveys

6.3.3.1.1. 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 (BALAR surveys, Massutí and Reñones, 2005). Since 2007, this survey has been included in the MEDITS program (Bertrand *et al.*, 2002). Mean stratified abundances and biomasses by km^2 has been computed using the methodology described by Grosslein and Laurec (1982), with the following formula:

-Mean catch by stratum: $\bar{Y}_{st} = \frac{1}{N_h} * \sum Y_h$

-Variance by stratum: $S^2(\bar{Y}_{st}) = \frac{1}{N_{h-1}} * \sum (Y_h - \bar{Y}_{st})^2$

-Mean total catch: $Y_t = \frac{1}{A} * \sum (\bar{Y}_{st} * A_h)$

-Total variance: $S^2(\bar{Y}_t) = \frac{1}{A^2} * \sum \frac{S^2(\bar{Y}_{st}) * A_h^2}{N_h}$

-SE (standard error): $SE = \sqrt{S^2(\bar{Y}_{st})}$

Nh: number of hauls in each sub-stratum; Yh: mean catch by haul in each sub-stratum; A: total stratum area; Ah: sub-estratum area; $S^2(\bar{Y}_{st})$ variance in each sub-stratum.

6.3.3.1.2. Geographical distribution patterns

Pink shrimp is mainly distributed in the south and west of Mallorca, although it is also found in the north and south of Menorca (Fig. 6.3.3.1.2.1.).

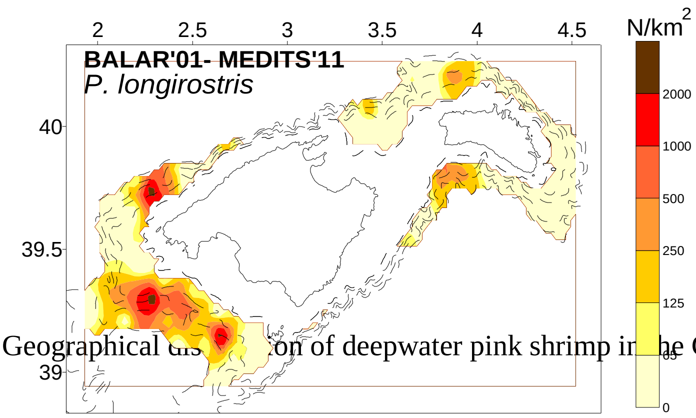


Fig. 6.3.3.1.2.1. Geographical distribution of deepwater pink shrimp in the GSA 5 (2001-2011).

6.3.3.1.3. Trends in abundance and biomass

Abundance and biomass indices from the scientific surveys showed a similar trend than the commercial landings, with high values in 2001-2002 and a decreasing trend since then (Fig. 6.3.3.1.3.)

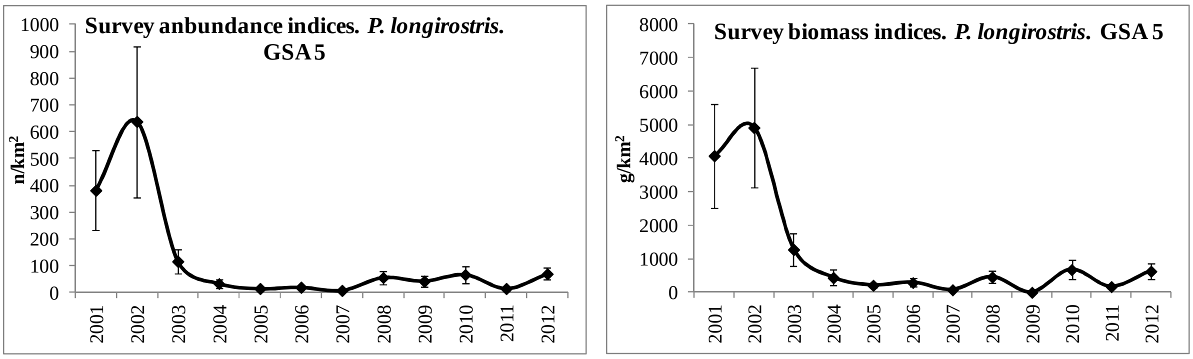


Fig. 6.3.3.1.3. Abundance and biomass indices from the scientific surveys.

6.3.3.1.4. Trends in abundance by length or age

No analysis were conducted during EWG 13-09.

6.3.3.1.5. Trends in growth

No analysis were conducted during EWG 13-09.

6.3.3.1.6. Trends in maturity

No analysis were conducted during EWG 13-09.

6.3.4. *Assessment of historic stock parameters*

6.3.4.1. Method 1: XSA

6.3.4.1.1. Justification

The assessment has been performed with an Extended Survivor Analysis (XSA) using the FLR library in R. This assessment is an update of the one performed in 2010 (SGMED-10-02).

6.3.4.1.2. Input parameters

Landings time series 2002-2012 from OTB in GSA 05. Age distributions obtained from slicing of length distributions 2002-2012 (Fig. 6.3.4.1.2.1). Biological parameters used correspond to those available from GSA 05 (Guijarro *et al*., 2009). BALAR-MEDITS survey used as tuning fleet.

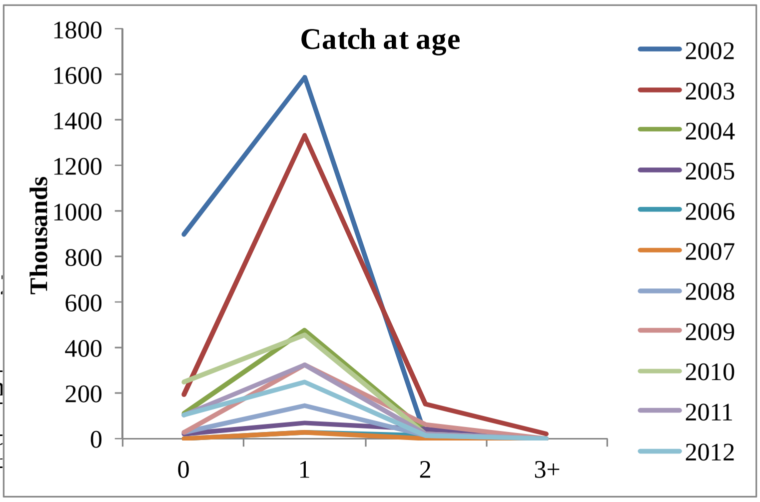


Fig. 6.3.4.1.:

Mean weigh	
0	1
0.007	0.0

Growth parameters		
L_∞	k	t_0
44	0.67	-0.21

Length-weight relationship	
a	b
0.0022	2.5626

Maturity oogive				
Age	0	1	2	3+
Prop. Matures	0.11	0.62	0.96	1.00

Natural mortality (PROBIOM; Abella et al., 1997)				
Age	0	1	2	3+
M	1.22	0.55	0.44	0.39

The number of individuals by age was SOP corrected [SOP = Landings / Σ*a* (total catch numbers at age *a* x catch weight-at-age *a*)] before performing any analysis.

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2002
1.51	1.06	0.88	0.86	1.27	1.67	1.23	0.88	0.88	0.88	1.07	1.51

Different sensitivity analyses were performed before running the final XSA, considering different weights and ages for shrinkage and different ages for catchability. For weight shrinkage, results were quite robust for recruitment and SSB, but F showed differences for shrinkage weight 0.5-1 and 1.5-2.5. For the age shrinkage, results were quite robust for recruitment and SSB, but not for F as it showed very different results when considering age 1. For the catchability, the results were very robust independently of the ages considered.

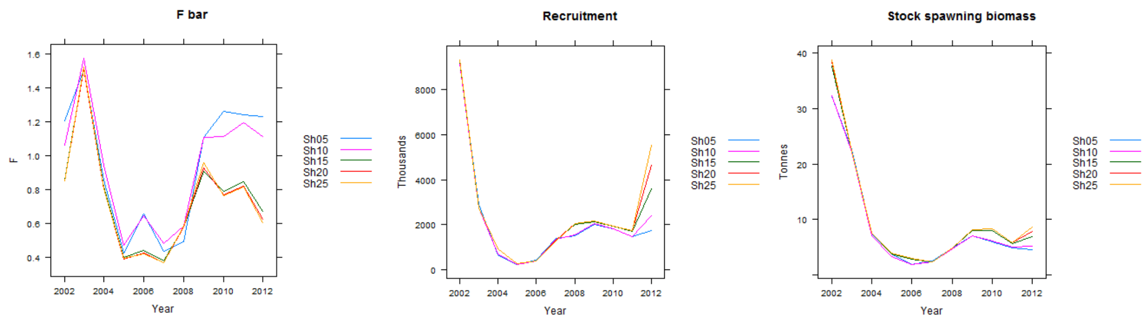


Fig. 6.3.4.1.2.2. Sensitivity analysis considering different weights for shrinkage for F, R and SSB.

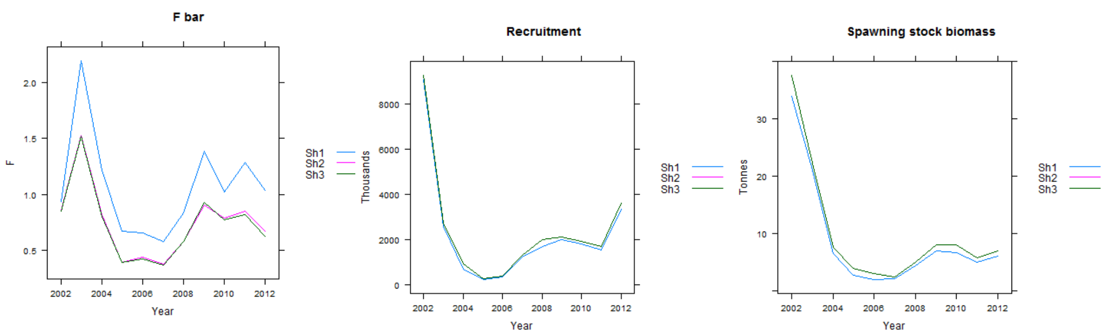


Fig. 6.3.4.1.2.3. Sensitivity analysis considering different ages for shrinkage for F, R and SSB.

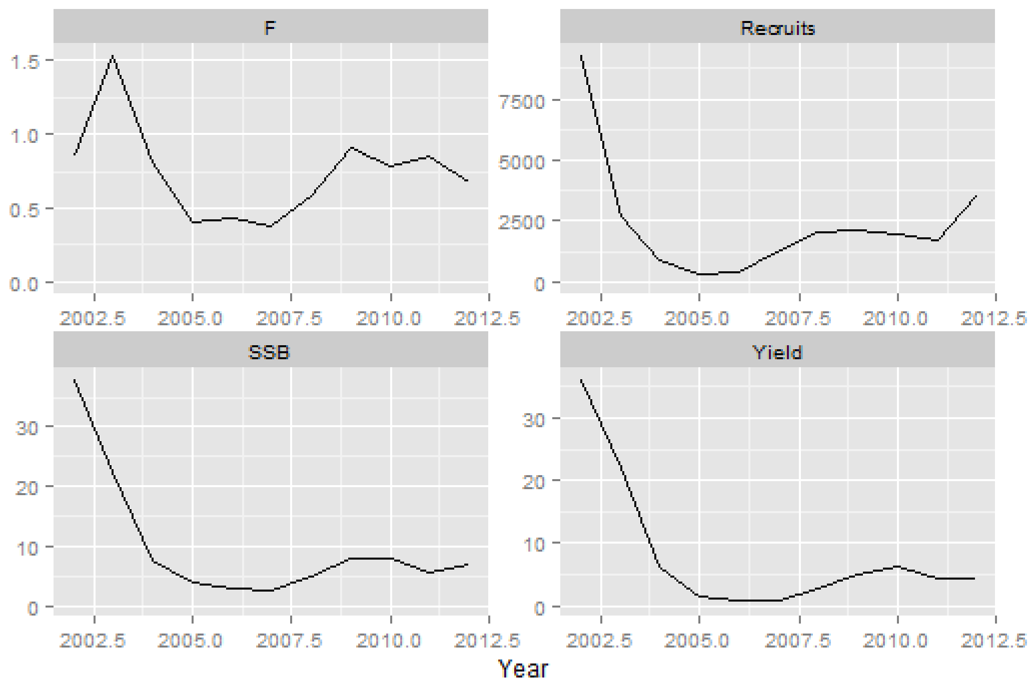
Fig. 6.3.4.1.2.4. Sensitivity analysis considering different ages for catchability for F, R and SSB.

For the final XSA run, the following settings were used:

fse	rage	qage	shk.n	shk.f	shk.yrs	shk.ages
1.5	-1	3	TRUE	TRUE	3	2

6.3.4.1.3.Results

Both recruitment and SSB showed the maximum values at the beginning of the period (2002), with minimum values in 2005-2006 and a slightly increasing trend since then. F showed oscillation along the data series (Fig. 6.3.4.1.3.1., Table 6.3.4.1.3.1.).



	Population in number (thousands)	Population in weight (tons)	Recruitment number (thousands)	SSB	F_{0-2}
2002	13140.09	110.86	9269.46	38.01	0.85
2003	5001.64	48.68	2737.30	22.30	1.53
2004	1700.20	16.49	918.67	7.52	0.82
2005	583.39	6.46	278.14	3.83	0.40
2006	567.03	5.82	398.95	2.91	0.44
2007	1453.09	12.42	1320.34	2.43	0.38
2008	2424.97	17.42	2002.33	4.92	0.58
2009	2799.52	24.27	2139.26	8.05	0.91
2010	2667.21	22.77	1934.38	8.05	0.79
2011	2191.27	18.33	1686.49	5.72	0.85
2012	3984.46	30.69	3493.04	6.85	0.68

Residuals from the BALAR-MEDITS tuning fleet did not show any particular trend in the residuals, although they were slightly high for certain years in age 0 (Fig. 6.3.4.1.3.2).

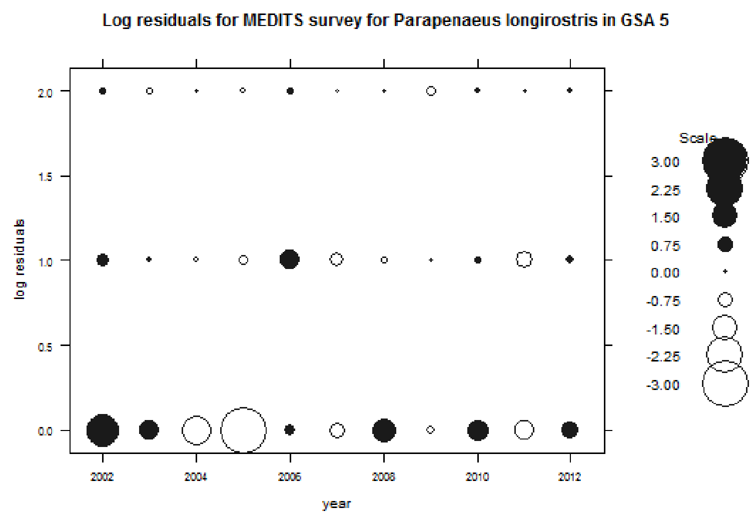
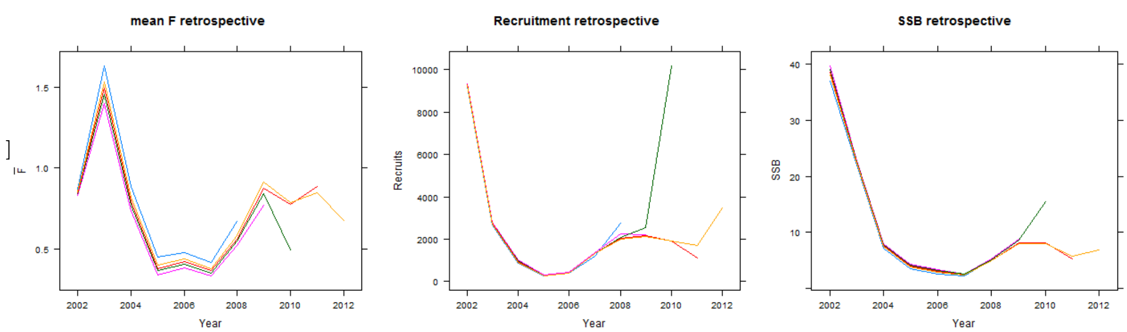


Fig. 6.3.4.1.3.2. Log catchability residual plots (XSA) for BALAR -MEDITS surveys.

Retrospective analysis was performed, showing quite robust results for R, SSB and F, except for 2010 (Fig. 6.3.4.1.3.3).



6.3.5. *Long term prediction*

6.3.5.1. Justification

6.3.5.1.1. Input parameters

Yield per recruit was calculated using FLR.

6.3.5.1.2. Results

Table 6.3.5.1.2.1 shows the reference F (F_{ref}) as well as the reference point F_{01} (as a proxy of F_{MSY}). Fig. 6.3.5.1.2.1. shows the yield per recruit graph.

Table 6.3.5.1.2.1. Reference F and reference points for deepwater pink shrimp in GSA 5.

$F_{ref\ (0\text{-}2,\ 2010\text{-}2012)}$	0.77
F_{01}	0.62

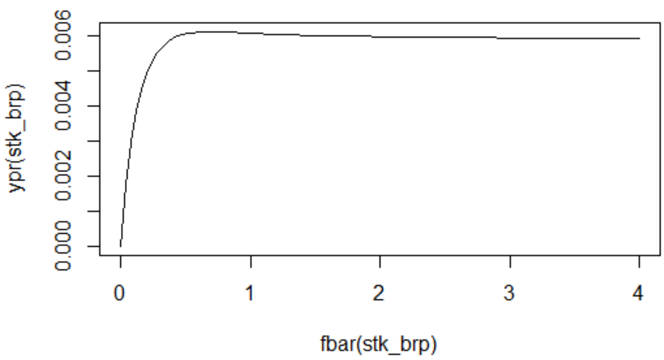


Fig. 6.3.5.1.2.1. Yield per recruit for the deepwater pink shrimp in GSA 5.

6.3.6. *Data quality*

Information about catches and length and age frequency distributions was available through the Official Data Call for all the years. Effort information was available only for 2009-2012. MEDITS data was also available.

6.3.7. *Scientific advice*

6.3.7.1. Short term considerations

6.3.7.1.1. State of the stock size

SSB showed the maximum values at the beginning of the period (2002), with minimum values in 2005-2006 and a slightly increasing trend since then.

6.3.7.1.2. State of recruitment

Recruitment showed the maximum values at the beginning of the period (2002), with minimum values in 2005-2006 and a slightly increasing trend since then.

6.3.7.1.3. State of exploitation

The current F (0.77) is larger than F_{MSY} (0.62), which indicates that pink shrimp in GSA 05 is exploited unsustainably.

6.3.7.2. Management recommendations

Although the stock is fished unsustainably, it is important to remark than the CPUEs (both from surveys and commercial fleet) oscillations found for this species are also found in other areas in the Mediterranean and probably caused not only by the fishing effort but also by environmental changes. For this reason, it is important to follow the evolution of this stock, especially because it seems it has started to recover during the last years. It is also important to consider that pink shrimp in GSA 5 is only caught as a by-catch in the trawl fishery and a management of this species should be undertaken in the framework of a multispecific approach.

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Ordines F., E. Massutí, B. Guijarro and R. Mas. Diamond *vs. s*quare mesh codend in a multi-species trawl fishery of the western Mediterranean: effects on catch composition, yield, size selectivity and discards. 2006. *Aquatic Living Resources*, 19: 329-338.

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6.4. STOCK ASSESSMENT OF DEEPWATER PINK SHRIMP IN GSA 6

6.4.1. *Stock identification and biological features*

6.4.1.1. Stock Identification

Due to the lack of information about the structure of deepwater pink shrimp (*Parapenaeus longirostris*) populations in the western Mediterranean, this stock is assumed to be confined within the GSA 06 boundaries.

6.4.1.2. Growth

The growth parameters used are those estimated by García-Rodríguez et al. (2009) based on the analysis of length distributions (L_∞= 45.0; k = 0.39; t_0= 0.1019). The length-to-weight coefficients used were those recently estimated by the Spanish Data Collection Programme for the years 2011-2012: a= 0.0030550, b= 2.4906080).

6.4.1.3. Maturity

The maturity ogive is taken from García-Rodríguez et al. (2009), with size at first maturity (50%) at 25.65 mm CL.

Age	0	1	2	3	4	5	gp+

class							
Maturity	0	0.134	0.504	0.787	0.901	0.973	1.000

6.4.2. *Fisheries*

6.4.2.1. General description of the fisheries

The trawl feet operating in GSA06 in 2012 consisted of 540 trawlers, according to the statistics of the Autonomous Governments of Valence (269 vessels in southern GSA06) and Catalonia (271 in northern GSA06). Some units (smaller vessels) operate almost exclusively on the continental shelf (targeting red mullet, octopus, hake and sea breams). Larger vessels operate almost exclusively on the upper and middle slope (targeting decapod crustaceans). The rest can operate indistinctly on the continental shelf or slope fishing grounds, depending on the season, the weather conditions and also economic factors (e.g. landings price). The percentages of these trawl fleet segments have been estimated at around 30, 40 and 30% of the boats, respectively (Alemany and Álvarez, 2003).

Note that the trawl fleet in GSA 06 has been decreasing by approximately 10% units annually over the last 2 years due to the Integral Management Plan for Mediterranean fisheries for the years 2011-2012. It is estimated that half of the trawl fleet operates on deepwater pink shrimp fishing grounds (270 units) and other deep-water fishing grounds, targeting other valuable crustaceans (Norway lobster; red shrimp).

6.4.2.2. Management regulations applicable in 2010 and 2011

Trawl fisheries in GSA 06 are regulated by “Orden AAA/2808/2012” published in the Spanish Official Bulletin (BOE nº 313 29 December 2012) containing an Integral Management Plan for Mediterranean fishery resources. To the traditional fisheries regulations already in place (e.g. the daily and weekly fishing effort limited to 12 hours per day five days a week; trawl cod end 40 mm square mesh or 50 mm stretched mesh; engine power of maximum 373 kW; license system; minimum landing size of 20 mm CL), this Plan adds that fishing mortality for *Parapenaeus longirostris* in GSA 06 be kept below the reference value F_{01} = 0.30, and that fishing effort be reduced by 20% or more over the period 2013-2017 (based on the effort established on 1 January 2013). This fishing effort reduction will be measured in terms of number of vessels, engine power and tonnage.

6.4.2.3. Catches

6.4.2.3.1. Landings

Landings of deepwater pink shrimp after 2004 differ significantly between the DCF data provided to the group and the official figures provided by the two Spanish Autonomous Communities in GSA 06 (Valence and Catalonia). Combining the figures provided by the latter, the official landings are 3 times higher than those reported to the group after 2004. As in the last assessment conducted for deepwater pink shrimp in area GSA 06, the landings used here are those reported by the Autonomous Communities.

Table 6.4.2.3.1.1 Landings reported to STECF EWG 13-09 and landings reported by the Fisheries Directorates of the Autonomous Communities of Valence and Catalonia

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Landings reported by the Fisheries Directorates	331	165	116	76	102	123	107	104	116	141	92	120
Landings reported to STECF EWG 13-09		144	116	89	35	32	32	33	49	72	66	86

As shown in the following figure, landings were high in 2002, decreased in 2003-2004, and are relatively stable since 2005. The years with highest landings corresponded to years with high catches of smaller individuals.

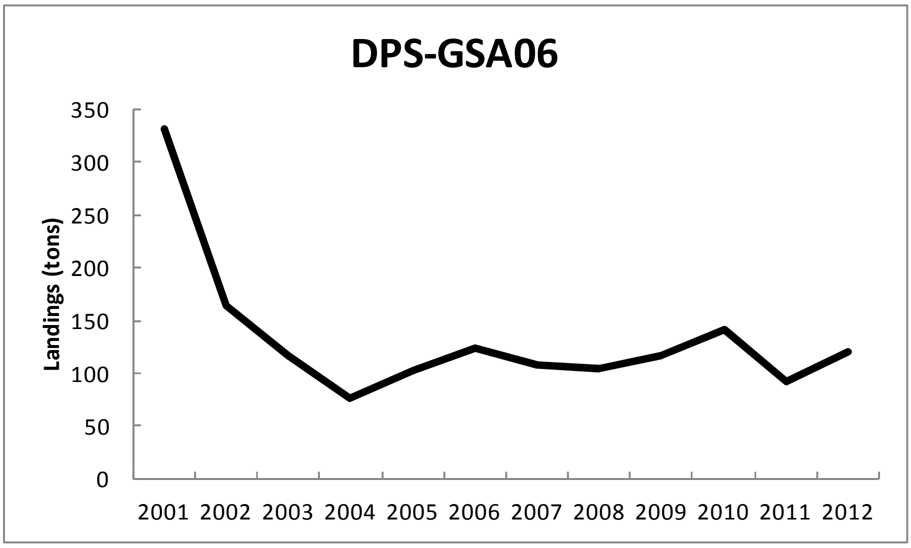


Fig. 6.4.2.3.1.1. Annual landings in GSA 06, in weight (tons) reported by the Fisheries Directorates.

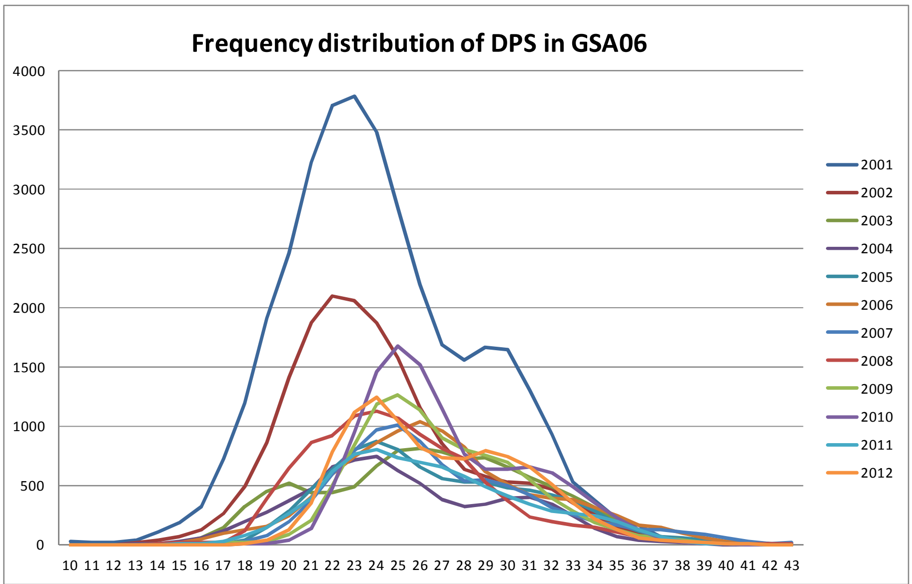


Fig. 6.4.2.3.1.2. Frequency distribution of the sampled commercial landings.

6.4.2.3.2. Discards

Reported discards to EWG 13-09 were neglegible, which is common given the high market value of the species. Undersized individuals (less than 20 mm CL) are scarce in the landings and less than 10% of the number of measured individuals in the annual length frequencies.

6.4.2.3.3. Fishing effort

Trawl (OTB) fishing effort data for GSA 06 was submitted by quarter, area, gear, fishery and vessel length class for the years 2009-2012 in the new data call. Data for the length classes VL1224 and VL2440 are shown in the following table and figure. The reduction in fishing effort is apparent, in accordance with the Integral Plan previously mentioned aiming to reduce fishing effort.

Table 6.4.2.3.3.1 Number of vessels, nominal fishing effort and capacity

Year	2009	2010	2011	2012
N of Vessels	558	546	540	540
Nominal effort kW x days at sea (000s)	28339	26306	24805	23553
GT x days at sea (000s)	6063	5673	5343	5109

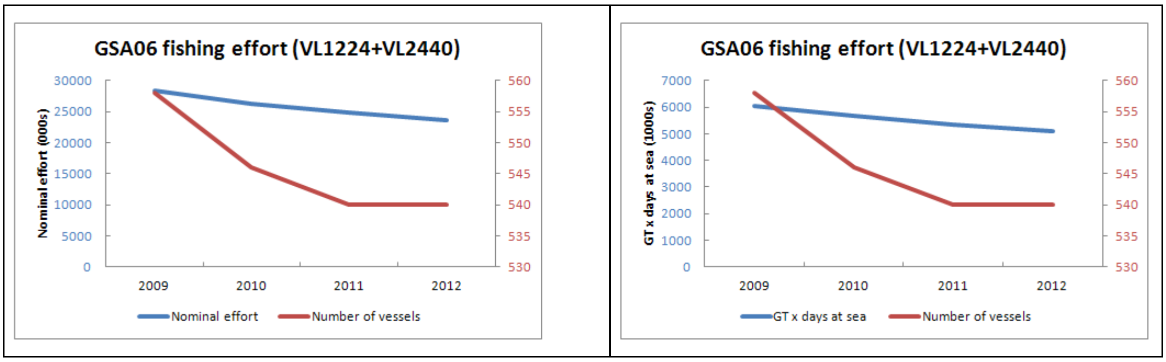


Fig. 6.4.2.3.3.1 Trend of number of vessels (OTB vessels VL1224 and VL2440), nominal effort (000s of kW*days at sea) and nominal capacity (GT*days at sea) in the period 2009- 2012 in GSA 06.

6.4.3. *Scientific surveys*

6.4.3.1. MEDITS surveys

6.4.3.1.1. Methods

Since 1994 standard bottom trawl surveys have been conducted in GSA 06 in spring, following the general methodology of the MEDITS protocol described in Bertrand et al. (2002). In GSA 06 the following number of hauls was reported per depth stratum in the DCF 2013 data call:

Table 6.4.3.1.1.1. Number of hauls per year and depth stratum in GSA 06, 1994-2012.

DEPTH_STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002
050-100	21	27	27	25	27	28	30	29	34
100-200	10	18	16	14	12	16	18	18	19
200-500	9	15	9	10	6	12	11	15	16
500-800	8	11	10	8	4	10	7	8	7

DEPTH_STRATUM	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
050-100	37	30	31	33	26	29	28	20	28	35
100-200	20	16	17	18	14	20	20	12	20	23
200-500	17	15	14	17	10	13	14	10	15	18

500-800	11	11	8	12	9	9	7	8	8	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:

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

$V(Yst) = \Sigma (Ai2 * si\ 2 / ni) / A2$

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

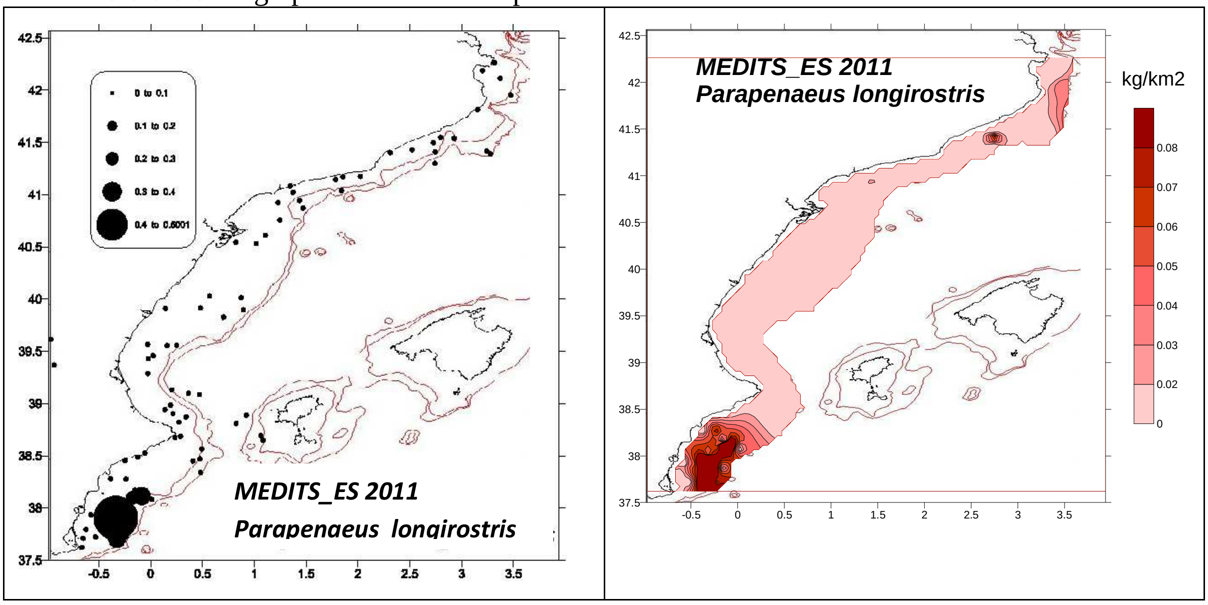


Fig. 6.4.3.1.2.1. Spatial distribution of *Parapenaus longirostris* from samples obtained during the MEDITS surveys in 2011. Left: point densities in kg/km^2; right: estimated density contours.

Deepwater pink shrimp is distributed from 150 to 400 m depth in GSA 06, with higher densities on soft muddy bottoms in the southern part of GSA and, in years of high abundance of the population also in the north of GSA 06.

6.4.3.1.3. Trends in abundance and biomass

Fishery independent information from the MEDITS surveys in the period 2001-2012 was used to derive indices of abundance and biomass for deepwater pink shrimp in GSA 06. Both abundance and biomass have fluctuated in the area during this period with no clear trend, but low abundances are apparent in the years 2003-2004.

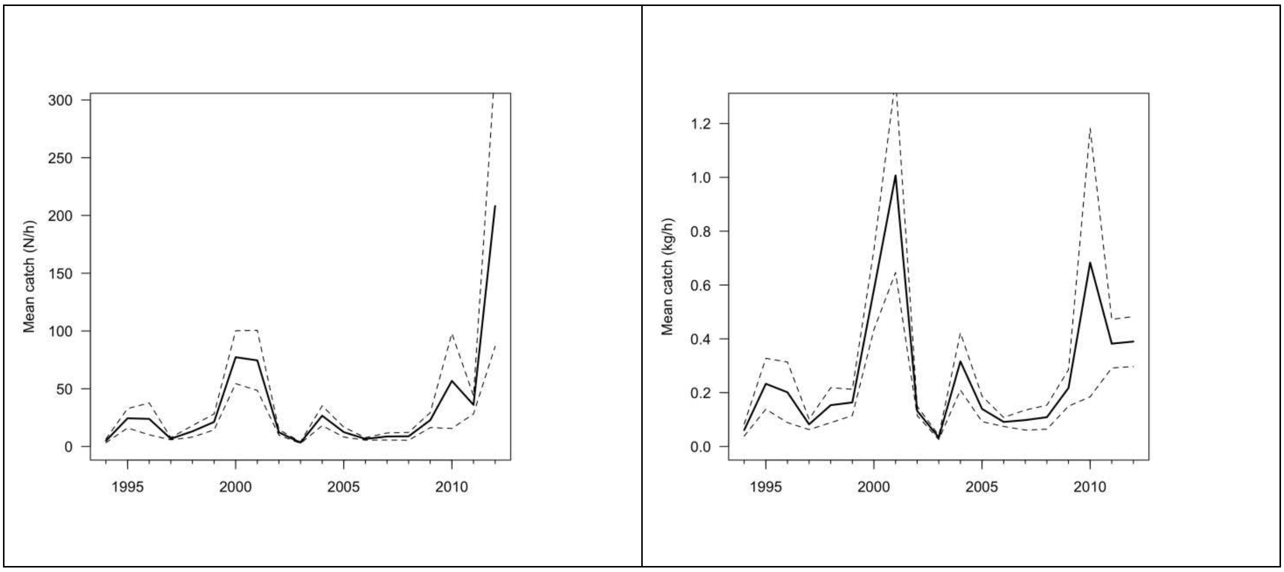
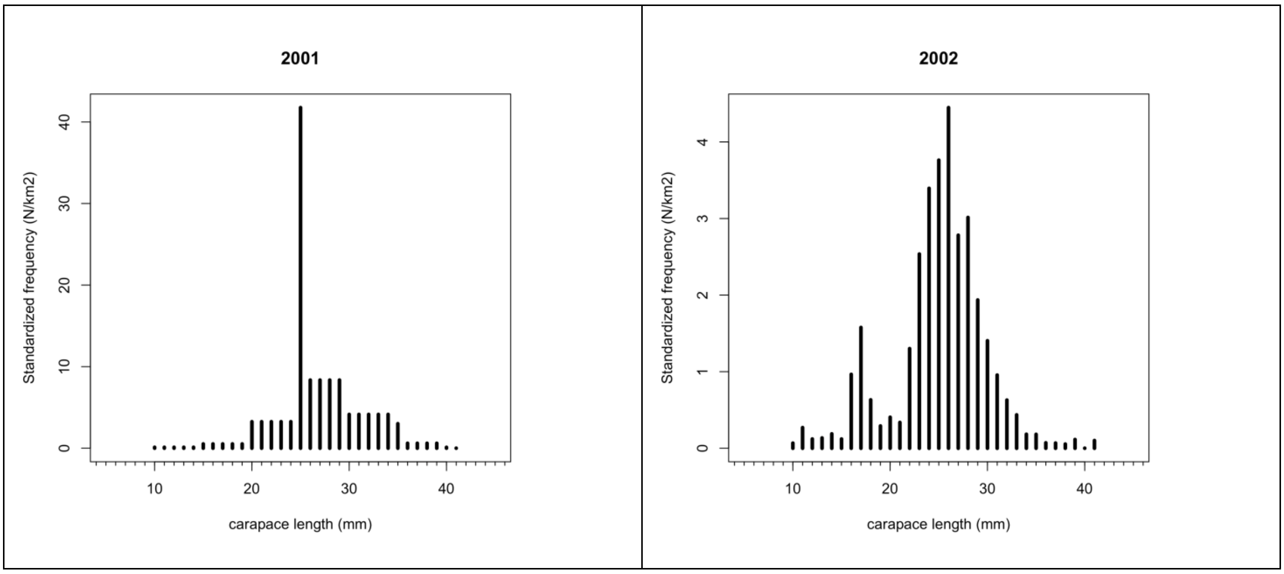
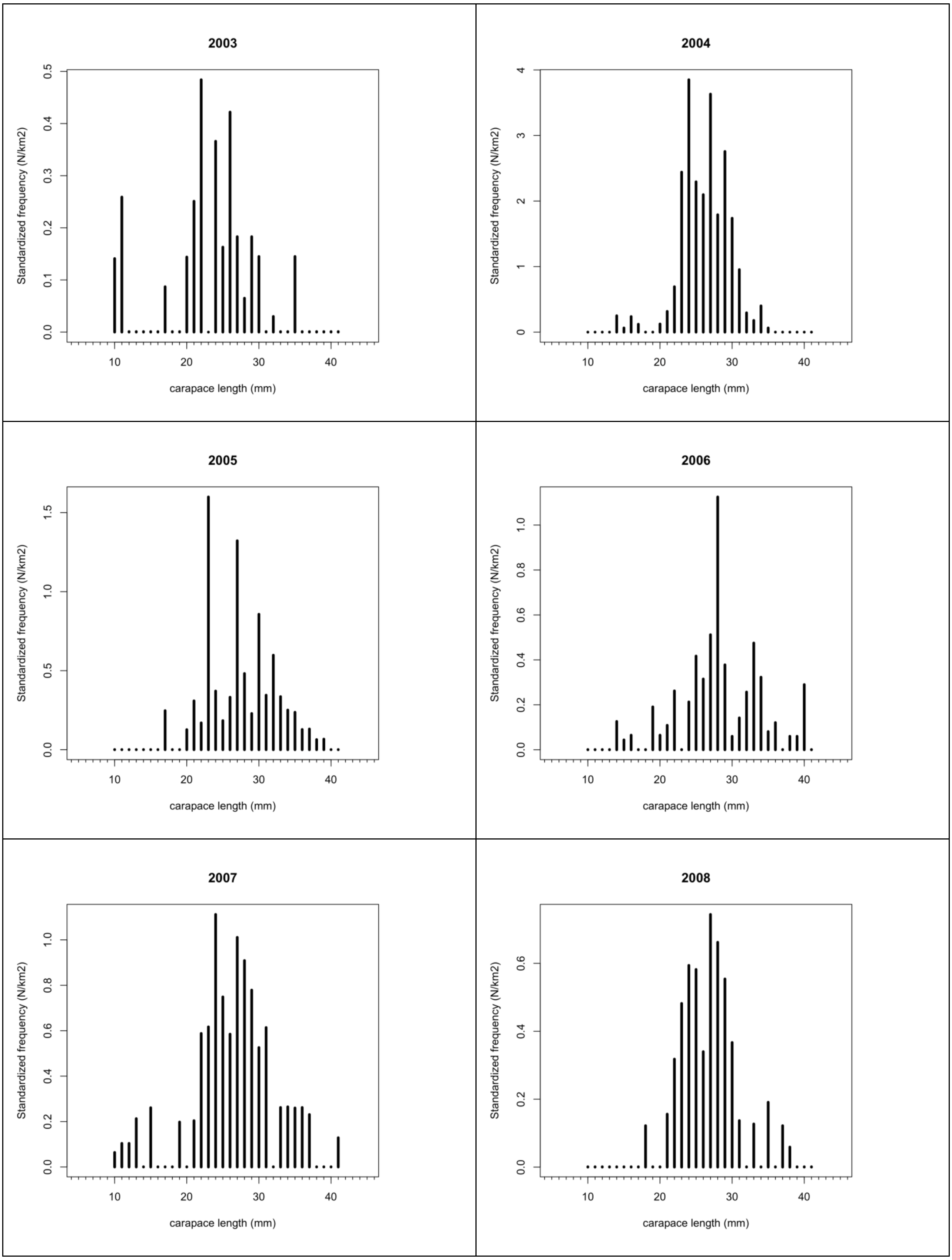


Fig. 6.4.3.1.3.1. Abundance and biomass indices of *Parapenaeus longirostris* in GSA 06 from MEDITS surveys (mean and 95% confidence intervals).

6.4.3.1.4. Trends in abundance by length or age

The following figures show the standardized size frequencies of pink shrimp in GSA 06 in the period 2001-2012. Although the modal size in the samples is around 25 mm CL in all years, some changes in the size composition of the samples are apparent, specially at sizes below 20 mm CL, which could be indicative of strong recruitment in the years 2007, 2009 and 2011.




2003
2004
2005
2006
2007
2008
Standardized frequency (N/km2)
carapace length (mm)

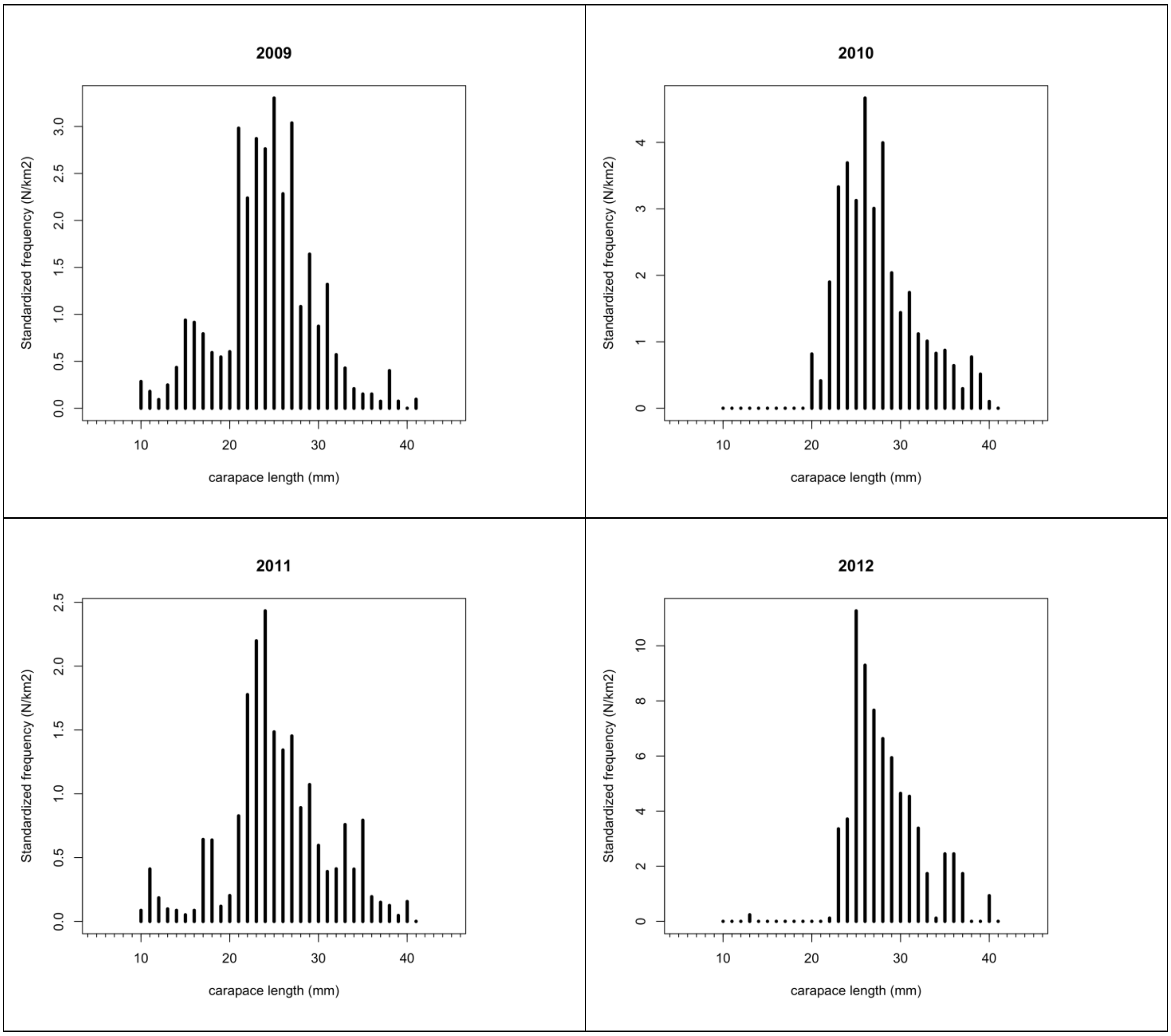


Fig 6.4.3.1.4.1. Standardized size frequencies of *Parapenaeus longirostris* in GSA 06 2001-2012 from MEDITS surveys.

6.4.3.1.5. Trends in growth

No information is available to assess trends in growth.

6.4.3.1.6. Trends in maturity

No information is available to assess trends in maturity.

6.4.4. *Assessment of historic stock parameters*

6.4.4.1. Method 1: XSA

6.4.4.1.1. Justification

Length frequency distributions of the commercial catch exist for the period 2001-2012 as well as acceptable biological parameters for the pink shrimp in GSA06 (García-Rodríguez et al., 2009). These conditions justify the application of XSA method (FLR) tuned with abundance indices (n/km^2) derived from the MEDITS database.

6.4.4.1.2. Input parameters

The growth parameters used for VBGF were Linf= 45.0 mm CL; K = 0.39 yr^{-1}; t0= 0.1019 yr (García-Rodríguez et al., 2009). The length-to-weight coefficients used were those recently estimated by the Spanish Data Collection Programme for the years 2011-2012: a= 0.0030550, b= 2.4906080).

Numbers at age were estimated transforming the annual size distribution of the landings to ages using the L2Age4 software. Commercial landings of pink shrimp are exclusively obtained by the trawl fleet (OTB in vessel length classes 12-24 and 24-40 m) and discards are negligible, due to the high commercial value of the species. The source of commercial landings are the official databases in the Autonomous Communities of Valence and Catalonia. The tuning parameters (MEDITS) were calculated by transforming standardized MEDITS length distributions to ages using L2Age4 software.

Table 6.4.4.1.2.1 lists the input parameters to the XSA, namely catch at age, weight at age, maturity at age, natural mortality at age and the tuning series at age (MEDITS). Natural mortality values (vector) were computed with the PROBIOM routine. M for age group 0 is the mean over the first 12 months.

Table 6.4.4.1.2.1. Input parameters to the XSA model.

Catch at age matrix

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	79.6	5.6	0.5	2.1	0	0	0	0	0	0	0	0
1	15872.2	8326.9	2636.4	2542.6	2012	2072.8	1698.5	3564.4	1284.6	1158.9	1938.8	1889
2	15966.7	7870.7	5047.3	3438.1	4540.2	5812	5208	5866.9	6758.8	7926.1	4500.2	6236.8
3	4056.8	1890.6	2164.9	1347.2	1811.3	1811.9	1478.2	943.8	1789	2482	1379.2	2149.3
4	424.4	254.6	362.5	128.6	339.4	554	415.1	200.9	243.9	374.1	363	205.8
5	40.4	23.3	49.3	17	83	136.8	182.4	35.8	40.8	23.8	30.2	42
gp+	3.7	3.6	9.7	1.7	30.9	39.8	79.9	27.8	1.8	1.3	5.6	11.6

Weight at age matrix

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.001	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
1	0.006	0.006	0.006	0.006	0.007	0.006	0.007	0.006	0.007	0.007	0.007	0.007
2	0.011	0.01	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
3	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.017	0.018	0.018	0.017
4	0.023	0.023	0.023	0.023	0.024	0.024	0.024	0.024	0.024	0.023	0.023	0.023
5	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
gp+	0.031	0.032	0.032	0.032	0.032	0.032	0.033	0.034	0.032	0.031	0.032	0.032

Maturity and natural mortality vectors. Length at first maturity L_{50} = 26.65 mm CL

Age	0	1	2	3	4	5	gp+

Maturity	0	0.134	0.504	0.787	0.901	0.973	1.000
M	1.25	0.82	0.39	0.28	0.24	0.22	0.21

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.4	0.5	0.4	0	0	0	0.3	0	0.6	0	0.7	0.1
1	14.3	7.3	1	3.1	1.7	0.9	1.7	0.9	11.8	4.9	5.7	2.1
2	81.8	21.2	1.5	18.4	4.1	3	5.7	3.9	15.8	22.7	10	48.2
3	19.2	3	0	2.8	2	1.2	1.5	0.5	3	5.6	2.4	12.6
4	3.9	0.3	0.1	0.1	0.5	0.2	0.7	0.3	0.5	1.9	1	6.2
gp+	1.1	0.3	0	0	0.1	0.4	0.1	0	0.4	1.1	0.3	0.9

6.4.4.1.3.Results including sensitivity analyses

Different sensitivity analyses were performed before running the final XSA, considering different ages for shrinkage. Both for F and SSB results were very similar for all the trials.

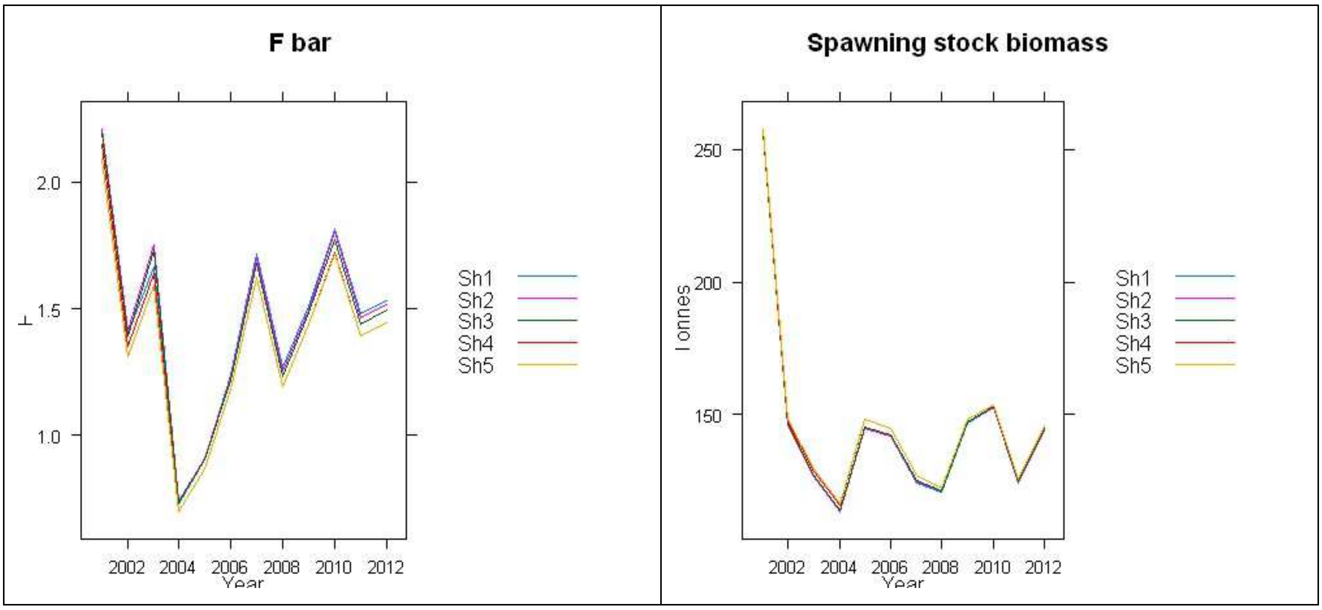


Fig.6.4.4.1.3.1 Sensitivity analysis considering different ages for shrinkage.

For the final XSA run the following settings were used:

fse	r age	q age	shk n	shk f	shk yrs	shk ages
0.5	1	5	True	True	3	3

The results of the XSA are shown in the following figure:

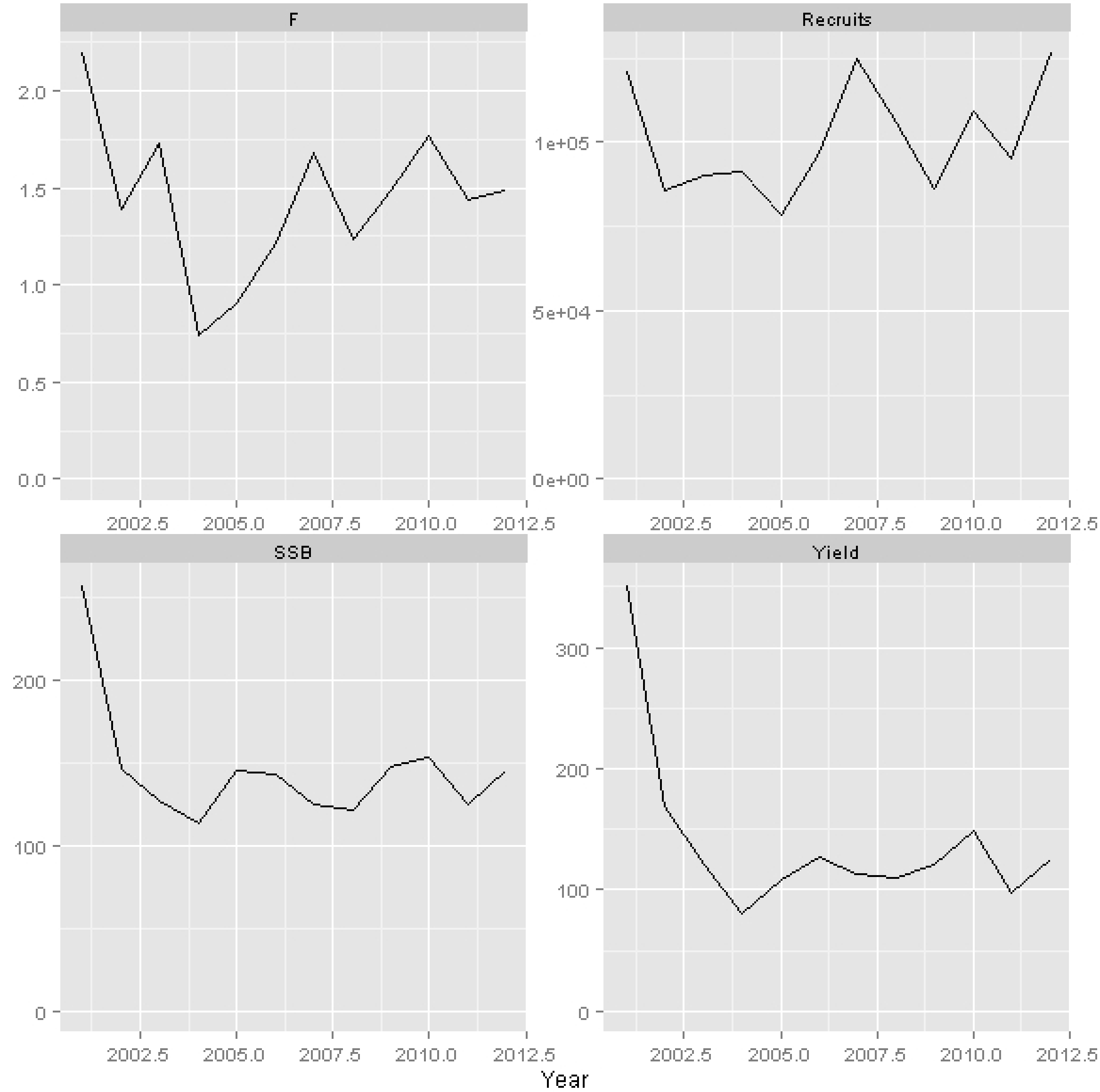


Fig. 6.4.4.1.3.2. XSA results for *Parapenaeus longirostris* in GSA 06.

The results show a fluctuating recruitment around a 12-year mean of 100 915 thousand individuals (age 0), with peaks in 2001 and 2007. Spawning stock biomass was high in 2001, but relatively stable over the following years. No SSB/R relationship is apparent from these results and recruitment can be considered stable around 100 915 thousand individuals annually with a CV of 0.16. Landings were relatively high in 2001 and 2002 and remained at a lower, but stable, level thereafter. Landings, biomass and SSB values have remained at the same level for the last eight years with fluctuations. Exploitation is based on very young age classes, mainly 1 and 2-year old individuals, indicating a dependence of this fishery on recruitments. Fishing mortality has remained relatively stable in the past 8 years, around a mean of F_{ref} = 1.40 for age classes 2-4 (mean over 2008-2012).

Residuals from the 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 5) (Fig. 6.4.4.1.3.3 and Table 6.4.4.1.3.1).

siduals for MEDITS survey for Parapenaeus longirostris in

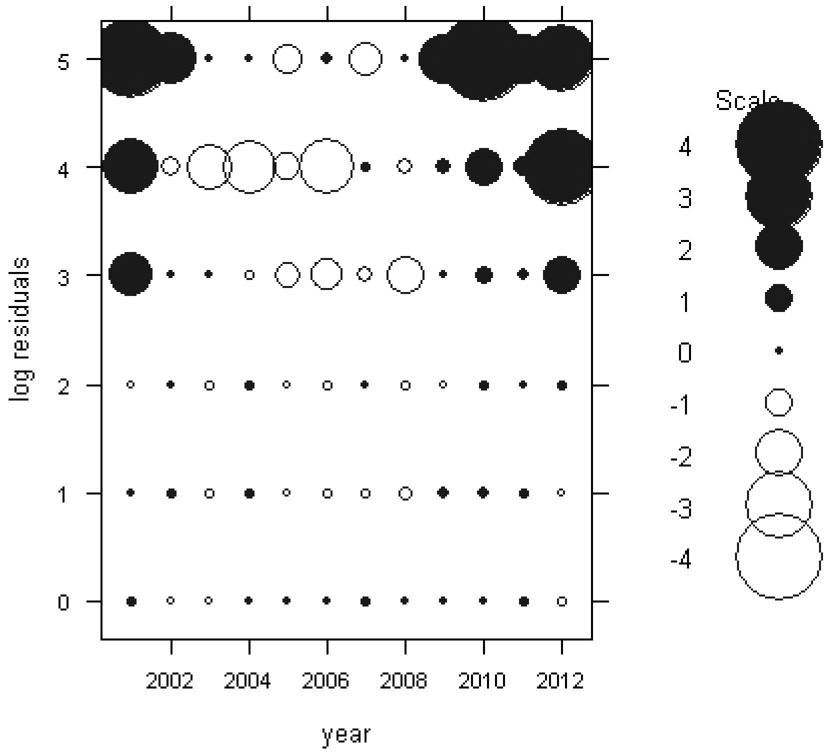


Fig. 6.4.4.1.3.3. Log catchability residuals for *Parapenaeus longirostris* in GSA 06.

Table 6.4.4.1.3.1. XSA model diagnosis for the tuning data from MEDITS *Parapenaeus longirostris* in GSA 06.

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.074	-0.025	-0.042	0	0	0	0.043	0	0.005	0	0.066	-0.119
1	0.014	0.089	-0.093	0.058	-0.04	-0.076	-0.065	-0.254	0.188	0.136	0.069	-0.026
2	1.562	0.532	-1.821	0.596	-0.87	-1.103	-0.229	-0.99	0.193	0.817	-0.057	1.369
3	1.513	0.007	0	-0.111	-0.784	-0.977	-0.36	-1.263	0.009	0.457	0.201	1.309
4	2.007	-0.546	-1.572	-1.896	-0.83	-2.022	0.117	-0.365	0.324	1.275	0.517	2.991
5	1.681	0.488	0	0	-2.228	-1.094	-2.452	0	0.284	1.996	0.265	1.06

The stock summary of the final XSA model is shown in Tables 6.4.4.1.3.2 and 6.4.4.1.3.3.

Table 6.4.4.1.3.2. Fishing mortality at age as estimated by XSA.

age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.0012	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.5642	0.4509	0.1761	0.1612	0.1234	0.1492	0.0967	0.1628	0.0660	0.0731	0.0980	0.1102
2	1.7462	1.1661	1.0008	0.6157	0.8482	1.1875	1.3482	1.0277	0.9516	1.4724	0.7753	0.9327
3	2.3505	1.5297	1.8946	1.0272	0.9854	1.3665	1.6620	1.2807	1.4483	1.6935	1.6999	1.5231

4	2.4772	1.4805	2.2962	0.5714	0.8817	1.0965	2.0256	1.3969	2.0492	2.1454	1.8446	2.0074
5	2.2115	1.4011	1.7572	0.7496	0.9837	1.2652	1.7496	1.2529	1.5039	1.7747	1.4550	1.4938
6	2.2115	1.4011	1.7572	0.7496	0.9837	1.2652	1.7496	1.2529	1.5039	1.7747	1.4550	1.4938

Table 6.4.4.1.3.3. Stock numbers at age as estimated by XSA.

age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	120810	85902	89845	91125	78656	96923	124790	105810	86443	109230	95250	126200
1	55464	34569	24608	25741	26107	22535	27769	35752	30316	24766	31296	27290
2	23505	13894	9699	9089	9650	10163	8550	11103	13381	12500	10139	12497
3	5158	2776	2931	2414	3325	2798	2099	1503	2690	3498	1941	3162
4	522	372	454	333	653	938	539	301	316	478	486	268
5	51	35	67	36	148	213	246	56	59	32	44	60
6	4	5	13	4	54	60	105	42	3	2	8	16

Table 6.4.4.1.3.4. Summary XSA results.

year	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	F_{bar} (2-4)
2001	120807	813.4	256.6	350.9	1.368	2.19
2002	85902	577.8	146.1	169.3	1.159	1.39
2003	89845	499.5	126.9	120.3	0.949	1.73
2004	91125	488.9	113.4	80.8	0.713	0.73
2005	78656	448.9	145.1	108.1	0.745	0.90
2006	96923	424.7	142.3	127.4	0.895	1.21
2007	124787	474.3	125.2	113.5	0.907	1.67
2008	105814	479.8	121.2	109.7	0.905	1.23
2009	86443	500.9	147.3	120.8	0.820	1.48
2010	109235	495.0	153.1	149.3	0.975	1.77
2011	95250	473.5	124.8	97.3	0.780	1.43
2012	126196	516.8	145.1	124.6	0.859	1.48
Arithmetic mean	100915	516.1	145.6	139.3	0.923	1.43
	thousands	tonnes	tonnes	tonnes	grams	

The results of the retrospective analysis (Fig. 6.4.4.1.3.4) show that the results are rather robust.

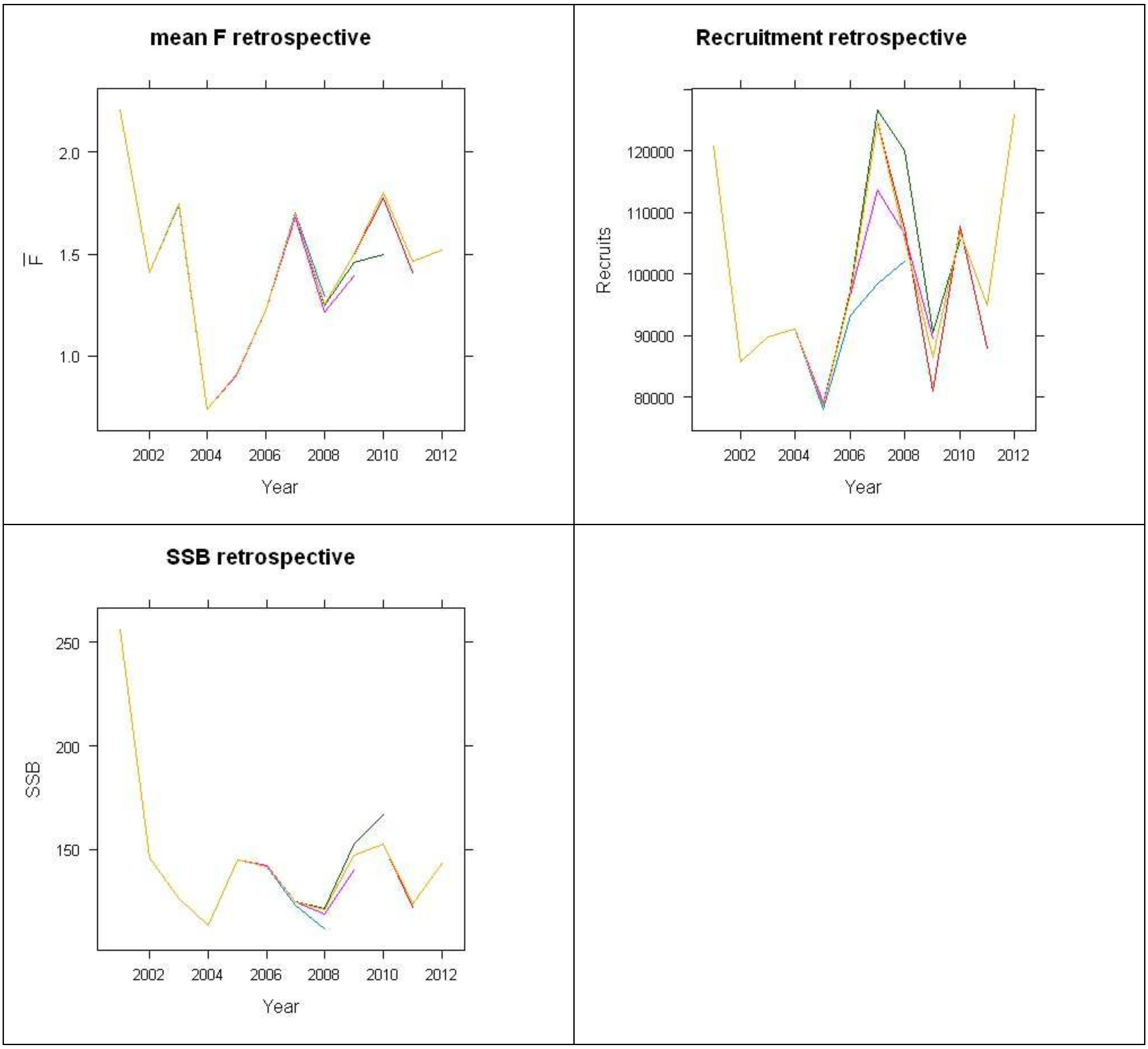


Fig. 6.4.4.1.3.4. Results of the retrospective analysis using the years 2008-2012.

6.4.5.*Long term prediction*

6.4.5.1. Justification

Yield per recruit (Y/R) analysis was used for the estimation of F_{01} and F_{max}, using the FLR routines.

6.4.5.1.1.Input parameters

F_{ref} is taken as F_{bar}(2-4) over the 2005-2012 period. All input parameters are listed in Table 6.4.5.4.1 below.

Table 6.4.5.4.1 Y/R inputs.

age group	stock weight	catch weight	maturity	Selectivity	M
0	0.002	0.002	0.134397	0.1344	1.25
1	0.006	0.006	0.504402	0.5044	0.82

2	0.011	0.011	0.787777	0.7878	0.39
3	0.018	0.018	0.901561	0.9016	0.28
4	0.024	0.024	0.973816	0.9738	0.24
5	0.03	0.03	1	1	0.22
6	0.032	0.032	1	1	0.21

6.4.5.1.2.Results

The yield curve is flat-topped for a wide range of relative fishing mortalities. Maximum yield is found at essentially the current F. Maximum catches (1.265 g / recruit) would be obtained at 73% of current F, and F_{01} corresponds to 19% of current F, as shown in the following figure.

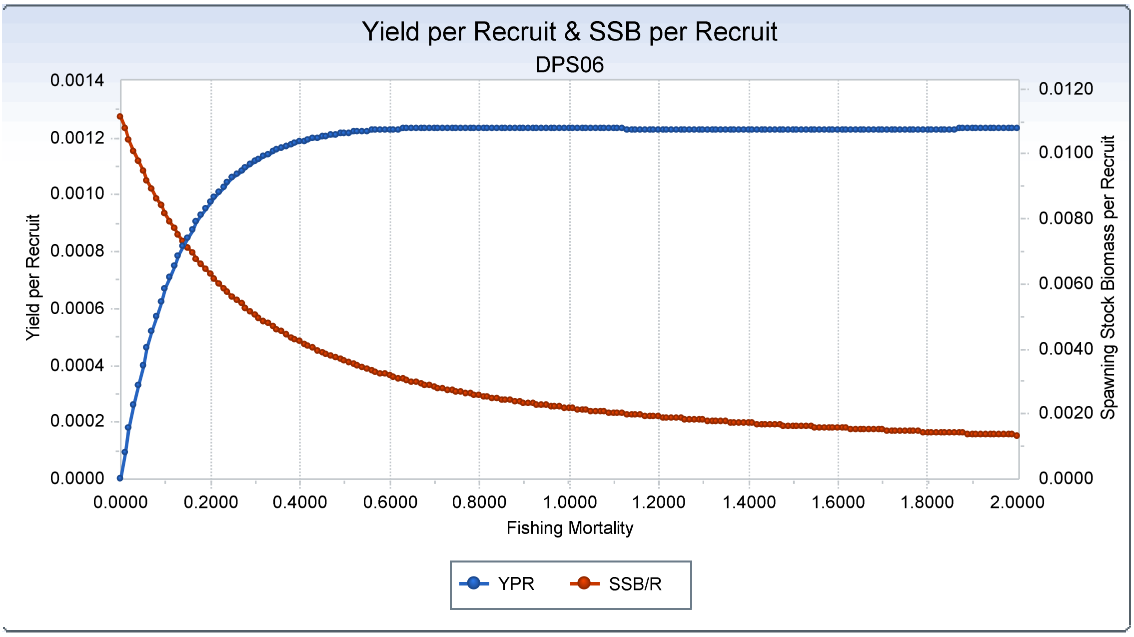


Fig. 6.4.5.1.2.1 Results of the Y/R analysis, Y/R and SSB/R for deepwater pink shrimp in GSA 06.

Table 6.4.5.1.2.1. Results summarising the YPR analysis for deepwater pink shrimp in GSA 06.

	Factor	Absolute F	Y/R (grams)	B/R (grams)	SSB/R
Virgin	0	0	0	15.652	11.697
F(0.1)	0.192	0.269	1.095	8.286	4.503
Fcurr	1.00	1.402	1.155	4.632	1.341
F(Max)	0.728	1.021	1.265	5.360	1.800

Reference F from the YPR analysis for the fully recruited ages 2-4, averaged over 2005-2012 is F_{ref}(2005-2012; 2-4) = 1.402 and the corresponding F_{01}=0.269.

6.4.6. *Data quality*

Data from DCF 2012 were used. The data available are of sufficient quality to perform XSA. The data submitted to the EWG 13 09 group are in general of good quality. The only important discrepancy for this stock regards the total landings by the fleet, which after 2004 are taken from fishermen's log books and amount to about 1/3 of the landings reported by the official statistics of the Fisheries Directorates of the Autonomous Governments of Valence and Catalonia. The latter are considered more accurate and were used in the present stock assessment, following the same criterion as in the previous assessment of this stock available (EWG 11 12). Reported discards are negligible and this is acceptable, considering the high value of the species.

The growth parameters of the VBGF used here are the same as in the previous assessment by EWG 11-12 (Linf= 45 mm, k= 0.39, to= -0.1019), based on length frequencies analysis assuming a slow grow hypothesis. The length-to-weight coefficients used were those recently estimated by the Spanish Data Collection Programme for the years 2011-2012: a= 0.0030550, b= 2.4906080).

6.4.7. *Scientific advice*

6.4.7.1. Short term considerations

6.4.7.1.1. State of the stock size

Since 2001, SSB oscillated without a clear trend. In the absence of a precautionary reference point STECF EWG 13-09 is unable to fully evaluate the stock size status.

6.4.7.1.2. State of recruitment

Since 2001 recruits (aged 0 individuals) were estimated to vary without a clear trend.

6.4.7.1.3. State of exploitation

The size composition of landings indicates that the exploitation is based on young age classes, mainly 1 and 2 years old. F and effort should be decreased until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

6.4.7.2. Management recommendations

The STECF EWG 13-09 recommends F_{01} = 0.269 (Fmsy proxy) as management reference point consistent with high long term yields and low risk of fisheries collapse.

EWG 13- 09 recommends the relevant fleets' effort and/or catches (OTB in vessel length classes VL1224 and VL2440) to be reduced until fishing mortality is below or at the proposed FMSY 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 FMSY should be estimated.

6.5. STOCK ASSESSMENT OF HAKE IN GSA 7

6.5.1. *Stock identification and biological features*

6.5.1.1. 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). Due to the lack of information about the structure of hake populations in the western Mediterranean, this stock is assumed to be confined within the GSA 07 boundaries.

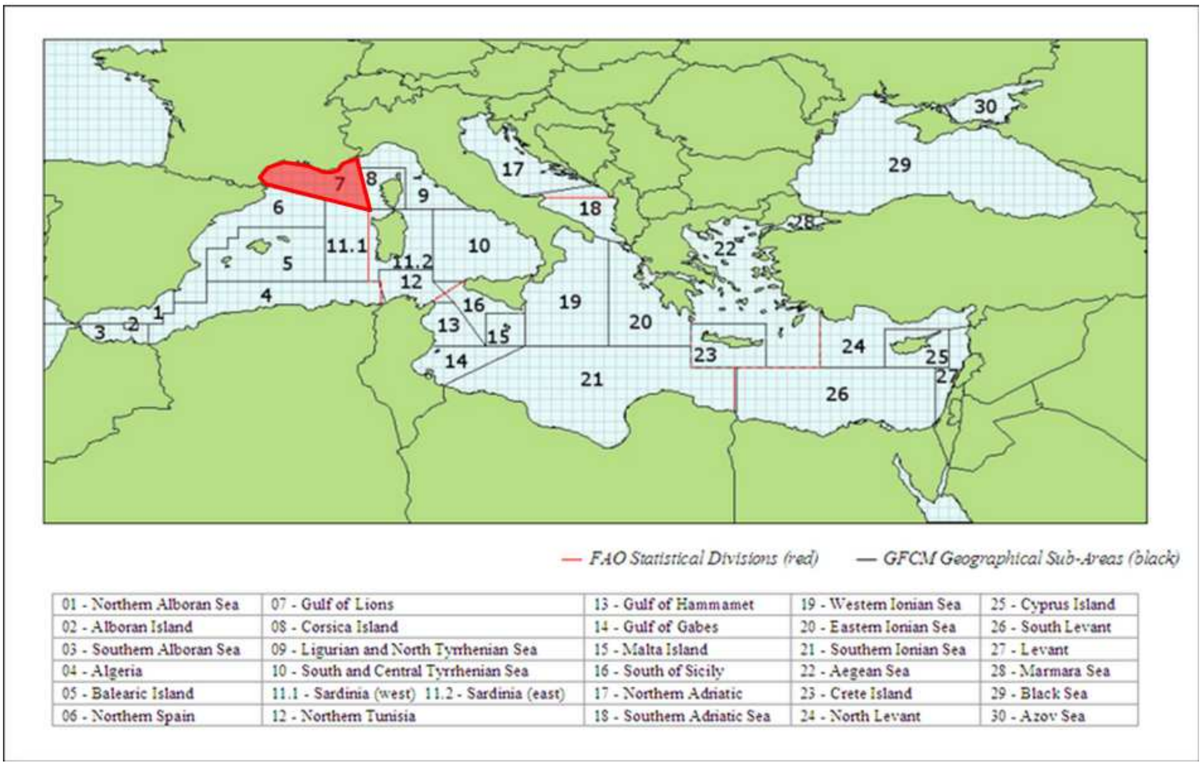


Fig. 6.5.1.1.1. Geographical location of GSA 07.

6.5.1.2. 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 SGMED-13.09 were:

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

6.5.1.3. Maturity

The maturity parameters were calculated using data collected within the DCF.

PERIOD	Age	0	1	2	3	4	5	6+
1998-2012	Prop. matures	0	0.11	0.63	0.91	0.98	0.99	1

6.5.2. *Fisheries*

6.5.2.1. 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 240 boats are involved in this fishery and, according to official statistics, the total annual landings for the period 1998-2012 have oscillated around an average value of 2030 tons (1123 tons in 2012). In 2009, because of the large decline of small pelagic fish species in the area, the trawlers fishing small pelagic have diverted their effort on demersal species. Since 2011, the fishing capacity of French trawlers in GSA 07 has decreased by nearly 30%.

The French trawler fleet is the largest in number of boats and catch (42 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 (~41 and 14% respectively, range 13-86 cm TL and average size 39 cm TL), followed by the Spanish trawlers (~11 and 8%, respectively, range 5-88 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*).

6.5.2.2. Management regulations applicable in 2010 and 2011

French Trawlers:
- Fishing license: fully observed
- Engine power limited to 316 KW or 500 CV: Not full compliance
- Cod-end mesh size (bottom trawl: square 40 mm or 50 mm diamond -by derogation-): not fully observed
- Fishing forbidden within 3 miles (France): not fully observed
- Time at sea: fully observed

French gillnetters:
- Fishing license: fully observed
- Maximum length of net: not fully observed

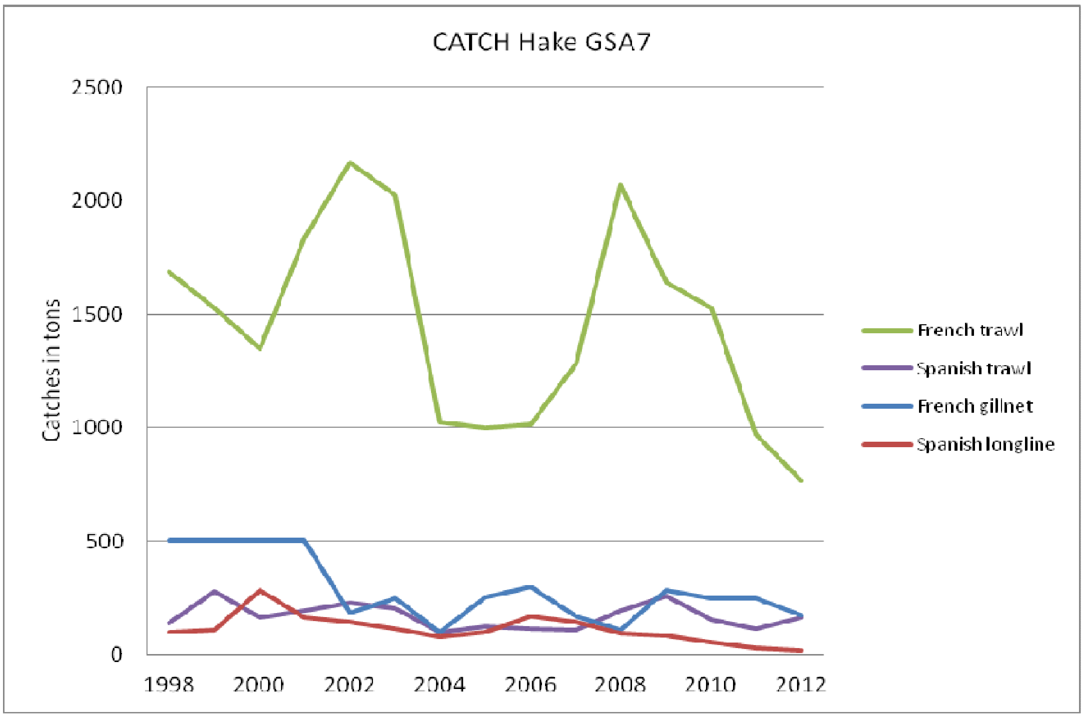
Spanish trawlers:
- Fishing license: fully observed
- Engine power limited to 316 KW or 500 CV: not observed
- Mesh size in the codend (before Jun 1st 2010: 40 mm diamond: after Jun 1st 2010: 40 mm square or 50 mm diamond -by derogation-): fully observed
- Fishing forbidden <50 m depth: fully observed
- Time at sea: fully observed

Spanish longliners:
- Fishing license: fully observed

- Number of hook per boat: not fully observed

6.5.2.3. Catches

Figure 6.5.3.1 Catches of hake by fishery



6.5.2.3.1.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	2012
French trawlers	1688	1525	1347	1835	2168	2024	1023	1002	1014	1282	1898	1633	1527	970	759
Spanish trawlers	140	279	166	196	231	206	101	125	116	107	192	258	156	113	162
French gillnetters	500	500	500	500	182	248	99	255	299	168	111	286	247	250	175
Spanish longliners	101	109	285	163	146	112	78	101	170	143	97	83	53	29	18

6.5.2.3.2.Discards

Discards were not included in french trawlers catches before 2008 because landings were almost equal to catches. Discards were not included in spanish trawlers catches before 2004 because landings were almost equal to catches. After 2004, the discards are very low, except for French trawlers in 2008, and but are included in the catches.

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

COUNTRY	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
French trawlers	-	-	-	-	-	-	-	-	-	-	173	9	-	-	9

Spanish trawlers	-	-	-	-	-	-	0.84	1.04	0.97	0.90	1.60	2.15	1.30	0.94	1.35

6.5.2.3.3. Fishing effort

For France, fishing effort data was provided on a yearly basis for OTB, OTM and GNS over the period 2003-2008. No data was available over 2009-2012. For Spain, fishing effort was provided for OTB and LLS over 2002-2012.

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

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
OTB	12970505	8450443	5870844	6219184	5938674	5277458				
OTM	3766550	1330992	1864890	2193060	1144433	931468				
GNS	6124547	6824957	8359103	10545454	9863621	7722831			4197978	

Fishing effort (kW·days) by gear for Spain, 2002-2012.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
LLS	195074	197896	202306	171414	177074	198536	236340	52941	175962	137453	115316
OTB	1493537	1355499	1243124	1223685	1379150	1535408	1601404	1623651	1456054	1630298	1339565

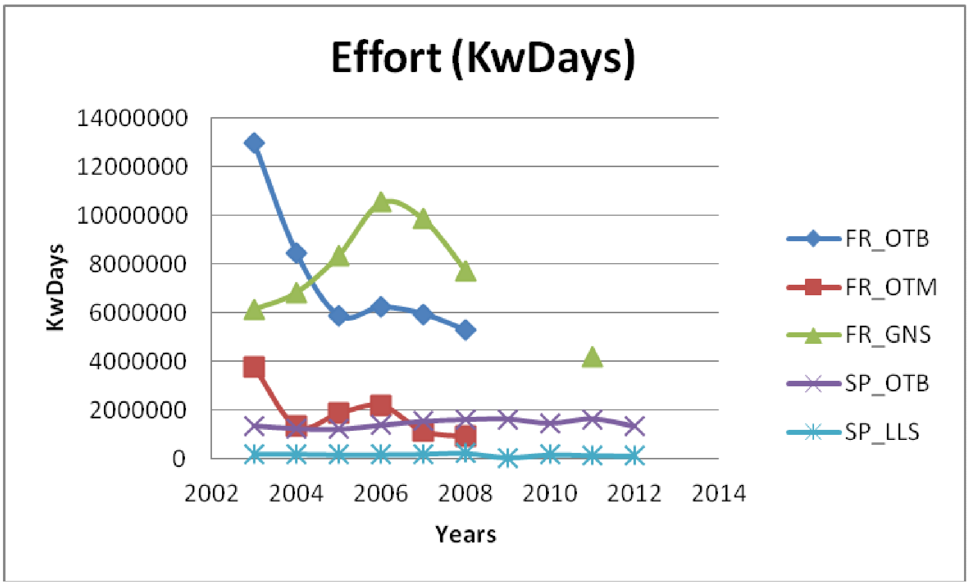


Figure 6.5.2.3.3.1. Effort by Spanish and French gear

6.5.3. *Scientific surveys*

6.5.3.1. BALAR and MEDITS surveys

6.5.3.1.1. 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 ± t(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.

6.5.3.1.2. Geographical distribution patterns

No information was documented during EWG13-19.

6.5.3.1.3. 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 6.1.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 07. The estimated abundance and biomass indices do not reveal a clear trend.

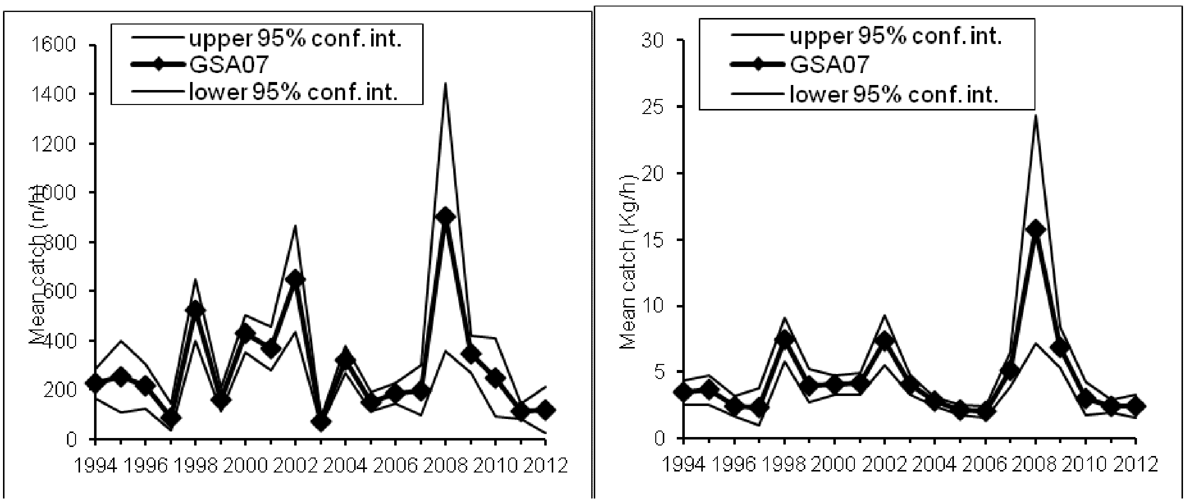
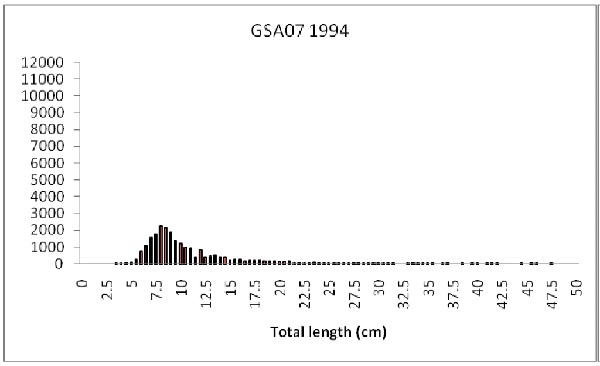
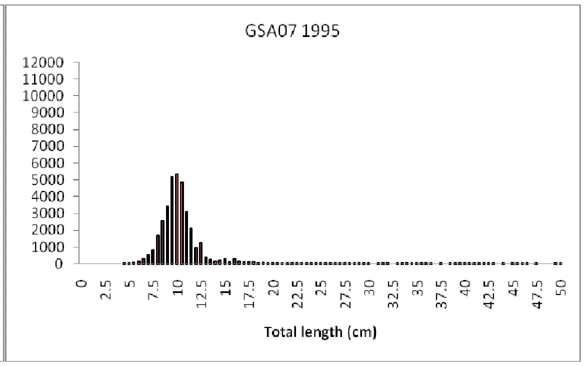
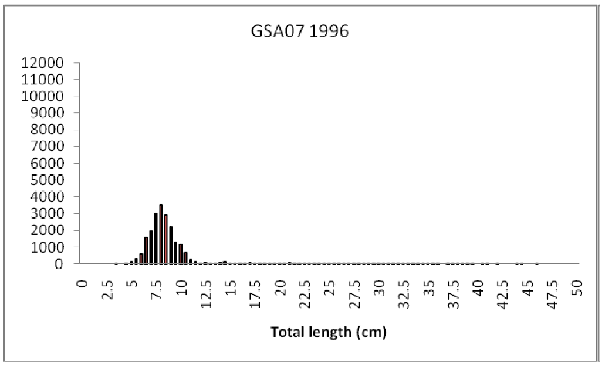


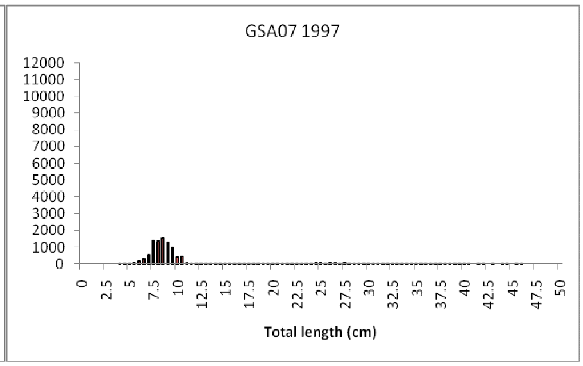
Fig. 6.5.3.1.3.1 Abundance and biomass indices of hake in GSA 07.

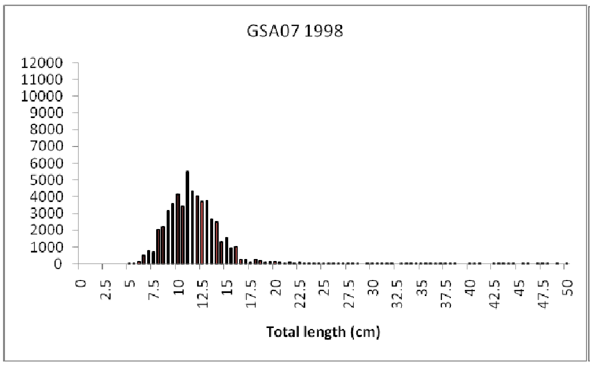
6.5.3.1.4. Trends in abundance by length or age

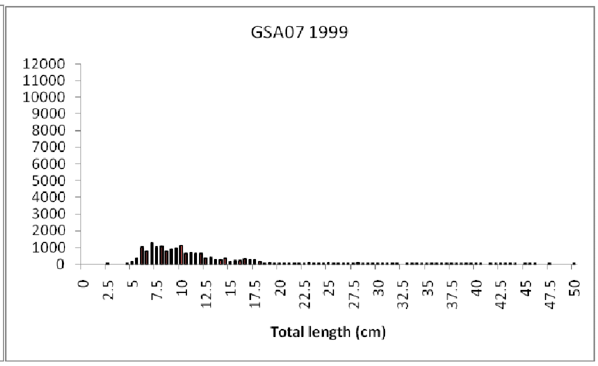

GSA07 1994
Total length (cm)

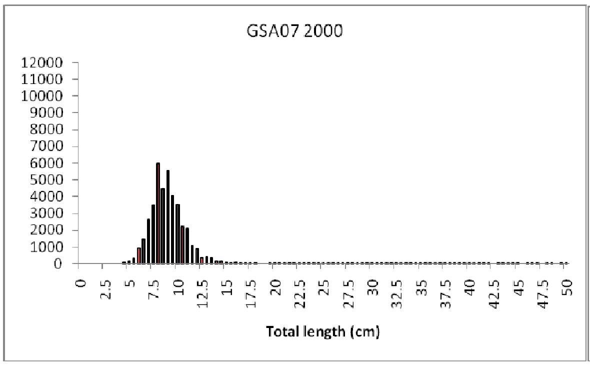

GSA07 1995
Total length (cm)

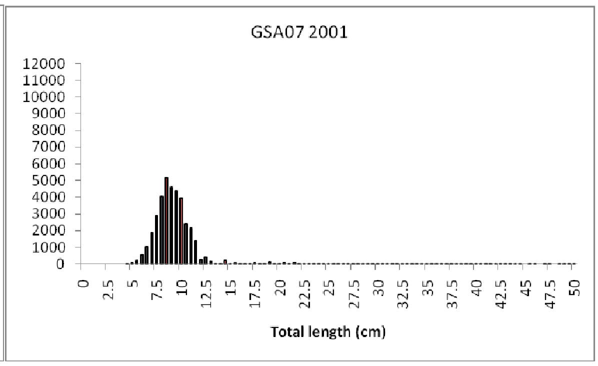

GSA07 1996
Total length (cm)

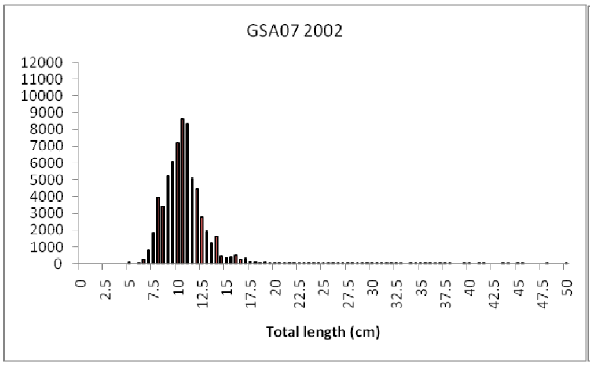

GSA07 1997
Total length (cm)

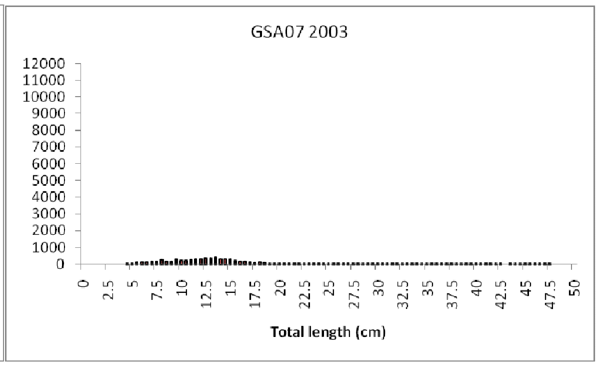

GSA07 1998
Total length (cm)

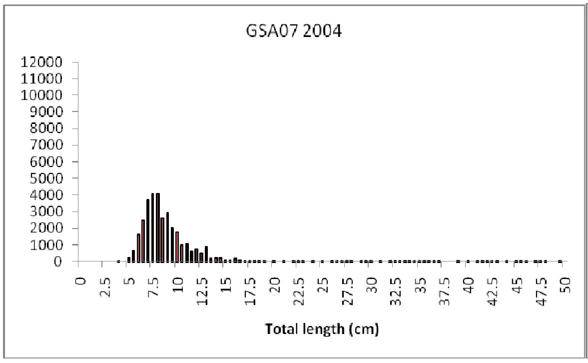

GSA07 1999
Total length (cm)

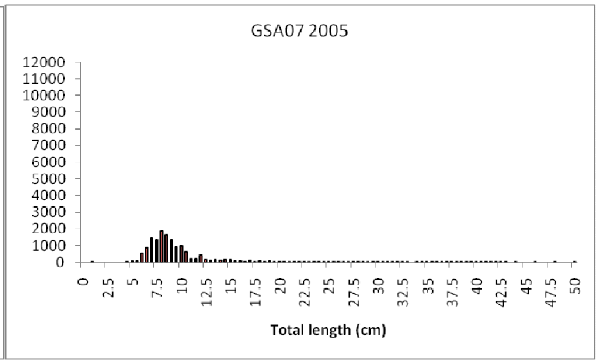

GSA07 2000
Total length (cm)

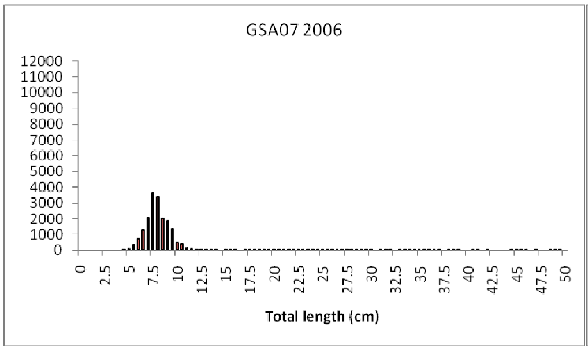

GSA07 2001
Total length (cm)

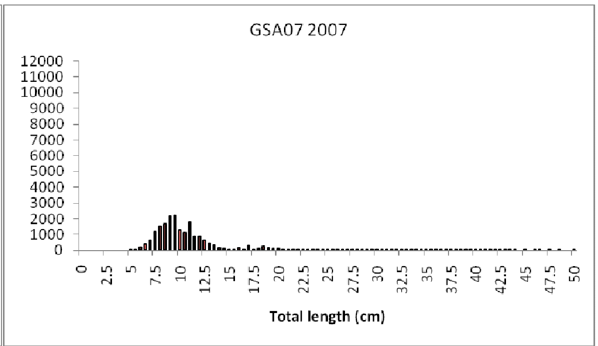

GSA07 2002
Total length (cm)

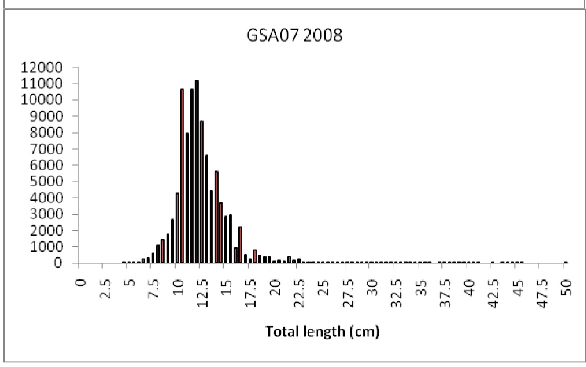

GSA07 2003
Total length (cm)

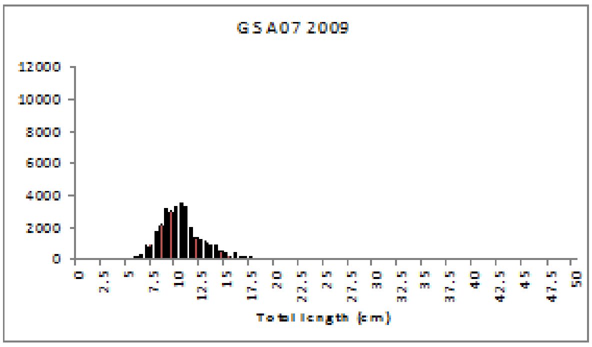

GSA07 2004
Total length (cm)

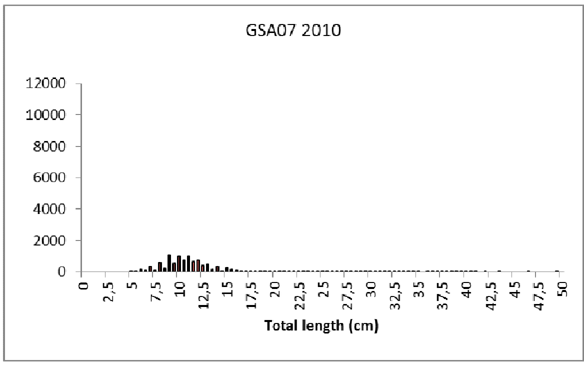

GSA07 2005
Total length (cm)

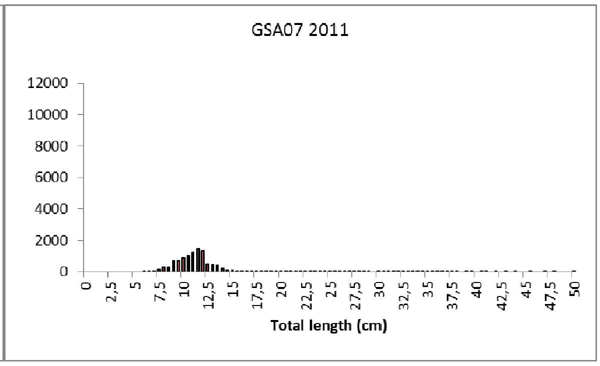

GSA07 2006
Total length (cm)


GSA07 2007
Total length (cm)


GSA07 2008
Total length (cm)


GSA07 2009


GSA07 2010
Total length (cm)


GSA07 2011
Total length (cm)

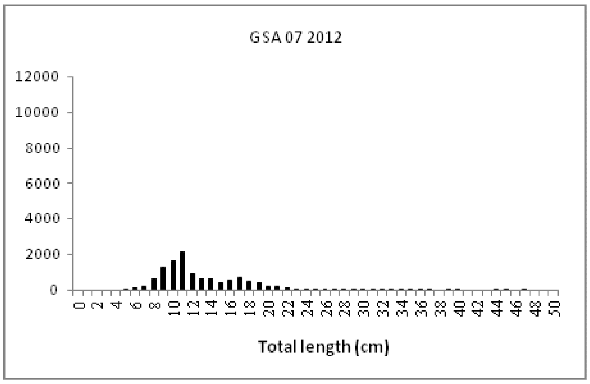


Fig. 6.1.3.1.4.1. Length frequency distribution of hake in GSA 07 obtained from MEDITS survey.

6.5.3.1.5. Trends in growth

No information has been documented.

6.5.3.1.6. Trends in maturity

No information has been documented.

6.5.4. *Assessment of historic stock parameters*

6.5.4.1. Method 1: XSA

6.5.4.1.1. Justification

During EWG13-09 an assessment was made (using XSA tuned using MEDITS survey data) over the period 1998-2012. XSA was run considering age classes from 0 to 6+.

6.5.4.1.2. Input parameters

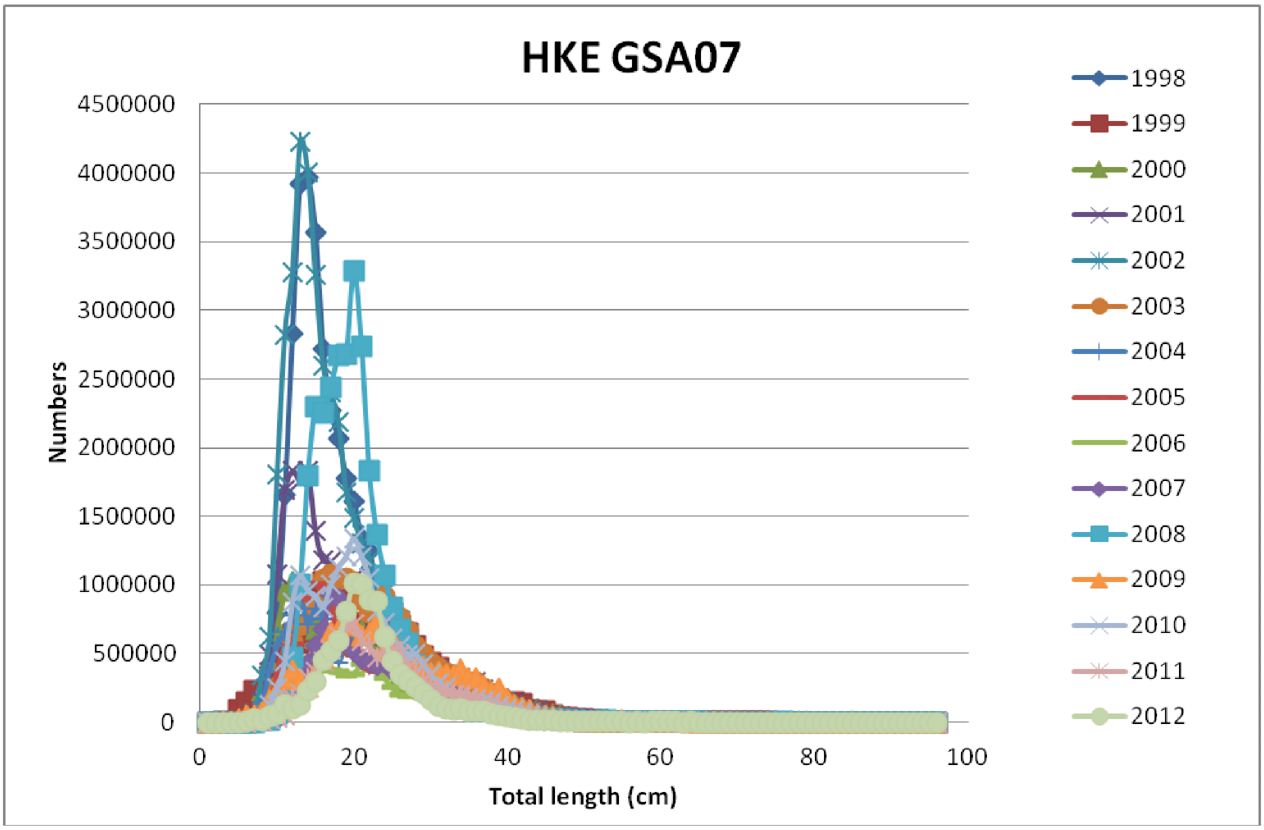


Fig: Length distributions of the total landings 1998-2012 (all gears combined) of hake in GSA 07.

Hake GSA 07 Catch at Age (thousands)

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	20751	6379	7366	12266	23919	5902	6098	5744	2690	3074	11172	3621	6884	2471	2540
1	13300	8954	6958	9822	14416	10309	5261	5613	4379	6067	17723	7643	9825	6242	6847
2	1721	2882	2321	2867	2207	2877	1425	1728	1800	1969	1692	2794	2145	1583	1007
3	207	269	313	318	238	321	153	170	247	243	152	327	186	136	90
4	45	37	66	38	29	32	15	19	34	27	18	20	15	6	7
5	15	10	25	18	12	9	2	3	6	6	5	3	1	1	1
6+	7	4	14	12	6	11	1	1	2	3	2	2	1	0	0

Hake GSA 07 Weight at Age (kg)

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0,025	0,024	0,023	0,023	0,023	0,028	0,023	0,025	0,027	0,031	0,032	0,026	0,028	0,032	0,032
1	0,104	0,128	0,131	0,131	0,113	0,131	0,125	0,127	0,135	0,130	0,100	0,141	0,119	0,131	0,112
2	0,406	0,409	0,420	0,409	0,408	0,393	0,404	0,412	0,432	0,418	0,397	0,395	0,389	0,380	0,387
3	0,892	0,871	0,879	0,846	0,842	0,848	0,871	0,851	0,849	0,856	0,864	0,854	0,868	0,839	0,869
4	1,419	1,437	1,433	1,441	1,417	1,405	1,399	1,379	1,385	1,385	1,379	1,340	1,402	1,414	1,362
5	1,961	1,964	1,995	2,014	1,993	1,972	1,949	1,957	1,954	1,961	2,003	1,980	1,962	1,936	1,923
6+	2,498	2,487	2,457	2,446	2,580	2,909	2,801	2,616	2,689	2,517	2,389	2,462	2,532	2,392	2,467

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 (1998-2012)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	46392	13757	40130	34419	61553	4944	30999	13668	17858	17108	76973	30477	22335	10230	11071
1	4606	1703	549	858	2523	1698	660	792	453	1583	11196	2803	1655	824	429
2	121	327	224	214	218	432	142	126	151	304	292	602	329	195	54
3	22	41	37	27	46	50	35	26	12	55	49	46	20	14	4
4	7	2	8	5	2	6	2	1	1	9	8	4	0	1	2
5	0	0	1	2	1	0	0	1	3	1	1	0	0	0	0
6+	0	0	0	2	3	0	0	0	0	10	0	0	0	0	0

6.5.4.1.3.Results

Three 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 6.5.4.1.3.1). The results showed some differences between the runs only considering the Fbar.

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 6.5.4.1.3.2). 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 6.5.4.1.3.1. The results of the final run are in figure 6.5.4.1.3.4. A retrospective analysis was conducted on mean F, recruitment and SSB (Figure 6.5.4.1.3.3).

Fig. 6.5.4.1.3.1. Sensitivity analysis on shrinkage. The shrinkage parameter (fse) was set from 0.5 to 2.5. The resulting time series of spawning stock biomass (left panel, SSB) and fishing mortality (right panel, F bar) were plotted.

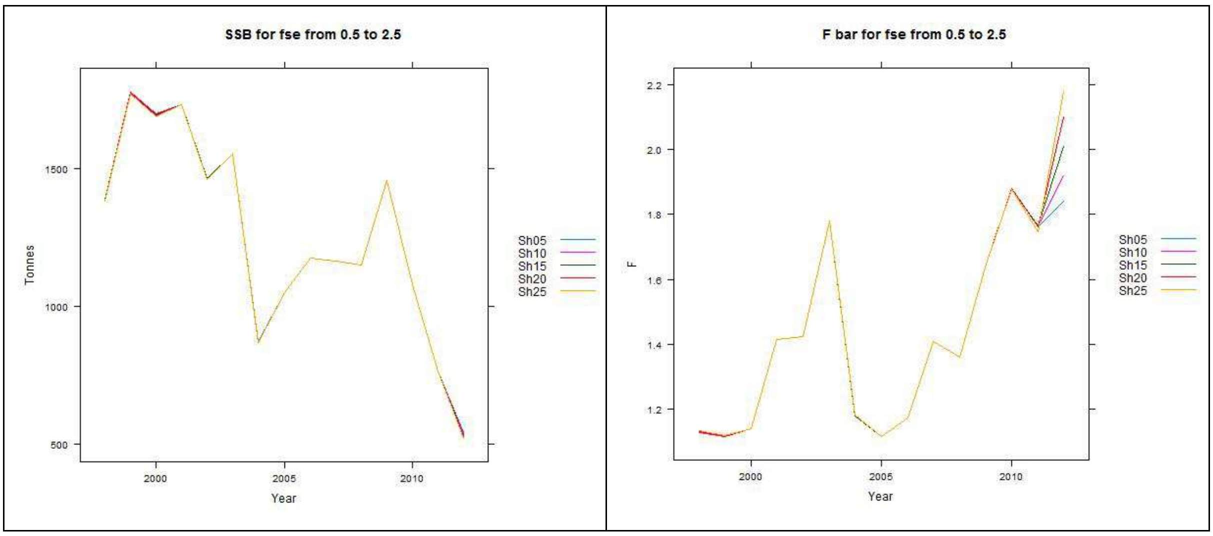


Fig. 6.5.4.1.3.2. Sensitivity analysis on catchability. The age after which catchability is no longer estimated (qage) was set from 0 to 6. The resulting time series of spawning stock biomass (left panel, SSB) and fishing mortality (right panel, F_{bar}) were plotted.

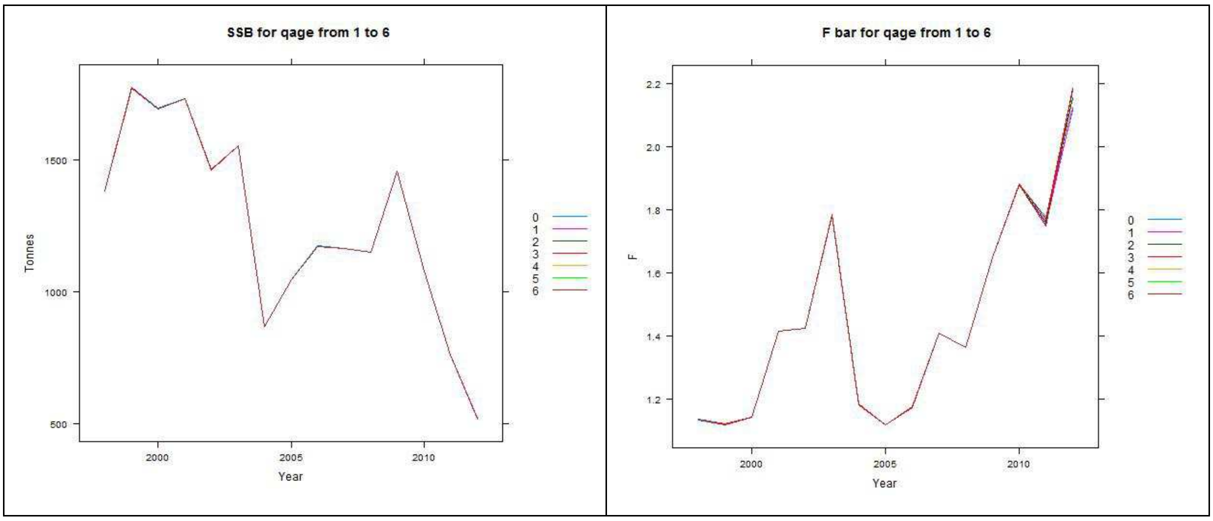


Fig. 6.5.4.1.3.3. Sensitivity analysis on shrinkage on the last ages. The shrinkage on last ages was testing using from 1 to 5 last ages. The resulting time series of spawning stock biomass (left panel, SSB) and fishing mortality (right panel, F_{bar}) were plotted.

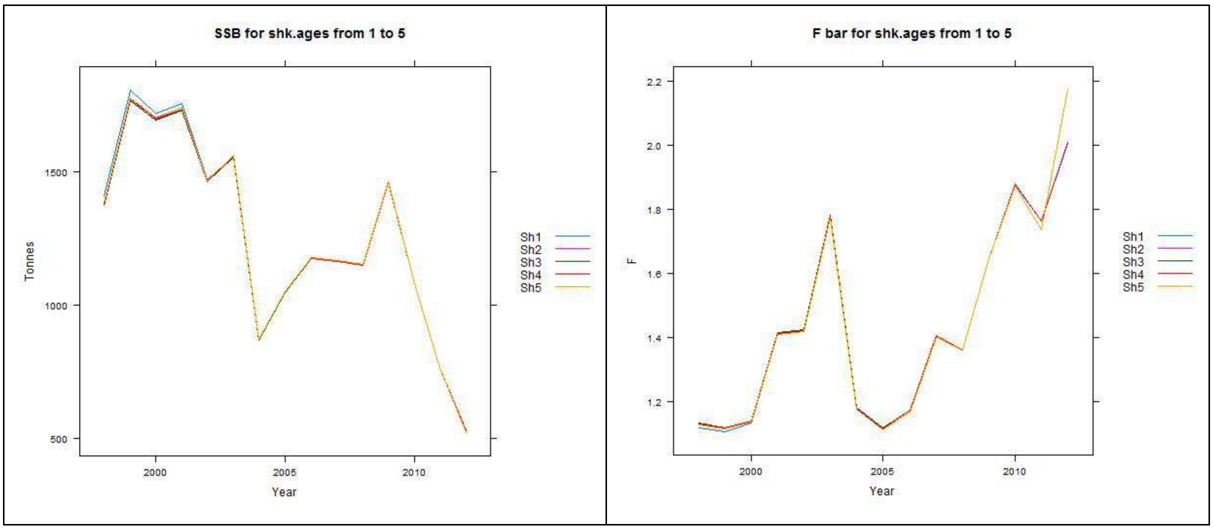


Table 6.5.4.1.3.1: Final parameters used to perform the SSB

Fse	shk.yrs	shk.ages	rage	qage
0.5	3	2	-1	6

Figure . 6.5.4.1.3.4. Assessment results: F, Recruitment, SSB and Yield

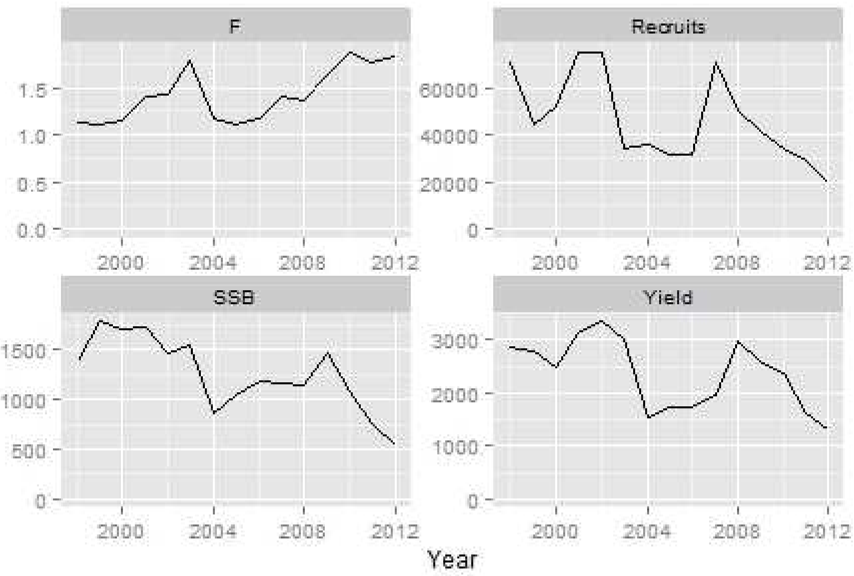


Fig 6.5.4.1.3.5. Log catchability residual plots (XSA) for the tuning fleet, MEDITS.

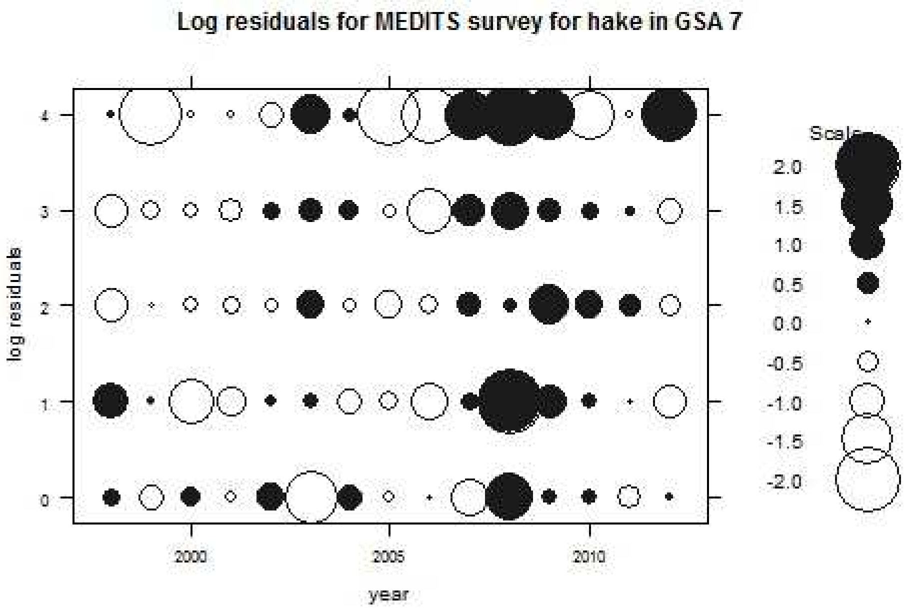
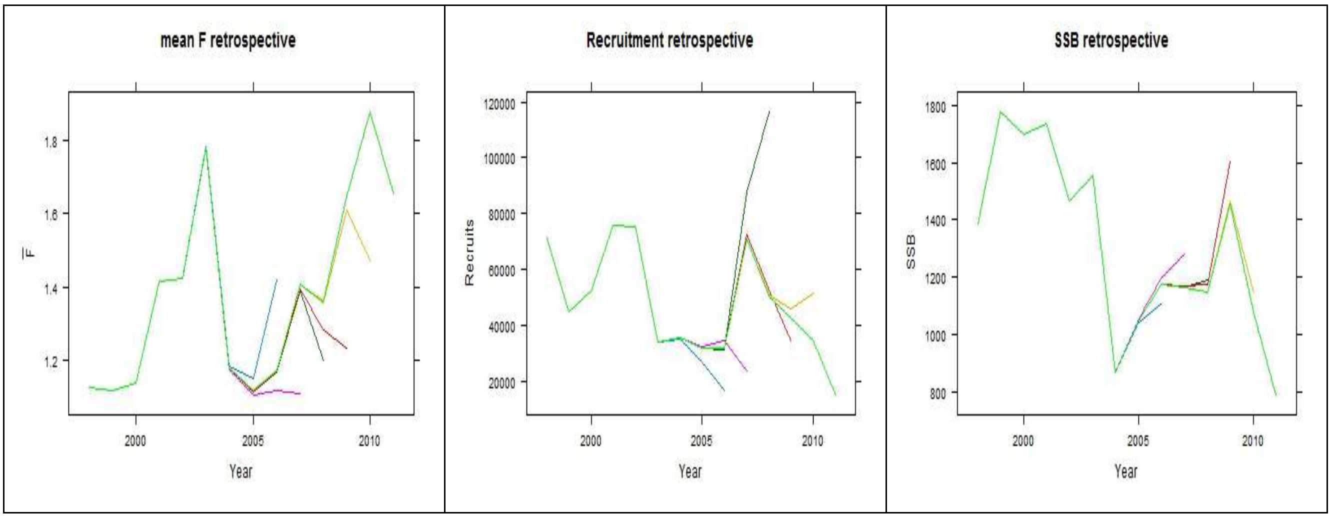


Fig 6.5.4.1.3.6. Retrospective analysis (mean F, Recruitement, SSB). Because of the large decline of small pelagic species in the area, trawlers fishing those species have diverted their effort on demersal species in 2009. This can explain the divergence of the mean F trajectories obtained from the retrospective analysis after 2008. Furthermore, the very high recruitment in 2007 and 2008 can explain the overestimation of the recruitment 2007.



6.5.5. *Long term prediction*

6.5.5.1. Justification

6.5.5.1.1. Input parameters

Yield per recruit analysis was used to calculate the reference point F_{01} and the estimated reference fishing mortality (F_{ref}). Reference F was estimated using the R script provided by STECF EWG 13-09, which used the default assumptions agreed in the meeting, e.g., weights are means of the last 3 years and future recruitment are obtained as the geometric mean of the last 3 years.

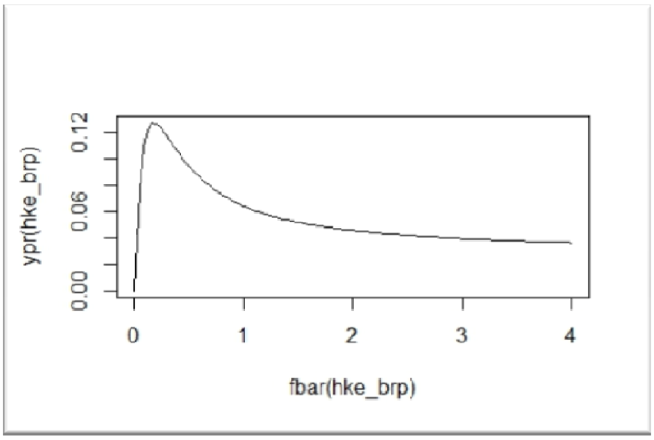
6.5.5.1.2. Results

The reference point $F_{0.1}$ and the estimated reference fishing mortality (F_{ref}) obtained were those of table 6.5.5.1.1 and the Yield per Recruit analysis is represented in the graph of the figure 6.5.5.1.1.

Table 6.5.5.1.1 Reference points

Fref (2010-2012, ages 1-3)	1.83
$F_{0.1}$	0.11

Figure 6.5.5.1.1



6.5.6. *Data quality*

All lengths informations were available through the database. French effort data were missing for the years 2008-2012. MEDITS data where not complete in the database, only data from 2008 to 2012 were available.

6.5.7. *Scientific advice*

6.5.7.1. Short term considerations

6.5.7.1.1. State of the stock size

The SSB shows a decreasing trend over the analyzed period. In the absence of a precautionary reference point the STECF EWG 13-09 is unable to fully evaluate the stock size status.

6.5.7.1.2. State of recruitment

The highest recruitment values observed over the period are in 1998, 2002-2003 and 2007. Since 2007, the recruitment follows a decreasing trend and is currently at the lowest level observed.

6.5.7.1.3. State of exploitation

The exploitation level is currently above the level estimated to be sustainable. The referent point F_{01} is equal to 0.11. The current fishing mortality F_{curr} = 1.83 is higher than $F_{MSY.}$ The exploitation is mainly concentrated on age classes 0 and 1.

6.5.7.2. Management recommendations

EWG 13- 09 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed $F_{0.1}$ 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.

6.6. STOCK ASSESSMENT OF GIANT RED SHRIMP IN GSA 9

6.6.1. *Stock identification and biological features*

6.6.1.1. Stock Identification

Due to a lack of enough information about the structure of giant red shrimp in the western Mediterranean, this stock was assumed to be confined within the GSA9 boundaries (Figure 6.6.1.1).

The giant red shrimp *Aristaeomorpha foliacea* is mainly to be found in the epibathyal and mesobathyal waters of the western Mediterranean

In the GSA 09, *A. foliacea* is more abundant in the Central Tyrrhenian (Ardizzone *et al.*, 1994) while lower concentrations are present in the Northern Tyrrhenian and in the Ligurian Sea, where this species considerably over time (Orsi Relini and Relini, 1985).

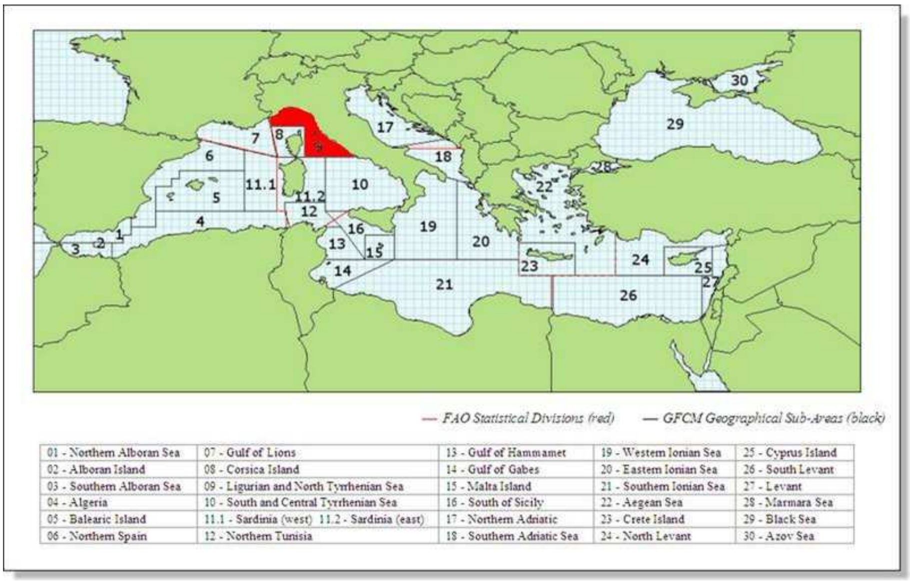


Figure 6.6.1.1. Geographical location of GSA 09.

6.6.1.2. Growth

In general the length-frequency distributions have a polymodal pattern, with 4-5 components for females (adult modes of are less defined) and 2 components for males (Leonardi and Ardizzone, 1994).

Analysis on the size structure histograms relating to the central-southern Tyrrhenian shown, particularly in spring, a highly differentiated structure. Both males and females are present in the young classes, with a certain prevalence of the latter. In the range from 32 to 38 mm a mode composed solely of males appears, and over 42 mm distribution is composed solely of females. This characteristic highlights a different mode of growth of the two sexes.

In the last decade different set of growth parameters were estimated for *A. foliacea* in the Tyrrhenian sea (Leonardi et al., 1994) but in this analysis were used the set of parameters obtained in the REDS project (FISH/2004/03-32) for the male and from the analysis of size distributions data gathered during GRUND surveys carried out in the GSA 9 for female.

The feeding of red shrimps (*A. foliacea*, *A. antennatus*), studied by Brian (1931) in the Ligurian sea, indicated the euryphagous feeding behaviour of the two species which alternate phases of active hunting with phases in which they consume small benthonic prey (Lagardere, 1972).

Red shrimps obtain food from an area of the sea which extends vertically for several hundred metres (Orsi Relini, 1984). Their diet includes both organisms from the muddy bed and herbivorous organisms which use surface plankton. The former include *Ophiocten abyssicolum*, which is probably useful to the shrimps as a source of calcium with which to build their exoskeleton. The latter include the shrimps of the genuses *Pasiphaea*, *Sergestes* and the *Eufasiacean Meganyctiphanes norvegica*. In the night these prey move up to the surface waters for feeding needs, while during the day they remain near the sea bed (Orsi Relini and Wurtz, 1977). *A. foliacea* is quite voracious, possibly due to needs imposed by the rapid maturing of the eggs, and is also capable of attacking shrimps of the *Plesionika* genus which can even measure up to 2/3 the size of the aggressor. Food characteristics of this type could entail a greater vulnerability of this species in an altered marine ecosystem (Orsi Relini, 1984).

6.6.1.3. Maturity

The reproduction period of *A. foliacea* lasts from May to September, with a peak in the summer (July-August). Four stages of ovary maturity were described by using a macroscopic colorimetric scale (Levi and Vacchi, 1989) and the mature ovaries can be recognised because initially they are grey coloured, with increasingly dark shades until they become black, due to the presence of carotenoproteins (Orsi Relini and Semeria, 1983).

Mature females are concentrated in the mesobathyal bottoms from spring to autumn. The fertility of *A. foliacea* has been estimated as being equal approximately to 1/3 of the fertility of *A. antennatus* (Orsi Relini and Semeria, 1983). Analyses of the ultrastructure of the ovary indicated cells arranged in a line. *A. foliacea* has a dome-shaped thelycum and characteristics which can be compared to those of decapod crustaceans with a closed thelycum, with coupling coinciding with the moult phases (Orsi and Relini, 1998a). In males the spermatophore originates by passing through the deferent duct, and the spermatic mass is contained in a chamber with “wings” at the edge that serve a protective purpose.

In the Northern Tyrrhenian (Righini and Abella, 1994) the smallest female with spermatophore had a carapace length (CL) of 40 mm. In the Central Tyrrhenian (southern Tuscan Archipelago), the smallest mature female measured 28 mm (CL), and the smallest mature male 29 mm (CL) (Mori et al., 1994). Mature males were observed all year round. In the Central Tyrrhenian (Latium), the size at first maturity is 30-31 mm for males and the smallest female with spermatophore measured 33 mm (Leonardi and Ardizzone, 1994).

Female maturity ogive (Fig. 6.6.1.3.1) was obtained using commercial data gathered during in the 2011 DCF grouping as mature, individuals belonging to the maturity stage 2b (according to the MEDITS maturity scale) onwards. The estimated size at first maturity resulted about 34mm CL.

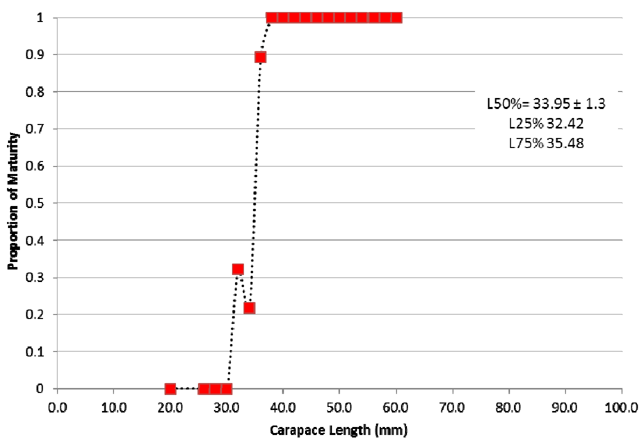


Figure 6.3.1.3.1 Maturity ogive and proportion of mature female of giant red shrimp in the GSA9.

Biological data gathered during MEDITS surveys (1994-2012) was used to estimate a sex ratio vector (Fig. 6.6.1.3.2). Smaller sizes were more represented by females, instead between 33 to 39mm CL males become predominant and from 40mm carapace length (CL) the proportion was totally to advantage of female.

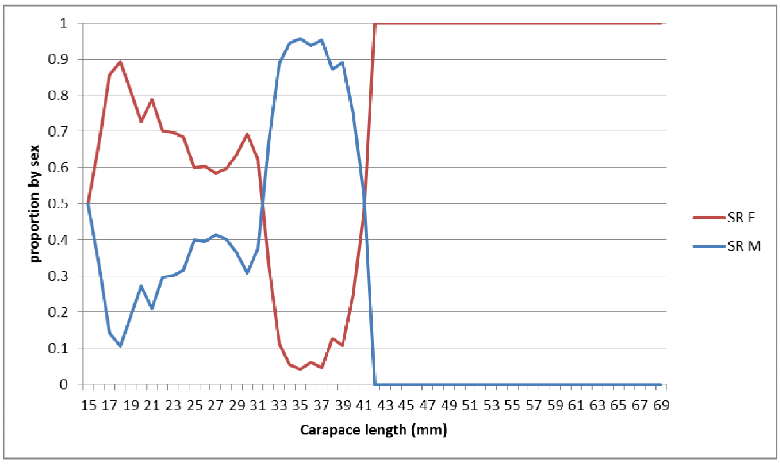


Figure 6.6.1.3.2. Sex ratio by length of giant red shrimp in the GSA9

6.6.2. *Fisheries*

6.6.2.1. General description of the fisheries

In the GSA 09 the giant red shrimp, *Aristaeomorpha foliacea*, is one of the most important target species of the otter bottom trawl fishery carried out on the muddy bottoms of the upper and middle slope. The main fishing grounds are located in the central and southern part of the GSA 09 (eastern Ligurian Sea, northern and central Tyrrhenian Sea). The species is mainly exploited by the trawl fleets of Porto S. Stefano and Porto Ercole, in Tuscany, and Fiumicino, Anzio, and Terracina, in Latium.

As an example, Fig. 6.6.2.1.1 shows the landings per unit of effort (LPUE, kg/vessel/day) by the Porto S. Stefano trawl fleet, which is one of the fleets historically targeting the giant red shrimp in the GSA 09. Seasonality fluctuations are a proper characteristic of the landings of this species, as shown by the LPUE produced by the fleet of Porto S. Stefano in the period 1991-2010. The highest catch rates are observed in late spring-summer; even though peaks due to recruitment and other biological aspects do exist, the main factor affecting this seasonal pattern is the spatial distribution of the fishing effort. In fact, the fishing grounds where the giant red shrimp is targeted are distant from the coast, thus this fishery is strongly influenced by the weather conditions (Sartor et al., 2003; Sbrana et al., 2003).

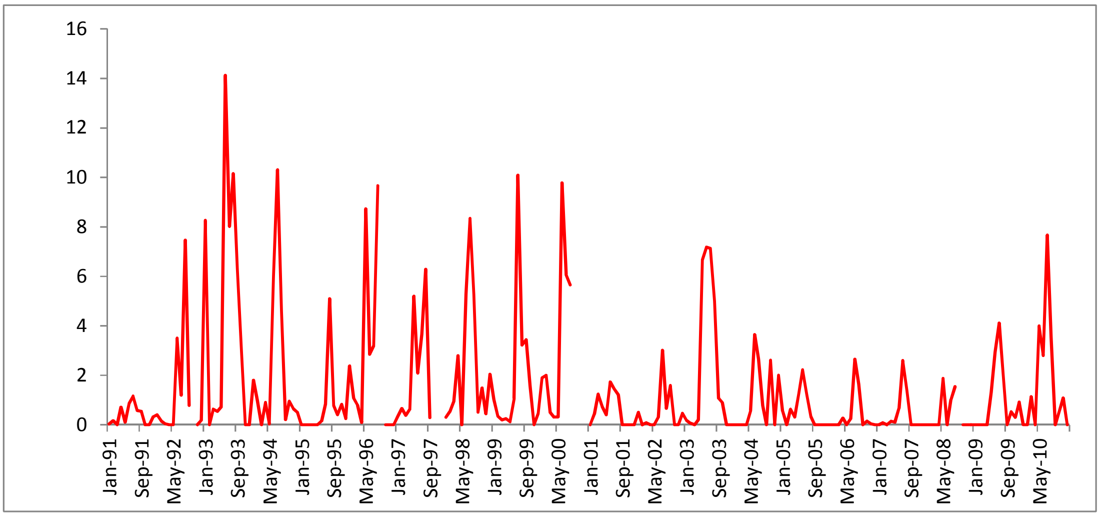


Figure 6.6.2.1.1. *A. foliacea* LPUE of Porto Santo Stefano from January 1991 to May 2010.

6.6.2.2. Management regulations applicable in 2010 and 2011

EC regulation 1967/2006 do not provide for a minimum length size for this species. Italian national law provided in the last years a fishing ban of a month which, for the Ligurian fleet, is enforced after the summer fishing season.

6.6.2.3. Catches

6.6.2.3.1. Landings

Total landings of giant red shrimps decreased from about 60 tons in 2006 to 24 tons in 2007, in 2008 and 2009 landings remain quite stable (around 30-40 tons) and then an increasing up to about 70 tons was observed in 2011 followed by a new decrease in the 2012 (Fig. 6.6.2.3.1.1; Tab. 6.6.2.3.1.1). The landings are entirely taken by OTB fleets. Seasonality fluctuations are a proper characteristic of the landings of this species, as shown by the LPUE produced by the fleet of Santa Stefano in the period 1991-2010 (Fig. 6.6.2.1.1).

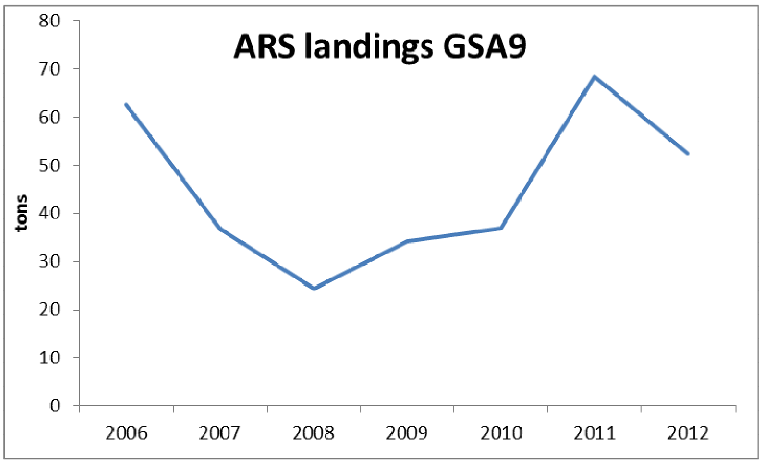


Fig. 6.6.2.3.1.1. Total landings (tons) of *Aristaeomorpha foliacea* (ARS) in GSA 09 2006-2012.

Tab. 6.6.2.3.1.1. Annual landings (tons) by fishing technique in GSA 09 as provided through the official DCF data call 2013.

YEAR	GEAR	FISHERY	LANDINGS
2006	OTB	MDDWSP	62.61
2007	OTB	MDDWSP	36.65
2008	OTB	MDDWSP	24.39
2009	OTB	MDDWSP	34.29
2010	OTB	MDDWSP	36.85
2011	OTB	DWSP	17.62
2011	OTB	MDDWSP	50.81
2012	OTB	MDDWSP	52.38

6.6.2.3.2.Discards

Discards data were available for the last four years (2009-2012) and resulted negligible (Fig.6.6.2.3.2.1).

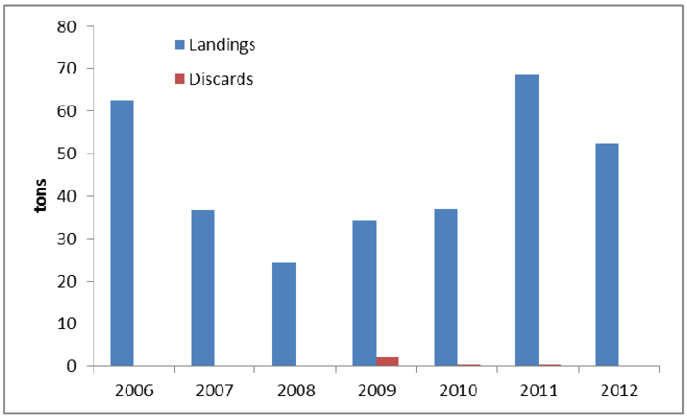


Fig. 6.6.2.3.2.1. Total landings and discards of giant red shrimp in GSA9 2006-2012.

6.6.2.3.3. Fishing effort

The trends in fishing effort by fishing technique are listed in Tab.6.6.2.3.3.1 From 2004 until now the effort slightly decreased. (Fig. .6.6.2.3.3.1).

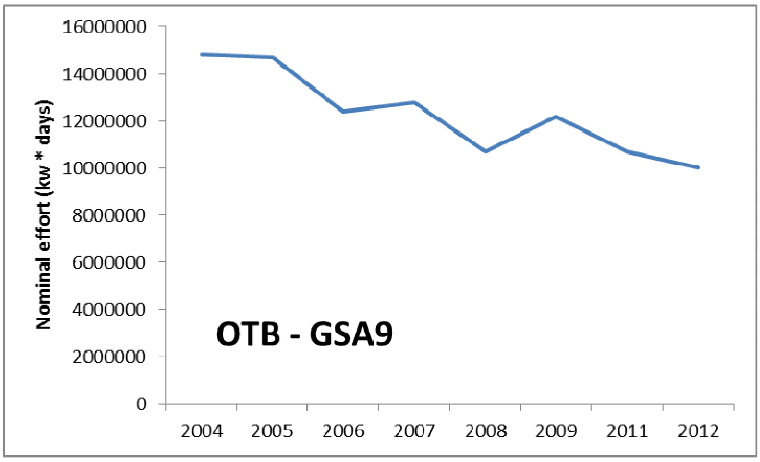


Fig. .6.6.2.3.3.1 Trends in annual trawlers fishing effort as nominal effort (kw*days) deployed in GSA 09 from 2004 to 2012.

Tab. .6.6.2.3.3.1 Trends in annual fishing effort as nominal effort (kW*days) deployed in GSA 09 from 2004 to 2012 as reported through the DCF official data call .

COUNTRY	AREA	GEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012
ITA	SA9	DRB	271634	264317	219582	230204	381592	277250	229384	219990	136966
ITA	SA9	FPO			1664		27551	9493	9919		
ITA	SA9	GND	15372	4992	62253			4431	14908	5877	
ITA	SA9	GNS	3758570	3903858	3261681	3761065	3048710	3251684	2817577	3711453	2061794
ITA	SA9	GTR	3279499	3814735	3861839	2761471	2415273	3047433	2981409	3231880	2854501
ITA	SA9	LLD	453740	821542	930859	523364	602955	365199	554045	429722	399733
ITA	SA9	LLS	424132	495263	383146	118928	31420	31260	20773	26691	23739
ITA	SA9	LTL			6987	2494		2603		13785	4765
ITA	SA9	none	1497515	1583872	939417	637514	547250	615676	320480	422085	167761
ITA	SA9	OTB	14820339	14700599	12404787	12782144	10693694	12176447	11228001	10696166	9997907
ITA	SA9	PS	1393298	1412031	1147523	1116579	1032017	1318198	990104	1162692	1105419
ITA	SA9	PTM			4599				100		

6.6.3. *Scientific surveys*

6.6.3.1. MEDITS surveys

6.6.3.1.1. Methods

MEDITS surveys were carried out from late spring to mid summer and the sampling design was always random depth-stratified in respect on five depth strata: 10–50, 50–100, 100–200, 200–500 and 500–800 m. GOC 73 trawl net was used during the surveys. The cod-end mesh size was of 20 mm in MEDITS surveys. Hauls duration was of 0.5 h for the hauls carried out on the shelf (10–200m depth) and 1 h for the hauls carried out on the slope (200–800m depth) fishing grounds. Details of sampling protocol can be found in Bertrand *et al*. (2002).

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 09 the following number of hauls was reported per depth stratum (Tab. 6.6.3.1.1.1).

Tab. 6.6.3.1.1.1. Number of hauls per year and depth stratum in GSA 09, 1994-2012.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
GSA09_010-050	*21*	*20*	*20*	*20*	*21*	*20*	*20*	*19*	*15*	*14*	*15*	*16*	*15*	*15*	*16*	*16*	*15*	*15*	*15*
GSA09_050-100	*21*	*21*	*20*	*20*	*20*	*21*	*22*	*23*	*17*	*18*	*17*	*16*	*18*	*18*	*16*	*16*	*19*	*19*	*19*
GSA09_100-200	*38*	*40*	*40*	*40*	*39*	*39*	*38*	*38*	*30*	*30*	*30*	*31*	*29*	*30*	*31*	*31*	*29*	*29*	*29*
GSA09_200-500	*40*	*40*	*42*	*42*	*41*	*41*	*42*	*41*	*32*	*33*	*36*	*35*	*36*	*37*	*34*	*34*	*35*	*35*	*35*
GSA09_500-800	*33*	*32*	*31*	*31*	*32*	*32*	*31*	*32*	*26*	*25*	*22*	*22*	*22*	*20*	*23*	*23*	*22*	*22*	*22*
Total	153	153	153	153	153	153	153	153	120	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 swept area. 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 standard deviation:
Confidence interval = Yst ± V(Yst)

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per square kilometers) over the stations of each stratum.

6.6.3.1.2. Geographical distribution patterns

The stock is more abundant in the southern part of the GSA (Tyrrhenian Sea) as showed in Figure 6.6.3.1.2.1a,b (from Ardizzone *et al*., Eds. CD-ROM Version)

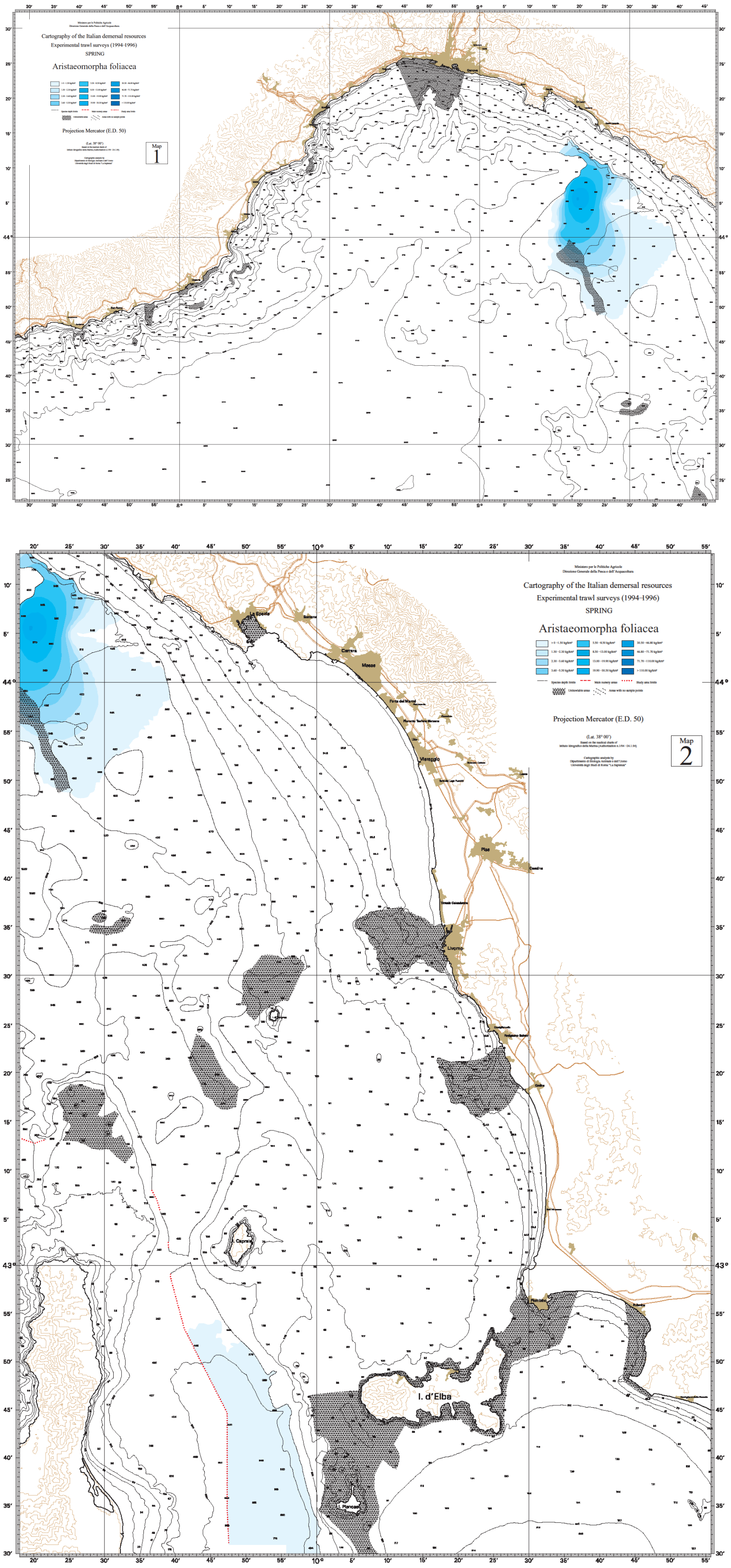


Fig. 6.6.3.1.2.1a *A. foliacea*: Biomass 1994-1996, GSA9 (Ligurian Sea).

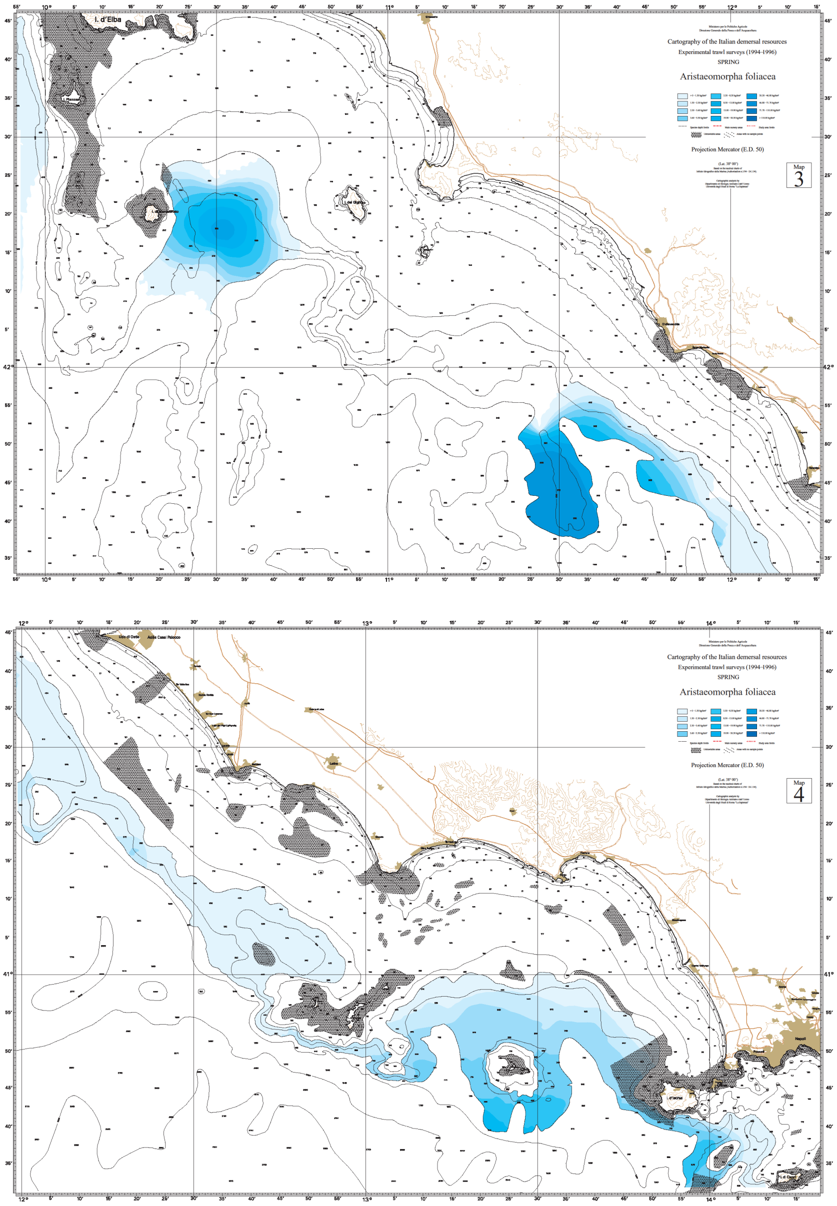


Fig. 6.6.3.1.2.1b *A. foliacea*: biomass 1994-1996, GSA 09 (Northern Tyrrhenian Sea).

6.6.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the giant red shrimp in GSA 09 was derived from the international survey MEDITS. Figure 6.9.8 displays the estimated trend in *A. foliacea* abundance and biomass in GSA 09. The estimated abundance and biomass indices do not reveal a clear trend. In the period analyzed (2006-2012) indices showed a remarkable increase in 2010 both in terms of biomass and abundance indices (Fig. 6.6.3.1.3).

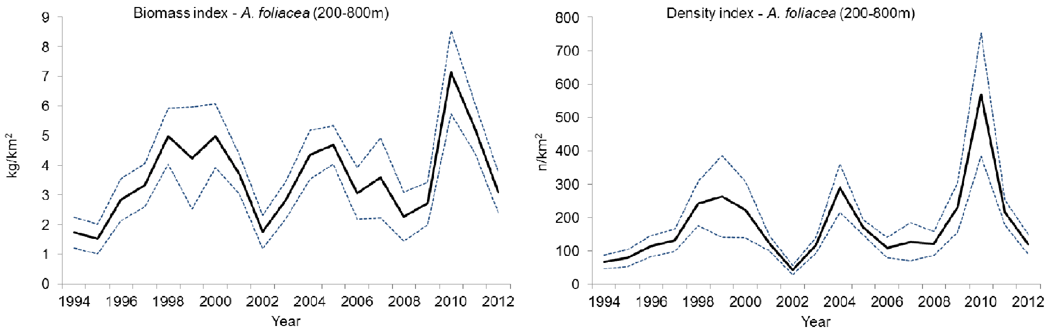


Fig. 6.6.3.1.3. *A. foliacea*: MEDITS trends in biomass and density from 1994 to 2012 in GSA 09 (200-800m depth).

6.6.3.1.4. Trends in abundance by length or age

The following Fig. 6.6.3.1.4.1,2,3 display the stratified abundance indices of GSA 09 in 1994-2012.

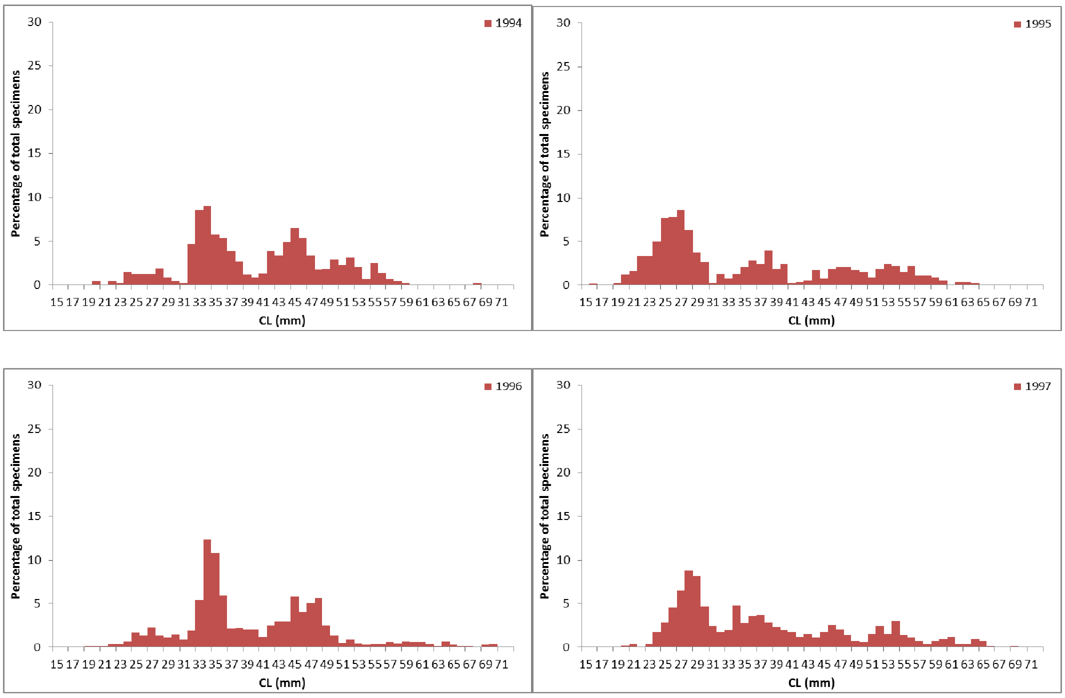


Fig. 6.6.3.1.4.1 Stratified abundance indices by size, 1994-1997.

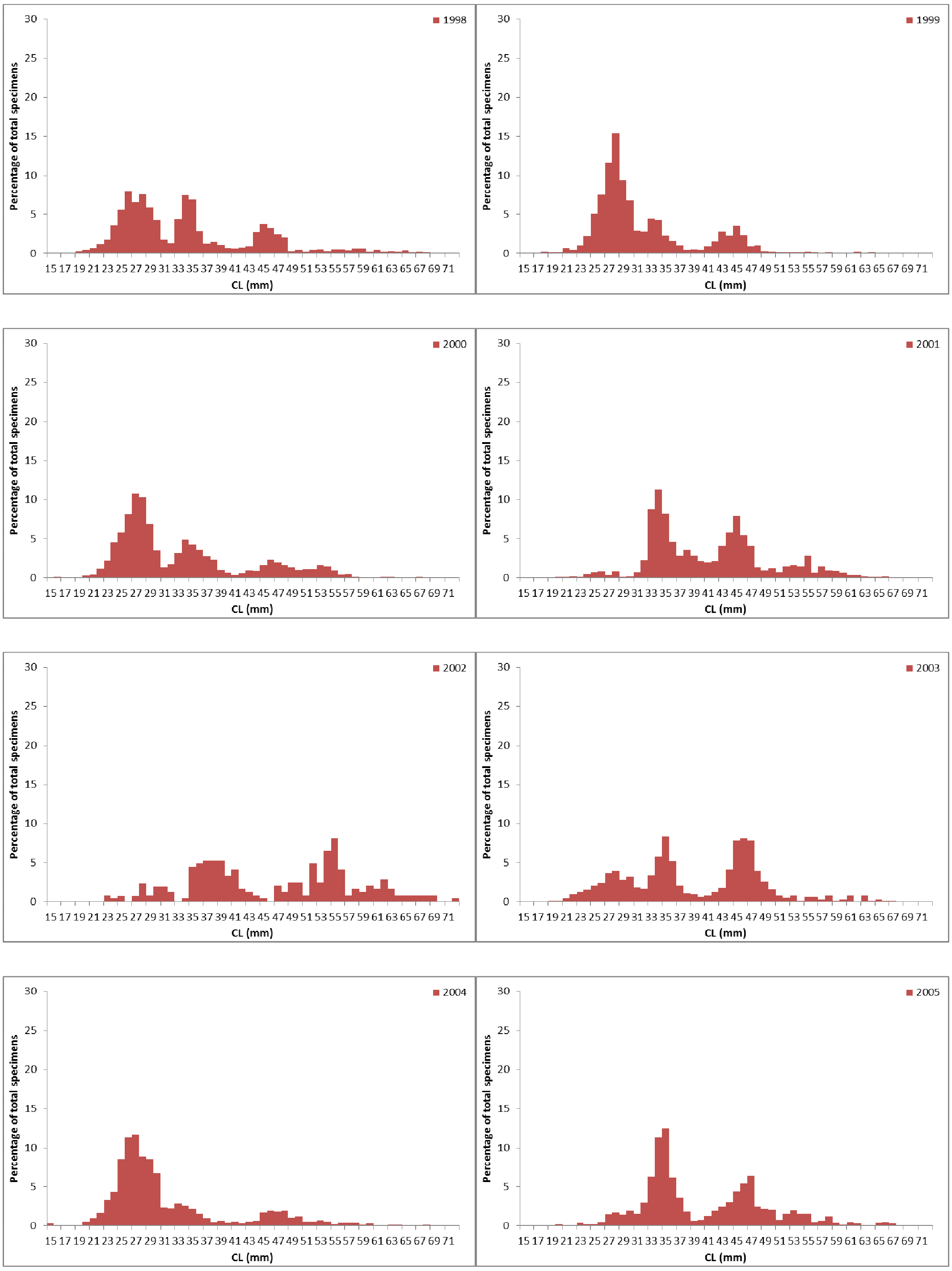


Fig. 6.6.3.1.4.2. Stratified abundance indices by size, 1998-2005.

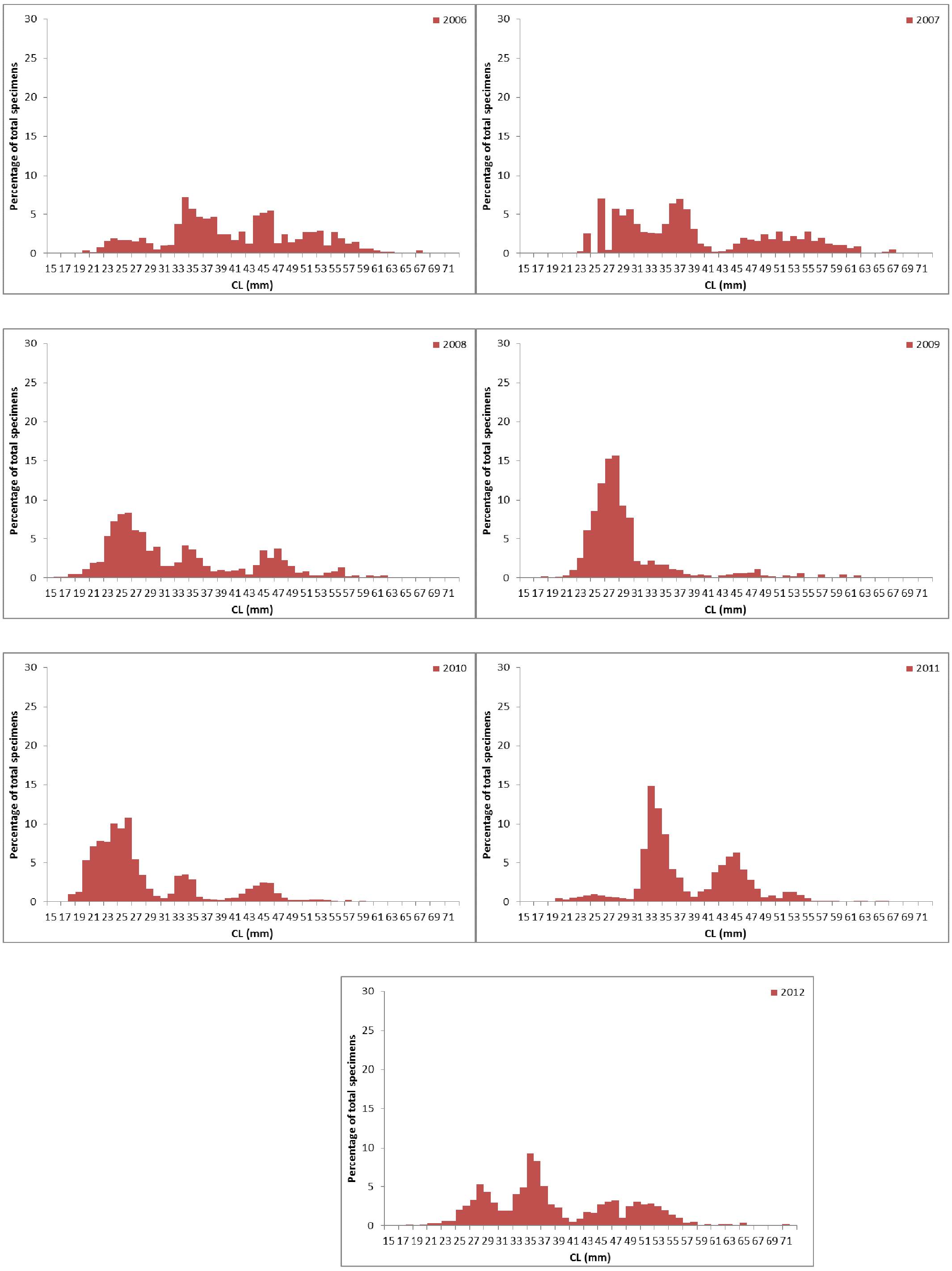


Fig. 6.6.3.1.4.3.Stratified abundance indices by size, 2006-2012.

6.6.3.1.5. Trends in growth

No analyses were conducted during EWG-13-09.

6.6.3.1.6. Trends in maturity

No analyses were conducted during EWG-13-09.

6.6.4.*Assessment of historic stock parameters*

6.6.4.1. Method 1: SURBA

6.6.4.1.1. Justification

SURBA software was applied using MEDITS abundance estimates by length to get indicative patterns of mortalities from fishery-independent data source (MEDITS survey).

6.6.4.1.2. Input parameters

The age groups were estimated by statistical age slicing (normal distribution) using the following growth parameters:
Females: CL_{∞}=72.0mm; K/year=0.40; t_0(year)=0.00
Males: CL_{∞}=42.7mm; K/year=0.77; t_0(year)=-0.27
Age slicing was computed by sex and numbers obtained was combined. A 4+ group was used.

Tab. 6.6.4.1.2.1. Age groups obtained after the statistical age, slicing procedure and used as input in SURBA.

	Age groups					Age groups			
Year	1	2	3	4+	Year	1	2	3	4+
1994	36	40	21	8	2004	131	46	10	21
1995	48	32	23	8	2005	54	66	25	9
1996	43	55	19	11	2006	37	47	28	10
1997	59	41	26	10	2007	50	45	28	9
1998	98	55	21	14	2008	60	38	19	10
1999	118	54	1	20	2009	119	34	4	21
2000	112	53	24	14	2010	206	74	6	19
2001	41	56	24	9	2011	66	75	18	11
2002	30	30	25	9	2012	48	48	26	8
2003	45	51	17	13					

The age group 0 was removed in the analysis due to a not fully recruitment to the gear. Natural mortality vector was obtained as mean of the estimated values by age per sex using Prodbiom method (Abella et al., 1997).

Table 6.6.4.1.2.2 Main SURBA settings for *A. foliacea* in the GSA 09.

Age	1	2	3	4+
M	0.58	0.44	0.38	0.34

Natural mortality vector				
Proportion of mature	0.8	1	1	1
q (catchabilities estimation)	0.0523	0.0514	0.8411	0.9999
Age weightings (manual definition)	1	1	1	1
Mean weight by age and year				
1994	0.01360	0.02653	0.03739	0.04566
1995	0.01042	0.02797	0.03845	0.04657
1996	0.01360	0.02699	0.03680	0.04782
1997	0.01159	0.02686	0.03816	0.04836
1998	0.01165	0.02675	0.03828	0.04756
1999	0.01116	0.02605	0.03809	0.04744
2000	0.01109	0.02754	0.03762	0.04587
2001	0.01476	0.02637	0.03827	0.04684
2002	0.01290	0.02675	0.03889	0.04819
2003	0.01234	0.02717	0.03708	0.04808
2004	0.01080	0.02761	0.03699	0.04692
2005	0.01399	0.02694	0.03762	0.04704
2006	0.01322	0.02671	0.03790	0.04686
2007	0.01226	0.02829	0.03785	0.04706
2008	0.01109	0.02725	0.03863	0.04782
2009	0.01043	0.02757	0.03824	0.04697
2010	0.01091	0.02593	0.03755	0.04604
2011	0.01417	0.02592	0.03751	0.04617
2012	0.01248	0.02726	0.03711	0.04618

Model computation was made considering a relative estimation configuration

6.6.4.1.3. Results

Estimates of fishing mortality (F_{1-3}) and relative SSB for sex combined are presented in Fig.6.6.4.1.3.1

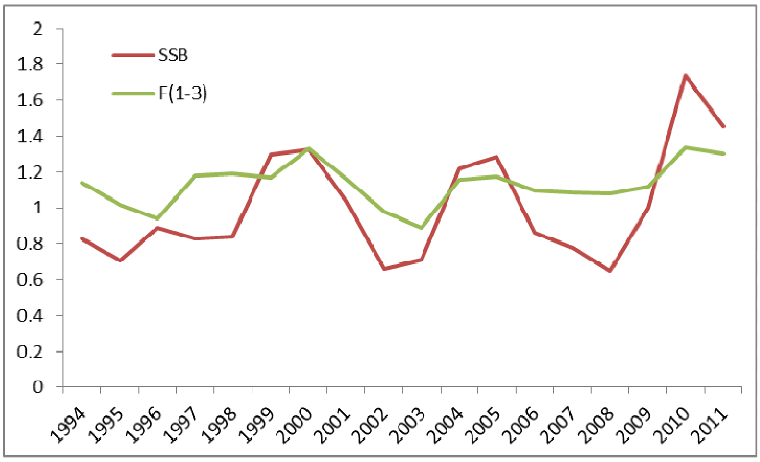


Figure 6.6.4.1.3.1. Relative estimates of fishing mortality $F_{1\text{-}3}$ and spawning stock biomass (SSB) obtained with SURBA.

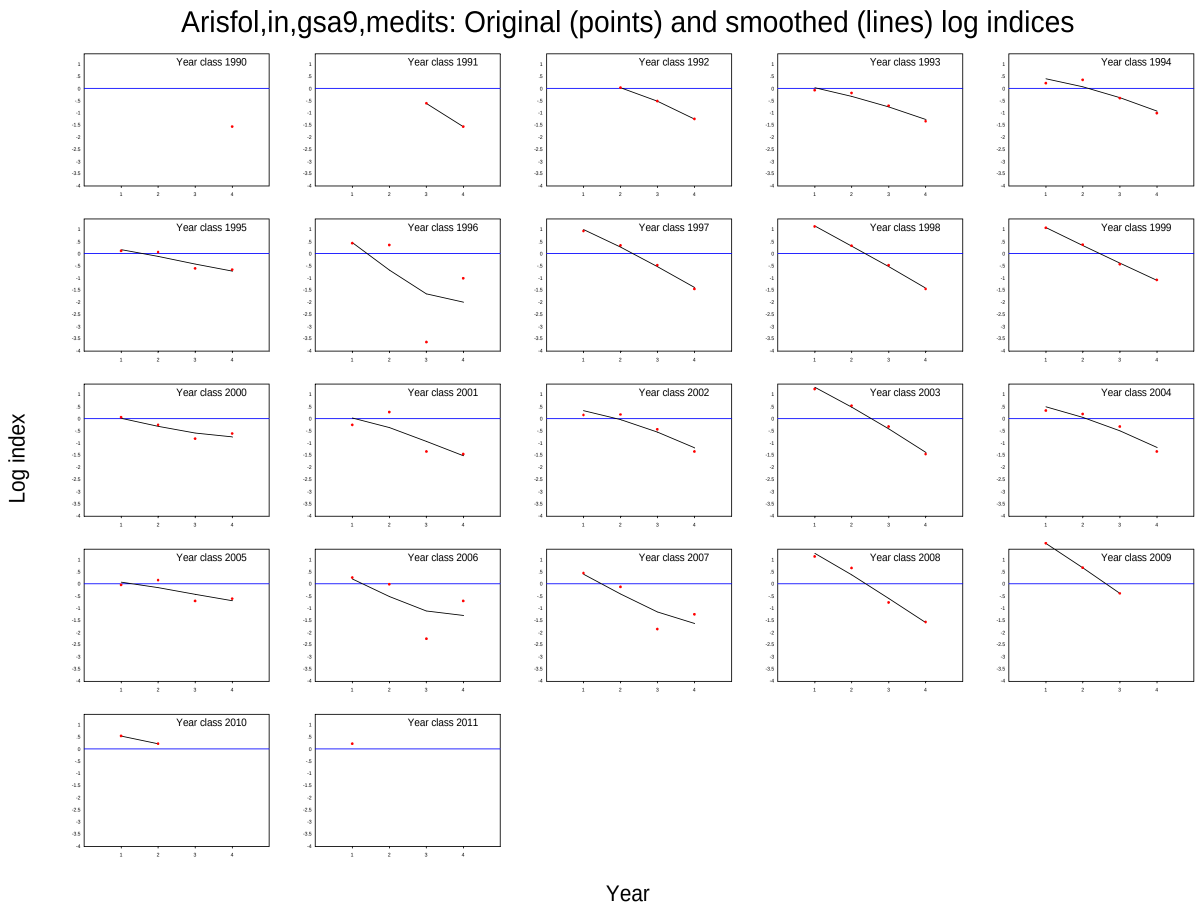
SSB show peaks with a period of about 5 years instead F, in the study period (2006-2012) varying between a minimum of about 0.6 to a maximum of about 1.6 in 2010.

Smoothed comparative scatterplot at age and cohort comparison results are showed in Fig. 6.6.4.1.3.2

Retrospective analysis results showed high variability pattern. Recruitment showed peaks with a cycle of about 5 years (Fig. 6.6.4.1.3.3).

Residuals by age varied without any remarkable trend (Fig. . 6.6.4.1.3.3).

Finally a summary of the main SURBA outputs are showed in Fig. . 6.6.4.1.3.4.



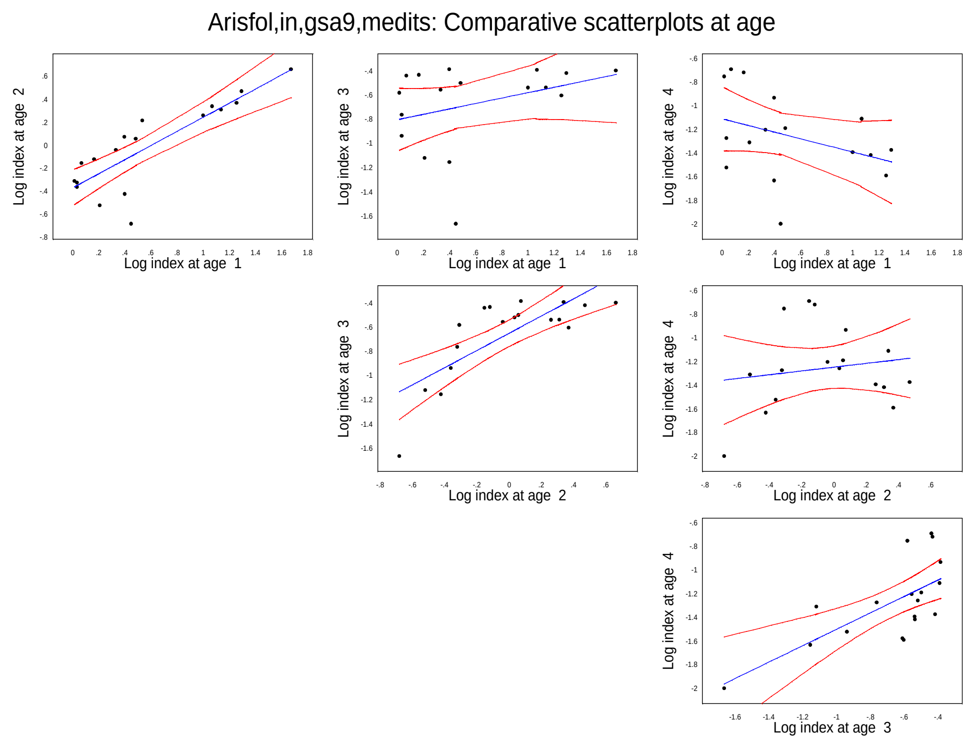
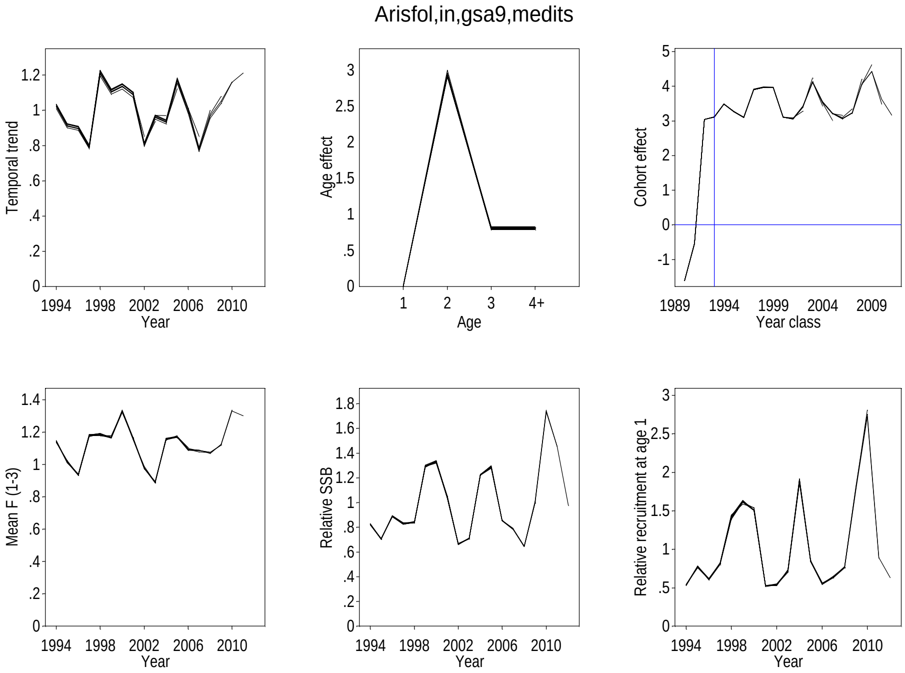


Fig. 6.6.4.1.3.2Scatter plots of log indices at consecutive ages and cohort comparison by SURBA



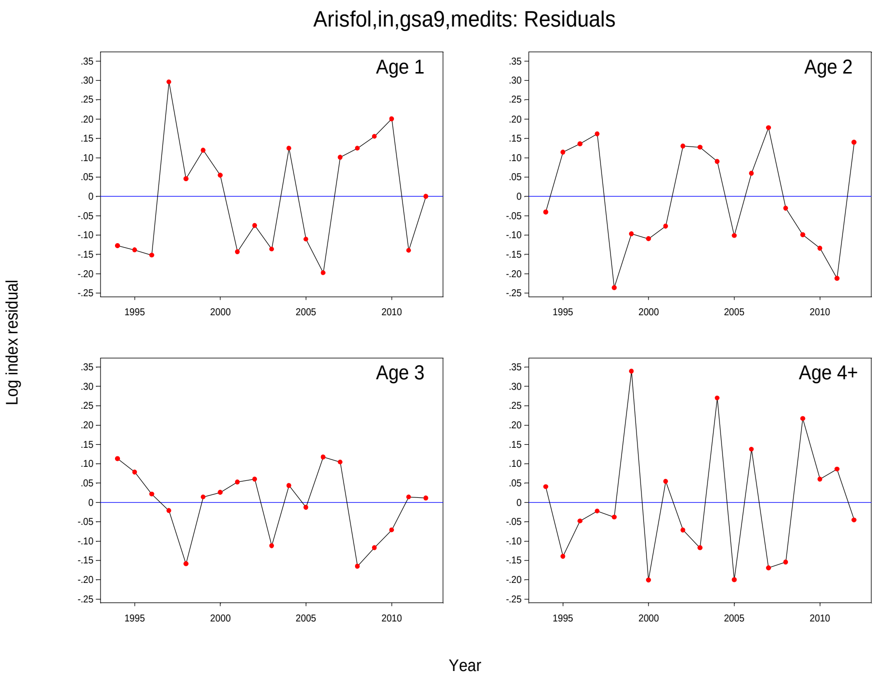


Fig. 6.6.4.1.3.3. Retrospective analysis and residuals by ages output of SURBA.

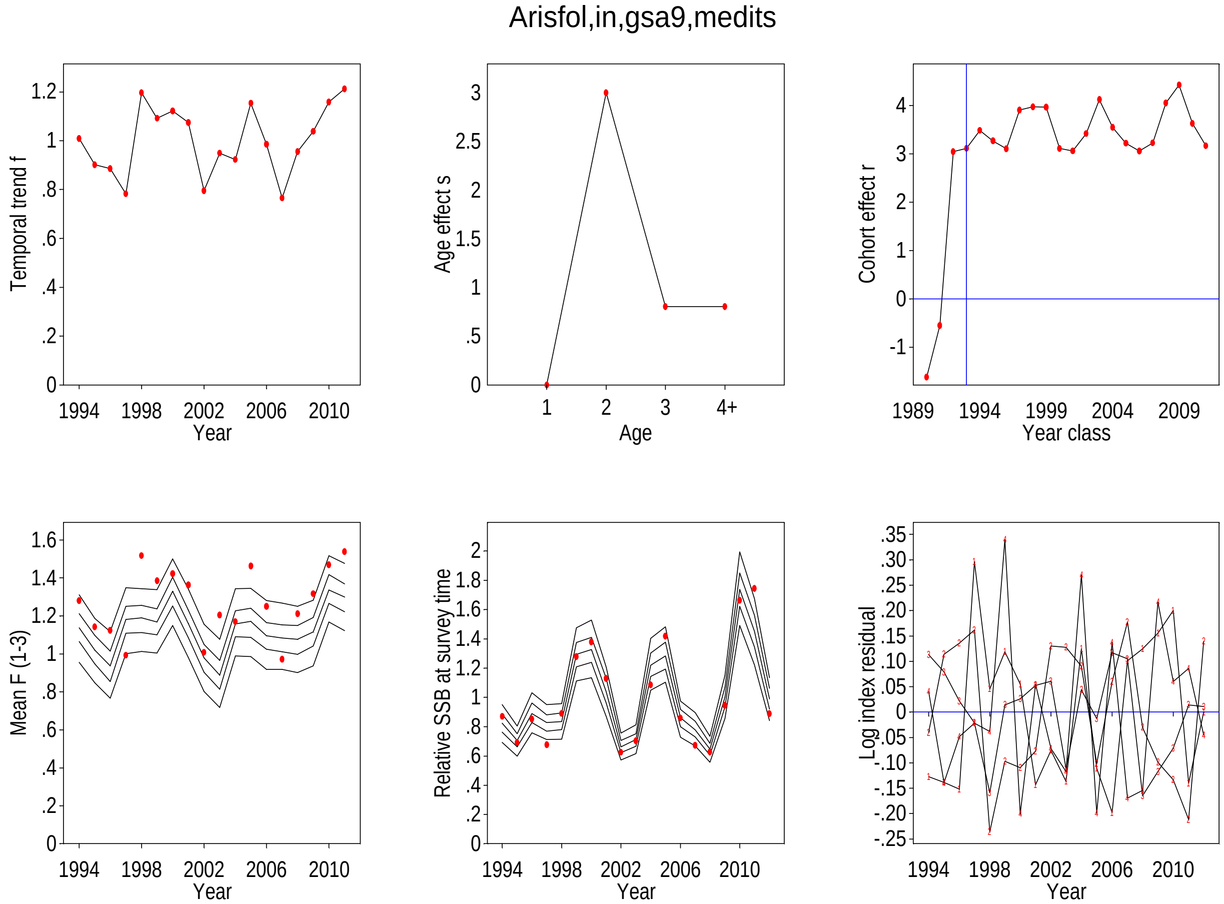


Fig. 6.6.4.1.3.4. Main outputs of SURBA model.

6.6.4.2. Method 2: XSA

6.6.4.2.1. Justification

The assessment of giant red shrimp in the GSA 09 has been performed during EWG 11-12 in Larnaka using LCA approach by VIT. In this last data call data from 2006 to 2012 have been provided and, since, the time series in long enough to cover the mean life span of the species during EWG 13-09 was possible to assess this species by XSA approach.

6.6.4.2.2.Input parameters

Data from DCF provided at EWG-13-09 contained information on giant red shrimp landings and the respective size structure for 2006-2012 were used. Total length frequencies were splitted by sex using a sex-ratio vector per length class and the relative age distributions were obtained using the statistical slicing routine (Fig. 6.6.4.2.2.1). Age distributions by sex were summed up and the analysis was carried out sex combined. A vector of natural mortality value by age was obtained using PRODBIOM (Abella et al., 1997). MEDITS survey indices were used for the tuning.

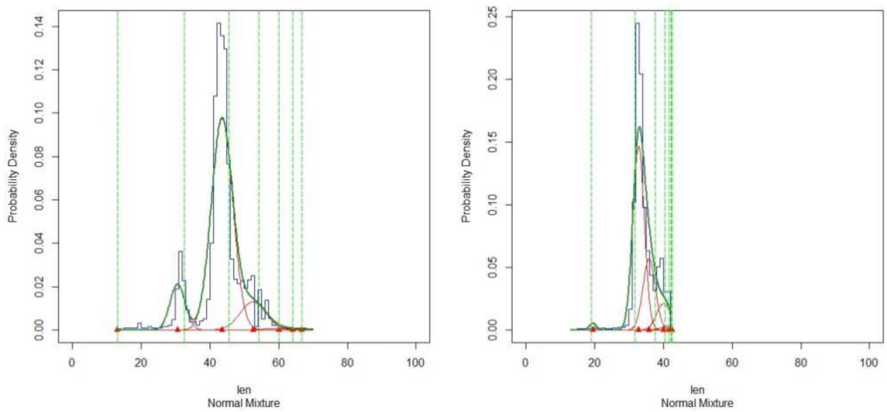


Fig. 6.6.4.2.2.1 Statistical age slicing for female (left) and male (right) of *A. foliacea* in the GSA 09 for 2011.

Catches in numbers were rescaling using Sum Of Product correction (SOP).

In figure 6.6.4.2.2.2 are showed catches in numbers by age and percentage of rescaling factor.

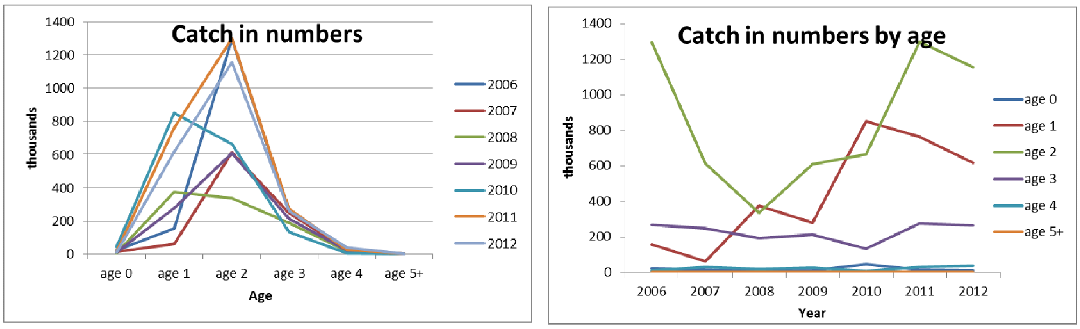


Fig. 6.6.4.2.2.2. Catch in numbers by age and year used in the XSA.

The other inputs are reported in the tables below:

Table 6.6.4.2.2.1 Catch in numbers by age and year used in XSA and SOP correction factor.

Catch in numbers (thousands)	0	1	2	3	4	5+	SOP
2006	22	156	1295	266	10	1	0.09
2007	15	62	613	249	30	3	0.29
2008	8	374	336	191	18	3	-0.06
2009	10	278	610	214	25	4	-0.04
2010	47	848	664	132	7	1	-0.07
2011	14	761	1298	275	28	3	0.13
2012	11	618	1154	263	39	4	-0.06

Table 6.6.4.2.2.2. Mean weigths at age used in the XSA (both in catch and stock).

Weight at age (kg)	0	1	2	3	4	5+
2006	0.004	0.020	0.035	0.052	0.070	0.090
2007	0.004	0.019	0.033	0.051	0.069	0.087
2008	0.009	0.012	0.030	0.044	0.056	0.087
2009	0.007	0.013	0.031	0.045	0.051	0.089
2010	0.006	0.012	0.030	0.048	0.060	0.085
2011	0.004	0.015	0.032	0.051	0.065	0.090
2012	0.007	0.013	0.027	0.040	0.054	0.090

Table 6.6.4.2.2.3. Indices from MEDITS survey used in XSA.

Survey indices (n/km^2)	0	1	2	3	4	5+
2006	2.64	12.14	22.78	10.31	2.74	0.44
2007	2.37	21.65	19.15	11.16	4.07	1.00
2008	11.59	24.57	14.48	3.81	0.86	0.20
2009	15.37	76.87	9.18	2.35	1.36	0.50
2010	109.69	103.50	43.20	5.46	1.98	0.42
2011	3.31	40.23	47.65	7.23	1.20	0.43
2012	3.48	33.83	41.62	18.78	1.38	0.91

Table 6.6.4.2.2.4. Proportion of matures ate age used in XSA.

Maturity					
Age0	Age1	Age2	Age3	Age4	Age5+
0	0.6	1	1	1	1

Table 6.6.4.2.2.5. Natural mortality at age used in XSA.

Natural mortality					
Age0	Age1	Age2	Age3	Age4	Age5+
1.28	0.58	0.44	0.38	0.34	0.32

Table 6.6.4.2.2.6. Growth and length weight relationships parameters used in PRODBIOM.

	Female	Male
Linf	72	42.7
K	0.4	0.77
t0	0	-0.27
a	0.0013	0.0042
b	2.67	2.35

6.6.4.2.3. Results

XSA was run setting shrinkage at 0.5, 1.0, 2.0. with these main settings min.nse=0.3, fse=1.0,rage=1, qage=2, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=5. As showed by Fig. 6.6.4.2.3.1 the three different settings produced quite similar estimates of recruitment and SSB.

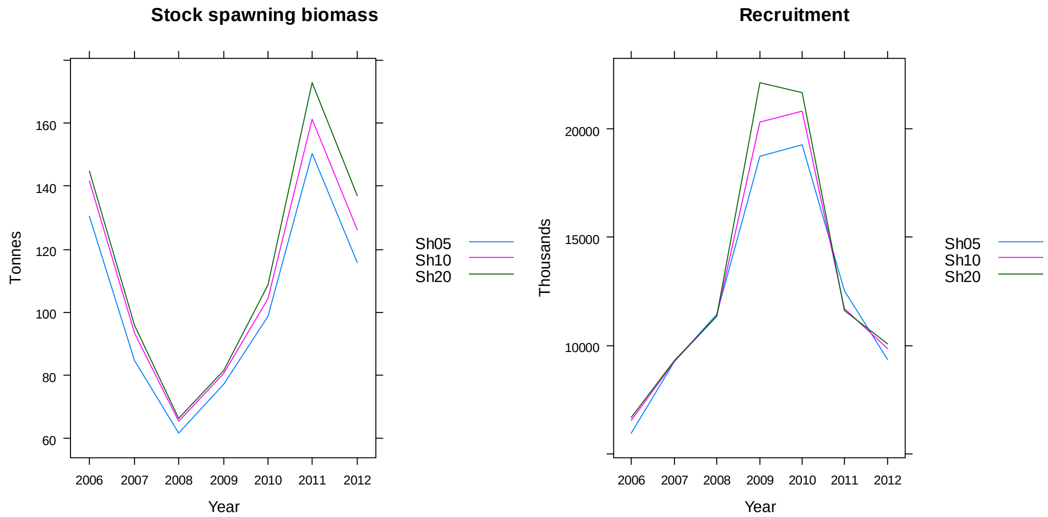


Fig. 6.6.4.2.3.1 Estimates of recruitment and SSB under different shrinkage settings

Model with 1.0 shrinkage was adopted as final model since it produced relatively small residuals, with no clear trend in their distribution (Fig. 6.6.4.2.3.2).

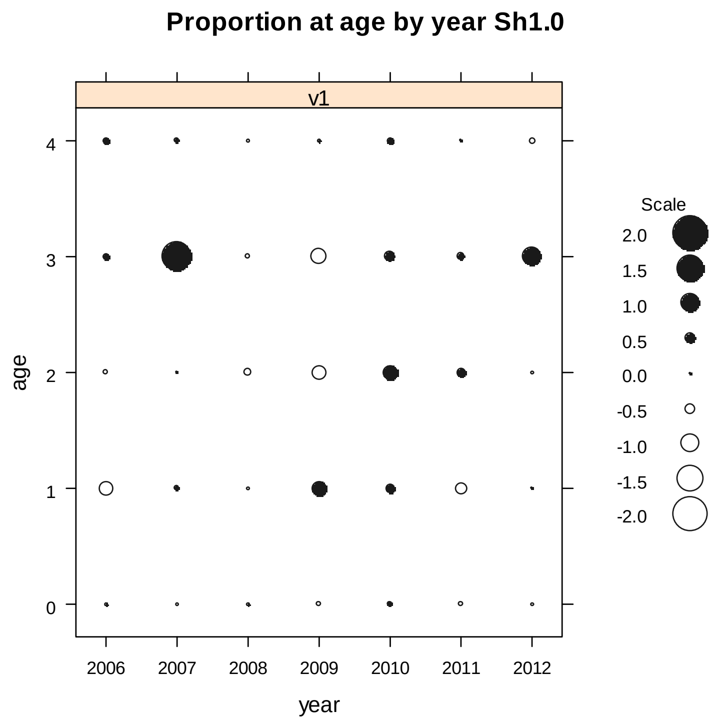


Fig. 6.6.4.2.3.2 Bubble plot of resisualds of model Sh1.0

Table 6.6.4.2.3.1 Log catchability residuals by age and year (Sh1.0)

	Log catchability residuals						
Age	2006	2007	2008	2009	2010	2011	2012
0	0.079	-0.058	0.072	-0.101	0.142	-0.099	-0.031
1	-0.517	0.097	-0.034	0.508	0.270	-0.373	0.018
2	-0.096	0.011	-0.208	-0.533	0.532	0.306	-0.029
3	0.194	1.134	-0.105	-0.593	0.360	0.205	0.653
4	0.187	0.124	-0.074	0.043	0.177	0.004	-0.193

The following Table 6.6.4.2.3.2 lists estimates for recruitment and spawning stock biomass (SSB) as estimated by XSA from 2006 to 2012. The annual yield including discards is also showed.

During 2006-2012 SSB oscillated between a minimum of about 65 tons (2008) to a maximum of about 161 tons (2011).

The largest year classes were observed in 2009-2010 (20 millions) followed by a decreasing phaseas showed in table 8.4.4.1.4.1. Trend in recruitment from XSA is in line with the MEDITS trend that shows a peak in 2010 (see Fig. 6.6.7.1.2.1).

Table 6.6.4.2.3.2 Yield, Recruitmen and SSB estimates by XSA 2006-2012 (Sh1.0)

	Yield(t)	R(age0)	SSB(t)
2006	63	6556	142
2007	36	9267	93
2008	24	11331	65
2009	34	20322	81
2010	37	20801	104
2011	69	11690	161
2012	52	9841	126

Table 6.6.4.2.3.3 Fishing mortality by age and year estimated by XSA.

Age	2006	2007	2008	2009	2010	2011	2012
0	0.006	0.003	0.001	0.001	0.004	0.002	0.002
1	0.088	0.047	0.216	0.126	0.224	0.194	0.294
2	1.335	0.914	0.567	1.068	0.761	1.022	0.780
3	0.894	1.669	1.209	1.316	0.974	1.242	0.784
4	0.143	0.266	0.591	0.581	0.137	0.696	0.694
5+	0.143	0.266	0.591	0.581	0.137	0.696	0.694
F_{1-3}	**0.772**	**0.877**	**0.664**	**0.837**	**0.653**	**0.820**	**0.619**

Table 6.6.4.2.3.4 Stock in numbers (thousands) estimated by age and year.

Age	2006	2007	2008	2009	2010	2011	2012
0	6556	9266	11331	20322	20801	11690	9841
1	2486	1811	2569	3146	5645	5759	3243
2	2190	1275	968	1158	1553	2526	2655
3	544	371	329	354	256	468	585
4	89	152	48	67	65	66	92
5+	9	15	8	11	9	7	9

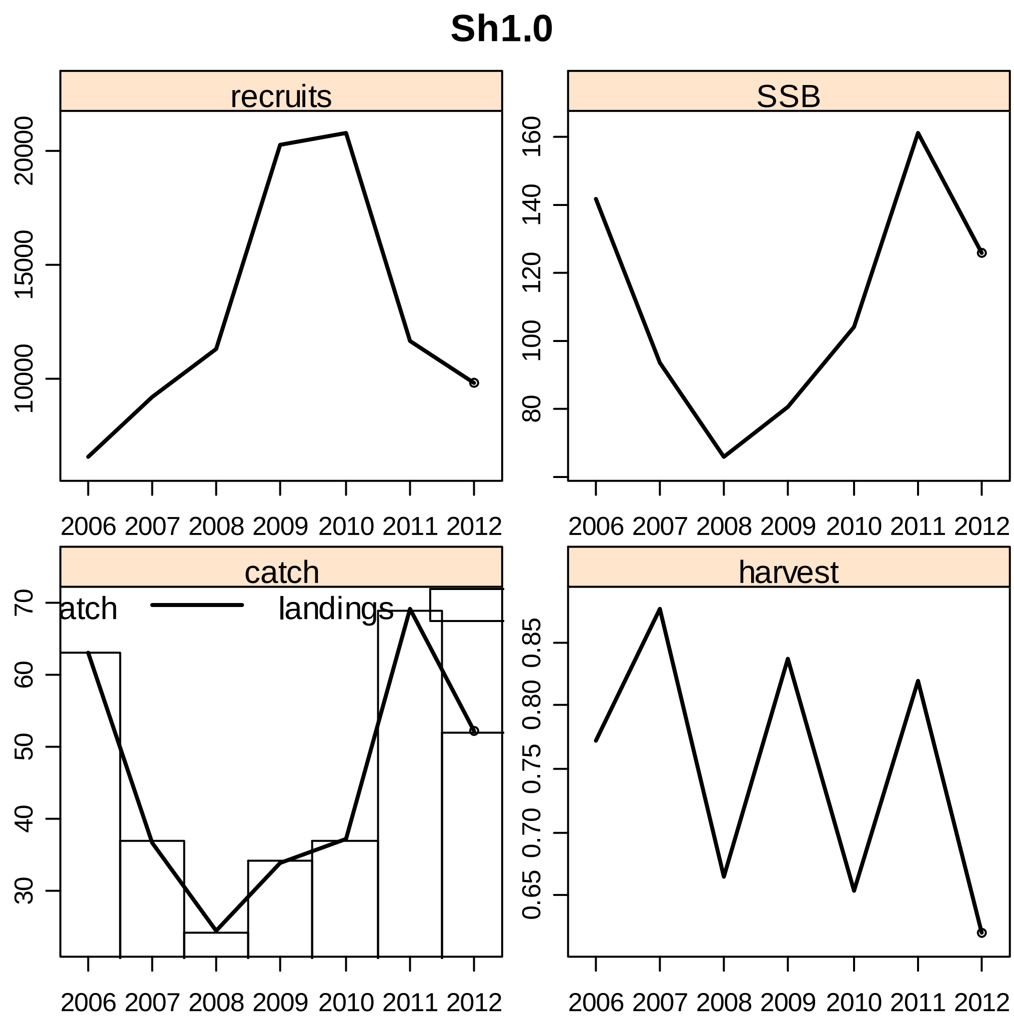


Fig. 6.6.4.2.3.3 Estimated recruitment, Fbar(1-3) and SSB by year

6.6.5. *Long term prediction*

6.6.5.1. Justification

Yield per recruit analysis has been conducted by means of VIT softare using the data of 2011 to compare the estimated BRPs with those estimated by FLBRP routine.

6.6.5.1.1. Input parameters

Analysis was computed by sex separated using length frequency distribution of 2012 and using the same input parameters used for XSA

6.6.5.1.2. Results

The resulting YpR (gr.) and SSBpR(gr.) are illustrated in the Fig.6.6.5.1.2.1 while in table 6.6.5.3.1 are reported the estimated values of F_{01} and F_{curr} using VIT and XSA.

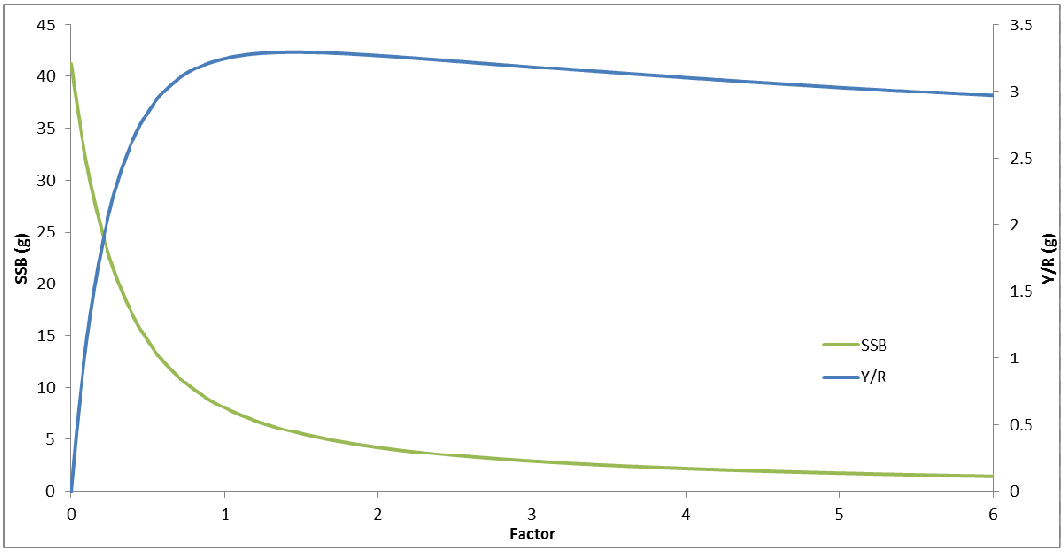


Fig. 6.6.5.3.1 LCA outputs: Yield per recruit per recruit and SSB per recruits curves of *A. foliacea* in the GSA 09.

Table 6.6.5.1.2.1. Comparison of estimated values of $F_{0.1}$ and $F_{current}$ using XSA and VIT.

Method	$F_{0.1}$	$F_{current(ages1-3)}$
XSA (2006-2012)	0.365	0.692
VIT (2012)	0.395	0.677

No differents were observed between estimated values and FLR BRP estimation was choose for advice.

6.6.6. *Data quality*

Commercial data by age were not very useful because the abundance by age in older age class seemed not correct (i.e. overestimated) as well as the mean length by age seemed. Thus the assessment were run using data by length. Length distribution of discards observed in the 2009 was not considered in the analysis, because represented in a very high percentage by only one length class (22mm CL) and the discard total weight was overestimated (about 2 tons) possibly due to the application of a wrong rising factor. Due to issue with the JRC database, MEDITS data is provided directly by the researchers of the GSA 09.

6.6.7. *Scientific advice*

6.6.7.1. Short term considerations

6.6.7.1.1. State of the stock size

Stock assessment has been computed by XSA using DCF data of landings at age (2006-2012). Results obtained did not show a clear trend in the stock size. MEDITS survey indices show a variable pattern of abundance and biomass without a clear trend. In the period analyzed indices of biomass and abundance showed a remarkable increase in 2009-2010. Since no precautionary level for the stock of giant red shrimp in GSA 09 was proposed, EWG 13-09 cannot evaluate the stock status in relation to the precautionary approach.

6.6.7.1.2. State of recruitment

To evalutate the state of recruitment the XSA output and index of recruitment estimated with MEDITS surveys were compared.

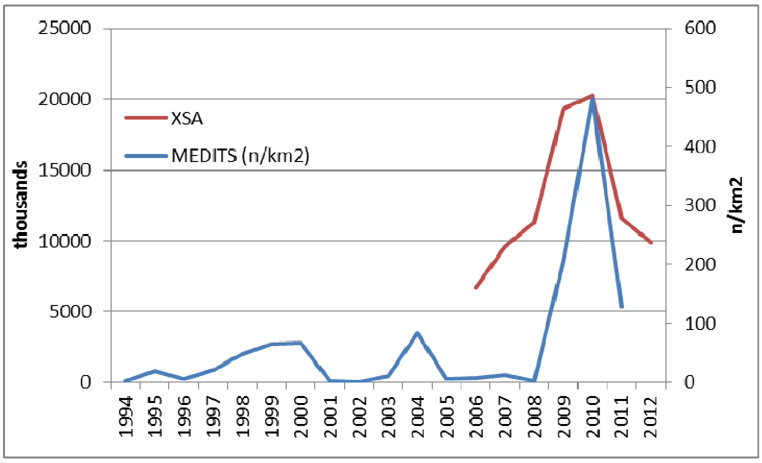


Fig. 6.6.7.1.2.1 Recruitment index obtained from MEDITS (n/km^2) survey (1994-2012) and from XSA (thousands)

Both approach indicate that in the 2008-2011 period an important recruitment took place with a main peak in 2010.

6.6.7.1.3. State of exploitation

EWG 13-09 proposes $F_{01\ (ages1.3)} \leq 0.36$ as limit management reference point consistent with high long term yields (F_{MSY} proxy).

According to the F estimates obtained using XSA, $F_{current\ (1-3)}$ (0.69) was above the average estimated F_{01} values. In this case, the stock would not appear to be able to sustain the current level of fishing effort in the GSA 09 and thus EWG 13-09 considers the stock to be exploited unsustainably.

6.6.7.2. Management recommendations

EWG 13-05 recommends the relevant fleets catches and/or effort to be reduced until fishing mortality is 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.

6.7. STOCK ASSESSMENT OF HAKE IN GSA 10

6.7.1. *Stock identification and biological features*

6.7.1.1. Stock Identification

The stock of European hake was assumed in the boundaries of the whole GSA 10, lacking specific information on stock identification. *M. merluccius* is with red mullet and deep-water pink shrimp a key species of fishing assemblages in the central-southern Tyrrhenian Sea (GSA 10) (Figure 6.7.1).

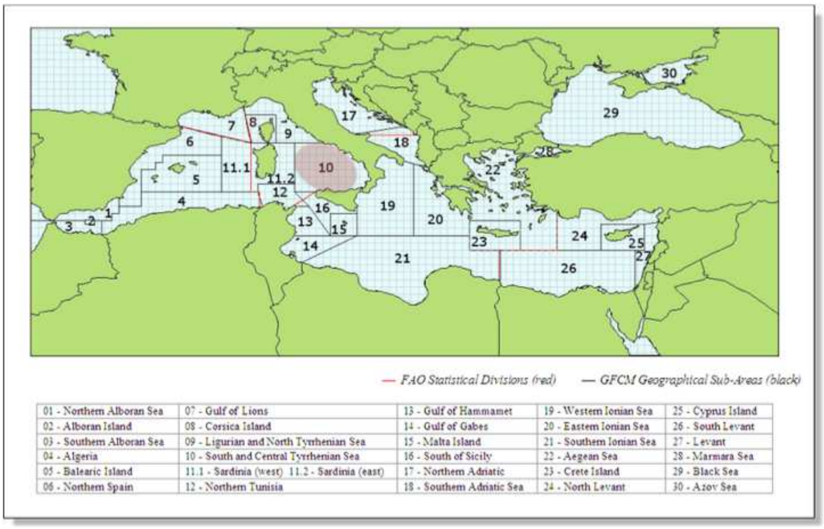


Figure 6.7.1. Geographical location of GSA 10.

European hake is generally also ranked among species with higher abundance indices in the trawl surveys (e.g. Spedicato *et al*., 2003). It is a long lived fish mainly exploited by trawlers, especially on the continental shelves of the Gulfs (e.g. Gaeta, Salerno, Palermo) but also by artisanal fishers using fixed gears (gillnets, bottom long-line).

Trawl-survey data have evidenced highest biomass indices on the continental shelf of the GSA 10 (100-200 m; Spedicato et al., 2003), where juveniles (less than 12 cm total length) are mainly concentrated. During autumn trawl surveys, one of the main recruitment pulses of this species is observed. Two main recruitment events (in spring and autumn; Spedicato et al. 2003) are reported in GSA 10 as for other Mediterranean areas (Orsi Relini *et al*., 2002). European hake is considered fully recruited to the bottom at 10 cm TL (from SAMED, 2002). The length structures from trawl surveys are generally dominated by juveniles, while large size individuals are rare. This pattern might be also due to the different vulnerability of older fish (Abella and Serena, 1998) beside the effect of high exploitation rates. The few large European hake caught during trawl surveys are generally females and inhabit deeper waters. The overall sex ratio (~0.41-0.47) estimated from trawl survey data is slightly skewed towards males.

6.7.1.2. Growth

Estimates of growth parameters were achieved during the SAMED project (SAMED, 2002) by the analysis of length frequency distributions. Historically, the following von Bertalanffy parameters were estimated by sex: females L_∞=74.2 cm; K=0.178; t_0= -0.20; males: L_∞=46.3cm; K=0.285; t_0= -0.20. In the DCF framework the growth has been studied ageing fish by otolith readings using the whole sagitta and thin sections for older individuals. Length frequency distributions were also analyzed using techniques as Batthacharya for separation of modal components. The observed maximum length of European hake was 88 cm for females and 58 cm for males both registered in the landings (bottom long-lines). DCF Von Bertalanffy growth parameters for each sex were estimated from average length at age using an iterative non-liner procedure that minimizes the sum of the square differences between observed and expected values (excel): females: L_∞=97.9 cm, K=0.135, t_0= -0.4; males: L_∞=50.8 cm, K=0.25, t_0= -0.4. Parameters of the length-weight relationship were a=0.00350, b=3.2 for females and a=0.0086, b=3.215 for males, for length expressed in cm (Fig. 6.7.2).

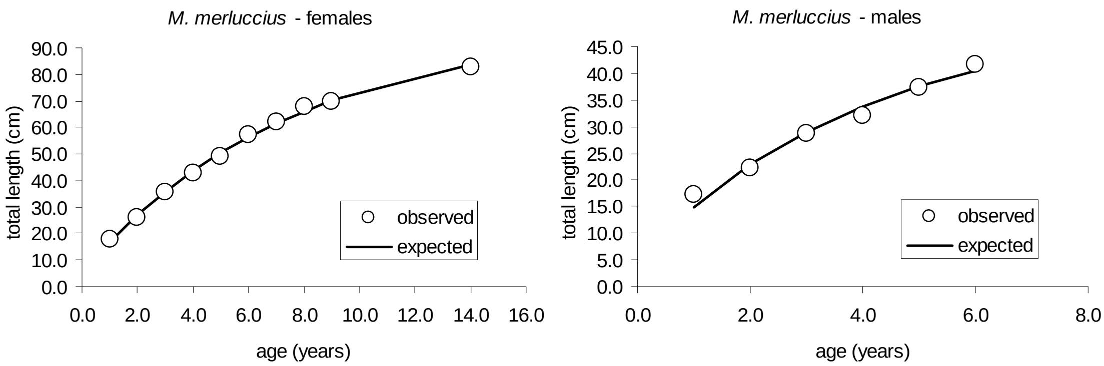


Fig. 6.7.2. Von Bertalanffy growth functions for female and male of hake in the GSA 10.

6.7.1.3. Maturity

A proxy of size at first maturity was estimated in the SAMED project (SAMED, 2002) using the average length at stage 2 (females with gonads at developing stage) that indicates an average length of about 30 cm. According to the data obtained in the DCF of 2008, the proportion of mature females (fish belonging to the maturity stage 2b onwards macroscopically classified using a 8 stage scale (MEDITS-Handbook_2007.v5) by length class in the period 2006-2008 is reported in the table below together with the estimated maturity ogive which indicates a $L_{m50\%}$ of about 33 cm (±0.27 cm) (Fig. 6.7.3). These estimates are similar to those of 2003-2005 (Lm50%=32.9±0.8; MR=6.4±0.9).

Proportion of mature females			
TL (cm)	p	TL (cm)	p
20	0.023	29	0.243
21	0.021	30	0.403
22	0.011	31	0.37
23	0.012	32	0.483
24	0.06	33	0.563
25	0.091	34	0.667
26	0.114	35	0.722
27	0.063	36	0.903
28	0.164	37	0.735

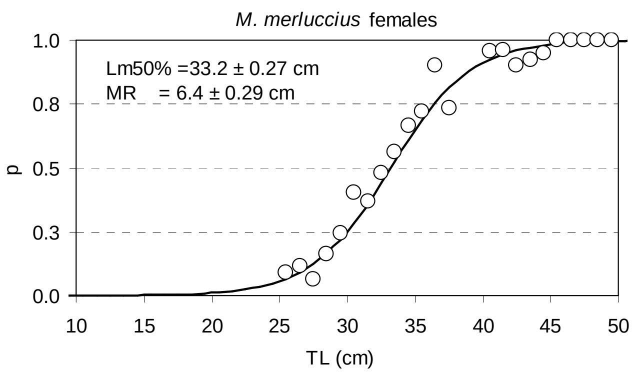


Fig. 6.7.3. Maturity ogive and proportions of mature female of hake in the GSA 10 (MR indicates the difference $Lm_{75\%}$-$Lm_{25\%}$).

The sex ratio is about 1:1 up to the size of 35 cm, above that females are prevailing (Fig. 6.7.4).

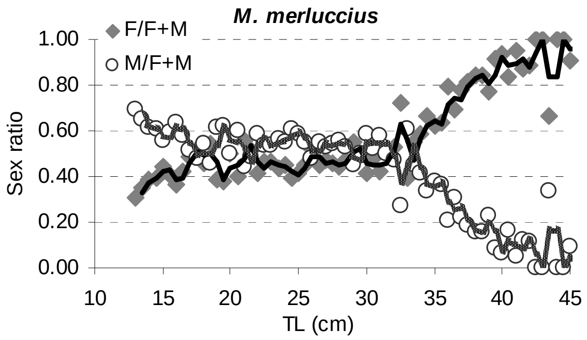


Fig. 6.7.4. Sex ratio for females and males by length.

6.7.2.*Fisheries*

6.7.2.1. General description of the fisheries

European hake is mostly targeted by trawlers, but also by small scale fisheries using nets and bottom long-lines. Fishing grounds are located on the soft bottoms of continental shelves and the upper part of continental slope along the coasts of the whole GSA. Catches from trawlers are from a depth range between 50-60 and 500 m and hake occurs with other important commercial species as *Illex coindetii*, *M. barbatus*, *P. longirostris*, *Eledone* spp., *Todaropsis eblanae*, *Lophius* spp., *Pagellus* spp., *P. blennoides, N. norvegicus*.

6.7.2.2. Management regulations applicable in 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 fishing fleet, the Italian fishing licenses have been fixed since the late eighties. Other measures on which the management regulations are based regard technical measures (mesh size) and minimum landing sizes (EC 1967/06).

After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity was implemented. Along northern Sicily coasts two main Gulfs (Patti and Castellammare) have been closed to the trawl fishery up 200 m depth, since 1990. In the GSA 10 the fishing ban has not been mandatory along the time, and from one year to the other it was adopted on a voluntary basis by fishers, whilst in the last three years it was mandatory. Regarding long-lines the management regulations are based on technical measures related to the number of hooks and the minimum landing sizes (EC 1967/06), besides the regulated number of fishing licences.

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). One is located along the mainland, in front of Sorrento peninsula in the vicinity of the MPA of Punta Campanella (Napoli Gulf, 60 km^2, within 200 m depth) and a second one is along the coasts of Amantea (Calabrian coasts, 75 km^2 up to 250 m depth). In these areas trawling is forbidden and other fishing activities are allowed under permission. 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.

6.7.2.3. Catches

6.7.2.3.1.Landings

Available landing data are from DCF regulations. EWG 13-09 received Italian landings data for GSA 10 by fishing gears, which are listed in Table 6.7.1.

The landings fluctuates around 1,100 and 1,600 tons with the maximum in 2006 and the minimum in 2012. Most part of the landings of hake is distributed almost homogenously between trawlers, nets (GNS and GTR) and longlines (LLS).

Table 6.7.1. Annual landings (t) by major gear type, 2004-2012.

Species	GEAR	FISHERY	2004	2005	2006	2007	2008	2009	2010	2011	2012
HKE	GND	SPF	7								
HKE	GNS	DEMF	177	294	326	213	311	282	431	287	311
HKE	GTR	DEMSP	202	124	148	157	68	107	202	153	138
HKE	LLS	DEMF	266	269	288	240	232	247	184	318	214
HKE	OTB	DWSP									7
HKE	OTB	DEMSP	186								307
HKE	OTB	MDDWSP	300	612							105
HKE	OTB	Aggregate			759	641	501	441	475	443	
		Total	1138	1299	1522	1251	1112	1077	1292	1200	1082

6.7.2.3.2.Discards

The discards of hake in the GSA 10 are reported for 2006, 2009-2012, oscillating between 28 tons in 2006 and 118 tons in 2012.

6.7.2.3.3.Fishing effort

The trends in fishing effort by year and major gear type is listed in Table 6.7.2. and shown in figure 6.7.5. The total fishing effort in kWdays from 2004 to 2012 is decreasing.

Table 6.7.2. Trend in fishing effort (kW*days) for the GSA 10 by fleet level, 2004-2012.

Sum of NOMINAL_EFFORT (kw*Days)

		GEAR					
AREA	**YEAR**	**GNS**	**GTR**	**LLS**	**OTB**	**PTM**	**Total**
SA 10	2004	4049992	3310756	4563626	8070376	6173	20000923
SA 10	2005	5028180	1740353	1812527	8029362		16610422
SA 10	2006	2954204	4295352	1436447	7500584		16186587
SA 10	2007	2154086	3857329	1204444	7287211		14503070
SA 10	2008	2489588	3170122	1314719	6080915		13055344
SA 10	2009	2551250	2502975	888264	6286555		12229044
SA 10	2011	2965530	2608589	1485904	5595272		12655295
SA 10	2012	2536182	2697356	1051670	6051158	902	12337268

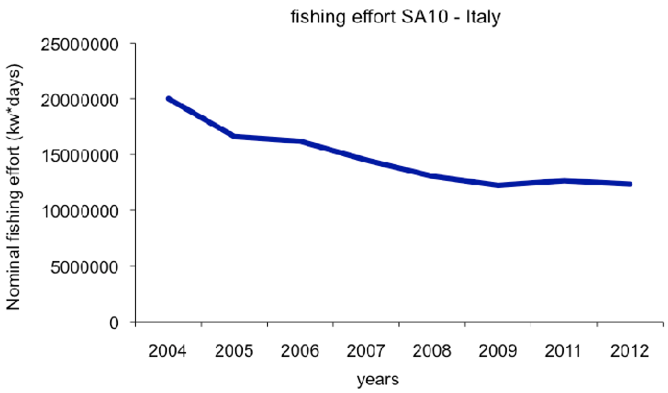


Figure 6.7.5. Trend in nominal fishing effort for the pulled fleet, from 2004 to 2012.

6.7.3. *Scientific surveys*

6.7.3.1. Medits

6.7.3.1.1. 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 per surface unit) were standardized to square kilometer, using the swept area method.

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 10 the following number of hauls was reported per depth stratum (Table 6.7.3.).

Table 6.7.3. Number of hauls per year and depth stratum in GSA 10, 1994-2012.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
GSA10_010-050	7	8	8	8	8	8	8	8	7	7
GSA10_050-100	10	10	10	10	10	10	10	10	8	8
GSA10_100-200	17	17	17	17	17	17	17	17	14	14
GSA10_200-500	22	23	22	22	22	22	22	24	18	18
GSA10_500-800	28	27	28	28	28	27	28	26	23	23

STRATUM	2004	2005	2006	2007	2008	2009	2010	2011	2012
GSA10_010-050	7	7	7	7	7	7	7	7	7
GSA10_050-100	8	8	8	8	8	8	8	8	8
GSA10_100-200	14	14	14	14	14	14	14	14	14
GSA10_200-500	18	18	18	18	19	18	18	18	18
GSA10_500-800	23	23	23	23	22	23	23	23	23

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 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 the 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 ± 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, 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 standardized length frequencies distribution raised to standardized haul abundance per square km over the stations of each stratum.

6.7.3.1.2. Geographical distribution patterns

The geographical distribution pattern of European hake has been studied in the area using trawl-survey data and applying geostatistical methods. In these studies both the total abundance indices (Lembo et al., 1998a) and the abundance indices of recruits were analysed (Lembo *et al*., 1998b, 2000). The higher concentration of recruits in the GSA 10 were localised in the northern side (Gulfs of Napoli and Gaeta). Recent estimations have confirmed the presence of important zone for recruits in the northernmost part of the GSA, although sites with a high probability of locating a nursery appeared also along the coasts of southern part of the mainland and North Sicily. From GRUND data (autumn survey) the higher abundance of recruits were instead localised in the central part of the GSA, along the mainland coasts. Persistence of the nursery areas along the time was estimated from the indicator kriging (figure 6.7.6).

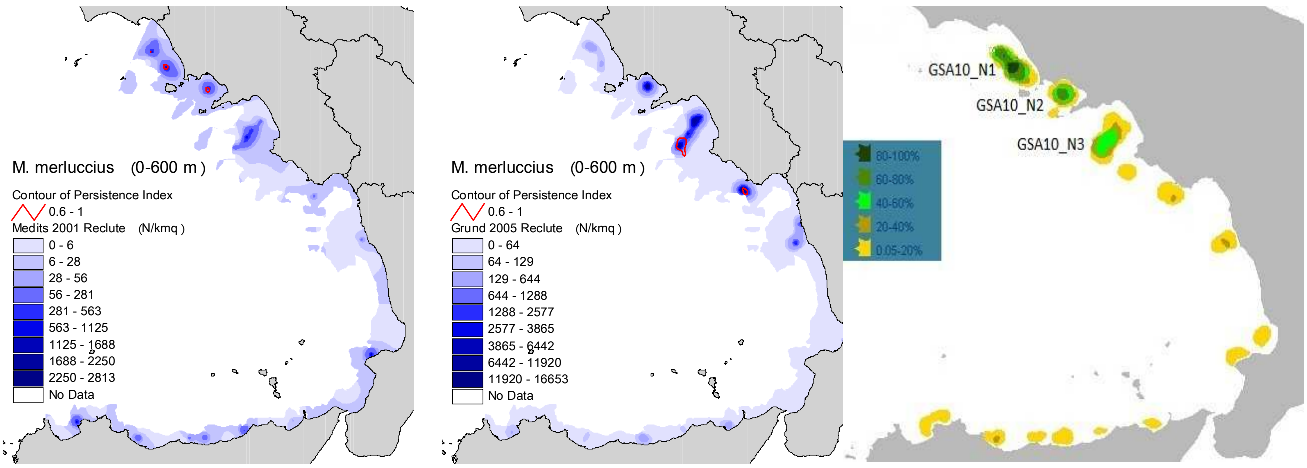


Fig. 6.7.6. Nursery of hake with the persistence along time.

6.7.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 10 was derived from the international survey MEDITS. Figure 6.1.3.1.3.1 displays the estimated trend of hake abundance and biomass indices standardized to the surface unit in the GSA10. Indices from MEDITS trawl-surveys show an increasing pattern up to 2009, although variability is high, and a decrease in 2012 (Figure 6.7.7).

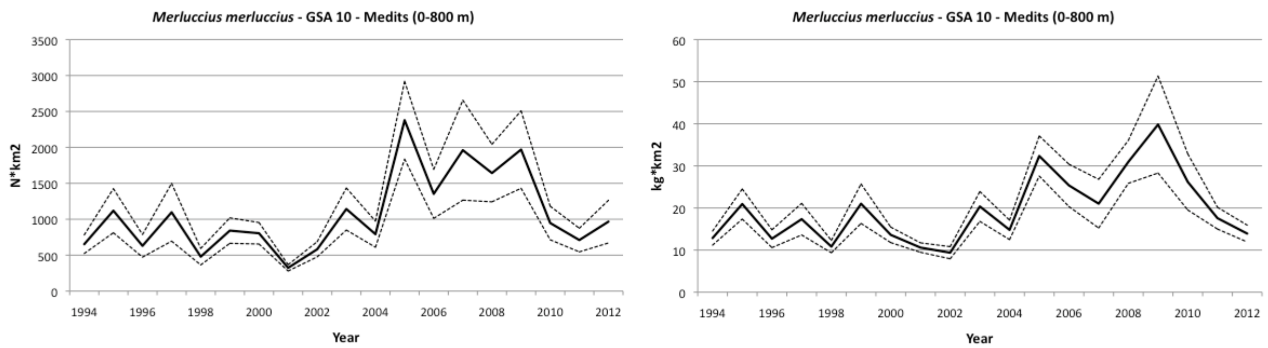


Fig. 6.7.7. Trends in survey Figure 6.7.7. Abundance and biomass of hake in GSA 10 derived from MEDITS (dotted lines indicated standard deviation).

6.7.3.2. Grund

6.7.3.2.1.Methods

Since 2003 Grund surveys (Relini, 2000) was conducted using the same vessel and gear in the whole GSA. Sampling scheme, stratification and protocols were similar as in MEDITS. All the abundance data (number of fish and weight per surface unit) were standardised to square kilometer, using the swept area method.

6.7.3.2.2.Geographical distribution patterns

Mapping of the hake recruits obtained applying the indicator kriging technique with contouring that represents probability (in percentage) is reported in the STECF_SGMED 02 2009 report.

Trends derived from the GRUND surveys are shown in Figure 6.7.8. Abundance indices increased significantly ($p<0.05$ on ln-transformed data), as well as recruitment indices, while biomass indices were almost stationary.

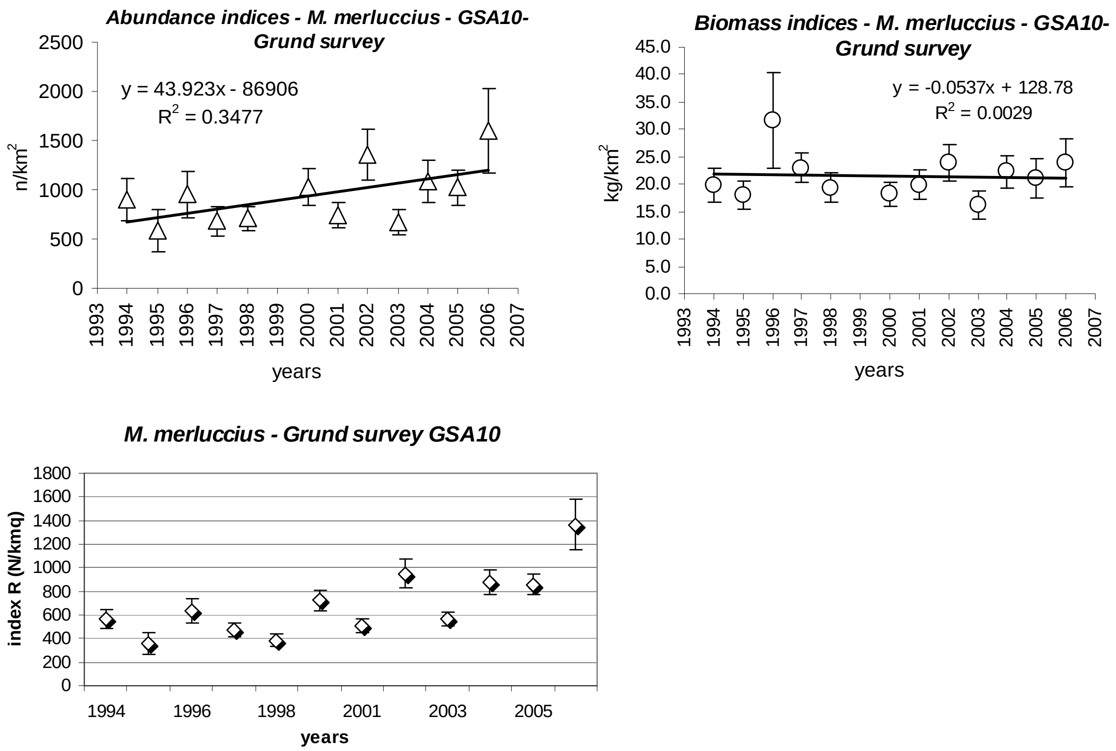


Fig. 6.7.8. Abundance and biomass indices of hake in GSA10 derived from GRUND surveys. Recruitment indices (N/km^2) with standard deviation are also reported.

6.7.3.2.3.Trends in abundance by length or age

No trend in the mean length was observed in MEDITS survey (Figure 6.7.9.), nor at the third quantile lengths as obtained from the length structures of GRUND time series from 1994 to 2006 (Figure 6.7.10.). However the mean length of older fish is reduced along the time.

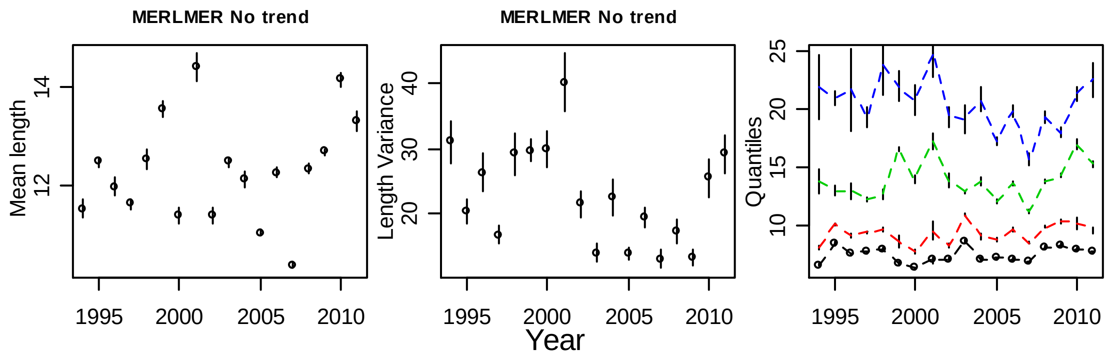


Fig. 6.7.9. Mean length, variance and quantiles derived from the MEDITS length compositions.

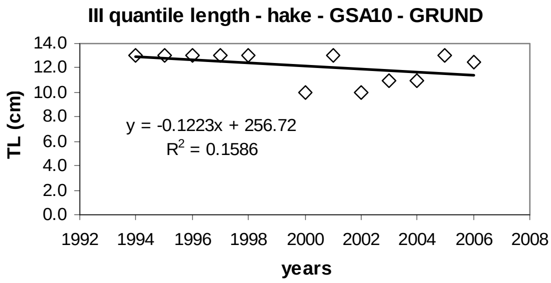


Fig. 6.7.10. III Quantile derived from the GRUND length structures in 1994-2006.

The following Fig. 6.7.11, 6.7.12 and 6.7.13 display the stratified abundance indices of GSA 10 in 1994-1999, 2000-2005, 2006-2012.

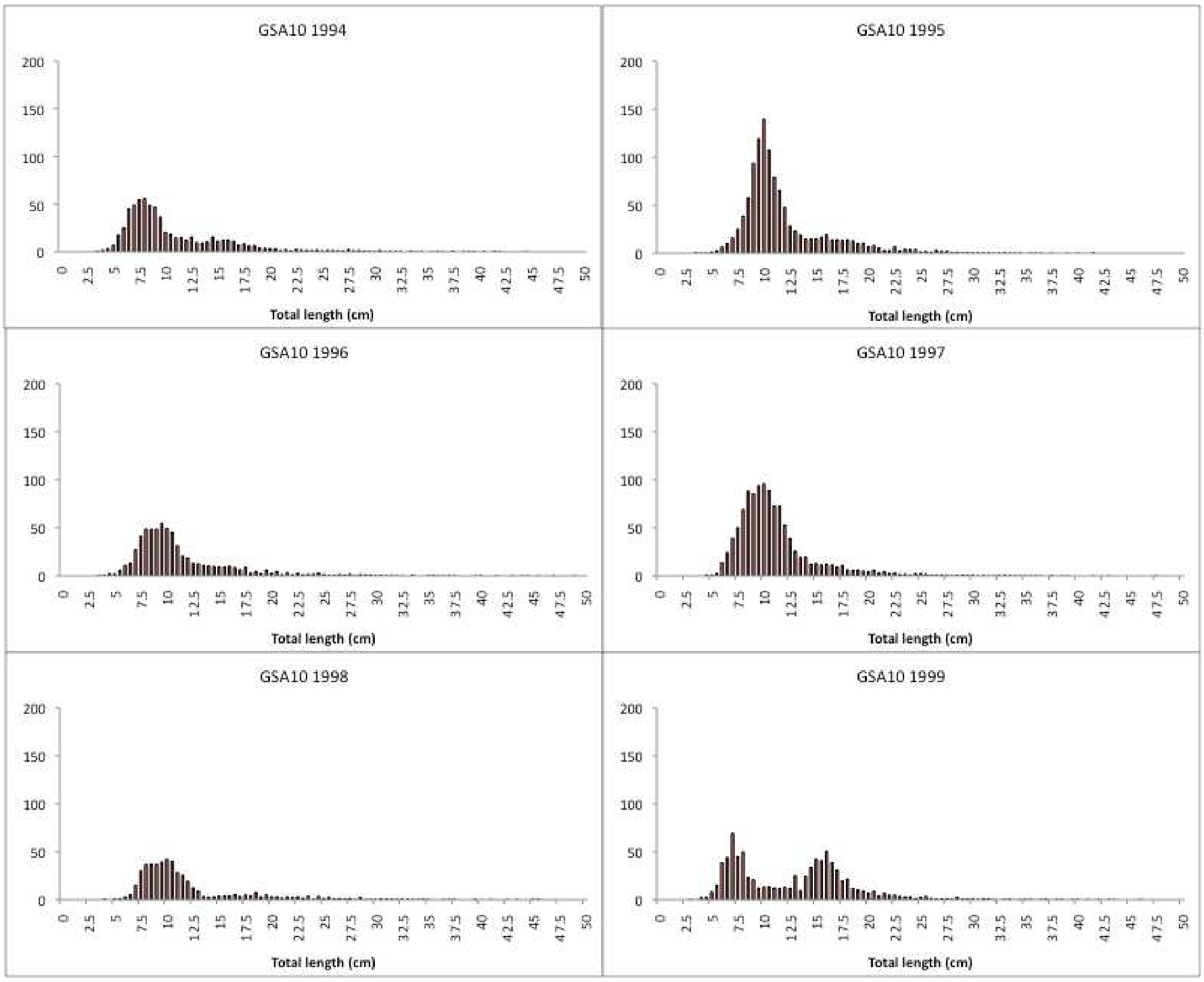


Fig. 6.7.11. Stratified abundance indices by size, 1994-1999.

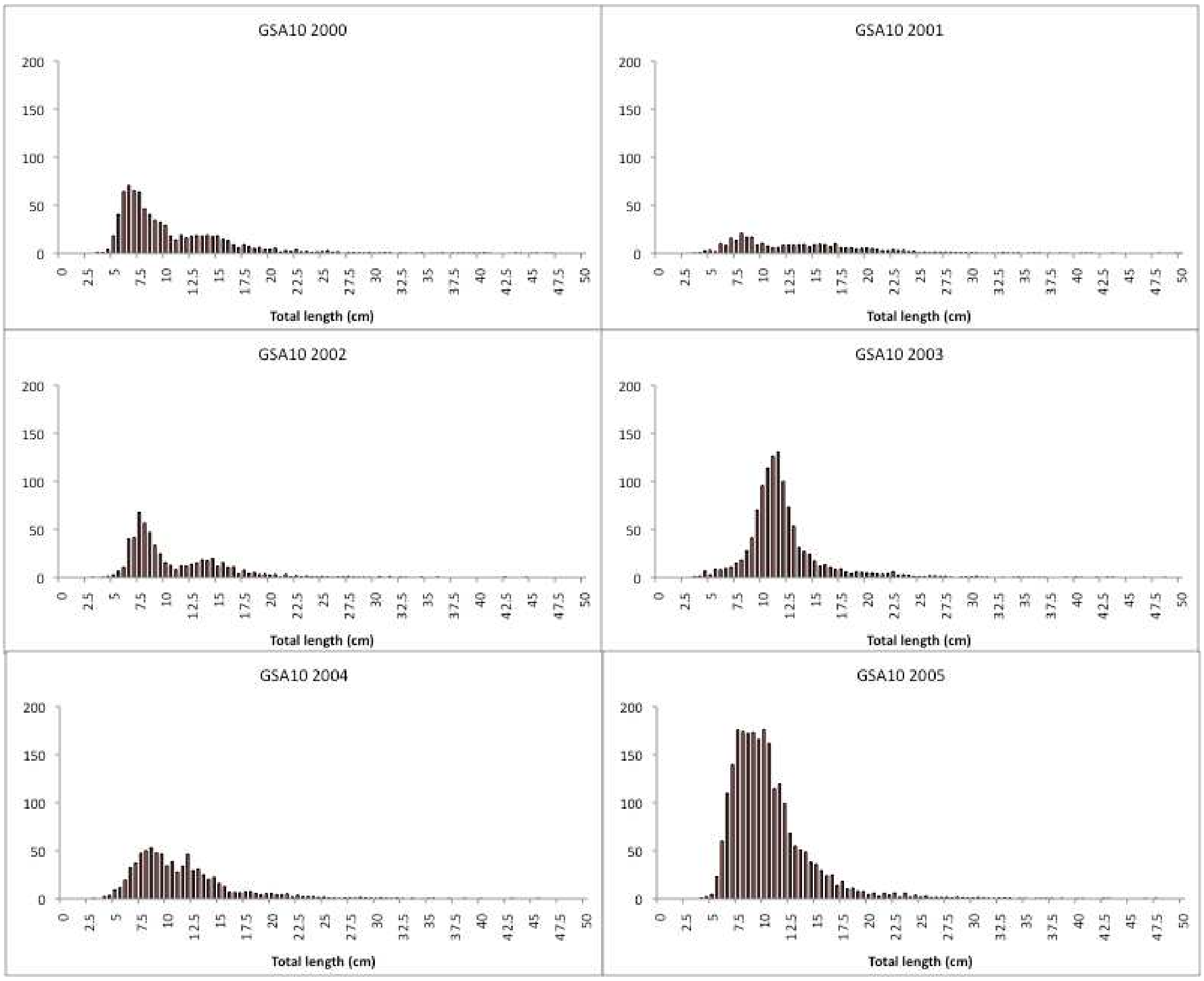


Fig. 6.7.12. Stratified abundance indices by size, 2002-2005.

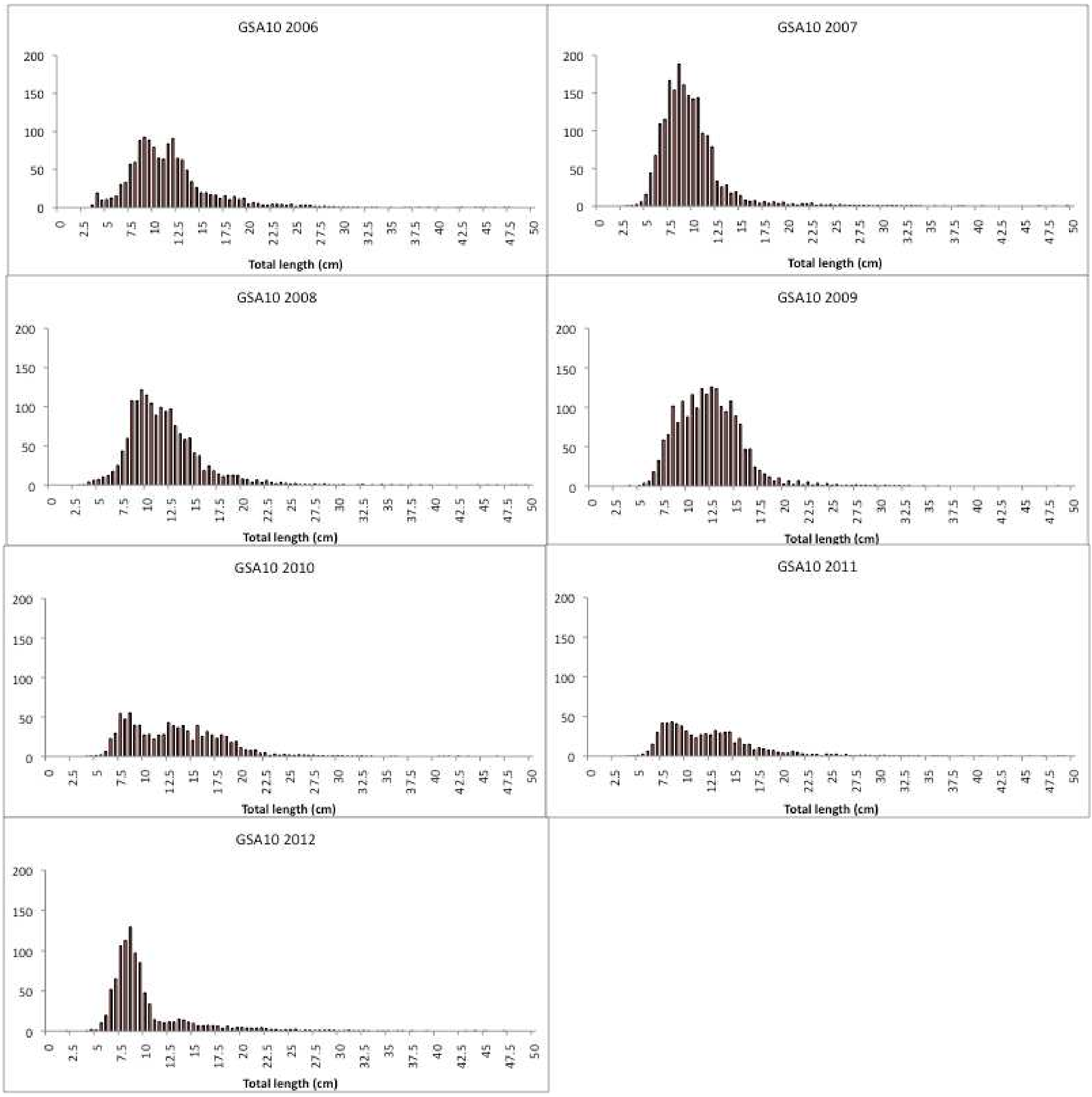


Fig. 6.7.13. Stratified abundance indices by size, 2006-2012.

– *Trends in growth*

No analyses were conducted.

– *Trends in maturity*

No analyses were conducted.

6.7.4. *Assessment of historic stock parameters*

6.7.4.1. Method 2: XSA

– *Justification*

The assessment of hake in GSA 10 has been previously done applying VIT, Aladym and Surba. Extended Survivors Analysis (XSA – Darby and Flatman, 1994) has been used for this stock during this EWG for the first time. Age range from 0 to 6+ was used. Discard was included in the analysis. Since no discard was available for 2006 and 2007, an estimate based on the length structure of the previous and following year discards has been done.

– *Input parameters*

For the assessment of hake in GSA 10 the DCF official data on the length structure has been used: no SOP correction has been applied. The age distribution has been estimated using the knife-edge slicing method (LFDA algorithm) with the growth parameters presented in table 6.7.8. A sex-combined analysis was carried out. The maturity at age has been estimated using the maturity at length transformed to ages by slicing procedure. The natural mortality has been calculated using PRODBIOM (Abella, 1998). The survey indices from MEDITS data from 2006 to 2012 have been used for the tuning.

The age distribution is showed in figure 6.7.14 and table 6.7.4.

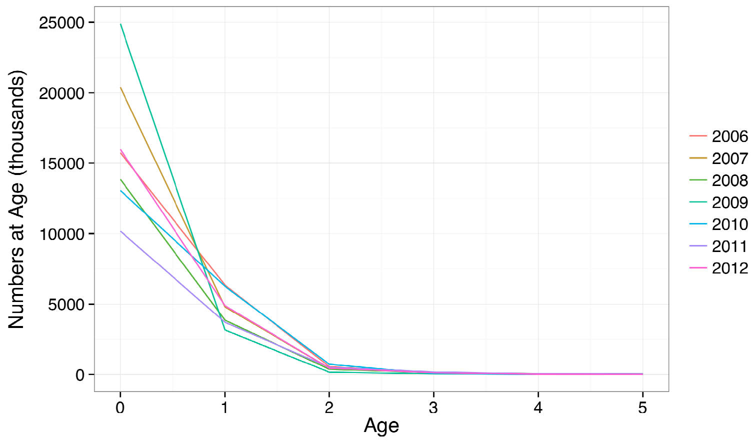


Fig. 6.7.14. Catch in numbers (including discard) by age and year used in the XSA.

Table 6.7.4. Catch in numbers (thousands, including discards) by age and year used in the XSA.

Age	2006	2007	2008	2009	2010	2011	2012
0	15744.09	20384.99	13856.90	24895.72	13061.99	10180.31	15987.94
1	6355.47	4805.31	3864.78	3168.18	6267.74	3711.84	4895.59
2	561.95	450.83	367.62	158.03	723.65	506.61	448.69
3	89.08	121.90	138.01	46.70	65.76	175.42	117.39
4	34.83	41.13	54.33	34.42	6.68	46.21	17.59
5	19.02	9.26	22.07	10.44	8.89	23.24	5.00
6+	0.00	1.54	4.17	7.32	6.35	5.91	1.13

Table 6.7.5. Weights at age (kg) used in the XSA (used for the stock and the catch).

Age	2006	2007	2008	2009	2010	2011	2012
0	0.020	0.018	0.018	0.018	0.016	0.016	0.016
1	0.115	0.118	0.118	0.122	0.108	0.129	0.120

2	0.430	0.471	0.469	0.439	0.481	0.443	0.458
3	1.200	1.195	1.115	1.192	1.101	1.164	1.106
4	1.935	1.813	1.918	1.881	2.007	1.860	1.920
5	2.760	3.003	2.723	2.821	2.935	2.684	2.991
6+	2.760	5.921	3.730	3.763	4.379	4.262	4.058

Table 6.7.6. Indices from MEDITS survey used in the XSA (numbers * square km).

Age	2006	2007	2008	2009	2010	2011	2012
0	1250.42	1907.19	1544.78	1890.43	813.51	639.35	907.40
1	99.67	51.52	92.69	78.11	131.46	67.18	56.44
2	2.32	0.95	2.97	0.38	1.46	2.45	2.37
3	0.49	0.97	1.52	0.32	0.30	1.20	0.29
4	0.00	0.14	0.00	0.00	0.17	0.00	0.00
5	0.00	0.14	0.00	0.32	0.15	0.00	0.16
6+	0	0	0.4	0	0.24	0	0

In table 6.7.7 the natural mortality vector from PRODBIOM and the maturity vector are shown.

Table 6.7.7. M at age and proportion of matures at age used in the XSA.

	Age0	Age1	Age2	Age3	Age4	Age5	Age6+
Natural mortality	1.16	0.53	0.4	0.35	0.32	0.3	0.3
Maturity	0	0.19	0.86	1	1	1	1

Table 6.7.8. Growth parameters and length-weight relationship coefficient used in PRODBIOM.

L_{inf}	k	t_0	a	b
104	0.2	-0.01	0.00437	3.1542

– *Results*

The XSA run with the following settings has been performed:

- Catchability (rage) independent on stock size for all ages.

- Catchability (qage) independent of age for ages >= 5.

- Minimum standard error for population estimates derived from each fleet = 0.300.

- Shrinkage of the mean (fse): 2.

Sensitivity analysis have been performed with S.E. of the mean to which the estimates are shrunk equal to 0.5, 1, 1.5 and 2 and the run with 2 has been chosen on the basis of the residuals and of the retrospective analysis.

The log-catchability residuals at age and the retrospective analysis results are shown in figure 6.7.15 and figure 6.7.16.

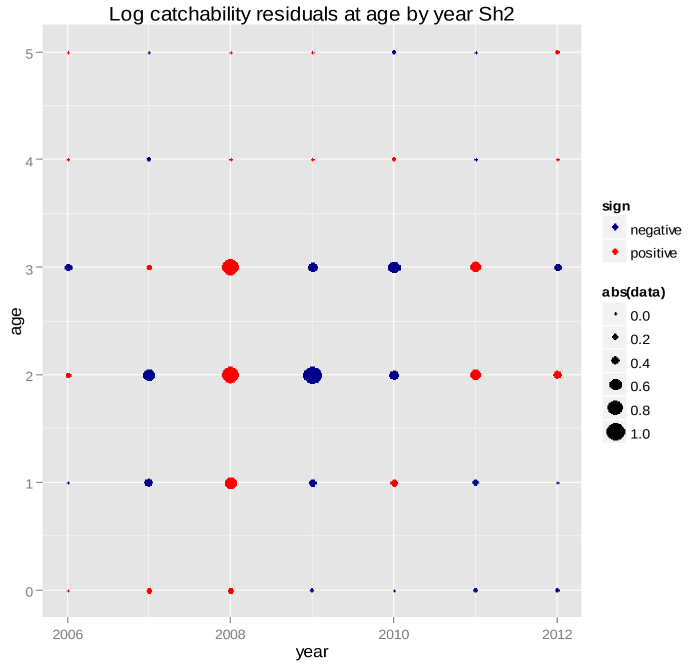


Figure 6.7.15. Log-catchability residuals at age for the tuning index, XSA of hake in GSA 10.

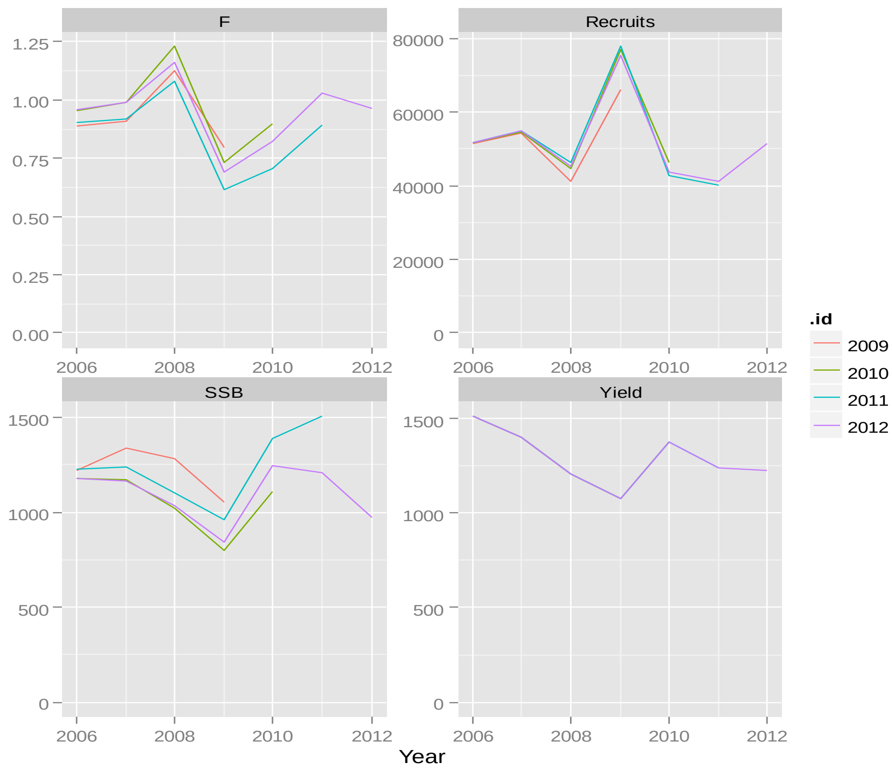


Figure 6.7.16. Retrospective analysis for hake in GSA 10.

The residuals show a slight age trend in 2008 but on the overall the absolute values are low. The retrospective analysis on the other hand doesn't show any pattern.

Both the $F_{bar(0-5)}$ and the SSB are fluctuating without any trend. The average F_{bar} along the time series is 0.98, with a minimum of 0.7 in 2009 and a maximum of 1.13 in 2008 (Table 6.7.9 and Figure 6.7.17). The SSB is about 1,000 t in 2012, being the average along the time series equal to 1093. The recruitment has a slightly decreasing trend, even if in 2012 it increased again to a value equal to 51,400. The maximum recruitment is reached in 2009 and it is equal to 75,500 thousands inviduals (Figure 6.7.17).

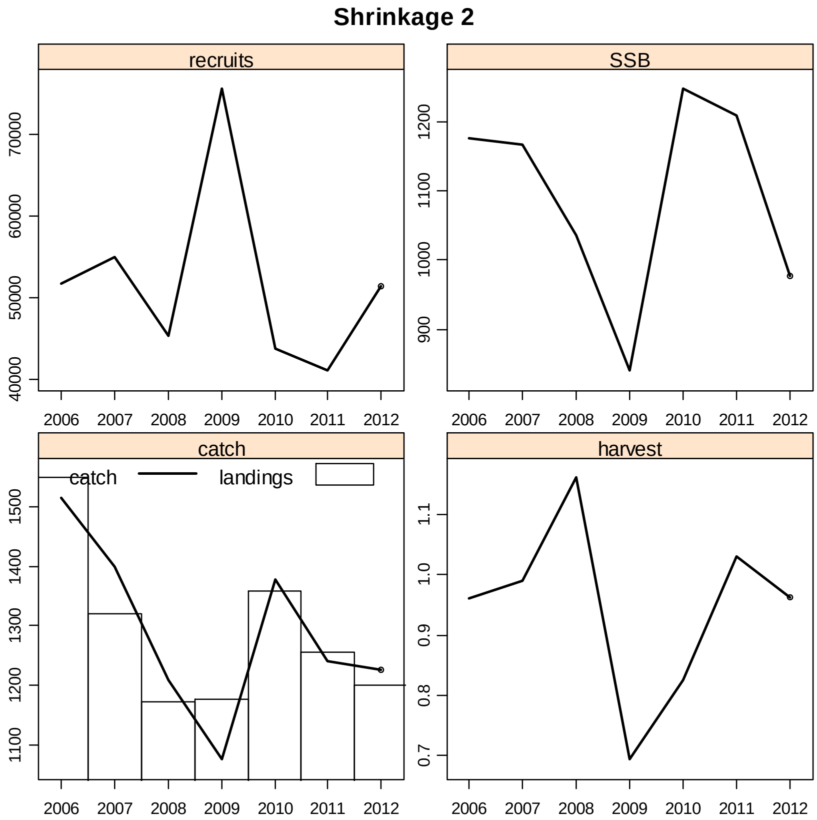


Figure 6.7.17. XSA results for Hake in GSA 10, in terms of: recruitment (top-left), SSB (top-right), landings and catch estimates (bottom-left) and harvest (bottom-right).

Table 6.7.9. Fishing mortality at age by year, $F_{bar(0-5)}$, total biomass (TB, t), spawning stock biomass (SSB, t) and Recruitment (R, thousands) estimated with XSA.

	Age0	Age1	Age2	Age3	Age4	Age5	Age6+	f_{bar} (0-5)	TB	SSB	R
2006	0.782	1.820	0.920	0.574	0.915	0.756	0.756	0.961	3210	1176.475871	51812
2007	1.083	1.853	0.877	0.647	0.693	0.782	0.782	0.989	2918	1166.174205	55046
2008	0.789	1.982	1.065	0.982	0.836	1.316	1.316	1.162	2446	1035.013912	45353
2009	0.888	1.020	0.523	0.433	0.872	0.419	0.419	0.693	2850	839.5345459	75533
2010	0.763	1.825	1.034	0.538	0.115	0.674	0.674	0.825	2900	1246.869448	43724
2011	0.584	1.414	1.107	1.021	1.202	0.860	0.860	1.031	2584	1211.308285	41095
2012	0.810	2.193	0.913	1.150	0.286	0.421	0.421	0.962	2539	978.085964	51457

Tab. 6.7.10. Stock in numbers (thousands) estimated by age and year.

	2006	2007	2008	2009	2010	2011	2012
Age0	51812	55046	45353	75533	43724	41095	51457
Age1	9886	7427	5843	6459	9740	6394	7183
Age2	1141	943	685	474	1371	924	916
Age3	243	305	263	158	188	327	205

Age4	68	97	113	69	72	78	83
Age5	42	20	35	35	21	47	17
Age6+	0	3	6	25	15	12	4

6.7.4.2. Method 2: Yield Per Recruit

To predict the effect of changes in fishing effort of future yields and to define reference points F_{01} (as a proxy for F_{MSY}) and F_{max} a Yield per Recruit analysis (YPR) was carried out in R. As input the same population parameters used for the XSA and its output of the exploitation pattern were used.

The reference points are shown in table 6.7.11.

Table 6.7.11. Reference point derived from XSA results for Hake in GSA 10

	F	Total Yield	Recruitment	SSB	Biomass
f0.1	0.141	3278	51066	29146	31796
fmax	0.198	3416	51066	21408	23949
spr.30	0.207	3413	51066	20449	22975
msy	0.198	3416	51066.	21408	23949

6.7.5. *Data quality and availability*

Data from DCF 2013 were used. Assessments were performed using the new submitted time series. A consistent sum of products compared to landings was observed (differences less than 10% for age data and less than 5% for length data). Discards data of 2009, 2010, 2011 and 2012 were available. In 2009, 2010 and 2011 data were provided by year gear and fishery. 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. MEDITS data used for this assessment have been provided directly by the scientists, given some difficulties in getting outputs from the JRC database.

6.7.6. *Scientific advice*

6.7.6.1. State of the spawning stock size

EWG 13-09 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points. Survey indices indicate a variable pattern of abundance (n/km^2) and biomass (kg/km^2) with an increasing up to 2010 and a decreasing in the last two years. The recent values are at the same level of those observed at the beginning of the time series.

No biomass reference points have been proposed for this stock. As a result, SGMED is unable to evaluate the status of the stock with respect to biomass.

6.7.6.2. State of recruitment

MEDITS data showed a sharp increase of recruitment in 2005 and thereafter a level similar or higher than in the past years (figure 6.7.18). From 2007 onward it decreased again until 2011. In 2012 a new increase was observed.

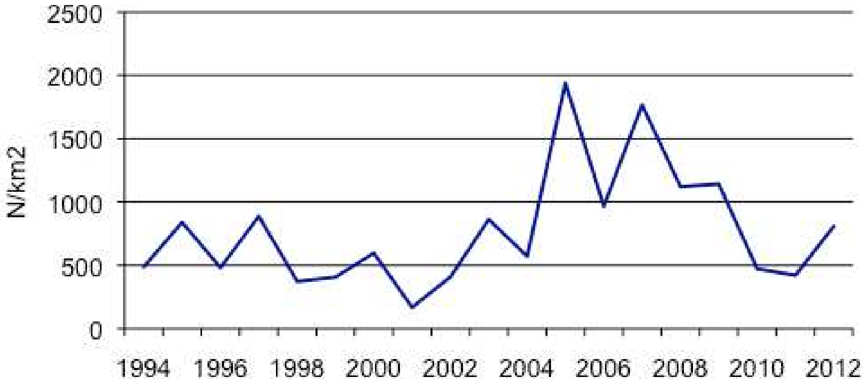


Figure 6.7.18. Trend in recruitment from MEDITS survey for Hake in GSA 10 from 1994 to 2012.

From the XSA assessment no particular trends are observed, with the recruitment fluctuating around an average.

6.7.6.3. State of exploitation

EWG 13-09 proposes $F \leq 0.14$ as proxy of F_{MSY}. Given the results of the present analysis (current F is around 1), the stock appeared to be exploited unsustainably. A considerable reduction is necessary to approach the reference point.

6.7.6.4. Management recommendations

The production of hake in GSA 10 almost homogenously distributed between trawlers and small scale fisheries. EWG 13-09 recommends the 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.

6.8. STOCK ASSESSMENT OF PINK SHRIMP IN GSA 10

6.8.1. *Stock identification and biological features*

6.8.1.1. Stock Identification

The stock of pink shrimp was assumed in the boundaries of the whole GSA 10, lacking specific information on the stock identification. The pink shrimp is an epibenthic species and inhabits the muddy or sandy-muddy bottoms of the continental shelf. A gradient of size increasing with depth has been observed in GSA 10 as in other areas, being the smallest specimens fished more frequently in the upper part of the continental shelf (100-200 m), while the largest ones are mainly distributed along the slope at depths greater than 200 m (Spedicato *et al*., 1996). Aggregations with higher abundance were localised between 100 and 200 m depth, with some intrusions in the deeper waters in three sub-areas. Two most important patches were located in the Gulf of Naples and along the Calabrian coasts in correspondence with Cape Bonifati, while a third one in the Gulf of Salerno (Lembo *et al*., 1999). These are the areas where also the main nurseries are localised (Lembo *et al*., 2000a). In the Central-Southern Tyrrhenian Sea the occurrence of mature females was observed in spring (May), summer (July-August) and autumn (October), with a higher relative frequency in spring-summer seasons (Spedicato et al., 1996). Thus, a continuous recruitment pattern is shown which, however, exhibits a main pulse in the autumn season. At 16 mm carapace length the pink shrimp is considered recruited to the grounds (SAMED, 2002). The overall sex ratio is about 0.5. The structure of the sizes of *P. longirostris* is characterised by differences in growth between the sexes, the larger individuals being females. The deepwater pink shrimp is a short-living crustaceans with a life span of about 4 years (Carbonara *et al*., 1998).

The deep-water rose shrimp with hake and red mullet is a key species of fishing assemblages in the central-southern Tyrrhenian Sea. In the last decade it is generally also ranked among the species with higher abundance indices (number of individuals) in the trawl surveys (e.g. Spedicato *et al*. 2003) as observed for different Mediterranean areas. The pink shrimp is caught on the same fishing grounds as European hake and the production of this shrimp is steadily growing in the last decade in the southern basin and it reached in 2006 about 10% of the demersal landings.

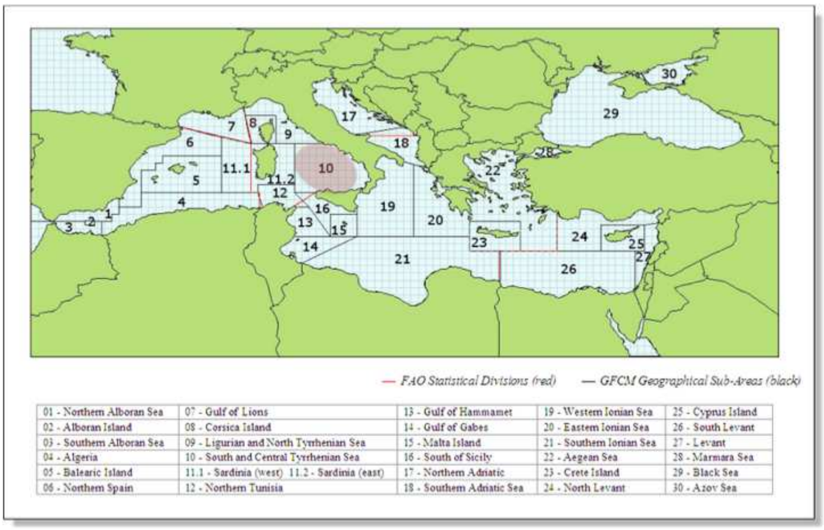


Figure 6.8.1. Geographical location of GSA 10.

6.8.1.2. Growth

Past estimates of the growth pattern of the pink shrimp females were obtained using different methods based on the LFD analysis (modal progression analysis-MPA, Elefan, Multifan) applied to GRUND data from 1990 to 1995. Parameters of VBGF were as follows: L_∞=45.9; K=0.673 t_0= -0.251 (Carbonara *et al*., 1998).

VBGF parameters were also re-estimated during the Samed project (SAMED, 2002) using the MEDITS time series from 1994 to 1999, that gave the following values: females: CL_∞=45.0 mm, K=0.7, t_0= -0.15; males: CL_∞=40.0 mm; K=0.78; t_0= -0.2. Maximum carapace lengths (CL) observed for females and males were respectively 42.3 mm and 39 mm. The growth parameters from DCF (2006-2008) are as follows: females CL_∞=46 mm, K=0.575, t_0= -0.2; males CL_∞=40 mm, K=0.68, t_0= -0.25. They also describe a fast growing pattern albeit slightly lower than that previously observed. The length weight relationships by sex and for sex combined are as follows: females: a=0.935, b=2.452; males a=0.974; b=2.335 sex combined a=0.920; b= 2.445.

6.8.1.3. Maturity

The maturity ogive Fig. 6.3.1.3.1 was obtained from a maximum likelihood procedure applied grouping as mature individuals belonging to the maturity stage 2b-2e (according to the Medits maturity scale). The fitting of the curve was fairly good, however the estimates of the size at first maturity $L_{m50\%}$ (18.7 mm ±0.06 mm) and of the maturity range (0.31 mm ±0.009 cm), reported in the figure below, seem underestimated if compared with literature values (average of the smallest females 24 mm CL; in Relini et al., 1999).

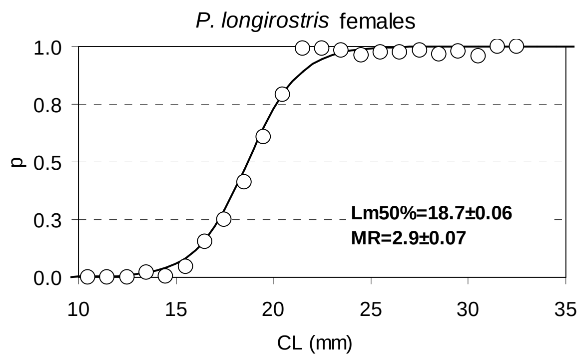


Fig. 6.8.1.3.1 Maturity ogive of pink shrimp in the GSA10 (MR indicates the difference $Lm_{75\%}$-$Lm_{25\%}$).

The sex ratio from DCF (2006-2008 data) evidenced the prevalence of males between 1.4 and 2.0 cm, while from 2.4 cm onwards the proportion of females was dominant (Fig. 6.3.1.3.2).

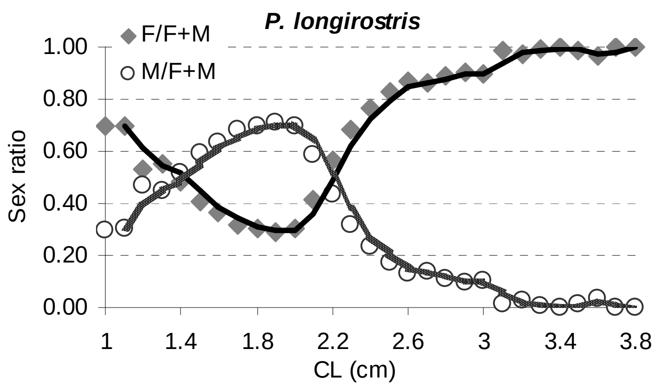


Fig. 6.8.1.3.2 Sex ratio over length of pink shrimp in the GSA10.

6.8.2. *Fisheries*

6.8.2.1. General description of the fisheries

The pink shrimp is only targeted by trawlers and fishing grounds are located on the soft bottoms of continental shelves and the continental slope along the coasts of the whole GSA. The pink shrimp occurs mainly with *M. merluccius*, *M. barbatus*, *Eledone cirrhosa*, *Illex coindetii* and *Todaropsis eblanae*, *N. norvegicus*, *P. blennoides*, depending on depth and area.

6.8.2.2. Management regulations applicable in 2010 and 2011

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 fishing fleet, the Italian fishing licenses have been fixed since the late eighties. Other measures on which the management regulations are based regard technical measures (mesh size) and minimum landing sizes (EC 1967/06).

After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity is implemented. Along northern Sicily coasts two main Gulfs (Patti and Castellammare) have been closed to the trawl fishery up 200 m depth, since 1990.

In the GSA 10 the fishing ban has not been mandatory along the time, and from one year to the other it was adopted on a voluntary basis by fishers, whilst in the last years it was mandatory.

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). One is located along the mainland, in front of Sorrento peninsula in the vicinity of the MPA of Punta Campanella (Napoli Gulf, 60 km^2, within 200 m depth) and a second one is along the coasts of Amantea (Calabrian coasts, 75 km^2 up to 250 m depth). In these areas trawling is forbidden and other fishing activities are allowed under permission. 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.

6.8.2.3. Catches

6.8.2.3.1.Landings

Available landing data are from DCF regulations. EWG 13-09 received Italian landings data for GSA 10 by fishing gears which are listed in Table 6.8.2.3.1. Almost all landings are from trawlers.

Table 6.8.2.3.1 Annual landings (in tons) by gear type, 2006-2012.

YEAR	GEAR	FISHERY	AREA	SPECIES	LANDINGS
2006	OTB		SA 10	DPS	1087.7
2007	OTB		SA 10	DPS	534.3
2008	OTB		SA 10	DPS	400.2
2009	OTB		SA 10	DPS	378.9
2010	OTB	DEMSP	SA 10	DPS	242.0
2010	OTB	DWSP	SA 10	DPS	3.1
2010	OTB	MDDWSP	SA 10	DPS	124.6
2010	Total		SA 10	DPS	369.7
2011	OTB	DEMSP	SA 10	DPS	282.5
2011	OTB	MDDWSP	SA 10	DPS	113.1
2011	Total		SA 10	DPS	395.6
2012	GNS	DEMF	SA 10	DPS	3.7
2012	OTB	DEMSP	SA 10	DPS	262.0
2012	OTB	DWSP	SA 10	DPS	15.3
2012	OTB	MDDWSP	SA 10	DPS	177.7
2012	Total		SA 10	DPS	458.6

The catches of the species in 2006 were 1088 tons, then declined to 370 tons in 2010 and increases until 2012 with 459 tons.

6.8.2.3.2.Discards

4 t of discards in 2006, 7 t in 2009, 3 t in 2010 and 2011 and 4.53 t in 2012 was reported to EWG 13-09 through the DCF data call. The discards are not included in the analysis because represent less than the 2 %.

6.8.2.3.3.Fishing effort

Trend in fishing effort (kW*days) for GSA 10 by gear type, for 2004 to 2010 as reported through the DCF official data call is in the Table 6.8.2.3.3.1.

Table 6.8.2.3.3.1 Trend in nominal effort (kW*days) for GSA10 by major gear types, 2004-2012. Data submitted through the DCF data call in 2013.

YEAR	OTB
2004	8070376
2005	8029362
2006	7500584
2007	7287211
2008	6080915
2009	6286555
2011	5595272
2012	6051158

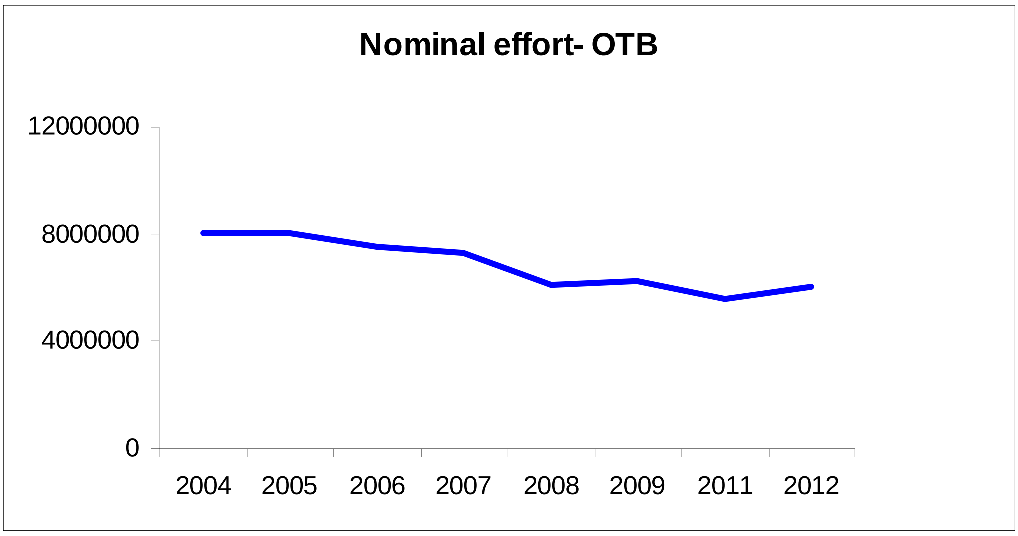


Figure 6.8.2.3.3.1 Trend in nominal effort (kW*days) for GSA10 by major gear types, 2004-2012.

6.8.3.*Scientific surveys*

6.8.3.1. BALAR and MEDITS surveys

6.8.3.2. MEDITS survey

6.8.3.2.1.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 10 the following number of hauls was reported per depth stratum (Tab. 6.8.3.1.1.1).

Tab. 6.8.3.1.1.1 Stratification of the hauls in MEDITS survey by year.

GSA 10	Year																		
Stratum	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
10-50 m	7	8	8	8	8	8	8	8	6	7	7	7	7	7	7	7	7	7	7
50-100 m	10	10	10	10	10	10	10	10	9	8	8	8	8	8	8	8	8	8	8
100-200 m	17	17	17	17	17	17	17	17	14	14	14	14	14	14	14	14	14	14	14
200-500 m	22	22	22	22	22	22	22	24	18	18	18	18	18	18	19	18	18	18	18
500-800 m	28	28	28	28	28	27	28	26	23	23	23	23	23	23	22	23	23	23	23
Total	84	85	85	85	85	84	85	85	70	70	70	70	70	70	70	70	70	70	70

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 (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 expressed in terms of 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, 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.

6.8.3.2.2. Geographical distribution patterns

Data on the the geographical distribution pattern of deepwater pink shrimp come from studies conducted in the area using trawl-survey data, length frequency distribution analyses and geostatistical methods (Lembo *et* *al*., 2000a). The indicator kriging approach combined with a persistence analysis showed that the nurseries of the pink shrimp were localised with higher level of probability offshore Cape Bonifati (Calabria coasts) Napoli and Salerno Gulfs between 100 and 200 m depth (Figure 6.8.3.1.2.1).

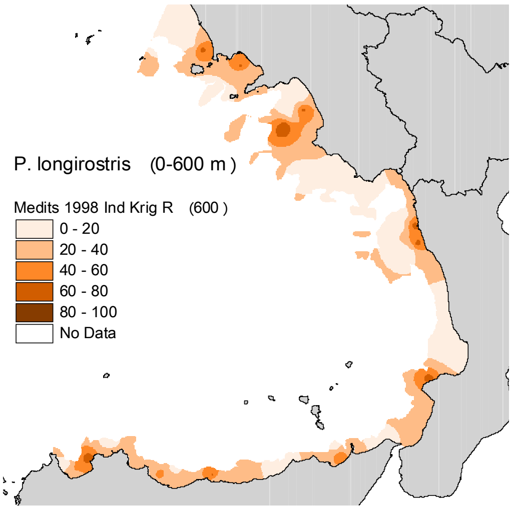


Fig. 6.8.3.1.2.1 Map of pink shrimp nursery area.

6.8.3.2.3.Trends in abundance and biomass

Fishery independent information regarding the state of pink shrimp in GSA 10 was derived from the international survey MEDITS. Figure 6.8.3.1.3.1 displays the estimated trend of *P. longirostris* abundance and biomass standardized to the surface unit in GSA 10. Indices from MEDITS trawl-surveys show two peaks in 1999 and 2005, but without any trend. From 2005 onwards the indices are decreasing and commercial catches follow a similar pattern. In 2012 there is another peak, slightly lower of 2005 peak.

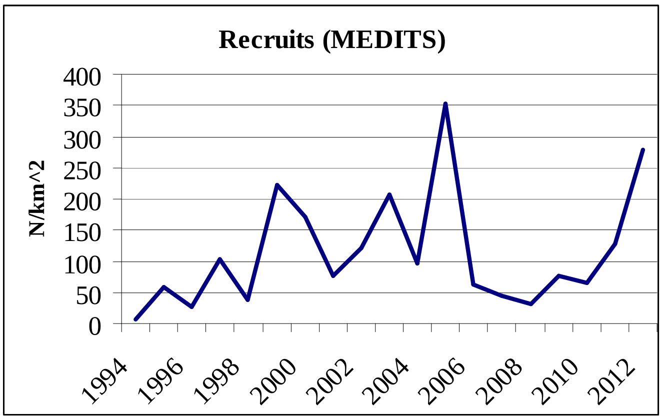
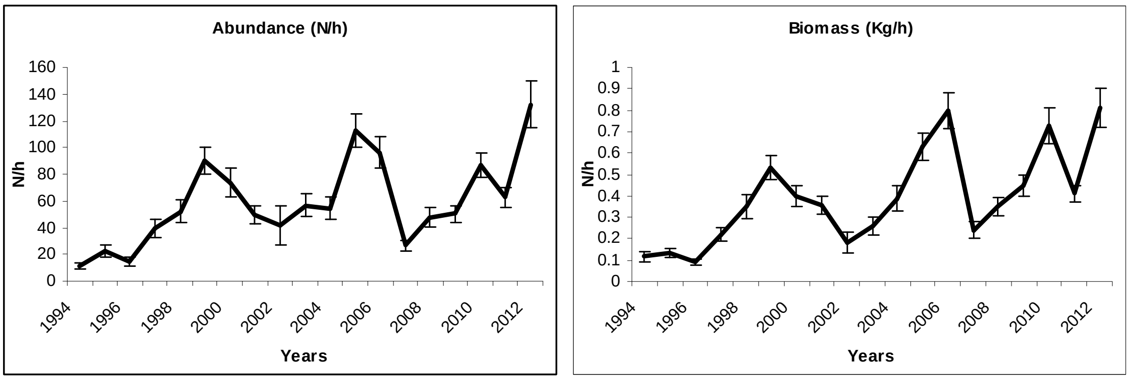


Fig. 6.8.3.1.3.1. Trends in recruitment (n/km^2) standardized to the surface unit.

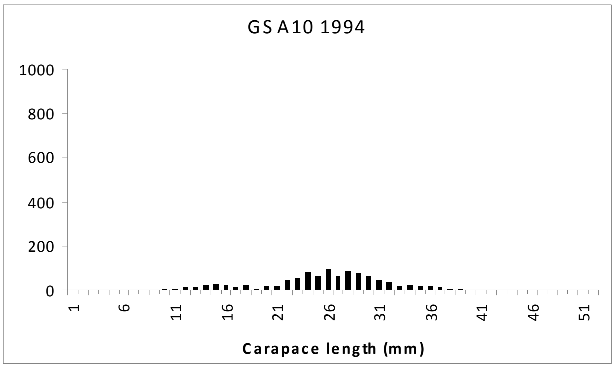
The re-estimated abundance indices (Figure 6.3.3.1.3.2) show the same temporal pattern.

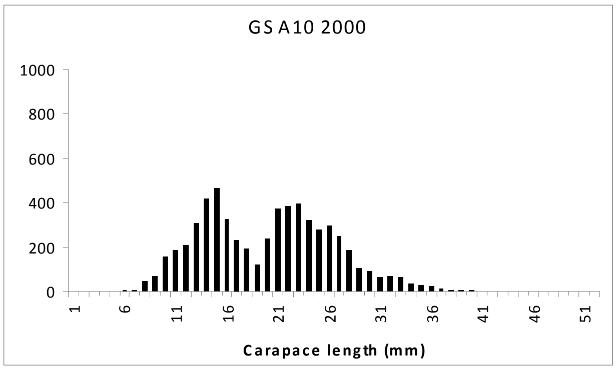


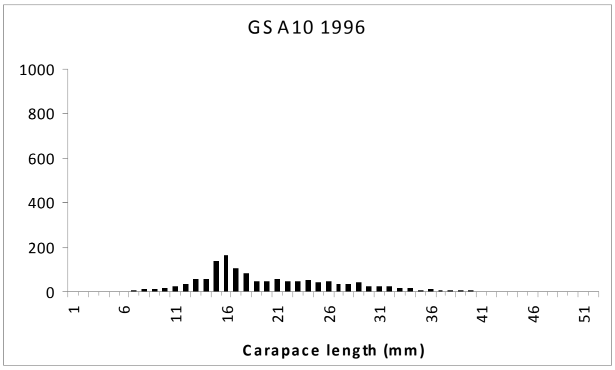
6.8.3.1.3.2 Trends in survey abundance and biomass indices (MEDITS) of pink shrimp in GSA 10. The standard deviation is also reported.

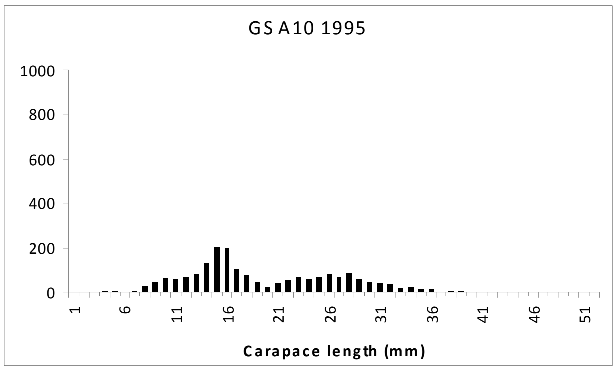
6.8.3.2.4.Trends in abundance by length or age

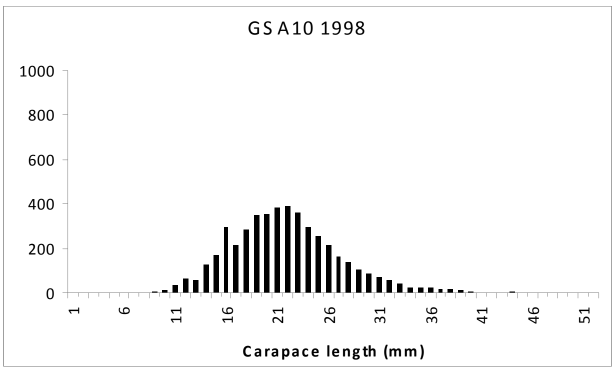
The following Fig. 6.8.3.1.4.1, 6.8.3.1.4.2, 6.8.3.1.4.3 display the stratified abundance indices of GSA 10 in 1994-2001, 2002-2009 and 2010-2012.

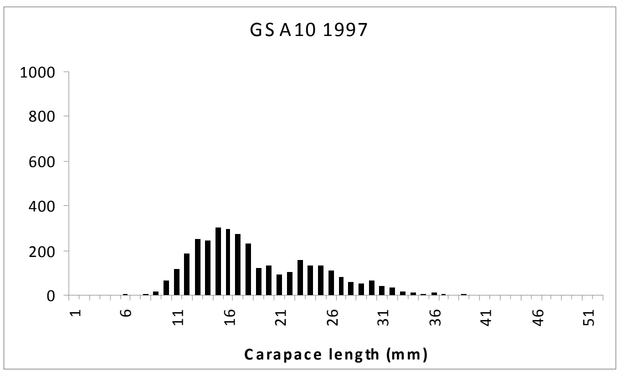












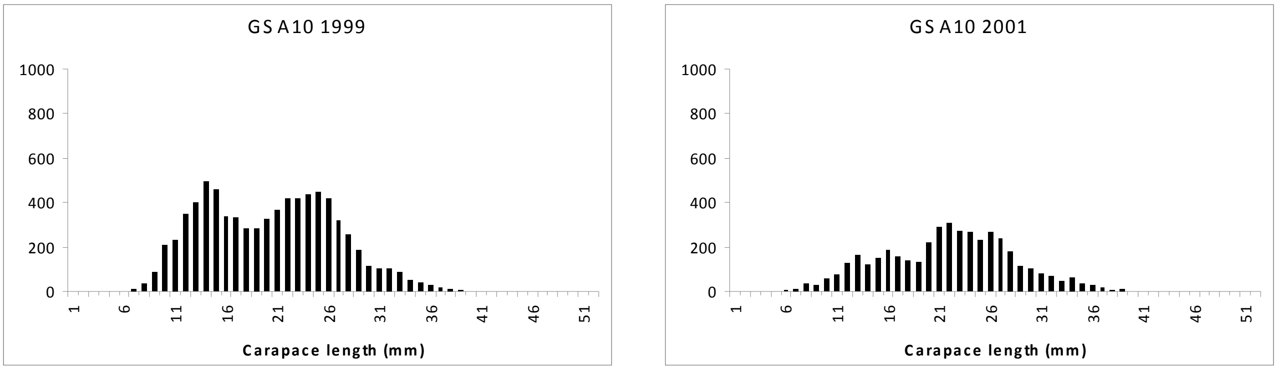
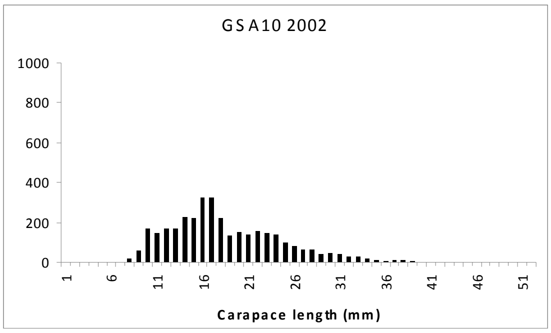
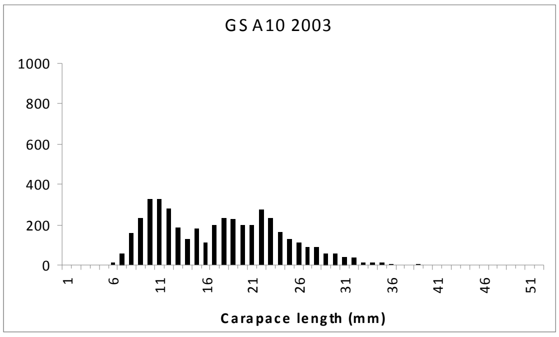
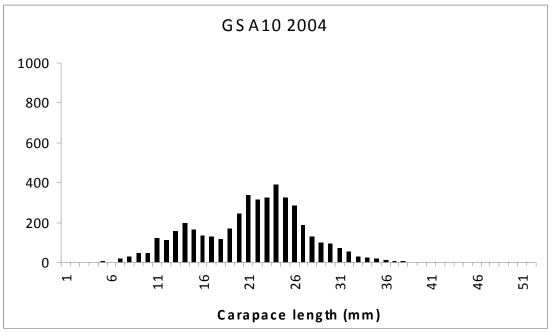
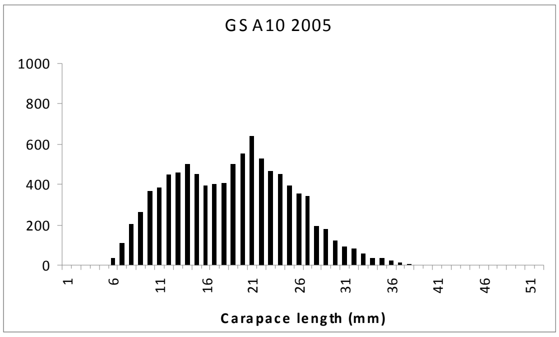


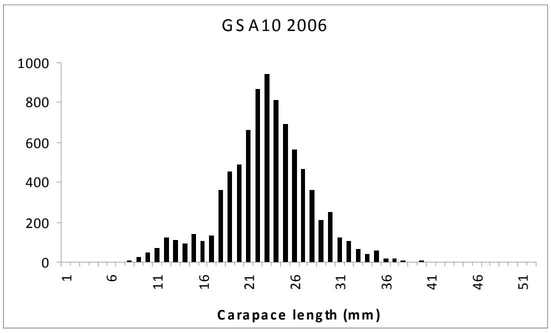
Fig. 6.8.3.1.4.1 Stratified abundance indices by size, 1994-2001.

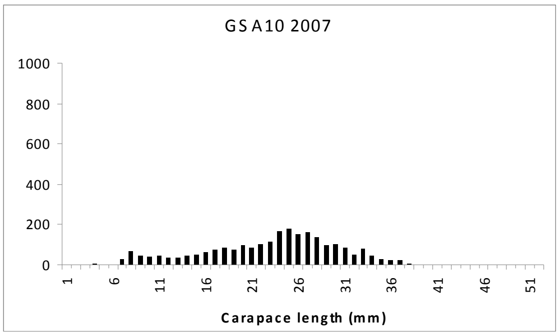

GSA10 2002
Carapace length (mm)

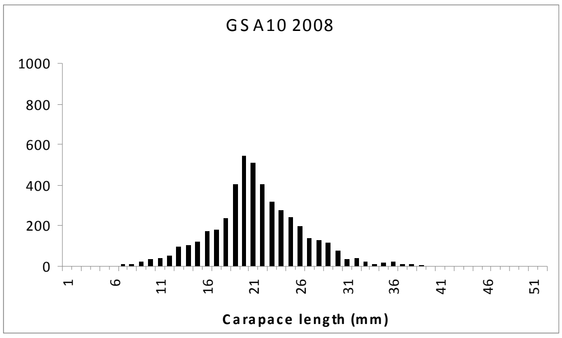

GSA10 2003
Carapace length (mm)


GSA10 2004
Carapace length (mm)


GSA10 2005
Carapace length (mm)


GSA10 2006
Carapace length (mm)


GSA10 2007
Carapace length (mm)


GSA10 2008
Carapace length (mm)

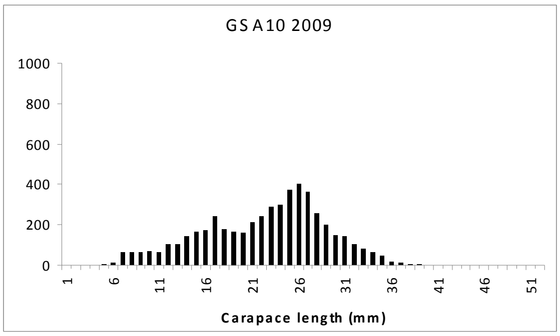

GSA10 2009
Carapace length (mm)

Fig. 6.8.3.1.4.2 Stratified abundance indices by size, 2002-2009.

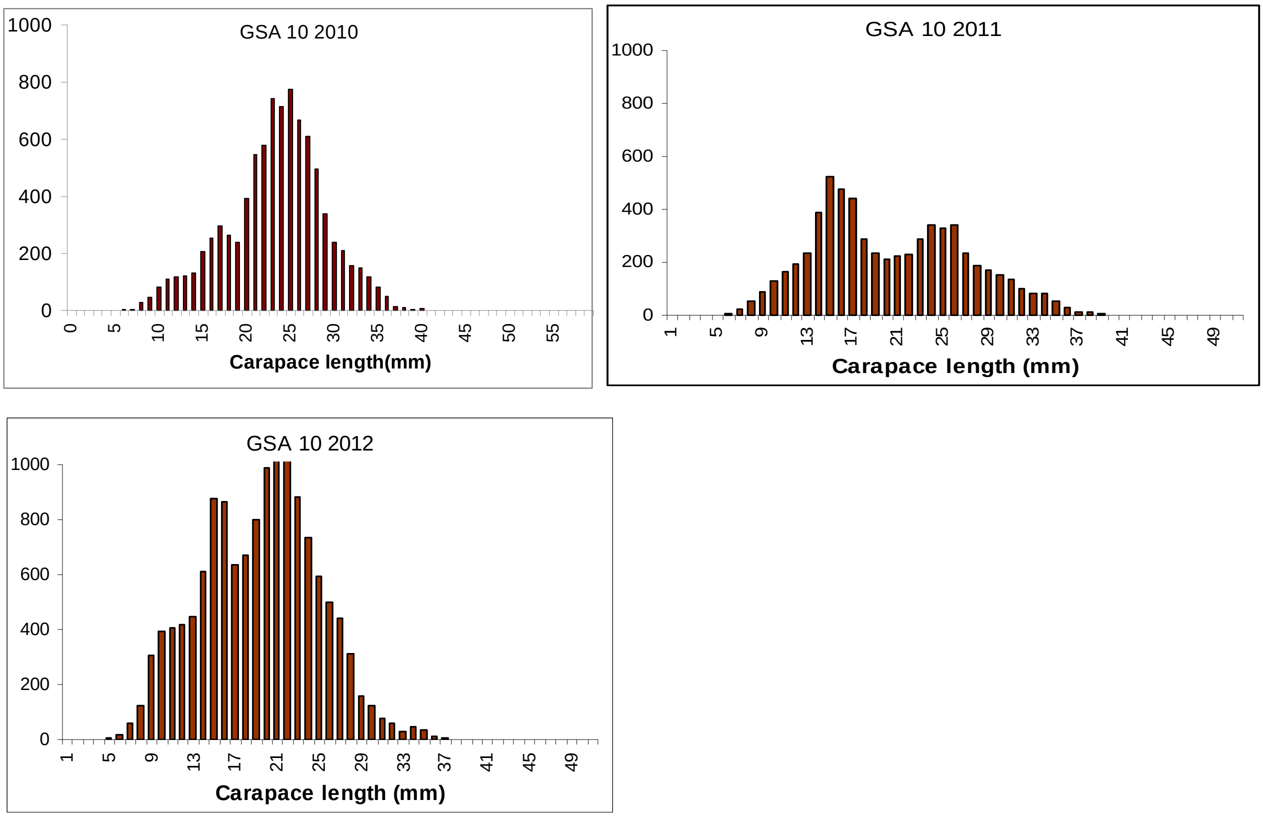


Fig. 6.8.3.1.4.3 Stratified abundance indices by size in 2010-2012.

No trend in the length indicators was observed in MEDITS survey (Figure 6.8.3.1.4.4) except for the quantiles that show a slightly rising trend.

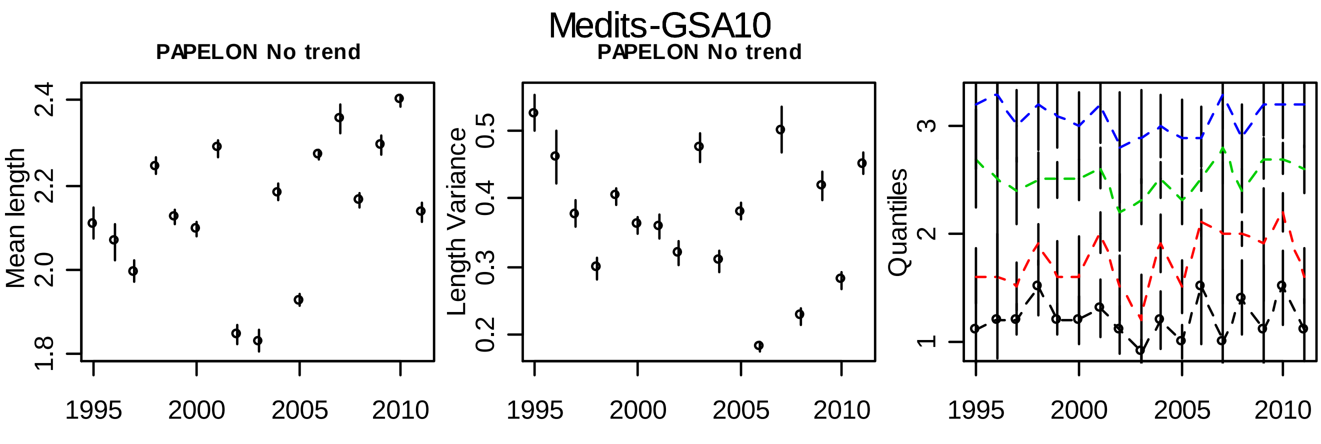


Fig. 6.8.3.1.4.4Mean length, variance and quantiles derived from the MEDITS length compositions.

6.8.3.3. GRUND survey

GRUND survey trends were estimated and are shown in the following sections.

6.8.3.3.1.Geographical distribution patterns

No analyses were conducted during EWG 13-09.

6.8.3.3.2.Trends in abundance and biomass

Trends derived from the GRUND surveys are shown in figure 6.3.3.2.3.1. Abundance and biomass indices as well as recruitment indices, show an increasing trend up to 2005 and a decreasing since 2006 (Figure 6.3.3.2.3.1). In 1999 the survey was not performed.

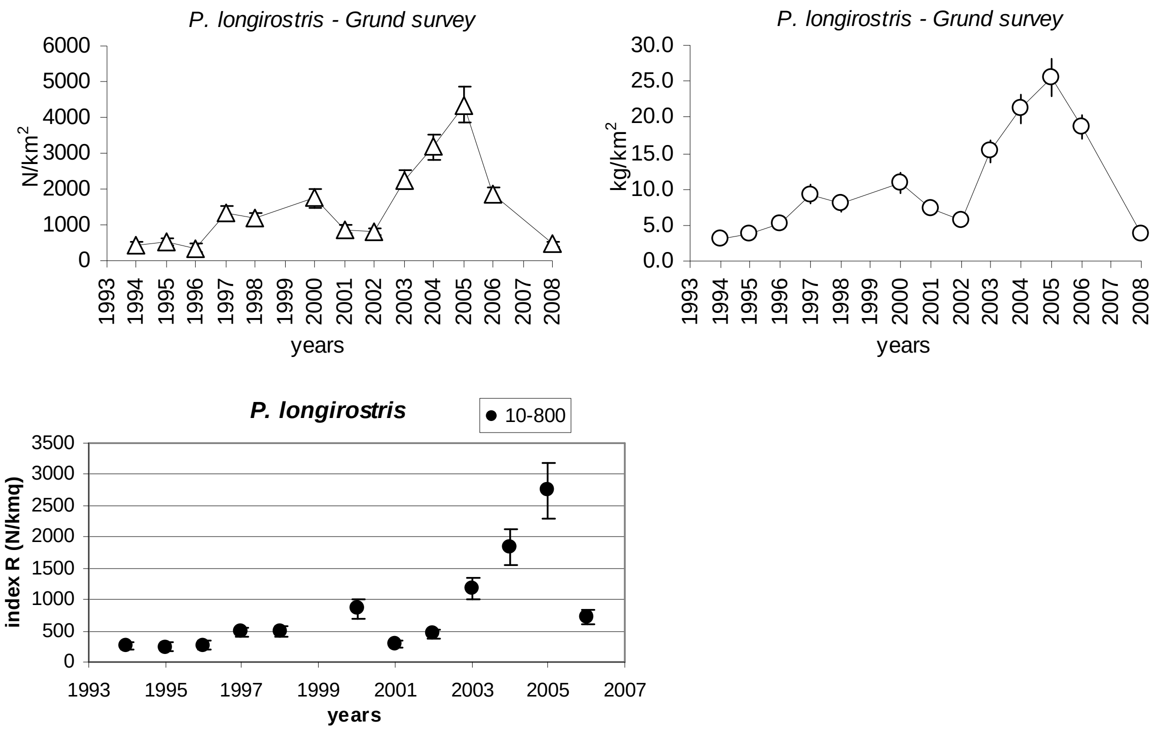


Fig. 6.8.3.2.2.1 Abundance and biomass indices of the pink shrimp in GSA 10 (bars indicate standard deviations) derived from GRUND surveys. Recruitment indices (n/km^2) computed in the total depth range with standard deviation is also reported.

6.8.3.3.3.Trends in abundance by length or age

Also time series of length structures of GRUND from 1994 to 2006 (Figure 6.8.3.2.3.1) did not show any trend.

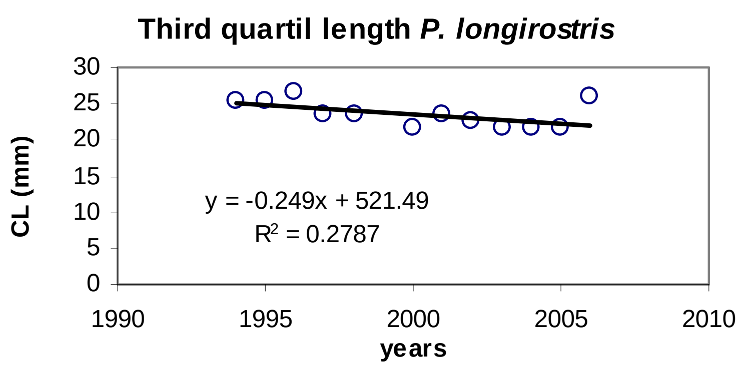


Fig. 6.8.3.2.3.1. III Quantile derived from the GRUND length structures in 1994-2006.

6.8.3.3.4.Trends in growth

No analyses were conducted during EWG 13-09.

6.8.3.3.5.Trends in maturity

No analyses were conducted during EWG 13-09.

6.8.4.*Assessment of historic stock parameters*

EWG 13-09 applied the XSA model to commercial landings and MEDITS survey data.

6.8.4.1. Method 1: XSA

6.8.4.1.1.Justification

The assessment of pink shrimp in GSA10 has been performed during this EWG 11-20 with VIT; during EWG 13-09 the assessment has been performed for the first time with XSA method. In the last data call 2013 the data from 2006 to 2012 have been provided; the time series from 2006 to 2012 has been considered covering more than the mean life span of the species, allowing to make an attempt of stock assessment with XSA method. XSA was applied using the landing structures at age and MEDITS survey data from 2006 to 2012.

6.8.4.1.2. Input parameters

For the assessment of pink shrimp stock in GSA10 the DCF official data on the age structure and landing of commercial catch have been used. A sex combined analysis was carried out using the following growth parameters:

CL_{∞} = 4.6 cm, K= 0.575, t_0= -0.2; length-weight relationship (cm-g): a = 0.935, b = 2.4523.

The maturity at age has been derived by the maturity at length by age slicing procedure.

The natural mortality has been calculated using PRODBIOM method (Abella,1998).

The age distribution is showed in the graph and in the table below:

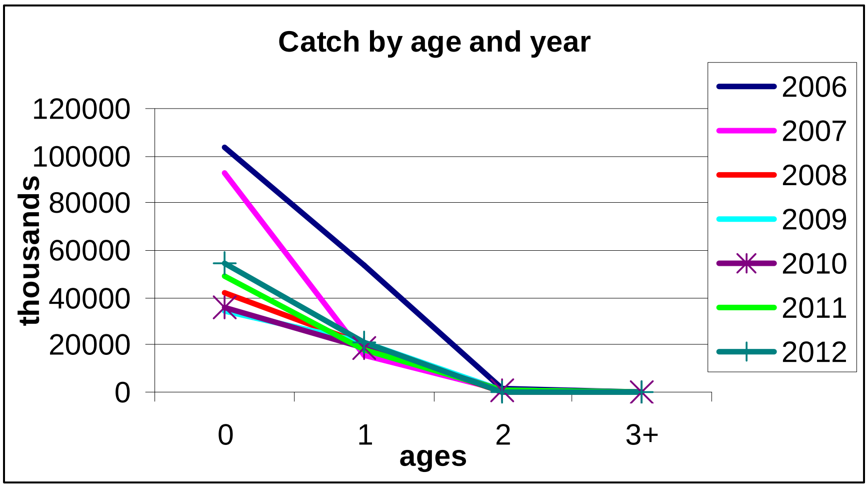


Fig. 6.8.4.1.2.1 Catch in numbers by age and year used in XSA.
The other input are reported in the tables below:

Tab. 6.8.4.1.2.1 Catch in numbers by age and year used in XSA.

Catch in numbers (thousands)	age 0	age 1	age 2	age 3+
2006	103439	53653	1555	0
2007	92569	15893	1116	5
2008	42453	20518	312	0
2009	34289	21334	453	0
2010	36007	18714	491	3
2011	49392	17906	456	0
2012	54559	21207	243	34

Tab. 6.8.4.1.2.2 Weights at age by age and year used in XSA (used for the stock and the catch).

Weight at age (kg)	Age 0	age 1	Age 2	age 3+
2006	0.006	0.01	0.02	0.026
2007	0.004	0.011	0.021	0.026
2008	0.005	0.01	0.021	0.026
2009	0.005	0.01	0.02	0.027
2010	0.005	0.01	0.021	0.0275
2011	0.005	0.01	0.021	0.026
2012	0.0045	0.01	0.02	0.0275

Tab. 6.8.4.1.2.3 Indices from Medits survey used in XSA.

Survey indices (n/km^2)	age 0	age 1	Age 2	Age 3
2006	458.23	494.46	14.04	0.21
2007	116.54	128.17	18.67	0.74
2008	297.47	160.07	10.70	0.55
2009	236.04	256.79	20.95	1.26
2010	338.31	499.75	42.17	1.21
2011	390.59	230.06	26.13	1.00
2012	964.18	395.94	13.13	0.05

Tab. 6.8.4.1.2.4 Proportion of mature at age used for XSA.

Maturity			
Age 0	**Age 1**	**age 2**	**age 3+**
0.47	0.98	1	1

Tab. 6.8.4.1.2.5 Natural mortality at age for XSA.

Natural mortality			
age 0	**age 1**	**age 2**	**Age 3+**
1.41	0.81	0.7	0.7

6.8.4.1.3.Results

The XSA run with the following settings has been performed:

- Catchability dependent on stock size for all ages;
- Catchability independent of age for ages > 1;
- S.E. of the mean to which the estimates are shrunk = 2;
- Minimum standard error for population estimates derived from each fleet = 0.300.

Four different runs have been performed, changing the S.E. of the mean to which the estimates are shrunk from 0.5 to 2 with a step of 0.5. and the run with 2 has been chosen on the basis of the residuals and of the retrospective analysis.

The log-catchability residuals of XSA are listed in the table below:

Tab. 6.8.4.1.3.1 Log-catchability residuals of XSA.

Age	2006	2007	2008	2009	2010	2011	2012
0	0.495	-1.05	-0.022	-0.1	0.32	0.234	0.112
1	-0.113	-0.301	-0.472	-0.258	0.635	0.281	0.192
2	-0.291	-0.062	0.032	0.055	0.074	0.053	0.025

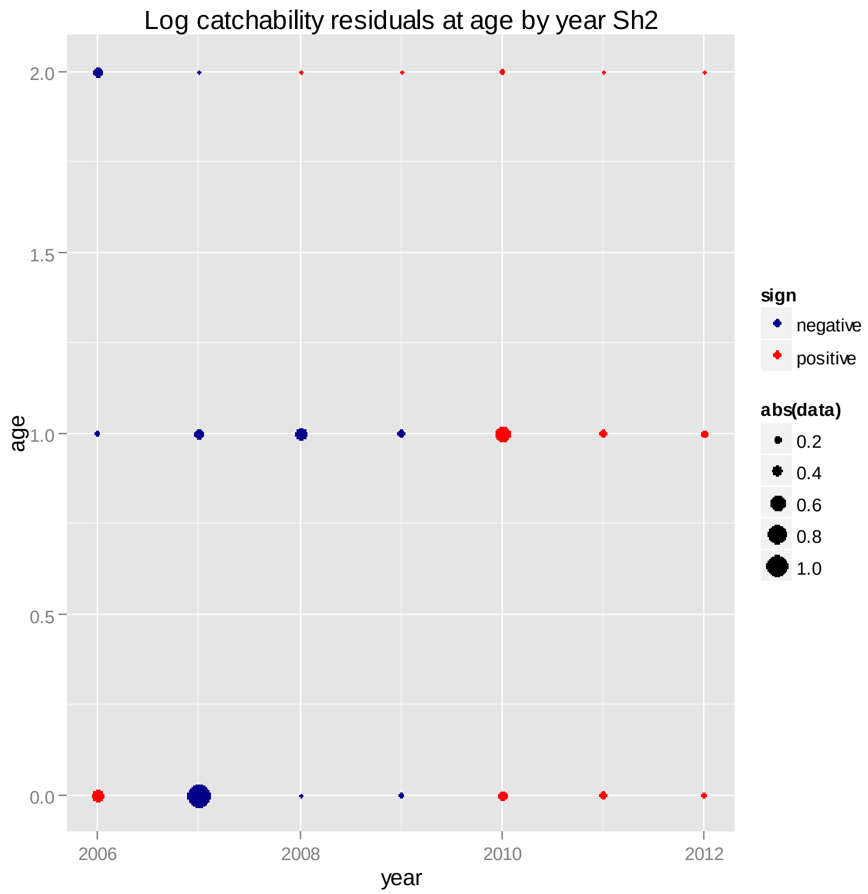


Fig. 6.8.4.1.3.1 Log-catchability residuals (XSA).

The residuals do not seem show any trend and are very small. The other results produced by XSA are:

Tab. 6.8.4.1.3.2 Fishing mortality by year estimated with XSA.

Fishing mortality	2006	2007	2008	2009	2010	2011	2012
0	1.11	0.873	0.469	0.444	0.491	0.532	0.221
1	3.058	2.975	2.768	2.449	2.588	3.153	2.464
2	2.838	2.278	1.495	1.212	0.73	1.016	1.041
3+	2.838	2.278	1.495	1.212	0.73	1.016	1.041
$\mathbf{F_{(0\text{-}2)}}$	2.34	2.04	1.58	1.37	1.27	1.57	1.24

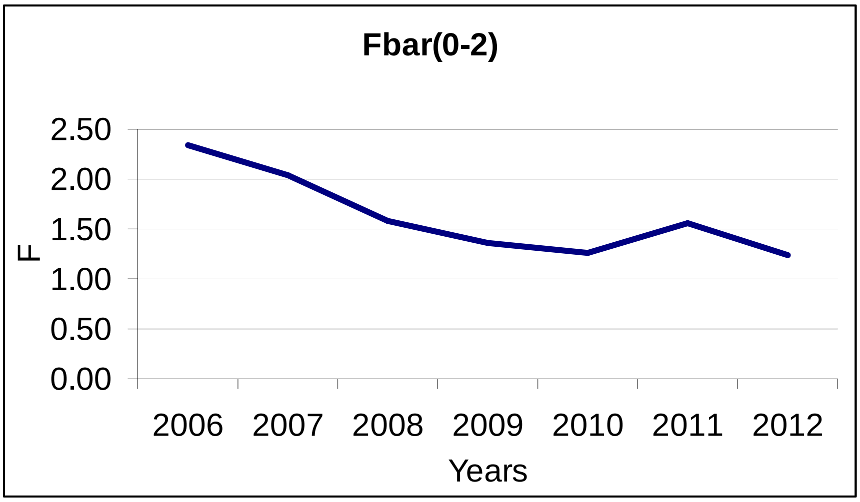


Fig. 6.8.4.1.3.2 Estimated fishing mortality by year (F(0-2)).

Tab. 6.8.4.1.3.3 Stock in numbers (thousands) estimated by age and year.

Stock numbers (thousands)	2006	2007	2008	2009	2010	2011	2012
0	312192	321786	229317	193669	187739	242302	557622
1	84409	25110	32823	35010	30340	28044	34751
2	2344	1765	570	916	1345	1015	533
3+	0	7	0	1	9	0	69
TOTAL	398945	348668	262710	229596	219433	271361	592975

Tab. 6.8.4.1.3.4 Recruits (thousands), Total biomass (tons), SSB, Landings(tons), Y/SSB.

YEAR	**RECRUITS (age 0)**	**TOTALBIO**	**TOTSPBIO**	**LANDINGS**	**YIELD/SSB**
2006	312192	2764	1754	1088	0.62
2007	321786	1601	913	534	0.59
2008	229317	1487	873	400	0.46
2009	193669	1337	817	379	0.46
2010	187739	1271	767	370	0.48
2011	242302	1513	866	396	0.46
2012	557622	2869	1532	459	0.30

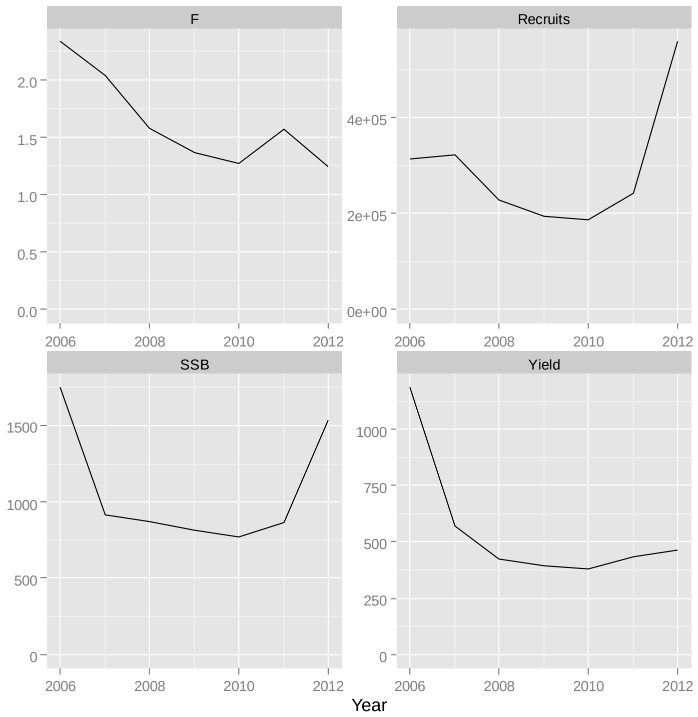


Fig. 6.8.4.1.3.3. Estimated recruitment, SSB, F current and yield by year.

The retrospective analysis shows a tendency to underestimate F, and slightly overestimate SSB and R.

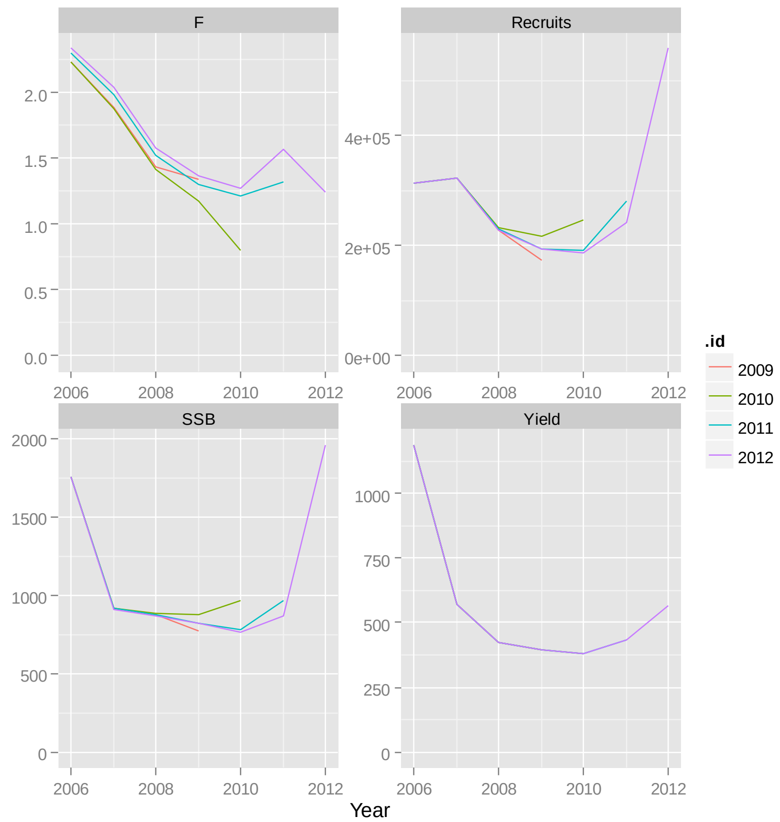


Fig. 6.8.4.1.3.4 Retrospective analysis (XSA) results.

The results obtained with XSA method showed a decreasing pattern in SSB (from 1754 in 2006 to 866 tons in 2011) except for 2012 where SSB increases to 1960 tons. Recruitment shows a decrease until 2010 and a pick in 2012. The F shows a decrease in time from 2.34 in 2006 to 1.24 in 2012.

6.8.5. *Long term prediction*

6.8.5.1. Justification

The reference point $F_{0.1}$ have been recalculated on the XSA results, using FLBRP package.

6.8.5.1.1. Input parameters

Input parameters are given in section 6.8.4.1.2 of this report.

6.8.5.1.2. Results

The reference point calculated during STECF EWG 11-20 with Yield package was 0.66 and with VIT was 0.71. Using FLBRP package on XSA results, the $F_{0.1}$ is 0.93.

6.8.6. *Data quality*

Data from DCF 2013 were used. Assessments were performed using the new submitted time series. A consistent sum of products compared to landings was observed (differences less than 10% for age data and less than 5% for length data). Discards data of 2006, 2009, 2010, 2011 and 2012 were available. In 2010, 2011 and 2012 data were provided by year gear and fishery. 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. MEDITS data used for this assessment have been provided directly by the scientists, given some difficulties in getting outputs from the JRC database.

6.8.7. *Scientific advice*

6.8.7.1. Short term considerations

6.8.7.1.1. State of the stock size

In the absence of proposed and agreed precautionary management references, EWG 13-09 is unable to fully evaluate the status of SSB. Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h) that was increasing in the last years. MEDITS indices indicate a sharp decrease from 2006 to 2007 and increase until 2012 that is the higher value of the abundance and biomass time series. GRUND data showed a decrease of abundance and biomass from 2005 to 2006 after a rising phase.

6.8.7.1.2. State of recruitment

Recruitment estimates from GRUND surveys showed a decrease in abundance from 2005 to 2006 after a rising phase from 2002 to 2005, whilst recruit indices from MEDITS show peaks in 1999, 2003, 2005 and 2012.

6.8.7.1.3. State of exploitation

EWG 13-09 proposes $F \leq 0.93$ as limit management reference point (basis $F_{0.1}$ as proxy of F_{MSY}) of exploitation consistent with high long term yield. Given the results of the present analysis (F_{curr} (2012) = 1.24), the stock is considered exploited unsustainably.

6.8.7.2. Management recommendations

EWG 13-09 recommends the relevant fleets catches and/or effort to be reduced to reach the proposed level $F_{0.1}$, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan. However the dynamics of this species seems also influenced by environmental changes.

6.9. STOCK ASSESSMENT OF HAKE IN GSA 11

6.9.1. *Stock identification and biological features*

6.9.1.1. 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.

6.9.1.2. Growth

The same fast growth of the previous SGMED meetings have been used in this assessment (L_∞=100,7 cm, K=0.248, t_0= -0.01).

6.9.1.3. Maturity

Due to the low catchability of large hake in the 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).

6.9.2. *Fisheries*

6.9.2.1. General description of fisheries

Population dynamic of hake in GSA 11 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.

6.9.2.2. 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 enforced almost every year.

The use of trawl nets is not allowed within 1,5 nautical miles of the coast (EU council regulation No 1967/2006).

6.9.2.3. Catches

6.9.2.3.1.Landings

Landings available for GSA 11 by major fishing gears are listed in Tab. 6.9.2.3.1.1.

Landings decreased from 867 t (2005) to 260.5 t in 2009 and then remain low (Figure 6.9.2.3.1.1). Landings of hake are mostly taken by the demersal trawl fisheries (OTB), which in average account for about 86% of the total. The remaining landings is taken by the GTR and LLS (Tab. 6.9.2.3.1.1).

Tab. 6.9.2.3.1.1 Landings (t) by year and major gear types, 2005-2012 as reported through DCF in 2013.

GEAR	2005	2006	2007	2008	2009	2010	2011	2012
GTR	101.6	206		28.6		87.9	102.3	67.6
LLS					7,02			0.8
OTB	765.4	593.8	442	278.7	260.5	329.9	286.8	286.5
Total landings	867.0	799.8	442.0	307.3	260.5	417.8	389.1	354.9

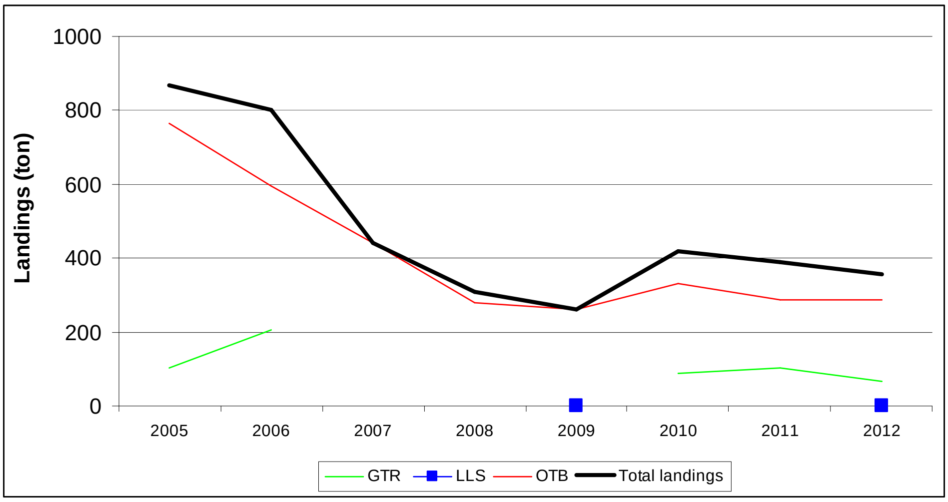
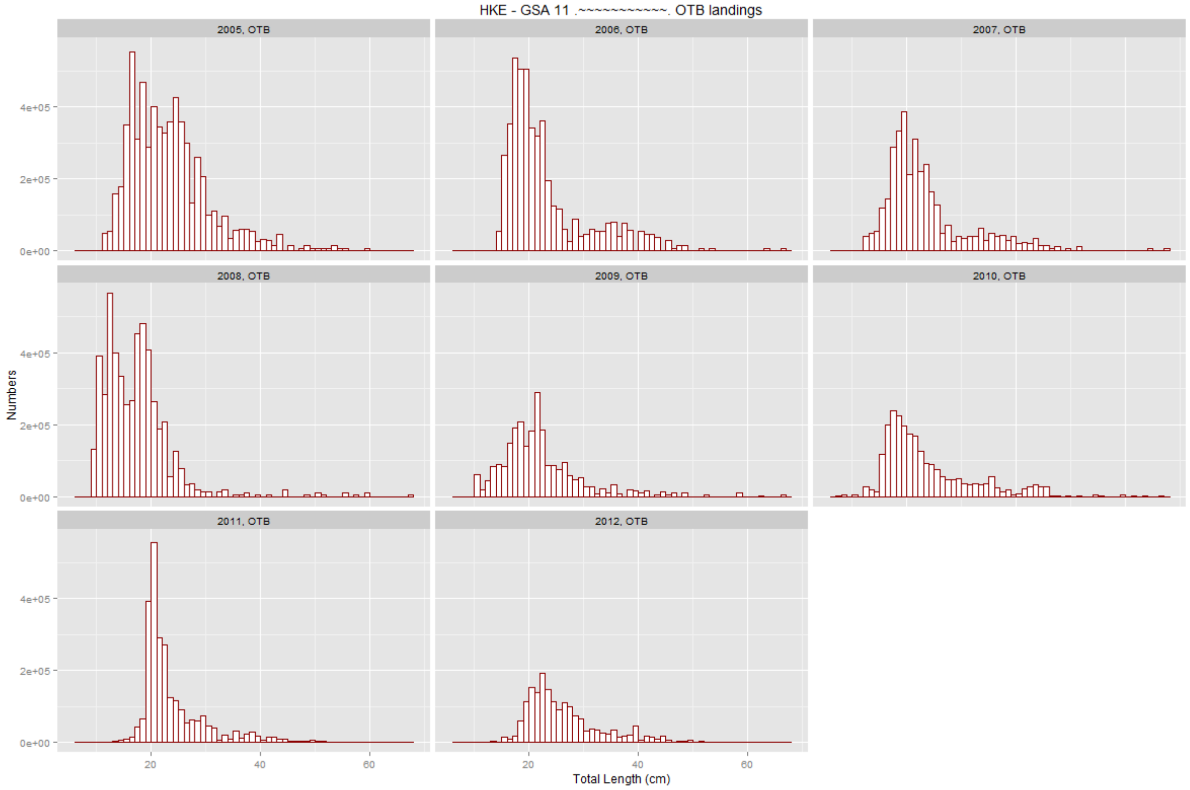


Figure 6.9.2.3.1.1. Landings (t) of hake in GSA 11 by year and major gear types, 2005-2012 as reported through DCF.

Data at length, shows for the OTB a variable structure of the landings LFD and relative quantities. In all years GTR and LLS landings are likely to derive from few samples (Figure 6.9.2.3.1.2).



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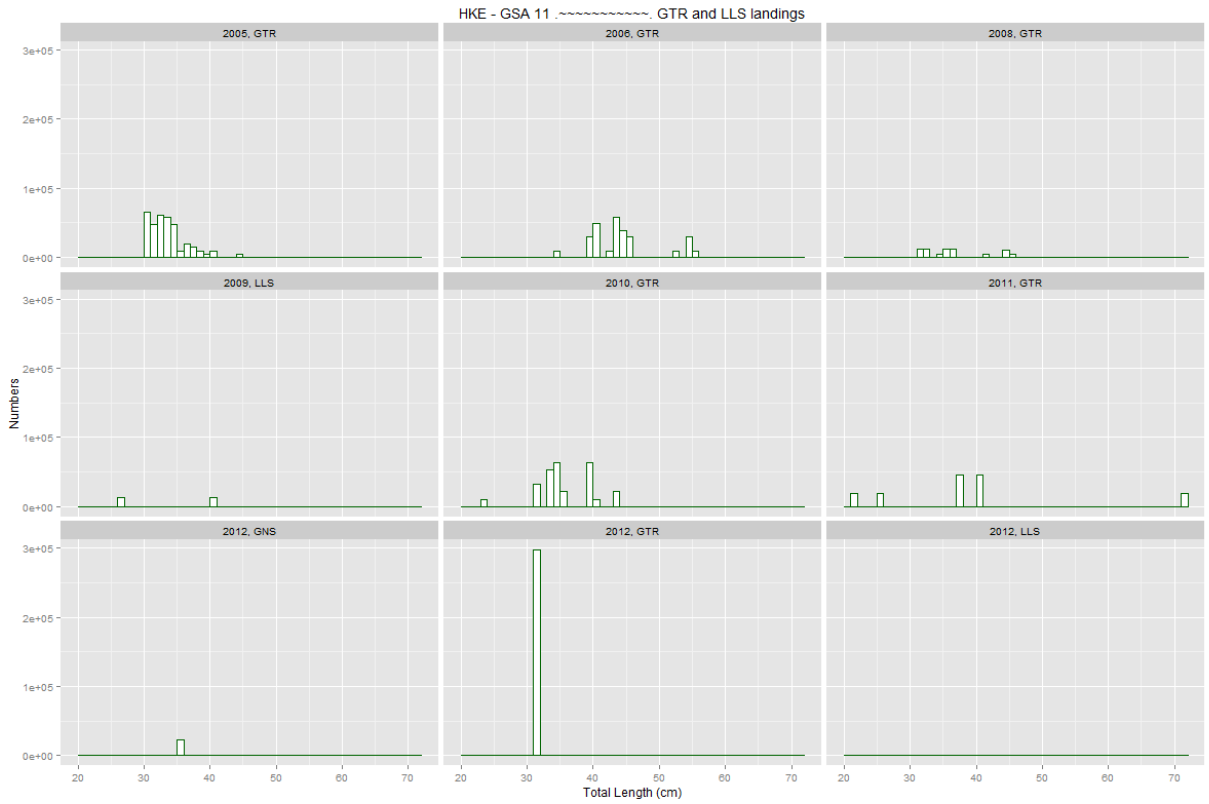


B

Figure 6.9.2.3.1.2. Landings by length, gear(A=OTB, B=GTR and LLS) and year (2005-2012) as reported through DCF.

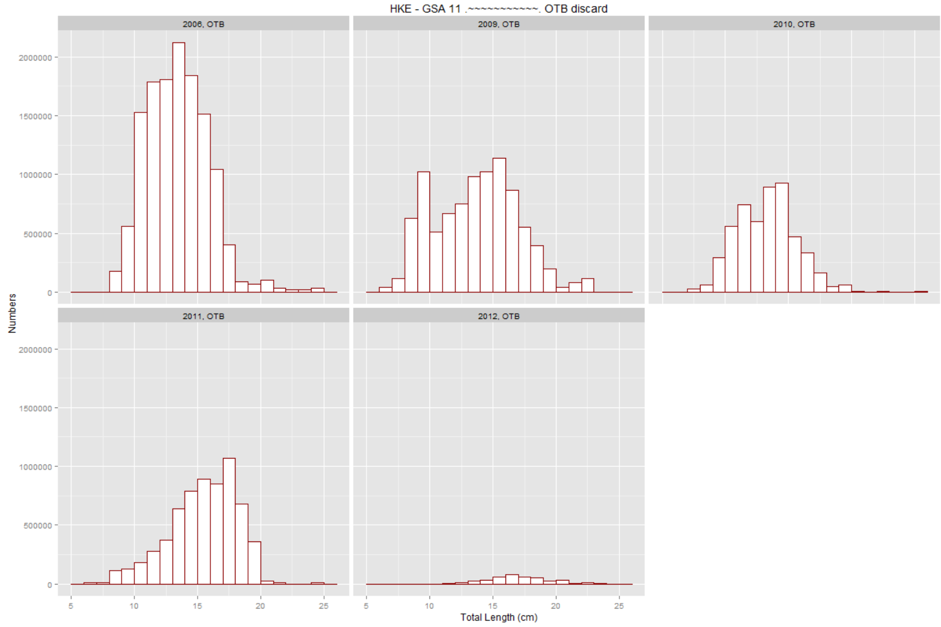
6.9.2.3.2. Discards

Discards reported to STECF EGW 12-10 were null for 2007 and 2008 as shown in Tab. 6.9.2.3.2.1. The decrease in discards observed in 2010 reflect the drop observed in the same period for the total landings, while the very high increase in discards reported in 2011 seems to be not realistic as it is more then 10 times greater of previous years. The pattern of abundances from the survey (MEDITS) in 2011 does not show any peak in recruitment nor in increase. Moreover, it seems not realistic that in 2011 OTB discards are 90% and OTB landings account only for 10% of the total catches of hake in GSA 11.

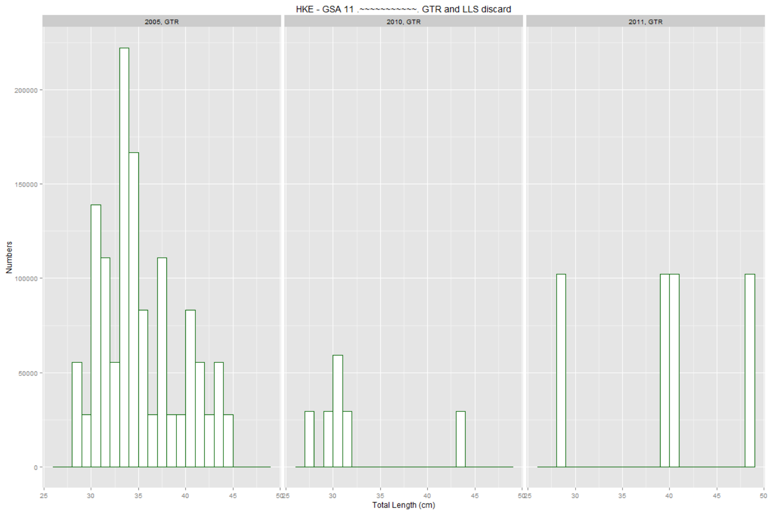
Tab. 6.9.2.3.2.1 Discards (t) by year, 2005-2012, as reported through DCF in 2013.

GEAR/YEAR	2005	2006	2007	2008	2009	2010	2011	2012
GTR	386.9	0	0	0		43.6	203.2	
OTB		233.9			168.5	81.8	1742.7	13.7
total discards	386.9	233.9	0	0	168.5	125.4	1945.9	13.7

Discard at length (figure 6.9.2.3.2.1) data were neither continuous by gear nor by year. Moreover the discard from GTR belongs to large size specimens, which usually are not discarded by other commercial fleets (Figure 6.9.2.3.2.1 a).



A



B

Figure 6.9.2.3.2.1. Discards (t) by length, year (2005-2012) and major gear types (A=OTB, B=GTR), as reported through DCF.

6.9.2.4. Fishing effort

The reported fishing effort values through the DCF data call were modified and updated for 2012.

Using data available to EGW-12-19, the trends in fishing effort by year and major gear type is listed in table 6.9.2.4.1 and shown in figure 6.9.2.4.1 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 minor increases in small scale fishery occur.

Table 6.9.2.4.1. Trend in nominal effort (kW*days) for GSA 11 by major gear types, 2004-2012. Data submitted through the DCF data call in 2012.

AREA	GEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012
SA 11	FPO	42030	77070	968055	1498812	946113	1061601		1776625	1497021
SA 11	FYK				4639				720	
SA 11	GNS	1157504	1027658	213439	778308	468615	1003413		320583	546139
SA 11	GTR	6546696	7186648	7221990	4932513	3756557	4110927		4425145	3824346
SA 11	LLD	108572	273844	468325	1311593	986310	533859		975176	1215442
SA 11	LLS	1048740	941723	1330567	1139974	654795	673775		442194	545670
SA 11	LTL			6941	2914	589	566			
SA 11	none	18500	786	67648	146165	65247	44038		17027	16347
SA 11	OTB	7706431	7324728	5752588	5867826	4358287	4380138		3823252	3824269
SA 11	PS	27293								

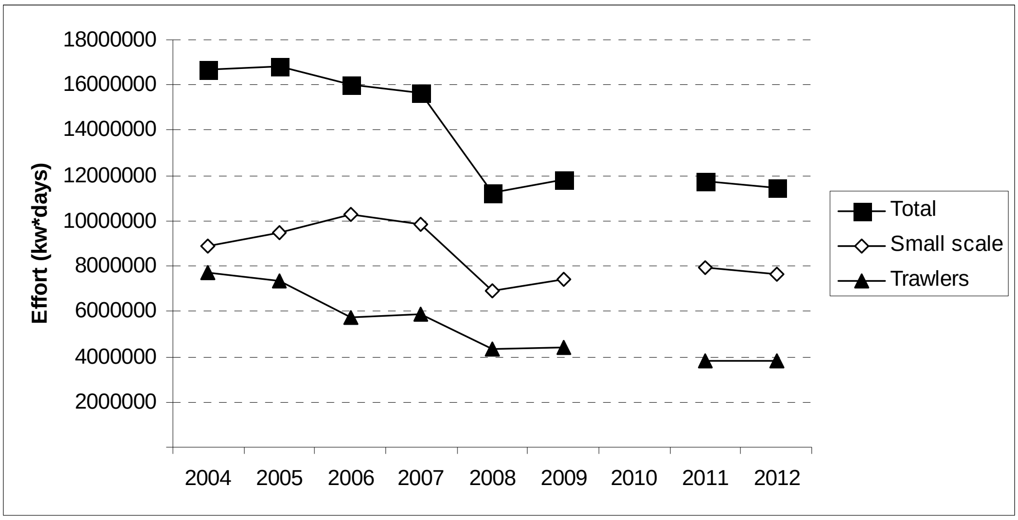


Figure 6.9.2.4.1. Trend in fishing effort (kW*days) for the Italian fleet in GSA 11 for the major gear types in 2004-2011.

6.9.3. *Scientific surveys*

6.9.3.1. MEDITS

6.9.3.1.1. 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 standardised to square kilometre, using the swept area method.

In GSA 11 the following number of hauls was reported per depth stratum (s. Tab. 6.9.3.1.1.1).

Tab. 6.9.3.1.1.1. Number of hauls per year and depth stratum in GSA 11, 1994-2012.

GSA 11 STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
010-050	17	19	21	21	21	21	19	18	20	18	17	17	19	19	17	18	19	20	20
050-100	28	21	23	23	21	22	22	24	19	19	18	22	19	20	19	20	19	19	19
100-200	22	23	30	31	31	30	31	30	24	24	24	24	24	24	22	24	24	24	24
200-500	35	29	29	26	25	27	24	25	20	24	21	20	20	20	21	19	20	21	21
500-800	23	16	22	25	25	24	27	26	16	14	15	14	16	17	16	16	17	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 around the stratified mean is 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 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. Given the sheer number of plots generated, these distributions are not presented in this report.

Length distributions represent the number of individual per km^2 (Cochran, 1977).

6.9.3.1.2. 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).

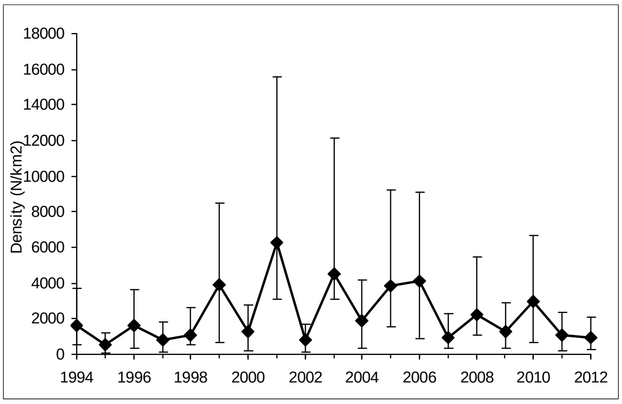
On average, considering the analyzed yearly distributions (1994-2005), the recruits were considered individuals smaller than 12.3 cm (±1.41). These individual are belonging to the age 0 group. Persistence of the nursery areas along the years was studied by applying indicator kriging technique (Journel 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.

6.9.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of hake in GSA 11 was derived from the international survey MEDITS. Figure 6.9.3.1.3.1 displays 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 variability is evident.

The estimated abundance and biomass indices since 1999 show high variation without any trend.



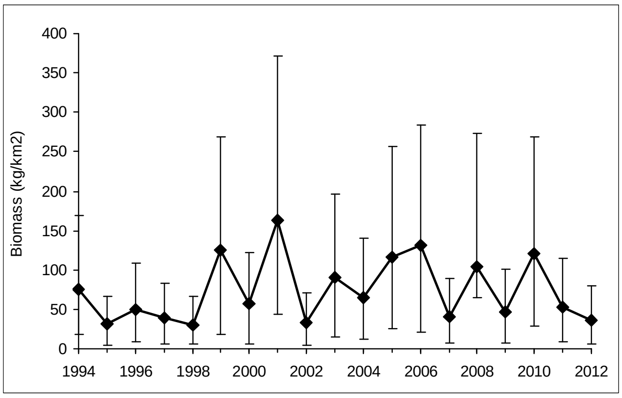


Figure 6.9.3.1.3.1. Abundance and biomass indices of hake in GSA 11.

6.9.3.1.4. Trends in abundance by length or age

Boxplots and histograms of the MEDITS standardized length frequencies distributions (LFD) are shown in Figure 6.9.3.1.4.1. All distributions are characterized by several outliers. The median show a small variability, as well as a small variation of the degree of dispersion along the time series. The greater variability is to account to the total abundances (box sizes are proportional to numbers).

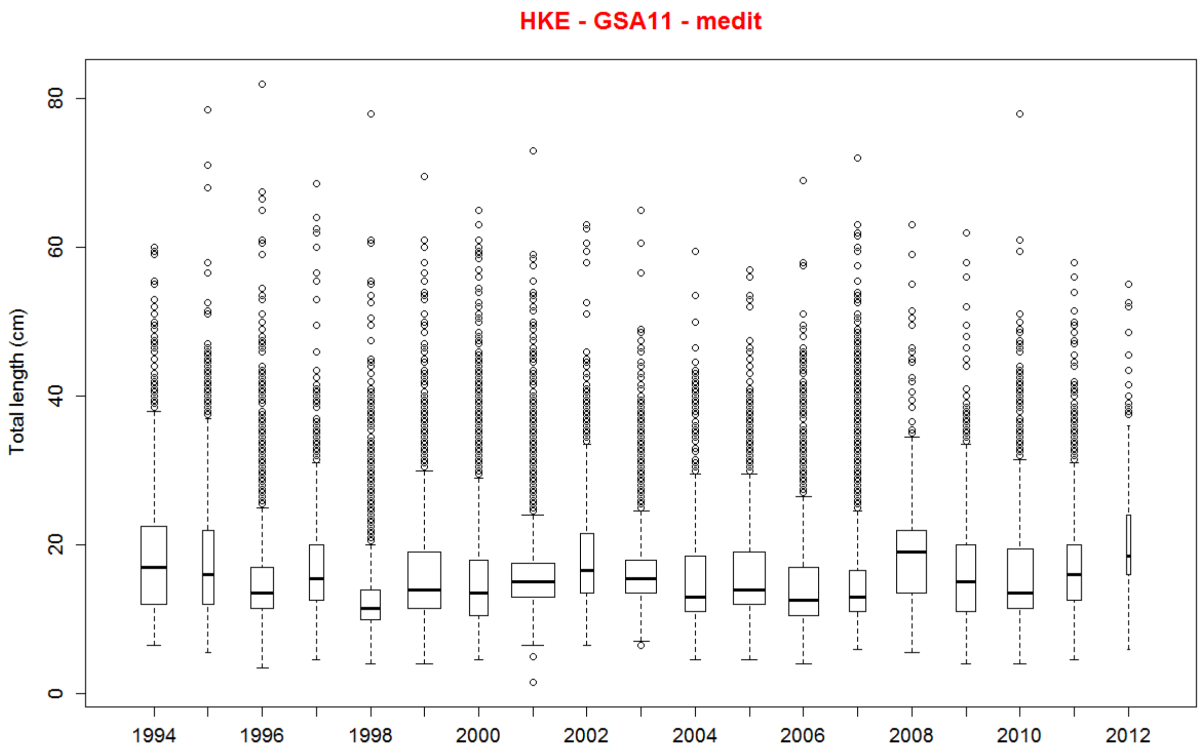


Figure 6.9.3.1.4.1 *M. merluccius*: Boxplot of the stratified length frequency distributions in GSA11 (MEDITS).

The following figure x.x.3.1.4.2 display the stratified abundance indices of GSA 11 (1994-2011).

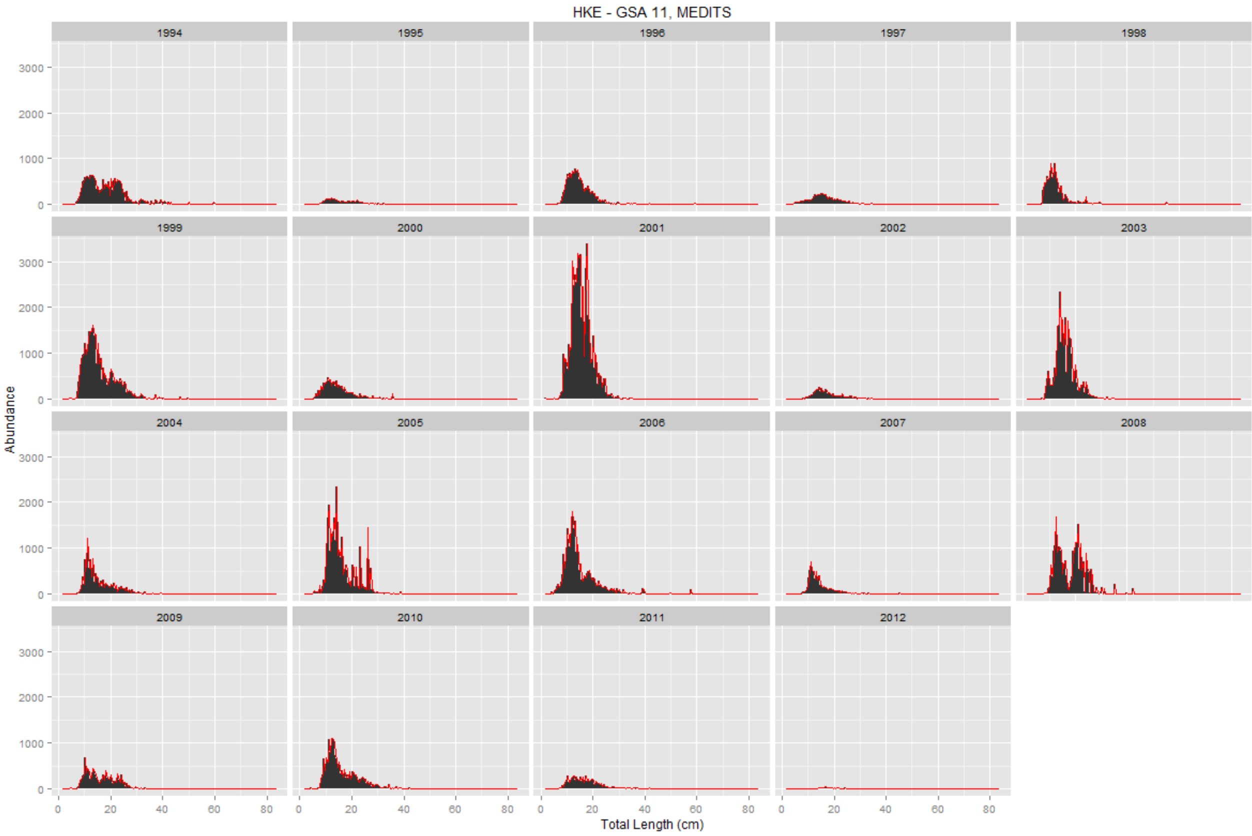


Figure 6.9.3.1.4.2 Stratified abundance indices by size, 1994-2011.

6.9.3.1.5. Trends in growth

No analyses were conducted.

6.9.3.1.6. Trends in maturity

No analyses were conducted.

6.9.4. *Assessments of historic stock parameters*

6.9.4.1. Method: XSA

6.9.4.1.1. Justification

Since several problems has been found in available landing and discard data from DCF, EGW 13-09 decided to correct some DCF data and use it as a new input data for the Extended Survivors Analysis (XSA – Darby and Flatman, 1994).

The age distributions from age class 0 to 5+ have been used.

Discard was included in the analysis. Since no discard was available for 2006 and 2007, an estimate based on the length structure of the previous and following year discards has been done.

6.9.4.1.2.Input parameters

EGW 13-09 noted that landing and discard seems to be misreported. More specifically because some landing and discard data are unrealistic it is not clear if this information are real or if data are erronously reported. This is the case for example for the OTB discards values in 2011 (1743 t) that are 6 times greater than landings (286.8 t) and of the OTB landing in 2012 (286.5 t) that are almost equal to those of the previous year (2011, 286.8 t) while the discards drop to 13.7 t (1743 t in 2011).

Looking at landing and discard data at length (Figure 6.9.2.3.1.2 b and 6.9.2.3.2.1 b respectively) EGW 13-09 note that length structures are very variable along the time and are represented by few length classess. In addition GTR discards at length show a wide range (from 27 to 48 cm) with sizes unusual for discards. Finally GSA 11 is the only SA in the Mediterranean region where discard have been reported for this gear.

To adjust landing and discard inconsistences and use it for the assessment EGW 13-09 perform several attempts with different approaches.

First of all EGW 13-09 decide to change the the very high value of discard of 2011 using the mean of available discard values of the previous years (2006, 2009, 2010).

Then to estimate OTB discard for the years not covered by DCF, STECF EGW 13-09 decided to estimate values by multiping landings of the year by a factor x. Factor x is estimated taking into account the ratio between landing and discard of the closest year available. The year chosen and the new values of discard caluculated are reported in tables 6.9.4.1.2.1 and 6.9.4.1.2.1.

Tab. 6.9.4.1.2.1 Criteria used to estimate discards for years where landings are >0 but discards are not reported.

	2005	2007	2008	2011
	closest year	closest year	closest year	mean previous years
OTB	2006	2006	2009	(2006, 2009, 2010)

Tab. 6.9.4.1.2.2 Discards (t) by year, 2005-2012, as reconstructed for missing years by STECF EGW 13-09 (new values in red).

GEAR/YEAR	2005	2006	2007	2008	2009	2010	2011	2012
OTB	301.5	233.9	174.1	180.2	168.5	81.8	161.4	13.7

For the OTB fleet discard at length data the same criteria were used to recontructed the size distribution for year missing (table 6.9.4.1.2.2).

Finally GTR landings at length were recontructed for all years taking in to account the total catches reported by DCF and the distribution of 2006, while GTR discard information were totally excluded due to their inconsistence in terms of numbers and class sizes.

A SOP correction has been applied.

The new abundance and length structure data have been used for the assessment of hake in GSA 11.

The survey indices from MEDITS data from 2005 to 2012 have been used for the tuning.

LFD of catches (figure 6.9.4.1.2.1) were pooled by year and splitted in age classes using the statistical slicing procedure developed by Scott et al. (2012, EWG 11-12). The same slicing routine was used for LFD of MEDITS survey (figure 6.9.4.1.2.2). In both cases the analysis was performed by sex combined using the same VBGF parameters used in the previous SGMED that correspond to a fast growth scenario (L_∞=100,7 cm, K=0.248, t_0= -0.01).

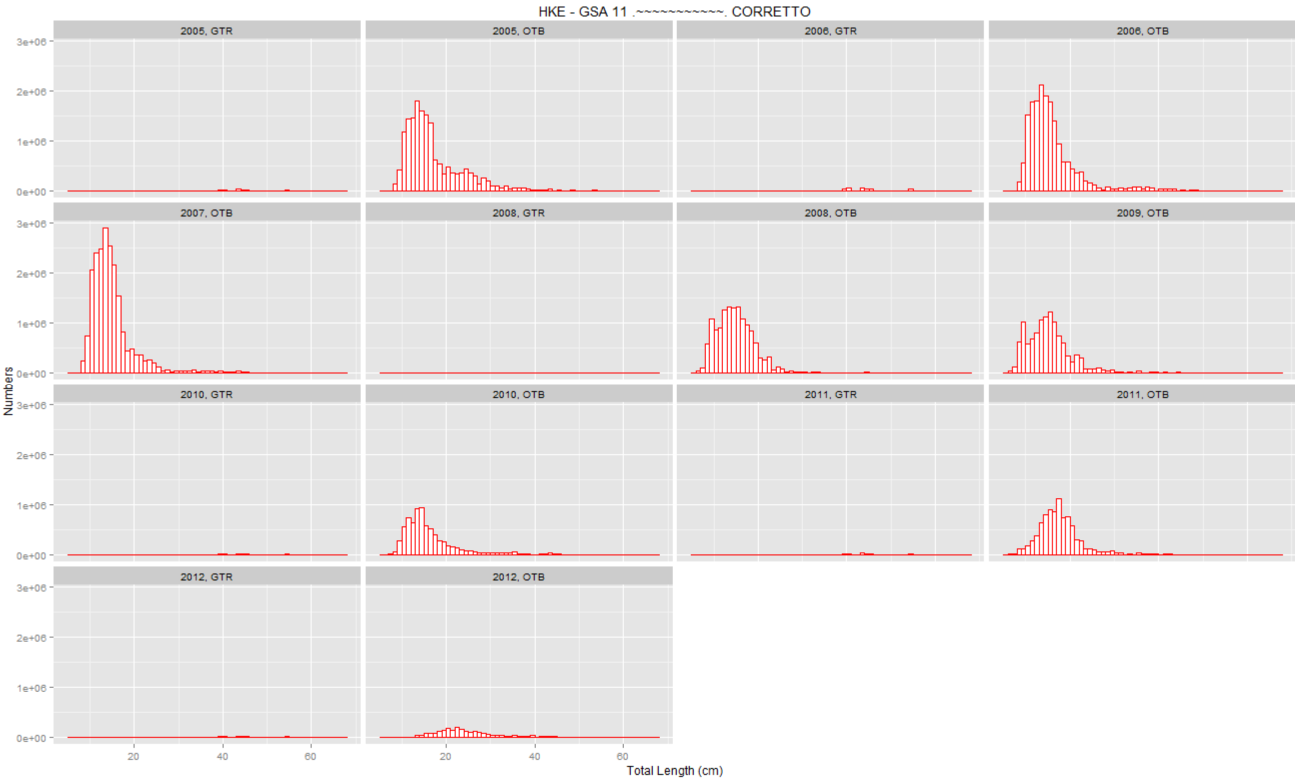


Figure 6.9.4.1.2.1 LFD of catches of *M. merluccius* in the GSA 11 by year and gear.

The best model selected are shown below (figures 6.9.4.1.2.2 and 6.9.4.1.2.3).

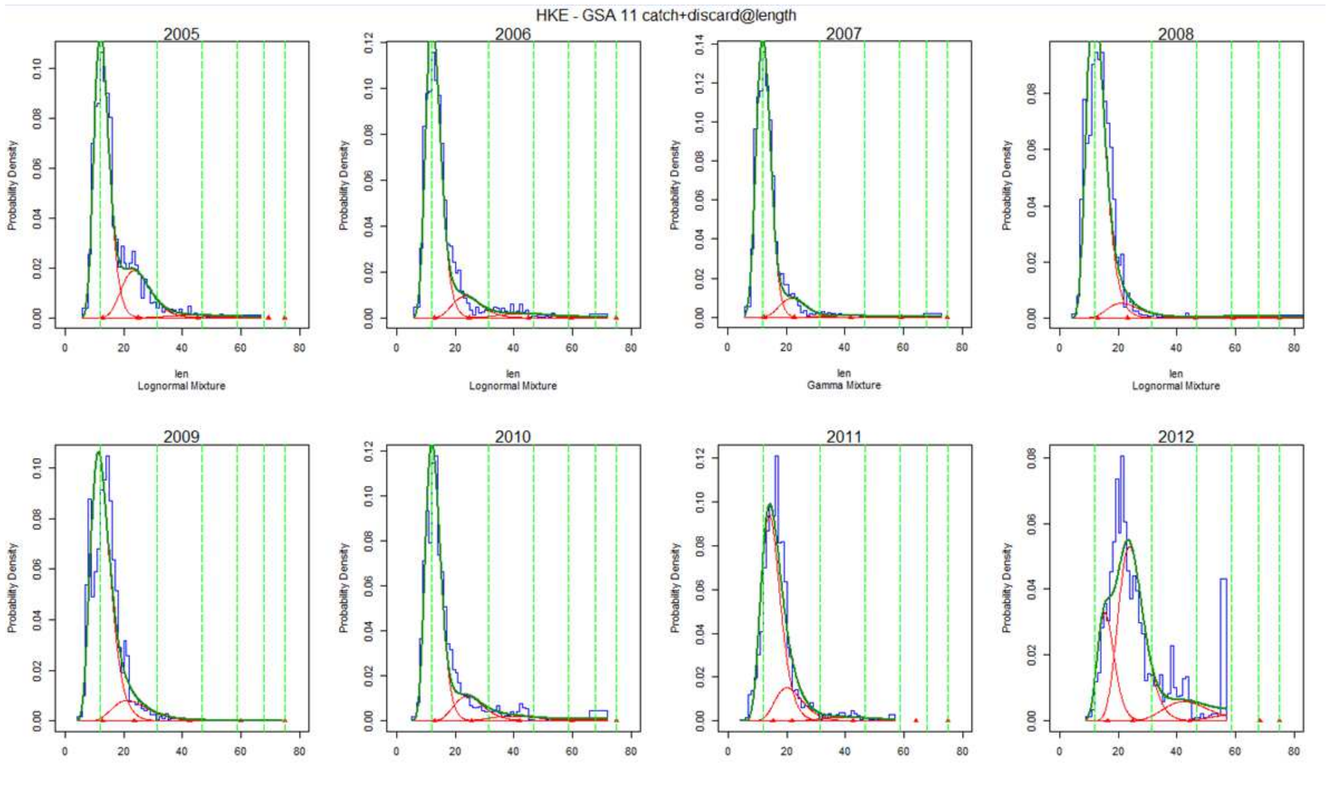


Figure 6.9.4.1.2.2 - Statistical age slicing of the catch at length frequency data of *M. merluccius* (2005-2012, OTB and GTR).

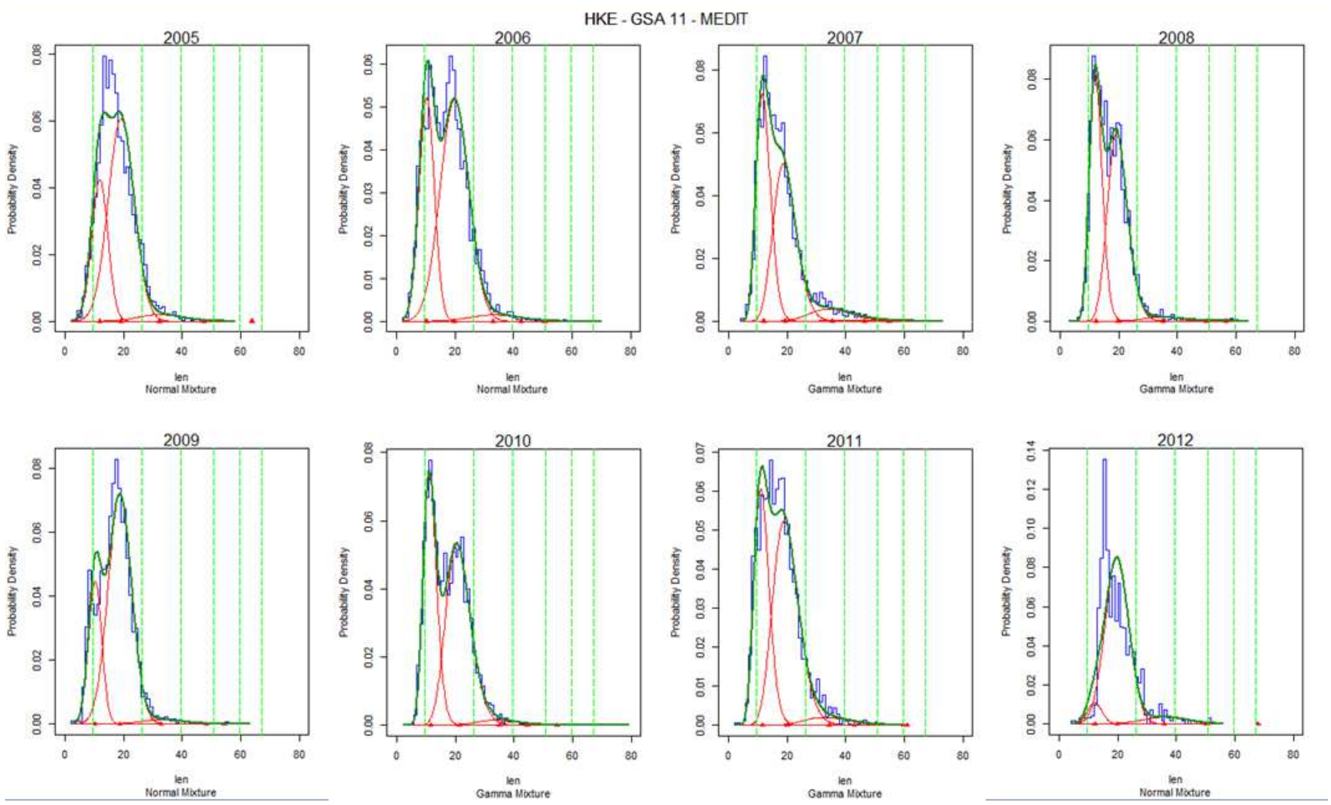


Figure 6.9.4.1.2.3 - Statistical age slicing of the MEDITS length frequency distributions of *M. merluccius* (2005-2012).

According to the PRODBIOM approach developed by Caddy and Abella (1999), a vectorial natural mortality at age was estimated. Guess-estimates of catchability (q) by age are also given in Tab. 6.9.4.1.2.3 where all input parameters used for the XSA are reported.

Tab. 6.9.4.1.2.3 Input parameters used for the XSA.

min,max, plusgroup, minyear, maxyear, minfbar, maxfbar

min	max	plusgroup	minyear	maxyear	minfbar	maxfbar
0	5	5	2005	2012	0	4

M vectors at age

age	0	1	2	3	4	5
M	1.1	0.51	0.39	0.33	0.31	0.29

Maturity at age

age	0	1	2	3	4	5
%	0	0.1	0.9	1	1	1

Mean weight in stock at age(kg)

age	2005	2006	2007	2008	2009	2010	2011	2012
0	0.02	0.01	0.02	0.02	0.01	0.01	0.02	0.02
1	0.07	0.07	0.08	0.07	0.06	0.07	0.08	0.08
2	0.53	0.56	0.6	0.64	0.61	0.54	0.59	0.48
3	1.18	1.37	0.87	1.12	0.99	1.3	0.91	2.11
4	1.55	3.57	1.27	1.57	1.76	2.47	1.47	2.11
5	3.23	3.57	1.76	2.43	3.15	4.16	3.19	3.29

catch in numbers by year

age	2005	2006	2007	2008	2009	2010	2011	2012
all	1554	1826	616	502	436	543	754	510

Catch at age in numbers (thousands)

age	2005	2006	2007	2008	2009	2010	2011	2012
0	17355	34168	21677	18472	12690	8346	8905	1078
1	6489	4433	2213	1680	2395	1455	3323	2524
2	935	1716	304	123	137	488	528	561
3	46	51	1	34	13	16	7	5
4	0	1	1	1	1	0	0	0
5	0	0	0	0	0	0	0	0

Mean weight in catch at age (kg)

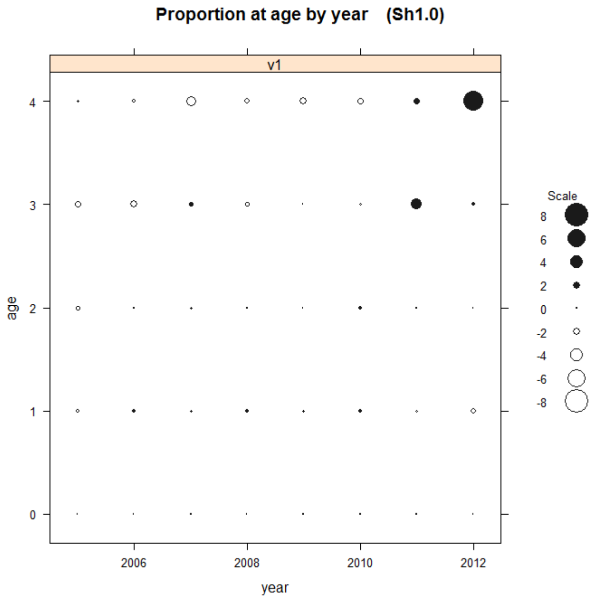
age	2005	2006	2007	2008	2009	2010	2011	2012
0	0.0136	0.0138	0.0122	0.0139	0.0136	0.0137	0.021	0.0253
1	0.1358	0.1176	0.0863	0.0874	0.07	0.1331	0.0825	0.0985
2	0.4328	0.4637	0.5064	0.5546	0.5995	0.4552	0.5345	0.4113
3	0.6903	0.6563	1.8704	0.8325	0.976	0.7624	1.4516	0.6117
4	2.3954	3.6829	3.7996	2.4152	1.201	3.695	1.4516	2.3789
5	3.3099	3.6887	3.7996	3.3148	2.7972	3.7092	3.0799	3.3059

6.9.4.1.3.Results

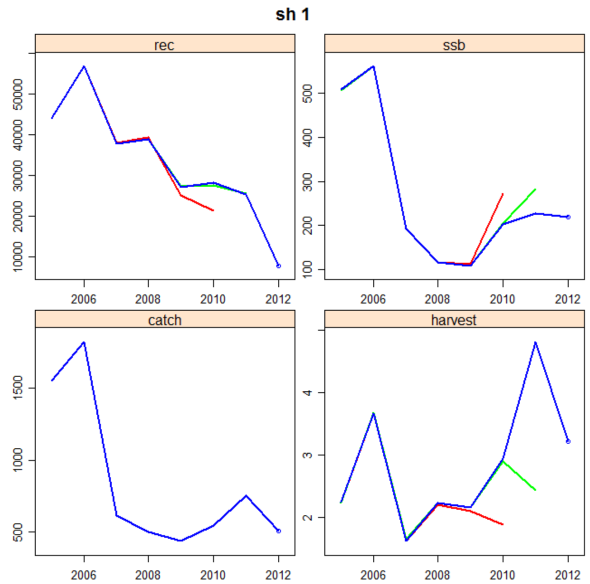
To evaluate the effecct of different settings on the outcome of the XSA a senstitive a sensitivity analyses have been conducted. EGW 1309 test four different shrinkage assumptions (i.e. fse 0.5, 1, 1.5, and 2), and the effect of the age after which catchability is no longer estimated (i.e. qage assigning values ranging from 0 to 5)

On the basis of the residuals and of the retrospective analysis the parameters finally retained for the final run are fse=1,shk.yrs=3,shk.ages=2, rage=0 and qage=4.

The residuals at age from the survey and the retrospective analysis results, shown in figure 6.9.4.1.3.1, do not highlight any particular trend but are very large for the oldest age classes.



A



B

Figure . 6.9.4.1.3.1. A) Log catchability residual plots for the tuning fleet, MEDITS and B) retrospective analysis.

As shown in the result of the XSA (Figure 6.9.4.1.3.2, Table 6.9.4.1.3.1), the total biomass and the SSB both decreased from 2006 to the minimum value in 2009 , then slightly increase again in 2011 and decline to low values in the last year (2012).

Recruitment rapidly decrease from 2006 (5.7 x 10^4) to the minimum 0.9 x 10^4 in 2012.

Mean $F_{0\text{-}4}$ ranged between 1.62- 4.82 with the maximum values in 2011.

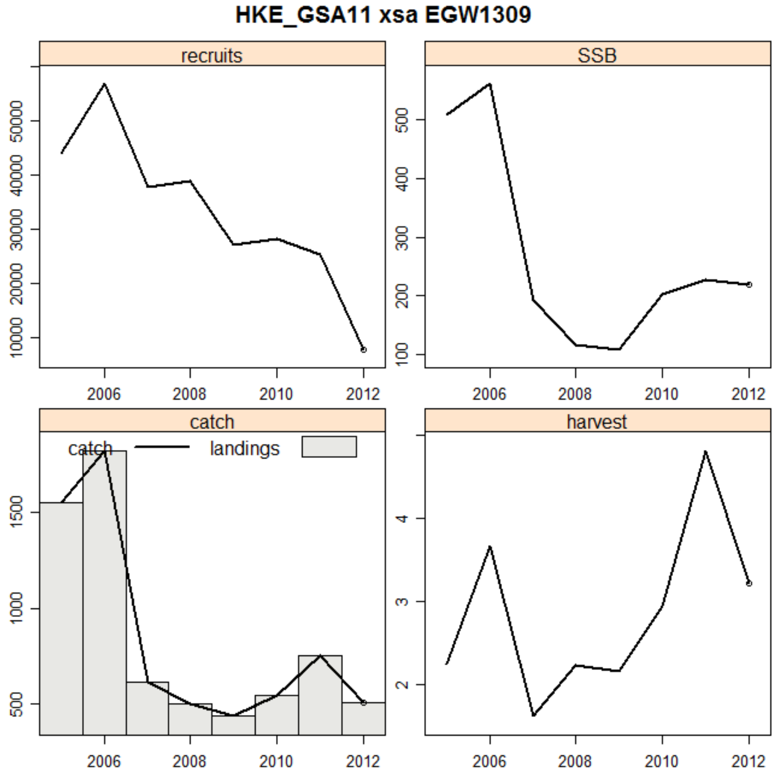


Figure 6.9.4.1.3.2. XSA results (recruitment fishing mortality, spawning stock, total biomass biomass and relative F at age)

Table 6.9.4.1.3.1 - XSA results for Hake in GSA 11.

	age	2005	2006	2007	2008	2009	2010	2011	2012
SSB	all	507	561	193	117	109	202	228	220
R	0	44094	56877	37914	38831	27157	28205	25347	7881
F at age	0	0.915	1.893	1.709	1.226	1.191	0.620	0.779	0.249
	1	1.278	2.170	2.362	2.023	1.432	1.044	1.557	1.528
	2	2.585	6.286	1.959	2.015	1.965	3.931	4.312	3.414
	3	3.448	3.227	0.695	3.269	3.474	4.776	10.200	6.149
	4	3.015	4.757	1.382	2.641	2.731	4.355	7.256	4.778
	5	3.015	4.757	1.382	2.641	2.731	4.355	7.256	4.778
Fbar	0-4	2.25	3.67	1.62	2.24	2.16	2.94	4.82	3.22

6.9.5. *Long term prediction*

6.9.5.1. Justification

No analyses were conducted.

6.9.5.1.1. Input parameters

6.9.5.1.2. Results

6.9.6. *Data quality*

Data quality of landing and discard for HKE in GSA 11 are poor and have conditionated the evaluation of the state of the stock of hake in GSA 11 during the last 5 years. Althouth different tentative to correct the input data an produce the assessment have been done the SGMED EGW 13-09 group was not able to produce an acceptable asssessment.

The main problem in data quality are related to landing and discard that seems to be misreported. More specifically some landing and discard data are unrealistic and it is not clear if this information are real or if data are erronously reported. For example the OTB discards values in 2011 (1743 t) are 6 times greater than landings (286.8 t). Another example are the OTB landing in 2012 (286.5 t) that are almost equal to those of the previous year (2011, 286.8 t). Moreover OTB discard from 2011 to 2012 drop down to 13.7 t (1743 t in 2011).

It is unusual to see some fleet that some years appear in landing and discard and disappear the following year.

Also landing and discard data at length submitted to SGMED highligh a deficit in sampling design: length structures are very variable along the time series and very often are represented by few length classess. Moreover GTR discards at length show a wide range (from 27 to 48 cm) with sizes unusual for discards. Finally GSA 11 is the only SA in the mediterranean region where discard have been reported for this gear (GTR).

The quality of Medits data is acceptable. However in the JRC database abundance were not standardized and because of these deficit the experts use the ELASMOSTAT R routine (Facchini et al.) to obtain the standardized abundance and biomass indices.

In the fishing effort database (D Fisheries effort data MED 2002-2012 20130807) effort data are missing for 2010. Moreover analyzing the fishing effort by year and major gear type EGW-12-19 noted that values of nominal effort (kW*days) by major gear (6.9.5.1.1) from 2005 to 2011 differ fom those submitted last year.

Table 6.9.5.1.1. Trend in nominal effort (kW*days) for GSA 11 by major gear types, submitted through the DCF data call in 2011 (A) and 2012 (B).

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							
SA11	**ALL**	**18787901**	**16862452**	**16114110**	**15823722**	**11262399**	**11825965**	**11426502**	**11895622**

A

AREA	**GEAR**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
SA 11	FPO	42030	77070	968055	1498812	946113	1061601		1776625	1497021
SA 11	FYK				4639				720	
SA 11	GNS	1157504	1027658	213439	778308	468615	1003413		320583	546139
SA 11	GTR	6546696	7186648	7221990	4932513	3756557	4110927		4425145	3824346
SA 11	LLD	108572	273844	468325	1311593	986310	533859		975176	1215442
SA 11	LLS	1048740	941723	1330567	1139974	654795	673775		442194	545670
SA 11	LTL			6941	2914	589	566			
SA 11	none	18500	786	67648	146165	65247	44038		17027	16347

SA 11	OTB	7706431	7324728	5752588	5867826	4358287	4380138		3823252	3824269
SA 11	PS	27293								
SA11	**ALL**	**16655766**	**16832457**	**16029553**	**15682744**	**11236513**	**11808317**	**0**	**11780722**	**11469234**

B

6.9.7. *Scientific advice*

6.9.7.1. Short term considerations

6.9.7.1.1. State of the stock size

6.9.7.1.2. State of recruitment

6.9.7.1.3. State of exploitation

6.9.7.2. Management recommendations

The assessment carried out by the experts on the basis of the information available to EWG 1309 were extremely conditioned by the poor quality of the catch data and depict an unrealistic status of the European Hake stock in GSA 11. The lack of the adults component in the landing at length data and the large decrease of the total catches in the last years of the data series determine a very high estimation of F values. However, the high uncertainty on the correctness of landing and discard reported to EWG 1309, as well as the evident incompleteness of the data series (e.g. some gear strangely come "out" and "in" from the fishery along the 7 years considered), do not allow to perfom an assessment of the stock. The suggestion is to go back to the row catch data of the catches and reestimate it. Thus, due to the poor quality of information, the assessment was not accepted.

6.10. STOCK ASSESSMENT OF NORWAY LOBSTER IN GSA 15 AND 16

6.10.1. *Stock identification and biological features*

6.10.1.1. Stock Identification

Due to the lack of information about the structure of Norway lobster (*Nephrops norvegicus*) population in the central Mediterranean, this stock was assumed to be confined within the GSA 15-16 boundaries (Fig. 6.10.1.1).

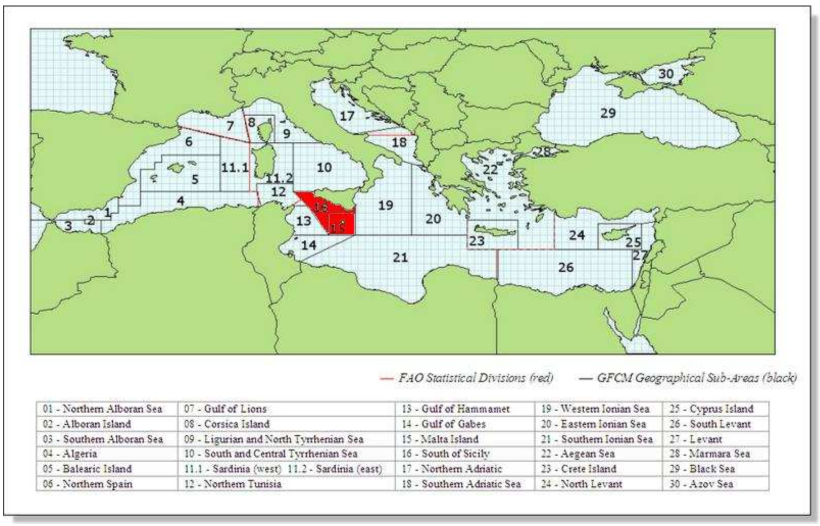


Fig. 6.10.1.1 Geographical location of GSAs 15-16.

N. norvegicus is a mud-burrowing species that prefers sediments with mud mixed with silt and clay in variable proportions. The emergence rhythmicity of individuals from burrows was found to be nocturnal with crepuscular peaks on the continental shelf, and diurnal on the continental slope. Emergence patterns were almost identical for males, females and berried females, and these were not size-dependent (Aguzzi et al., 2003).

6.10.1.2.Growth

The adopted growth parameters for the two sexes combined are: L_∞=72.1, K=0.17, t0=0. As growth parameters are lacking for GSA 15-16, those estimated for the GSA 09 were used:

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

6.10.1.3.Maturity

Mature and ovigerous females occur throughout the Italian side of the Strait of Sicily and were caught in the whole depth range in which Norway lobster is distributed (150-600 m), thus no specific spawning zone is evident (Bianchini et al., 1998). The main spawning period is Spring. Bianchini et al. (1998) observed females with green eggs on the pleopods are observed in Summer and Autumn in almost equal proportions, 40.0% and 40.4% respectively. No ovigerous females were captured in Spring; a very low number (12; i.e. 1.05%) appears in the Winter catch, scattered in the size classes (from 29 mm to 42 mm CL). The smallest ovigerous specimen was 22 mm CL. The gonadic maturity appeared therefore prolonged (Spring and Summer) and spawning activity (Summer-Autumn) with a brief resting phase (Winter). The estimated sizes at 50% of maturity are 30.9, 29.9 and 32.1 mm for Spring, Summer and Autumn respectively (Fig. 1.1.1.3.1). Temporal changes in the proportion of mature females have been observed in the area in more recent years (Fig. 1.1.3.1.2).

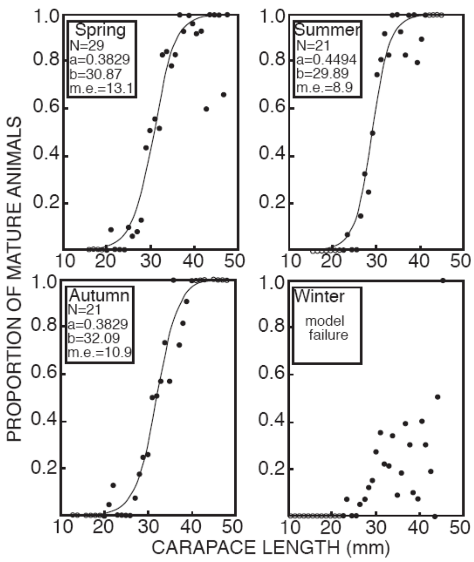


Fig. 6.10.1.2. Seasonal maturity ogive for Norway lobster females in the Strait of Sicily (from Bianchini et al., 1998). The overall sex-ratio (fem/tot) was 0.48, and that all specimens above 51 mm CL are males, the largest size being 66 mm; females are slightly more abundant in the smallest classes (20-30 mm CL), then the ratio decreases linearly (Bianchini et al., 1998). The recruitment appears to be continuous during the year.

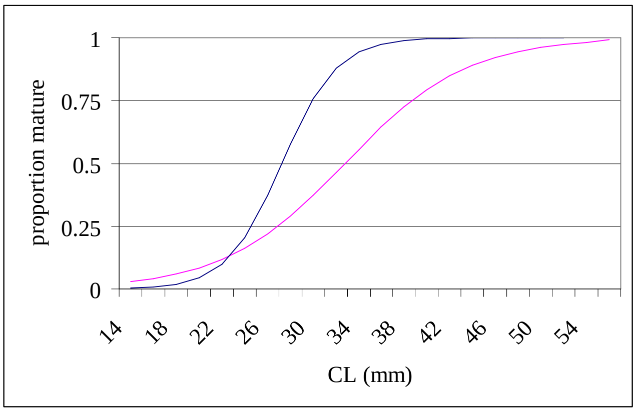


Fig. 6.10.1.3. Maturity ogives of females Norway lobster in GSA 16 in 2002-2006 (pink) and 2009 (blue curve).

6.10.2. *Fisheries*

6.10.2.1. General description of fisheries

Norway lobster is one of the main commercial species for trawlers exploiting fishing grounds on the upper slope to target mainly the deep sea pink shrimp (*Parapenaeus longirostris*) and the giant red shrimp (*Aristaeomorpha foliacea*).

6.10.2.2. Management regulations

There are no formal management objectives for Norway lobster in the Strait of Sicily. As in other areas of the Mediterranean, the stock management in Italy and Malta is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area/season closures). The minimum landing size (Reg. EC 1967/06) is 20 mm CL.

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 currently underway. Maltese fishing capacity licenses had been fixed at a total of 16 trawlers since 2000, but eight new licenses were issued in 2008 and one in 2011, a move made possible by capacity reductions in other segment of the Maltese fishing fleet.

A compulsive fishing closure for trawlers is usually applied in Italy at end of summer (September) for 30 days. There is no closed season in place in Malta, but the Maltese Islands are surrounded by a 25 nautical miles 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. Vessels fishing in the management zone hold a special fishing permit in accordance with Regulation EC 1627/94. 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 200m depth cannot exceed 185 kW.

In order to protect coastal habitats the use of towed gears is prohibited within 3 nm of the coast or within the 50 m isobath if the latter is reached closer to the coast (EC 1967/2006; Res. GFCM 36/2012/3). In order to protect deep water habitats trawling at depths beyond 1000 m is also prohibited at EU and GFCM level (EC 1967/2006; Rec. GFCM 2005/1).

In terms of technical measures, EC 1967/2006 fixed a minimum mesh size of 40 mm for bottom trawling of EU fishing vessels. Mesh size had to be modified to square 40 mm square or at the duly justified request of the ship owner a 50 mm diamond mesh in July 2008; derogations were only possible up to 2010. Moreover diamond mesh panels can only be used if it is demonstrated that size selectivity is of equivalent or higher than using 40 mm square mesh panels (EC 1343/2011).

6.10.2.3. Catches

6.10.2.3.1. Landings

The stock is exploited by trawlers being basically a by-catch of vessels targeting deep-sea pink shrimps and giant-red shrimps. Landings data for GSA16 collected within the Data Collection Framework (DCF) ranged between 428 (2004) and 797 t (2007). The contribution of the Maltese fleet was less than 1% in 2005- 2011 (Tab. 6.10.2.1).

Table 6.10.2.1. Annual landings (t) by fishing technique as reported to STECF EWG 12-10 through the DCF data call in GSA 16 and 15

GSA 16

Fishery	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
DEMSP	460.1	678.2	428	489.9	673.4	797.23	672.55	371.25	320.29	366.19	229.40
VL1218									41.04	38.30	17.90
VL1224						797.23	672.55	371.25			
VL1824									75.85	108.45	78.60
VL2440									203.40	219.45	132.90
DWSP								68.69	32.40	49.39	27.90
VL2440								68.69	32.40	49.39	27.90
MDDWSP								196.55	268.13	215.46	186.20
VL2440								196.55	268.13	215.46	186.20
Total	460.1	678.2	428	489.9	673.4	797.23	672.55	636.50	620.82	631.04	443.50

GSA 15

Fishery	2005	2006	2007	2008	2009	2010	2011	2012
DEMSP						0.27	0.13	
DWSP						0.64	0.53	0.20
MDDWSP	3.40	0.01	0.63	1.21	3.72	3.46	2.17	0.45
Total	3.40	0.01	0.63	1.21	3.72	4.37	2.83	0.65

Length frequency distribution of landings appears almost constant through time (Fig. 6.10.2.1).

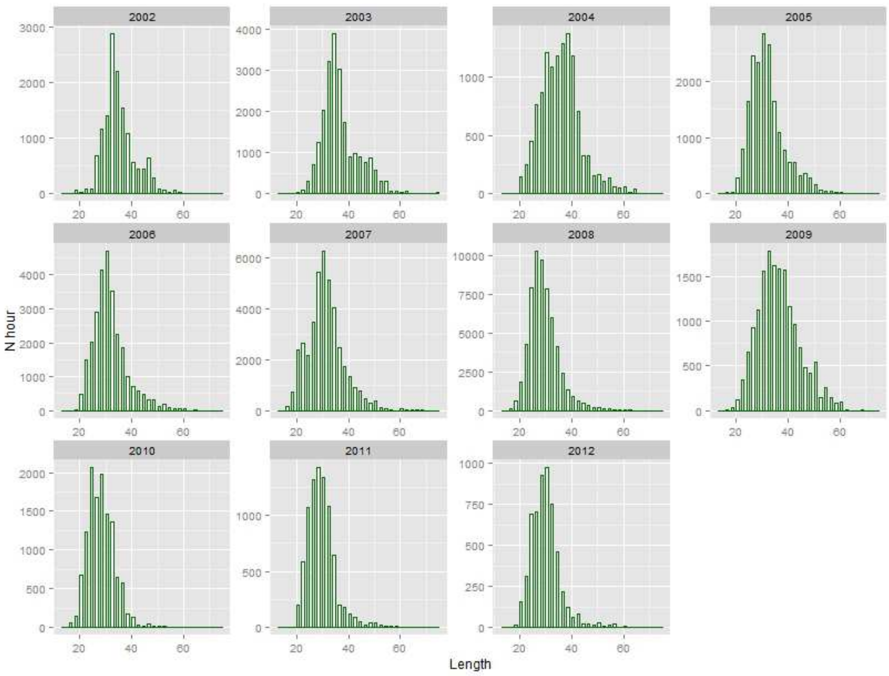


Fig. 6.10.2.1. Length frequency distributions of *Nephrops* annual landings in GSAs 15-16 for the period 2002-2012.

6.10.2.3.2. Discards

Discards for this stock are negligible and thus are not included in the assessment.

6.10.2.4. Fishing effort

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 (Figs. 6.10.2.2- 6.10.2.3).

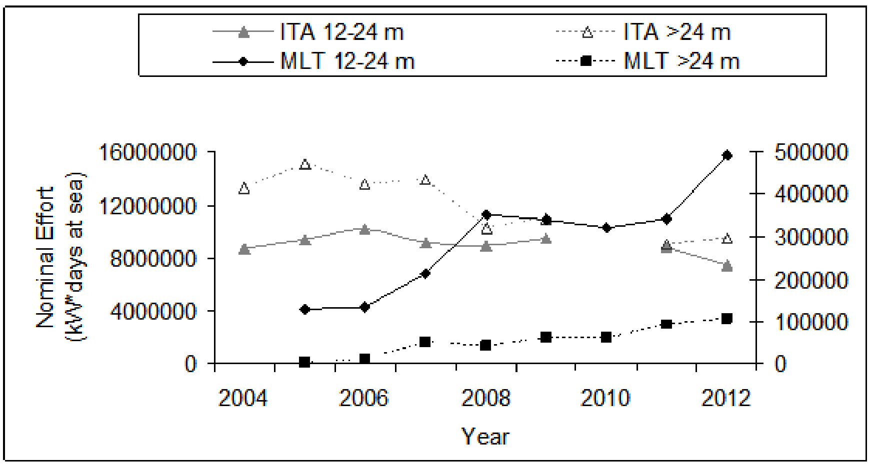


Fig. 6.10.2.2. Nominal effort (kW*days at sea) trends of trawlers (OTB) by segments of Maltese (right) & Italian fleet (left), 2004-2011.

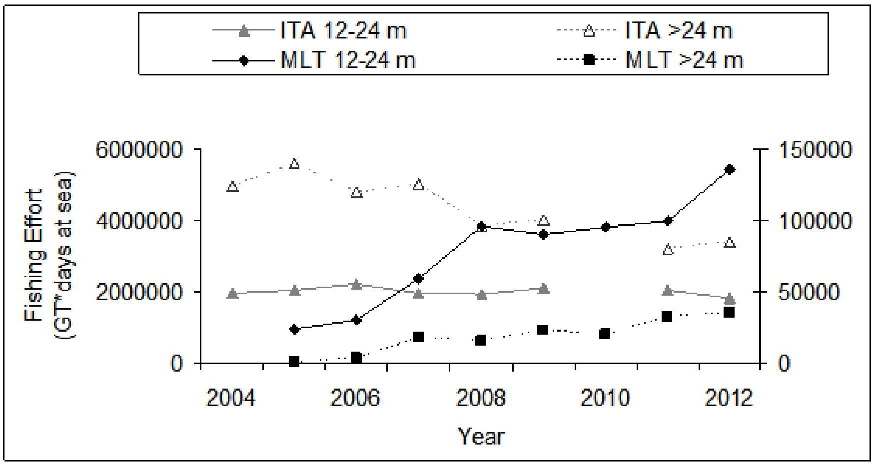


Fig. 6.10.2.3. Fishing effort (GT*days at sea) trends of trawlers (OTB) by segments of Maltese (right) & Italian fleet (left), 2004-2011.

6.10.3.*Scientific surveys*

6.10.3.1.MEDITS

6.10.3.1.1.Methods

The total number of trawl stations by depth strata in GSA 16 and 15 is showed in Tables 6.10.3.1.1.1 and 6.10.3.1.1.2. In GSA 16 the total number of hauls increased from 1994 to the current 120 hauls.

Table 6.10.3.1.1.1 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**	**2012**
10-50	7	7	10	10	11	11	11	11	11	11
50-100	12	12	20	22	23	23	23	23	23	23
100-200	8	9	18	19	21	21	21	21	21	21
200-500	18	19	28	31	27	27	27	27	27	27
500-800	20	19	32	33	38	38	38	38	38	38

Table. 6.10.3.1.1.2. 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**	**2012**
10-50	1	1	2	1	1	0	0	0	0	0	0
50-100	5	5	4	5	5	12	6	6	6	6	6
100-200	13	13	13	13	13	12	13	14	14	14	14
200-500	10	10	10	9	10	4	9	10	10	10	10
500-800	16	16	15	17	16	17	17	15	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.

6.10.3.1.2.Geographical distribution patterns

The species is distributed in the whole area below 150 m depth. Two main nursery grounds have been identified on the Eastern and West side of the Adventure bank (Fig. 6.10.3.1.2.1).

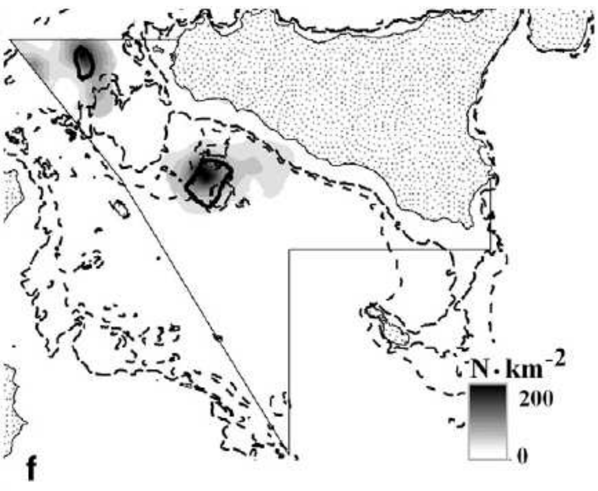


Fig. 6.10.3.1.2.1. Distribution map of Norway lobster recruits in the Strait of Sicily. Recruits (CL<23 mm) were distributed on the upper slope between 250 and 500 m depth, with a peak of abundance between 400 and 500 m.

6.10.3.1.3. Trends in abundance and biomass

MEDITS indices for GSA 16 clearly showed an increased in the density and biomass of the stock since mid ‘90s whereas in Maltese waters the trend is opposite (Fig. 6.10.3.1.3.1).

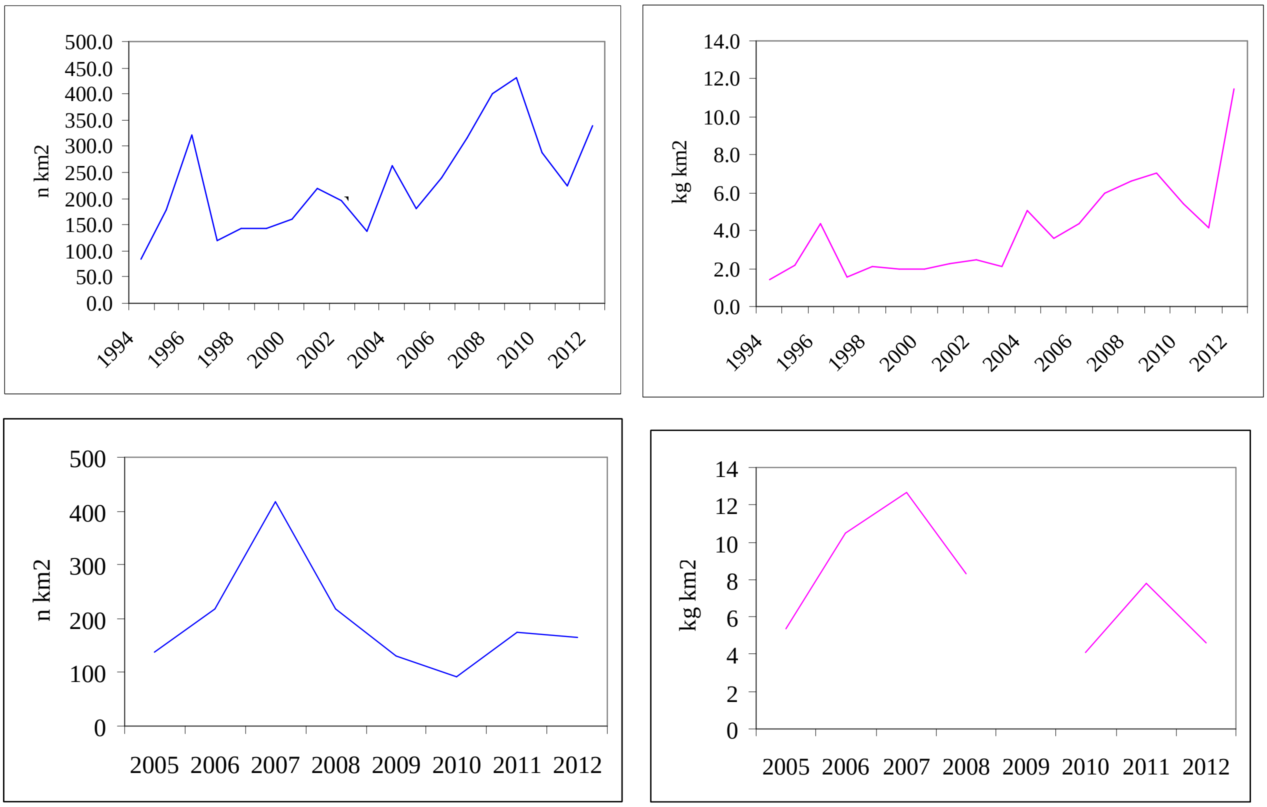


Fig. 6.10.3.1.3.1. Abundance and biomass indices of Norway lobster in GSA 16 (above) GSA 15 (below).

The MEDITS trend for adults Norway lobster in GSA 16 shows a clear increasing trend since 2000, whereas any trend can be observed for juveniles (Fig. 6.10.3.1.3.2).

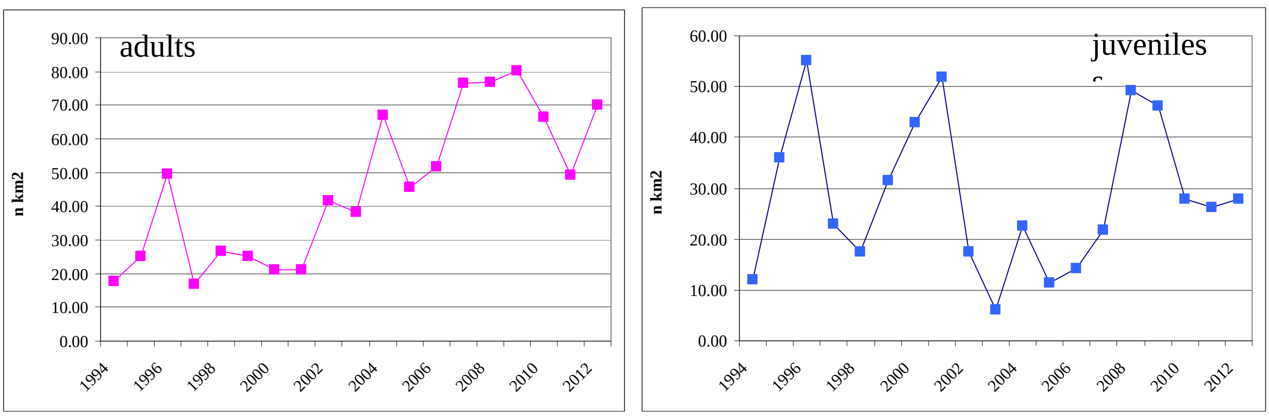


Fig. 6.10.3.1.3.2. Abundance indices of Norway lobster adults (ages 4-8+) and juveniles (ages 1-2) in GSA 16.

6.10.3.1.4. Trends in abundance by length or age

No analyses were conducted during SGMED-10-02.

The length frequency distributions of Norway lobster in GSAs 15-16 are shown in Figs. 6.10.3.1.4.1 and Fig. 6.10.3.1.4.2 by year (n km^2).

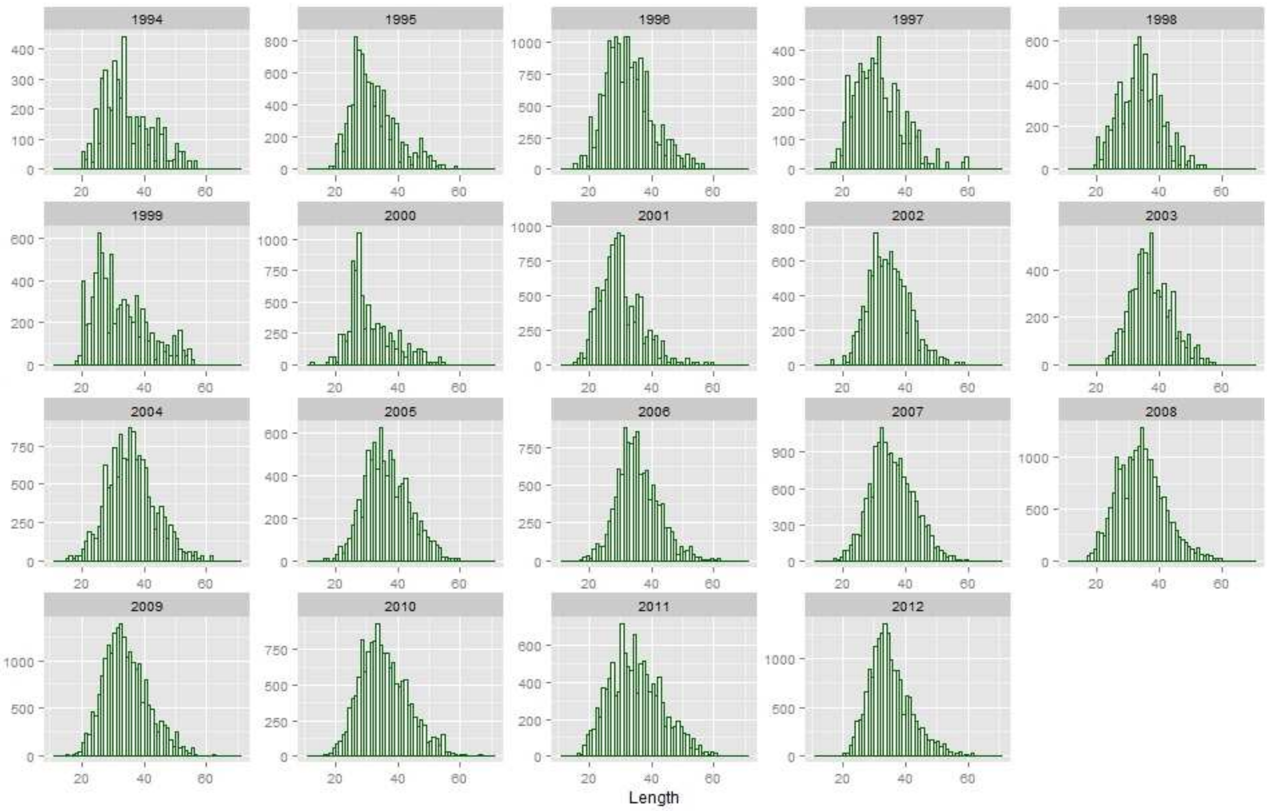


Fig. 6.10.3.1.4.1. Medits length frequency distributions of Norway lobster in GSA 16.

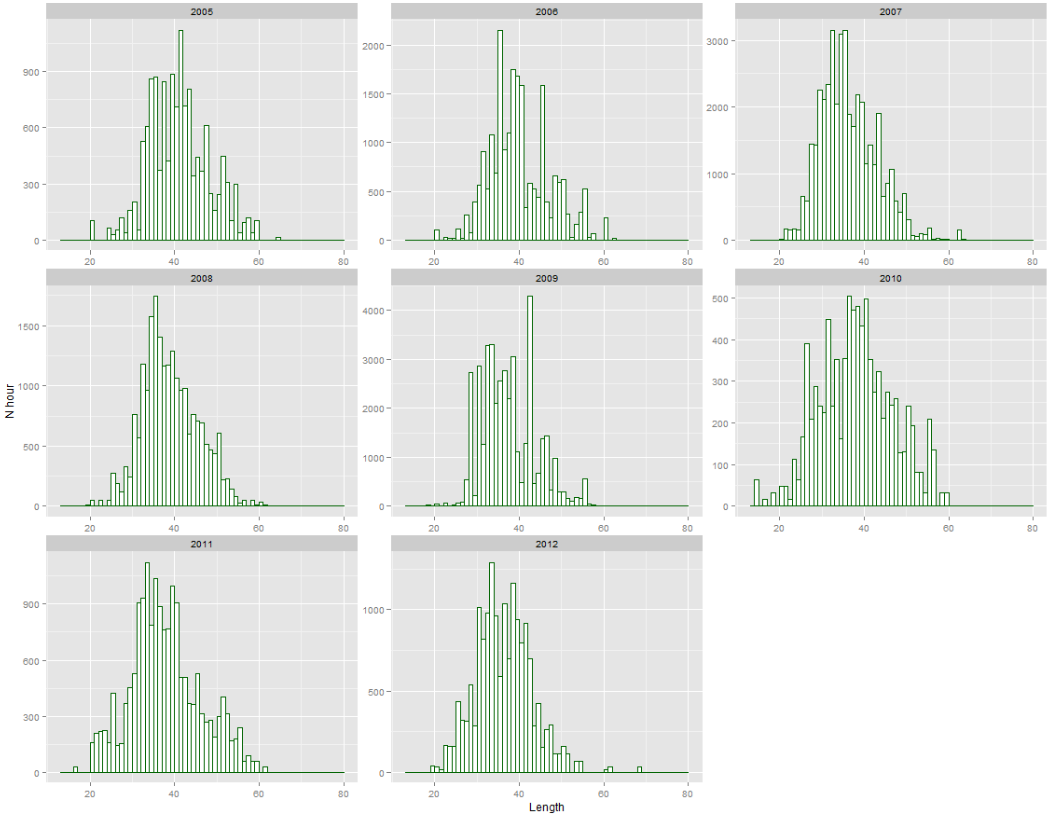


Fig. 6.10.3.1.4.2. Medits length frequency distributions of Norway lobster in GSA 15.

6.10.3.1.5. Trends in growth

No analyses were conducted during EWG-13-09.

6.10.3.1.6. Trends in maturity

No analyses were conducted during EWG-13-09.

6.10.4. *Assessments of historic stock parameters*

Norway lobster of GSAs 15-16 was for the first time assessed during EWG 13-09 using both XSA and Statistical Catch at Age using the a4a assessment model.

6.10.4.1. Method1: XSA

6.10.4.1.1. Justification

An XSA assessment was run using the Italian and Maltese annual landings data of the GSAs 15-16 for the period 2002 to 2012 and calibrated with MEDITS survey data for the same period 2002-2012. The Maltese landings (GSA 15), corresponding to a proportion generally less than 0.25% of the Italian landings, were available for the period 2006-2012. An average proportion of 0.25% was added to the Italian landings for the period 2002-2006.

6.10.4.1.2. Input parameters

The annual size distributions of the catch as well as of the surveys (MEDITS) were converted in numbers at ages classes 1-8+ using the slicing statistical approach developed during STECF-EWG 11-12 (Scott et al., 2011) and using the same growth parameters adopted to slice the MEDITS size distributions. Input data (mortality and maturity at age data) and XSA settings are given below. Fig. 1.1.4.1.2.1. shows the catch data used for the analysis.

XSA settings: Fse: 0.5, 1.0, 2.0 ; Rage: 2; Qage: 5; shk.yrs: 5; shk.ages: 5
Catch at Age (thousands)

age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	81.55	6.77	36.47	67.49	54.51	1203.71	203.99	70.93	687.23	45.66	92.43
2	2012.33	1733.24	2185.65	6695.24	9559.24	9205.07	10040.23	2837.89	12236.06	12081.88	7530.74
3	7468.74	8791.57	4021.56	8584.88	13113.02	14687.92	11120.46	6028.93	10336.79	9976.17	7440.99
4	2449.44	3162.95	3848.10	2193.15	2891.87	3432.23	2955.92	4395.14	2834.74	2846.43	1906.12
5	1163.33	1537.33	653.27	798.69	863.01	936.72	897.01	1293.39	741.77	754.62	488.19
6	502.62	1305.28	386.90	517.32	532.34	504.42	555.22	1089.77	535.26	597.68	378.26
7	28.85	177.64	97.72	59.85	94.93	60.29	103.47	227.22	99.51	109.77	92.25
8	106.17	263.69	287.95	76.41	195.11	157.31	212.93	393.22	112.97	161.32	155.33

Natural Mortality (M) at age (PROBIOM)

age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
2	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
3	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
4	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
6	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
7	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
8	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27

Maturity at age

age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
2	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.01	0.01
3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.57	0.1	0.05
4	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.94	0.67	0.89
5	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.99	0.99	0.99
6	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1

MEDITS index (2002-2012)

age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	32.58	1726.35	4421.22	2959.2	844.89	281.9	53.73	24.48	32.58	1726.35	4421.22
2	0.01	602	2506.38	2234.6	1035.68	402.89	106.47	33.93	0.01	602	2506.38
3	118.22	2142.03	4823.98	4173.12	1483.83	729.71	170.29	144.5	118.22	2142.03	4823.98
4	29.55	1099.73	3492.02	2644.94	1170.17	565.51	125.64	45.76	29.55	1099.73	3492.02
0	7.21	83.99	212.94	150.78	69.08	33.95	17.69	8.03	12.25		
5	62.6	1364.75	5388.18	3294.78	1276.42	400.38	118.73	90.02	62.6	1364.75	5388.18

6	48.43	2123.67	6544.02	4729.04	2040.71	704.52	124.94	41.28	48.43	2123.67	6544.02
7	201.1	4728.11	7519.6	5013	1670.63	649.76	205.19	143.12	201.1	4728.11	7519.6
8	114.97	4496.65	8852.7	5183.95	1737.13	837.88	179.26	94.79	114.97	4496.65	8852.7

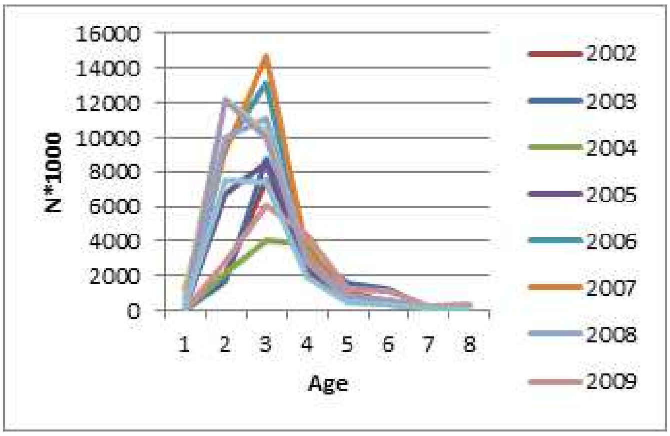


Fig. 6.10.4.1.2.1. Catch at age data for Norway lobster in GSAs 16.

6.10.4.1.3.Results

XSA was run setting shrinkage at 0.5, 1.0, 2.0 to assess the effect of different settings on the outcomes of the method. As showed in Figure 1.1.4.1.4.1, the three different settings produced similar trend for recruitment and SSB. F_{bar} was estimated to be higher by the model with 0.5 shrinkage. Shrinkage set at 1.0 and 2.0 produced very similar F_{bar} estimates (Fig. 1.1.4.1.3.1). The final model adopted was the model with 2.0 shrinkage based on both residuals and retrospective analysis (Fig. Fig. 1.1.4.1.3.2 and Fig. Fig. 1.1.4.1.3.3):

Shrinkage=0.5 Shrinkage=1.0 Shrinkage=2.0

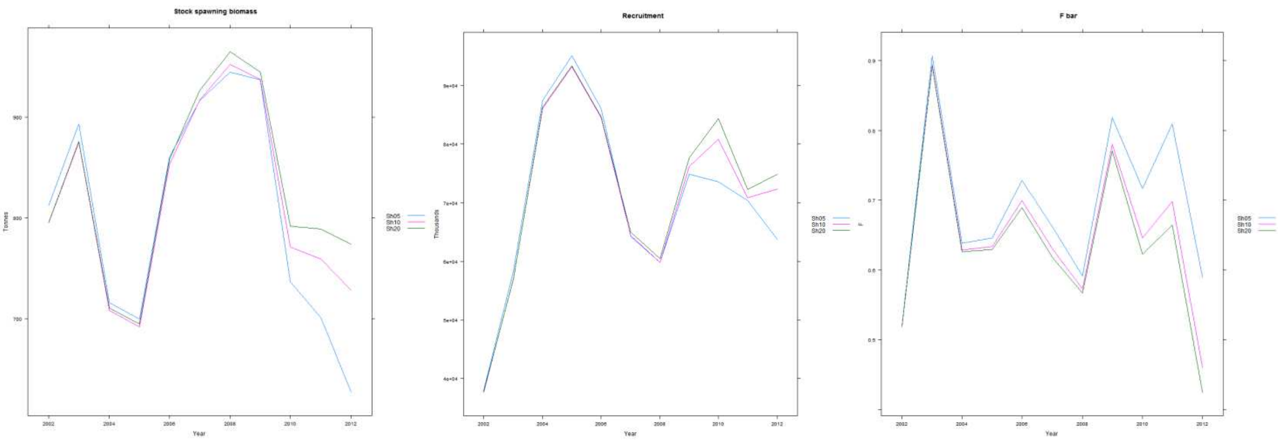


Fig. 1.1.4.1.3.1. Estimates of SSB, recruitment and F using different values of shrinkage.

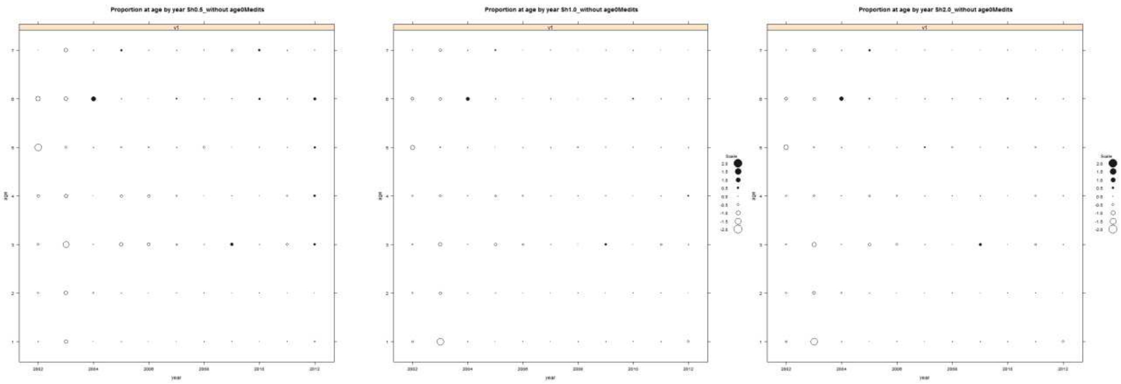
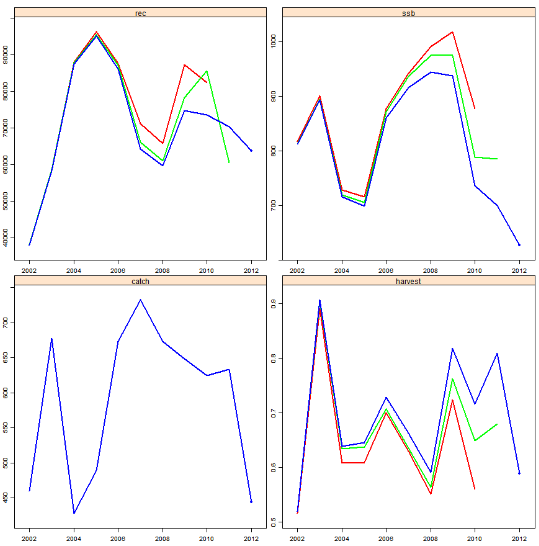
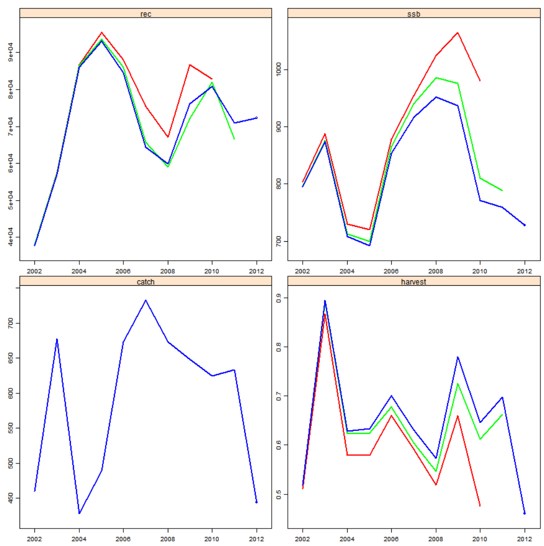


Fig. 1.1.4.1.3.2. Residuals at age obtained with XSA models with different level of shrinkage

Shrinkage 0.5



Shrinkage 1.0



Shrinkage 2.0

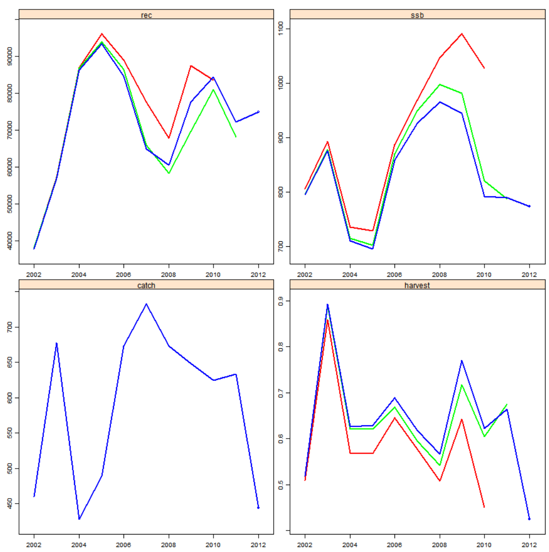


Fig. 1.1.4.1.3.3. Retrospective analysis for Norway lobster in GSAs15-16 using three different values of shrinkage.

The final model is showed in Fig. 1.1.4.1.3.4.

In 2002-2012, the SSB ranged between about 690 and 960 t. In the same period recruitment at age 1 fluctuated widely between 37.7 and 93.3 million (Table 1.1.4.1.3 1). XSA estimates of $Fbar_{2-7}$ showed a declining temporal trend from 0.89 in 2003 to 0.42 in 2012 (Table 1.1.4.1.3 2). F was generally higher for age classes 3-6.

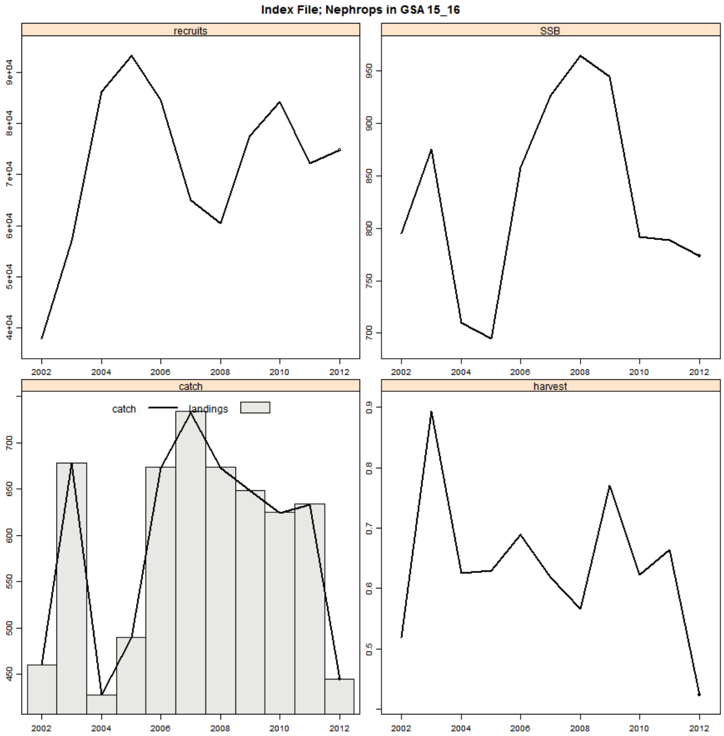


Fig. 6.10.4.1.3.4. XSA results for Norway lobster in GSAs 15 and 16: F, Recruitment, SSB and Yield.

Table 6.10.4.1.3 1. Spawning stock biomass (SSB), and recruitment estimates by XSA for Norway lobster in GSA 15 & 16 from 2006 to 2011.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
SSB (tons)	795.3	875.75	710.22	694.57	857.84	926.21	964.8	944.5	791.7	788.86	773.77
Recruitment (millions)	37.781	56.934	86.337	93.391	84.656	65.004	60.500	77.642	84.391	72.266	74.866

Table 6.10.4.1.3 2. Fishing mortality and numbers at age at age as estimated by XSA.

F-at-age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.01	0.00	0.00
2	0.08	0.10	0.08	0.18	0.24	0.27	0.41	0.10	0.41	0.37	0.25
3	0.68	0.69	0.45	0.70	0.81	0.98	0.75	0.57	0.89	0.90	0.51
4	0.58	0.86	0.93	0.57	0.65	0.63	0.62	0.93	0.72	0.79	0.50
5	0.44	1.11	0.49	0.59	0.53	0.54	0.37	0.71	0.46	0.49	0.34
6	0.81	1.71	1.17	1.11	1.21	0.83	0.81	1.25	0.88	0.96	0.55
7	0.52	0.89	0.63	0.63	0.69	0.46	0.43	1.07	0.38	0.49	0.41
8	0.52	0.89	0.63	0.63	0.69	0.46	0.43	1.07	0.38	0.49	0.41
$Fbar_{(2-7)}$	**0.52**	**0.89**	**0.63**	**0.63**	**0.69**	**0.62**	**0.57**	**0.77**	**0.62**	**0.66**	**0.42**

6.10.4.2. Method: a4a

6.10.4.2.1. Justification

The assessment model a4a (Millar et al., 2012) is based on a simple statistical catch at age (SCA) model in which the population dynamics are simply that the numbers of fish in a cohort declines from year to year due to a combination of natural mortality and fishing mortality. A4a uses splines and random effects to provide a robust and efficient way to constrain the model, and this is packaged in a robust and user friendly statistical framework under FLR. A4a assume a separable annual fishing mortality-at-age into age (selectivity) and year (fully selected fishing mortality) components to assist in fitting models to catch-at-age data. SCA approaches, in their simplest form, make the assumption of an invariant fishing selectivity-at-age pattern over time that determines the true age distribution of the total catch taken each year (Butterworth and Rademeyer, 2008). Differently to VPA-XSA that assume that the observed catch-at-age data are exact, with the fishing selectivity pattern consequently varying from year to year, SCA approaches assume the selectivity pattern to be fixed in time and consider the differences between observed and (constant selectivity) model-predicted catch-at-age data to reflect errors associated with age reading and other sources. VPA-XSA approaches. One of the advantages of a4a over the XSA is related to a more flexible parameterizations of selectivity-at-age that can be critical for species with a dome shaped selectivity-at age pattern. Differently to XSA which forces asymptotically flat selectivity the SCA-a4a allows this to be estimated from the data.

6.10.4.2.2. Input parameters

Modelling was based on the same input parameters and catch data used for the XSA.

6.10.4.2.3. Results

Different models assuming a separable effect on F (age, year) and a survey catchability effect were developed and evaluated against AIC. Models were also evaluated looking at the residuals about what the model predicts the catch should be.

```
fit1 <- a4a(~ age + year, list( ~ 1 ), stock = NEP.stk,  indices = NEP.idx)
fit1a <- a4a(~ age + s(year, k=3), list( ~ 1 ), stock = NEP.stk,  indices = NEP.idx)
fit1b <- a4a(~ age + s(year, k=3), list( ~ 1 ), stock = NEP.stk,  indices = NEP.idx)
fit2<-a4a(~age+ s(year,k=3), list(~factor(age)), stock = NEP.stk,  indices = NEP.idx)
fit3<-a4a(~ year*age, list( ~ 1 ), stock = NEP.stk,  indices = NEP.idx)
fit4<-a4a(~ s(year, k=3)+factor(age),list(~1), stock = NEP.stk, indices = NEP.idx)
fit5<-a4a(~ s(year, k=3)+s(age,k=3),list(~s(age, k=3)), stock = NEP.stk, indices = NEP.idx)
fit6<-a4a(~ s(age, k = 4)+factor(year),list(~s(age, k=3)), stock=NEP.stk, indices=NEP.idx)
fit7<-a4a(~ s(year, k=4)+s(age,k=3),list(~1), stock = NEP.stk, indices = NEP.idx)
fit8<-a4a(~ s(year, k=3)+factor(age),list(~factor(age)), stock = NEP.stk, indices = NEP.idx)
fit9<-a4a(~ factor(year)+factor(age),list(~factor(age)), stock = NEP.stk, indices = NEP.idx)
```

model	df	AIC
1	26	656.75
1a	27	620.90
1b	27	620.90
2	34	495.43
4	33	548.06
5	30	523.05
6	39	510.79
7	29	616.62
8	40	404.78
9	48	383.17

Based on the AIC score, the best model resulted model 9 assuming year, age and survey catchability as factors (Fig. 6.10.4.2.3.1). Fig. 6.10.4.2.3.2 shows the log residuals for modeled catch at age.

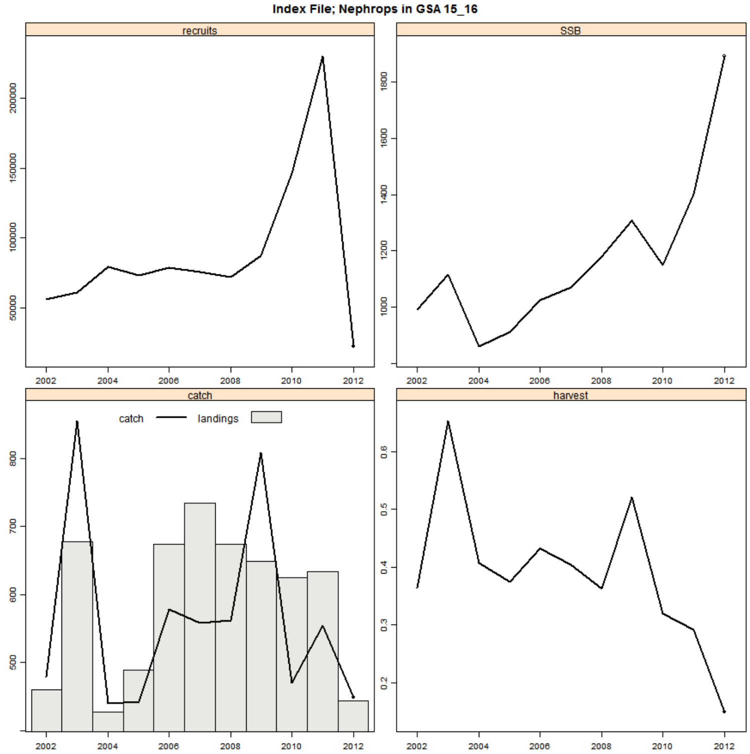


Fig. 6.10.4.2.3.1. Model 9: a4a assessment results for Norway lobster in GSAs 15 and 16: F, Recruitment, SSB and catch.

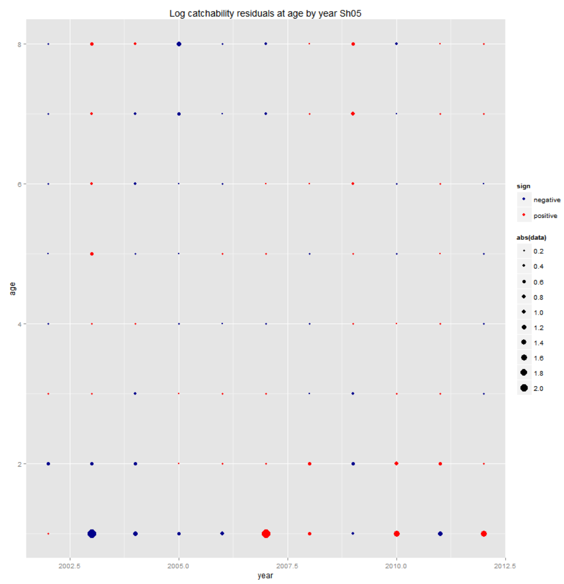


Fig. 6.10.4.2.3.2. Model 9: Log residuals for catch at age.

The final model run estimated a fixed (invariant) selectivity at age (Fig. 6.10.4.2.3.3.). In 2002-2012, the SSB ranged between about 860 and 1892 t with a large increases in 2012. Recruitment at age 1 showed large fluctuations from about 230 and 22 million (Table 6.10.4.1.3 1) with an abrupt decline in 2012. (F_{bar} 2-7) was generally lower than 0.5 with a declining trend from 0.65 in 2003 to 0.15 in 2012 (Table 6.10.4.1.3 2). F was generally higher for age classes 3-6. The differences in the observed and reconstructed landings from the final a4a model (i.e. SOP corrections) ranged between 1%26% in 2012 to 26% in 2033, and were in average around 14%.

Table 6.10.4.2.3.1. Spawning stock biomass (SSB), and recruitment estimates by SCA for Norway lobster in GSA 15 & 16 from 2006 to 2011.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
SSB (tons)	990.9	1117.5	860.0	913.2	1026.2	1071.9	1180.1	1309.1	1151.0	1400.7	1892.4
Recruitment age 1 (millions)	56.178	61.146	79.374	73.290	78.717	76.003	72.141	87.502	146.460	230.332	22.383

Table 6.10.4.2.3.2. Fishing mortality and numbers at age at age as estimated by SCA.

F-at-age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0	0	0	0	0	0	0	0	0	0	0
2	0.14	0.26	0.16	0.15	0.17	0.16	0.14	0.21	0.13	0.12	0.06
3	0.53	0.94	0.59	0.54	0.63	0.59	0.52	0.75	0.46	0.42	0.22
4	0.49	0.88	0.55	0.51	0.58	0.55	0.49	0.7	0.43	0.39	0.2
5	0.34	0.61	0.38	0.35	0.4	0.38	0.34	0.48	0.3	0.27	0.14
6	0.5	0.9	0.56	0.52	0.6	0.56	0.5	0.72	0.44	0.4	0.21
7	0.18	0.33	0.2	0.19	0.22	0.2	0.18	0.26	0.16	0.15	0.08
8	0.3	0.53	0.33	0.3	0.35	0.33	0.29	0.42	0.26	0.24	0.12
Fbar$_{(2-7)}$	**0.36**	**0.65**	**0.41**	**0.37**	**0.43**	**0.40**	**0.36**	**0.52**	**0.32**	**0.29**	**0.15**

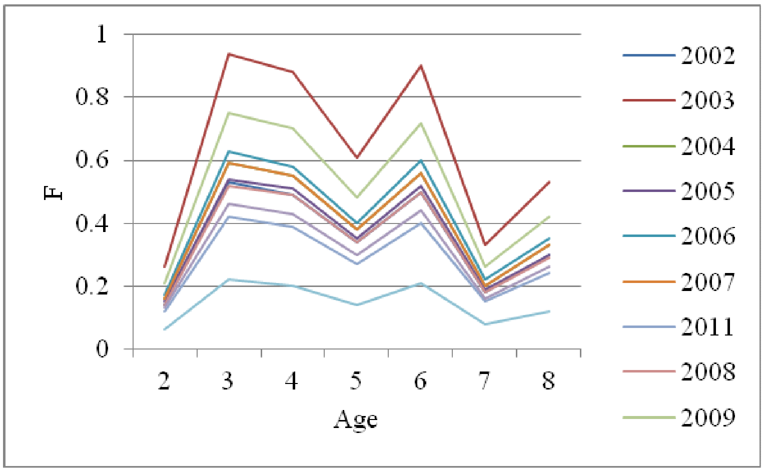


Fig. 6.10.4.2.3.3. F at age estimated by a4a-SCA model 9.

6.10.5.*Long term prediction*

6.10.5.1.Justification

Reference F for the Yield per recruit (YPR) analysis was estimated using 1 to 8+ years age classes using the FLR routine based on the exploitation pattern estimated by the statistical catch at age. F_{01} was estimated to be 0.20 (Fig. 6.10.5.1.2.1).

6.10.5.1.1.Input parameters

Reference F for the Yield per recruit (YPR) analysis was estimated using 1 to 8+ years age classes using the FLR routine based on the exploitation pattern estimated by the statistical catch at age. F_{01} was estimated to be 0.20 (Fig. 6.10.5.1.2.1).

6.10.5.1.2.Results

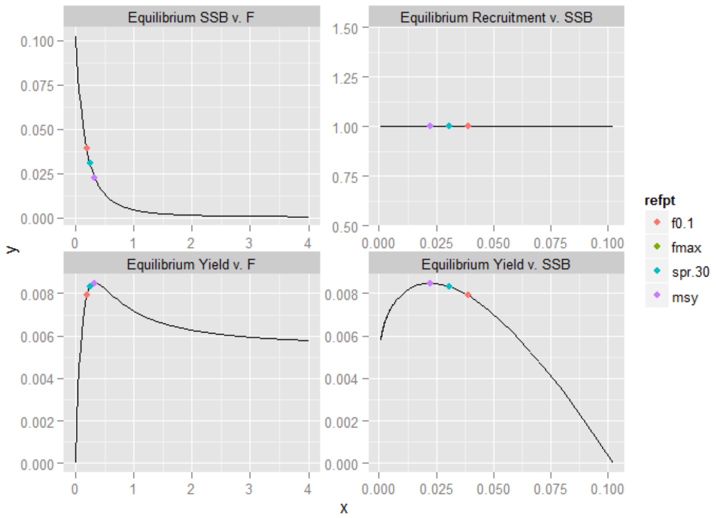


Fig. 6.10.5.1.2.1. Equilibrium reference points for Norway lobster in GSAs 15-16

6.10.6.*Data quality*

The time series of catch at age data and landings covered the period 2002-2012 for the Italian side of GSA 16. Data for GSA 15 were available since 2006. A fixed proportion of annual landings and a constant catch at age matrix was assumed for Maltese landings for the period 2002-2005. This assumption was considered to very poorly affect the quality of the input data for the assessment considering that the Maltese landing represents less than 1% of the Italian landing. Fishing effort data for the bottom otter trawl (OTB) fleet in GSA 16 was missing for the year 2010

6.10.7.*Scientific advice*

The advice has been based on the results of the statistical catch at age (SCA) carried out using the a4a package. The SCA was considered as more suitable in assessing F in the more recent years than the XSA also considering its flexible parameterization of selectivity-at-age. SCA, compared with XSA, returned a lower (30-60%) estimate of F_{bar} combined with higher and apparently, more reliable, estimates of SSB.

6.10.7.1.Short term considerations

6.10.7.1.1.State of the stock size

In the period 2002-2012 the SSB, as reconstructed by SCA, showed an increases from 990 t to about 1.892 t in 2012.

6.10.7.1.2.State of recruitment

Recruitment at age 1 varied between 60.5 and 85.4 million in the period 2002-2011 showing an abrupt decline to 19.3 million in 2012.

6.10.7.1.3.State of exploitation

The SCA model estimates similar stock trends compared to the XSA in the final run. F declined from 0.65 in 2003 to 0.15 in 2012.

6.10.7.2.Management recommendations

STECF EWG 13-09 proposes $F_{0.1} \leq 0.20$ as a limit management reference point consistent with high long term yields (F_{MSY} proxy) for the Norway lobster stock in GSAs 15 and 16. Based on the F_{cur} estimated by the statistical catch at age (a4a assessment), the stock was exploited unsustainably in the period 2002-2011. The estimated F_{cur} was however below F_{MSY} in 2012 indicating that in the this year the stock was exploited sustainably. EWG 13-09 recommends the relevant fleets' effort and/or catches are not increased to maintain fishing mortality below 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.

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6.11. STOCK ASSESSMENT OF BLUE AND RED SHRIMP IN GSA 15 AND 16

6.11.1. *Stock identification and biological features*

6.11.1.1. Stock Identification

Population genetics of blue and red shrimp (*Aristeus antennatus*) carried out based on an analysis of enzyme systems by Sarda et al. (1998) did not detect any significant differences in eight samples collected from the Strait of Sicily and the Western Mediterranean Sea. In a more recent study based on mitochondrial DNA techniques, a similar lack of genetic differentiation was found for samples from the Strait of Sicily, Catalonia, Liguria and Sardinia (Maggio et al. 2009). However some genetic differences have been recorded for populations in the Tyrrhenian and the Algero-Ligurian basins (Cannas et al. 2011). It has thus been suggested that large panmictic populations of blue and red shrimp exist in certain bathyal basins or areas isolated by geographic and oceanographic features which act to limit larval exchange (Orsi-Relini et al. 2013).

For the purpose of the current assessment, the blue and red shrimp was assumed to be confined within the boundaries of the GSA 15 and 16 due to a lack of more conclusive information about the structure of the blue and red shrimp population in the central Mediterranean.

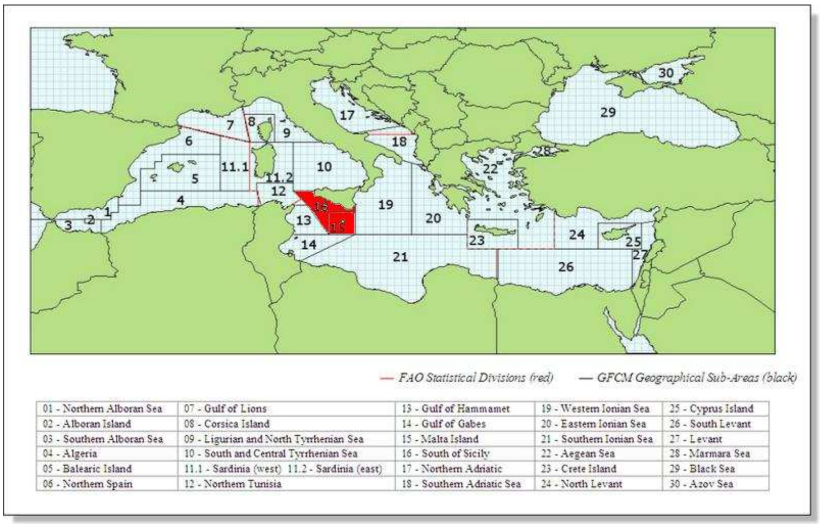


Fig. 6.11.1.1.1 Geographical location of GSA 15 and 16.

6.11.1.2. Growth

Following the interpretation of a slow growth pattern in blue and red shrimp by Orsi Relini and Relini (1998), subsequent studies of blue and red shrimp growth parameters have shown a trend of assigning an increasingly longer life span (and hence obviously a slower growth and lower natural mortality rate) to *A. antennatus* (Cau et al. 2002, Orsi Relini and Relini 2013). Based on a study of the key instars occurring in the life of female blue and red shrimp, Orsi Relini et al. (2013) developed a size/age key, and used it to estimate the von Bertalanffy growth function of female *A. antennatus*. These parameters were used to model the female portion of the stock in the present assessment.

Tab. 6.11.1.2.1 Von Bertalanffy growth function estimates for the Mediterranean; L_∞, k and t_0 refer to the asymptotic carapace length (CL; mm), the curvature coefficient (year^{-1}) and the theoretical age at size 0.

Author	Area	Sex	L∞	k	t_0
Yahiaoui et al. (1986)	Algeria	F	65.1	0.37	0.00
Demestre and Lleonart (1993)	Balearic Sea	F	76.00	0.3	-0.07
Demestre and Lleonart (1993)	Balearic Sea	M	54	0.25	-0.5
Spedicato et al. (1995)	Tyrrhenian Sea	F	66.8	0.56	-0.23
Ragonese and Bianchini (1996)	Strait of Sicily	F	69.1	0.53	0.00
Orsi Relini and Relini (1998)	Ligurian Sea	F	76.99	0.21	-0.019
Orsi Relini and Relini (1998)	Ligurian Sea	M	46	0.213	-0.019
Tursi et al. (1998)	Ionian Sea	F	77.2	0.35	-0.36
Tursi et al. (1998)	Ionian Sea	M	51.5	0.40	-0.35
Garcia Rodriguez (2003)	Alicante Gulf	F	77	0.38	-0.065
Red Shrimps Project (AAVV)	Ligurian Sea	F	66	0.243	-0.2
Orsi Relini et al. (2013)	Ligurian Sea	F	71	0.260	-0.05

6.11.1.3.Maturity

The period of reproductive activity of blue and red shrimp is somewhat extended, starting in spring and peaking in summer (July- August), when most of the females have reached sexual maturity. In GSAs 15-16 recruitment of *A. antennatus* occurs from mid-summer and throughout autumn.

Female spawners have been reported to reach the highest densities on the continental slope at around 500-700 m (Orsi-Relini and Relini 2012), whilst males and juveniles live at deeper depths. In fact the youngest modal group observed from commercial length frequency distributions in the Strait of Sicily has a mean length equal to 29 mm, which is composed predominantly of female individuals. This renders large mature females (which are the most valuable fraction of the population) more susceptible to fishing impacts, and limits the amount of information available on the reproductive patterns for male specimens.

Based on biological stock related parameters collected under the DCF from GSA 16, the average $CL_{m50\%}$ in 2009-2012 for females was 25.79 mm for female blue and red shrimp. Whilst females show a marked reproductive seasonality, males have been reported to have a more prolonged year-round ability to reproduce (Demestre 1995).

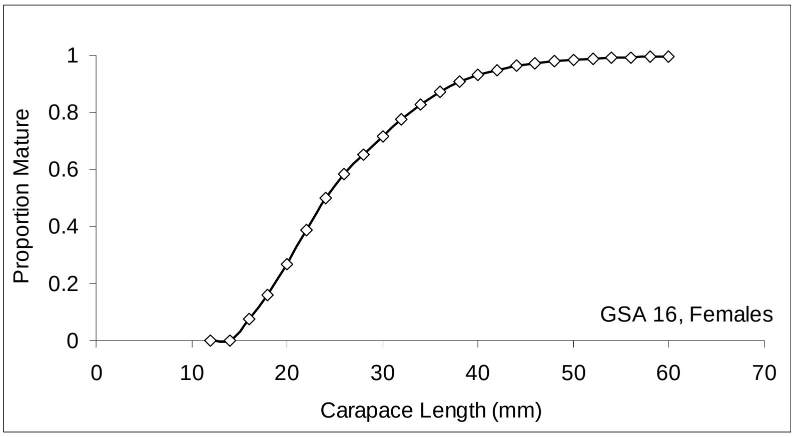


Fig. 6.11.1.3.1 Maturity ogive of blue and red shrimp in the Strait of Sicily (GSA 16) estimated based on 2009-2012 commercial fisheries DCF data.

The sex ratio was calculated based on biological stock related parameters collected under the DCF from GSA 16 in 2009-2012. The results show a prevalence of males in the first size classes, while from 24 mm CL onwards the proportion of females was dominant.

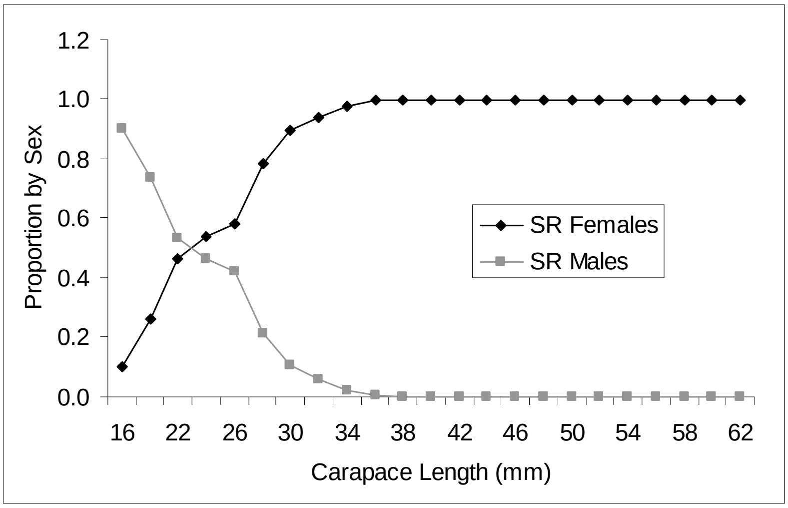


Fig. 6.11.1.3.2 Mean sex ratio of blue and red shrimp landings at length data in the Strait of Sicily (GSA 16) estimated based on 2009-2012 commercial fisheries DCF data.

6.11.2. *Fisheries*

6.11.2.1. General description of fisheries

The key target species for the Sicilian and Maltese bottom otter trawl fleets operating on the slope of the continental shelf in the Strait of the Sicily is the giant red shrimp, *Aristaeomorpha foliacea*. However whilst *A. foliacea* is fished mainly in the central – eastern side of the Strait of Sicily, it is substituted by the blue and red shrimp *A. antennatus* on the western side of the channel.

Other commercial species frequently caught together with blue and red shrimp are the deep water rose shrimp (*Parapenaeus longirostris*), Norway lobster (*Nephrops norvegicus*), greater forkbeard (*Phycis blennoides*) and hake (*Merluccius merluccius*).

In Maltese waters, trawlers targeting the giant red shrimp *A. foliacea* within the 25nm fisheries management zone trawl either to the north/north-west of the Island of Gozo, or to the west / south-west of Malta, at depths of about 600-700m (Dimech et al., 2012). Blue and red shrimp are caught as a by-catch together with the target species giant red shrimp.

6.11.2.2. Management regulations applicable in 2011 and 2012

At present there are no formal management objectives for blue and red or giant red shrimp fisheries in the Strait of Sicily. As in other areas of the Mediterranean, the stock management in Italy and Malta is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area/season closures).

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 currently underway. Maltese fishing capacity licenses had been fixed at a total of 16 trawlers since 2000, but eight new licenses were issued in 2008 and one in 2011, a move made possible by capacity reductions in other segment of the Maltese fishing fleet.

A compulsive fishing ban for 30 days in August-September was recently adopted by Sicilian Government. There is no closed season in place in Malta, but the Maltese Islands are surrounded by a 25 nautical miles 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. Vessels fishing in the management zone hold a special fishing permit in accordance with Regulation EC 1627/94. 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 200m depth can not exceed 185 kW.

In order to protect coastal habitats the use of towed gears is prohibited within 3 nm of the coast or within the 50 m isobath if the latter is reached closer to the coast (EC 1967/2006; Res. GFCM 36/2012/3). In order to protect deep water habitats trawling at depths beyond 1000 m is also prohibited at EU and GFCM level (EC 1967/2006; Rec. GFCM 2005/1).

In terms of technical measures, EC 1967/2006 fixed a minimum mesh size of 40 mm for bottom trawling of EU fishing vessels. Mesh size had to be modified to square 40 mm square or at the duly justified request of the ship owner a 50 mm diamond mesh in July 2008; derogations were only possible up to 2010. Moreover diamond mesh panels can only be used if it is demonstrated that size selectivity is of equivalent or higher than using 40 mm square mesh panels (EC 1343/2011).

There is no minimum landings size for *A. antennatus* in European legislation.

6.11.2.3.Catches

6.11.2.3.1.Landings

Yield for Italian and Maltese trawlers combined in the period 2009-2012 peaked in 2012, at 94 tonnes. The lowest landings were reported in 2009, at 42.18 tonnes. The average of blue and red shrimp landings was 61 tonnes from Sicilian trawlers and 2 tonnes from Maltese trawlers in 2009-2012; the average annual contribution of Maltese catches to the total catch in this period was 3.6%. Whilst Maltese landings have remained stable in 2009-2012, landings by the Sicilian fleet have increased by almost 60%. No information is available on blue and red shrimp catches by the Tunisian trawl fleet.

In both GSA 15 and GSA 16, the great majority of catches are from the Deep Water Species (DWSP) fishery /metier; landings from the metier DWSP for GSA 15 and 16 combined accounted for 86.7% of total declared landings.

Tab. 6.11.2.3.1.1 Landings (t) of *A. antennatus* by year for the bottom otter trawl gear in 2009-2012 as reported through the EU DCF for GSA 15 and GSA 16.

Area	Country	2009	2010	2011	2012
15	Malta	2.13	1.71	2.29	2.31
16	Italy	40.05	54.23	59.80	91.69
15&16	Italy & Malta	42.18	55.94	62.09	94.00

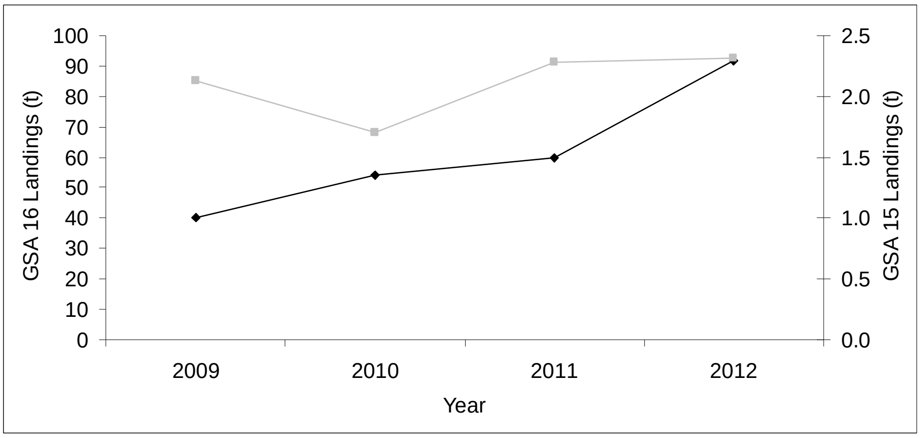


Fig. 6.11.2.3.1.1 Evolution of *A. antennatus* landings in 2009-2012 for Italian trawlers (left axis) and Maltese trawlers (right axis).

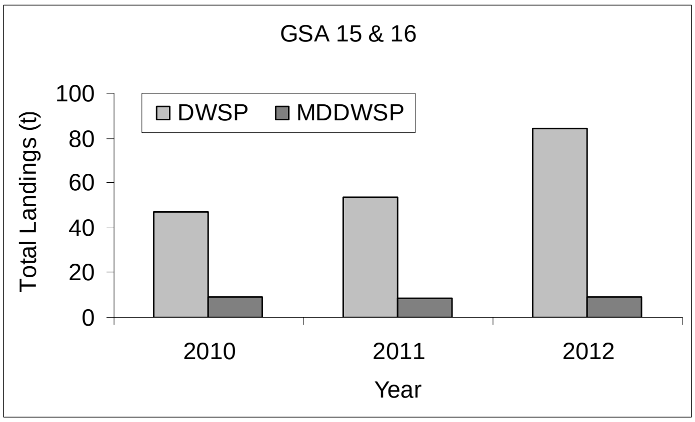


Fig. 6.11.2.3.1.2 Declared *A. antennatus* landings by fishery / metier in GSA 15 and 16 in 2010-2012.

6.11.2.3.2. Discards

No information on total discards or discarded sizes was available in the official data.

However shrimp fisheries generally generate low amounts of discards (Ragonese et al., 2001), mainly due to the fact that a significant part of the by-catch is made up of species with commercial value.

Discarded species with no commercial value caught as by-catch in the giant red / blue and red shrimp fishery include several species of grenadier (*Hymenocephalus italicus*, *Nezumia sclerorhynchus*, *Coelorhynchus coelorhynchus*), argentines (*Argentina sphyraena*, *Glossanodon leioglossus*), shortnose greeneye (*Chlorophthalmus agassizi*) and several species of cartilaginous fish: blackmouth catshark (*Galeus melastomus*), small-spotted catshark (*Scyliorhinus canicula*), velvet belly lanternshark (*Etmopterus spinax*), thornback ray (*Raja clavata*), longnosed skate (*Dipturus oxyrinchus*) and rabbit fish (*Chimaera monstrosa*) (L. Knittweis, pers. obs.).

6.11.2.4. Fishing effort

Blue and red shrimp are caught exclusively by bottom otter trawlers. In 2011 250 Italian trawlers measuring 12-24 m, operating mainly on short-distance fishing trips and fishing on the outer shelf and upper slope, were active. In addition 140 Italian trawlers measuring over 24m in length carrying out longer fishing trips (up to 4 weeks) were active in both the Italian and the international waters of the Central Mediterranean. In the Maltese Islands 14 trawlers measuring 12-24 m and 8 measuring over 24 m in length were active in 2011, 11 of which had a license to operate within the 25 nm Maltese Fisheries Management Zone. Trawlers from Egypt, Tunisia and Libya also operate in the Central Mediterranean, however only few vessels target blue and red / giant red shrimp.

With regards to fishing effort, data submitted by Italy and Malta in response to the annual EU fisheries Data Collection Framework (DCF) data-call in 2013 revealed a 40% decrease in fishing effort for Italian bottom otter trawl vessels larger than 24 m in the period 2004-2012. Maltese vessels were only responsible for 3.5% of total trawling effort in GSAs 15 and 16 in 2012, however the total nominal effort of Maltese trawlers increased by 78% in 2005-2012 and fishing effort exerted by Maltese trawlers increased by 27% in 2011-2012.

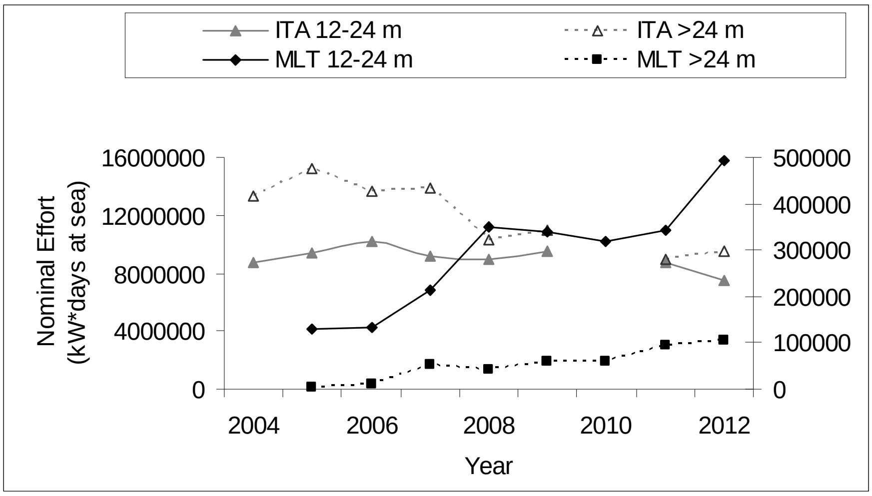


Fig. 6.11.2.4.1 Nominal effort (kW*days at sea) trends of trawlers (OTB) by Italian (left y-axis) and Maltese (right y-axis) fleet segments.

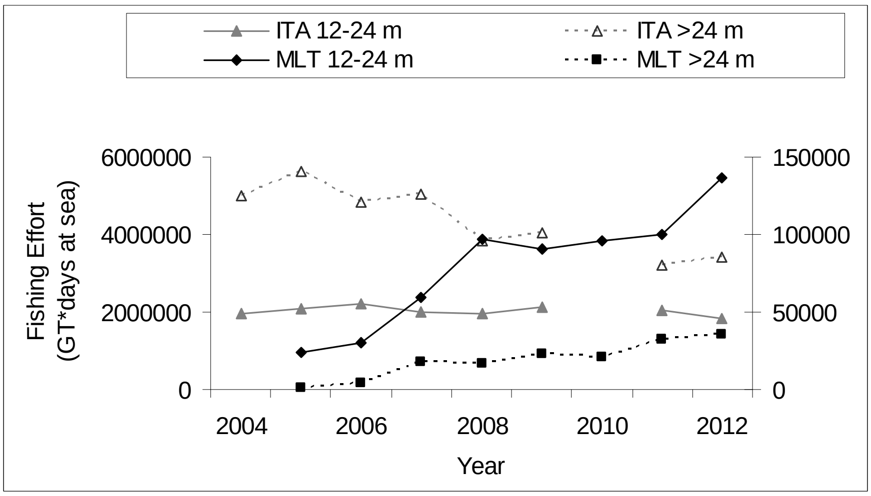


Fig. 6.11.2.4.2 Fishing effort (GT*days at sea) trends of trawlers (OTB) by Italian (left y-axis) and Maltese (right y-axis) fleet segments.

6.11.3. *Scientific surveys*

6.11.3.1. MEDITS

6.11.3.1.1. Methods

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 1994-2012 (GSA 16) and 2002-2012 (GSA 15) is reported below.

Tab. 6.11.3.1.1.1 Number of hauls per year and depth stratum in GSA 16, 1994-2011.

Depth (m)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
10-50	4	4	4	4	4	4	4	4	7	7
50-100	8	8	8	8	8	8	7	8	11	12
100-200	4	4	4	4	5	5	6	5	10	8
200-500	10	11	11	12	11	11	11	11	19	18
500-800	10	14	14	13	14	14	14	14	19	20

Depth (m)	2004	2005	2006	2007	2008	2009	2010	2011	2012
10-50	7	10	10	11	11	11	11	11	11
50-100	12	20	22	23	23	23	23	23	23
100-200	9	18	19	21	21	21	21	21	21
200-500	19	28	31	27	27	27	27	27	27
500-800	19	32	33	38	38	38	38	38	38

Tab. 6.11.3.1.1.2 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	2012
10-50	1	1	2	1	1	0	0	0	0	0	0
50-100	5	5	4	5	5	12	6	6	6	6	6
100-200	13	13	13	13	13	12	13	14	14	14	14
200-500	10	10	10	9	10	4	9	10	10	10	10
500-800	16	16	15	17	16	17	17	15	15	15	14

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:

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

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 standard deviation.

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

In the Central Mediterranean there is a longitudinal segregation between the two species of red shrimp: A. antennatus increased in abundance from the eastern to the western Mediterranean, whilst the opposite is true for *A. foliacea* (Bianchini and Ragonese, 1994; Cau et al. 2002; D'Onghia 2003; Company et al. 2004; Guillen 2012). In Tunisian waters the relative abundance of the two species has been reported to be 50% *A. foliacea* and 50% *A. antennatus* at La Galite and 80% *A. foliacea* and 20% *A. antennatus* on the nearby Sentinelle Bank (Ben Meriem, 1994). In Spanish waters, the Gulf of Lions and the Ligurian Sea *A. antennatus* outnumbers individuals of *A. foliacea* (Cau et al. 2002); in the Central Mediterranean, eastern Ionian Sea and waters around Greece *A. foliacea* is dominant (Politou et al. 2004; Ragonese, 1995; Cau et al. 2002). A number of hypotheses have been proposed to explain this pattern, including differences in productivity between the Mediterranean basins (Politou et al., 2004), differences in hydrological conditions (Ghidalia and Bourgeois, 1961; Orsi and Relini, 1985; Bianchini, 1999; Politou et al., 2004), and different levels of fishing pressure being exerted across the Mediterranean.

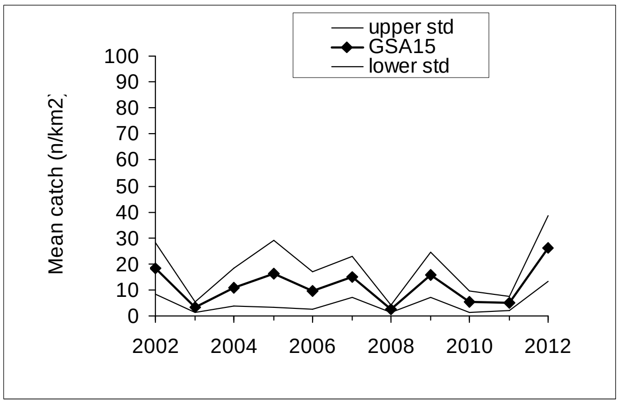
There is at present no published information on the location of nursery or spawning areas of blue and red shrimp. However available data shows that there is a concentration of large, mature adult specimens to the west of the Adventure Bank off the coast of Sicily, as well as in the deep basin to the west of the Maltese Islands. Ragonese and Bianchini (1996) reported that *A. antennatus* in the Strait of Sicily is mainly abundant around Edgadi Island north-west of Sicily.

Large adults are found at depths of 500-700 m, and are often concentrated close to deeper trenches and canyons. Juvenile specimens are found in deeper waters which are less accessible to trawlers. Exploratory surveys found low densities of blue and red shrimp at 2000-2500 m depth on the abyssal plain, with a record depth of 3300 m in an Ionian trench (Sarda et al. 2004).

6.11.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the blue and red shrimp stock in GSAs 15 and 16 can be derived from the international bottom trawl survey MEDITS, which has been carried out in GSA 15 since 2002 and in GSA 16 since 1994.

The patterns recorded in GSA 15 and GSA 16 in 2002-2012 were generally similar, however total abundance and total biomass recorded in GSA 15 in 2002-2012 were lower than in GSA 16. However in 2012 a more pronounced increase in both abundance and biomass was recoded in GSA 15 compared to GSA 16. In the longer time series available from GSA 16, fluctuations in both abundance and biomass are evident. Similar oscillations have in the past been identified for blue and red shrimp in other Mediterranean GSAs (e.g. GSA 6, 9, 10).



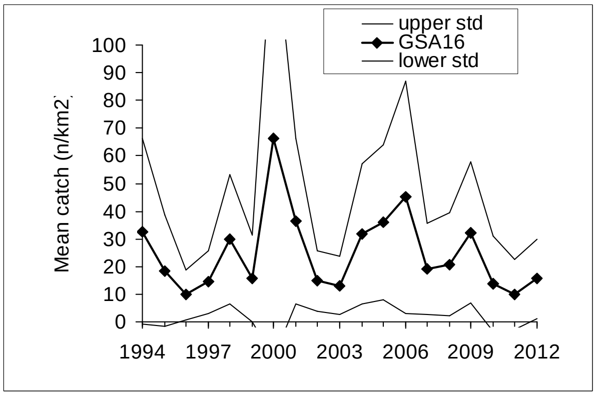
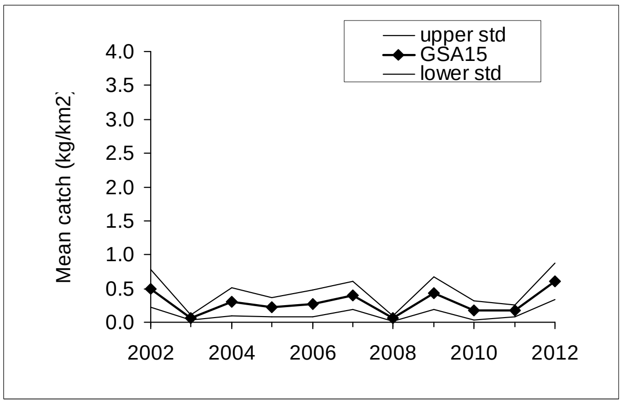


Fig. 6.11.3.1.3.1 Abundance indices of *Aristeus antennatus* for the years 2002-2011 in GSA 15 (left) and 1994-2011 in GSA 16.



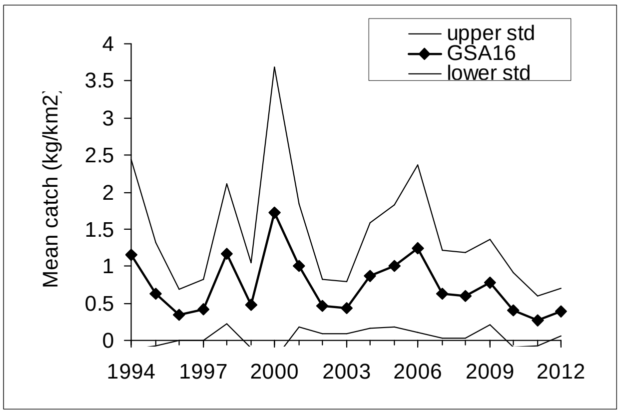
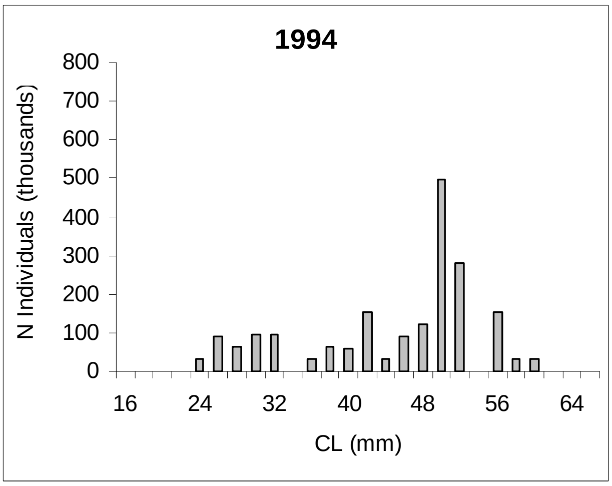
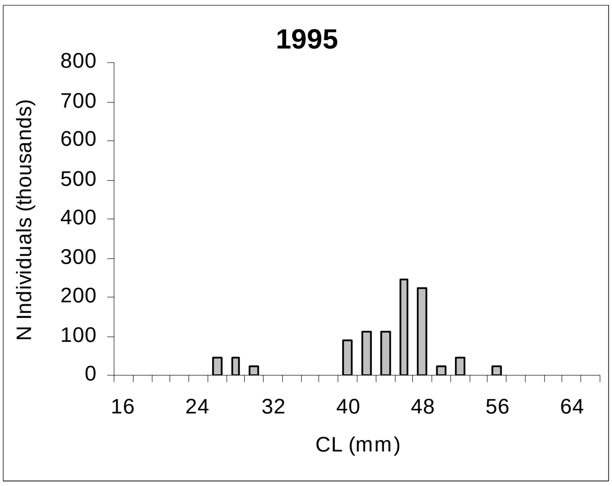


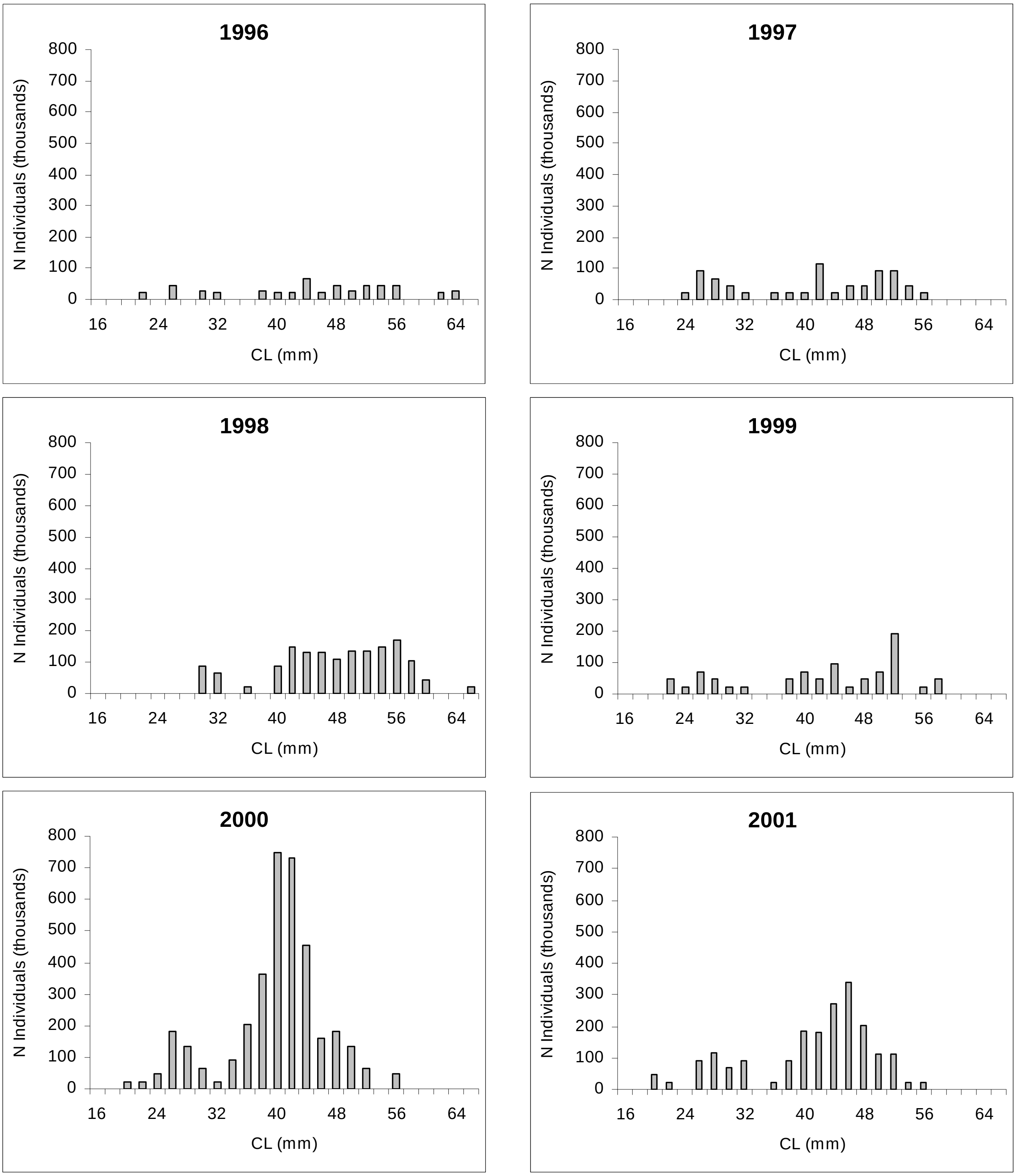
Fig. 6.11.3.1.3.2 Biomass indices of *Aristeus antennatus* for the years 2002-2011 in GSA 15 (left) and 1994-2011 in GSA 16 (right).

6.11.3.1.4. Trends in abundance by length or age

The following Figure 6.11.3.1.4.1 displays the stratified abundance indices (strata of blue and red shrimp in GSA 16 in 1994-2004.






1996
1997
1998
1999
2000
2001
N Individuals (thousands)
800
700
600
500
400
300
200
100
0
16
24
32
40
48
56
64
CL (mm)

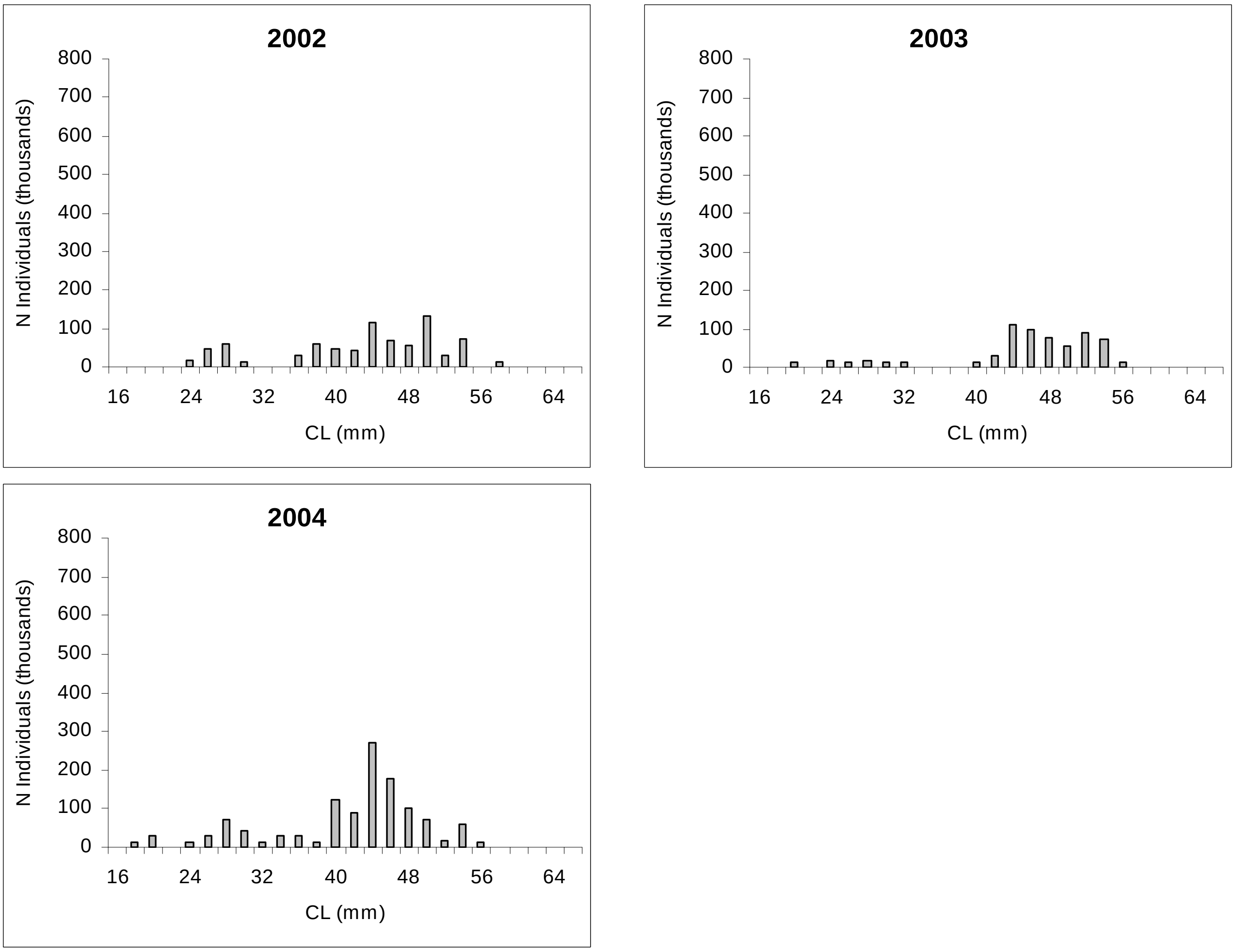
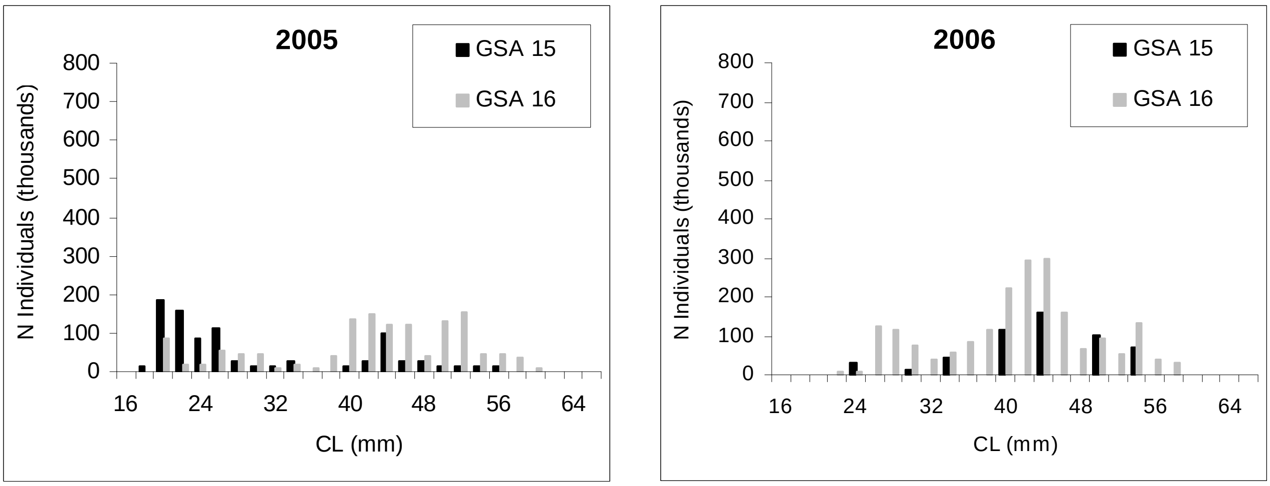


Fig. 6.11.3.1.4.1 Stratified abundance indices by size class in GSA 16, 1994-2004

The following Figure 6.11.3.1.4.2 displays the stratified abundance indices (strata d and e) of giant red shrimp in GSA 15 and GSA 16 in 2005-2011.



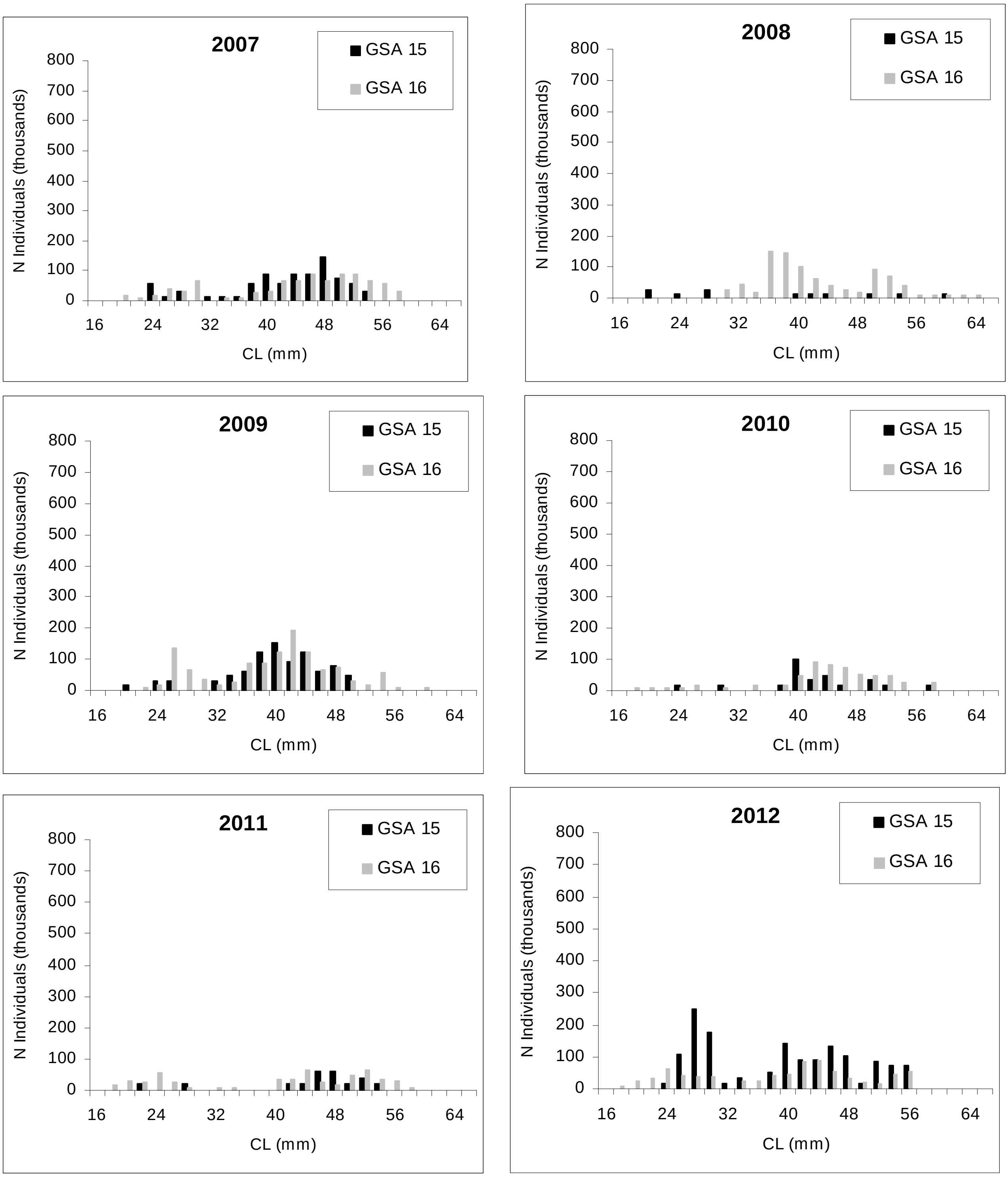


Fig. 6.11.3.1.4.2 Stratified abundance indices by size class in GSA 15 and 16, 2005-2012.

6.11.3.1.5.Trends in growth

No analyses were conducted during EWG 13-09.

6.11.3.1.6.Trends in maturity

No analyses were conducted during EWG 13-09.

6.11.4. *Assessments of historic stock parameters*

6.11.4.1. Method 1: VIT

6.11.4.1.1. Justification

Four complete years (2009-2012) of length frequency distributions from GSA 16 commercial landings data (fished in GSA 15 as well as GSA 16) were available, so an approach under steady state (pseudocohort) assumptions was used. Cohort (VPA equation) and Y/R analysis as implemented in the package VIT4win were thus used (Lleonart and Salat, 2000).

Data were derived from the 2013 DCF data call for GSA 15 and 16.

6.11.4.1.2. Input parameters

The annual catch length frequency distributions were converted in numbers at ages using the statistical slicing method approach developed during STECF-EWG 11-12 (Scott et al. 2011), keeping both sexes and data for GSA 15 and GSA 16 separate.

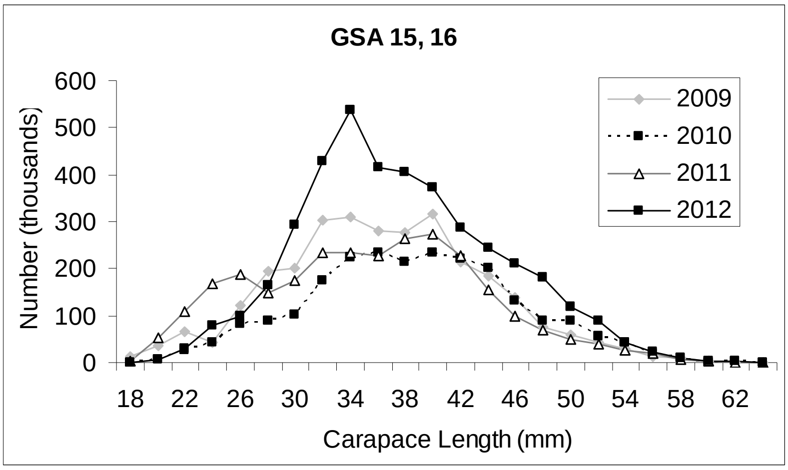


Fig. 6.11.4.1.2.1 *A. antennatus* commercial catch length frequency distributions; GSA 15, 16 and sexes combined.

Natural mortality rates by age group but constant for all years were calculated based on ProdBiom (Abella et al. 1997), as recommended by SGMED 09-01. Length weight relationship parameters were calculated based on 2009-2012 commercial data from GSA 16. Terminal F was fixed at 0.3.

The VIT model was run keeping sexes as well as catches from GSA 15 and GSA 16 separate. Results were then combined taking into account the ratios of female and male specimens of *A. antennatus*.

Additional VIT input data as well as model settings are given below.

Tab. 6.11.4.1.2.1 *A. antennatus* VBGF / length-weight parameters

Sex	L_∞ (cm, TL)	k	t_0	a	b
Females	71	0.26	-0.05	0.003	2.403
Males	46	0.213	-0.019	0.005	2.318

Tab. 6.11.4.1.2.2 *A. antennatus* total yield; % contribution to total yield by fleet segment (GSA 15 and GSA 16); total yield by sex

	Total Yield	% GSA 16	% GSA 15	F Yields	M Yields
2009	42.18	94.95	5.05	40.90	1.28
2010	55.94	96.95	3.05	52.84	3.10
2011	62.09	96.32	3.68	56.50	5.59
2012	94.00	97.54	2.46	89.30	4.70

Tab. 6.11.4.1.2.3 *A. antennatus* catch at age - females

	2009		2010		2011		2012	
Age	GSA 16	GSA 15	GSA 16	GSA 15	GSA 16	GSA 15	GSA 16	GSA 15
1	100991	2000	83280	1530	248425	2177	44804	628
2	1027913	25049	688052	17806	794759	15252	1694244	7541
3	1126461	54161	944244	36578	1106172	39996	1320362	100231
4	254562	8059	324721	8777	193410	15600	572101	2854
5	51878	346	77593	613	47464	3157	92796	3202
6	6041	1	7450	25	6524	170	9607	55
7+	117	0	341	0	142	1	438	0

Tab. 6.11.4.1.2.4 *A. antennatus* catch at age - males

	2009		2010		2011		2012	
Age	GSA 16	GSA 15	GSA 16	GSA 15	GSA 16	GSA 15	GSA 16	GSA 15
2	53462	0	7103	0	47799	0	2671	0
3	53108	464	32613	95	145061	333	104552	13
4	124350	3402	53828	1178	50708	776	71230	1205
5	40954	464	2339	52	53275	957	12593	42
6	1560	2	431	12	6700	95	462	1
7+	0	0	0	0	1425	27	0	0

Tab. 6.11.4.1.2.5 Maturity at Age

Age	1	2	3	4	5	6	7+
F	0.34	0.93	0.99	1	1	1	1
M	0.8	1	1	1	1	1	1

Tab. 6.11.4.1.2.6 Mortality at Age

Age	1	2	3	4	5	6	7+
F	0.54	0.38	0.31	0.27	0.25	0.23	0.22
M	0.50	0.35	0.29	0.25	0.23	0.22	0.21

6.11.4.1.3. Results

Blue and red shrimp catches are concentrated on adults of age class 2 onwards; the highest landings were observed in 2012. The highest fishing mortality impact was found on blue and red shrimp individuals aged 2-6 years. Overall the observed patterns were similar for the time period analysed, and thus consistent with the steady state assumption of the LCA method (Jones, 1981).

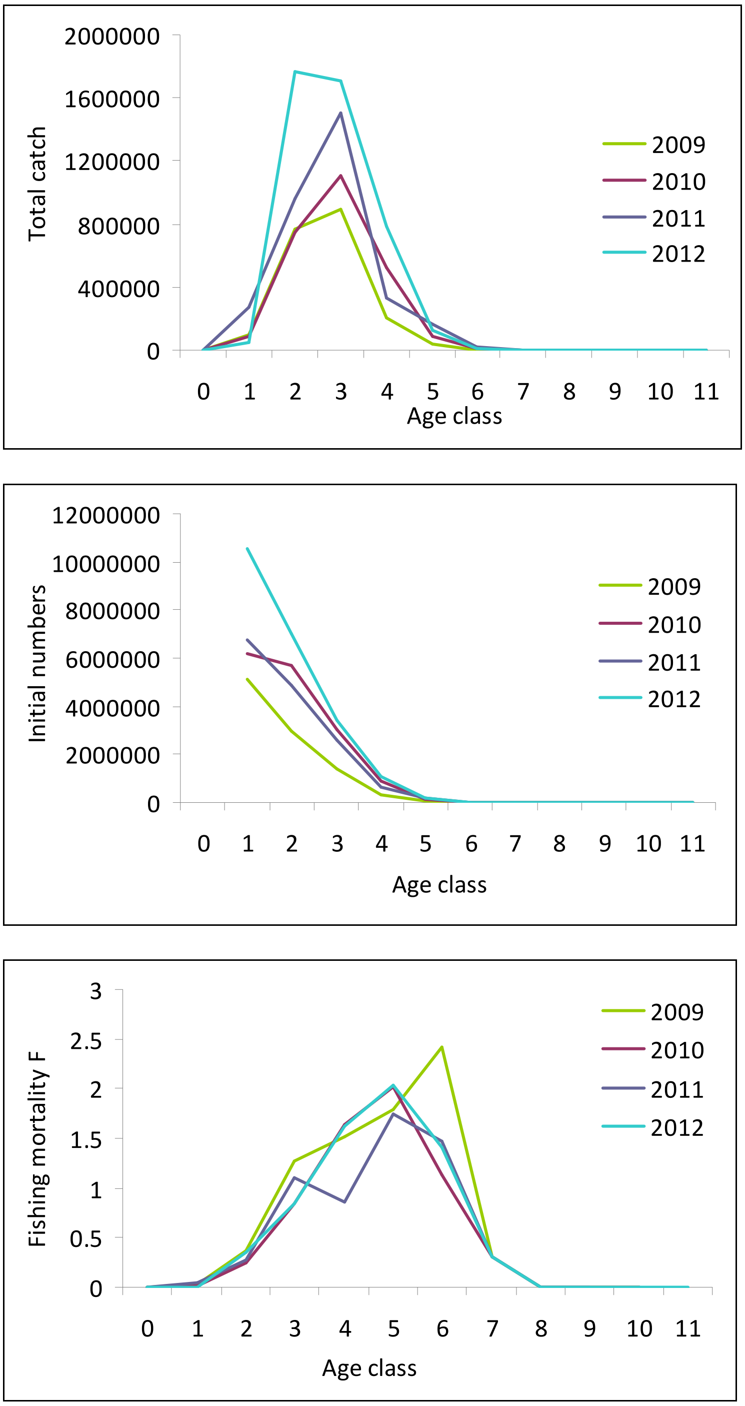


Fig. 6.11.4.1.3.1 VIT outputs: catch numbers, numbers at age and fishing mortality of *A. antennatus* in GSA 15 and 16.

6.11.5. *Long term prediction*

6.11.5.1. Justification

The VIT approach to biomass and yield per recruit analysis has been applied in order to analyse the stock production with increasing exploitation under equilibrium conditions.

6.11.5.1.1. Input parameters

The input parameters are presented in section 6.11.4.1.2.

6.11.5.1.2. Results

The results of estimating spawning stock biomass as well as yield per recruit, by varying current fishing mortality (F_{cur}) through a multiplicative factor for 2009-2012 is illustrated in the following figures.

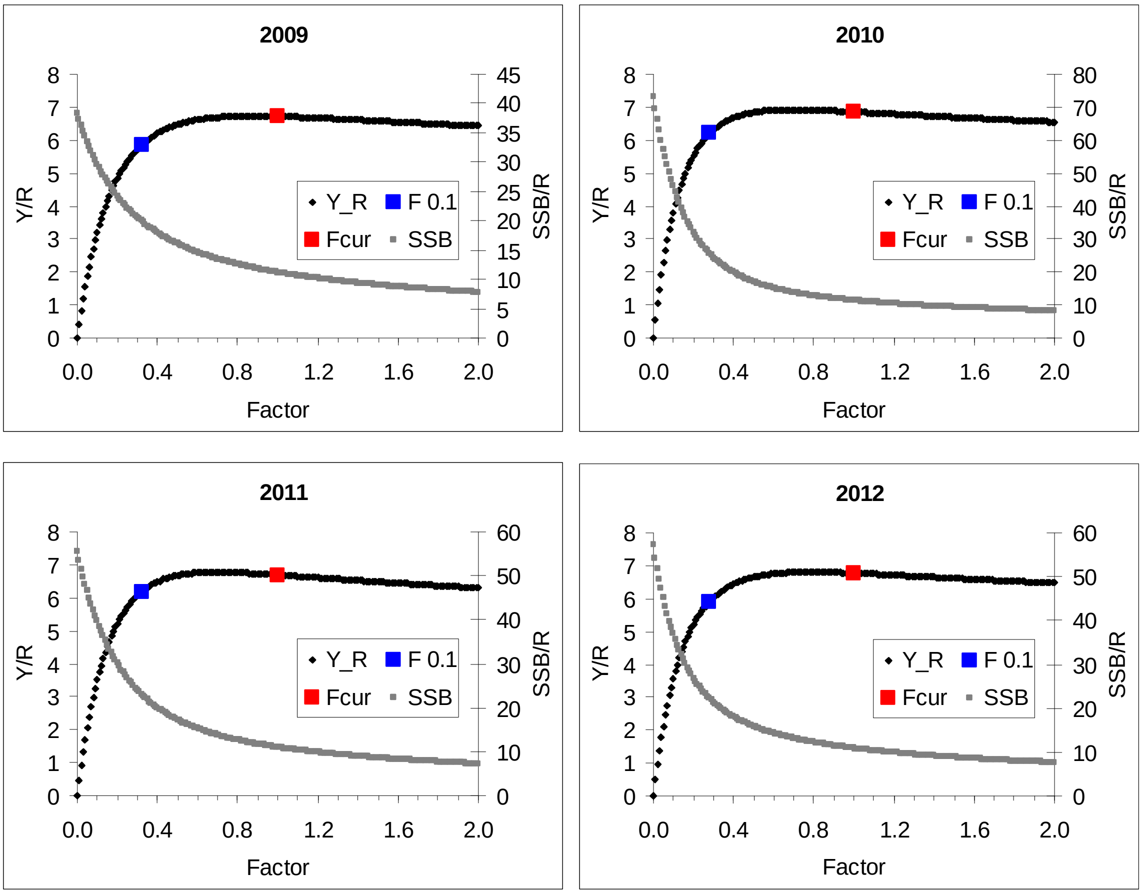


Fig. 6.11.5.1.2.1 Yield per recruit (left) and spawning stock biomass (right) curves of *A. antennatus* for both sexes combined in GSA 15 and 16. The multiplicative factors of current F (i.e. Factor 1) and $F_{0.1}$ are shown.

The main results of the yield per recruit analysis, including the estimated biological reference points are reported in Table 6.11.5.1.2.1 below. The analyses indicate that the reference point $F_{0.1}$ is 0.26 (average of the analysed time period 2009-2012).

Tab. 6.11.5.1.2.1 Estimation of yield (Y in g), biomass (B in g) and spawning stock biomass (SSB in g) per recruit (R) varying current fishing mortality by a multiplicative factor for blue and red shrimp in GSA 15 and 16.

		Factor	Absolute F	Y/R	B/R	SSB
2012	Virgin	0.00	0.00	0.00	87.05	83.60
	$F_{0.1}$	0.28	**0.26**	7.64	31.97	28.57
	F_c	1.07	1.01	8.14	15.05	11.76
	F_{max}	0.63	0.59	8.33	20.06	16.70
2011	Virgin	0.00	0.00	0.00	55.95	52.77
	$F_{0.1}$	0.32	**0.27**	7.38	26.19	23.08
	F_c	1.01	0.84	7.82	14.35	11.38
	F_{max}	0.66	0.55	7.96	18.05	15.01
2010	Virgin	0.00	0.00	0.00	89.58	86.16
	$F_{0.1}$	0.28	**0.25**	7.65	32.71	29.33
	F_c	1.35	1.19	8.09	14.31	11.07
	F_{max}	0.65	0.57	8.37	20.38	17.05
2009	Virgin	0.00	0.00	0.00	53.59	50.04
	$F_{0.1}$	0.32	**0.24**	7.75	26.73	23.23
	F_c	1.05	0.81	8.19	14.74	11.36
	F_{max}	0.65	0.50	8.36	18.86	15.42
	Mean	$\boldsymbol{F_{0.1}}$	***0.26***			
		$\boldsymbol{F_c}$	***0.96***			
		$\boldsymbol{F_{max}}$	***0.55***			

6.11.6. *Data quality*

The time series of data available for assessing the stock status of blue and red shrimp was too short to perform an XSA assessment as only 4 years of data were available (2009-2013). This is due to the fact that biological stock related variables have only been collected in GSA 15 and 16 since the start of the DCF in 2009 (such data was not collected under the previous DCR).

There was no information on discards of *A. antennatus* from GSA 15 and 16, fishing effort data for the bottom otter trawl (OTB) fleet in GSA 16 was missing for the year 2010, and length frequency distributions for the MDDWSP fishery/métier was not available for GSA 16 in 2012. In GSA 15 length frequency distributions of blue and red shrimp catches in 2012 for the DWSP segment in quarter 3 seem to be erroneous.

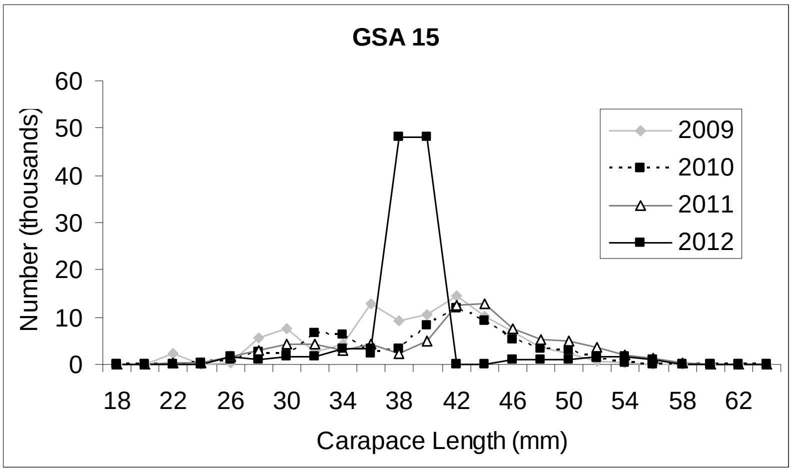


Fig. 6.11.6.1 *A. antennatus* commercial catch length frequency distributions in GSA 15, as submitted by the Maltese authorities in response to the 2013 DCF data call.

6.11.7. *Scientific advice*

6.11.7.1. Short term considerations

6.11.7.1.1. State of the stock size

In the absence of proposed and agreed precautionary management references, EWG 13-09 is unable to fully evaluate the status of the spawning stock biomass.

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h), with the current estimates at a low level) of the 1994-2012 time series available from GSA 16 (mean catch of 0.38 kg/h in 2012 compared to an average biomass index of 0.74 kg/h).

6.11.7.1.2. State of recruitment

Recruitment estimates based on GSA 15 and GSA 16 MEDITS data (individuals with 16-28 mm carapace length, i.e. individuals aged 1 year) show important inter-annual variations. Values recoded in 2012 were above the average recorded in GSA 16 during the available time series 1994-2012 (3.8 juveniles per km^2, compared to an average of 2.4). Similarly in GSA 15 the highest number of juveniles recorded during the 2005-2012 time series was recorded in 2012. However a standard deviation was observed for the annual abundance indices measured in both GSAs.

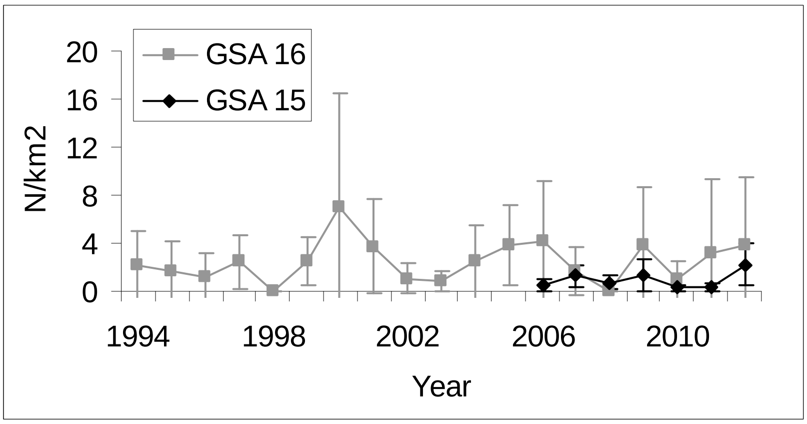


Fig. 6.11.7.1.2.1 Abundance indices of recruits (individuals with 16-28 mm carapace length) ± standard deviation recorded at 200-800 m depth in GSA 15and 16 Medits data in 1994-2012.

6.11.7.1.3. State of exploitation

6.11.7.2. Management recommendations

From yield per recruit analysis (Table 6.11.5.1.2.1), STECF EWG 13-09 proposes $F_{0.1} \leq 0.26$ as a limit management reference point consistent with high long term yields (F_{MSY} proxy).

Given the results of the present analysis (mean F_{cur} 2009-2012 = 0.96; F_{cur} 2012 = 0.81), the stock is considered to be exploited unsustainably during the period 2006-2012. EWG 13-09 recommends the relevant fleets' effort and/or catches to be reduced to reach the proposed $F_{MSY,}$ in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan.

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6.12. STOCK ASSESSMENT OF COMMON SOLE IN GSA 17

6.12.1. *Stock identification and biological features*

6.12.1.1. Stock Identification

Tagging experiments carried out on common sole in the northern Adriatic Sea (Figure 6.12.1.1.1), using the traditional mark-and-recapture procedure, showed that all individuals were re-captured within the sub-basin (Pagotto *et al.*, 1979). Local currents, eddies and marked differences of oceanographic features of this sub-basin with respect to those of southern Adriatic and Ionian Sea (Artegiani *et al.*, 1997) may prevent a high rate of exchange of adult spawners and the mixing of planktonic larval stages from nursery areas of adjacent basins (Magoulas *et al.*, 1996). Guarniero *et al.* (2002), taking into account differences of sole specimens from five different central Mediterranean areas in the control region sequence marker, suggested that two near-panmictic populations of common sole could exist in the Adriatic Sea. The former population would inhabit the entire GSA 17 (northern Adriatic Sea). The second unit seems to be spread along the Albanian coasts (eastern part of the GSA 18). The hydrogeographical features of this semi-enclosed basin might support the overall pattern of differentiation of the Adriatic common soles. Further analysis of the Adriatic populations showed a low, but significant, differentiation between GSA 17 and GSA 18 populations, with possible gene flow only from the eastern coastal side of GSA 18 into GSA 17 (AdriaMed, 2012).

The northern Adriatic Sea has a high geographical homogeneity, with a wide continental shelf and eutrophic shallow-waters. The southern Adriatic in contrast is characterized by narrow continental shelves and a marked, steep continental slope (1200 m deep; Adriamed, 2000). This deep canyon could represent a significant geographical barrier for *S. solea*.

On these bases, different actions for fishery management should be proposed for the Adriatic common sole stocks in GSA 17 and GSA 18. In the former area the stock is shared among Italy, Slovenia and Croatia, while in the latter one seems to be shared only between Montenegro and Albania.

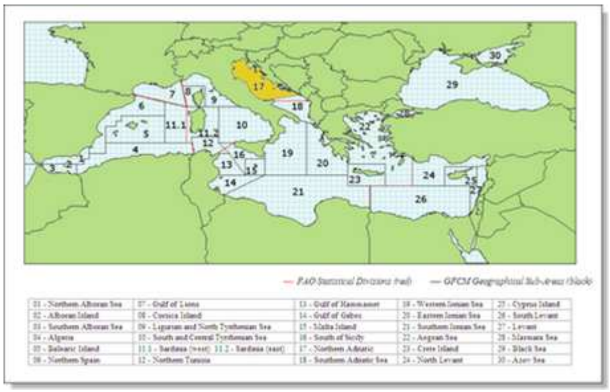


Figure 6.12.1.1.1 Geographical location of GSA 17.

S. solea is a demersal and sedentary species, living on sandy and muddy bottoms (Tortonese, 1975, Fisher *et al.*, 1987, Jardas, 1996). Although Jardas (1996) stated that the species is distributed from coastal waters to 250 m depth, it was exclusively caught up to 100 m during the MEDITS expedition in 1996-1998 (Vrgoč, 2000).

Common sole usually feeds very often on small quantities of prey (Sà *et al.*, 2003). This suggests a high evacuation rate between the stomach and the intestine, and a lack of digestion in the stomach (Lagardère, 1987). The fish feeds night and day and for the remaining time usually lives embedded in the seabed. In the Adriatic Sea food items mostly include invertebrates and small fish (Tortonese, 1975; Fisher *et al.*, 1987; Jardas, 1996). Within the framework of SoleMon project, a study of gut content using carbon- and nitrogen stable isotopes along the sole food web was carried out, indicating that *S. solea* diet depends on both the geographical position and the size of soles, which change their feeding habit with the increase of the age. This could be related to the fact that the sole selects its preys based on both their energetic value and the energy spent to catch them. The choice of sole would be also related to prey abundance, as postulated by the "*optimal foraging theory*" (MacArthur and Pianka, 1966) and observed in other flatfish (Hinz *et al.*, 2005). Stergiou and Karpouzi (2002) found that in the Mediterranean Sea the sole increases its trophic level as it increases in size, reaching values around 3.4. The mean trophic level estimated from the SoleMon project data through the stable isotope analysis was slightly higher (3.9), but similar to the value obtained in a study carried out in the mouth of the river Rhone (Darnaude, 2005).

6.12.1.2.Growth

In the Adriatic sea, growth analyses on this species have been made using otoliths, scales and tagging experiments. A great variability in the growth rate was noted: some specimens had grown 2 cm in one month, while others, of the same age group, needed a whole year (Piccinetti and Giovanardi, 1984; Tab. 6.12.1.2.1). Von Bertalanffy growth equation parameters have been calculated using various methods. Within the framework of SoleMon project, growth parameters of sole were estimated through the length-frequency distributions obtained from surveys (Fig. 6.12.1.2.1.; Tab. 6.12.1.2.2).

Tab. 6.12.1.2.1. Growth rates of *S. solea* from different studies. (TL, cm; age, yr).

Author	**Sex**	**Age**					
		1	**2**	**3**	**4**	**5**	**6**
Ghirardelli (1959)	M+F	16.8	21.4	23.9	25.6	33.1	-
Piccinetti and Giovanardi (1984)	M+F	18-20	21-30	-	-	-	-
Vallisneri *et al.* (2000)	F	20	25	29	32	34	37

Tab. 6.12.1.2.2 Von Bertalanffy parameters of *S. solea* estimated in different studies. *(k, yr^{--1}; t_0, yr).

Author	**Sex**	**W_∞(g)**	**L_∞(cm)**	**k ($month^{-1}$)**	**t_0 (month)**
Piccinetti and Giovanardi (1984)	M+F	-	40.10	0.68*	-
Froglia and Giannetti (1985)	M+F	-	38.25	0.041	-3.57
Froglia and Giannetti (1986)	M	323	23.20	0.069	-1.66
	F	562	37.87	0.042	-5.36
	M+F	576	38.25	0.041	-3.57
Fabi *et al.* (2009)	M+F	-	39.60	0.44*	-0.46*

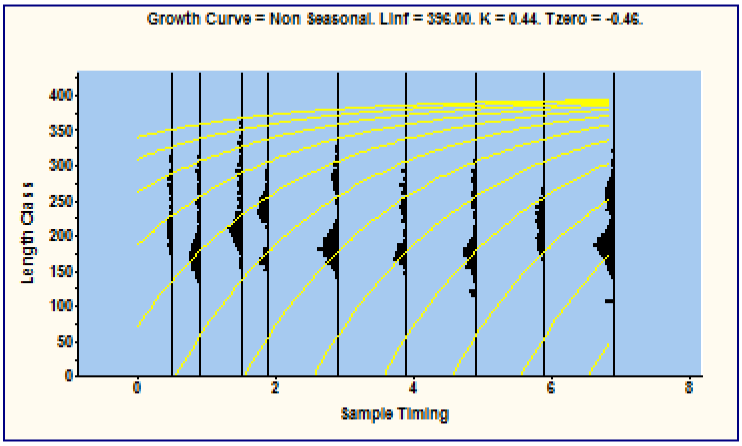


Fig. 6.12.1.2.1 - Von Bertalanffy growth functions for sole in the GSA 17, based on SoleMon length frequency distributions (2005-2012).

6.12.1.3.Maturity

In the Mediterranean Sea, the reproduction of common sole occurs from December to May (Bini; 1968-70), Tortonese, 1975, Fisher *et al*., 1987). Within the framework of SoleMon project, it has been observed that in the central and northern Adriatic Sea the reproduction takes place from November to March. Data on the spatial distribution of spawners provided by the project show a higher concentration of reproducers off the western coast of Istria (Fabi *et al.*, 2009).

Length at first maturity is 25 cm (Fisher *et al.*, 1987; Jardas, 1996; Vallisneri *et al.*, 2000); this value has been estimated at 25.8 using data from SoleMon project. The proportion of mature by age estimated by SoleMon data is presented in table 6.12.4.1.2.1.

Females having a weight of 300 g have about 150,000 eggs, while those weighting 400 g have about 250,000 eggs (Piccinetti and Giovanardi, 1984); eggs are pelagic. The male-female ratio is approximately 1:1 (Piccinetti and Giovanardi, 1984; Fabi *et al.*, 2009).

Hatching occurs after eight days and the larva measures 3 to 4 mm TL (Tortonese, 1975). Eye migration starts at 7 mm TL and ends at 10-11 mm TL. Benthic life begins after seven or eight weeks (15 mm) in coastal and brackish waters (Bini (1968-70); Fabi *et al*., 2009).

6.12.2. *Fisheries*

6.12.2.1.General description of fisheries

The common sole is a very important commercial species in the central and northern Adriatic Sea (Ghirardelli, 1959; Piccinetti, 1967; Jardas, 1996; Vallisneri *et al.*, 2000; Fabi *et al.*, 2009). Italian *rapido* trawlers exploit this resource, usually providing more than 40% of landings. Sole is also a target species of the Italian and Croatian set netters, and it represents an accessory species for otter trawlers.

From censuses carried out at the landing sites, the Italian rapido trawl fleet operating in GSA 17 was made of 155 vessels in 2005 and 124 vessels in 2006 ranging from 9 to 30 m in vessel length. GRT ranged from 4 to 100 and the engine power from 60 to 1000 HP. Each vessel can tow from 2 to 4 rapido trawls depending on its dimensions. The *rapido* trawl is a gear used specifically for catching flatfish and other benthic species (e.g. cuttlefish, mantis shrimp, etc.). It resembles a toothed beam-trawl and is made of an iron frame provided with 3-5 skids and a toothed bar on its lower side. These gears are usually towed at a greater speed (up to 10-13 km h^{-1}) in comparison to the otter trawl nets; this is the reason of the name "*rapido*", the Italian word for "fast". The mesh opening of the codend used by the Italian *rapido* trawlers is larger (48 mm stretched or more) than the legal one. The main Italian *rapido* trawl fleets of GSA17 are sited in the following harbours: Ancona, Rimini and Chioggia (Figures 6.12.1.2.3.1.1 and 6.12.1.2.3.1.2.)

The Italian artisanal fleet in GSA 17, according to SoleMon project data (end of 2006), accounted for 469 vessels widespread in many harbours along the coast. They use gill nets or trammel nets especially from spring to fall and target small and medium sized sole (usually smaller than 25 cm TL).

6.12.2.2.Management regulations applicable in 2011 and 2012

Italy and Slovenia :

- In Italy and Slovenia the main rules in force are based on the applicable EU regulations (mainly EC regulation 1967/206):
- Minimum landing sizes: 20 cm TL for sole.
- 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.
- Set net minimum mesh size: 16 mm stretched.
- Set net maximum length x vessel x day: 5,000 m

Croatia

Since the accession of Croatia to the EU the 1st if July 2013, the same regulations of Italy and Slovenia are implemented. Furthermore the following regulation are applied:

- Beam trawl (“*rapido*”), according to the Fishing acts (Narodne novine, 148/2010, 25/2011), is gear for catching only shellfish, and the rate of other species in the catches cannot exceed 20%. Allowed mesh size for “rapido” is 40 mm (from knots to knots), and it is allowed to use only two rapido per vessel. Each rapido can be wide up to 4 meters.
- The species is mainly caught with trammel nets, and minimum mesh size for trammel nets is 40 mm (inner nets) and 150 mm (outer nets). Maximum length of the nets allowed on the vessel is 6,000 m. If only one fisherman present on the vessel, the maximum allowed length is 4,000 m; for each additional fisherman an extra 1,000 m of net is allowed, up to 6000 m of total length per vessel. Maximum height of the nets is 4 m. Trammel nets can only be used only in the period from 10 September to 15 January.

6.12.2.3.Catches

6.12.2.3.1.Landings

Common sole landings estimated in the framework of Italian Official Data Collection submitted in response to the 2013 data call are shown in Fig. 6.12.1.2.3.1.1, together with the Slovenian and Croatian data provided respectively in the framework of Slovenian Official Data Collection of 2013 and Croatian Primo Project.

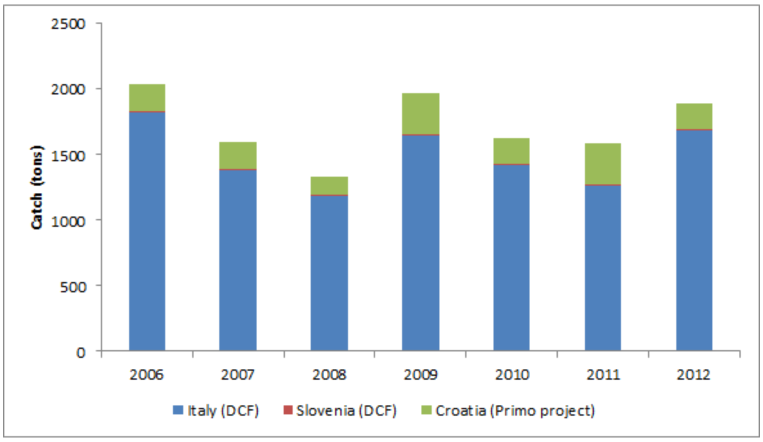


Fig. 6.12.1.2.3.1.1 Landings of sole (all gears) in the GSA 17, from 2006 to 2012.

The eastern part of the basin contributes for about the 10% of the total landings, with on average 8 tons from Slovenia and 200 tons from Croatia.

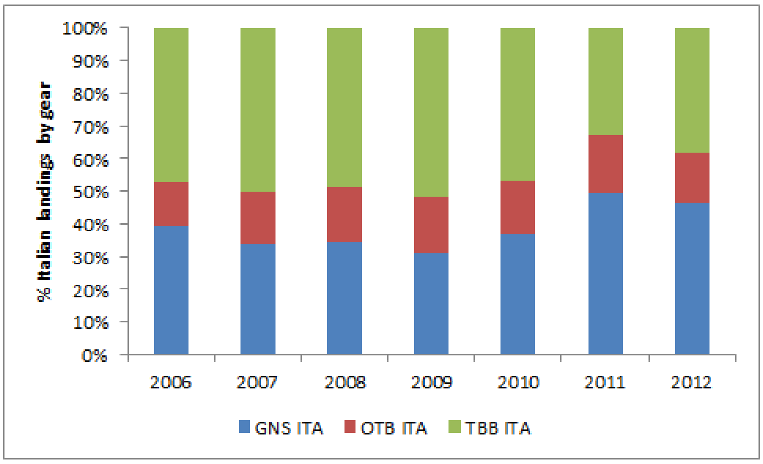


Fig. 6.12.1.2.3.1.2 Percentage of Italian landings of sole (by gears) in the GSA 17, from 2006 to 2012.

Rapido trawl landings were traditionally dominated by small sized specimens; they are basically composed by 1 and 2 year old individuals. Set net fishery lands mostly the same portion of the population, while the otter trawl fishery, exploiting wider fishing grounds, shows a different size distribution of the landings (Fig. 6.12.1.2.3.1.2). In the eastern part of the basin common sole is exploited mainly by set netters (using trammel net), and the catch composition, as suggested by preliminary data collection carried out in 2010 by Croatian colleagues in the framework of Primo Project, is dominated by adult (Fig. 6.12.1.2.3.1.3). In figure 6.12.1.2.3.1.4, the length frequency DCF data from the Italian landings are shown.

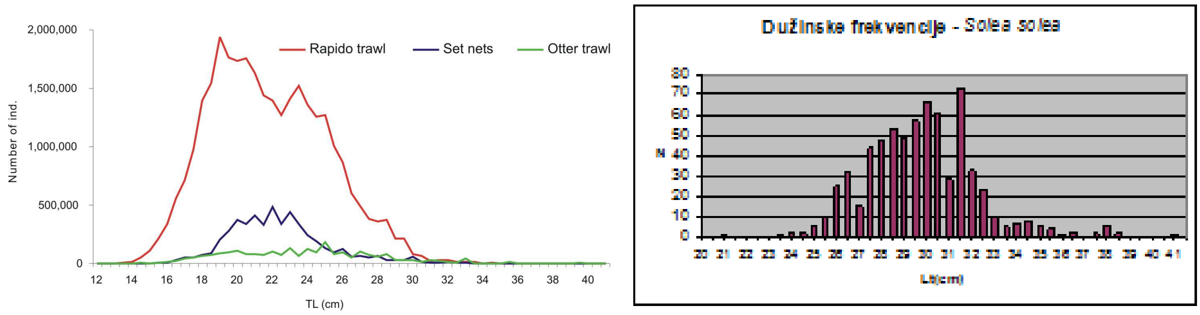


Fig. 6.12.1.2.3.1.3 Size structure of the landings of common sole provided in 2005-2006 by *rapido* trawl, otter trawl and set nets in the GSA 17 (SoleMon project data; left). Size structure of the landings of common sole in 2010 by set nets in the eastern part of GSA 17.

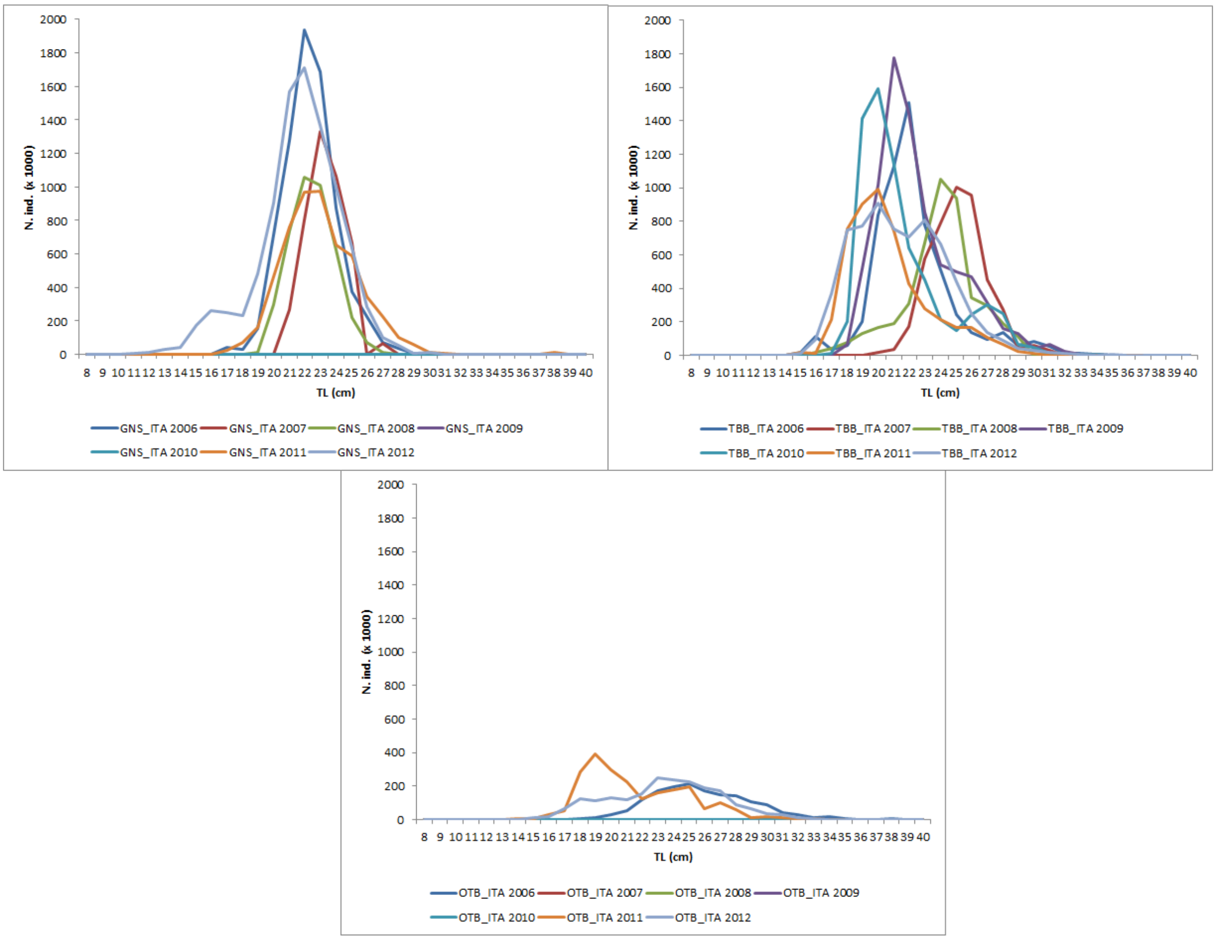


Fig. 6.12.1.2.3.1.4 Size structure of the landings of common sole in 2006-2012 provided by the 2013 Italian DCF data call for GSA 17. (GNS = gill nets; TBB = *rapido* trawl, OTB = otter trawl).

6.12.2.3.2. Discards

Several projects carried out in a portion of GSA17 highlighted that discards of sole both by *rapido* trawl and set net fisheries is negligible (Fabi *et al.*, 2002a; 2002b) since the damaged specimens are also commercialized, even though at a lower price.

In the Italian DCF data discard data by age and length are available only for 2011 and 2012 and represent respectively the 5% and 0.02% of the total catches. The discard data of 2011 and 2012 were considered in the assessment (both XSA and SCAA), but considering the low amount and the variability observed the discard structure of the catches has not been estimated for the years 2006-2010 (Figs 6.12.2.3.2.1 and 6.12.2.3.2.2).

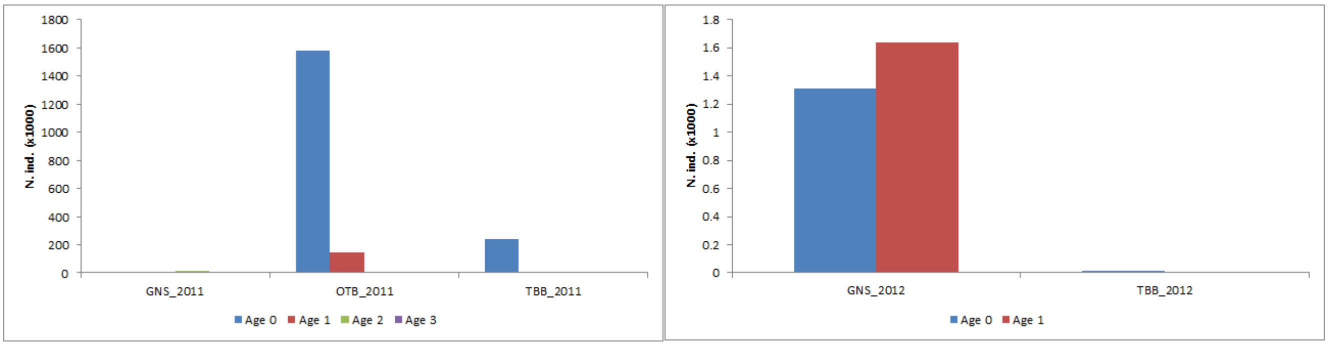


Fig. 6.12.2.3.2.1 Discard data by age available in Italian DCF 2013.

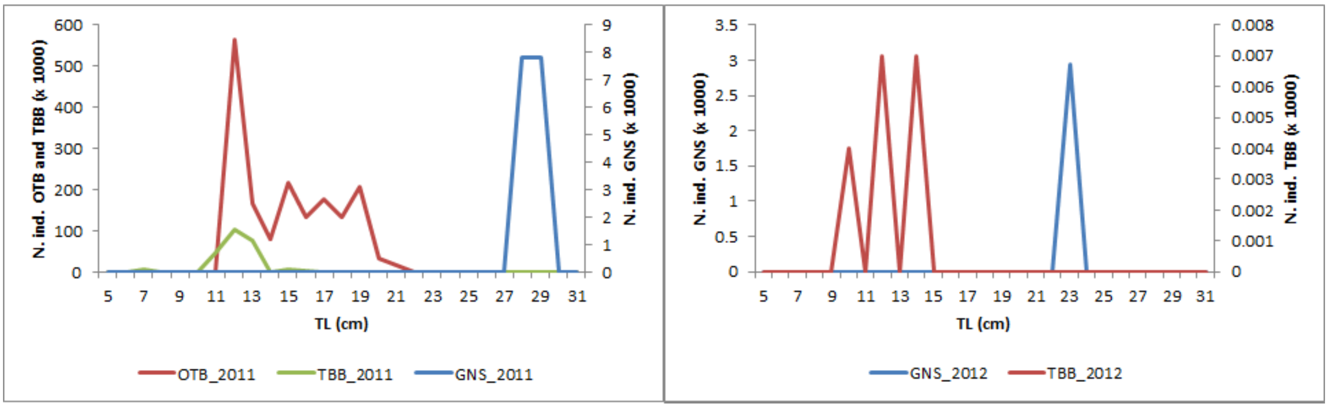


Fig. 6.12.2.3.2.1 Discard data by length available in Italian DCF 2013.

In the Slovenia DCF data discard is not available by age and length. The total amount of discard is available since 2005 and represents on average the 0.35% of the total catch.

6.12.2.4.Fishing effort

Effort data from the 2013 DCF data call are listed in the tables below respectively for Italy and Slovenia (Tables 6.12.2.4.1 and 6.12.2.4.2) and shown in Fig. 6.12.2.4.1 It is possible to observe a remarkable decrease of the OTB effort in Italy, while the other gears show a generally constant trend in fishing effort. Conversely, Slovenian effort data shows a clear increasing trend for all the gear categories.

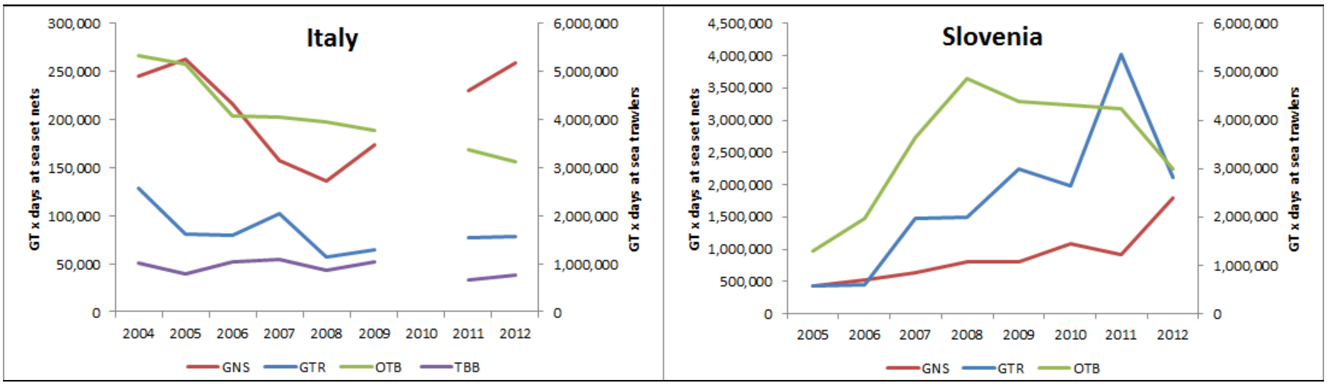


Figure 6.12.2.4.1 Effort data from Italian and Slovenia DCF 2013 expressed in GT x working days.

Table 6.12.2.4.1 Italian effort from 2013 DCF data.

Year	Gear	NOMINAL EFFORT	GT DAYS AT SEA
2004	GNS	4,476,609	245,401
2004	GTR	1,790,055	129,028
2004	OTB	27,823,853	5,324,756
2004	TBB	4,232,537	1,003,129
2005	GNS	4,980,544	262,674
2005	GTR	1,275,558	80,535
2005	OTB	24,094,431	5,165,331
2005	TBB	3,812,915	785,589
2006	GNS	4,315,531	216,424
2006	GTR	1,157,336	79,544
2006	OTB	19,896,811	4,079,669
2006	TBB	4,946,237	1,052,912
2007	GNS	2,538,855	156,782
2007	GTR	1,463,360	101,669
2007	OTB	19,409,042	4,056,776
2007	TBB	5,231,834	1,096,364
2008	GNS	2,456,661	135,755
2008	GTR	890,098	56,449
2008	OTB	19,141,918	3,961,550
2008	TBB	4,256,290	875,295
2009	GNS	3,278,725	173,251
2009	GTR	1,068,830	64,168
2009	OTB	18,598,084	3,777,751
2009	TBB	4,340,202	1,035,663
2011	GNS	4,524,279	229,986
2011	GTR	1,475,946	77,291
2011	OTB	16,050,252	3,378,533
2011	TBB	2,625,526	670,632
2012	GNS	5,314,329	259,488
2012	GTR	1,505,889	78,308
2012	OTB	14,020,762	3,130,643
2012	TBB	3,254,187	772,706
Total		234,247,486	42,514,052

Table 6.12.2.4.2 Slovenian effort from 2013 DCF data.

Year	Gear	NOMINAL EFFORT	GT DAYS AT SEA
2005	GNS	5,288,929	433,333
2005	GTR	7,479,684	436,343
2005	OTB	14,824,767	1,306,298
2006	GNS	7,026,978	525,500
2006	GTR	8,357,902	449,787
2006	OTB	21,946,724	1,963,964
2007	GNS	7,612,145	637,539
2007	GTR	29,085,357	1,482,231
2007	OTB	36,475,949	3,631,210
2008	GNS	13,548,520	812,959
2008	GTR	27,493,876	1,493,514
2008	OTB	47,504,644	4,857,259
2009	GNS	14,910,574	807,833
2009	GTR	39,439,838	2,241,223
2009	OTB	45,029,312	4,399,362
2010	GNS	20,414,817	1,082,202
2010	GTR	37,830,757	1,986,779
2010	OTB	45,322,719	4,306,395
2011	GNS	17,643,895	916,959
2011	GTR	80,413,417	4,011,741
2011	OTB	41,135,645	4,227,010
2012	GNS	38,271,483	1,791,291
2012	GTR	42,487,120	2,115,613
2012	OTB	28,317,034	2,978,721
Total		677,862,086	48,895,066

Spatial distribution of rapido trawl fishing effort

Figure 6.12.2.4.2 shows the fall rapido-trawl effort of Italian vessels over the years 2006–2011 in GSA 17. The first zone of effort concentration is inshore between 3 and 9 nautical miles from the Italian coast, between 43° and 44° latitude, and is mainly exploited by vessels belonging to Ancona and Rimini Harbours. The second zone is between Po river mouth and Venice lagoon and is concentrated at the same distance from the coast as the first region. This region is mainly exploited by the Chioggia rapido trawl fleet. The third area of effort concentration is offshore, near Istria peninsula and is exploited by both Chioggia and Rimini rapido trawl fleets. As expected, the area is characterised by a low abundance of sole, as suggested by survey data in Grati et al. (2013), and has a relatively low fishing effort. The area southward of this last region is not exploited by rapido trawlers mainly due to the high concentrations of debris and benthic communities that are dominated by holothurians (Despalatović et al., 2009). The data presented in the Figure 6.12.2.4.2 are quite important in order to explain the population selectivity curves used in the SS3 model in order to carry out the Statistical Catch at Age analysis (see discussion below).

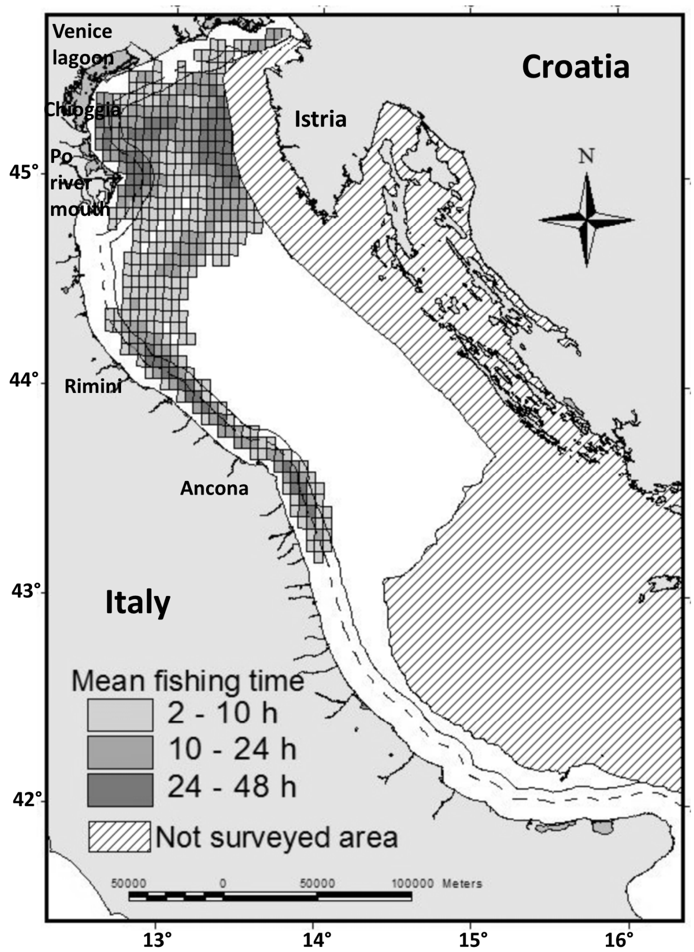


Figure 6.12.2.4.2 Maps of spatial distribution of rapido trawl fishing effort estimated in mean fishing hours in each 5 x 5 km rectangle. The 6 and 9 nautical miles from the Italian coast are shown respectively by broken and continuous black lines (Scarcella et al., submitted).

6.12.3. *Scientific surveys*

6.12.3.1. SoleMon

6.12.3.1.1. Methods

Ten *rapido* trawl fishing surveys were carried out in GSA 17 from 2005 to 2012: two systematic "pre-surveys" (spring and fall 2005) and four random surveys (spring and fall 2006, fall 2007-2012) 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 (Tab. 6.12.3.1.1).

Tab. 6.12.3.1.1 Number of hauls per year and depth stratum in GSA 17, 2005-2012.

Depth strata	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Fall 2007	Fall 2008-2012
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, spawning females and juveniles. Underestimation of small specimens in catches due to gear selectivity was corrected using the selective parameters given by Ferretti and Froglia (1975).

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.

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.

6.12.3.1.2.Geographical distribution patterns

According to data collected during SoleMon surveys (Scarcella *et al.*, submitted), age class 0+ aggregates inshore along the Italian coast, mostly in the area close to the Po river mouth (Fig. 6.12.3.1.2.1). Age class 1+ gradually migrates off-shore and adults concentrate in the deepest waters located at South West from Istria peninsula (Fig. 6.12.3.1.2.1).

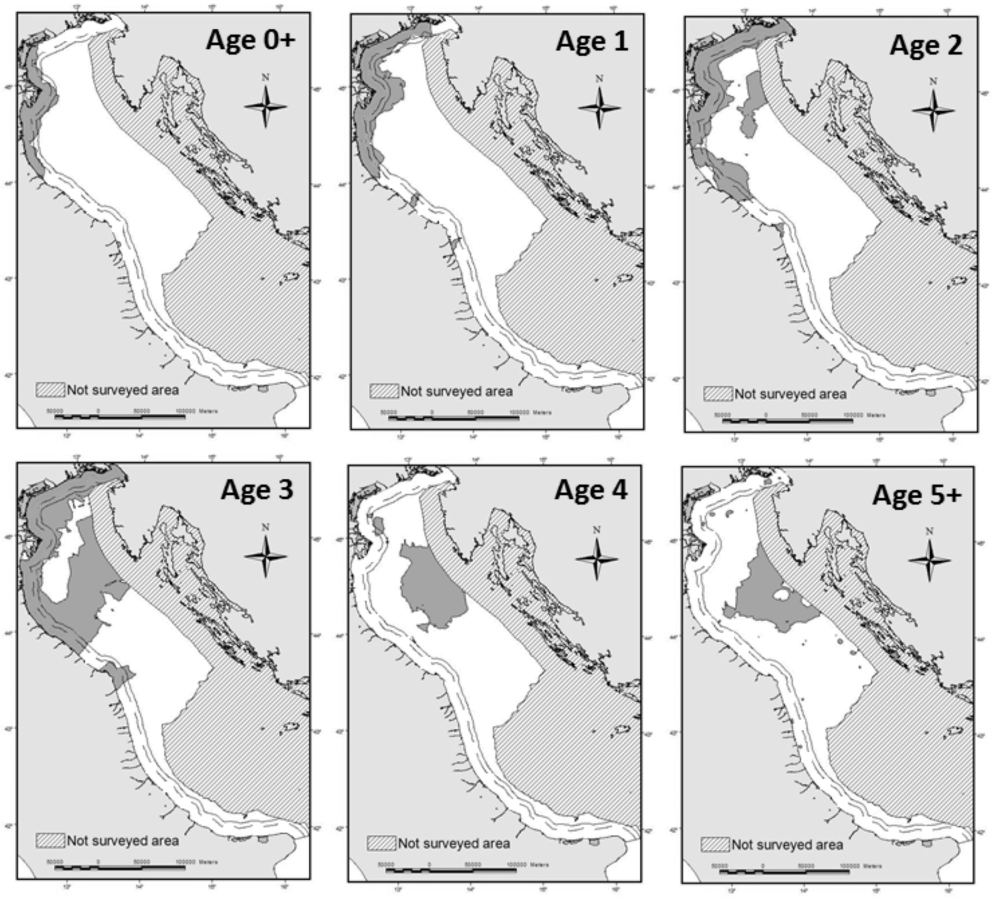


Fig. 6.12.3.1.2.1 Maps of hotspots calculated for the age classes of soles. The 6 and 9 nautical miles from the Italian coast are shown respectively by broken and continuous black lines (Scarcella et al., submitted).

6.12.3.1.3.Trends in abundance and biomass

The SoleMon trawl surveys provided data either on sole total abundance and biomass as well as on important biological events (recruitment, spawning).

Fig. 6.12.3.1.3.1 shows the abundance and biomass indices of sole obtained from 2005 to 2012; slightly increasing trends occurred till fall 2007, followed by a decrease in fall 2008-2009, and an increase in 2010-2012.

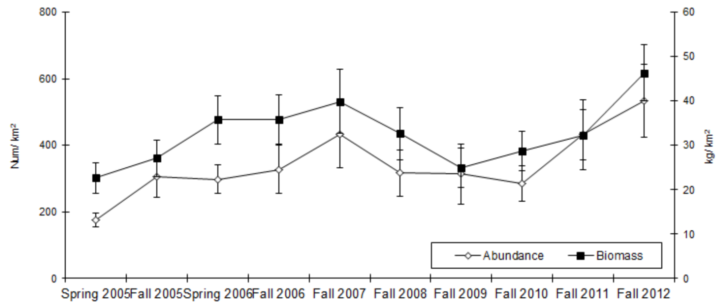


Fig. 6.12.3.1.3.1 Abundance and biomass indices of sole obtained from SoleMon surveys.

Fig. 6.12.3.1.3.2 shows the abundance and biomass indices of sole recruits (less than 20 cm) obtained from 2005 to 2012; wide oscillation were observed in the period 2005 – 2010 followed by a clear increase in the last 2 years.

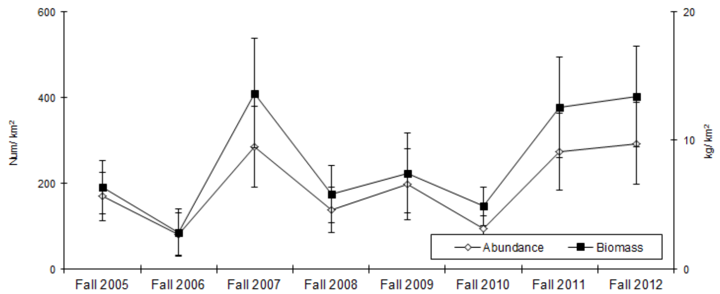


Fig. 6.12.3.1.3.2 Abundance and biomass indices of sole recruits obtained from SoleMon surveys.

Fig. 6.12.3.1.3.3 shows the abundance and biomass indices of sole adults (more than 25.8 cm) obtained from 2005 to 2012; after a decreasing trend observed from 2007 to 2010 an increase has been observed in the last two years.

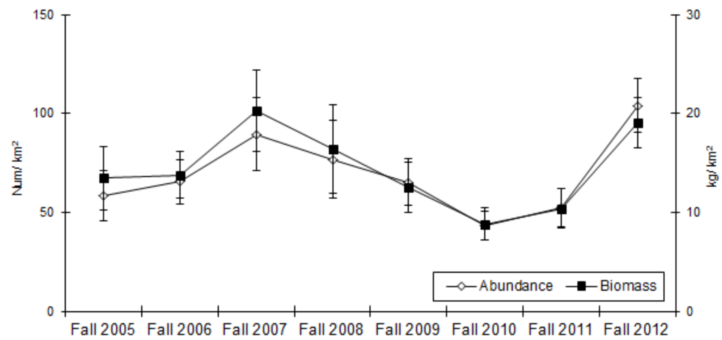


Fig. 6.12.3.1.3.2 Abundance and biomass indices of sole adults obtained from SoleMon surveys.

6.12.3.1.4. Trends in abundance by length or age

Fig. 6.12.3.1.4.1 displays the stratified abundance indices obtained in the GSA 17 in the years 2005-2012.

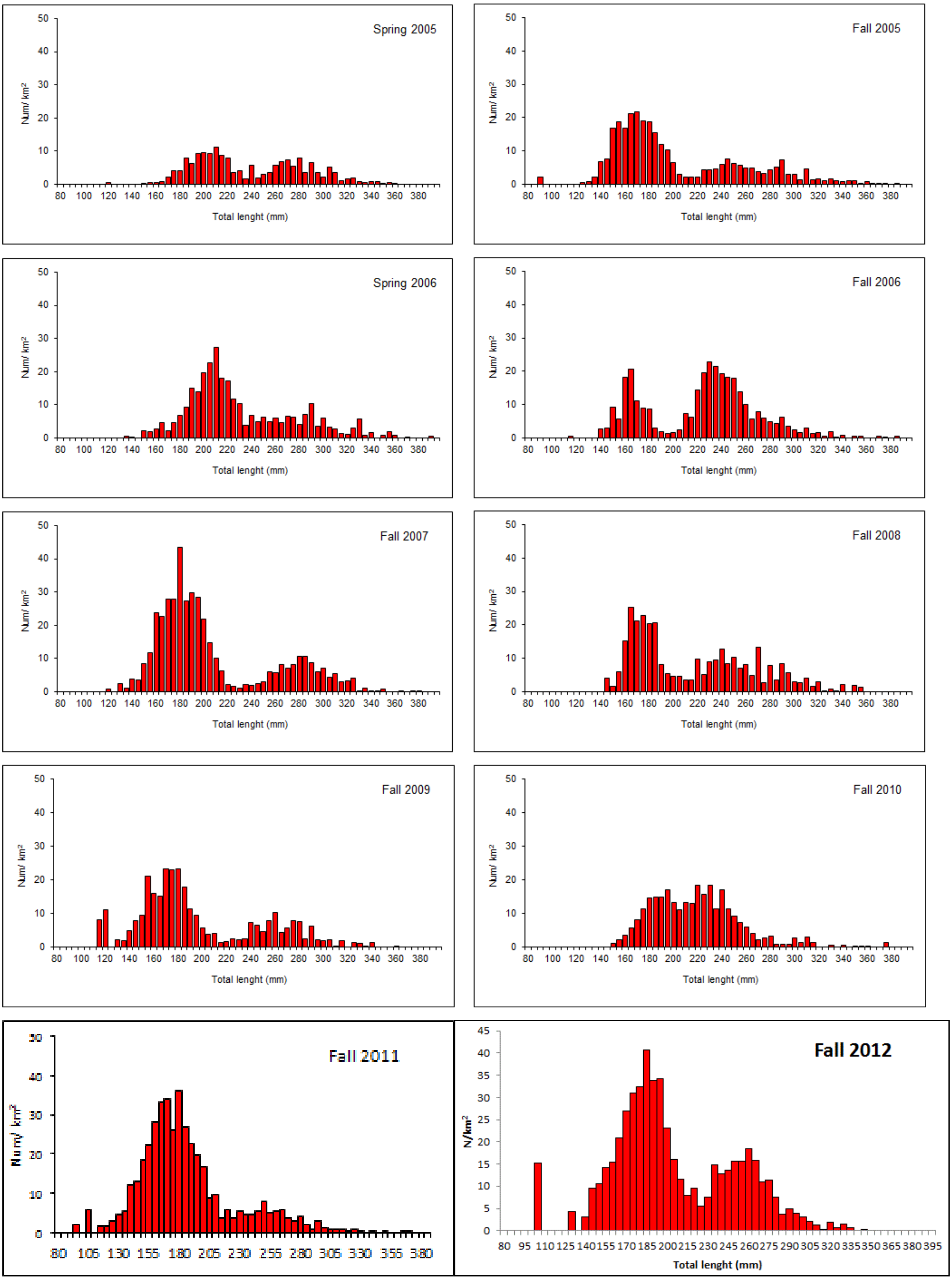


Fig. 6.12.3.1.4.1 Stratified abundance indices by size, 2005-2012.

6.12.3.1.5.Trends in growth

No assessment of trend in growth has been carried out.

6.12.3.1.6.Trends in maturity

No assessment of trend in growth has been carried out.

6.12.4. *Assessments of historic stock parameters*

Sole has been the object of several stock assessments in GSA17; results are published and regularly updated in the GFCM SAC sheets and in STECF-EWGs. The assessments, often performed with different approaches, showed substantially convergent results. The most recent assessment of the common sole stock in GSA 17 was out during the 2012 GFCM-WG on demersal stocks (Scarcella et al., 2012), showing a situation of clear overexploitation.

6.12.4.1.Method: XSA

6.12.4.1.1. Justification

Considering the variability observed in the recruitment, the assessment is based on non-equilibrium method. FLR libraries were used in order to perform an XSA (Darby and Flatman 1994). The set of data has been provided by the 2013 official data call from 2006 to 2012.

6.12.4.1.2. Input data and parameters

Catch at age data series of the period 2006-2011 were provided by official statistics from the 2013 DCF data call (Fig. 6.12.4.1.2.1). Italian GNS and OTB catch at age data were missing from official statistics in 2008 and 2009, and have thus been reconstructed on the basis of the mean catch composition available and landings provided by the DCF in 2013 (Fig. 6.12.4.1.2.1).

Croatian catch at age data were reconstructed in 2006-2012 on the base of the total landings suggested by Croatian colleagues (Fig. 6.12.1.2.3.1.1) and catch at age data composition observed for set netters (mainly using trammel nets).

The total catch numbers at age were rescaled based on the SOP correction observed between the reconstructed total catch and the total catch provided by 2013 Italian and Slovenia DCF official statistics and Croatian colleagues. The following analyses are carried out using rescaled catch numbers at age.

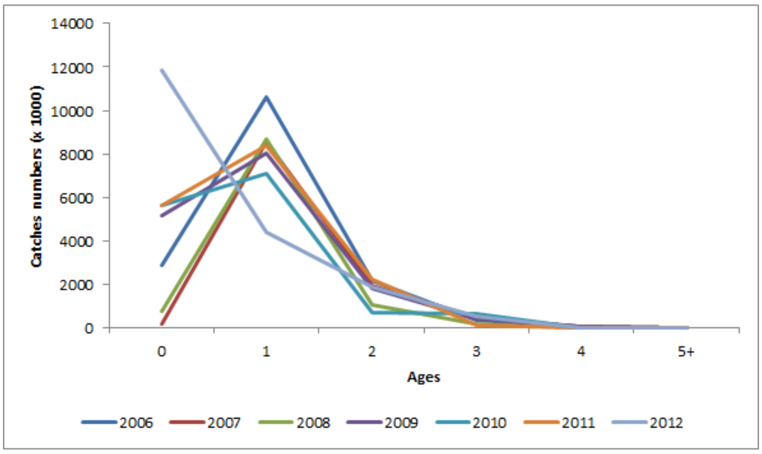


Fig. 6.12.4.1.2.1. Catch at age data used in the VPA and XSA runs.

Maturity at age, Length-Weight relationships, growth parameters were provided in the framework of SoleMon project.

Tuning data were provided by SoleMon surveys, carried out in fall for the years 2006-2012.

A vector of natural mortality rate at age was estimated using the PRODBIOM spreadsheet (Abella et al., 1997).

Tab. 6.12.4.1.2.1 Input data and parameters.

Catch at age in numbers (x 1000)						
	0	1	2	3	4	5+
2006	2858	10617	2154	371	46	18
2007	208	8574	1974	496	47	19
2008	799	8681	1058	171	32	12
2009	5180	8051	1840	395	70	28
2010	5614	7124	706	655	29	10
2011	5649	8364	2243	103	15	30
2012	11864	4424	1892	531	26	10

Survey indexes (N. ind. km^{-2})						
	0	1	2	3	4	5
2005	162	86	39	12	3	1.9
2006	91	174	49	9	2	1.2
2007	192	146	74	18	1	0.6
2008	128	114	58	11	5	0.6
2009	177	83	47	6	1	0.2
2010	55	200	23	5	0.2	1.3
2011	199	172	34	5	0.5	0.8
2012	206	248	74	6	0.33	0.1

Mean weight in catch (kg)						
	0	1	2	3	4	5+
2006	0.066	0.125	0.186	0.356	0.453	0.522
2007	0.066	0.125	0.186	0.356	0.453	0.522
2008	0.077	0.133	0.211	0.356	0.453	0.522
2009	0.077	0.137	0.224	0.356	0.453	0.522
2010	0.079	0.156	0.254	0.356	0.453	0.522
2011	0.065	0.116	0.2	0.356	0.453	0.522
2012	0.08	0.151	0.204	0.267	0.453	0.522

Mean weight in stock (kg)						
Period	0	1	2	3	4	5+
2006-2012	0.024	0.104	0.207	0.304	0.380	0.522

Growth parameters			
PERIOD	L_∞	K	T_0
2006-2012	39.6 cm	0.44 y^{-1}	-0.46 y

Length-weight relationships		
PERIOD	a	b
2006-2012	0.007	3.0638

Maturity at Age						
PERIOD	0	1	2	3	4	5+
2006-2012	0	0.16	0.76	0.96	0.99	1.00

Natural mortality (M)						
PERIOD	0	1	2	3	4	5+
2006-2012	0.70	0.35	0.28	0.25	0.23	0.22

Sensitivity analyses were conducted to assess the effect of the main parameters, i.e. shrinkage (fse) and age above which q is independent from age (q_{age}). Values ranging from 0 to 2 (0.5 increasing) for the shrinkage and from 0 to 5 for the q_{age} parameter have been tested. As a result, the setting that minimized the residuals and showed the best diagnostics output both of the residuals and retrospective analyses were used for the final assessment.

On the base of the sensitivity analyses the XSA run were made using the following settings:

- Catchability dependent on stock size for ages = 0.

- Catchability independent of age for ages >= 4.

- S.E. of the mean to which the estimates are shrunk = 1.

- Minimum S.E. for population estimates derived from each fleet = 0.30.

-Number of years used for the shrinkage = 5.

-Number of ages used for the shrinkage = 5.

-Ages used for tuning from the survey = 1-4.

The other setting employed were:

-F_{bar} = 0-4.

- Proportion of M before spawning = 0.5.

-Proportion of F before spawning = 0.5.

6.12.4.1.3.Results

A separable VPA was run as exploratory analysis. Log catchability residual plots was produced (Fig. 6.12.4.1.3.1) and no major conflict between ages seems to appear, except for age 0/1 in 2010-2011.

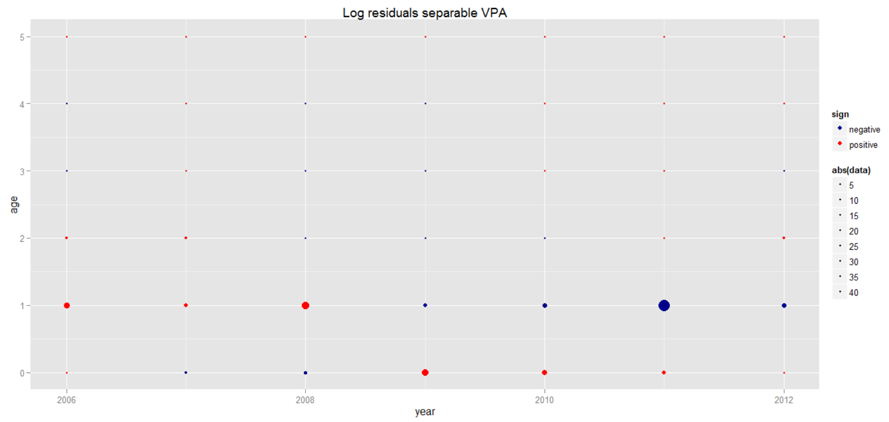


Fig. 6.12.4.1.3.1 Residual plot of the separable VPA. (Residuals = Log(Catch observed – Catch Hat); Catch Hat = F/Z * N. ind *(1-exp(-Z))

XSA Diagnostics in the form of residuals by survey data are shown in the figure 6.12.4.1.3.2.

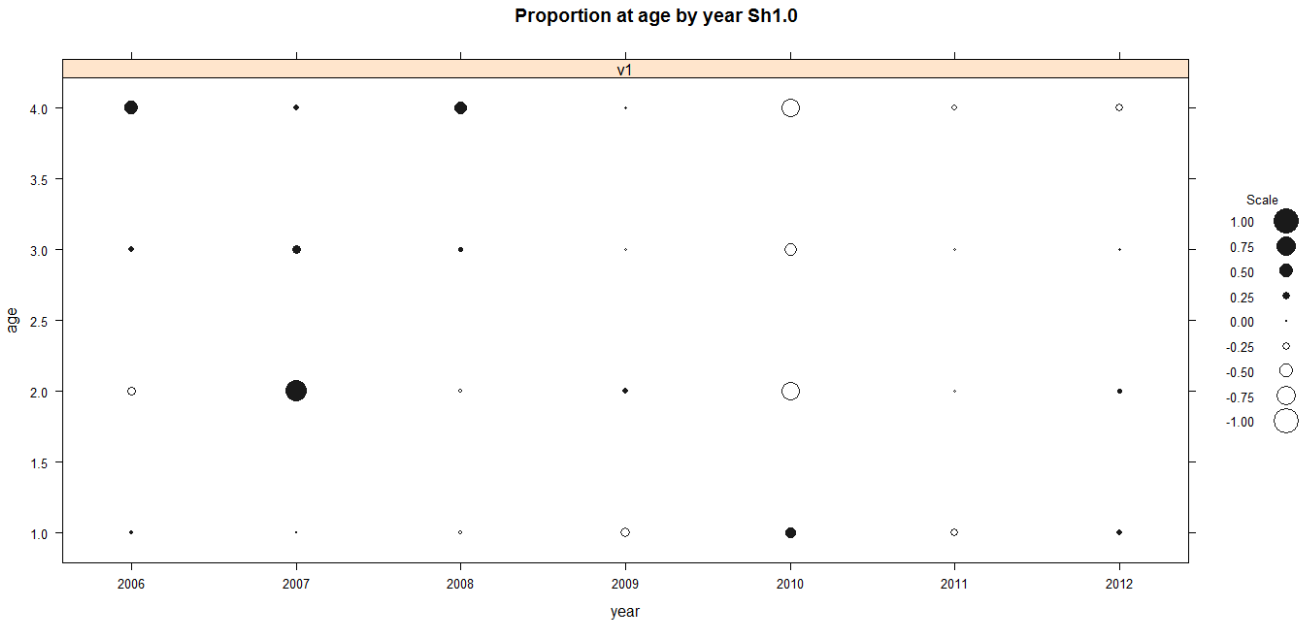


Fig. 6.12.4.1.3.2 Residuals by survey.

No trends in the residuals were observed.

The figures 6.12.4.1.3.3 present the main results from the XSA run: fishing mortality F_{bar1-4} (harvest), spawning stock biomass (SSB), recruitment (in thousands) and catches (in tons).

Fig. 6.12.4.1.3.3 Final assessment results XSA run.

State of exploitation: Exploitation varied without any trend in the years 2006-2012, reaching a minimum in 2008. The most recent estimate of fishing mortality (F_{0-4}) is 1.16. As showed in Table 6.12.4.1.3.1 the higher values of F are observed for the ages from 3 to 5+.

State of the juveniles (recruits): Recruitment varied without any trend in the years 2006-2012, reaching a minimum in 2011, followed by an increase in 2012, observed also in survey data.

State of the adult biomass: The SSB showed a general decrease from 2006 to 2010, increased in 2011 and 2012 (SSB_{2012}: 445 tons), as observed in the survey data.

Table 6.12.4.1.3.1Fishing mortality by age estimated from the XSA.

age	2006	2007	2008	2009	2010	2011	2012
0	0.15	0.01	0.06	0.52	0.34	0.31	0.49
1	1.61	1.46	1.58	1.41	1.06	0.97	0.70
2	0.79	1.14	0.30	0.59	0.36	0.95	0.83
3	2.52	2.19	1.68	3.10	2.26	2.95	2.42
4	0.73	1.05	0.24	1.30	1.52	1.53	1.35
5+	0.73	1.05	0.24	1.30	1.52	1.53	1.35

A retrospective analysis was also carried out. The retrospective analysis confirm the stability of the estimates of XSA (Fig. 6.12.4.1.3.4).

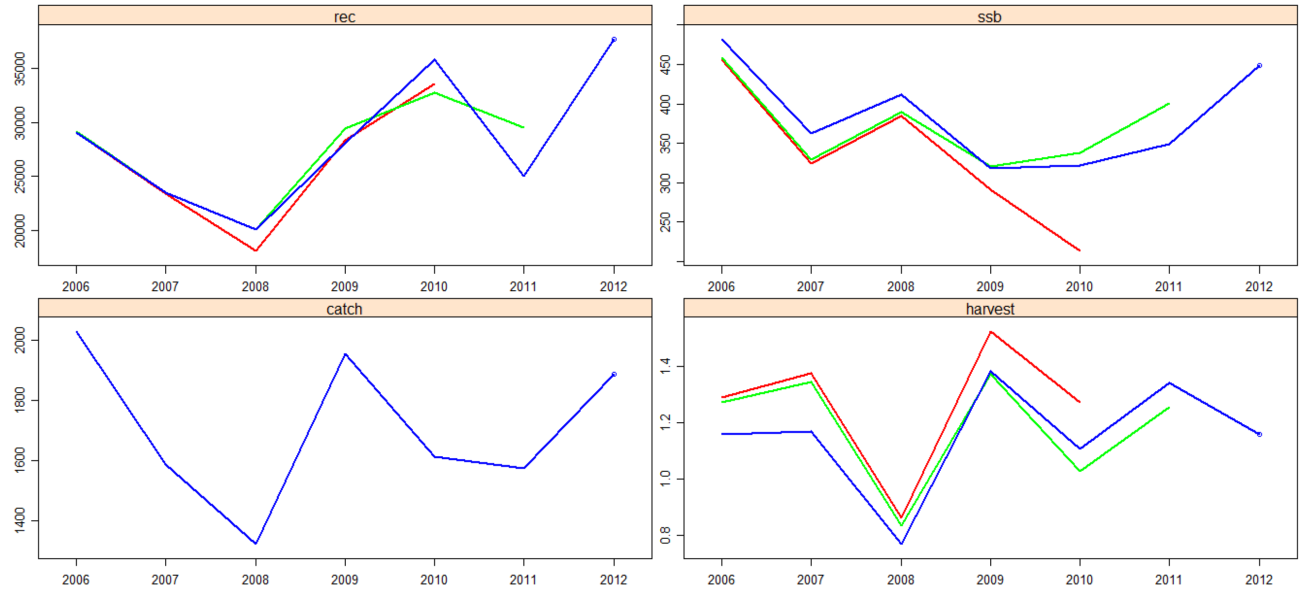


Fig. 6.12.4.1.3.4 Retrospective analyses on rescaled data.

6.12.4.2.Method: Statistical catch at age (SS3 model)

6.12.4.2.1.Justification

Stock Synthesis 3 provides a statistical framework for the calibration of a population dynamics model using fishery and survey data. It is designed to accommodate both population age and size structure data and multiple stock sub-areas can be analysed. It uses forward projection of population in the "statistical catch-at-age" (hereafter SCAA) approach. SCAA estimates initial abundance at age, recruitments, fishing mortality and selectivity. Differently from VPA based approaches (e.g. by XSA) SCAA calculates abundance forward in time and allows for errors in the catch at age matrices. Selectivity has been generated as age-specific by fleet, with the ability to capture the major effect of age-specific survivorship. The overall model contains subcomponents which simulate the population dynamics of the stock and fisheries, derive the expected values for the various observed data, and quantify the magnitude of difference between observed and expected data. Some SS features include ageing error, growth estimation, spawner-recruitment relationship, movement between areas; in the present assessment such features are not summarized in the results. The

ADMB C++ software in which SS is written searches for the set of parameter values that maximize the goodness-of-fit, then calculates the variance of these parameters using inverse Hessian methods.

In the present assessment the variance is not shown for fishing mortality results, because the model outputs provide F values (called continuous F) within a year as standardized into selection coefficients by dividing each F value by the maximum value observed for any age class in the year (e.g., Derio et al., 1985; Sampson and Scott, 2011). For a better comparison with the results of previous assessments carried out both in the framework of STECF-EWGs and GFCM-WGs and with the outputs of the XSA carried out in the present assessment, the F values are standardized by estimating the average (called F_{bar}) of the F values observed over a defined range of age classes (e.g., Darby and Flatman, 1994; Sampson and Scott, 2011).

The same SOP corrected data and parameters utilized in the XSA were employed, with the main difference that the catch at age matrix from the fishery has been extrapolated backwards until 2000, utilizing the same input data presented in the FAO-GFCM-WG of demersal held in Ancona in 2010 (http://151.1.154.86/meetingdocs/2009/SCSA_WG_Demersal_Species_Ancona/StockAssessmentForms, accessed July 2013). The catch at age data from 2000 to 2005 has been provided in the framework of two different projects carried in 2000 and 2004 about the study of the Adriatic *rapido* trawl activity and sole exploitation in GSA 17. The model allowed to specify the different source of data, providing different uncertainties estimates for each data set. Moreover also the total landings presented from 1970 to 2005 (FAO-FishstatJ source) has been used in the model, together with the DCF and Croatian data for the period 2006-2012. Also in this case the model considered the different sources of the data sets and treated the error separately for each period. In order to facilitate the convergence of the model a higher number of ages has been employed for natural mortality, fecundity and weight at age. Moreover, for the same reason, the initial catch before 1970 has been assumed to be null (Fig. 6.12.4.2.2.1).

The SS3 analyses has been carried out considering the following three fleets:

1. Italian gill netters
2. Italian rapido and otter trawler
3. Croatian and Slovenian set netters.

The catch at age for the three fleets are summarized in figure 6.12.4.2.2.1.

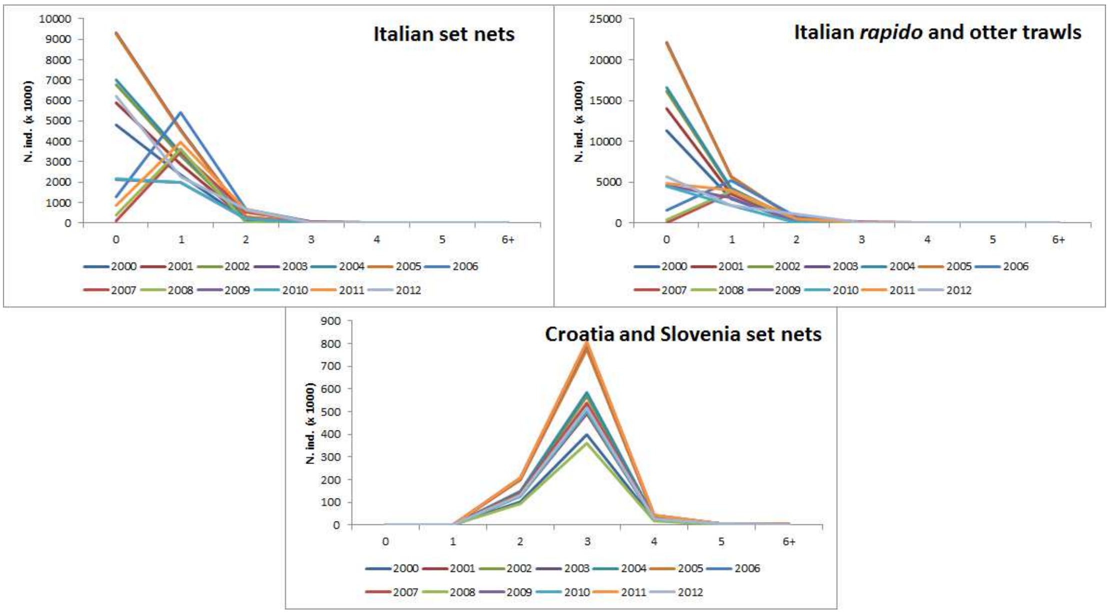


Figure 6.12.4.2.2.1 Catch at age data used in SCAA analysis.

6.12.4.2.2.Input parameters

Tab. 6.12.4.1.2.1 Input data and parameters.

Catch at age in numbers (x 1000)							
	0	1	2	3	4	5	6+
2000	1753	6681	1016	81	13	6	3
2001	1815	6919	1052	84	14	6	3
2002	1690	6444	980	78	13	5	3
2003	3599	13720	2086	166	27	11	3
2004	3185	12143	1847	147	24	10	3
2005	2190	12910	3120	138	11	8	3
2006	2858	10547	1618	702	26	5	3
2007	139	7224	1145	782	27	5	3
2008	738	7507	440	353	18	3	2
2009	4646	3120	359	793	40	7	4
2010	4508	2180	197	491	25	5	3
2011	5649	7948	1306	842	46	14	19
2012	11864	4424	1892	531	26	5	3

Mean weight in stock (kg)											
PERIOD	0	1	2	3	4	5	6	7	8	9	10
2006-2012	0.024	0.104	0.207	0.304	0.38	0.46	0.5	0.54	0.56	0.6	0.62

Growth parameters			
PERIOD	L_∞	k	t_0
2006-2012	39.6 cm	0.44 y^{-1}	-0.46 y

Length-weight relationships		
PERIOD	a	b
2006-2012	0.007	3.0638

Fecundity at Age											
PERIOD	0	1	2	3	4	5	6	7	8	9	10
2006-2012	0	0.016	0.157	0.292	0.376	0.46	0.5	0.54	0.56	0.6	0.62

Natural mortality (M)											
PERIOD	0	1	2	3	4	5	6	7	8	9	10
2006-2012	0.70	0.35	0.28	0.25	0.23	0.22	0.21	0.2	0.2	0.2	0.2

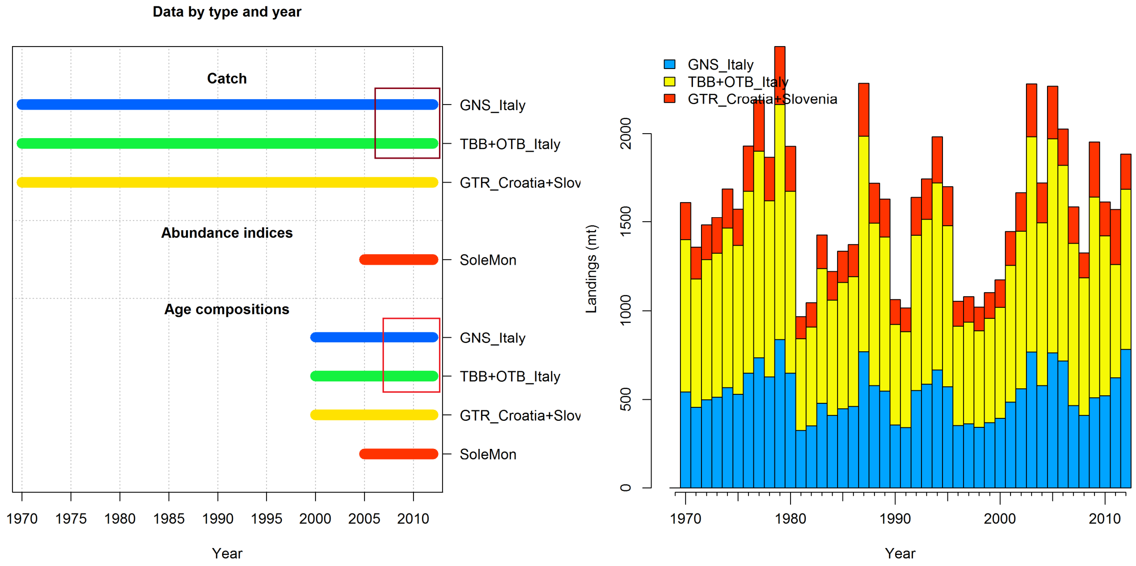


Fig. 6.12.4.2.2.2 Input data (the red squares represent DCF data) and landings imputed in the SS3 model.

Considering the information provided in Fig. 6.12.2.4.1, 6.12.3.1.2.1 and 6.12.1.2.3.1.3 the selectivity patterns of the fleets and the survey have been rescaled as in the Fig. 6.12.4.2.2.2.

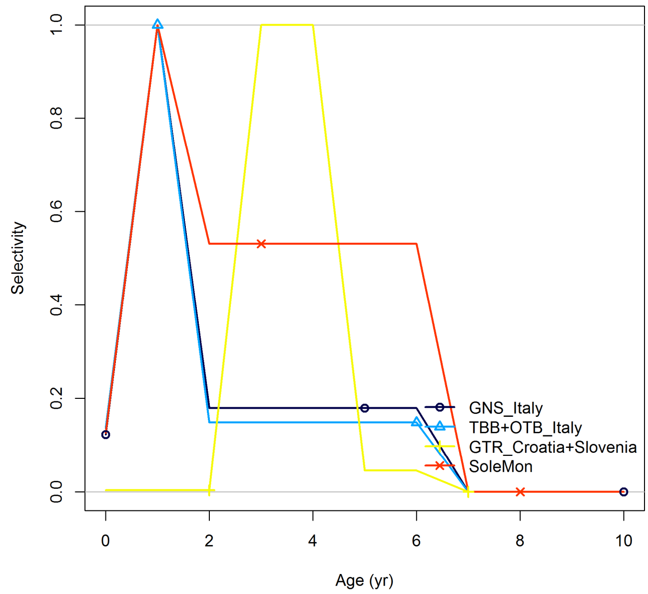


Fig. 6.12.4.2.2.2. Selectivity by age utilized in the SS3 model.

6.12.4.2.3. Results

SCAA Diagnostics in the form of residuals by survey and fleet data are shown in Fig. 6.12.4.1.3.2.

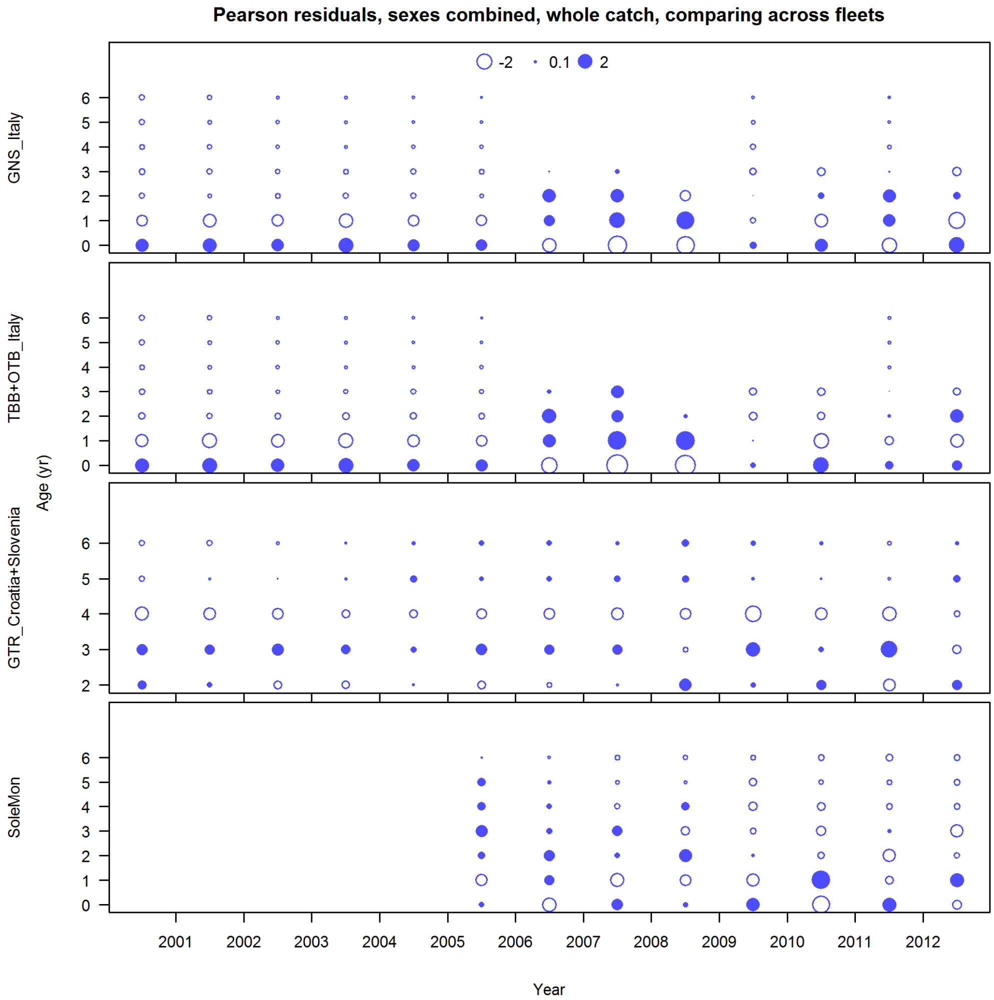


Fig. 6.12.4.1.3.2 Pearson residuals for SoleMon survey and the fleets.

No particular trends in the residuals were observed.

Fig. 6.12.4.1.3.3 presents the main results from the SCAA run: fishing mortality (Fbar0-4 and by fleet), total biomass, spawning stock biomass (SSB) and recruitment.

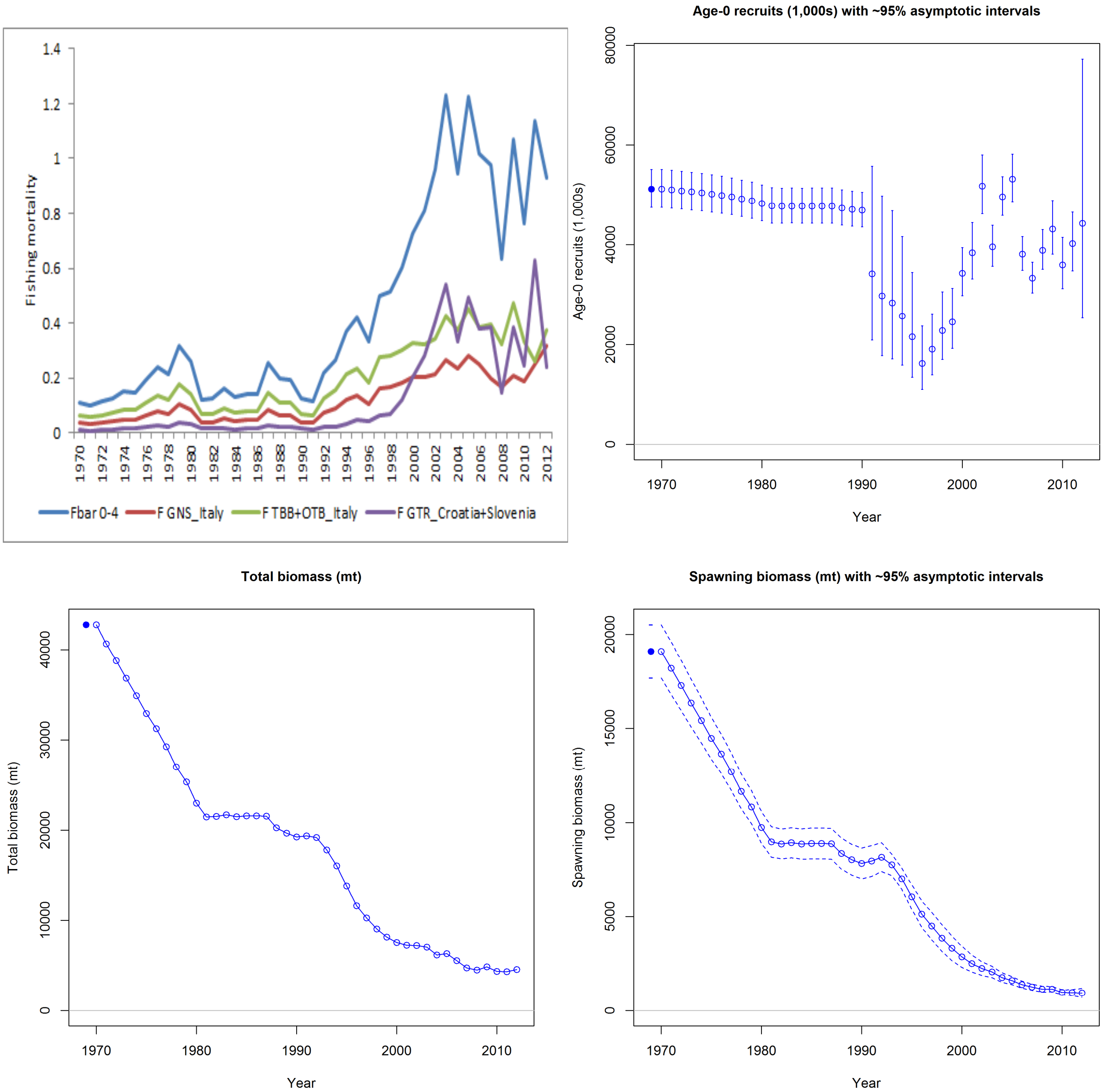


Fig. 6.12.4.1.3.3 Final assessment results SCAA run.

State of exploitation: The stock status is based on the results of the SS3 model. Exploitation increased from the beginning of the time-series, with a more pronounced increase after 2000. In the period 2006-2012 the F_{bar} showed important oscillations around a value of 0.9. The most recent estimate of fishing mortality (F_{bar} 0-4) is 0.93, the partial F for each fleet is 0.37 for the Italian trawlers, 0.32 for the Italian gill netters and 0.24 for the Slovenian and Croatian set netters.

State of the juveniles (recruits): Recruitment varied without any trend in the years 1970-2012, reaching a minimum in 1998, followed by a general increase until 2012. The same trend was also observed in survey data.

State of the adult biomass: The SSB showed a strong decrease since the begin of the series. The last estimate of SSB in 2012 is around 1,900 tons.

6.12.5. *Long term prediction*

6.12.5.1.Justification

Due to the short time series it was not possible to estimate a stock recruitment relationship. As a consequence the biological reference point has been estimated using the Yield per Recruits approach, where F_{01} is considered a proxy of F_{MSY}.

6.12.5.1.1. Input parameters

Biological reference points have been estimated using the XSA and SCAA input data and selectivity patterns.

6.12.5.1.2.Results

RPs suggest an overfishing situation for the *S. solea* stock both for the XSA and SCAA results (Figure 6.12.5.1.2; Table 6.12.5.1.2.1).

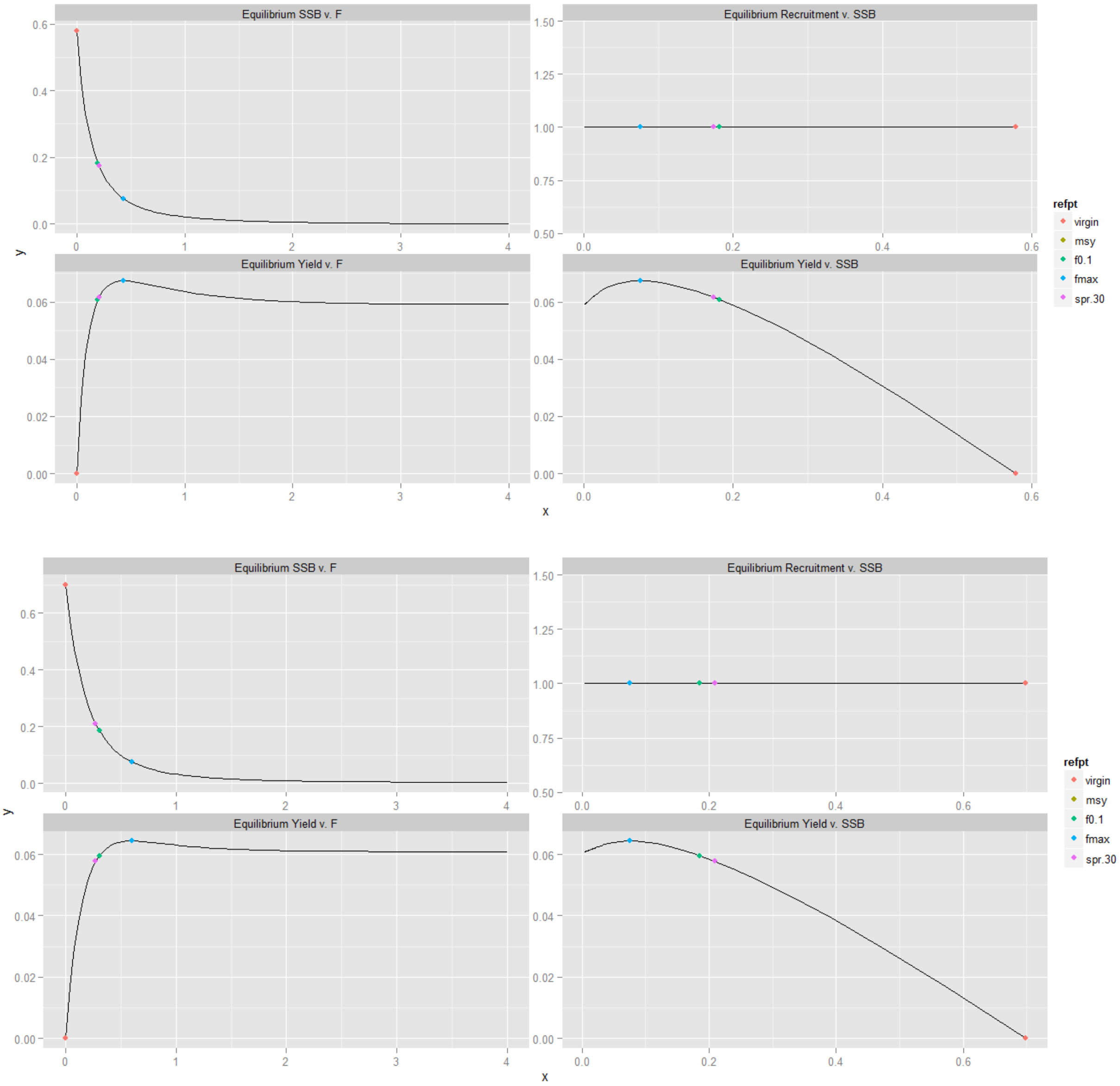


Figure 6.12.5.1.2 Yield per Recruit analyses for XSA (above) and SCAA (below).

Table 6.12.5.1.2.1 Yield per Recruit outputs for XSA and SCAA.

	Current F ($F_{BAR\ 0-4}$)	Reference Points	Harvest	Yield/R	SSB/R	Total biomass/R
XSA	1.16	$F_{0.1}$	0.19	0.059	0.17	0.239
		F_{max}	0.45	0.065	0.06	0.11
SCAA	0.93	$F_{0.1}$	0.31	0.05958	0.185	0.263
		F_{max}	0.60	0.06439	0.075	0.146

6.12.6.*Data quality*

Common sole 2013 DCF data in GSA17 are delivered by Italy and Slovenia, but because the latter contribute for less than 1%, data quality analyses focused only on the Italian data.

For sole in GSA17 landings at age and at length were available only for beam trawl from 2006 to 2012; no data from gillnet and otter trawls were available with continuity for the same time period.

Differences in the comparison between total landings data submitted in the previous official DCF data and 2011 official DCF data were observed.

The comparison between total landings and landings reconstructed as the sum of the landings at age evidenced differences from 2.4 to 33.6% of the total landings by gear and year (Figure 6.12.6.1).

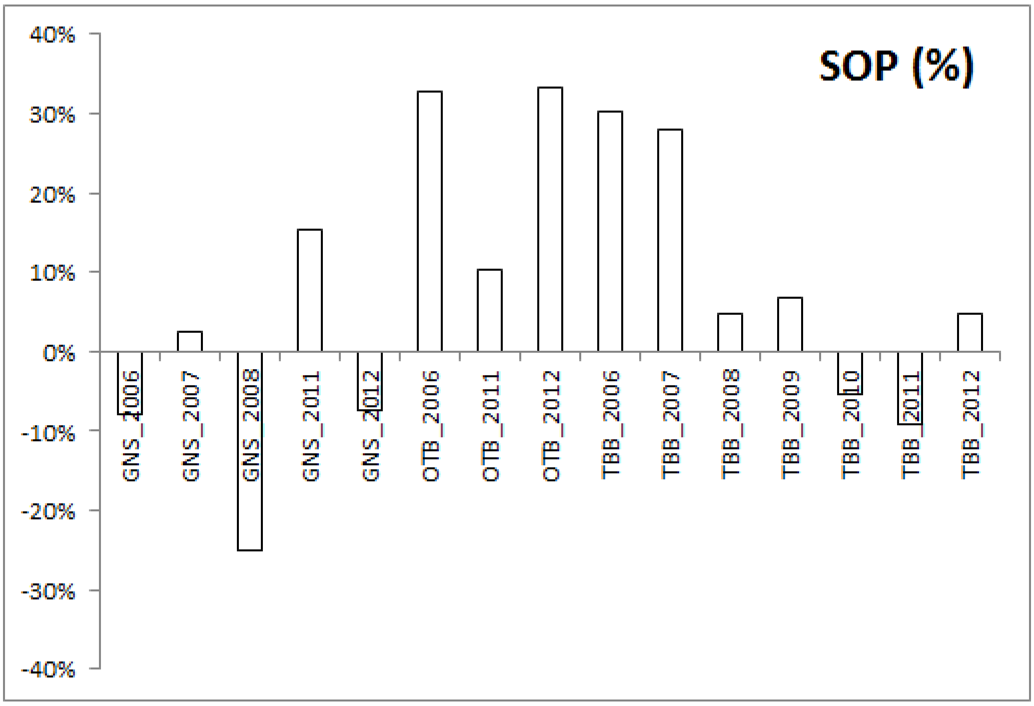


Figure. 6.12.6.1. Differences in percentage between the declared landings and the reconstructed landings as sum of products (2013 DCF data).

The official survey data from MEDITS were not used in the present nor in the previous assessments (SGMED-09-02, SGMED-10-02, EWG 12-21), because the otter trawl net used in the MEDITS survey has very low catchability for species such as common sole, and thus does not provide representative data on stock status. The use of independent SoleMon survey data were useful in the present assessment to provide an overall perception of the status of the stock, but also to obtain tuning values for the XSA and SCAA analysis.

6.12.7. *Scientific advice*

Considering the results of XSA and SCAA analyses, it can be concluded that the stock is exploited unsustainably. A reduction of fishing pressure, especially by *rapido* trawling and Italian and Croatian gill netters, which toghether account for more than 70% of the total F, would be recommended.

SSB shows general stable trends in the XSA run, while the SCAA showed a clear decreasing trend of SSB. It is important to point ut that the absolute values of XSA are underestimated due the use of a costant catchability at the older ages. Differently, the SS3 model allows the assumption of a dome-shaped population selection curve, which determines more reliable values of SSB if compared with the historical yields. Nevertheless the clear decreasing pattern of SSB observed in the SCAA analysis since the begin of the series appears evident, considing that at the moment the level of SSB is less than 20% of the SSB observed in the 1990s.

6.12.7.1. Short term considerations

6.12.7.1.1. State of the stock size

According to the XSA and SCAA analyses the SSB was practically constant in the period 2006-2012, but the estimates made by the SS3 model with SCAA show a critical situation. The population is characterized by an SSB which is less than 20% of the 90s, and demonstrates a clear decreasing pattern of the older ages (Fig. 6.12.7.1.1.1). Nevertheless, the EWG 13-09 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points.

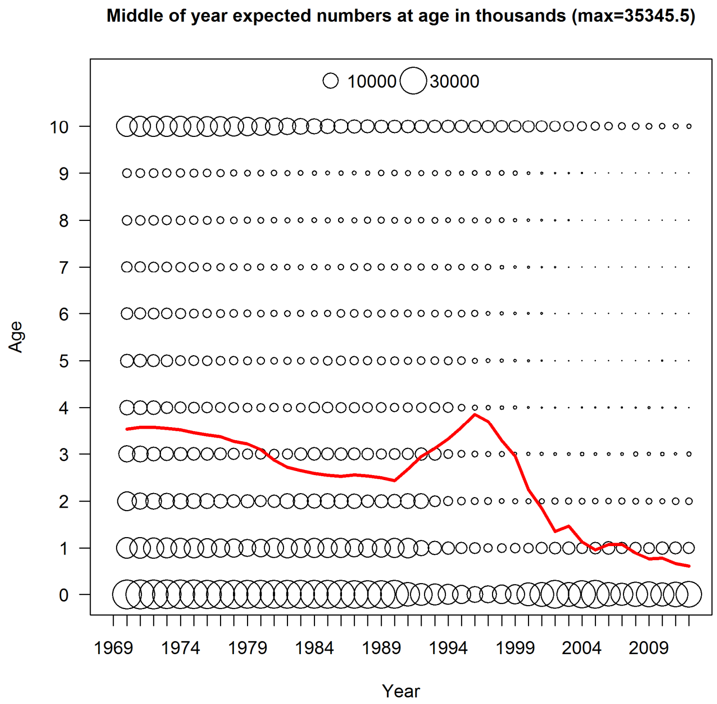


Figure 6.12.7.1.1.1 Bubble plot showing the middle of year expected numbers at age in thousands (max bubble = 35,345) from SS3 model. Red line represents the mean age of the population.

6.12.7.1.2. State of recruitment

According to the XSA and SCAA analyses the recruitment of sole in GSA 17 fluctuated since 2006 without a clear increasing or decreasing pattern. The SoleMon survey data show higher values in the last two years.

6.12.7.1.3. State of exploitation

Based on the XSA and SCAA estimates, in 2012 the fishing mortality appears much higher than the respective estimates of $F_{0.1}$ (6 times in the XSA and 3 times in the SCAA). EWG 13-09 believes that, due to the reasons expressed in paragraph 6.12.7, the more accurate methodology to assess the stock is the SCAA carried out with SS3, thus EWG 13-09 proposes $F \leq 0.31$ as proxy for F_{MSY}. Given the results of the present analysis (current F is around 0.93), the stock is exploited unsustainably. A considerable reduction in F is necessary to approach the reference point.

6.12.7.2. Management recommendations

Considering the overexploited situation and the low values of SSB of the sole stock in GSA 17 a reduction of fishing effort, especially of *rapido* trawl and gillnetters, is advisable. It should also be taken into account that the exploitation of the Italian fleets is mainly orientated towards juveniles. and that the success of recruitment seems to be strictly related to environmental conditions. Hence, in the case of both increasing fishing effort and poor annual recruitment, there could be a high risk of stock depletion. A closure for *rapido* trawling inside 11 or 17 km off-shore along the Italian coast during the summer-fall period, would be advisable to reduce the portion of juvenile specimens in the catches. For the same reason, specific studies on *rapido* trawl selectivity are necessary. In fact, it is not sure that the adoption of a larger mesh size would correspond to a decrease of juvenile catches, considering that the mesh opening currently used by the Italian rapido trawlers is larger (50 mm or more diamond) than the legal one. The same uncertainty regards the adoption of a square mesh.

As shown in Fig. 6.12.2.4.1 and 6.12.3.1.2.1 the main spawning area is only partially exploited by *rapido* trawlers and the Croatian artisanal fleet, considering the information gathered from Croatian colleagues about the fishing zones of set netters targeting sole. It is important to mention that in the last two-three years some Italian artisanal fleets are fishing with gill net in the main spawning area during the trawl fishing ban in August or during the week ends. Safeguarding this area (identified by the SoleMon trawl survey, Grati et al., 2013) to prevent a dramatic increase of the fishing pressure both of *rapido* trawlers and set netters might be crucial for the sustainability of the Adriatic sole stock.

6.13. Stock assessment of hake in GSA 18

6.13.1. *Stock identification and biological features*

6.13.1.1. Stock Identification

The stock of European hake was assumed in the boundaries of the whole GSA 18 (Fig. 6.13.1.1.1).

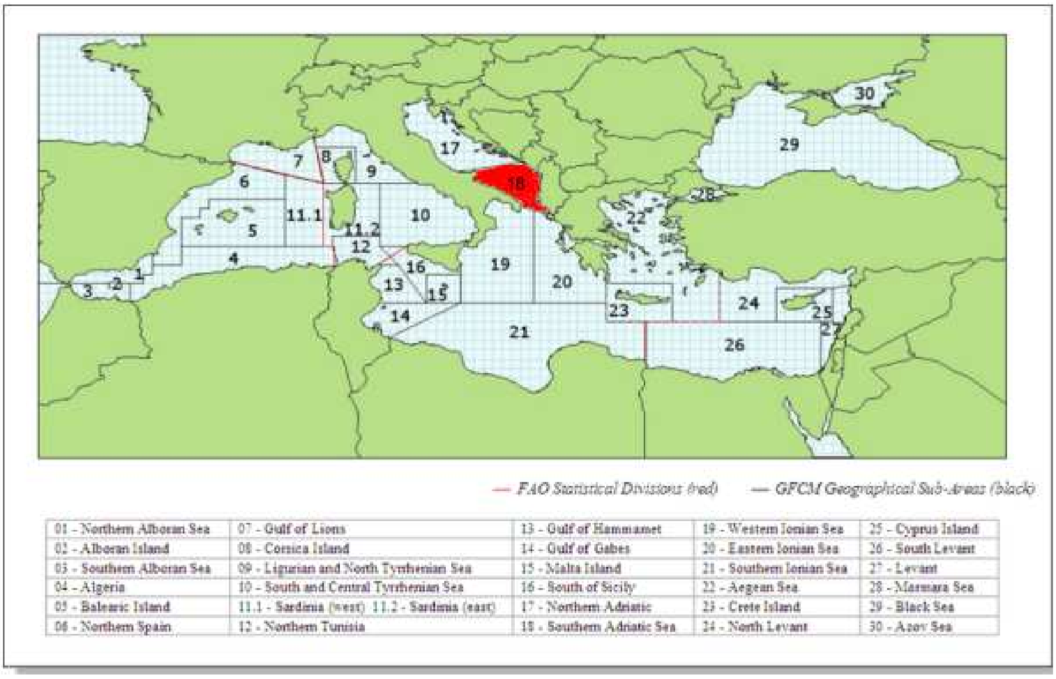


Fig. 6.13.1.1.1. Geographical location of GSA 18.

The species depth distribution is from several meters in the coastal area down to 800 m in the South Adriatic Pit (Kirincic and Lepetic, 1955; Ungaro et al., 1993), though it is most abundant at depths between 100 and 200 m, where the catches are mainly composed of juveniles (Bello et al., 1986; Ungaro et al., 1993). In the southern Adriatic the largest individuals are caught in waters deeper than 200 m, whereas medium-sized fish appear in the waters not deeper than 100 m (Ungaro et al., 1993).

M. merluccius spawns throughout the year, but with different intensities. The spawning peaks are in the summer and winter periods (Zupanovic, 1968; Ungaro et al., 1993; Donnaloia, 2009). Recent estimates of the batch fecundity (Donnaloia, 2009) reported higher values in comparison to the fecundity reported by Morua et al.(2006) for the Atlantic Sea and Recasens et al (2008) for the Northern Tyrrhenian Sea.

Karlovac (1965) recorded young hake larvae from October to June, the highest numbers were recorded in January and February. Larvae and post-larvae were mainly distributed between 40 and 200 m; the highest number of individuals was caught mainly between 50 and 100 m.

Recruitment peaks in the winter and late spring (Ungaro et al., 1993; Donnaloia, 2009).

The geographical distribution pattern of European hake has been studied in the area using trawl-survey data and the geostatistical methods. In the GSA18 nursery areas have been localised off Gargano promontory along the west side (100-200 m depth) and in the southern part of Albanian coasts (Frattini and Paolini, 1995; Lembo et al., 2000; Carlucci et al., 2009).

Kirinčić and Lepetić (1955) and De Zio *et al.* (1998) investigated the catch size structure from the bottom long-line fishery in the Southern Adriatic. The average total length of the European hake was 58.6 cm (Kirinčić and Lepetić, 1955), while De Zio *et al.* (1998) found a median total length of 70 cm. The average catch was 5.6 specimens per 100 hooks.

6.13.1.2. Growth

Estimates of growth parameters were achieved during the SAMED project (SAMED, 2002) by the analysis of length frequency distributions. The following von Bertalanffy parameters were estimated by sex: females L_∞=83.4 cm; K=0.15; t_0= -0.11; males: L_∞=58.2cm; K=0.23; t_0= -0.06.

The observed maximum lengths of European hake were 93.5 cm for females and 66.5 cm for males both registered during Medits samplings. In the commercial sampling also a female of 93.5 cm length was observed in 2009. In the DCF framework the growth has been studied ageing fish by otolith readings using the whole sagitta and thin sections for older individuals. Length frequency distributions were also analyzed using techniques as Batthacharya for separation of modal components. The estimates of von Bertalanffy growth parameters (L_∞=96 cm, K=0.129, t0= -0.73 for sex combined) were obtained from average length at age using an iterative non-liner procedure that minimizes the sum of the square differences between observed and expected values.

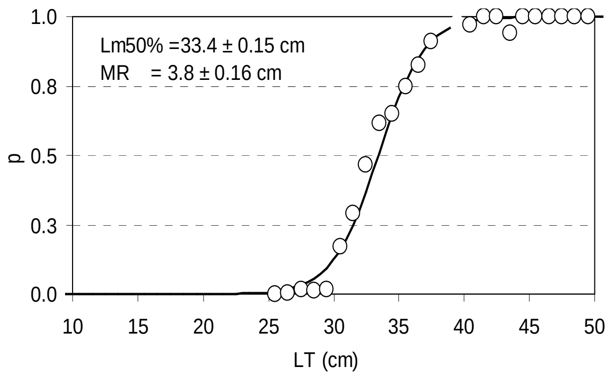
According to the previous assessment in the GSA the fast growth scenario of growth rate was used for sex combined in the following assessment sections: L_∞=104 cm, K=0.2, t0= -0.01. Parameters of the length-weight relationship from the data collected in the DCF were a=0.0036, b=3.2 for length expressed in cm and weight in grams.

6.13.1.3. Maturity

Mature females were found all year round with peaks in early winter and late spring.

A proxy of size at first maturity as estimated in the SAMED project (SAMED, 2002) using the average length at stage 2 (females with gonads at developing stage) indicated an average length of about 29 cm.

According to the data of the DCF framework, the proportion of mature females (fish belonging to the maturity stage 2 onwards) allowed to estimate a maturity ogive with a size at first maturity varying around 33.4 (±0.15 cm) (maturity range 3.8 ±0.16 cm). (Fig. 5.12.1.3.1). This size of first maturity is higher that the literature reported for the Adriatic Sea (Zupanovic, 1968; Zupanovic and Jardas, 1986; Alegria Hernandez and Jukic, 1992), while it is in accordance with data reported for other areas along the Italian seas and western Mediterranean.



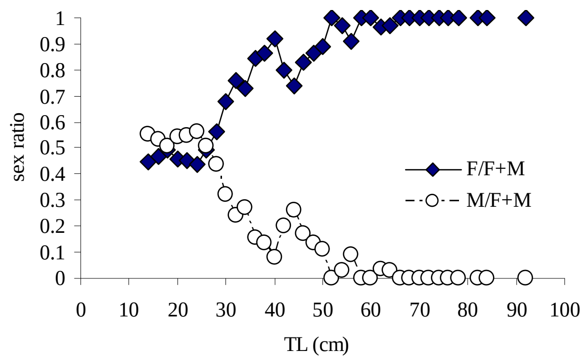


Fig. 6.13.1.3.1 Maturity ogive and proportions of mature female of hake in the GSA 18 (MR indicates the difference $Lm_{75\%}$-$Lm_{25\%}$) (left) and sex ratio for females and males by length (right).

6.13.2. *Fisheries*

6.13.2.1. General description of fisheries

Merluccius merluccius is one of the most important species in the Geographical Sub Area 18 representing more than 20% of landings from trawlers. Trawling represents the most important fishery activity in the southern Adriatic Sea and a yearly catch of around 30,000 tonnes could be estimated for the last decades.

The Mediterranean hake is also caught by off-shore bottom long-lines, but these gears are utilised by a low number of boats (less than 5% of the whole South-western Adriatic fleet).

Fishing grounds are located on the soft bottoms of continental shelves and the upper part of continental slope along the coasts of the whole GSA. Catches from trawlers are from a depth range between 50-60 and 500 m and hake occurs with other important commercial species as *Illex coindetii*, *M. barbatus*, *P. longirostris*, *Eledone spp*., *Todaropsis eblanae*, *Lophius spp*., *Pagellus spp*., *P. blennoides*, *N. norvegicus*.

6.13.2.2.Management regulations applicable in 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 fishing fleet, the Italian fishing licenses have been fixed since the late eighties and the fishing capacity has been gradually reduced. Other measures on which the management regulations are based regards technical measures (mesh size), minimum landing sizes (EC 1967/06) and seasonal fishing ban, that in southern Adriatic has been mandatory since the late eighties. Regarding long-lines the management regulations are based on technical measures related to the number of hooks and the minimum landing sizes (EC 1967/06), besides the regulated number of fishing licences.

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 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 the 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.

In Montenegro, management regulations are based on technical regulations, such as mesh size (Official Gazette of Montenegro, 8/2011), including the minimum landing sizes (Official Gazette of Montenegro, 8/2011), and a regulated number of fishing licenses and area limitation (no–fishing zone up to 3 NM from the coastline or 8 NM for trawlers of 24+ m LOA). Currently there are no MPAa or fishing bans in Montenegrin waters.

In Albania, a new law “On fishery” has now been approved, repealing the Law n. 7908. The new law is based on the main principles of the CFP, it reflects Reg. 1224/2009 CE ; Reg.1005/2008 CE; Reg. 2371/2002 CE; Reg. 1198/2006 CE; Reg. 1967/2006 CE; Reg. 104/2000; Reg. 1543/2000 as well as the GFCM recommendations. The legal regime governing access to marine resources is being regulated by a licensing system. Regarding conservation and management measures, minimum legal sizes and minimum mesh sizes is those reflected in the CE Regulations. Albania has already an operational vessel register system. It is forbidden to trawl at less than 3 nautical miles (nm) from the coast or inside the 50m isobath when this distance is reached at a smaller distance from the shore.

6.13.2.3.Catches

6.13.2.3.1.Landings

Available landing data are from DCF regulations. EWG 13-09 received Italian landings data for GSA 18 by fisheries which are listed in Tab. 6.13.2.3.1.1.

In general, demersal trawlers account for the major landing quantity. Landings are decreasing since 2009 to 2012 (Fig. 6.13.2.3.1.1).

Tab. 6.13.2.3.1.1. Annual landings (tons) by fishery, from 2007 to 2012 (Italy data).

YEAR	LLS	OTB	Total
2007	620	3497	4117
2008	551	3640	4191
2009	534	3536	4070
2010	601	3391	3992
2011	519	3312	3831
2012	566	2520	3086

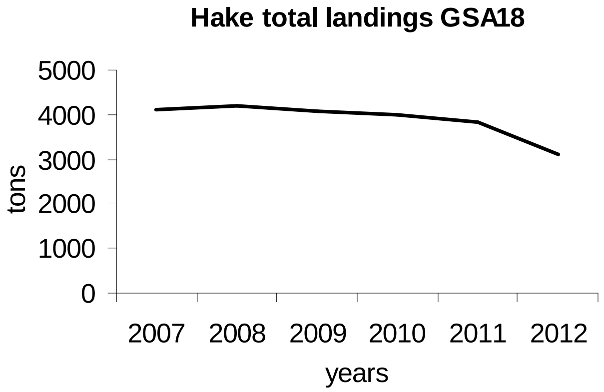


Fig. 6.13.2.3.1.1. Total annual landings (tons) of hake in the GSA18 from 2007 to 2012 (Italy data).

Time series of landing data from the whole GSA is reported in (tab. 6.13.2.3.1.2.).

The production in 2011 is lower than in the other years also for the whole GSA.

Production data for 2012 will be updated in the forthcoming WG demersals of ADRIAMED – FAO regional project.

Tab. 6.13.2.3.1.2. Annual landings (tons) by fishery, from 2008 to 2011 for the whole GSA18

Year	Italy-LLS	Italy-OTB	Montenegro	Albania	Total Landings
2008	550	3640	59	390	4639
2009	532	3540	52	456	4580
2010	597	3372	46	375	4390
2011	534	3285	37	402	4258

6.13.2.3.2. Discards

Discards data of 2009, 2010, 2011 and 2012 were available. The proportion of the discards of hake in the GSA 18 was generally less than 10%. Considering the amount of discards 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.

6.13.2.4. Fishing effort

EWG 13-09 received the following information from Italy of fishing effort in the GSA 18 through the official DCF data call (Tab. 6.13.2.4.1). Effort by trawlers is about 75% of the total effort. The total fishing effort (Italian data) is decreasing (Fig. 6.13.2.4.1).

Tab. 6.13.2.4.1 Nominal Fishing effort in d KW*DAYS by fishing technique deployed in GSA 18, 2004-2012 received by Italy.

Sum of NOMINAL_EFFORT		GEAR					
AREA	YEAR	GNS	GTR	LLS	OTB	PTM	Total
SA 18	2004	1457047	396599	556022	14685616	224372	17319656
	2005	2035861	515167	1082879	13563127	1046113	18243147
	2006	1833287	70950	754338	14684386	1433668	18776629
	2007	1280477	324507	688853	12729135	1968559	16991531
	2008	894323	1021626	1260704	11463435	2085703	16725791
	2009	1205076	837252	884150	13878367	2027392	18832237
	2010	570405	885271	1263867	11856268	2121029	16696840
	2011	450946	777735	922942	11329443	2104853	15585919
	2012	395458	541056	967941	9821959	1267443	12993857

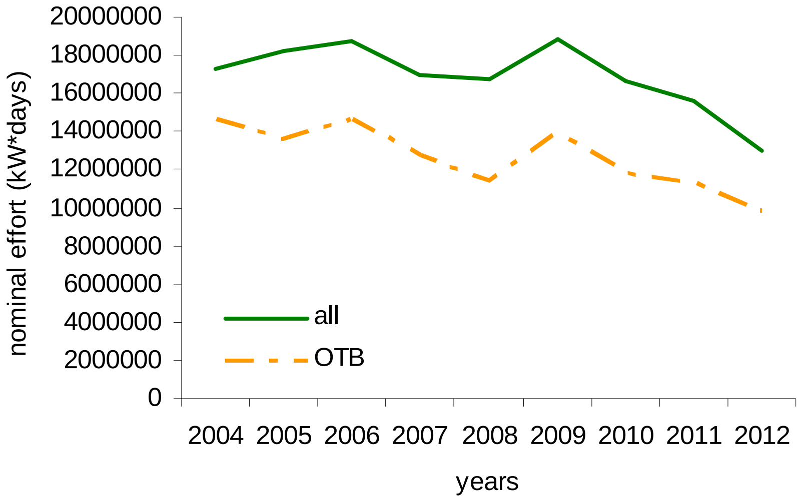


Fig. 6.13.2.4.1. Trend in nominal Fishing effort in d KW*DAYS by fishing technique deployed in GSA 18 (2004-2012 time series from Italy).

6.13.3. *Scientific surveys*

6.13.3.1. MEDITS

6.13.3.1.1. 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.

In GSA 18 the following number of hauls was reported per depth stratum (Tab. 6.13.3.1.1).

Tab. 6.13.3.1.1. Number of hauls per year and depth stratum in GSA 18, 1996-2012.

STRATUM	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
GSA18_ 010-050	18	17	17	17	17	18	12	12	11	10	11	10	13	12	12	12	12
GSA18_ 050-100	24	25	25	26	25	24	20	19	21	20	21	22	21	20	20	20	19
GSA18_ 100-200	33	33	33	32	33	33	31	32	31	33	31	31	33	30	31	31	32
GSA18_ 200-500	18	18	18	19	18	18	13	13	13	13	13	13	12	14	13	13	13
GSA18_ 500-800	19	19	19	18	19	19	14	14	14	14	14	14	11	14	14	14	14

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 around the stratified mean is 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, 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 represent the number of individual per km^2 (Cochran, 1977).

6.13.3.1.2. Geographical distribution patterns

In the GSA 18 the geographical distribution pattern of the hake recruits has been studied using the spatial indicator approach (Woillez et al., 2009; Spedicato et al., 2007) and geostatistical methods (Lembo, 2010) applied to GRUND and MEDITS data. A Gravity Centre of recruit density of hake was stably localised in the northernmost part of the GSA with significant relationships between Gravity Centre, abundance of recruits and Positive Area. Spatial continuity appeared higher in the GRUND series. Nursery areas of *M. merluccius* were identified within 100-200 m depth in the Gulf of Manfredonia and off Gargano Promontory. Other less relevant nuclei were also identified in the central and southern part of the GSA (Fig. 6.13.3.1.2.1).

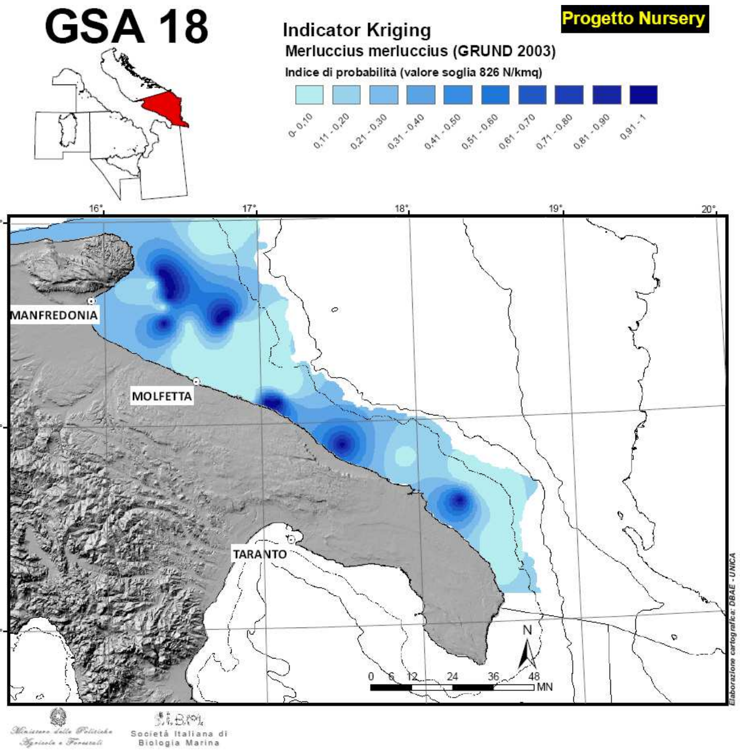


Fig. 6.13.3.1.2.1 Nursery areas of hake in the GSA 18.

In the MEDISEH project (DG MARE Specific Contract SI2.600741, call for tenders MARE/2009/05) the nursery localised off-shore Gargano Promontory were found to be persistent over 17 years, while new high density nuclei were identified in the southernmost part of the GSA both eastward (off-shore Vlora) and westward, mainly between 100 and 200 m depth. (Fig. 6.13.3.1.2.2). Other nuclei are located along the border of Otranto Channel and off-shore Dürres. The bottom is muddy characterized by the detritic bottom biocenosis (DL). The direction of the current in the sampling period (spring) is from north to south on the west side and viceversa on the east side.

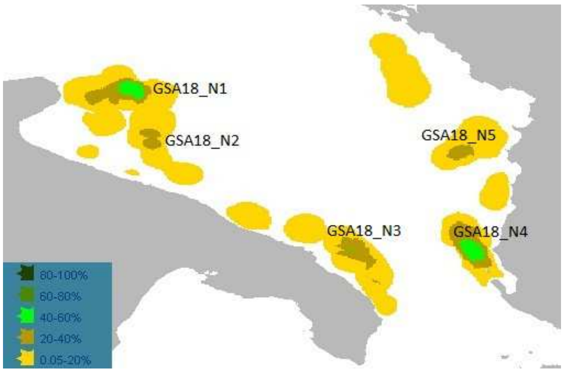


Fig. 6.13.3.1.2.2 Position of persistent nursery areas of hake in GSA18 (MEDISEH project)

6.13.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 18 was derived from the international survey MEDITS. Figure 6.13.3.1.3.1 displays the estimated trend of hake abundance and biomass in the GSA 18.

The estimated abundance indices do not reveal any significant trends since 1995 until 2004. Peaks of abundance indices were observed in 2005, 2008 and 2012, while biomass indices were highest in 2005 and 2010.

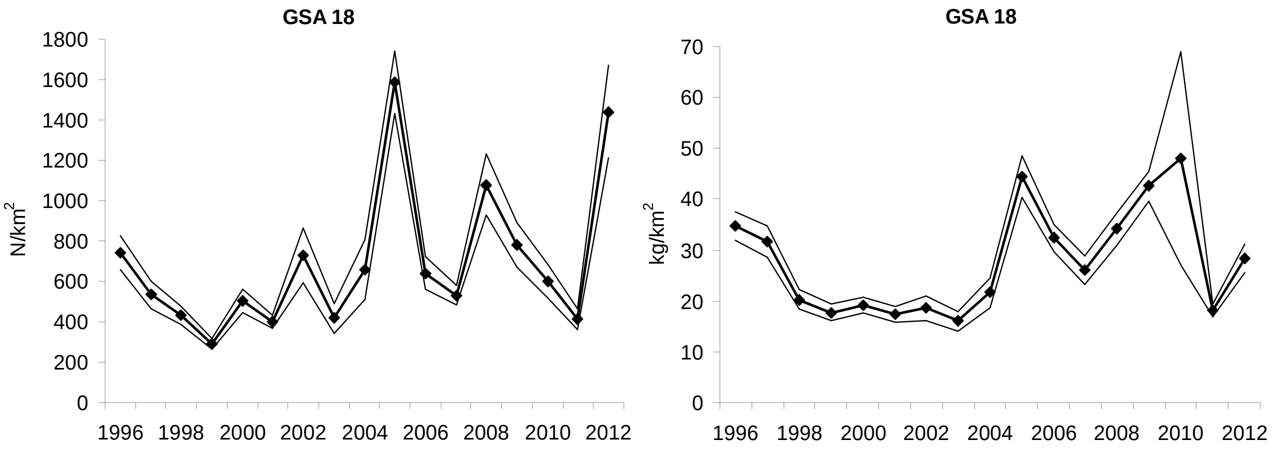
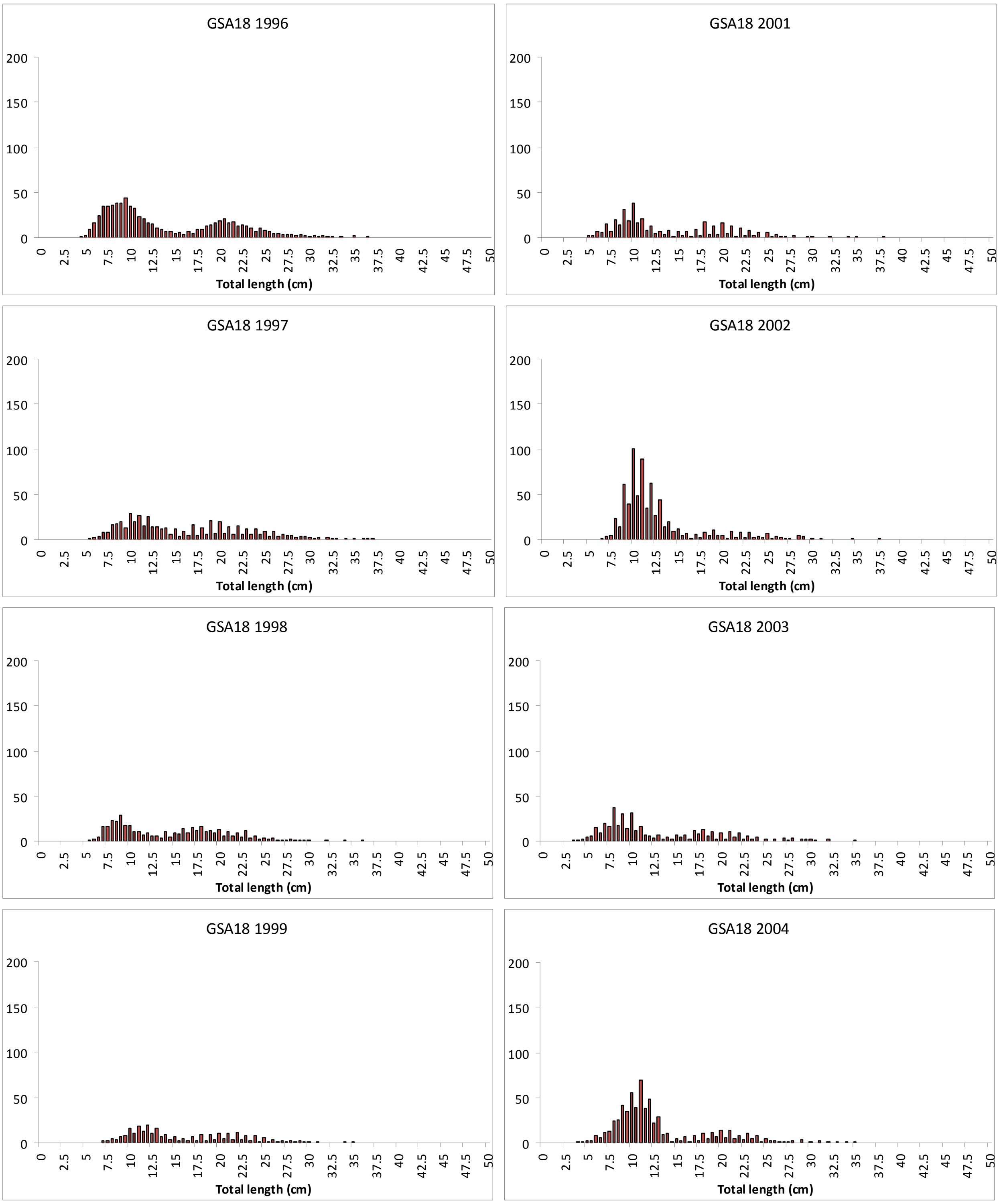
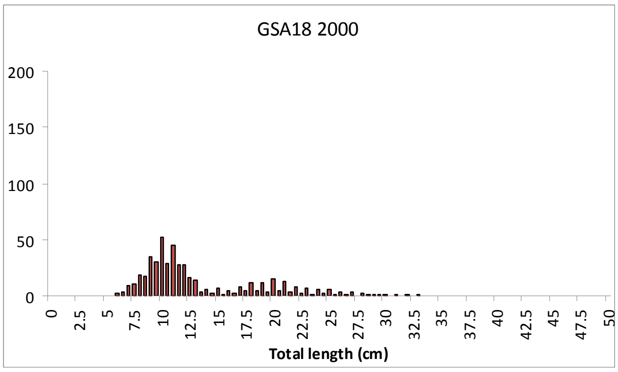


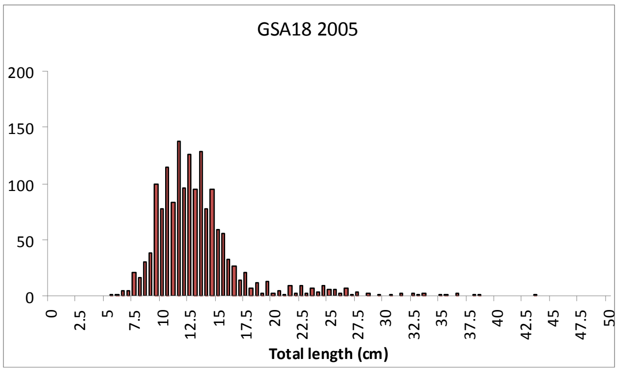
Fig. 6.13.3.1.3.1 Abundance and biomass indices of hake in GSA 18.

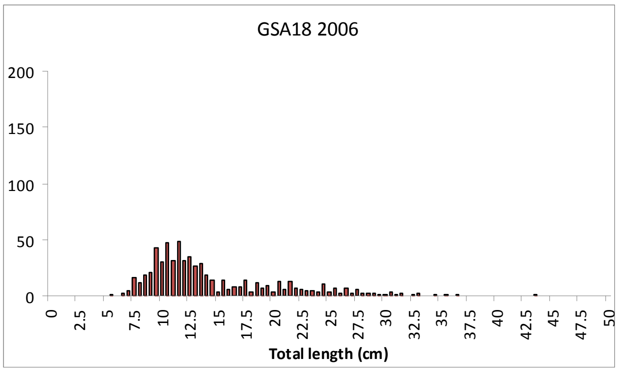
6.13.3.1.4. Trends in abundance by length or age

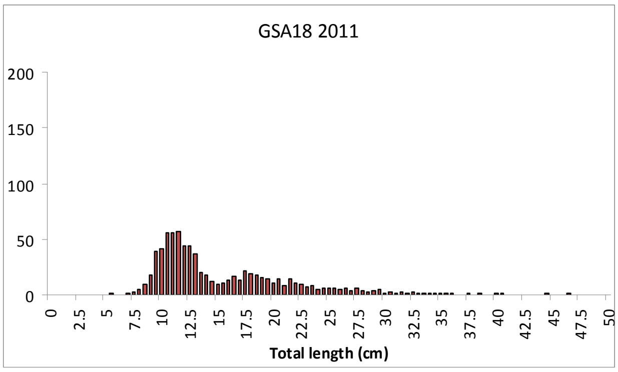
The following Fig. 6.13.3.1.4.1 shows the time series from 1996 to 2012 of stratified abundance indices by length in the GSA 18.


GSA18 1996
GSA18 2001
GSA18 1997
GSA18 2002
GSA18 1998
GSA18 2003
GSA18 1999
GSA18 2004
0
50
100
150
200
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)


GSA18 2000
200
150
100
50
0
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)


GSA18 2005
200
150
100
50
0
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)


GSA18 2006
200
150
100
50
0
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)


GSA18 2011
200
150
100
50
0
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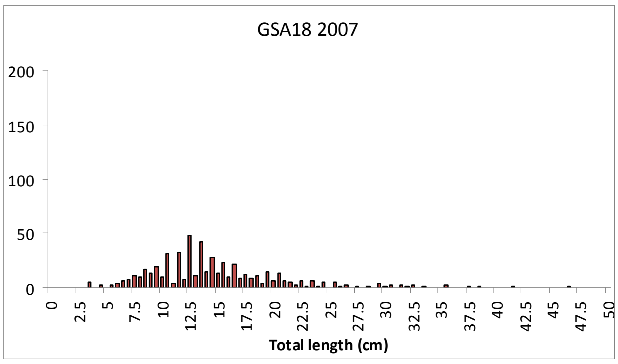
Total length (cm)


GSA18 2007
200
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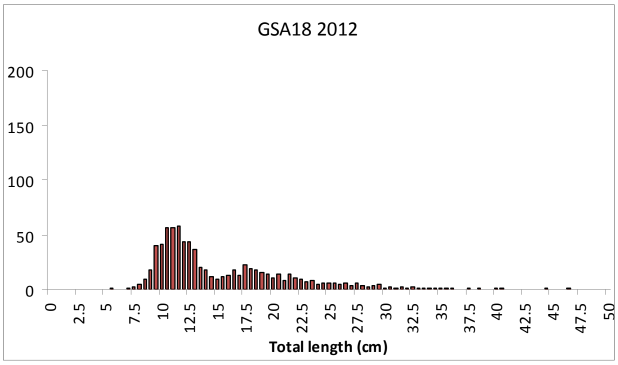
Total length (cm)


GSA18 2012
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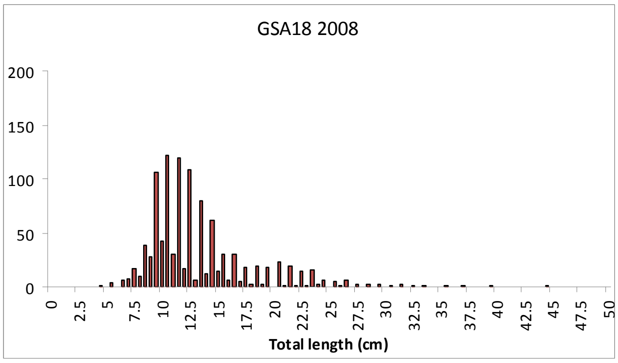
Total length (cm)


GSA18 2008
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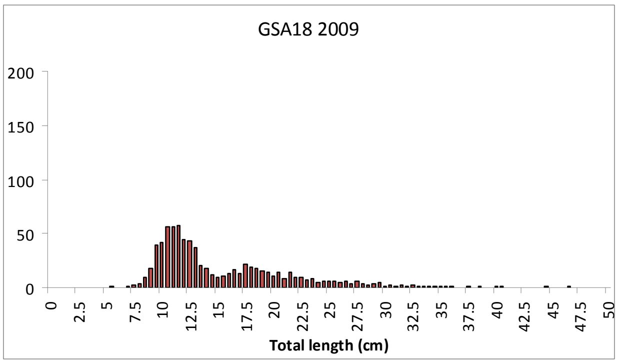
Total length (cm)


GSA18 2009
200
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Total length (cm)

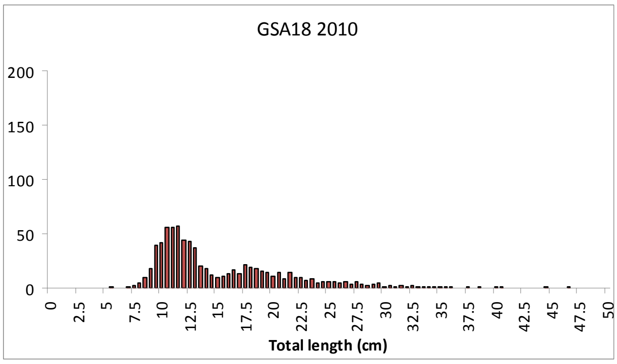

Fig. 6.13.3.1.4.1 Time series from 1996 to 2012 of stratified abundance indices by length in the GSA 18

6.13.3.1.5. Trends in growth

No analyses were conducted during EWG-13-09.

6.13.3.1.6. Trends in maturity

No analyses were conducted during EWG-13-09.

6.13.4. *Assessments of historic stock parameters*

6.13.4.1. Method: XSA

6.13.4.1.1. Justification

The assessment of hake in GSA 18 has been performed during EWG 13-09 for the first time using XSA, because the time series from 2007 to 2012 has been considered covering the mean life span of the species represented in the catches. In the past VIT and SURBA have been used and ALADYM for predicting the effects of management measures.

The age distributions from age class 0 to 5+ have been used.

6.13.4.1.2. Input parameters

LFDs by fleet and production

- Italy: 2007-2012 LFDs from DCF;
- Montenegro: 1 trimester of 2008 was lacking and it was estimated using the average of the same trimester of 2010 and 2011; the year 2009 was estimated as an average of 2008 and 2010. The same production and LFD as 2008 was assumed for 2007, and the same as in 2011 for 2012.
- Albania: LFD 2008-2011 obtained raising the proportion of the Italian LFD to Albanian adjusted production. This adjustment was based on the Albanian exports (data are recorded at national level) that accounts for about 64% of the total Albanian production (FAO Yearbook of Fishery Statistics). The same production and LFD as 2008 was assumed for 2007, and the same as in 2011 for 2012.

These assumptions will be revised in the forthcoming Adriamed WG for demersals.

The age distributions by sex have been estimated using the age slicing method (LFDA algorithm). A sex combined analysis was carried out. The maturity at age has been estimated using the maturity at length transformed to ages by slicing procedure. The natural mortality has been calculated using PRODBIOM (Abella, 1998). The survey indices from MEDITS data from 2007 to 2012 for the whole GSA have been used for the tuning.

The age distribution is showed in the graph 6.13.4.1.2.1 and in the table 6.13.4.1.2.1.

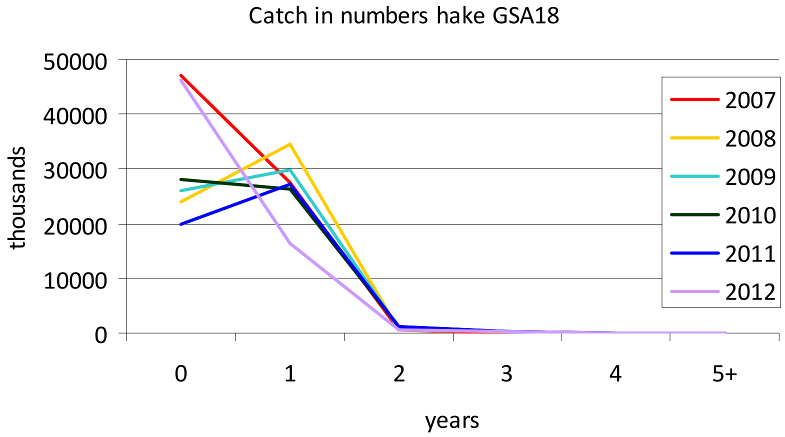

Fig. 6.13.4.1.2.1 Catch in numbers at age and year used in the XSA.

Tab. 6.13.4.1.2.1. Catch in numbers at age and year used in the XSA.

Catch in numbers (thousands)	age 0	age 1	age 2	age 3	age 4	age 5+
2007	47189	27413	698	116	100	59
2008	24099	34608	709	279	106	24
2009	25994	29810	955	168	72	56
2010	27980	26193	1084	271	108	59
2011	19757	27071	1096	209	69	94
2012	46304	16307	712	236	35	48

The other inputs are reported in the tables from 6.13.4.1.2.2 to 6.13.4.1.2.6

Tab. 6.13.4.1.2.2. Weights at age used in the XSA (used for the stock and the catch).

Weight at age (kg)	age 0	age 1	age2	age 3	age 4	age 5+
2007	0.0225	0.0909	0.4577	1.2436	1.8198	3.7226
2008	0.0261	0.0848	0.4663	1.1712	1.8851	2.7884
2009	0.0244	0.0984	0.4490	1.0628	1.9569	3.0469
2010	0.0267	0.0914	0.4728	1.1182	1.9172	3.3534
2011	0.0270	0.0974	0.4689	1.0705	1.9563	3.2935
2012	0.0208	0.0998	0.4374	1.1453	1.8612	3.3209

Tab. 6.13.4.1.2.3. Indices from MEDITS survey used in the XSA.

Survey indices (n/km^2)	age 0	age 1	age 2	age 3	age 4	age 5+
2007	416.51	104.05	6.89	2.08	0.63	0.75
2008	918.92	150.54	5.12	1.93	0.37	0.16
2009	564.34	199.78	14.27	2.03	1.01	0.36
2010	479.98	109.03	6.55	2.56	0.84	0.58
2011	319.15	87.36	4.33	1.68	0.97	0.12
2012	1344.65	89.72	5.24	1.08	0.61	0.34

Tab. 6.13.4.1.2.4. Proportion of matures at age used in the XSA.

Maturity					
age 0	age 1	age 2	age 3	age 4	age 5+
0.008	0.248	0.887	1.000	1.000	1.000

Tab. 6.13.4.1.2.5. Natural mortality at age used in the XSA.

Natural mortality					
age 0	age 1	age 2	age 3	age4	age 5+
1.16	0.53	0.40	0.35	0.32	0.32

Tab. 6.13.4.1.2.6. Growth parameters and length-weight relationship coefficient used in PRODBIOM.

Growth parameters	
Linf	104
K	0.2
t_0	-0.01
a	0.0043
b	3.2

Yield by year is reported in the table 6.13.4.1.2.7

Tab. 6.13.4.1.2.7 - Yield by year in the whole GSA 18.

Year	Landings (tons)
2007	4566
2008	4639
2009	4580
2010	4390
2011	4258
2012	3525

6.13.4.1.3. Results

The XSA run with the following settings has been performed:

- Catchability independent on stock size for ages > 0;
- Catchability independent of age for ages > 4;
- Minimum standard error for population estimates derived from each fleet = 0.300.

Four runs have been performed with S.E. of the mean to which the estimates are shrunk equal to 0.5, 1, 1.5 and 2 and the run with 2 has been chosen on the basis of the residuals and of the retrospective analysis.

The log-catchability residuals are listed in the table 6.13.4.1.3.1 and shown in figure 6.13.4.1.3.1.

Tab. 6.13.4.1.3.1 Log-catchability residuals of XSA.

Age	2007	2008	2009	2010	2011	2012
0	-0.598	0.306	-0.035	-0.174	-0.144	0.623
1	-0.132	-0.02	0.374	-0.162	-0.198	0.135
2	-0.11	-0.24	0.535	0.05	-0.299	0.058
3	0.191	-0.201	-0.092	0.019	0.1	-0.013
4	-0.056	-0.218	0.143	0.133	-0.039	0.031
5+	-0.598	0.306	-0.035	-0.174	-0.144	0.623

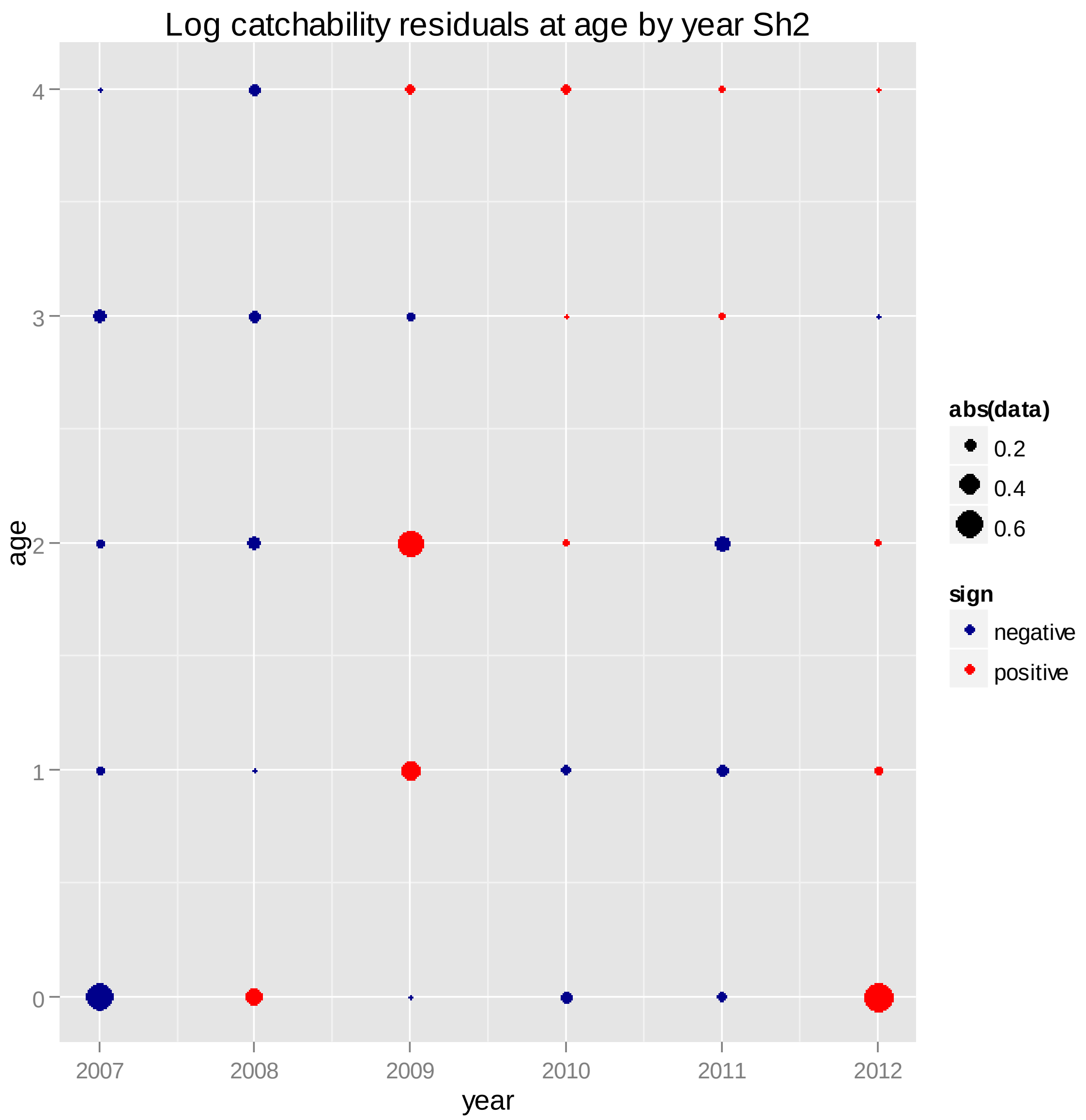

Fig. 6.13.4.1.3.1. Log-catchability residuals of the XSA.

The residuals do not show any particular trend (Fig. 6.13.4.1.3.1.).

The fishing mortality estimated by XSA is in table 6.13.4.1.3.2 and the stock in number in the table 6.13.4.1.3.3.

Tab. 6.13.4.1.3.2. Fishing mortality by year estimated with XSA.

Fishing mortality	2007	2008	2009	2010	2011	2012
0	0.433	0.277	0.329	0.355	0.456	0.507
1	2.622	2.587	2.531	2.447	2.723	2.472
2	0.633	0.745	0.777	1.108	1.154	0.947
3	0.431	0.72	0.479	0.664	0.803	1.197
4	0.824	1.182	0.479	0.801	0.388	0.35
5+	0.824	1.182	0.479	0.801	0.388	0.35
F_{bar}(0-4)	**0.988**	**1.102**	**0.919**	**1.075**	**1.105**	**1.095**

Tab. 6.13.4.1.3.3. Stock in numbers (thousands) estimated by age and year.

Stock numbers (thousands)	2007	2008	2009	2010	2011	2012
0	239883	177700	165654	167185	116851	207984
1	38531	48779	42214	37376	36744	23213
2	1818	1648	2160	1977	1905	1421
3	393	647	525	666	438	402
4	209	180	222	229	242	138
5+	120	40	171	123	330	188
TOTAL	280954	228994	210946	207556	156510	233346

In the figure 6.13.4.1.3.2 estimated recruitment, Fbar (0-4), SSB and yield by year are represented.

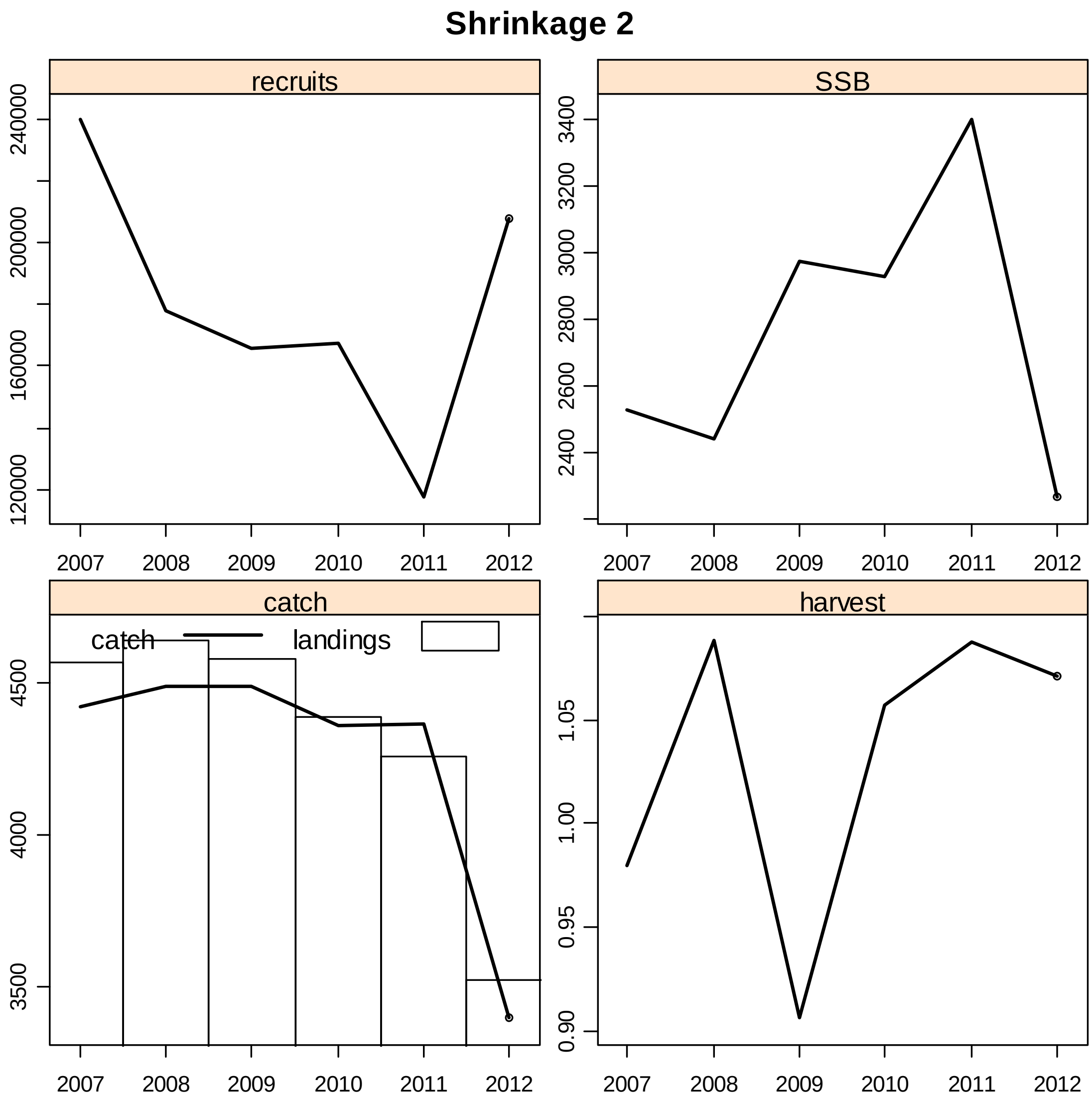

Fig. 6.13.4.1.3.2 Estimated recruitment, Fbar (0-4), SSB and yield by year.

From the results obtained with XSA method, the recruitment shows, a decrease until 2011 followed by an increase in 2012. The fishing mortality is varying around 1. The SSB is quite low compared to the yield in the area, probably due to selectivity assumption in XSA.

The recruitment estimated by XSA and recruitment indices by MEDITS survey present a fairly consistent pattern (Fig. 6.13.4.1.3.3).

Fig. 6.13.4.1.3.3 Recruitment estimates from MEDITS survey and XSA.

The retrospective (Fig. 6.13.4.1.3.4) analysis shows that SSB is generally overestimated while F is underestimated.

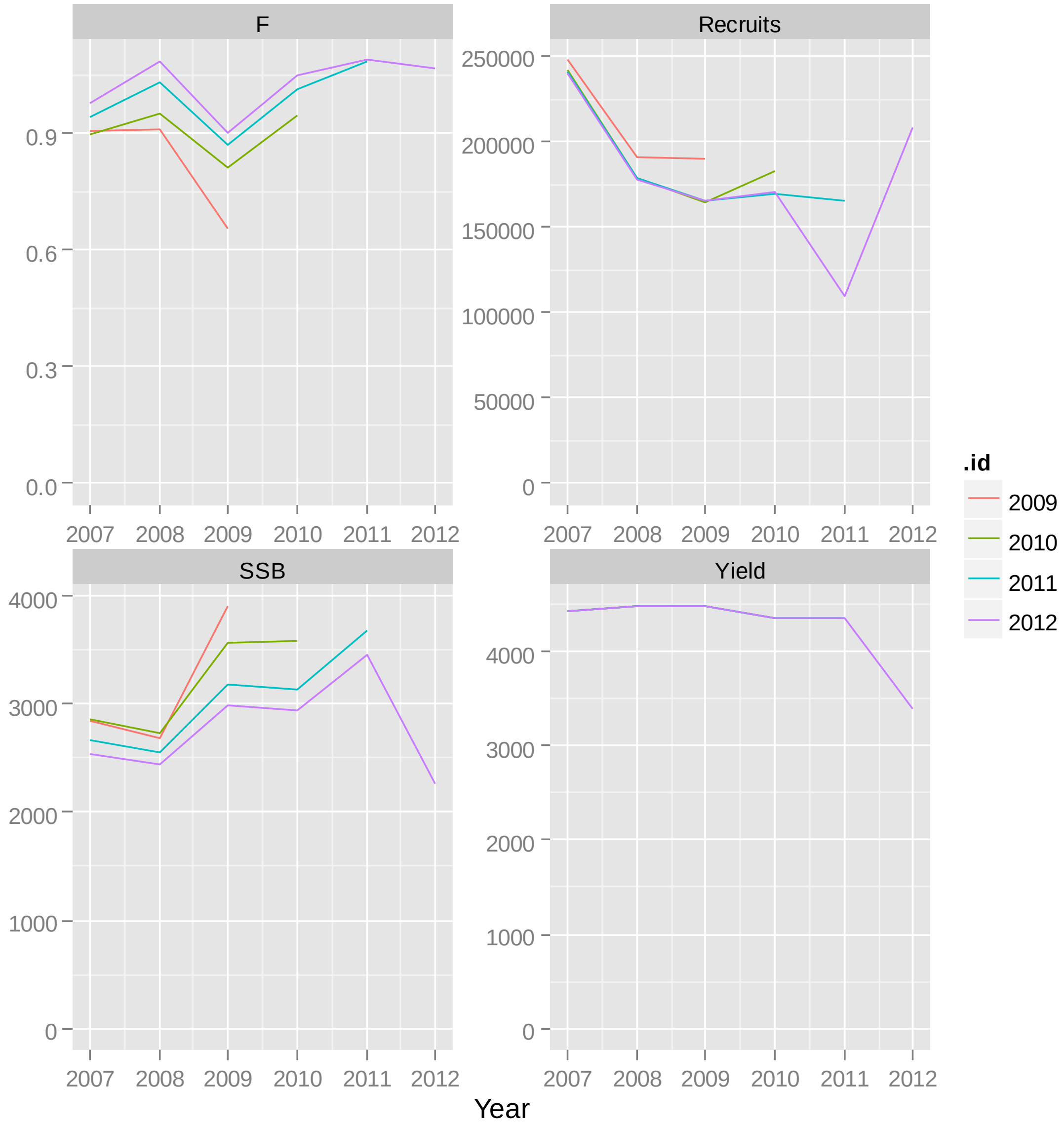

Fig. 6.13.4.1.3.4. Retrospective analysis of the XSA.

6.13.5.*Long term prediction*

6.13.5.1.Justification

Yield per recruit analysis has been conducted by means of VIT software using the data of 2012 to estimate BRPs.

6.13.5.1.1.Input parameters

The same input parameters used for XSA have been used in VIT to perform the Y/R analysis.

6.13.5.1.2.Results

The F_{01} and F_{max} obtained by VIT software are respectively 0.19 and 0.25. $F_{0.1}$ and F_{max} from FLR had the same values. $F_{0.1}$ is used in the advice as proxy of F_{msy}.

6.13.6. *Data quality*

Data from DCF 2013 were used. Assessments were performed using the new submitted time series. A consistent sum of products compared to landings was observed (differences less than 10% for age data and less than 5% for length data). Discards data of 2009, 2010, 2011 and 2012 were available. In 2009, 2010 and 2011 data were provided by year gear and fishery. 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. MEDITS data used for this assessment have been provided directly by the scientists, given some difficulties in getting outputs from the JRC database.

6.13.7. *Scientific advice*

6.13.7.1. Short term considerations

6.13.7.1.1. State of the stock size

EWG 13-09 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points. Survey indices indicate a variable pattern of abundance (n/km^2) and biomass (kg/km^2) without a temporal trend. However, recent values are higher than those observed since 1996.

6.13.7.1.2. State of recruitment

MEDITS data showed a sharp increase of recruitment in 2005 and thereafter a level similar or higher than in the past years. In 2008 a new, though lower peak, was observed and a new one in 2012.

6.13.7.1.3. State of exploitation

EWG 13-09 proposes $F \leq 0.19$ as proxy of F_{MSY}. Given the results of the present analysis (current F is around 1), the stock appeared to be subject to overfishing in 2007-2012. A considerable reduction is necessary to approach the reference point.

6.13.7.2. Management recommendations

As observed in 2011, the production of hake in GSA 18 is split in 77% caught by Italian trawlers, 12% by Italian longlines, about 1% by Montenegrin trawlers and about 9% by Albania trawlers. Thus a similar share of fishing mortality among the fleet is assumed.

EWG 13-09 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 DEEPWATER PINK SHRIMP IN GSA 19

6.14.1. *Stock identification and biological features*

6.14.1.1. Stock Identification

Due to a lack of information about the structure of deepwater pink shrimp population, this stock was assumed to be confined within the boundaries of the GSA19.

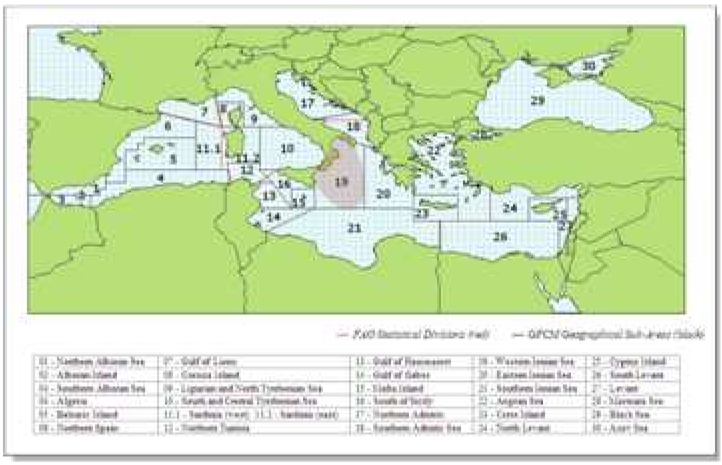

Figure 6.14.1.1. Geographical location of GSA 19.

6.14.1.2. Growth

Growth parameters (Linf= 46.0, k= 0.575; to= -0.2, sex combined) and length- weight relationship parameters (a=0.94 and b=2.45, length in cm and weight in g) were from DCF.

6.14.1.3. Maturity

In GSA 19 the deepwater pink shrimp showed an extended reproductive period between late spring and autumn. The highest percentage of mature females was recorded during autumn.

The maturity ogive Fig. 6.14.1.3.1 was obtained in DCF 2008 framework from a maximum likelihood procedure applied grouping as mature individuals belonging to the maturity stage 2b-2e (according to the Medits maturity scale).

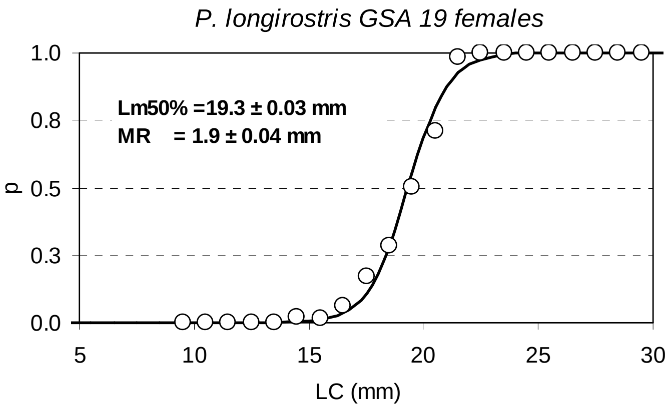

Figure 6.14.1.3.1 Maturity ogive of deepwater pink shrimp in the GSA 19 (MR indicates the difference $Lm_{75\%}$-$Lm_{25\%}$) from DCF 2008.

6.14.2. *Fisheries*

6.14.2.1. General description of fisheries

In the north-western Ionian Sea, fishing occurs from coastal waters to 700–750 m. The most important demersal resources in the north-western Ionian Sea are represented by the red mullet (*Mullus barbatus*) on the continental shelf, hake (*Merluccius merluccius*), rose shrimp (*Parapenaeus longirostris*) and Norway lobster (*Nephrops norvegicus*) over a wide bathymetric range and the deep-water red shrimps (*Aristeus antennatus* and *Aristaeomorpha foliacea*) on the slope. Pink shrimp is only targeted by trawlers in this area. Gallipoli, Taranto, Crotone and Reggio Calabria represent the most important fisheries in the north-west Ionian Sea, although with a different distribution of the fishing effort.

6.14.2.2. Management regulations applicable in 2010 and 2011

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 fishing fleet, the Italian fishing licenses have been fixed since the late eighties. Other measures on which the management regulations are based regard technical measures (mesh size) and minimum landing sizes (EC 1967/06).

In the GSA 19 the fishing ban has not been mandatory along the time, and from one year to the other it was adopted on a voluntary basis by fishers, whilst in the last years it was mandatory.

Porto Cesareo MPA was permanently established in 1997 (Decree of Ministry of Environment of 12.12.1997; G.U. n. 45 del 24/02/1998). Porto Cesareo MPA is delimited by Punta Prosciutto and Torre dell'Inserraglio and its surface is 16.654 hectares. The MPA is divided in three zones with different level of protection, from total to partial.

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.

6.14.2.3. Catches

6.14.2.3.1. Landings

Available data landing are from DCF. EWG 13-09 received landings data for GSA19 from 2006 to 2012. We have also included historic landing data recorded in SGMED 0804 report from 2002 to 2007. These landings are listed in Table 6.14.2.3.1.1. and are shown in Figure 6.14.2.3.1.1.

Landings show a decreasing tendency along the period, with an important reduction on landings from 2007 to 2012.

Table 6.14.2.3.1.1. Annual landings (tons) from 2002 to 2012.

OTB	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Landings	1126	1391	1201	1244	1245	608	785	767	716	593	488

Data on annual landings by metier are available for 2010 and 2012 (Table 6.14.2.3.1.2.)

Table 6.14.2.3.1.2. OTB landings by métier (tons) in GSA19.

	2010	2011	2012
MDDWSP	503.99		317.20
DEMSP	109.11		106.40
DWSP	102.51		64.01
OTB Total	715.60	592.85	487.61

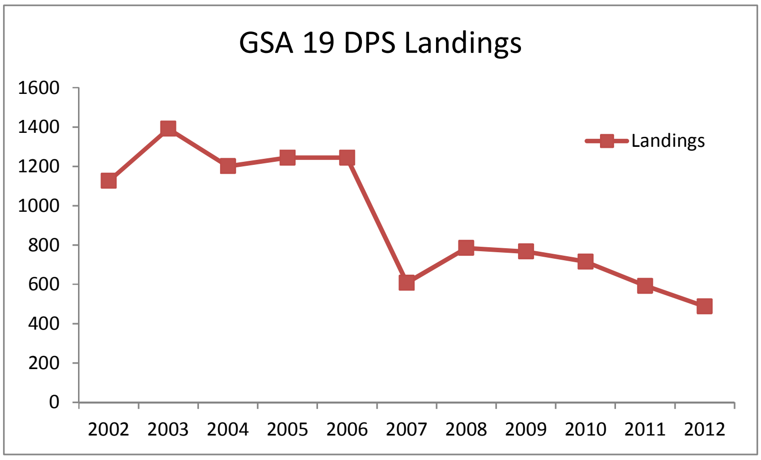

Figure 6.14.2.3.1.1. Annual landings (tons) from 2002 to 2012.

6.14.2.3.2. Discards

The proportion of the discards of pink shrimp in the GSA19 was generally low (less than 7%). Discards data of 2006, 2009, 2010, 2011 and 2012 were available and are listed in the Table 6.14.2.3.2.1. Considering the low amount of discard and that the collection of discard data was not foreseen in all years during the period, these data were not used in the analyses.

Table 6.14.2.3.2.1. Discards data (tons) over the period considered.

OTB	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Discards					18.96			54.55	36.14	13.48	7.97
Catch %					1.5			6.6	4.8	2.2	1.6

6.14.2.4. Fishing effort

The trends in fishing effort by year are listed in Table 6.14.2.4.1. and in Figure 6.14.2.4.1.

The fishing effort of the trawlers is increasing in the GSA19. The number of vessels is very variable along the period, especially for big trawlers (VL1824).

Table 6.14.2.4.1. Effort for OTB in the GSA19, from 2004 to 2012 as reported through the DCF official data call. *2010 data were not available and has been obtained from data published in the 2013-04_STECF 13-05-Med. st. ass.-JRC81592.

NO_VESSELS	2004	2005	2006	2007	2008	2009	2010*	2011	2012
VL0612									7
VL1218	249	107	238	205	232	258	267	264	282

VL1824	32	0	12	0	20	35	36	21	33
TOTAL	**281**	**107**	**250**	**205**	**252**	**293**	**303**	**285**	**322**

NOMINAL_EFFORT	2004	2005	2006	2007	2008	2009	2010*	2011	2012
VL0612									19427
VL1218	4996900	4181999	6175498	5312380	4788636	5281372	5553941	6014924	5318032
VL1824	878574	0	594979	0	562290	1079645	1088556	817305	1045212
TOTAL	**5875474**	**4181999**	**6770477**	**5312380**	**5350926**	**6361017**	**6642497**	**6832229**	**6363244**

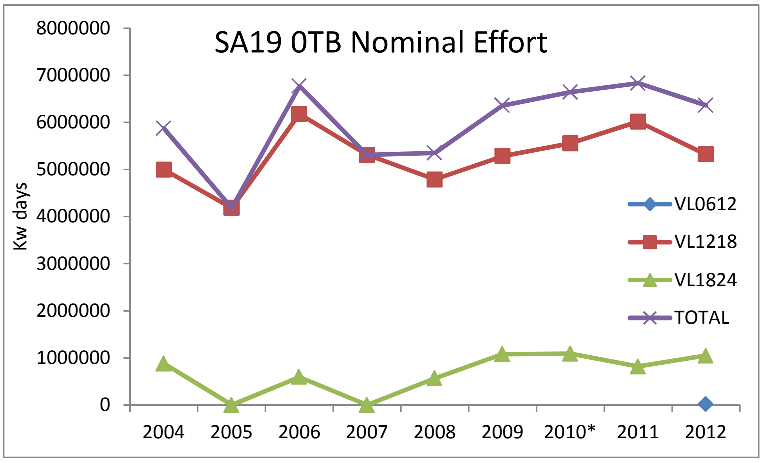

Figure 6.14.2.4.1. Effort for GSA 19, 2004-2012.

6.14.3. *Scientific surveys*

6.14.3.1. MEDITS

6.14.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 19 the following number of hauls was reported per depth stratum (Tab. 6.14.3.1.1.1).

Table 6.14.3.1.1.1. Number of hauls per year and depth stratum in GSA19, 1994-2012.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
GSA19_010-050	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	9	9	9	9
GSA19_050-100	8	8	8	8	8	8	8	8	8	8	8	8	8	9	8	8	8	8	8
GSA19_100-200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
GSA19_200-500	16	15	15	15	15	15	15	15	14	14	14	15	14	14	14	14	14	14	14

GSA19_500-800	31	32	32	32	32	32	32	32	29	29	29	28	29	29	29	29	29	29	29

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 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, 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 the number of individuals per km^2 (Cochran, 1977).

6.14.3.1.2. Geographical distribution paterns

Nursery areas of *P. longirostris* were frequently detected on the shelf and shelf break between Otranto and Santa Maria di Leuca, offshore Torre Ovo, around the Amendolara Bank, in the Gulf of Squillace, offshore Punta Stilo and Siracusa. However, the more persistent nursery area was identified on the shelf between Otranto and Santa Maria di Leuca.

6.14.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of pink shrim in GSA 19 was derived from the international survey MEDITS and was compiled during STECF 13-09. Fig. 6.14.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSA 19.

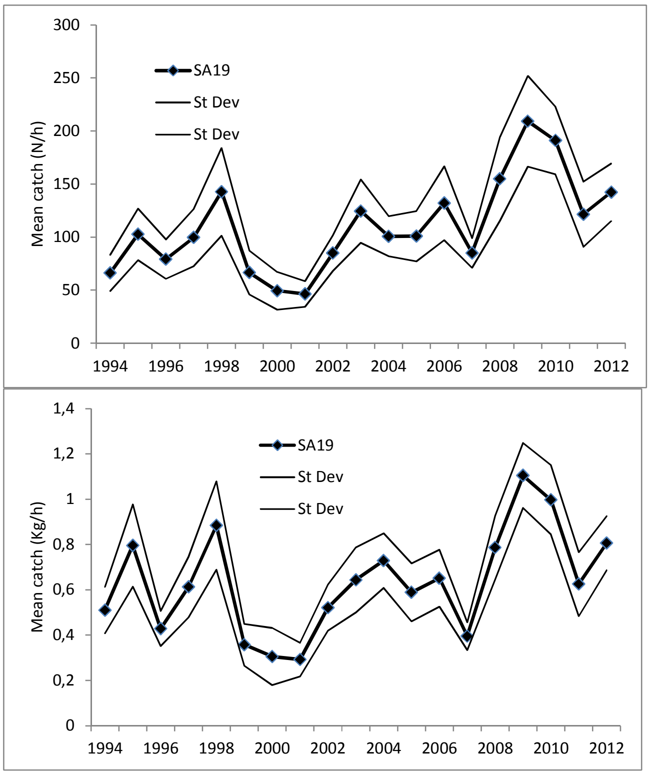

Figure 6.14.3.1.3.1. Abundance and biomass indices of pink shrimp in GSA19.

6.14.3.1.4. Trends in abundance by length or age

The following figures display pink shrimp abundance by size in GSA 19 over 1994-2001, 2002-2009 and 2010-2012 respectively, and were compiled by the experts during STECF 13-09.

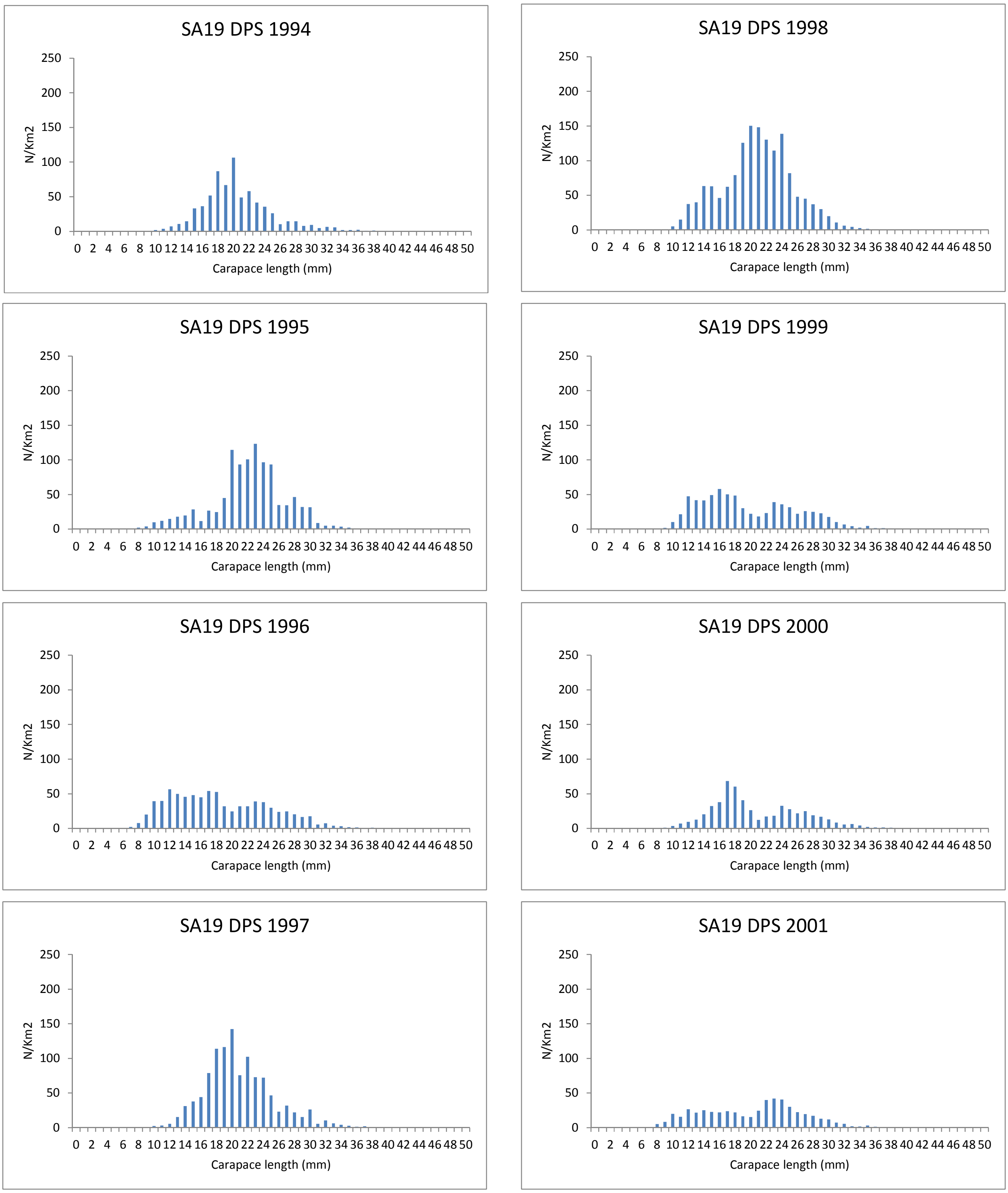

Figure 6.14.3.1.4.1. Deepwater pink shrimp abundance indices by size, 1994-2001.

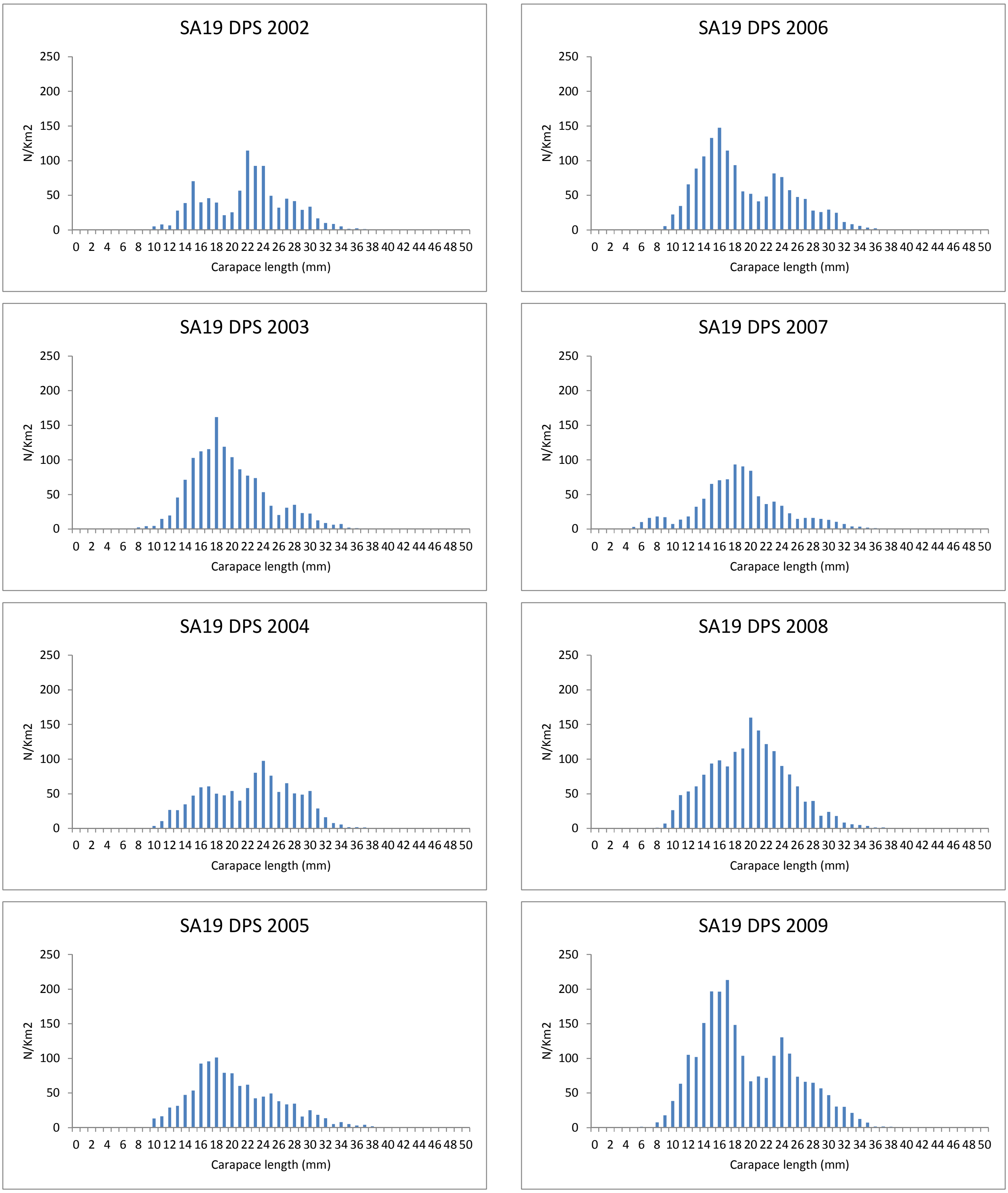

Figure 6.14.3.1.4.2. Deepwater pink shrimp abundance indices by size, 2002-2009.

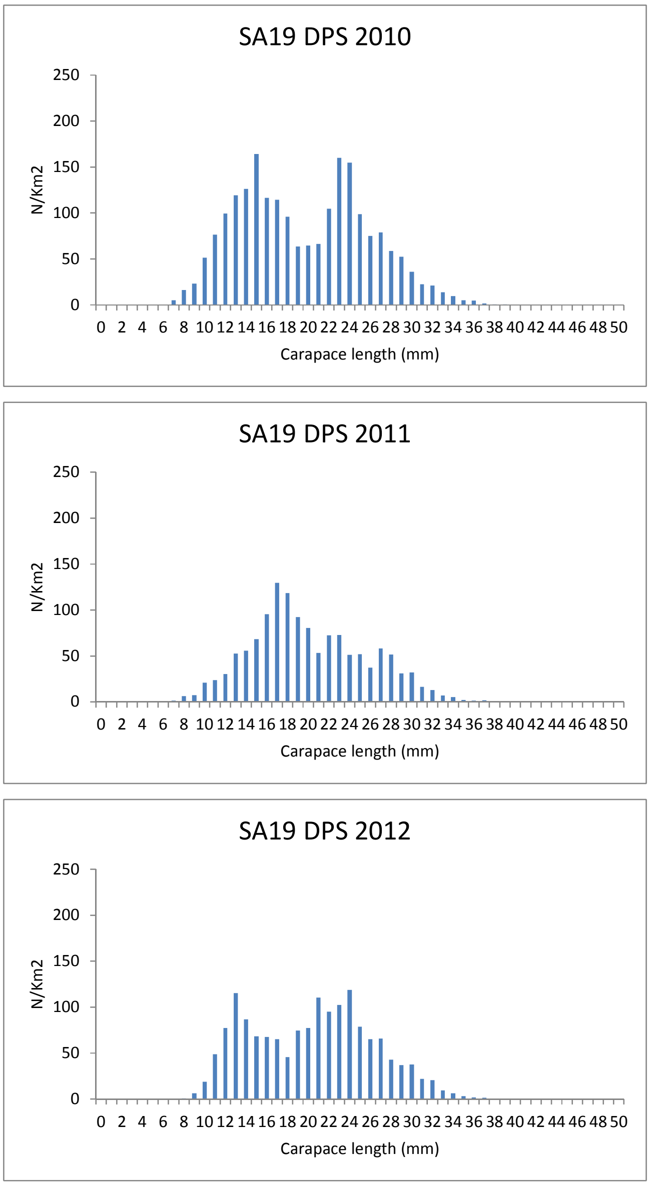

Figure 6.14.3.1.4.3. Deepwater Pink shrimp abundance indices by size, 2010-2012.

6.14.3.1.5. Trends in growth

No analyses were conducted during STECF 13-09.

6.14.3.1.6. Trends in maturity

No analyses were conducted during STECF 13-09.

6.14.4. *Assessments of historic stock parameters*

EWG 13-09 applied the XSA model to commercial landings and MEDITS survey data.

6.14.4.1. Method: XSA

6.14.4.1.1. Justification

This is the first assessment of deepwater pink shrimp in the GSA 19. In the last data call 2013 the data from 2006 to 2012 have been provided; the time series from 2006 to 2012 has been considered covering more than the mean life span of the species, allowing to make an attempt of stock assessment with XSA method.

XSA was applied using the landing structures at age and MEDITS survey data from 2006 to 2012.

6.14.4.1.2. Input parameters

For the assessment of deepwater pink shrimp stock in GSA 19 the DCF official data on the age structure and landing of commercial catch have been used. A sex combined analysis was carried out using the following growth parameters:

CL_{∞} = 4.6 cm, K= 0.575, t_0= -0.2; length-weight relationship (cm-g): a = 0.935, b = 2.4523.

Catch numbers at age (Figure 6.14.4.1.2.2) were derived from the DCF annual size distributions (Figure 6.14.4.1.2.1) using the LFDA (FAO package) algorithm to slice the LFDs. For big individuals a 3+ group has been used.

The maturity at age has been derived by the maturity at length by age slicing procedure.

The natural mortality has been calculated using PRODBIOM method (Abella, 1998).

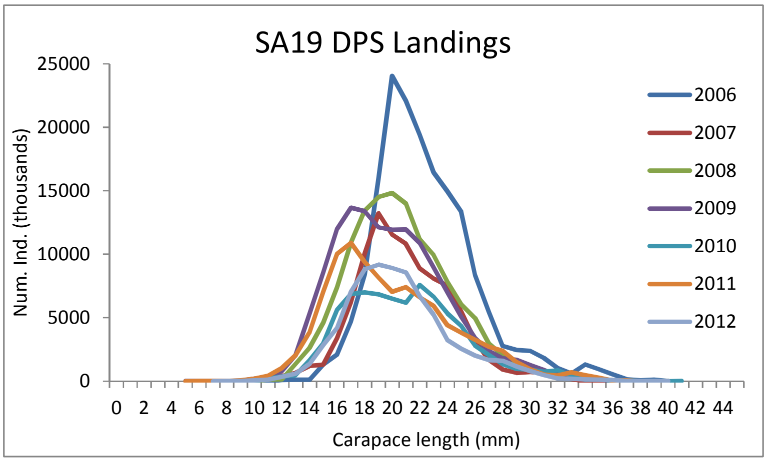

Figure 6.14.4.1.2.1. Pink shrimp annual distributions by size.

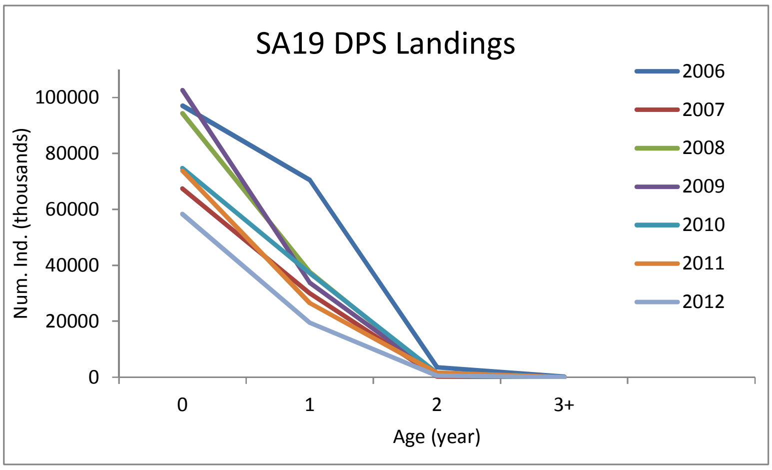

Figure 6.14.4.1.2.2. Deepwater pink shrimp annual distributions by age.

The other input data are reported in the tables below:

Table 6.14.4.1.2.1 Catch in numbers by age and year used in XSA.

Catch in numbers (thousands)	**Age 0**	**Age 1**	**Age 2**	**Age 3+**
2006	97034	70538	3587	155
2007	67395	30102	230	0
2008	94337	37695	735	13
2009	102563	33765	718	2
2010	74717	37263	1495	46
2011	73810	26468	1546	1
2012	58313	19523	562	22

Table 6.14.4.1.2.2 Weights at age by age and year used in XSA (used for the stock and the catch).

Weight at age (kg)	**Age 0**	**Age 1**	**Age 2**	**Age 3+**
2006	0.006	0.009	0.017	0.02
2007	0.005	0.01	0.02	0.02
2008	0.005	0.01	0.021	0.029
2009	0.004	0.01	0.021	0.028

2010	0.004	0.011	0.021	0.029
2011	0.004	0.01	0.02	0.028
2012	0.005	0.01	0.021	0.027

Table 6.14.4.1.2.3 Indices from Medits survey used in XSA.

Survey indices (N/km^2)	**Age 0**	**Age 1**	**Age 2**	**Age 3+**
2006	1005.2	429.5	19.9	0.5
2007	737.2	192.1	11.7	0.5
2008	1195.1	496.1	17.5	1.0
2009	1553.2	714.7	44.3	0.4
2010	1298.9	765.5	34.2	0.8
2011	903.9	420.4	17.3	0.3
2012	950.0	597.2	21.2	0.9

Table 6.14.4.1.2.4 Proportion of mature at age used for XSA.

Maturity			
Age 0	**Age 1**	**Age 2**	**Age 3+**
0.47	0.98	1	1

Table 6.14.4.1.2.5 Natural mortality at age for XSA.

Natural mortality			
Age 0	**Age 1**	**Age 2**	**Age 3+**
1.41	0.81	0.7	0.7

6.14.4.1.3. Results

The XSA run with the following settings has been performed:

- Catchability dependent on stock size for all ages;

- 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.

Four different runs have been performed, changing the S.E. of the mean to which the estimates are shrunk from 0.5 to 2 with a step of 0.5 and the run with 1 has been chosen on the basis of the residuals and of the retrospective analysis.

The log-catchability residuals of XSA are listed in the table below:

Table 6.14.4.1.3.1. Log-catchability residuals of XSA.

Age	2006	2007	2008	2009	2010	2011	2012
0	-0.102	-0.534	-0.057	0.119	0.311	0.18	0.051
1	0.289	-0.851	-0.056	-0.057	-0.002	0.106	0.552
2	-0.923	0.289	-0.18	0.286	-0.388	-0.783	0.007

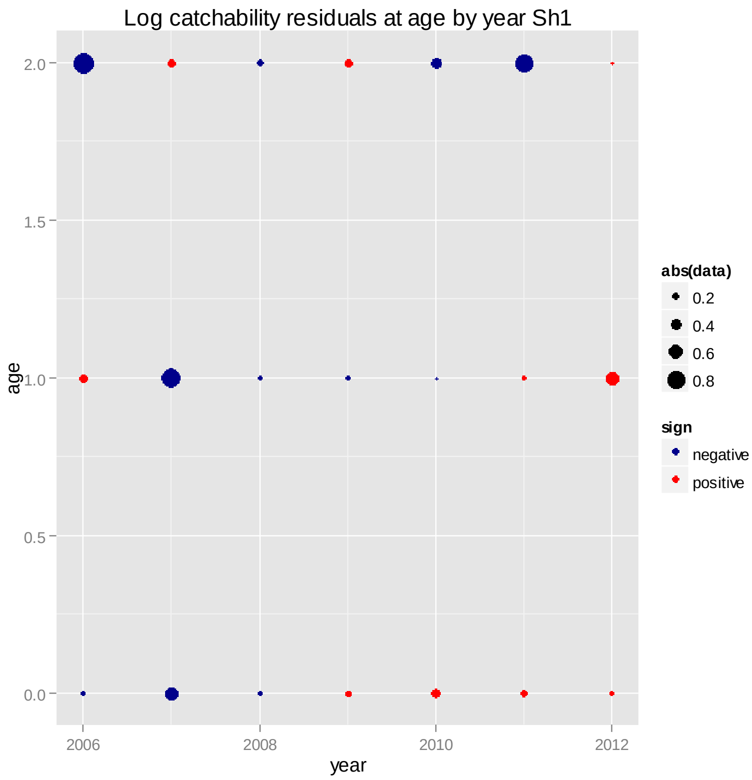

Figure 6.14.4.1.3.2 Log-catchability residuals (XSA).

The residuals do not seem show any trend and are very small. The other results produced by XSA are:

Table 6.14.4.1.3.2 Fishing mortality by year estimated with XSA.

Fishing mortality	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
0	0.69	0.44	0.60	0.60	0.63	0.77	0.53
1	4.76	2.87	2.98	2.28	2.40	2.94	2.63

2	2.99	1.61	1.98	1.40	1.76	2.17	1.64
3+	2.99	1.61	1.98	1.40	1.76	2.17	1.64
F_{BAR}(0-2)	2.81	1.64	1.85	1.43	1.60	1.96	1.60

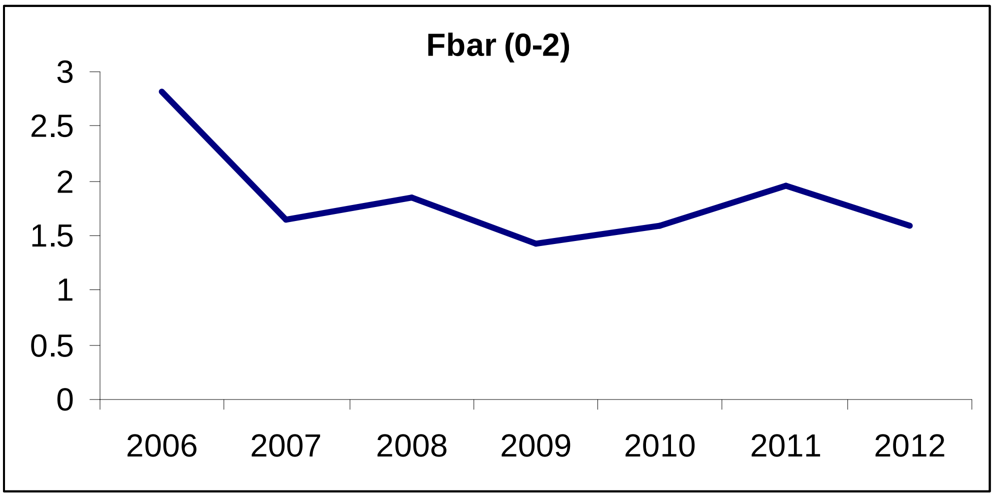

Figure 6.14.4.1.3.3 Estimated fishing mortality by year (F(0-2)).

Table 6.14.4.1.3.3 Stock in numbers (thousands) estimated by age and year.

Stock numbers (thousands)	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
0	392382	380335	421858	459200	322867	278638	287445
1	106672	47852	59556	56381	61433	41908	31557
2	5360	407	1210	1352	2561	2476	990
3+	196	0	19	4	70	1	35
TOTAL	**504610**	**428594**	**482643**	**516937**	**386931**	**323023**	**320027**

Table 6.14.4.1.3. 4 Recruits (thousands), Total biomass (tons), SSB, Landings(tons), Y/SSB.

YEAR	**RECRUITS (age 0)**	**TOTALBIO**	**TOTSSBIO**	**LANDINGS**	**YIELD/SSB**
2006	392382	3409	2142	1245	0.58
2007	380335	2388	1371	608	0.44

2008	421858	2731	1601	785	0.49
2009	459200	2429	1444	767	0.53
2010	322867	2023	1325	716	0.54
2011	278638	1583	984	593	0.60
2012	287445	1775	1006	488	0.48

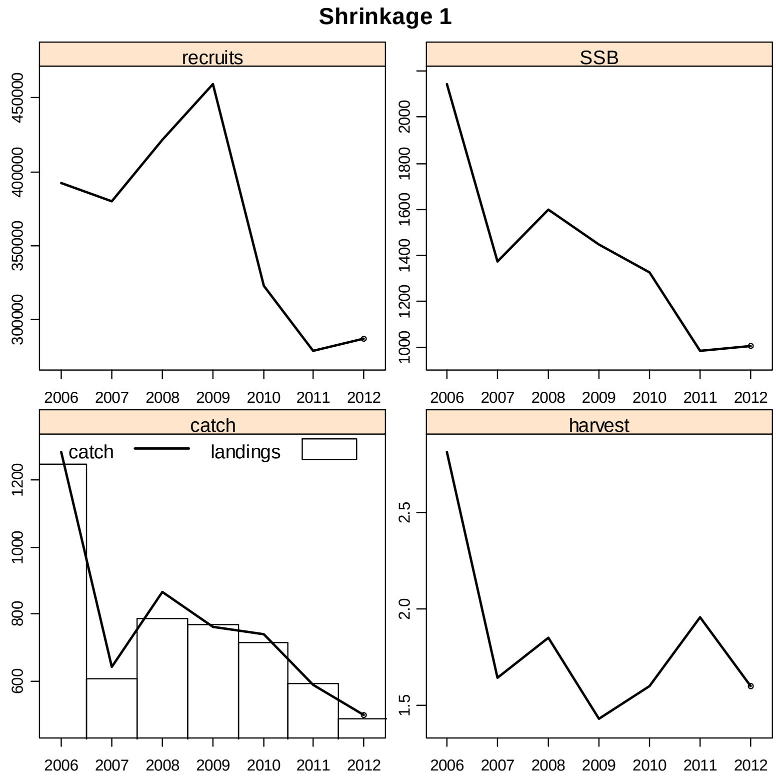

Figure 6.14.4.1.3.5. Estimated recruitment, SSB, F current and yield by year.

The results obtained with XSA method showed a decreasing pattern in SSB (from 2142 in 2006 to 984 tons in 2011) except for 2012 where SSB shows a very small increase to 1006 tons. Recruitment shows a global decrease until 2012 and a pick in 2009. The F shows a decrease in time from 2.81 in 2006 to 1.6 in 2012.

The retrospective analysis shows that R, SSB and F are generally overestimated (Fig. 6.14.4.1.3.5).

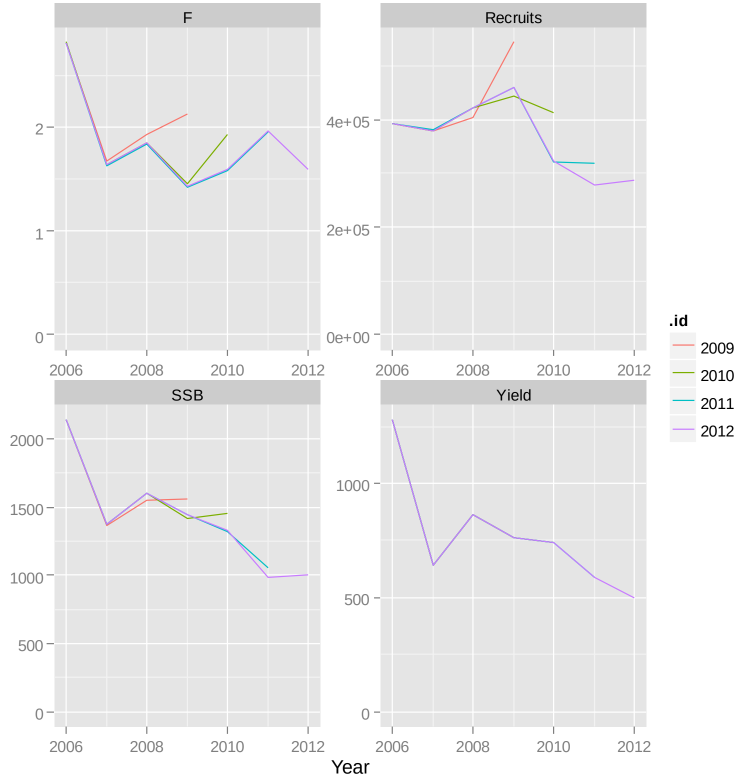

Figure 6.14.4.1.3.5. Retrospective analysis (XSA) results.

6.14.5. *Long term prediction*

6.14.5.1. Justification

The reference point $F_{0.1}$ has been recalculated on the XSA results, using FLBRP package.

6.14.5.1.1. Input parameters

Input parameters are given in section 6.14.4.1.2 of this report.

6.14.5.1.2. Results

Using FLBRP package on XSA results, the F_{01} is 0.67.

6.14.6. *Data quality*

Data from DCF 2013 were used. Assessments were performed using the new submitted time series. A consistent sum of products compared to landings was observed (differences less than 10% for age data and less than 5% for length data) and there has not done any correction on data used in analyses. Discards data of 2006, 2009, 2010, 2011 and 2012 were available. In 2010 and 2012 data were provided by year gear and fishery. 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. Row MEDITS data used for this assessment have been provided by JRC. The standardized abundance and biomass indices as well as the length distributions were obtained using the routine R_Elasmostat ver1.1 - R routine for the calculation of Density and Biomass indices from scientific survey data for elasmobranchs (Authors: M.T. Facchini, I. Bitetto, M.T. Spedicato, G. Lembo, P. Carbonara) 2013.

Regarding OTB effort data in GSA19, there are some inconsistencies comparing to old data provided in STECF13-05. A comparison between the two series is shown in Table 6.14.6.1. Data from DCF 2013

(STCF13-09) report low effort values for the first part of the series (2004-2007) and there are no effort data for the year 2010.

Table 6.14.6.1. Effort data provided on STCF13-09 (2013) compared with effort data provided on STCF 13-05 (2012).

OTB STCF 13-09	2004	2005	2006	2007	2008	2009	2010	2011	2012
NOMINAL_EFFORT	5875474	4181999	6770477	5312380	5350926	6361017		6832229	6382671
GT_DAYS_AT_SEA	761067	430253	672536	491942	574366	711619		805415	785235
NO_VESSELS	281	107	238	205	252	293		285	322

OTB STCF 13-05	2004	2005	2006	2007	2008	2009	2010	2011	
NOMINAL_EFFORT	6293262	4309873	6373213	5247464	5350926	6361017	6642497	6832229	
GT_DAYS_AT_SEA	840177	450755	614647	484660	574366	711619	759137	805415	
NO_VESSELS	308	116	248	202	252	294	303	285	

2013/2012 data	2004	2005	2006	2007	2008	2009	2010	2011	
dif nominal effort	-417788	-127874	397264	64916	0	0		0	
dif GT_days_at_sea	-79110	-20502	57889	7282	0	0		0	
dif No_vessels	-27	-9	-10	3	0	-1		0	

6.14.7. *Scientific advice*

6.14.7.1. Short term considerations

6.14.7.1.1. State of the stock size

In the absence of proposed and agreed precautionary management references, EWG 13-09 is unable to fully evaluate the status of SSB. Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h) that was increasing in the last years. An increasing pattern is observed both in abundance and biomass in MEDITS indices. The results obtained with XSA method showed a decreasing pattern in SSB until 2011 and a small increase for 2012.

6.14.7.1.2. State of recruitment

Recruit indices from MEDITS show a variable pattern with peaks in 1996, 1999, 2006 and especially in 2010. Recruitment as estimated from the XSA shows a general decreasing pattern but with a peak in 2009 and a small increase in 2012.

6.14.7.1.3. State of exploitation

EWG 13-09 proposes $F \leq 0.67$ as limit management reference point (basis $F_{0.1}$ as proxy of F_{MSY}) of exploitation consistent with high long term yield. Given the results of the present analysis (F_{curr} (2012) = 1.31), the stock is exploited unsustainably.

6.14.7.2. Management recommendations

EWG 13-09 recommends the relevant fleets catches and/or effort to be reduced to reach the proposed level $F_{0.1}$, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan. However the dynamics of this species seems also influenced by environmental changes.

6.15. STOCK ASSESSMENT OF HAKE IN GSA 19

6.15.1. *Stock identification and biological features*

6.15.1.1. Stock Identification

No information was documented during EWG 13-09 and therefore the stock of European hake was assumed in the boundaries of the GSA 19 (figure 6.15.1).

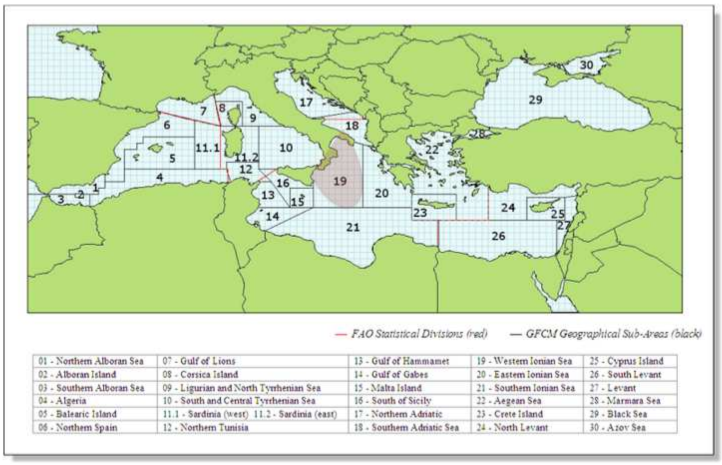

Figure 6.15.1. Geographical location of GSA 19.

6.15.1.2. Growth

Growth parameters for the fast growth from GSA 18 (Linf = 104 cm, K=0.2, t_0= -0.01) were used. The length-weight relationship parameters used are a=0.00437 and b=3.1542 (again from hake, GSA 18).

6.15.1.3. Maturity

Maturity ogive was taken from García- Rodríguez and Esteban (1995) (Table 6.15.1.).

Table 6.15.1. Maturity ogive for hake in GSA 19 from age 0 to age 5+.

Age	0	1	2	3	4	5+
Prop mature	0	0.15	0.82	0.98	1	1

6.15.2. *Fisheries*

6.15.2.1. General description of fisheries

Merluccius merluccius is one of the most important species in GSA 19, considering both the amount of catch and the commercial value. It is fished with bottom trawl (OTB) and different small-scale gears (long-line (LLS), gillnet (GNS) and trammel net (GTR)). The main fisheries operating in GSA 19 are from Gallipoli, Taranto, Schiavonea and Crotone. The fishing pressure varies between fisheries and fishing grounds. No new documentation on the hake fishery in GSA 19 was submitted to EWG 13-09. During 2006-2012 annual landings ranged between 1565 t in 2006 and 657 t in 2012.

6.15.2.2.Management regulations applicable in 2012 and 2013

No information was documented.

6.15.2.3.Catches

Data on landings were available by gear from 2006 to 2012. Data on discards (weight and sizes) were available for OTB in 2006, and from 2009 to 2012.

6.15.2.3.1.Landings

Table 6.15.2. Hake catch (t) in GSA 19 by gear, 2006-2012 (Data source: DCF).

GEAR	2006	2007	2008	2009	2010	2011	2012
OTB	1329.55	571.50	681.98	651.53	563.93	533.70	405.89
GNS	7.75	0.00	36.74	0.00	0.00	20.65	29.14
GTR	91.82	24.63	16.18	0.00	0.00	17.90	56.67
LLS	136.19	274.60	196.30	296.00	240.30	237.49	165.72
TOTAL	1565	871	931	948	804	810	657

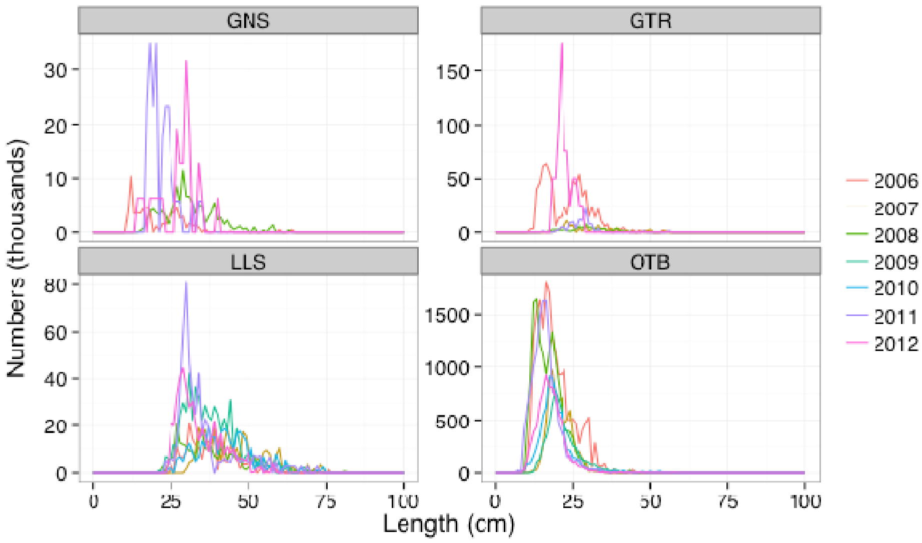

Fig. 6.15.2. Size frequency distributions of the landings (TL in cm), by gear, 2006-2012 (Data source: DCF).

By far, the highest catches in number were from the bottom otter trawls, most of them made up by immature individuals. The smallest caught size class was 5 cm TL (OTB discards) and the largest one was 82 cm TL (LLS landings).

6.15.2.3.2.Discards

Discards data (weight and size distributions) were available for OTB for 2006 and from 2009 to 2012. Since the discard was in general lower than 10 % of the catches and since it was not available for 2007 and 2008, it was decided not to use it in the assessment. The amount of discard in % is presented in table 6.15.3 and the overall length distribution for the entire time series is shown in figure 6.15.3.

Table 6.15.3. Percentage of discard of hake GSA 19 on the overall catches for OTB gear in 2006 and from 2009 and 2012.

	2006	2009	2010	2011	2012
% of discard on the total catches	2.5	7.5	1.9	1.6	2.8

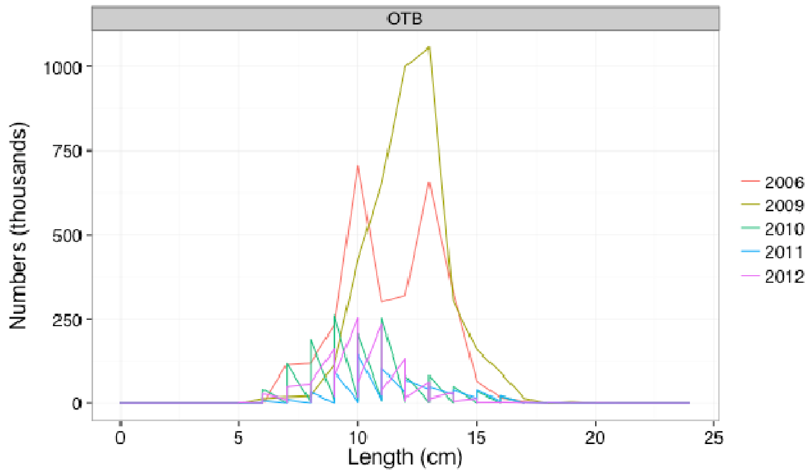

Fig. 6.15.3. Size distribution of discard by year for hake in GSA 19.

6.15.2.4. Fishing effort

Table 6.15.4. Fishing effort in different units, by gear, deployed in GSA 19 over 2004-2012 (Data source: DCF). The number of vessels is an average along the years.

* 2010 was derived from last year report since not available in the database.

	YEAR	2004	2005	2006	2007	2008	2009	2010*	2011	2012
GNS	NOMINAL EFFORT	797996	1197159	1402176	1473754	1292445	1403795	1813781	1696773	1627697
	GT DAYS AT SEA	78308	101868	123299	123789	99854	104009	134114	116970	114717
	N° OF VESSELS	187	221	194	182	91	108	193	107	84
GTR	NOMINAL EFFORT	2742293	2115507	1106682	925004	1124657	1555241	1896850	1728179	1590170
	GT DAYS AT SEA	233891	197023	104406	88113	101088	132755	149802	135745	130340
	N° OF VESSELS	272	177	112	79	97	120	371	122	100
LLS	NOMINAL EFFORT	1143710	861956	870853	1062369	640459	705530	852696	1086930	1307624
	GT DAYS AT SEA	110883	69009	68640	89442	65899	68600	71070	106161	128798
	N° OF VESSELS	107	75	36	52	47	44	61	56	53

OTB	**Nominal Effort**	5875474	4181999	6770477	5312380	5350926	6361017	6642497	6832229	6382671
	Gt Days At Sea	761067	430253	672536	491942	574366	711619	759137	805415	785235
	N° of vessels	71	78	87	135	53	52	303	46	44

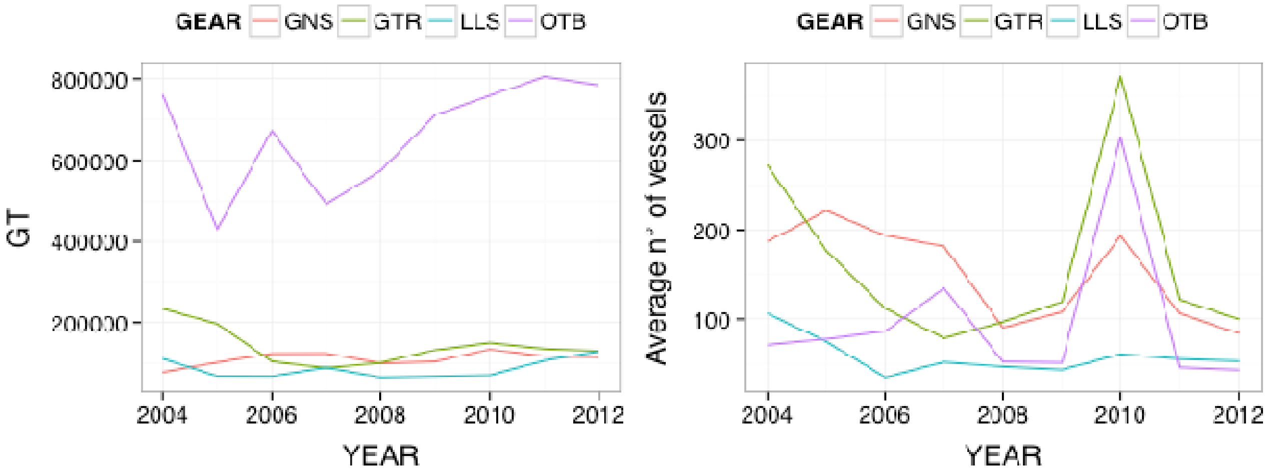

Fig. 6.15.4. Trend of fishing effort by gear, expressed in GT·days at sea (on the left) and number of vessels (on the right).

6.15.3. *Scientific surveys*

6.15.3.1.MEDITS

6.15.3.1.1.Methods

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 19 the following number of hauls was reported per depth stratum (Table 6.15.5).

Table 6.15.5. Number of hauls per year and depth stratum in GSA19, 1996-2012.

STRATUM	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
GSA19_010-050	9	9	9	9	9	9	9	9	9	9	9	8	9	9	9	9	9
GSA19_050-100	8	8	8	8	8	8	8	8	8	8	8	9	8	8	8	8	8
GSA19_100-200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
GSA19_200-500	15	15	15	15	15	15	14	14	14	15	14	14	14	14	14	14	14
GSA19_500-800	32	32	32	32	32	32	29	29	29	28	29	29	29	29	29	29	29

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to the swept area. 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 ± standard deviation.

Length distributions represented an aggregation of all standardized length frequencies (subsamples raised to standardized haul abundance per square km) over the stations of each stratum.

6.15.3.1.2. Geographical distribution patterns

In figure 6.15.5 is shown the distribution and abundance of hake for 2012.

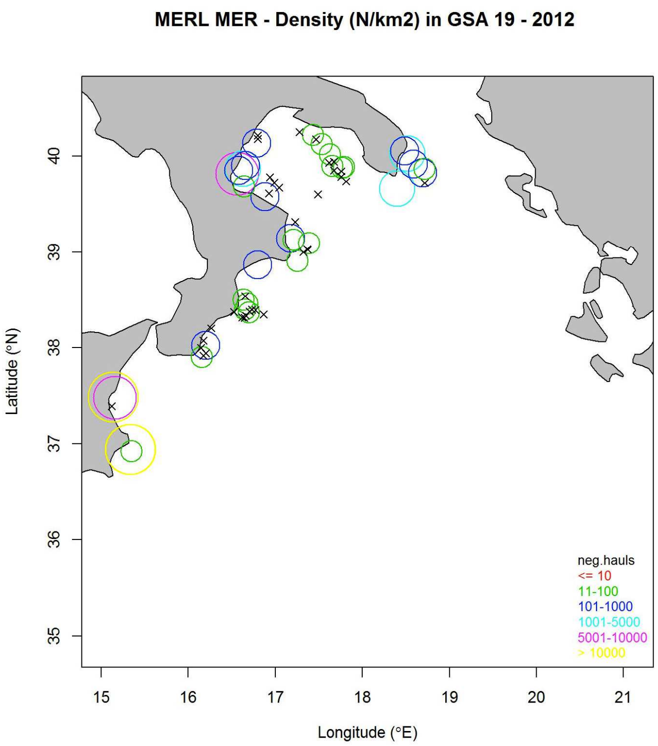

Figure 6.15.5. Haul distribution and abundance per square km of hake in GSA 19 from MEDITS survey (the map has been drawn with the R-ELASMOSTAT routine (Facchini *et al.*).

6.15.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the European hake in GSA 19 were derived from the international survey MEDITS and were compiled during STECF EWG 13-09 using the R-ELASMOSTAT ver 1.1 routine (Facchini *et al.*).

Fig. 6.15.6. displays the estimated trend in European hake abundance and biomass in GSA 19: an increasing in the number per km^2 is observed in the last two years, while the biomass looks stable.

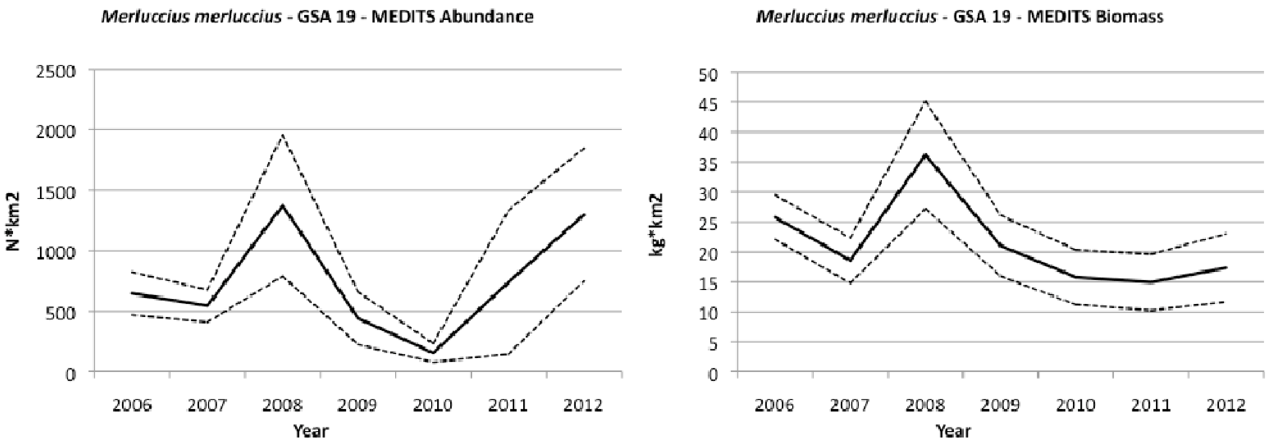

Figure 6.15.6. Abundance and biomass indices of European hake in GSA 19 from 2006 to 2009.

6.15.3.1.4. Trends in abundance by length or age

The following figures (fig. 6.15.7.) show hake abundance by size in GSA 19 over 2006-2012 and were compiled during STECF EWG 13-09 (R-ELASMOSTAT ver 1.1 routine, Facchini *et al.*).

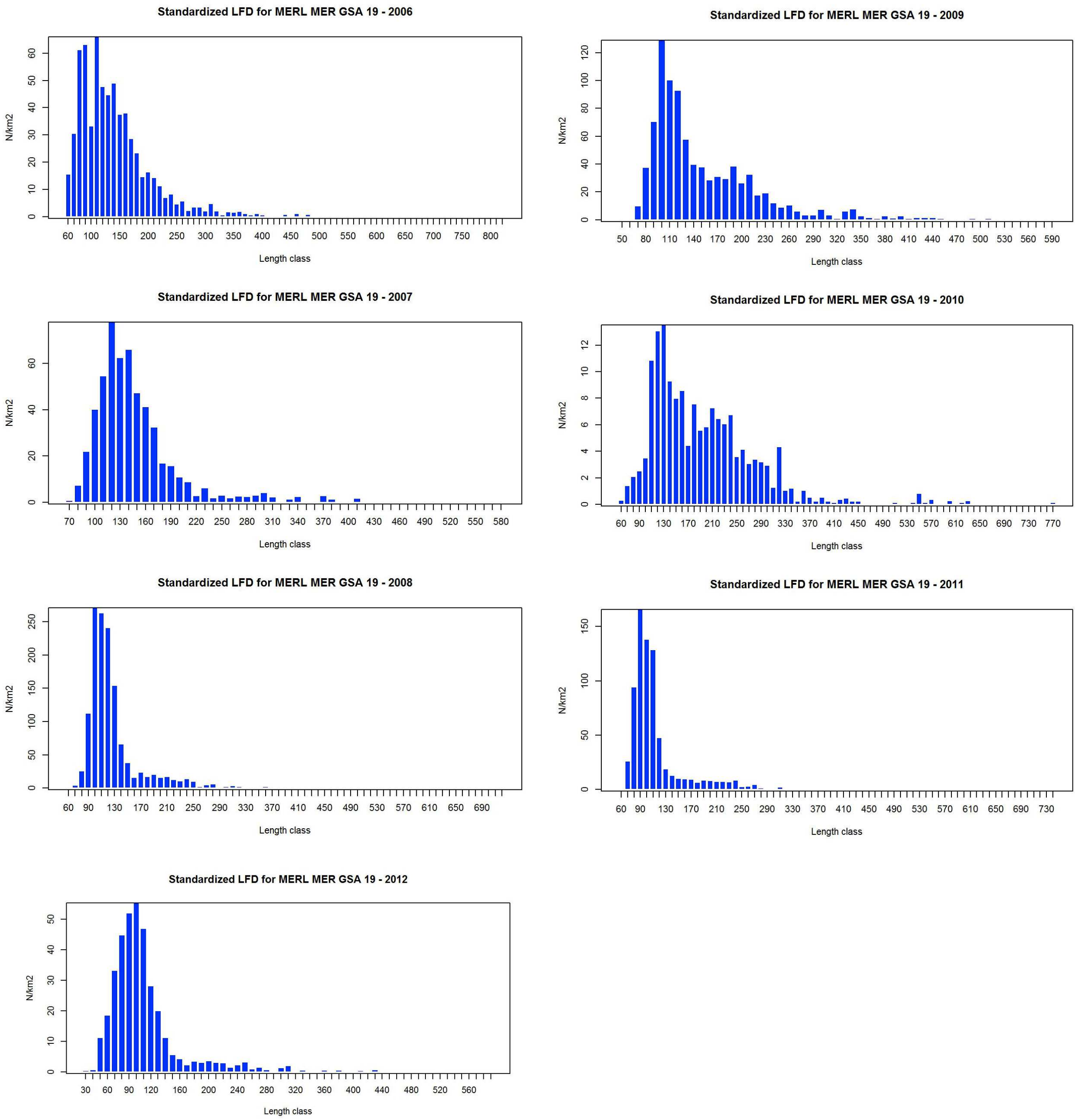

Fig. 6.15.7. Hake abundance indices by size, 2006-2012.

6.15.3.1.5.Trends in growth

No analyses were conducted during STECF EWG 13-09.

6.15.3.1.6.Trends in maturity

No analyses were conducted during STECF EWG 13-09.

6.15.4.*Assessment of historic stock parameters*

6.15.4.1.Method 1: XSA

6.15.4.1.1.Justification

FLR libraries were used in order to carry out an XSA based assessment (Darby and Flatman 1994). This stock was assessed for the first time during in SGMED-09-02: LCA (VIT program from Lleonart and Salat, 1992) was performed using as input data the mean pseudo-cohort for the period 2006-2008. XSA has been carried out for the first time for this stock in 2012 (STECF EWG 12-19).

6.15.4.1.2.Input Data

Landings at length data form the DCF annual size distributions (Figure 6.15.8.) for the period 2006-2012 have been employed in the analysis and were divided into age classes by LFDA package using a knife edge slicing approach (figure 6.15.9). No SOP correction has been applied.

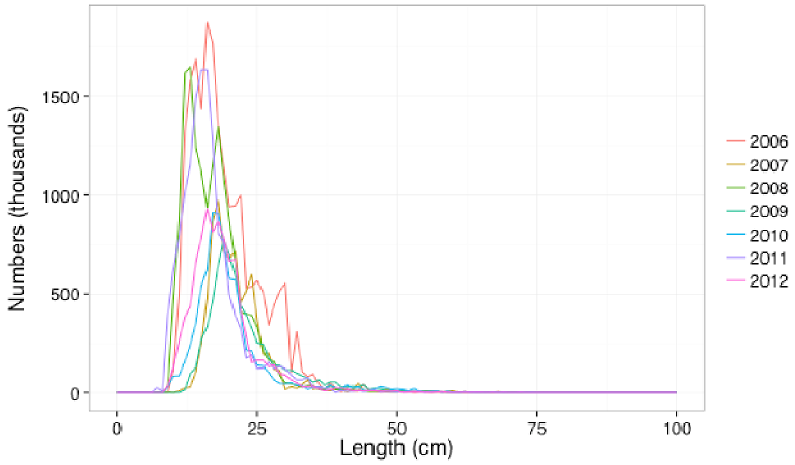

Fig. 6.15.8. Hake in GSA 19annual distributions by size, all gears combined, 2006- 2012.

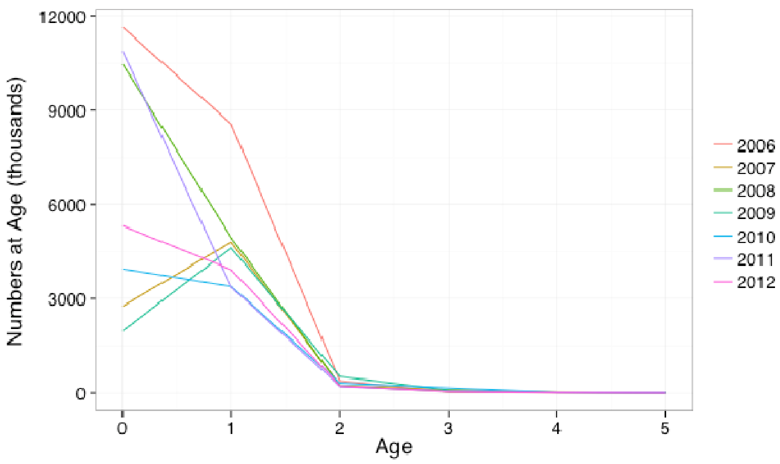

Fig. 6.15.9. Hake in GSA 19 annual distributions by age, all gears combined, 2006- 2012.

The standardized numbers at age final index have been obtained using the same procedure applied to the commercial data and it is shown in fig 6.15.10.

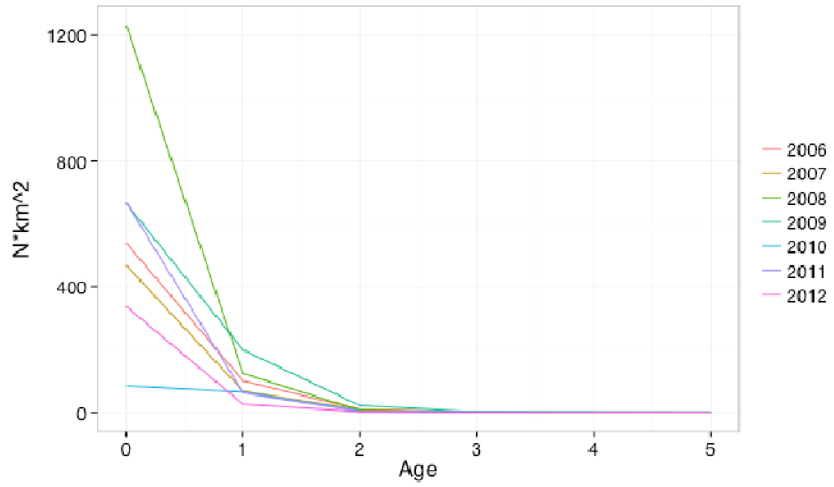

Fig. 6.15.10. MEDITS numbers at age for hake in GSA 19 from 2006 to 2012.

Natural mortality was estimated using PROBIOM (Abella et al., 1997). M at the mid-point of the year was selected as M representative for that annual class.

Table 6.15.6. Natural mortality vector for hake GSA 19 from age 0 to 5+.

Age	0	1	2	3	4	5+
M	1.08	0.50	0.38	0.33	0.30	0.29

Maturity at age is shown in section 6.15.1.3, figure 6.15.1.

In table 6.15.7 the input data used in the XSA assessment are presented.

Table 6.15.7. Catch numbers at age (thousands) used in the XSA of hake in GSA 19.

Age	2006	2007	2008	2009	2010	2011	2012
0	11637.84	2758.837	10461.64	1968.714	3950.1	10869.03	5313.996
1	8558.328	4799.917	4940.2	4613.338	3387.458	3366.925	3924.322
2	379.073	240.947	227.935	517.521	313.215	212.865	222.52
3	42.565	99.252	51.698	91.521	162.445	58.665	45.157
4	17.723	29.527	23.881	19.224	23.922	22.68	9.563
5+	9.962	10.626	9.624	7.068	6.677	10.008	0.039

Table 6.15.8. Catch weight at age (kg) used in the XSA of hake in GSA 19 The mean weight for 2007, 2008, and 2010 have been adjusted to reflect the total landings.

Age	2006	2007	2008	2009	2010	2011	2012
0	0.033	0.031	0.031	0.038	0.031	0.034	0.029

1	0.117	0.123	0.102	0.150	0.152	0.101	0.109
2	0.209	0.209	0.209	0.216	0.205	0.195	0.195
3	0.423	0.435	0.435	0.442	0.463	0.412	0.435
4	0.723	0.758	0.758	0.747	0.763	0.754	0.800
5+	2.531	2.221	2.221	2.411	1.926	1.926	1.740

Table 6.15.9. Numbers at age from MEDITS survey for hake in GSA 19.

Age	2006	2007	2008	2009	2010	2011	2012
0	539.012	468.569	1232.447	665.593	85.153	668.548	337.437
1	100.776	67.94	124.33	198.754	65.263	62.513	26.203
2	9.662	8.451	7.061	21.923	4.763	2.678	2.44
3	1.301	0.48	1.335	1.95	1.337	0.997	0.307
4	0.12	0.12	0.891	0.25	0.853	0.319	0.213
5+	0.12	0	0.165	0	0.13	0.154	0

Sensitivity analyses were conducted to assess the effect of the main parameters, i.e. shrinkage (fse) and age above which q is independent from age (qage). Values ranging from 0 to 2 (0.5 increasing) for the shrinkage and from 0 to 5 for the qage parameter have been tested. Comparison of trends between the settings has been done: no changes in the general trend were observed, nevertheless there were differences between the absolute values. Besides, different combinations between the set of settings that looked more stable were tested. As a result, the setting that minimized the residuals and showed the best diagnostics output were used for the final assessment (Fbar = 0-4, fse = 2, rage = 0, qage = 4, shk.yrs = 2, shk.ages = 2).

6.15.4.1.3.Results

The residuals from the survey do no show any particular trend (Fig 6.15.11). The retrospective analysis show that F is generally underestimated and SSB is overestimated. (Fig. 6.15.12).

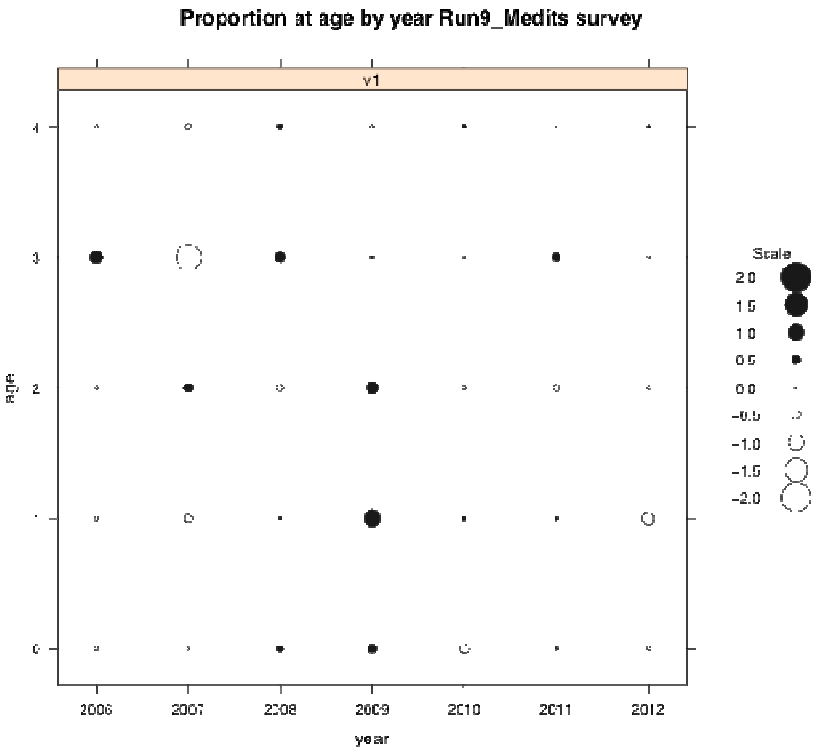

Fig 6.15.11. XSA residuals for the MEDITS survey from 2006 to 2012.

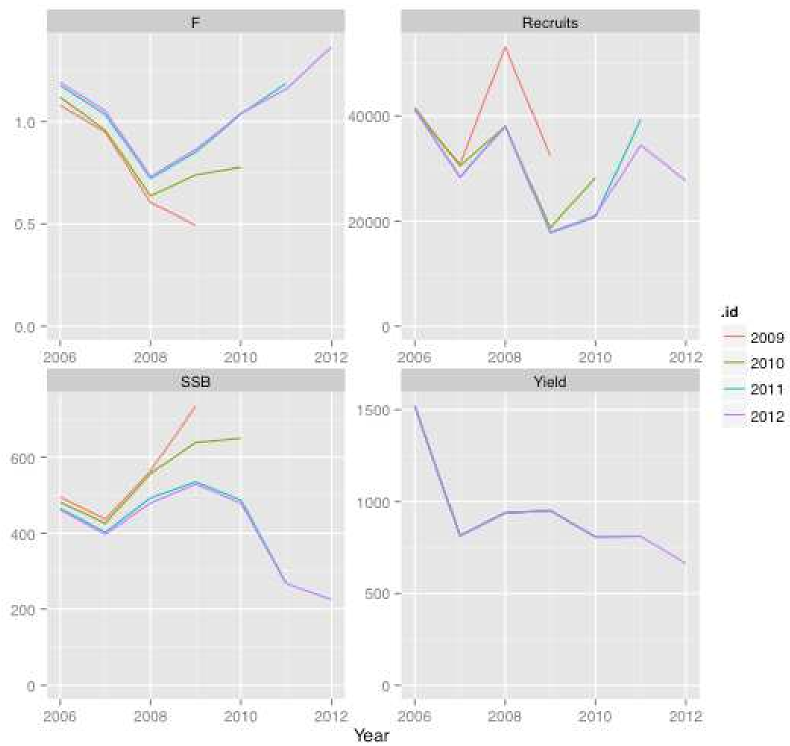

Fig 6.15.12. Retrospective analysis for the years 2009 to 2012.

As shown in the results of the XSA (fig. 6.15.13 and table 6.15.10) the SSB decreased from the maximum of 530 t in 2009 to the historical minimum of 225 t in 2012. Recruitment is fluctuating around 40,000 thousands and the minimum of about 20,000; in 2012 has an average value of 30,000 thousands. The $F_{bar(0-4)}$ started increasing in 2008, from a value of 0.48 to a value of 1.21.

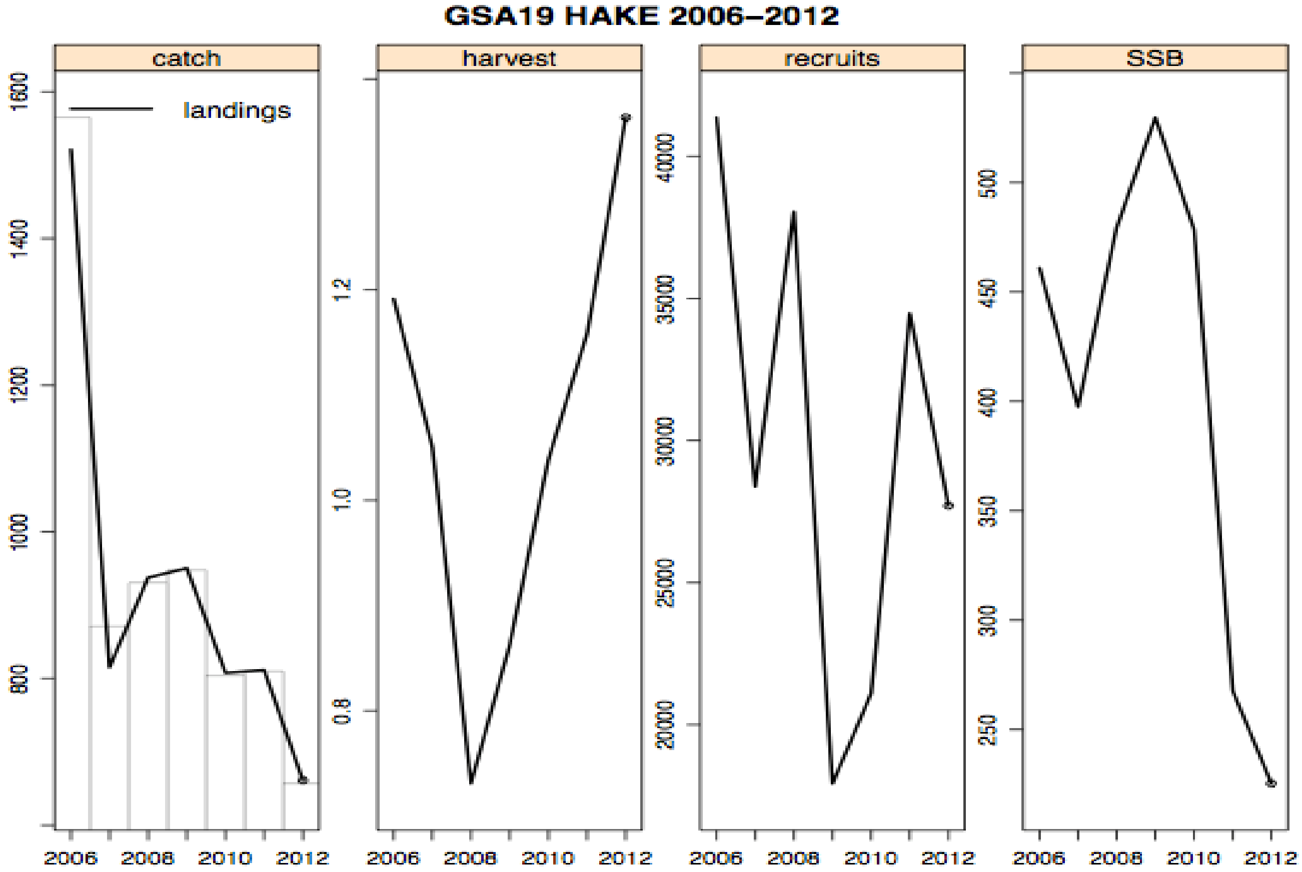

Fig 6.15.13. XSA results (fishing mortality, recruitment, SSB, and yield).

Table 6.15.10. XSA results

Year	Recruitment (thousands)	TB (t)	SSB (t)	Fbar (0-4)	F at age					
					Age0	Age1	Age2	Age3	Age4	Age5
2006	41373	3063	461	1.191	0.659	2.703	0.759	0.621	1.214	1.214
2007	28373	2085	398	1.051	0.183	1.884	0.938	0.553	1.697	1.697
2008	38052	2409	479	0.731	0.638	1.561	0.530	0.646	0.279	0.279
2009	17925	2157	530	0.862	0.209	2.024	0.948	0.511	0.620	0.620
2010	21095	1817	479	1.038	0.388	2.124	1.178	1.229	0.272	0.272
2011	34469	1884	268	1.158	0.779	2.200	1.269	0.919	0.622	0.622
2012	27706	1550	225	1.364	0.399	2.781	1.736	1.490	0.412	0.412

6.15.4.2.Method 2: Yield per Recruit model

6.15.4.2.1.Justification

To predict the effect of changes in fishing effort of future yields and to define reference points F_{01} (as a proxy for F_{MSY}) and F_{max} a Yield per Recruit analysis (YPR) was carried out in R. As input the same population parameters used for the XSA and its output for the exploitation pattern were used.

6.15.4.2.2.Results

The results of the YPR in terms of F_{01}, F_{max} and F_{cur} were respectively 0.22, 0.34 and 1.21 (figure 6.15.14).

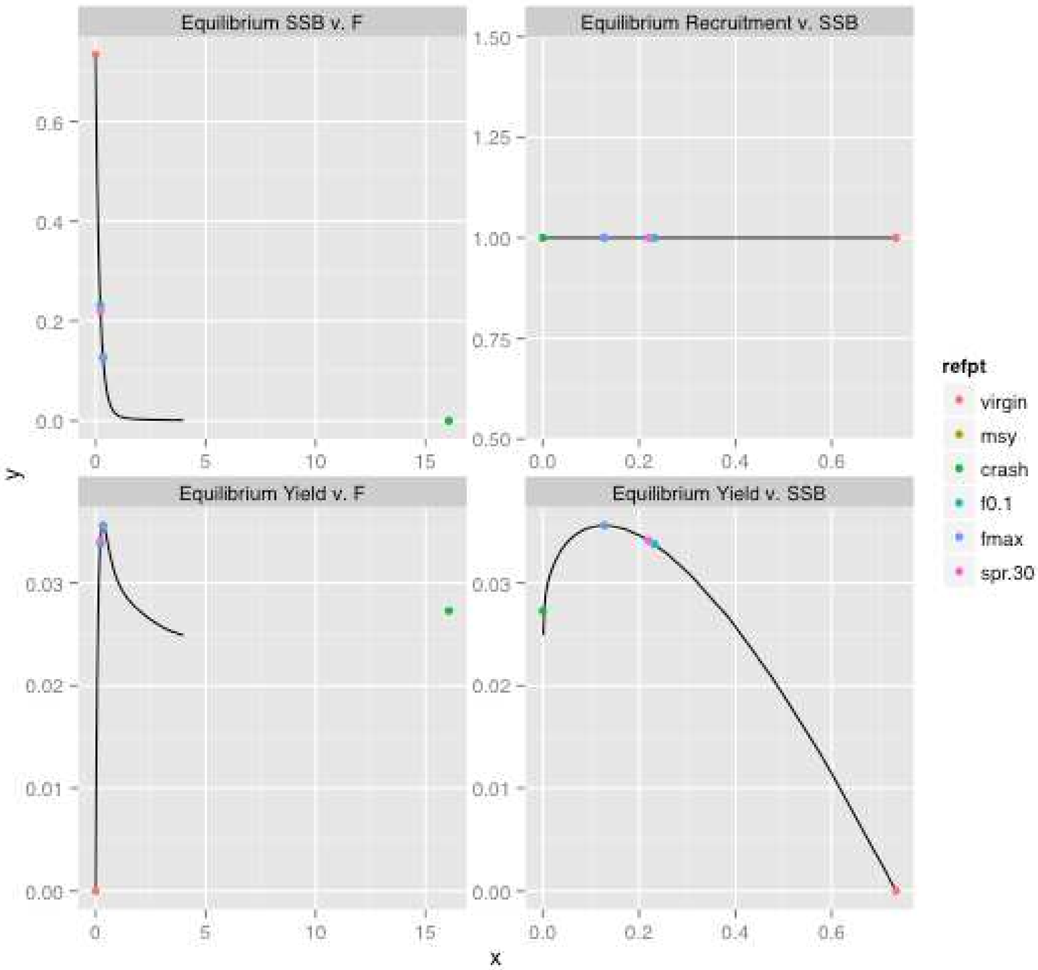

Fig 6.15.14. Results summarizing the YPR analysis performed on 2012 data.

Data quality and availability

Data from DCF 2013 were used. Assessments were performed using the new submitted time series. The difference observed in the sum of products of submitted data compared to submitted landings are in the range 0.96 - 5.51 %. Differences between total landings of 2011 database and 2012 database for the years from 2008 to 2010 were of 2 - 4% (2% in 2008, 2.6% in 2009 and 4% in 2010). No differences have been found between 2012 and 2013 databases. Discards data of 2009, 2010, 2011 and 2012 were available. 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. MEDITS raw data used for this assessment have been provided by JRC; the abundance indices have been calculated by the experts using ELASMOSTAT R routine (Facchini et al.) given some difficulties in getting outputs from the JRC database.

6.15.5. *Scientific advice*

6.15.5.1. Short term considerations

6.15.5.1.1. State of the spawning stock size

EWG 13-09 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points. Nevertheless, even though the survey indices of abundance increased in the last couple of years, the indices of biomass from both the survey and the assessment indicate a strong decrease in the stock size which started in 2008-2009. The recent values are lower than those observed at the beginning of the time series.

6.15.5.1.2. State of recruitment

The estimated recruitment, even if it is following a slightly decreasing trend, it is on an average level respect to the whole time series. The MEDITS data shows an increase in the abundance index, which, given the fact that the biomass index did not show any particular increase, suggest an increasing of smaller individual in the population (with size distribution in 2012 starting from 30 mm length class, the lowest of the time series).

6.15.5.1.3. State of exploitation

EWG 13-09 proposes $F \leq 0.22$ as proxy for F_{MSY}. Given the results of the present analysis (current F is around 1.21), the stock is exploited unsustainably. A considerable reduction is necessary to approach the reference point.

6.15.5.2. Management recommendations

The catches of hake in GSA 19 is mainly due to otter trawler, with an important contribution from longlines. EWG 13-09 recommends the 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.

7. ToR C Short term, medium term and long term forecasts of stock size and yield

7.1. Short and medium term predictions for Hake in GSA 1

7.1.1.*Short term prediction 2013-2014*

A deterministic short term prediction for the period 2013 to 2015 was performed using the FLR routines provided by JRC, which takes into account the catch and landings in numbers and weight and the discards, and is based on the results of the XSA stock assessments performed during EWG13-09 for the years 2003 – 2012 (section 6.1).

7.1.1.1. Input parameters

An average of the last three years has been used for weight at age, maturity at age and F at age. Mortality at age was the same as used as input data in the XSA.

Recruitment

Recruitment (class 0+) in 2013 has been estimated as the geometric mean (2010-2012), taken from XSA results = 11889.8 (thousands).

Outlook until 2014

Table 7.1.1.1. Short term forecast for different F scenarios computed for hake in GSA 1.

Basis: F_{sq}= 1.61 mean (F_{bar12} over 2008- 2012); R(2013)= GM (2010-2012)= 11889.8 (thousands); SSB (2012) = 265.8; landings (2012)= 418 (weight in tonnes).

Rationale	F scenario	F factor	Catch 2014	Catch 2015	SSB 2015	Change SSB 2014-2015 (%)	Change catch 2012-2014 (%)
zero catch	0	0	0	0	923.6	300.1	-100.0
High long-term yield (F0.1)	0.2	0.1	66.4	152.6	810.1	250.9	-84.1
Status quo	1.6	1	400.0	444.5	278.3	20.5	-4.3
Different scenarios	0.3	0.2	124.7	258.0	711.9	208.4	-70.2
	0.5	0.3	175.9	329.7	627.0	171.6	-57.9
	0.6	0.4	221.0	377.4	553.5	139.7	-47.2
	0.8	0.5	260.7	408.2	489.9	112.2	-37.7
	0.9	0.6	295.7	427.2	434.7	88.3	-29.3
	1.1	0.7	326.7	438.1	386.9	67.6	-21.9
	1.3	0.8	354.1	443.5	345.5	49.6	-15.3
	1.4	0.9	378.4	445.1	309.5	34.1	-9.5
	1.7	1.1	419.3	442.3	251.2	8.8	0.3
	1.9	1.2	436.4	439.4	227.7	-1.4	4.4
	2.0	1.3	451.8	436.1	207.2	-10.3	8.0
	2.2	1.4	465.5	432.7	189.4	-18.0	11.3
	2.3	1.5	477.8	429.4	173.9	-24.7	14.3
	2.5	1.6	488.9	426.3	160.4	-30.5	16.9
	2.7	1.7	498.9	423.5	148.7	-35.6	19.3
	2.8	1.8	507.9	421.1	138.5	-40.0	21.4
	3.0	1.9	516.1	418.9	129.6	-43.9	23.4
	3.1	2	523.5	417.0	121.8	-47.3	25.2

Short-term implications

A short term projection table (Table 7.1.1.1.) assuming a *statu-quo* F of F_{stq}=1.61 in 2013 and a recruitment of 11889.8 thousand individuals shows that:

- Fishing at F_{stq} from 2013 to 2014 would produce a decrease in catches of -4.3%, with a high increase in SSB between 2014 and 2015 (20.5%).

- Fishing at $F_{0.1}$ =0.2 from 2013 to 2014 would generate a decrease of 84.15% in the catches and an increase of 250% in SSB.

- STECF EWG 13-09 recommends that catch in 2014 does not exceed 66.4 t, corresponding to $F_{0.1.}$=0.2.

7.1.2. *Medium term prediction*

7.1.2.1. Method and justification

Medium term predictions were not made since from the available data on SSB and R no reliable fit of a stock-recruitment relationship could be established. Nevertheless, the preliminary fit of the stock-recruitment relationship is promising (Fig. 7.3.2.1.1.) and will be probably reliable when a longer data series is available.

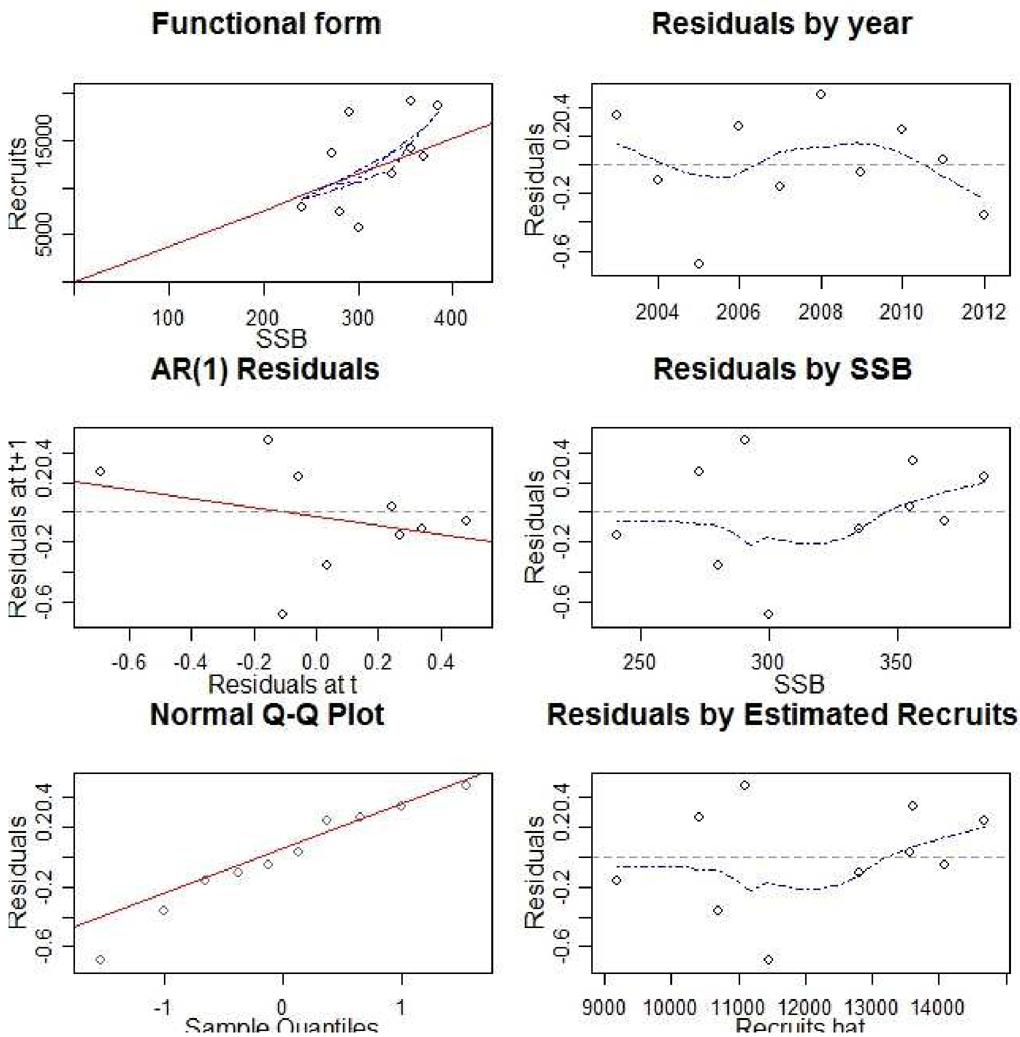

Fig. 7.1.2.1.1. Beverton and Holt stock recruitment relationship for European hake in GSA 01 (steepness= 0.5).

7.2. SHORT TERM PREDICTIONS FOR DEEPWATER PINK SHRIMP IN GSA 1

7.2.1. *Short term prediction 2013-2014*

A deterministic short term prediction for the period 2013 to 2015 was performed using the FLR routines provided by JRC, which takes into account the catch and landings in numbers and weight and the discards, and based on the results of the XSA stock assessments performed during EWG13-09 for the years 2003–2012.

7.2.1.1. Input parameters

An average of the last three years has been used for weight at age, maturity at age and F at age. Mortality at age was the same as used as input data in the XSA.

Recruitment

Recruitment (class 0+) in 2013 has been estimated as the geometric mean (2010-2012), taken from XSA results = 314300 (thousands).

A short term projection table (Table 7.2.1.1.1). assuming a *statu-quo* F of F_{stq}=0.42 in 2013 and a recruitment of 314300 thousand individuals shows that:

- Fishing at F_{stq} from 2013 to 2014 would produce an increase in catches of 33.35% and an increase in SSB of 2.4% between 2014 and 2015.

- Fishing at $F_{0.1}$ (0.26) from 2013 to 2014 would generate a decrease of 9.16% of the catches and an increase of 16.75% in SSB.

- STECF EWG 13-09 recommends that catch in 2014 does not exceed 217.2 t, corresponding to $F_{0.1.}$=0.26.

Table 7.2.1.1.1. Short term forecast for different F scenarios computed for *Parapenaeus longirostris* in GSA 1. Basis: F(2013) =0.420; R(2013-2015): 314300 (thousands); SSB(2012)= 415.69 t; landings(2012)= 239.10 t.

Rationale	F scenario	F factor	Catch 2014	Catch 2015	SSB 2015	Change SSB 2014-2015 (%)	Change catch 2012-2014 (%)
zero catch	0	0	0	0	1087.82	48.23	-100
High long-term yield (F0.1)	0.26	0.63	217.2	278.44	856.84	16.75	-9.16
Status quo	0.42	1	318.85	366.93	751.54	2.4	33.35
Different scenarios	0.04	0.1	39.25	59.27	1045.58	42.47	-83.59
	0.08	0.2	76.6	112.03	1005.57	37.02	-67.96
	0.13	0.3	112.18	158.96	967.64	31.85	-53.08
	0.17	0.4	146.08	200.63	931.69	26.95	-38.91
	0.21	0.5	178.38	237.59	897.59	22.31	-25.4
	0.25	0.6	209.17	270.31	865.25	17.9	-12.52
	0.29	0.7	238.54	299.24	834.56	13.72	-0.23
	0.34	0.8	266.56	324.75	805.44	9.75	11.49
	0.38	0.9	293.31	347.21	777.79	5.98	22.67
	0.46	1.1	343.24	384.19	726.6	-0.99	43.56
	0.5	1.2	366.56	399.26	702.9	-4.22	53.31
	0.55	1.3	388.84	412.36	680.38	-7.29	62.63
	0.59	1.4	410.15	423.71	658.96	-10.21	71.54
	0.63	1.5	430.55	433.49	638.6	-12.98	80.07
	0.67	1.6	450.06	441.87	619.23	-15.62	88.23
	0.71	1.7	468.75	449	600.8	-18.13	96.05

	0.76	1.8	486.66	455.02	583.26	-20.53	103.54
	0.8	1.9	503.81	460.05	566.55	-22.8	110.71
	0.84	2	520.26	464.21	550.64	-24.97	117.59

7.3. SHORT TERM PREDICTIONS FOR DEEPWATER PINK SHRIMP IN GSA 5

7.3.1. *Short term prediction 2013-2015*

7.3.1.1. Method and justification

A deterministic short term prediction for the period 2013 to 2015 was performed using the FLR routines provided by JRC, which takes into account the catch and landings in numbers and weight and the discards, and based on the results of the XSA stock assessments performed during EWG13-09 for the years 2003–2012.

7.3.1.2. Input parameters

The input parameters were the same used for the XSA stock assessment and its results.

Maturity and M vectors

Maturity	0	1	2	3+
2010-2012	0.11	0.62	0.96	1.00

M	0	1	2	3+
2010-2012	1.22	0.55	0.44	0.39

F vector

F	0	1	2	3+
2010-2012	0.13	1.74	0.44	0.44

Weight-at-age in the stock

Age	0	1	2	3+
2010-2012	0.007	0.012	0.021	0.026

Weight-at-age in the catch

Age	0	1	2	3+
2010-2012	0.007	0.012	0.021	0.026

Number at age in the catch

Thousands	0	1	2	3+
2010	249.1	457.7	19.4	0.4
2011	103.1	324.8	22.2	0.2
2012	102.8	245.1	12.4	0

Number at age in the stock

Thousands	0	1	2	3+

2010	1934.4	617.2	113.4	2.3
2011	1686.5	452.6	51.7	0.5
2012	3493.0	448.4	43.0	0.0

Different scenarios of constant harvest strategy with F_{bar} calculated as the average of ages 0 to 2 (F_{bar} ages 0-2) and F status quo (F_{stq} = 0.77) were performed.

Recruitment

Recruitment (class 0) has been estimated from the population results from the geometric mean of the last three years 2010-2012 (2250 thousands individuals) estimated with FLR.

7.3.1.3. Results

A short term projection (Table 7.3.1.3.1), assuming an F_{stq} of 0.77 in 2012 and a recruitment of 2250 thousands individuals shows that:

- Fishing at the F_{stq} (0.77) generates an increase of the catch of 52% from 2012 to 2014 along with a decrease of the spawning stock biomass of 2% from 2014 to 2015.
- Fishing at $F_{0.1}$ (0.62) generates an increase of the catch of 33% from 2012 to 2014 and an increase of the spawning stock biomass of 6% from 2014 to 2015.

Outlook until 2013

Table 7.3.1.3.1 – Short term forecast in different F scenarios computed for deepwater pink shrimp in GSA 5.

Basis: F(2013) = mean(F_{bar}0-2 2010-2012)= 0.77; R(2012) = geometric mean of the recruitment of the last 3years; R = 2250 (thousands); SSB(2012) = 6.8 t, Catch (2012)= 4.2 t.

Rationale	Ffactor	fbar	Catch 2014	Catch 2015	SSB 2015	Change SSB 2014-2015 (%)	Change Catch 2012-2014 (%)
zero catch	0.00	0.00	0.000	0.000	15.394	76.413	-100.000
High long-term yield (F0.1)	0.80	0.62	5.585	5.619	9.260	6.119	32.973
Status quo	1.00	0.77	6.371	6.129	8.532	-2.225	51.679
Different scenarios	0.10	0.08	1.028	1.267	14.177	62.463	-75.513
	0.20	0.15	1.932	2.301	13.133	50.500	-54.005
	0.30	0.23	2.728	3.148	12.236	40.215	-35.037
	0.40	0.31	3.434	3.844	11.462	31.346	-18.237
	0.50	0.38	4.062	4.417	10.792	23.676	-3.291
	0.60	0.46	4.623	4.892	10.212	17.020	10.068
	0.70	0.54	5.127	5.286	9.706	11.223	22.067
	0.80	0.61	5.582	5.616	9.263	6.154	32.898
	0.90	0.69	5.994	5.894	8.875	1.702	42.722
	1.00	0.77	6.371	6.129	8.532	-2.225	51.679
	1.10	0.85	6.715	6.329	8.228	-5.705	59.887
	1.20	0.92	7.033	6.502	7.958	-8.806	67.445
	1.30	1.00	7.326	6.651	7.716	-11.581	74.438
	1.40	1.08	7.599	6.781	7.498	-14.080	80.940
	1.50	1.15	7.855	6.896	7.300	-16.340	87.013
	1.60	1.23	8.094	6.998	7.121	-18.396	92.708

	1.70	1.31	8.319	7.089	6.957	-20.277	98.073
	1.80	1.38	8.532	7.172	6.806	-22.006	103.145
	1.90	1.46	8.734	7.247	6.667	-23.603	107.958
	2.00	1.54	8.927	7.317	6.537	-25.086	112.541

Data consistency

No particular issue was identified with data quality and data consistency.

7.3.2. *Medium term prediction*

7.3.2.1. Method and justification

Following the agreement reached during the discussions of the EWG-12-19, medium term prediction would only be performed if there is a reliably fit of a stock-recruitment relationship. In the case of the pink shrimp, no medium term predictions were made, although the preliminary fit of the stock-recruitment relationship is promising (Fig. 7.3.2.1.1.) and will be probably reliable when a longer data series is available.

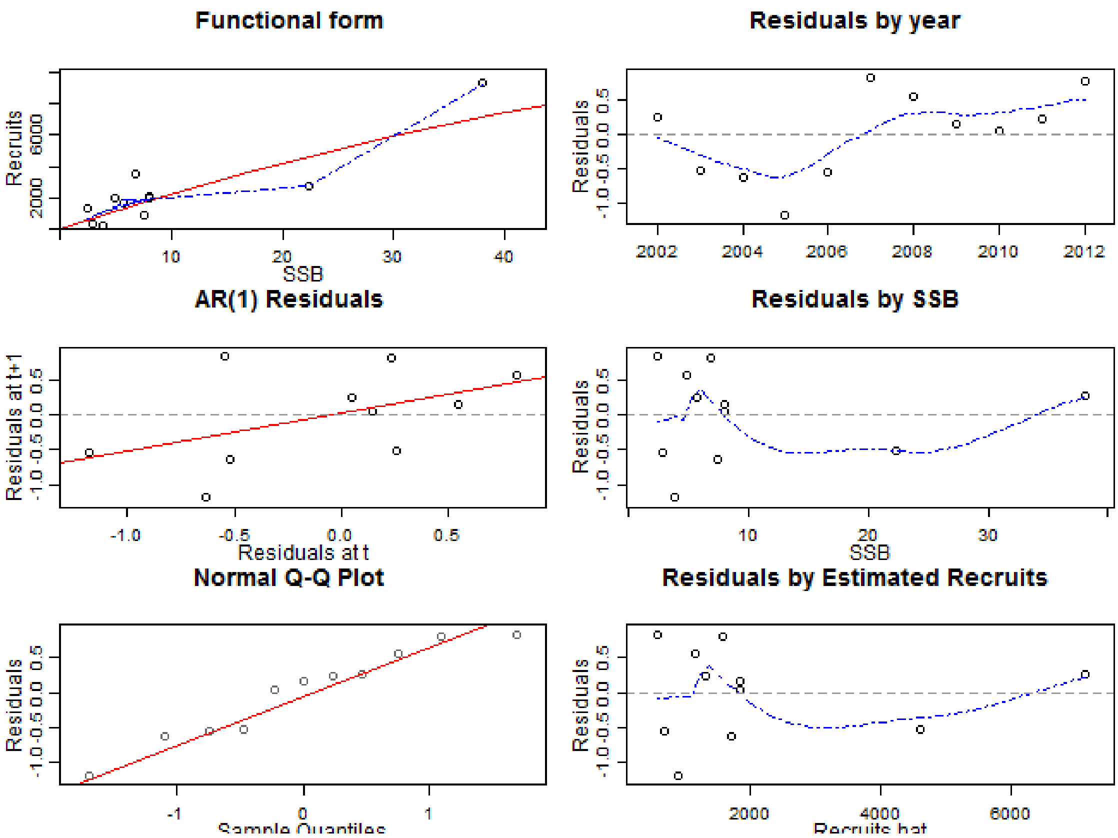

Fig.7.3.2.1.1. Beverton and Holt stock recruitment relationship for deepwater pink shrimp in GSA 05 (steepness= 0.5).

7.4. SHORT TERM PREDICTIONS FOR DEEPWATER PINK SHRIMP IN GSA 6

7.4.1. *Short term prediction 2013-2015*

A deterministic short term prediction for the period 2013 to 2015 was performed using the FLR routines provided by JRC, which takes into account the catch and landings in numbers and weight and the discards, and based on the results of the XSA stock assessments performed during EWG13-09 for the years 2001 – 2012.

7.4.1.1. Input parameters

An average of the last three years has been used for weight at age, maturity at age and F at age. Mortality at age was the same as used as input data in the XSA.

Recruitment

Recruitment (class 0) has been estimated from the population results from the geometric mean of the last three years 2010-2012 (109503 thousands individuals) estimated with FLR.

Short-term implications

A short term projection table (Table 7.4.2.1) assuming a *statu-quo* F of F_{stq}=1.402 in 2013 and a recruitment of 109503 thousand individuals shows that:

- Fishing at F_{stq} from 2013 to 2014 would produce an increase in catches of 14.46%, with a small decrease in SSB between 2014 and 2015 (1.1%).

- Fishing at $F_{0.1}$ (0.269) from 2013 to 2014 would generate a decrease of 68.35% of the catches and an increase of 60.56% in SSB.

- STECF EWG 13-09 recommends that catch in 2014 does not exceed 39.45 t, corresponding to $F_{0.1.}$=0.269.

Table 7.4.2.1. Short term forecast for different F scenarios computed for *Parapenaeus longirostris* in GSA 06. Basis: F(2013) =1.402 mean (Fbar 2-4 over 2005-2012); R(2013-2015) : GM (2010-2012) = 109 503 (thousands); F(2013)=0.269; SSB(2012)= 145 t; landings(2012)= 125 t. Weights in tons.

Rationale	**F scenario**	**F factor**	**Catch 2014**	**Catch 2015**	**SSB 2015**	**Change SSB 2014-2015 (%)**	**Change catch 2012-2014 (%)**
zero catch	0	0	0	0	302.76	84.41	-100
High long-term yield (F0.1)	0.27	0.19	39.45	66.52	263.60	60.56	-68.35
Status quo	1.40	1.00	142.67	142.72	166.16	1.21	14.46
Different scenarios	0.14	0.10	21.53	39.27	281.30	71.34	-82.73
	0.28	0.20	40.91	68.54	262.16	59.68	-67.18
	0.42	0.30	58.39	90.28	245.08	49.28	-53.16
	0.56	0.40	74.18	106.35	229.81	39.98	-40.49
	0.70	0.50	88.47	118.17	216.15	31.65	-29.02
	0.84	0.60	101.43	126.79	203.90	24.20	-18.62
	0.98	0.70	113.22	133.02	192.91	17.50	-9.17
	1.12	0.80	123.94	137.46	183.04	11.49	-0.57
	1.26	0.90	133.73	140.58	174.16	6.08	7.29
	1.54	1.10	150.87	144.13	158.94	-3.19	21.04
	1.68	1.20	158.39	145.02	152.42	-7.16	27.07
	1.82	1.30	165.31	145.53	146.52	-10.76	32.63

	1.96	1.40	171.69	145.77	141.17	-14.02	37.74
	2.00	1.50	173.30	145.80	139.84	-14.82	39.03

7.5. SHORT TERM PREDICTIONS FOR HAKE IN GSA 7

7.5.1. *Short term prediction 2013-2014*

Short term predictions were implemented in R (www.r-project.org) using the FLR routines provided by JRC and based on the results of the Extended Survivor Analyses (XSA. Darby and Flatman. 1994)

7.5.1.1. Input parameters

The following data have been used to derive the input data for the short term projection of the hake stock in GSA7:

Maturity and M vectors

PERIOD	Age	0	1	2	3	4	5	6+
2012	Prop. Matures	0	0.11	0.63	0.91	0.98	0.99	1

PERIOD	Age	0	1	2	3	4	5	6+
2012	M	0.88	0.43	0.33	0.25	0.22	0.20	0.19

F vector

PERIOD	Age	0	1	2	3	4	5	6+
2010	F	0.376	1.596	2.486	3.059	2.491	2.813	2.813
2011		0.139	1.594	2.604	2.715	1.925	2.355	2.355
2012		0.224	1.595	2.604	2.933	2.355	2.682	2.682
Mean 2010-2012		0.246	1.595	2.565	2.902	2.257	2.617	2.617

Weight-at-age in the stock

PERIOD	Age	0	1	2	3	4	5	6+
2010	Mean weight in stock (kg)	0.028	0.119	0.389	0.868	1.402	1.962	2.532
2011		0.032	0.131	0.38	0.839	1.414	1.936	2.392
2012		0.032	0.112	0.387	0.869	1.362	1.923	2.467
Mean 2010-2012		0.031	0.121	0.385	0.859	1.393	1.940	2.464

Weight-at-age in the catch

PERIOD	Age	0	1	2	3	4	5	6+
2010	Mean weight in catch (kg)	0.028	0.119	0.389	0.868	1.402	1.962	2.532
2011		0.032	0.131	0.38	0.839	1.414	1.936	2.392
2012		0.032	0.112	0.387	0.869	1.362	1.923	2.467
Mean 2010-2012		0.031	0.121	0.385	0.859	1.393	1.940	2.464

Number at age in the catch

PERIOD	Age	0	1	2	3	4	5	6+
2010	Catch at age in numbers (thousands)	6884	9825	2145	186	15	1	1
2011		2471	6242	1583	136	6	1	0
2012		2540	6847	1007	90	7	1	0

Number at age in the stock

PERIOD	Age	0	1	2	3	4	5	6+
2010	Stock numbers at age (thousands)	6884	9825	2145	186	15	1	1
2011		2471	6242	1583	136	6	1	0
2012		2540	6847	1007	90	7	1	0

Recruitment

Recruitment (class 0) has been estimated from the population results from the geometric mean of the last three years 2010-2012 (27757 thousands individuals) estimated with FLR.

Short-term implications

A short term projection table (Table 7.5.1.1.1). assuming a statu-quo F of F_{stq}= 1.83 in 2013 and a recruitment of 27757 thousands individuals shows that:

- Fishing at F_{stq} from 2012 to 2014 would produce a decrease in catches of 10.74% and an increase in SSB of 12.49% between 2014 and 2015.

- Fishing at F_{01} (0.11) from 2012 to 2014 would generate a decrease of 89.82% of the catches and an increase in SSB of 385.31% between 2014 and 2015.

- STECF EWG 13-09 recommends that catch in 2014 does not exceed 135.05 t. corresponding to F_{01}=0.11.

Outlook until 2014

Table 7.5.1.1.1. Short term forecast for different F scenarios computed for *Merluccius merluccius* in GSA 7. Basis: F(2013) =1.83; R(2013-2015): 27757 (thousands); SSB(2012)= 543 t; Catch (2012)= 1123 t.

Rationale	F scenario	F factor	Catch 2014	Catch 2015	SSB 2015	Change SSB 2014-2015 (%)	Change catch 2012-2014 (%)
zero catch	0.00	0.00	0.00	0.00	2103.95	438.57	-100.00
High long-term yield (F0.1)	0.06	0.11	135.05	418.07	1895.91	385.31	-89.82
Status quo	1.00	1.83	1184.63	1257.80	439.46	12.49	-10.74
Different scenarios	0.10	0.18	220.86	640.07	1765.12	351.83	-83.36
	0.20	0.37	406.46	1010.72	1486.64	280.55	-69.37
	0.30	0.55	563.25	1215.13	1257.11	221.79	-57.56
	0.40	0.73	696.38	1317.83	1067.40	173.23	-47.53
	0.50	0.91	810.04	1359.16	910.17	132.98	-38.97
	0.60	1.10	907.59	1364.30	779.51	99.54	-31.62
	0.70	1.28	991.79	1348.86	670.64	71.67	-25.27
	0.80	1.46	1064.86	1322.46	579.67	48.38	-19.77
	0.90	1.64	1128.64	1290.94	503.47	28.88	-14.96
	1.00	1.83	1184.63	1257.80	439.46	12.49	-10.74
	1.10	2.01	1234.04	1225.05	385.56	-1.31	-7.02

	1.20	2.19	1277.91	1193.78	340.04	-12.96	-3.71
	1.30	2.37	1317.07	1164.53	301.50	-22.82	-0.76
	1.40	2.56	1352.23	1137.51	268.77	-31.20	1.89
	1.50	2.74	1383.96	1112.72	240.91	-38.33	4.28
	1.60	2.92	1412.76	1090.06	217.11	-44.42	6.45
	1.70	3.10	1439.02	1069.37	196.73	-49.64	8.43
	1.80	3.29	1463.10	1050.48	179.22	-54.12	10.24
	1.90	3.47	1485.28	1033.19	164.12	-57.99	11.91
	2.00	3.65	1505.80	1017.34	151.06	-61.33	13.46

7.5.2. *Medium term prediction*

7.5.2.1. Method and justification

Because no reliably stock-recruitment relationship could be fitted to the dataset (Fig. 7.5.2.1.1). no medium term predictions were made.

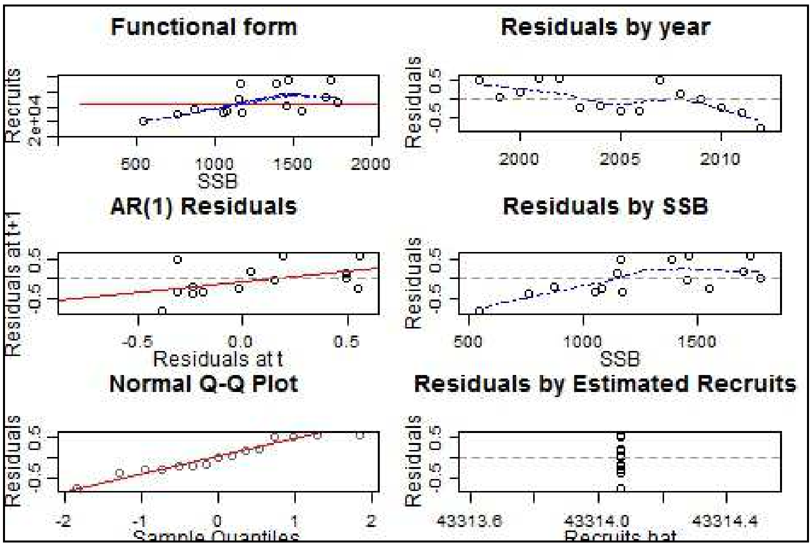

Figure 7.5.2.1.1: Scatter plot of the SSB/Recruitment and fit of an Hockey stick relationship.

7.6. SHORT TERM PREDICTIONS FOR GIANT RED SHRIMP IN GSA 9

7.6.1. *Short term prediction 2014-2015*

Short term predictions for 2013 and 2015 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of XSA carried out on 2006-2012 of catch data collected under DCF.

7.6.1.1. Input parameters

The following data have been used to derive the input data for the short term projection of the giant red shrimp stock in GSA9:

Maturity and M vectors

PERIOD	Age	0	1	2	3	4	5+
2012	Prop. Matures	0.0	0.6	1.0	1.0	1.0	1.0

PERIOD	Age	0	1	2	3	4	5+
2012	M	1.28	0.58	0.44	0.38	0.34	0.32

F vector

PERIOD	Age	0	1	2	3	4	5+
2010	F	0.004	0.224	0.761	0.974	0.137	0.137
2011		0.002	0.194	1.022	1.242	0.696	0.696
2012		0.002	0.294	0.780	0.784	0.694	0.694
Mean 2010-2012		0.003	0.237	0.854	1.000	0.509	0.509

Weight-at-age in the stock

PERIOD	Age	0	1	2	3	4	5+
2010	Mean weight in stock (kg)	0.006	0.012	0.030	0.048	0.060	0.085
2011		0.004	0.015	0.032	0.051	0.065	0.090
2012		0.007	0.013	0.027	0.040	0.054	0.090
Mean (2010-2012)		0.006	0.013	0.030	0.046	0.060	0.088

Weight-at-age in the catch

PERIOD	Age	0	1	2	3	4	5+
2010	Mean weight in catch (kg)	0.006	0.012	0.030	0.048	0.060	0.085
2011		0.004	0.015	0.032	0.051	0.065	0.090
2012		0.007	0.013	0.027	0.040	0.054	0.090
Mean (2010-2012)		0.006	0.013	0.030	0.046	0.060	0.088

Number at age in the catch

PERIOD	Age	0	1	2	3	4	5+
2010	Catch at age in numbers (thousands)	47	848	664	132	7	1
2011		14	761	1298	275	28	3
2012		11	618	1154	263	39	4

Number at age in the stock

PERIOD	Age	0	1	2	3	4	5+
2010	Stock numbers at age (thousands)	20801	5645	1553	256	65	9
2011		11690	5759	2526	468	66	7
2012		9841	3243	2655	585	92	9

Recruitment

Recruitment (class 0) has been estimated from the population results from the geometric mean of the last three years 2010-2012 (13 millions individuals) estimated with FLR.

Short-term implications

A short term projection (Table 7.6.1.1), assuming an F_{stq} of 0.692 and a recruitment of about 13 millions individuals, shows that:

- Fishing at the F_{stq} from 2014 to 2015 generates a slightly increase of about 4% in SSB and from 2012 to 2014 a decrease of about 22 %.in catch

- Fishing at $F_{0.1}$ for the same time frame gives an increase of about 25% in the spawning stock biomass and a decrease of about 52% in catches

- The analysis shows that in order to reach $F_{0.1}$, a decrease of F_{stq} by 50% is needed.

- SGMED recommends that fishing mortality in 2014 should not exceed $F_{0.1}$=0.365, corresponding to catches of about 25 t.

Outlook until 2015

Table 7.6.1.1 Short term forecast in different F scenarios computed for giant red shrimp in GSA 9.

Basis: Fstq =GM(2010-1012)=0.692 ; R (2012) = GM (2010–2012) = 14.1 (millions); SSB (2014) = 92 t; Catch (2012) = 52t, Fbar(2012)=0.692

Rationale	F scenario	F factor	Catch 2014 (t)	Catch 2015 (t)	SSB 2015 (t)	Change SSB 2014 -2015 (%)	Change Catch 2012 -2014(%)
Zero catch	0.000	0	0	0	145.91	59.00	-100.00
High long term yield ($F_{0.1}$)	0.365	0.53	24.88	31.96	115.11	25.44	-52.39
Status quo	0.692	1	40.92	42.80	95.54	4.11	-21.69
Different scenarios	0.069	0.1	5.41	8.60	139.18	51.66	-89.65
	0.138	0.2	10.46	15.80	132.90	44.82	-79.97
	0.208	0.3	15.19	21.80	127.05	38.44	-70.93
	0.277	0.4	19.62	26.80	121.59	32.49	-62.46
	0.346	0.5	23.76	30.94	116.49	26.93	-54.53
	0.415	0.6	27.64	34.35	111.72	21.74	-47.10
	0.484	0.7	31.28	37.16	107.26	16.88	-40.13
	0.554	0.8	34.70	39.45	103.10	12.34	-33.60
	0.623	0.9	37.91	41.31	99.19	8.09	-27.46

	0.761	1.1	43.76	43.98	92.11	0.37	-16.27
	0.830	1.2	46.42	44.91	88.90	-3.13	-11.16
	0.900	1.3	48.93	45.63	85.89	-6.41	-6.35
	0.969	1.4	51.30	46.16	83.06	-9.49	-1.82
	1.038	1.5	53.54	46.55	80.40	-12.39	2.45
	1.107	1.6	55.64	46.81	77.90	-15.12	6.48
	1.176	1.7	57.63	46.98	75.54	-17.68	10.29
	1.246	1.8	59.52	47.06	73.33	-20.10	13.90
	1.315	1.9	61.30	47.07	71.24	-22.37	17.30
	1.384	2	62.98	47.03	69.27	-24.52	20.53

7.6.2. *Medium term prediction*

7.6.2.1. Method and justification

Since a not acceptable stock recruitment relationships was obtained the Medium term forecast were not computed.

7.7. SHORT TERM PREDICTIONS FOR HAKE IN GSA 10

7.7.1. *Short term prediction 2014-2015*

7.7.1.1. Method and justification

Short term prediction for 2014 and 2015 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed using XSA (Darby and Flatman, 1994) that was conducted in the framework of the EWG 13-09.

7.7.1.2. Input parameters

A short term projection for 2013 to 2015 was performed using the R-routine and was and based on the results of the XSA, assuming an F_{stq} of 0.96 and a recruitment of 45425 thousands (geometric mean of the last 3 years). An average of the last three years has been used for weight at age, maturity at age and F at age. No clear stock recruitment relationship is evident (Fig 7.7.1) thus no medium term forecast were conducted.

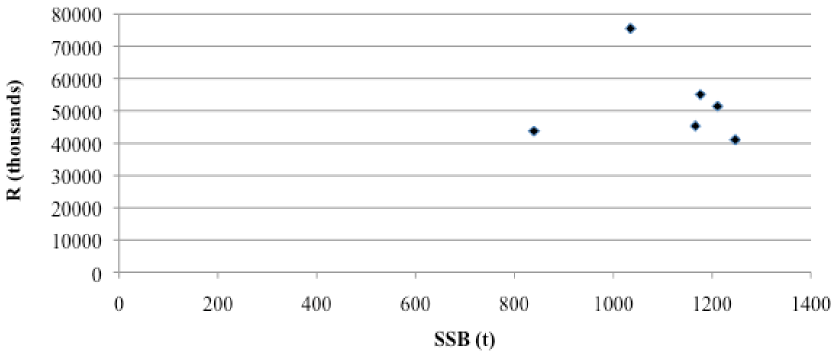

Figure 7.7.1. Stock recruitment relationship for hake in GSA 10 coming from XSA estimates.

7.7.1.3. Results

A short term projection (Table 7.7.1), assuming an F_{stq} of 0.96 in 2013 and a recruitment of 45425 (thousands) individuals, shows that:

- Fishing at the F_{stq} (0.962) from 2012 to 2014 generates a decrease of the catch for 11.03 % and a decrease of the spawning stock biomass of 8.62% from 2014 to 2015.
- Fishing at $F_{0.1}$ (0.145) from 2012 to 2014 generates a decrease of the catch of 77.82 % and a spawning stock biomass increase of 169.57 % from 2014 to 2015.
- A 30% reduction of the F_{stq} (F=0.673) generates a decrease of catch for 27.2% in 2014 and an increase of spawning stock biomass of about 28.2% from 2014 to 2015, indicating that this level of reduction could generate a slight decrease of catches but a significant increase of the spawning stock biomass.
- EWG 13-09 recommends that fishing mortality in 2014 should not exceed $F_{0.1}$= 0.145, corresponding to catches of 272 tons.

Outlook for 2014-2015

Table 7.7.1. Short term forecast in different F scenarios computed for hake in GSA 10.

	Fbar	Ffactor	Catch_2014	Catch_2015	SSB_2015	Change_SSB 2014-2015(%)	Change_Catch 2012-2014(%)
Zero catch	0	0.0	0.000	0.000	2583.271	240.122	-100.000
High long-term yield ($F_{0.1}$)	0.145	0.2	272.059	572.943	2047.438	169.572	-77.816
Status quo	0.962	1.0	1091.052	1069.210	694.042	-8.620	-11.033
Different scenarios	0.096	0.1	187.284	416.137	2211.083	191.119	-84.728
	0.192	0.2	348.570	697.320	1902.623	150.506	-71.577
	0.289	0.3	488.206	882.018	1646.102	116.731	-60.191
	0.385	0.4	609.751	998.154	1431.990	88.541	-50.280
	0.481	0.5	716.123	1065.947	1252.573	64.918	-41.606
	0.577	0.6	809.721	1100.002	1101.601	45.040	-33.974
	0.673	0.7	892.518	1110.835	974.007	28.241	-27.222
	0.770	0.8	966.145	1105.986	865.676	13.978	-21.219
	0.866	0.9	1031.950	1090.839	773.262	1.810	-15.853
	1.058	1.1	1144.385	1043.787	625.793	-17.606	-6.684
	1.154	1.2	1192.727	1016.441	566.701	-25.386	-2.743
	1.251	1.3	1236.730	988.460	515.278	-32.157	0.846
	1.347	1.4	1276.944	960.710	470.307	-38.078	4.125
	1.443	1.5	1313.833	933.760	430.782	-43.282	7.133
	1.539	1.6	1347.789	907.970	395.878	-47.877	9.902
	1.635	1.7	1379.147	883.548	364.911	-51.955	12.459
	1.732	1.8	1408.194	860.601	337.312	-55.588	14.827
	1.828	1.9	1435.176	839.168	312.610	-58.841	17.027
	1.924	2.0	1460.303	819.236	290.411	-61.764	19.076

7.8. SHORT TERM PREDICTIONS FOR DEEPWATER PINK SHRIMP IN GSA 10

7.8.1. *Short term prediction 2013-2014*

Short term prediction for 2013 and 2014 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed with XSA method conducted in the framework of the EWG 13-09.

7.8.1.1. Input parameters

The following data have been used to derive the input data for the short term projection of deepwater pink shrimp in the GSA 10.

Maturity and M vectors

PERIOD	Age	0	1	2	3+
2006-2012	Prop. Matures	0.47	0.98	1	1

PERIOD	Age	0	1	2	Mean 0-2
2006-2012	M	1.41	0.81	0.70	0.97

F vector

F	0	1	2	3+
2006	1.11	3.06	2.84	2.838
2007	0.873	2.98	2.28	2.278
2008	0.469	2.77	1.5	1.495
2009	0.444	2.45	1.21	1.212
2010	0.491	2.59	0.73	0.73
2011	0.532	3.15	1.02	1.016
2012	0.221	2.46	1.04	1.041

F at age and number at age in the stock as estimated from XSA in 2012 have been used.

Several scenarios with different harvest strategy were run, with F_{stq} (F_{bar} ages 0-2)set equal to the F_{bar} of the last year (2012).

These short term predictions were done without taking into account the change in the mesh as adopted by Council Regulation (EC) No 1967/2006 of 21 December 2006.

Weight-at-age in the stock

Weight at age (kg)	**age 0**	**age 1**	**Age 2**	**age 3+**
2006	0.006	0.01	0.02	0.026

2007	0.004	0.011	0.021	0.026
2008	0.005	0.01	0.021	0.026
2009	0.005	0.01	0.02	0.027
2010	0.005	0.01	0.021	0.0275
2011	0.005	0.01	0.021	0.026
2012	0.0045	0.01	0.02	0.0275

Weight-at-age in the catch

Weight at age (kg)	**age 0**	**age 1**	**Age 2**	**age 3+**
2006	0.006	0.01	0.02	0.026
2007	0.004	0.011	0.021	0.026
2008	0.005	0.01	0.021	0.026
2009	0.005	0.01	0.02	0.027
2010	0.005	0.01	0.021	0.0275
2011	0.005	0.01	0.021	0.026
2012	0.0045	0.01	0.02	0.0275

Number at age in the catch

Catch in numbers (thousands)	**age 0**	**age 1**	**age 2**	**age 3+**
2006	103439	53653	1555	0
2007	92569	15893	1116	5
2008	42453	20518	312	0
2009	34289	21334	453	0
2010	36007	18714	491	3
2011	49392	17906	456	0
2012	54559	21207	243	34

Number at age in the stock

Stock numbers (thousands)	2006	2007	2008	2009	2010	2011	2012
0	312192	321786	229317	193669	187739	242302	557622

1	84409	25110	32823	35010	30340	28044	34751
2	2344	1765	570	916	1345	1015	533
3+	0	7	0	1	9	0	69
TOTAL	398945	348668	262710	229596	219433	271361	592975

Stock recruitment

The recruitment used for the short term projection was estimated as the geometric mean from 2010-2012 (293821 thousands).

Short-term implications

A short term projection (Table 7.8.1.1.1), assuming an F_{stq} of 1.24 in 2013 and a recruitment of 293,821 (thousands) individuals, shows that:

- Fishing at the F_{stq} (1.24) generates an increase of the catch of 30 % from 2012 to 2014 and a decrease of the spawning stock biomass of 2% from 2014 to 2015.

- Fishing at $F_{0.1}$ (0.93) generates an increase of the catch of 11 % from 2012 to 2014 and an increase of the spawning stock biomass of 4 % from 2014 to 2015.

- A 30% reduction of the F_{stq} (F=0.87) generates an increase of catch of 7.55 % from 2012 to 2014 and an increase of spawning stock biomass of about 5.43 % from 2015 to 2014, indicating that this level of reduction could generate an increase of catches and of the spawning stock biomass.

EWG recommends that fishing mortality in 2014 should not exceed $F_{0.1}$ = 0.93, corresponding to catches of 518 t.

Outlook until 2014

Table 7.8.1.1.1 Short term forecast in different F scenarios computed for pink shrimp in GSA 10.
Basis: F (2013) = F (2012) = 1.24; R (2013) = GM (2010–2012) = 293,821 (thousands); SSB (2014) = 1275; Catch (2013) = 949 t. Weights in tons.

Rationale	F factor	F scenario	Catch 2014	Catch 2015	SSB 2015	Change SSB 2014-2015 (%)	Change Catch 2012-2014 (%)
zero catch	0	0.00	0	0	1896	48.75	-100.00
High long-term yield ($F_{0.1}$)	0.75	0.93	518	547	1326	4.00	11.81
Status quo	1	1.24	605	592	1250	-1.95	30.48
Different scenarios	0.1	0.12	109	155	1763	38.31	-76.38
	0.2	0.25	201	269	1655	29.86	-56.52
	0.3	0.37	280	355	1568	22.97	-39.67
	0.4	0.50	346	419	1495	17.32	-25.26
	0.5	0.62	404	468	1436	12.64	-12.82

	0.6	0.75	454	506	1386	8.73	-1.98
	0.7	0.87	498	535	1344	5.43	7.56
	0.8	0.99	538	558	1308	2.61	16.03
	0.9	1.12	573	577	1277	0.18	23.62
	1.1	1.37	634	605	1226	-3.82	36.74
	1.2	1.49	660	616	1205	-5.50	42.48
	1.3	1.61	685	625	1185	-7.01	47.80
	1.4	1.74	708	634	1168	-8.39	52.75
	1.5	1.86	729	641	1152	-9.66	57.40
	1.6	1.99	750	647	1137	-10.84	61.77
	1.7	2.11	769	653	1122	-11.94	65.91
	1.8	2.24	787	659	1109	-12.98	69.84
	1.9	2.36	804	664	1097	-13.96	73.59
	2	2.48	821	669	1085	-14.90	77.18

7.8.2.*Medium term prediction*

7.8.2.1. Method and justification

No medium term forecast has been performed, because of lacking of a reliable stock-recruitment relationship.

7.9. SHORT AND MEDIUM TERM PREDICTIONS FOR HAKE IN GSA 11

7.9.1. *Short term prediction 2012-2014*

7.9.1.1. No short term predictions were performed as the assessment of hake in GSA 11 was not accepted due to data deficiency.

7.10. SHORT TERM PREDICTIONS FOR NORWAY LOBSTER IN GSA 15 AND 16

7.10.1. *Short term prediction 2012-2014*

Short term predictions for 2014 and 2015 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of a4a statistical catch at age (SCA) carried out on 2002-2012 catch data for Norway lobster in GSA 15 and 16.

7.10.1.1. Input parameters

The analyses was based on the natural mortality, maturity at age data, stock numbers, catch numbers, catch and stock weight, used to run the SCA assessment. The F_{stq} adopted (Fstq = 0.24).was the geometric average of the $F_{2\text{-}7}$ calculated for 2010-2012. For the other parameters an average of the last 3 years was used.

7.10.1.2. Results

A short term projection (Table 1.1.1.2.1), assuming an F_{stq} of 0.24 and a recruitment at age 1 of 74.500 individuals, shows that:

- Fishing at the F_{stq} from 2013 to 2014 generates an minor decreases of 2.1 % in SSB in 2015 and an increase of catch of about 92.6 % in 2012 to 2014.

- Fishing at $F_{0.1}$ (0.21) for the same time frame gives an increase of about 1.5% in the spawning stock biomass and an increases of about 68.9% in catches from 2012 to 2014

- EWG 13-09 recommends that fishing mortality in 2014 should not exceed $F_{0.1}$ = 0.21, corresponding to catches of about 757 t.

Outlook until 2015

Table 1.1.1.2.1. Short term forecast in different F scenarios computed for Norway lobster in GSAs 15-16. Basis: F_{stq} = mean($F_{bar1\text{-}7}$ 2010-2012) = 0.24; R (2014) = GM (2002-2012) = 74500 (thousands); SSB (2012) =1892 t; landings (2012)= 444.6 t.

Ffactor	Fbar	Catch 2012	Catch 2013	Catch 2014	Catch 2015	SSB 2014	SSB 2015	Change SSB 2014-2015(%)	Change Catch 2012-2014(%)
0	0.00	448.4	992.1	0.0	0.0	3177.6	4041.2	27.2	-100.0
0.1	0.02	448.4	992.1	97.3	106.0	3177.6	3935.5	23.8	-78.3
0.2	0.05	448.4	992.1	191.9	204.5	3177.6	3832.7	20.6	-57.2
0.3	0.07	448.4	992.1	284.0	295.8	3177.6	3733.0	17.5	-36.7
0.4	0.10	448.4	992.1	373.6	380.4	3177.6	3636.0	14.4	-16.7
0.5	0.12	448.4	992.1	460.9	458.7	3177.6	3541.9	11.5	2.8
0.6	0.14	448.4	992.1	545.8	531.1	3177.6	3450.5	8.6	21.7
0.7	0.17	448.4	992.1	628.5	598.0	3177.6	3361.7	5.8	40.2
0.8	0.19	448.4	992.1	709.0	659.6	3177.6	3275.4	3.1	58.1
0.9	0.22	448.4	992.1	787.3	716.3	3177.6	3191.6	0.4	75.6
1	0.24	448.4	992.1	863.6	768.5	3177.6	3110.2	-2.1	92.6
1.1	0.27	448.4	992.1	937.9	816.3	3177.6	3031.1	-4.6	109.2
1.2	0.29	448.4	992.1	1010.2	860.1	3177.6	2954.2	-7.0	125.3
1.3	0.31	448.4	992.1	1080.6	900.1	3177.6	2879.5	-9.4	141.0
1.4	0.34	448.4	992.1	1149.2	936.5	3177.6	2807.0	-11.7	156.3
1.5	0.36	448.4	992.1	1216.0	969.6	3177.6	2736.5	-13.9	171.2
1.6	0.39	448.4	992.1	1281.1	999.6	3177.6	2667.9	-16.0	185.7
1.7	0.41	448.4	992.1	1344.5	1026.7	3177.6	2601.4	-18.1	199.8

	1.8	0.43	448.4	992.1	1406.2	1051.0	3177.6	2536.7	-20.2	213.6
	1.9	0.46	448.4	992.1	1466.4	1072.8	3177.6	2473.8	-22.2	227.0
	2	0.48	448.4	992.1	1525.0	1092.2	3177.6	2412.6	-24.1	240.1
F_{01}	0.86	0.21	448.4	992.1	757.1	694.9	3177.6	3223.8	1.5	68.9

7.11. SHORT TERM PREDICTIONS FOR BLUE AND RED SHRIMP IN GSA 15 AND 16

7.11.1. *Short term prediction 2014-2015*

7.11.1.1. Input parameters

Short term predictions for 2014 and 2015 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of VIT Analysis carried out on 2009-2012 blue and red shrimp catch data collected under DCF.

7.11.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the blue and red shrimp stock in GSA 15-16:

Maturity at Age

Age	1	2	3	4	5	6	7+
F	0.34	0.93	0.99	1	1	1	1
M	0.8	1	1	1	1	1	1

Mortality at Age

Age	1	2	3	4	5	6	7+
F	0.54	0.38	0.31	0.27	0.25	0.23	0.22
M	0.50	0.35	0.29	0.25	0.23	0.22	0.21

F vector

F	1	2	3	4	5	6	7
2009	0.02	0.37	1.27	1.51	1.79	2.43	0.30
2010	0.02	0.24	0.84	1.64	2.03	1.14	0.30
2011	0.05	0.27	1.11	0.86	1.75	1.46	0.30
2012	0.01	0.35	0.85	1.62	2.03	1.41	0.30
Mean 09-12 scaled to 2012	0.03	0.31	1.02	1.41	1.90	1.61	0.30

Weight at Age in the Catch / Stock

Age	1	2	3	4	5	6	7
Weight (g)	6.19	15.09	22.61	29.37	37.02	48.68	65.95

Catch at Age

Age	1	2	3	4	5	6	7
2012	46904	1768080	1707208	783918	130595	11167	454

Numbers at Age in the Stock

Age	1	2	3	4	5	6	7
2012	10556079	7039818	3398905	1075111	163014	16715	787

Stock recruitment

For the short term projection a recruitment of 6898 thousand individuals was computed based on the geometric mean of recruitment estimated by the VIT assessment for the last four years (2009-2012).

Short-term implications

A short term projection, assuming an F_{stq} of 0.94 and a recruitment of 6898 thousand individuals, shows that:

- Fishing at the F_{stq} (0.94) from 2014 to 2015 generates a decrease of 15 % in SSB and a decrease in the relative catch of 16 % in 2012 to 2014;

- Fishing at $F_{0.1}$ (0.26) gives an increase of about 14% in the spawning stock biomass and a decrease of about 68% in catches from 2012 to 2014;

- The analysis shows that in order to reach $F_{0.1}$, a decrease of F_{stq} by 30% is needed;

- STECF EWG 13-09 recommends that fishing mortality in 2014 should not exceed $F_{0.1}$ = 0.26, corresponding to catches of about 30 t.

Outlook until 2015

Table 7.11.1 – Short term forecast in different F scenarios computed for blue and red shrimp in GSA 15 and 16. Basis: F_{stq} =0.94 (F_{bar} 1-7, mean of 2009-2012 rescaled to 2012); R (2012) = GM (2009–2012) = 6.9 (millions); SSB (2014) = 188.16 t; Catch (2013) = 92t, F_{bar}(2012)=0.94.

Rationale	F scenario	F factor	Catch 2014 (t)	Catch 2015 (t)	SSB 2015 (t)	Change SSB 2014 -2015 (%)	Change Catch 2012 -2014 (%)
Zero catch	0.00	0.0	0.00	0.00	249	32	-100
High long term yield ($F_{0.1}$)	0.26	0.3	30.08	39.31	215	14	-68
Status quo	0.94	1.0	79.06	62.93	160	-15	-16
Different scenarios	0.09	0.1	11.88	18.18	235	25	-87
	0.19	0.2	22.59	31.55	223	19	-76
	0.28	0.3	32.25	41.33	212	13	-66
	0.38	0.4	40.99	48.43	203	8	-56
	0.47	0.5	48.91	53.52	194	3	-48
	0.56	0.6	56.10	57.12	186	-1	-40
	0.66	0.7	62.65	59.60	179	-5	-33
	0.75	0.8	68.62	61.27	172	-9	-27
	0.85	0.9	74.07	62.32	166	-12	-21
	1.03	1.1	83.64	63.21	155	-17	-11
	1.13	1.2	87.85	63.25	151	-20	-7
	1.22	1.3	91.73	63.13	147	-22	-2
	1.32	1.4	95.32	62.89	143	-24	1
	1.41	1.5	98.63	62.57	139	-26	5
	1.50	1.6	101.70	62.20	136	-28	8
	1.60	1.7	104.56	61.80	133	-29	11
	1.69	1.8	107.21	61.39	130	-31	14
	1.79	1.9	109.69	60.97	127	-32	17
	1.88	2.0	112.01	60.56	125	-34	19

7.11.2. *Medium term prediction*

7.11.2.1. Method and justification

No medium term forecast could be calculated by STECF EWG 13-09 due to the short time series of the available stock recruitment relationship.

7.12. SHORT TERM FORECAST FOR COMMON SOLE IN GSA 17

7.12.1. *Short term predictions 2014-2015*

7.12.1.1. Method and justification

Short term prediction for 2014 and 2015 was implemented in R (www.r-project.org) using the FLR libraries, based on the results of the stock assessment performed using XSA and SCAA that were conducted in the framework of the STECF EWG 13-09.

7.12.1.2. Input parameters

A short term projection for 2013 to 2015 was performed using the R-routine based on the results of the XSA and SCAA assessments, assuming respectively an F_{stq} of 1.20 and 0.94, with a recruitment of respectively 31800 and 40015 thousands (geometric mean of the last 3 years). For weight at age, maturity at age an F at age a 3 years average was used.

7.12.1.3. Results

The short term projection for the XSA results (Table 7.15.1.1), shows that:

- Fishing at the F_{stq} (1.20) from 2012 to 2014 would generate a decrease of the catches by 3%, while the spawning stock biomass would decrease by about 6% between 2014-2015.

- Fishing at $F_{0.1}$ (0.19) from 2012 to 2013 would generates a decrease of the catches by 80% in 2014 and a spawning stock biomass would increase by 140 % from 2012 to 2013.

The short term projection for the SCAA results (Table 7.15.1.2), shows that:

- Fishing at the F_{stq} (0.94) from 2012 to 2014 would generate an increase of the catches by 39%, while the spawning stock biomass would decrease by about 3% between 2014-2015.

- Fishing at $F_{0.1}$ (0.31) from 2012 to 2013 would generates a decrease of the catches by 38% in 2014 and a spawning stock biomass would increase by 66 % from 2012 to 2013.

As explained in paragraph 6.12.7, the SCAA estimation of SSB is more accurate, thus STECF EWG 11-20 recommends that catch in 2014 should not exceed 1179 tons, corresponding to $F_{0.1}$ = 0.31 estimated by SCAA outputs. Nevertheless both short term results are presented.

Outlook until 2015 – XSA results

Table 7.12.1.1 Short term forecast for different F scenarios computed for sole in GSA 17.

Basis: F(2013) = mean (Fbar 0-4, 2010-2012); R(2011) = GM (2010-2012) = 31,800 (thousands); F (2012) = 1.16; SSB (2012) = 445 t; Catches (2012)= 1887.

Rationale	F scenario	F factor	Catch 2014	Catch 2015	SSB 2015	Change SSB 2014-2015 (%)	Change Catch 2012-2014 (%)
zero catch	0	0	0	0	1797.22	196.20	-100.00
High long-term yield ($F_{0.1}$)	0.19	0.14	379.89	686.93	1356.27	147.36	-79.87
Status quo	1.20	1.00	1828.15	1811.18	280.01	-6.67	-3.12
Different scenarios	0.14	0.10	273.06	513.66	1473.47	160.79	-85.53
	0.27	0.20	519.30	890.89	1211.32	130.19	-72.48
	0.41	0.30	741.85	1167.44	998.55	103.70	-60.69
	0.55	0.40	943.46	1369.52	825.47	80.73	-50.00
	0.68	0.50	1126.51	1516.42	684.32	60.77	-40.30
	0.82	0.60	1293.10	1622.38	568.96	43.40	-31.47
	0.96	0.70	1445.05	1697.94	474.42	28.26	-23.42
	1.09	0.80	1583.96	1750.95	396.76	15.04	-16.06
	1.23	0.90	1711.25	1787.24	332.81	3.47	-9.31
	1.50	1.10	1935.76	1826.02	236.30	-15.58	2.59
	1.64	1.20	2035.02	1834.22	200.02	-23.41	7.85
	1.77	1.30	2126.80	1837.60	169.83	-30.32	12.71
	1.91	1.40	2211.84	1837.55	144.64	-36.42	17.22
	2.05	1.50	2290.81	1835.10	123.55	-41.82	21.40
	2.18	1.60	2364.30	1831.01	105.86	-46.61	25.30
	2.32	1.70	2432.83	1825.87	90.97	-50.86	28.93
	2.46	1.80	2496.87	1820.11	78.41	-54.65	32.32
	2.59	1.90	2556.82	1814.03	67.77	-58.03	35.50
	2.73	2.00	2613.07	1807.88	58.75	-61.05	38.48

Outlook until 2015 – SCAA results

Table 7.15.1.2 Short term forecast for different F scenarios computed for sole in GSA 17.

Basis: F(2013) = mean (F_{bar} 0-4, 2010-2012); R(2011) = GM (2010-2012) = 40,015 (thousands); F (2012) = 0.94; SSB (2012) = 1900 t; Catches (2012)= 1887.

Rationale	F scenario	F factor	Catch 2014	Catch 2015	SSB 2015	Change SSB 2014-2015 (%)	Change Catch 2012-2014 (%)
zero catch	0	0	0	0	3780.39	128.45	-100.00
High long-term yield ($F_{0.1}$)	0.31	0.33	1179.69	1477.05	2753.22	66.37	-37.44

Status quo	0.94	1.00	2619.35	2614.05	1605.72	-2.97	38.90
Different scenarios	0.09	0.10	406.52	561.55	3420.57	106.70	-78.44
	0.19	0.20	769.36	1016.39	3104.28	87.59	-59.20
	0.28	0.30	1093.86	1385.48	2826.00	70.77	-41.99
	0.37	0.40	1384.71	1685.41	2580.90	55.96	-26.57
	0.47	0.50	1645.99	1929.40	2364.77	42.90	-12.71
	0.56	0.60	1881.27	2127.96	2173.95	31.37	-0.24
	0.65	0.70	2093.68	2289.55	2005.25	21.18	11.03
	0.75	0.80	2285.95	2420.95	1855.88	12.15	21.22
	0.84	0.90	2460.48	2527.64	1723.41	4.14	30.48
	1.02	1.10	2764.41	2683.79	1500.96	-9.30	46.60
	1.12	1.20	2897.26	2739.80	1407.53	-14.94	53.64
	1.21	1.30	3019.30	2784.47	1324.01	-19.99	60.11
	1.30	1.40	3131.77	2819.78	1249.18	-24.51	66.08
	1.40	1.50	3235.74	2847.34	1181.97	-28.57	71.59
	1.49	1.60	3332.18	2868.48	1121.44	-32.23	76.71
	1.58	1.70	3421.90	2884.31	1066.79	-35.53	81.46
	1.68	1.80	3505.64	2895.74	1017.30	-38.53	85.90
	1.77	1.90	3584.04	2903.52	972.34	-41.24	90.06
	1.86	2.00	3657.67	2908.28	931.38	-43.72	93.97

7.12.2.*Medium term prediction*

7.12.2.1.Method and justification

No medium term forecast has been performed, because of lacking of a reliable stock-recruitment relationship (Fig. 7.12.1.1.1).

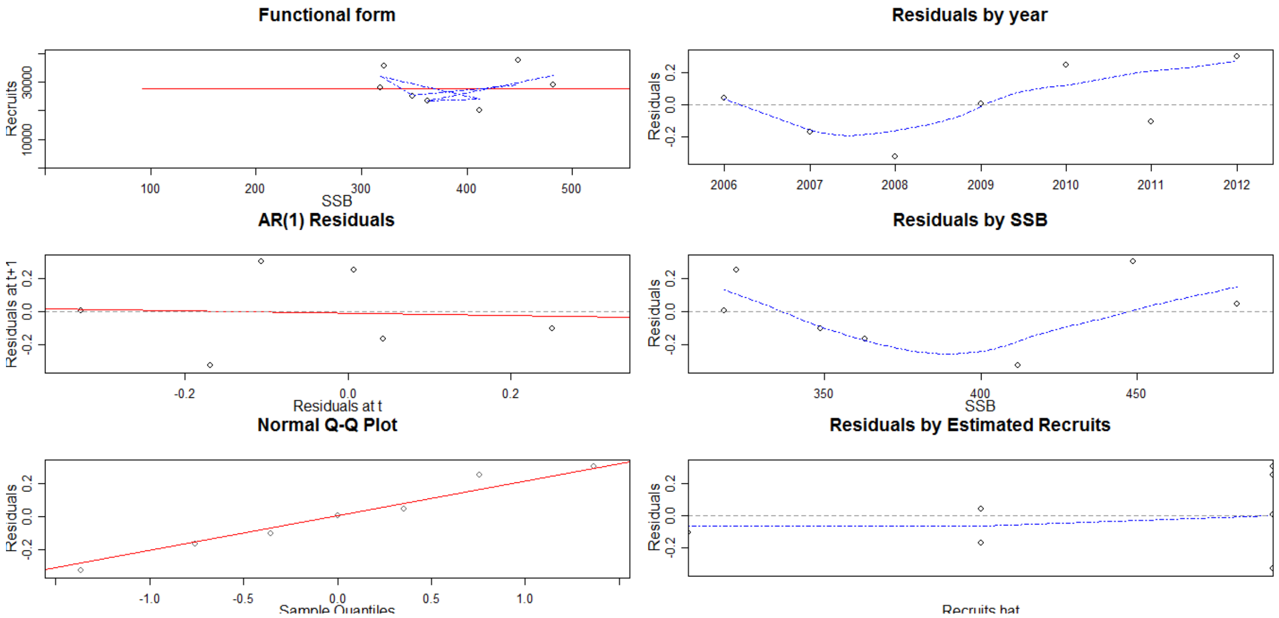

Fig. 7.12.1.1.1. Stock recruitment relationship for common sole in GSA 17.

7.13. SHORT TERM PREDICTIONS FOR HAKE IN GSA 18

7.13.1. *Short term prediction 2013-2014*

7.13.1.1. Method and justification

Short term prediction for 2013 -2014 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed using XSA method conducted in the framework of the EWG 13-09.

7.13.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of hake in the GSA 18.

Maturity and M vectors

PERIOD	Age	0	1	2	3	4	5+
2007-2012	Prop. Matures	0.008	0.248	0.887	1.000	1.000	1.000

PERIOD	Age	0	1	2	3	4	5+
2007-2012	M	1.16	0.53	0.40	0.35	0.32	0.32

F vector

F	0	1	2	3	4	5+
2007	0.433	0.277	0.329	0.355	0.456	0.507
2008	2.622	2.587	2.531	2.447	2.723	2.472
2009	0.633	0.745	0.777	1.108	1.154	0.947
2010	0.431	0.72	0.479	0.664	0.803	1.197
2011	0.824	1.182	0.479	0.801	0.388	0.35
2012	0.824	1.182	0.479	0.801	0.388	0.35

Several scenarios with different harvest strategy were run, with F_{stq} (F_{bar} ages 0-4) set equal to the F_{bar} of the last year (2012).

Weight-at-age in the stock

Mean weight at age (kg)	0	1	2	3	4	5+
2007	0.0225	0.0909	0.4577	1.2436	1.8198	3.7226
2008	0.0261	0.0848	0.4663	1.1712	1.8851	2.7884
2009	0.0244	0.0984	0.4490	1.0628	1.9569	3.0469
2010	0.0267	0.0914	0.4728	1.1182	1.9172	3.3534
2011	0.0270	0.0974	0.4689	1.0705	1.9563	3.2935
2012	0.0208	0.0998	0.4374	1.1453	1.8612	3.3209

Weight-at-age in the catch

Mean weight at age (kg)	0	1	2	3	4	5+
2007	0.0225	0.0909	0.4577	1.2436	1.8198	3.7226
2008	0.0261	0.0848	0.4663	1.1712	1.8851	2.7884
2009	0.0244	0.0984	0.4490	1.0628	1.9569	3.0469

2010	0.0267	0.0914	0.4728	1.1182	1.9172	3.3534
2011	0.0270	0.0974	0.4689	1.0705	1.9563	3.2935
2012	0.0208	0.0998	0.4374	1.1453	1.8612	3.3209

Number at age in the stock

Stock at age in numbers (thousands)	0	1	2	3	4	5+
2007	239883	38531	1818	393	209	239883
2008	177700	48779	1648	647	180	177700
2009	165654	42214	2160	525	222	165654
2010	167185	37376	1977	666	229	167185
2011	116851	36744	1905	438	242	116851
2012	207984	23213	1421	402	138	207984

Number at age in the stock, weight at age in the stock and in the catches as estimated from XSA in 2012 have been used.

Stock recruitment

The recruitment used for the short term projection was estimated as the geometric mean from 2010-2012 (159,571 thousands).

7.13.1.3.Results

A short term projection (Table 7.13.1.3.1), assuming an F_{stq} of 1.09 in 2013 and a recruitment of 159571 (thousands) individuals, shows that:

- Fishing at the F_{stq} (1.09) generates an increase of the catch of 17% from 2012 to 2014 and a decrease of the spawning stock biomass of about 2% from 2014 to 2015.

- Fishing at $F_{0.1}$ (0.19) for the same time generates a decrease of the catch of 63% from 2012 to 2014 but an increase of spawning stock biomass of 227% from 2014 to 2015.

- A 30% reduction of the F_{stq} (F=0.75) generates a decrease of catch for 3.6% from 2012 to 2014 and an increase of spawning stock biomass of about 45% from 2014 to 2015, indicating that this level of reduction could generate a small decrease of catches but a significant increase of the spawning stock biomass.

EWG 13-09 recommends that fishing mortality in 2014 should not exceed F_{01}= 0.19, corresponding to catches of 1247 t.

Outlook until 2014

Table 7.13.1.3.1. Short term forecast in different F scenarios computed for hake in GSA 18.

Basis: F (2013) = F (2012) = 1.09; R (2013) = GM (2010–2012) = 159,571 (thousands); SSB (2014) = 2224; Catch (2013) = 4594 t. Weights in tons

Rationale	F Factor	F scenario	Catch 2014	Catch 2015	SSB 2015	Change SSB 2014-2015 (%)	Change Catch 2012-2014 (%)

Zero catch	0	0	0	0	10265	361	-100
High long-term yield (F_{MSY})	0.19	0.2	1247	2378	7281	227.45	-63.28
Status quo	1	1.066	3967	3990	2182	-1.88	16.79
Different scenarios	0.1	0.107	714	1481	8524	283.35	-78.99
	0.2	0.213	1317	2481	7123	220.32	-61.23
	0.3	0.320	1831	3142	5992	169.45	-46.10
	0.4	0.427	2272	3566	5075	128.23	-33.12
	0.5	0.533	2653	3826	4330	94.70	-21.91
	0.6	0.640	2985	3971	3721	67.32	-12.14
	0.7	0.746	3276	4038	3221	44.85	-3.57
	0.8	0.853	3533	4053	2809	26.31	4.00
	0.9	0.960	3762	4033	2467	10.94	10.74
	1.1	1.173	4153	3934	1942	-12.65	22.24
	1.2	1.280	4321	3870	1740	-21.74	27.19
	1.3	1.386	4474	3802	1568	-29.48	31.70
	1.4	1.493	4615	3732	1421	-36.10	35.85
	1.5	1.600	4745	3663	1294	-41.81	39.67
	1.6	1.706	4865	3596	1184	-46.76	43.21
	1.7	1.813	4977	3532	1088	-51.09	46.51
	1.8	1.919	5081	3470	1003	-54.89	49.58
	1.9	2.026	5179	3411	928	-58.26	52.46
	2	2.133	5271	3356	862	-61.25	55.16

7.13.2.*Medium term prediction*

7.13.2.1.Method and justification

No medium term forecast has been performed, because of lacking of a reliable stock-recruitment relationship (Fig. 7.13.2.1.1).

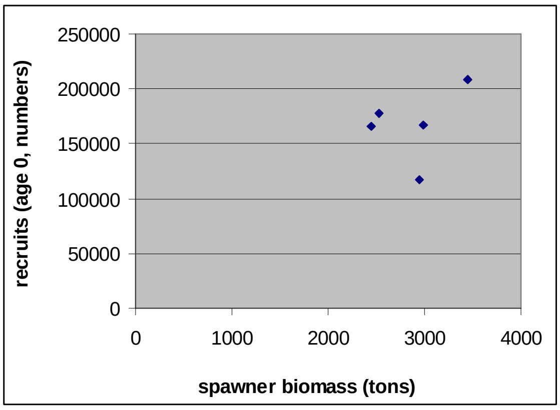

Fig. 7.13.2.1.1. Relationship between biomass in tons and recruits (age 0 in the stock) from XSA (spawners time t, recruits time t+1).

7.14. Short and medium term predictions for deepwater pink shrimp in GSA 19

7.14.1. *Short term prediction 2013-2014*

Short term prediction for 2013 and 2014 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed with XSA method conducted in the framework of the EWG 13-09.

7.14.1.1. Input parameters

The following data have been used to derive the input data for the short term projection of deepwater pink shrimp in the GSA 19. The values of the last year (i.e. 2012) for WAA and F have been used.

Maturity and M vectors

Period	Age	0	1	2	3+
2006-2012	Prop. Matures	0.47	0.98	1	1

Period	Age	0	1	2	Mean 0-2
2006-2012	M	1.41	0.81	0.70	0.97

F

Fishing mortality	2006	2007	2008	2009	2010	2011	2012
0	0.69	0.44	0.60	0.60	0.63	0.77	0.53
1	4.76	2.87	2.98	2.28	2.40	2.94	2.63
2	2.99	1.61	1.98	1.40	1.76	2.17	1.64
3+	2.99	1.61	1.98	1.40	1.76	2.17	1.64
F_{BAR} (0-2)	2.81	1.64	1.85	1.43	1.60	1.96	1.60

Several scenarios with different harvest strategy were run, with F_{stq} (F_{bar} ages 0-2) set equal to the F_{bar} of the last year (2012).

Weight at age in stock and catches

Weight at age (kg)	**Age 0**	**Age 1**	**Age 2**	**Age 3+**
2006	0.006	0.009	0.017	0.02
2007	0.005	0.01	0.02	0.02
2008	0.005	0.01	0.021	0.029
2009	0.004	0.01	0.021	0.028
2010	0.004	0.011	0.021	0.029
2011	0.004	0.01	0.02	0.028
2012	0.005	0.01	0.021	0.027

Number at age in the stock

Stock numbers (thousands)	2006	2007	2008	2009	2010	2011	2012
0	392382	380335	421858	459200	322867	278638	287445
1	106672	47852	59556	56381	61433	41908	31557
2	5360	407	1210	1352	2561	2476	990
3+	196	0	19	4	70	1	35
TOTAL	504610	428594	482643	516937	386931	323023	320027

Number at age in the catch

Catch in numbers (thousands)	age 0	age 1	age 2	age 3+
2006	97034	70538	3587	155
2007	67395	30102	230	0
2008	94337	37695	735	13
2009	102563	33765	718	2
2010	74717	37263	1495	46
2011	73810	26468	1546	1
2012	58313	19523	562	22

The recruitment used for the short term projection was estimated as the geometric mean from 2010-2012 (295715 thousands).

Short-term implications

A short term projection (Table 7.14.1.1.1), assuming an F_{stq} of 1.31 in 2013 and a recruitment of 295.715 (thousands) individuals, shows that:

- Fishing at the F_{stq} (1.31) generates an increase of the catch of 35% from 2012 to 2014 and a stable spawning stock biomass (+0.3%) from 2014 to 2015.
- Fishing at $F_{0.1}$ (0.67) generates a decrease of the catch of 15% from 2012 to 2014 and an increase of the spawning stock biomes of 19% from 2014 to2015.
- A 30% reduction of the F_{stq} (F=0.92) generates an increase of the catch of 7% from 2012 to 2014 and an increase of spawning stock biomass of about 10.5% from 2014 to 2015, indicating that this level of reduction could generate an increase of both catches and spawning stock biomass.

EWG 13-09 recommends that fishing mortality in 2014 should not exceed $F_{0.1}$=0.67, corresponding to catches of 422 t.

Outlook until 2014

Table 7.14.1.1.1. Short term forecast in different F scenarios computed for pink shrimp in GSA 19. Basis: F (2013) = F (2012) = 1.31; R (2011) = GM (2010–2012) = 295.715 (thousands); SSB (2014) = 1218; Catch (2013) = 661 t. Weights in tons.

Rationale	F factor	F scenario	Catch 2014	Catch 2015	SSB 2015	Change SSB 2014-2015 (%)	Change Catch 2012-2014 (%)
zero catch	0	0	0	0	1898.71	55.87	-100
High long-term yield	0.5	0.67	422.22	522.92	1448.76	18.93	-15.42

($F_{0.1}$)							
Status quo	1	1.31	675.77	677.75	1221.41	0.27	35.37
Different scenarios	0.1	0.13	101.64	164.55	1783.52	46.41	-79.64
	0.2	0.26	192.55	289.51	1683.92	38.24	-61.43
	0.3	0.39	274.26	385.21	1597.39	31.13	-45.06
	0.4	0.52	348.09	459.26	1521.87	24.93	-30.27
	0.5	0.66	415.11	517.24	1455.65	19.50	-16.85
	0.6	0.79	476.25	563.26	1397.28	14.71	-4.60
	0.7	0.92	532.28	600.36	1345.59	10.46	6.63
	0.8	1.05	583.85	630.77	1299.57	6.69	16.96
	0.9	1.18	631.53	656.16	1258.41	3.31	26.51
	1.1	1.44	716.99	696.45	1188.01	-2.47	43.63
	1.2	1.57	755.51	712.94	1157.70	-4.96	51.34
	1.3	1.70	791.63	727.73	1130.09	-7.23	58.58
	1.4	1.83	825.61	741.18	1104.84	-9.30	65.39
	1.5	1.97	857.65	753.59	1081.65	-11.20	71.80
	1.6	2.10	887.95	765.16	1060.29	-12.96	77.87
	1.7	2.23	916.65	776.06	1040.53	-14.58	83.62
	1.8	2.36	943.92	786.40	1022.22	-16.08	89.08
	1.9	2.49	969.85	796.28	1005.19	-17.48	94.28
	2	2.62	994.58	805.77	989.31	-18.78	99.23

7.14.2. *Medium term prediction*

7.14.2.1. Method and justification

No medium term forecast has been performed, because of lacking of a reliable stock-recruitment relationship as it is shown in Figure 7.14.2.1.1.

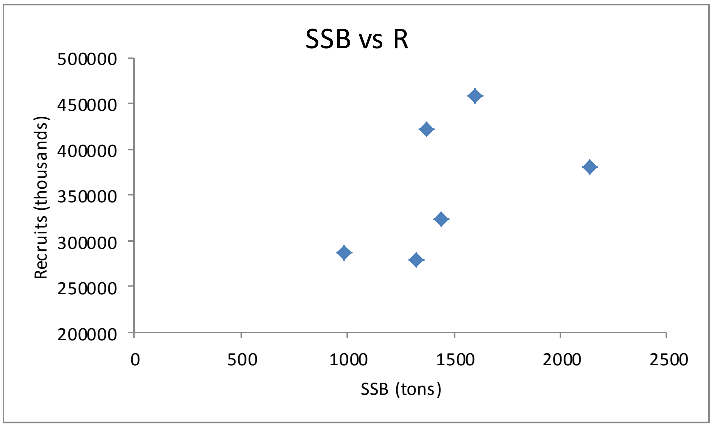

Figure 7.14.2.1.1. GSA 19 deepwater pink shrimp stock-recruitment relationship as estimated from the XSA.

7.15. Short term predictions for Hake in GSA 19

7.15.1. *Short term predictions 2014-2015*

7.15.1.1. Method and justification

Short term prediction for 2014 and 2015 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed using XSA (Darby and Flatman, 1994) that was conducted in the framework of the EWG 13-09.

7.15.1.2. Input parameters

A short term projection for 2013 to 2015 was performed using the R-routine and was and based on the results of the XSA, assuming an F_{stq} of 1.18 and a recruitment of 27210 thousands (geometric mean of the last 3 years). An average of the last three years has been used for weight at age, maturity at age and F at age.

7.15.1.3. Results

The short term projection (Table 7.15.1), shows that:

- Fishing at the F_{stq} (1.18) from 2012 to 2014 would generate an increase of the catches by 21%, while the spawning stock biomass would decreas by about 2.6% between 2014-2015.

- Fishing at $F_{0.1}$ (0.22) from 2012 to 2013 would generates a decrease of the catches by 61% in 2014 and a spawning stock biomass would increase by 198 % from 2012 to 2013.

- STECF EWG 11-20 recommends that catch in 2014 should not exceed 256 tons, corresponding to $F_{0.1}$ = 0.22.

Outlook until 2015

Table 7.15.1. Short term forecast for different F scenarios computed for hake in GSA 19.

Basis: F(2013) = mean (Fbar 0-4, 2010-2012); R(2011) = GM (2010-2012) = 27210 (thousands); F (2012) = 1.36; SSB (2012) = 225 t; landings(2012)= 657.

Rationale	F scenario	F factor	Catch 2014	Catch 2015	SSB 2015	Change SSB 2014-2015 (%)	Change Catch 2012-2014 (%)
zero catch	0.00	0.00	0	0	2710	310	-100.0
High long-term yield ($F_{0.1}$)	0.22	0.2	256	435	633	198	-61
Status quo	1.18	1.00	805	803	212	-2.62	21.7
Different scenarios	0.12	0.1	147.8	270.5	731.7	244.6	-77.7
	0.24	0.2	272.0	457.2	618.3	191.2	-58.9
	0.35	0.3	377.2	584.7	526.1	147.8	-43.0
	0.47	0.4	466.8	670.7	450.7	112.3	-29.4
	0.59	0.5	543.7	727.4	388.9	83.2	-17.8
	0.71	0.6	610.3	763.6	338.0	59.2	-7.7
	0.83	0.7	668.4	785.5	295.9	39.4	1.1
	0.94	0.8	719.4	797.5	260.8	22.8	8.8
	1.06	0.9	764.5	802.7	231.5	9.0	15.6

	1.30	1.1	841.0	800.6	185.8	-12.5	27.2
	1.42	1.2	873.7	795.9	168.0	-20.9	32.1
	1.53	1.3	903.4	790.0	152.7	-28.1	36.6
	1.65	1.4	930.7	783.3	139.4	-34.3	40.7
	1.77	1.5	955.8	776.3	127.9	-39.8	44.5
	1.89	1.6	979.0	769.1	117.8	-44.5	48.0
	2.00	1.7	1000.6	762.0	108.9	-48.7	51.3
	2.12	1.8	1020.7	755.1	101.0	-52.4	54.3
	2.24	1.9	1039.5	748.4	94.0	-55.7	57.2
	2.36	2.0	1057.2	741.9	87.6	-58.7	59.9

8. ToR D Data quality and Completeness

Review the quality and completeness of all data resulting from the official Mediterranean DCF data call issued on April 2013. 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 the data format of the official DCF data calls for the Mediterranean issued on April 2013.

The data call issued on April 2013 for the Mediterranean and Black Sea had a deadline on the 2th of June 2013. Data was uploaded by each country according to the following table:

Table 8.1. Timeline of data upload from Mediterranean Member States, data call deadline of the 2th of June 2013.

COUNTRY	First Upload	Last Upload
ITA	5/23/2013	7/4/2013
ESP	6/28/2013	7/2/2013
FRA	5/31/2013	6/3/2013
SVN	5/27/2013	6/3/2013
MLT	5/29/2013	7/4/2013
CYP	None	None
GRC	None	None

The timeline of upload has been in many cases well after the data call deadline and up to 6 working days before the STECF EWG 13-09.

The data call does not put explicit restrictions on the numbers of files to be uploaded for each requested table, however large amount of separate files with no standard naming convention can create problems to both Member States (MS) and JRC. Table 8.2 summarizes the numbers of files uploaded by MS with a distinction of files uploaded with success and with errors according to the checks done by the JRC upload facility.

Table 8.2. Number of files uploaded by country. In some cases files uploaded with errors where re-uploaded with success but in other cases the file uploaded with errors were the only files provided.

COUNTRY	Number of files uploaded with success	Number of files uploaded with errors
ITA	146	57
ESP	29	2
FRA	10	8
SVN	7	8
MLT	17	2
CYP	0	0

GRC	0	0

Normally each country should provide 4 fisheries tables, 6 MEDITS tables and 3 acoustic surveys tables (the latter are not necessary for countries which does not conduct an acoustic survey). In the case of the large size of TC MEDITS file, splitting of the data in more files is necessary, thus 15-20 files are considered normal in a data call. However reaching almost 150+ files implies unnecessarily splitting of the individual tables by year and GSA. This is an unjustified practice that can cause serious problems. For instance, several files named with the same name contained different data, or in another case files with different names contained the same or partially overlapping data. Finally in many instances the fields of the files where not conform to the data call and integers instead of text or vice versa appeared in the uploaded data.

All of the above has required an extra amount of work and time for the JRC data collection team to check for duplicated records and errors. The JRC data collection team has been able to deliver the fisheries data the day before the beginning of EWG 13-09 and the MEDITS survey data representative of the last data call only, at the end of the second day of the EWG 13-09. Raw uploaded files were also available during the meeting.

Data Overview

A summary of the main data gaps is presented below while specific issues related to individual stocks are described in the dedicated chapter under each stock assessment section.

Italy

Fishing effort data (Table D) for all Italian GSAs in 2010 was missing from the file provided, the other fisheries tables are updated to 2012. MEDITS data appears complete.

Spain

All fisheries tables were uploaded up to 2012, MEDITS data appears complete.

France

France did not provide any fisheries data (Tables A-D) for GSA 08 (Corsica). This is a recurrent omission and with no apparent justification and it undermines the possibility of EWG 13-09 to perform any assessment in GSA 08. Also no data on effort for GSA 7 (Table D) was uploaded. MEDITS TC data did not cover the time series before 1997.

Malta

Fisheries tables where all uploaded up to 2012, MEDITS appears complete with the exception of MEDITS TE file which was not uploaded.

Slovenia

Fisheries tables (A-D) where uploaded up to 2012, MEDITS appears complete.

Cyprus

No data was provided

Greece

No data was provided

Fisheries Data Quality

A Fisheries data overview R routine was developed for the main target species under assessment in EWG 13-09. Age based data was aggregated over ages, mesh sizes, fleet segment and metiers to identify the main temporal patterns. The landing numbers at age (Figure 8.1) show that none of the species under assessment are reported in Table A for GSA 7, 8, 15 and 17 (SVN). In the case of GSA 11 there is a 1-5 folds increase in the landings from 2011 to 2012, which seems suspiciously high.

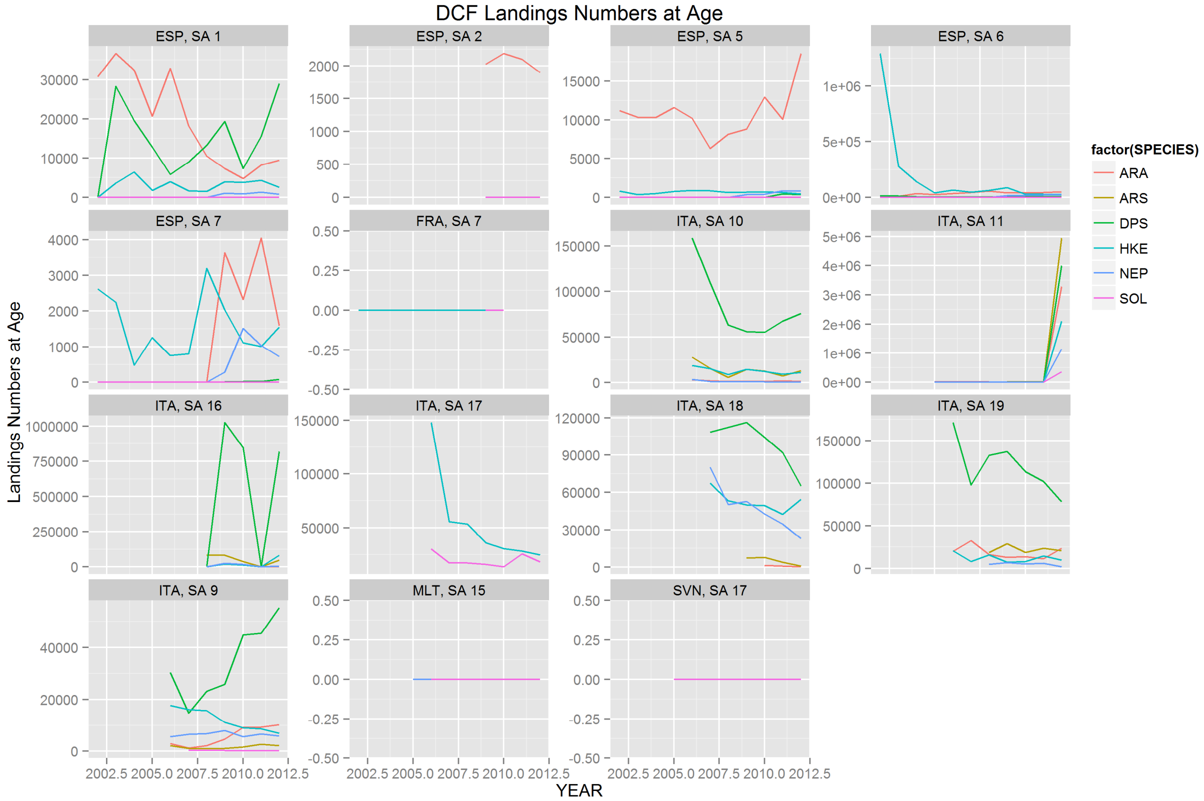

Figure 8.1 Landings numbers aggregated over ages and métiers from the 2013 data call for the species under assessment in EWG 13-09 (*Aristeus antennatus* (ARA), *Aristaeomorpha foliacea* (ARS), *Parapenaeus longirostris* (DPS), *Merluccius merluccius* (HKE), *Nephrops norvegicus* (NEP) and *Solea solea* (SOL)).

An exploration of the aggregated landings extracted from fisheries table A (Figure 2) for the stocks for which there are detailed numbers at age and weight at age information shows for which combination of species and GSA data have been reported. The scaling of the weight on the *y* axis shows variations up to 3 orders of magnitude from one GSA to another and this might be related to inconsistent unit of weight.

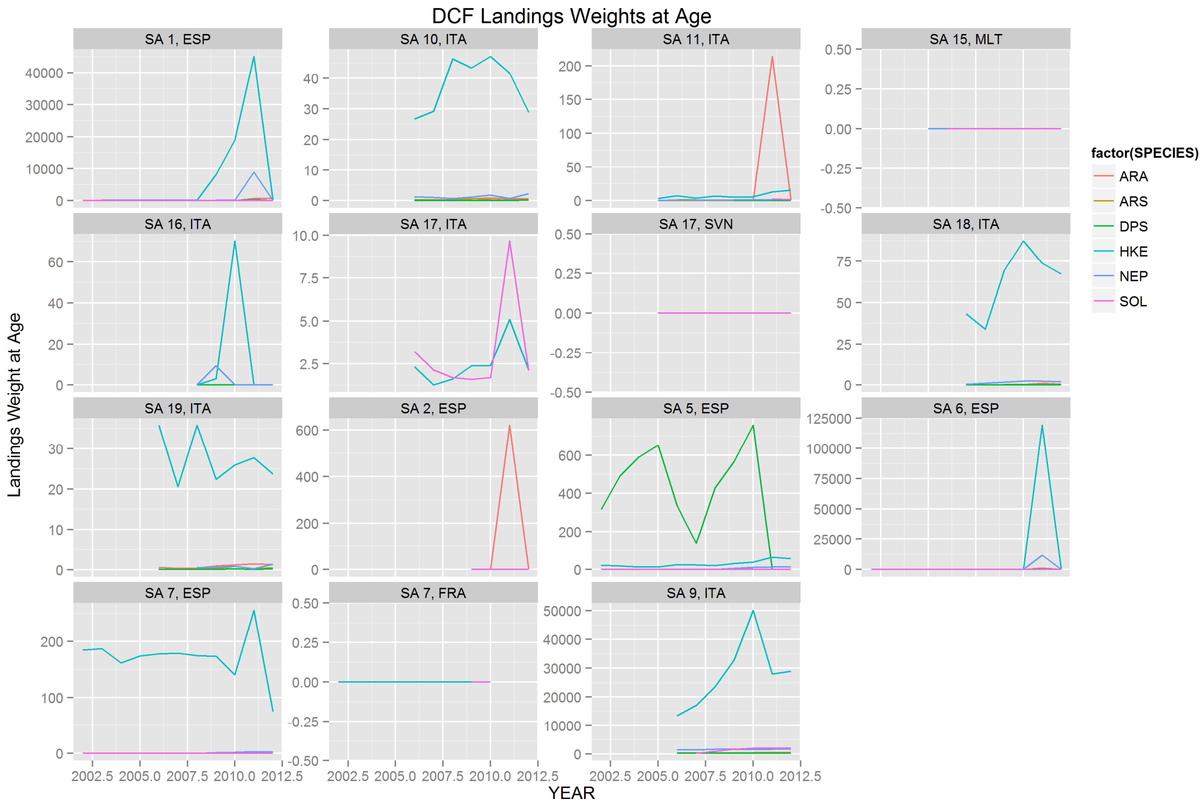

Figure 2. Landings aggregated over ages and métiers from the 2013 data call for the species under assessment in EWG 13-09 (*Aristeus antennatus* (ARA), *Aristaeomorpha foliacea* (ARS), *Parapenaeus longirostris* (DPS), *Merluccius merluccius* (HKE), *Nephrops norvegicus* (NEP) and *Solea solea* (SOL)).

Similar plotting functions apply the same approach to DCF discards at length (Figure 8.3) extracted from fisheries Table B to explore level and trends in discarding.

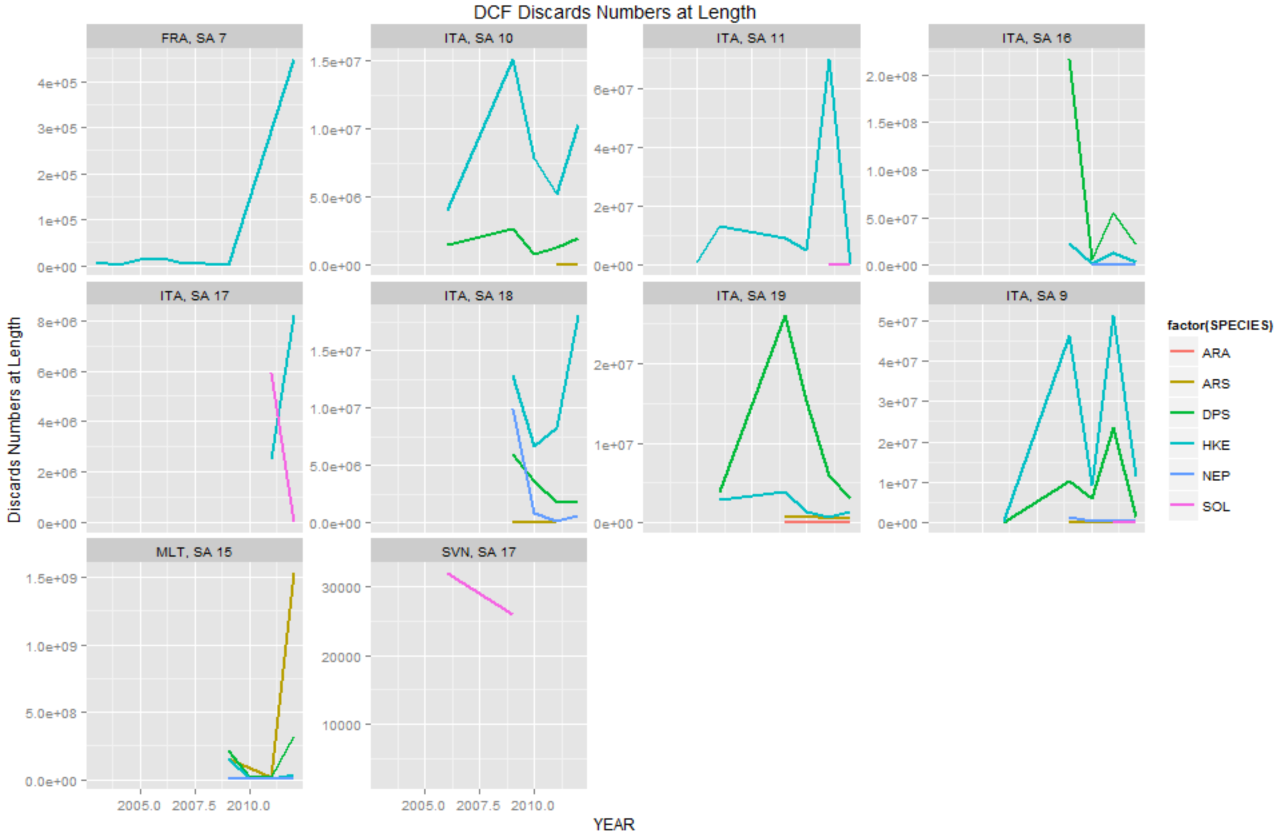

Figure 8.3. Discard numbers at length aggregated by species, year and GSA from the 2013 DCF data call for *Aristeus antennatus* (ARA), *Aristaeomorpha foliacea* (ARS), *Parapenaeus longirostris* (DPS), *Merluccius merluccius* (HKE), *Nephrops norvegicus* (NEP) and *Solea solea* (SOL)).

<u>MEDITS data quality</u>

Since December 2012 JRC has developed quality checks with SQL routines in the MEDITS Postgres database of JRC to do cross table consistency tests and conformity to the survey manual checks. In total 26 routines where developed, these share a similar philosophy to the ROME routines (Spedicato and Bitetto 2012) and when ROME is used before data upload the JRC routines correctly show no error patterns.

A reduced number of quality check reports (number of erroneous records by year) are plotted for the data call of 2012 and the data call in 2013 to identify changes in error patterns or corrections of previously identified errors. The checks has been run on the data in June 2013 and, in the case of upload of incomplete time series, the data from previous data call was used to complete the time series. This affects only few countries and returns at most a non fully updated number of errors if corrections where applied.

The check of the vertical opening equal to zero in case of valid hauls (Figure 8.4) returns several errors in GSA 7 and GSA 8 in 2004, while it shows that in GSA 16 the data where corrected compared to the 2012 data call.

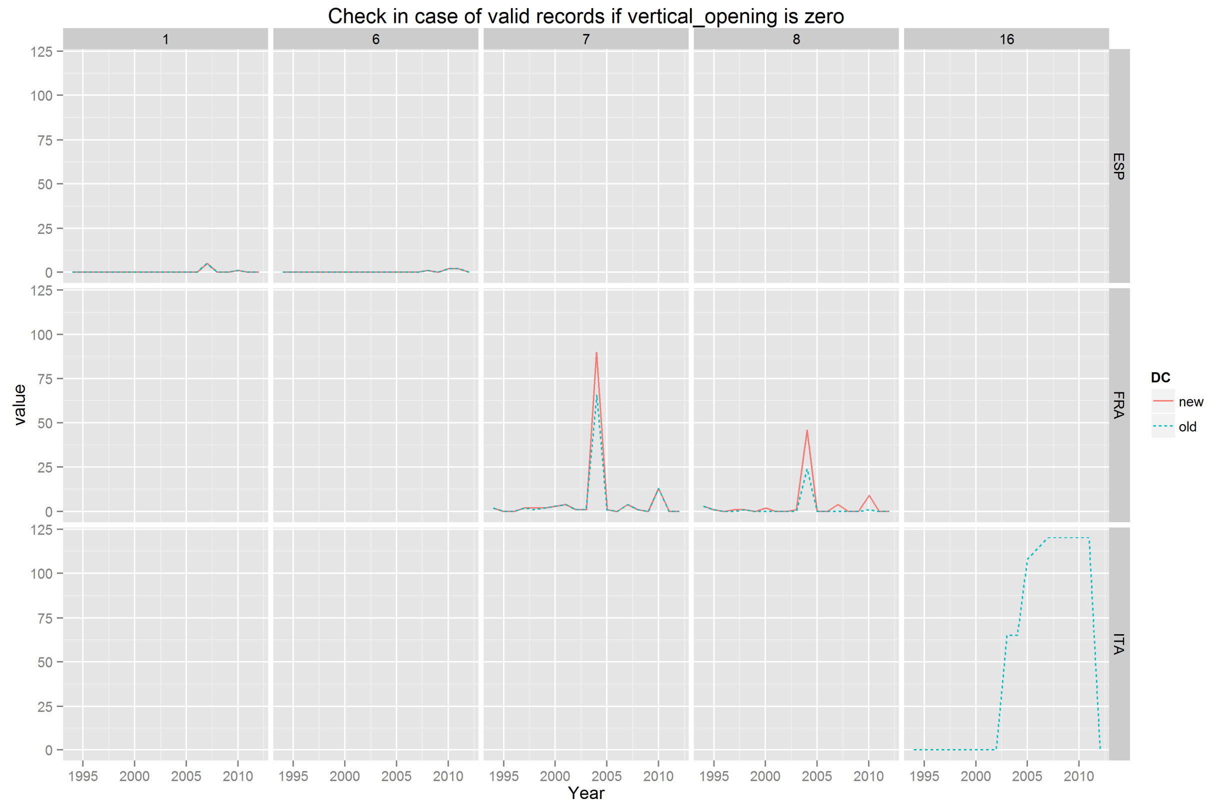

Figure 8.4. Check of valid hauls where vertical opening is declared as zero. The value is the number of errors by year, the columns indicate the GSA and the rows the country. In red the report from the 2013 data call and in dashed green from the 2012. As an example the lack of a red line in GSA 16 indicates that all the erroneous records where corrected in 2013. In case of overlapping lines there was no change or correction of the records.

A similar check is implemented for the wing opening equal to zero and hauls declared valid (Figure 8.5). Here the only errors pertain Spain but these were not corrected during the last two data calls.

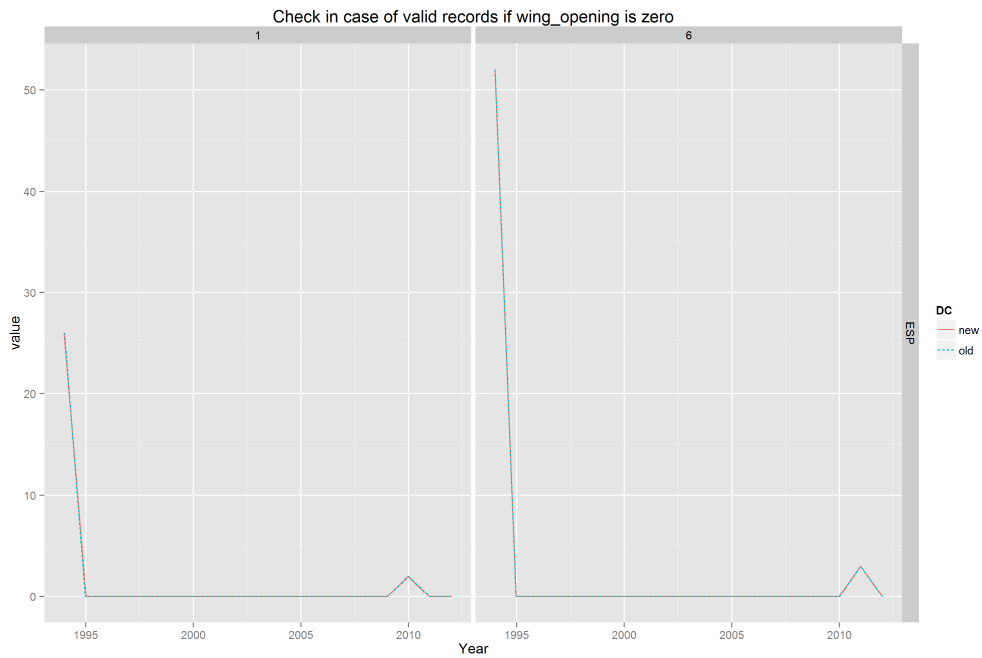

Figure 8.5. Erroneous records when wing opening is zero but the hauls are declared valid in the new and old data calls (2012 and 2013).

The consistency of the haul duration was evaluated against haul start time and end time (Figure 8.6). In the case of GSA 9 all erroneous records where corrected compared to the 2012 data call, while very few errors remain for the other GSAs.

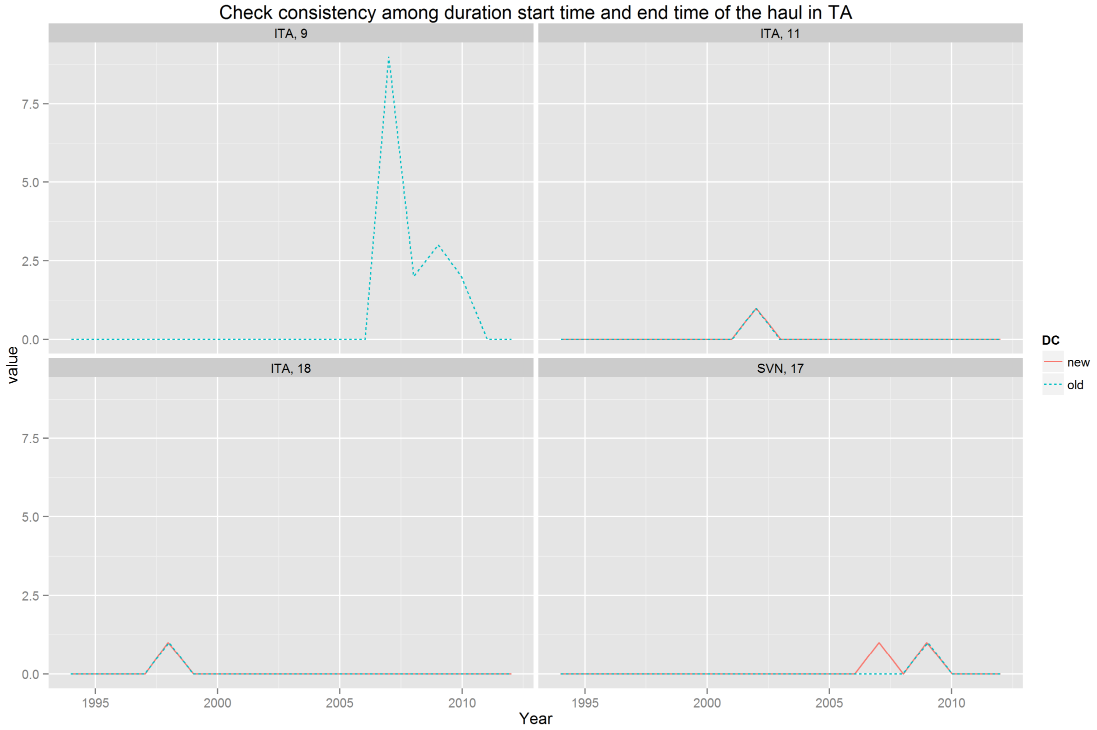

Figure 8.6. Erroneous records identifying inconsistent haul duration when compared to haul start and end time in the new and old data calls (2012 and 2013).

A check of the consistency of the bridle length and the haul mean depth was performed according to the MEDITS manual (Figure 8.7). Violations of the protocol emerge in different areas, in GSA 9 and GSA 11 the newest submitted records have been corrected.

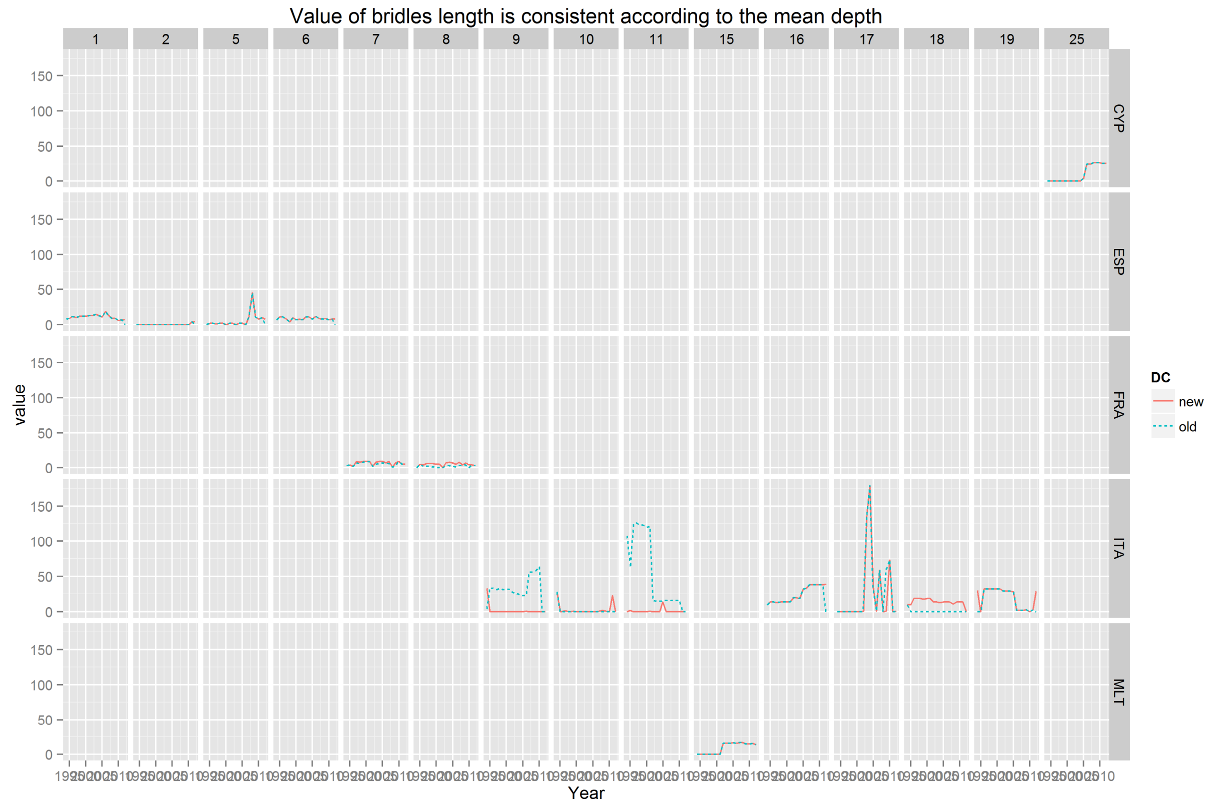

Figure 8.7. Consistency of the bridle length and the haul mean depth according to the MEDITS manual in new and old data calls (2012 and 2013). The values correspond to the number of hauls presenting violations.

A check on the total number of individual and the corresponding numbers of females, males and indetermined individuals was done for TB file (Figure 8.8). Corrections were performed in the latest data call by GSA 9 and GSA 17 while some errors remain for the other GSAs.

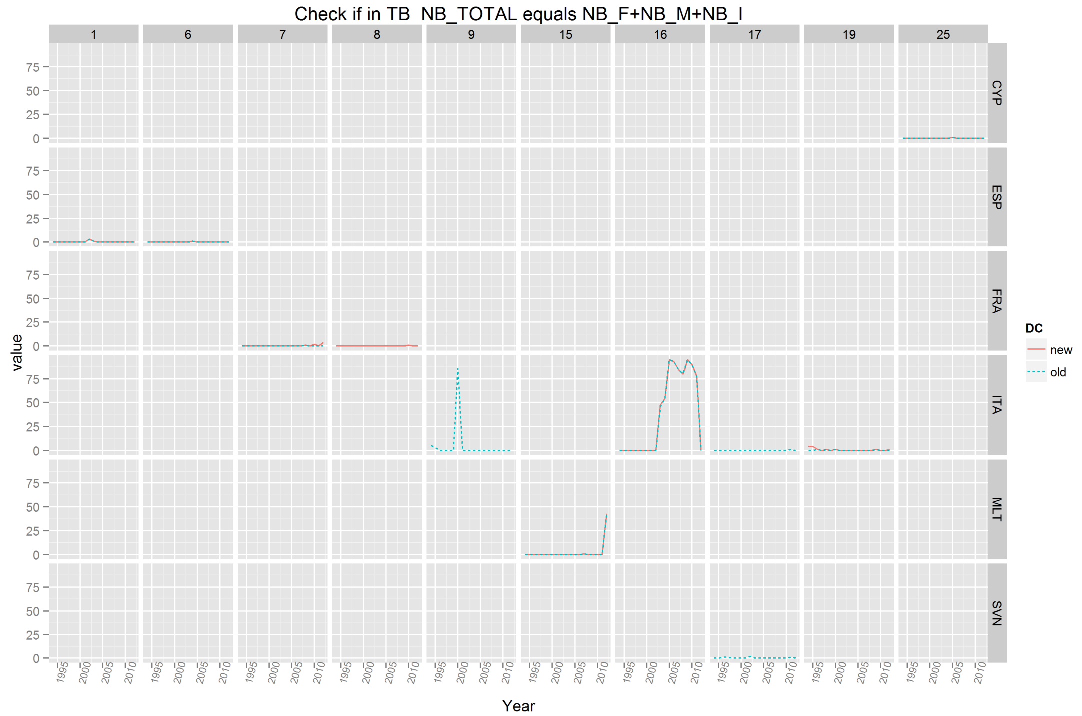

Figure 8.8. Consistency between the total number of individual and the corresponding numbers of females, males and indetermined individuals in the new and old data calls (2012 and 2013).

Another check was performed to verify that in the case of subsampling in TC the numbers per sex in Tb are raised correctly (Figure 8.9). For this check few corrections are noticeable but new errors emerged in particular in the last year of the survey in GSA 16. The reason for this is unclear and will be investigated.

Figure 8.9. Check that in case of subsampling in TC the numbers per sex in Tb are raised correctly in new and old data calls (2012 and 2013).

9. TOR E REVIEW, UPDATE AND CONSOLIDATION OF R SCRIPTS

Review, update and consolidate the R scripts developed by SGMED and JRC over the period 2008-2012 to: perform deterministic and statistical age slicing on DCF catch at length and MEDITS data extract and standardize MEDITS indexes of biomass and abundance R plotting functions to produce standard plots for STECF reports

To address TOR e, the JRC team distributed at the beginning of the EWG 13-09 meeting the latest releases of Fisheries Libraries in R (FLR) and supported the experts in running assessments and solving specific R issues. JRC also distributed a revised and cleaned version of the short and medium term forecast R script.

Concerning the rest of the TOR (i.e. revisiting and extending the existing R routines) the work was initiated during EWG 13-09 with the aim to further improve the main outline of the R scripts structure to be finalised prior to the next EWG.

There will be two main scripts divided in the structure by the type of data:

1. DCF catch at age, landings at length, effort and discards
2. MEDITS

1. DCF functions

The R script for DCF data queries the Access databases via RODBC connection and extract individual stocks and areas and/or the whole table. Several summarizing and plotting functions allow data exploration. The objectives are:

1. Converting the numbers, weights, discards at age from the database plain tables into an R FLStock object (the standard data format in FLR) that can be feed to an assessment method automatically without having to manually process the data in Excel.
2. In the case of length based data, a slicing function will be called (after passing the appropriate growth parameters) and it will slice the data and produce an FLStock object. There are different slicing functions currently available and several options will be given.

Hitherto the extractor and plotting functions are completed, while the slicing and conversion to an R FLStock object are in progress and will be finalized for the next EWG.

In detail, we show the plots to explore all the data after summary statistics that where developed to produce standard plots for a subset of species aggregated over numbers or weight at age and métiers (Figure 9.1-9.2) or by individual stocks on an age basis (Figure 9.3) using as reference species the species under assessment in EWG 13-09.

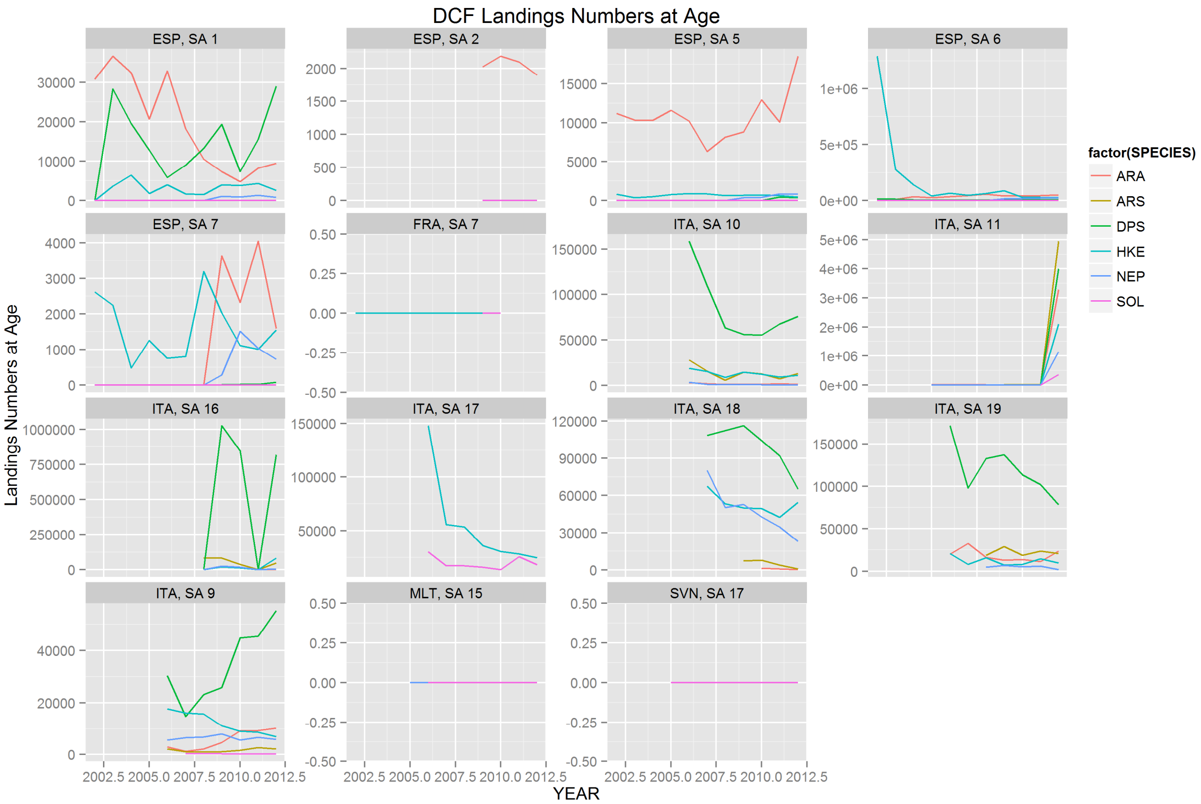

Figure 9.1. Example of plot of aggregated landings number aggregated over ages and métiers from the 2013 data call for the species under assessment in EWG 13-09 (*Aristeus antennatus* (ARA), *Aristaeomorpha foliacea*

(ARS), *Parapenaeus longirostris* (DPS), *Merluccius merluccius* (HKE), *Nephrops norvegicus* (NEP) and *Solea solea* (SOL))

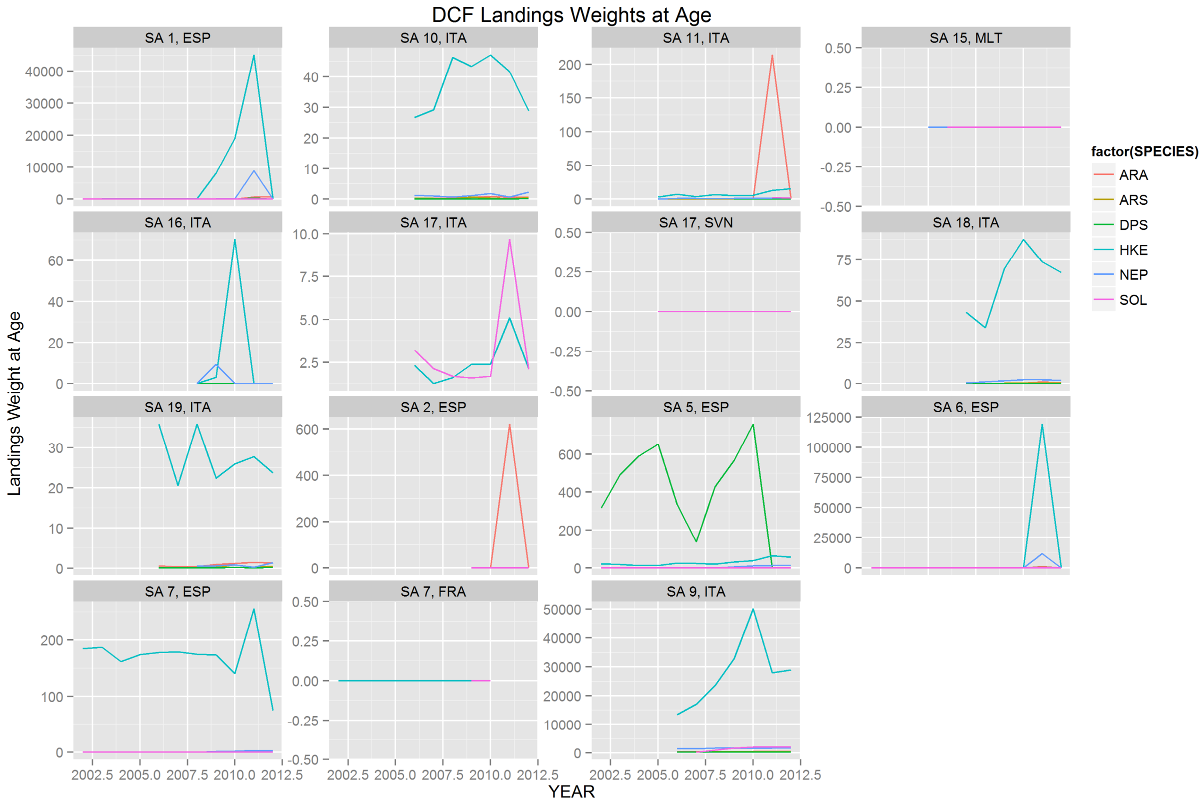

Figure 9.2. Example of plot of aggregated landings weights aggregated over ages and métiers from the 2013 data call for the species under assessment in EWG 13-09 (*Aristeus antennatus* (ARA), *Aristaeomorpha foliacea* (ARS), *Parapenaeus longirostris* (DPS), *Merluccius merluccius* (HKE), *Nephrops norvegicus* (NEP) and *Solea solea* (SOL)).

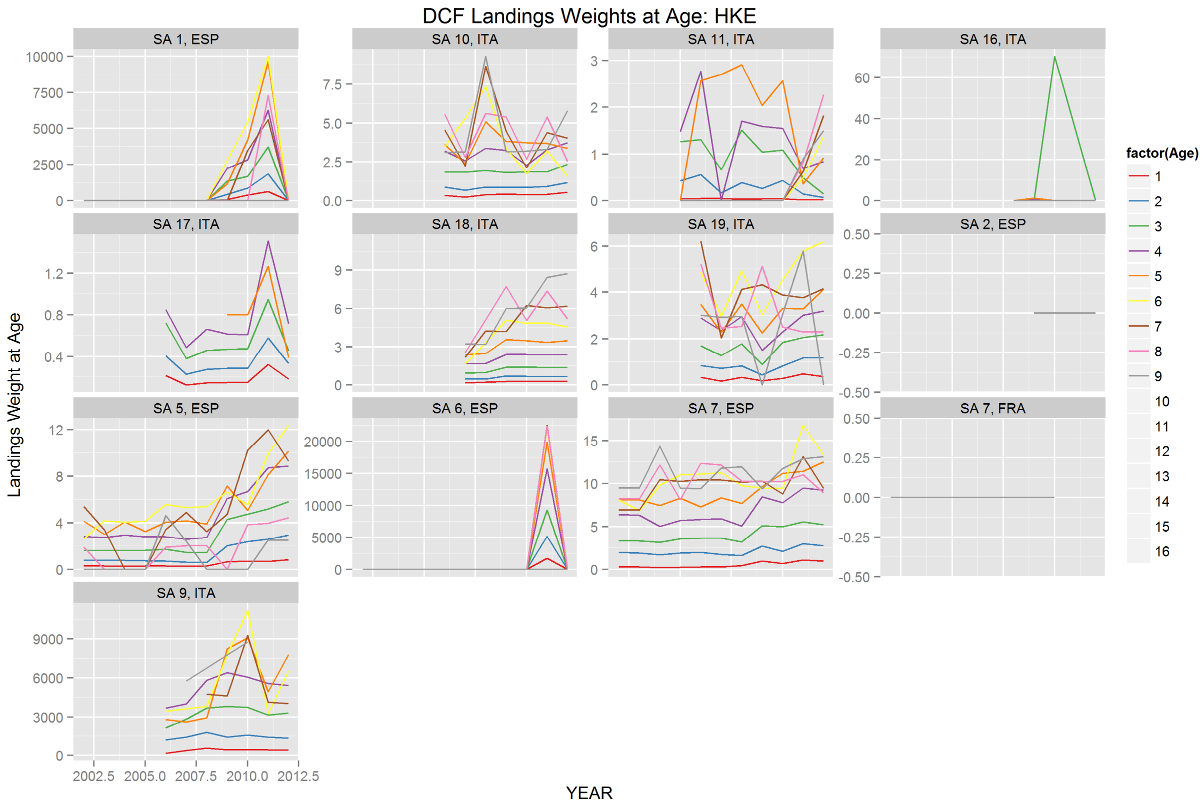

Figure 9.3. Example plot of raw landings weights at age for *Merluccius merluccius* (HKE) from the DCF 2013 data call by statistical area.

Similar plotting functions apply the same approach to DCF discards at length (Figure 9.4), discards at age (Figure 9.5) and to fishing effort

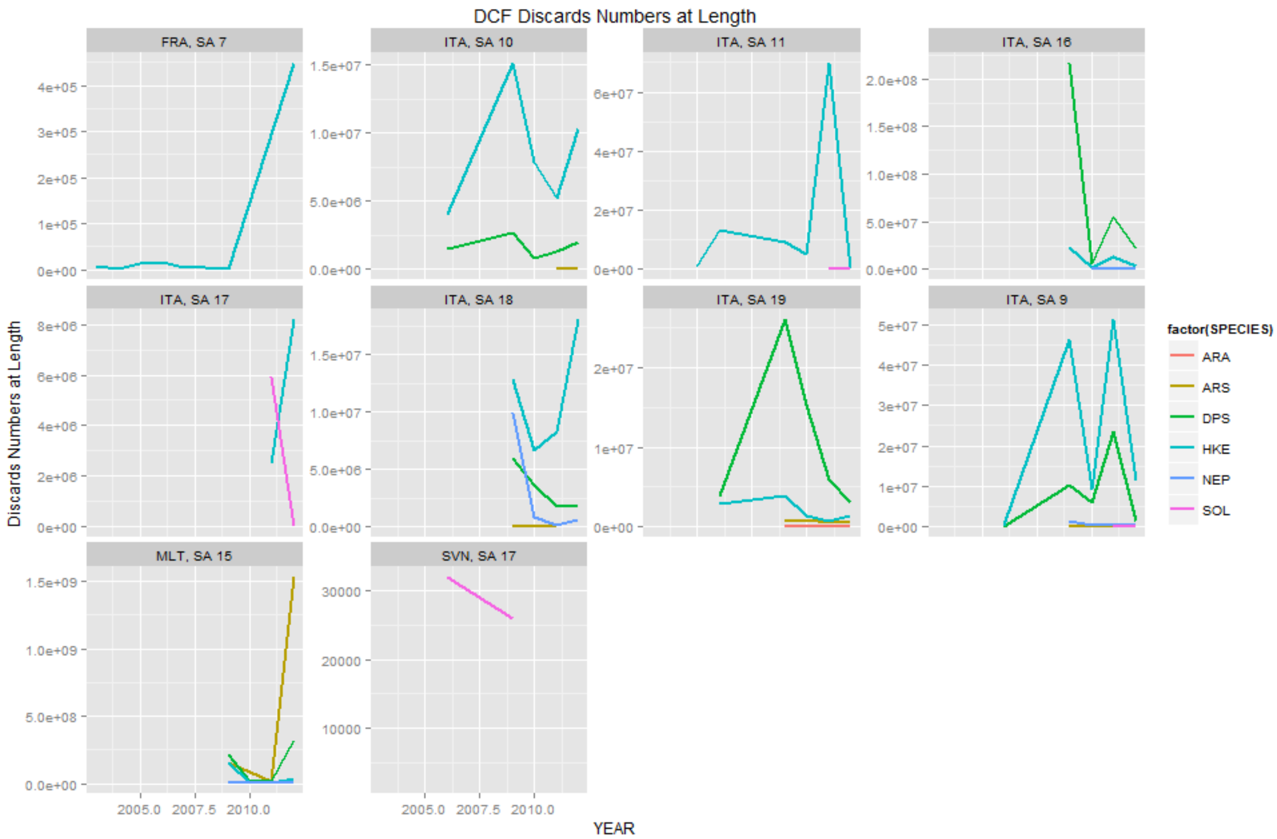

Figure 9.4. Discard Numbers at length aggregated by species, year and statistical area from the 2013 DCF data call for *Aristeus antennatus* (ARA), *Aristaeomorpha foliacea* (ARS), *Parapenaeus longirostris* (DPS), *Merluccius merluccius* (HKE), *Nephrops norvegicus* (NEP) and *Solea solea* (SOL)).

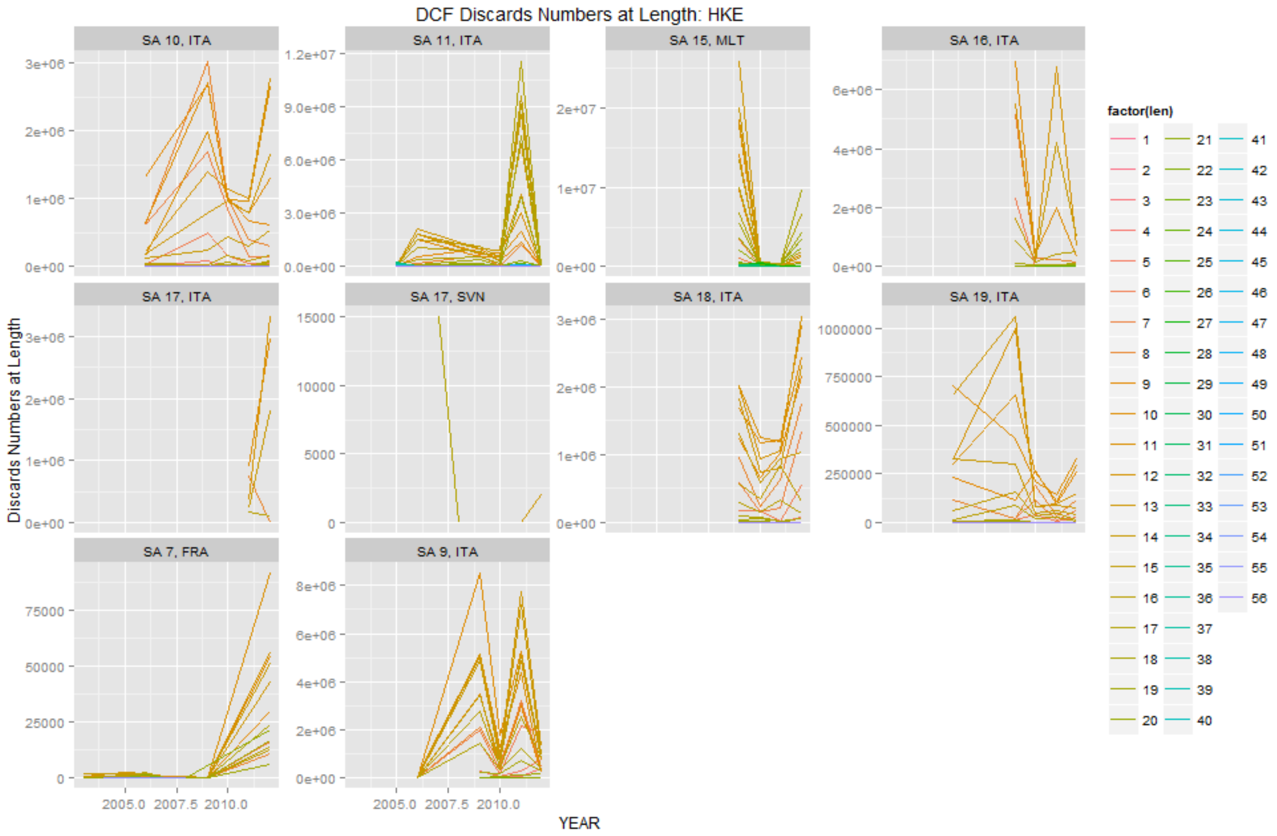

Figure 9.5. Disaggregated discard numbers at length for *Merluccius merluccius* (HKE) from the DCF 2013 data call by statistical area and year.

2. MEDITS

The existing R routines (developed for SGMED by Valerio Bartolino, Chato Osio, Graham Pilling and Finlay Scott in March 2010) query the MEDITS database, extract one specie and area at a time (although can be expanded to multiple areas and species), create an un-standardized CPUE index (n/km^2 or kg/km^2), allow the set up of standardization via regression models (GLM or GAM) and have different functions to plot temporal maps of the CPUE. Additionally these routines allow the age slicing using an a deterministic slicing as well as the statistical slicing package (developed by Finlay Scott, Chato Osio and Max Cardinale in 2011) which is based on the R mixdist() package.

This routines need to be expanded to incorporate the calculation of the stratified numbers (n/km^2) at length that reflects the survey stratification (according to the Cochran method) to replace the functions previously available in the JRC ACCESS MEDITS database and to standardize what individual experts use to perform this step. The transition of the Access routines in R will give more flexibility and ease of use and allow experts to have more control of the data preparation steps.

A new slicing function from the FLa4a package will be added to the slicing tools and the sliced data will be generated as an R FLIndex (the FLR standard format for trawl survey data) to be used for stock assessment. Data will also be generated as .csv files so that any assessment method can be used, before or after slicing.

10. ToR F BEMTOOL

General features of the model

EWG 1309 recognise the effort made by developers of BEMTOOL to generate a comprehensive bio-economic model for simulating management scenarios of the Mediterranean fisheries. BEMTOOL is a new integrated bio-economic model developed to support multi-objective fisheries management for the Mediterranean. The model allows simulating and forecasting the effects of different harvesting strategies in the short, medium and long-term.

Different levels of fishing effort and/or catches can be simulated in the medium and long term in order to estimate the level corresponding to the maximum production in the long term (either in biological or economic terms). Moreover, BEMTOOL is able to run several different management scenarios and to evaluate them by means of the multi-criteria decision analysis (MCDA).

A total of 11 management scenarios can be simulated by the BEMTOOL model. The basic scenario is represented by the Status Quo, where the management system remains unchanged during the simulation period. Other scenarios consist of changes in fishing gear selectivity, fishing effort (in terms of number of vessels and/or days at sea), fishing mortality and the introduction or variation of Total Allowed Catches (TAC). Furthermore, Status Quo scenarios, changes in gear selectivity and changes in fishing effort can also be simulated assuming active fishermen behaviour, which affects the levels of fishing effort. Finally, each scenario can be combined into a more complex management system.

The output of each simulation is represented by all variables included in the logical-conceptual scheme of the model, for which the values are reported for each year of a simulation period defined by the model user.

The BEMTOOL model has been developed taking into account the work already done in previous projects on this topic. The existing bio-economic models specifically developed for or applied to Mediterranean fisheries have been used as a background for the development of BEMTOOL.

This has allowed BEMTOOL to be flexible enough to accommodate different features of the Mediterranean fisheries. Seven case studies were chosen in the BEMTOOL project, covering fisheries from Spanish waters to Greece, have been simulated and combined with MCDA (Multi Criteria Decision Analysis) to evaluate the different management measures against biological, economic and social objectives.

These seven fisheries selected reflect the vast range of biological and socio-economical situations of the marine resources and the fishing sector in the different EU Mediterranean countries. These fisheries differ in terms of size of vessels, types of fishing gears, fishing areas, exploited species and their stock status, and implemented management measures.

Biological and pressure/impact background

The biological BEMTOOL module consists of 4 components and a set of biological indicators describing the evolution and the status of the stocks. The aim of this module is to simulate variations in the biological dynamics of a population in response to changes of the fishing pressure.

This module is strongly related to the life history traits and the historical exploitation of a stock. Therefore, it is used only for stocks analytically assessed or simulated. In BEMTOOL the pooled landing and revenues related to other species for which stock assessments and simulations have not been run are estimated as fixed proportions of landings and revenues of stocks for which stock assessments and simulations have been run.

The evolution of each single stock is explained according to four main biological processes occurring during its life:

1. growth

2. recruitment

3. sexual maturity and sex ratio

4. mortality.

In the simulation model, in order to account for uncertainty in the biological parameters, a set of 100 values is randomly sampled from user specified distributions (log-normal, normal, gamma and uniform) for recruits, growth parameters and sizes at maturity, from which average parameters are estimated to initialize the model (see Lembo et al. 2009 for details)

Each single stock can follow a different population dynamics (in terms of biological parameters) and is simulated independently from the other stocks (i.e. there are no biological interactions between the different stocks in the model). The models are age and/or length structured, which allows accounting for changes in the exploitation pattern, as age and length based indicators are a direct output of the simulation model.

In BEMTOOL, the components related to the biological and pressure modules are developed to encompass assessment and forecast tools widely used in the Mediterranean (e.g. FLXSA (Kell et al. 2007), VIT, SURBA, FLR (Kell et al. 2007) Short and medium term forecasts, ALADYM simulation model). Moreover, the object oriented programming method and the use of the R language make the model very flexible to further implementations.

The model is fleet based which is particularly useful to evaluate the impact of the different fleet segments on the fish stocks, thus allowing taking into account the fleet specific exploitation patterns. The biological module includes processes as growth, maturity, natural mortality, recruitment, stock-recruitment relationships, total and fishing mortality, while the pressure component uses several selectivity functions (six selectivity functions are available to account for the multi-fleets and multispecies characteristics of the Mediterranean fisheries). The stock dynamic can be modelled at month scale, accounting for differences by sex in the stocks.

The recruitment can be calculated as a function of the spawning stock biomass at a previous time step (e.g. one month or year) by means of several stock-recruitment relationships (Beverton-Holt; Ricker; Shepherd; Hockey stick; Hockey-stick quadratic); however in the simulation approach of BEMTOOL, other alternatives are provided (constant recruitment, a recruitment vector, etc), thus accommodating different situations of data and parameter availability.

A vector of monthly proportion of offspring entering in the population each month and the age of recruitment (in months) allows to better estimate the peaks in recruitment during the year.

In ALADYM, which is the biological simulation and forecast tool of the model (the other tool is the FLR (Kell et al. 2007) routine for STF and MTF currently used in the EWG), a function related to recruitment calibration has been introduced that can be activated when the recruitment vector is used. This function calculates the constant of proportionality that will allow transforming an input recruitment time series from a relative abundance index to an absolute abundance. An iterative procedure is aimed to minimize an objective function based on the difference between observed and simulated yield time series in order to find the scaling value and, thus, the absolute abundance vector that better allow to recreate the observed yield. This function is particularly useful when absolute estimates of recruitment are not available or are unreliable, but recruitment indices can be derived, for example, from surveys as MEDITS.

If the stock-recruitment relationship has been selected, the related parameters have to be input; moreover, the user has to indicate the unit for the spawners to be used to calculate the recruits, because the spawners can be considered in biomass (tons) or in numbers (thousands), depending on the settings used in the stock-recruitment relationship. The user can also choose if the spawners regards only females or both sexes and if there is a delay for spawners calculation (in months) (e.g. the spawner of the month x produce the recruits at the month x+1 as in the spawning pattern of some species (cfr Lembo et al., 2009).

In the simulation model a source of perturbation in the recruitment can be added by a multiplier of the monthly number of recruits (from a vector or from an S-R relationship) distributed according to a user defined probability distribution function (log-normal, normal, gamma and uniform). Nevertheless, it is important to highlight that the model do not provide any sort of confidence intervals for the estimates of the different biological indicators.

In BEMTOOL, besides landings also discards can be modelled, allowing the discard-related dynamics to be included in the process.

In the forecast phase four different models can be chosen to reach the target reference point in a given time: knife-edge, linear, exponential negative and logistic models.

The MCDA is a new tool which permits to score different management alternative against objectives, giving specific weights to the biological and economic processes, besides the association of utility functions to the key biological indicators, economic indicators and reference points.

BEMTOOL platform requires R, R specific libraries (FLCore_2.5.0, FLAssess_2.5.0, FLXSA_2.5, FLash_2.5.0, FLBRP_2.5.0, ggplotFL_0.1, FLAdvice_1.0; akima_0.5-7, ggplot2_0.8.9, plyr_1.8, proto_0.3-10, rcom_2.2-5, reshape_0.8.4, RGtk2_2.20.25, rscproxy_2.0-5) and the statconnDCOM Server to be installed. Once this operation has been accomplished the model can be run using a Graphical User Interface (GUI).

EWG 13-09 was requested to:

1.*Test the current Beta version of the software and identify possible problems in its installation, running and compatibility with the outcomes of stock assessment tools regularly used by the STECF EWG.*

In BEMTOOL the components related to the biological and pressure modules are developed in a way to encompass, in a wide R platform, both assessment and forecast tools widely used in the Mediterranean (e.g. FLXSA (Kell et al. 2007), VIT, SURBA, FLR (Kell et al. 2007) Short and Medium term forecasts, ALADYM simulation model). In case of FLXSA the object can be easily read by BEMTOOL, while for the other models based on executable proprietary software, templates have been prepared to import the stock assessment outputs into the BEMTOOL frame. The Graphical User Interface (GUI) can re-call all the inputs of an already run case study to implement a new case study. The BEMTOOL graphical interface allows users to run the BEMTOOL model even if they are not experts in programming languages, like R. Using GUI, the user can configure the case study setting the input in logically separated tabs for general configuration, biological parameterization and economic settings. It is also possible to recall an already configured case study loading the configuration file located in the BEMTOOL application folder and re-run the simulation with a modified parameterization. Many functionalities are included in the GUI to facilitate the user when running the simulations using one or a combination of the provided management measures; e.g. if the users want to reduce the effort (number of vessels or the days at sea) of a given percentage in a given time span they do not need to manually calculate the reduction, but they can use the automatic function in the GUI. The object oriented programming method and the use of R language makes the model very flexible to further implementations.

During the meeting, the current Beta version of the BEMTOOL software was installed and run in one new computer (with a user who had no previous contact with the BEMTOOL software). The installation procedure is detailed in Annex 1 of the TOR F (Annex 1 of the BEMTOOL evaluation available online under request to the JRC). The installation and running of the BEMTOOL platform is rather complex. BEMTOOL requires a standard R installation and the installation of a number of libraries from .zip local file provided in the "installation files" folder. The running of BEMTOOL with the graphical interface requires the installation of StatconnDCOM Server that involves the manual modification of the Windows environment variables. In case the default path value has not been automatically set by the OS during the R installation, the modification of a registry key has to be done by the user by means of a explorer window that ease the retrieval of the variable to be modified. This might create some problems during the installation of the software and especially the manual modification of the registry key is risky and should be avoided in an improved version of the software.

Fortunately, there is a detailed user's manual that guides through the whole process. However, this complex and time consuming installation could hamper the initial use of the BEMTOOL platform in expert groups (i.e. SGMED) for regular scientific advice. A more user friendly installation procedure could solve this issue

The major outcomes of the assessment/simulation models in BEMTOOL are: SSB, F (overall and by fleet), Z, Yield (overall and by fleet), Reference points (e.g. F_{01}, F_{MSY}). In addition, other metrics are produced as, for example, mean length of the stock, mean length of the catches (overall and by fleet), landings (overall and by fleet) discards (overall and by fleet), SPR and further reference points as F_{02}, ZMBP, F_{max}. In the "Case Study on the Demersal fishery in GSA 18 - Southern Adriatic Sea” no variation was added to the month recruitment. However, uncertainty around the trajectories in the Kobe plot cannot be displayed because the model does not provide estimates of the confidence intervals. Thus, it is important to highlight that the model do not provide any sort of confidence intervals for the estimates of the different biological indicators.

2.*Run at least one case study in relation to the management scenarios indicated in point c) above while taking into account whether advisable improvements in the exploitation pattern of the fisheries concerned are needed (see also ToRs b) and g.2)).*

A case study (Annex 2 of the BEMTOOL evaluation available online under request to the JRC) has been carried out for the four main species (*M. barbatus, P. longirostris, N. norvegicus* and *M. merluccius*) and fleets operating in GSA18 (VL0612-VL1218; DTS VL1218-1824; DTS VL1824-2440; HOK VL1218 m; and PGP VL0612). EWG 13-09 stress the fact that at that stage the interpretation of the results of the simulations presented here should not be used for management purposes but only to show the potentiality of the model to simulate different management scenarios.

The following scenarios indicated by the point c) of the ToRs have been simulated:

1) the status quo;

2) target to Fmsy for 2015.

The target to F_{msy} has been simulated for 5 years (to 2016), running the simulations for 5 additional years to see the consequences of the harvesting strategy after the system was stabilised. The F_{msy} of both the species with higher (hake) and lower (Norway lobster) F/ F_{msy} ratio were tested.

To simulate the scenario 2) different trajectories were used accounting as much as possible for the complexity given by the number of stocks and fleet segments:

- permanent withdrawal (vessels reduction) to F_{msy} of hake in 5 years for the fleet segments of trawlers;

- reduction of F (50% from activity reduction; 50% from vessels reduction) by fleet segment (all the fleet segments affected) to F_{msy} of hake in 5 years;

- reduction of F (50% from activity reduction; 50% from vessels reduction) by fleet segment (all the fleet segments affected) to F_{msy} of Norway lobster in 5 years;

In addition, two further scenarios were run in relation to the ToRs b) and g.2) and to the point 6) (seasonal closure) of the ToR F):

- change the length at first capture of the four species according to a mesh size of trawl net of 60 mm opening (only trawl fleet segments affected);

- seasonal closure of 4 months (100% of the trawler fishing activity reduced from July to October).

Three of the four stocks involved in the case study are located in the red zone of the Kobe plot (i.e. risky zone); only *N. norvegicus*, is in the orange area, which indicated that the stock is subject to a fishing mortality higher than the reference point (i.e. F_{01}), but with a SSB higher that the SSB at level $F=F_{0.1}$. Variations around the trajectories in the resulting metrics could not be displayed because the model does not provide estimates of the confidence intervals

Running the scenarios with the current exploitation patterns (status quo scenario) shows that the status of most stocks and economic performance in the fishery will worsens. On the other hand, significant improvements in the status of stocks and economic performance in the fishery can be obtained when the exploitation patterns are improved (e.g. through changes in selectivity). Therefore, results of the different simulations on selectivity changes highlight variations in the relevant metrics towards sustainability. Consequently, improvements in the exploitation pattern in the fishery are needed. The results of the different simulations are reported in the Annex 2 of the ToR F) - Case study on the demersal fishery in the GSA 18 - Southern Adriatic Sea.

3.*Integrate, where necessary, with latest updated data/parameters the case studies currently uploaded in the Beta version.*

BEMTOOL developers have already set up and simulated management scenario for several case studies; in particular fisheries in the following areas were included as case studies: GSA 06 (data update to 2011); GSA 07 (data update to 2011); GSA 09 (data update to 2010); GSA 15&16 (data update to 2011); GSA 18 (data update to 2011) GSA 20 (data update to 2006) and GSA 22 (data update to 2006). During EWG 13-09 the case study of GSA 18 has been updated using the results of the last assessment (i.e. obtained during EWG 1309) of hake performed in the area using XSA. These results are reported in the Annex 2 (available online under request to the JRC) to the TOR F) - Case study on the demersal fishery in GSA 18 - Southern Adriatic Sea.

4.*Discuss the consistency and results of the different fleet, stock and socio-economic projections obtained with BEMTOOL.*

It is important to stress that before to apply the BEMTOOL for regular scientific advice it is necessary to check the robustness and consistency of the model results by extensive running of case studies different than these collated so far by the development team. Unfortunately, time and personnel constrains, did not allow the working group to perform a very detailed evaluation of the model in that respect.

The current version of the software BEMTOOL is a Beta version. All the documentation of the BEMTOOL project was provided for the evaluation made by the EWG 13-09. However, it is important to highlight that no assessment of the BEMTOOL platform is currently available by third parties or in peer-reviewed journals. Nevertheless, most of the bio-economic models considered in the BEMTOOL have been historically used to model data in Mediterranean fisheries and have been also largely reviewed:

•BIRDMOD/ALADYM: Lembo et al. (2009), and Spedicato et al. (2010).

•BEMMFISH: none.

•FISHRENT: Frost et al. (2013).

•IAM: Macher (2008), Macher & Boncoeur (2010), Raveau et al. (2012), and Guillen et al. (2013).

•MEFISTO: Lleonart et al. (1999), Lleonart et al. (2003), Maynou et al. (2006), Mattos et al. (2006), Merino et al. (2007a), Merino et al. (2007b), Merino et al. (2007c), Merino et al. (2008), Silvestri and Maynou (2009), and Guillen et al. (2012).

It is also important to notice that the major objective of the BEMTOOL project was to make the model flexible to accommodate different model functions and data availability. However, it is also important to stress that in some cases, as for example concerning some of the equations taken from MEFISTO, these equations were adapted to the different structure of BEMTOOL (for example because MEFISTO works at vessel level while BEMTOOL operates at fleet segment level). These differences are generally documented in the manual but the effect on the results when modelling the same data set has never been tested. EWG 13-09 consider also that in order to avoid confusion, when existing models are modified they should be given a different name (e.g. “modified from MEFISTO original equation”) in the BEMTOOL manual.

Indeed, in the BEMTOOL platform, the functions that relate the landings and revenues of the “assessed species” (assuming as “assessed species” the ones that input data have been introduced and consequently have been actively modelled) with the total landings and revenues from the fleet are not the same as in the MEFISTO or IAM models. In the “Economic indicators label” inside the “Economic parameters form”, appears a table to input data named “ALL MODELS, Coefficients for economic indicators”. The first two variables “landings corr. factor” and “revenues corr. factor” relate the “assessed species” landings and revenues with the total landings and revenues with just a multiplicative relation. This leads total landings and revenues to be proportional to the “assessed species” landings and revenues. This implies that any change in the landings or revenues from the “assessed species” proportionally affects the total profitability of the fleets, even if the “assessed species” represent just a minor share of the total revenues. This assumption might be appropriate in fisheries where a very large share of the landings and revenues come from the “assessed species”. However, in the Mediterranean, many fisheries are multispecies, and consequently the total landings and revenues are unlikely coming mostly from one species, but usually are generated from a large number of species. Thus, when assessed species represent a small percentage of the total landings and/or total revenues, the accuracy of the BEMTOOL economic outcomes will be necessarily lower. The correction factor for total landings and total revenues can be used also as a measure of the reliability of the outcomes. Thus, results for fleets with a very high correction factor should be taken carefully (see Annex 3 of the BEMTOOL evaluation available online under request to the JRC).

In this context, models like MEFISTO and IAM (which were considered in BEMTOOL) allow also for a constant component added to the proportional one. This would mitigate the problems highlighted above. However, assuming constant levels of landings and revenues for species other than the target ones could produce another type of problem. The constant levels of landings and revenues would be present independently on the level of the fishing effort of the modelled fleet which instead has an impact only on target species, unless this relation is weighted by the number of vessels or effort as in MEFISTO and IAM models. In any case, the accuracy of the simulations will be strongly dependent on the availability of data on most of the species exploited by the modelled fleets.

It is important to notice that BEMTOOL does not make any assumption on the impact of fleets which are not included in the simulations (e.g. non EU fleets exploiting shared stocks for which data are not available) but which are known to exploit the same resources of the modelled fleets. Therefore, if there is any fleet missing from the modelled scenarios (as for example in the presented case studies), results should be taken with caution. However, this is the case also for stock assessment when catches from non EU fleets cannot be reliably estimated and thus are not included in the model.

In the BEMTOOL platform, the concept of “economic yield” is associated to three economic outcomes: the gross value added, the profit and the ROI (return of investment). Therefore, the MEY would be the maximum long-term gross value added estimated at different levels of the control variable” (Annex II, D2 final report, Page 21). BEMTOOL does not estimate the opportunity cost of labour, which would be needed to calculate MEY. However, a general model which estimate the opportunity cost of labour does not exist. Therefore, BEMTOOL estimates a proxy of MEY using the maximum profits or GVA.

5.*Make recommendations to better integrate BEMTOOL forecasts and evaluation of management scenarios in regular scientific advice.*

BEMTOOL is a complex tool in which several models could interact and the flow of information in the model is managed by structured software arranged in an R platform. The knowledge of the operational modules and components of BEMTOOL and their interactions would have required a deep analysis of the available documentation, which was not possible during EWG 13-09. Notwithstanding the limited amount of time and human resources available, the EWG 13-09 advice that:

•As outlined before in points 1-3, BEMTOOL would benefit from an easier procedure of installation of the software. Further recommendations and minor issues on the BEMTOOL software are detailed in the Annex 4 of the TOR F (Annex 4 of the BEMTOOL evaluation available online under request to the JRC).

•Simulation testing is generally used to evaluate model performance against data with known underlying properties. Although several tests were already done for some case studies in BEMTOOL, a thorough simulation testing with economic and biological data would be necessary as well as a peer review of the software.

•As outlined in sections 1-3, BEMTOOL does not allow the propagation of different kind of uncertainty (i.e. observation error, model uncertainty, implementation error) across models (biological and economic) and in the projections. This means it is not possible to obtain the estimates of the confidence intervals or quantiles around the projected means. Thus, EWG 13-09 consider that if managers wish to carry out a risk analysis between alternative management scenarios, BEMTOOL should account for uncertainty in the simulations.

Suggestions for future development of the BEMTOOL model

✓Even though multispecies projections can be produced by BEMTOOL, no species interactions are modelled explicitly (e.g. food dynamics or predatory behaviour). This is a challenging task and should be considered in a future development of the BEMTOOL model.

✓In the current implementation there is no evident way to model how changes in environmental conditions, e.g. food availability, temperature, etc., affect stock productivity as for example recruitment and growth. This is a challenging task and should be considered in a future development of the BEMTOOL model.

✓In the pressure module a function linking the fishing effort to the fishing mortality levels could be added in order to account for the possible deviations from the one-to one relationships between the two entities, which is now the standard default of BEMTOOL.

✓BEMTOOL should include more flexible relations between “assessed species” and total species” to allow for a better estimation of the total landings and revenues from non assessed species.

✓In general, EWG 13-09 consider that the direction for future development and improvement of BEMTOOL should be along the lines of the Management Strategy Evaluation (Punt and Donovan, 2007) in order to be able to test proposed management plans and include a formal consideration of the uncertainty. This will move towards a risk based management which supports the Precautionary Approach to fisheries as recommended by FAO and by the current reform of the Common Fisheries Policy.

6. *Indicate whether BEMTOOL is adequate to evaluate the effects on fisheries and stocks of area based management approaches (i.e. marine protected areas, fisheries restricted areas, fishing protected areas etc.) and/or seasonal closures. Provide information on format, data needed and time/spatial scale to these ends and comment as adequate whether data submitted following the data calls carried out so far are suitable to this scope.*

The BEMTOOL was not built with a spatial module, consequently it is not adequate to evaluate the effects of area based management approaches on fisheries and stocks. On the other hand, seasonal closures can be implemented considering that the model has the month as time step.

Biological, transversal and economic data collected under the DCF are not suitable for proper spatial analysis because they lack of enough disaggregated spatial dimension. Seasonal closures can be modelled using DCF data under certain assumptions. One simplification that needs to be applied would be to assume that costs are the same each month, since economic data is collected and reported by year.

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11. TOR G OTHER BUISINESS

11.1. IDENTIFICATION OF THE STOCK PRIORITY LIST FOR FUTURE MEETINGS

TOR G1. Taking into account the catch composition of the different fisheries/metier, the biological characteristics and the current level of overfishing identify the major stocks of the different species whose scientific assessment has to be carried (yearly, biennial, triennial etc). The suggested framework would enable a regular monitoring of recovery of major stocks in the Mediterranean. This should support the formulation of scientific advice for the management of mixed fisheries, in line with the Mediterranean EWG-advice.

The previous EWG meeting 12-19 proposed a prioritized schedule for assessments including 30 major stocks to be assessed per year. Thus, 16 stocks have been assessed in the current EWG 13-09, with the view to assess the remaining 14 stocks in the second yearly EWG 13-19 meeting in December (Table 11.1).

The set of criteria adopted to identify major stocks to be assessed was:

- Contribution to the catch and prominence in landings. The selection is limited for each GSA to the first ranked species that cover most (around 80%) of the total landings.
- Commercial value to prioritize the commercially important species by area. This is particularly critical for small pelagics that were assessed only in a very limited number of GSAs, despite of their high commercial importance.
- Conservation status including threatened species (species included in red lists, elasmobranchs action plans, etc.).
- Availability of fisheries data (e.g. catches, landings,) and essential information that enables to run "analytical" assessment (e.g. age structure, biological features, etc…). Whenever data availability allows, species that have never been assessed will have a higher priority.
- Classification according to life span into two categories short and long living species. Small pelagics species (e.g. anchovy and sardine) together with cephalopods (e.g *Sepia officinalis*) should be in the first category (short living), and the remaining stock species in the second class (long living). This categorization will help to specify the frequency of assessment and revisions of stocks.

The results of fish stock selection and ranking is summarized in Table 11.1 presenting major stocks in each GSA planned to be assessed in the forthcoming meetings. The EWG 13-09 noted that taking in account the limited number of stocks, the current established priority list would not support the development of a mixed fisheries framework advice. Evaluation of mixed fisheries would need a minimum number of stocks (e.g. 5-6) per area (i.e. GSA). However, EWG 13-09 consider that the number of stocks to be assessed by GSA in the forthcomings meetings (i.e. Table 11.1) should not be modified and thus the EWG 13-09 advises to conserve the current list of stocks for the forthcomings meetings. Therefore, the EWG 13-09 also advises that in order to develop mixed fisheries framework advice results of stock assessment conducted in the previous 2 or 3 years (i.e. 2010-2012) could be combined in order to satisfy the criteria of a minimum number of stocks per GSA. EWG 13-09 also advises that it would be optimal to develop mixed fisheries framework advice in ad-hoc working groups and not within the regular stock assessment meetings.

Table 11.1 Proposed priority list for which stock assessment should be performed in each calendar year.

						Year
GSA	**CODE**	**Common name**	**Species**	**2013 (1)**	**2013 (2)**	**2014 (both meetings)**
1	PIL	Sardine	*Sardina pilchardus*		1	
1	ARA	Blue and red shrimp	*Aristeus antennatus*			
1	HKE	Hake	*Merluccius merluccius*	1		
1	DPS	Deepwater Pink shrimp	*Parapenaeus longirostris*	1		
1	MUT	Red mullet	*Mullus barbatus*			1
5	ARA	Blue and red shrimp	*Aristeus antennatus*			1
5	MUR	Striped red mullet	*Mullus surmuletus*		1	
5	HKE	Hake	*Merluccius merluccius*			1
5	NEP	Norway lobster	*Nephrops norvegicus*			1
5	DPS	Deepwater Pink shrimp	*Parapenaeus longirostris*	1		
5	MUT	Red mullet	*Mullus barbatus*		1	
6	PIL	Sardine	*Sardina pilchardus*			1
6	HKE	Hake	*Merluccius merluccius*			
6	ANK	Black-bellied angler	*Lophius budegassa*			1
6	DPS	Deepwater Pink shrimp	*Parapenaeus longirostris*	1		
6	MUT	Red mullet	*Mullus barbatus*		1	
6	ARA	Blue and red shrimp	*Aristeus antennatus*			1
7	PIL	Sardine	*Sardina pilchardus*		1	
7	ANE	Anchovy	*Engraulis encrasicolus*			1
7	HKE	Hake	*Merluccius merluccius*	1		1
7	ANK	Black-bellied angler	*Lophius budegassa*			1
7	MUT	Red mullet	*Mullus barbatus*			1
9	PIL	Sardine	*Sardina pilchardus*		1	1
9	HKE	Hake	*Merluccius merluccius*			
9	MUT	Red mullet	*Mullus barbatus*			1
9	DPS	Deepwater Pink shrimp	*Parapenaeus longirostris*			1
9	NEP	Norway lobster	*Nephrops norvegicus*			1
9	ARS	Giant red shrimp	*Aristaeomorpha foliacea*	1		
10	HKE	Hake	*Merluccius merluccius*	1		
10	DPS	Deepwater Pink shrimp	*Parapenaeus longirostris*	1		
10	MTS	Spottail mantis	*Squilla mantis*			1
10	MUT	Red mullet	*Mullusbarbatus*			1

11	HKE	Hake	*Merluccius merluccius*	1		
11	MUR	Striped red mullet	*Mullus surmuletus*		1	
11	MUT	Red mullet	*Mullus barbatus*		1	
11	ARS	Giant red shrimp	*Aristaeomorpha foliacea*			1
11	DPS	Deepwater Pink shrimp	*Parapenaeus longirostris*			1
15&16	ANE	Anchovy	*Engraulis encrasicolus*			1
15&16	PIL	Sardine	*Sardina pilchardus*			1
12-16	ARS	Giant red shrimp	*Aristaeomorpha foliacea*			
12-16	DPS	Deepwater Pink shrimp	*Parapenaeus longirostris*			
12-16	NEP	Norway lobster	*Nephrops norvegicus*	1		
15&16	ARA	Blue and red shrimp	*Aristeus antennatus*	1		
15&16	PAC	Common Pandora	*Pagellus erythrinus*			
12-16	HKE	Hake	*Merluccius merluccius*			
15&16	MUT	Red mullet	*Mullus barbatus*			
15&16	MUR	Striped red mullet	*Mullus surmuletus*		1	
15&16	OCC	Common octopus	*Octopus vulgaris*			1
4,5,11-16	DOL	Common dolphinfish	*Coryphaena hippurus*		1	
17	ANE	Anchovy	*Engraulis encrasicolus*		1	
17	PIL	Sardine	*Sardina pilchardus*		1	
17	HKE	Hake	*Merluccius merluccius*			1
17	MUT	Red mullet	*Mullus barbatus*			1
17	MTS	Spottail mantis	*Squilla mantis*			1
17	SOL	Common sole	*Soleasolea*	1		
18	ANE	Anchovy	*Engraulis encrasicolus*		1	
18	HKE	Hake	*Merluccius merluccius*	1		
18	MUT	Red mullet	*Mullus barbatus*			1
18	MTS	Spottail mantis	*Squilla mantis*			1
18	DPS	Deepwater Pink shrimp	*Parapenaeus longirostris*			1
19	DPS	Pink shrimp	*Parapenaeus longirostris*	1		
19	ANE	Anchovy	*Engraulis encrasicolus*		1	
19	HKE	Hake	*Merluccius merluccius*	1		
22&23	ANE	Anchovy	*Engraulis encrasicolus*		1	
22&23	PIL	Sardine	*Sardina pilchardus*			1
22&23	HKE	Hake	*Merluccius merluccius*			
22&23	MUT	Red mullet	*Mullus barbatus*			1
25	MUR	Striped red mullet	*Mullus surmuletus*			1
25	MUT	Red mullet	*Mullus barbatus*			1
TOTAL STOCK NUMBER				15	15	32

11.2. MISMATCH BETWEEN THE LEGAL MINIMUM CATCHING SIZE OF A STOCK AND THE ACTUAL EXPLOITATION PATTERN OF THE VARIOUS FISHERIES EXPLOITING IT

ToR G2: Identify and comment as adequate possible mismatching between the legal minimum catching size of a stock and the actual exploitation pattern of the various fisheries exploiting it. Due account shall be given to the data submitted through the official data call and/or additional expert knowledge.

Identify the specific target fishing mortality to restore and maintains populations of harvested species above levels which can produce the maximum sustainable yields is also related to the specific exploitation pattern of the fisheries concerned. The Council Regulation (EC) N° 1967/2006 stipulates the minimum catching size, for several species.

EWG 1309 notes that there is an evident mismatch between the enforced legal minimum catch size and the exploitation pattern of several Mediterranean fisheries. This is particularly evident for bottom trawling, which utilize small mesh sizes in the codend producing a high by-catch of undersized specimens. Despite the recent increases in the legal codend mesh size of trawlers, no major changes have been observed in their catch/size composition, which is still composed by a high proportion of undersized specimens. The assessments performed for many stocks in the Mediterranean suggest that the current exploitation pattern produce a clear loose in potential yields and a lower probability of individuals to reach the adult phase and thus to spawn at least once.

In a recent paper, Colloca et al (2013) analysing data regarding several 36 Mediterranean stocks, observed that the current age at first capture generally occurs in the first or second year of life, which is often before the age of first maturity and well below the optimal length (L_{opt}; i.e.: the mean length of the age group in which the biomass of an unexploited stock achieve its maximum level). They found that under the current fishing regime, stock productivity and fleet profitability are generally impaired by a combination of high fishing mortality and inadequate selectivity patterns. For most of the stocks analysed, a simple reduction in the current fishing mortality (F_{cur}) towards an MSY reference value (F_{MSY}), without any change in the fishing selectivity, will allow neither stock biomass nor fisheries yield and revenue to be maximized.

Controlling exploitation pattern has an important role in terms of conservation. The technical measures can also contribute to the regulation of exploitation rate. The existence of a trade-off between exploitation rate and exploitation pattern is evident: a lower exploitation of juveniles allows for a moderately increased exploitation rates of adults.

Catching fish after they have spawned at least once is a concept supported by several studies. The benefits from allowing fish to spawn at least once are associated with the goal of allowing individual fish to grow up to the size linked to the optimal yields (L_{opt}) and with the production of enough number of spawners that will guarantee the replacement of the population. There is however an increasing number of studies that suggest also alternative ways of optimal exploitation patterns, which may include the protection of older and larger females, keeping fishing pressure directed mostly to younger adults (even though at moderate rates).

There is also an increasing awareness that rebuilding the size- and age-structure of exploited populations is a management objective that combines single species targets such as MSY with specific goals of the ecosystem approach to fisheries management (EAF), preserving community size-structure and the ecological role of different species.

The current compliance of Mediterranean trawl fisheries with the current minimum catch sizes enforced by EU reg 1967/2006 was analised during EWG 13-09 for a set of demersal stocks (Table 11.2). Results showed a very reduced compliance for hake stocks in GSAs 10, 11 and 19 with a percentage of specimens below the minimum legal size (20 cm) between 60% and 72%. Also for the deep-sea pink shrimp there was a high catch of undersized specimens (43-44%) in GSAs 10 and 19. It is however important to notice that for several stocks the minimum legal size is smaller than the length at first maturity and always much smaller than the L_{opt} (Colloca et al., 2013). This implies that the current minimum legal size is inadequate to achieve MSY and allow rhe revenue from the fleets to be maximized.

Table 11.2. Index of legal compliance (% catch below of minimum size) for the stocks assessed during EWG 13-09

GSA	CODE	Common name	Species	Index of legal compliance (% catch below legal size)
1	HKE	Hake	*Merluccius merluccius*	6.6%
1*	DPS	Pink shrimp	*Parapenaeus longirostris*	12.4%
5	DPS	Pink shrimp	*Parapenaeus longirostris*	4.3%
6	DPS	Pink shrimp	*Parapenaeus longirostris*	2.0%
7	HKE	Hake	*Merluccius merluccius*	25.0% SP trawlers 36.0% F trawlers
9	ARS	Giant red shrimp	*Aristaeomorpha foliacea*	N/A
10	HKE	Hake	*Merluccius merluccius*	60%
10	DPS	Pink shrimp	*Parapenaeus longirostris*	44%
11	HKE	Hake	*Merluccius merluccius*	72%
15-16*	NEP	Norway lobster	*Nephrops norvegicus*	2.1%
15-16*	ARA	Blue and red shrimp	*Aristeus antennatus*	N/A
19	HKE	Hake	*Merluccius merluccius*	68%
19	DPS	Pink shrimp	*Parapenaeus longirostris*	42.8%

Others

Selectivity of Mediterranean fisheries, use of discard data and slicing methodologies in the assessment

Selectivity

During previous EWGs the assessment of the different stocks has been performed using model of increasing complexity, which were generally constrained by the length of the time series of the available data. In the first years, when time series of catch at age were short (i.e. less than 3 years), the assessment has been often conducted using VIT (i.e. pseudochort analysis), moving successively to VPA (i.e. XSA) when time series of catch at age were usually longer than 5 years. However, one of the major issues with XSA is that the method does not allow the use of different functional form of selectivity than the logistic (e.g. dome shaped) and it does not allow the estimation of selectivity. Such shortcoming restricts the number of selectivity scenarios that can be modeled for each stock assessment. Mediterranean demersal fisheries are often characterized by an intense exploitation of juveniles, while older individuals are less available to the gears, especially trawls, as they are more abundant in non trawlable areas as for example is the case for hake, and for sole in GSA 17. Moreover, often different gears exploit different age classes within the population. This implies that using a single logistic selectivity as assumed in the XSA might tend to overestimate F and underestimate SSB.

Nowadays, more flexible models exists (e.g. statistical catch at age), which can actually estimate or use different selectivity functions but these models are more complex and have been limited tested in the Mediterranean: only for 2 stocks during EWG 13-09 , sole in GSA 17 with SS3 and Norway lobster in GSA 15&16 and Hake in GSA 07 with FLa4a. EWG 13-09 consider that it would be crucial to evaluate the possibility of using statistical catch at age models in the future with different assumption on selectivity by fleet.

EWG 13-09 also consider that, in order to have a concrete rationale behind the choice of the more appropriate methodology (i.e. constant selectivity after a certain age or other functional form of selectivity), the availability of VMS data and/or AIS (Automatic Identification System) where available is crucial to verify the overlap between the effort of the main fisheries and the different age classes of the target species. VMS data are already requested in the framework of Commission decision 2010/93/EU for the definition of environmental indicators to measure the effects of fisheries on the marine ecosystem (Appendix XIII).

Discard data

For many of the assessments, discard data are not used as there are gaps in the times series (i.e. missing estimates for particular years or gears). Thus EW 13-09 consider that would be important to set up and agree on a common methodology to reconstruct times series of discard data to be used in stock assessment in the future.

Slicing

Slicing is a crucial step in the stock assessment of Mediterranean fisheries as it allows to convert numbers at length to number at age from both catches and surveys to be used in the analysis. However, in the last years several methods have been used for the different stock, i.e. knife edge slicing, LFDA package, statistical slicing and deterministic slicing with no clear rule on whether the numbers at length are/should be sliced before or after the stratification of the index. Thus EWG 13-09 also consider that would be important to set up and agree on a common slicing methodology to reconstruct times series of catch at age data to be used in stock assessment in the future.

EWG 13-09 therefore recommends that an ad-hoc methodological EWG should be held in the beginning of 2014 to set up and test different assumption of selectivity for a set of stocks and about the use of discard data and slicing methodologies in the assessment. Thus, the EWG should:

TORs

- Collate and assemble the necessary input data by fleet for stocks of hake and Norway lobster in selected GSAs

- Run statistical catch at age assessment models with different assumptions on selectivity (i.e. dome shaped, logistic, etc)
- Discuss and compare the results with previous assessment conducted by XSA or other models
- Set up a common methodology to reconstruct times series of discard data to be used in future stock assessment
- Decide upon a common slicing methodology to reconstruct times series of catch at age data to be used in future stock assessment

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ANNEX I LIST OF PARTICIPANTS TO STECF EWG 13-09

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ANNEX II STOCK SUMMARY TABLE

GSA	Common name	Species	Presentation	Assessment	Comment	Status	F/F_{MSY}
1	Hake	*Merluccius merluccius*	Yes	XSA	Accepted	Overexploited	7.32
1	Pink shrimp	*Parapenaeus longirostris*	Yes	XSA	Accepted	Overexploited	1.65
5	Pink shrimp	*Parapenaeus longirostris*	Yes	XSA	Accepted	Overexploited	1.24
6	Pink shrimp	*Parapenaeus longirostris*	Yes	XSA	Accepted	Overexploited	5.48
7	Hake	*Merluccius merluccius*	Yes	XSA	Accepted	Overexploited	16.64
9	Giant red shrimp	*Aristaeomorpha foliacea*	Yes	XSA	Accepted	Overexploited	1.72
10	Hake	*Merluccius merluccius*	Yes	XSA	Accepted	Overexploited	7.14
10	Pink shrimp	*Parapenaeus longirostris*	Yes	XSA	Accepted	Overexploited	1.33
11	Hake	*Merluccius merluccius*	Yes	XSA	Not accepted	Unknown	NA
15-16	Norway lobster	*Nephrops norvegicus*	Yes	a4a	Accepted	Exploited sustainably	0.75
15-16	Blue and red shrimp	*Aristeus antennatus*	Yes	VIT	Accepted	Overexploited	3.12
17	Common sole	*Solea solea*	Yes	SS3 by fleet	Accepted	Overexploited	3.00
18	Hake	*Merluccius merluccius*	Yes	XSA	Accepted	Overexploited	5.26
19	Pink shrimp	*Parapenaeus longirostris*	Yes	XSA	Accepted	Overexploited	1.96
19	Hake	*Merluccius merluccius*	Yes	XSA	Accepted	Overexploited	5.50

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Abstract

The Expert Working Group meeting of the Scientific, Technical and Economic Committee for Fisheries EWG 13-09 was held from 15 – 19 July 2013 in Ispra, Italy to assess the status of demersal and small pelagic stocks in the Mediterranean Sea against the proposed FMSY reference points. The report was reviewed and endorsed by the STECF during its plenary meeting held from 4 to 8 November 2013 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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