European Commission

JRC SCIENTIFIC AND POLICY REPORTS

Scientific, Technical and Economic Committee for Fisheries (STECF)

Mediterranean Assessments part 2 (STECF-15-06)

Edited by
Massimiliano Cardinale (EWG chair),
Dimitrios Damalas and Chato Giacomo Osio (JRC)

This report was reviewed by the STECF during its spring plenary meeting held from 13 to 17 April 2015 in Brussels, Belgium

Report EUR 27221 EN

Joint Research Centre

European Commission
Joint Research Centre (JRC)
Institute for the Protection and Security of the Citizen (IPSC)

Contact information
STECF secretariat
Address: Maritime Affairs Unit, Via Enrico Fermi 2749, 21027 Ispra VA, Italy
E-mail: stecf-secretariat@jrc.ec.europa.eu
Tel.: 0039 0332 789343
Fax: 0039 0332 789658

JRC Science Hub
https://ec.europa.eu/jrc

JRC 95822
EUR 27221 EN
ISBN 978-92-79-48047-8
ISSN 1831-9424
doi:10.2788/20044

Luxembourg: Publications Office of the European Union, 2015

How to cite this report:
Scientific, Technical and Economic Committee for Fisheries (STECF) – Mediterranean Assessments part 2 (STECF-15-06). 2015. Publications Office of the European Union, Luxembourg, EUR 27221 EN, JRC 95822, 396 pp.

Abstract

The STECF expert working group "EWG 1419 - Mediterranean assessment part 2", has convened in Rome during 19-23 January 2015 and addressed a series of issues as requested by DG MARE in the correspompnding terms of references. The detailed output of this working group efforts is included in the following report. The report was reviewed by the STECF spring plenary during 13-17 April 2015.

TABLE OF CONTENTS

SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

Mediterranean assessments part 2 (STECF-15-06)

THIS REPORT WAS REVIEWED BY THE STECF DURING THE SPRING PLENARY 13-17 APRIL 2015

1.1. Request to the STECF

STECF is requested to review the report of the STECF Expert Working Group meeting 14-19, evaluate the findings and make any appropriate comments and recommendations.

1.2 Observations of the STECF

The meeting was held in Rome, Italy, from 19-23 January 2015. It was the second of the STECF expert meetings, within STECF's 2014 work programme, planned to undertake stock assessments of demersal/small pelagic species in the Mediterranean Sea. The meeting was chaired by Massimiliano Cardinale and attended by 20 experts in total, including 4 STECF members. Furthermore, two JRC experts and one DG MARE representative were present.

Historical fisheries and scientific surveys data were obtained from the official Mediterranean DCF data call issued to Member States on April 15th 2014 with deadline on 9th of June 2014. The data call also defined a second deadline on 12th January 2015 for the submission of trawl surveys data for Mediterranean Member States. The data call and its format are documented on the JRC's DCF website (http://datacollection.jrc.ec.europa.eu/data-calls). The timeline of upload has been in many cases well after the data call deadline and therefore the deadline was not respected by several MSs. Moreover, not all the requested data were provided by the MS; details can be found online in the following link:

https://visualise.jrc.ec.europa.eu/t/dcf/views/medbs_coverage/Coverage?:embed=y&:display_count=no

as well as in the DCF Data Call Coverage Report for the Mediterranean and Black Sea in 2014 (JRC 2015).

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

ToRs(1-2) Update and assess historic and recent stock parameter for a list of stocks and provide a synoptic overview for each stock: the EWG-14-19 analysed the data of 16 stocks.
9 out of 10 assessed stocks were classified as exploited unsustainably; the status of the remaining 6 stocks could not be defined due to data deficiencies or poor model fits (Table 4.1.1.).

ToR(3) Provide short and medium term forecasts of stock biomass and yield: the EWG-14-19 conducted short-term forecasts of stock size and catches for seven stocks. For three stocks it was not possible to carry out short-term forecasts due the use of a steady state approach in the assessment and to the high uncertainty evidenced by the retrospective analyses. Medium-term forecasts were not carried out due the lack of meaningful stock recruitment relationships (Table 1.3.1.).

ToR(4) Review the quality and completeness of all data: in fulfilment of TOR(4), stock-specific evaluation of the data quality were conducted for all stocks requested under TORs (1-3) by the EWG-14-19 experts. Moreover, the JRC team examined the data coverage and quality for the fisheries and survey data.

Issues in catch data of giant red shrimp and deep sea pink shrimp stocks of GSA 11 were evidenced. Such issues impeded to conduct an analytical stock assessment for these stocks. Issues with catch data of GSA 11 have been repeatedly highlighted by STECF in previous reports.

As in the past, France did not provide any fisheries data for GSA 8 (i.e. Corsica); moreover effort data for all French GSA's are absent prior to 2012.

Italy did not provide any catch data prior to 2004, no abundance-biomass data for small pelagics before 2008 and no MEDITS data for Italian GSA 17 prior to 2002.

As a result of not conducting DCF, Greece did not submit any data for 2009-2012 and submitted only last quarter of 2013.

Due to the very narrow time interval between data submission deadline and the meetings starting date, access to data was made available to the experts too late. As a result data deficiencies for certain stocks were not possible to be identified in due time before the meeting and this resulted in assessing less stocks than initially foreseen.

STECF supports the request of the EWG to anticipate future deadlines for data submissions by Member States, that should be set at least one month before the meeting so that access to the compiled data could be given to the experts one or two weeks before the meetings' starting date.

ToR(5) Update the proposed priority list for which stock assessment should be performed in each calendar year: in fulfilment of TOR (5), a document with the criteria defined for prioritising the stocks to be assessed between 2015 and 2017 have been produced. Also, a table with the list of the stocks proposed to be assessed in 2015, 2016 and 2017, based on the defined criteria, has been included in the report of the EWG.

ToR(6) Explore the possibilities to apply data-limited stock methods to assess the status of cephalopods: in fulfilment of TOR (6), a Multi-annual General Depletion Model was explored to produce a preliminary assessment of the cuttlefish *Sepia officinalis* in the Barcelona maritime district (comprising the ports of Arenys de Mar, Badalona, Barcelona and Vilanovai la Geltrú) in GSA 6. The model is able to satisfactorily fit the data and the diagnostics of the final model show that the catches (in number) can be reasonably predicted and that predictions are unbiased. The evolution of the vulnerable biomass of cuttlefish shows an increase in the last 10 years of the series, probably linked to a decrease in the fishing effort (and therefore fishing mortality) exerted by bottom trawlers.

ToR(7) The EU has the intention to adopt a multiannual management plan for small pelagic species in the North Adriatic Sea. Discuss and propose the most scientifically sound MSY value or range of values and safeguard points, in terms of F and stock biomass: in fulfilment of TOR (7), EWG 14-19 estimated reference points (fishing mortality and biomass) for anchovy and sardine in GSA 17. Estimation of reference points was done based on the methodology recently used by ICES for North Sea and Baltic Sea stocks. The same procedure was applied to the same stocks during the EWG 12-19 and EWG 13-19. Several different scenarios with different values of B_{lim} and length of the time series were fitted to the latest stock assessment data (i.e. data up to 2013). The F_{MSY} values ranged from 0.057 to 0.198 for sardine and between 0.225 and 0.429 for anchovy, and were dictated by the choice of B_{lim} and the length of the time series used. However, EWG 14-19 did not reach consensus on which scenario should be used to define reference points (fishing mortality and biomass) for the stocks anchovy and sardine in GSA 17.

During the STECF Plenary 15-01, the experts revised the outcomes of the EWG-14-19 regarding TOR

(7). The lack of an acceptable fitting for both stocks makes results uncertain and not useful. However, the range of F values derived from the analyses obtained under different assumptions appear to be in line with what shown by ICES (ICES 2014) for other species of small pelagics as sprat and herring in the North Sea and Baltic Sea.

The methodology developed by ICES to estimate F_{MSY} ranges (i.e. MSY package) allows mixing different stock-recruitment relationships for a single stock. This feature allows the analysis to take into account model uncertainty, which is more important when there is not a clear S/R emerging from the assessment results. The application of this methodology to the stocks of sardine and anchovy in the Adriatic Sea was explored by SGMED but neither Beverton and Holt model nor Ricker or a combination of the two models were able to fit the stock and recruitment observation for the two species, and thus an hockey-stick model was chosen. STECF Plenary 15-01 considers that the evaluation of biological risk (i.e. probability of SSB falling below B_{lim}) could be done using also other methods. STECF consider that by restricting the risk evaluation to the outcomes of the same runs that are used to estimate the F_{MSY} ranges, might underestimate risk by conditioning the analysis on the same levels of productivity. An MSE algorithm could be an alternative to MSY package in the future, integrating across several plausible scenarios to evaluate the robustness of the F_{MSY} ranges to uncertainty in stock dynamics and initial population status

1.3 Conclusions of the STECF

Based on the findings in the EWG-14-19 report, STECF concludes the following:

Among the 16 demersal and small pelagic stocks analysed by the EWG-14-19, nine are currently being exploited at rates not consistent with achieving MSY (overfishing is occurring), one is sustainably exploited and 6 stocks were not assessed due to data deficiencies or poor model fits. A summary of stock status is given in Table 1.3.1.

Table 1.3.1. Summary of stock status for the 16 stocks analysed by the EWG-14-19, stocks for which current F is larger than F_{MSY} are highlighted in red.

Stock area	Species	Common name	Assessment	Comment	F	F_{MSY}	F/F_{MSY}	B/B_{lim}	Short term	Medium term
GSA 1	*Mullus barbatus*	Red mullet	XSA	Accepted	1.31	0.27	4.85		Yes	No
GSA 1	*Lophius budegassa*	Black-bellied anglerfish	VIT	Accepted	0.25	0.16	1.56		No	No
GSA 5	*Lophius budegassa*	Black-bellied anglerfish	XSA	Accepted	0.84	0.08	10.50		Yes	No
GSA 5	*Nephrops norvegicus*	Norwegian lobster	XSA	Accepted	0.29	0.17	1.71		No	No
GSA 6	*Sardina pilchardus*	Sardine	XSA	Accepted	1.94	0.56	3.46		Yes	No
GSA 6	*Engraulis encrasicolus*	Anchovy	ByoDim	Not accepted					No	No
GSA 6	*Lophius budegassa*	Black-bellied anglerfish	XSA	Accepted	0.91	0.14	6.50		Yes	No
GSA 7	*Engraulis encrasicolus*	Anchovy	XSA, ASPIC	Not accepted					No	No
GSA 7	*Sardina pilchardus*	Sardine	XSA	Not accepted					No	No
GSA 9	*Parapenaeus longirostris*	Deep sea pink shrimp	XSA	Accepted	0.69	0.71	0.97		Yes	No
GSA 9	*Sardina pilchardus*	Sardine	SepVPA	Accepted			> 1		No	No
GSA 11	*Aristaeomorpha foliacea*	Giant red shrimp		Not assessed					No	No
GSA 11	*Parapenaeus longirostris*	Deep sea pink shrimp		Not assessed					No	No
GSA 17	*Nephrops norvegicus*	Norwegian lobster		Not assessed					No	No
GSA 18	*Nephrops norvegicus*	Norwegian lobster	XSA	Accepted	0.85	0.14	6.07		Yes	No
GSA 18	*Mullus barbatus*	Red mullet	XSA	Accepted	0.48	0.45	1.07		Yes	No

STECF notes that stock-specific evaluations of the data quality were conducted for all stocks requested under ToR (1-3) by the EWG-14-19 experts and endorses the main findings. It is worth noting that still remain unsolved several issues linked to data quality. Such problems prevented the assessment of the status of some stocks due to unreliable data. Other causes that prevented analyses were linked to delays in data submission.

STECF considers that safeguard points for small pelagic in the Adriatic Sea, in terms of stock biomass that have been defined are too uncertain. The main advantage of the methodology developed by ICES to estimate F_{MSY} ranges is the possibility of mixing different stock-recruitment relationships for a single stock. This feature permits model uncertainty to be explicitly incorporated, which is more important when there is not a clear S/R emerging from the assessment results. This possibility was not exploited by the EWG-14-19. STECF considers that its application to the stocks of sardine and anchovy in the Adriatic Sea should explore that feature and not restrict the analysis to a hockey-stick model.

STECF concludes that the EWG-14-19 adequately addressed the Terms of Reference.

Expert Working Group EWG-14-19 report

Report to the STECF

EXPERT WORKING GROUP ON Mediterranean assessments part 2 (EWG-14-19)

Rome, Italy, 19-23 January 2015

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 second of two STECF expert meetings, within STECF's 2014 work programme, planned to undertake stock assessments of demersal/small pelagic species in the Mediterranean Sea. The meeting was organized by JRC in Rome (Italy) from 19th to 23th of January 2015. The meeting was chaired by Massimiliano Cardinale and attended by 20 experts in total, including 4 STECF members. Furthermore, two JRC experts and one DG MARE representative were present (see Chapter 13).

Historical fisheries and scientific survey data were obtained from the official Mediterranean DCF data call issued to Member States on April 15th 2014 with deadline on 9th of June 2014. The data call also defined a second deadline on 12 January 2015 for the submission of trawl surveys data for Mediterranean MSs. The data call and its format are documented on the JRC's DCF website (http://datacollection.jrc.ec.europa.eu/data-calls). The timeline of upload has been in many cases well after the data call deadline and therefore the deadline was not respected by several MSs. Moreover, not all the requested data were provided by the MS; details can be found online in the following link https://visualise.jrc.ec.europa.eu/t/dcf/views/medbs_coverage/Coverage?:embed=y&:display_count=no as well as in the DCF Data Call Coverage Report for the Mediterranean and Black Sea in 2014 (JRC 2015).

In fulfilment of TORs (1-2), the EWG 14-19 undertook the stock assessment of 13 stocks, while 3 stocks were not assessed due to data issues (see details below). For 3 stocks, the assessment was conducted but not accepted due to data issues, while a total of 9 out of 10 stocks with an accepted assessment were classified as exploited unsustainably with the exception of deep sea pink shrimp in GSA 9 (see Table 1 for details).

Table 1. Synoptic table of the stock assessed during EWG 14-19. In red are stocks for which current F is larger than F_{MSY}.

Stock area	Species	Common name	Assessment	Comment	F	F_{MSY}	F/F_{MSY}	B/B_{lim}	Short term	Medium term
GSA 1	*Mullus barbatus*	Red mullet	XSA	Accepted	1.31	0.27	4.85		Yes	No
GSA 1	*Lophius budegassa*	Black-bellied anglerfish	VIT	Accepted	0.25	0.16	1.56		No	No
GSA 5	*Lophius budegassa*	Black-bellied anglerfish	XSA	Accepted	0.84	0.08	10.50		Yes	No
GSA 5	*Nephrops norvegicus*	Norwegian lobster	XSA	Accepted	0.29	0.17	1.71		No	No
GSA 6	*Sardina pilchardus*	Sardine	XSA	Accepted	1.94	0.56	3.46		Yes	No
GSA 6	*Engraulis encrasicolus*	Anchovy	ByoDim	Not accepted					No	No
GSA 6	*Lophius budegassa*	Black-bellied anglerfish	XSA	Accepted	0.91	0.14	6.50		Yes	No
GSA 7	*Engraulis encrasicolus*	Anchovy	XSA, ASPIC	Not accepted					No	No
GSA 7	*Sardina pilchardus*	Sardine	XSA	Not accepted					No	No
GSA 9	*Parapenaeus longirostris*	Deep sea pink shrimp	XSA	Accepted	0.69	0.71	0.97		Yes	No
GSA 9	*Sardina pilchardus*	Sardine	SepVPA	Accepted			> 1		No	No
GSA 11	*Aristaeomorpha foliacea*	Giant red shrimp		Not assessed					No	No
GSA 11	*Parapenaeus longirostris*	Deep sea pink shrimp		Not assessed					No	No
GSA 17	*Nephrops norvegicus*	Norwegian lobster		Not assessed					No	No
GSA 18	*Nephrops norvegicus*	Norwegian lobster	XSA	Accepted	0.85	0.14	6.07		Yes	No
GSA 18	*Mullus barbatus*	Red mullet	XSA	Accepted	0.48	0.45	1.07		Yes	No

Following TOR (3), the EWG 14-19 also conducted short term forecasts of stock size and catches for 7 stocks. However, no medium term forecasts were carried out for any of the stocks assessed at the meeting because no meaningful stock-recruitment relationship was estimated for any of the stock assessed.

In fulfilment of TOR (4), stock specific evaluations of the data quality were conducted for all stocks requested under ToR (1-3) by the EWG 14-19 experts. Moreover, JRC team examined the data coverage and quality of the fisheries and survey data. Results of the evaluations are reported under Chapter 7 and at the end of the assessment section of each stock. The main issues found by EWG 14-19 were with the catch data of both stocks of GSA 11, which did impede to conduct an analytical stock assessment for these stocks. Issues with catch data of GSA 11 have been repeatedly highlighted by STECF in previous reports. Moreover, as in the past, France did not provide any fisheries data for GSA 8 (i.e. Corsica); moreover effort data for all French GSA's are absent prior to 2012. Italy in general did not provide any catch data prior to 2004, no abundance-biomass data for small pelagics before 2008 and no MEDITS data for Italian GSA 17 prior to 2002. As a result of not conducting DCF, Greece did not submit any data for 2009-2012 and submitted only last quarter of 2013. More detailed issues identified in the data are described at the end of each stock assessment sections.

Nephrops norvegicus in GSA 17 was not assessed on the basis that, owing to hypothesized differing biological characteristics among sub-areas within GSA 17, data have to be compiled for these separate putative stock units and an assessment of GSA 17 as one stock unit was not considered appropriate by the EWG 14-19.

In fulfilment of TOR (5), a document with the criteria defined for prioritising the stocks to be assessed between 2015 and 2017 have been produced. Also, a table with the list of the stocks proposed to be assessed in 2015, 2016 and 2017, based on the defined criteria, has been included in the report. This list is provisional and subject to revisions based on the availability and quality of data to be submitted in all future data calls.

In fulfilment of TOR (6), a MultiAnnual General Depletion Model was explored to produce a preliminary assessment of the cuttlefish *Sepia officinalis* in the Barcelona maritime district (comprising the ports of Arenys de Mar, Badalona, Barcelona and Vilanova i la Geltrú) in GSA 6. The model is able to satisfactorily fit the data and the diagnostics of the final model show that the catches (in number) can be reasonably predicted and that predictions are unbiased. The evolution of the vulnerable biomass of cuttlefish shows an increase in the last 10 years of the series, probably linked to a decrease in the fishing effort (and therefore fishing mortality) exerted by bottom trawlers.

In fulfilment of TOR (7), EWG 14-19 estimated reference points (fishing mortality and biomass) for two stocks, namely anchovy and sardine in GSA 17. Estimation of reference points was done based on the methodology recently used by ICES for North Sea and Baltic Sea stocks. The same procedure was applied to the same stocks during the EWG 12-19 and EWG 13-19. Several different scenarios with different values of B_{lim} and length of the time series were fitted to the latest stock assessment data (i.e. data up to 2013). The F_{MSY} values ranged from 0.057 to 0.198 for sardine and between 0.225 and 0.429 for anchovy, and were dictated by the choice of B_{lim} and the length of the time series used. However, EWG 14-19 did not reach consensus on which scenario should be used to define reference points (fishing mortality and biomass) for the stocks anchovy and sardine in GSA 17.

This EWG report will be presented and reviewed during the STECF spring plenary meeting PLEN 15-01, 13-17 April 2015.

2. Findings And Conclusions Of The Working Group

Findings and conclusion of the STECF EWG 14-19 are reported under the executive summary and summed up in Table 1.

3. Follow Up Items

The text below highlights some issues that arose during the EWG 14-19 meeting and created difficulties for the meeting or the process of completing the report. The EWG offers the following comments/suggestions for next year to improve the process for preparing assessments of the Mediterranean Sea stocks:

Due to the very narrow time interval between data submission deadline (Monday 12 Jan 2015) and the meetings starting date (Monday 19 Jan 2015), access to data was made available to the experts on late afternoon of Friday 16 Jan 2015. As a result data deficiencies for certain stocks were not possible to be identified in due time before the meeting and this resulted in assessing less stocks than initially foreseen.

To overcome such issues, future deadlines for data submissions by Member States should be set at least one month before the meeting so that access to the compiled data could be given to the experts 1 or 2 weeks before the meetings starting date. This would allow for identifying errors and

(i) communicate with Member States for acquiring correct data,

or

(ii) replace some of the scheduled stocks with others having sufficient data quality.

4. INTRODUCTION

The expert working group on Mediterranean stock and fisheries assessment part 2 STECF EWG 14-19 held its second meeting planned for 2014-2015 in Rome (Italy), 19-23 January 2015.

The chairman opened the meeting at 09:00 on Monday, 19 January 2015, and adjourned the meeting by 13.00 on Friday, 23 January 2015. The meeting was attended by 20 experts in total, including 4 STECF members and a additional 2 JRC experts.

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

4.1 TERMS OF REFERENCE FOR EWG-14-19

For the 15 stocks given in Table 4.1.1, the STECF-EWG 14-19 is requested to:

ToR 1 – **Update and assess historic and recent stock parameters** for the longest time series possible, including growth, maturity and natural mortality where needed. 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.

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.

Provide the percentage of individuals below the minimum size at first capture. Discuss whether a size-based reference point could be envisaged for those fisheries with little information available on total biomass and/or fishing mortality levels. Furthermore, identify some case studies for which could be appropriate to apply size-based reference points.

Assessment data and methods are to be fully documented with particular reference to the completeness and quality of the data submitted by Member States as response to the official Mediterranean DCF data call issued on April and reminded in May 2014.

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.

Table 4.1.1 – List of proposed stocks.

N°	FAO CODE	Species scientific name	GSA	Reference year[1] of the last assessment	PRIORITY
1	SBR	*Pagellus bogaraveo*	Strait of Gibraltar	2011	Very high
2	ANE	*Engraulis encrasicolus*	7	2010	Very high
3	PIL	*Sardina pilchardus*	7	2010	Very high
4	NEP	*Nephrops norvegicus*	17	There are no previous assessments	High
5	MUT	*Mullus barbatus*	1	2010	High
6	ANK	*Lophius budegassa*	1	There are no previous assessments	High
7	PIL	*Sardina pilchardus*	9	2012	High
8	ARS	*Aristaeomorpha foliacea*	11	2010	High
9	DPS	*Parapenaeus longirostris*	11	2011	High
10	MUT	*Mullus barbatus*	18	2011	High
11	PIL	*Sardina pilchardus*	6	2009	High
12	ANE	*Engraulis encrasicolus*	6	2009	High
13	ANK	*Lophius budegassa*	6	2011	Medium
14	ANK	*Lophius budegassa*	5	2011	Medium
15	NEP	*Nephrops norvegicus*	5	2011	Medium

In case it is not possible to carry out an evaluation of those stocks listed in Table 4.1.1, here below it is provided a reserve list of stocks (Table 4.1.2.).

Table 4.1.2. – Reserve stock list

N°	FAO CODE	Species scientific name	GSA	Reference year of the last assessment	PRIORITY
1	DPS	*Parapenaeus longirostris*	9	2010	Medium
2	NEP	*Nephrops norvegicus*	18	2011	Medium
3	ARA	*Aristeus antennatus*	18	There are no previous assessments	Medium
4	HKE	*Merluccius merluccius*	1	2012	Low
5	DPS	*Parapenaeus longirostris*	5	2012	Low
6	MUT	*Mullus barbatus*	5	2012	Low

[1] "Reference year" means the most recent year of the time-series used in the stock assessment.

ToR 2 **– Provide a synoptic overview** on: (1) the fishery; (2) the most recent state of the stock (such as spawning stock size, recruitment or exploitation level) in relation to the reference points estimated under ToR 1.1; (3) the source of data and methods and; (4) the management advice, including target, precautionary and limit reference points.

ToR 3 – **Provide short and medium term forecasts of stock biomass and yield**.
The forecasts shall include different F scenarios, inter alia: zero catch, the status quo, target to FMSY or other appropriate proxy for 2015 and 2020 respectively.
Whenever the quality of the data series allows it , produce catch forecasts to get high yield while avoiding with high probability the risk that SSB falls under Blim. In particular:
−Using the framework developed at ICES-WKFRAME 2010 adopted in the STECF EWG 12-13, estimate the levels of F which minimize the risk of SSB falling below SSBtrigger or crashing the stock and provide MSY or maximize the total yield from the stock in the long term.
− Estimate the level of fishing effort by métier which is commensurate to the sustainable short-term and medium-term forecasts and the implications of the proposed changes.
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.

ToR 4 – **Review the quality and completeness of all data** resulting from the official Mediterranean DCF data call issued on April 2014. STECF-EWG 14-19 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 2014.

In addition, the STECF-EWG 14-19 is requested to:

ToR 5 – Update the proposed priority list for which stock assessment should be performed in each calendar year (report STECF 13-05). It should be taken into account the criteria identified in the aforementioned report and the latest stock assessments carried out by the STECF and the GFCM-SAC.

ToR 6 – Explore the possibilities to apply data-limited stock methods to assess the status of cephalopods and perform a preliminary assessment for some cephalopod species, with priority given to *Sepia officinalis, Eledone cirrhosa, and Illex coindetii* in GSA 06.

ToR 7 – The EU has the intention to adopt a multiannual management plan for small pelagic species in the North Adriatic Sea. Discuss and propose the most scientifically sound MSY value or range of values and safeguard points, in terms of F and stock biomass.

5. UPDATE AND ASSESS HISTORIC AND RECENT STOCK PARAMETERS (SUMMARY SHEETS)

5.1 SUMMARY SHEETS

5.1.1 SUMMARY SHEET OF RED MULLET IN GSA 1

Species common name: Red mullet
Species scientific name *Mullus barbatus*
Geographical Sub-area(s) GSA(s): 1

5.1.1.1 Most recent state of the stock

State of the adult abundance and biomass

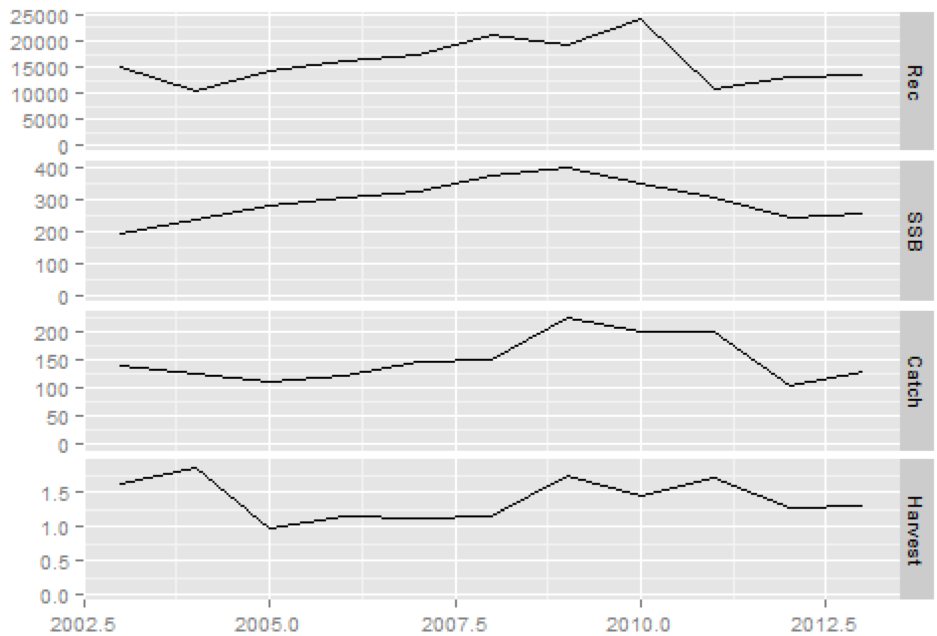
The SSB does not show any significant trends during the analyzed period 2003-2013. Abundance and biomass indices from MEDITS surveys do not reveal any significant trends since 1994, but large fluctuations since 2006. EWG 14-19 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points.

State of the juveniles (recruits)

There was an increasing trend in the number of recruits since 2003 to 2010. Afterwards, recruits number descended at similar values observed at the beginning of the time series. The recruitment estimated for 2014 is 12,385 thousand individuals, slightly lower compared to the average of the time series (15,881 thousand).

State of exploitation

The current F (1.31) is larger than $F_{0.1}$ (0.27), chosen as proxy of F_{MSY} and as the exploitation reference point consistent with long term yield, which indicates that red mullet in GSA 1 is exploited unsustainably. The size composition of landings indicates that the exploitation is concentrated on age classes 1-2.



Red mullet in GSA 1. XSA summary results. SSB and cath are in tonnes, recruitment in 1000s individuals.

Source of data and methods

The stock of red mullet in GSA 1 was assessed 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 landings, transforming length data to ages using the *L2Age4*. Input data landings and length frequencies were taken from DCF. Von Bertalanffy growth parameters and length-weight relationship were taken from parameters estimated for red mullet in GSA 1. Natural mortality (vector) was estimated using PRODBIOM.

5.1.1.2 Outlook and management advice

EWG 14-19 advises the relevant fleets' effort 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.

5.1.1.3 Fisheries

Red mullets are among the most important target species for the trawl fisheries but are also caught with set gears, in particular trammel-nets (about the 14% of the catches). Over the period 2002-2013 annual landings oscillated between 100 and 200 tons, with maximum landings in 2009 of around 225 tons. The amount of discards reported is very low (<2 tons) and represent a maximum of 2% of the catch. There are no data on length for these discards. In the current stock assessment presented in section 5.2.1, discards were assumed to be 0.

5.1.1.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-19 is: $F_{0.1}$ = 0.27, chosen as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields.

5.1.1.5 Comments on the assessment

The detailed assessment can be found in section 5.2.1.

5.1.2 SUMMARY SHEET OF BLACK-BELLIED ANGLERFISH IN GSA 1

Species common name: Black-bellied anglerfish
Species scientific name: *Lophius budegassa*
Geographical Sub-area(s) GSA(s): 1

5.1.2.1 Most recent state of the stock

This is the first assessment of *L. budegassa* in GSA 1.

State of the adult abundance and biomass

The stock size ranged between around. $1900 \cdot 10^3$ individuals. The SSB decreased slightly from 2003 (779 t) to 2012 (403 t) but then increased again in 2013 (503 t). Survey indices and commercial catches indicate increased abundance over 2011-2013. EWG 14-19 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points.

State of the juveniles (recruits)

Recruitment showed a slight increase in the number of recruits from 2009 ($1387 \cdot 10^3$) to 2013 ($1779 \cdot 10^3$).

State of exploitation

The F_{stq} (0.25) is larger than $F_{0.1}$ (0.16), which indicates that *Lophius budegassa* in GSA 1 is fished unsustainably.

Source of data and methods

The data used in the assessment were: (i) Landings time series 2003-2013 from OTB; (ii) Age distributions obtained from slicing of length distributions 2003-2013 (Figure 5.2.4.6.3.1); (iii) Set of natural mortality vector, maturity ogive and growth parameters calculated in the study area during DCF. The assessment was based on a pseudocohort analysis using the VPA equations, and was carried out using the VIT software (Lleonart and Salat, 1992). Data of number at age were obtained from the slicing procedure using the L2age4 software. A Yield Per Recruit analyses (YPR) (Beverton and Hold, 1957) and Spawning Stock Biomass per Recruit (SPR) (Gabriel et al, 1989) was carried out to calculate the biological reference points F_{max} and $F_{0.1.}$ using the output results of the VIT.

5.1.2.2 Outlook and management advice

EWG 14-19 proposes $F_{0.1}$=0.16 (average of age classes 2 to 6) as proxy of F_{MSY} and as limit reference point consistent with high yield in the long term, therefore recommends the relevant fleets' effort 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.

5.1.2.3 Fisheries

The species is of secondary commercial importance in GSA 1, but regularly caught by bottom trawlers and to, a lesser extent, set nets (2-3% of the total landings in 2013). Most of the landings correspond to individuals between 20 and 50 cm TL, which are often sold together with *L. piscatorius* (about 20% of the catches in GSA 1 during the last years)

5.1.2.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-19 is: $F_{0.1}$ = 0.16, chosen as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields.

5.1.2.5 Comments on the assessment

It is advisable to increase the number of years in the length size distribution data, in order to perform a tuned VPA in future assessments.

The detailed assessment can be found in section 5.2.2.

5.1.3 SUMMARY SHEET OF BLACK-BELLIED ANGLERFISH IN GSA 5

Species common name: Black-bellied anglerfish
Species scientific name: *Lophius budegassa*
Geographical Sub-area(s) GSA(s): 5

5.1.3.1 Most recent state of the stock

This is the first assessment of *L. budegassa* in GSA5.

State of the adult abundance and biomass

The stock size ranged between. 220-275·10^3 individuals, except with a peak of 300·10^3 individuals in 2009. The SSB increased slightly from 2003 (12.34 t) to 2007 (17.06 t) but then decreased progressively to 8.17 t in 2013. EWG 14-19 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points.

State of the juveniles (recruits)

Recruitment showed a gradual increase from 2004 (147.93·10^3) to 2009 (192.38·10^3) followed by an abrupt decrease in 2010 (109.76·10^3); from then, recruits have increased smoothly again up to 151.83·10^3 in 2013.

State of exploitation

The F_{stq} (0.84) is larger than $F_{0.1}$ (0.08), which indicates that *Lophius budegassa* in GSA 5 is fished unsustainably.

Source of data and methods

Landings, tuning fleet (MEDITS) and size-frequency distributions: 2003-2013. Growth, maturity and Length-Weight relationship parameters from the Spanish DCF. Natural mortality: PRODBIOM. XSA, Y/R and projections: R scripts developed by STECF EWG 13-19.

5.1.3.2 Outlook and management advice

The main XSA results are shown in the figure below (recruitment, SSB, catch and harvest-F). STECF EWG 14-19 recommends the relevant fleets' effort 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.

5.1.3.3 Fisheries

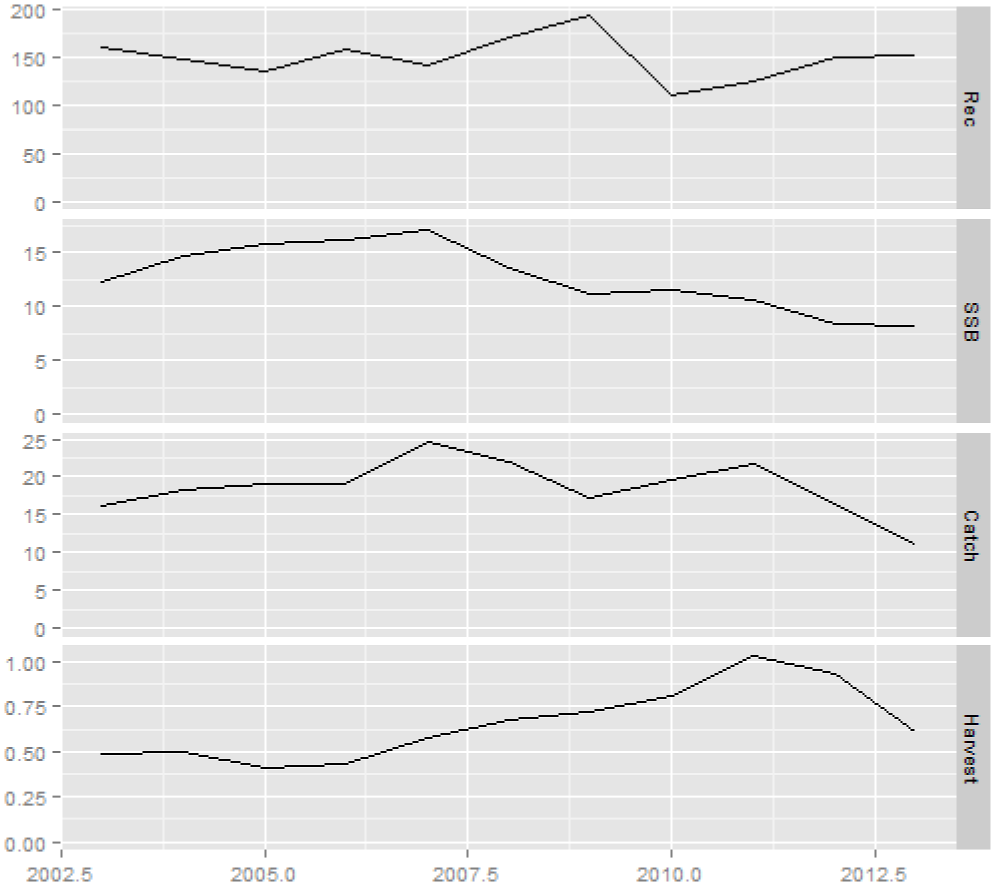
Lophius budegassa is a typical by-catch species of the bottom trawl fishery. This fishery takes two different anglerfish species (*L. budegassa* and *L. piscatorius*), which are sold in a single commercial category. These species have relatively high commercial value whereby the discards are negligible.

5.1.3.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-19 is: $F_{0.1}$ = 0.08, chosen as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields.

5.1.3.5 Comments on the assessment

As anglerfishes are sold in a single commercial category, the landings corresponding to *L. budegassa* are an estimation based on onboard sampling.



Black-bellied anglerfish in GSA 5. XSA summary results. SSB and cath are in tonnes, recruitment in 1000s individuals.

The detailed assessment can be found in section 5.2.3.

5.1.4 SUMMARY SHEET OF NORWAY LOBSTER IN GSA 5

Species common name: Norway lobster
Species scientific name *Nephrops norvegicus*
Geographical Sub-area(s) GSA(s): 5 (Balearic Islands)

5.1.4.1 Most recent state of the stock

State of the adult abundance and biomass

The stock abundance showed a maximum of $4.5 \cdot 10^6$ individuals in 2008 with a deacreasing trend until 2012-2013, with the minimum values of $4.5 \cdot 10^6$ individuals observed in 2012. The SSB ranged between 40 and 52 t between 2002 and 2011, with the minimum values of 31-34 t in the last years of the data series (2012-2013). EWG 14-19 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points.

State of the juveniles (recruits)

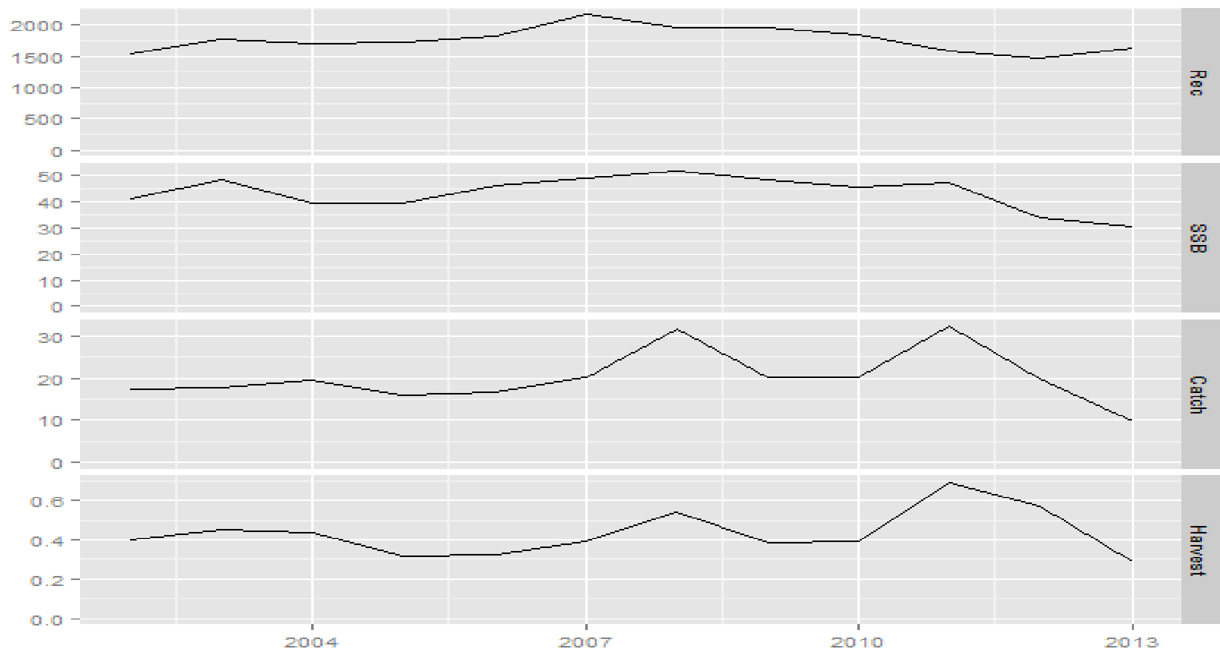
Recruitment showed a maximum of $2.2 \cdot 10^6$ individuals in 2007, with a decreasing trend since then.

State of exploitation

The current F (0.29) is larger than $F_{0.1}$ (0.17), which indicates that Norway lobster in GSA 5 is exploited unsustainably.

Source of data and methods

The data used in the XSA assessment were: (i) Landings time series 2002-2013 from OTB; (ii) Age distributions obtained from slicing of length distributions 2002-2013 (Figure 5.2.4.6.3.1); (iii) Set of growth parameters calculated in the study area during DCF and (iv) BALAR-MEDITS survey used as tuning fleet. As both ages 1 and 2 are poorly represented both in the commercial data and in the survey, they were excluded in the model. Age2 was considered as recruitment to the fishery.



Norway lobster in GSA 5. XSA summary results. SSB and cath are in tonnes, recruitment in 1000s individuals.

5.1.4.2 Outlook and management advice

STECF EWG 14-19 recommends the relevant fleets' effort 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.

5.1.4.3 Fisheries

In the Balearic Islands (western Mediterranean), commercial trawlers develop up to four different fishing tactics, which are associated with the shallow shelf (SS), deep shelf (DS), upper slope (US) and middle slope (MS), 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 large *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 MS fishing tactics coincides with the metier OTB_DWSP; OTB_DEMSP and corresponds to those days in one of the other fishing tactics is present (SS, DS and/or US) while OTB_MDDWSP corresponds to those days in which one haul in MS and at least one of the other fishing tactics is performed. The Norway lobster is the main target species in the US and is caught in all the metiers.

5.1.4.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-19 is: $F_{0.1}$ = 0.17, chosen as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields.

5.1.4.5 Comments on the assessment

The detailed assessment can be found in section 5.2.4.

5.1.5 SUMMARY SHEET OF SARDINE IN GSA 6

Species common name: sardine
Species scientific name: *Sardina pilchardus*
Geographical Sub-area(s) GSA(s): 6

5.1.5.1 Most recent state of the stock

State of the adult abundance and biomass

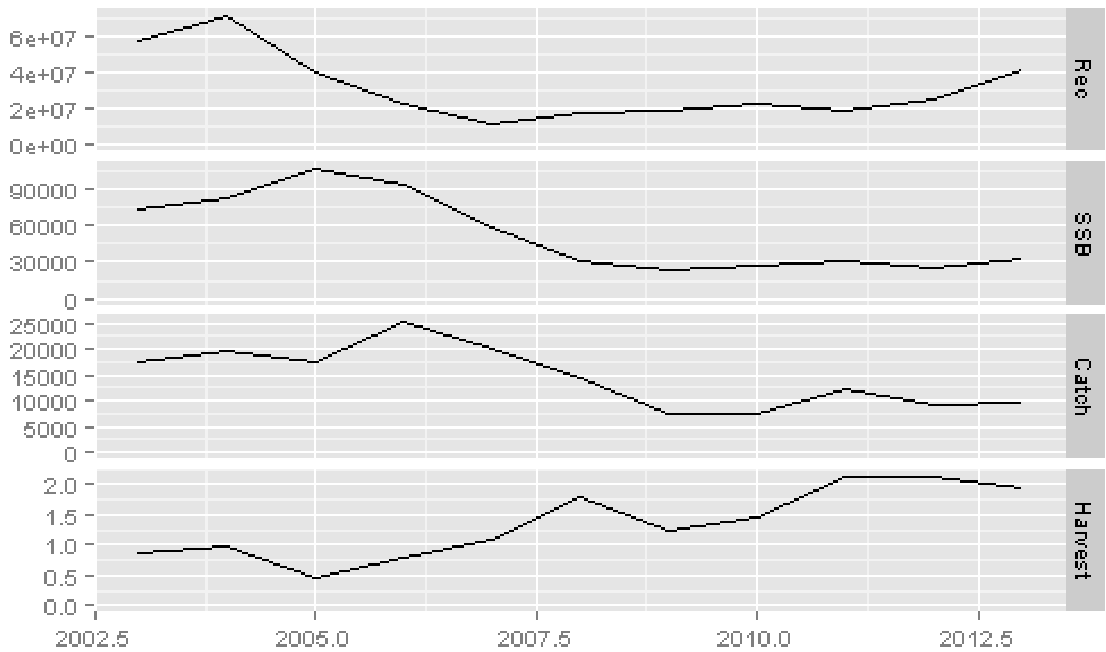
SSB in the period 2003-2013, oscillated between 106.5 and 24.1 thousand tons. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-19 is unable to evaluate the status of the stock spawning biomass in respect to these.

State of the juveniles (recruits)

Recruitment oscillated between a peak in 2004 of 71619 10^6 in 2004 and 12074 10^6 individuals in 2007. In the last year (2013) recruitment was higher than in the previous years (40849 10^6 individuals).

State of exploitation

The current F ($F_{(1-3)}$= 1.94) is larger than F_{MSY} (0.56). The current exploitation rate (E= 0.70) is much higher than the reference E= 0.4, which indicates that sardine in GSA 6 is exploited unsustainably.



Sardine in GSA 6. XSA summary results. SSB and catch are in tons, recruitment in 1000s individuals.

Source of data and methods

Input data for the assessment were taken from DCF. XSA and short term forecast were performed in R using FLR routines and scripts provided by JRC.

5.1.5.2 Outlook and management advice

EWG 14-19 advise the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed level FMSY, 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

5.1.5.3 Fisheries

The current fleet (2013) in GSA 06 is composed by 140 units; 2 of them are smaller than 12 m, 120 bigger than 12 m, and 18 are over 24 m. The purse seine fleet has continuously decreased in the last two decades, from 222 vessels in 1990 to 140 in 2013. It is the smallest units that have disappeared.
Sardine, even if facing a lower market price than anchovy, represents an important resource for the fishery. In the period 2002- 2013 sardine landings ranged between around 25,000 t in 2006 and 7500 t in 2009- 2010. At present (2013) sardine landings are low, around 9700 t.

5.1.5.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-19 is: E = 0.40 (i.e. F=0.56), chosen as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields.

5.1.5.5 Comments on the assessment

The detailed assessment can be found in section 5.2.5

5.1.6 SUMMARY SHEET OF ANCHOVY IN GSA 6

Species common name: European Anchovy
Species scientific name: *Engraulis encrasicolus*
Geographical Sub-area(s) GSA(s): Northern Spain GSA 6

5.1.6.1 Most recent state of the stock

State of the adult abundance and biomass

The results of the assessment were not accepted due to poor fitting of the model used (see details in section 5.2.6 of this report).

State of the juveniles (recruits)

Not assessed

State of exploitation

Not assessed

Source of data and methods

The input data used for the adopted modelling approach was total yearly landing of the purse seine fleet (tons) and a series of abundance indices (acoustic biomass estimates ECOMED 1996-2008 and MEDIAS 2009-2013). A modelling approach based on the fitting of a non-equilibrium surplus production model (BioDyn package; FAO, 2004) on the series of observed abundance indexes, allowing for the optional incorporation of an environmental index. Von-Bertalanffy growth parameters, necessary for the calculation of natural mortality, were estimated with DCF data collected in GSA 6 in 2013, running the last version of the program INBIO 2.0 (Sampedro et al., 2005, last update 2012 pers. Comm.). Natural mortality was estimated following Pauly (1980).

5.1.6.2 Outlook and management advice

The model was not accepted, thus no management advice was provided.

5.1.6.3 Fisheries

Anchovy is the main target species of the purse seine fleet in Northern Spain due to its high economic value. Catches in the period 1990-2013 has been highly variable, with a minimum of 1900 tons in 2007 and an average of 11,700 tons. Higher catches occurred in the period 1990-94, with catches between 17,000 and 22,000 tons. Thereafter catches have been continuously decreasing with three recoveries in 2002, 2009 and 2012. In 2013 shows higher catches 17,178 t, a similar value to the one in 1990, but it is still not close to the peak of the landings occurred between 1991 and 1994. Years with higher landings are usually correlated with a successful and high recruitment period, while unsuccessful recruitment in a given year is correlated with a low level of landings. The catches evolution is consistent with the result of the acoustic assessments.

5.1.6.4 Limit and precautionary management reference points

A reference exploitation rate E=0.4 as proxy of F_{MSY} was set following Patterson (1992).

5.1.6.5 Comments on the assessment

The detailed assessment can be found in section 5.2.6.

5.1.7 SUMMARY SHEET OF BLACK-BELLIED ANGLERFISH IN GSA 6

Species common name: Black-bellied anglerfish
Species scientific name *Lophius budegassa*
Geographical Sub-area(s) GSA(s): 6

5.1.7.1 Most recent state of the stock

State of the adult abundance and biomass

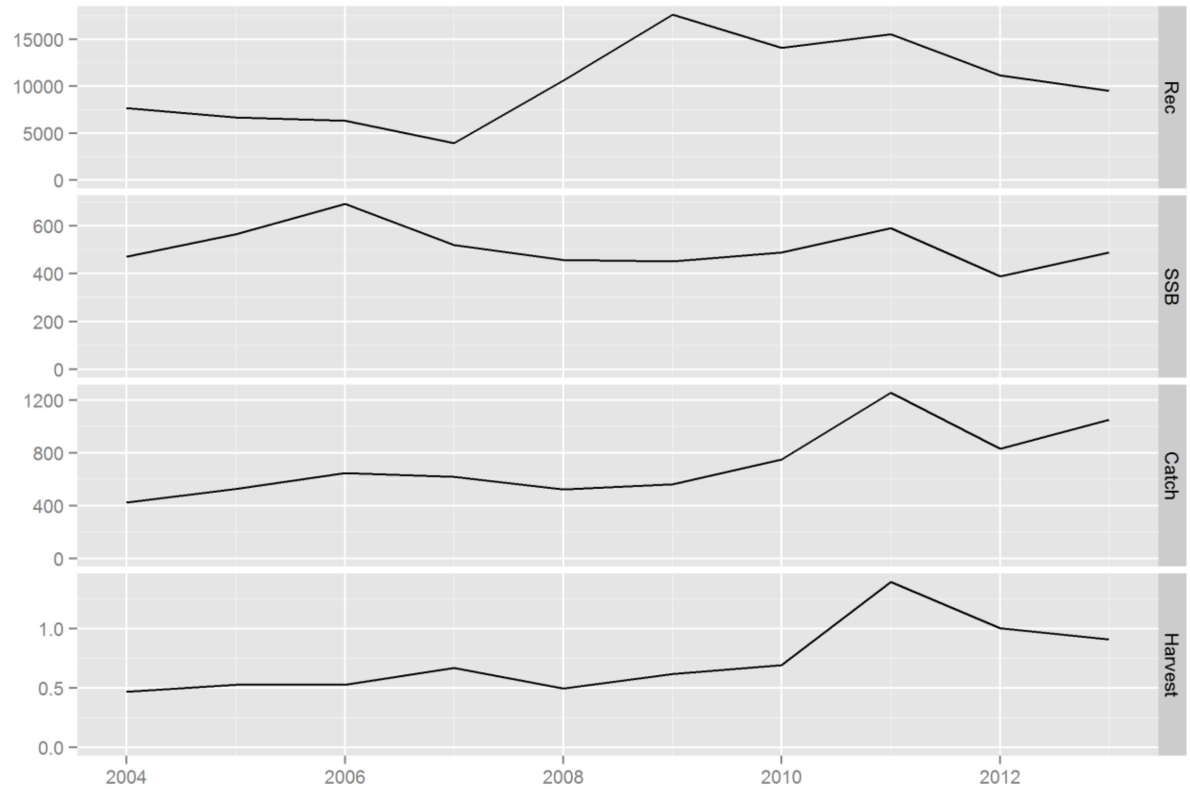
The SSB is fluctuating during the time series with an average of 510 t. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-19 is unable to evaluate the status of the stock spawning biomass in respect to these.

State of the juveniles (recruits)

The recruitment estimated for 2014 is 11,800 thousand individuals, slightly higher compared to the series average (10,300 thousand).

State of exploitation

The current F (0.91) is larger than $F_{0.1}$ (0.14), chosen as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields, which indicates that black-bellied anglerfish in GSA 6 is exploited unsustainably. The size composition of landings indicates that the exploitation is based on age classes 1-4 with age 0 not fully recruited to the fisheries.



Black-bellied anglerfish in GSA 6. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

Source of data and methods

The stock of black-bellied anglerfish in GSA 6 was assessed 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 using the statistical age slicing script developed by Scott et al. (2012) during EWG 11-12. Input data landings and length frequencies were taken from DCF. Von Bertalanffy growth parameters and length-weight relationship were taken from parameters estimated for black-bellied anglerfish in GSA 6. Natural mortality (vector) was estimated using PROBIOM.

5.1.7.2 Outlook and management advice

STECF EWG 14-19 advises the relevant fleets' effort 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.

5.1.7.3 Fisheries

Black-bellied anglerfish is a demersal species of secondary commercial importance in GSA 6, but regularly caught by bottom trawlers and to, a lesser extent, set nets (mainly trammel nets). Over the period 2002-2013 annual landings increased to around 1000 t. Trawl discards in weight are high in the last three years (2011-2013) but there are not length frequencies distributions in DCF associated to these discards. In the current stock assessment presented in section 5.2.7, discards were assumed to be 0.

5.1.7.4 Limit and precautionary management reference points

The limit and precautionary management reference point proposed by EWG 14-19 is: $F_{0.1}$ = 0.14, chosen as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields.

5.1.7.5 Comments on the assessment

The detailed assessment can be found in section 5.2.7.

5.1.8 SUMMARY SHEET OF ANCHOVY IN GSA 7

Species common name: European Anchovy
Species scientific name : *Engraulis encrasicolus*
Geographical Sub-area(s) GSA(s): GSA 7

5.1.8.1 Most recent state of the stock

State of the adult abundance and biomass

The results of the assessment were not accepted due to model poor fitting (see details in section 5.2.8 of this report).

State of the juveniles (recruits)

Not assessed.

State of exploitation

Not assessed.

Source of data and methods

Data coming from DCF (catch at age) for the period 2003-2013 were used to run an Extended Survivor Analysis (XSA) as well as a4a models, tuned with PELMED abundance indices for 2003-2013. Discards were not included in the catches due to lack of consistent information along the period however when discard data were available, the quantities of discards were considered negligible.
Age slicing was redone according to revised age-length keys derived from new otolith readings computed at IFREMER. Maturity at age and weight-length relationship were also estimated from IFREMER data. Natural mortality was estimated using both Gislason (2010) and Lorenzen (1996) equations.

5.1.8.2 Outlook and management advice

No model was accepted, so that no management advice was produced.

5.1.8.3 Fisheries

The number of pelagic trawlers strongly decreased a few years ago. While 12 trawlers landed more than 1 t of anchovies each in 2013, only 1 vessel targets small pelagics all year round, while the others alternate between small pelagics and demersal species. As a consequence, the total catches remained low in 2013. They have been fluctuating around 2000 t for the last 5 years. Most regulations (no fishing activity during the week-end, length of trawlers, etc.) are fully respected, possibly with the exception of the limitation of engine power for trawlers.

5.1.8.4 Limit and precauationary management reference points

No reference points defined

5.1.8.5 Comments on the assessment

The detailed assessment can be found in section 5.2.8.

5.1.9 SUMMARY SHEET OF SARDINE IN GSA 7

Species common name: European sardine
Species scientific name : *Sardina pilchardus*
Geographical Sub-area(s) GSA(s): GSA 7

5.1.9.1 Most recent state of the stock

State of the adult abundance and biomass

No analytical assessment was run due to the recent low level of exploitation (low catches and low effort due to the absence of market for the current small-sized sardines) and to the fact that the population (composed almost only by ages 0 and 1). No analytical assessment was run due to several data issues. Acoustic estimates showed an intermediate level of biomass in 2014.

State of the juveniles (recruits)

No analytical assessment was run due to several data issues. For the first time, recruits were practically absent in the 2014 PELMED survey.

State of exploitation

Not assessed.

Source of data and methods

No assessment.

5.1.9.2 Outlook and management advice

No assessment.

5.1.9.3 Fisheries

The present fishing pressure is very low, landings being lower than 1000 t. Due to a decrease in the average length of sardine, the fishing effort has strongly decreased. The number of pelagic trawlers (OTM) decreased and only 1 is now focusing on small pelagics all year round. Most other OTM alternate between bottom trawling and pelagic trawling.

5.1.9.4 Limit and precauationary management reference points

No reference points were defined

5.1.9.5 Comments on the assessment

The detailed assessment can be found in section 5.2.9.

5.1.10 SUMMARY SHEET OF SARDINE IN GSA 9

Species common name: European sardine
Species scientific name : *Sardina pilchardus*
Geographical Sub-area(s) GSA(s): GSA 9

5.1.10.1 Most recent state of the stock

State of the adult abundance and biomass

Fishery independent information regarding the state of sardine in GSA 9 was derived from the international survey MEDITS in term of estimated trend in density and biomass. The estimated biomass indices reveal a clear decreasing trend. The outputs of the separable VPA confirm this trend.

State of the juveniles (recruits)

Also for the recruits the outputs of the separable VPA showed a clear decreasing trend from 2006 up to now.

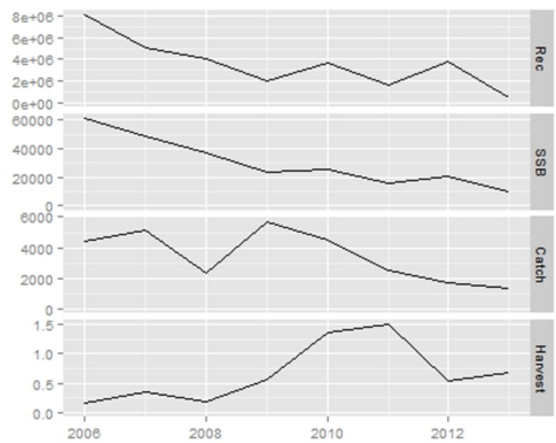
State of exploitation

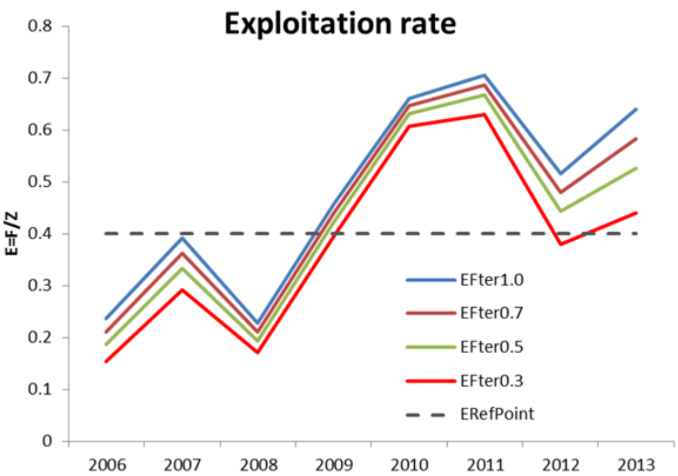
EWG 14-19 Consider E=0.4 as limit management reference point consistent with high long term yields for small pelagic species. The exploitation rate for sardine in GSA 9 was higher than the reference point in any of the scenario tested so the stock was considered exploited unsustainably. Anyway without an independent source of information especially coming from an Echo-survey the results of the present assessment should be considered as qualitative but not reliable as absolute estimates.

Source of data and methods

Data from DCF provided at EWG-14-19 containing information on sardine landings and the respective age structure for 2006-2013 were used. A vector of natural mortality value by age was obtained using Gislason method (Gislason et al.,2010). Catch at age, weight at age, mortality at age and maturity at age data for the 2006-2013 period were compiled for age classes 0 to 4+ and used as input data for the Separable VPA. Catches belonged mainly to age 1 class. Separable VPA was computed for four different scenarios of F terminal: 0.3, 0.5, 0.7 and 1.0 considering as S terminal value 1 and a reference age for unit selection, the first age at which the selection pattern may be regarded as fully recruited and subsequently flat equal to 3. The computation was made by R-project software and the FLR libraries.

Summary of the stock assessment





Sardine GSA 9. Separable VPA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals. The outputs of Separable VPA can be considered valid only for the estimates of the harvest level while they should be considered only as trend in term of recruits and SSB.

5.1.10.2 Outlook and management advice

STECF EWG 14-19 advises the relevant fleets' effort 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.

5.1.10.3 Fisheries

In the GSA 9, sardine is mainly exploited by purse seiners. Due to its low economic value, however, sardine does not represent the main target species for this fleet, while anchovy (*Engraulis encrasicolus*) is the most important species exploited by this fishery. The fishing season starts in spring (March) and ends in autumn (October). Favourable weather conditions and abundance in the catches can extend the fishing activity to the end of November. However, the maximum activity of the fleet is normally observed in the summer. Sardine is also a by-catch in the bottom trawl fisheries. However, the landings yielded by these metiers are very low (about 1%) in comparison to those by purse seiners. Pelagic trawling is not carried out in the GSA 9.

5.1.10.4 Limit and precautionary management reference points

A reference exploitation rate E=0.4 as proxy of FMSY was set following Patterson (1992). Detailed comments are to be found in the assessment section (5.2.10).

5.1.10.5 Comments on the assessment

Data provided from DCF at the EWG 14-19 contained information on total landings and catch at age of sardine in GSA 9 for the years 2006-2013. Despite data available were enough to perform an Extended Survivor Analysis (XSA) the lack of corresponding abundance indexes for the same period, useful for model tuning, led to the decision of consider the opportunity to assess the species using a Separable VPA approach. Tuning data should be derived from the data collected during surveys at sea and in the case of small pelagic species especially with the acoustic survey. It would therefore be wise to plan acoustic survey campaigns also in the GSA 9 along the lines of those currently made in other Italian areas (i.e. MEDIAS surveys in the Adriatic Sea and Strait of Sicily).

The detailed assessment can be found in section 5.2.10.

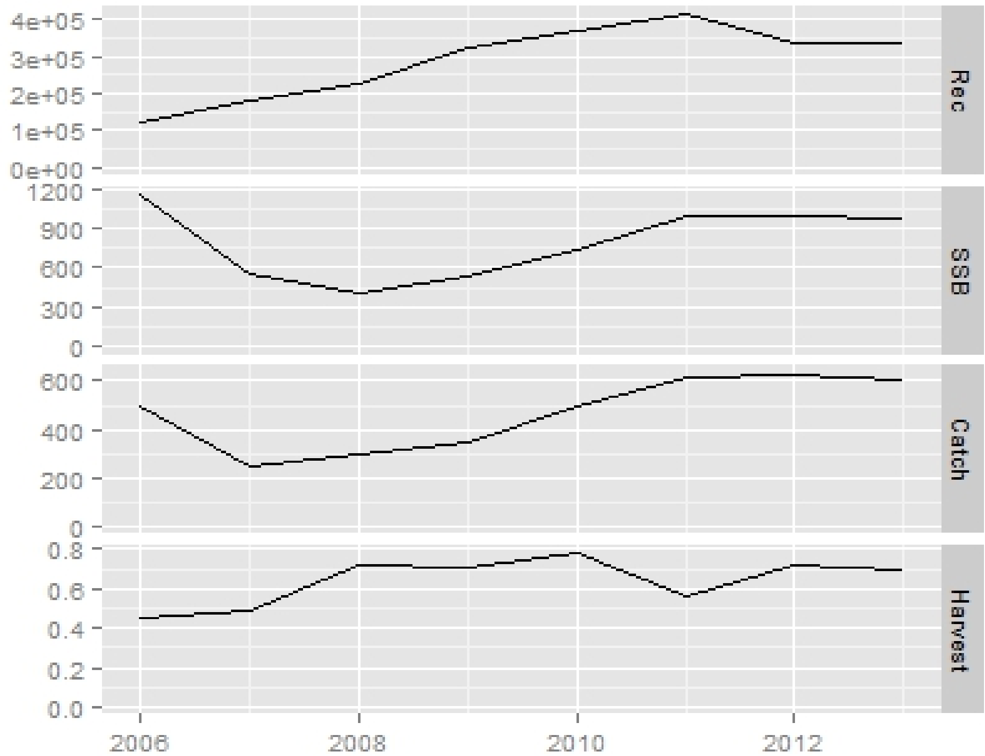
5.1.11 SUMMARY SHEET OF DEEP SEA PINK SHRIMP IN GSA 9

Species common name: Deep sea pink shrimp
Species scientific name : *Parapenaeus longirostris*
Geographical Sub-area(s) GSA(s): GSA 9

5.1.11.1 Most recent state of the stock

State of the adult abundance and biomass

Stock assessment has been performed applying Extended Survivors Analysis (XSA) to the DCF data of landings for the period 2006-2013. According to the XSA results, SSB estimates showed an increasing pattern since 2008, with a high peak in 2011. MEDITS indices show very high values in 2010-2013. No precautionary biomass reference points have been proposed for the Deep sea pink shrimp stock. Therefore, STECF EWG 14-19 is unable to fully evaluate the status of the stock spawning biomass with respect to the precautionary approach.



Deep sea pink shrimp GSA 9. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

State of the juvenile (recruits)

From landing data, recruitment is indicated to have increased over time and a strong year class was observed in 2011 (424.8 millions). Survey data confirm this positive trend. Relative indices for age 0 from MEDITS indicated a general fluctuating trend since 1994, with three main recruitment peaks in 1998, 2003 and 2005. Since 2009, very high abundance of recruits was detected.

State of exploitation

STECF EWG 14-19 proposes the estimated $F_{0.1}$=0.71 as limit management reference point for sustainable exploitation, consistent with high long term yield (F_{MSY} proxy). According to the F estimates obtained with XSA, F_{curr} (0.69) was below the estimated reference value of $F_{0.1}$ in 2009, 2011 and 2013 and slightly above in 2010 and 2012. STECF-EWG 14-19 considers the stock has been harvested sustainably, consistent with high long term yield and lower risk of stock collapse.

Source of data and methods

An XSA analysis was performed using 2006-2013 DCF data (biomass landed and age composition of the catches), tuned with fishery independent abundance indices (MEDITS survey). A vector of natural mortality was obtained applying PRODBIOM. In addition, Yield per Recruit (YPR) analysis was performed for the estimation of $F_{0.1}$ (i.e. proxy of F_{MSY}).

5.1.11.2 Outlook and management advice

EWG 14-19 advises to not increase the current level of effort of the relevant fleets, in order to avoid future loss in stock productivity. Such advice shall be considered when multi-annual management plan taking into account mixed-fisheries effects will be designed.

5.1.11.3 Fisheries

Deep sea pink shrimp is one of the most important target species of the fishery carried out on the shelf break and upper part of continental slope of GSA 9. The species is exclusively exploited with otter bottom trawling. *P. longirostris* belongs to a fishing assemblage distributed from 150 to 350 m depth, where the main target species are European hake, *Merluccius merluccius*, Horned octopus, *Eledone cirrhosa* and Norway lobster, *Nephrops norvegicus*, at greater depths. In the last four years the total landing of *P. longirostris* in GSA 9 showed an evident increasing trend, with a maximum of 621 tons in 2012. The landing is mainly composed by adult individuals over the size at first maturity, while discarding represents, on average, about 10% of the total biomass caught.

5.1.11.4 Limit and precautionary management points

The limit and precautionary management reference point proposed by EWG 14-19 is: $F_{0.1}$ = 0.71, chosen as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields.

5.1.11.5 Comments on the assessment

The detailed assessment of the species in GSA 9 can be found in section 5.2.11 of this report.

5.1.12 SUMMARY SHEET OF GIANT RED SHRIMP IN GSA 11

Species common name: Giant red shrimp
Species scientific name *Aristaeomorpha foliacea*
Geographical Sub-area(s) GSA(s): 11

5.1.12.1 Most recent state of the stock

Due to inconsistency in the short data series STECF EWG 14-19 decided to do not perform the assessment of this stock. Medits survey indices show a variable pattern of abundance (n/h) and biomass (kg/h) without an increasing trend in the last years.

State of the adult abundance and biomass

The assessment from the SURBA analysis on MEDITS survey data do detect a decreasing trend in SSB from 2002 to 2007, followed by an increasing pattern in recent years.

State of the juveniles (recruits)

Recruitment shows high fluctuations in the whole time series with a peak in 2002.

State of exploitation

Fishing mortality (F_{1-3}) estimated by SURBA on MEDITS 1994-2013 did not show any clear temporal trend, fluctuating beween 0.23 and 1.58.

Source of data and methods

Considering the data quality and the inconsistences in the landing data, and taking in to account that for GSA 11 a specific request for a deep revision of the data was often requested, STECF EWG 14-19 decided to do not perform the assessment.

5.1.12.2 Outlook and management advice

EWG 14-19 did not provide advice on giant red shrimp in GSA 11

5.1.12.3 Fisheries

The GSA 11 fishing fleet is made up by about 1300 boats, 150 of which are small medium and big trawlers. Administratively vessels belong to few major fishing ports ("compamare") namely Cagliari, La Maddalena, Olbia, Oristano and Porto Torres. Other important ports are Alghero, Porto Torres, La Caletta and Sant'Antioco. The giant red shrimp is a high-value species, being a target of a specific deep trawl fishery in the whole GSA 11. The big trawlers of GSA11 operate all the week from Monday to Friday accomplishing daily or bi-daily fishing trips and delivering products to local markets.
Moreover, due to the distance of the fishing grounds to the main portsof the western cost and the dominant weather conditions, the fleet targeting *A. foliacea* shows some seasonal variations, with more time spent at sea from mid spring to mid-autumn. The big trawlers of GSA11 operate all the week from Monday to Friday accomplishing daily or bi-daily fishing trips and delivering products to local markets. Trawl fishing effort (KW*fishing days) is decreasing since 2004 with the lowest values achieved in 2013. Annual landings of giant red shrimp show a maximum of 170 tons in 2005 followed by a gradual decline in the successive years. The lowest value (63.3 t) was obtained in 2013.

5.1.12.4 Limit and precauationary management reference points

No reference points were calculated during EWG 14-19.

5.1.12.5 Comments on the assessment

The detailed assessment can be found in section 5.2.12.

5.1.13 SUMMARY SHEET OF DEEP SEA PINK SHRIMP IN GSA 11

Species common name: Deep-water rose shrimp (FAO)
Species scientific name: *Parapenaeus longirostris*
Geographical Sub-area(s) GSA(s): 11

5.1.13.1 Most recent state of the stock

Due to inconsistency in the data time series STECF EWG 14-19 decided not to perform the assessment of this stock. MEDITS survey indices show a variable pattern of abundance (n/h) and biomass (kg/h) without an increasing trend in the last years

State of the adult abundance and biomass

According to the MEDITS data (SURBA analysis), SSB was at the lowest levels in mid-'90s (1994-1996). It started increasing rapidly in 1997 to peak in 1999. Since then SSB declined to achieve the lowest value in 2008. In the perod 2009-2012 there was an increase in SSB followed by a reduction in 2013.

State of the juveniles (recruits)

Recruitment during MEDITS show peaks in 1998 and 2010 without any temporal trend.

State of exploitation

Fishing mortality ($F_{0\text{-}2}$) estimated by SURBA on MEDITS 1994-2013 did not show any clear temporal trend, fluctuating beween 0.7 and 2.0.

Source of data and methods

Considering the data quality and the inconsistences in the landing data (numbers at-age, size structures) and taking into account that for GSA 11 a specific need for a thorough revision and update of data is required, STECF EWG 14-19 decided not to perform the assessment for this stock.

5.1.13.2 Outlook and management advice

EWG 14-19 did not provide advice on deep-sea pink shrimp in GSA 11

5.1.13.3 Fisheries

The GSA 11 fishing fleet is made up by about 1300 boats, 150 of which are small medium and big trawlers. Administratively vessels belong to few major fishing ports ("compamare") namely Cagliari, La Maddalena, Olbia, Oristano and Porto Torres. Other important ports are Alghero, Porto Torres, La Caletta and Sant'Antioco. The deep-sea pink shrimp is one of the most important target species of the fishery carried out on bottoms of the upper slope and it is part of an important fishing assemblage targeted exclusively by trawlers. The discard fraction is composed of species such as Glossanodon leioglossus, Capros aper, Galeus melastomus and Raja sp.
The big trawlers of GSA11 operate all week long from Monday to Friday accomplishing daily or bi-daily fishing trips and delivering products to local markets. The mid-sized and small trawlers perform daily fishing trips, before the sunrise until the early morning, remaining sometimes two days at sea.
Moreover, due to the distance of the fishing grounds to the main ports of the western coast and the dominant weather conditions, the fleet targeting *P. longirostris* shows some seasonal variations, with more time spent at sea from mid spring to mid-autumn. Some large trawlers move seasonally to different fishing grounds far from the usual ports.
Fishing effort (KW*fishing days) is decreasing since 2004 with the lowest values achieved in 2013.
Total landings of deep see pink shrimp according to DCF data shows a peak of 552 tons in 2005 followed by a fast decline in the successive years. The lowest value (23.2 t) was obtained in 2013.

5.1.13.4 Limit and precauationary management reference points
No reference points calculated during EWG 14-19.

5.1.13.5 Comments on the assessment
The detailed assessment can be found in section 5.2.13.

5.1.14 SUMMARY SHEET OF NORWAY LOBSTER IN GSA 17

Species common name: Norway lobster
Species scientific name: *Nephrops norvegicus*
Geographical Sub-area(s) GSA(s): GSA 17

5.1.14.1 Most recent state of the stock

No previous assessments performed.

State of the adult abundance and biomass

Not assessed.

State of the juveniles (recruits)

Not assessed.

State of exploitation

Not assessed.

Source of data and methods

Not assessed.

5.1.14.2 Outlook and management advice

Nephrops norvegicus in GSA 17 was not assessed on the basis that, owing to differing biological characteristics among areas within GSA 17, data have to be compiled for these separate areas and an assessment of GSA 17 as one stock unit was not considered appropriate.

5.1.14.3 Fisheries

Nephrops norvegicus is exploited by bottom trawls in the entire GSA 17 and by baited traps/creels in the northeastern channels of Croatia.

5.1.14.4 Limit and precauationary management reference points

Not assessed

5.1.14.5 Comments on the assessment

Nephrops norvegicus in GSA 17 was not assessed on the basis that, owing to differing biological characteristics among areas within GSA 17, data have to be compiled for these separate areas and an assessment of GSA 17 as one stock unit was not considered appropriate.

The detailed information can be found in section 5.2.14.

5.1.15 SUMMARY SHEET OF NORWAY LOBSTER IN GSA 18

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

5.1.15.1 Most recent state of the stock

State of the adult abundance and biomass

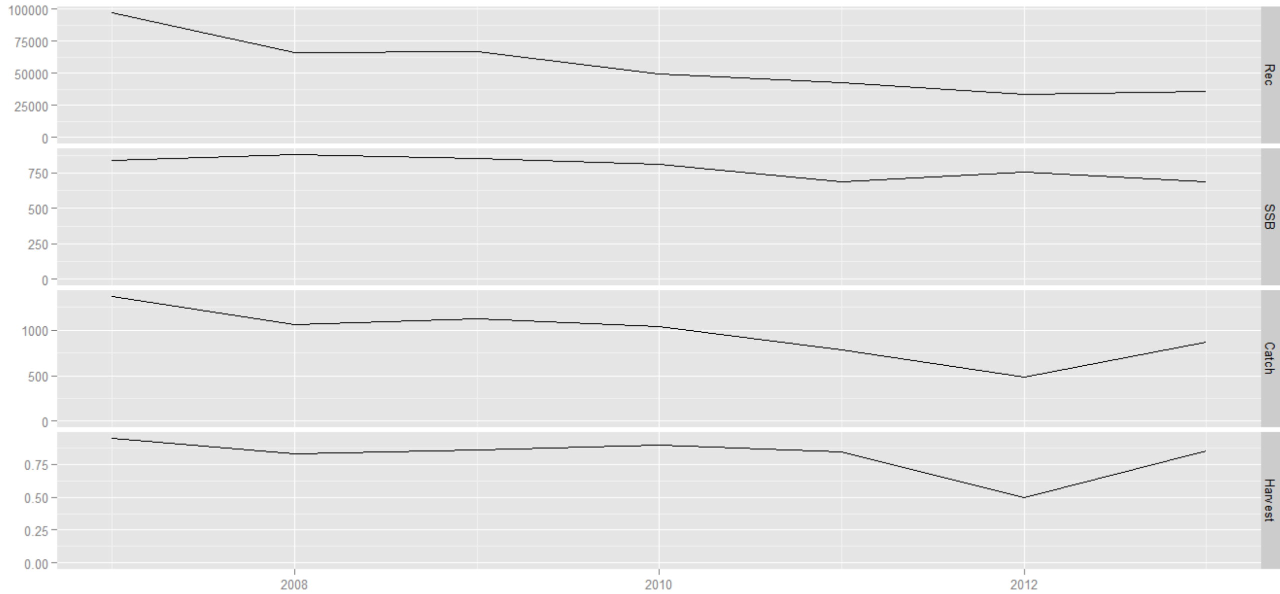
The SSB pattern observed in the XSA results is rather stable trend from 2006 to 2013. In the absence of proposed and agreed precautionary management references, STECF EWG 14-19 is unable to fully evaluate the status of SSB.

State of the juveniles (recruits)

Recruitment showed a decreasing trend from 2007 to 2013 .

State of exploitation

STECF EWG 14-19 proposes F = 0.14 as limit management reference point (basis $F_{0.1}$) of exploitation consistent with high long term yield. Given the results of the present analysis (Fcurrent (2013) = 0.85), the stock is considered exploted unsustainably during the period 2007-2013. EWG 14-19 recommends the relevant fleets' 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.



Norway lobster in GSA 18. XSA results: Recruitment, SSB, Catch and F. SSB and catch are in tonnes, recruitment in 1000s individuals.

Source of data and methods

The data used in the analyses were from trawl surveys (time series of MEDITS survey from 1994 to 2013) and from fisheries. The stock is assessed by XSA method in 2007 and 2013. A sex combined analysis was carried out. The growth parameters used are females L_{inf}=62 mm; k=0.19; t_0= -0.5; males L_{inf}=80 mm; k=0.17; t_0= -0.5.

Parameters of the length-weight relationship were a=0.5749, b=3.1626 for sexes combined (length in cm).

A vector of natural mortality was calculated using the PRODBIOM approach.
The XSA was calculated on the age range between 1 and 7+, as these were the age classes most represented in the catches. The F_{bar} was calculated considering ages 1-6.
Management reference points were estimated by an YPR implemented in FLR.

5.1.15.2 Outlook and management advice

STECF EWG 14-19 advises the relevant fleets' effort 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.

5.1.15.3 Fisheries

In GSA 18, Norway lobster is only targeted by trawlers on offshore fishing grounds. Norway lobster may co-occur with other important commercial species as *M. merluccius*, *Illex coindetii*, *Eledone cirrhosa*, *Lophius* spp., *Lepidorhombus boscii*, *P. longirostris*.
In 2008 a management plan was adopted, that foresaw the reduction of fleet capacity associated with a reduction of the time at sea. Available landing data are from DCF regulations. EWG 14-19 received Italian landings data for GSA 18 by fisheries (listed in Tab. 5.2.15.4.4.1).
In general, demersal trawlers account for the majority of the landings. Landings are decreasing from 2007 to 2013.
The fishing effort of trawlers, that is the major component of fishing in the area, is also decreasing.

5.1.15.4 Limit and precauationary management reference points

Limit and precautionary management reference point proposed by EWG 14-19 is F_{MSY} = 0.14.

5.1.15.5 Comments on the assessment

The detailed assessment of Norway lobster can be found in section 5.2.15.

5.1.16 SUMMARY SHEET OF RED MULLET IN GSA 18

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

5.1.16.1 Most recent state of the stock

State of the adult abundance and biomass

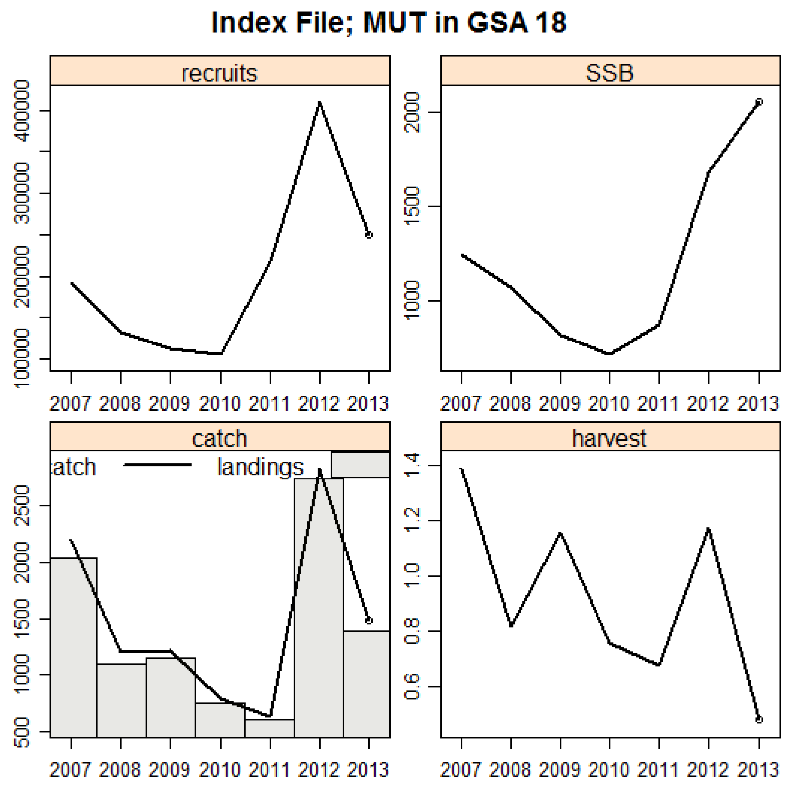
XSA indicates an increasing biomass in recent years that is also in line with survey indices. However, EWG 14-19 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points.

State of the juveniles (recruits)

XSA results indicates a huge recruitment peak in 2012 in accordance with the observation in the trawl survey time series .

State of exploitation

EWG 14-19 proposed F0.1 = 0.45 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the XSA and ALADYM analysis (current F corresponding to the F in the 2013 is around 0.48), the stock is considered exploited at levels close to sustainability.



Red mullet in GSA 18. XSA results. Recruitment, SSB, Catch and F. SSB and catch are in tonnes, recruitment in 1000s individuals.

Source of data and methods

Available landing data collected under the DCF refer only to the western side of the GSA 18. Commercial data from the eastern side of the GSA for the same period were not available from FAO-Fishstat. Survey data were available for the whole area from 1996 to 2013.

Growth parameters (L_{inf}= 30 cm; k= 0.4; t_0 = -0.3) were used and a natural mortality vector M was estimated using PRODBIOM and a maturity vector by age derived from the maturity at length estimated within DCF.

The analysis was performed with the assumption that the catch at age structure on the Eastern side of the GSA was the same of the Western side. A sensitivity analysis has been performed, assuming the Eastern landings to be the 5%, 10% and 20% of the Western side landings.

XSA model has been applied to the three scenarios. The result were rather similar in terms of SSB, R and F and thus the run with the Eastern catches assumed to be equal to 10% of these of the Western side has been used for advice and to parameterize ALADYM simulation model in order to provide a set of management scenarios by fleet as required by ToR 3.

5.1.16.2 Outlook and management advice

EWG 14-19 recommends the relevant fleets' effort 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.

5.1.16.3 Fisheries

Red mullet in GSA 18 is mainly targeted by trawlers and to a much lesser extent by small scale fisheries using gill nets and trammel nets. Fishing grounds are located along the coasts of the whole GSA 18.

Red mullet co-occurs with other important commercial species like *Pagellus sp*., *Eledone sp*., *Octopus sp*., *M. merluccius*, etc.

5.1.16.4 Limit and precAutionary management reference points

Limit and precautionary management reference point proposed by EWG 14-19 is F_{MSY} = 0. 45.

5.1.16.5 Comments on the assessment

The detailed assessment can be found in section 5.2.16.

5.2 STOCK ASSESSMENT

5.2.1 STOCK ASSESSMENT OF RED MULLET IN GSA 1

5.2.1.1 Stock Identification

Due to a lack of information about the structure of red mullet population in the western Mediterranean, this stock was assumed to be confined within the GSA 1 boundaries (Fig. 5.2.1.1.1). Red mullet in the GSA 1 is distributed on the coastal zone, and it is more abundant on the eastern part of the GSA 1 (Fig. 5.2.1.1.2).

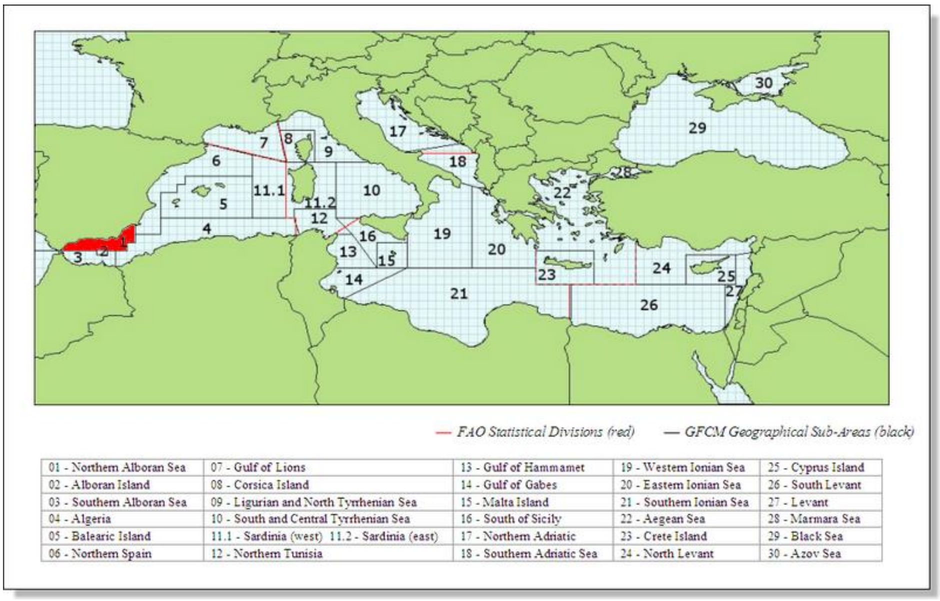


Figure 5.2.1.1.1. Geographical localization of GSA 1.

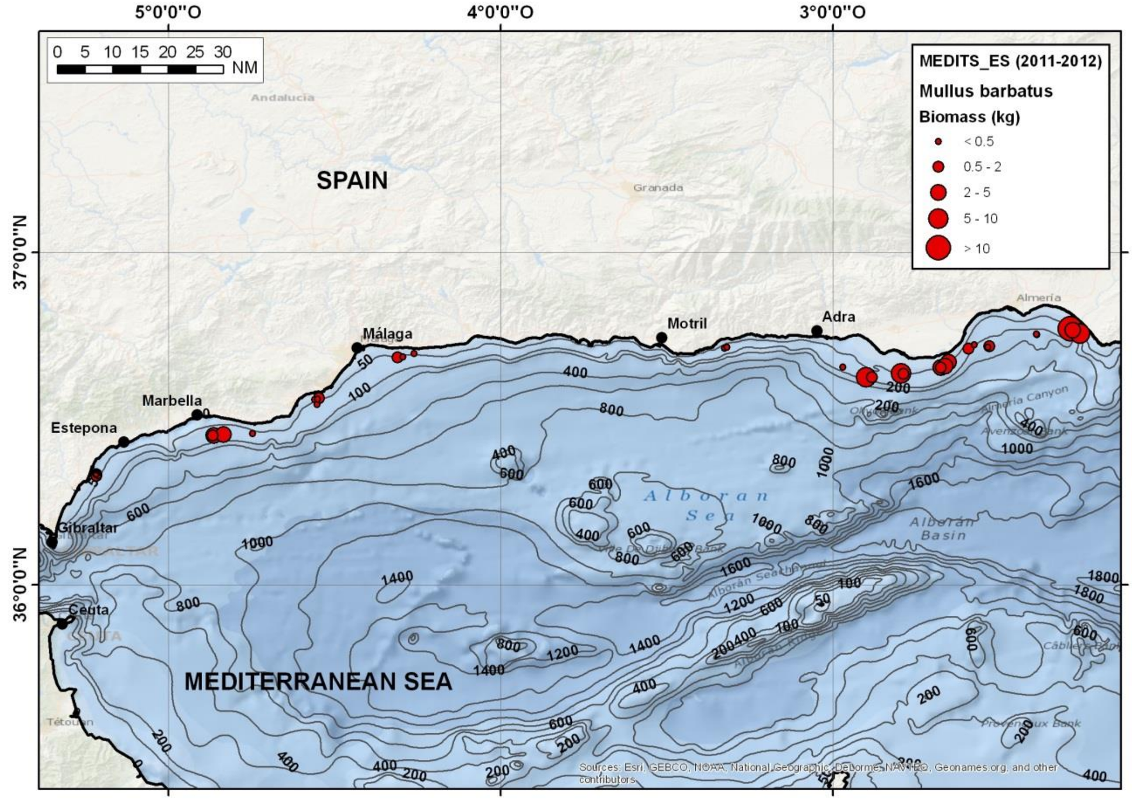


Fig. 5.2.1.1.2 Red mullet in GSA 1. Distribution as estimated from MEDITS survey data.

5.2.1.2 Growth

The parameters selected for the analyses were the same used in the last assessment done during EWG 11-12 meeting and are the following: L_{inf}=34.5, k=0.34, t_0=-0.143, length-weight parameters are: a=0.00624, b=3.1597 (data source: Spanish DCF).

5.2.1.3 Maturity

No new information was presented during EWG 14-19. Maturity ogive used is the same used in the last assessment. Size at first maturity (50%) is around 13 cm total length (TL) and an age of 1.3 years old.

Age	0	1	2	3	4+
Maturity	0.46	0.76	1	1	1

5.2.1.4 Fisheries

5.2.1.4.1 General description of the fisheries

No updated information was available to EWG 14-19. Red mullet is among the most important target species for the trawl fisheries but is also caught with set gears, in particular trammel-nets (about the 14% of the catches). From official data, the total trawl fleet of the geographical sub-area GSA 1 (Northern Alboran Sea region) is composed by about 170 boats (data compiled in EWG 11-12). Smaller vessels operate almost exclusively on the continental shelf (targeting red mullets, octopus, hake and sea breams), bigger vessels operate almost exclusively on the continental slope (targeting decapod crustaceans) and the remaining can operate indistinctly on the continental shelf and slope fishing grounds. Red mullet is intensively exploited during its recruitment from August to November.

5.2.1.4.2 *Management regulations applicable in 2014*

Trawl fisheries in GSA 1 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 diamond stretched mesh; engine power of maximum 373 kW; license system; minimum landing size of 11 cm TL).

Minimum landing size for red mullet is established at 11 cm TL from the CE Regulation 1967/2006.

5.2.1.4.3 *Catches*

5.2.1.4.4 *Landings*

Landings data were reported to EWG 14-19 through the Data Collection regulation. The majority of landings are for OTB and GTR and are provided for 2002-2013. Landings by trammel nets represent in average around 14% of the total catches except in 2012 when trammel nets represented around 30% of the total catch.

Table 5.2.1.4.4.1 Red mullet in GSA 1. Annual landings (in tons) by fishing technique as reported to EWG 14-19 through the DCR data call.

	LHP	PS	GTR	OTB
2002			14	81
2003			20	119
2004			15	113
2005			18	94
2006			19	105
2007			18	130
2008			17	136
2009		2	23	203
2010		1	14	187
2011		1	18	182
2012		1	34	73
2013	1	0.3	14	116

The time series of landings data (tons) by gear for the period 2002-2013 is shown in Figure 5.2.1.4.4.1. Total landings oscillated between 100 and 200 tons, with a maximum landings in 2009 of around 225 tons.

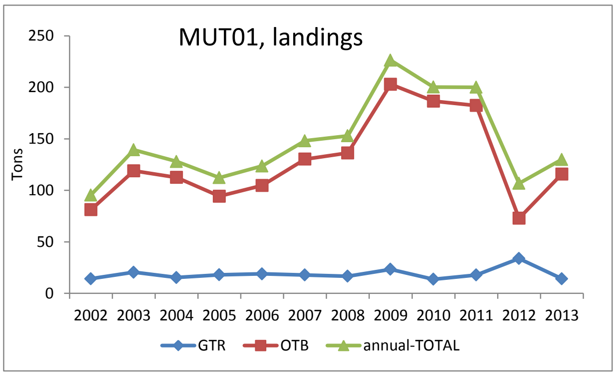
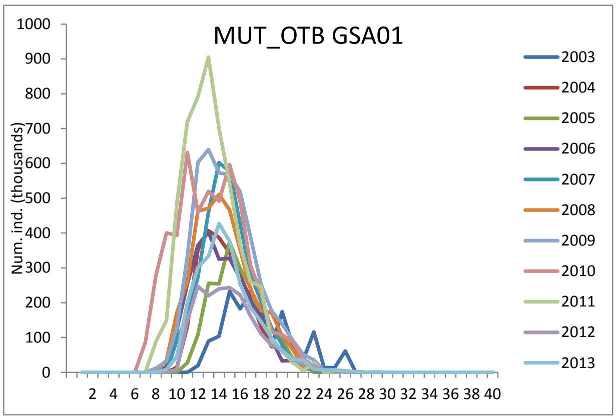


Fig. 5.2.1.4.4.1 Annual landings (in tons) by fishing technique as reported to EWG 14-19 through the DCR data call

DCF data on length structure of red mullet in GSA 1 are provided for 2003-2013 for OTB and for 2009-2013 for GTR, and are shown in Figure 5.2.1.4.4.2.



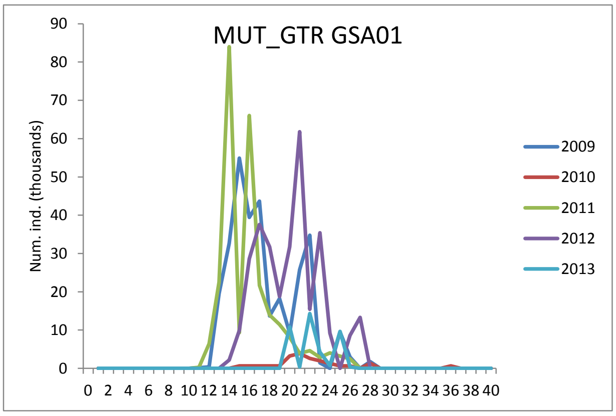
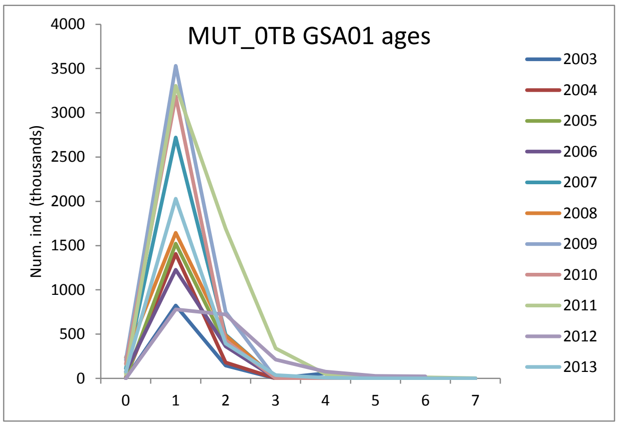


Fig. 5.2.1.4.4.2. Red mullet in GSA 1. Length frequency distributions of the landings from 2003 to 2013 for OTB and GTR from the DCF.

DCF data on age structure of red mullet from OTB and GTR in GSA 1 were available for the same period as length data, and are shown in Figure 5.2.1.4.4.3.



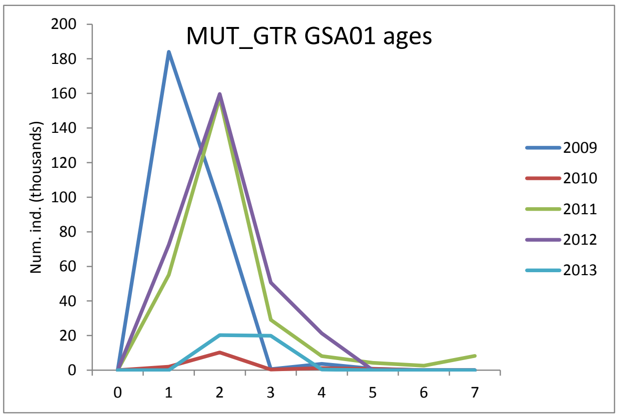


Figure 5.2.1.4.4.3. Red mullet in GSA 1. Age frequency distribution of the landings (OTB and GTR) as obtained from DCF.

5.2.1.4.5 *Discards*

Discards data were reported to STECF EWG 14-19 through the DCF. There is information on OTB discards from 2008 to 2013 (Table 5.2.1.4.5.1). The amount of discards reported is very low (<2 tons) and represent a maximum of 2% of the catch. There are no data on length for the discards.

Table 5.2.1.4.5.1. Red mullet in GSA 1. Annual discards (in tons) as reported to EWG 14-19 through the DCR data call.

	2008	2009	2010	2011	2012	2013
Discards	0.1	1.1	0.01	0.1	1.69	0.3

5.2.1.4.6 Fishing effort

Trawl (OTB) and trammel net (GTR) fishing effort data for GSA 1 was submitted by quarter, area, gear, fishery and vessel length class for the years 2009-2013 in the new data call. The total trawl fleet of the geographical sub-area GSA 1 (Northern Alboran Sea region) is composed by about 170 boats (data compiled in EWG 11-12).

Data for the number of vessels and effort are shown in the following table and figure. The reduction in fishing effort is apparent only for OTB. The number of vessels, nominal effort and GT days at sea of OTB and GTR fleet in GSA1 in the period 2009-2013 is presented in Table 5.2.1.4.6.1

Table 5.2.1.4.6.1. Number of vessels, nominal fishing effort and capacity by gear.

OTB	2009	2010	2011	2012	2013
number vessels	170				
Nominal effort kW x days at sea (000s)	5096	5269	5079	4675	4372
GT x days at sea (000s)	1521	1568	1508	1395	1295

GTR	2009	2010	2011	2012	2013
number vessels	184	175	193	180	206
Nominal effort kW x days at sea (000s)	415	364	402	393	468
GT x days at sea (000s)	34	30	32	32	37

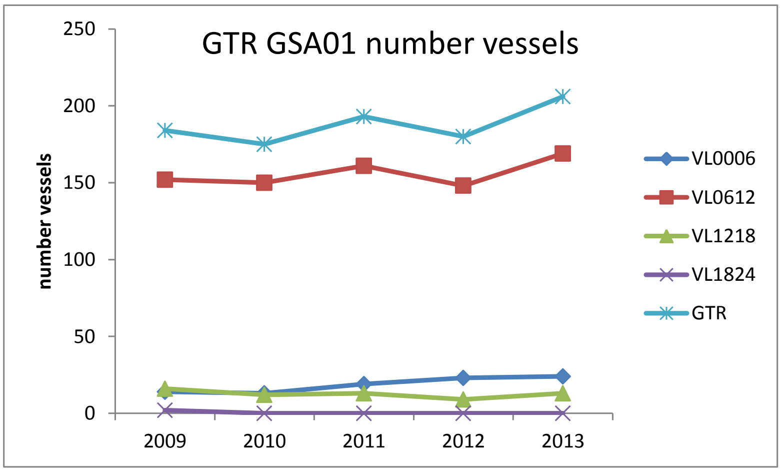


Fig. 5.2.1.4.6.1. Number of GTR vessels by fleet segment in GSA 1 during the period 2009 to 2013.

5.2.1.5 Scientific surveys

MEDITS

5.2.1.5.1 Methods

Since 1994 standard bottom trawl surveys have been conducted in GSA 1 in spring, following the general methodology of the MEDITS protocol described in Bertrand *et al.* (2002). In GSA 1 the following number of hauls was reported per depth stratum in the DCF 2014 data call:

Table 5.2.1.5.1.1. Number of hauls per year and depth stratum in GSA 1, 1994-2013.

MEDITS_ES_GSA01	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
30-50	3	1	2	2	2	2	2	4	4	4	4	2	3	4	4	2	3	3	3	3	4
50-100	6	5	5	7	6	9	6	7	8	12	8	8	9	8	8	8	6	6	8	11	14
100-200	3	3	3	5	5	5	5	6	8	8	5	6	6	7	7	7	4	4	4	5	7
200-500	8	9	11	10	8	11	13	10	11	9	13	11	14	13	12	13	6	8	8	10	14
500-800	8	10	13	10	13	12	13	13	15	14	13	11	19	13	12	9	7	7	8	10	13

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:

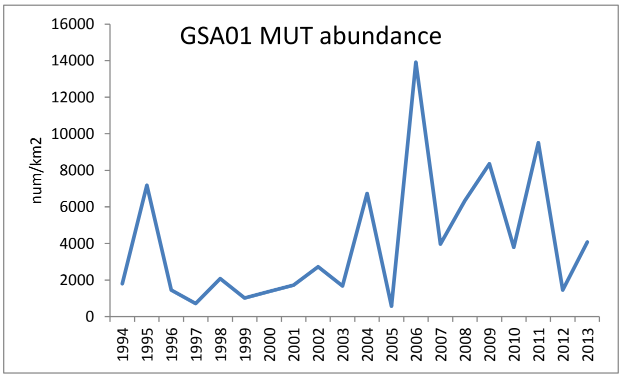
$$Yst = \Sigma (Yi*Ai) / A$$
$$V(Yst) = \Sigma (Ai2 * si\ 2 / ni) / A2$$

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.

5.2.1.5.2 Geographical distribution
No specific analyses were conducted during STECF EWG14-19.

5.2.1.5.3 Trends in abundance and biomass
Fishery independent information from the MEDITS surveys in the period 1994-2013 was used to derive indices of abundance and biomass for red mullet in GSA 1. Both abundance and biomass do not reveal any significant trends but have fluctuated in the area during this period with a maximum values in 2006.



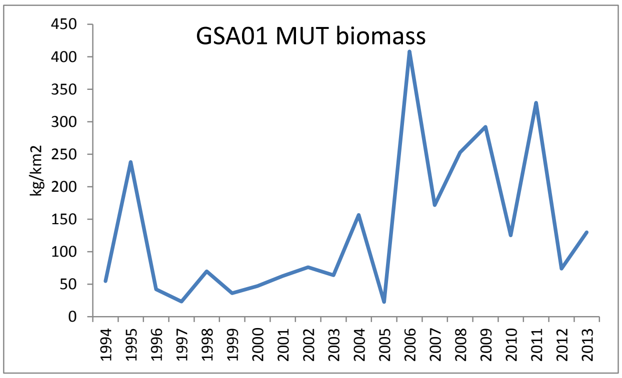


Fig. 5.2.1.5.3.1. Red mullet in GSA 1. Abundance and biomass indices from the MEDITS survey.

5.2.1.5.4 Trends in abundance by length or age

The following Figure 5.2.1.5.4.1 displays the stratified abundance indices of red mullet in GSA 1.

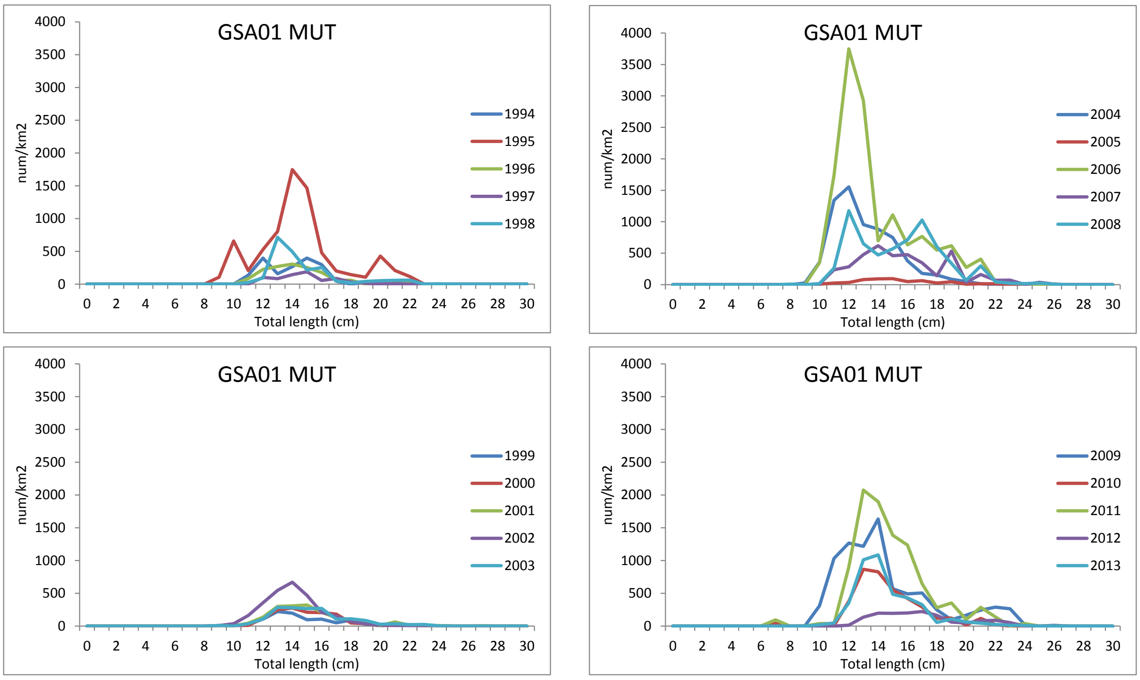


Fig. 5.2.1.5.4.1. Red mullet in GSA 1. Stratified abundance indices by size, 1994-2013.

5.2.1.5.5 Trends in growth

No specific analyses were conducted during STECF EWG14-19.

5.2.1.5.6 Trends in maturity

No specific analyses were conducted during STECF EWG14-19.

5.2.1.6 Assessment of historic stock parameters

5.2.1.6.1 *Methods: XSA*

5.2.1.6.2 *Justification*

FLR libraries were employed in order to carry out an XSA based assessment (Darby and Flatman 1994). This stock was assessed the last time during in EWG 11-12: XSA was performed using as input data the period 2003-2010. XSA has been carried out for this stock in 2014 (STECF EWG 14-09) using as input data the period 2003-2013 for the catch data and 2003-2013 for the MEDITS tuning fleet.

5.2.1.6.3 Input parameters

Input data were taken from DCF: total landings (OTB and GTR) for the period 2003-2013, combined with the available annual length frequencies per year. The OTB length frequency distribution available was for the period 2003 to 2013. Since GTR length frequency data are available only from 2009 to 2013, we have assumed the same GTR length frequency distribution for the period 2003 to 2008 as a mean of the length frequencies from 2009-2013, taking in account the relative importance of GTR catches in the different years. A combined length frequency (OTB and GTR) data has been used for the analyses (Figure 5.2.1.6.3.1).

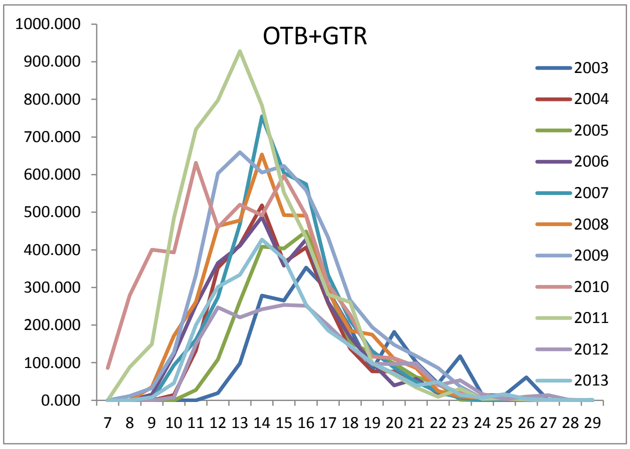


Fig. 5.2.1.6.3.1. Red mullet in GSA 1. OTB and GTR length frequencies for the period 2003 to 2013.

The growth parameters used for VBGF were: L_{inf}=34.5, k=0.34, t_0=-0.143, length-weight parameters are: a=0.00624, b=3.1597. The annual length distributions of the landings and survey data were transformed to ages by slicing using L2Age4 and are shown in Figure 5.2.1.6.3.2 and Figure 5.2.1.6.3.3 respectively. Age class 1 was the smallest age fully recruited and age classes 1 and 2 represented the 90% of the catch in number. A group plus was set at age 4.

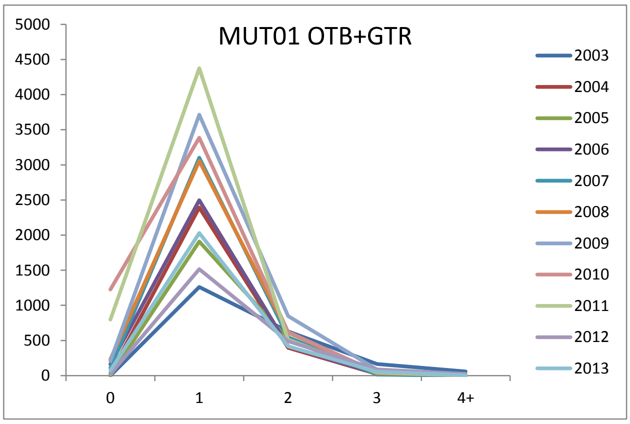


Fig.5.2.1.6.3.2. Red mullet in GSA 1. Age frequencies of the landings for the period 2003-2013.

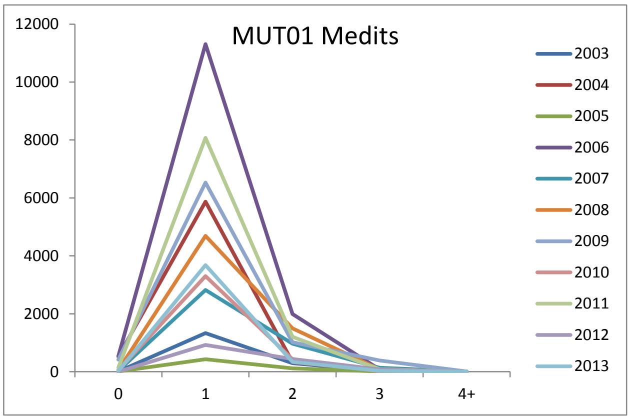


Fig.5.2.1.6.3.3. Red mullet in GSA 1. Age frequencies of the MEDITS survey for the period 2003-2013.

Table 5.2.1.6.3.1.lists the input parameters to the XSA, namely landings, catch number 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 PRODBIOM routine.

Table 5.2.1.6.3.1. Red mullet in GSA 1. Input data to the XSA model.

Catch (t)

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
139.4	128	112.3	123.7	148.1	153	226.4	200.3	200.1	106.8	130

Catch numbers at age, Numbers*10**-3											
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0	28.3	2.9	163.8	110.2	234.4	206.6	1226.4	798.9	23.9	75.1
1	1260.1	2393.9	1909.3	2496.6	3102.1	3055.9	3714	3384.6	4375.6	1516.7	2029
2	627.9	395.4	513.3	416.7	545.2	615.4	848.1	620	510.4	490.9	415.1
3	164.8	22.3	18	26	14.9	31.6	86.4	47.7	43.6	88.9	55.8
4+	57.6	0	0	1	0	5.4	4.5	2.8	2.3	23	7.2

Catch weights at age (kg)											
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0	0.012	0.014	0.011	0.011	0.011	0.01	0.008	0.01	0.013	0.011
1	0.039	0.031	0.036	0.031	0.033	0.031	0.031	0.029	0.027	0.031	0.03
2	0.079	0.076	0.077	0.074	0.073	0.076	0.078	0.077	0.071	0.08	0.077
3	0.139	0.128	0.119	0.141	0.125	0.141	0.135	0.135	0.139	0.137	0.143
4+	0.196	0.205	0.205	0.22	0.205	0.202	0.215	0.219	0.196	0.211	0.219

Natural mortality (M) at age											
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
1	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
2	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
4+	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27

MEDITS numbers tune data: effort 100 hours											
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	11.6	525.7	11.3	533	33.8	55.1	420.9	47	138	0	24.4
1	1334.6	5869.8	431.9	11313	2821.5	4690.7	6525.9	3298.2	8075.5	925.8	3682.5
2	294.4	330	114.5	1993.1	970.6	1499.5	1017	432	1206.9	440.8	336.8
3	33.6	9.1	12.8	78	138.5	84.8	385.9	12.2	88.4	83.9	32.1
4+	0	0	0	0	6.6	8.4	9.9	0	0	0	0

5.2.1.6.4 *Results*

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 0.5 to 2.5 (0.5 increasing) for the shrinkage, from 0 to 2 for rage parameter and from 2 to 3 for the qage parameter have been tested.

Comparison of trends between the settings has been done. Different combinations between the set of settings that looked more stable were tested.

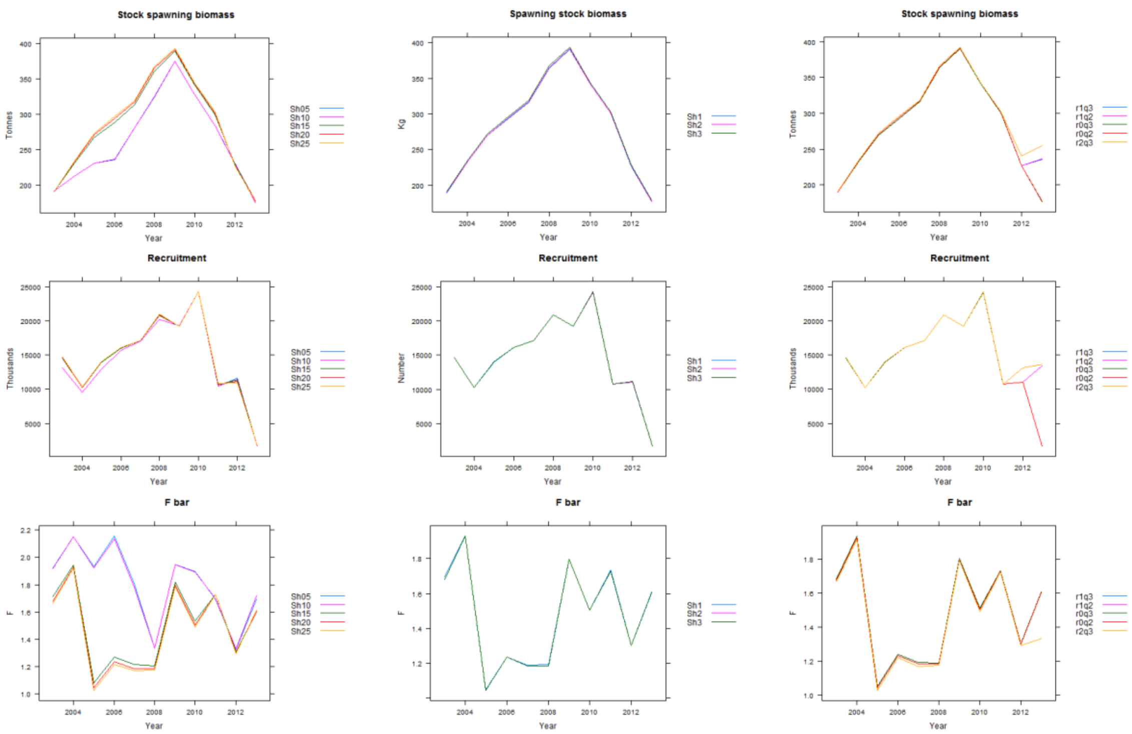


Figure 5.2.1.6.4.1. Red mullet in GSA 1. Sensitivity analysis for the main XSA parameters.

As a result, the settings that minimized the residuals and showed the best diagnostics output were used for the final assessment, and are the following:

Fbar	fse	rage	qage	shk.yrs	shk.age
1-2	2	1	3	3	2

The residuals pattern of the MEDITS trawl survey is shown in figure 5.2.1.6.4.2.

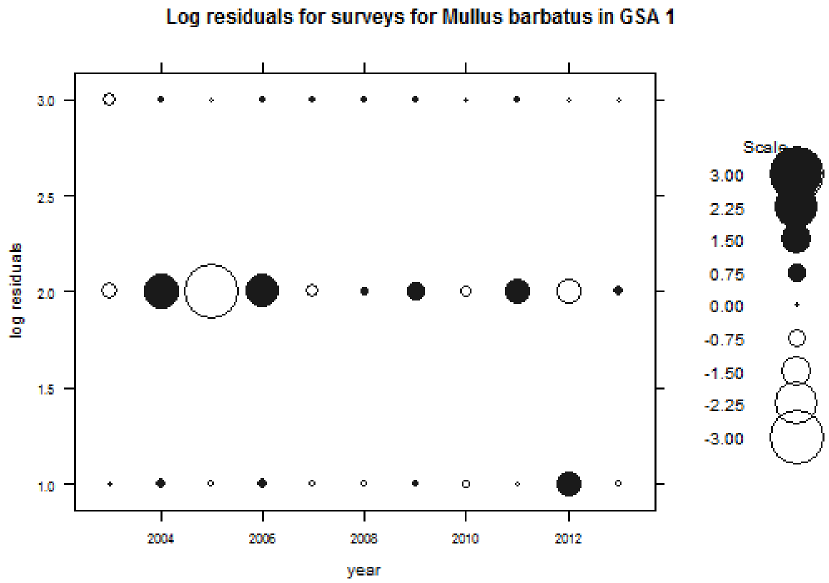


Figure 5.2.1.6.4.2. Red mullet in GSA 1. XSA residuals for the MEDITS survey from 2003 to 2013.

The results of the retrospective analysis are shown in Figure 5.2.1.6.4.3

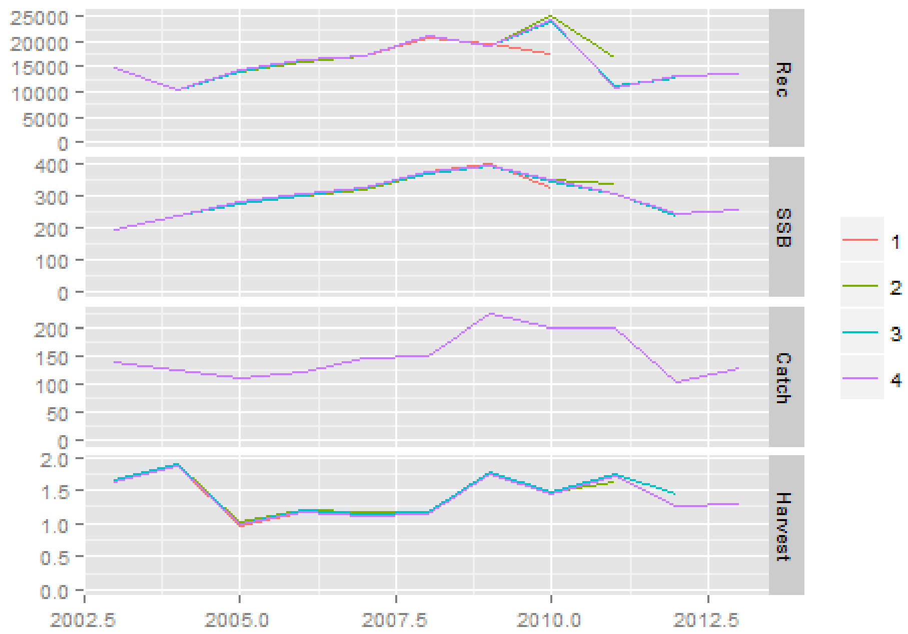


Figure 5.2.1.6.4.3. Red mullet in GSA 1. XSA retrospective analysis.

The results of the XSA are shown in the figure 5.2.1.6.4.4.

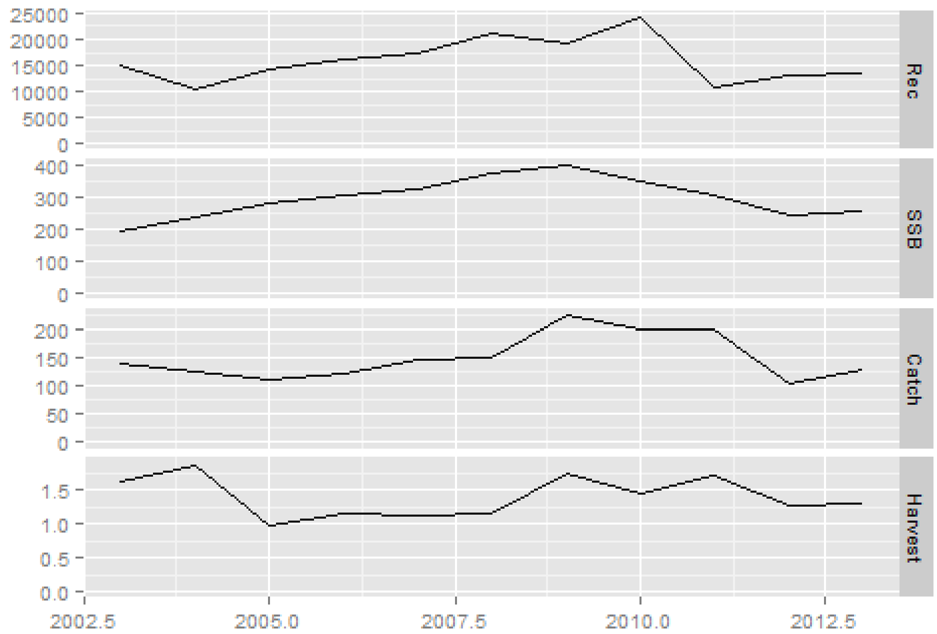


Figure 5.2.1.6.4.4. Red mullet in GSA 1. XSA results SSB and cath are in tonnes, recruitment in 1000s individuals..

In the tables 5.2.1.6.4.1 and 2 the population estimates of *Mullus barbatus* in GSA 1 obtained by XSA are provided.

Table 5.2.1.6.4.1. Red mullet in GSA 1. Stock numbers at age (thousands) as estimated by XSA.

age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	14878	10371	14198	16219	17156	21030	19256	24257	10782	13129	13421
1	2639.1	5311.7	3682.4	5067.1	5683.9	6057.5	7364.7	6731.9	7758.0	3283.8	4672.5
2	876.8	604.9	1065.4	766.6	1023.8	1051.8	1315.6	1211.1	914.5	750.1	816.7
3	214.8	65.2	30.9	312.7	160.4	254.8	212.9	104.6	212.9	136.7	103.9
4	70.4	0.0	0.0	11.9	0.0	43.2	10.8	6.0	11.1	34.0	12.9

Table 5.2.1.6.4.2. Red mullet in GSA 1. XSA summary results.

	Fbar1-2	Recruitment (thousands)	SSB (t)	TB (t)
2003	1.63	14878	191.14	215.85
2004	1.88	10371	236.7	343.43
2005	0.99	14198	277.9	417.05
2006	1.17	16219	304.89	438.93
2007	1.13	17155	324.14	471.06
2008	1.15	21030	373.71	543.7
2009	1.76	19256	395.78	554.56
2010	1.46	24257	346.32	497.96

2011	1.71	10782	305.49	413.99
2012	1.27	13129	241.79	358.39
2013	1.31	13421	255	368.36

	F at age				
	0	1	2	3	4+
2003	0.00	1.00	2.25	2.73	2.73
2004	0.01	1.14	2.63	0.64	0.64
2005	0.00	1.10	0.88	1.17	1.17
2006	0.02	1.13	1.21	0.11	0.11
2007	0.01	1.22	1.04	0.12	0.12
2008	0.02	1.06	1.25	0.16	0.16
2009	0.02	1.34	2.18	0.79	0.79
2010	0.11	1.53	1.39	1.06	1.06
2011	0.16	1.87	1.55	0.33	0.33
2012	0.00	0.92	1.63	1.51	1.51
2013	0.01	1.18	1.44	1.54	1.54

The XSA results summarized in Table 5.2.1.6.4.2 and in Figure 5.2.1.6.4.4 show maximum stock values (recruitment, SSB and total Biomass) during the period 2008-10 and then values are stabilising at previous levels. Considering the whole period, no significant trend in recruitment, SSB and F was observed. F_{cur} is calculated as the F of the last year (2013) and was equal to 1.31.

5.2.1.7 Long term prediction

5.2.1.7.1 *Justification*

The yield per recruit (YpR) analysis was run using the NOAA Yield per recruit software and FLBRP routine. Similar results were obtained with both methods. $F_{0.1}$ from FLBRP resulted equal to 0.265 and $F_{0.1}$ from NOAA routine was equal to 0.27.

5.2.1.7.2 *Results*

YpR output curve is illustrated in the Figure 5.2.1.7.2.1 while in Table 5.2.1.7.2.1 the main results of the analysis are reported.

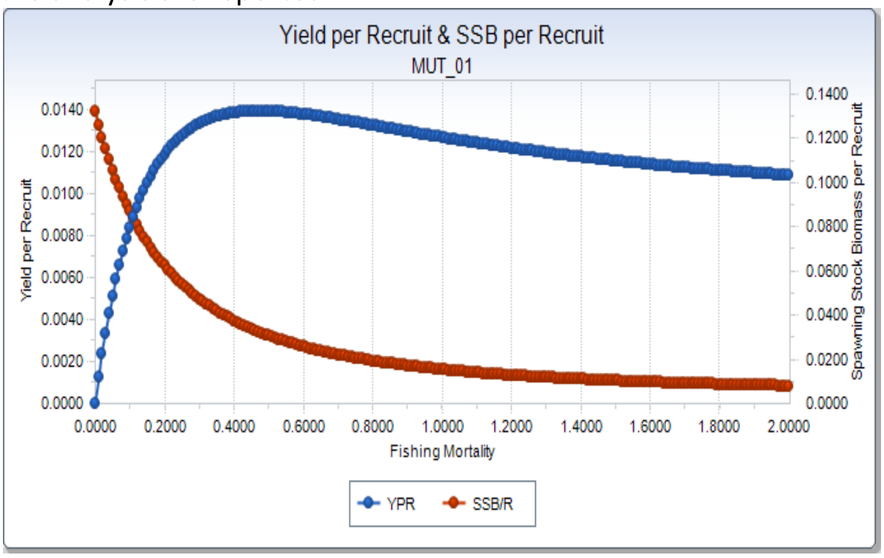


Figure 5.2.1.7.2.1. Red mullet in GSA 1. Yield per Recruit curve.

Table 5.2.1.7.2.1. Red mullet in GSA 1. Summary results of the Yield per Recruit analysis.

	F	YPR	SSB/R	B/R	Mean Age
Virgin	0	0.000	0.132	0.163	2.17
$F_{0.1}$	0.27	0.013	0.051	0.078	0.99
F_{max}	0.47	0.014	0.032	0.057	0.73
F20%	0.58	0.014	0.027	0.050	0.64

5.2.1.8 Data quality

Data from DCF 2013 as submitted through the Official data call in 2014 were used. Fishing effort data should be checked. At the present is not possible know the effective number of OTB working on GSA 1 due to the different gears used by the same boat during the same quarter.

5.2.1.9 Scientific advice

The current F (1.31) is larger than $F_{0.1}$ (0.27), chosen as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields, which indicates that red mullet in GSA 1 is exploited unsustainably.

5.2.1.10 Short term considerations

5.2.1.10.1 State of the stock size

No significant trends in SSB were observed during the period of 2003-2013. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-19 is unable to evaluate the status of the stock spawning biomass in respect to these.

5.2.1.10.2 State of recruitment

The recruitment estimated for 2014 is 12385 thousand individuals, slightly lower compared to the time series average (15881 thousand).

5.2.1.10.3 State of exploitation

The current F (1.31) is larger than $F_{0.1}$ (0.27), chosen as proxy of F_{MSY} and as the exploitation reference point consistent with long term yield, which indicates that red mullet in GSA 1 is exploited unsustainably. The size composition of landings indicates that the exploitation is based mainly on age classes 1-2.

5.2.1.11 Management recommendations

EWG 14-19 advises the relevant fleets'effort 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.

5.2.2 STOCK ASSESSMENT OF BLACK-BELLIED ANGLERFISH IN GSA 1

5.2.2.1 Stock Identification

Due to a lack of information about the structure of Black-bellied anglerfish (*Lophius budegassa*) population in the western Mediterranean, this stock was assumed to be confined within the GSA 1 boundaries.

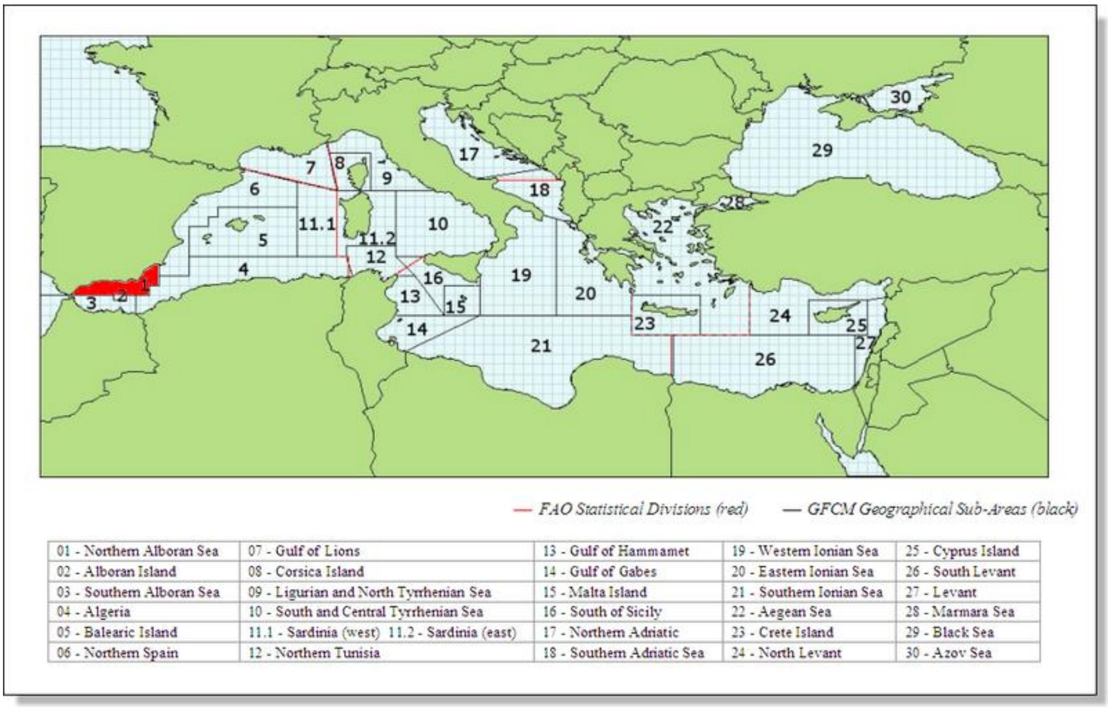


Figure 5.2.2.1.1. Geographical localization of GSA 1.

5.2.2.2 Growth

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

5.2.2.3 Maturity

The proportion of mature individuals by age class (both sexes combined) was determined from the length-based logistic maturity ogive with parameters b_0 = 2.3454, b_1 = 0.4987, L_{50} = 4.7 yr, transformed to ages, based on pooled samples over several years (Spanish Data Collection Programme).

5.2.2.4 Fisheries

5.2.2.4.1 General description of the fisheries

The species is of secondary commercial importance in GSA 1, but regularly caught by bottom trawlers and to, a lesser extent, set nets (2-3% of the total landings in 2013). From the official data, in 2013 the total trawl fleet of the whole GSA 1 (Northern Alboran Sea) comprise an average of 230 boats, averaging 34.9 GRT and 175.8 HP. Most of the landings correspond to individuals between 20 and 50 cm TL which are often sold together with *L. piscatorius* (about 20% of the catches in the area for the last years) (Fig. 5.2.2.4.1).

5.2.2.4.2 Management regulations applicable in 2014

- Fishing license
- Engine power limited to 316 KW or 500 HP
- Mesh size in the cod end (40 mm square or 50 mm diamond -by derogation-)
- Time at sea (12 hours per day and 5 days per week)
- Minimum landing size (Spain regulation RD/560/1995, 30 cm TL):

5.2.2.4.3 Catches

5.2.2.4.4 Landings

In the DCF 2013 data set the two species are reported separately, with commercial landings apportioned to *L. piscatorius* or *L. Budegassa*. The percentage applied comes from experimental trawl survey and sampling on board in commercial trawlers. (Spanish Data Collection Programme). During 2002-2013 period, the annual landings of *L. Budegassa* in GSA 1 have a decreasing trend followed by an increasing trend from 2011 to 2013. In the total series landings oscillated between 125 and 200 tons (Fig 5.2.2.4.4.1).

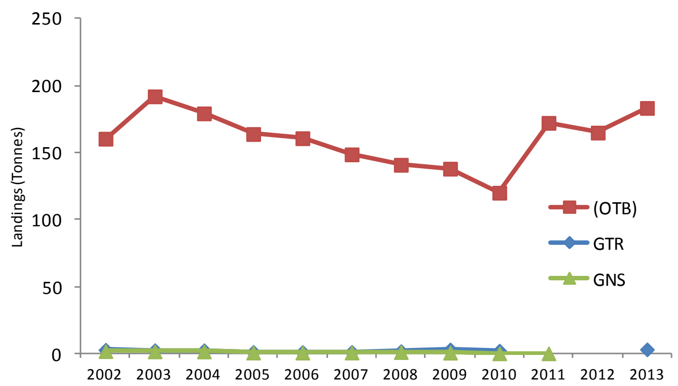


Fig. 5.2.2.4.4.1. Black-bellied anglerfish in GSA 1. Total annual landings by fishing gear.

Table 5.2.2.4.4.1. Black-bellied anglerfish in GSA 1. Landings by fishing gear from DCF 2013 data call.

YEAR	GTR	GNS	OTB
2002	3	1.8	160.4
2003	2.7	1.8	192
2004	2.6	1.7	179.3
2005	1.4	0.9	163.9
2006	1.3	0.9	160.8
2007	1.4	0.9	148.7
2008	2	1.3	141
2009	3.2	0.8	138.1
2010	2.3	0.4	120.2
2011			172.3
2012			165
2013	3.3	0.6	183.4

5.2.2.4.5 Discards

Discards of anglerfish in GSA 1 are considered small and none was reported in the DCF 2013 data call and thus they were not included in the assessment. Anyhow, there are no length frequencies of these discards because Spain making use of the derogation in the Commission Regulation (EC) No 1581/2004 which does not oblige the MS to collect detailed discard data for this species due to the low level of landings.

5.2.2.4.6 Fishing effort

Trawl (OTB) fishing effort data for GSA 1 was submitted by quarter, area, gear, fishery and vessel length class for the years 2009-2013 in the 2013 data call. Data for the length vessel classes VL1224 and VL2440 are shown in the Table 5.2.2.4.6.1. and Figure 5.2.2.4.6.1. The number of vessels and the nominal effort of OTB fleet in GSA 1 for the period 2009-2013 , shows a reduction in fishing effort and number of vessels. (Fig 5.2.2.4.6.1).

Table. 5.2.2.4.6.1. Black-bellied anglerfish GSA 1: Nominal effort and GT during 2009-2013.

	2009	2010	2011	2012	2013
Nominal effort	4067855	4158857	3967817	3661382	3367200
GT days at sea	1305178	1334692	1274035	1174291	1078696

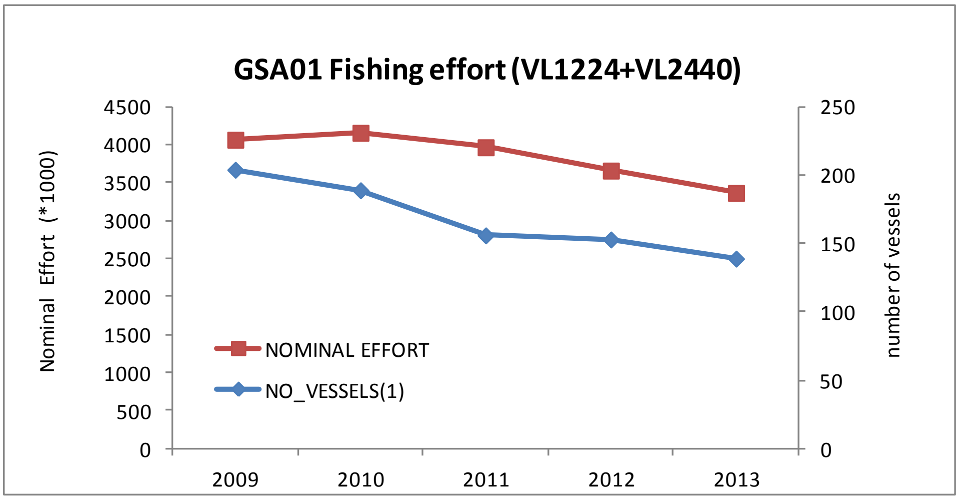


Fig. 5.2.2.4.6.1. Black-bellied anglerfish GSA 1: Nominal effort (left) and No of vessels (right) during 2009-2013.

5.2.2.5 Scientific surveys

MEDITS

5.2.2.5.1 Methods

From 1994, the Spanish Institute of Oceanography has performed annual bottom trawl surveys following the same methodology and sampling gear described in the MEDITS protocol, carries out about 170 – 180 hauls in spring. It samples 4 GSAs, including GSA 1 area. Mean stratified abundances and biomasses by km^2 has been computed using the methodology described by Grosslein and Laurec (1982).

Table 5.2.2.5.1. Number of MEDITS hauls per year and depth stratum in GSA 1, 1994-2013.

DEPTH_STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
030-050	3	1	2	2	2	2	2	4	4	4
050-100	6	5	5	7	6	9	6	7	8	12
100-200	3	3	3	5	5	5	5	6	8	8
200-500	8	9	11	10	8	11	13	10	11	9
500-800	8	10	13	10	13	12	13	13	15	14

DEPTH_STRATUM	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
030-050	4	2	3	4	4	2	3	3	3	3
050-100	8	8	9	8	8	8	6	6	8	11
100-200	5	6	6	7	7	7	4	4	4	5
200-500	13	11	14	13	12	13	6	8	8	10
500-800	13	11	19	13	12	9	7	7	8	10

5.2.2.5.2 Geographical distribution

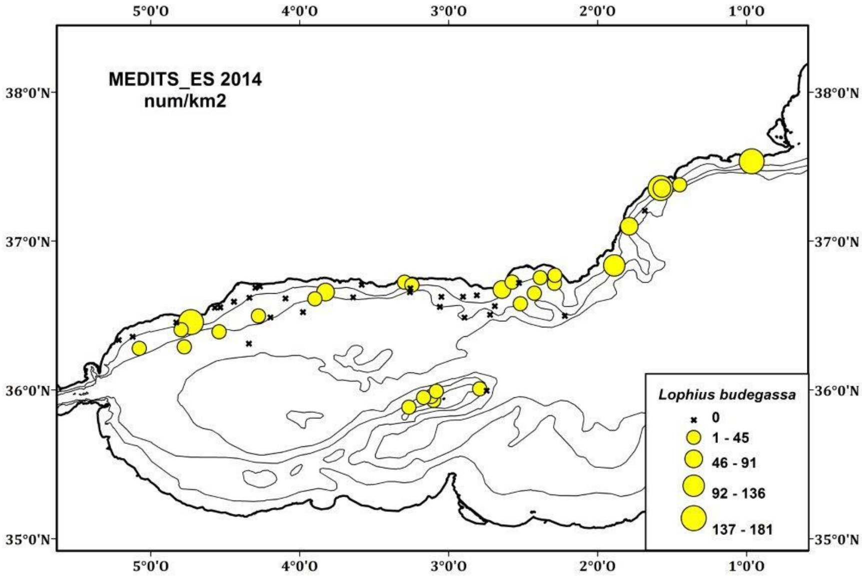
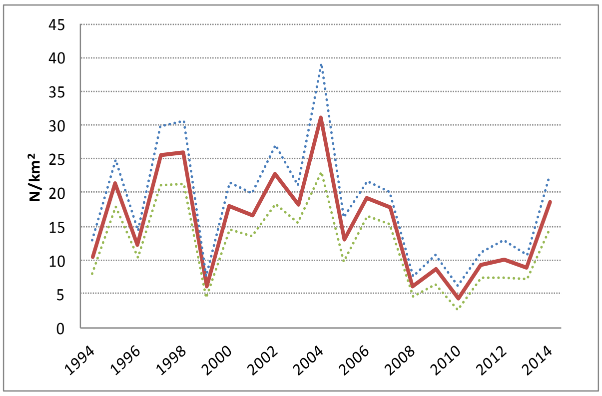


Figure 5.2.2.5.2.1. Black-bellied anglerfish in GSA 1. Geographical distribution based on bottom trawl surveys (2014).

5.2.2.5.3 Trends in abundance and biomass

Biomass and abundance indices from the surveys showed a different trend, with oscillations along the data series for abundance indices (Figure 5.2.2.5.3.1). The average biomass index of anglerfish from experimental trawl surveys is shown in figure 5.2.2.5.3.1. The abundance index shows interannual fluctuations with no significant trend, although density of anglerfish has increased over the last 4 years (matching the pattern seen in the commercial catches).



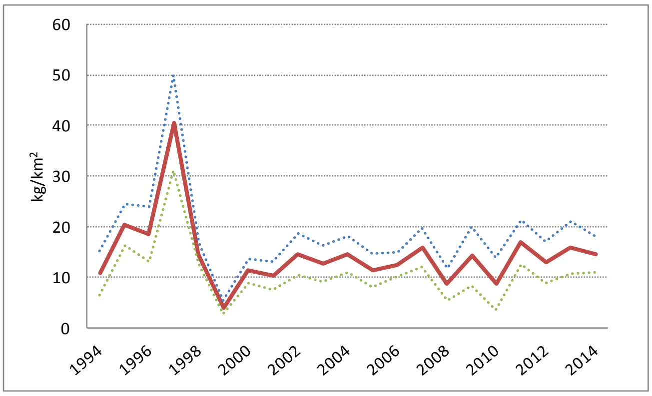


Fig. 5.2.2.5.3.1. Black-bellied anglerfish in GSA 1: Abundance indices from the MEDITS surveys (left) and the commercial fishery (right) 1994-2014.

5.2.2.5.4 Trends in abundance by length or age

No analysis was conducted during EWG 14-19.

5.2.2.5.5 Trends in growth

No analysis was conducted during EWG 14-19.

5.2.2.5.6 Trends in maturity

No analysis was conducted during EWG 14-19.

5.2.2.6 Assessment of historic stock parameters

5.2.2.6.1 *Methods*

The assessment was based on a pseudocohort analysis using the VPA equations, and was carried out using the VIT software (Lleonart and Salat, 1992). This model assumes equilibrium conditions. The use of this software is only recommended when the model is applied to short time series of consecutive annual data and the resulting variation in the estimated stock parameters appears reasonably low. (H.J.Ratz et al, 2010). Data of number at age were obtained from the slicing procedure using the L2age4 software.

5.2.2.6.2 *Justification*

5.2.2.6.3 Input parameters

The data used in the assessment were: (i) Landings time series 2003-2013 from OTB; (ii) Age distributions obtained from slicing of length distributions 2003-2013 (Figure 5.2.2.6.3.1); (iii) Set of natural mortality vector, Maturity ogive and growth parameters calculated in the study area during DCF. (Table 5.2.2.6.3.1)

Table 5.2.2.6.3.1. Black-bellied anglerfish in GSA 1. Inputs parameters. Natural mortality, maturity ogive and growth parameters.

Mean weight in catch (g)													
0	1	2	3	4	5	6	7	8	9	10	11	12	13+
10.3	136.6	447.1	943.4	1597.8	2347.8	3146.1	3957	4757.2	5522.4	6241.1	6905.5	7513.4	8064.6

Natural Mortality (Vector from PROBIOM)													
0	1	2	3	4	5	6	7	8	9	10	11	12	13+
1.109	0.489	0.365	0.312	0.282	0.263	0.25	0.24	0.233	0.227	0.223	0.219	0.216	0.21

Maturity (from DCF 2003-2012)													
0	1	2	3	4	5	6	7	8	9	10	11	12	13+
0.087	0.136	0.206	0.3	0.413	0.537	0.656	0.759	0.838	0.895	0.933	0.959	0.974	0.984

Growth parameters (from DCF 2003-2012)		
L_{inf}	K	t_0
102	0.150	-0.05

LWR (from DCF 2003-2012)	
a	b
0.0201	2.8979

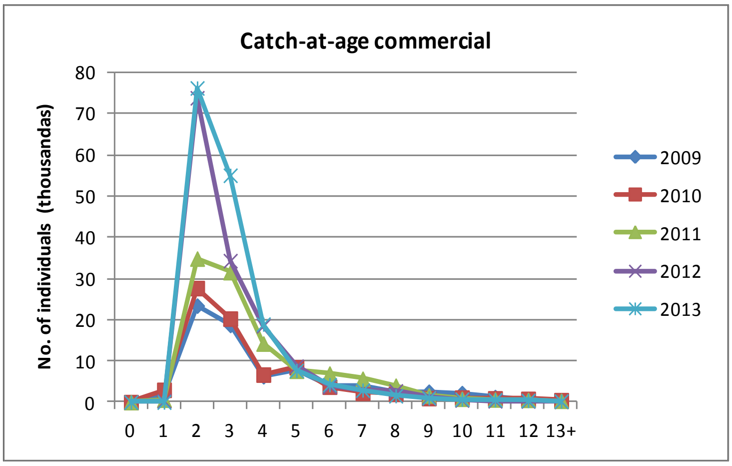


Figure 5.2.2.6.3.1. Black-bellied anglerfish in GSA 1. Age distribution by year for the commercial data.

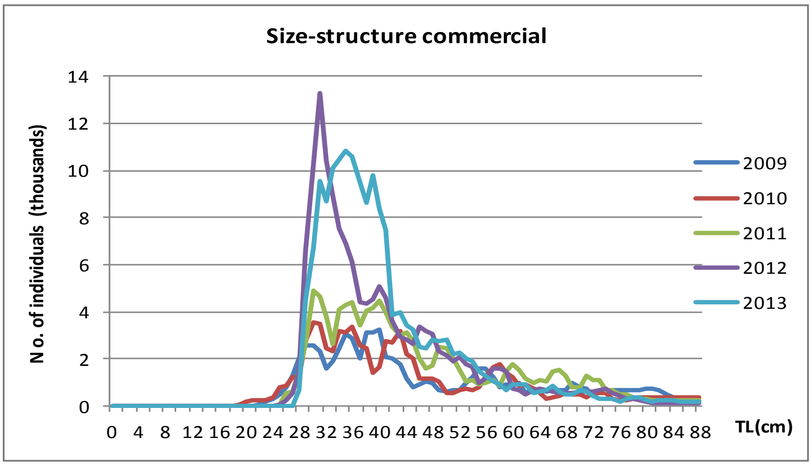


Figure 5.2.2.6.3.2. Black-bellied anglerfish in GSA 1. Size distribution by year for the commercial data.

The catches in weight are dominated by age 1 to age 3 classes in all five years, with high catches of age 2 anglerfish in 2012 and 2013, as shown in the figure.

5.2.2.6.4 *Results*

Three independent annual VIT assessments were carried out in 2009, 2010, 2011, 2012 and 2013. Results of pseudocohort VPA analysis showed a decreasing trend in the number of recruits (R) from 2009 to 2013. Biomass (B) and Spawning stock biomass (SSB) showed a decrease trend in the last years. The fishing mortality increased from 0.1 in 2009 to 0.25 in 2013. (Table. 5.2.2.6.4.1).

Table. 5.2.2.6.4.1. Black-bellied anglerfish in GSA 1. VIT analysis. Summary results.

Year	R (thousands)	B (t)	SSB(t)	Fstq	Fbar (ages)
2009	1387	1263	759	0.10	2-6
2010	1382	1265	779	0.11	2-6
2011	1613	1205	687	0.14	2-6
2012	1528	775	403	0.25	2-6

2013	1779	934	503	0.25	2-6

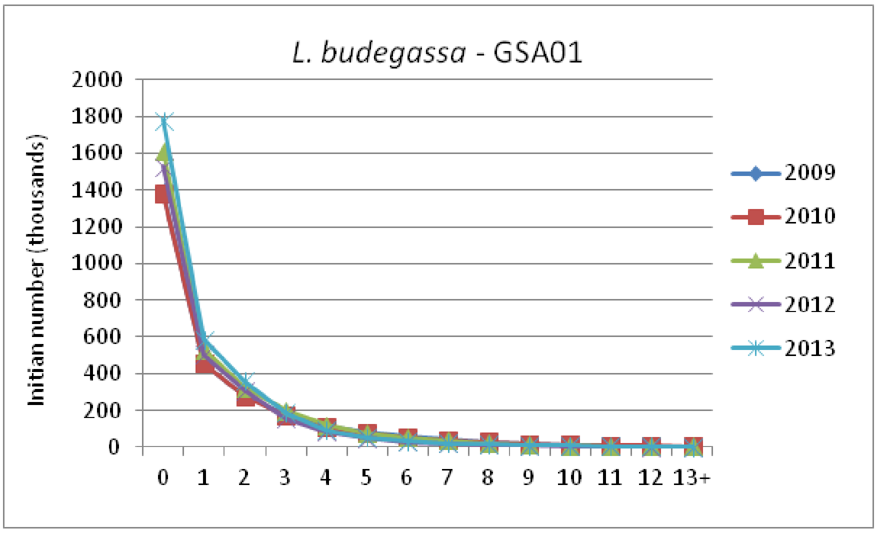


Fig. 5.2.2.6.4.1. Black-bellied anglerfish in GSA 1. Initial number for 2009-2013.

Fishing mortality values were different for the different age classes used in the analysis (1 to 13+). F in 2013 focuses on ages 2-6, while in the others years (2009-2012) F is rather high also for older ages.

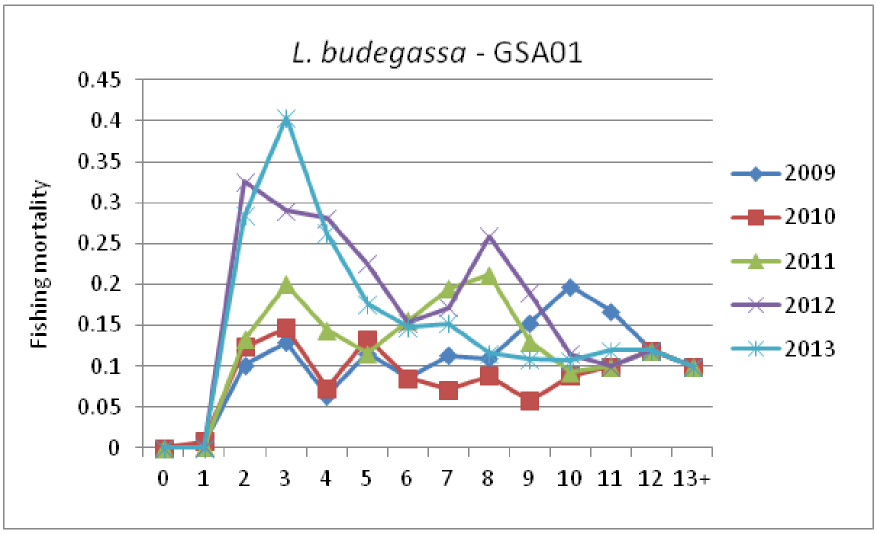


Fig. 5.2.2.6.4.2. Black-bellied anglerfish in GSA 1. Fishing mortality by OTB for 2009-2013.

5.2.2.7 Long term prediction

5.2.2.7.1 *Justification*

A Yield Per Recruit analyses (YPR) (Beverton and Hold, 1957) and Spawning Stock Biomass per Recruit (SPR) (Gabriel et al, 1989) was carried out to calculate the biological reference points F_{max} and $F_{0.1.}$ using the output results of the VIT. Ages 2-6 were selected as the Fbar.

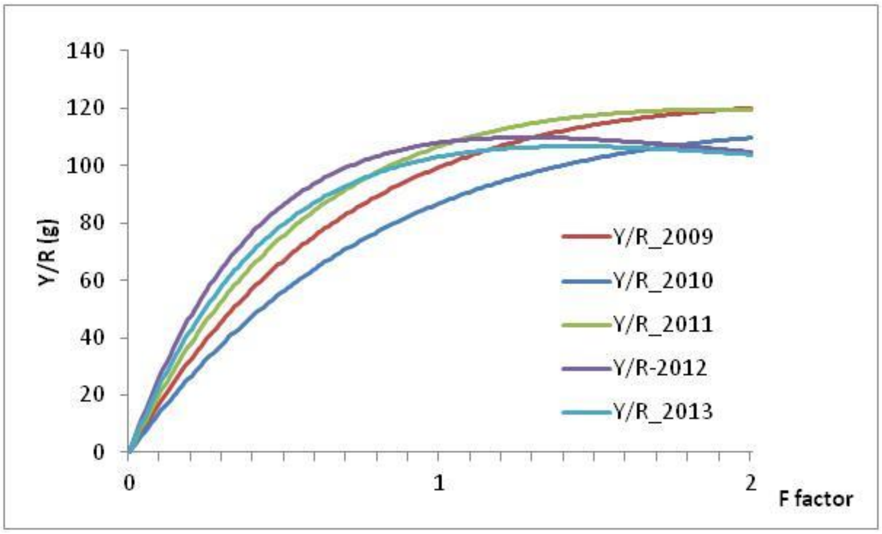


Fig. 5.2.2.7.1.1. Black-bellied anglerfish in GSA 1. Annual Y/R over the period 2009-2013, with current F (factor = 1) shown for comparison.

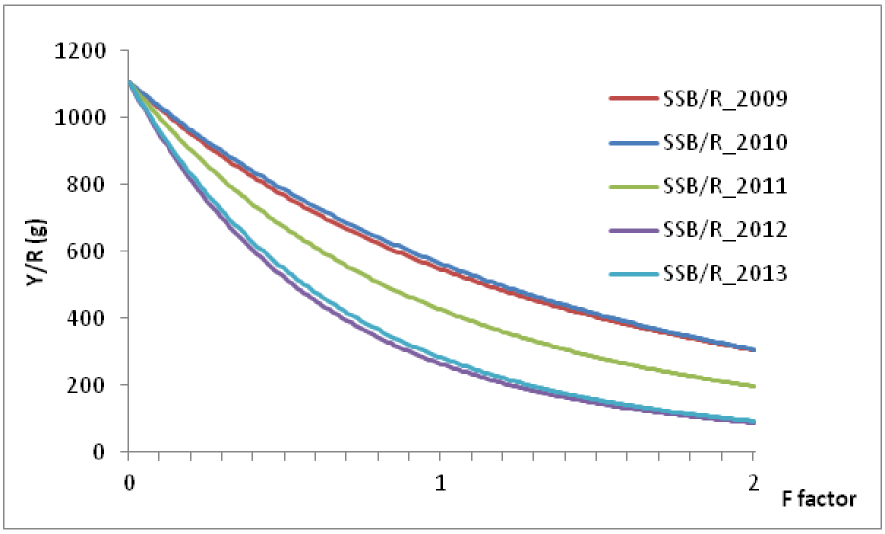


Fig. 5.2.2.7.1.2. Black-bellied anglerfish in GSA 1. Annual SSB/R over the period 2009-2013, with current F (factor = 1) shown for comparison.

Table 5.2.2.7.1.1. Black-bellied anglerfish in GSA 1. Summary results of the YPR analysis. The results for 2013 (shaded) were chosen to provide advice.

		Fishing mortality	Y/R (g)	B/R (g)	SSB/R (g)
2009	Virgin	0	0	1599	1107
	$F_{0.1}$	0.18	114.2	721.7	403.5
	F_{stq}	0.10	99.6	910.8	547.2
	F_{Max}*	-	-	-	-
2010	Virgin	0	0	1559.8	1107.1
	$F_{0.1}$	0.17	106.5	644	360
	F_{stq}	0.11	86.9	915.6	563.7
	F_{Max}*	-	-	-	-
2011	Virgin	0	0	1599	1107
	$F_{0.1}$	017	113.4	646.6	351
	F_{stq}	0.14	106.8	747	425.7
	F_{Max}	0.27	119.6	439.1	204.7
2012	Virgin	0	0	1599.8	1107.7
	$F_{0.1}$	0.17	104.59	592.91	324.5
	F_{stq}	0.25	107.97	506.81	263.9
	F_{Max}	0.3	109.77	395.7	187.5
2013	Virgin	0	0	2179	1544
	$F_{0.1}$	0.16	116	971.5	518.6
	F_{stq}	0.25	124.7	723.2	336.8
	F_{Max}	0.3	125.5	649	273.5

*Asymptotic Y/R curve

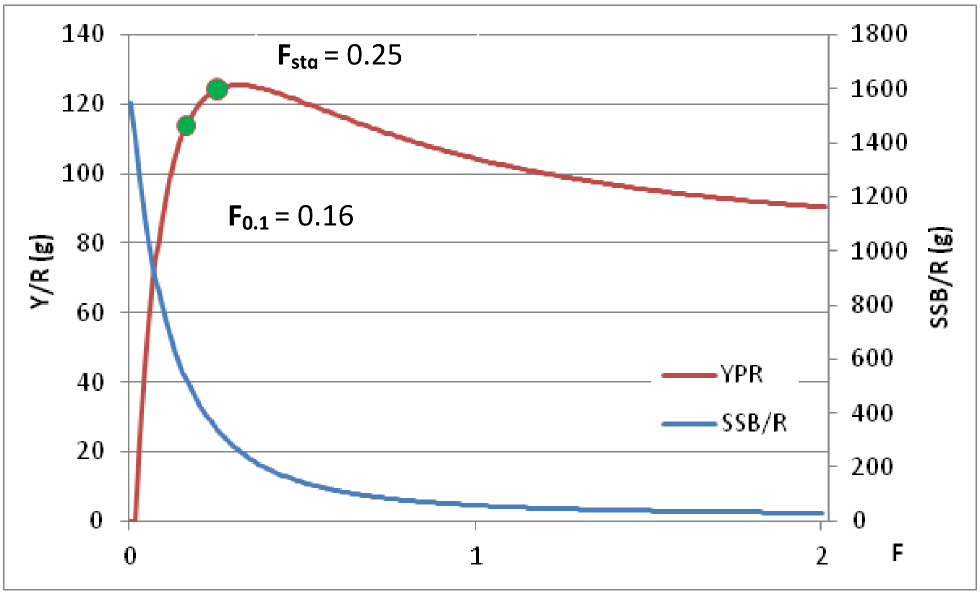


Fig. 5.2.2.7.1.3. Black-bellied anglerfish in GSA 1. Annual Y/R and SSB/R for 2013, including F_{01} and $F_{current\ (stq)}$ absolute values.

5.2.2.8 Data quality

Data from DCF 2013 were used. The data submitted to the EWG 14-19 are of sufficient quality to perform a VPA on pseudocohorts at annual scale, but incomplete to perform a tuned VPA.

5.2.2.9 Scientific advice

The F_{stq} (0.25) is larger than $F_{0.1}$ (0.16), which indicates that *Lophius budegassa* from GSA 1 is fished unsustainably.

5.2.2.10 Short term considerations

5.2.2.10.1 State of the stock size

The stock size ranged between aprox. $1900 \cdot 10^3$ individuals. The SSB decreased slightly from 2003 (779 t) to 2012 (403 t) but then increased to 2013 (503 t). EWG 14-19 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points. However, survey indices and commercial catches indicate increased abundance over 2011-2013.

5.2.2.10.2 State of recruitment

Recruitment showed a slight increase in the number of recruits from 2009 ($1387 \cdot 10^3$) to 2013($1779 \cdot 10^3$).

5.2.2.10.3 State of exploitation

The F_{stq} (0.25) is larger than $F_{0.1}$ (0.16), which indicates that *Lophius budegassa* from GSA 1 is fished unsustainably.

5.2.2.11 Management recommendations

EWG 14-19 proposes a $F_{0.1}$=0.16 (average of age classes 2 to 6 over the period 2013) as limit reference point consistent with high yield in the long term, therefore recommends the relevant fleets' effort 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.

5.2.3 STOCK ASSESSMENT OF BLACK-BELLIED ANGLERFISH IN GSA 5

5.2.3.1 Stock Identification

No analyses were conducted during STECF EWG 14-19. Due to a lack of information about the structure of the black-bellied anglerfish (*Lophius budegassa*) population in the western Mediterranean, this stock was assumed to be confined within the boundaries of the GSA 5 (Fig. 5.2.3.1.1).

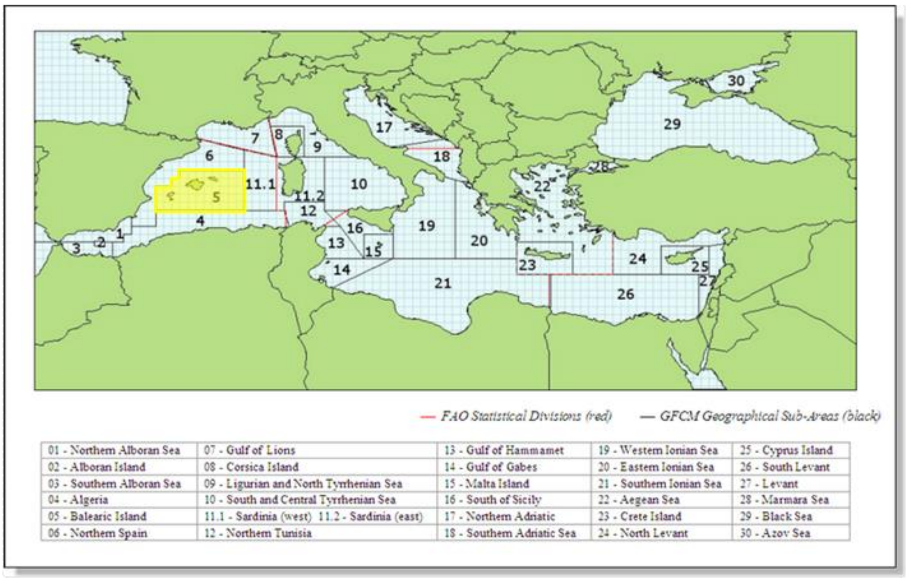


Figure 5.2.3.1.1. Geographical localization of GSA 5.

5.2.3.2 Growth

Both growth and length-weight parameters were taken from the Spanish DCF (see tables below).

5.2.3.3 Maturity

Maturity parameters were also taken from the Spanish DCF (see tables below).

5.2.3.4 Fisheries

5.2.3.4.1 General description of the fisheries

In the Balearic Islands (GSA 5), commercial trawlers employ up to four different fishing tactics (Palmer et al. 2009), which are associated with the shallow and deep continental shelf, and the upper and middle continental slope (Guijarro and Massutí 2006; Ordines et al. 2006). Vessels mainly target striped red mullet (*Mullus sumuletus*) and European hake (*Merluccius merluccius*) on the shallow and deep shelf respectively. However, these two target species are caught along with a large variety of fish and cephalopod species. The Norway lobster (*Nephrops norvegicus*) and the red shrimp (*Aristeus antennatus*) are the main target species on the upper and middle slope respectively. The Norway lobster is caught at the same time as a large number of other fish and crustacean species, but the red shrimp fishery is the only Mediterranean fishery that could be considered monospecific. The species assessed, *Lophius budegassa*, is a typical by-catch species from the bottom trawl fishery. This fishery takes two different anglerfish species (*L. budegassa* and *L. piscatorius*) which are sold in a single commercial category.

5.2.3.4.2 Management regulations applicable in 2014

- 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 (30 cm CL): mostly full compliance

5.2.3.4.3 *Catches*

5.2.3.4.4 *Landings*

Between 2000 and 2013, the annual landings of *L. budegassa* in GSA 5 have oscillated between 9.2 and 24.5 tons, with an increasing trend from 2000 to 2007 followed by a decreasing trend down to 2013 (Fig. 5.2.3.4.4A). The size structure of the population taken by the fishery shows a modal size (30-34 cm) well above the size at first maturity (24.1 cm) (Fig. 5.2.3.4.4 B).

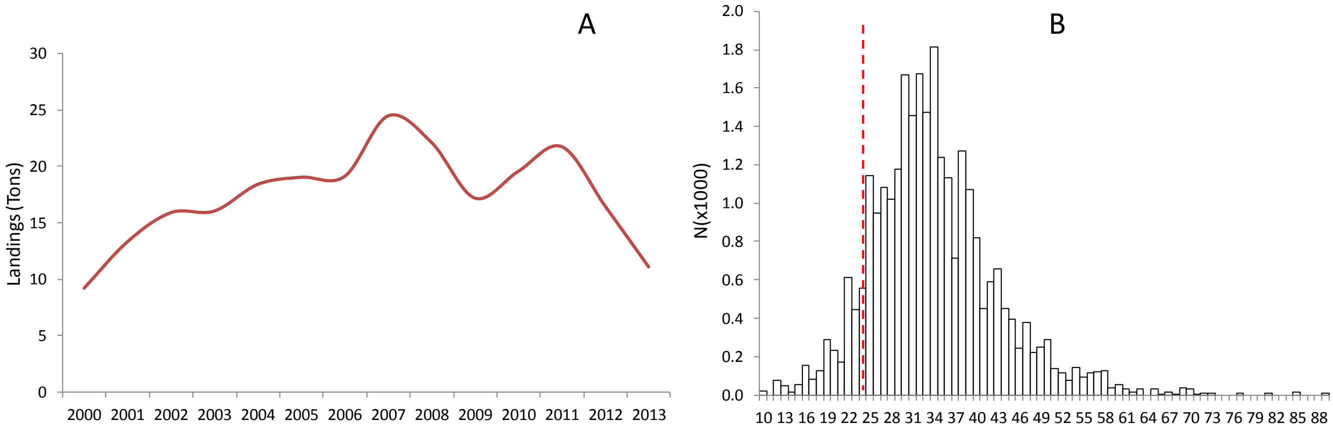


Fig. 5.2.3.4.4. Black-bellied anglerfish in GSA 5. Total annual landings (left) and mean size distribution including L_{50} (right) during 2000-2013.

5.2.3.4.5 *Discards*

Discards of *Lophius budegassa* in GSA 5 are considered to be small because it is a high-valued species. Anyway, data on discards are included in the present assessment.

5.2.3.4.6 Fishing effort

The fishing effort (in days) did not show a clear trend with time since it remained close to a main value of 2000 days (ranging between 1500 and 2250 days); catch-effort data from the time series 2000-2013 showed a highly significant positive relationship (Fig. 5.2.3.4.6).

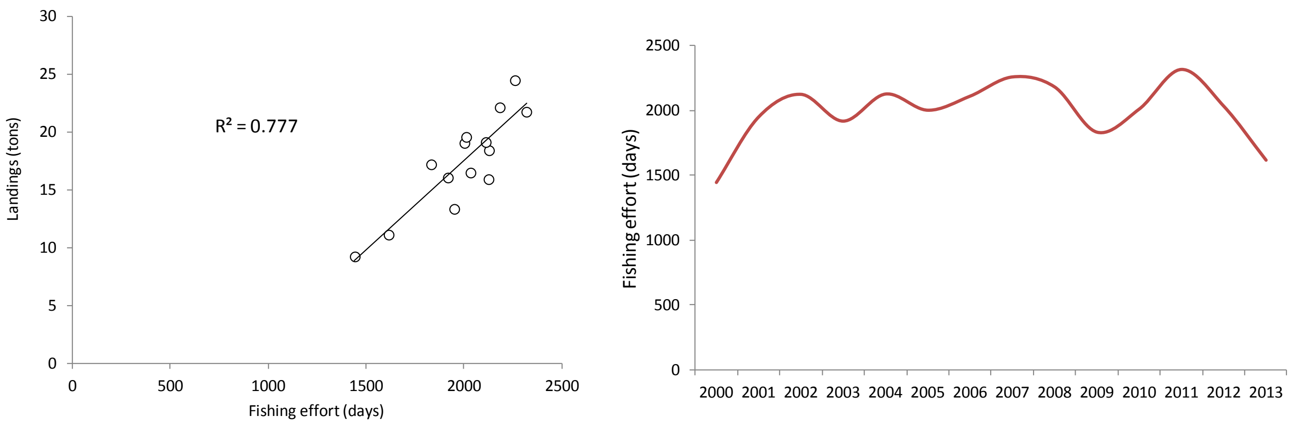


Fig. 5.2.3.4.6. Black-bellied anglerfish in GSA 5: Fishing effort in days (left) and catch-effort relationship (right) during 2000-2013.

5.2.3.5 Scientific surveys

MEDITS

5.2.3.5.1 Methods

In 2007, the GSA 5 was included in the annual MEDITS surveys, although during 2001 and 2006 another series of surveys (BALAR) using the same methodology as MEDITS were carried in GSA 5.

5.2.3.5.2 Geographical distribution

In GSA 5, *Lophius budegassa* abundances are relatively low, with values of <10 individuals per km^2. The species is mainly distributed in deep shelf and upper slope grounds around the Balearic Islands (Fig. 5.2.3.5.2).

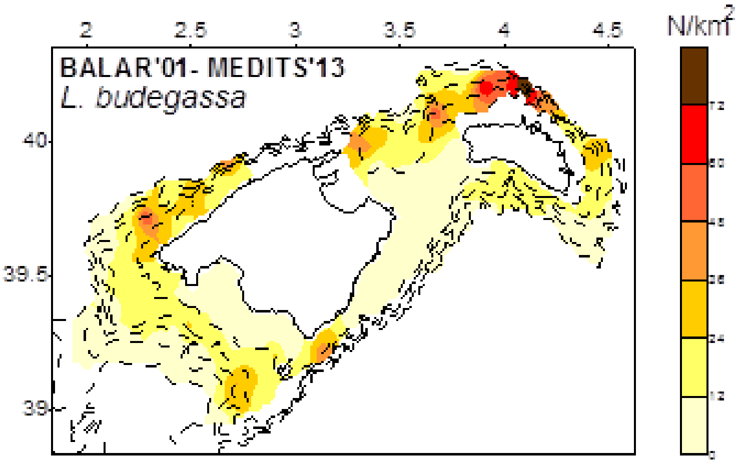


Fig. 5.2.3.5.2. Black-bellied anglerfish in GSA 5. population abundance (N/Km^2) based on survey data from 2001 to 2013.

5.2.3.5.3 Trends in abundance and biomass

Biomass CPUEs from MEDITS decreased from 20 to 10 kg/km^2 during 2003-2005 and then remained low between 10 and 5 kg/km^2 up to the present. The biomass index from the commercial fishery was rather homogeneous during the entire time series, approximately between 8 and 10 kg/day.

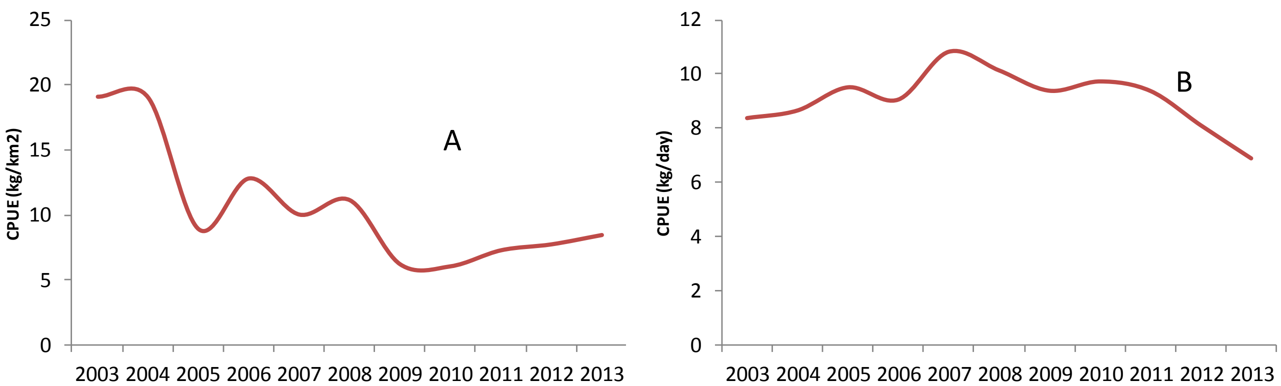


Fig. 5.2.3.5.3. Black-bellied anglerfish in GSA 5. Abundance indices from the MEDITS surveys (A) and the commercial fishery (B) during 2003-2013.

5.2.3.5.4 Trends in abundance by length or age

No major changes were found in abundance by length during the time series from 2003 to 2013 (Fig. 5.2.3.5.4.1). The comparison of the size distributions between MEDITS and the fishery fleet also did not show important differences, neither for the modal size nor the size range (Fig. 5.2.3.5.4.2).

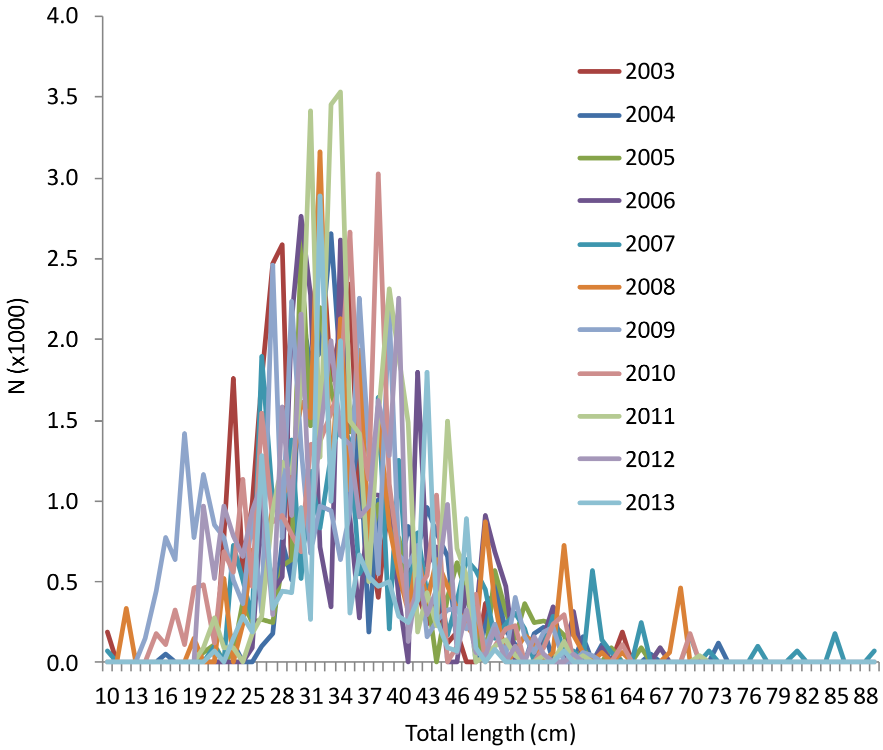


Fig. 5.2.3.5.4.1. Black-bellied anglerfish in GSA 5. size-structure of catches during 2003-2013.

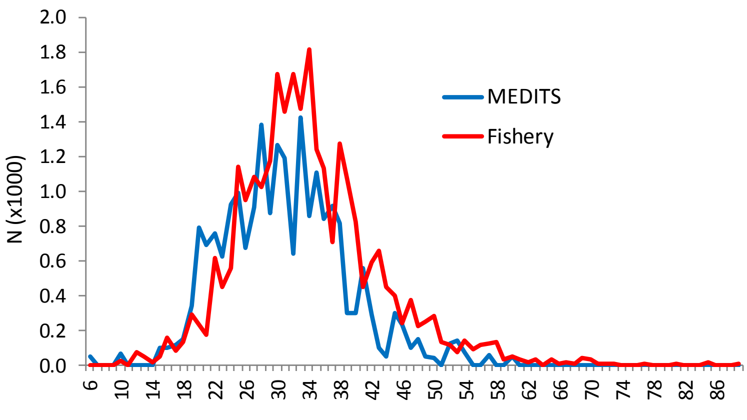


Fig. 5.2.3.5.4.2. Black-bellied anglerfish in GSA 5. mean size-structure of populations from MEDITS and the fishery fleet during 2003-2013.

5.2.3.5.5 Trends in growth

No analyses were conducted during the STECF EWG 14-19 meeting.

5.2.3.5.6 Trends in maturity

No analyses were conducted during the STECF EWG 14-19 meeting.

5.2.3.6 Assessment of historic stock parameters

This is the first assessment of *L. budegassa* from GSA 5.

5.2.3.6.1 *Methods*

An XSA was applied using the R libraries developed in the framework of the EWG.

5.2.3.6.2 *Justification*

The length of the available data series (11 years, from 2003 to 2013) allowed the use of a VPA type of assessment tuned with MEDITS data. Although catch and MEDITS data from previous years exist, size-frequency distributions are only available from 2003.

5.2.3.6.3 Input parameters

Landings time series: 2003-2013.

Size-distributions were sliced to age-distributions using the L2AGE4 software.

Group plus was set at age 8.

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	2013
SOP	0.963	0.984	0.964	0.966	0.979	0.969	0.946	0.969	0.958	0.972	0.962

Growth parameters (from DCF 2003-2012)		
L_{inf}	K	t_0
102	0.150	-0.05

LWR (from DCF 2003-2012)	
a	b
0.0201	2.8979

Natural mortality (from PROBIOM)								
0	1	2	3	4	5	6	7	8+
0.960	0.477	0.375	0.293	0.260	0.241	0.230	0.222	0.200

Maturity (from DCF 2003-2012)								
0	1	2	3	4	5	6	7	8
0.087	0.136	0.206	0.300	0.413	0.537	0.656	0.759	1.000

CATCH	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
	16.062	18.422	19.054	19.132	24.485	22.138	17.204	19.577	21.755	16.491	11.118

CATNUM	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.2	0.3	0.1	0.1	0.1	0.4	0.1	0.01	0.01	0.01	0.1
1	4.7	1.3	1.1	1.1	4.1	2.2	8.8	6.4	1.2	6	2
2	15.9	14.7	14.3	13.4	12.6	17.7	13.6	14.4	21.5	13.1	9.4
3	4.3	6.7	5	6.1	7.1	6.6	6.3	8.1	9.3	8	4.3
4	1.2	1.6	2.4	2.8	3.2	2.3	1.7	1.4	1.2	0.8	1.1
5	0.6	0.5	1	0.8	1.2	1.2	0.6	0.6	0.2	0.2	0.1
6	0.2	0.1	0.2	0.1	0.6	0.1	0.1	0.1	0.1	0.01	0.01
7	0.01	0.01	0.1	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01
8+	0.01	0.01	0.01	0.01	0.1	0.01	0.01	0.01	0.01	0.01	0.01

CATWT	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.018	0.034	0.03	0.03	0.018	0.03	0.047	0.03	0.03	0.03	0.03
1	0.221	0.22	0.219	0.265	0.238	0.213	0.137	0.19	0.172	0.193	0.247
2	0.468	0.501	0.507	0.47	0.483	0.495	0.472	0.52	0.5	0.489	0.503
3	0.97	1.011	0.956	0.961	0.958	0.965	0.93	0.909	0.973	0.947	1.013
4	1.573	1.655	1.697	1.654	1.642	1.652	1.7	1.646	1.513	1.626	1.477
5	2.468	2.409	2.376	2.475	2.667	2.523	2.421	2.442	2.53	2.295	2.527
6	3.283	3.255	3.451	3.07	3.344	3.219	3.177	3.369	3.343	3.331	3.338
7	4.196	3.851	4.039	4.039	4.231	4.286	4.196	4.561	4.751	4.196	4.196
8+	5.622	5.146	5.622	5.622	6.969	5.622	5.622	5.622	4.751	5.622	5.622

The input data are shown in the table below:

XSA tuning were performed using abuncance indices from MEDITS (N/km^2) carried out around the Balearic Islands during 2003–2013. As the species is most abundant on deep shelf and upper slope grounds, the C and D standardized strata from MEDITS were used to calculate these indices. Given that the landings were composed mainly of individuals between 1 and 3 years (Fig. 5.2.3.6.3.1), these ages were selected as the Fbar. Then, r-age and q-age were set at 1 and 4, respectively (see table below).

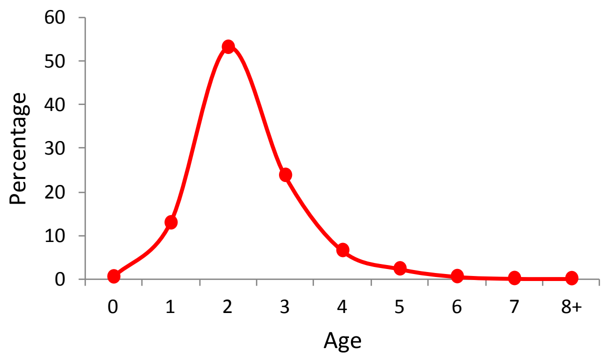


Fig. 5.2.3.6.3.1. Black-bellied anglerfish in GSA 5. composition (in percentage) of landings by age.

Different sensitivity analyses were performed before running the final XSA. The first sensitivity analysis tested different shrinkage weights (0.5, 1.0, 1.5, 2.0 and 2.5); since the results did not show significant differences (Fig. 5.2.3.6.3.2A), the middle option (1.5) was chosen. The second sensitivity analysis tested different shrinkage ages (1, 2 and 3) using shrinkage weight of 1.5; again, as the results did not show import significant ant differences (Fig. 5.2.3.6.3.2B), the middle option (2 ages shrinkage) was selected. 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	1	4	TRUE	TRUE	3	2

Log residuals of the sensitivity analyses of a set of trials for the shrinkage weights (0.5, 1.5 and 2.5) and the three shrinkage ages (1, 2 and 3) are shown in Figure 5.2.3.6.3.3.

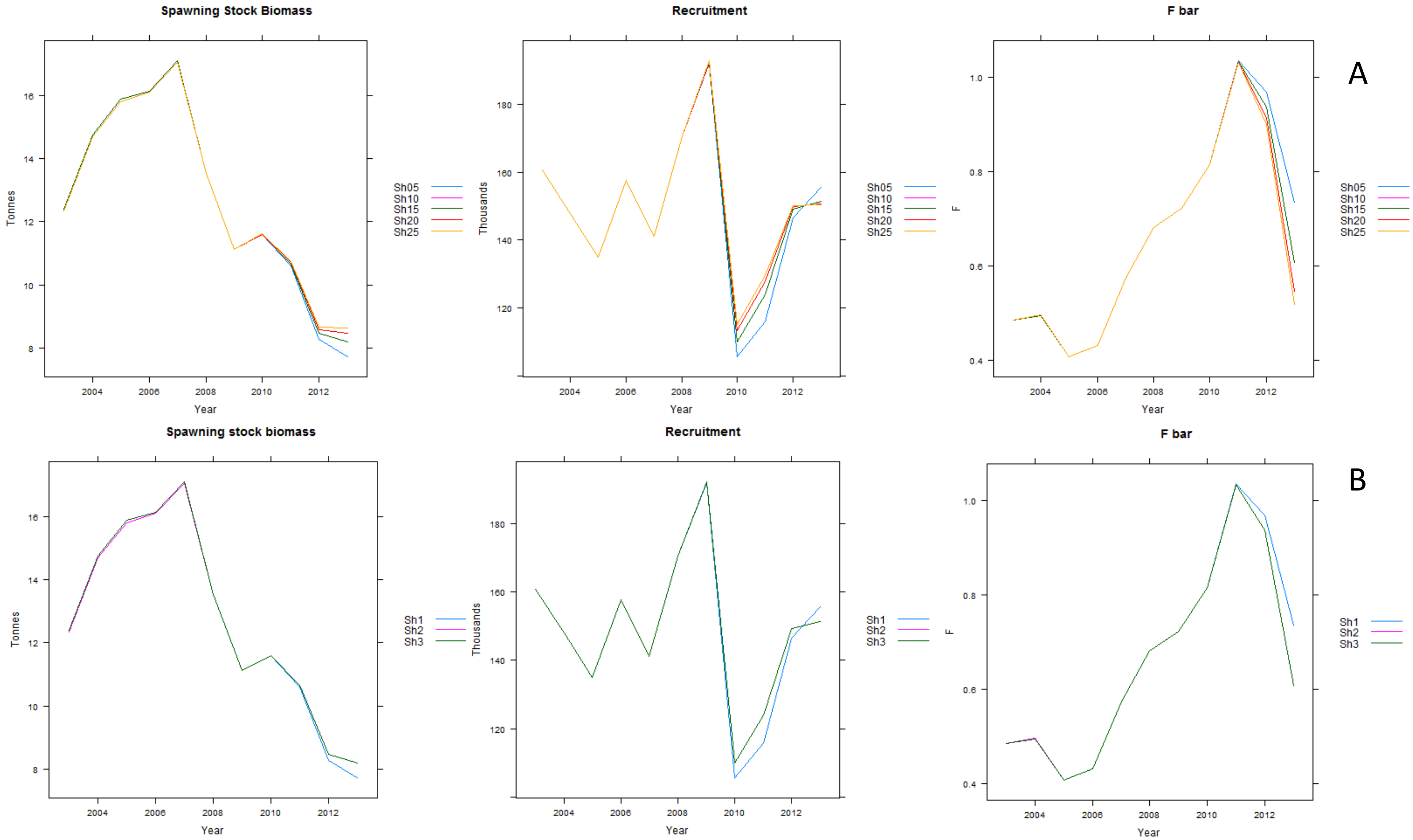


Fig. 5.2.3.6.3.2. Black-bellied anglerfish in GSA 5. Sensitivity analyses using different shrinkage weights (A) and shrinkage ages (B). Shrinkage weights modeled were 0.5, 1.0, 1.5, 2.0 and 2.5 (Sh05 to Sh25) and shrinkage ages were 1, 2 and 3 (Sh1, Sh2 and Sh3).

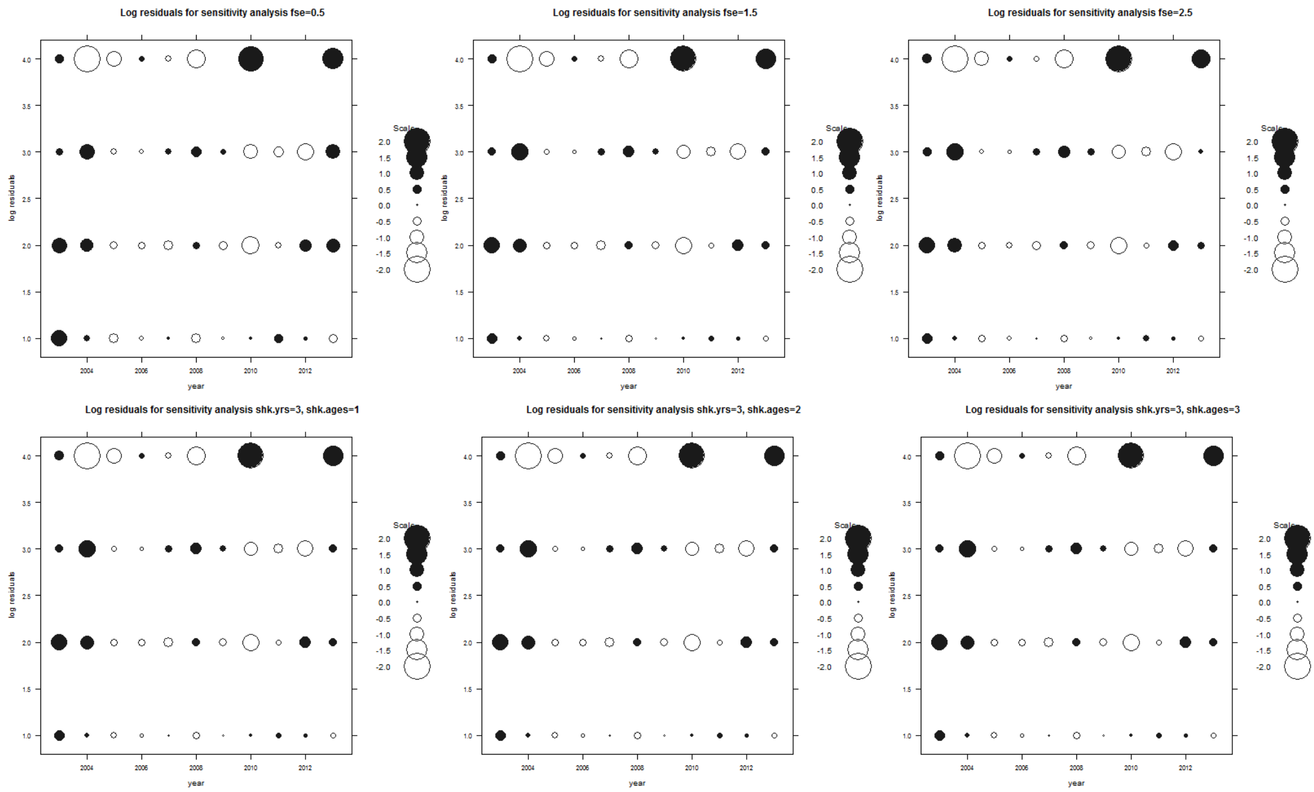


Fig. 5.2.3.6.3.3. Black-bellied anglerfish in GSA 5. Log residuals of the sensitivity analyses of a set of trials for the shrinkage weights (0.5, 1.5 and 2.5) and the three shrinkage ages (1, 2 and 3).

5.2.3.6.4 *Results*

Age 0 and the oldest ages (5 to 8) which were not well represented in the survey catches (see input parameters above) were removed from the analysis. Similarly, data from age 4 in 2011 and 2012 were also removed because they produced very large residuals. Once removed all these values, the residuals per age and year of the tuning fleet were relatively low, ranging from 2 to -2, and did not show any tendency with time (Fig. 5.2.3.6.4.1).

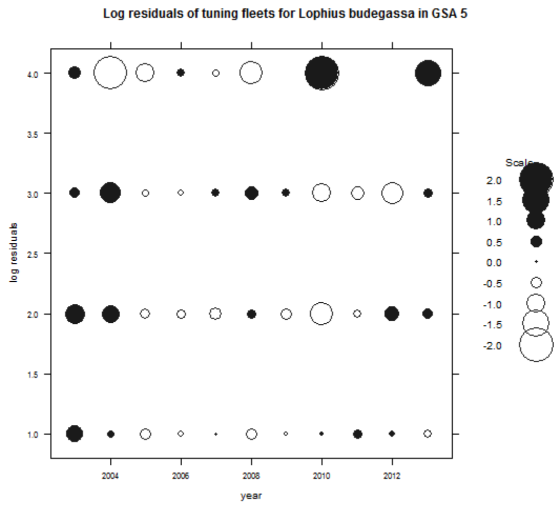


Fig. 5.2.3.6.4.1. Black-bellied anglerfish in GSA 5. Log residuals for the tuning fleets.

Results of XSA (Fig. 5.2.3.6.4.2) showed a progressive increase in the number of recruits from 2004 to 2009 followed by an abrupt decrease in 2010; from then recruits has increased slowly again. The SSB increased slightly from 2003 to 2007 but then decreased also progressively down to 2013. The fishing mortality increased from 0.41 in 2005 to 1.0 in 2011 and then decreased progressively down to 0.6 in 2013.

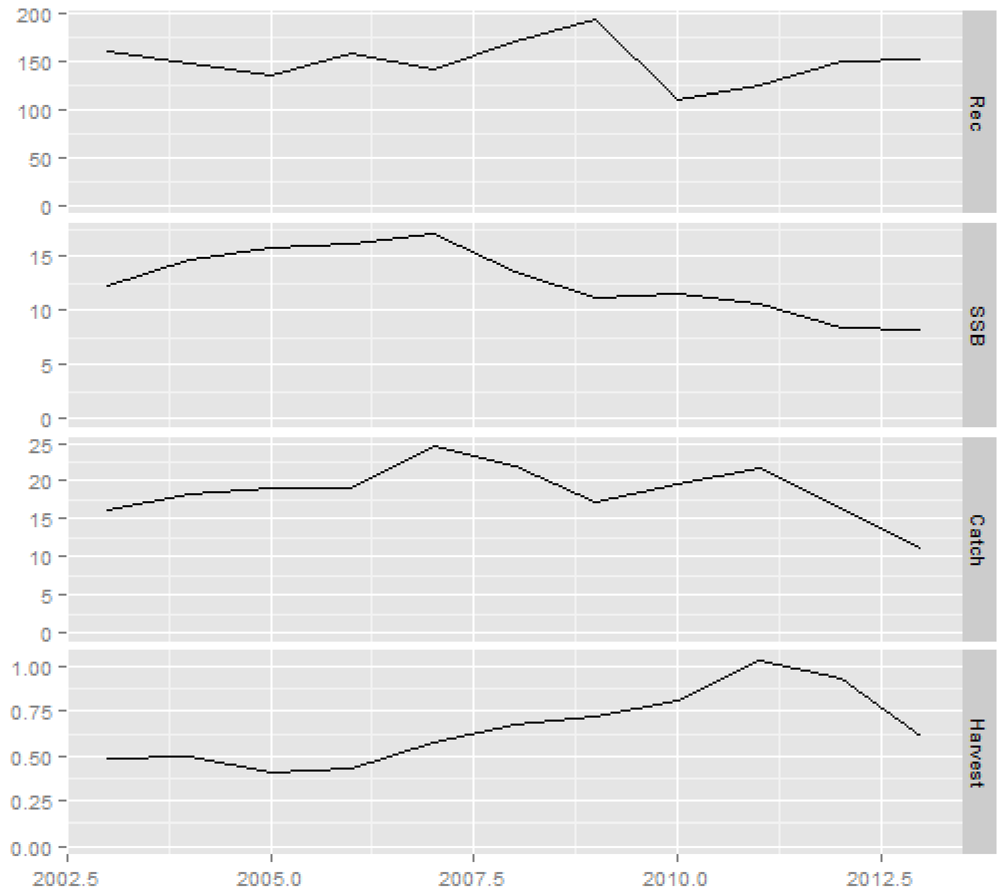


Fig. 5.2.3.6.4.2. Black-bellied anglerfish in GSA 5. XSA summary results. SSB and cath are in tonnes, recruitment in 1000s individuals.

The XSA diagnostics are reported below:

FLR XSA Diagnostics 2015-01-22 10:58:33

CPUE data from indices

Catch data for 11 years 2003 to 2013. Ages 0 to 8.

	fleet	first age	last age	first year	last year	alpha	beta
1	Surveys (N/km2)	1	4	2003	2013	<NA>	<NA>

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of size for ages >   1

Catchability independent of age for ages >   4

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	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.003	0.001	0.001	0.001	0.004	0.001	0.000	0.000	0.000	0.001
1	0.027	0.024	0.026	0.088	0.051	0.177	0.113	0.035	0.169	0.043
2	0.682	0.592	0.607	0.646	0.921	0.666	0.686	0.939	0.937	0.574
3	0.775	0.605	0.657	0.986	1.070	1.322	1.646	2.127	1.703	1.215
4	0.749	0.776	0.955	1.057	1.239	1.005	1.749	1.664	1.879	1.635
5	0.745	2.074	0.700	2.238	2.246	1.618	1.634	1.993	2.610	2.129
6	0.486	0.792	2.139	3.783	2.067	2.028	2.077	1.984	0.520	1.553
7	0.622	1.454	1.420	3.059	2.189	1.852	1.886	2.021	1.587	1.862
8	0.622	1.454	1.420	3.059	2.189	1.852	1.886	2.021	1.587	1.862

XSA population number (Thousand)

year	0	1	2	3	4	5	6	7	8
2004	148	61	35	14	3	1	0	0	0
2005	135	56	37	12	5	1	0	0	0
2006	158	52	34	14	5	2	0	0	0
2007	141	60	31	13	5	1	1	0	0
2008	170	54	34	11	4	1	0	0	0
2009	192	65	32	9	3	1	0	0	0
2010	110	74	34	11	2	1	0	0	0
2011	124	42	41	12	2	0	0	0	0
2012	149	47	25	11	1	0	0	0	0
2013	152	57	25	7	1	0	0	0	0

Estimated population abundance at 1st Jan 2014

year	0	1	2	3	4	5	6	7	8
2014	33	58	34	10	2	0	0	0	0

Fleet: Surveys (N/km2)

Log catchability residuals.

age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	0.564	0.156	-0.331	-0.146	0.008	-0.356	-0.056	0.023	0.254	0.121	-0.238
2	0.713	0.603	-0.298	-0.271	-0.403	0.261	-0.338	-0.827	-0.202	0.462	0.298
3	0.294	0.744	-0.197	-0.116	0.231	0.461	0.206	-0.663	-0.444	-0.800	0.285
4	0.401	-1.273	-0.640	0.214	-0.162	-0.845	NA	1.317	NA	NA	0.988

Regression statistics
Ages with q dependent on year class strength
[1] "-0.623804944825223" "5.14869200001174"

Terminal year survivor and F summaries:

,Age 0 Year class =2013

source

	scaledWts	survivors	yrcls
fshk	0.011	460	2013
nshk	0.989	57	2013

Age 1 Year class =2012

source

	scaledWts	survivors	yrcls
Surveys (N/km2)	0.898	50	2012
fshk	0.102	13	2012

Age 2 Year class =2011

source

	scaledWts	survivors	yrcls
Surveys (N/km2)	0.828	13	2011
fshk	0.172	5	2011

Age 3 Year class =2010

source

	scaledWts	survivors	yrcls
Surveys (N/km2)	0.722	2	2010
fshk	0.278	1	2010

Age 4 Year class =2009

source

	scaledWts	survivors	yrcls
Surveys (N/km2)	0.324	1	2009
fshk	0.676	0	2009

,Age 5 Year class =2008

source

	scaledWts	survivors	yrcls
fshk	1	0	2008

,Age 6 Year class =2007

source

	scaledWts	survivors	yrcls
fshk	1	0	2007

Age 7 Year class =2006

source

	scaledWts	survivors	yrcls
fshk	1	0	2006

Year	Population numbers	Population weight	Recruitment numbers	SSB	F1-3
2003	275.630	51.683	160.77	12.340	0.484
2004	263.590	59.847	147.93	14.703	0.495
2005	247.530	60.159	135.04	15.817	0.407
2006	264.680	61.620	157.71	16.119	0.430
2007	253.130	60.225	141.04	17.059	0.574
2008	275.130	54.527	170.48	13.542	0.681
2009	302.420	49.012	192.38	11.124	0.721
2010	231.250	50.678	109.76	11.596	0.815
2011	220.470	46.351	123.92	10.651	1.034
2012	234.180	38.789	149.26	8.454	0.936
2013	242.270	40.724	151.83	8.167	0.611

Finally, retrospective analyses showed rather consistent results except for recruitment (Fig. 5.2.3.6.4.3).

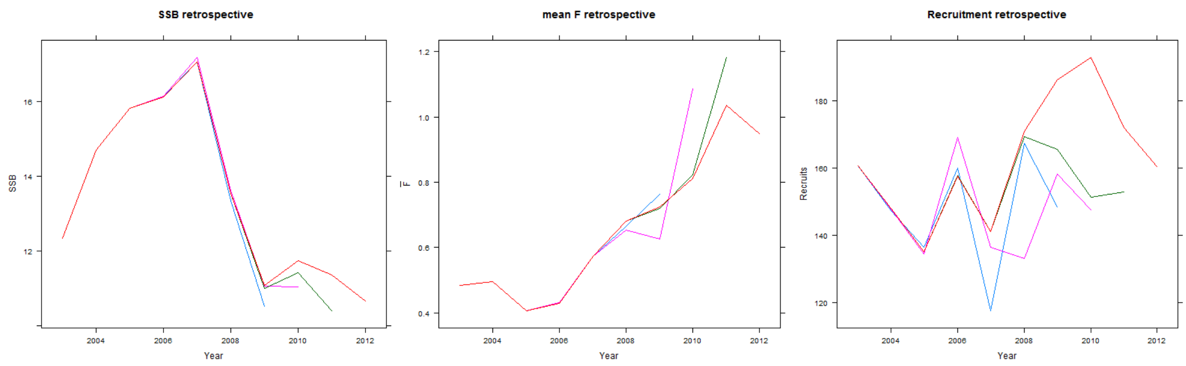


Fig. 5.2.3.6.4.3. Black-bellied anglerfish in GSA 5. XSA retrospective analyses.

5.2.3.7 Long term prediction

5.2.3.7.1 *Justification*

Yield per recruit analysis was used to calculate the reference point $F_{0.1}$.

5.2.3.7.2 *Results*

The yield per recruit graph, together with the reference point $F_{0.1}$ and the estimated reference fishing mortality (F_{ref}), revealed a highly overexploited stock (Fig. 5.2.3.7.2).

$F_{0.1}$	0.079
F_{ref} (2013; ages 1-3)	0.611

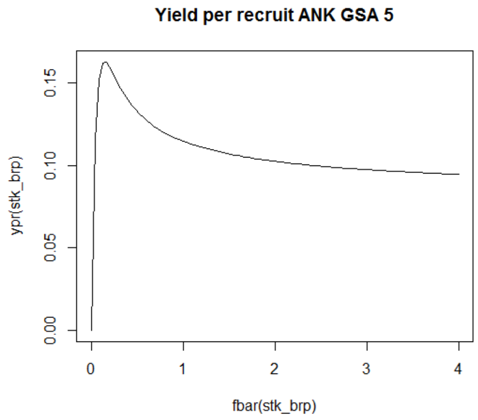


Fig. 5.2.3.7.2. Black-bellied anglerfish in GSA 5. Yield per recruit analysis.

5.2.3.8 Data quality

Data from DCF 2014 were used. The data available are of sufficient quality to perform an XSA. The data submitted to the EWG 14-19 were in general of good quality. Reported discards are negligible and this is reasonable, considering the important commercial value of the species in GSA 5.

5.2.3.9 Scientific advice

The F_{stq} (0.84) is larger than $F_{0.1}$ (0.08), which indicates that *Lophius budegassa* from GSA 5 is fished unsustainably.

5.2.3.10 Short term considerations

5.2.3.10.1 State of the stock size

The stock size ranged between aprox. 220-275·10^3 individuals, except with a peak of 300·10^3 individuals in 2009. The SSB increased slightly from 2003 (12.34 t) to 2007 (17.06 t) but then decreased also progressively down to 2013 (8.17 t).

5.2.3.10.2 State of recruitment

Recruitment showed a progressive increase in the number of recruits from 2004 (147.93·10^3) to 2009 (192.38·10^3) followed by an abrupt decrease in 2010 (109.76·10^3); from then, recruits have increased smoothly again up to 151.83·10^3 in 2013.

5.2.3.10.3 State of exploitation

The F_{stq} (0.84) is larger than $F_{0.1}$ (0.08), which indicates that *Lophius budegassa* from GSA 5 is fished unsustainably.

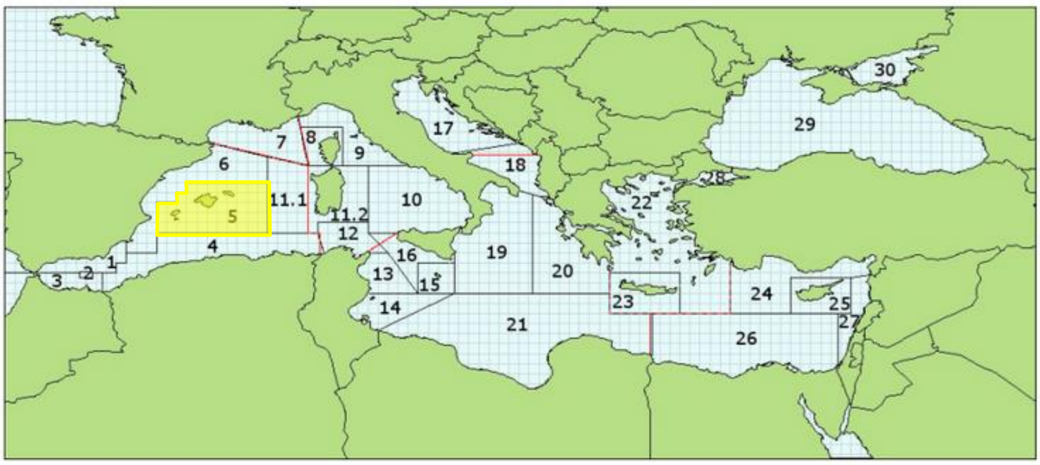
5.2.3.11 Management recommendations

STECF EWG 14-09 recommends the relevant fleets' effort 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.

5.2.4 STOCK ASSESSMENT OF NORWAY LOBSTER IN GSA 5

5.2.4.1 Stock Identification

GSA 5 (Figure 5.2.4.1.1) 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. These include: 1) Geomorphologically, the Balearic Islands (GSA05) are clearly separated from the Iberian Peninsula (GSA 6) 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 5 compared to GSA 6, 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 5 and GSA 6, 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 5 but landing their catches in GSA 6; 5) Trawl fishing exploitation in GSA05 is much lower than in GSA 6; 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 5 are in a healthier state than in GSA 6, 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.



— *FAO Statistical Divisions (red)* — *GFCM Geographical Sub-Areas (black)*

01 - Northern Alboran Sea	07 - Gulf of Lions	13 - Gulf of Hammamet	19 - Western Ionian Sea	25 - Cyprus Island
02 - Alboran Island	08 - Corsica Island	14 - Gulf of Gabes	20 - Eastern Ionian Sea	26 - South Levant
03 - Southern Alboran Sea	09 - Ligurian and North Tyrrhenian Sea	15 - Malta Island	21 - Southern Ionian Sea	27 - Levant
04 - Algeria	10 - South and Central Tyrrhenian Sea	16 - South of Sicily	22 - Aegean Sea	28 - Marmara Sea
05 - Balearic Island	11.1 - Sardinia (west) 11.2 - Sardinia (east)	17 - Northern Adriatic	23 - Crete Island	29 - Black Sea
06 - Northern Spain	12 - Northern Tunisia	18 - Southern Adriatic Sea	24 - North Levant	30 - Azov Sea

Figure 5.2.4.1.1. Geographical localization of GSA 5.

5.2.4.2 Growth

The growth and length-weight parameters used during the EWG 14-19 were those estimated by Guijarro *et al.* (2013) from the study area (Table 5.2.4.2.1), in the framework of the Spanish DCF: L_{inf} = 86.1 mm carapace length, k= 0.126 y^{-1}; a=0.00017 and b=3.3566.

5.2.4.3 Maturity

The maturity ogive was obtained from stock-related sampling carried out in the Spanish DCF in GSA 5 (Guijarro *et al.*, 2013).

Maturity oogive										
Age	0	1	2	3	4	5	6	7	8	9+
Prop. Matures	0.00	0.01	0.05	0.20	0.51	0.78	0.92	0.97	0.99	1.00

5.2.4.4 Fisheries

5.2.4.4.1 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 (SS), deep shelf (DS), upper slope (US) and middle slope (MS) (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 MS fishing tactics coincides with the metier OTB_DWSP; OTB_DEMSP corresponds to those days in one of the other fishing tactics is present (SS, DS and/or US) and OTB_MDDWSP corresponds to those days in which one haul in MS and at least one of the other fishing tactics is performed. The Norway lobster is the main target species in the US and is caught in all the metiers.

5.2.4.4.2 Management regulations applicable in 2014

- Fishing license: number of licenses observed
- Engine power limited to 316 KW or 500 HP: not fully observed.
- Mesh size in the codend (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.

5.2.4.4.3 *Catches*

5.2.4.4.4 *Landings*

Norway lobster landings came exclusively from bottom trawlers (OTB) in GSA 5. By métier, 60% of landings come from DEMSP, 27% come from MDDWSP and 13% come from MDD. Landings between 2002 and 2013 were between a minimum of 9.6 t in 2013 and maxima around 32 t in 2008 and 2011. Historical data landings showed oscillations between 5 and 35 tons (Figure 5.2.4.4.4.1), without a clear trend.

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
17.319	17.775	19.472	16.112	16.635	20.318	31.682	20.352	20.304	32.260	19.993	9.655

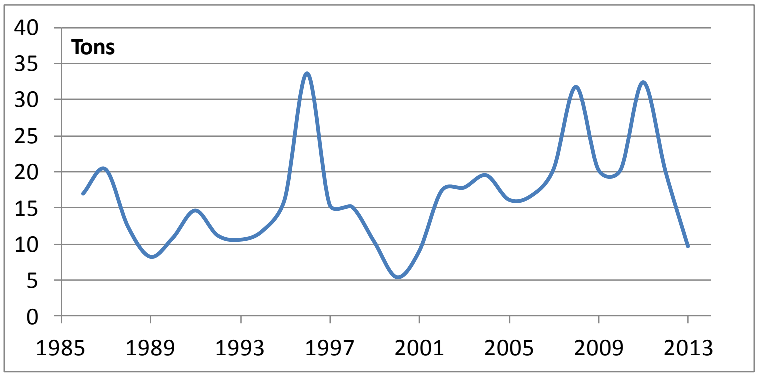


Figure 5.2.4.4.4.1. Norway lobster in GSA 5. Historical landings data.

5.2.4.4.5 *Discards*

Discards of Norway lobster in GSA 5 can be considered negligible.

5.2.4.4.6 Fishing effort

Fishing effort available from the Data Call included years 2009-2013. Table 5.2.4.4.6. summarizes the effort data for the gear OTB according to the DCF Data Call in terms of nominal effort and GT days at sea. Number of boats cannot be calculated from the information available in the Data Call as it is disaggregated by quarter and by métier (OTB_DEF, OTB_MDD and OTB_DWS) and so it cannot be accumulated, as the same boat may be included in different quarters and/or in different métiers.

Table 5.2.4.4.6. Effort data for OTB according to the DCF Data Call.

	2009	2010	2011	2012	2013
Nominal effort	2784175	2927650	2694399	2675591	2745967
GT days at sea	648576	672070	616593	630594	641522

Available fishing effort information, as number of fishing trips (in days at sea), comes from the Spanish Institute of Oceanography (IEO) for the period 2000-2013 (Figure 5.2.4.4.6.1).

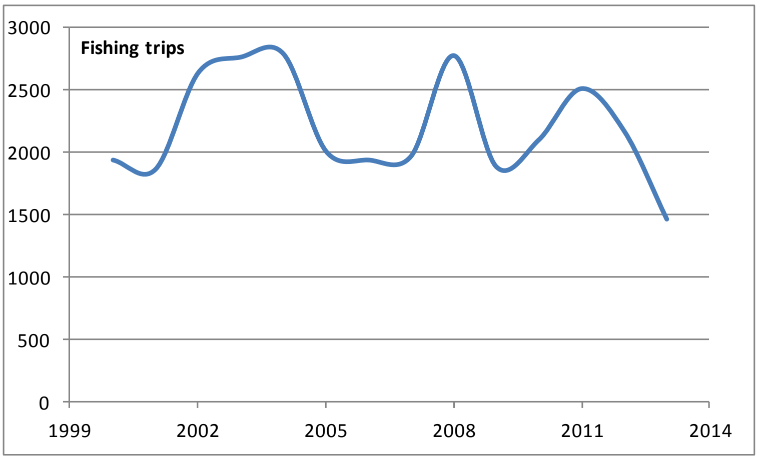


Figure 5.2.4.4.6.1. Norway lobster in GSA 5: Fishing effort (as number of days at sea) for OTB.

5.2.4.5 Scientific surveys

MEDITS

5.2.4.5.1 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.

5.2.4.5.2 *Geographical distribution*

Norway lobster is distributed in fishing grounds sited in the north-west, south and north of Mallorca and south and south-east of Menorca (Figure 5.2.4.5.2.1).

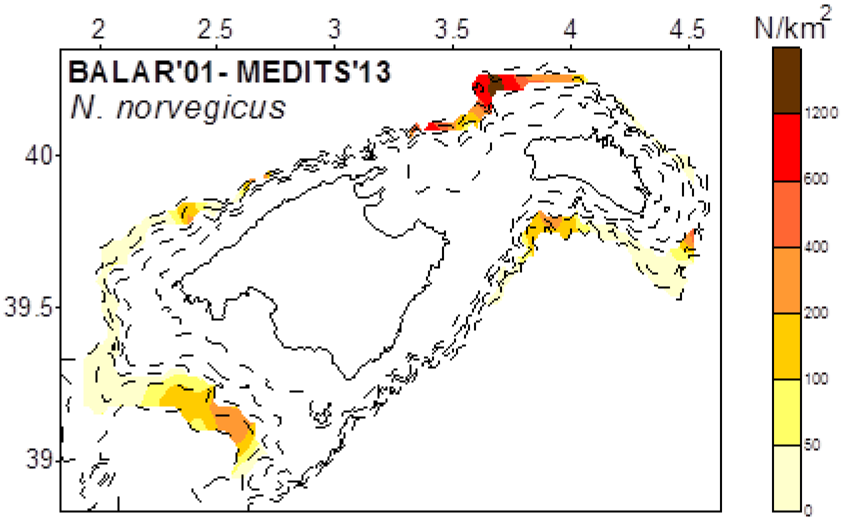


Figure 5.2.4.5.2.1. Norway lobster in GSA 5: Geographical distribution based on bottom trawl surveys (2001-2013).

5.2.4.5.3 *Trends in abundance and biomass*

Biomass and abundance indices from the surveys showed a similar trend, with clear oscillations during the data series (Figure 5.2.4.5.3)

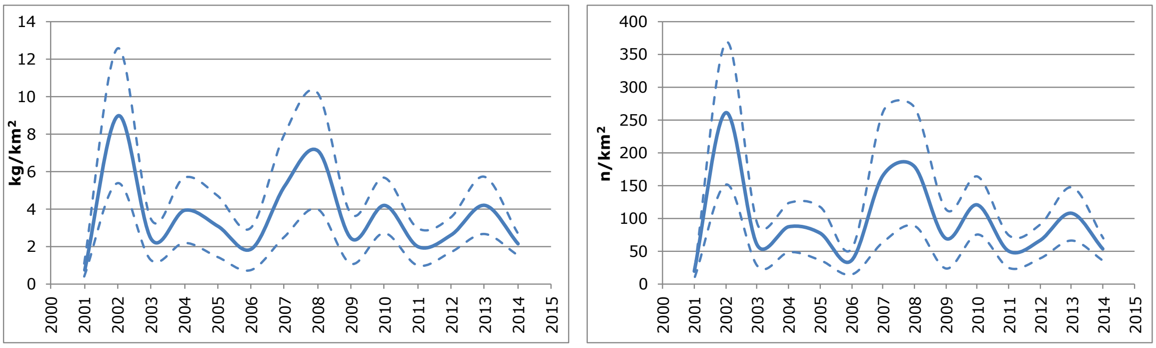


Figure 5.2.4.5.3. Norway lobster in GSA 5: Abundance and biomass indices from the bottom trawl surveys.

5.2.4.5.4 *Trends in abundance by length or age*

No analysis were conducted during EWG 14-19.

5.2.4.5.5 *Trends in growth*

No analysis were conducted during EWG 14-19.

5.2.4.5.6 *Trends in maturity*

No analysis were conducted during EWG 14-19.

5.2.4.6 Assessment of historic stock parameters

5.2.4.6.1 *Methods*

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 2012 (SGMED-12-10).

5.2.4.6.2 *Justification*

5.2.4.6.3 Input parameters

The data used in the assessment were: (i) Landings time series 2002-2013 from OTB; (ii) Age distributions obtained from slicing of length distributions 2002-2013 (Figure 5.2.4.6.3.1); (iii) Set of growth parameters calculated in the study area during DCF and (iv) BALAR-MEDITS survey used as tuning fleet (abundances by age in n/km^2, Figure 5.2.4.6.3.1). As both ages 0 and 1 are poorly represented both in the commercial data and in the survey, they were excluded from the model. Age 2 was considered as recruitment to the fishery.

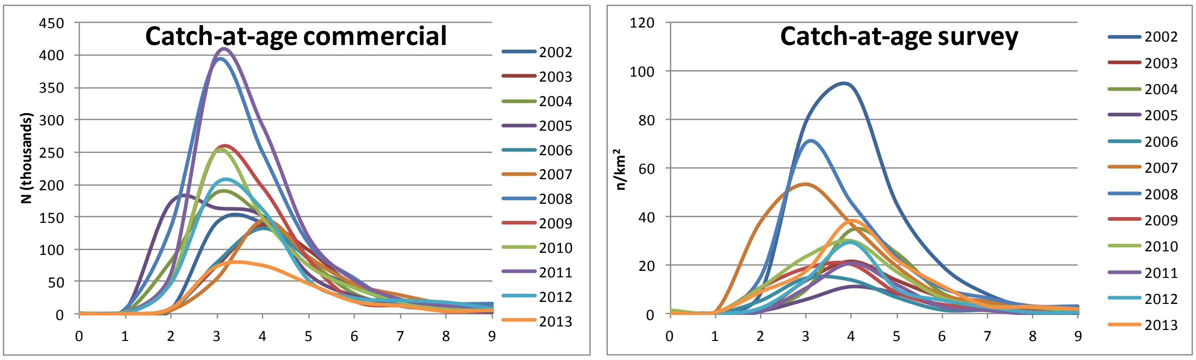


Figure 5.2.4.6.3.1. Norway lobster in GSA 5. Age distribution by year for the commercial and survey data.

2	3	4	5	6	7	8	9+
0.009	0.018	0.031	0.050	0.074	0.099	0.128	0.181

Mean weight in catch									
0	1	2	3	4	5	6	7	8	9+
0.001	0.003	0.009	0.018	0.031	0.050	0.074	0.099	0.128	0.181

Growth parameters		
L_∞	k	t_0
86.1	0.126	-

Length-weight relationship	
a	b
0.00017	3.3566

Maturity oogive										
Age	0	1	2	3	4	5	6	7	8	9+
Prop. Matures	0.00	0.01	0.05	0.20	0.51	0.78	0.92	0.97	0.99	1.00

Natural mortality (PROBIOM; Abella et al., 1997)										
Age	0	1	2	3	4	5	6	7	8	9+
M	1.24	0.73	0.47	0.39	0.35	0.32	0.31	0.29	0.28	0.28

The number of individuals by age was SOP corrected [SOP = Landings / Σa (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	2013
0.999	0.990	1.007	1.015	1.003	0.983	1.008	1.014	1.010	1.006	1.054	0.962

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, except when fse was set at 0.5 (Figure 5.2.4.6.3.2). For the age shrinkage, results were quite robust (Figure 5.2.4.6.3.3). For the catchability, the results were showed differences depending on on the ages considered, especially for the last two years of recruitment (Figure 5.2.4.6.3.4).

Figure 5.2.4.6.3.2. Norway lobster in GSA 5. Sensitivity analysis for F, R and SSB considering different weights for shrinkage.

Figure 5.2.4.6.3.3. Norway lobster in GSA 5. Sensitivity analysis for F, R and SSB considering different weights for shrinkage.

Figure 5.2.4.6.3.4. Norway lobster in GSA 5. Sensitivity analysis for F, R and SSB considering different ages for catchability.

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

fse	rage	qage	shk.n	shk.f	shk.yrs	shk.ages
1	3	7	TRUE	TRUE	3	4

5.2.4.6.4 *Results*

Recruitment was about 1.5-2.0 millions for all the data series and SSB between 31 and 52 tons. SSB showed a decreasing trend for the last 2 years, with the minimum values of the data series in the last year (Figure 5.2.4.6.1, Table 5.2.4.6.4.1). F has oscillated between 0.3 and 0.7, with the lowest value in 2013.

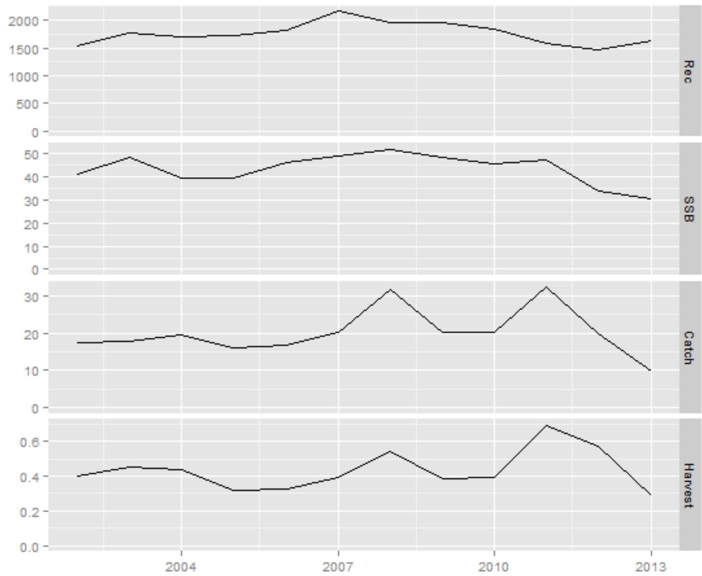


Figure 5.2.4.6.4.1. Norway lobster in GSA 5. XSA summary results. SSB and cath are in tonnes, recruitment in 1000s individuals.

Table 5.2.4.6.4.1. Norway lobster in GSA 5. XSA results.

	Population in number (thousands)	Population in weight (tons)	Recruitment number (age 2, thousands)	SSB	F_{3-7}
2002	3439.4	78.2	1542.3	41.0	0.397
2003	3742.1	89.5	1780.5	48.6	0.450
2004	3827.2	80.4	1709.2	39.7	0.437
2005	3777.2	77.2	1716.1	39.3	0.318
2006	3839.5	87.2	1819.9	46.5	0.325
2007	4386.8	97.4	2158.4	48.8	0.389
2008	4556.4	100.1	1958.7	51.9	0.539
2009	4168.3	93.2	1945.9	48.4	0.384
2010	4067.9	89.4	1850.8	45.5	0.392
2011	3787.3	89.5	1585.4	47.2	0.691
2012	3171.1	68.3	1463.4	34.0	0.573
2013	3255.9	66.8	1619.3	30.7	0.287

Residuals from the BALAR-MEDITS tuning fleet show low values for all the ages and years considered. After some trials, in the last run only ages 2-8 from the BALAR-MEDITS tuning fleet were used in the assessment (Figure 5.2.4.6.4.2).

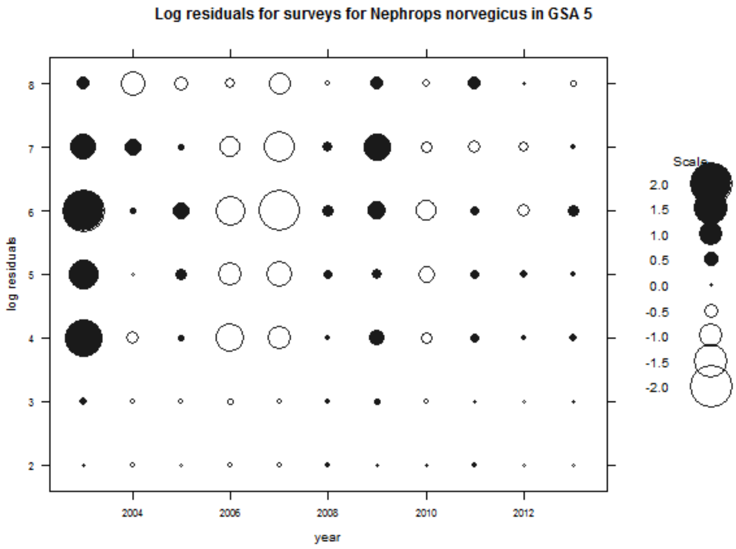


Figure 5.2.4.6.4.2. Norway lobster in GSA 5. Log catchability residual plots (XSA) for BALAR -MEDITS surveys.

Retrospective analysis was performed and it did not show a very robust situation for any of the parameters considered (Figure 5.2.4.6.4.3).

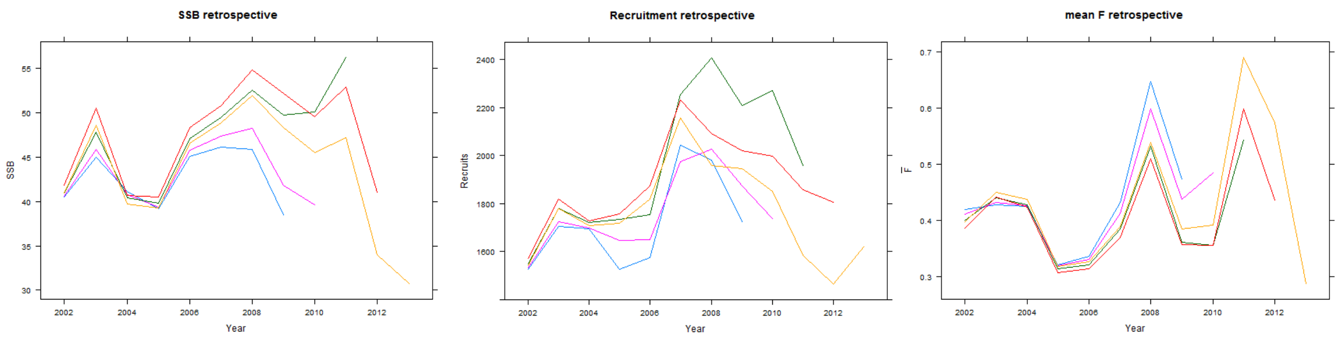


Figure 5.2.4.6.4.3. Norway lobster in GSA 5. Restrospective analysis for F, recruitment and SSB.

Yield per recruit was calculated using FLR. Table 5.2.4.6.4.3 shows the reference F (F_{ref}) as well as the reference point $F_{0.1}$ (as a proxy of F_{MSY}). Figure 5.2.4.6.4.4 shows the yield per recruit graph.

Table 5.2.4.6.4.3. Norway lobster in GSA 5. Reference F and reference point ($F_{0.1}$).

$F_{ref\ (3\text{-}7)}$	0.287
$F_{0.1}$	0.172

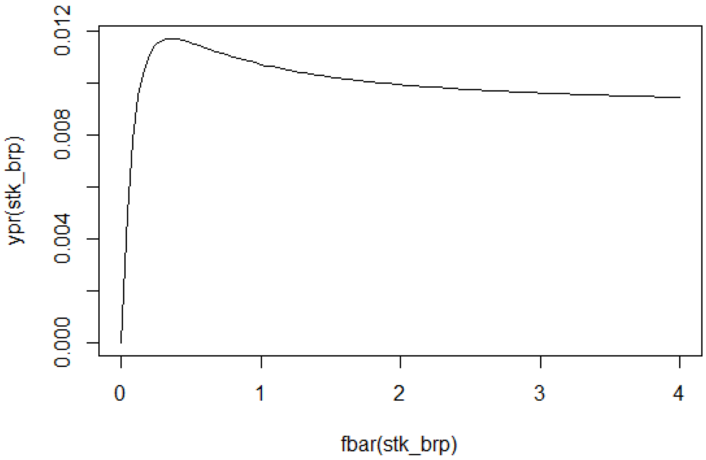


Figure 5.2.4.6.4.4. Norway lobster in GSA 5. Yield per recruit.

5.2.4.7 Long term prediction

5.2.4.7.1 *Justification*

5.2.4.7.2 *Results*

5.2.4.8 Data quality

Information about catches and length and age frequency distributions was available through the Official Data Call for years 2009-2013, when the concurrent sampling was implemented. Before that, length and age frequency distributions were not available as the species was not a target species for the DCR. Available information from IEO was used. Effort information was available only for 2009-2013. The current format of the Data Call for the variable “number of boats” prevents the calculation of a total number of boats for OTB by year: as information is requested by metier and quarter, it is not possible to sum up this data, as a same boat during a same quarter can operate in more than one OTB metier. MEDITS data was also available for 1994-2014. However, no MEDITS was carried in GSA 5 until 2007 except for some hauls (around 4 by year) performed in the southwestern part of the area (Ibiza channel). The hauls carried out in this area are systematically excluded from the analysis for all the years.

5.2.4.9 Scientific advice

Fishing mortality shows oscillations between 0.3 and 0.7 during last years. SSB showed a decreasing trend for the last two years.

5.2.4.10 Short term considerations

5.2.4.10.1 State of the stock size

The stock abundance showed a maximum of $4.5 \cdot 10^6$ individuals in 2008 with a deacreasing trend until 2012-2013, with the minimum values of the data series of $4.5 \cdot 10^6$ individuals in

2013. The SSB showed oscillations between 40 and 52 t between 2002 and 2011, with the minimum values of 31-34 t in the last years of the data series (2012-2013).

5.2.4.10.2 State of recruitment

Recruitment showed a maximum of $2.2 \cdot 10^6$ individuals in 2007, with a decreasing trend since then.

5.2.4.10.3 State of exploitation

The current F (0.29) is larger than $F_{0.1}$ (0.17), which indicates that Norway lobster in GSA 5 is exploited unsustainably.

5.2.4.11 Management recommendations

STECF EWG 14-19 recommends the relevant fleets' effort 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.

5.2.5 STOCK ASSESSMENT OF SARDINE IN GSA 6

5.2.5.1 Stock Identification

No information was provided on stock identification of sardine in GSA 6 during EWG14-19 meeting. Therefore, due to a lack of information about the stock structure of the sardine population in the western Mediterranean, this stock was assumed to be confined within the GSA 6 boundaries.

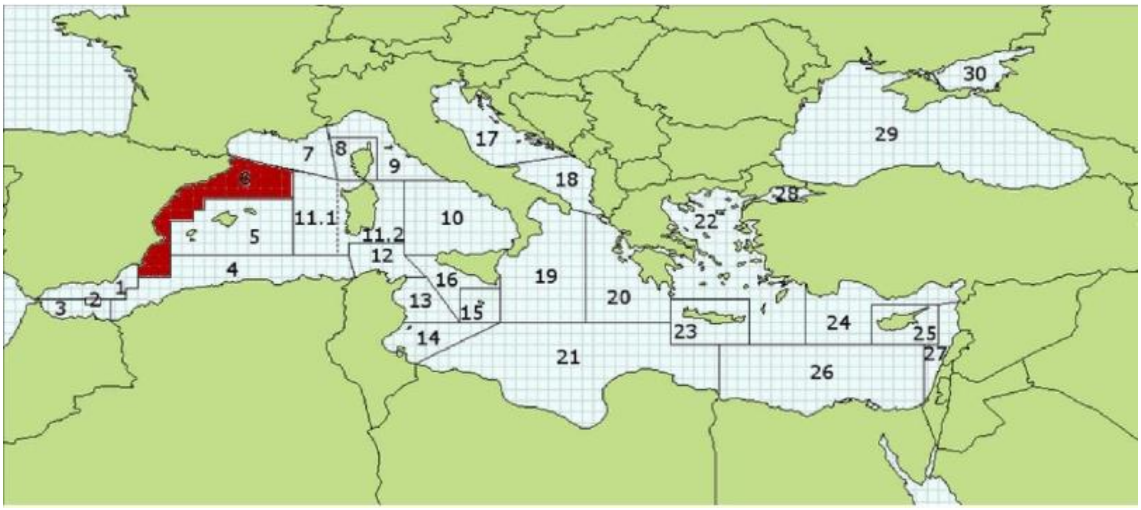


Fig. 5.2.5.1. Geographical location of GSA 6.

5.2.5.2 Growth

Growth parameters estimated for GSA 6 (DCF 2008) are: L_{inf}= 23.9; k= 0.3055; t_0= -1.9962; and for the length- weight relationship: a= 0.0056; b= 3.1064.

5.2.5.3 Maturity

Maturity at age was estimated taking into account the species growth and that the mean size at first maturity over 2004- 2013 was 12.6 cm TL (data source: DCF)

Table 5.2.5.3.1. Sardine in GSA 6. Maturity ogive.

ages	0	1	2	3	4	5+
% mature	0.5	1.0	1.0	1.0	1.0	1.0

5.2.5.4 Fisheries

5.2.5.4.1 General description of the fisheries

The current fleet (2013) in GSA 6 is composed by 140 units; 2 of them are smaller than 12 m, 120 bigger than 12 m, and 18 are over 24 m. The purse seine fleet has continuously decreased in the last two decades, from 222 vessels in 1990 to 140 in 2013. In particular, the smallest units have disappeared.

Sardine, even if with a lower price than anchovy, represents an important resources for the fishery. In the period 2002- 2013 sardine landings ranged between around 25000 t in 2006 and 7500 t in 2009- 2010. At present (2013) sardine landings are low, around 9700 t.

5.2.5.4.2 Management regulations applicable in 2014

- Fishing license
- Minimum landing size 11cm total length.
- No fishing allowed on weekend.
- Time at sea 12 hours per day and 5 days a week.
- Several technical regulations regarding specifications on the characteristics of the gear, dimension, mesh size, floodlight and light intensity (Orden ARM/2529/2011).
- Authorized target species for purse seining (Orden ARM/2529/2011).
- Daily landing by vessel limited to 5000 kg (Orden ARM/143/2010).

Further details on the purse seining regulations in force can be found in the above mentioned regulations by the Spanish Ministry responsible for fishing issues (Ministerio de Medio Ambiente, y Medio Rural y Marino).

5.2.5.4.3 Catches

Sardine landings in GSA 6 is caught principally from the purse seine fleet. Small amounts of sardine are reported for GNS and OTB.

Table 5.2.5.4.3.1. Sardine in GSA 6. Landings by fleets other than purse seine are negligible. Discards are reported only for fleets different from the purse seine fleet (data source: DCF).

	landings-PS	landings(all)	PS/all gears	discards (no PS)
2002	16998.0	17167.6	99.0	
2003	17360.2	17523.4	99.1	
2004	19473.2	19599.5	99.4	
2005	17559.1	17602.6	99.8	0.1
2006	25160.0	25192.0	99.9	
2007	19971.7	20098.2	99.4	
2008	14333.6	14333.6	100.0	0.5
2009	7406.1	7506.7	98.7	0.2
2010	7475.3	7627.2	98.0	0.0
2011	12134.7	12568.3	96.5	226.8
2012	9193.5	9395.3	97.9	1506.2
2013	9733.7	9928.8	98.0	281.1

5.2.5.4.4 Landings

Sardine landings in GSA 6 come from purse seining (see Table 5.2.5.4.3.1). Lowest landings over 2002- 2013 were around 7500 t in 2009- 2010. Over 2002- 2013, landed sardines ranged between 6 and 23 cm TL.

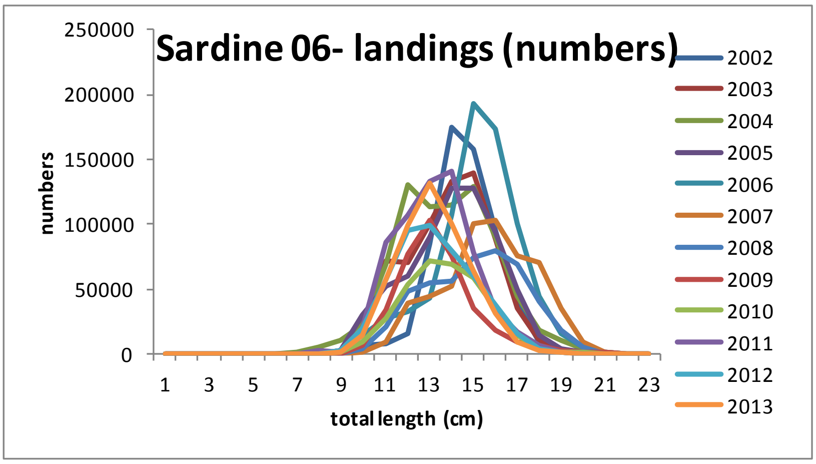


Fig. 5.2.5.4.4. Sardine in GSA 6. Purse seining landings by length and year (2002- 2013).

5.2.5.4.5 *Discards*

Small amounts of discards were reported for fleets different from the purse seine fleet (see Table 5.2.5.4.3.1).

5.2.5.4.6 Fishing effort

Data of fishing effort were available to EWG 14-19 for the period 2009- 2013.

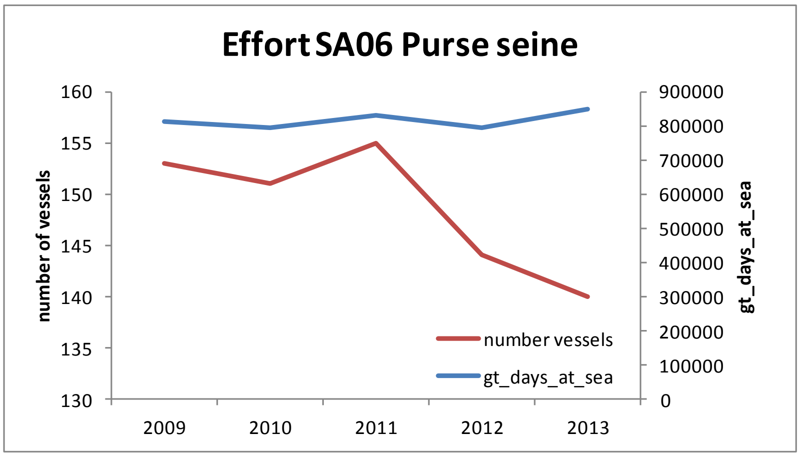


Fig. 5.2.5.4.6.1. Purse seine fishing effort in GSA 6 expressed as number of vessels and gt_days_at_sea.

5.2.5.5 Scientific surveys

Acoustic surveys: ECOMED and MEDIAS

ECOMED and MEDIAS Acoustic Surveys allows for the estimation of an abundance index of sardine by GSA (abundance and biomass, by species and area). ECOMED data were available for the period 2003- 2008, and MEDIAS data were available for 2009- 2013. ECOMED and MEDIAS surveys were conducted at different time of the year, in November-December and in early summer, respectively. Data from ECOMED and MEDIAS were used for XSA tuning.

5.2.5.5.1 Methods

No info on the methodology of the acoustic surveys conducted in GSA 6 was provided to the EWG.

5.2.5.5.2 Geographical distribution

No analyses were conducted during EWG 14-19.

5.2.5.5.3 Trends in abundance and biomass

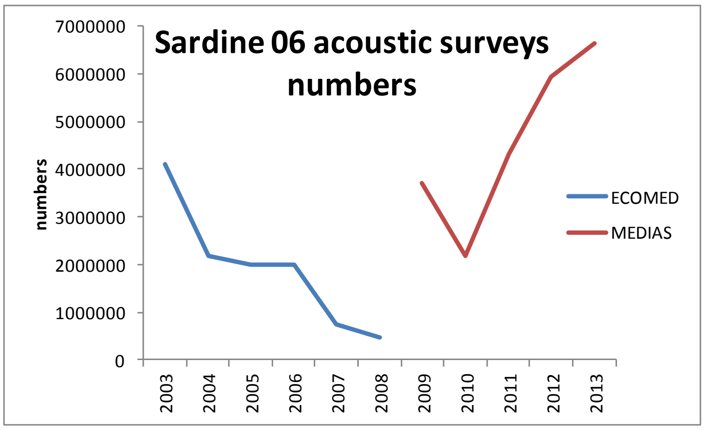


Fig. 5.2.5.5.3.1. Sardine in GSA 6. ECOMED (2003- 2008) and MEDIAS (2009- 2013) acoustic surveys: trends in abundance by year (data source: DCF).

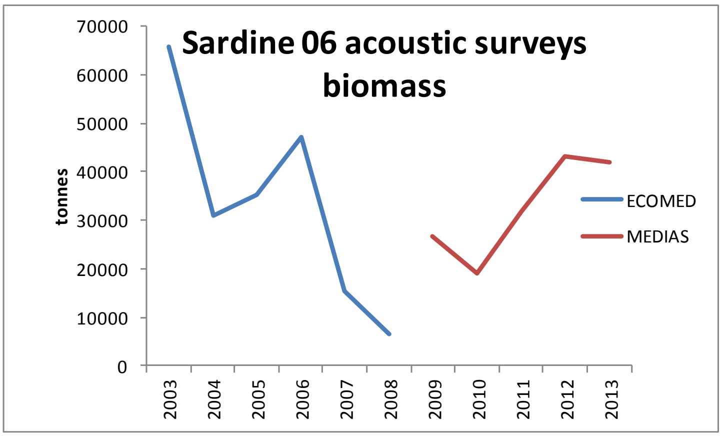


Fig. 5.2.5.5.3.2. Sardine in GSA 6. ECOMED (2003- 2008) and MEDIAS (2009- 2013) acoustic surveys: trends in biomass by year (data source: DCF).

5.2.5.5.4 Trends in abundance by length or age

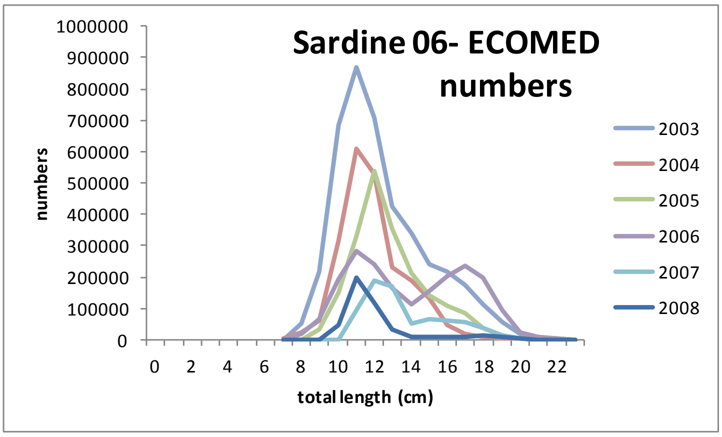


Fig. 5.2.5.5.4.1. Sardine in GSA 6. ECOMED (2003- 2008) acoustic survey: trends in abundance by length (data source: DCF).

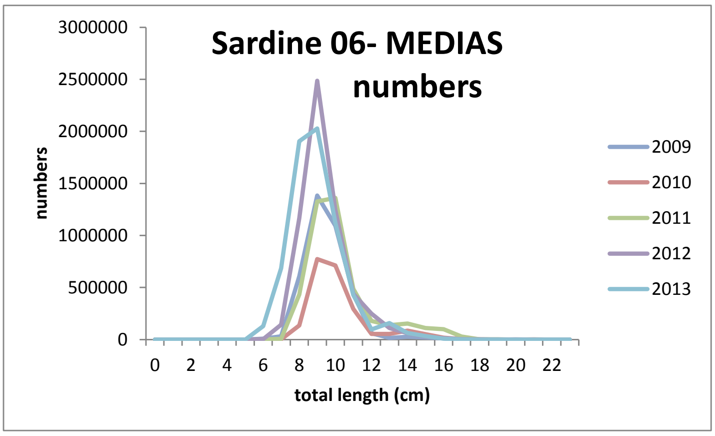


Fig. 5.2.5.5.4.2. Sardine in GSA 6. MEDIAS (2009- 2013) acoustic survey: trends in abundance by length (data source: DCF).

5.2.5.5.5 Trends in growth

No analyses were conducted during EWG 14- 19.

5.2.5.5.6 Trends in maturity

No analyses were conducted during EWG 14- 19.

5.2.5.6 Assessment of historic stock parameters

5.2.5.6.1 *Methods*

Method 1: XSA

5.2.5.6.2 *Justification*

DCF data provided to EWG 14-19 included landings, catches and catch at length during 2002-2013. Fishery independent abundance indexes (ECOMED and MEDIAS acoustic surveys) were available for the period 2003- 2013. These data series were long enough to perform an Extended Survivor Analysis (XSA). The analyses were made using R software and the FLR libraries with scripts provided by JRC.

A first assessment (assessment1) was performed using as input the growth parameters estimated for sardine in GSA 6 (DCF 2008). The values of M vector calculated with these parameters and the method proposed by Gislason *et al.* (2010) were much higher than those estimated for sardine in other areas, for example in the Adriatic Sea. In addition, the species growth according to these parameters would be faster than that shown by the length distributions from the acoustic surveys in summer (Fig. 5.2.5.5.4.1) and late autumn (Fig. 5.2.5.5.4.2). Thus, a second assessment (assessment 2) was performed using modified growth parameters and M vector calculated using a second set of growth parameters, with M values by age much higher and similar to those calculated for the Adriatic. The modification of the growth parameters was made by fixing L_{inf}= 23.9 (DCF 2008) and using the Solver routine of Excel 2010 solution for the estimation of k, for different t_0. The k value was chosen considering that the growth curve reproduced better the observed length frequencies from the acoustic surveys (younger ages) and coincided with original DCF (2008) growth curve in the older ages.

ASSESSMENT1

5.2.5.6.3 Input parameters

The landings annual size distributions were transformed into ages using L2A. M vector was estimated with the method proposed by Gislason *et al.*, 2010. Growth parameters and maturity ogive indicated above.

Table 5.2.5.6.3.1. XSA input parameters to the XSA model. Assessment1.

M natural mortality

ages	0	1	2	3	4	5+
	0.87	0.63	0.51	0.44	0.40	0.36

Maturity ogive

ages	0	1	2	3	4	5+
	0	1	1	1	1	1

Catch at age (thousands)

	0	1	2	3	4	5
2003	309250.9	303919.5	56514.2	6228.1	616.9	71.2
2004	385582.6	282962.9	71367.8	15600.3	3571.7	980.7
2005	273061.1	293852.1	74599.8	8791.5	1050.9	306
2006	151719.6	411020.2	157999.8	30297.7	4390.6	793.6
2007	110587.9	221683.1	140325.1	58097.4	8239.5	782.3
2008	144716.7	177915	108370.7	31191.3	4667.3	242
2009	244326.1	100896.5	16243.9	4858	1597.3	460.3
2010	183050.4	133917.5	22004.8	1936.4	1060.3	321.8
2011	392824.5	201114.3	26115.2	3071.7	261.7	33.4
2012	298141	144357.3	24139.3	1797.2	61.4	22.9
2013	334442.6	157817.8	14754.4	1197.5	76.1	4.1

Weight at age (kg)

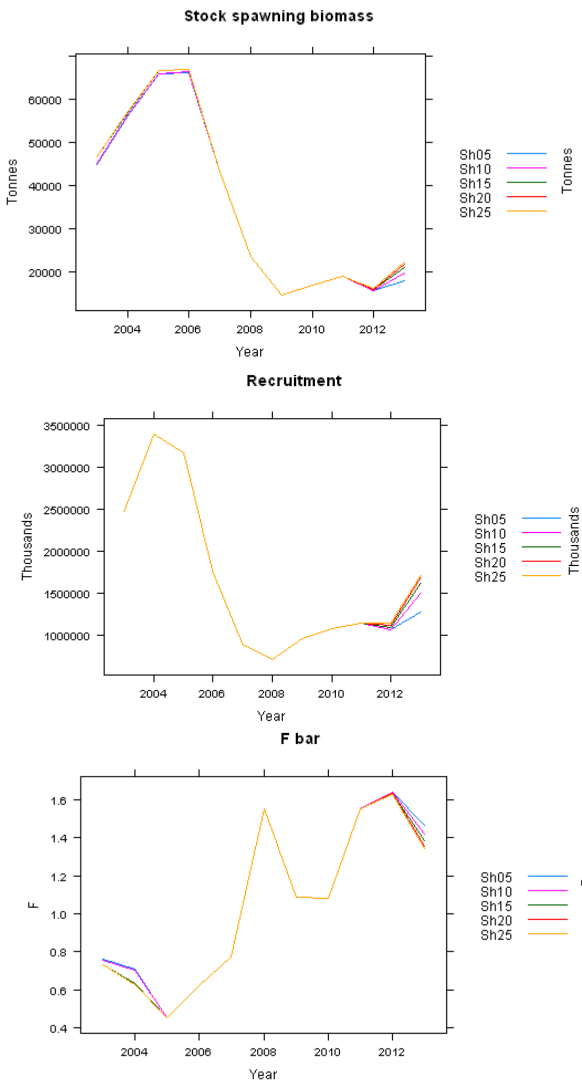
	0	1	2	3	4	5
2003	0.015	0.028	0.04	0.052	0.067	0.078
2004	0.015	0.028	0.041	0.054	0.067	0.078
2005	0.015	0.028	0.04	0.053	0.067	0.079
2006	0.016	0.029	0.041	0.053	0.067	0.079
2007	0.017	0.029	0.043	0.054	0.067	0.079
2008	0.016	0.029	0.042	0.054	0.067	0.077
2009	0.016	0.026	0.041	0.054	0.067	0.078
2010	0.016	0.027	0.04	0.052	0.067	0.078
2011	0.015	0.026	0.041	0.052	0.067	0.078
2012	0.015	0.027	0.04	0.051	0.067	0.077
2013	0.016	0.027	0.039	0.052	0.067	0.077

Tuning parameters

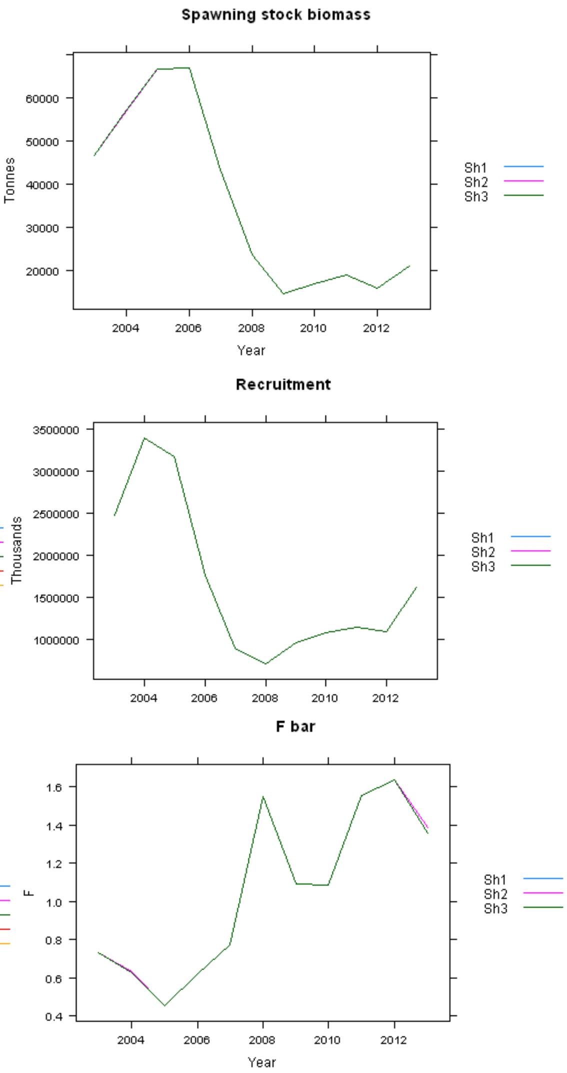
MEDIAS 2009- 2013	0	1	2			
2009	3643898	45853	6604.5			
2010	2047198	125266.9	7699			
2011	3978871	298447.9	45691.4			
2012	5857538	80715.9	6343.7			
2013	6565760	81975.7	3165.5			
ECOMED 2003-2008	0	1	2	3	4	5
2003	3067111	650855.7	284249.3	90917.3	16562.4	2371
2004	1829575	303084.8	32954.5	7989.5	2748.1	817.9
2005	1473889	377637	127257.8	24187.8	2788.6	2830.8
2006	1001670	400210.4	403725.2	158654.6	20885.4	10226.9
2007	473200.4	154266.3	91649.6	27404.3	3253.3	686.4
2008	403452.7	19409.3	21238.9	12152.1	2558.9	368.5

Different sensitivity analyses were performed before running the final XSA, considering different weight and ages for shrinkage.

Sensitivity on shrinkage weight



sensitivity on shrinkage ages



Sensitivity for different rage and qage.

Fig. 5.2.5.6.3.1. Sardine in GSA 6. Assessment1. Sensitivity analysis considering different weight and ages for shrinkage and different rage and qage.

For the final run, the following settings were used:
fse=1.5, rage=-1, qage=2, shk.n=TRUE, shk.f=TRUE, shk.yrs=3, shk.ages=3

5.2.5.6.4 *Results- Assessment1*

XSA results for Assessment1 are presented in Fig. 5.2.5.6.4.1 to Fig. 5.2.5.6.4.6 and Table 5.2.5.6.4.1 to Table 5.2.5.6.4.3.

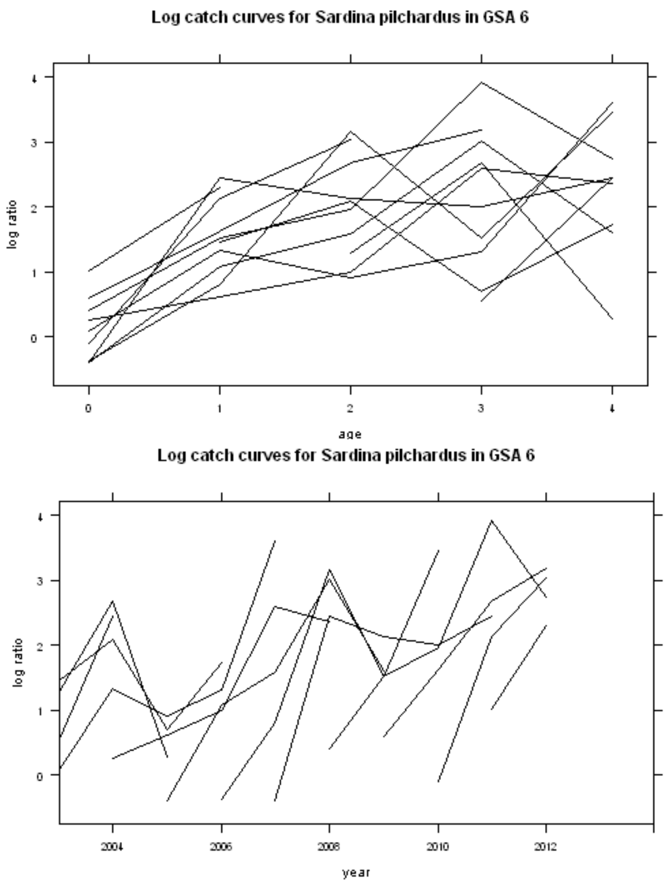


Fig. 5.2.5.6.4.1. Sardine in GSA 6. Log catch curves. Assessment1.

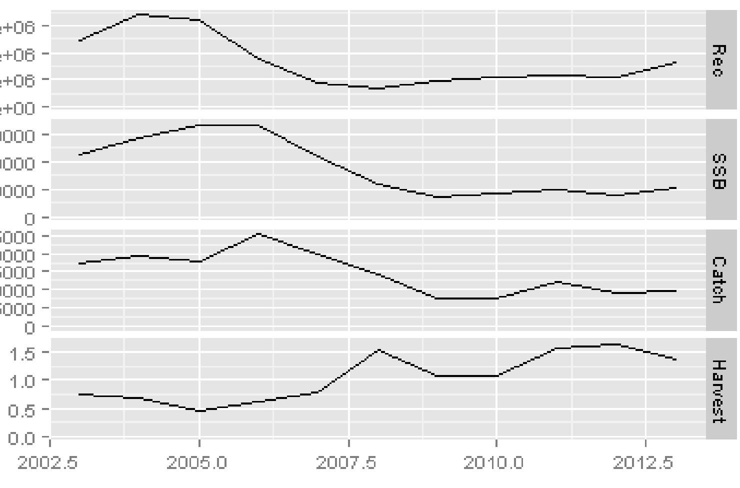


Fig. 5.2.5.6.4.2. Sardine in GSA 6. Assessment1. XSA summary results. SSB and catch are in tons, recruitment in 1000s individuals.

Table 5.2.5.6.4.1. Sardine in GSA 6. Assessment1. XSA summary results.

	Population in number (thousands)	Population in weight (t)	Recruitment (thousands)	SSB (t)	F0-2
2003	3354441.73	63911.7	2470500	45383	0.76
2004	4392207.1	81724.2	3395700	56256	0.69
2005	4561917.8	89845.6	3172200	66054	0.46
2006	3343581.5	80549.3	1761300	66459	0.62
2007	1901038.6	50969.9	895680	43357	0.77
2008	1206703.16	29237.3	703410	23610	1.55
2009	1198733.07	22291.2	962830	14589	1.09
2010	1358501.35	25516.4	1069900	16957	1.08
2011	1518244.06	27551.1	1145000	18963	1.56
2012	1355460.87	24008.5	1089800	15835	1.64
2013	1908126.13	34003.6	1618000	21060	1.38

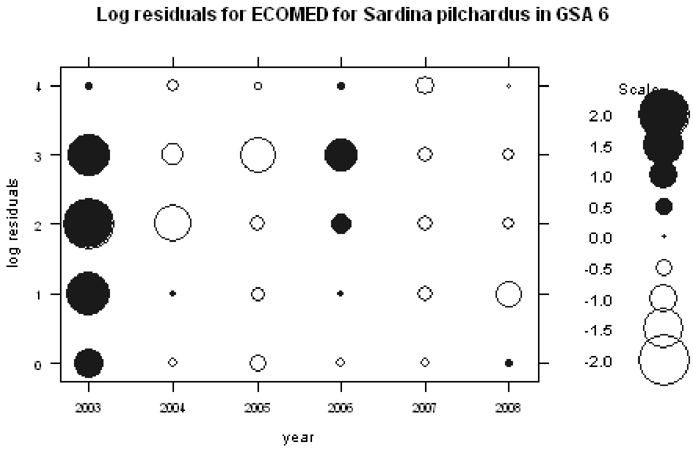


Fig. 5.2.5.6.4.3. Sardine in GSA 6. Log catchability residuals of the tuning data used from ECOMED surveys. Assessment1.

Table 5.2.5.6.4.2. Sardine in GSA 6. Log catchability residuals of the tuning data used from ECOMED surveys. Assessment1.

	2003	2004	2005	2006	2007	2008
0	0.710	-0.149	-0.348	-0.146	-0.147	0.081
1	1.140	0.062	-0.293	0.066	-0.332	-0.644
2	1.374	-0.955	-0.308	0.444	-0.339	-0.216
3	1.091	-0.490	-0.897	0.841	-0.329	-0.216
4	0.099	-0.238	-0.082	0.103	-0.431	-0.002

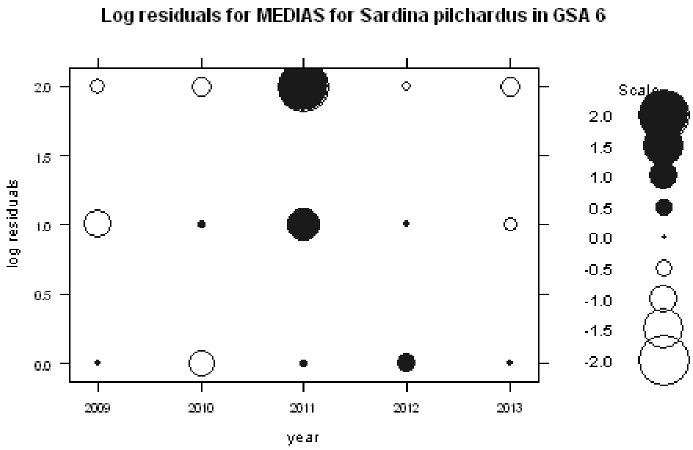


Fig. 5.2.5.6.4.4. Sardine in GSA 6. Log catchability residuals of the tuning data used from MEDIAS surveys. Assessment1.

Table 5.2.5.6.4.3. Sardine in GSA 6. Log catchability residuals of the tuning data used from MEDIAS surveys. Assessment1.

	2009	2010	2011	2012	2013
0	0.069211	-0.712176	0.122483	0.447358	0.073124
1	-0.75593	0.106842	0.909385	0.039726	-0.300022
2	-0.360228	-0.505899	1.519252	-0.16623	-0.486894

Fig. 5.2.5.6.4.5. Sardine in GSA 6. Assessment1. Retrospective analysis for SSB, F and R.

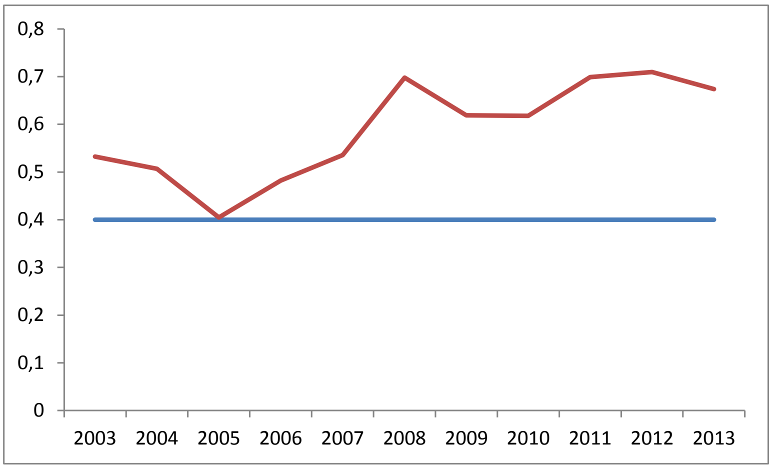


Fig. 5.2.5.6.4.6. Sardine in GSA 6. Assessment1. Exploitation rate trend considering F_{0-2} plotted against the reference point E= 0.4.

ASSESSMENT2

5.2.5.6.5 Input parameters

For the XSA- Assessment2 the input parameters were modified as follows:

L_{inf}= 23.9; k= 0.40; t_0= -0.4.

M natural mortality (using Gislason *et al*. 2010)

ages	0	1	2	3	4	5+
	2.8	1.14	0.78	0.60	0.53	0.48

Maturity at age was estimated taking into account the species growth according to the modified growth parameters and that the mean size at first maturity over 2004- 2013 was 12.6 cm TL (data source: DCF)

Maturity ogive.

ages	0	1	2	3	4	5+
% mature	0.0	1.0	1.0	1.0	1.0	1.0

Table 5.2.5.6.5.1. XSA input parameters to the XSA model. Assessment2.

Catch at age (thousands)

AGE	2003	2004	2005	2006	2007	2008	2009
0	8308.4	20071.4	9378.8	4465.9	328.3	1125.7	1844.2
1	356462.3	413567.6	317084.9	191985.6	132203.0	166977.5	274240.5
2	288764.9	282675.5	292908.1	468826.8	273091.4	218531.7	79093.5
3	21689.6	36729.3	29872.7	81757.9	116276.2	70985.5	10354.2
4	1308.0	6092.0	2124.9	8429.8	17071.9	9254.2	2413.5
5+	67.5	930.3	291.9	755.6	744.6	228.2	436.2

AGE	2010	2011	2012	2013
0	3186.1	8702.7	7978.0	4414.9
1	208637.5	443023.9	323432.4	372216
2	121103.1	160010.3	128720.6	126846
3	7753.2	11106.0	8162.1	4606.8
4	1306.0	546.4	204.5	204.9
5+	305.1	31.7	21.6	3.8

Weight at age (kg)

AGE	2003	2004	2005	2006	2007	2008	2009
0	0.008	0.006	0.008	0.008	0.007	0.008	0.008
1	0.017	0.016	0.017	0.018	0.018	0.017	0.017
2	0.03	0.031	0.031	0.032	0.033	0.033	0.029
3	0.046	0.048	0.046	0.047	0.049	0.048	0.048
4	0.062	0.063	0.062	0.062	0.062	0.062	0.064
5+	0.078	0.078	0.08	0.079	0.079	0.077	0.078

AGE	2010	2011	2012	2013
0	0.008	0.007	0.007	0.008
1	0.017	0.017	0.016	0.017
2	0.03	0.029	0.03	0.029
3	0.046	0.046	0.045	0.046
4	0.066	0.062	0.06	0.061
5+	0.078	0.078	0.077	0.077

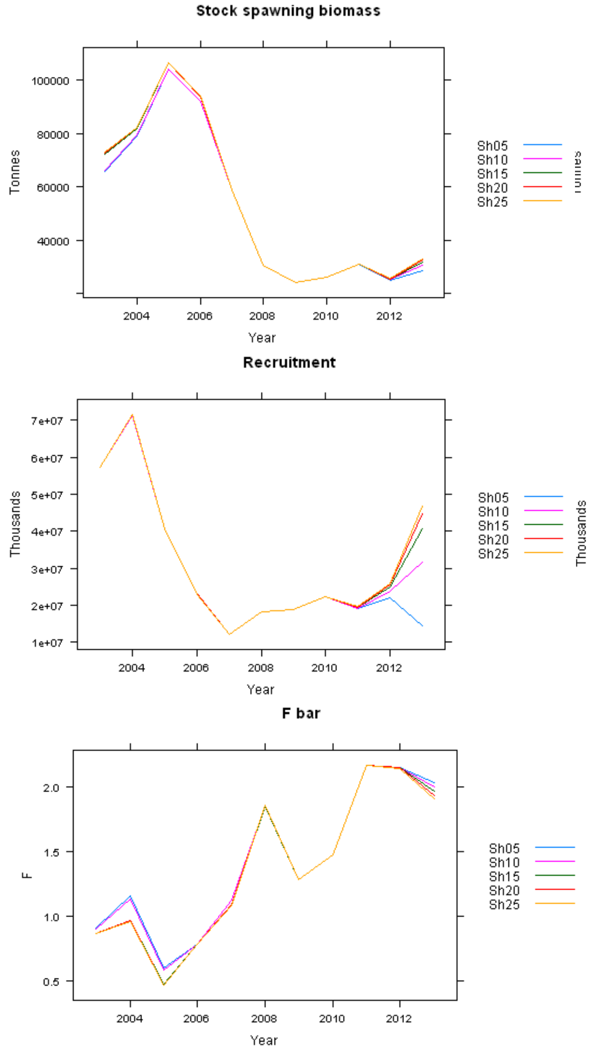
Tuning parameters

MEDIAS 2009- 2013		0	1	2
2009	2290047	1364776	39594.4	1938.2
2010	1079567	1003387	94890.1	2319.6
2011	2093229	1950254	270315.2	9212.1
2012	4096433	1786005	60419.9	1740.3
2013	5014871	1577085	58453.3	490.8

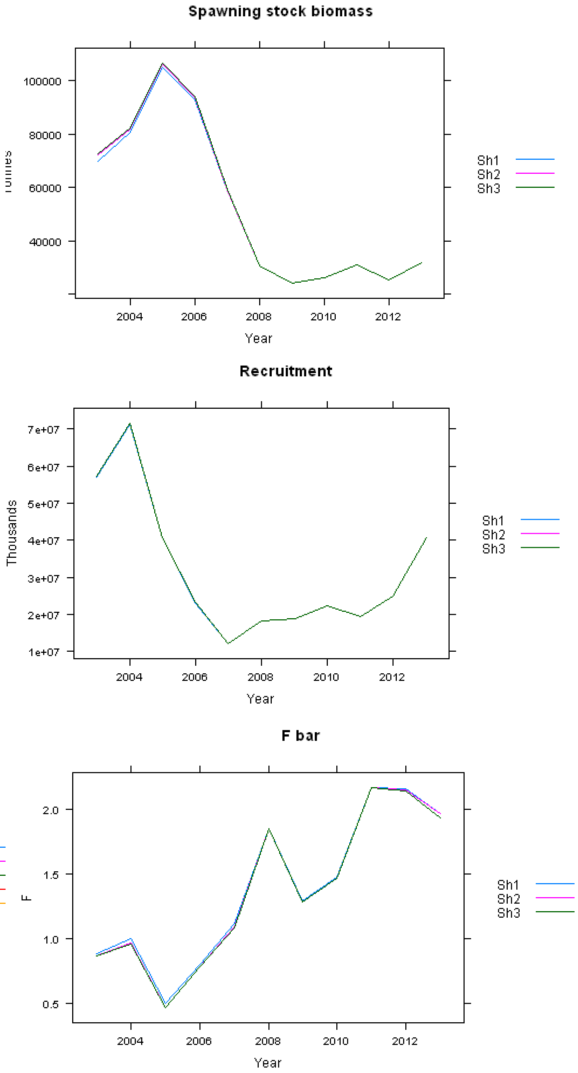
ECOMED 2003-2008		0	1	2	3	4	5
2003	437176.6	2771740.0	673547.0	196862.2	30462.8	2278.8	
2004	161918.2	1747181.0	246048.6	17054.9	4192.7	774.8	
2005	70356.7	1492092.0	370036.1	67418.5	5929.6	2758.4	
2006	130938.5	918063.1	562172.2	329647.8	44724.8	9825.5	
2007	3308.4	495328.3	183596.6	63529.8	7050.1	647.0	
2008	11746.1	394589.3	26135.6	21784.2	4572.7	352.4	

Different sensitivity analyses were performed before running the final XSA, considering different weight and ages for shrinkage.

Sensitivity on shrinkage weight



sensitivity on shrinkage ages



Sensitivity for different rage and qage.

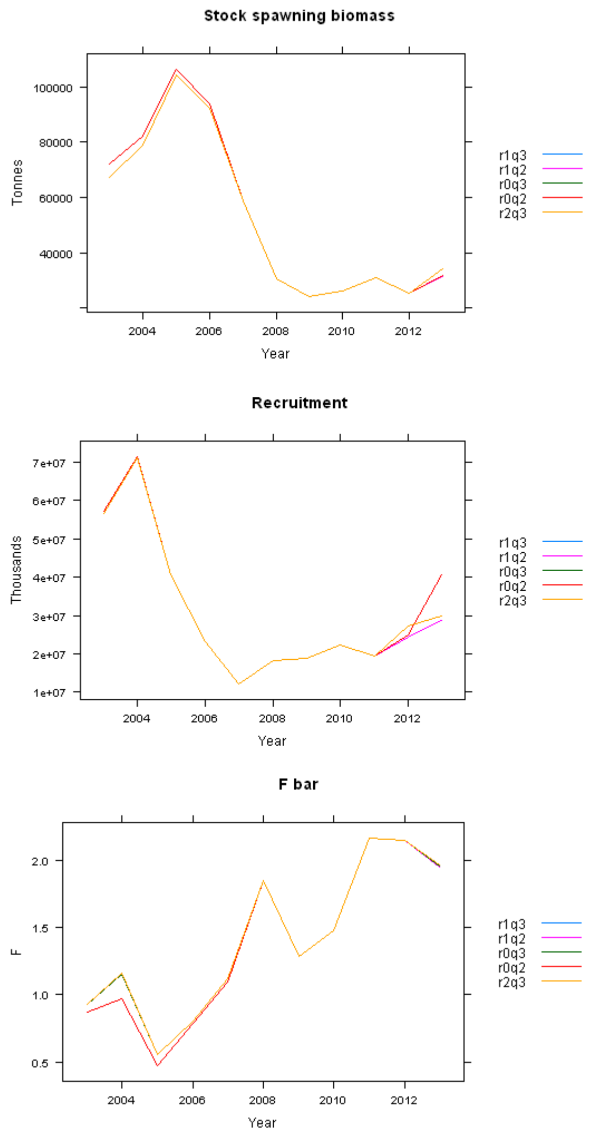


Fig. 5.2.5.6.5.1. Sardine in GSA 6. Sensitivity analysis considering different weight and ages for shrinkage and different rage and qage. Assessment2.

For the final run, the following settings were used:
fse=1.5, rage=-1, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=3, shk.ages=3

5.2.5.6.6 *Results- Assessment2*

The use of the modified growth parameters meant a shift of 1 year in the catch composition and a much higher M vector (Fig. 5.2.5.6.6.1) .

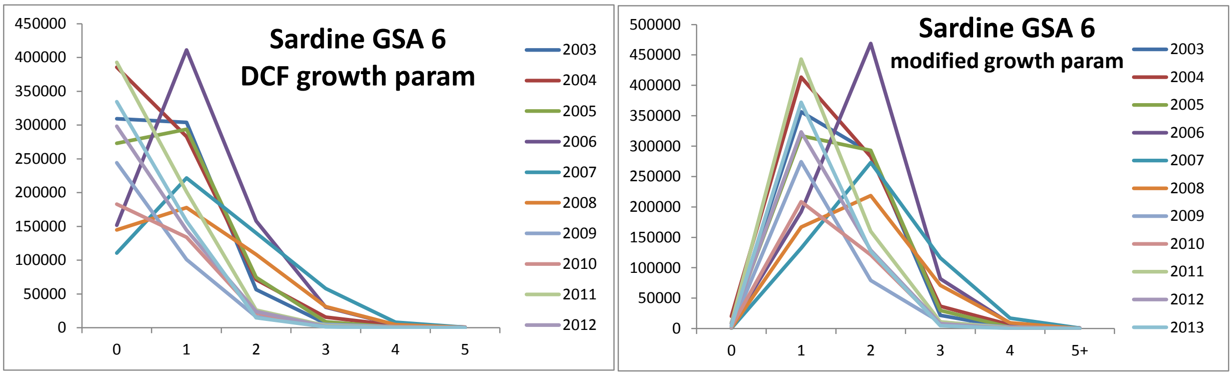


Fig. 5.2.5.6.6.1. Sardine in GSA 6. Catch at age considering the DCF growth parameters (DCF 2008; left) and according to the modified growth parameters (right).

XSA results- Assessment2 are presented in Fig. 5.2.5.6.6.1 to Fig. 5.2.5.6.6.7 and Tables 5.2.5.6.6.1 to Figs. 5.2.5.6.6.3.

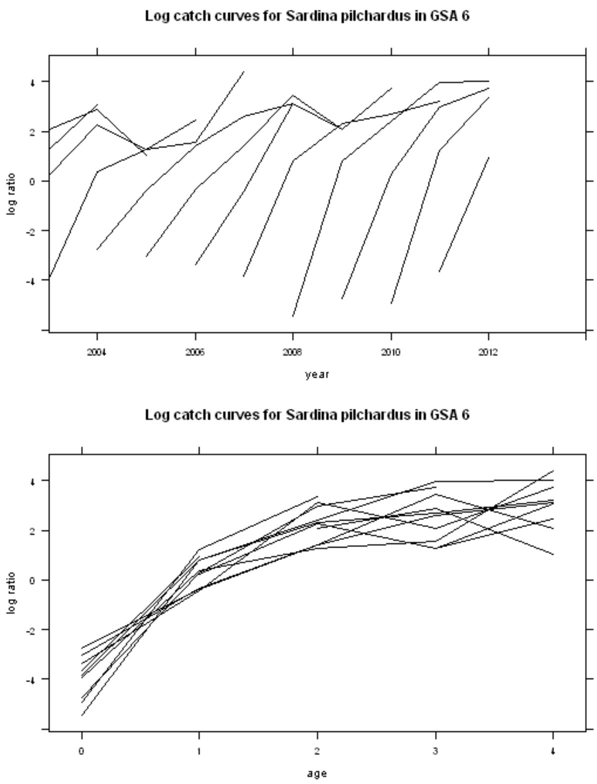


Fig. 5.2.5.6.6.2. Sardine in GSA 6. Log catch curves. Assessment2.

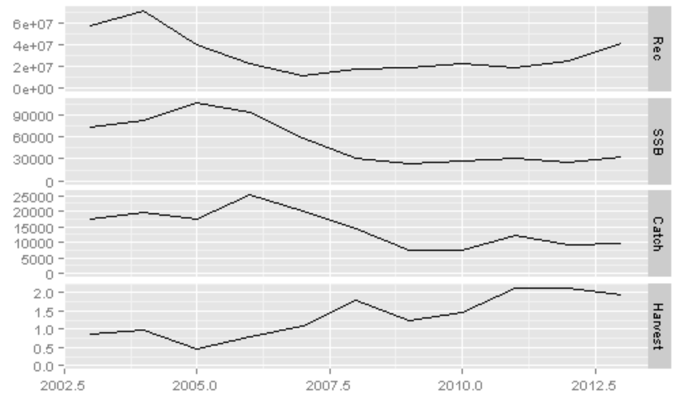


Fig. 5.2.5.6.6.3. Sardine in GSA 6. XSA- Assessment2 summary results. SSB and catch are in tons, recruitment in 1000s individuals.

Table 5.2.5.6.6.1. Sardine in GSA 6. XSA-Assessment2 summary results.

	Population in number (thousands)	Population in weight (t)	Recruitment (thousands)	SSB (t)	F1-3
2003	60882609	530270	57252000	72250	0,87
2004	75900473	511833	71619931	82113	0,97
2005	46036029	432125	40702603	106505	0,47
2006	26983971	278636	23095240	93876	0,78
2007	14379839	143664	12074472	59143	1,09
2008	19557080	177280	18336131	30590	1,81
2009	19991046	173843	18715864	24113	1,25
2010	23784461	205650	22426194	26240	1,46
2011	20979360	166578	19351941	31117	2,15
2012	26344314	199981	24960005	25261	2,12
2013	42570233	358621	40849623	31822	1,94

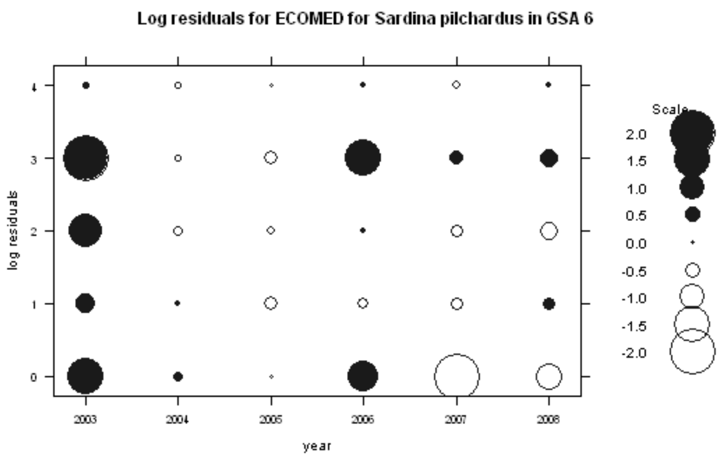


Fig. 5.2.5.6.6.4. Sardine in GSA 6. Log catchability residuals of the tuning data used from ECOMED surveys. Assessement2.

Table 5.2.5.6.6.2. Sardine in GSA 6. Log catchability residuals of the tuning data used from ECOMED surveys.

	2003	2004	2005	2006	2007	2008
0	1.467	0.251	-0.018	1.170	-1.859	-1.011
1	0.690	0.056	-0.430	-0.340	-0.354	0.378
2	1.331	-0.229	-0.193	0.088	-0.396	-0.601
3	1.878	-0.102	-0.429	1.453	0.449	0.632
4	0.118	-0.119	-0.020	0.043	-0.196	0.053

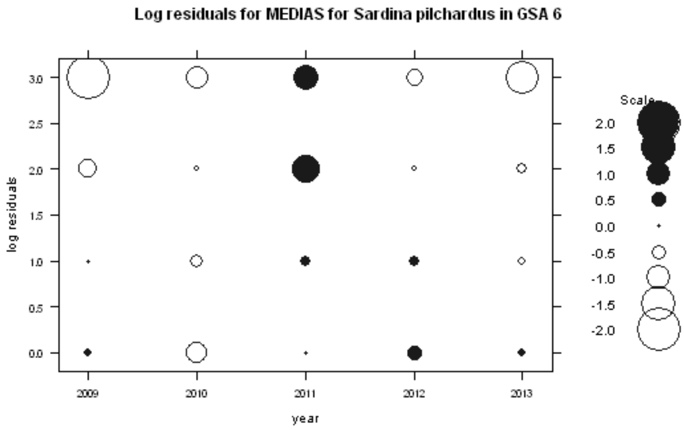


Fig. 5.2.5.6.6.5. Sardine in GSA 6. Log catchability residuals of the tuning data used from MEDIAS surveys. Assessment2.

Table 5.2.5.6.6.3. Sardine in GSA 6. Log catchability residuals of the tuning data used from MEDIAS surveys. Assessment2.

	2009	2010	2011	2012	2013
0	0.152	-0.781	0.029	0.446	0.155
1	0.007	-0.413	0.296	0.275	-0.165
2	-0.634	-0.075	1.037	-0.032	-0.296
3	-1.772	-0.856	0.937	-0.608	-1.290

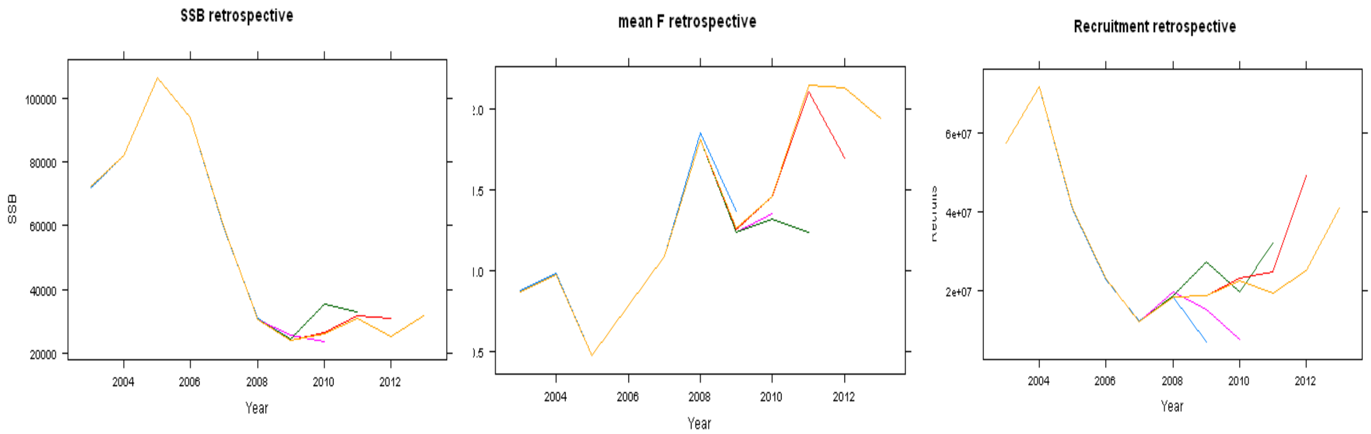


Fig. 5.2.5.6.6.6. Sardine in GSA 6. Retrospective analysis for SSB, F and R. Assessment2.

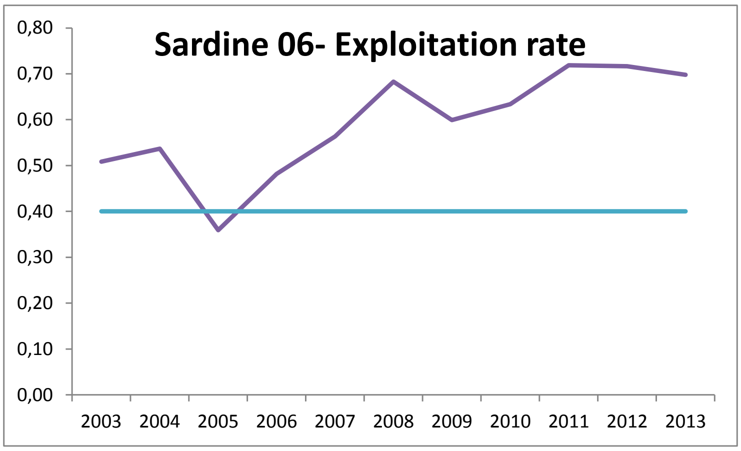


Fig. 5.2.5.6.6.7. Sardine in GSA 6. Exploitation rate trend considering F $_{1-3}$ plotted against the reference point E= 0.4.

The modified growth parameters reproduced better than the original set (DCF 2008) the younger ages when comparing the growth curve with the length distributions of sardine from the acoustic surveys, improved substantially the log catch curves and also moderately the residuals pattern and the retrospective. Based on these considerations, the Assessment2 was considered as the best one.

However, it is also important to notice that results regarding E trend from Assessment1 and Assessment2 were very similar. Considering E=0.4 as reference point, it can be concluded that the sardine stock in GSA 6 is being exploited unsustainably.

5.2.5.7 Long term prediction

5.2.5.7.1 *Justification*

5.2.5.7.2 *Results*

5.2.5.8 Data quality

With the exception of the growth parameter (which was described above), no other particular data issue was found with the sardine assessment in GSA 6.

5.2.5.9 Scientific advice

5.2.5.10 Short term considerations

Considerations below are based on the Assessment2 results).

5.2.5.10.1 State of the stock size

According to the acoustic surveys observations in the last three years (2011-2013) sardine abundance have increased. However, sardine abundance and biomass are estimated to be at low historical levels according to the XSA assessment.

5.2.5.10.2 State of recruitment

During 2003- 2004, recruitment peaked in 2004 (71600 million). In the most recent year (2013), recruitment increased in relation to the previous years, but it was far from the peak observed in 2004 (40850 million).

5.2.5.10.3 State of exploitation

The current F ($F_{(1-3)}$= 1.94) is larger than F_{MSY} (0.56). The current exploitation rate (E= 0.70) is much higher than the reference E= 0.4, which indicates that sardine in GSA 6 is exploited unsustainably.

5.2.5.11 Management recommendations

EWG 14-19 advise 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 considered

5.2.6 STOCK ASSESSMENT OF ANCHOVY IN GSA 6

5.2.6.1 Stock Identification

The assessment of anchovy corresponds to the GSA 6 (Northern Spain), but it is not known yet if this is a shared Mediterranean French stock or a single stock unit. Studies of larvae transport from the Golf of Lion to Spanish waters suggest that this is a shared stock. Howvere, due to a lack of information about the structure of anchovy population in the western Mediterranean, this stock was assumed to be confined within the GSA 6 boundaries.

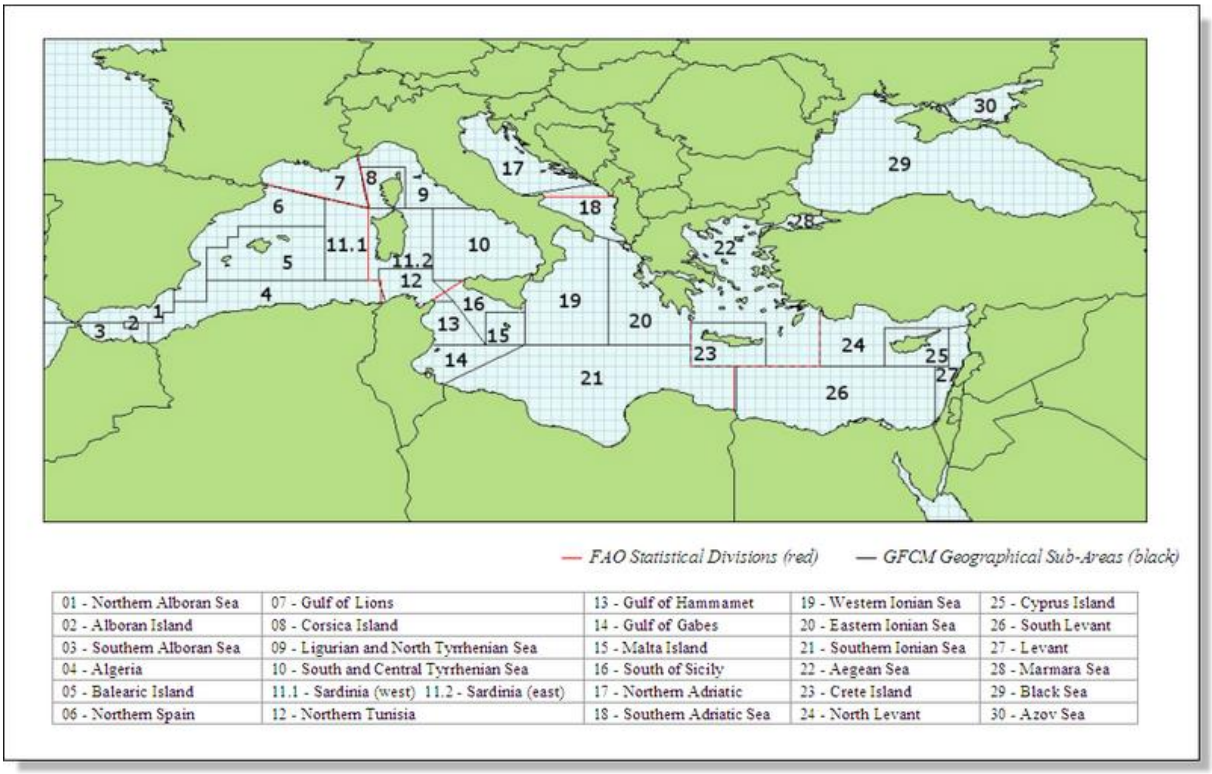


Fig. 5.2.6.1. Geographical location of GSA 6.

5.2.6.2 Growth

Von-Bertalanffy growth parameters, necessary for the calculation of natural mortality, were estimated with DCF otolith reading collected in GSA 6 in 2013, running the last version of the program INBIO 2.0 (Sampedro et al., 2005, last update 2012 pers. Comm): L_{inf}= 19, k= 0.2985, t_0= -2.7562 and for the length- weight relationship: a=0.0034, b= 3.2282

5.2.6.3 Maturity

Maturity at age was estimated from maturity at size. Maturity at size was calculated as the ratio of mature fish in a size class over the total number of fish in that size class: Age 0 =0.88 and Age 1+= 1

5.2.6.4 Fisheries

5.2.6.4.1 General description of the fisheries

The current purse seine fleet targeting anchovy in GSA 6 is composed by 119 units, average GB is 39.1. About 3% of them are smaller than 12 m (operational Unit 1), 97% > 12 m (operational Unit 2) and 13% are over 24m. The fleet has been continuously decreasing in the last two decades, from 222 vessels in 1990 to 119 in 2013. They have been lost the smallest units.

Fig. 5.2.6.4.1.1 Comparison of fleet composition in 2000 and 2013.

Anchovy is the main target species of the purse seine fleet in Northern Spain due to its high economic value. Anchovy catches in the period 1990-2013 have been highly variable. Species with a lower economical value are also fished, sometimes representing a high percentage of landings: horse mackerel (*Trachurus spp*.), mackerel (*Scomber spp*.), and gilt sardine (*Sardinella aurita*). The interest about some of these species has been increasing as there is a new market for them; gilt sardine and mackerel, especially the first, are sold for tuna farming.

Fig. 5.2.6.4.1.2. Purse seine fleet landings in Northern Spain 80% of landings and 89% of economic value correspond to anchovy and sardine.

5.2.6.4.2 Management regulations applicable in 2014

Regulated by Fishery European regulations REGULATION (EC) Nº 1967/2006 of December 21, 2006, with a more restrictive Spanish regulations.
Features gear: Minimum aperture of 14 mm mesh, the height of the purse seine shall not exceed 82 m and the use of purse seines is not allowed at a depth less than 70 percent of the net length, length net will not exceed more than 300 m except for Alboran Sea which may be up to 450 m. Characteristics of vessels: No less than 9 m long, maximum power 450 hp, only one auxiliary boat and there is a Regulating for its power lights. Fishing areas: prohibited fishing less than 35 m deep, although at a distance of 300 m offshore it is permitted at a lower depth than 50m. There are a forbidden areas to safe anchovy recruitment. Fishing effort: No fishing on weekend, restricted fishing areas and seasonal closures in some regions. Minimum sizes: Minimum legal landing size 9 cm. List of species authorized to be fished by the gear. A margin of 2% of others species.

5.2.6.4.3 Catches

Discard data are not available and anyhow considered negligible for this fishery, thus catches are assumed to be equal to the landings.

5.2.6.4.4 *Landings*

Landings in the period 1990-2013 have been highly variable, with a minimum of 1900 tons in 2007 and an average of 11700 tons. Higher catches occurred in the period 1990-94, they were caught between 17000 and 22000 tons. Thereafter it has been continuously decreasing with three recoveries in 2002, 2009 and 2012. In 2013 shows higher catches around 17200 t, a similar value to the one observed in 1990, but it is still not close to the peak of the landings occurred between 1991 and 1994. Years with higher landings are usually correlated with a successful and high recruitment period, while unsuccessful recruitment in a given year is correlated with a low level of landings.

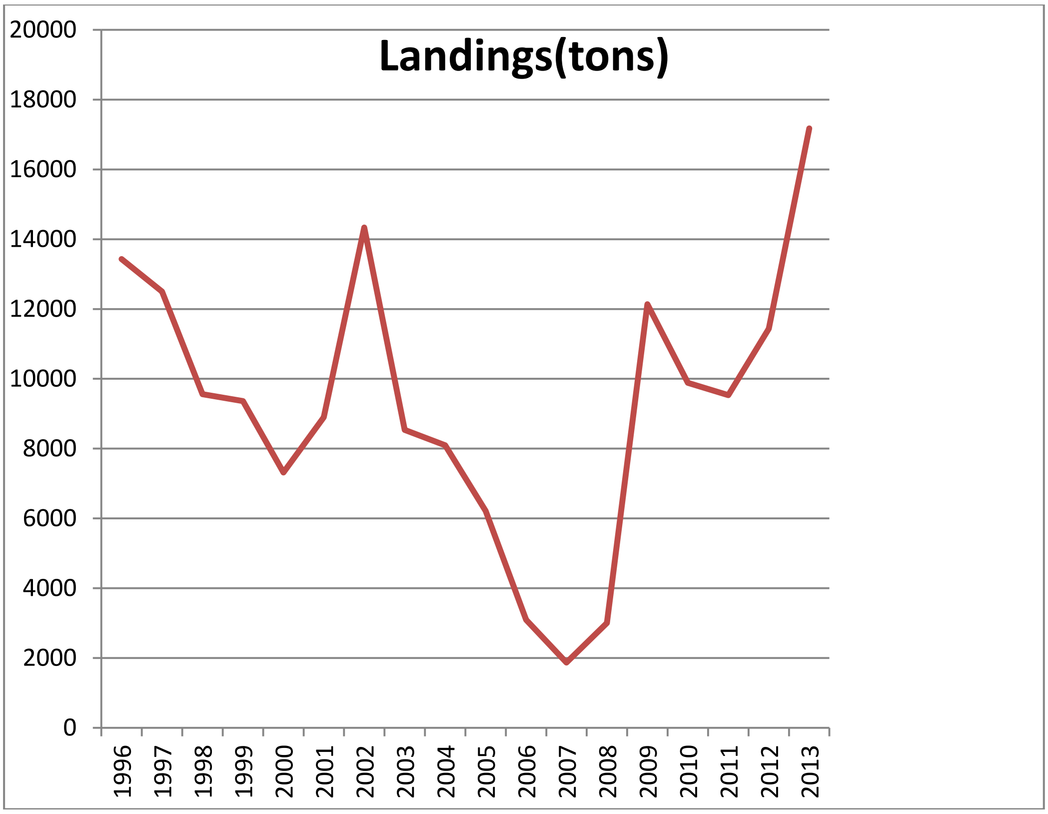


Fig. 5.2.6.4.4. Anchovy in GSA 6. Landings from 1996 to 2013.

5.2.6.4.5 *Discards*

Discards data are not available and anyhow considered negligible for this fishery.

5.2.6.4.6 Fishing effort

The current fleet in GSA 06 the Northern Spain is composed by 119 units, average GB is 39.1. About 3% of them are smaller than 12 m (operational Unit 1), 97% > 12 m (operational Unit 2) and 13% are over 24m. The purse seine fleet has been continuously decreasing in the last two decades, from 222 vessels in 1990 to 119 in 2013. They have lost the smallest units, but as the resource has increased during the last years part of the fleet from GSA 1 has moved to the GSA 6.

Table 5.2.6.4.6. Trips by year for the purse seine fleet targeting anchovy in GSA 6.

Year	Nº Trips
1996	29304
1997	29304
1998	29304
1999	27852
2000	26532
2001	23628
2002	20592
2003	21252
2004	20460
2005	19404

2006	18348
2007	16234
2008	16734
2009	17644
2010	17227
2011	17904
2012	17528
2013	18978

5.2.6.5 Scientific surveys

In the Spanish Mediterranean waters an acoustic survey has been annually carried out since the 1990s. Until 2009 the survey (ECOMED) was carried out in late autumn focusing on anchovy recruitment. Since 2009 the acoustic survey season changed to summer in order to standardize with the rest of the acoustic surveys carried out by the European countries in Mediterranean Sea and to start the MEDIAS (Mediterranean acoustic surveys) series. The pelagic community is nowadays assessed using MEDIAS, focusing on the spawning stock biomass (SSB) for anchovy and the recruitment of sardine.

5.2.6.5.1 Methods

The acoustic surveys prospects the continental shelf (20 to 200 m depth) by means of a scientific echosounder EK60 (Simrad), equipped with 5 frequencies (18, 38, 70, 120 and 200 kHz).

Acoustic data are recorded continuously at a constant ship speed of 10 knots from sunrise to sunset, along parallel equidistant transects lying perpendicular to the bathymetry. The echosounder is calibrated before each survey following standard techniques (Foote et al., 1987).

Midwater pelagic trawls were deployed to determine the species proportions present in the area. Acoustic data are processed using Echoview (Miryax Ltd.) software and PESMA (VisualBasic) software. Echo trace classification is based on echogram visual scrutinisation, usually the allocation account of representative fishing stationS and very few times on direct allocation. Results of biomass (in tons) and abundance (in nº individuals) are presented by species, length and age.

Table 5.2.6.5.1. MEDIA acoustic survey information.

Date	**June-July 2013**		
Cruise	MEDIAS 2013	**R/V**	Miguel Oliver
Target species	Anchovy and sardine		
Sampling strategy	66 tracks normal to the coast. Inter-transect distance: 4 or 8 nautical miles		
Sampling season	Summer (29 June - 31 July)		
Investigated depth range (m)	20-200 m depth		
Echo-sounder	Scientific Echo-sounder EK60 equipped with 5 frequencies (18, 38, 70, 120 & 200 kHz)		
Fish sampler	Pelagic trawls with 10, 16 & 18 m vertical opening		
Cod –end mesh size as opening (mm)	20 mm		
ESDU (i.e. 1 nautical mile)	Elementary Distance Sampling Unit: 1 nautical mile		
TS (Target Strength)/species	-72.6 dB for anchovy and sardine		

Software used in the post-processing	SonarData Echoview, PESMA (Visual Basic), ArcGis 9.3
Samples (gear used)	Pelagic trawl
Biological data obtained	Length-weight relationship, age, sex, maturity
Age slicing method	Otolith
Maturity ogive used	

5.2.6.5.2 Geographical distribution

The usual distribution of the species is shown in figure *5.2.6.5.2,*with higher abundance of anchovy in the North area and sardine in the South area. As new feature in the pelagic ecosystem it has been an increasing biomass and distribution area of the species *Sprattus* sprattus (L: 1758) since 2010 (brown color in the map: N_SPR). In 2013, 29500 tons of sprat were estimated in the area.

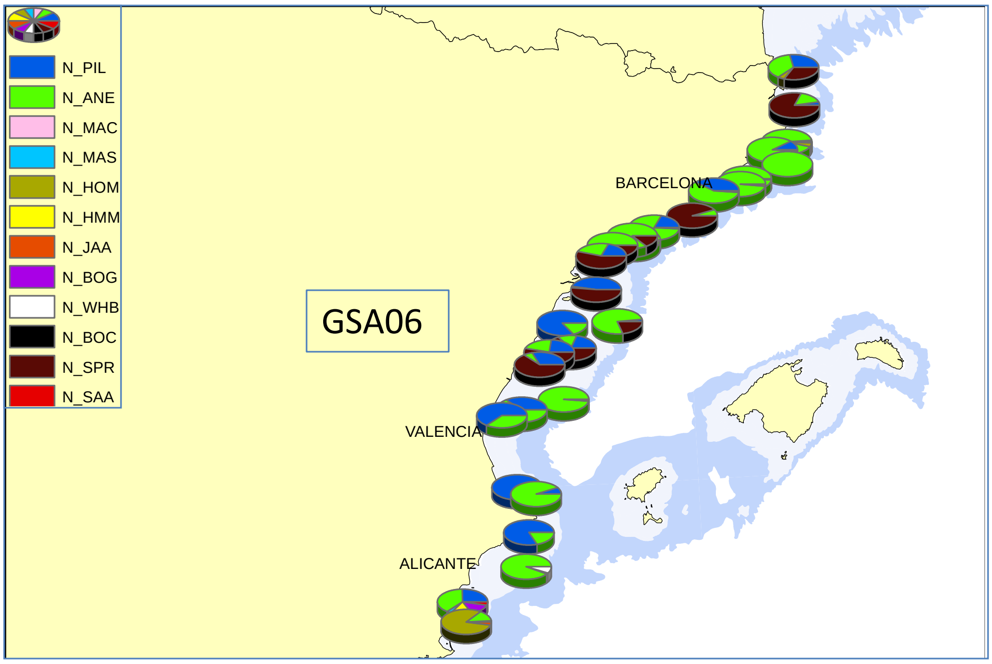


Fig. 5.2.6.5.2. Proportion of pelagic species in MEDIAS survey.

5.2.6.5.3 Trends in abundance and biomass

The biomass estimated of anchovy by acoustic surveys has been highly variable, with a minimum of 2400 tons in 1998 and a maximum of 67000 tons in 2012. It shows an increasing trend since 2005, although in 2013 was lower than the previous one. Preliminary data from 2014 shows the same increasing trend.

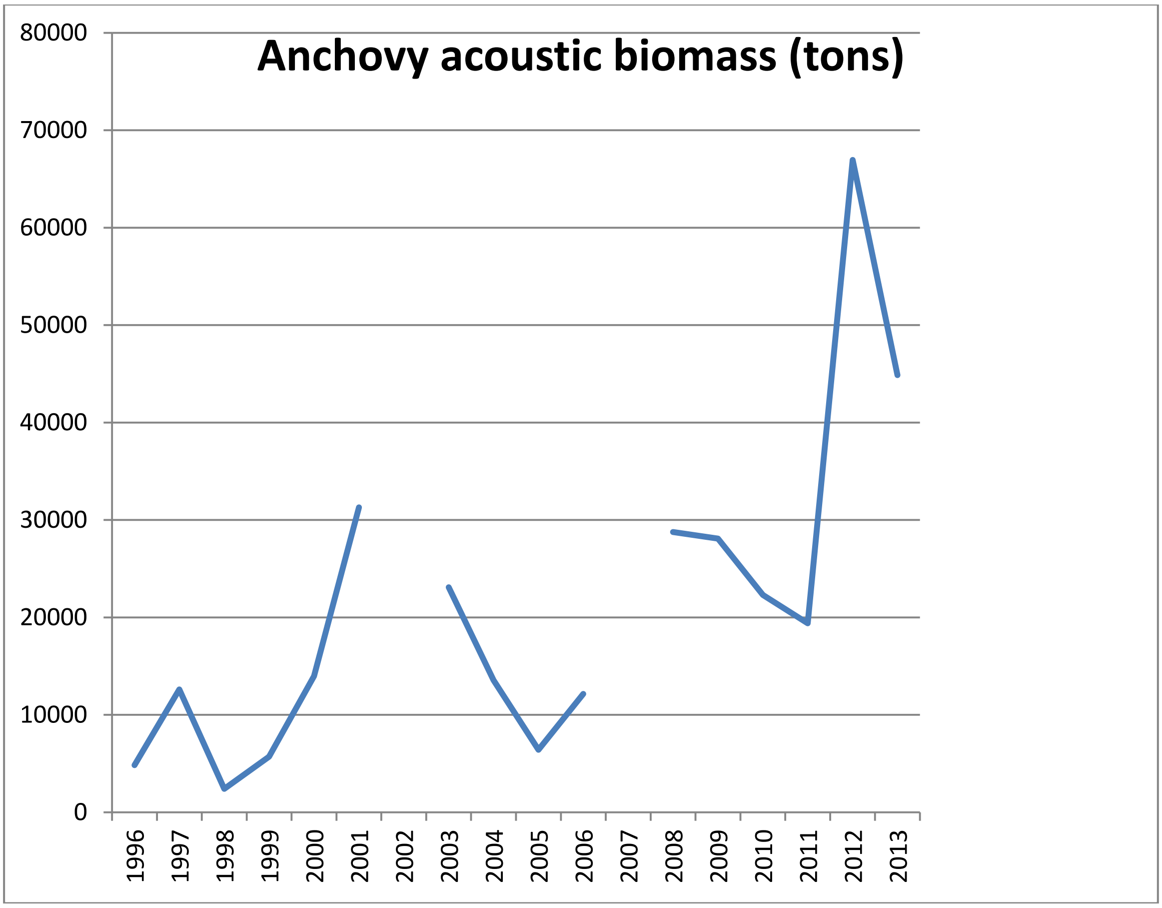


Fig. 5.2.6.5.3. Trends in anchovy biomass in acoustic surveys, years 1996-2013.

5.2.6.5.4 Trends in abundance by length or age

No analyses were conducted during EWG 14- 19.

5.2.6.5.5 Trends in growth

No analyses were conducted during EWG 14- 19.

5.2.6.5.6 Trends in maturity

No analyses were conducted during EWG 14- 19.

5.2.6.6 Assessment of historic stock parameters

5.2.6.6.1 *Methods*

Non-equilibrium surplus production model (BioDyn package; FAO, 2004).

5.2.6.6.2 *Justification*

Due to that age composition in the landings and surveys are mainly classes 0 and 1, a model approach based on the fitting of a non-equilibrium surplus production model (BioDyn package; FAO, 2004) was run. Data used were a series of observed abundance indexes, allowing for the optional incorporation of an environmental index, so that the r and/or K parameters of each year can be considered to depend on the corresponding value of the applied index. In the actual case were tested different environmental indexes, neither of them showed any improvement in the model fit.

5.2.6.6.3 Input parameters

The model was implemented in an MS Excel spreadsheet, modified from the spreadsheets distributed by FAO under the BioDyn package. Details about the implementation of the applied logistic modeling approach can be found in a FAO report on the Assessment of Small Pelagic Fish off Northwest Africa (FAO, 2004). The report is available at the web site http://www.fao.org/docrep/007/y5823b/y5823b00.htm.

The model uses four base parameters:

–virgin biomass K

–intrinsic growth rate of the population r

–initial rate of reduction D (initial biomass related to K)

–catchability q

–All other estimated parameters derive from these four.

Basic Assumptions:

- Stock can be described solely by its biomass.
- “Natural” Rate of change in biomass depends on current biomass only.
- There is a maximum biomass that the system can support (K).
- The relative rate of increase of biomass is maximum when the biomass is close to zero, and zero when the biomass is at the maximum level.
- Simplest model: Logistic (Schaefer) model

Table 5.2.6.6.3.1. Parameters limits to minimization, tolerance ratio and parameters calculated by Biodyn (K in Tons).

Parameter	Initial Value	Tolerance Ratio	Min Value	Max Value	Calculated by Biodyn
R	0.25	5	0.05	1.25	0.92
K	66948	5	13390	3344740	48926
BI/K	40%		0.5	0.95	40%

The input data used for the adopted model were total yearly catch (tons) and a series of abundance indices (acoustic biomass estimates) over the period (1996-2013).

Table 5.2.6.6.3.2. Anchovy in GSA 6. Catches and acoustic biomass estimates used in the assessment 1996-2013.

YEAR	Catch (tons)	ACOUSTIC (tons)
1996	13430	4843
1997	12500	12608
1998	9558	2404
1999	9361	5717
2000	7315	13968
2001	8898	31297
2002	14338	
2003	8538	23093
2004	8097	13562
2005	6216	6412
2006	3096	12159
2007	2820	
2008	3532	28767
2009	12137	28090
2010	9886	22305
2011	9534	19405
2012	11434	66948
2013	17178	44874
Average	9326	21028

5.2.6.6.4 *Results*

The results based on the implementation of a non-equilibrium logistic surplus production model were not accepted by EWG 14-19 as the predicted abundance index due to poor model fitting (Fig. 5.2.6.6.4.1*)*.

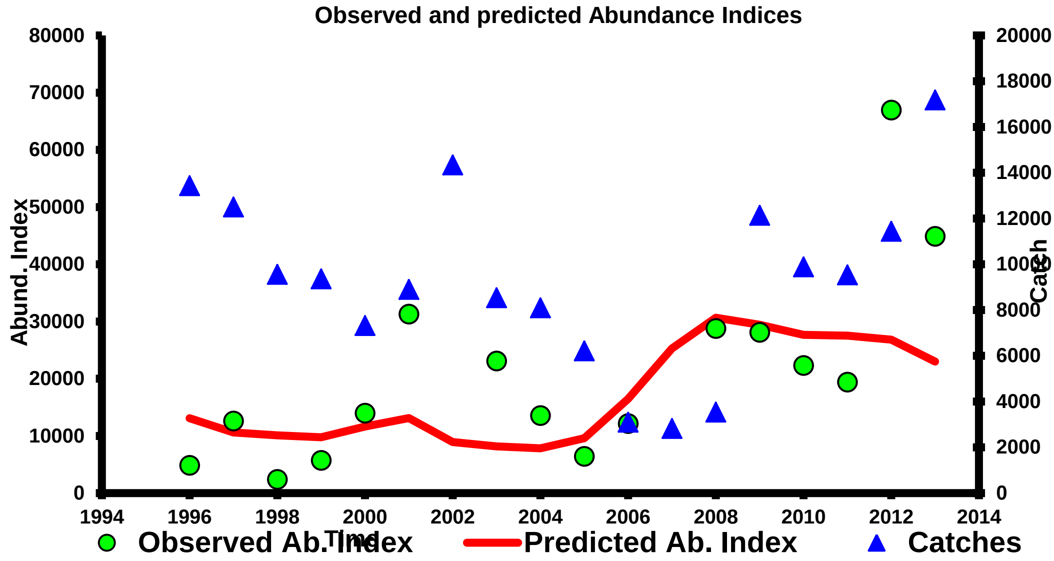


Fig. 5.2.6.6.4.1. Anchovy in GSA 6. Catches and Observed-predicted abundance indices(tons).

The quality of input data is good although the obtained output is not satisfactory. The goodness of the best fit obtained using the surplus production modelling approach was also considered unsatisfactory (RpearsonIndex=0.60). Pearson linear regression coefficient will not detect a non-linear relation, but will measure how closely the predicted abundance indices follow the observed ones. This plot presents, in a graphical way, the relation between the Abundance Index observed (and used in the model) and the Abundance index estimated by the model, on the basis of the estimated biomass. The desirable characteristic for this plot is a linear relation between the predicted and observed indices, with slope 1.

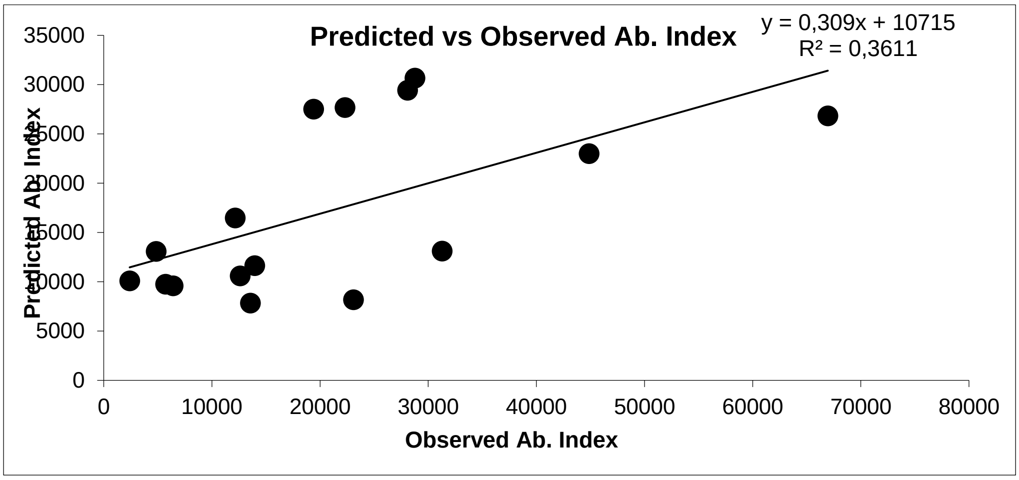


Fig. 5.2.6.6.4.2. Anchovy in GSA 6. Plot of the relation between the predicted and the observed abundance indices. This plot can be used to detect severe deviations from the linear relationship between the observed abundance indices and those predicted by the model.

The residual plot shown in Fig 5.2.6.6.4.3 is used to evaluate whether there are trends in the deviations between the observed and predicted abundance indices data. As long as the residuals are reasonably well-dispersed, with no patterns, there is usually no reason to concern. Unusually large or small residuals concentrated at a given range of the predicted abundances, however, should be looked into carefully, as they may indicate a model misspecification, or problems with the data.

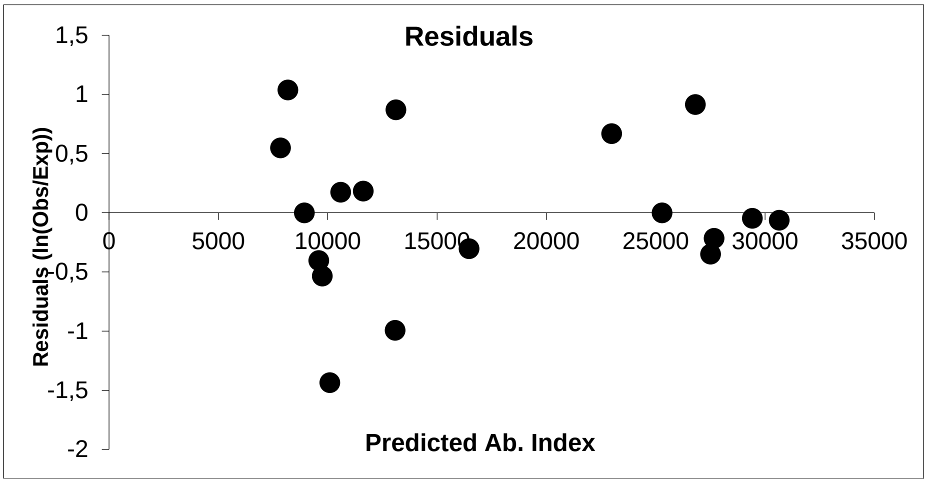


Fig 5.2.6.6.4.3. Anchovy in GSA 6. Plot of residuals used to assess if there are indications of any lack of fit in the adjustment of the model to the data.

5.2.7 STOCK ASSESSMENT OF BLACK-BELLIED ANGLERFISH IN GSA 6

5.2.7.1 Stock Identification

Due to a lack of information about the structure of black-bellied anglerfish population in the western Mediterranean, this stock was assumed to be confined within the boundaries of the GSA 6 (Figure 5.2.7.1.1).

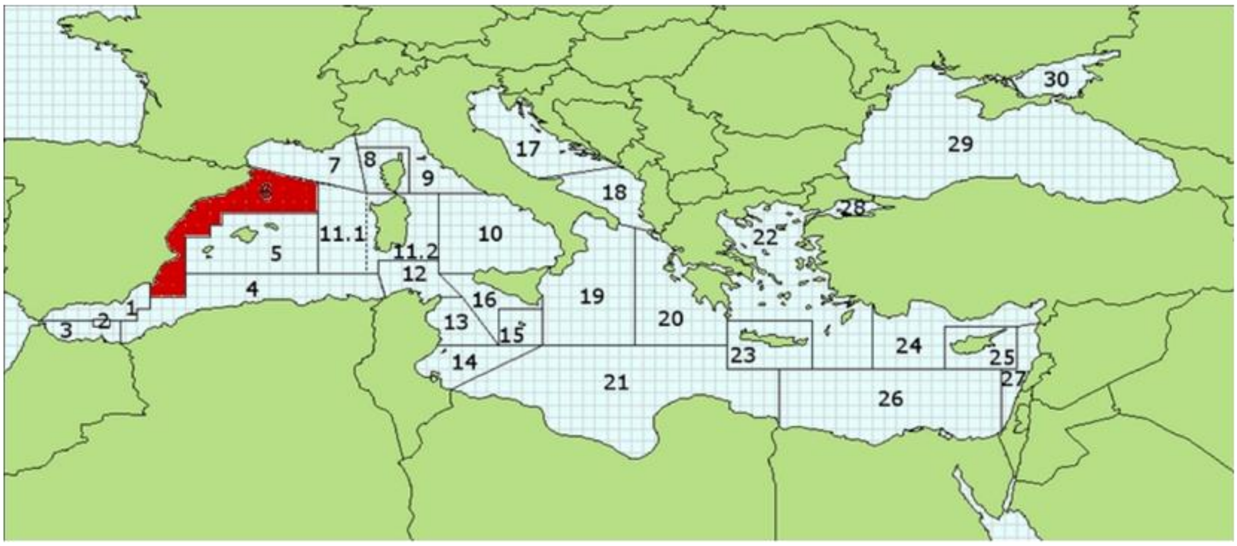


Figure 5.2.7.1.1 Geographical location of GSA 6.

The species is of secondary commercial importance in GSA 6, but regularly caught by bottom trawlers and to, a lesser extent, set nets (mainly trammel nets). The bulk of catches correspond to individuals between 10 and 50 cm TL which are often sold together with *L. piscatorius*.

5.2.7.2 Growth

Growth parameters of *L. budegassa* were determined by modal progression analysis based on the analysis of length frequency distributions merged for several years from the data collection samples (Spanish Data Collection Programme) because of the difficulty of obtaining representative annual size frequencies. The values of the Von Bertalanffy growth function for GSA 6 (combining males and females) were: L_∞ = 102 cm TL, k = 0.15 yr^{-1}, t = -0.05 yr, while the length-weight relationship parameters were: a = 0.0232 g cm^{-3} and b = 2.8455.

5.2.7.3 Maturity

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

5.2.7.4 Fisheries

5.2.7.4.1 General description of the fisheries

No updated information was available to STECF EWG 14-99. Black-bellied anglerfish are by catch of commercial importance of bottom trawl fisheries. They are also caught by a variety of static fishing gear (trammel nets, gillnets and baited traps).

5.2.7.4.2 Management regulations applicable in 2014

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

5.2.7.4.3 *Catches*

5.2.7.4.4 *Landings*

Landings data were reported to STECF EWG 14-19 through the DCF. In GSA 6 the bulk of catches (98% in weight) are from otter trawl, while artisanal fisheries represents the rest of the catches. The largest individuals are caught by trammel nets, but these are not sampled.

Table 5.2.7.4.4.1. Black-bellied anglerfish in GSA 6. Annual landings (t) by gear in GSA 6 from the DCF data.

	LLS	FPO	GNS	GTR	OTB
2002			0.77	2.84	350.17
2003				7.97	434.15
2004				6.73	415.20
2005			0.61	5.03	520.15
2006				6.95	640.62
2007			0.77	8.09	609.74
2008			0.81	10.16	513.02
2009					562.50
2010					747.4152
2011	8.28	0.36	32.71	18.19	1193.80
2012	8.59	0.54	2.88	20.20	798.26
2013	5.29	0.40	2.30	16.04	1024.05

The time series of landings data (tons) by gear for the period 2002-2013 is shown in Figure 5.2.7.4.4.1. Maximum landings values are observed in 2011 and 2013 and minimum values in 2002.

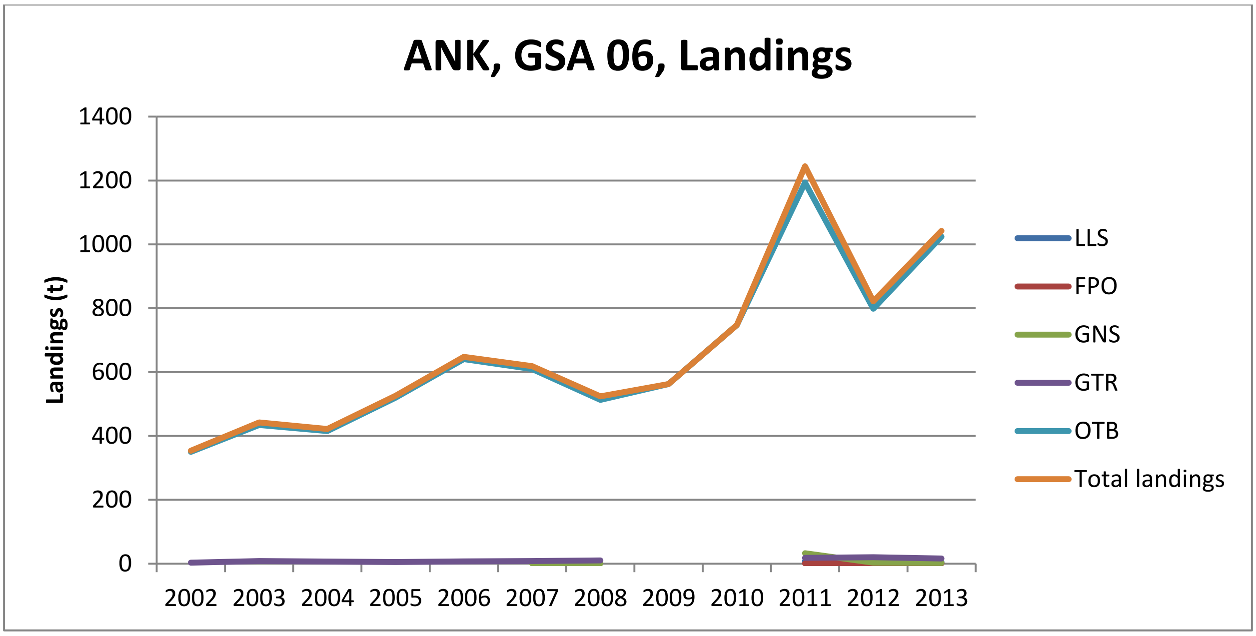


Figure 5.2.7.4.4.1. Black-bellied anglerfish in GSA 6. Total annual landings by gear for the period 2002-2013.

DCF data on length structure of black-bellied anglerfish from otter trawl in GSA 6 were available for the period 2003-2013, and are shown in Figure 5.2.7.4.4.2.

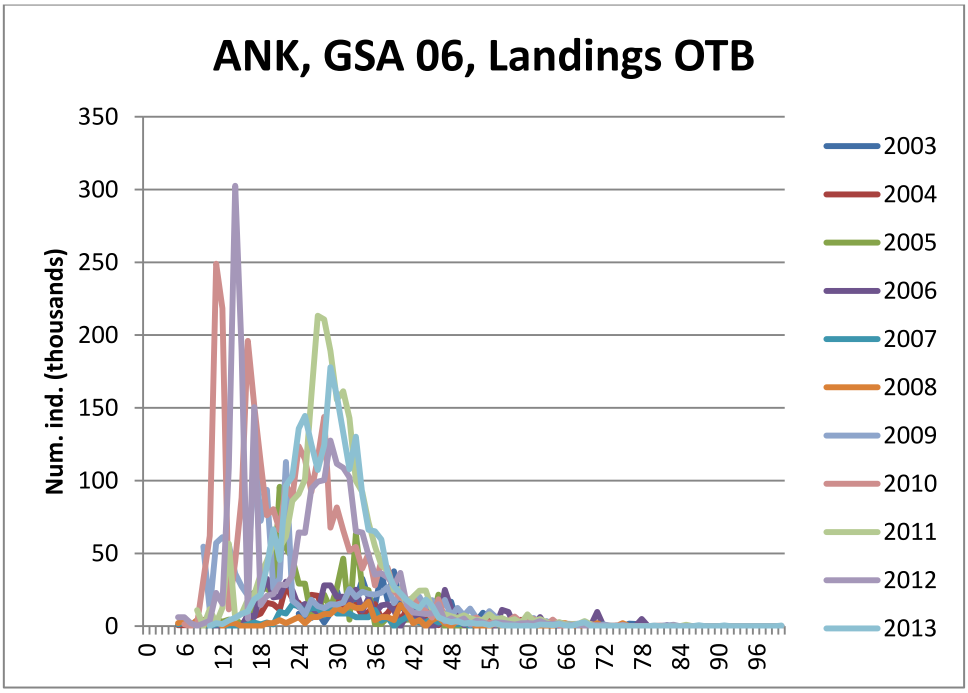


Figure 5.2.7.4.4.2. Black-bellied anglerfish in GSA 6. Length frequency distribution of the landings from 2003 to 2013 as obtained from the DCF.

DCF data on age structure of black-bellied anglerfish from otter trawl in GSA 6 were available for the period 2003-2013, and are shown in Figure 5.2.7.4.4.3.

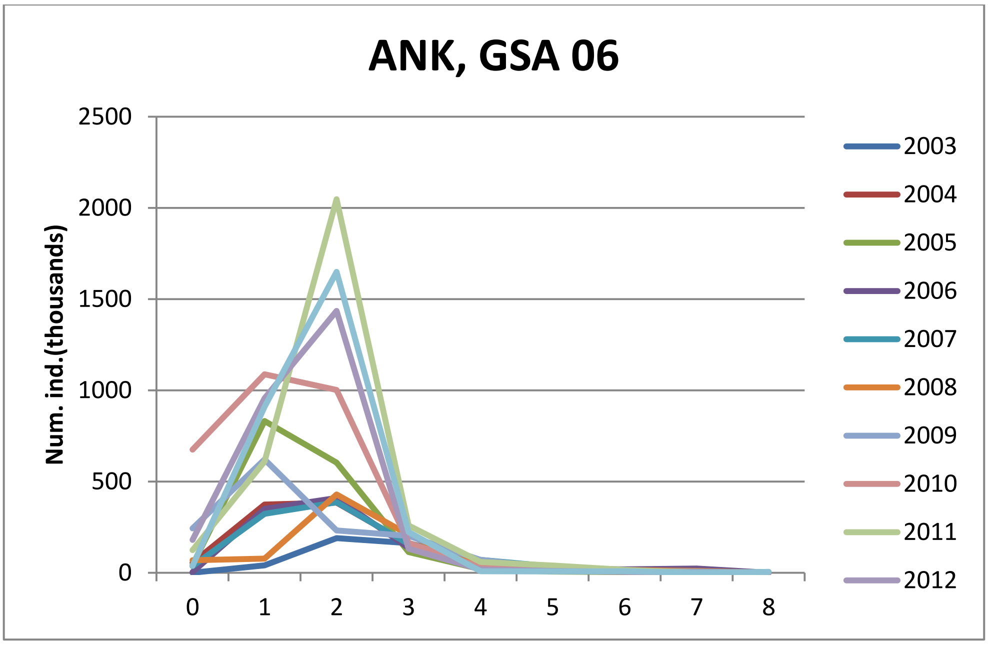


Figure 5.2.7.4.4.3. Black-bellied anglerfish in GSA 6. Age frequency distribution of the landings from 2003 to 2013 as obtained from the DCF.

5.2.7.4.5 *Discards*

Discards data were reported to STECF EWG 14-19 through the DCF. Information on OTB discards was available from 2009 to 2013 and it is shown in Table 5.2.7.4.5.1. Discards of anglerfish are negligible for 2008-2010 but in the last 3 years they have increased and they represent 10%, 8% and 12% of the total landings respectively. Nevertheless, no data on the length frequency of discards is available.

Table 5.2.7.4.5.1. Black-bellied anglerfish in GSA 6. Discards data in tons.

	OTB	OTB Discards
2008	513.02	0.09
2009	562.50	0.02
2010	747.4152	0.05
2011	1193.80	141.28
2012	798.26	74.21
2013	1024.05	146.24

5.2.7.4.6 Fishing effort

Trawl (OTB) fishing effort data for GSA 6 was submitted by quarter, area, gear, fishery and vessel length class for the years 2009-2013 in the new data call, but due to differences respect to data provided in previous meetings we have used the series of previous data (see chapter 5.2.7.8 Data quality). Data for the length classes VL1224 and VL2440 are shown in the following table. The reduction in fishing effort is apparent, in accordance with the Integral Plan previously mentioned aiming to reduce fishing effort. The number of vessels and GT days at sea of OTB fleet in GSA 6 in the period 2009-2012 by fleet segment is presented in Table 5.2.7.4.6.1.

Table 5.2.7.4.6.1 Black-bellied anglerfish in GSA 6. Number of vessels, nominal fishing effort and capacity.

	2009	2010	2011	2012
Nb 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

5.2.7.5 Scientific surveys

MEDITS

5.2.7.5.1 Methods

Since 1994 standard bottom trawl surveys have been conducted in GSA 6 in spring, following the general methodology of the MEDITS protocol described in Bertrand *et al.* (2002). In GSA 6 the following number of hauls was reported per depth stratum in the DCF 2014 data call:

Table 5.2.7.5.1.1 Number of MEDITS hauls per year and depth stratum in GSA 6, 1994-2013.

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	2013
050-100	37	30	31	33	26	29	28	20	28	35	38
100-200	20	16	17	18	14	20	20	12	20	23	24
200-500	17	15	14	17	10	13	14	10	15	18	17
500-800	11	11	8	12	9	9	7	8	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

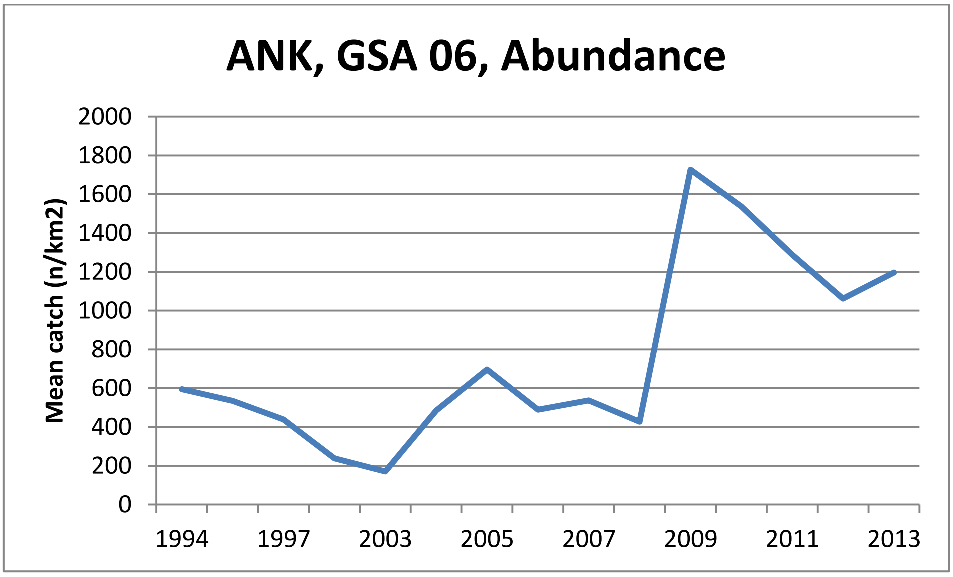
The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n
Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) 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.

5.2.7.5.2 Geographical distribution

No specific analyses were conducted during STECF EWG 14-19.

5.2.7.5.3 Trends in abundance and biomass

Fishery independent information from the MEDITS surveys in the period 1994-2013 was used to derive indices of abundance and biomass for black-bellied anglerfish in GSA 6. Both abundance and biomass have fluctuated in the area during this period with no clear trend.



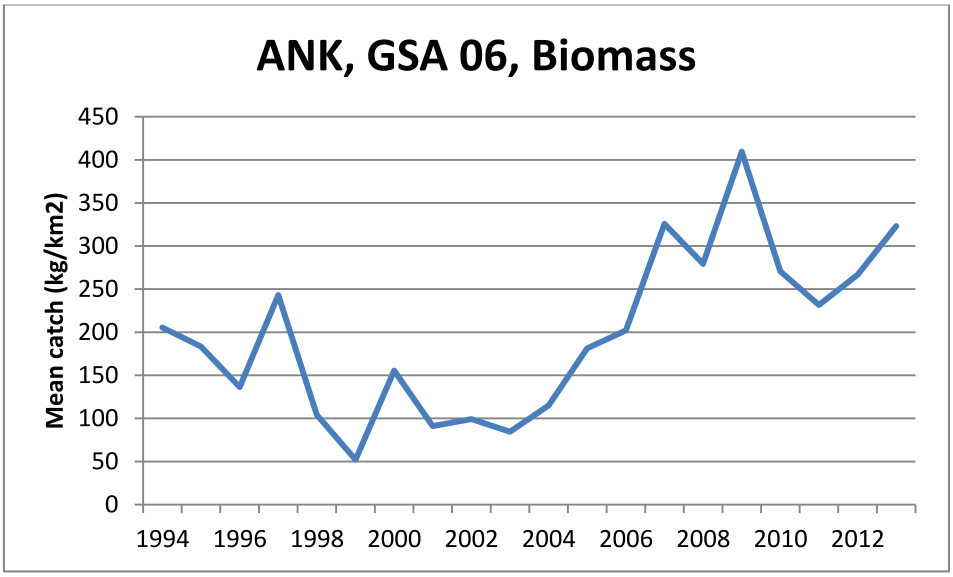


Figure 5.2.7.5.3.1. Black-bellied anglerfish in GSA 6. Abundance and biomass indices from the MEDITS survey.

5.2.7.5.4 Trends in abundance by length or age

The following Figure 5.2.7.5.4.1 displays the stratified abundance indices of black-bellied anglerfish in GSA 6.

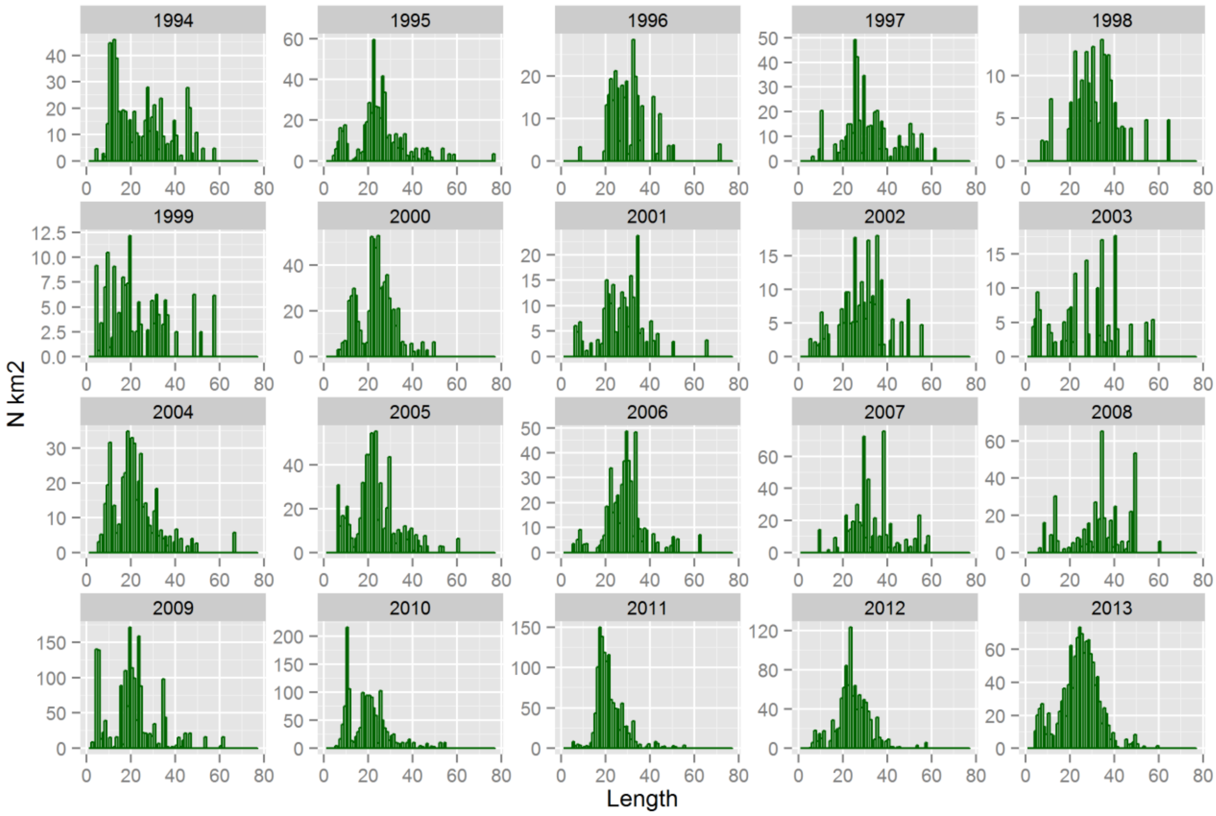


Figure 5.2.7.5.4.1. Black-bellied anglerfish in GSA 6. Stratified abundance indices by size, 1994-2013.

5.2.7.5.5 Trends in growth
No specific analyses were conducted during STECF EWG14-19.

5.2.7.5.6 Trends in maturity
No specific analyses were conducted during STECF EWG14-19.

5.2.7.6 Assessment of historic stock parameters

5.2.7.6.1 *Method: XSA*

5.2.7.6.2 *Justification*
FLR libraries were employed in order to carry out an XSA based assessment (Darby and Flatman 1994). This stock was assessed for the first time during in STECF 12-19 EWG 12-10: LCA (VIT program from Lleonart and Salat, 1992) was performed using as input data the period 2009-2011. XSA has been carried out for the first time for this stock in 2014 (STECF EWG 14-09) using as input data the period 2004-2013 for the catch data and 2005-2013 for the tuning file.

5.2.7.6.3 Input parameters
The growth parameters used for VBGF were L_{inf}= 102 cm TL; K = 0.15 yr^{-1}; t_0= -0.05 yr. The length-to-weight coefficients used were a= 0.0232, b= 2.8455.
Statistical age slicing script developed by Scott et al. (2012) during EWG 11-12 has been used to transform the annual size distribution of the landings and MEDITS LFDs in age distributions in order to apply XSA model.
Commercial landings of black-bellied anglerfish are exclusively obtained by the trawl fleet. The source of commercial landings is the DCF.
Table 5.2.7.6.3.1 lists the input parameters to the XSA, namely landings, catch number 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.

Table 5.2.7.6.3.1. Black-bellied anglerfish in GSA 6. Input data to the XSA model.
Catch (t)

2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
422	526	648	619	524	562	747	1253	830	1048

Catch number at age matrix (thousands)

Age	2004	2005	2006	2007	2008	2009	2010
0	54.586	42.489	3.690	36.026	68.762	243.711	674.647
1	373.941	832.416	350.346	323.561	77.244	621.152	1088.036
2	384.915	604.030	409.785	386.238	429.540	231.539	1001.939
3	158.961	113.514	136.377	157.308	207.996	202.373	163.570
4	16.142	19.519	59.122	70.551	29.223	70.358	31.477
5	13.588	6.218	22.175	34.693	12.902	27.629	18.763
6	4.951	3.881	19.128	10.577	14.879	10.194	7.793
7	0.803	0.459	23.370	4.714	9.646	5.976	2.002
8+	0.005	0.024	0.001	0.018	0.005	0.004	0.001

Age	2011	2012	2013
0	123.537	180.226	38.017
1	609.753	957.011	910.026
2	2047.946	1435.626	1649.612
3	259.436	132.286	222.722
4	58.680	17.561	7.793
5	39.492	9.491	7.285
6	16.451	4.853	8.037
7	0.000	1.506	0.003
8+	1.084	0.006	4.828

Weight at age (kg)

Age	2004	2005	2006	2007	2008	2009	2010
0	0.0122	0.0217	0.0170	0.0069	0.0096	0.0198	0.0224
1	0.1389	0.1287	0.1224	0.1740	0.1318	0.0893	0.0998
2	0.4038	0.4056	0.3978	0.3984	0.4191	0.4397	0.3490
3	0.8415	1.0161	0.9966	0.9904	0.8279	0.9017	0.8795
4	1.8828	1.4855	1.6055	1.7525	1.3187	1.5473	1.7218
5	2.4638	2.4779	2.2840	2.2699	2.7871	2.1313	2.4504
6	2.6292	2.8551	3.5043	2.9416	3.2259	2.5861	2.8241
7	3.9839	3.9839	3.9839	3.9839	3.9839	3.9839	3.9839
8+	4.7814	4.7814	4.7814	4.7814	4.7814	4.7814	4.7814

Age	2011	2012	2013
0	0.0240	0.0241	0.0374
1	0.1462	0.0657	0.1627
2	0.3414	0.3956	0.3828
3	0.8577	0.9033	0.8331
4	1.6718	1.6766	1.4434
5	2.3230	2.6035	2.7827
6	2.7026	3.2169	3.3555
7	3.9839	3.9839	3.9839
8+	4.7814	4.7814	4.7814

Maturity and natural mortality vectors

Age	0	1	2	3	4	5	6	7	8+
Maturity	0.09	0.14	0.21	0.3	0.41	0.54	0.66	0.91	1
M	1.08	0.48	0.37	0.32	0.29	0.27	0.26	0.25	0.24

MEDITS number at age

Age	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	109.571	27.117	14.459	63.865	367.489	483.817	22.409	73.571	126.552
1	377.253	125.632	105.780	19.952	1035.547	767.713	1021.592	594.426	516.492
2	149.041	294.083	247.028	210.448	221.495	219.943	218.389	364.902	511.664

3	47.419	20.128	108.497	89.594	66.754	39.019	19.583	19.902	30.655
4	6.506	13.892	41.939	39.629	13.680	22.369	4.589	4.854	9.838
5	5.284	6.145	18.145	2.791	9.407	3.865	0.866	4.022	0.989

5.2.7.6.4 *Results*

Sensitivity analyses were conducted to assess the effect of the main parameters, i.e. shrnkage (fse) and age above which q is independent from age (qage). Values ranging from 0.5 to 3 (0.5 increasing) for the shrinkage and from 2 to 4 for the qage parameter have been tested. Comparison of trends between the settings has been done. Different combinations between the set of settings that looked more stable were tested.

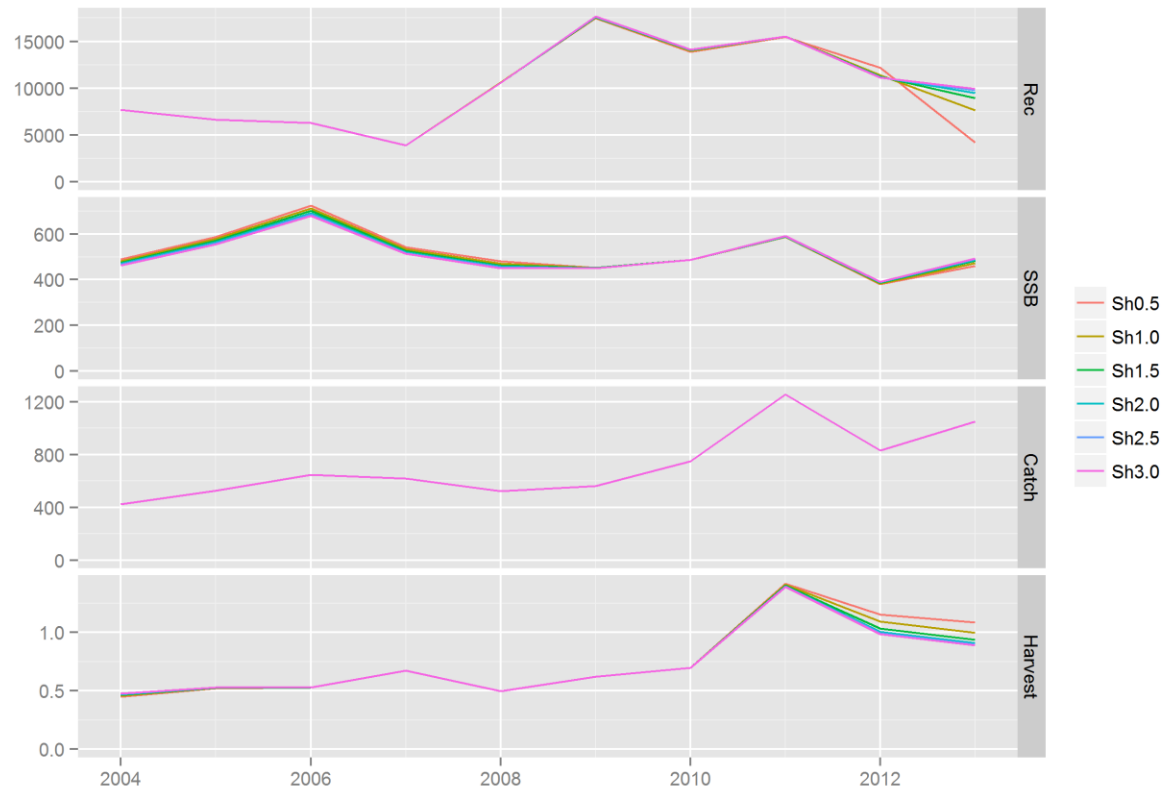


Figure 5.2.7.6.4.1. Black bellied anglerfish in GSA 6. Sensitivity on shrinkage weight. SSB and catch are in tons, recruitment in 1000s individuals.

As a result, the settings that minimized the residuals and showed the best diagnostics output were used for the final assessment, and are the following:

Fbar	fse	rage	qage	shk.yrs	shk.age
1-4	2	2	3	3	3

The residuals pattern of the MEDITS trawl survey is shown in Figure 5.2.7.6.4.2.

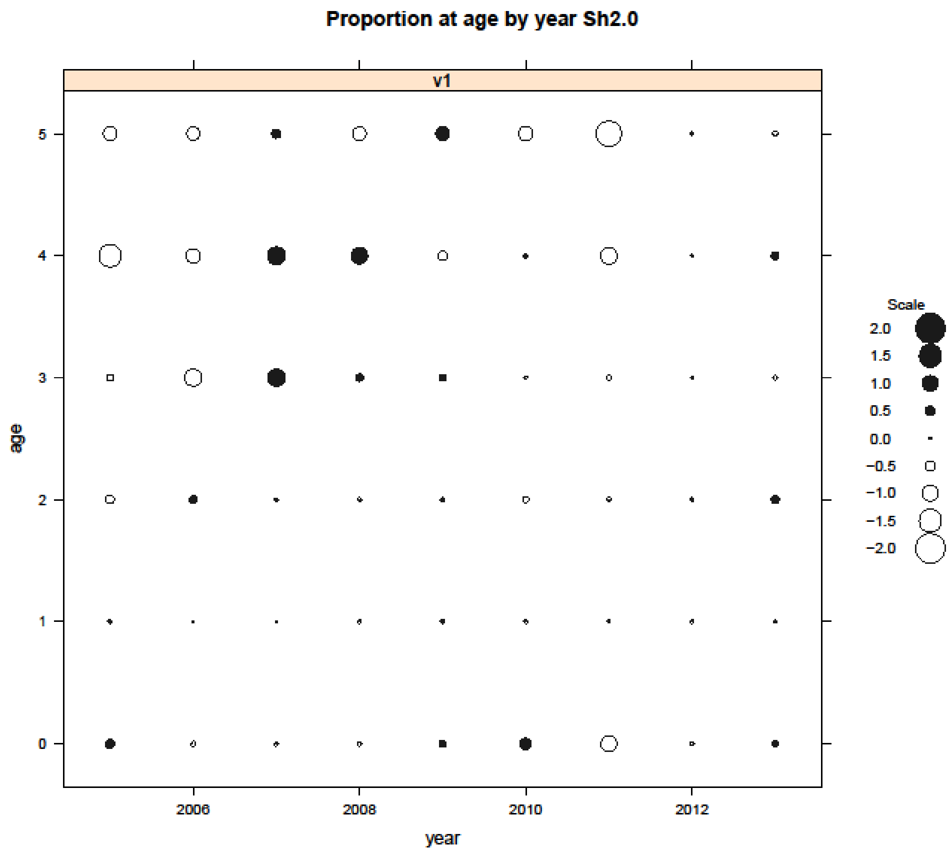


Figure 5.2.7.6.4.2. Black-bellied anglerfish in GSA 6. XSA residuals for the MEDITS survey from 2005 to 2013.

The results of the retrospective analysis are shown in Figure 5.2.7.6.4.3

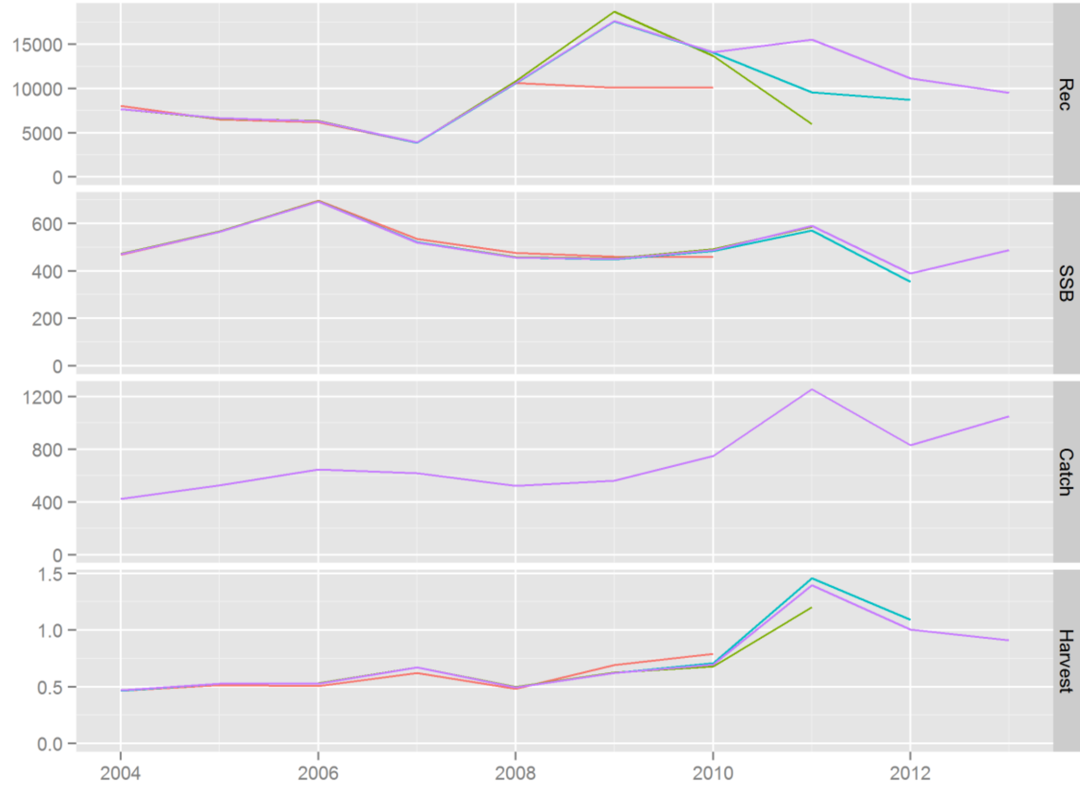


Figure 5.2.7.6.4.3. Black-bellied anglerfish in GSA 6. XSA retrospective analysis. SSB and catch are in tons, recruitment in 1000s individuals.

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

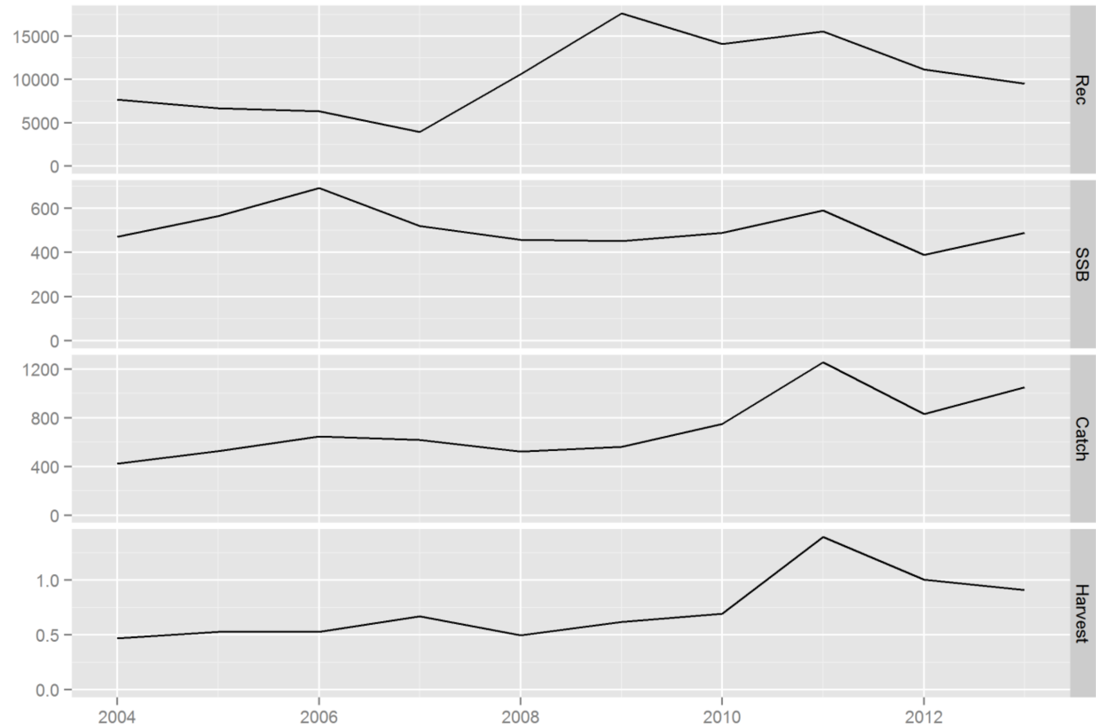


Figure 5.2.7.6.4.4. Black-bellied anglerfish in GSA 6. XSA results. SSB and catch are in tons, recruitment in 1000s individuals.

In the tables 5.2.7.6.4.1 and 2 the population estimates of *Lophius budegassa* obtained by XSA are provided.

Table 5.2.7.6.4.1. Black-bellied anglerfish in GSA 6. Stock numbers at age (thousands) as estimated by XSA.

Age	2004	2005	2006	2007	2008	2009	2010
0	7696.900	6671.700	6323.500	3932.700	10614.000	17624.000	14104.000
1	2433.000	2582.000	2240.900	2145.300	1314.500	3564.600	5843.000
2	999.150	1211.400	942.900	1111.000	1072.900	752.650	1717.100
3	341.960	370.250	334.710	310.720	446.430	384.120	327.450
4	85.888	112.860	172.120	126.840	91.581	146.930	106.480
5	111.220	50.304	67.561	77.652	33.880	43.248	49.084
6	10.580	73.030	32.969	32.200	28.966	14.591	8.875
7	2.823	3.810	52.901	8.624	15.540	9.269	2.299
8+	0.016	0.194	0.003	0.032	0.008	0.006	0.001

Age	2011	2012	2013
0	15542.000	11169.000	9506.700
1	4396.500	5206.100	3688.000
2	2759.600	2240.800	2468.600
3	353.320	204.130	354.650
4	98.392	35.489	35.500
5	52.447	22.864	11.364
6	21.076	5.532	9.161
7	0.000	1.805	0.004
8+	1.413	0.007	5.464

Table 5.2.7.6.4.2. Black-bellied anglerfish in GSA 6. XSA summary results.

	Fbar1-4	Recruitment (thousands)	SSB (t)	TB (t)
2004	0.47	7696.90	469.78	1598.10
2005	0.53	6671.70	563.96	1861.30
2006	0.53	6323.50	691.57	1847.20
2007	0.67	3932.70	520.23	1678.60
2008	0.50	10614.50	457.32	1465.40
2009	0.62	17623.90	450.88	1738.70
2010	0.70	14103.90	487.32	2124.20
2011	1.39	15542.20	589.94	2611.40
2012	1.00	11169.10	388.49	1826.60
2013	0.91	9506.70	487.60	2335.80

	F at age								
	0	1	2	3	4	5	6	7	8
2004	0.01	0.22	0.62	0.79	0.24	0.15	0.76	0.39	0.39

2005	0.01	0.53	0.92	0.45	0.22	0.15	0.06	0.15	0.15
2006	0.00	0.22	0.74	0.65	0.51	0.47	1.08	0.69	0.69
2007	0.02	0.21	0.54	0.90	1.03	0.72	0.47	0.97	0.97
2008	0.01	0.08	0.66	0.79	0.46	0.57	0.88	1.22	1.22
2009	0.02	0.25	0.46	0.96	0.81	1.31	1.59	1.31	1.31
2010	0.09	0.27	1.21	0.88	0.42	0.58	11.66	4.30	4.30
2011	0.01	0.19	2.23	1.98	1.17	1.98	2.20	1.81	1.81
2012	0.03	0.27	1.47	1.43	0.85	0.64	7.01	2.90	2.90
2013	0.01	0.38	1.63	1.34	0.29	1.32	7.05	2.94	2.94

The XSA results summarized in Table 5.2.7.6.4.2 and in Figure 5.2.7.6.4.4 show a slight decreasing trend in recruitment from 2009 and in the fishing mortality from 2011, a fluctuation on SSB and an estimated F_{cur} of 0.91.

5.2.7.7 Long term prediction

5.2.7.7.1 *Justification*

The yield per recruit (YpR) analysis was run using the NOAA Yield per recruit software because using the FLBRP routine the $F_{0.1}$ resulted (0.08) was almost half compared to the one proposed during STECF 12-19 EWG 12-10 (0.15).

5.2.7.7.2 *Results*

YpR output curve is illustrated in the Figure 5.2.7.7.2.1 while in Table 5.2.7.7.2.1 the main results of the analysis are reported.

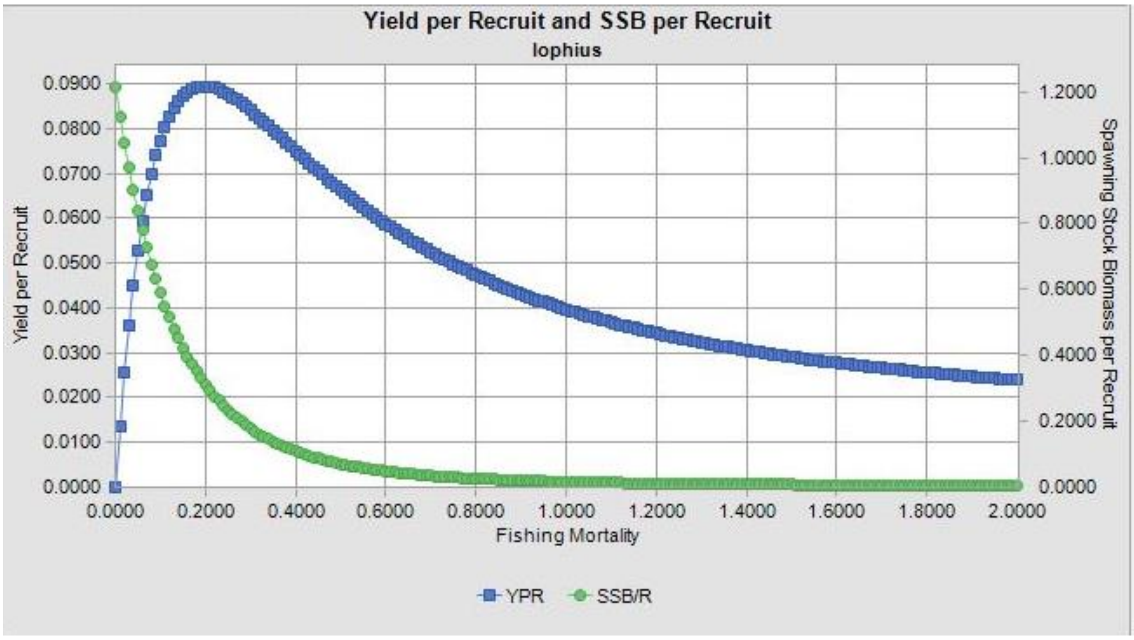


Figure 5.2.7.7.2.1. Black-bellied anglerfish in GSA 6. Yield per Recruit curve.

Table 5.2.7.7.2.1. Black-bellied anglerfish in GSA 6. Summary results of the Yield per Recruit analysis.

Reference Point	F	Yield per Recruit	SSB per Recruit	Total Biomass per Recruit	Mean Age	Mean Generation Time	Expected Spawnings
F Zero	0.00	0.00000	1.22	1.70	1.97	8.20	0.28
F0.1	0.14	0.08556	0.46	0.78	1.19	6.98	0.16
F Max	0.20	0.08942	0.32	0.59	1.00	6.49	0.13
F at 40% MSP	0.13	0.08428	0.49	0.81	1.22	7.05	0.16

5.2.7.8 Data quality

Data from DCF 2013 as submitted through the Official data call in 2014 were used. Fishing effort data should be checked. Values provided to EWG 14-19 were much higher than those submitted in previous meetings. As an example, see the number of OTB vessels in Table 5.2.7.8.1. When checked against the values reported by the autonomous governments of Catalonia, Valencia and Murcia (the zones included in GSA 6), the total number of vessels from these regions are similar to those reported in previous EWGs. For this reason, fishing effort data in the present report have been taken from the EWG 13-19 report.

Table 5.2.7.8.1. Number of OTB vessels by vessel length in GSA 6 in the period 2009-2013 according to the DCF. For comparison, the number of vessels in the EWG 13-19 report is given in the right column.

	VL0612	VL1218	VL1224	VL1824	VL2440	EWG 14-09	EWG 13-19
2009	21	141		451	230	**843**	**558**
2010	27		582		218	**827**	**546**
2011	27	136		393	200	**756**	**540**
2012	19	132		367	211	**729**	**540**
2013	19	127		362	205	**713**	

Discards data of 2008 to 2013 were available in catch but there are no length frequencies of these discards so they were not included in the assessment because Spain making use of the derogation in the Commission Regulation (EC) No 1581/2004 was not obliged to collect detailed data for the discarded species.
We excluded the year 2003 from the assessment because the length frequencies distribution of the landings data seems truncated.

5.2.7.9 Scientific advice

The current F (0.91) is larger than $F_{0.1}$ (0.14), chosen as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields, which indicates that black-bellied anglerfish in GSA 6 is exploited unsustainably.

5.2.7.10 Short term considerations

5.2.7.10.1 State of the stock size

The SSB is fluctuating along the series with an average of 510 t. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 14-19 is unable to evaluate the status of the stock spawning biomass in respect to these.

5.2.7.10.2 State of recruitment

The recruitment estimated for 2014 is 11800 thousand individuals, slightly higher compared to the series average (10300 thousand). However, recruitment may not be well estimated with the present assessment because the age 0 group (recruits) is not well represented in the commercial landings.

5.2.7.10.3 State of exploitation

The current F (0.91) is larger than $F_{0.1}$ (0.14), chosen as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields, which indicates that black-bellied anglerfish in GSA 6 is exploited unsustainably. The size composition of landings indicates that the exploitation is based on age classes 1-4.

5.2.7.11 Management recommendations

STECF EWG 14-19 advises the relevant fleets' effort 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.

5.2.8 STOCK ASSESSMENT OF ANCHOVY IN GSA 7

5.2.8.1 Stock Identification

The assessment covers the entire GSA 7 area corresponding to the Gulf of Lions. However, the Gulf of Lions may not correspond to a single stock unit. Hydrological exchanges between the Gulf of Lions and the Catalan Sea for instance are well known, which should at least affect larval transport (Ospina-Alvarez et al. 2013) and then recruitment of juvenile anchovy in both areas. Similarly, part of the young recruited in the Gulf of Lions anchovy population may come from larval transport from spawners of the Ligurian Sea. However, due to a lack of specific information about the stock structure of the anchovy population in the western Mediterranean, this stock was assumed to be confined within the GSA 7 boundaries in this assessment.

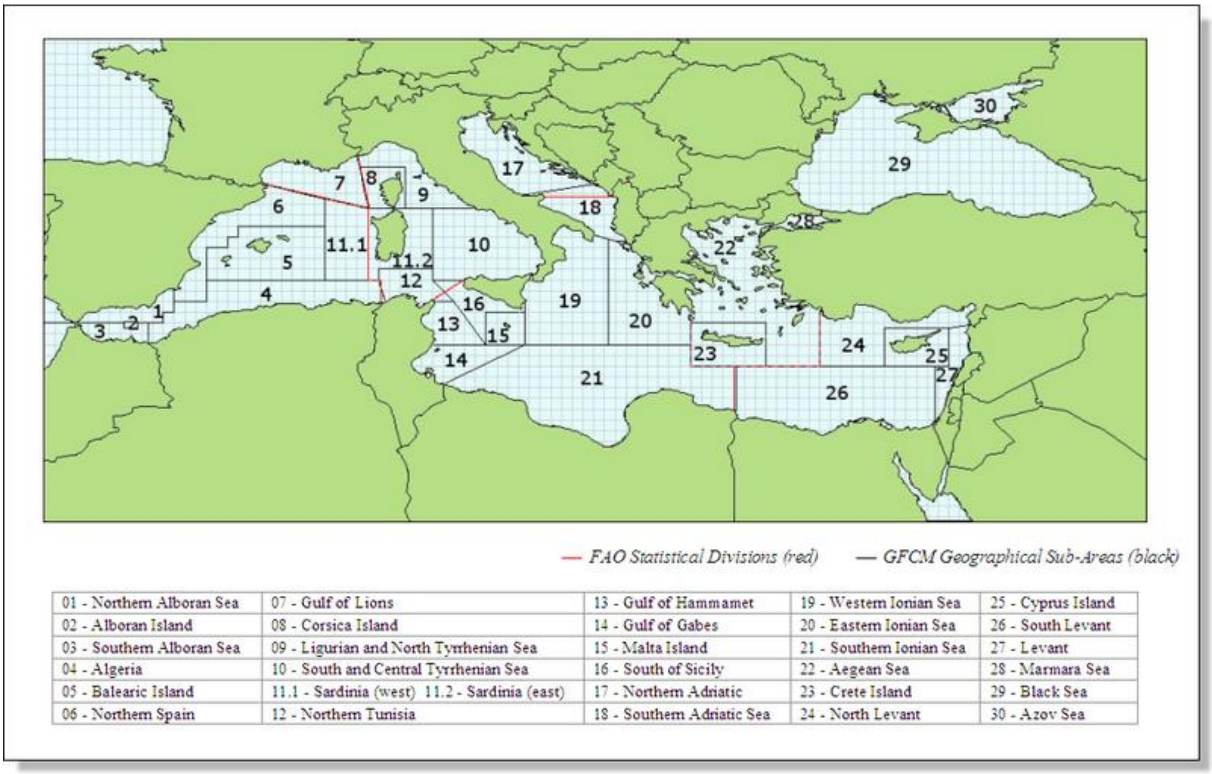


Fig. 5.2.8.1.1. Geographical location of GSA 7.

5.2.8.2 Growth

Growth parameters have been estimated from 6886 otolith readings. A recent analysis of these readings (Van Beveren et al. 2014) has shown the existence of different age-length keys in different time periods. The 2003-2013 period was thus divided into 2 periods: 1) 2006-2007 period of rapid growth and 2) 2003-2005 + 2008-2013 period of slow growth.

Table 5.2.8.2.1. Anchovy in GSA 7. Von Bertalanffy growth parameters.

Period	L_∞	K	t_0
2006-2007	16.397	0.877	-1.874
2003-2005 & 2008-2013	16.350	0.448	-0.994

5.2.8.3 Maturity

Maturity at age were estimated from maturity at size. Maturity at size was calculated as the ratio of mature fish in a size class over the total number of fish in that size class, considering samples from May, June and July. Maturity ogives displayed important changes across time and the decrease in size of anchovies that has occurred since 2008 (Van Beveren et al. 2014) resulted in a smaller size at first maturity. We thus used two different maturity ogives (before and after 2008) using a total of 9161 samples.

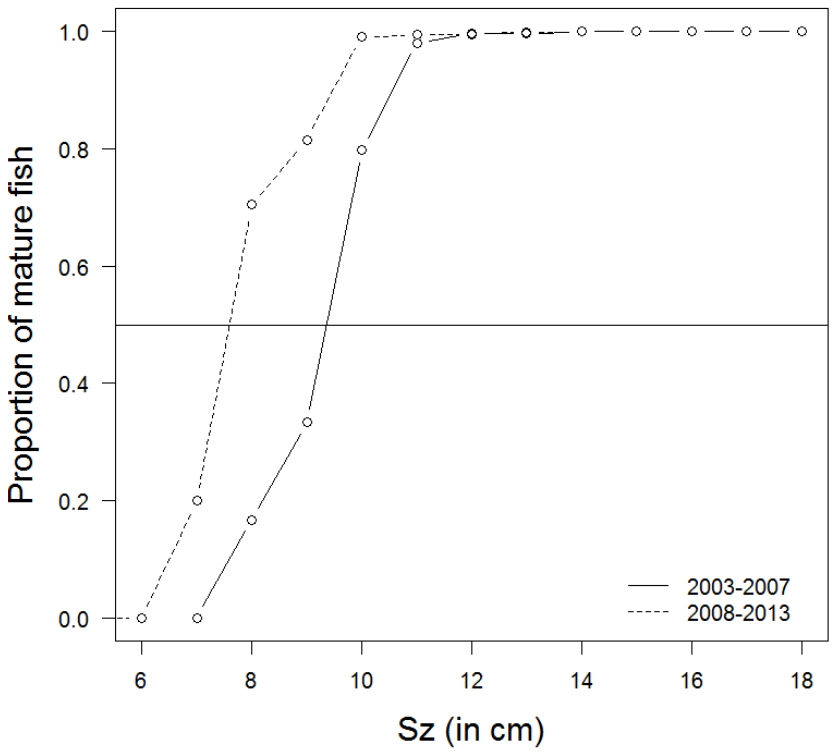


Figure 5.2.8.3.1. Anchovy in GSA 7. Maturity ogives per period.

The maturity by age was then estimated by combining maturity by size and the size structure of each age in the catches. We have to note that for age 0, only the largest individuals were fished (due to net selectivity) so that the size structure of age 0 is biased and the % of mature individuals in age 0 overestimated.

5.2.8.4 Fisheries

5.2.8.4.1 General description of the fisheries

The number of pelagic trawlers strongly decreased a few years ago. While 12 trawlers landed more than 1 t of anchovies each in 2013, only 1 targets small pelagics all year round, the others alternating between small pelagics and demersal species. As a consequence, the total catches remained low in 2013. They have been fluctuating around 2000 t for the last 5 years. Most regulations (no fishing activity during the week-end, length of trawlers, etc.) are fully respected, with the exeception of the limitation of engine power for trawlers.

5.2.8.4.2 Management regulations applicable in 2014

- Exclusive licence for trawling, with a given number each year (both for small pelagics and demersals) - fully respected
- Limited engine power for trawlers to 318 kW or 430 hp - not respected
- Length of fishing trawlers inferior to 25 meters - fully respected
- Fishing effort limitation :
    - No fishing on Saturdays and Sundays, authorised hours trip: 3.00am to 8.00pm - fully respected
    - Trawling forbidden from coast to 3NM - mostly respected
    - Professional organisation regulations: Additional holidays: on average 40 days/year - fully respected

Management plans per engine have also been established in the Gulf of Lions in 2014. Anchovies appear in both trawler and purse seine management plans. They are not targeted or landed by purse seines, so the main management rules concerns the trawler management plan. Objectives in terms of biomass are given in the management plan and have to be evaluated each year, affecting the number of licences delivered the following year or the number of days a trawler is allowed to fish.

5.2.8.4.3 Catches

Due to the absence of discard data in most years, catches are assumed to equal landings. In the few years, where discards are given in the dataset, the quantities were negligible.

5.2.8.4.4 *Landings*

Landings decreased sensibly since the 1990s.

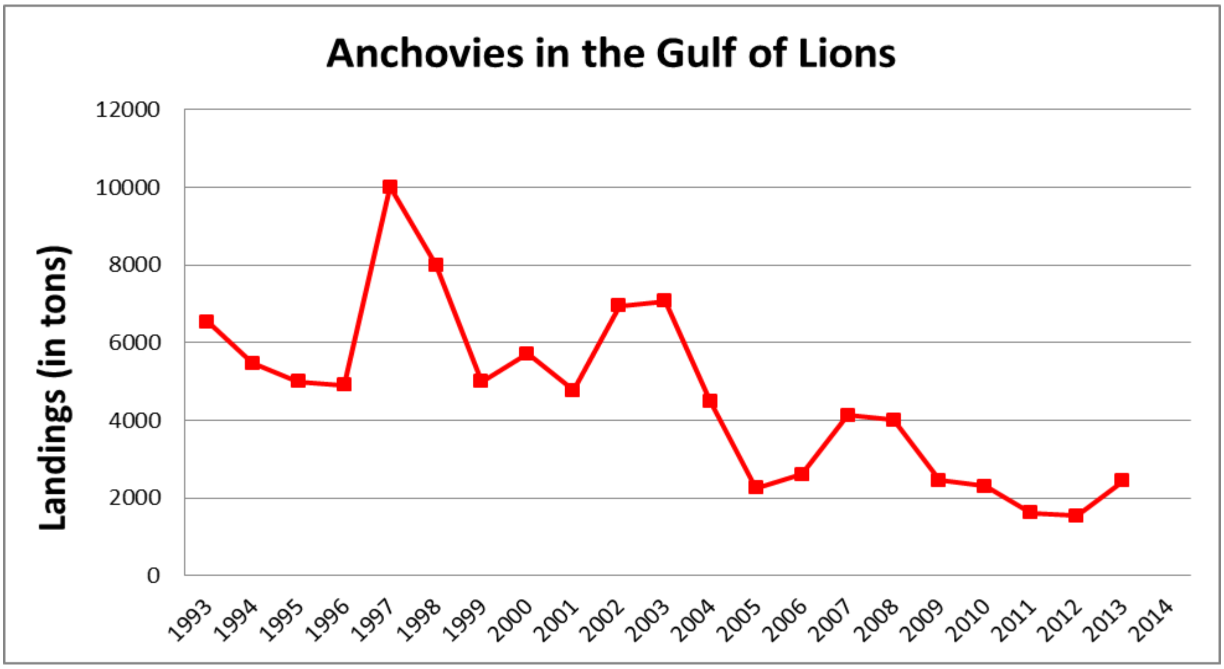


Figure 5.2.8.4.4.1. Anchovy in GSA 7. Landings from 1993 to 2013.

5.2.8.4.5 *Discards*

Discard data are not available and were considered as negligible in the stock assessment.

5.2.8.4.6 Fishing effort

Due to a decrease in stock biomass and market changes, the fishing effort has strongly decreased. The number of pelagic trawlers (OTM) decreased and only 1 is now focusing on small pelagics all year round. Most other OTM alternate between bottom trawling and pelagic trawling. However, the number of fishing days is not available to measure the fishing effort more precisely.

5.2.8.5 Scientific surveys

The scientific survey (PELMED) used is an acoustic and trawl-survey that has been conducted every July since 1993. It follows the Mediterranean Acoustic Survey (MEDIAS) protocol.

5.2.8.5.1 Methods

Sampling is performed along 9 parallel and regularly interspaced transects (inter-transect distance = 12 nautic miles, see map below). Acoustic data are obtained by means of echosounders (Simrad ER60) and recorded at constant speed of 8 nm.h-1. The size of the elementary distance sampling unit (EDSU) is 1 nautical mile. Discrimination between species is then done both by echo trace classification and trawls output (Simmons & MacLennan 2005). Indeed, each time a fish trace is observed for at least 2 nm on the echogram, the boat turns around to conduct a 30 min-trawl at 4 nm.h-1 in order to evaluate the proportion of each species (by randomly sampling and sorting of the catch before counting and weighing each individual species). While all frequencies are visualized during sampling and help deciding when to conduct a trawl, only the energies from the 38kHz channel are used to estimate fish biomass. Acoustic data are preliminarily treated with Movies + software in order to perform bottom corrections and to attribute to each echotrace one of the 5 different echotypes previously defined. Acoustic data analyses (stock estimation, length-weight relationships, etc.) are later performed using R scripts.

The biomass estimation then relies on trawl allocation. Two different methods have been tested and 2 trawl allocations to echotraces have also been tested. The two methodologies only differed on the use of mean size and weight per species per trawl vs. the use of the whole size distribution estimated per trawl. Trawl allocation has been done in two different ways: 1) closest trawl allocation, where each echotrace is attributed the closest trawl under the condition that the trawl is in the correct stratum (surface vs pelagic), 2) expert allocations. In allocation 2, each echotrace was allocated a trawl according to the form and intensity of the echotrace. This also enables to put more importance on depth strata than the closest trawl allocation. Indeed, depth has been shown to be an important factor of the spatial distribution of these species and of the size structuration (sardines are more coastal than anchovies and small individuals are also more coastal regardless of the species). The 2 allocations for bottom energy are then compared and used to estimate error around the estimate.

5.2.8.5.2 Geographical distribution

A recent study on spatial distribution of small pelagics in the Gulf has been published (Saraux et al. 2014). Below are the maps for anchovies from this publication.

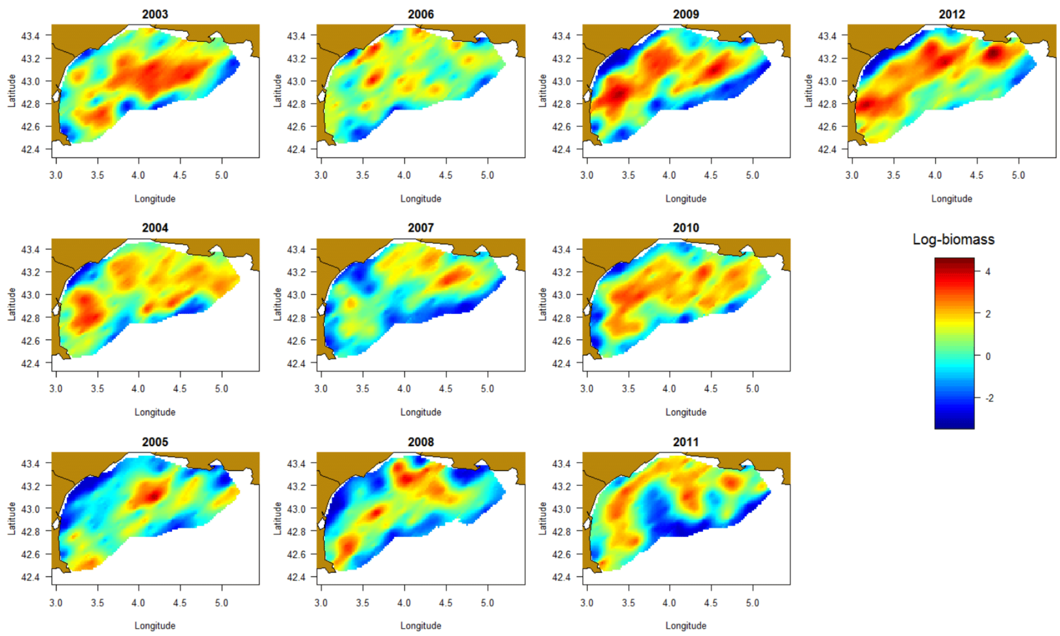


Figure S3. Annual maps of log-biomass for anchovies.

Figure 5.2.8.5.2.1. Spatial distribution of anchovies from acoustic survey (from Saraux et al. 2014)

5.2.8.5.3 Trends in abundance and biomass

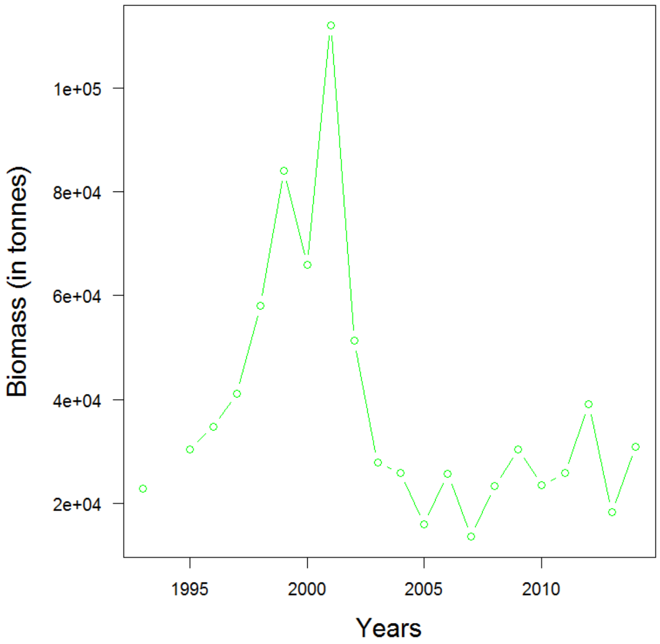


Figure 5.2.8.5.3.1. Anchovy in GSA 7. Biomass index estimated by direct acoustic method from PELMED survey

The biomass estimated by PELMED survey has shown a strong decrease before 2003 and has been more or less stable around low values between 2003 and 2014.

5.2.8.5.4 Trends in abundance by length or age

A recent study worked on length and age composition of small pelagics in the Gulf of Lions from the acoustic survey (Van Beveren et al. 2014).

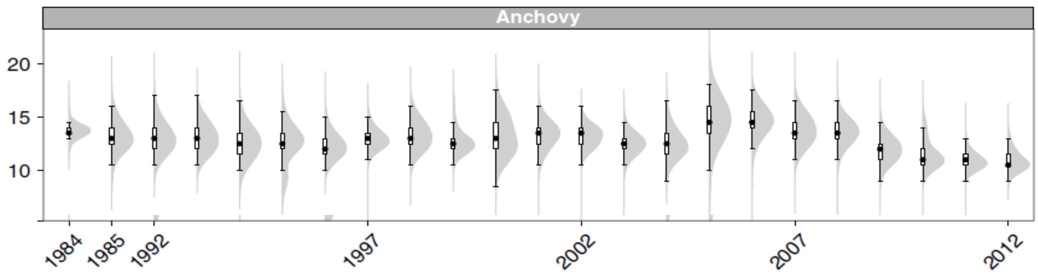


Figure 5.2.8.5.4.1. Anchovy in GSA 7.Length composition (Van Beveren et al. 2014).

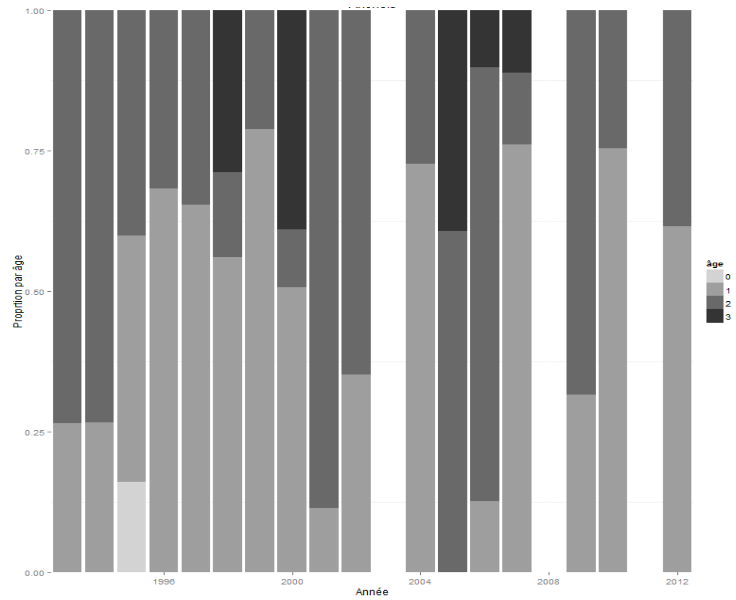


Figure 5.2.8.5.4.2. Anchovy in GSA 7. Age composition obtained by Bayesian decomposition (Van Beveren et al. 2014).

5.2.8.5.5 Trends in growth

Growth rate was really high during 2006-2007 , but it is quite slow again in recent years (see 5.2.8.2).

5.2.8.5.6 Trends in maturity

Since 2008, the size at first maturity has decreased (see above in 5.2.8.3).

5.2.8.6 Assessment of historic stock parameters

5.2.8.6.1 *Methods*

Different catch at age models were performed over the period 2003-2013, when ge structure was available. We first used simple XSA and then used a4a to test for different models of F, q and the variance depending on year and age.
Finally, a surplus production model was tested on a longer time-series (1993-2013), as catches and acoustic biomass were available on that period.

5.2.8.6.2 *Justification*

The models were first run on 0 to 4+ ages and then on 0-3+, as the age 4 represented a very small portion of the population both in catches and survey. This did not improve the results. A further test was done removing age 0, as age 0 are also almost absent from survey and catch. This was not considered an optimal solution as a high proportion of age 0 is already mature and anyhow it did not improve the results.

5.2.8.6.3 Input parameters

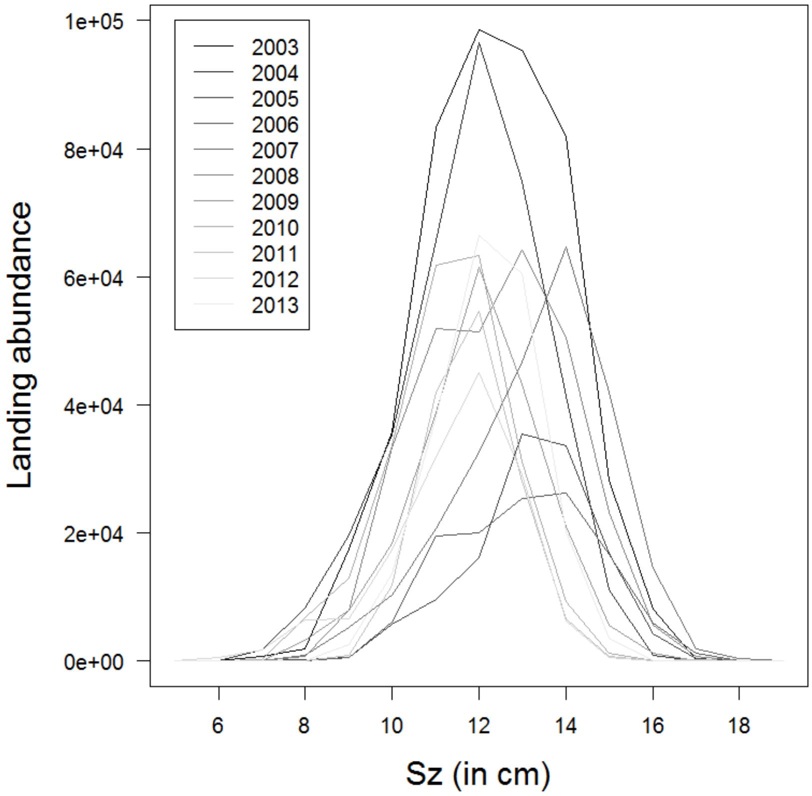


Figure 5.2.8.6.3.1. Anchovy in GSA 7. Length distribution of landings from 2003 to 2012.

Input data were the same for XSA and a4a (see tables below)

Table 5.2.8.6.3.1. Anchovy in GSA 7. Catch at age abundance (in thousands).

	0	1	2	3	4+
2003	17612.52134	240807.099	172846.2513	20173.68608	154.360992
2004	23624.95658	203506.5023	117096.5017	10821.88547	39.91685203
2005	1726.325423	50799.64396	60949.06796	8877.657516	86.47062507
2006	12839.50279	66323.61008	35292.21045	5930.383838	927.2786417
2007	23064.09882	129331.1963	70541.81777	14281.39072	2324.589623
2008	10667.16068	153549.3805	111294.2728	13620.70705	116.5412936
2009	10114.14248	116747.9105	67690.84966	5891.014285	26.38706241
2010	18061.02131	143760.5239	54982.13802	3156.076106	4.236686764
2011	4195.191602	93266.96032	44591.27298	2548.220131	2.288958239
2012	13669.17474	88656.53553	40379.63605	2467.8755	1.962187281
2013	4874.571018	117893.4883	75805.55872	6181.21807	10.66684731

Table 5.2.8.6.3.2. Anchovy in GSA 7. Mean weight at age in catches (in kg).

	0	1	2	3	4+
2003	0.007471	0.013320	0.018966	0.022356	0.029900
2004	0.005270	0.011245	0.015976	0.019612	0.027070
2005	0.009607	0.015723	0.020229	0.022336	0.028394
2006	0.012056	0.021213	0.023383	0.031483	0.033795
2007	0.007452	0.017020	0.019095	0.024540	0.026867
2008	0.006975	0.011561	0.016900	0.019787	0.025806
2009	0.005940	0.011016	0.014866	0.018134	0.025570
2010	0.005648	0.009891	0.013277	0.016771	0.024493
2011	0.007736	0.010444	0.012897	0.015806	0.023787
2012	0.004674	0.010154	0.013306	0.016024	0.024317
2013	0.007211	0.010796	0.013558	0.016022	0.022050

Table 5.2.8.6.3.3. Anchovy in GSA 7. Mean weight at age in survey (in kg).

	0	1	2	3	4+
2003	0.008338	0.010428	0.012042	0.014553	0.022999
2004	0.007369	0.010442	0.014157	0.018460	0.027118
2005	0.005916	0.017622	0.019896	0.020808	0.026320
2006	0.010661	0.017137	0.018664	0.023458	0.025453
2007	0.010172	0.017847	0.019813	0.022377	0.023839
2008	0.008682	0.012891	0.014703	0.016617	0.022629
2009	0.006985	0.009381	0.012110	0.015370	0.023558
2010	0.006649	0.008091	0.010099	0.013858	0.021693
2011	0.006069	0.007565	0.009831	0.012914	0.021161
2012	0.006218	0.007514	0.009517	0.013770	0.022735
2013	0.006041	0.006891	0.008377	0.013743	-

Table 5.2.8.6.3.4. Anchovy in GSA 7. Maturity at age.

	0	1	2	3	4+
2003	0.607419	0.935435	0.995326	0.999303	1
2004	0.460120	0.916471	0.993777	0.998944	1
2005	0.792786	0.972070	0.997629	0.999456	1
2006	0.904210	0.990234	0.994803	0.999837	1
2007	0.769638	0.990062	0.996381	0.999876	1
2008	0.696168	0.934837	0.994741	0.999327	1
2009	0.865591	0.986211	0.997554	0.999311	1
2010	0.852857	0.981909	0.996568	0.998895	1
2011	0.975993	0.993877	0.996825	0.998796	1
2012	0.732385	0.979107	0.996919	0.998850	1
2013	0.962090	0.993123	0.997650	0.999174	1

Table 5.2.8.6.3.5. Anchovy in GSA 7. Natural mortality at age (using Gislason 2010 method).

	0	1	2	3	4+
2003	1.152	0.847	0.691	0.623	0.530
2004	1.280	0.874	0.721	0.644	0.546
2005	1.015	0.764	0.651	0.610	0.532

2006	1.854	1.402	1.344	1.108	1.061
2007	2.013	1.348	1.282	1.106	1.056
2008	1.093	0.851	0.684	0.618	0.533
2009	1.206	0.860	0.725	0.646	0.535
2010	1.237	0.909	0.770	0.674	0.548
2011	0.996	0.854	0.763	0.681	0.546
2012	1.400	0.893	0.757	0.681	0.545
2013	1.020	0.829	0.728	0.662	0.555

Table 5.2.8.6.3.6. Anchovy in GSA 7. Natural mortality at age (from Lorenzen 1996).

	0	**1**	**2**	**3**	**4+**
2003	2.075	1.739	1.561	1.485	1.359
2004	2.250	1.785	1.604	1.507	1.365
2005	1.906	1.640	1.518	1.473	1.369
2006	1.883	1.585	1.538	1.405	1.375
2007	1.984	1.542	1.489	1.379	1.341
2008	2.031	1.741	1.551	1.478	1.363
2009	2.132	1.766	1.612	1.517	1.366
2010	2.171	1.830	1.673	1.558	1.388
2011	1.949	1.779	1.668	1.567	1.384
2012	2.285	1.804	1.661	1.569	1.382
2013	1.968	1.740	1.623	1.542	1.399

Gislasson mortality were estimated very low for age 0, therefore Lorenzen was used in the assessment.

Table 5.2.8.6.3.7. Anchovy in GSA 7. Tuning abundance at age (from PELMED).

	0	**1**	**2**	**3**	**4+**
2003	48624.28046	1642092.693	812063.1807	37827.03029	28.67011701
2004	76855.28801	1420776.017	682018.8868	48095.44982	255.1248907
2005	8694.239898	254983.0057	489591.3668	78973.37511	1234.338805
2006	51883.48729	844130.2291	447264.3014	83908.11755	12652.29576
2007	6353.427847	395316.3344	243804.7739	64462.48647	10944.10295
2008	8706.036886	761382.9036	818303.8419	88164.30026	304.5965017
2009	132925.1566	2057359.835	789913.4878	40624.12287	98.9216012
2010	190174.2595	2137835.666	474356.9531	11624.51603	4.463631048
2011	284492.2672	2516853.97	506906.9931	11985.46318	0.421159491
2012	570606.8856	4007842.061	556653.2831	7199.392218	1.044554555
2013	435130.368	2100826.814	149286.9085	618.2527784	0

5.2.8.6.4 *Results*

The present analysis is the first attempt of an age-structured assessment for anchovy in GSA 7. Catch at age was available from age 0 to age 4+. Sensitivity analyses were carried out to explore which parameter values for shrinkage, years shrinked, ages shrinked and age after which catchability is no longer estimated, were the most suitable. Models with different age classes were also tested (0-4+ / 0-3 / 1-3). None of them was judged satisfactory due to the instability of the retrospective analysis, as well as to the unrealistic recruitment results they produced. An example on ages 0-4+ and its final parametrisation (Lorenzen mortality, shrinkage = 4, shrink_years = 3, shrink_ages = 2, qage = 3) is shown below.

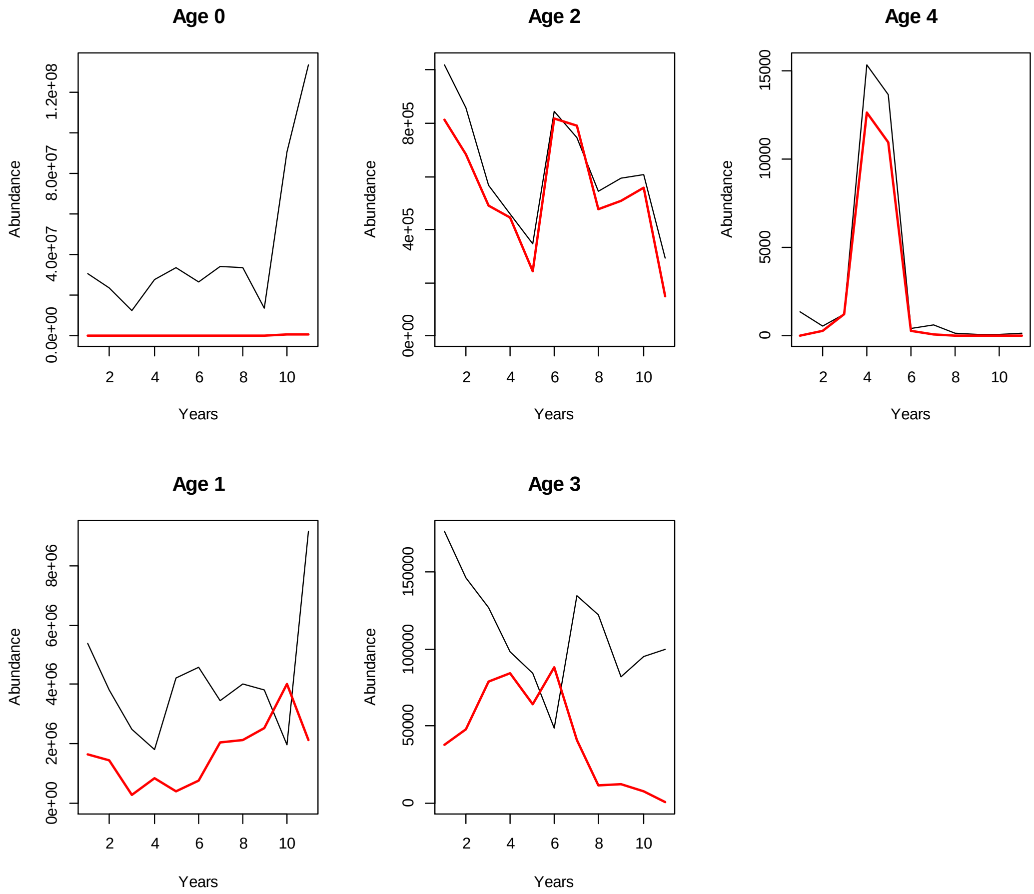


Figure 5.2.8.6.4.1. Anchovy in GSA 7. Comparison of XSA resulting abundance by age and tuning abundance at age.

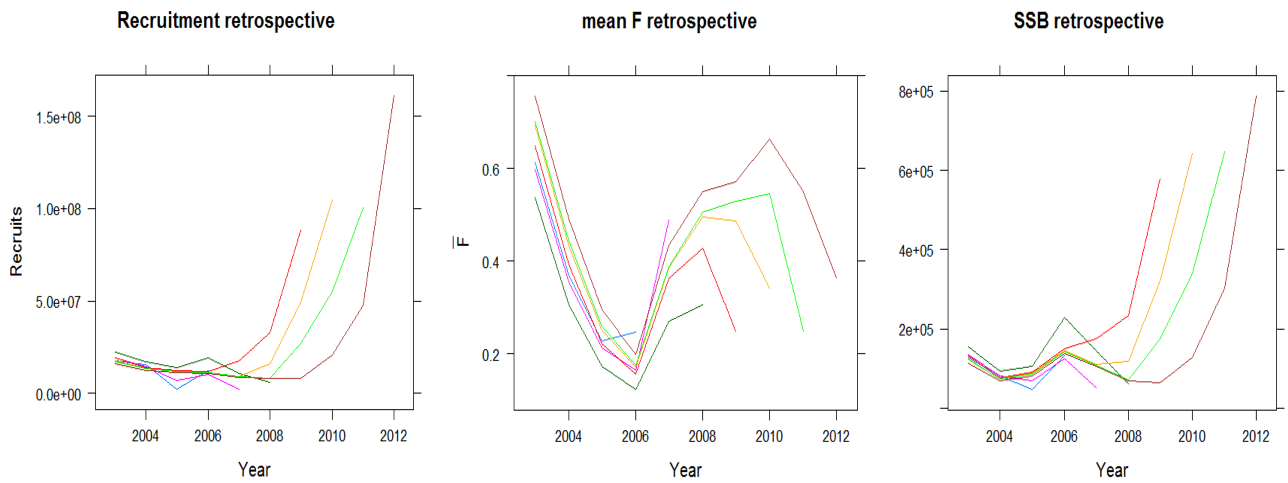


Figure 5.2.8.6.4.2. Anchovy in GSA 7. Retrospective analysis (year 2006-2013) for SSB, mean F and Recruitment.

Following this attempt, a combination of a4a models was performed (combination of different f, q and variance models in function of age and years resulting in 1792 models). The 5 best models (according to a combination of AIC, BIC and residuals) were examined more closely.

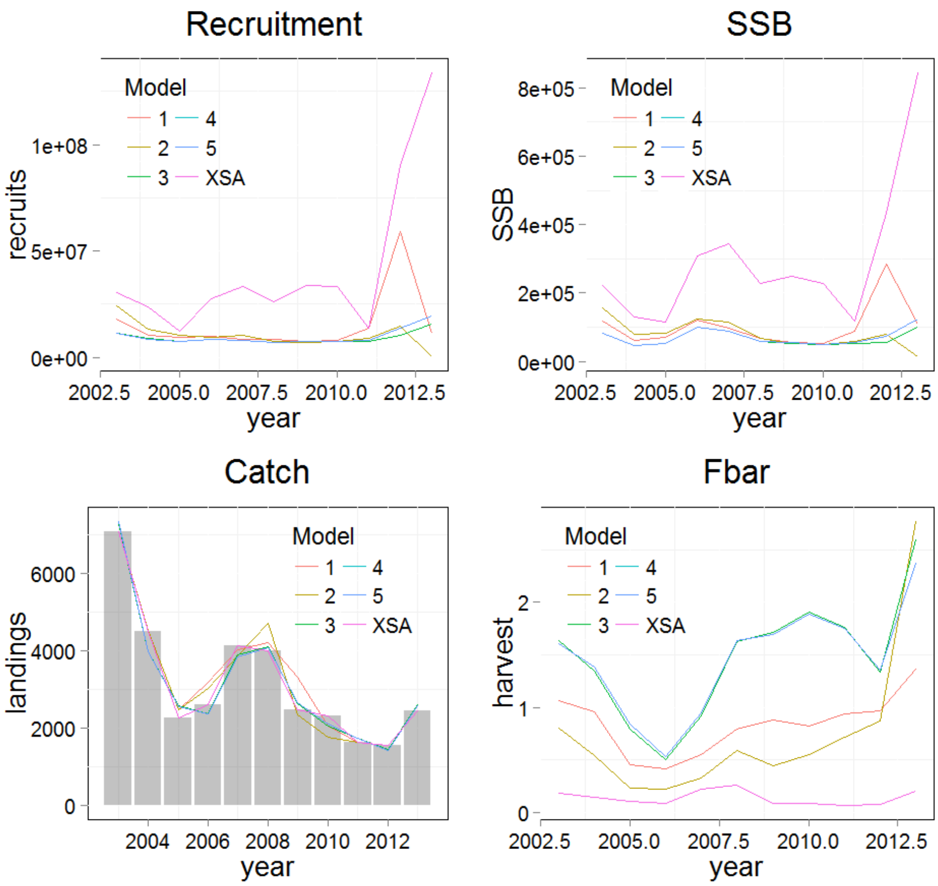


Figure 5.2.8.6.4.3. Anchovy in GSA 7. Comparison of XSA, 5 best a4a models for Recruitment, SSB, catch and Fbar.

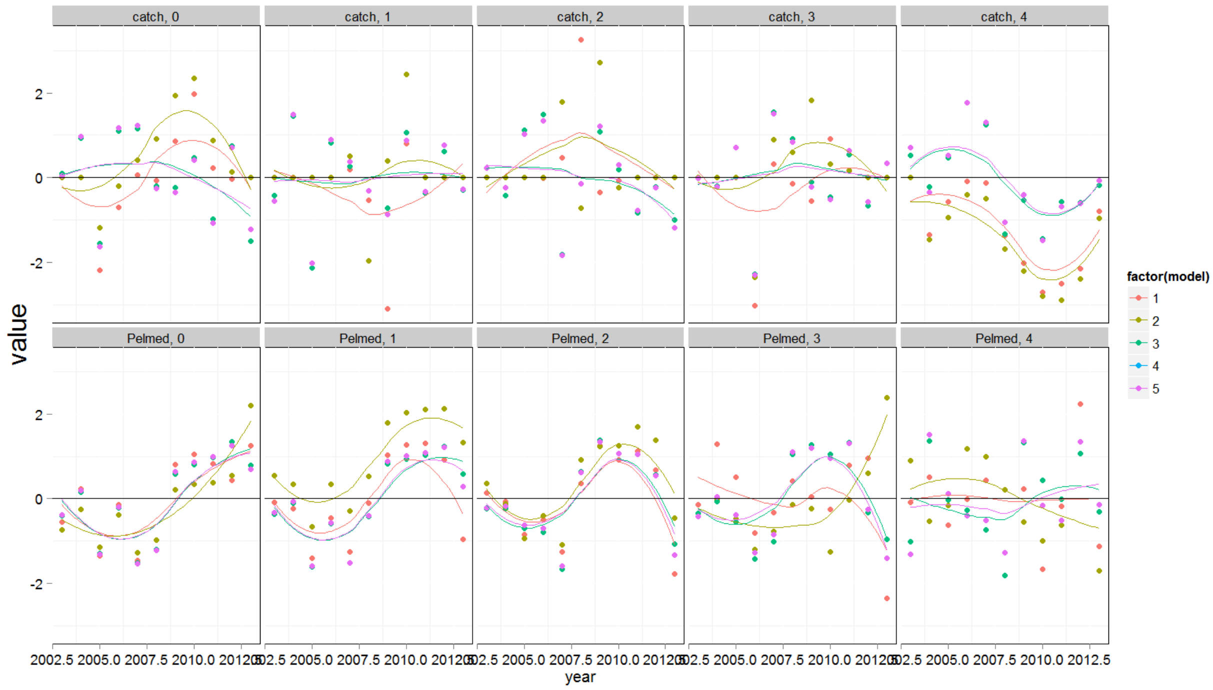


Figure 5.2.8.6.4.4. Anchovy in GSA 7. Residuals by age for catches and survey.

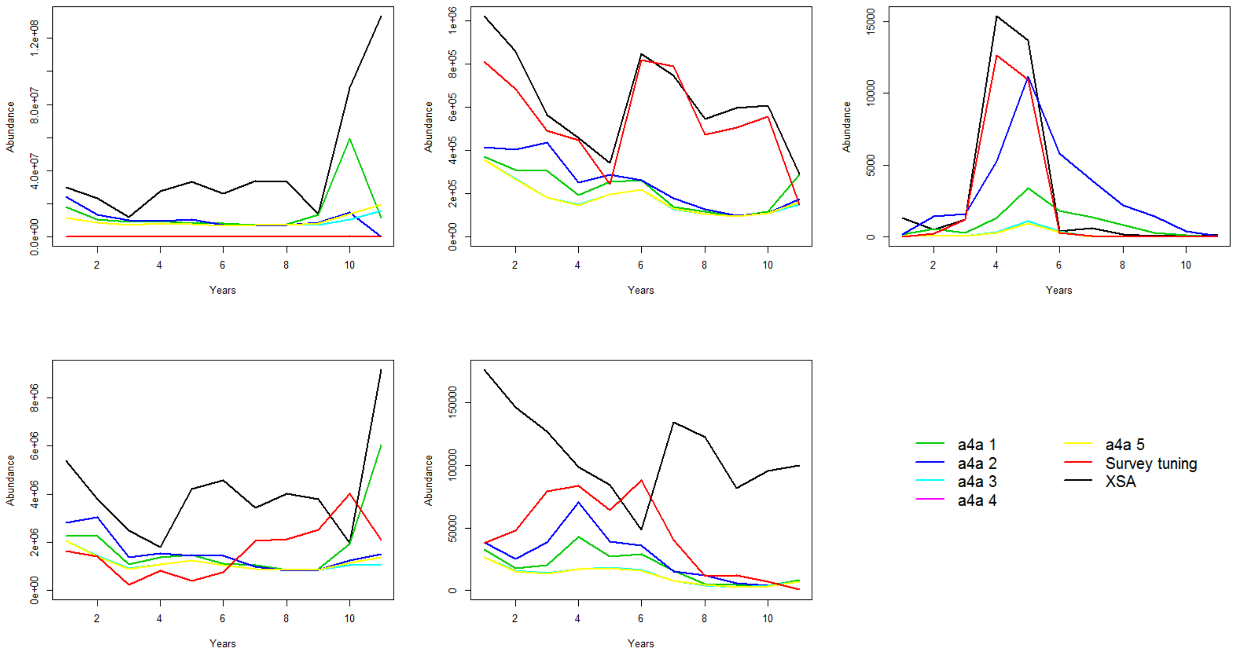


Figure 5.2.8.6.4.5. Anchovy in GSA 7. Comparison of abundance by ages (top panel: 0, 2, 4+; bottom panel: 1, 2) for XSA and the 5 best a4a models with abudance at age of the tuning index.

Though some of these models managed to avoid the explosion of recruitment at the end of the series, they all present serious problems such as tendency in residuals, poor fit and very high F on the 4+ age class. None of these models were accepted. And the EWG 14-19 group concluded that age structured models were not suitable to assess this stock.

A subsequent trial of surplus production model was run on the longer time series (1993-2013) using ASPIC. However, this necessitates a series of effort, which was considered as not very good. Further, trends in CPUE and acoustic biomass were quite different, so that the model could not reproduce the observed data and stayed mostly flat along the entire period. This model was thus considered not suitable.

No analytical assessments were accepted for this stock despite the trials of XSA, a4a and production models.

5.2.8.7 Long term prediction

5.2.8.7.1 *Justification*

No analytical assessment was accepted, thus no predictions were computed.

5.2.8.7.2 *Results*

5.2.8.8 Data quality

In order to compute the XSA or a4a, a lot of assumptions had to be made.

1 Age slicing: Age slicing of the tuning series and landings were done using age-length keys from the otolith readings. Because, a lot of otolith readings have been done in the last 2 years (in the framework of the EcoPelGol scientific project), including readings of otoliths sampled in old years, we decided to recompute age-length keys and redo the slicing. Also a recent study has shown important changes in age-length keys (Van Beveren et al. 2014). Therefore, two different age-length keys were used.

2 Mean weight of catches: Because revised age-slicing was used in this assessment, we re-estimated mean weight of the catches per age. As we had no access to original individual weights of fish sampled in landings, we used another biological dataset from IFREMER Sète combining samples from PELMED and MEDITS surveys as well as individual fish from fishermen to compute length-weight relationships.

3 Discards: Discard data were not reported consistently along the 2003-2013 period, so that the model was run without taking discards into account (i.e., catches = landings)

4 Natural mortality: Natural mortality was estimated from Gislason equation (2010) based on growth parameters. However, natural mortality at age 0 appeared rather low, so that a second natural mortality vector was produced using Lorenzen (1996). Both vectors were used as inputs to test for its effect on the assessment.

5 Effort: A time series (1993-2013) of effort had to be used for the surplus production model. However, this was not available from the DCF tables. Therefore, we used an estimation on the number of fishing days obtained from IFREMER. However, some discrepencies were detected and the confidence in this time series was low.

5.2.8.9 Scientific advice
No advice could be given on the present basis.

5.2.8.10 Short term considerations

No analytical assessment was accepted, so that no predictions were computed.

5.2.8.10.1 State of the stock size

5.2.8.10.2 State of recruitment

5.2.8.10.3 State of exploitation

5.2.8.11 Management recommendations

No management recommendations were produced.

5.2.9 STOCK ASSESSMENT OF SARDINE IN GSA 7

5.2.9.1 Stock Identification

GSA 7 area corresponds to the entire Gulf of Lions. However, the Gulf of Lions may not correspond to a single stock unit. Hydrological exchanges between the Gulf of Lions and the Catalan Sea for instance are well known, which might affect larval transport and then recruitment of juvenile sardine in both areas. Similarly, part of the young recruited in the Gulf of Lions (GSA 7) sardine population may come from larval transport from spawners of the Ligurian Sea (GSA 9). Yet, it should be noted that the spatial distribution of sardine in GSA 6 shows concentrations mostly in the Southern area, so that a large spatial gap would exist between Gulf of Lions and GSA 6 sardine distribution. This does not exclude exchanges between the two of course but reduces the possibility of a continuous population. However, due to a lack of specific information about the stock structure of the sardine population in the western Mediterranean, this stock was assumed to be confined within the GSA 07 boundaries in this assessment.

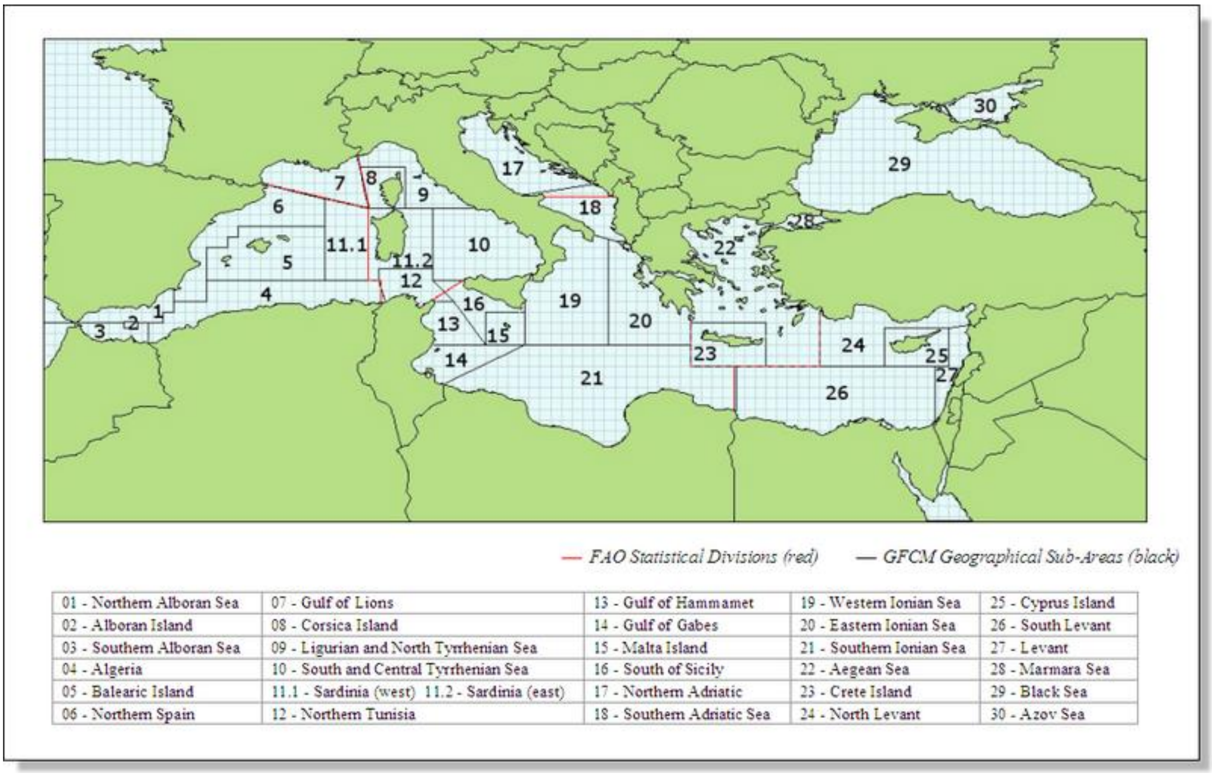


Fig. 5.2.9.1.1. Geographical location of GSA 7.

5.2.9.2 Growth

5.2.9.3 Maturity

5.2.9.4 Fisheries

5.2.9.4.1 General description of the fisheries

The present fishing pressure is very low, landings being lower than 1 000 t. Trawlers in 2013 landed slightly more sardines than last year, but purse seiners decreased their effort. 14

trawlers have landed more than 1T during the year. Yet, only one of these 14 trawlers seems to fish small pelagic fish all along the year (though anchovy is its main target), the 13 others alternate with demersal species as well and sardines appear mostly as by-catch for them. The landings of the purse seines are also very seasonal, one season offshore Marseille from January to May and one season of Port-Vendres in July-August. This activity is very opportunistic and none of these boats are focusing on sardines all throughout the year, the landings per boat vary between 1 and 100 t.

5.2.9.4.2 Management regulations applicable in 2014

- Exclusive licence for trawling, with a given number each year (both for small pelagics and demersals) - fully respected
- Limited engine power for trawlers to 318 kW or 430 hp - not respected
- Length of fishing trawlers inferior to 25 meters - fully respected
- Fishing effort limitation :
    - No fishing on Saturdays and Sundays, authorised hours trip: 3.00am to 8.00pm - fully respected
    - Trawling forbidden from coast to 3NM - mostly respected
    - Professional organisation regulations: Additional holidays: on average 40 days/year - fully respected

Management plans have also been established in the Gulf of Lions in 2014. Sardines appear in both trawler and purse seine management plans. Objectives in terms of biomass are given in the management plan and have to be evaluated each year, affecting the number of licences delivered the following year or the number of days a trawler is allowed to fish.

5.2.9.4.3 Catches

Due to the absence of discard data in most years, catches are assumed to be equal to landings. In the few years, where discards are given in the dataset, the quantities were estimated to negligible.

5.2.9.4.4 ***Landings***

Landings have decreased sensibly since the 1990s, almost collapsing in 2010.

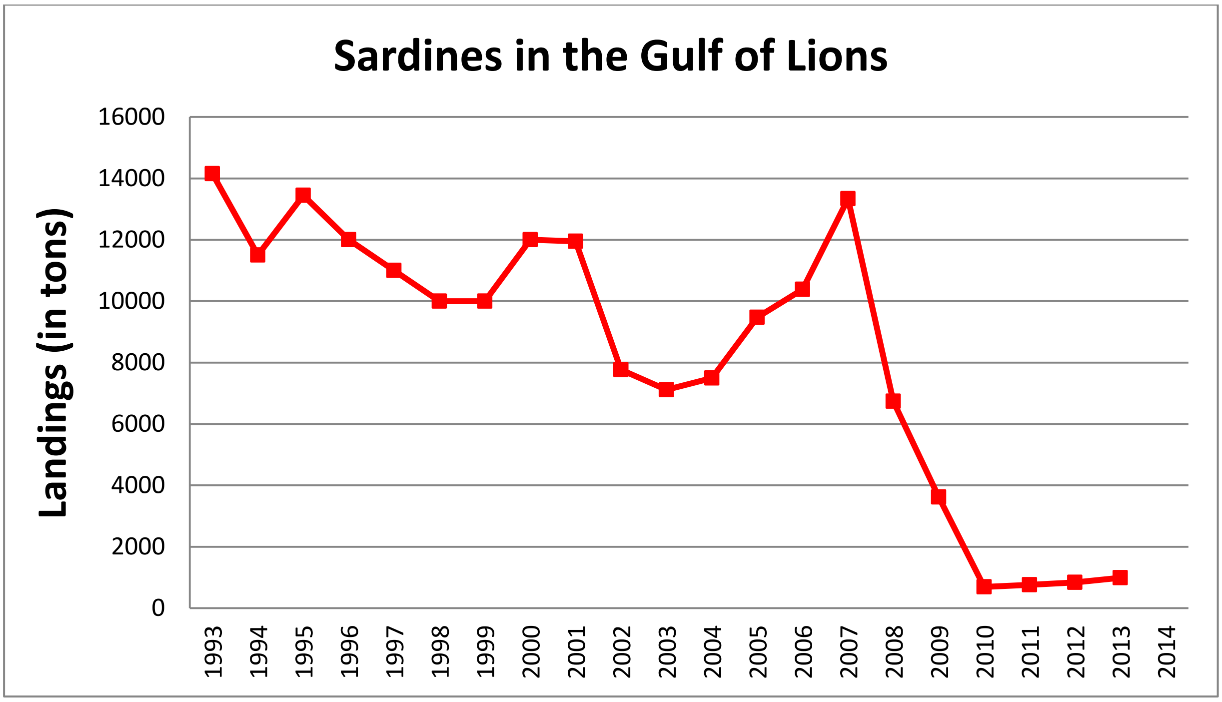


Figure 5.2.9.4.4.1. Sardine in GSA 7. Landings from 1993 to 2013.

5.2.9.4.5 *Discards*

Discard data are not available but were considered as negligible in the stock assessment.

5.2.9.4.6 Fishing effort

Due to a decrease in sardine average size, the fishing effort has strongly decreased. The number of pelagic trawlers (OTM) decreased and only 1 is now focusing on small pelagics all year round. Most other OTM alternate between bottom trawling and pelagic trawling. Purse seines have a very opportunistic sardine fishing behaviour and their effort is complicated to measure. The number of fishing days is not available as a measure of the fishing effort.

5.2.9.5 Scientific surveys

The scientific survey (PELMED) used is an acoustic and trawl-survey that has been conducted every July since 1993. It follows the Mediterranean Acoustic Survey (MEDIAS) protocol.

5.2.9.5.1 Methods

Sampling is performed along 9 parallel and regularly interspaced transects (inter-transect distance = 12 nautic miles, see map below). Acoustic data are obtained by means of echosounders (Simrad ER60) and recorded at constant speed of 8 nm.h^{-1}. The size of the elementary distance sampling unit (EDSU) is 1 nautical mile. Discrimination between species is then done both by echo trace classification and trawls output (Simmons & MacLennan 2005). Indeed, each time a fish trace is observed for at least 2 nm on the echogram, the boat turns around to conduct a 30 min-trawl at 4 nm.h^{-1} in order to evaluate the proportion of each species (by randomly sampling and sorting of the catch before counting and weighing each individual species). While all frequencies are visualized during sampling and help deciding when to conduct a trawl, only the energies from the 38kHz channel are used to estimate fish biomass. Acoustic data are preliminarily treated with Movies + software in order to perform bottom corrections and to attribute to each echotrace one of the 5 different echotypes previously defined. Acoustic data analyses (stock estimation, length-weight relationships, etc.) are later performed using R scripts.

The biomass estimation then relies on trawl allocation. Two different methods have been tested and 2 trawl allocations to echotraces have also been tested. The two methodologies only differed on the use of mean size and weight per species per trawl *vs.* the use of the whole size distribution estimated per trawl. Trawl allocation has been done in two different ways: 1) closest trawl allocation, where each echotrace is attributed the closest trawl under the condition that the trawl is in the correct stratum (surface vs pelagic), 2) expert allocations. In allocation 2, each echotrace was allocated a trawl according to the form and intensity of the echotrace. This also enables to put more importance on depth strata than the closest trawl allocation. Indeed, depth has been shown to be an important factor of the spatial distribution of these species and of the size structuration (sardines are more coastal than anchovies and small individuals are also more coastal regardless of the species). The 2 allocations for bottom energy are then compared and used to estimate error around the estimate.

5.2.9.5.2 Geographical distribution

A recent study on spatial distribution of small pelagics in the Gulf has been published (Saraux et al. 2014). Below are the maps for sardines from this publication.

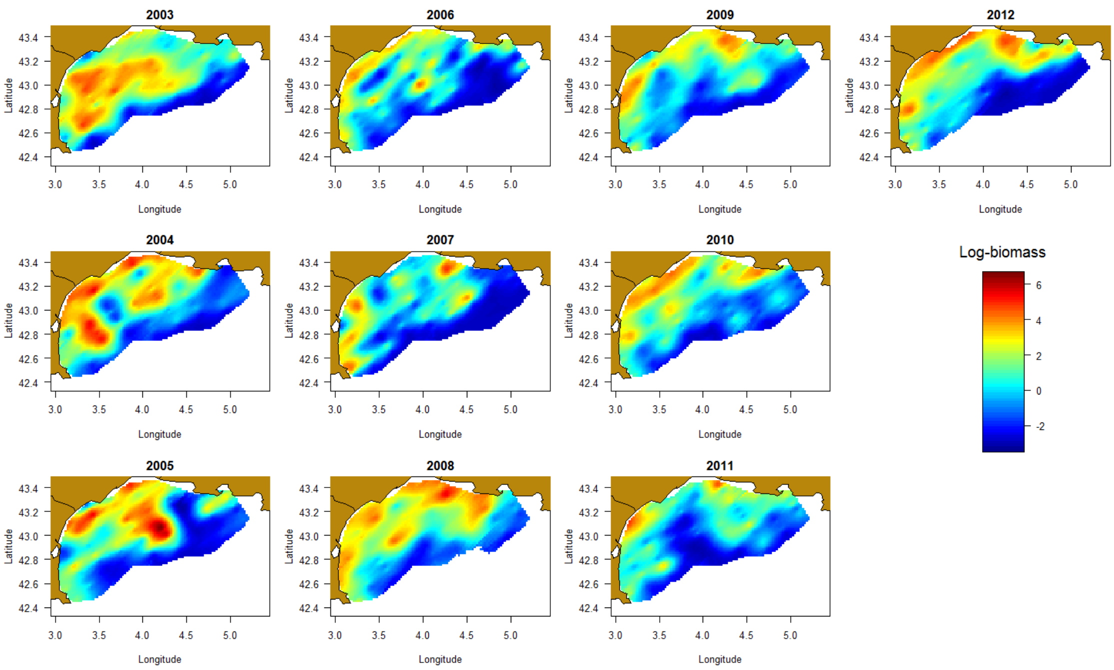


Figure 5.2.9.5.2.1. Sardine in GSA 7. Spatial distribution estimated from acoustic survey (Saraux et al. 2014).

5.2.9.5.3 Trends in abundance and biomass

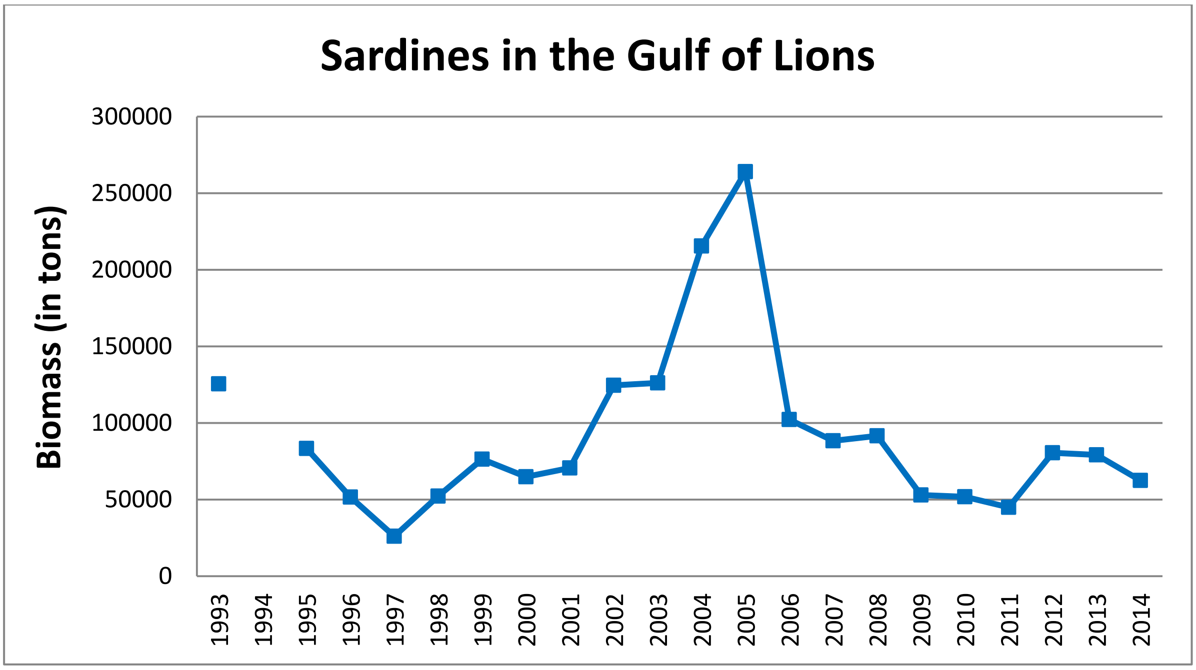


Figure 5.2.9.5.3.1. Sardine in GSA 7. Biomass index estimated by direct acoustic method from PELMED survey.

5.2.9.5.4 Trends in abundance by length or age

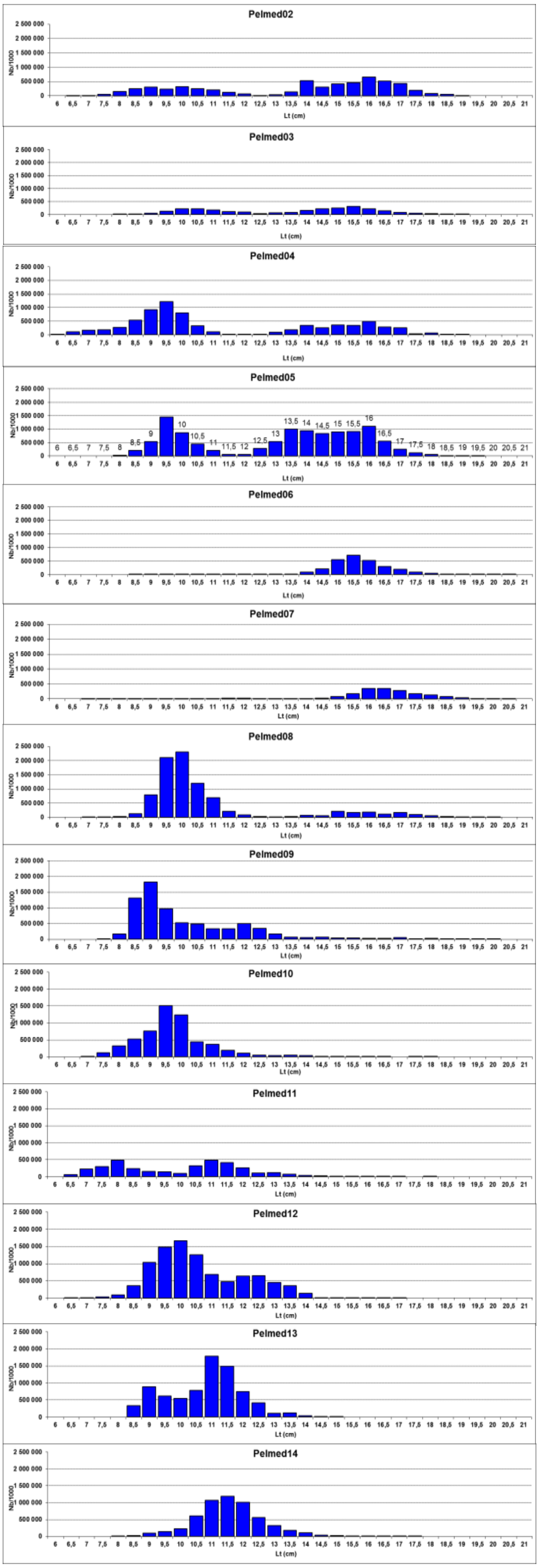


Figure 5.2.9.5.4.1. Sardine in GSA 7. Size distribution from PELMED survey.

5.2.9.5.5 Trends in growth

5.2.9.5.6 Trends in maturity

5.2.9.6 Assessment of historic stock parameters

5.2.9.6.1 *Methods*

The disappearance of old individuals during the last years might suggest a high adult mortality, which might violate the assumption that natural mortality is constant during the time period as landings are rather small. Therefore, the use of production model was not possible and no assessment was conducted on this stock. On the other hand, an alternative explanation would be changes in the spatial distribution of the large and old individuals, which moved out of the assessment area in recent years. A first visual analysis did not show any increase in the adult portion in GSA 6, while the large spatial gap between GSA 7 and the southern distribution of sardine in GSA 6 reduces the possibility of a continuous population. However, a more thorough sensitivity analysis would consist in conducting a joint assessment with the neighboring GSA as GSA 6 and/or GSA 9. Different stock assessment configurations should be tested and compared to refuse or confirm the hypothesis that the disappearance of large and old sardine is due to an increased natural mortality instead of a change in the spatial distribution of the adult portion of the stock. At this stage, the only information available is derived from the acoustic survey. In the last acoustic survey recruitment is estimated to be very small. The size distribution of sardines is usually bimodal during the PELMED survey in July. However, this year the first peak (between 8 and 10 cm) was practically absent. Similar observations were made on sprats for which the first peak was barely visible. This suggests poor environmental conditions for recruits of winter spawners species. Indeed, despite the decline in large and old individuals, recruitment has been large in the last years, preventing the population from collapse. This year, some large individuals were observed but still very few compared to a decade ago. Further, the body condition index is at a low level and the same is observed for anchovy. It is important to note that the uncertainty around the biomass estimation of 2014 might be higher than usual due to a reduced survey coverage, which was caused by very bad weather conditions. Finally, the fishing pressure is still extremely low with landings being lower than 1000 t.

5.2.9.6.2 *Justification*

5.2.9.6.3 Input parameters

5.2.9.6.4 Results

5.2.9.7 Long term prediction

5.2.9.7.1 *Justification*

5.2.9.7.2 *Results*

5.2.9.8 Data quality

5.2.9.9 Scientific advice

5.2.9.10 Short term considerations

5.2.9.10.1 State of the stock size

5.2.9.10.2 State of recruitment

5.2.9.10.3 State of exploitation

5.2.9.11 Management recommendations

5.2.10 STOCK ASSESSMENT OF SARDINE IN GSA 9

5.2.10.1 Stock Identification

Due to a lack of information about the stock structure of the sardine population in the western Mediterranean, this stock was assumed to be confined within the GSA 9 boundaries. Studies are needed on the biological stock identification of this species in the Mediterranean Sea.

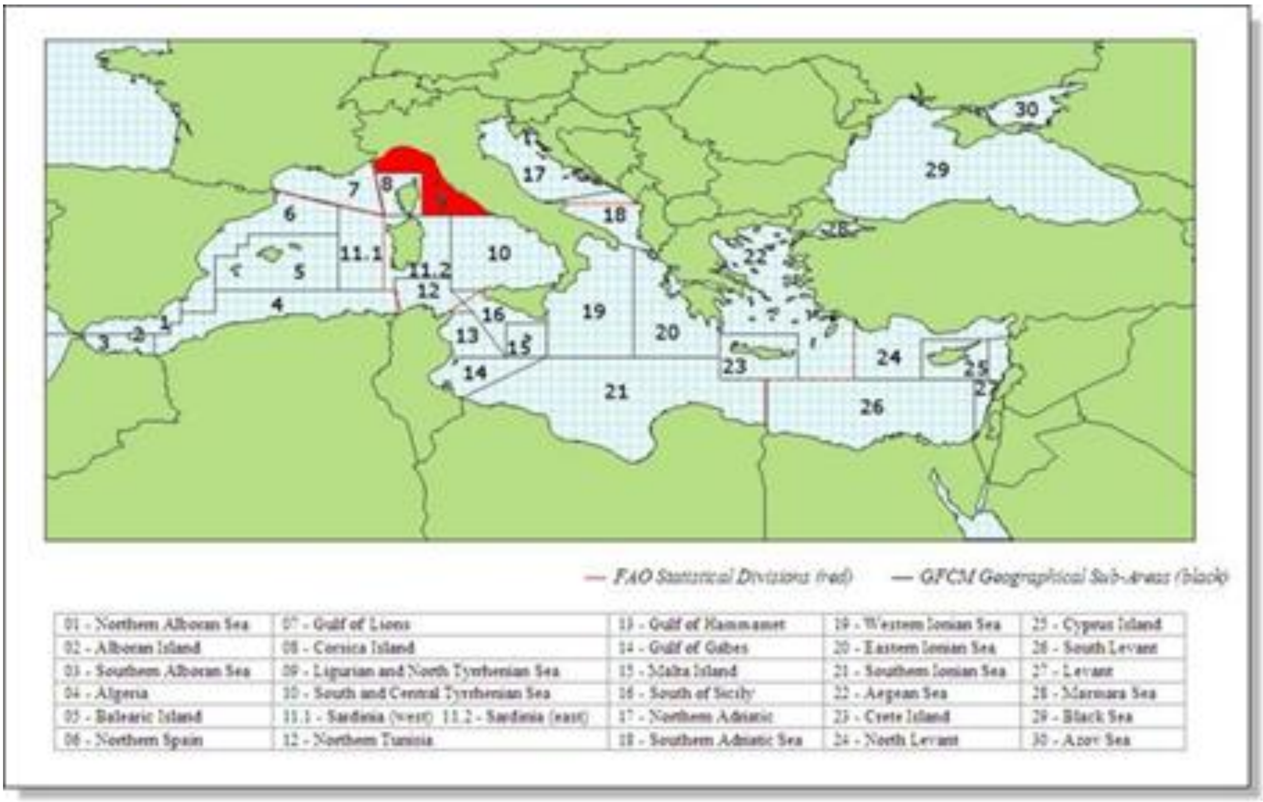


Figure 5.2.10.1.1. Geographical location of GSA 9 (Ligurian and North Tyrrhenian seas).

5.2.10.2 Growth

This species can reach the size of 25 cm TL, with a relatively short life cycle (8-12 years), although in the Mediterranean seems more plausible to a maximum age of 8 years (Sinovčić, 2000). This species has a very fast initial growth, reaching sexual maturity at the end of the first year of life (Sinovčić, 1984).

Growth parameters were estimated using data collected within the Data Collection Framework (DCF). The method applied was the von Bertalanffy equation fit to the age and growth data estimated using otoliths and using nonlinear estimation with minimum least squares. In Figure 5.2.10.2.1 is reported the growth function and the parameters adopted in the GSA 9 for the assessment.

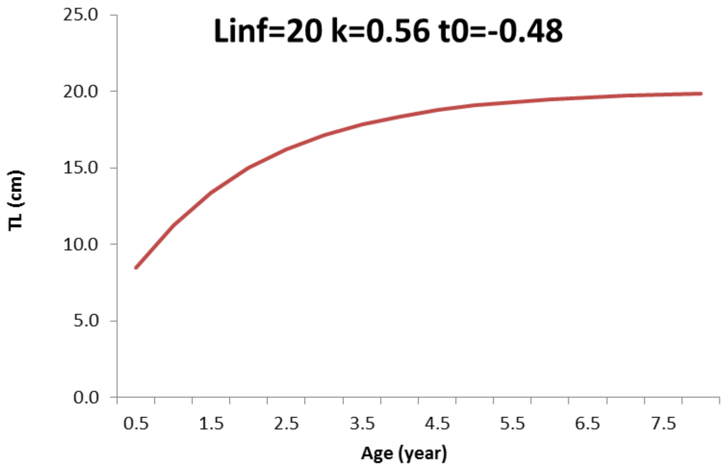


Figure 5.2.10.2.1. Sardine in GSA 9. Von Bertalanffy growth function.

VBGF set of growth parameters were different from those used in the previous assessment (EWG 13-19) since these new ones resulted more suitable to describe the actual sardine growth rate in the area.

5.2.10.3 Maturity

Sardines, as most of the Clupeidae, is a batch-spawner: females emit groups of pelagic eggs asynchronously, with different ovulations during the breeding season (autumn-winter) (Ganias et al., 2004). In the Mediterranean the breeding season is between October and April (Muzinić, 1954; 1984, Morello and Arneri 2009) and the size of first sexual maturity is 12.5 cm TL (MedSudMed, 2004). Reproduction occurs both in the open sea and close to shoreline, producing 50000-60000 eggs with a diameter of 1.5 mm. The larval (so called "bianchetto") and post larval forms are present in the period between January and March close to the coast. The hatching of eggs depends strongly on the temperature. In the peak of the breeding season each female lays from 11337 to 12667 eggs (Sinovčić, 1983).

5.2.10.4 Fisheries

5.2.10.4.1 General description of the fisheries

In the GSA 9, sardine is mainly exploited by purse seiners. Due to its low economic value, however, sardine does not represent the main target species for this fleet, while anchovy (*Engraulis encrasicolus*) is the most important species exploited by this fishery. The fishing season starts in spring (March) and ends in autumn (October). Favourable weather conditions and abundance in the catches can extend the fishing activity to the end of November. However, the maximum activity of the fleet is normally observed in the summer. Sardine is also a by-catch in the bottom trawl fisheries. However, the landings yielded by these metiers are very low (about 1%) in comparison to those by purse seiners. Pelagic trawling is not carried out in the GSA 9.

Tab. 5.2.10.4.1.1 Sardine in GSA 9. Contribution of the different gear (PS Purse Seine, OTB Otter Trawler, GNS Gillnet and GRT Trammel net) to the total landing in tonnes (2006-2013).

YEAR	GNS	GTR	PS	OTB	TOTAL	%GNS	%GTR	%PS	%OTB
2006	0.9	0.0	4344.2	43.3	4388.4	0.02	0.00	98.99	0.99
2007	0.1	0.0	5111.9	41.3	5153.3	0.00	0.00	99.20	0.80
2008	1.0	0.0	2288.1	34.9	2324.0	0.04	0.00	98.46	1.50
2009	0.5	0.0	5673.9	51.5	5725.9	0.01	0.00	99.09	0.90
2010	0.2	0.0	4475.7	30.9	4506.8	0.00	0.00	99.31	0.69
2011	0.0	0.5	2543.4	30.1	2574.0	0.00	0.02	98.81	1.17
2012	0.0	0.4	1705.2	29.2	1734.8	0.00	0.02	98.29	1.68
2013	0.0	0.0	1308.6	11.9	1320.5	0.00	0.00	99.10	0.90

5.2.10.4.2 Management regulations applicable in 2014

In Italy, the legal minimum size for sardine is 11 cm (Reg. (CE) 1967/2006), while 14 mm is the minimum mesh size allowed for purse seine and 40 mm squared or 50 mm diamond cod end mesh size for bottom trawl.

5.2.10.4.3 Catches

Purse seine mostly caught specimens belonging to age 1. The maximum size of the species as observed in the catch length frequency distributions collected was 18 cm of total length (TL). The age/length structures of the catches, according to the EU Data Collection Framework (DCF) data, are shown in Fig. 5.2.10.4.3.1 and 5.2.10.4.3.2.

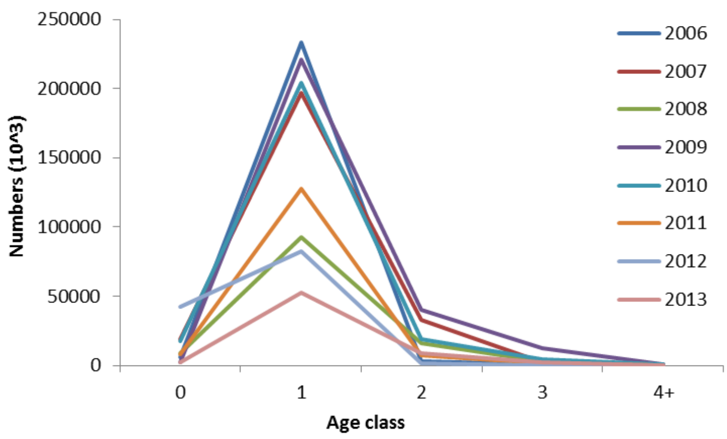


Fig. 5.2.10.4.3.1. Sardine in GSA 9. Age frequency distributions of sardine catches from 2006 to 2013.

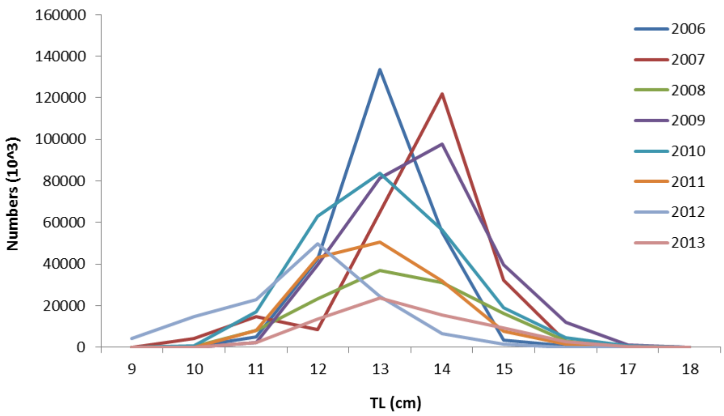


Fig. 5.2.10.4.3.2. Sardine in GSA 9. Length frequency distributions of catches from 2006 to 2013.

5.2.10.4.4 *Landings*

Sardine landing showed large variation in the study period with a maximum in the 2009 with about 5700 tons and a minimum in the last year of about 1300 tons. Generally, landings of the trawlers were very low with a maximum of about 50 tons in 2009 and landings of the set nets were absolutely negligible (about 1 tons at maximum) (table 5.2.10.4.4.1 and figure 5.2.10.4.4.1).

Table 5.2.10.4.4.1. Sardine in GSA 9. Sardine annual landings (t) by fishery (data source: DCR and DCF)

COUNTRY	AREA	YEAR	GEAR	FISHERY	SPECIES	LANDINGS
ITA	SA9	2006	GNS	DEMF	PIL	0.9
ITA	SA9	2006	OTB	DEMSP	PIL	14.5
ITA	SA9	2006	OTB	MDDWSP	PIL	28.7
ITA	SA9	2006	PS	SPF	PIL	4344.2
ITA	SA9	2007	GNS	DEMF	PIL	0.1
ITA	SA9	2007	OTB	DEMSP	PIL	22.5
ITA	SA9	2007	OTB	MDDWSP	PIL	18.8
ITA	SA9	2007	PS	SPF	PIL	5111.9
ITA	SA9	2008	GNS	DEMF	PIL	1.0
ITA	SA9	2008	OTB	DEMSP	PIL	33.7
ITA	SA9	2008	OTB	MDDWSP	PIL	1.3
ITA	SA9	2008	PS	SPF	PIL	2288.1
ITA	SA9	2009	GNS	DEMF	PIL	0.5
ITA	SA9	2009	OTB	DEMSP	PIL	51.2
ITA	SA9	2009	OTB	MDDWSP	PIL	0.2
ITA	SA9	2009	PS	SPF	PIL	5673.9
ITA	SA9	2010	GNS	DEMF	PIL	0.2
ITA	SA9	2010	OTB	DEMSP	PIL	23.9
ITA	SA9	2010	OTB	MDDWSP	PIL	6.9
ITA	SA9	2010	PS	SPF	PIL	4475.7
ITA	SA9	2011	GNS	DEMF	PIL	0.0
ITA	SA9	2011	GTR	DEMSP	PIL	0.5
ITA	SA9	2011	OTB	DEMSP	PIL	28.5
ITA	SA9	2011	OTB	MDDWSP	PIL	1.6
ITA	SA9	2011	PS	SPF	PIL	2543.4
ITA	SA9	2012	GTR	DEMSP	PIL	0.4
ITA	SA9	2012	OTB	DEMSP	PIL	28.9
ITA	SA9	2012	OTB	MDDWSP	PIL	0.3
ITA	SA9	2012	PS	SPF	PIL	1705.2
ITA	SA9	2013	OTB	DEMSP	PIL	11.8
ITA	SA9	2013	OTB	MDDWSP	PIL	0.1
ITA	SA9	2013	PS	SPF	PIL	1308.6

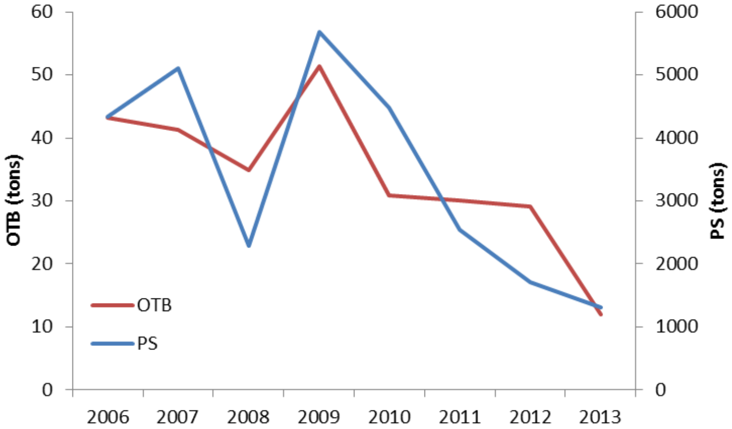


Figure 5.2.10.4.4.1. Sardine in GSA 9. Sardine annual landings (t) by fishery (data source: DCR and DCF).

5.2.10.4.5 *Discards*

Studies carried out in the framework of the DCF in 2011 showed that discards of sardine by the commercial fleet in GSA 9 can be considered as negligible.

5.2.10.4.6 Fishing effort

The fishing effort, expressed as GT per fishing days, remained quite constant during the investigated period (2004-2013). However, it is worth to note that this estimate of fishing effort is relative to the entire purse seine fleet in the GSA 9, without any information about the specific targeting effort for sardine.

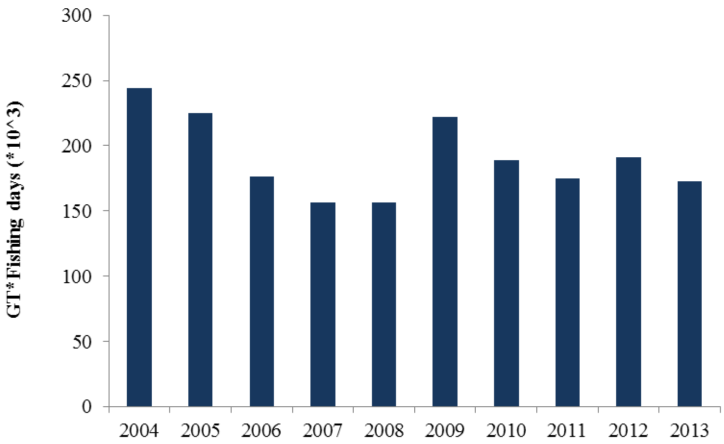


Fig. 5.2.10.4.6.1 Sardine in GSA 9. Annual total fishing effort (GT per fishing days) of purse seine vessels.

5.2.10.5 Scientific surveys

MEDITS

5.2.10.5.1 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 the following number of hauls was reported per depth stratum (Tab. 5.2.10.5.1.1).

Tab. 5.2.10.5.1.1. Number of MEDITS hauls per year and depth stratum in GSA 9, 1994-2013.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
GSA09 010-050	21	20	20	20	21	20	20	20	15	15	15	16	15	15	16	16	15	15	15	16
GSA09 050-100	21	21	20	22	20	21	22	22	17	17	17	16	18	18	16	16	19	18	17	17
GSA09 100-200	38	39	40	38	39	39	38	38	30	30	30	31	29	29	31	31	29	30	31	30
GSA09 200-500	40	40	40	41	40	41	42	42	33	31	34	34	35	35	34	34	34	33	35	35
GSA09 500-800	33	33	33	32	33	32	31	31	25	27	24	23	23	23	23	23	23	24	22	22
Total	153	153	153	153	153	153	153	153	120	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 = $Yst \pm V(Yst)$

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

5.2.10.5.2 Geographical distribution

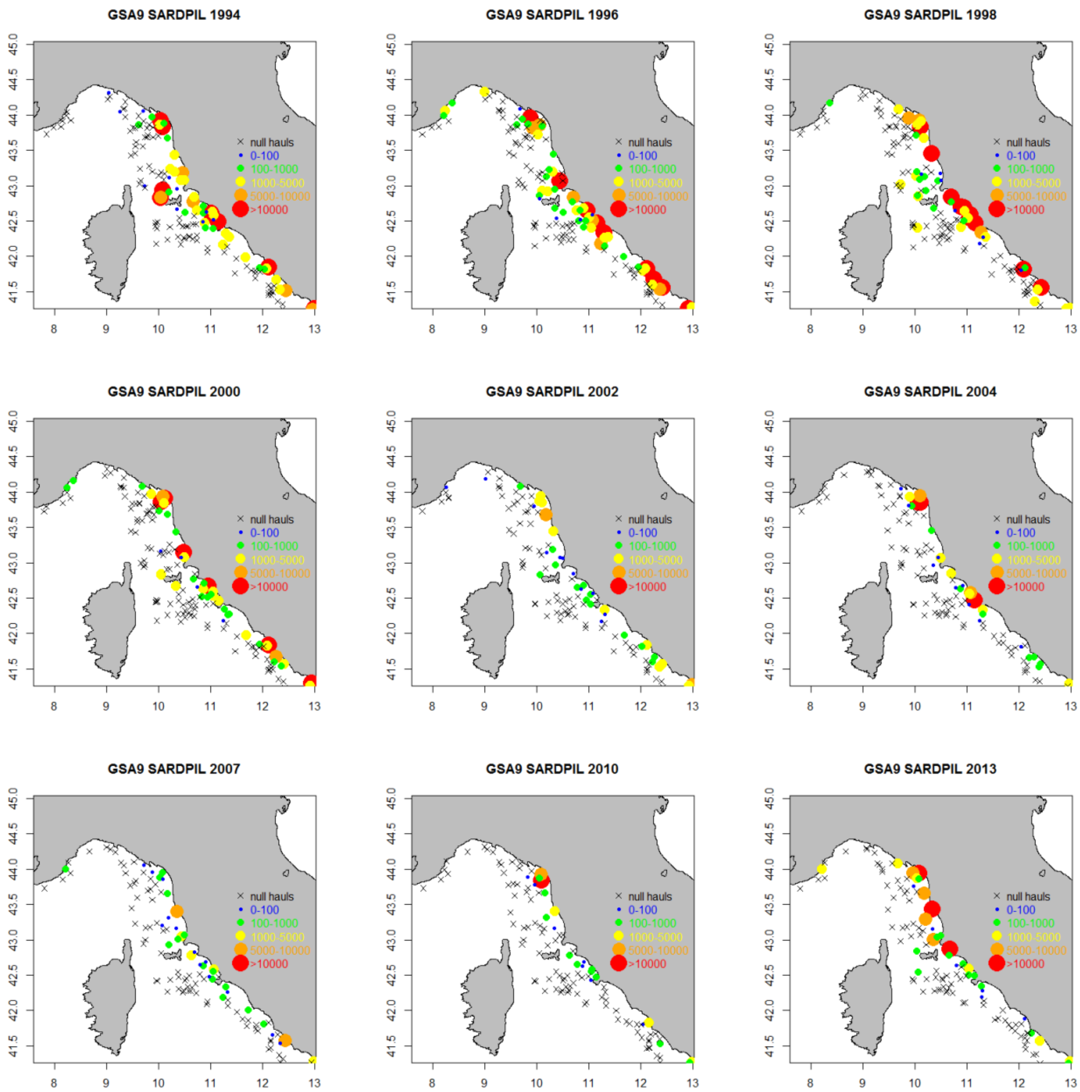


Fig. 5.2.10.5.2.1. Sardine in GSA 9. Abundance indeces per square kilometers by hauls (MEDITS 1994-2013)

In Figure 5.2.10.5.2.1 are reported some bubble maps of Sardine in the GSA 9 based on the Medits data (1994-2013). Bubble maps were obtained by an *ad hoc* R-script compiled by Bitetto et al. 2015. Sardine was caught mainly in hauls carried out very close to the coast and was more abundant along Tuscany coasts.

5.2.10.5.3 Trends in abundance and biomass

Fishery independent information regarding the state of sardine in GSA 9 was derived from the international survey MEDITS. Figure 5.2.10.5.3.1. displays the estimated trend in *S. pilchardus* density and biomass in GSA 9. The estimated biomass indices reveal a clear decreasing trend.

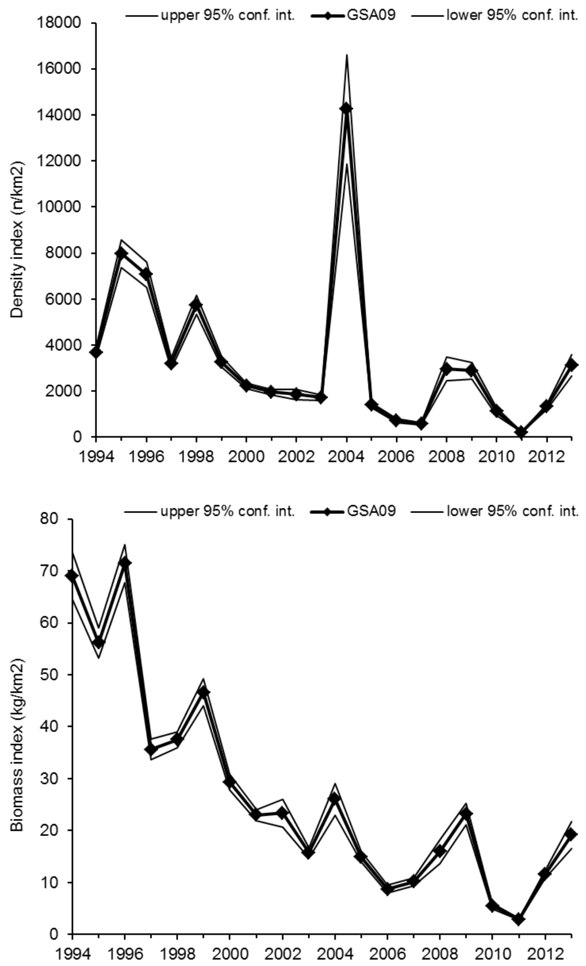


Figure. 5.2.10.5.3.1. Sardine in GSA 9. MEDITS survey trends in density and biomass indexes.

5.2.10.5.4 Trends in abundance by length or age

Figure 5.2.10.5.4.1 display the only two years in which was possible computed a stratified abundance indices by length of GSA 9 sardine. In the LFDs was possible detected collected two main modal components: the first ranging between about 7 – 11cm TL and the second from 11 to 14cm TL.

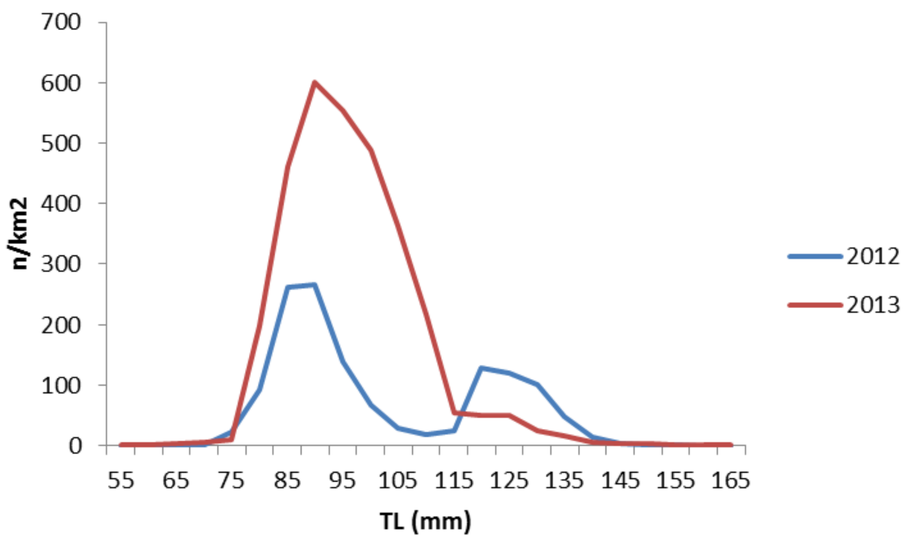


Fig. 5.2.10.5.4.1. Sardine in GSA 9. MEDITS stratified (10-200m depth) abundance indices by size (years 2012-2013).

5.2.10.5.5 Trends in growth

No information has been documented.

5.2.10.5.6 Trends in maturity

No information has been documented.

5.2.10.6 Assessment of historic stock parameters

5.2.10.6.1 *Methods 1: Separable VPA*

5.2.10.6.2 Justification

Data provided from DCF at the EWG 14-19 with information on total landings and catch at age of sardine in GSA 9 for the years 2006-2013 were used. Despite data available were enough to perform an Extended Survivor Analysis (XSA) the lack of corresponding abundance indexes for the same period, useful for model tuning, led to the decision of consider the opportunity to assess the species using a Separable VPA approach.

5.2.10.6.3 Input parameters

Data from DCF provided at EWG-14-19 containing information on sardine landings and the respective age structure for 2006-2013 were used. A vector of natural mortality value by age was obtained using Gislason method (Gislason et al., 2010). Catch at age, weight at age, mortality at age and maturity at age data for the 2006-2013 period were compiled for age classes 0 to 4+ and used as input data for the Separable VPA. Figure 5.2.10.6.3.1. showed that the catches belonged mainly to age 1 class. Separable VPA was computed for four different scenarios of F terminal: 0.3, 0.5, 0.7 and 1.0 considering as S terminal value 1 and a Reference age for unit selection, the first age at which the selection pattern may be regarded as fully recruited and subsequently flat equal to 3. The computation was made by R-project software and the FLR libraries.

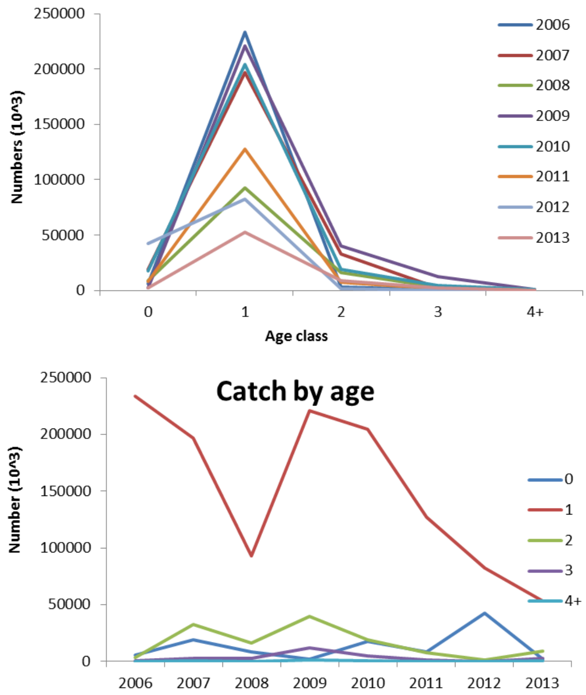


Fig. 5.2.10.6.3.1. Sardine in GSA 9. Catch in numbers by age and year (2006-2013)

Input data for the assessment are reported in the tables below:

Table 5.10.6.3.1. Sardine in GSA 9. Catch in numbers by age per year used in Separable VPA and SOP correction factor.

	Age					
Catch in numbers (thousands) by year	0	1	2	3	4+	SOP
2006	5696	233403	3354	867	0	0.990
2007	18997	196988	32707	2625	288	0.992
2008	8537	92909	16431	2926	59	0.985
2009	2395	220857	39875	12193	1171	0.991
2010	17934	204274	18962	4546	817	0.993
2011	8360	127489	7743	1321	0	0.988
2012	42518	82098	1328	98	45	0.983
2013	2261	52918	9168	2547	344	0.991

Table 5.2.10.6.3.2. Sardine in GSA 9. Mean weights at age used in Separable VPA (both in catch and stock).

	Age				
Weight at age (kg) by year	0	1	2	3	4+
2006	0.0106	0.0180	0.0270	0.0326	0.0398
2007	0.0103	0.0202	0.0270	0.0326	0.0390
2008	0.0107	0.0182	0.0270	0.0326	0.0426
2009	0.0107	0.0189	0.0270	0.0326	0.0390
2010	0.0107	0.0177	0.0270	0.0326	0.0399
2011	0.0108	0.0175	0.0270	0.0326	0.0398
2012	0.0095	0.0157	0.0270	0.0326	0.0390
2013	0.0108	0.0180	0.0270	0.0326	0.0390

Table 5.2.10.6.3.3. Sardine in GSA 9. Proportion of matures ate age used in Separable VPA.

Proportion of matures				
Age0	Age1	Age2	Age3	Age4+
0.5	1	1	1	1

Table 5.2.10.6.3.4. Sardine in GSA 9. Vector of natural mortality at age used in separable VPA.

Natural mortality				
Age0	Age1	Age2	Age3	Age4+
2.336	1.111	0.816	0.701	0.646

Table 5.2.10.6.3.5. Sardine in GSA 9. Growth and length weight relationships parameters used.

Linf	20
K	0.58
t0	-0.48
a	0.007
b	3.046

5.2.10.6.4 *Results*

Separable VPA was run setting four different scenarios for *Fterminal* 1.0, 0.7, 0.5 and 0.3. In the followings figures are showed the main results.

Scenario 1: Fterminal 1.0

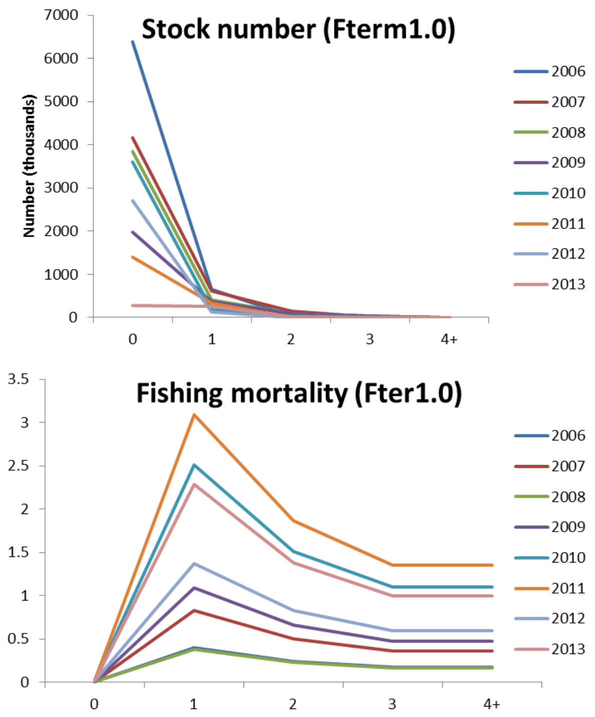


Figure 5.2.10.6.4.1. Sardine in GSA 9. Stock number and fishing mortality by age (*F terminal* 1.0).

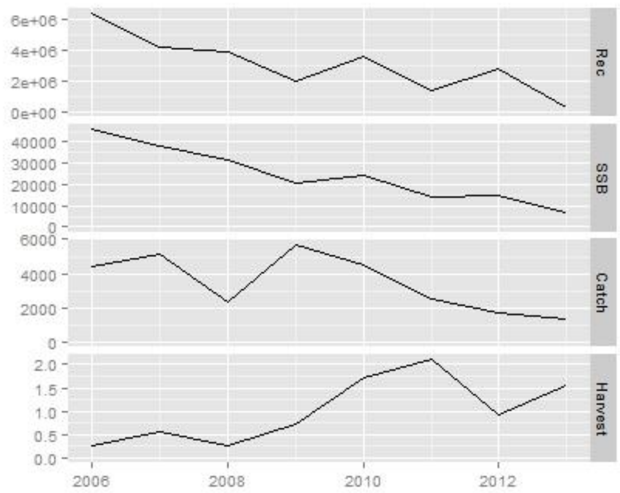


Figure 5.2.10.6.4.2. Sardine in GSA 9. Main output of the Separable VPA analysis (F terminal 1.0).

Scenario 2: Fterminal 0.7

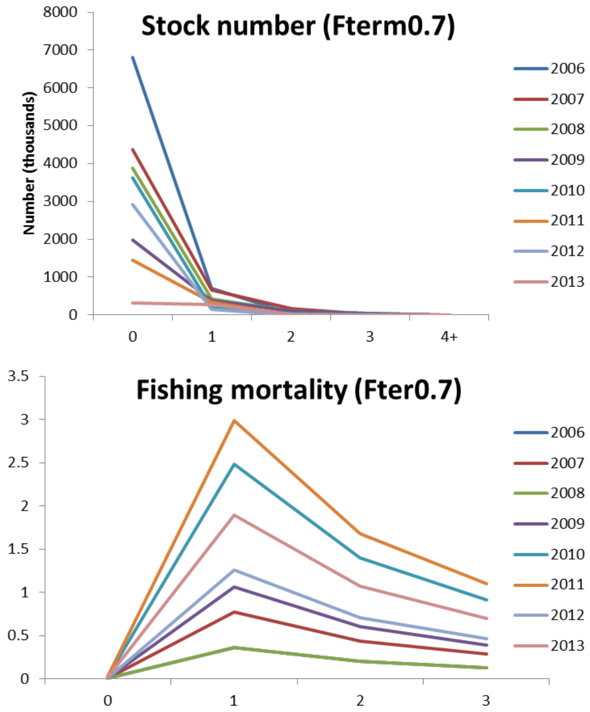


Figure 5.2.10.6.4.3. Sardine in GSA 9. Stock number and fishing mortality by age (F terminal 0.7).

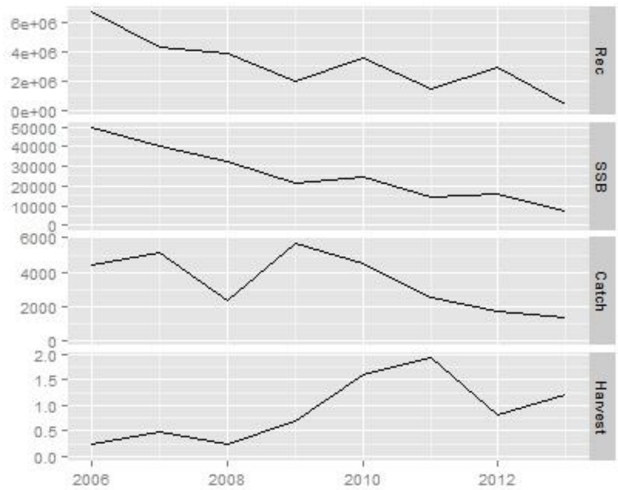


Figure 5.2.10.6.4.4. Sardine in GSA 9. Main output of the Separable VPA analysis (F terminal 0.7).

Scenario 3: Fterminal 0.5

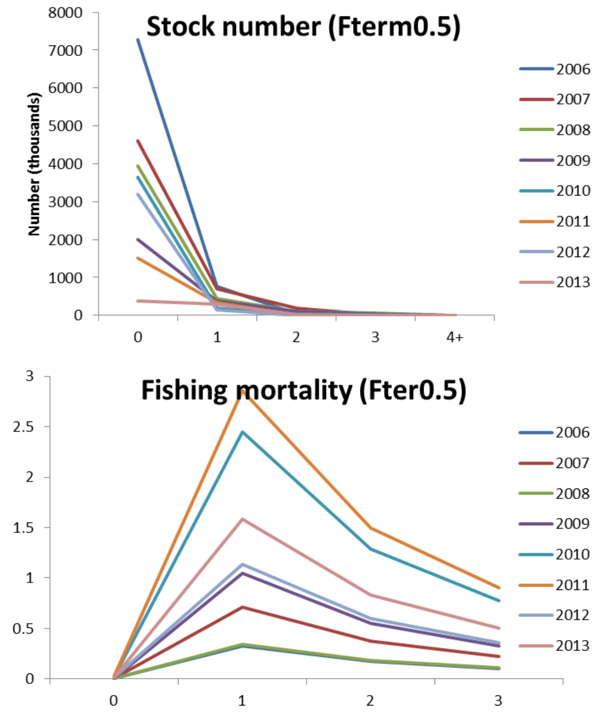


Figure 5.2.10.6.4.5. Sardine in GSA 9. Stock number and fishing mortality by age (F terminal 0.5).

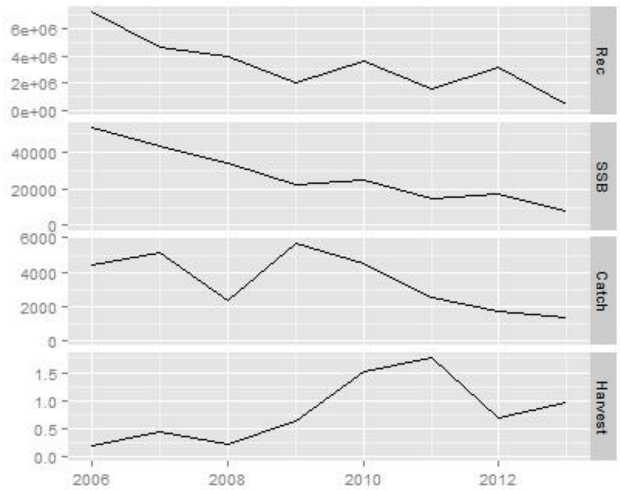


Figure 5.2.10.6.4.6. Sardine in GSA 9. Main output of the Separable VPA analysis (F terminal 0.5).

Scenario 4: Fterminal 0.3

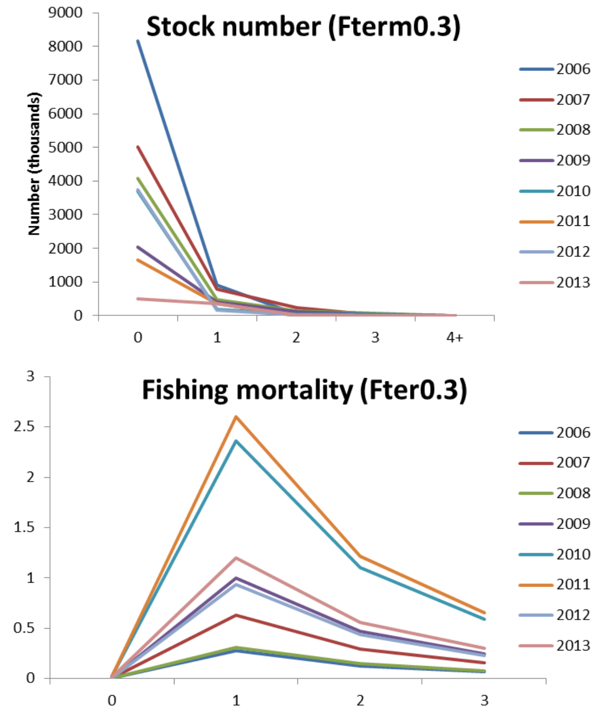


Figure 5.2.10.6.4.7. Sardine in GSA 9. Stock number and fishing mortality by age (*F terminal* 0.3).

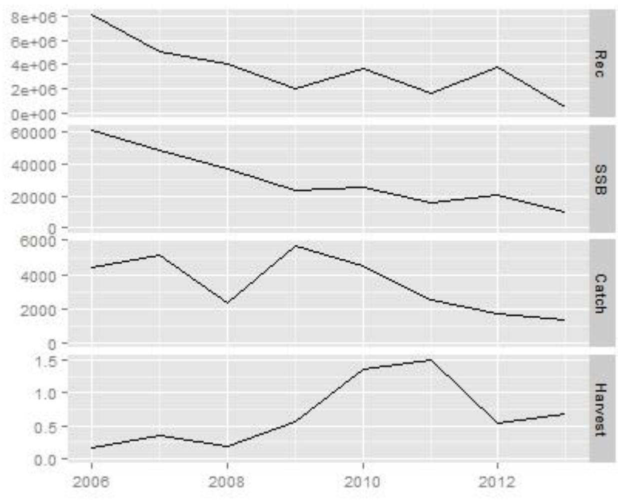


Figure 5.2.10.6.4.8. Sardine in GSA 9. Main output of the Separable VPA analysis (F terminal 0.3).

The four scenarios gave very similar results showing a decreasing trend both in termS of recruits than in term of spawners. Harvest, instead, showed a specular trend with an increasing trend followed in the last year of an inversion. Separable VPA outputs can be considered valid only for the estimates of the harvest level while they must be considered only as trend in term of recruits and SSB. The mainly exploited ages were from 1 to 3 and for this age range were estimated the corresponding mean F_{1-3} for each scenarios. These values were used to computed a corresponding value of exploitation rate (E) to compare with Small Pelagics Reference Point E=0.4 proposed by Patterson (1992) (Fig. 5.2.10.6.4.9)

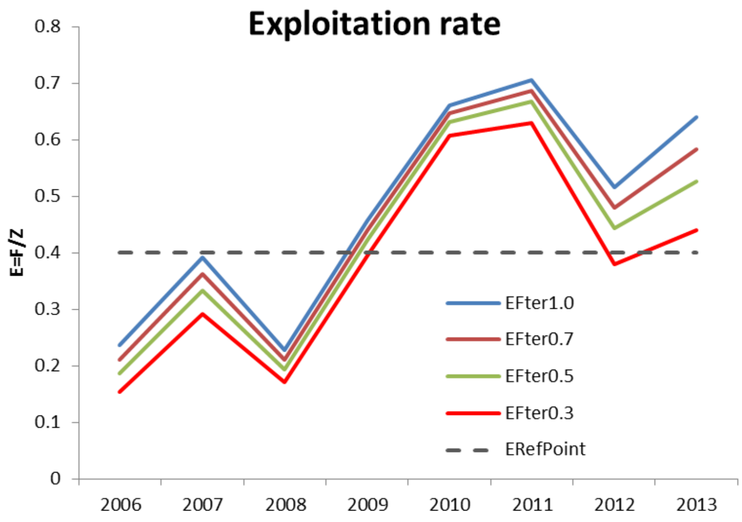


Figure 5.2.10.6.4.9. Sardine in GSA 9. Trend in the exploitation rate obtained for the four scenarios compare to E=0.4.

5.2.10.7 Long term prediction

5.2.10.7.1 *Justification*

No information has been documented.

5.2.10.7.2 *Results*

No information has been documented.

5.2.10.8 Data quality

Data provided from DCF at the EWG 14-19 contained information on total landings and catch at age of sardine in GSA 9 for the years 2006-2013. Despite data available were enough to perform an Extended Survivor Analysis (XSA) the lack of corresponding abundance indexes for the same period, useful for model tuning, led to the decision of consider the opportunity to assess the species using a Separable VPA approach. Tuning data should be derived from the data collected during surveys at sea and in the case of small pelagic species especially with the acoustic survey. It would therefore be wise to plan campaigns also in the GSA 9 along the lines of those currently made in other Italian areas (i.e. MEDIAS surveys in the Adriatic Sea and Strait of Sicily).

5.2.10.9 Scientific advice

5.2.10.10 Short term considerations

5.2.10.10.1 State of the stock size

Fishery independent information regarding the state of sardine in GSA 9 was derived from the international survey MEDITS in term of estimated trend in density and biomass. The estimated biomass indices reveal a clear decreasing trend. The outputs of Separable VPA confirm this trend.

5.2.10.10.2 State of recruitment

Also for the recruits the outputs of Separable VPA showed a clear decreasing trend from 2006 up to now.

5.2.10.10.3 State of exploitation

Considering E=0.4 as limit management reference point consistent with high long term yields for small pelagic species. The exploitation rate for sardine in GSA 9 was higher than the reference point so the stock was considered in overfishing situation. Anyway without an independent source of information especially coming from Echo-survey the results of the present assessment should be considered indicative but not reliable as absolute estimates.

5.2.10.11 Management recommendations

For the relevant fleets'effort exploitation rate should be reduced until fishing mortality is below or at the same level of the proposed management reference point (E=0.4), in order to avoid future loss in stock productivity and landings

5.2.11 STOCK ASSESSMENT OF DEEP SEA PINK SHRIMP IN GSA 9

5.2.11.1 Stock Identification

Due to a lack of information about the structure of pink shrimp population in the western Mediterranean, this stock was assumed to be confined within the GSA 9 boundaries.

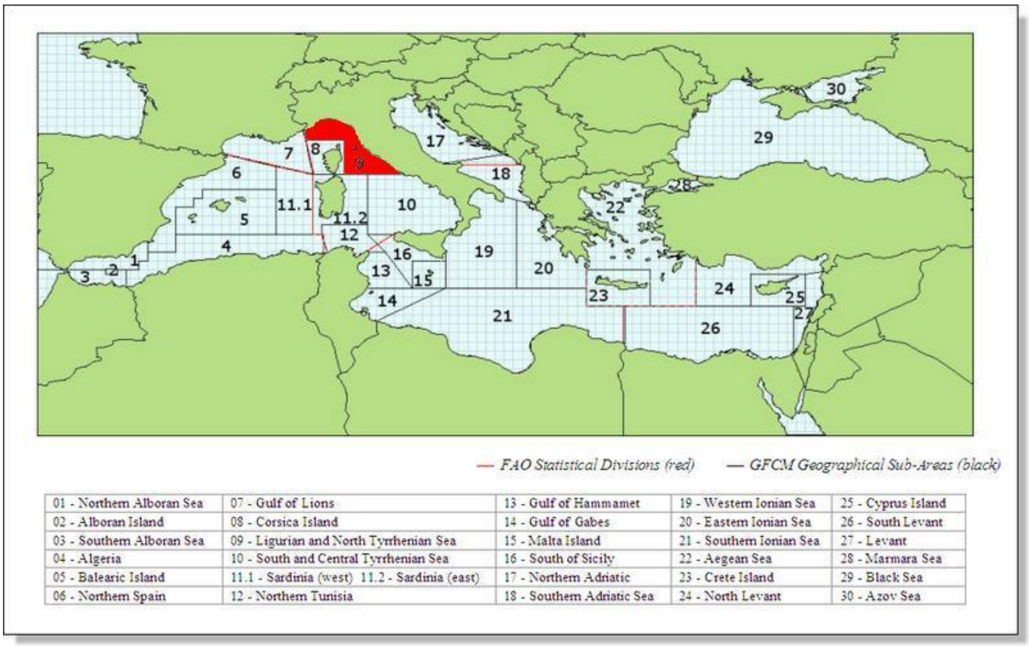


Fig. 5.2.11.1.1. Geographical location of GSA 9.

The species shows a wide bathymetric distribution in GSA 9, being present from 50 to 650 m depth with greatest abundance between 150 and 400 m depth over muddy or sandy-muddy bottoms (Ardizzone and Corsi, 1997; Biagi *et al.*, 2002).

The highest abundances have been found in the Tyrrhenian part of the GSA (south Tuscany and Latium).

Recruits (CL 15 mm) occur all year round, with a main peak from July to October (De Ranieri *et al.*, 1997). The main nurseries revealed a high spatio-temporal persistency (Fig. 5.2.11.1.2) between 60 and 220 m depth.

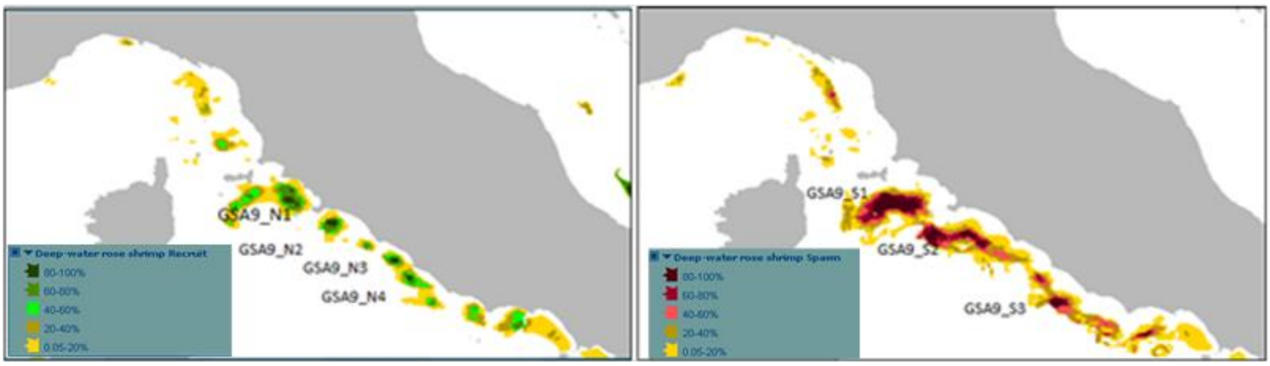


Fig 5.2.11.1.2. Temporal persistence of deep sea pink shrimp nurseries (left) and adults distribution (right) calculated from MEDITS time-series density maps (1994-2012). The figure is taken from the MEDISEH project.

The core of nursery areas overlap with crinoid beds (*Leptometra phalangium*) areas over the shelf-break (Colloca *et al*., 2004, 2006a; Reale *et al.*, 2005). This is a peculiar habitat in the GSA 9 which is also an essential fish habitat for other commercially important species as the European hake, *Merluccius merluccius*. A positive size-depth distribution was found with an increased abundance of larger females with depth (Ardizzone *et al*., 1990).

5.2.11.2 Growth

The growth of *P. longirostris* has been studied in the southern part of the GSA 9 (central Tyrrhenian Sea) using modal progression analysis (Ardizzone *et al*., 1990). The following sets of Von Bertalanffy growth parameters were estimated: Females: Linf = 43.5, K=0.74, t_0=-0.13; Males: Linf = 33.1, K=0.93, t_0=-0.05. The life cycle is of 3-4 years. Females grow faster than males attaining larger size-at-age.

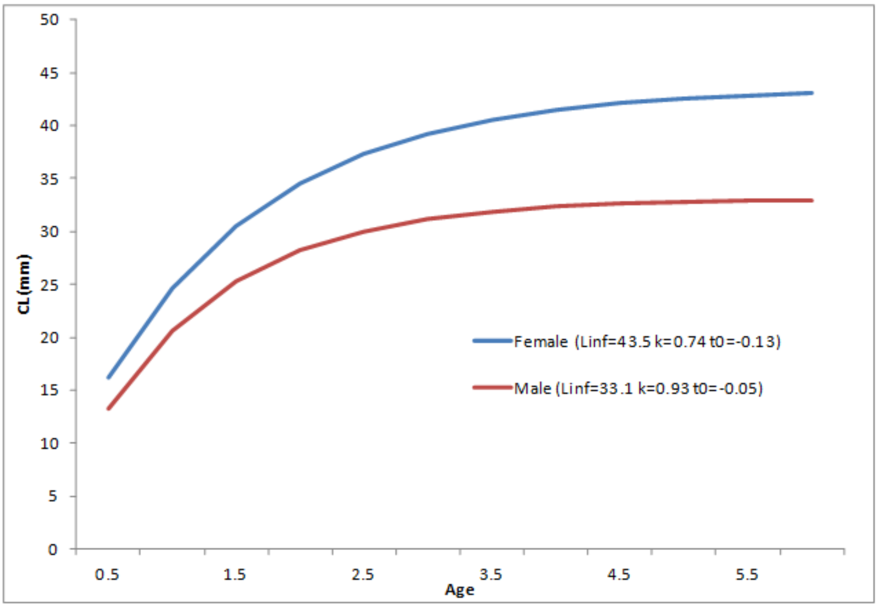


Fig 5.2.11.2.1. Deep sea pink shrimp in GSA 9. Von Bertalanffy curves used in the analysis.

P. longirostris diet is composed of a great variety of organisms; the prey items consisted mostly of external skeletons of bottom organisms, always crushed and often in an advanced state of deterioration. Crustaceans dominated the diet both qualitatively and quantitatively; they were characterized by a high abundance of peracarids, mainly represented by mysids (*Lophogaster typicus*) and amphipods (Lysianassidae). Molluscs (juvenile bivalves and gastropods), cephalopods (Sepiolids), small echinoderms, annelids, small fishes, foraminiferans, (Globigerinidae) and organic detritus are other important food item in the diet of the species (Mori *et al*., 2000b).

5.2.11.3 Maturity

In the northern Tyrrhenian Sea, the reproduction area of *P. longirostris* is located from 150 to 350 m; mature females are present all year round, even though the species shows two peaks in reproductive activity, one in spring and another at the beginning of autumn (Mori *et al*., 2000a). In the central Tyrrhenian Sea, the southern part of GSA 9, a main winter spawning was hypothesized (Ardizzone *et al*., 1990). The size at onset of sexual maturity

estimated for different years in northern Tyrrhenian Sea is about 24 mm CL (Mori *et al.*, 2000a).
The number of oocytes in the ovary was related to the size of the females and ranged from 23,000 oocytes at 26 mm CL to 204,000 at 43 mm CL. An exponential relationship was observed between fecundity and carapace length: Fecundity = $0.0569 * CL^{4.0177}$ (r = 0.829) (Mori *et al.*, 2000a).

5.2.11.4 Fisheries

5.2.11.4.1 General description of the fisheries

In GSA 9 the deep sea pink shrimp is one of the most important target species of the fishery carried out on the shelf break and upper part of continental slope. The species is exclusively exploited with otter bottom trawling.
The main fishing grounds are located in the southern part of the GSA 9, to the south of Elba Island (northern and central Tyrrhenian Seas); they are mainly exploited by several trawlers of Porto Santo Stefano, Porto Ercole, Fiumicino, Terracina and Gaeta. *P. longirostris* belongs to a fishing assemblage distributed from 150 to 350 m depth, where the main target species are European hake, *Merluccius merluccius*, Horned octopus, *Eledone cirrhosa* and Norway lobster, *Nephrops norvegicus*, at greater depths (Biagi *et al*., 2002; Colloca *et al*., 2003; Sartor *et al*., 2003; Sbrana *et al*., 2006).
The majority of bottom trawlers of GSA 9 operate daily fishing trips with some vessels (especially those of Porto Santo Stefano) staying out for two-three days and mainly in the summer. The mean number of fishing days/year per vessel carried out by the GSA 9 trawlers varied from 187 in 2004 to 177 in 2006. Due to the distance of the fishing grounds to the main harbours, fishing activity targeting *P. longirostris* shows some seasonal variations, with maxima from mid spring to mid autumn.

5.2.11.4.2 Management regulations applicable in 2014

- Minimum conservation size: 20 mm CL.
- Fishing closure for trawling: 30-45 days in late summer – beginning of autumn (not every year have been enforced).
- Cod end mesh size of trawl nets: 40 mm square meshes or, under certain conditions, 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast. However, towed gears are always forbidden inside 1.5 miles from the coast with the exception of some areas of the Ligurian Sea that have benefited from the derogation according by the EC Regulation 1967/2006 for the Mediterranean Sea.
- Two small No Take Zones ("Zone di Tutela Biologica", ZTB) are present inside the GSA 9; one off the Giglio Island (50 km^2, northern Tyrrhenian Sea) another off Gaeta, (125 km^2, central Tyrrhenian Sea). Bottom fishing was not allowed in the two ZTBs. A recent regulation of the Italian Ministry of Agricultural, Food and Forestry Policies has established that fishing activity can be carried out in these two areas from July 1st to December 31st.

5.2.11.4.3 Catches

5.2.11.4.4 Landings

Total landings of deep sea pink shrimp fluctuated from 161 tons in 2002 to 576 tons in 2013; fluctuations have been observed with a peak in 2006 corresponding to 462 tons and very high values in the last two years (Fig. 5.2.11.4.4.1; Tab. 5.2.11.4.4.1). The landings were mainly taken by demersal otter trawlers.

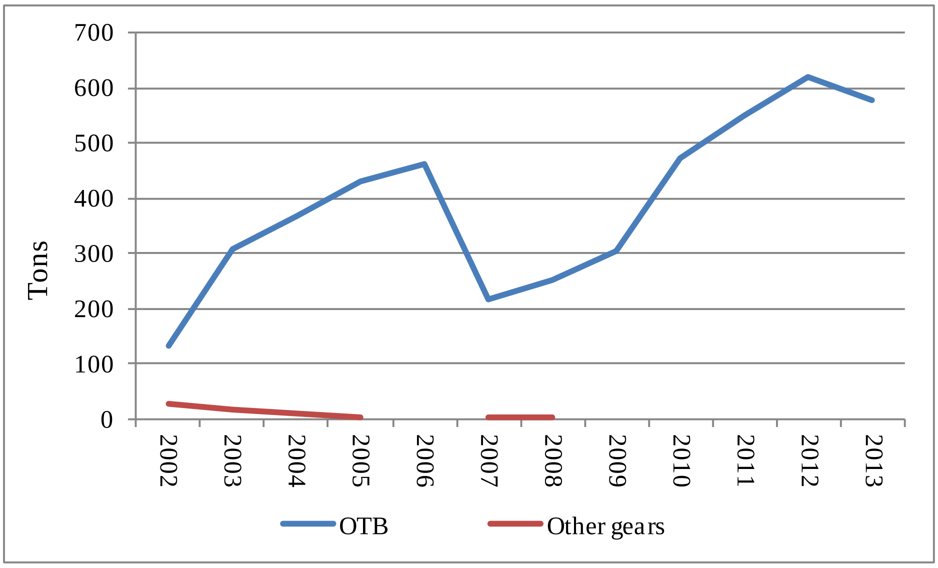


Fig. 5.2.11.4.4.1. Deep sea pink shrimp in GSA 9. Total landings.

Tab. 5.2.11.4.4.1. Deep sea pink shrimp in GSA 9. Annual landings (t) by fishing technique as provided through the official DCF data call 2014.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OTB	133	308	367	430	462	215	253	303	473	551	621	576
Other gears	28	15	9	1		2	1					
Total	161	323	376	431	462	217	254	303	473	551	621	576

The fluctuating trend is a proper characteristic of the landings of this species, as shown by the LPUE produced by the fleets of Porto Santo Stefano and Castiglione della Pescaia in the period 1991-2013 (Fig. 5.2.11.4.4.2). The values of the two fleets showed the same temporal pattern with maxima in 1992, 1999-2000, 2005-2006 and 2010-2012.

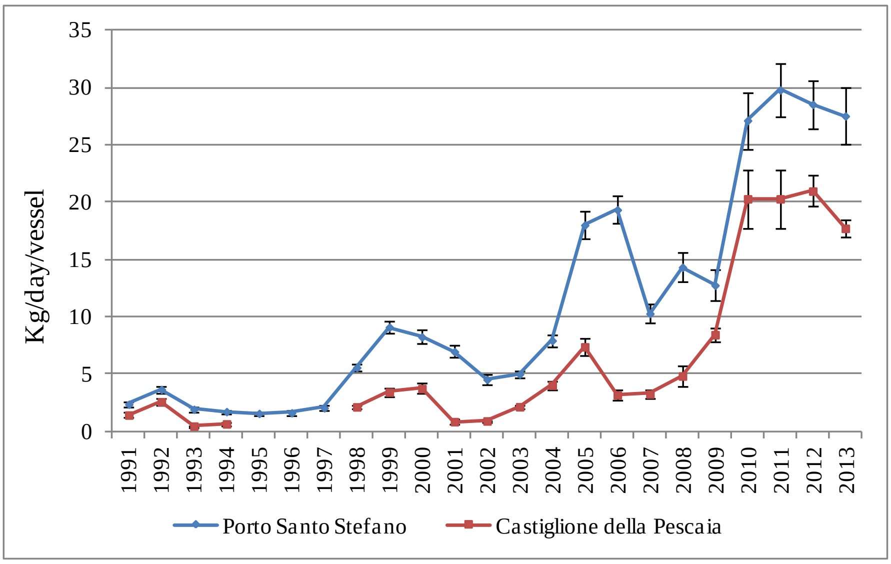


Fig. 5.2.11.4.4.2. Deep sea pink shrimp in GSA 9. LPUE of Porto Santo Stefano and Castiglione della Pescaia trawlers for the period 1991-2013.

The size structure of the landings, according to the DCR-DCF data, shows that the most exploited sizes ranged from 20 to 35 mm CL (Fig. 5.2.11.4.4.3); specimens under the MLS (20 mm CL) represent, on average, 12% of the number of individuals annually landed. According to the growth pattern of the species, fishing exploits mainly 1 and 2 age classes.

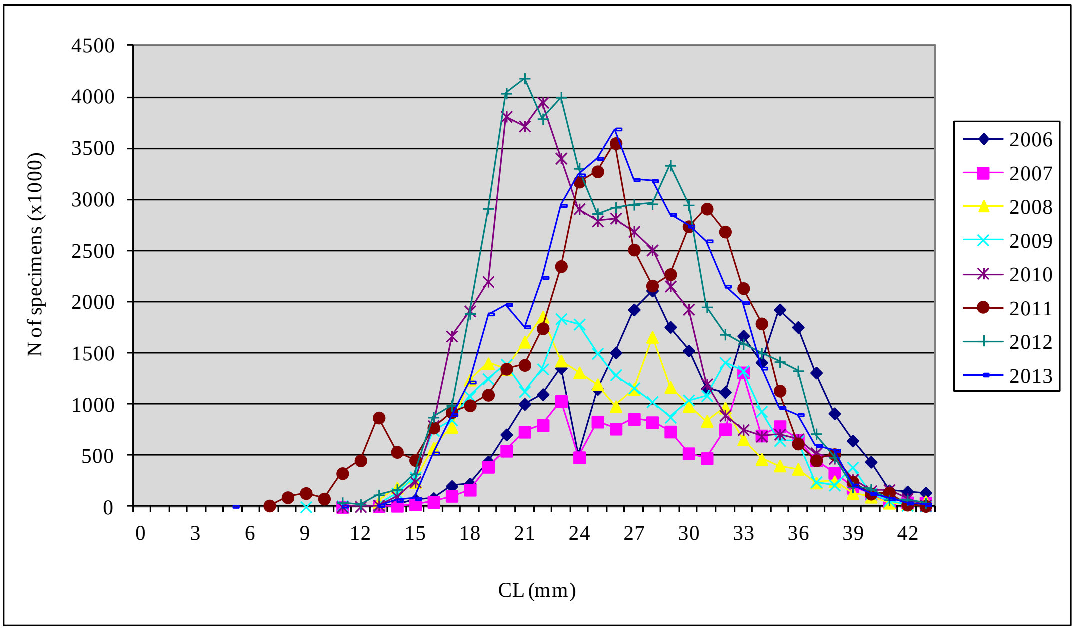


Fig. 5.2.11.4.4.3. Deep sea pink shrimp in GSA 9. Length frequency distributions of landing in the period 2006-2013.

5.2.11.4.5 *Discards*

According to Sbrana *et al*. (2006), discards of *P. longirostris* are generally low. They mainly occur on the fishing grounds located at depths of less than 200 m, where juvenile specimens are more abundant. In the period considered (2006-2013), discard represented about 9% of the annual total catch. The discarded biomass of *P. longirostris* ranged from a minimum of 8 tons in 2012 to a maximum of 63 tons in 2011 (Tab. 5.2.11.4.5.1.). The length frequency distributions of discard (Fig. 5.2.11.4.5.1) are mainly composed by specimens under the minimum conservation size (20 mm CL).

Tab. 5.2.11.4.5.1. Deep sea pink shrimp in GSA 9. Annual discard (t) for OTB as provided through the official DCF data call 2014.

	2006	2007	2008	2009	2010	2011	2012	2013
OTB	34	35	41	49	27	63	8	30

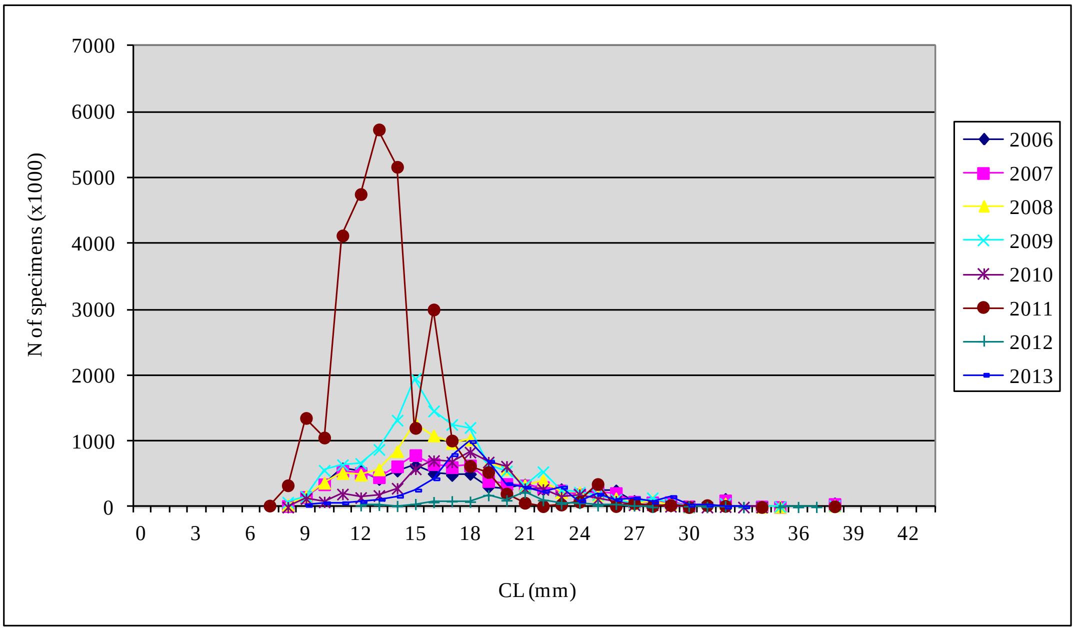


Fig. 5.2.11.4.5.1. Deep sea pink shrimp in GSA 9. Length frequency distributions of discarding in the period 2006-2013.

5.2.11.4.6 Fishing effort

The total fishing effort of the GSA 9 trawl fleet, expressed as kw*days at sea, has shown a progressive decrease in the last 10 years (Fig. 5.2.11.4.6.1). It varied from about 14,800,000 in 2004 to 10,000,000 in 2012 (Tab. 5.2.11.4.6.1). Anyway, there is no information on the specific effort directed to *P. longirostris* in GSA 9.

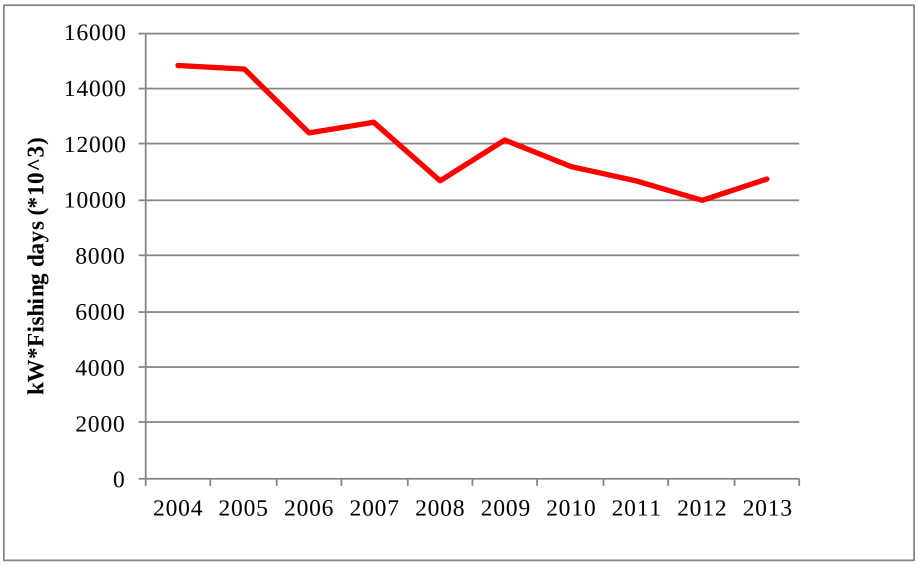


Fig. 5.2.11.4.6.1. Deep sea pink shrimp in GSA 9. Effort trend (days and kW*days) by OTB fleet, 2004-2013.

Tab. 5.2.11.4.6.1. Trend in annual fishing effort (kW*days) deployed by OTB in GSA 9, 2004-2013.

2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
14820339	14700599	12404787	12782144	10693694	12176447	11228001	10696166	9997907	10724881

5.2.11.5 Scientific surveys

MEDITS

5.2.11.5.1 Methods

Since 1994 MEDITS trawl surveys has been regularly carried out each year during the spring season. Based on the DCF data, abundance and biomass indices were recalculated. In GSA 9 the following number of hauls was reported per depth stratum (Tab. 5.2.11.5.1.1).

Tab. 5.2.11.5.1.1. Number of MEDITS hauls per year and depth stratum in GSA 9, 1994-2013.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
GSA09 010-050	21	20	20	20	21	20	20	20	15	15	15	16	15	15	16	16	15	15	15	16
GSA09 050-100	21	21	20	22	20	21	22	22	17	17	17	16	18	18	16	16	19	18	17	17
GSA09 100-200	38	39	40	38	39	39	38	38	30	30	30	31	29	29	31	31	29	30	31	30
GSA09 200-500	40	40	40	41	40	41	42	42	33	31	34	34	35	35	34	34	34	33	35	35
GSA09 500-800	33	33	33	32	33	32	31	31	25	27	24	23	23	23	23	23	23	24	22	22
Total	153	153	153	153	153	153	153	153	120	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 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

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

5.2.11.5.2 Geographical distribution

The stock is more abundant in the southern part of the GSA (Tyrrhenian Sea) as showed in Figures 5.2.11.5.2.1-2. The bubble plots show the increasing trend of the abundance and of the spatial distribution to the north part of the area.

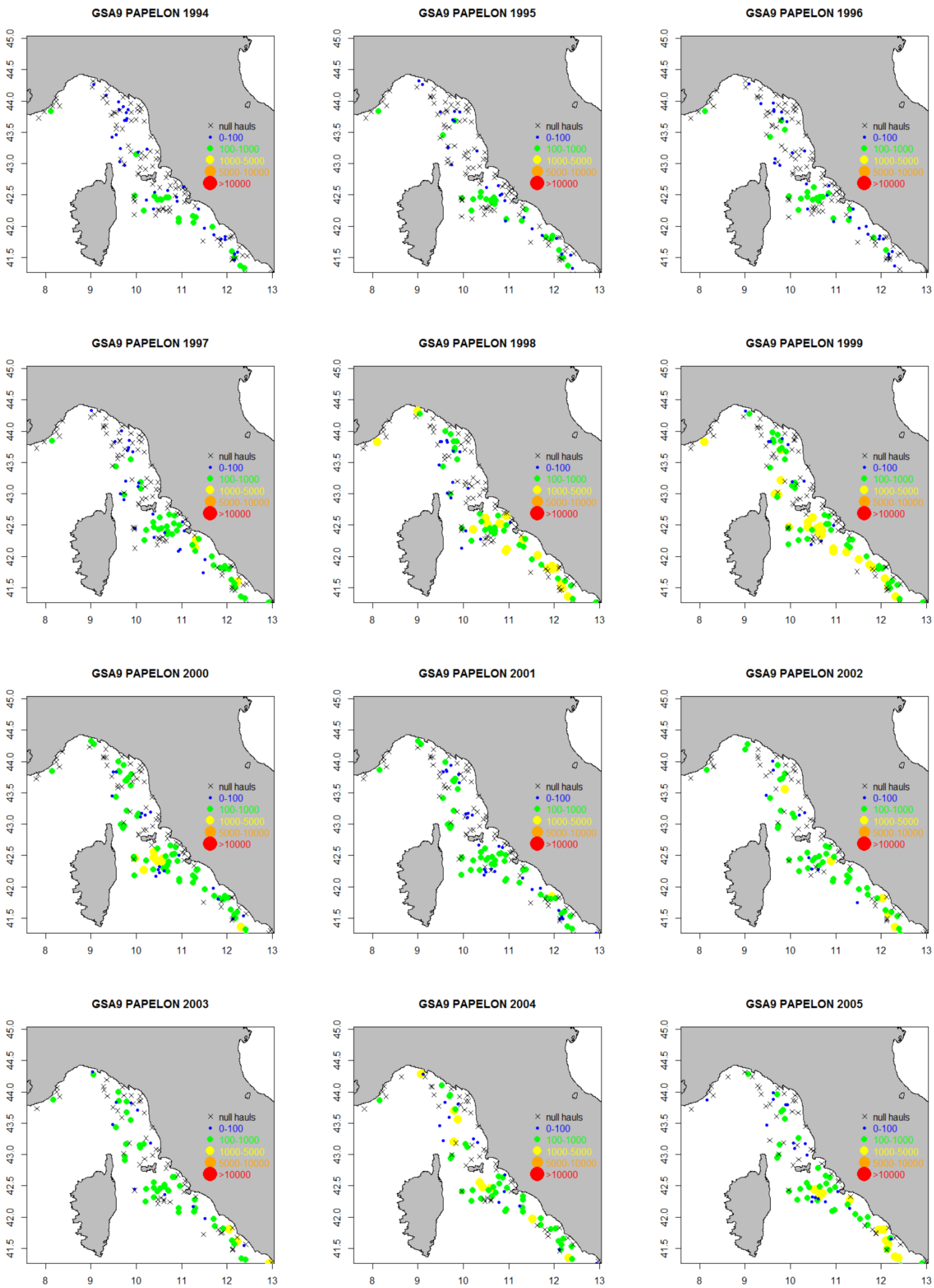


Fig. 5.2.11.5.2.1. Deep sea pink shrimp in GSA 9. Spatial distribution pattern in the period 1994-2005.

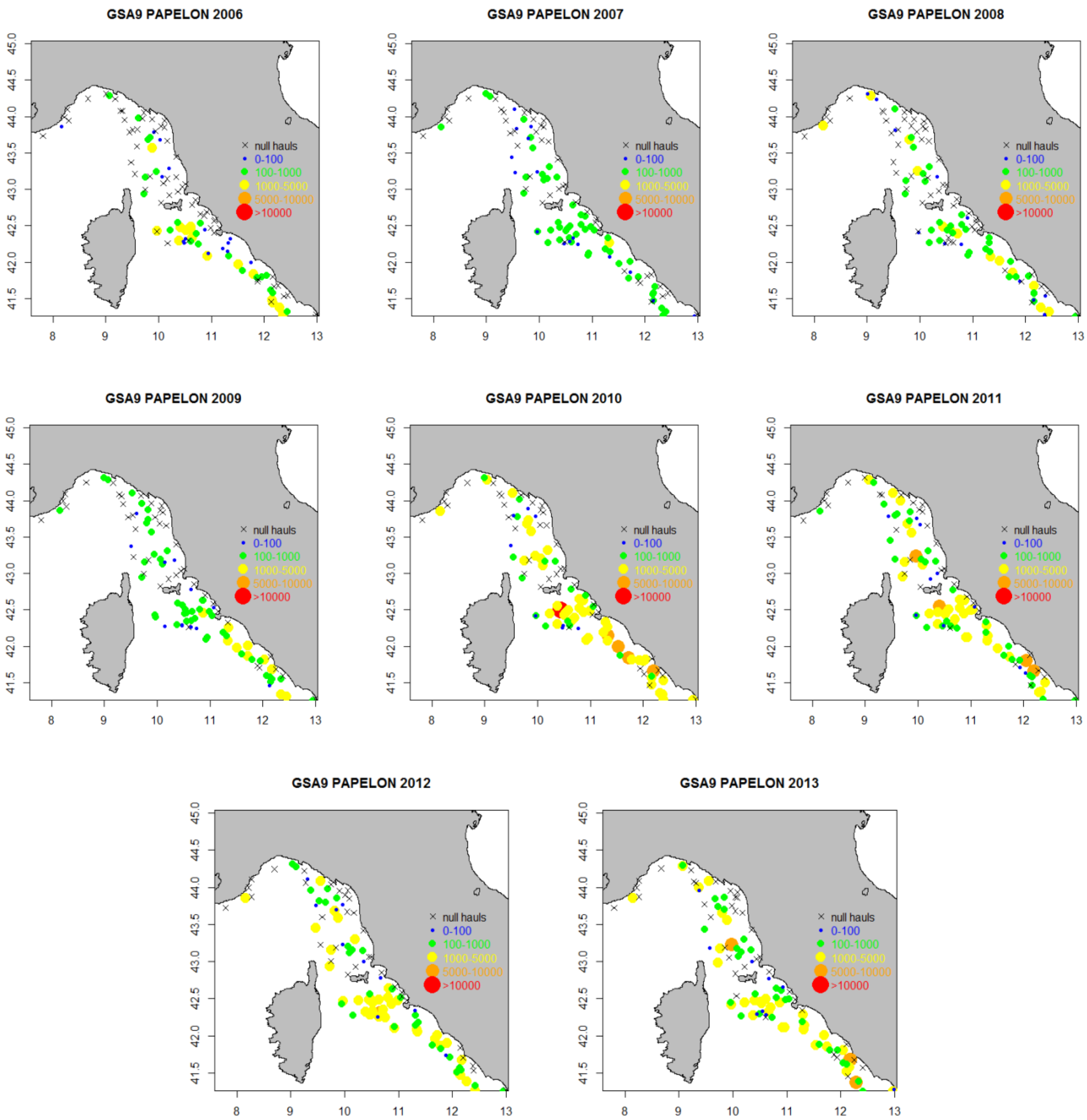


Fig. 5.2.11.5.2.2. Deep sea pink shrimp in GSA 9. Spatial distribution pattern in the period 2006-2013.

5.2.11.5.3 Trends in abundance and biomass

Since 1994 two trawl surveys were regularly carried out each year: MEDITS, in spring, and GRUND, in autumn. The two surveys gave a similar temporal increasing trend in density and biomass of deep sea pink shrimp, even though large fluctuations were present from year to year (Fig. 5.2.11.5.3.1). A similar increasing trend in abundance has been observed also in other Italian geographic subareas and could be related to the warming trend in water temperature. *P. longirostris* is a thermopile species that could benefit by the ongoing climatic change in the Mediterranean region. The relationship between environmental variability and deep sea pink shrimp population dynamic has not been investigated yet.

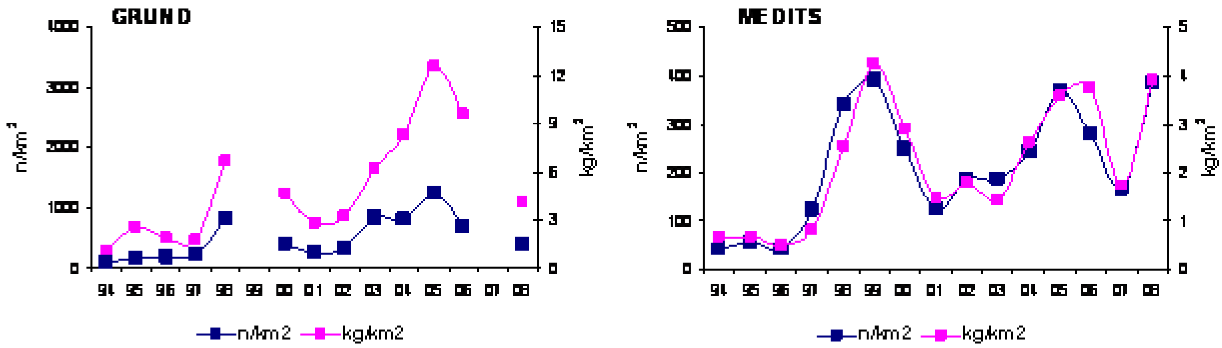


Fig. 5.2.11.5.3.1. Deep sea pink shrimp in GSA 9. GRUND and MEDITS trends in density and biomass from 1994 to 2008.

Figure 5.2.11.5.3.2 displays the estimated trend in pink shrimp abundance and biomass in GSA 9 for the period 1994-2013. The indices reveal a clear growing trend since 1998 with an abrut increase in the last 4 years.

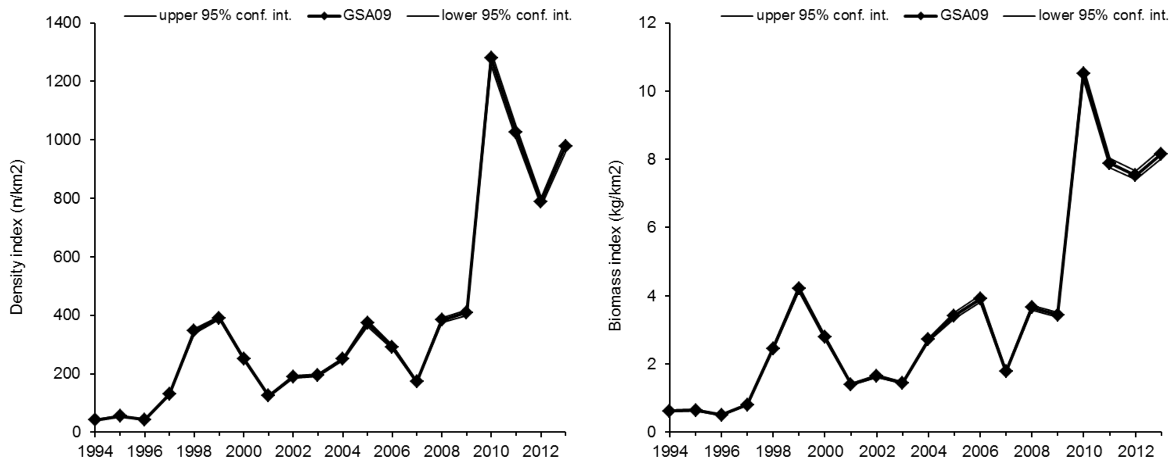


Fig. 5.2.11.5.3.2. Deep sea pink shrimp in GSA 9. MEDITS standardized abundance and biomass indices (10-800 m).

5.2.11.5.4 Trends in abundance by length or age

The following Figures 5.2.11.5.4.1-3 display the stratified abundance indices of GSA 9 collected during MEDITS surveys from 1994 to 2013.

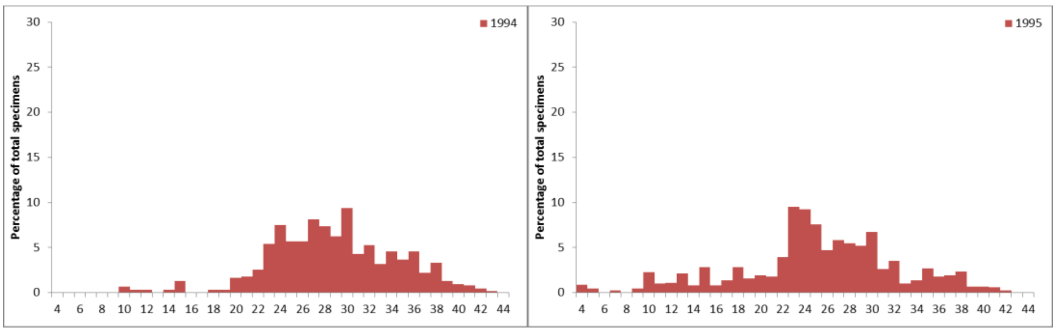


Fig. 5.2.11.5.4.1. Deep sea pink shrimp in GSA 9. Stratified abundance indices by size, 1994-1995.

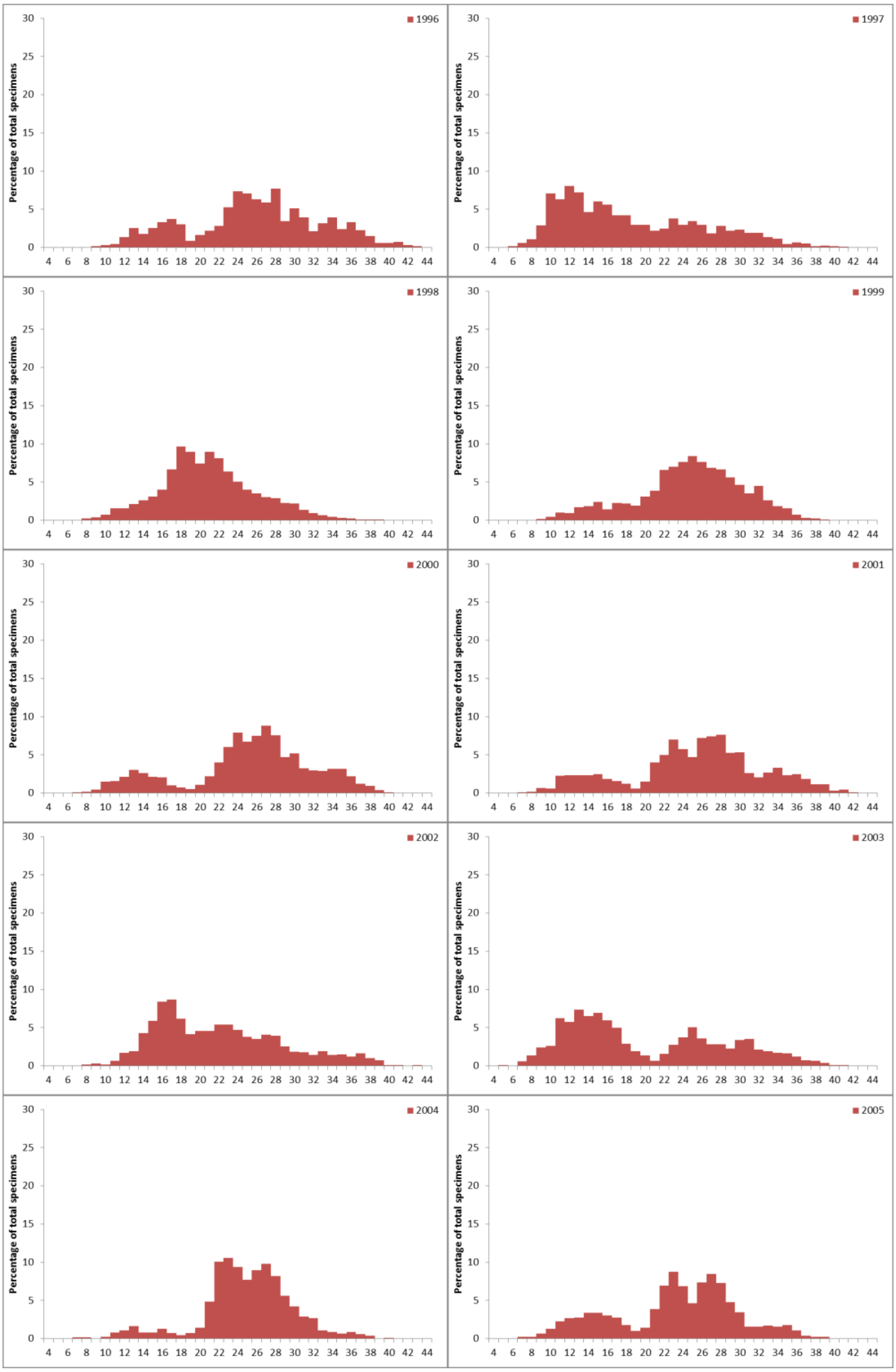


Fig. 5.2.11.5.4.2. Deep sea pink shrimp in GSA 9. Stratified abundance indices by size, 1996-2005.

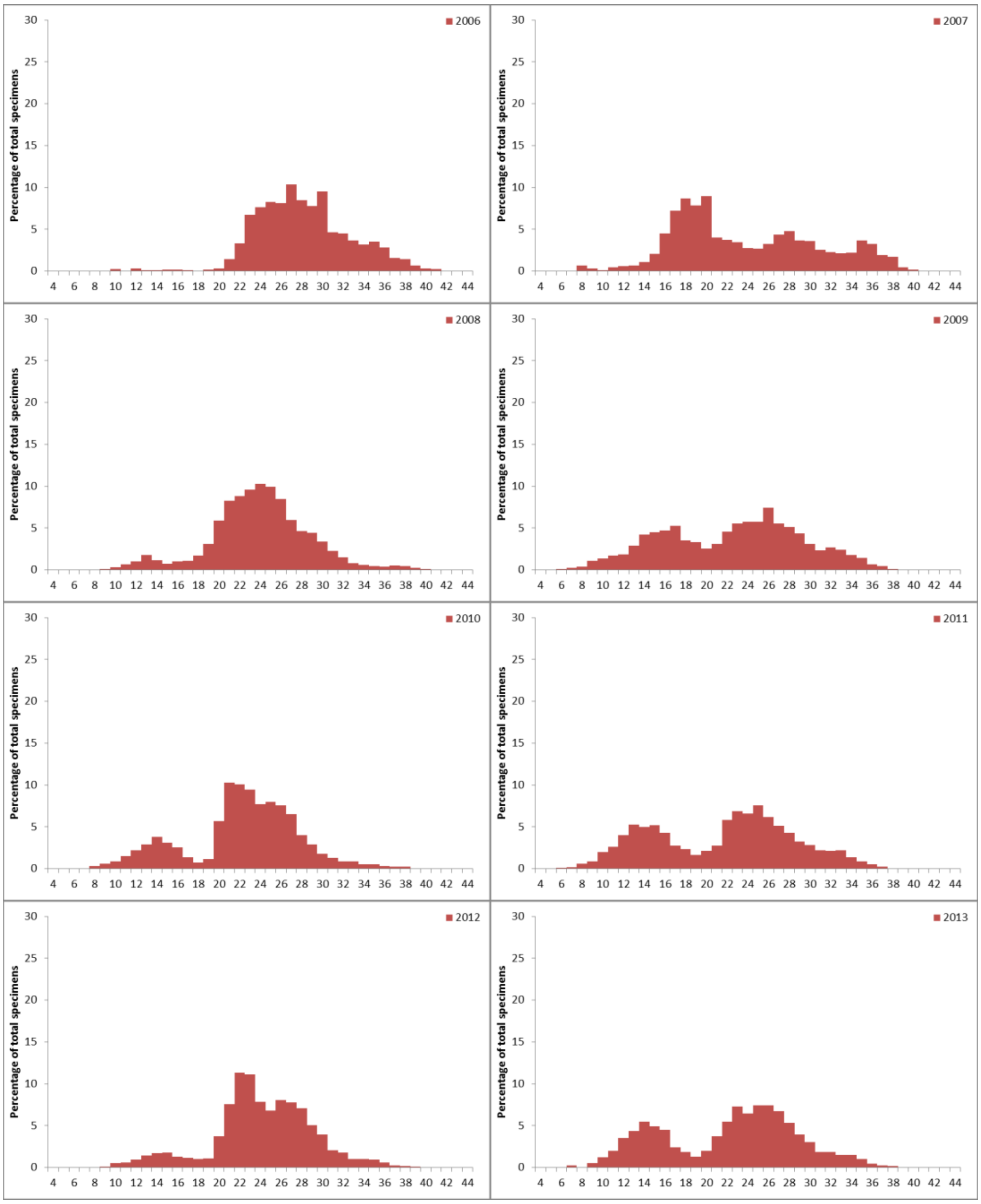


Fig. 5.2.11.5.4.3. Deep sea pink shrimp in GSA 9. Stratified abundance indices by size, 2006-2013.

The boxplot of the MEDITS length frequencies distributions (LFDs) is shown in Fig. 5.2.11.5.4.4. Some evident fluctuations in the LFD are observed before 2004 due to the high presence of recruits in the years 1997-1998 and 2002-2003. In the last years the demographic structure of the populations resulted more stable.

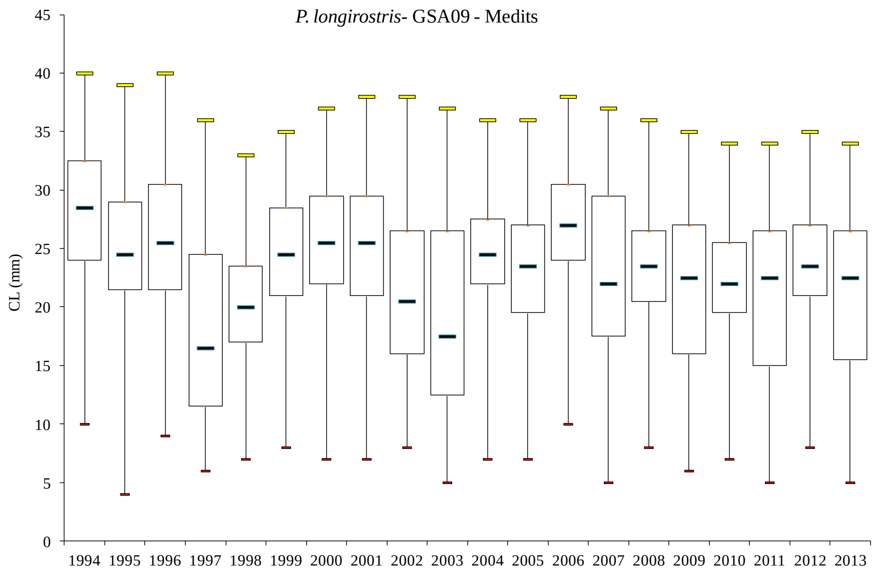


Fig. 5.2.11.5.4.4. Deep sea pink shrimp in GSA 9. Boxplot of the length frequency distributions obtained in the MEDITS surveys.

5.2.11.5.5 Trends in growth

No analyses were conducted during EWG 14-19.

5.2.11.5.6 Trends in maturity

No analyses were conducted during EWG 14-19.

5.2.11.6 Assessment of historic stock parameters

5.2.11.6.1 *Method 1: XSA*

5.2.11.6.2 *Justification*

An XSA assessment was carried out during EWG 14-19 using landing data collected under DCR-DCF from 2006 to 2013 and calibrated with surveys data (MEDITS 2006-2013).

5.2.11.6.3 Input parameters

Data from DCF provided at EWG 14-19 contained information on pink shrimp landings and the respective age structure for 2006-2013. Plus group was set at age 3. 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*)]. However, the correction factor resulted low (Tab. 5.2.11.6.3.1).

Tab. 5.2.11.6.3.1. Deep sea pink shrimp in GSA 9. Sum of product correction factor (SOP).

	2006	2007	2008	2009	2010	2011	2012	2013
% SOP correction	-8.2	5.6	4.5	1.9	0.7	-1.1	-4.6	-11.7

Biological parameters are listed in Tab. 5.2.11.6.3.2 and data used are reported in Tab. 5.2.11.6.3.3. A natural mortality vector computed using ProdBiom (Abella, 1998) was used. Length frequency distributions of commercial catches and surveys were splitted by sex and then transformed in age classes (up to the age class 3+) applying Statistical slicing with different growth parameters. XSA analysis was performed by sex combined. Given that the landings were composed mainly of individuals between 0 and 2 years, these ages were selected as the Fbar.

Tab. 5.2.11.6.3.2. Deep sea pink shrimp in GSA 9. Biological parameters.

	Growth parameters			Length-weight relationship	
Sex	L_{inf}	k	t_0	a	b
Male	33.1	0.93	-0.05	0.0044	2.359
Female	43.5	0.74	-0.13	0.0045	2.377

Tab. 5.2.11.6.3.3. Deep sea pink shrimp in GSA 9. Input parameters for XSA.

Catch at age (thousands)	Age 0	Age 1	Age 2	Age 3+
2006	4395.8	23193.9	11389.2	0.1
2007	4860.3	13319.2	3407.3	0.0
2008	9632.8	20746.8	2264.4	0.0
2009	13108.8	22058.0	3394.3	0.1
2010	7500.9	40072.5	4032.3	635.4
2011	33228.3	39861.6	2343.3	1354.5
2012	7621.0	44716.8	6701.4	754.1
2013	12024.8	42138.7	3819.5	1609.5

Mean weight at age (Catch)	Age 0	Age 1	Age 2	Age 3+
2006	0.0047	0.0116	0.0182	0.0238
2007	0.0046	0.0124	0.0181	0.0236
2008	0,0051	0.0098	0.0187	0.0238
2009	0.0034	0.0112	0.0176	0.0232
2010	0.0040	0.0096	0.0181	0.0232
2011	0.0029	0.0112	0.0177	0.0231
2012	0.0043	0.0102	0.0178	0.0241
2013	0.0030	0.0110	0.0177	0.0233

Mean weight at age (Stock)	Age 0	Age 1	Age 2	Age 3+
2006	0.0047	0.0116	0.0182	0.0238
2007	0.0046	0.0124	0.0181	0.0236
2008	0,0051	0.0098	0.0187	0.0238
2009	0.0034	0.0112	0.0176	0.0232
2010	0.0040	0.0096	0.0181	0.0232
2011	0.0029	0.0112	0.0177	0.0231
2012	0.0043	0.0102	0.0178	0.0241
2013	0.0030	0.0110	0.0177	0.0233

Proportion of mature	Age 0	Age 1	Age 2	Age 3+
2006	0	0.8	1	1
2007	0	0.8	1	1
2008	0	0.8	1	1
2009	0	0.8	1	1
2010	0	0.8	1	1
2011	0	0.8	1	1
2012	0	0.8	1	1
2013	0	0.8	1	1

Natural mortality	Age 0	Age 1	Age 2	Age 3+
2006	1.45	0.60	0.43	0.35
2007	1.45	0.60	0.43	0.35
2008	1.45	0.60	0.43	0.35
2009	1.45	0.60	0.43	0.35
2010	1.45	0.60	0.43	0.35
2011	1.45	0.60	0.43	0.35
2012	1.45	0.60	0.43	0.35
2013	1.45	0.60	0.43	0.35

Tuning Medits data	Age 0	Age 1	Age 2	Age 3+
2006	3.77	207.47	79.87	0.41
2007	86.29	28.86	54.96	0.00
2008	29.14	339.68	10.57	0.00
2009	133.67	263.39	8.59	0.89
2010	240.89	1015.70	22.23	0.00
2011	342.74	652.04	20.21	0.00
2012	77.75	655.89	35.97	0.01
2013	300.31	645.83	29.41	0.00

5.2.11.6.4 *Results*

XSA was run setting shrinkage at 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0. As showed by Fig. 5.2.11.6.4.1, the six different settings produced similar estimates of recruitment and SSB.

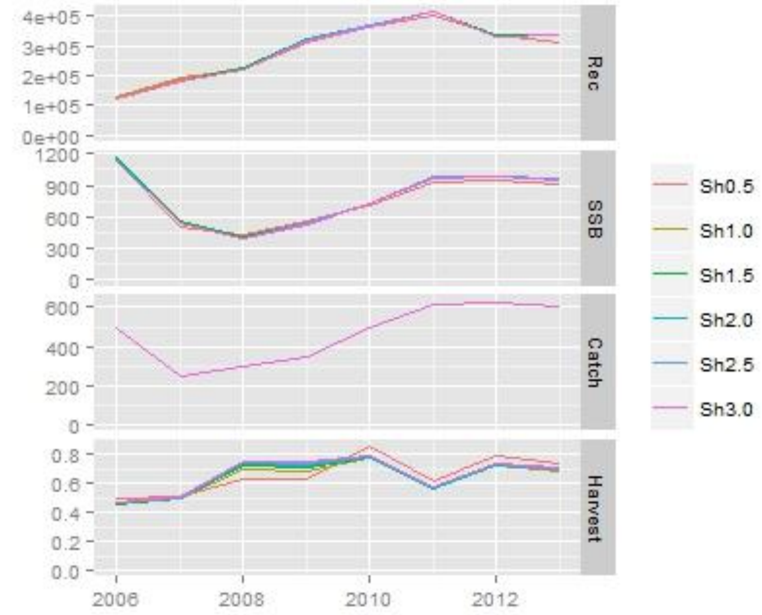


Fig. 5.2.11.6.4.1. Deep sea pink shrimp in GSA 9. XSA outputs for different shrinkage scenario.

Model with 1.5 shrinkage was adopted as final model based on the analysis of residual distributions (Fig. 5.2.11.6.4.2). Residuals from tuning fleets (MEDITS) per age and year were relatively low, ranging from 1 to - 1, and did not show any trend with time.

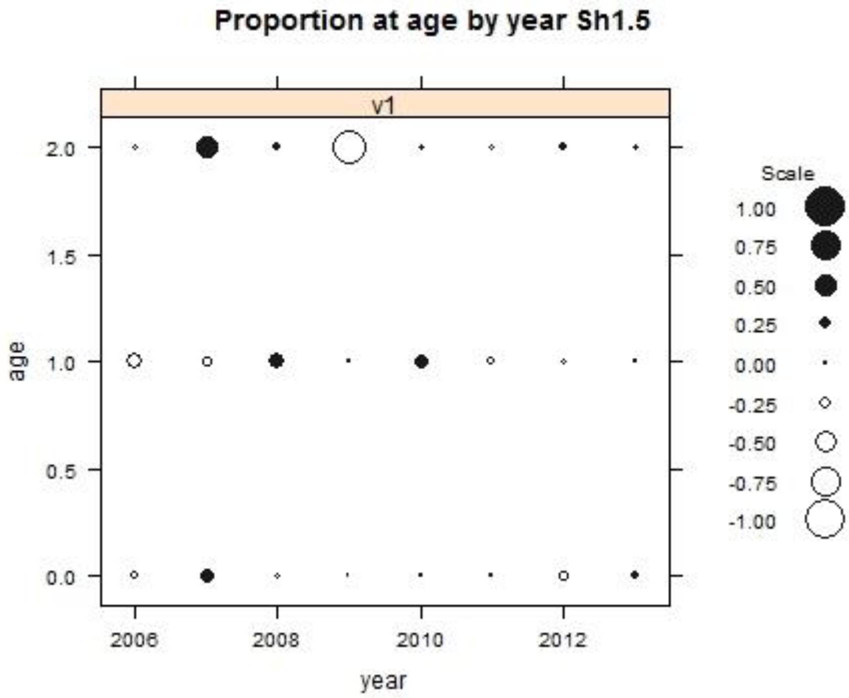


Fig. 5.2.11.6.4.2. Deep sea pink shrimp in GSA 9. Residuals at age obtained with shrinkage set at 1.5.

Moreover a retrospective analysis was conducted on recruitment, mean F and SSB (Figure 5.2.11.6.4.3) to ensure the robustness of the final estimates. The retrospective series indicate good agreement between years in the assessment results, with no systematic bias.

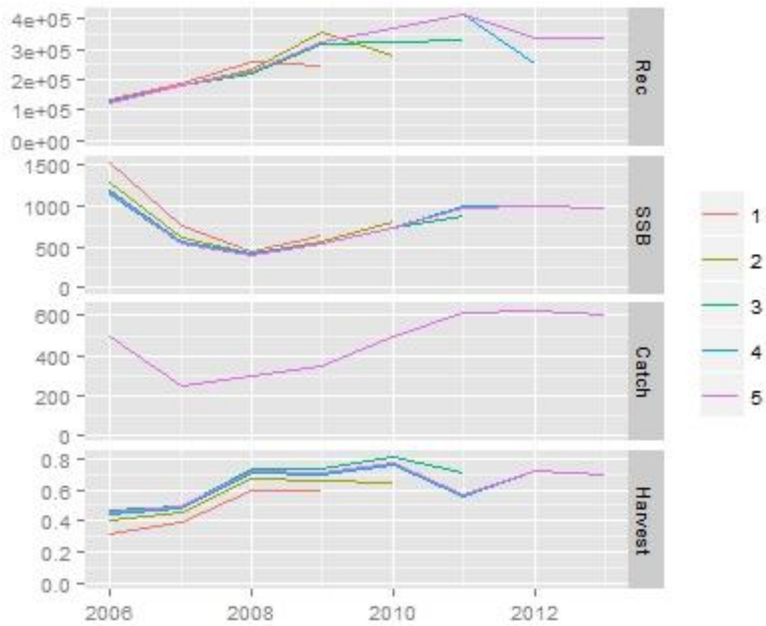


Fig. 5.2.11.6.4.3. Deep sea pink shrimp in GSA 9. Retrospective analysis with shrinkage set at 1.5.

Based on these simulation analyses, the inputs reported in Table 5.2.11.6.4.1 were selected to run the final XSA.

Tab. 5.2.11.6.4.1. Deep sea pink shrimp in GSA 9. Inputs selected to run the final XSA.

fse	rage	qage	shk.n	shk.f	shk,yrs	Shk.ages
1.5	1.0	2.0	true	true	4.0	3.0

XSA main outputs (Fig. 5.2.11.6.4.3) showed a constant or slightly decreasing fishing mortality in the last three years. Both SSB and recruits showed an increasing trend with maximum values in 2011. Recruitment varied from a minimum of 124 millions in 2006 to 415 millions in 2011. In the last two years (2012-2013) the estimated number of recruits was quite stable, around 330-340 millions of individuals. SSB showed high and stable values in the last three years around 1000 tons. XSA stock summary results are reported in Tab. 5.2.11.6.4.2.

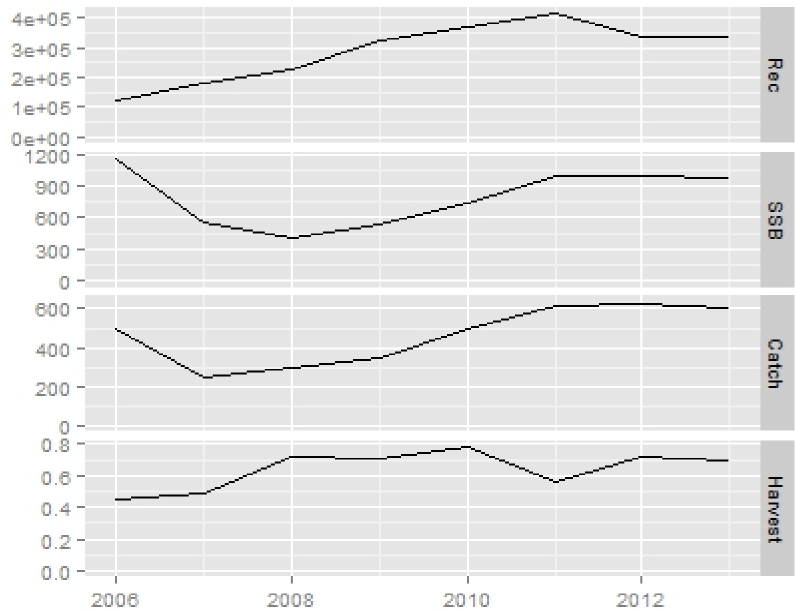


Fig. 5.2.11.6.4.3. Deep sea pink shrimp in GSA 9. XSA summary results. SSB and catch are in tons, recruitment in thousands of individuals.

Tab. 5.2.11.6.4.2. Deep sea pink shrimp in GSA 9. XSA stock summary results.

SSB	2006	2007	2008	2009	2010	2011	2012	2013
Tons	1160.6	550.5	403.0	541.2	733.4	985.2	ì986.8	965.2

REC	2006	2007	2008	2009	2010	2011	2012	2013
(x1000)	124002	180658	222641	320787	368756	415470	333439	338251

F by age	2006	2007	2008	2009	2010	2011	2012	2013
0	0.08	0.06	0.09	0.093	0.04	0.18	0.05	0.08
1	0.74	1.11	1.21	0.99	1.55	1.05	1.37	1.45
2	0.55	0.32	0.86	1.05	0.73	0.45	0.75	0.54
3+	0.55	0.32	0.86	1.05	0.73	0.45	0.75	0.54

Fbar	2006	2007	2008	2009	2010	2011	2012	2013
(0-2)	0.46	0.49	0.72	0.71	0.78	0.56	0.72	0.69

The XSA diagnostics are reported below:

XSA Diagnostics 22/01/2015 08:58:42						
CPUE data from indices						
Catch data for 8 years 2006 to 2013 Ages 0 to 3+						
fleet	first age	last age	first year	last year	alpha	beta
Medits	0	2	2006	2013	<NA>	<NA>
Time series weights:						
Tapered time weighting applied						
Power = 3 over 20 years						

Catchability analysis:

Catchability independent of size for ages > 1

Catchability independent of size for ages > 2

Terminal population estimation:

Survivor estimates shrunk towards the maen F
of the final 4 years of the 3 oldest ages.

S.E. of the mean to which the estimates shrunk = 1.5

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighing not applied

weights

year								
age	2006	2007	2008	2009	2010	2011	2012	2013
all	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

year								
age	2006	2007	2008	2009	2010	2011	2012	2013
0	0.076	0.057	0.094	0.088	0.043	0.181	0.048	0.076
1	0.74	1.107	1.212	0.99	1.552	1.055	1.366	1.453
2	0.553	0.315	0.863	1.045	0.733	0.455	0.752	0.542
3	0.553	0.315	0.863	1.045	0.733	0.455	0.752	0.542

XSA population number (Thousand)

age				
year	0	1	2	3
2006	124002	59948	33329	0
2007	180658	26888	15659	0
2008	222641	39920	4866	0
2009	320787	47435	6505	0
2010	368756	68718	9649	1470
2011	415470	82655	7972	4499
2012	333439	81140	15758	1713
2013	338251	74333	11337	4649

Estimated population abundance at 1st Jan 2014

age				
year	0	1	2	3
2014	0	73305	9507	4259

Fleet: Medits

Log catchability residuals.

year								
age	2006	2007	2008	2009	2010	2011	2012	2013
0	-0.059	0.126	-0.042	-0.009	0.002	0.007	-0.076	0.052
1	-0.135	-0.085	0.138	0.013	0.122	-0.06	-0.024	0.016
2	-0.03	0.204	0.064	-0.322	0.042	-0.035	0.044	0.042

Regression statistics

Ages with q dependent on year class strength

0.311230044039014   0.385177352811046   10.828491434393   8.27404730779469
Terminal year survivor and F summaries:
,Age 0 Year class 2013
scaledWts survivors   yrcls
0.599   86740   2013
0.026   56001   2013
0.375   57053   2013
,Age 1 Year class 2012
scaledWts survivors   yrcls
0.854   9912   2012
0.146   11777   2012
,Age 2 Year class 2011
scaledWts survivors   yrcls
0.936   4452   2011
0.064   2585   2011

5.2.11.7 Long term prediction

5.2.11.7.1 *Justification*

The yield per recruit (YpR) analysis was run using NOAA software. The analysis was performed to estimate $F_{0.1}$ as target equilibrium YPR reference point for the stock.

5.2.11.7.2 *Results*

YpR output curve is illustrated in the Figure 5.2.11.7.2.1 while in Figure 5.2.11.7.2.2 $F_{0.1}$ and F_{bar} are compared. $F_{0.1}$ estimated by the model was 0.71

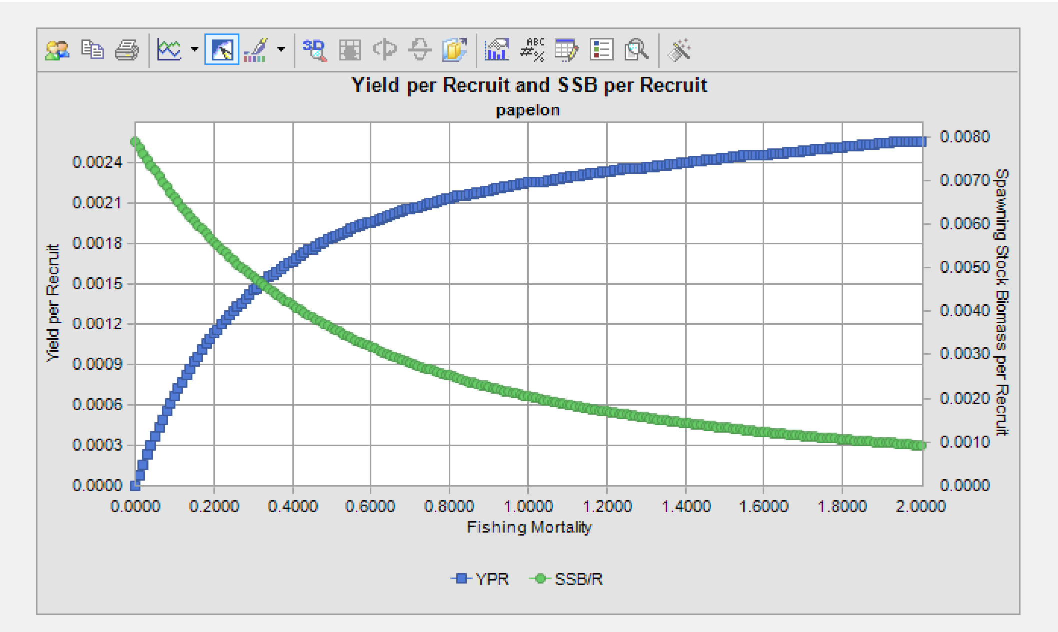


Fig. 5.2.11.7.2.1. Deep sea pink shrimp in GSA 9. Yield per Recruit curve.

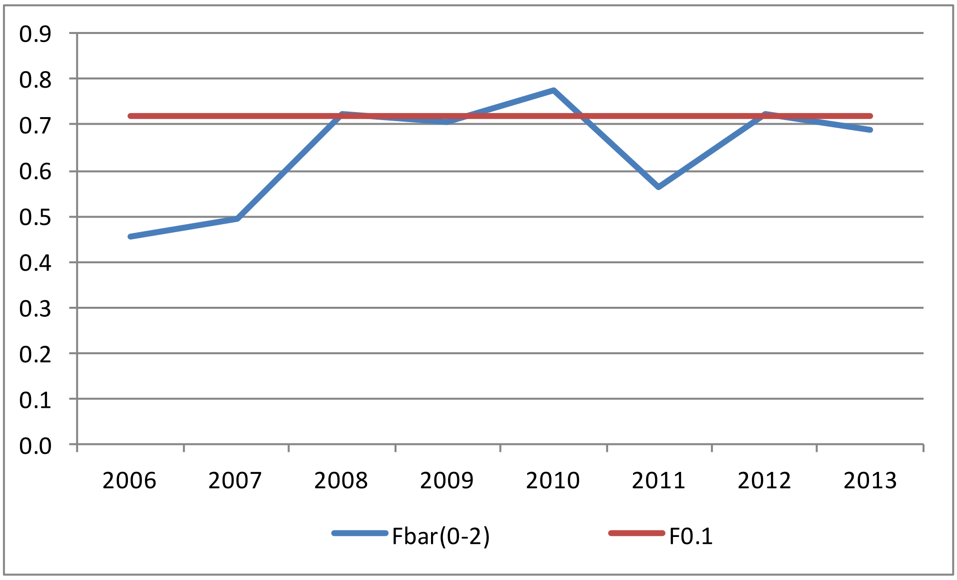


Fig. 5.2.11.7.2.2. Deep sea pink shrimp in GSA 9. Trend of F_{bar} obtained by XSA and comparison with $F_{0.1}$.

5.2.11.8 Data quality

Since standardized survey data were not available, MEDITS abundance indexes and length frequency distributions (LFDs) were computed by the experts during the meeting. Landing and discard data were available for the period 2006-2013.

5.2.11.9 Scientific advice

SSB and recruitment increased during the analysed time period and F is slightly higher or below than F_{MSY}.

5.2.11.10 Short term considerations

5.2.11.10.1 State of the stock size

SSB showed an increasing trend during the period analysed (2006-2013) with high and stable values in the last three years.

5.2.11.10.2 State of recruitment

According to the XSA analysis, the recruitment of pink shrimp in GSA 9 showed an increase until 2011. Stable and high values were observed also in 2012 and 2013.

5.2.11.10.3 State of exploitation

STECF-EWG 14-19 proposes $F_{0.1}$=0.71 as limit management reference point consistent with high long term yield and lower risk of stock collapse.

According to the F estimates obtained using landing and discard data with XSA, F_{curr} (0.69) was below the estimated reference value of $F_{0.1}$=0.71 in 2009, 2011 and 2013 and slightly above in 2010 and 2012.

STECF-EWG 14-19 considers the stock has been harvested sustainably consistent with high long term yield and lower risk of stock collapse. It is important to consider that this stock could be strongly driven by environmental and ecological factors (e.g. water temperature, predatory release effect) that can make difficult to evaluate the effect of fishing on the stock.

5.2.11.11 Management recommendations

EWG 14-19 advises to not increase the current level of effort of the relevant fleets, in order to avoid future loss in stock productivity.

5.2.12 STOCK ASSESSMENT OF GIANT RED SHRIMP IN GSA 11

5.2.12.1 Stock Identification

Due to a lack of information about the structure of giant red shrimp population in the western Mediterranean, this stock was assumed to be confined within the GSA 11 boundaries (Fig. 5.2.12.1.1).

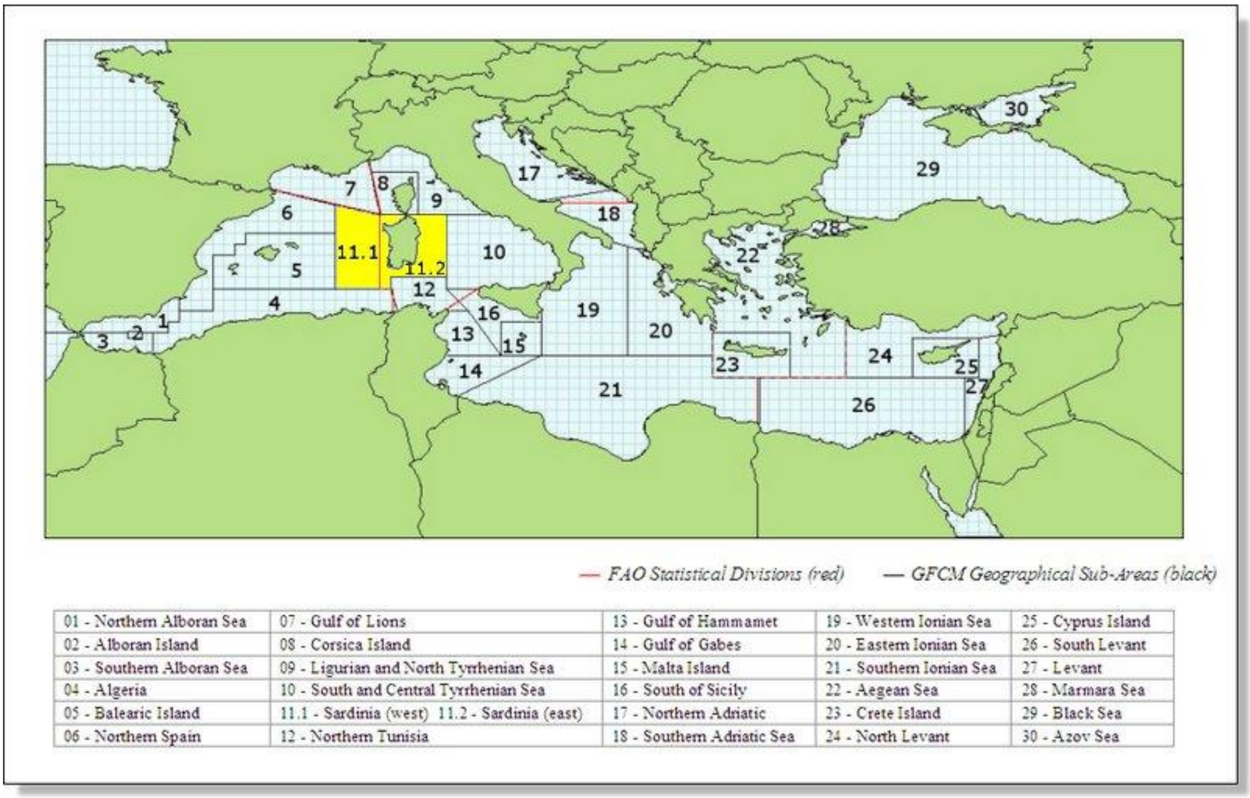


Fig. 5.2.12.1.1 Geographical localization of GSA 11.

Aristaeomorpha foliacea (Risso, 1827) is a dominant species of bathyal megafaunal assemblages and it is sympatric with *Aristeus antennatus* in all the GSA 11. Both the species have considerable interest for fisheries.

The giant red shrimp is considered midbathyal occupying mainly the middle slope, between 450 and 600 m of depth, although the range of occurrence is wider (250 and 1300 m) and includes also the epibathyal grounds.

By studying its trophic ecology Cartes et al (2014), find a significant relation with environmental variable, such us temperature and salinity of intermediate waters, and feeding intensity (gut fullness, *F*) and prey diversity (H´and *J*) and stated that the GSA 11 is one of the optimal ecological habitat of A. foliacea in Mediterranean. In their preferred (core) habitats species may reach their greatest densities and best biological condition in terms of size, survivorship and fecundity. In the case of *A. foliacea*, the best trophic conditions coincide with areas with the highest densities, areas where the species has more structured populations, with peaks of small recruits and larger females.

The giant red shrimp shows high densities and well-structured populations with a clear multimodal size pattern in the GSA 11. Seasonal changes have been reported from southern Sardinia in both the vertical distribution and size-related spatial abundance of *A. foliacea*, with large females (preferentially) tending to move gradually deeper (to 650-740 m) from spring to summer (Mura et al., 1997).

5.2.12.2 Growth

The latest references available in the scientific literature for von Bertalanffy Growth Function parameters of *A. foliacea* by sex in Sardinian seas are derived (Table 5.2.12.2.1) by the report of the “RedS” program (FISH/2004/03-32), a concerted action funded by the European Union (AA.VV. 2008).

Tab. 5.2.12.2.1. Giant red shrimp in GSA 11. Von Bertalanffy Growth function parameters.

sex	linf	k	t0
F	72.2	0.50	0.0
M	42.71	0.77	-0.27

Like most of Decapod crustaceans the giant red shrimps show sexual dimorphism and a noticeable difference in growth among sexes being females bigger and less quickly growing than males. The maximum length for females resulted 68 mm CL and for males 48 mm CL (AA.VV. 2008).

5.2.12.3 Maturity

In western Mediterranean the spawning season occurs between end of July and September, with a peak in summer (July-August) (Mura et al., 1992; Cau et al., 1994; Mori et al., 1994; Spedicato et al., 1994; Ragonese and Bianchini, 1995, Perdichizzi et al., 2012). Before spawning large females gradually move deeper, to 650–740 m for reproduction (Mura et al., 1997). The size at onset of sexual maturity occurs at about 32.6 mm CL for females (AAVV, 2008).

5.2.12.4 Fisheries

5.2.12.4.1 General description of the fisheries

As a consequence of government incentives aimed at the fleet modernization, since 1994 up to 2004 the trawl sector showed gradually but remarkable changes, with a general increase in the number of vessels and the replacement of the older ones, low tonnage wooden boats by larger steel boats.

Actually in the GSA 11 operate a total of about 1300 boats, 150 of which are small medium and big trawlers. Administratively they all belong to the major fishing ports (“compamare”) namely Cagliari, La Maddalena, Olbia, Oristano and Porto Torres (Fig. 5.2.12.4.1). Other important ports are Alghero, Porto Torres, La Caletta and Sant’Antioco.

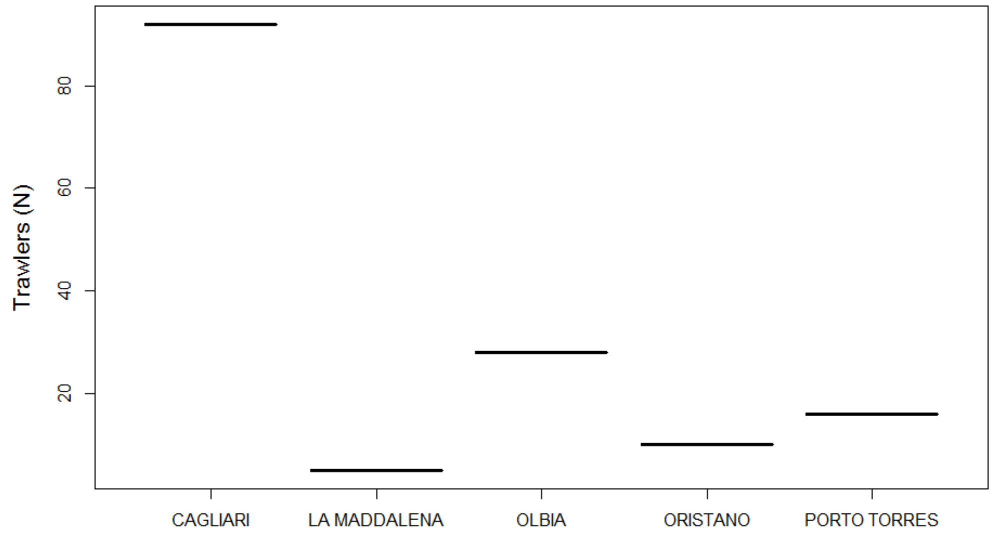


Fig. 5.2.12.4.1. Number of trawlers operating in GSA 11 grouped by the main ports.

The giant red shrimp is a high-value species, being a target of a specific deep trawl fishery in the whole GSA 11.
The large trawlers of GSA 11 operate all the week from Monday to Friday accomplishing daily or bi-daily fishing trips and delivering products to local markets.
Moreover, due to the distance of the fishing grounds (Murenu et al., 2011) to the main harbors of the western cost and the dominant weather conditions, the fleet targeting *A. foliacea* shows some seasonal variations, with more time spent at sea from mid spring to mid-autumn. Some large trawlers move seasonally to different fishing grounds far from the usual ports. When weather is good and sea is calm, also small trawlers perform daily fishing trips to targets deep shrimps.

5.2.12.4.2 Management regulations applicable in 2014

As in other areas of the Mediterranean, the stock management is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area/season closures). EC regulation 1967/2006 does not provide for a minimum length size for this species.
Since 2012 a reduction of the fishing ban period that generally was enforced for 45 days occurs. In 2012 and 2013 the fishing ban was established by the Autonomous region of Sardinia from from 1st to 30th of September, while in 2014 it has been split from the 15th of September until the 15th of October.

5.2.12.4.3 *Catches*

5.2.12.4.4 *Landings*

Giant red shrimp fishery are targeted only by trawlers. According to DCF data uploaded for the purposes of EWG14-19 the landings of giant red shrimp shows a maximum of 170 tons in 2005 followed by a gradual decline in the successive years (Fig. 5.2.12.4.4.1). The lowest value (63.3 t) was obtained in 2013.

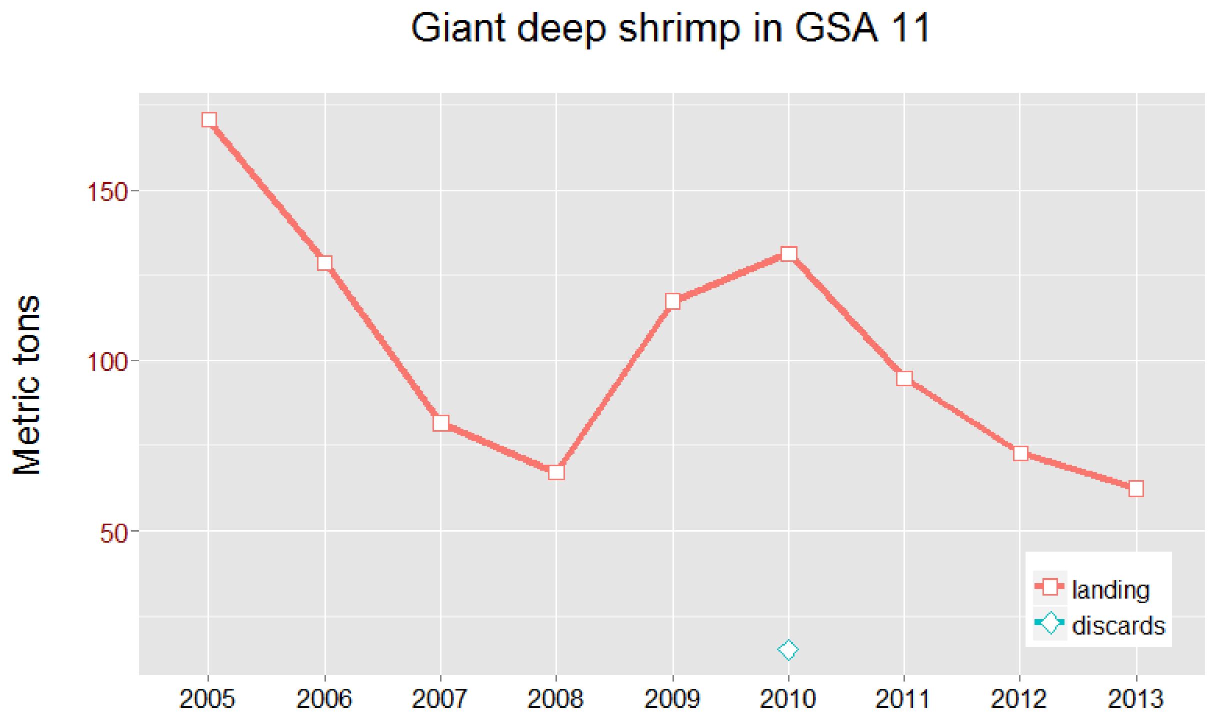


Fig. 5.2.12.4.4.1. Giant red shrimp in GSA 11. Annual landings (metric tons) by bottom trawlers in GSA 11.

The age structure of the landings, according to the DCF data, shows that most of the catch is composed by the age groups 1 and 2, nearly in the length range between 22 and 37 mm CL. In 2010-13 the exploited sizes ranged from 12 to 73 mm CL (Figs 5.2.12.4.4.2 and 5.2.12.4.4.3).

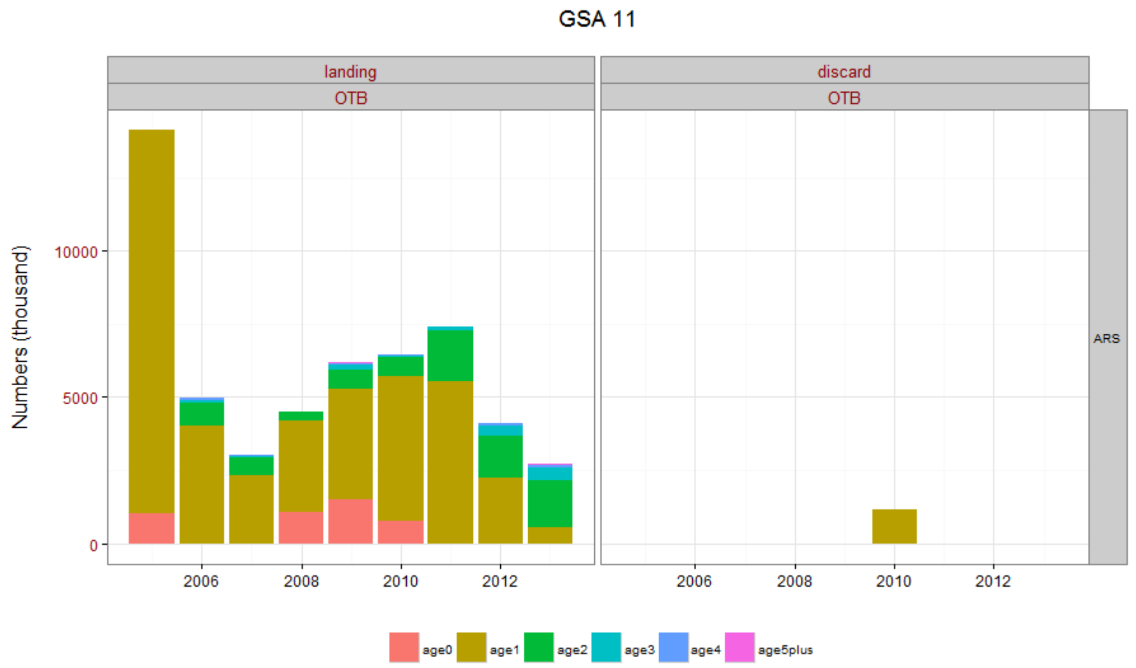


Fig. 5.2.12.4.4.2. Giant red shrimp in GSA 11. Catch composition by age from 2009 to 2013.

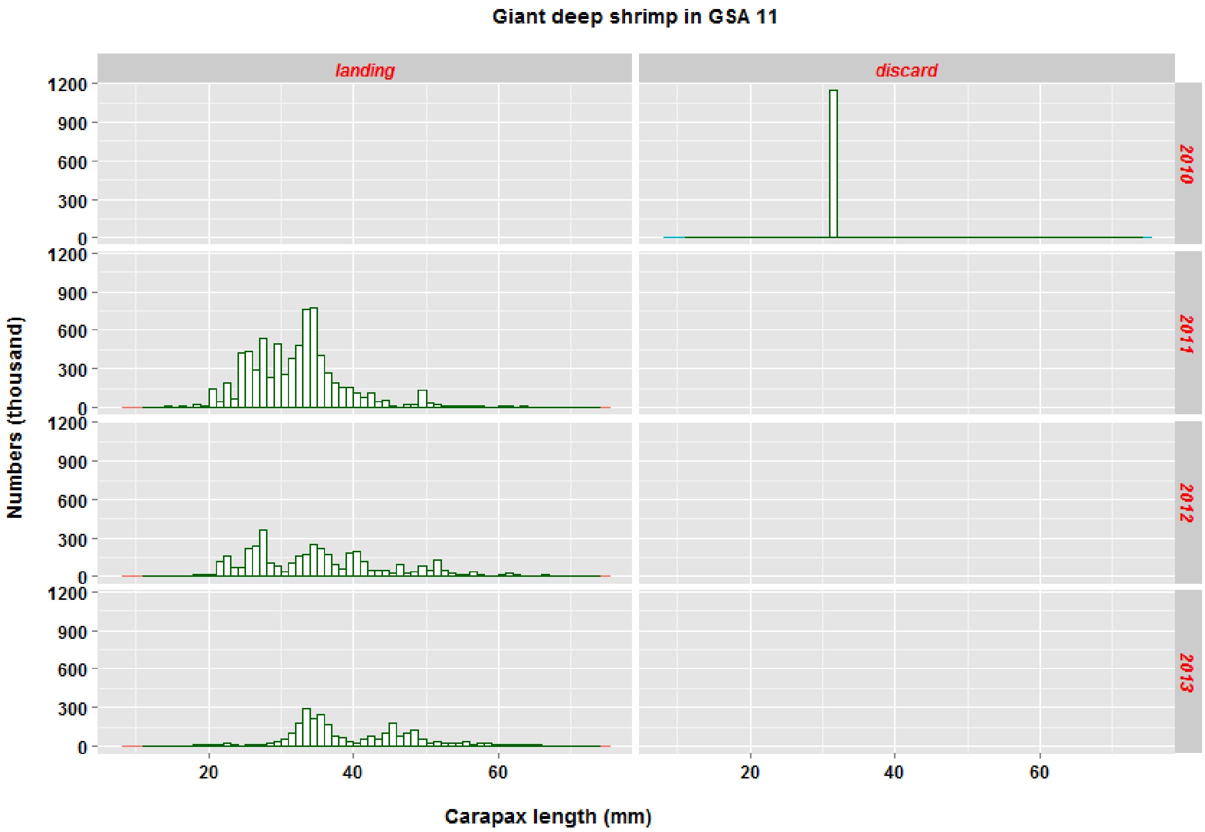


Fig. 5.2.12.4.4.3. Giant red shrimp in GSA 11. Catch composition by length from 2011 to 2013.

5.2.12.4.5 *Discards*

Discards are reported only in 2010. Since its size composition belongs to a unique class it is not clear if it is a misreported data.

5.2.12.4.6 Fishing effort

Fishing effort (KW*fishing days) is decreasing since 2004 with the lowest values achieved in 2013 (Fig. 5.2.12.4.6.1.).

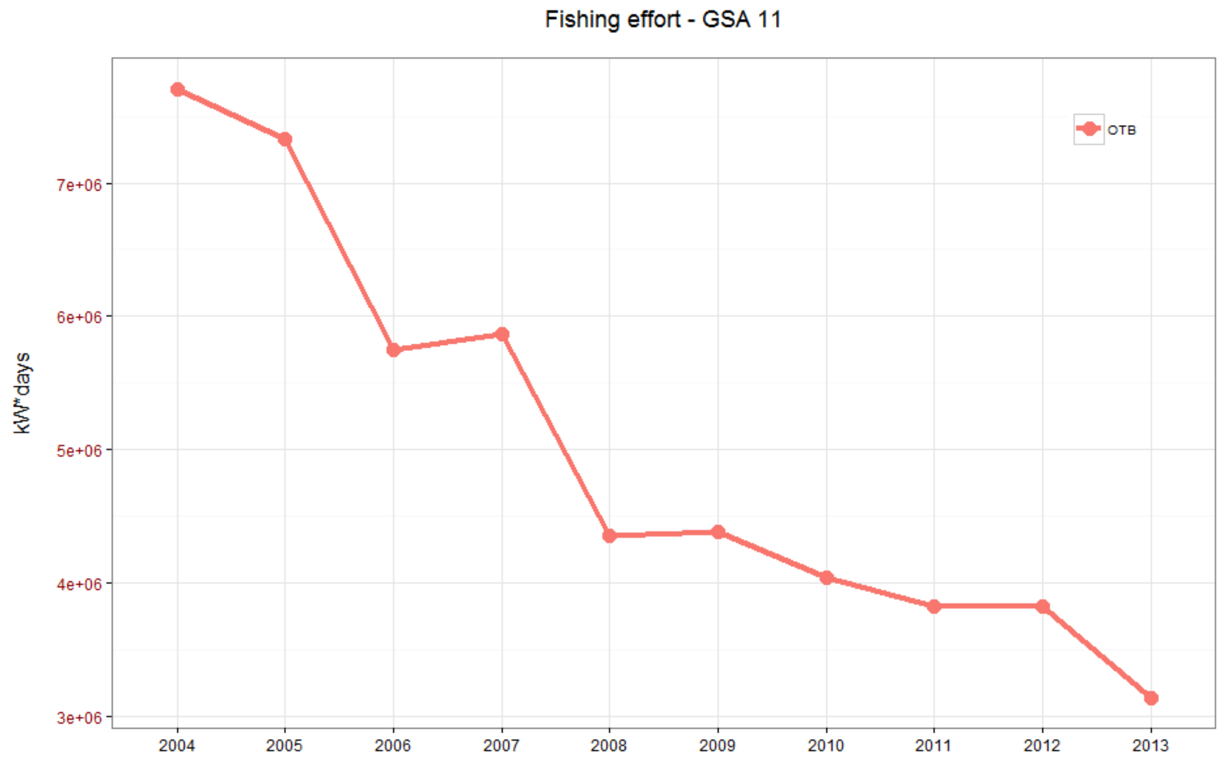


Fig. 5.2.12.4.6.1 Trends in fishing effort (kW*days) for trawl fleet in GSA 11 in the period 2004-2013.

5.2.12.5 Scientific surveys

MEDITS

5.2.12.5.1 Methods

Since 1994 the MEDITS trawl surveys have been carried out annually between May and July (except in 2007).

According to the MEDITS protocol (Relini, 2000; Bertand *et al.*, 2002) a stratified random sampling design with allocation of hauls proportional to depth strata extension (depth strata: 10–50 m, 51–100 m, 101–200 m, 201–500 m, 501–800 m) was adopted. A specific gear (GOC 73, with a 20 mm stretched mesh size in the cod-end) was always used following the instruction stated and reported in Dremière and Fiorentini (1996).

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 11 the following number of hauls was reported per depth stratum (s. Tab. 5.2.12.5.1.1).

Tab. 5.2.12.5.1.1 Number of hauls per year and depth stratum in GSA 11, 1994-2013.

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
A	16	18	20	21	20	19	19	17	20	18	15	17	19	20	17	18	19	20	19	20
B	25	20	23	23	22	22	22	25	19	19	20	22	19	19	19	20	19	18	20	19
C	20	24	31	31	31	30	31	29	24	24	24	23	24	24	22	24	24	25	23	24
D	26	22	24	24	23	26	21	21	20	20	18	20	20	21	21	19	20	20	21	21
E	29	23	27	27	27	26	30	29	16	18	18	15	16	16	16	16	17	18	18	17

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n
It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, 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.

5.2.12.5.2 Geographical distribution

The spatial distribution of *Aristaeomorpha foliacea* has been described by modeling the spatial correlation structure of the abundance indices using geostatistical techniques.
The stock is more abundant in the southern part of the GSA (Sardinian Sea) as shown in Figure 5.2.12.5.2.1.
The species shows a wide depth distribution over muddy and sandy-muddy bottoms from 450 to 700 m depth. The highest densities are found around the shelf break and deep slope of the south-western coast where are located the most persistent nursery and spawning areas (Fig. 5.2.12.5.2.1).

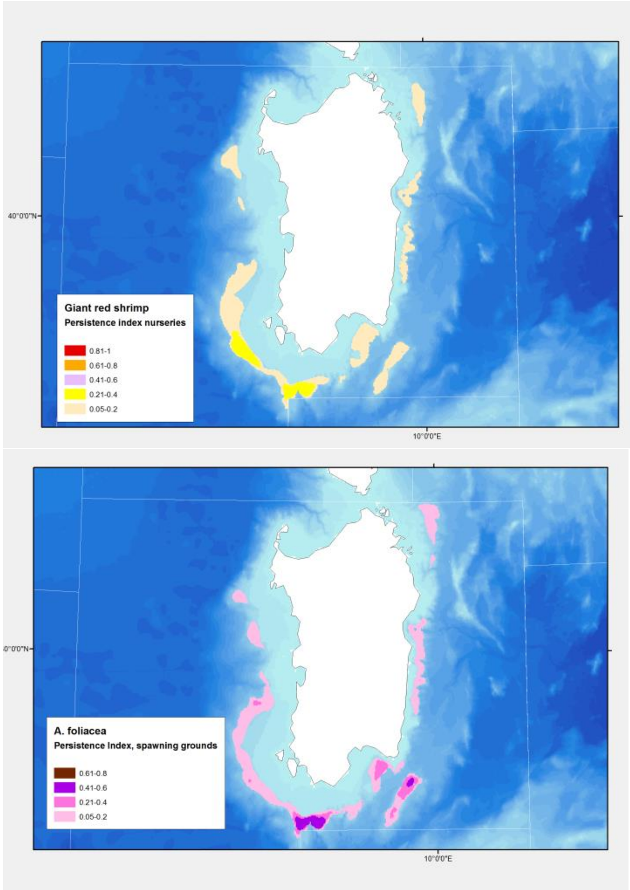
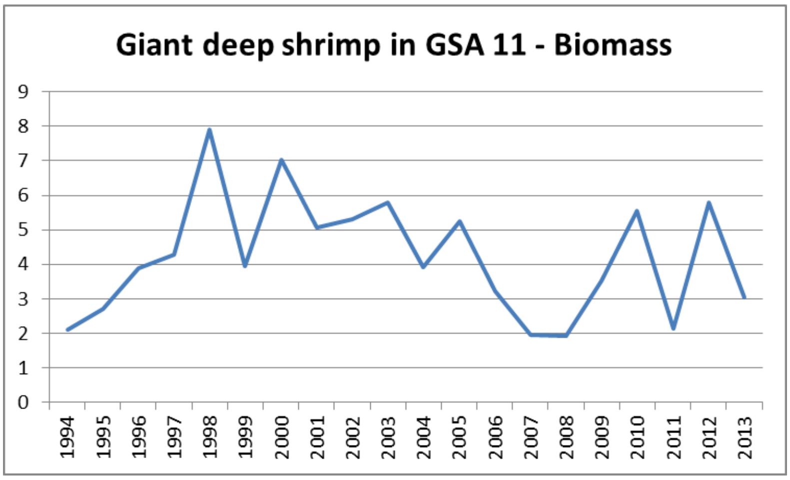


Fig. 5.2.12.5.2.1. Giant red shrimp in GSA 11. Temporal persistence of nursery areas (left) and spawning areas (right) based on MEDITS data 1994-2010 (maps from the EU Mediseh-marea project).

5.2.12.5.3Trends in abundance and biomass

Fishery independent information regarding the state of the deep-water rose shrimp in GSA 11 was derived from the international survey MEDITS. Figure 5.2.12.5.3.1 displays the estimated trend in deep-water rose shrimp abundance and biomass in GSA 11. The estimated abundance and biomass indices since 2000 show high variation without any trend.

A)



B)

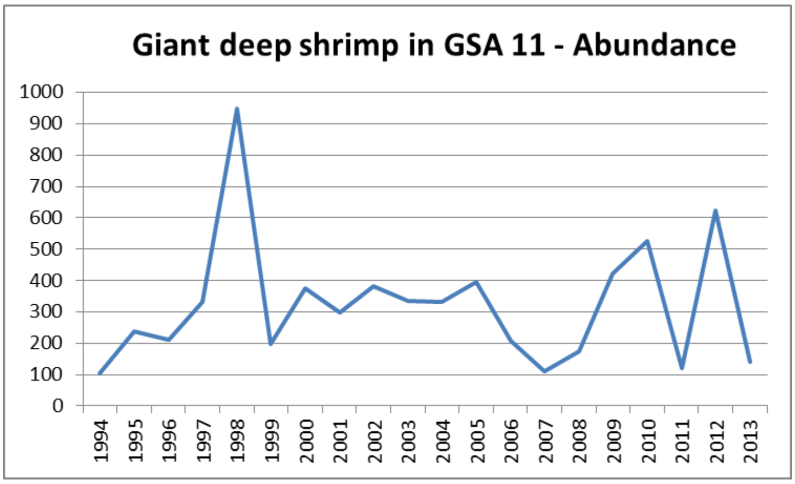


Fig. 5.2.12.5.3.1. Giant red shrimp in GSA 11. Medits biomass (A) and abundance (B) indices.

From 1994 to 2005 two trawl surveys are regularly carried out each year: MEDITS, in spring, and GRUND, in autumn, although the MEDITS data only are available to the STECF.
The main peak in density occurred in 2009, followed by a deep decrease in 1999 a stable period a new decrease a then a temporal increasing trend in density and biomass from 2008.
The same general pattern was observed for biomass of giant red shrimp. Even though the peak of 1998 and the successive decline of 1999 are less evident, the pattern shows a decline until the 2007 and a successive increasing trend, with some fluctuations from year to year (Fig. 5.2.12.5.3.1).

5.2.12.5.4 Trends in abundance by length or age

Figs 5.2.12.5.4.1 and 5.2.11.5.4.2 show standardized length frequency distribution (n/Km^2) of *A. foliacea* females and males in GSA 11 for the period 1994-2013.

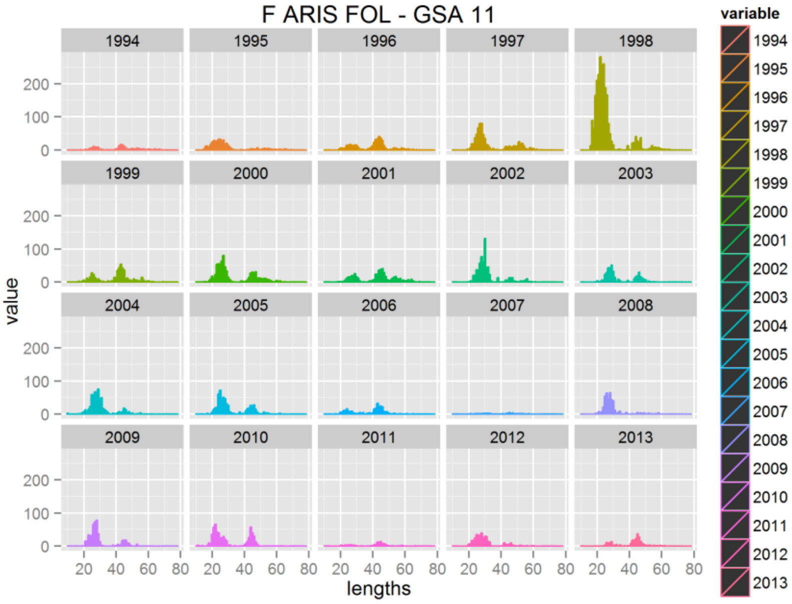


Fig. 5.2.12.5.4.1. Giant red shrimp in GSA 11. Stratified abundance indices (n/km^2) of females by size, 1994-2013.

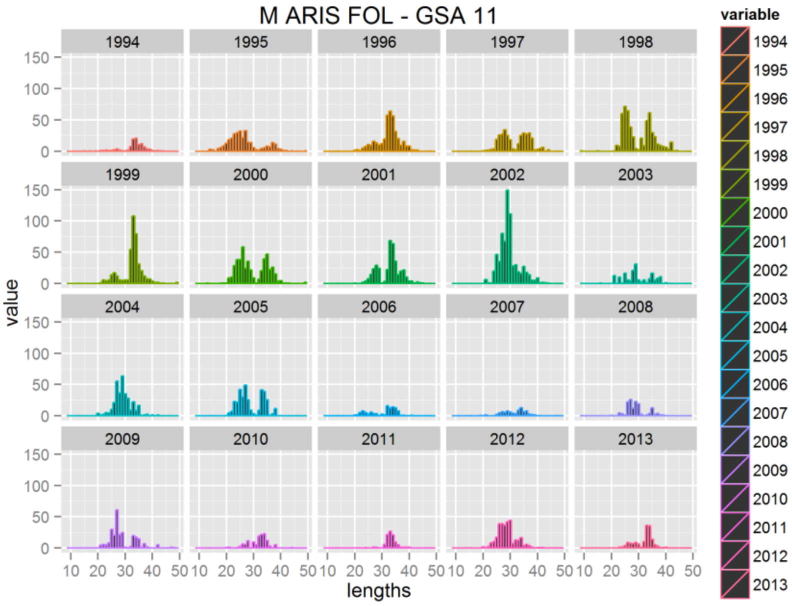


Fig. 5.2.12.5.4.2. Giant red shrimp in GSA 11. Stratified abundance indices (n/km^2) of males by size, 1994-2013.

5.2.12.5.5 Trends in growth

No information available.

5.2.12.5.6 Trends in maturity

No information available.

5.2.12.6 Assessment of historic stock parameters

5.2.12.6.1 *Methods*

Due to inconsistency in the short data series (see Data quality for details) STECF EWG 14-19 decided to postpone the assessment of this stock. The state of the adult abundances was not fully evaluated.

Method 1: SURBA

5.2.12.6.2 *Justification*

SURBA software (Needle, 2003) was applied using abundance estimates by length gatered from a 20 years' time series fishery-independent data source (MEDITS survey). The SURBA assessment tool estimates the trend in population structure and the fishing mortality vector (F) from the length frequency distribution of Aristaeomorpha foliacea in the GSA11.

5.2.12.6.3 Input parameters

The age groups were estimated by statistical age slicing (knife method) using the following growth parameters (Tab. 5.2.11.6.3.1.).

Tab. 5.2.11.6.3.1. Giant red Shrimp in GSA 11. Growth and length-weight input parameter used for age slicing and SURBA.

ARS	Female	Male
Growth parameters		
CL∞ (mm)	72	42.7
K/year	0.4	0.77
t0 (year)	0	-0.27
Length-weight		
a	0.0013	0.0042
b	2.67	2.35

Age slicing was computed by sex and numbers obtained was combined (Tab. 5.2.11.6.3.2). A 5+ group was used.

Tab. 5.2.11.6.3.2. Giant red Shrimp in GSA 11. Age groups obtained after the statistical age slicing procedure.

	Medits CPUE (n/km^2) at age					
Year	0	1	2	3	4	5+
1994	19.3	73.0	49.9	7.7	2.9	2.9
1995	244.8	117.6	36.3	11.0	4.3	3.4
1996	47.7	237.3	91.8	17.5	5.6	3.1
1997	92.7	217.0	122.5	14.9	6.1	4.8
1998	783.6	255.2	97.5	24.5	5.9	5.5
1999	77.6	281.7	96.1	18.6	2.2	2.9
2000	221.1	273.1	187.5	18.6	6.3	1.3
2001	35.3	216.6	141.5	22.7	10.8	3.9
2002	123.6	694.9	90.4	21.5	0.6	2.4

	Medits CPUE (n/km^2) at age					
Year	0	1	2	3	4	5+
2003	74.0	197.0	90.6	2.8	0.8	0.0
2004	182.7	519.8	59.1	3.2	0.5	0.4
2005	283.5	379.7	100.7	0.5	1.6	0.0
2006	76.7	161.8	77.5	2.3	1.6	0.3
2007	11.1	67.1	32.6	3.8	0.0	0.3
2008	128.5	242.3	32.0	7.6	0.6	0.0
2009	224.6	293.6	66.0	0.6	0.0	5.1
2010	272.1	196.3	80.7	2.7	1.8	0.7
2011	25.0	124.4	46.6	5.9	1.2	2.0
2012	186.1	313.7	31.1	3.9	0.6	0.9
2013	27.6	200.7	101.5	9.3	1.6	0.3

The age group 0 was removed for the analysis due to a not fully recruitment to the gear.
Natural mortality vector (M) was obtained as mean of the estimated values by age per sex using Prodbiom method (Abella et al., 1997).
Model computation was made considering a relative estimation configuration and the main SURBA settings are reported below in table 5.2.11.6.3.3.

Tab. 5.2.11.6.3.3. Giant red shrimp in GSA 11. Main SURBA settings.

Age	1	2	3	4	5+
Natural mortality vector (M)	0.82	0.56	0.47	0.43	0.41
Proportion of mature	0.6	0.8	1	1	1
catchabilities estimation (q)	0.8	1	1	1	1
Age weightings	1	1	1	1	1
Mean weight by age					
1994-2013	0.025	0.037	0.045	0.049	0.052

5.2.12.6.4 Results

The fitted year effect shows high fluctuations in the whole time series, showing a peak in 2002 and a successive decline until 2008 (Fig. 5.2.12.6.4.1). The age effect do not shows a any pattern. The Fitted cohort effects are progressively decreasing from 2002.

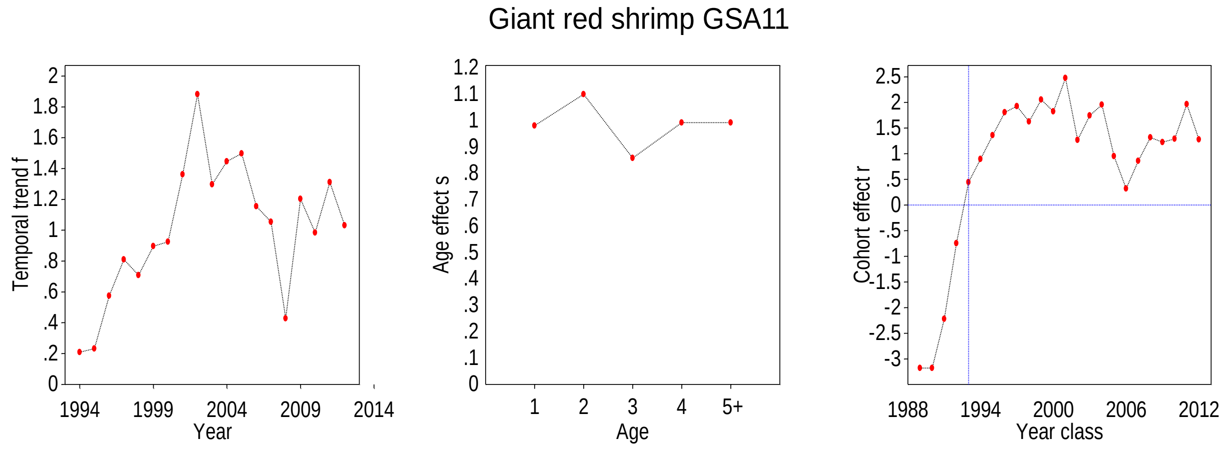


Fig. 5.2.12.6.4.1. Giant red shrimp in GSA 11. MEDITS survey. Fitted year, age and cohort effects estimated by SURBA.

As shown in figure 5.2.11.6.4.2 the mean fishing mortality (F_{1-3}) fitted from the Medits range from 0.23 (1994) to 1.58 (2002), with a mean value of 0.99. Relative indices of spawning stock biomass (SSB) showed a peak in 2002, a successive decreasing trend until 2007 followed by an increasing in recent years.

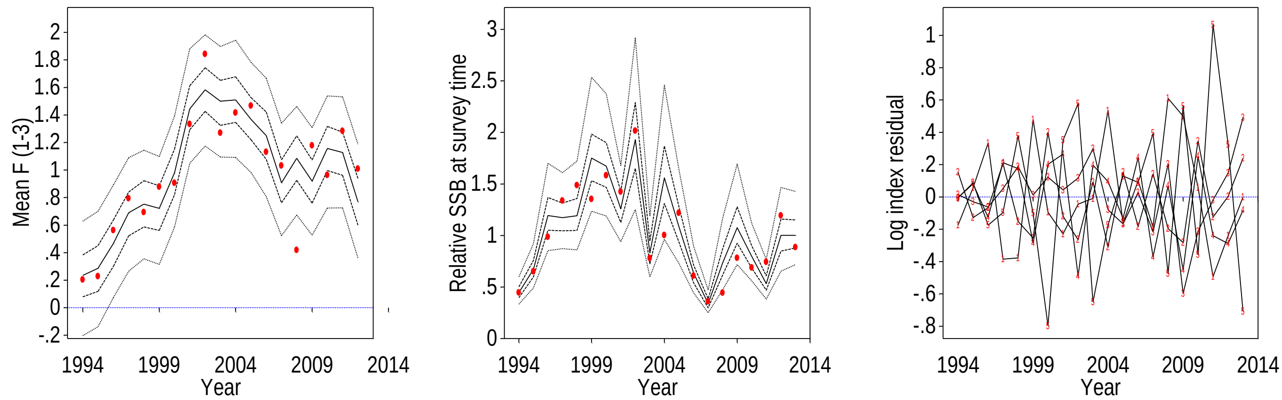
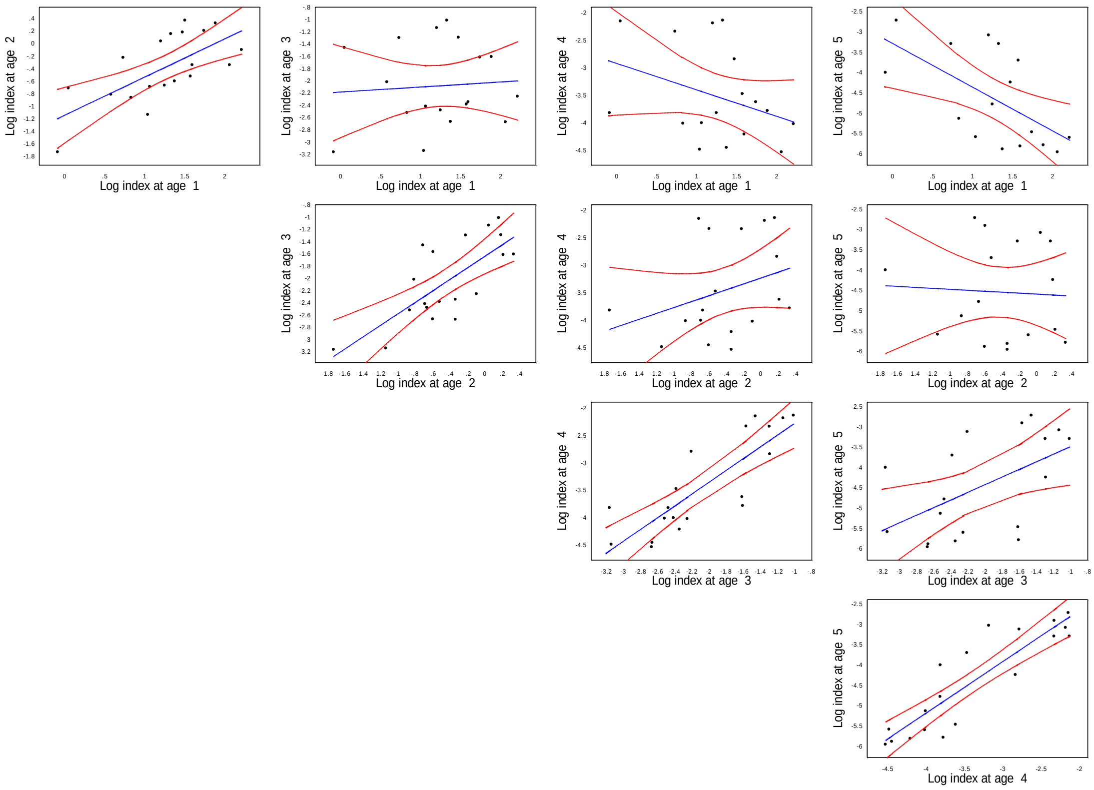


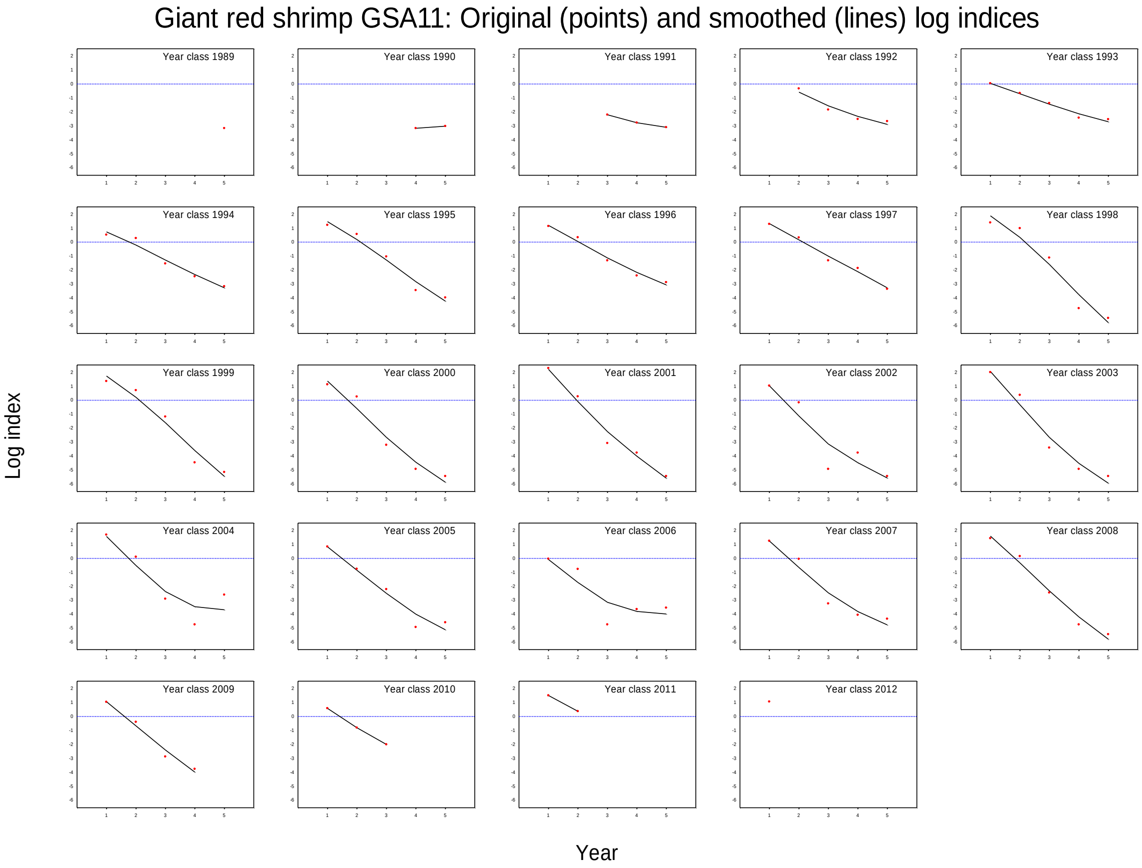
Fig. 5.2.11.6.4.2. Giant red shrimp in GSA 11. Estimated trend in F_{1-3}, relative SSB and relative recruitment index at age 1 in the GSA11, dotted lines are 2.5% and 97.5% confidence intervals.

The SURBA model diagnostic show a good results for the fitting procedure (Fig. 5.2.12.6.4.3). The comparisons between observed and fitted abundance indices per year, comparative scatterplot at age (Fig. 5.2.12.6.4.3a), catch curves (Fig. 5.2.12.6.4.3b) and residuals of the log index abundance (Fig. 5.2.12.6.4.3c) do not highlight particular problems.

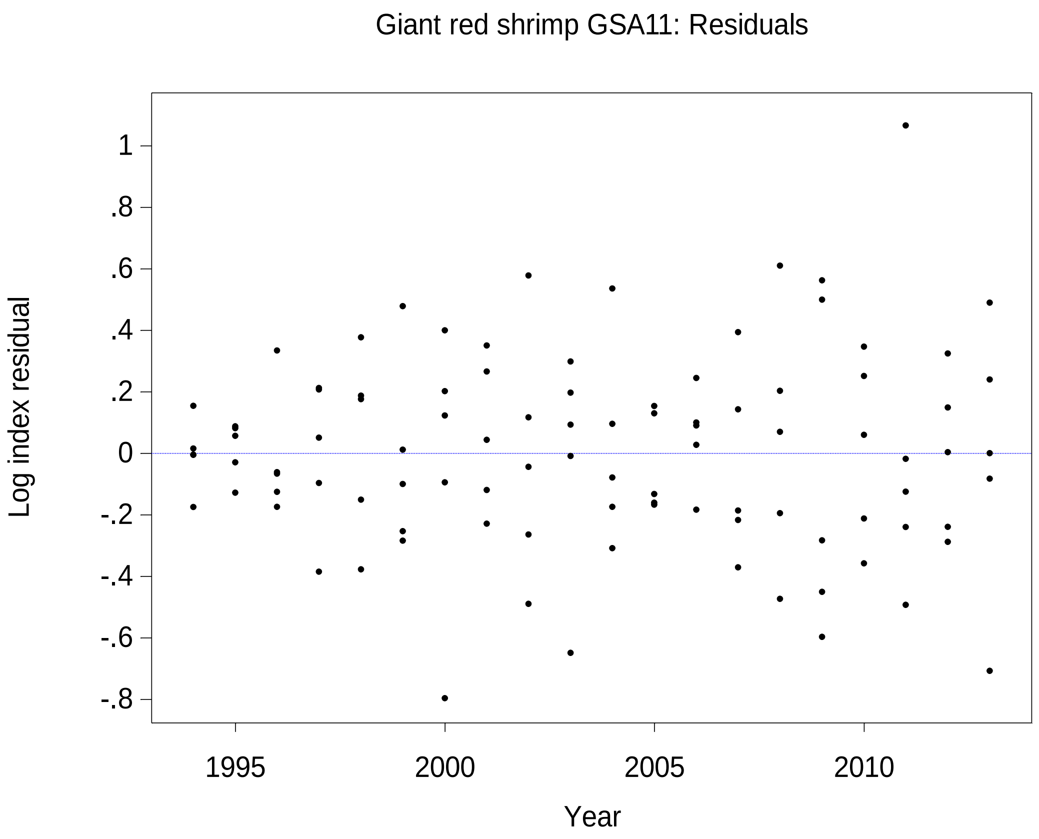
Giant red shrimp GSA11: Comparative scatterplots at age



A


Giant red shrimp GSA11: Original (points) and smoothed (lines) log indices
Log index
Year class 1989
Year class 1990
Year class 1991
Year class 1992
Year class 1993
Year class 1994
Year class 1995
Year class 1996
Year class 1997
Year class 1998
Year class 1999
Year class 2000
Year class 2001
Year class 2002
Year class 2003
Year class 2004
Year class 2005
Year class 2006
Year class 2007
Year class 2008
Year class 2009
Year class 2010
Year class 2011
Year class 2012
Year

B



C

Fig. 5.2.11.6.4.3. Giant red shrimp in GSA 11. SURBA Model diagnostic: a) comparative scatterplot at age; b) comparison between observed (points) and fitted (lines) MEDITS survey abundance indices, for each year; c) residual of the log index abundance.

The retrospective analysis results shows a high variability pattern. Recruitment showed a peak in 2002 (Fig. 5.2.11.6.4.4).

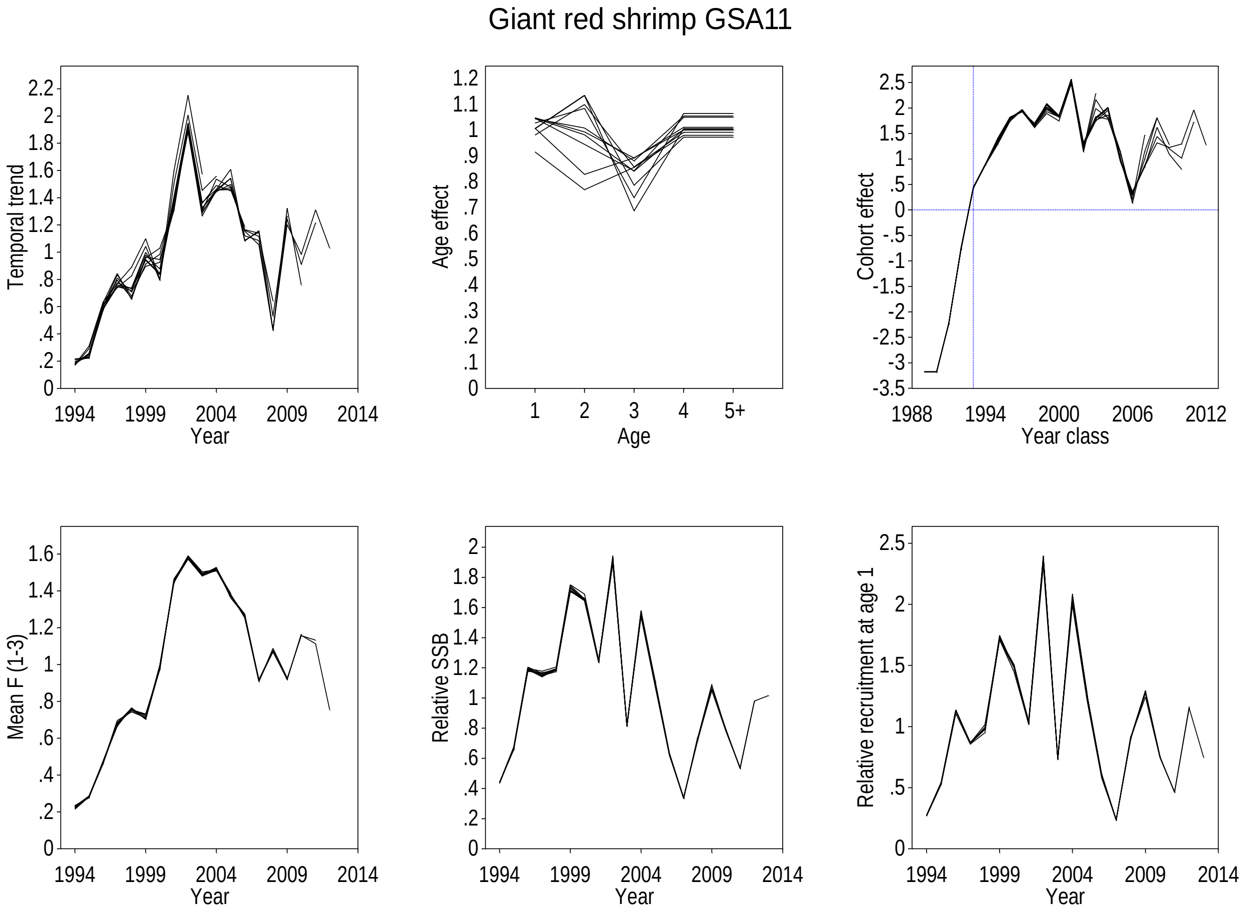


Fig. 5.2.11.6.4.4. Giant red shrimp in GSA 11. Retrospective analysis and residuals by ages output of SURBA.

5.2.12.7 Long term prediction

5.2.12.7.1 Justification

5.2.12.7.2 Results

5.2.12.8 Data quality

Data available during EWG 14-19 for giant red shrimp were incomplete and rather inconsistent for several aspects that are listed and commented below.

Landings

The official landings data were reported only for different time series (2005-2013 catch by age and 2011-2013 landings by length).

The composition in age (numbers-at-age) and length (numbers-at-length) of the landings were available for different time series periods. The first are available since 2005, the latter only for the last three years (2011-2013) (Tables 5.2.12.8.1 and 5.2.12.8.2). Numbers-at-age appear inconsistent in 2005 and 2006 when the catch appear composed by only two and three age classes respectively (i.e. lack of big specimens).

Moreover, when the LFD of the landings at length are splitted by age (with knife slicing using female VBG parameters) and compared with the information derived by the catch at age DB they apper to be are rather different (Fig. 5.2.12.8.1). In particular the 0 group (specimens below 28.4 mm CL), as showed in figure 5.2.12.8.1 A and table 5.2.12.8.1, is not reported for the catch at age DB in 2011-2013 (Figure 5.2.12.8.1 B), and chatches reported in 2010 (Figure 5.2.12.8.1 B) do not appear in the landings at length DB (Figure 5.2.12.8.1 A).

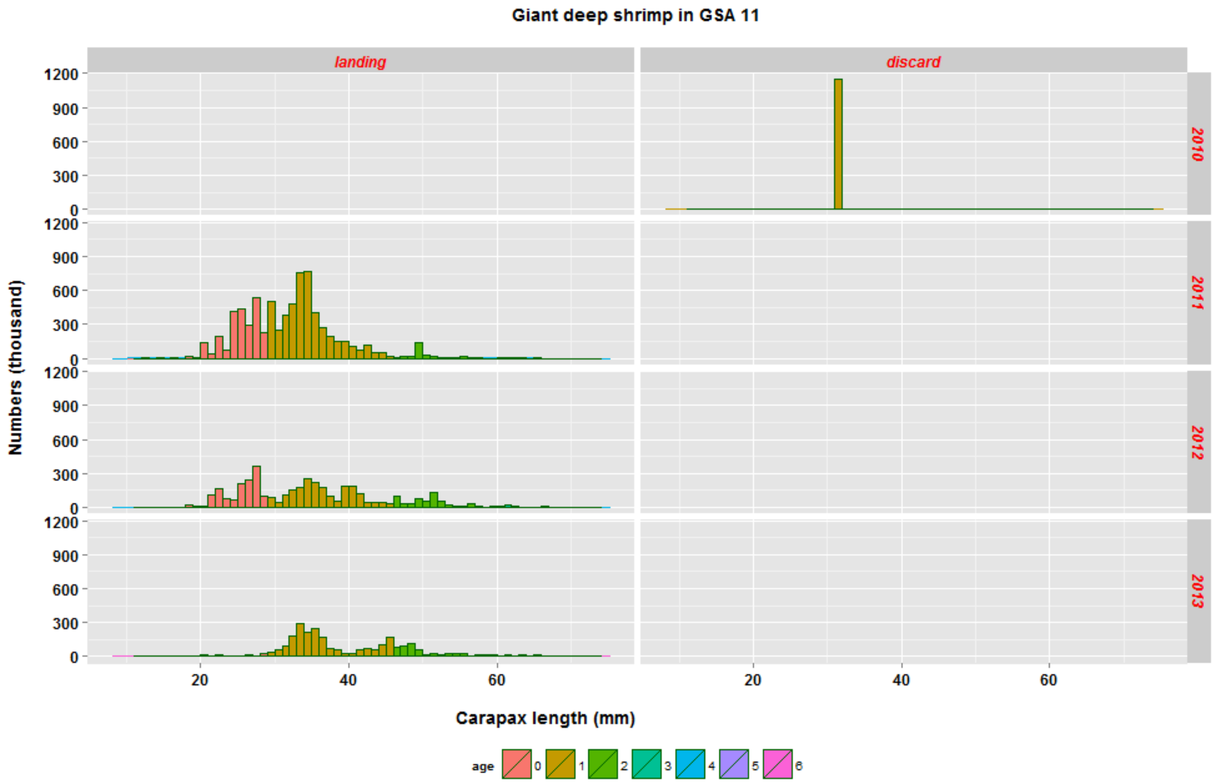
Table 5.2.12.8.1. Giant red shrimp in GSA 11. Estimated annual landings and numbers at-age.

year	age0	age1	age2	age3	age4	age5plus
2005	1011.387	13128.49	0	0	0	0
2006	0	4013.462	772.575	116.932	65.529	0
2007	0	2338.564	574.655	78.895	34.122	5.716
2008	1070.186	3123.813	312.942	0	0	0
2009	1477.875	3790.588	679.242	170.042	42.531	19.776
2010	762.936	4927.078	687.308	47.07	12.16	2.657
2011	0	5533.428	1733.235	121.909	15.131	3.688
2012	0	2231.407	1453.738	349.492	64.232	22.378
2013	0	545.691	1595.701	441.001	82.288	46.254

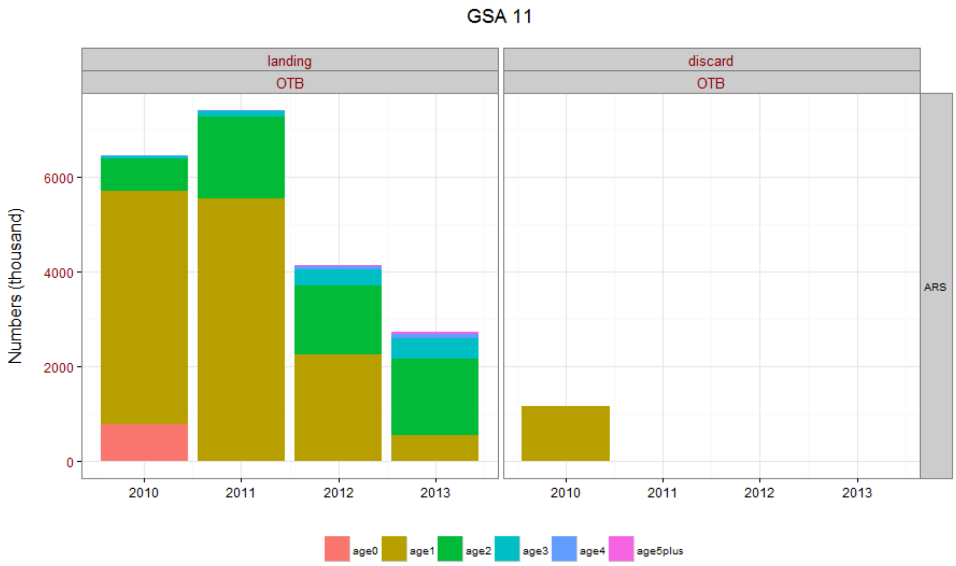
Table 5.2.12.8.2. Giant red shrimp in GSA 11. Numbers at-length data (landings).

AGE	LEN	2010	2011	2012	2013
0	12	0	1.684	0	0
0	13	0	0	0	0
0	14	0	8.914	3.619	0
0	15	0	0	5.429	0
0	16	0	4.457	5.429	0
0	17	0	0	3.619	0
0	18	0	17.828	19.528	9.05
0	19	0	4.457	10.858	6.033
0	20	0	143.372	14.099	12.067
0	21	0	39.617	116.027	6.522
0	22	0	189.13	165.182	21.117
0	23	0	67.177	72.68	9.05
0	24	0	420.11	68.682	3.017
0	25	0	437.543	212.526	6.116
0	26	0	294.767	244.342	14.375
0	27	0	540.903	368.66	10.374
0	28	0	230.559	100.119	26
1	29	0	497.605	86.021	33.658
1	30	0	252.401	40.485	61.066
1	31	0	376.529	108.808	98.783
1	32	0	478.561	157.088	177.665
1	33	0	758.749	174.467	293.033
1	34	0	770.025	254.056	216.658
1	35	0	407.055	216.326	249.94
1	36	0	272.041	176.885	166.333
1	37	0	189.168	97.708	74.996
1	38	0	151.479	59.606	63.088

1	39	0	150.55	189.282	29.424
1	40	0	105.378	191.562	27.477
1	41	0	76.121	116.91	55.633
1	42	0	111.591	46.238	73.613
1	43	0	48.036	46.238	61.141
1	44	0	50.215	49.561	104.811
1	45	0	12.012	28.224	175.303
2	46	0	3.368	99.71	80.011
2	47	0	16.778	31.843	97.973
2	48	0	20.542	35.379	119.25
2	49	0	138.183	79.611	55.433
2	50	0	29.921	51.849	20.549
2	51	0	19.644	127.418	28.82
2	52	0	8.914	51.288	19.468
2	53	0	8.821	26.414	26.002
2	54	0	4.364	10.858	25.611
2	55	0	12.546	14.477	30.637
2	56	0	8.728	38.185	5.678
3	57	0	8.728	14.477	18.448
3	58	0	0	5.429	17.985
3	59	0	0	7.239	16.243
3	60	0	6.273	14.099	9.545
3	61	0	4.364	22.712	12.208
3	62	0	1.909	15.473	8.269
4	63	0	4.364	3.619	11.961
4	64	0	0	5.429	7.339
4	65	0	1.909	0	13.736
4	66	0	0	15.473	3.55
5	68	0	0	0	1.283
6+	69	0	0	0	4.862
6+	73	0	0	0	4.862



A



B

Figure 5.2.12.8.1 Giant red shrimp in GSA 11. Comparison of data by lengths and ages. A) Landings at length splitted by age; B) catches at age (since 2010).

Discards

Discards are unusual for giant red shrimp. They are reported in GSA 11 for one year only and with high numbers. EWG 14-19 considet that most likely a problem in the expansion procedure has occurred for this year (Figure 5.2.12.8.1, Table 5.2.12.8.3).

Table 5.2.12.8.3. Giant red shrimp in GSA 11. Numbers at-length data (discards).

AGE	LEN	2010	2011	2012	2013
1	31	1149.863	0	0	0

<u>Comparison with old databases</u>

The latest JRC DBs (catch.csv; landings.csv; discards.csv; effort.csv) were compared with the old DBs (A Fisheries landings and discards at age data MED 2002-2011-2013.accdb; B Fisheries landings at length data MED 2002-2011 2013.accdb; C Fisheries discards at length data MED 2002-2011 2013.accdb; D Fisheries effort data MED 2002-2011 2013.accdb).

From the comparison of the fisheries data landings at age, niether the total values nor the values by age which were reported for 2011 and 2012 in EWG 13-19 correspond to the data submitted these year (JRC 2014). (A Fisheries landings and discards at age data MED 2002-2011-2013.mdb). Differences were also found for landings at length. The latest information do not match the old one again for 2011 and 2012 (B Fisheries landings at length data MED 2002-2011 2013.mdb). Both total values and values by length class differ. In particular total values differ only for 2011 while relative values by length class differ for all years. The discards at length and at age are always the same among DBs (“discards.csv” and “C Fisheries discards at length data MED 2002-2011 2013.mdb”). Also the effort DBs agree between the different version used in different EWG, even though in 2013, 2010 and 2012 information were missing. The data gap has been covered in 2014.

Medits TA

Code for survey strata (strate field) were provided for 2007, 2008, 2009 during the meeting after we discovered it was missing in the official database. This information is required to calculate standardized survey indices (i.e. standardized LFDs, abundance and biomass stock indices).

Thus, considering the data deficiency listed above, STECF EWG 14-19 decided to postpone the assessment of this stock.

5.2.12.9 Scientific advice

EWG 19-19 did not provide scientific advice for the stock.

5.2.12.10 Short term considerations

Information on the stock status and trend has been derived from data independent from fishery (scientific survey). Indeed a SURBA analysis on 1994-2013 time series of MEDITS survey data was carried out.

5.2.12.10.1 *State of the stock size*

According to SURBA analysis on survey data, SSB was at the lowest levels in 1994 and 2007. After these minima a progressive increasing to the peak in 2002 occurs. Another lower peak is observed in 2009.

5.2.12.10.2 *State of recruitment*

Recruitment shows high fluctuations in the whole time series.

5.2.12.10.3 *State of exploitation*

Fishing mortality (F1-3) did not show any clear temporal trend, fluctuating beween a wide range (0.2-1.58).

5.2.12.11 Management recommendations

5.2.13 STOCK ASSESSMENT OF DEEP SEA PINK SHRIMP IN GSA 11

5.2.13.1 Stock Identification

Due to a lack of information about the structure of deep sea pink shrimp population in the western Mediterranean, this stock was assumed to be confined within the GSA 11 boundaries (Fig. 5.2.13.1).

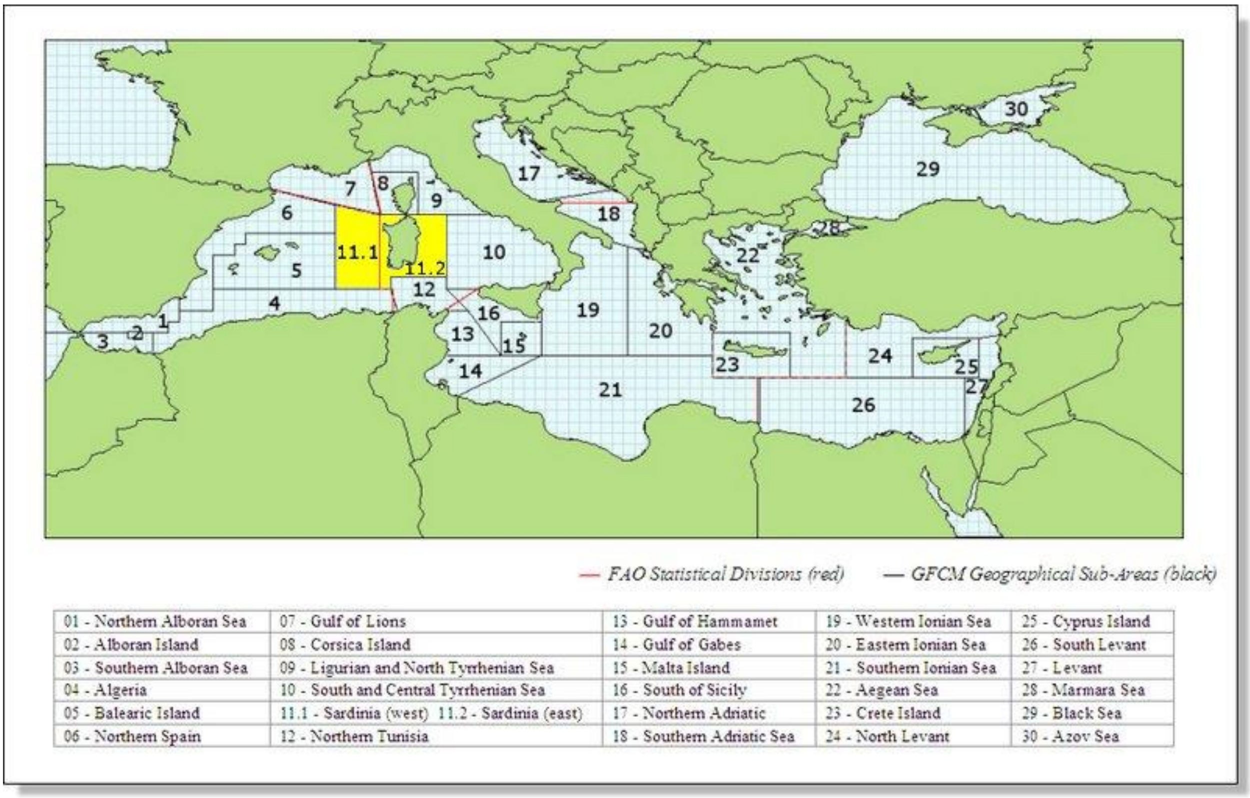


Fig. 5.2.13.1. Geographical localization of GSA 11.

5.2.13.2 Growth

There are no specific studies on the growth pattern of the species in Sardinian waters.

5.2.13.3 Maturity

The reproductive areas of *P. longirostris* are located in the upper slope where mature females are present all year round. However, the main peak seems to occur in spring.
The size at onset of sexual maturity occurs at about 24 mm CL.

5.2.13.4 Fisheries

5.2.13.4.1 General description of the fisheries

The species is one of the most important target species of the fishery carried out on bottoms of the upper slope and it is part of an important fishing assemblage targeted exclusively by trawlers of which as *Nephrops norvegicus*, *Merluccius merluccius*, *Eledone cirrhosa*, *Illex coindetii*, *Todaropsis eblanae*, *Helicolenus dactylopterus, Phycis blennoides, Micromesistius poutassou*, *Lophius* sp. are the most priceless species.
The discard fraction is composed of species such as *Glossanodon leioglossus, Capros aper, Galeus melastomus* and *Raja* sp.

The large trawlers of GSA 11 operate all the week from Monday to Saturday, generally coming back daily to the closest port at the coast for few hours early in the morning in order to send all the fish to the market. The mid-sized and small trawlers perform daily fishing trips, before the sunrise until the early morning, staying sometimes two days at sea. Moreover, due to the distance of the fishing grounds (Murenu et al., 2011) to the main harbors of the western cost and the dominant weather conditions, the fleet targeting *P. longirostris* shows some seasonal variations, with more time spent at sea from mid spring to mid-autumn. Some large trawlers move seasonally to different fishing grounds far from the usual ports. Most of the effort in GSA 11 is concentrated around the major fishing ports (Cagliari, Alghero, Porto Torres, La Caletta, Sant'Antioco, Oristano, Alghero). The trawl fleet showed remarkable changes from 1994 to 2004, with a general increase in the number of vessels and the replacement of the older ones, low tonnage wooden boats by larger steel boats. Actually in the GSA 11 operate a total of about 1300 boats, 150 of which are small medium and big trawlers. Administratively they all belong to the major fishing ports ("compamare") namely Cagliari, La Maddalena, Olbia, Oristano and Porto Torres (Fig. 5.2.13.4.1.1). Other important ports are Alghero, Porto Torres, La Caletta and Sant'Antioco.

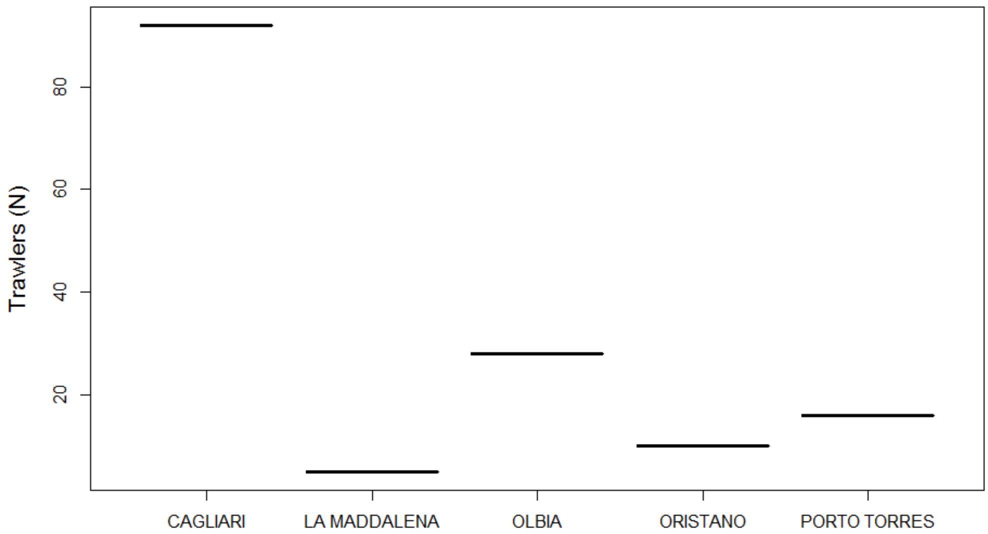


Fig. 5.2.13.4.1.1 Number of trawlers operating in GSA 11 grouped by main port.

5.2.13.4.2 Management regulations applicable in 2014

As in other areas of the Mediterranean, the stock management is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area/season closures). EC regulation 1967/2006 does not provide for a minimum length size for this species. The minimum legal landing size is 20 mm carapace length (EC regulation 1967/2006). The other management regulations are the same applied to trawl fisheries in the Mediterranean Sea.

Since 2012 a reduction of the fishing ban period that generally was enforced for 45 days occurs. In 2012 and 2013 the fishing ban was established by the Autonomous region of Sardinia from from 1st to 30th of September, while in 2014 it has been split from the 15th of September until the 15th of October.

5.2.13.4.3 *Catches*

5.2.13.4.4 Landings

Total landings of deep see pink shrimp according to DCF data shows a peak of 552 tons in 2005 followed by a fast decline in the successive years (Fig. 5.2.13.4.4.1). The lowest value (23.2 t) was obtained in 2013 (official data call 2014) (Tab. 5.2.13.4.4.1).

Table 5.2.13.4.4.1. Deep-sea pink shrimp in GSA 11. Landings .

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OTB (tons)	232	548	127	79.4	45.8	42.6	54	71.3	42.3	23.2

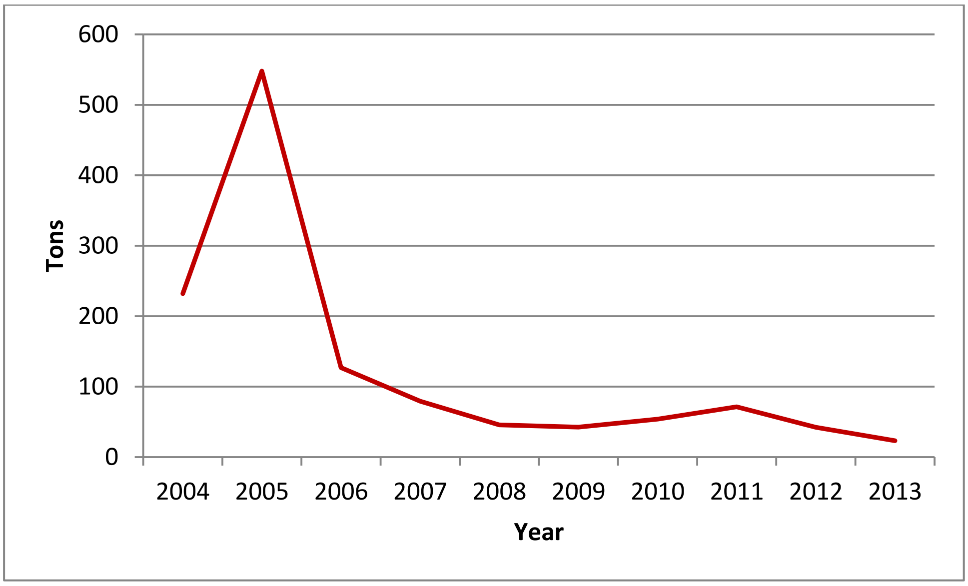


Fig. 5.2.13.4.4.1. Deep-sea pink shrimp in GSA 11. Annual landings (tons) of bottom trawlers.

The age structure of the landings, according to the DCF data, shows that most of the catch is composed by the age groups 1 and 2, approximately in the length between 22 and 37 mm CL in 2010-13, with the most exploited sizes ranging from 22 to 37 mm CL (Figs 5.2.13.4.4.2 and 5.2.13.4.4.3).

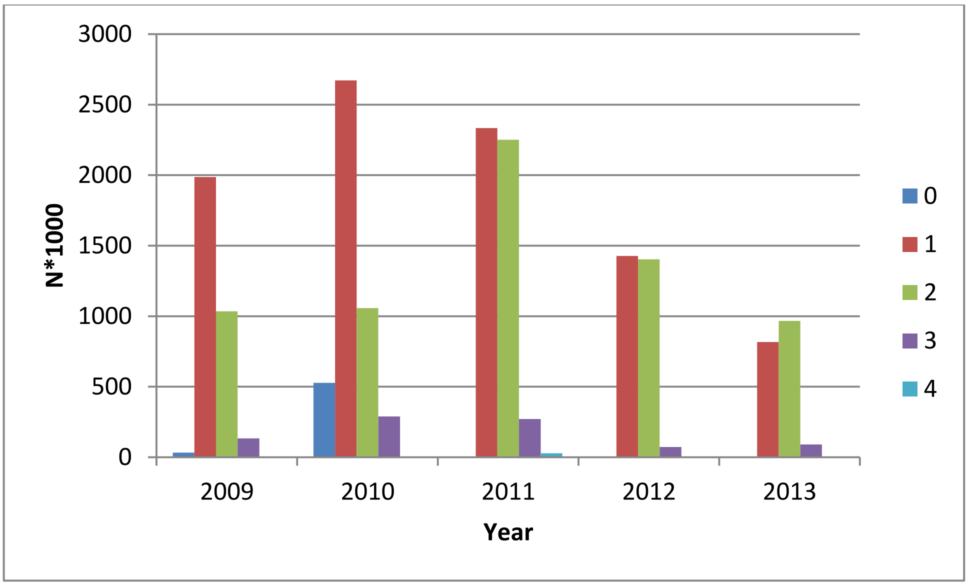


Fig. 5.2.13.4.4.2. Deep-sea pink shrimp in GSA 11. Catch composition by age from 2009 to 2013.

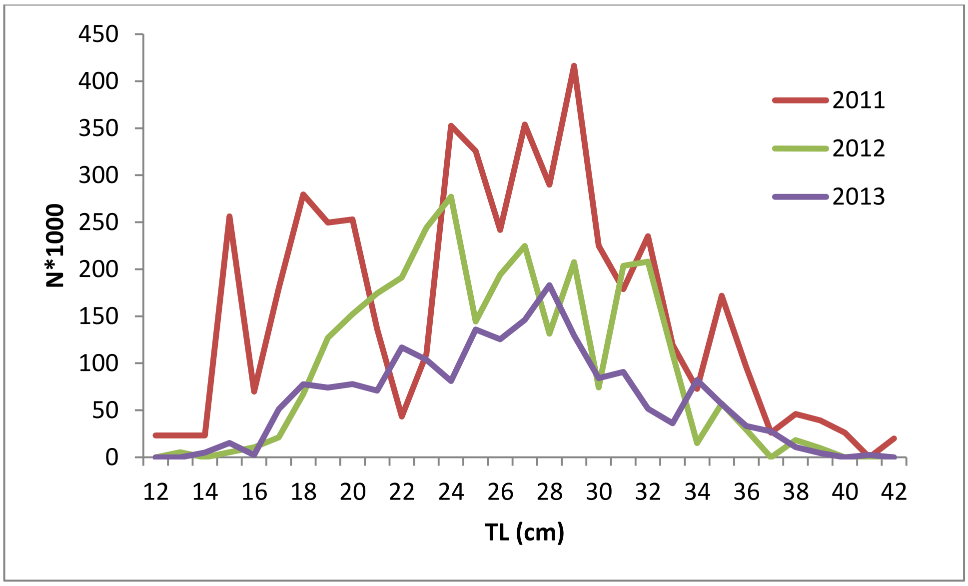


Fig. 5.2.13.4.4.3. Deep-sea pink shrimp in GSA 11. Catch composition by length from 2011 to 2013.

5.2.13.4.5 Discards

No discards data were available during the EWG 14-19.

5.2.13.4.6 Fishing effort

Fishing effort (KW*fishing days) is decreasing since 2004 with the lowest values achieved in 2013 (Fig. 5.2.13.4.6.1).

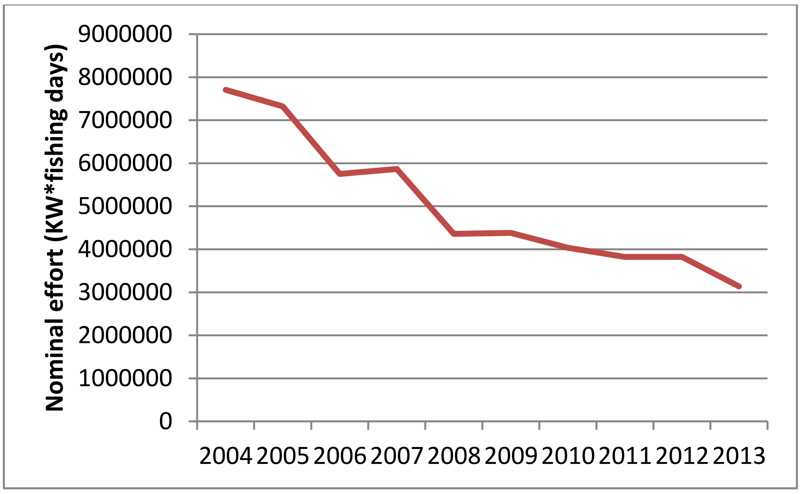


Fig. 5.2.13.4.6.1. Trends in fishing effort (kW*days) for trawl fleet in GSA 11 in the period 2004-2013.

5.2.13.5 Scientific surveys

MEDITS

5.2.13.5.1 Methods

Since 1994 the MEDITS trawl surveys have been carried out annually between May and July (except in 2007).

According to the MEDITS protocol (Relini, 2000; Bertand *et al.*, 2002) a stratified random sampling design with allocation of hauls proportional to depth strata extension (depth strata: 10–50 m, 51–100 m, 101–200 m, 201–500 m, 501–800 m) was adopted. A specific gear (GOC 73, with a 20 mm stretched mesh size in the cod-end) was always used following the instruction stated and reported in Dremière and Fiorentini (1996).

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 11 the following number of hauls was reported per depth stratum (s. Tab. 5.2.13.5.1.1).

Tab. 5.2.13.5.1.1. MEDITS number of hauls per year and depth stratum in GSA 11, 1994-2013.

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
A	16	18	20	21	20	19	19	17	20	18	15	17	19	20	17	18	19	20	19	20
B	25	20	23	23	22	22	22	25	19	19	20	22	19	19	19	20	19	18	20	19
C	20	24	31	31	31	30	31	29	24	24	24	23	24	24	22	24	24	25	23	24
D	26	22	24	24	23	26	21	22	20	20	18	20	20	21	21	19	20	20	21	21
E	29	23	27	27	27	26	30	29	16	18	18	15	16	16	16	16	17	18	18	17

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

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

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

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

Where:

- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

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

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, 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.

5.2.13.5.2 Geographical distribution

The spatial distribution of *Parapaeneus longirostris* has been described by modeling the spatial correlation structure of the abundance indices using geostatistical techniques.

The stock is more abundant in the south-western part of the GSA 11 (Sardinian Sea) as shown in Figure 5.2.13.5.2.1. The species shows a wide depth distribution over muddy and sandy-muddy bottoms from 150 to 570 m depth, with a higher abundance between 200 and 450 m depth. The highest densities are found around the shelf break and upper slope of the south-western coast where are located the most persistent nursery and spawning areas (Fig. 5.2.13.5.2.1.).

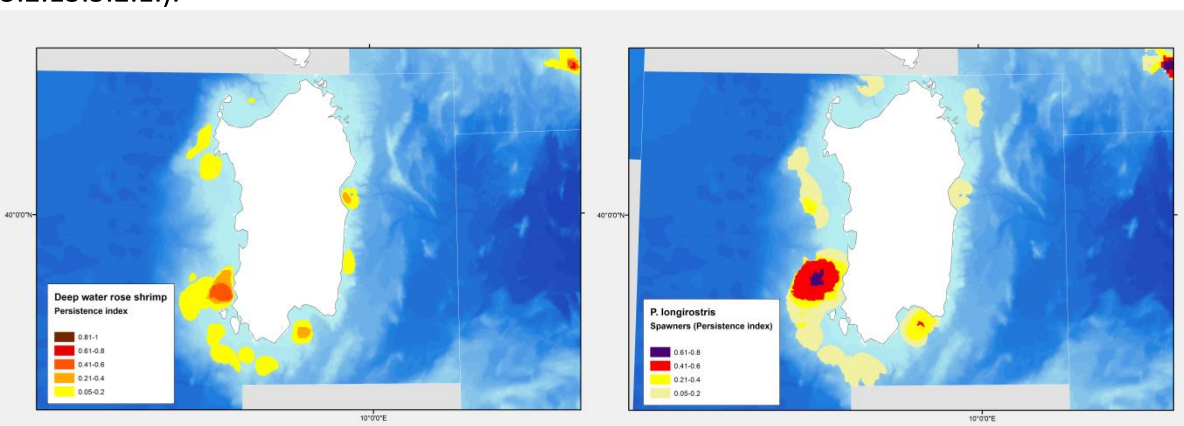


Fig. 5.2.13.5.2.1. Deep-sea pink shrimp in GSA 11. Temporal persistence of nursery areas (left) and spawning areas (right) based on MEDITS data 1994-2010 (maps from the EU Mediseh-marea project).

5.2.13.5.3 Trends in abundance and biomass

Fishery independent information regarding the state of the Deep-sea pink shrimp in GSA 11 was derived from the international survey MEDITS. Figure 5.2.13.5.3.1 displays the estimated trend in Deep-sea pink shrimp abundance and biomass in GSA 11.

The estimated abundance and biomass indices since 2000 show high variation without any trend.

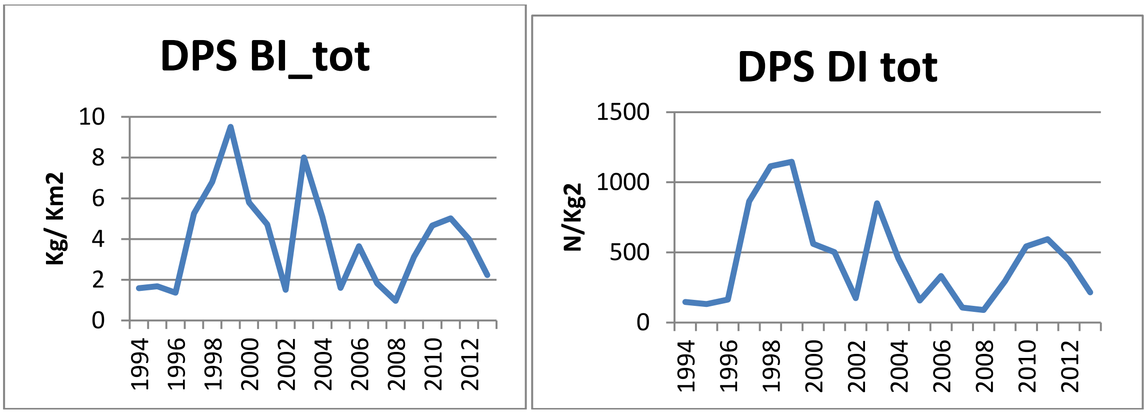


Fig. 5.2.13.5.3.1 Deep-sea pink shrimp in GSA 11. MEDITS abundance and biomass indices. The recent observed MEDITS trend in abundance looks similar to the observed MEDITS trend in GSA 9 (Fig.5.2.12.5.3.1).

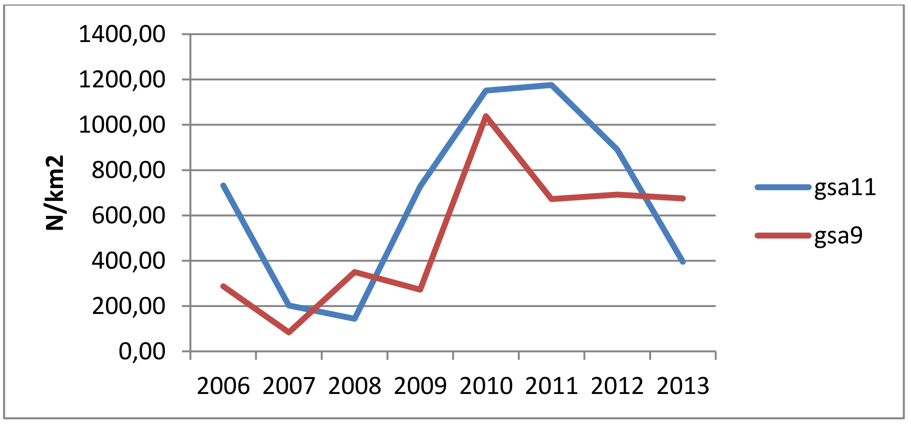


Fig. 5.2.13.5.3.2. Deep-sea pink shrimp in GSA 11. Comparison with MEDITS abundance in GSA 9.

From 1999, when the main peak occurred, a temporal decreasing trend in density and biomass of deep water pink shrimp was observed, even though large fluctuations are present from year to year (Fig. 5.2.13.5.3.1).

5.2.13.5.4 Trends in abundance by length or age

Figs. 5.2.13.5.4.1 and 5.2.13.5.4.2 show standardized length frequency distribution (n/Km^2) of *P. longirostris* females and males in GSA 11 for the period 1994-2013.

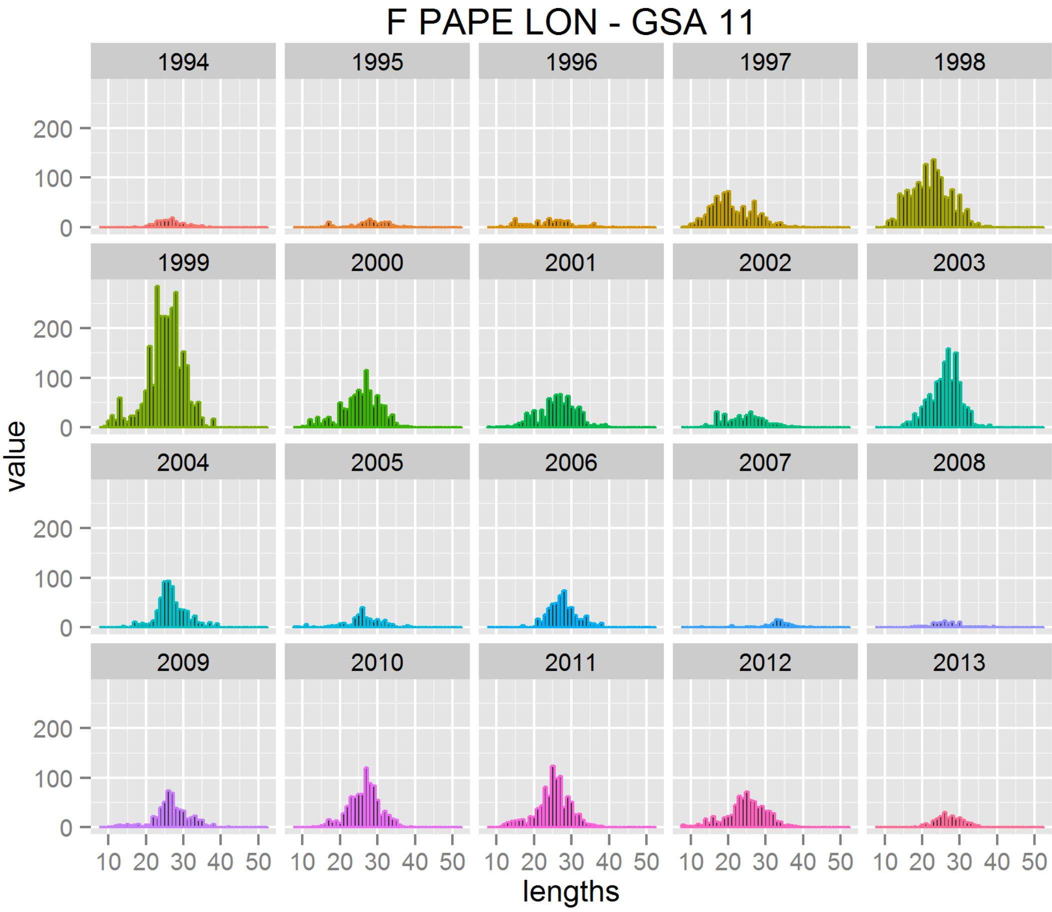


Fig. 5.2.13.5.4.1. Deep-sea pink shrimp in GSA 11. Stratified abundance indices (n/km^2) of females by size, 2002-2013.

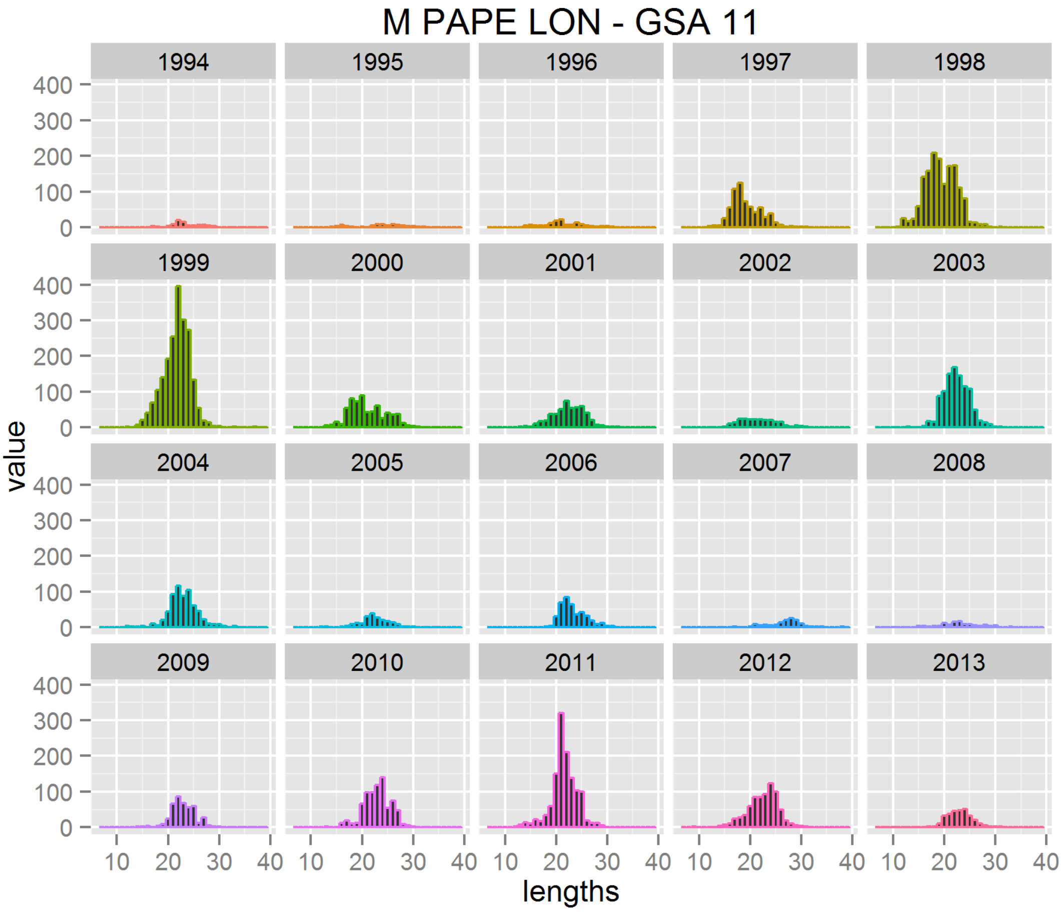


Fig. 5.2.13.5.4.2. Deep-sea pink shrimp in GSA 11. Stratified abundance indices (n/km^2) of males by size, 2002-2013.

5.2.13.5.5 Trends in growth

No information available.

5.2.13.5.6 Trends in maturity

No information available.

5.2.13.6 Assessment of historic stock parameters

Given the short-time series available during EWG 14-19 and clear inconsistencies in catch data as reported in the data quality section, EWG 14-19 decided to not perform a standard analytical assessments. A survey based assessment (SURBA) was carried out to reconstruct the stock trend as depicted by the MEDITS survey.

5.2.13.6.1 *Methods*

Method 1: SURBA

5.2.13.6.2 *Justification*

The MEDITS survey provided the longer standardized time-series data on abundance and population structure of *P. longirostris* in the GSA 11 which allows to utilize the SURBA software for the assessment. The SURBA assessment tool estimates the evolution of F from length frequency distribution (LFD).

5.2.13.6.3 Input parameters

The survey-based stock assessment model SURBA (Needle, 2003) was used to estimate the trend in population structure and the fishing mortality vector.

The following set of input data and parameters were used (Tabs 5.2.13.6.3.1 and 5.2.13.6.3.2).

Tab. 5.2.13.6.3.1. Deep-sea pink shrimp in GSA 11. Input data used in the SURBA model.

	Medits CPUE (n/km2) at age				**Weight-at-age (Kg)**			
Year	0	1	2	3+	0	1	2	3+
1994	59.27	154.09	8.93	0.61	0.003	0.011	0.018	0.023
1995	45.63	145.88	14.51	3.11	0.003	0.011	0.018	0.023
1996	177.89	122.93	19.44	2.59	0.003	0.011	0.018	0.023
1997	1062.77	352.38	10.12	3.23	0.003	0.011	0.018	0.023
1998	2138.11	886.87	16.56	1.96	0.003	0.011	0.018	0.023
1999	1935.42	2695.07	46.97	3.16	0.003	0.011	0.018	0.023
2000	728.68	825.13	26.08	3.90	0.003	0.011	0.018	0.023
2001	415.58	761.10	29.23	6.28	0.003	0.011	0.018	0.023
2002	278.09	254.39	19.56	2.10	0.003	0.011	0.018	0.023
2003	761.80	1463.48	21.76	1.79	0.003	0.011	0.018	0.023
2004	335.63	920.24	46.20	8.38	0.003	0.011	0.018	0.023
2005	136.44	295.83	11.06	1.00	0.003	0.011	0.018	0.023
2006	206.36	682.58	44.76	4.85	0.003	0.011	0.018	0.023
2007	22.01	136.92	54.63	10.84	0.003	0.011	0.018	0.023
2008	69.34	125.68	14.48	4.14	0.003	0.011	0.018	0.023
2009	242.21	693.72	31.97	2.51	0.003	0.011	0.018	0.023
2010	480.06	1121.24	29.61	0.50	0.003	0.011	0.018	0.023
2011	987.69	1150.08	25.10	0.81	0.003	0.011	0.018	0.023
2012	577.59	861.39	26.26	2.66	0.003	0.011	0.018	0.023
2013	133.55	383.83	9.66	1.70	0.003	0.011	0.018	0.023

Tab. 5.2.13.6.3.2. Deep-sea pink shrimp in GSA 11. Input parameters used in the SURBA model.

Growth parameters
-males: Linf=33.81; K=0.93, to=-0.05
-females: Linf=43.50; K=0.74, to=-0.13
Length-weight
a= 0.00727
b=2.21
Natural mortality (from Prodbiom)
Age 0=1.45 Age 1=0.60 Age 2=0.43 Age 3+=0.35

Proportion of mature at age
Age 0=0.5 Age 1=1.0 Age 2=1.0 Age 3+=1.0

Standardized time series of MEDITS length-frequency-distributions were sliced into different age-groups using the same growth parameters for the whole time series.

5.2.13.6.4 *Results*

The fitted year effect show high fluctuations in the whole time series. Moreover a decreasing trend could be observed since 2005 (Fig. 5.2.13.6.4.1). The age effect shows a flat pattern with high values for stock mortality after age 3. The fitted cohort effects are progressively decreasing from 1997.

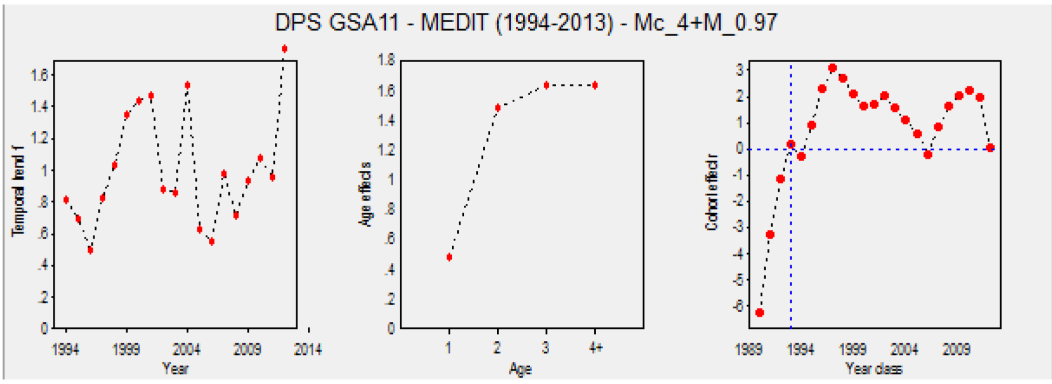


Fig. 5.2.13.6.4.1. Deep-sea pink shrimp in GSA 11. MEDITS survey. Fitted year, age and cohort effects estimated by SURBA.

Average fishing mortality (F_{0-2}) estimated from trawl survey data (MEDITS) ranges between 0.74 and 1.55 (excluding the last year, F=0.42) with a mean value of 1.1 (5.2.13.6.4.2). Relative indices of spawning stock biomass (SSB) showed a peak in 1999, a successive decreasing trend until 2008 followed by an increasing in recent years.

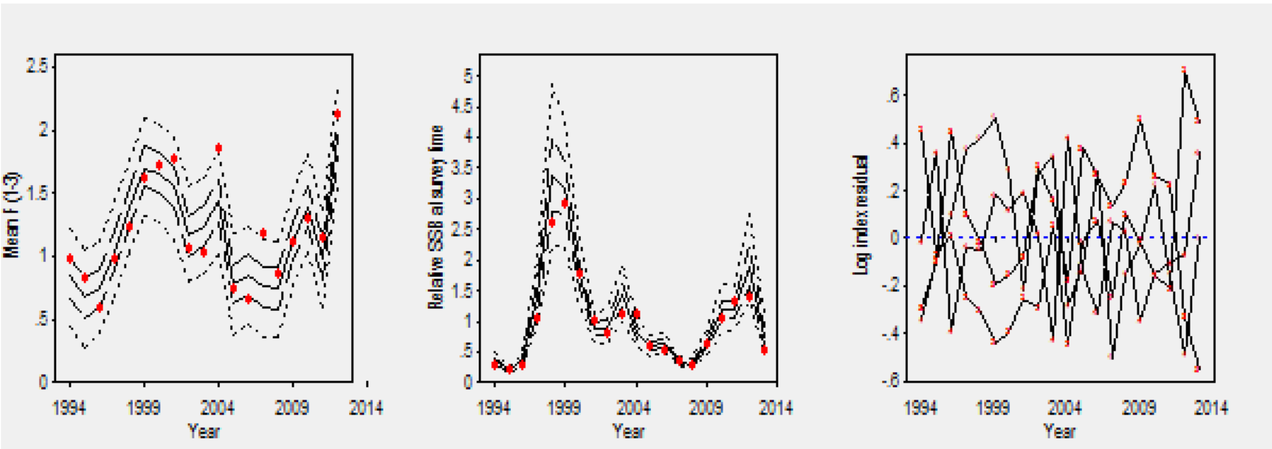
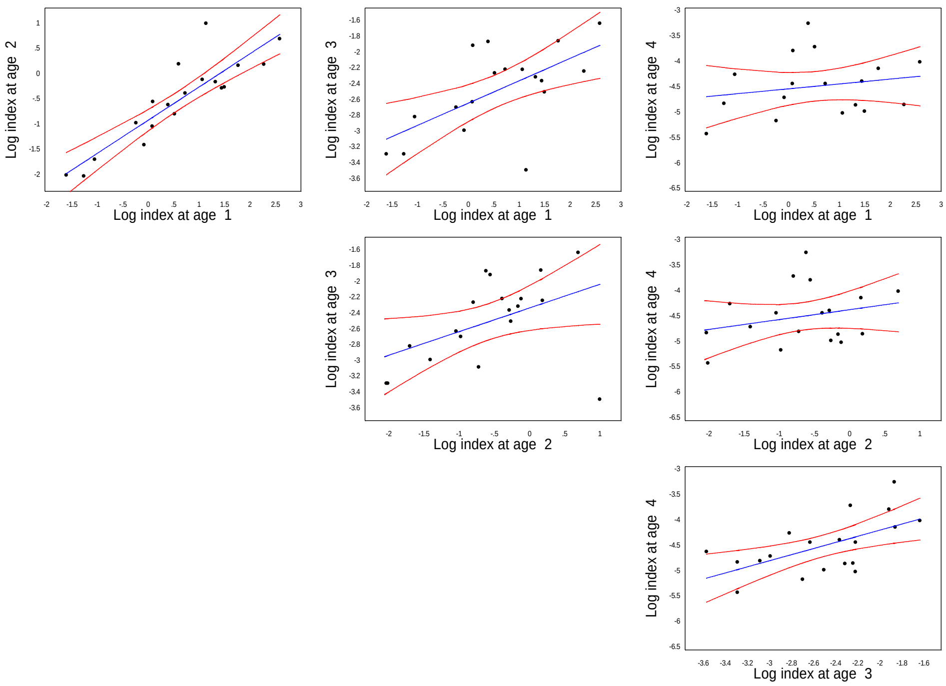


Fig. 5.2.13.6.4.2. Deep-sea pink shrimp in GSA 11. Estimated trend in F_{1-3}, relative SSB and relative recruitment index at age 1+ in the GSA 11, dotted lines are 2.5% and 97.5% confidence intervals.

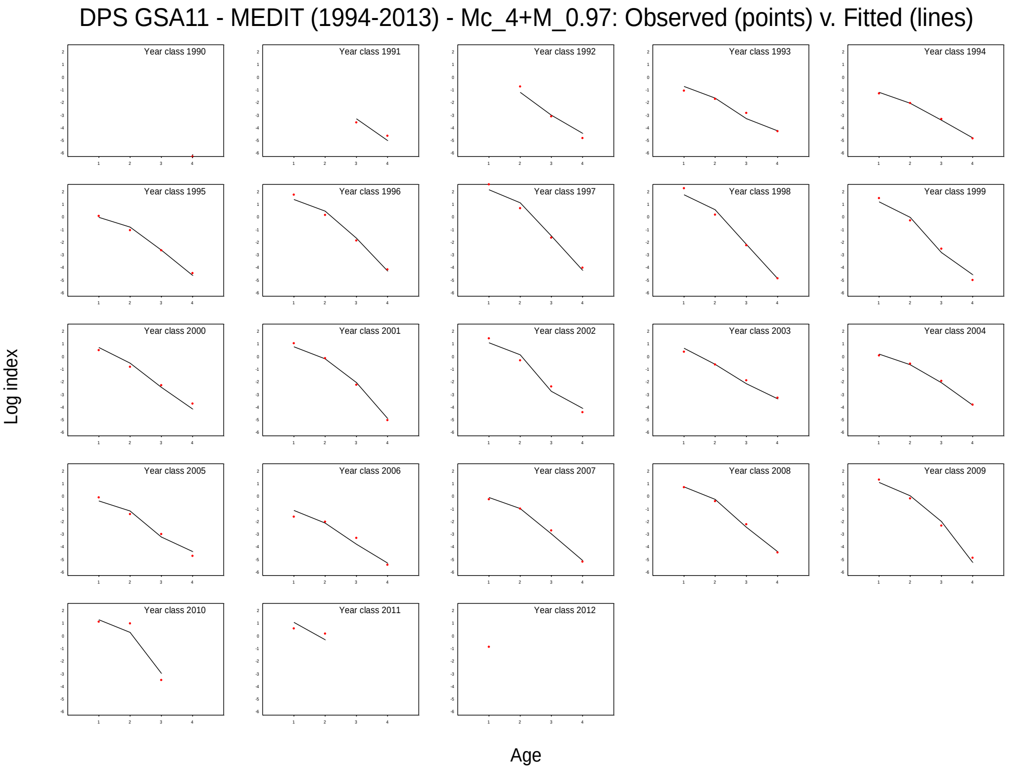
The SURBA model for *P. longirostris* fits well on survey data and do not highlight trends in the residuals as showed by the comparisons between observed and fitted abundance indices per year, comparative scatterplot at age (Fig. 5.2.13.6.4.3a), catch curves (Fig. 5.2.13.6.4.3b) and residuals of the log index abundance (Fig. 5.2.13.6.4.3c).

a)

DPS GSA11 - MEDIT (1994-2013) - Mc_4+M_0.97: Comparative scatterplots at age



b)


DPS GSA11 - MEDIT (1994-2013) - Mc_4+M_0.97: Observed (points) v. Fitted (lines)
Year class 1990
Year class 1991
Year class 1992
Year class 1993
Year class 1994
Year class 1995
Year class 1996
Year class 1997
Year class 1998
Year class 1999
Year class 2000
Year class 2001
Year class 2002
Year class 2003
Year class 2004
Year class 2005
Year class 2006
Year class 2007
Year class 2008
Year class 2009
Year class 2010
Year class 2011
Year class 2012
Log index
Age

c)

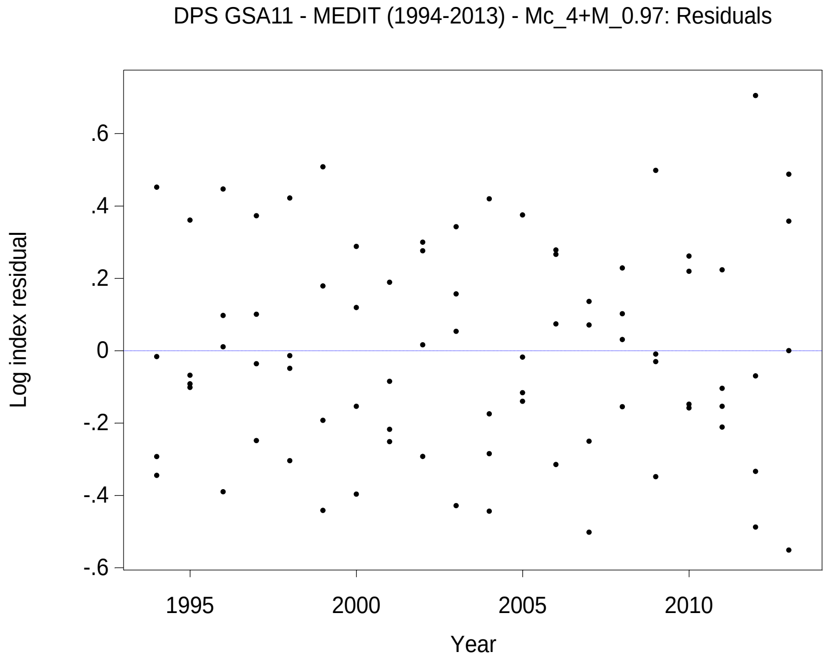


Fig. 5.2.13.6.4.3. Deep-sea pink shrimp in GSA 11. Model diagnostic for SURBA model of in the GSA 11: a) comparative scatterplot at age; b) comparison between observed (points) and fitted (lines) MEDITS survey abundance indices, for each year; c) residual of the log index abundance.

5.2.13.7 Long term prediction

A long term prediction was not carried out during EWG 14-19. This is also due to the lack of biological parameters (e.g. growth parameters, length at maturity, size of first capture. etc.) available during EWG 14-19 to carry out a yield per recruit model.

5.2.13.7.1 *Justification*

5.2.13.7.2 *Results*

5.2.13.8 Data quality

Data for the catches of deep-sea pink shrimp available during EWG 14-19 were incomplete and rather inconsistent for several aspects that are listed and commented here below.

Landings

The official landings data were reported only for the period 2009-2013. They appear much lower (from about 21 to 71 tons) than the landings registered in the period 2004-2006. Landings declined from a peak of about 550 t in 2005 to 21 t in 2013. The reliability of this trend in landings should be carefully explored for its consistency, also analysing the CPUE of Sardinian trawlers, which were not available at the meeting. The composition in age (numbers-at-age) and length (numbers-at-length) of the landings were available for 2011-2013 and 2009-2013 respectively (Tables 5.2.13.8.1 and 5.2.13.8.2). However, the two datasets were not provided for the same time period. Moreover, numbers-at-age are not consistent with the numbers-at-length provided, in particular for the catch of the 0 group (specimens below 20-24 mm CL) as showed in table 5.2.13.8.2. No catch of age 0 specimens was reported in catch-at-age data for 2011-2013 whereas these specimens appear in the numbers-at-age matrix.

Table 5.2.13.8.1. Deep-sea pink shrimp in GSA 11. Estimated annual landings and numbers at-age.

Country	Year	Landings	Age 0	Age 1	Age 2	Age 3	Age 4
ITA	2009	42.561	32.436	1986.628	1035.1	134.244	-1
ITA	2010	55.337	527.301	2671.707	1057.534	289.654	5.141
ITA	2011	53.32507	0	2334.529	2251.121	270.754	27.866
ITA	2012	31.94111	0	1427.08	1403.811	72.31	0
ITA	2013	21.20557	0	816.496	966.4	91.117	2.485

Table 5.2.13.8.2. Deep-sea pink shrimp in GSA 11. Numbers at-length data.

year	2011	2012	2013
quarter	-1	-1	-1
vessel_length	-1	-1	-1
gear	OTB	OTB	OTB
area	SA 11	SA 11	SA 11
species	DPS	DPS	DPS
landings	53.32506	33.76837	21.20557
unit	mm	Mm	mm
lengthclass12	23.3	0	0
lengthclass13	23.3	5.309	0
lengthclass14	23.3	0	4.97
lengthclass15	256.296	5.309	15.307
lengthclass16	69.899	10.618	2.485
lengthclass17	179.774	21.238	51.13
lengthclass18	279.596	67.215	77.681
lengthclass19	249.673	127.082	74.15
lengthclass20	252.984	152.167	77.955
lengthclass21	136.486	174.309	70.876
lengthclass22	43.288	191.142	116.811
lengthclass23	109.875	244.236	103.715
lengthclass24	352.619	277.211	81.158
lengthclass25	325.704	144.473	135.88
lengthclass26	241.764	194.066	125.482
lengthclass27	353.97	224.675	146.16
lengthclass28	289.901	131.488	182.986
lengthclass29	416.451	207.497	129.582
lengthclass30	224.901	74.219	84.12
lengthclass31	178.792	203.65	90.879
lengthclass32	235.14	208.057	51.617
lengthclass33	119.623	109.905	36.217

lengthclass34	72.719	15.024	82.185
lengthclass35	171.864	57.155	56.542
lengthclass36	95.53	29.145	33.311
lengthclass37	26.121	0	27.497
lengthclass38	46.109	18.295	10.795
lengthclass39	39.181	9.715	4.522
lengthclass40	26.121	0	0
lengthclass41	0	0	2.485
lengthclass42	19.988	0	0

Discards
Annual discard data were not provided (annual estimates and size distributions) as for other GSAs.

Medits TA
Code for survey strata (strate field) were not provided for 2007, 2008, 2009. This information is required to calculate standardized survey indices (i.e. standardized LFDs, abundance and biomass stock indices). Thus, considering the data deficiency listed above, STECF EWG 14-19 decided to postpone the assessment of this stock.

5.2.13.9 Scientific advice

No scientific advice is provided by EWG 14-19.

5.2.13.10 Short term considerations

The only information on the stock status and trend has been derived from a SURBA analysis on MEDITS survey data 1994-2013.

5.2.13.10.1 State of the stock size

According to the MEDITDS data (SURBA analysis), SSB was at the lowest levels in mid-‘90s (1994-1996). It started increasing quickly in 1997 to peak in 1999. Since then SSB declined to achieve the lowest value in 2008. In the perod 2009-2012 there was an increasing in SSB followed by a reduction in 2013.

5.2.13.10.2 State of recruitment

Recruitment shown peaks in 1998 and 2010 without any temporal trend.

5.2.13.10.3 State of exploitation

Fishing mortality (F_{0-2}) did not show any clear temporal trend, fluctuating beween 0.7 and 2.0 .

5.2.13.11 Management recommendations

5.2.14 STOCK ASSESSMENT OF NORWAY LOBSTER IN GSA 17

5.2.14.1 Stock Identification

The geographic distribution of *N. norvegicus* is generally highly discontinuous because heavily dependent upon sediment composition which should be muddy and preferably medium-grained (~ 40% of clay and silt) (Farmer, 1975; Afonso-Dias, 1998; Bell et al., 2007). Importantly, there seems to be a stock-specificity to the relationship between burrow density and sediment composition which has been found to hold true over time (Campbell et al., 2009). This, added to the fact that *N. norvegicus* is a sedentary species (Chapman & Rice, 1971), means that this species is generally characterised by spatially segregated populations (or stocks) with little or no exchange between them in the adult phase, while on the other hand the larvae have a pelagic phase of 2-7 weeks (Bell et al., 2007). This heterogeneity in distribution is also present within smaller areas, giving rise to smaller "sub-populations" or "stocklets" with different densities and life-history characteristics (Maynou & Sardà, 1997; Bell et al., 2007).

Numerous studies carried out in GSA 17 have highlighted that Norway lobster has different growth rates and sizes at first maturity within different areas of GSA 17. It must be said that studies on growth were based on non-homogenous sampling and the most recent one is from 1998 (Table 5.2.14.2.1.). The MEDISEH project (Mediterranean Sensitive Habitats, 2013) used Zero Inflated General Additive Modelling to identify one prevalent nursery area (R1) and four prevalent spawning grounds (S1 – S4) in GSA 17 (Fig. 5.2.14.1.1). The Pomo pit area is of particular interest as it was identified as both a nursery area (R1) and a spawning ground (S1; Fig. 5.2.14.1.1).

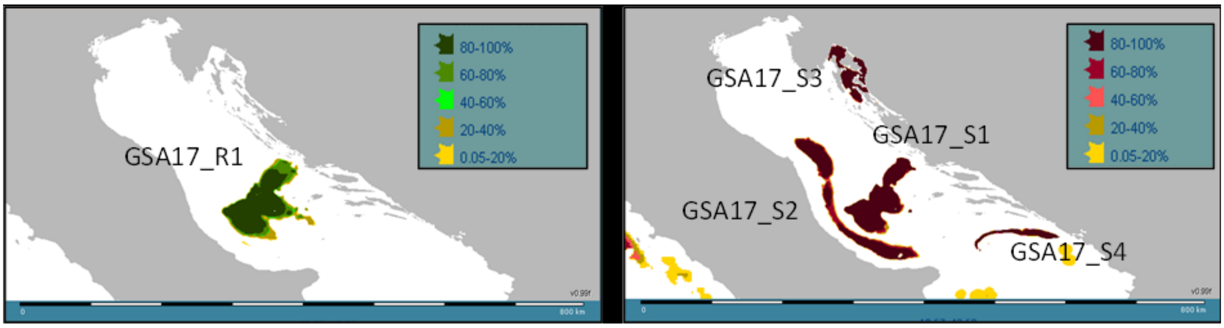


Fig. 5.2.14.1.1. Norway lobster in GSA 17. Position of persistent nursery (left) and spawning areas (right) of as identified by the MEDISEH project (Mediterranean Sensitive Habitats, 2013).

The reality is that the individuals characterising the nursery area are unlikely to be true recruits as the Pomo/Jabuka pit, for reasons related to its geography, morphology and oceanography, is likely to be inhabited by a very dense "subpopulation" of smaller animals with slower growth rates (see section 5.2.14.2) (Froglia and Gramitto, 1981; Froglia and Gramitto, 1988; IMBC et al., 1994). As a result the Pomo/Jabuka pit "subpopulation" should be considered as separate from the other grounds off the eastern Italian coast south of Ancona (S2, Fig. 5.2.14.1.1; Froglia and Gramitto, 1981, Froglia and Gramitto, 1988, IMBC et al., 1994) and in the northern Croatian channels (S3, Fig. 5.2.14.1.1; Vrgoč et al., 2004). Genetic analyses did not reveal differences between the "Ancona subpopulation" and the

"Pomo/Jabuka subpopulation" that went beyond the population level allowing the inference that the differences in growth and maturity are mainly due to environmental differences (Mantovani and Scali, 1992).

From a biological point of view on the basis of the above information, it appears that treating the *N. norvegicus* population in GSA 17 as one single stock unit may be questionable and could lead to an inaccurate and imprecise evaluation of the status of the resource. Therefore, the assessment should likely be carried out , at least, on two stock units (i.e. two separate assessments; see section 5.2.14.8) or models which assume one stock unit with two different morphs (with limited exchange) should be used. These more complex assessment models should be then compared against a simpler assessment which combine the entire GSA 17 and possibly also GSA 18, but in which spatial growth differences are accounted for, using spatially separate ALK to derive the catch at age matrix. The model results should be used to verify the differences in the models output between the different stock structure configurations.

In the north-east Atlantic *N. norvegicus* stocks are managed by Total Allowable Catch advised annually by ICES (ICES, 2003). Although TACs are delivered for aggregated areas, all advice is based on small Management Areas taking into account the poor connectivity between stocks and the possibility of different life history characteristics. It is also important to notice that in the ICES area landings are split using ALK which are estimated at a smaller scale than the stock assessment area. In other words, if there are spatial variations in growth within a stock, these are accounted for when the catch at age matrix is generated by using spatially specific ALK. In GSA 17, different growth curves are available for different sub-areas. However, due to the fact that landings of the different subareas are not available, it is not possible at the moment to take spatial variations in growth into account when splitting the landings. Thus, using a single growth curve to split the landings will introduce a bias if growth (even if not genetic) differences are present between the different subareas.

5.2.14.2 Growth

Norway lobster is characterised by discontinuous growth with moults interspersed by intermoult periods and growth only occurring during the latter period. In the Mediterranean, Norway lobster juveniles moult year-round but adult females only have one growing period per year, in December – March, soon after hatching; in the Adriatic Sea the moulting peak for males is between June and September (Gramitto, 1998). Whilst juveniles of both sexes have similar growth curves, those of mature animals differ resulting in males growing to be larger than females (Vrgoč et al., 2004; Bell et al. 2007). Information for the spawning prevalence area identified in the Croatian northern channels is yet to be retrieved, but growth rates have been reported to differ markedly between the Pomo/Jabuka pit (S1, Fig. 5.2.14.1.1) and the area off and south of Ancona (S2, Fig. 5.2.14.1.1; Table 5.2.14.2.1). The available length – weight relationships for the two areas are summarised in Table 5.2.14.2.3. The DCF on the Italian side has generated some length – weight relationships (Santojanni et al. 2012), but at the time of writing they are not sub-divided by area (Table 5.2.14.2.2). It should be noted that, due to the lack of a reliable method for the determination of *N. norvegicus* age, its growth curves have to be established using indirect methods. This relies either on the progression of modes in length-frequency distributions, or on tagging animals or on captivity experiments; all these alternatives have some serious shortcomings (Bell et al., 2007). Furthermore, growth rate is discontinuous and sex- and stage-dependent with different parameters describing adult males and females, as well as pre- and post-maturation females.

Table 5.2.14.2.1. Norway lobster in GSA 17. Summary of the parameters for the Von Bertalanffy growth function in the Pomo/Jabuka Pit and in the area off Ancona (equivalent to area S2 in Fig. 5.2.14.1.1) (modified from Vrgoč et al., 2004).

Area	Reference	Sex	L_∞(mm)	K(yr^{-1})	t_0(yr)	Φ'	Method
Pomo/Jabuka Pit	Froglia and Gramitto, 1988	M	59.0*	0.324	-0.16	9.47	NORMSEP
		F	41.7*	0.528	-0.02	9.25	
	Šarčević, 1992	M+F	62.8*	0.215	-0.23	9.20	BHATTACH
	IMBC *et al.*, 1994	M	43.4	0.382	-	6.58	MULTIFAN
		F	43.2	0.437	-	6.70	
		M	55.9	0.229	-0.56	6.57	MIX
		F	36.0	0.498	-0.27	6.47	
off Ancona	Froglia and Gramitto, 1988	M	70.2*	0.432	-0.14	10.00	NORMSEP
		F	69.9*	0.528	0.12	10.24	
	IMBC *et al.*, 1994	M	56.6	0.426	-	7.22	MULTIFAN
		F	-	-	-	-	
		M	63.5	0.327	-0.13	7.18	MIX
		F	55.4	0.361	-0.18	7.01	
	Marano *et al.*, 1998	M	71.4	0.11	-1.18	6.33	Gauss - Newton
		F	68.0	0.14	-0.21	6.47	
		M	83.3	0.11	-1.24	6.64	FISHPARM
		F	68.5	0.14	-1.02	6.49	
	Sardà *et al.*, 1998	M	81.5	0.11	-0.95	6.59	-
		F	67.0	0.14	-0.88	6.44	
Open Adriatic	Vrgoč, 1995	M	227+	0.324	-0.29	9.72	BHATTACH
		F	179+	0.397	-0.03	9.45	

*originally reported as total length and converted to carapace length using Froglia & Gramitto (1988)
+Total length (mm)

The commonly used Von Bertalanffy growth function, in the case of *N. norvegicus* thus appears to have some shortcomings related to the shape of the growth curve at different life stages, in particular for females. This has prompted the ICES Working Group on *N. norvegicus* to assess the species using a "combined" growth curve for females whereby the growth of immature females (up to the size at 50% maturity) is represented by the male growth curve while that of mature females by the female growth curve (Bell et al., 2007). This is of particular relevance for a species that lacks a routine age-determination method whose assessment may require the conversion of catches at length into catches at age based on the assumed Von Bertalanffy growth function (Bell et al. 2007, Dobby & Hillary, 2008).

The hypothesized variability in growth rates within the same biological population is likely due to a number of interacting factors (from temperature to sediment composition, food availability and population density and more); pinpointing the exact causal relationship is impossible and area-dependent (Tully & Hillis, 1995; Tuck et al., 1997, Bell et al., 2007). In addition to GSA 17, this has also been found in the Clyde (west Scotland; Tuck et al., 1997) and in south and south-west Portugal (de Figueiredo, 1984).

Table 5.2.14.2.2. Summary of the parameters for the length – weight relationship (in mm, where W = $a*CL^b$) for Norway lobster in the Pomo/Jabuka Pit and in the area off Ancona (equivalent to area S2 in Fig. 5.2.14.1.1) (modified from Vrgoč et al., 2004) and for the whole the DCF

Area	Reference	Sex	*a*	*b*
Pomo/Jabuka Pit	Froglia and Gramitto, 1981	M	0.000246	3.28
		F	0.000489	3.07
	Šarčević, 1992 (TL)	M+F	0.0098	3.217
off Ancona	Froglia and Gramitto, 1981	M	0.000263	3.27
		F	0.0049	3.09
	Sardà et al., 1998	F	0.00043	3.12
			0.00056	3.11
		M	0.00028	3.26
			0.00036	3.19
GSA 17 (Italy)	Santojanni et al., 2012	F	0.00061	3.041
		M	0.0009	2.941
		F+M	0.00075	2.992

Table 5.2.14.2.3. Norway lobster in GSA 17. Summary of the information available for length at first maturity (modified from Vrgoč et al., 2004).

Area	Author	Length (CL, mm)	Smallest berried female (CL, mm)
Northern Adriatic	Karlovac, 1953	95-100 (TL)	17-17.5
Pomo/Jabuka Pit	Froglia and Gramitto, 1979	25.9	-
	Gramitto and Froglia, 1980	26	-
	Froglia and Gramitto, 1981	85 (TL)	-
	IMBC et al., 1994	26	-
off Ancona	Froglia and Gramitto, 1979	32.5	17.0
	Gramitto and Froglia, 1980	32	16-17
	Froglia and Gramitto, 1981	105 (TL)	16-17
	IMBC et al., 1994	30	17-18
	Orsi Relini et al., 1998	30	17-18
Velebit Channel	Cetinić et al., 1999	35	16

5.2.14.3 Maturity

Norway lobster in the Adriatic Sea spawns once per year. Mating occurs during the soft post-moult phase in winter/early spring. Ovaries mature and eggs are laid in late spring/summer and incubated on the pleiopods for 6 – 10 months; straight after spawning females carrying eggs hide in their burrows until hatching in late winter (up to early spring) after which they moult again (Vrgoč et al., 2004; Bell et al. 2007). The size at first maturity too appears to be different when taking into account different areas of GSA 17, the one at the Pomo/Jabuka pit being considerably smaller on average(~26 cm CL) than that off and south of Ancona (~31cm CL) or the Velebit channel (Table 5.2.14.2.3). These sizes generally correspond to 2 or 3 years of age (Froglia & Gramitto, 1981; Orsi Relini, 1998).

5.2.14.4 Behavioural traits of note

N. norvegicus are bottom-dwellers, building complex burrows in muddy sediments, emergence from which varies with time of day, season, animal size, sex, and reproductive status, so the fishery exploits the population selectively and in a different manner according to sex (Froglia, 1972; Atkinson and Naylor, 1976; Naylor and Atkinson, 1976; Aréchiga et al., 1980; Chapman, 1980; Froglia and Gramitto, 1986; Tuck et al., 2000). Furthermore, emergence patterns follow diel and seasonal patterns. Diel patterns of peak emergence differ according to depth as follows (Bell et al., 2007):

- Shallow depths (< 30 – 40m): one peak during night time
- Intermediate depths (40 – 100m): two peaks one at dawn and one at dusk
- Deep waters (>100m): one peak during day time

The regulatory mechanisms driving these diurnal emergence patterns are yet to be pinpointed, but are believed to be entirely exogenous, from light to hydrodynamics to predation (Bell et al., 2007; Aguzzi & Sardà, 2008; Aguzzi et al. 2009a, 2008b).
Seasonal patterns are also present and most important for females who do not leave their burrows during the egg-bearing period; the emergence of both sexes is more sporadic during winter (Marrs et al., 2000; Bell et al., 2007). Juveniles tend to spend more time in their burrows.
All these factors affect the catchability of *N. norvegicus* in trawls, their absolute catches and the sex ratio of animals caught. Thus, care has to be taken when using trawl surveys to generate abundance indices: a good estimate of population density based on catchability can only be obtained if the trawl surveys are scrupulously carried out at specific times of the day and under the same conditions of time and season from year to year (Aguzzi & Sardà, 2008), or if a proper GLM/GAM, or similar methods, standardization of the CPUE is performed. An alternative would be to carry out surveys based on methods that are independent of the emergence behaviour of the animal: underwater TV (UWTV) surveys counting burrow openings are the most common of these methods (see section 5.2.14.6.2; Marrs et al., 2000).

5.2.14.5 Fisheries

N. norvegicus in GSA 17 is exploited prevalently by means of bottom trawls and to a lesser extent in smaller areas (e.g. the northern-eastern Adriatic channels) by means of baited traps. These gears sample different portions of the population: trawls will only catch individuals when they happen to be outside of their burrows, whilst the bait in traps entices animals out of their burrows meaning they can also catch berried females.

The trawl fishery for *N. norvegicus* in GSA 17 is characterised by fluctuating landings (DCF 2014 data call) throughout the years with a decrease in more recent years in Italy (Fig. 5.2.14.5.1). The available data cannot, at the time of writing, be subdivided into “subpopulations” within GSA 17.
Discards of the trawl fishery are negligible amounting to 0.5% of catches in Italy and 4.7% of catches in Croatia, both based on one year of sampling (2013; DCF 2014 data call).

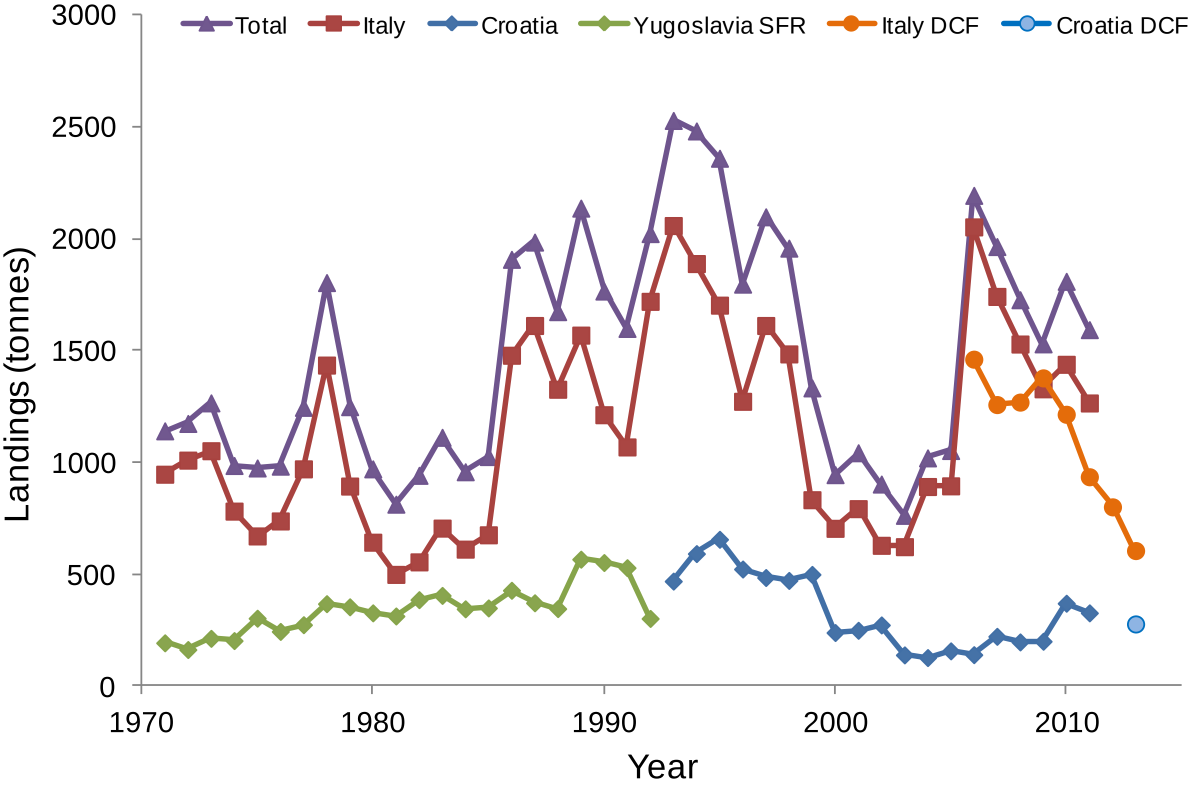


Fig. 5.2.14.5.1 Norway lobster in GSA 17. FISHSTAT landings from trawl fisheries in Italy, the Yugoslavian republic (1970 – 1992) and Croatia (1993 – 2011), and including the landings reported by the Data Collection Framework (DCF) for Italy and Croatia.

Based on DCF data call 2014, Italian landings between 2006 and 2013 had three prevalent length modes (Fig. 5.2.14.5.2, Table 5.2.14.5.1). At first sight this appears to imply that in some years the samples originated prevalently from the Pomo/Jabuka pit (mode at 20-24 mm CL), in other years mainly from the Italian inshore grounds (e.g. off Ancona, with mode at 30 -34 mm CL) and some years from both areas (either two modes at 20-24 mm CL and 30 -34 mm CL or one mode at 25-29 mm CL) (Fig. 5.2.14.5.2, Table 5.2.14.5.1). The two modes present in the length-frequency distribution available from Croatia (2013 HRV) seem to indicate samples came from both the Pomo/Jabuka pit and the Croatian inshore *N. norvegicus* grounds (Table 5.2.14.5.1). These are mere hypotheses and should be cross-checked with the data for single harbours sampled each month, but they may indicate a possible unequal sampling of the two areas by Italy. Should it be decided to assess *N. norvegicus* of GSA 17 taking into account different “subpopulations”, then this may have to be adjusted. It should be noted that for the purposes of this exploratory analysis, the Croatian length-frequency distributions, which were reported in terms of total length (TL, cm), were converted to carapace length (CL, mm) using an average of the coefficients reported by Froglia and Gramitto (1988):

$$CL\ (mm) = 0.017275 + ((TL/10) * 0.30265)$$

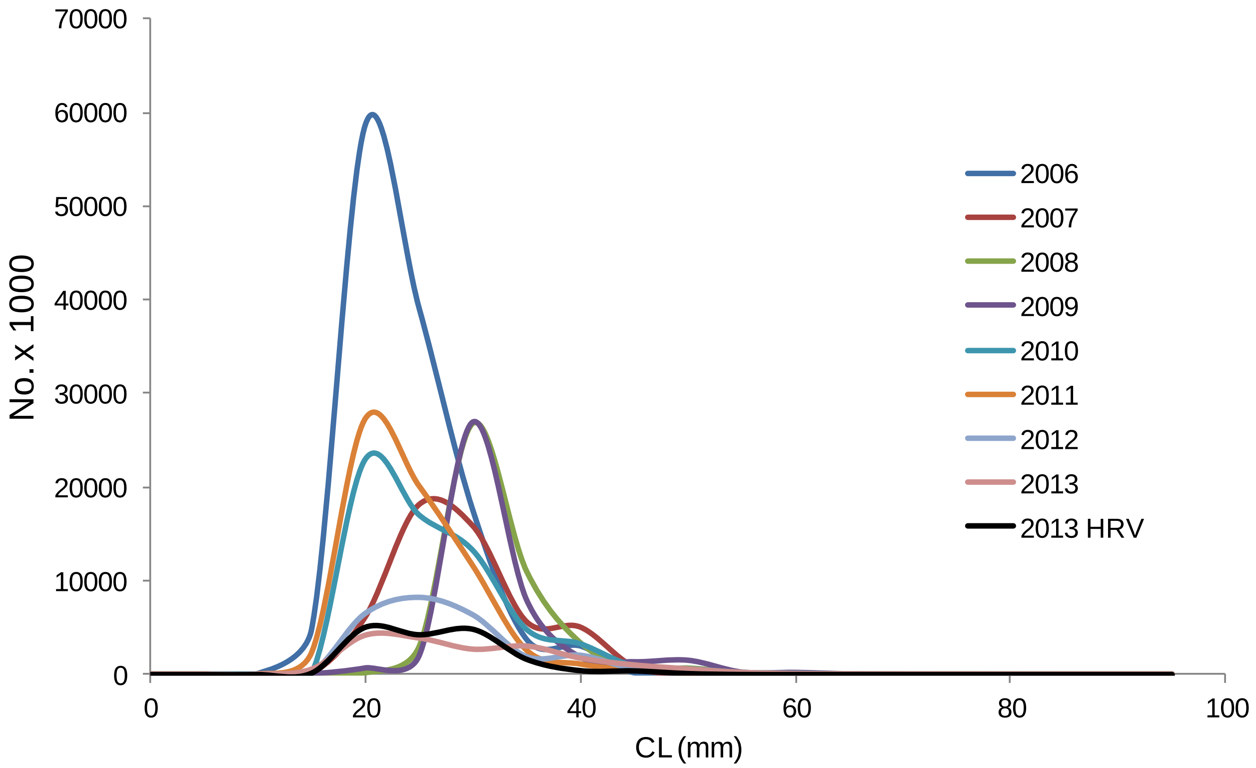


Fig. 5.2.14.5.2. Norway lobster in GSA 17. Length-frequency distributions (carapace length, CL) of the landings from the Data Collection Framework in Italy (2006 – 2013) and Croatia (2013 HRV). Note: data shown here are grouped in 5 mm bins (e.g. 0-4, 5-9 … 95-99 mm CL).

Table 5.2.14.5.1. Norway lobster in GSA 17. Summary of the main modes emerging from the DCF sampling length-frequency distributions, including a hypothetical area of origin of the samples.

Year	Mode	Hypothetical origin?
2006	20-24	Pomo/Jabuka
2007	25-29	Pomo/Jabuka + Italy inshore
2008	30-34	Italy inshore
2009	30-34	Italy inshore
2010	20-24	Pomo/Jabuka
2011	20-24	Pomo/Jabuka
2012	25-29	Pomo/Jabuka + Italy inshore
2013	20-24	Pomo/Jabuka
	35-39	Italy inshore
2013 HRV	20-24	Pomo/Jabuka
	30-34	Croatia Inshore

VMS data reveals that the Italian trawl fishery distributes its effort covering the main spawning and recruitment prevalence areas highlighted by the MEDISEH project (Mediterranean Sensitive Habitats, 2013) and this includes a significant presence in the Pomo/Jabuka Pit (Fig. 5.2.14.5.3).

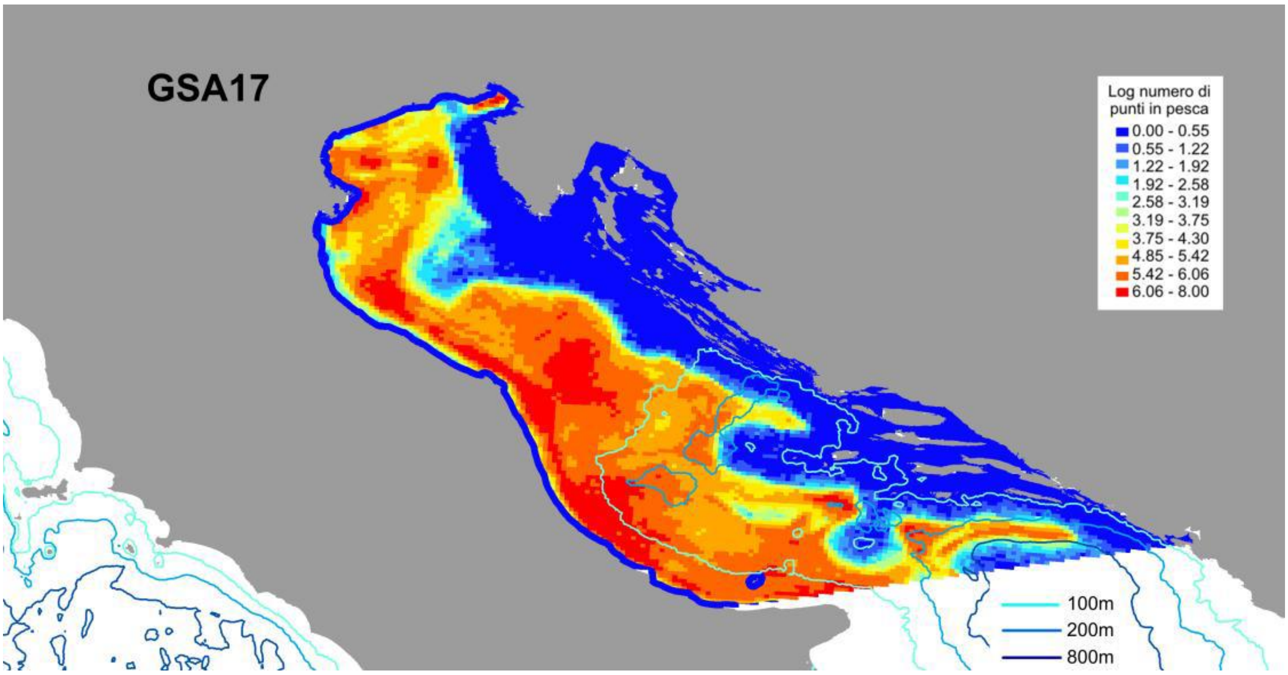


Fig. 5.2.14.5.3. VMS data from 2007 – 2010 (LOA > 15 m), showing the spatial distribution the Italian trawling fleet (Russo et al., 2011).

Croatia has a trap fishery for *N. norvegicus* which employs baited creels in the north eastern channels. At the time of writing we do not have information on this fishery but, depending on data availability, we may be able to derive what proportion of the total catch of *N. norvegicus* the Croatian trap fishery constitutes in GSA 17.

Spawning area S3 (Fig. 5.2.14.1.1) is exploited by Croatian vessels only and spawning area S2 by Italian vessels only, whilst both Italian and Croatian trawling fleets exploit spawning area S1/nursery area R1 (Fig. 5.2.14.1.1). To complicate matters, there are a number of vessels fishing in GSA 17 but landing in GSA 18 and possibly vice versa. VMS analysis could be used to define the overlap in fishing patterns between the two GSAs.

5.2.14.6 Scientific surveys

At the time of writing two scientific surveys were available for the tuning of an analytical stock assessment of *N. norvegicus* in GSA 17: the MEDITS survey covering the whole GSA and the UWTV survey covering the Pomo/Jabuka pit area only.

5.2.14.6.1 MEDITS

According to the MEDITS protocol (Bertrand et al., 2002), trawl surveys have been carried out yearly (May-July), applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed through the time) since 1994. Haul allocation is 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, has been employed throughout the years. Detailed data on gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention is assumed. All the abundance data (number of individuals and weight) are standardised to square kilometre, using the swept area method. The total number of hauls carried out between

2002 and 2012 were on average 180; the coverage increased in 2013 with 239 stations sampled.
This survey serves to determine the densities (No·km^{-2} or kg·km^{-2}) of a whole array of demersal species; for *N. norvegicus* additional data collected include sex, maturity and length composition per haul.
With respect to *N. norvegicus*, this sampling method suffers the same problems as the trawl fishery because of the burrowing behaviour of the species (see sections 5.2.14.4 and 5.2.14.5). Furthermore, MEDITS survey hauls start one hour after dawn and stop one hour before dusk every day; this means than in both *N. norvegicus* prevalence areas they miss the peak emergence times of the species (see section 5.2.14.4). The advantage of MEDITS, if fully standardised, is that it covers the whole GSA 17 East and West side, thus returning a complete spatial overview of the Nephrops in the area.

5.2.14.6.2 UWTV

Since 2009 Italy and Croatia have been carrying out a yearly underwater television (UWTV) survey covering the entire Pomo/Jabuka area using a stratified random sampling design. This survey has the aim of quantifying the density of *N. norvegicus* via an estimation of the number of burrows seen by a towed underwater camera using the same method used in the eastern Atlantic and North Sea (ICES, 2012). All details on the method and the survey are provided in Morello et al. (2007) and Martinelli et al. (2013). Burrow densities are available for 2009, 2010, 2012, 2013 and 2014. A survey is scheduled for April 2015. These data should be accompanied by a warning regarding their status as relative or absolute. The issue here is related to the application of a mean biomass to burrow numbers to generate an overall biomass at sea: this relies on a number of assumptions such as single-occupancy, burrow detection (there is a lower limit to the size of burrows that can be identified) and the actual mean weight of individuals within the burrows (ICES, 2013). Nevertheless, if area-specific sources of bias are accounted for systematically, UWTV estimates can be considered as absolute indicators of *N. norvegicus* biomass (ICES, 2009).

As mentioned previously (section 5.2.14.4) the burrowing behaviour of *N. norvegicus* significantly affects its catchability in trawls, their absolute catches and the sex ratio of animals caught, which will vary daily and seasonally. This makes trawl surveys not ideal when attempting to generate abundance indices for this species (Aguzzi & Sardà, 2008). An alternative would be to use data derived from underwater TV (UWTV) surveys counting burrow openings (see section 5.2.14.6.2; Marrs et al., 2000). The bias associated to the abundance indices obtained by these methods is well documented and will have to be accounted for (Aguzzi & Sardà, 2011).

5.2.14.7 Assessment and management of Norway lobster in the world

The assessment of *N. norvegicus* is fraught by a number of difficulties, from the lack reliable age-determination methods, to the marked sexual dimorphism, the uncertainty about growth, to their burrowing behaviour which results in different selectivities according to time of the day, season and sex.

To bypass the age-determination issue the first analytic assessments were based on length cohort analyses (LCA) using catch at length data, M and growth parameters to estimate stock size, F at size and determine the level of current exploitation (Dobby & Hillary, 2008). These methods, though, are at risk of providing misleading results should the equilibrium assumption at their basis not be met. LCA was thus abandoned in favour of dynamic assessment models such as XSA where catch at length is sliced into catch at age on the basis of the growth function assumed. This method though is not capable of accounting for growth variability resulting in smoother year class signals and derived F and biomass (Dobby & Hillary, 2008). The fact that the growth of *N. norvegicus* is sex- and stage-dependent, and the animals long-lived (14 + years old), means that simple selection of ages from a growth curve is not sufficient (Dobby & Hillary, 2008). Moreover, the length distributions of *N. norvegicus*, especially commercial-sized ones, are generally not characterised by strong modes making the slicing difficult. These issues with slicing and others related to mis-reporting of catches have led ICES to stop the use of analytic assessments. This was done in favour of the direct use of UWTV data to provide absolute estimates of abundance to which harvest rates are applied to recommend catch and landings (ICES, 2013). This is now the standard and ICES strongly recommends the development and use of UWTV surveys where *N. norvegicus* assessments are required (ICES, 2013). The UWTV method has a number of shortcomings which mean that the estimates may be biased and possibly overestimated (Sardà & Aguzzi, 2011); this will have to be taken into account when making use of these data in the context of an assessment.

Nevertheless not all stocks are surveyed with UWTV and exploration of additional analytical models may yield interesting results. Explicit length-structured assessment methods, directly using length data in the form of size-transition matrices and using fishery-independent surveys or commercial LPUE information for tuning, have been put forward as an alternative (ICES, 2013). These are used extensively in Australia and New Zealand (e.g. for southern rock lobster and abalone). The most interesting case being the one of *Metanephrops challengeri* which makes use of the CASAL software suite to perform a Bayesian length-structured assessment using catch-at-length data and burrow counts from underwater photographic surveys (Dobby & Hillary, 2008). The use of transition matrices, and the results yielded in terms of F, are heavily dependent upon, and confounded by, the growth function assumed (Dobby & Hillary, 2008).

5.2.14.8 Data issues

Should there be an agreement on the fact that GSA 17 is the host of *N. norvegicus* "subpopulations" with different life-history characteristics which should be assessed as separate stock units or by models which assume one stock unit with two different morphs (with limited exchange), then a stock assessment could be carried out taking into account the following two stock units:

(i) The *N. norvegicus* in the Pomo/Jabuka pit;
(ii) The *N. norvegicus* inhabiting the rest of GSA 17.

Anyhow, when assessing *N. norvegicus* as two separate stock units in GSA 17, a number of issues emerge with respect to existing data and the methodologies used to collect them. In summary:

- Data on catches, landings and discards are not divided by area, only by country. Addressing this issue for retrospective data would require the use of VMS data to yield an indication of fishing effort on each of the two stock units. More specifically, the VMS data required would be by fishing harbour and month from 2006 onwards for Italy and from 2013 for Croatia. If the hypothesis of two sub-stocks is validated, future, sampling should take into account the two stock units when determining its spatial coverage;
- In order to be able to carry out a complete assessment, Croatian landings/catches are needed from 2006. In the absence of such data one would have to estimate a mean catch from Croatia from 2013 and apply it to all missing years, decreasing the precision and accuracy of the assessment. Furthermore, these data should be divided among the stock units considered;
- Similar problems apply to the length frequency distributions (LFDs) sampled for the DCF. Retrospectively these could be cross matched with VMS data by harbour and month to determine if the hypotheses put forward in Table 5.2.14.5.1 (section 5.2.14.5); unfortunately if LFDs are not available for an area in any year, these will be missing. Future sampling should take into account the two different areas;
- A further issue that should be tackled using VMS data is that of vessels registered and landing in GSA 18, but that fish in GSA 17;
- Given the sexual dimorphism and the difference in life-history traits of male and female *N. norvegicus*, the assessments should account for the two sexes separately (ICES, 2013). At the time of writing the data provided in the 2014 DCF data call for *N. norvegicus* are not separated by sex;
- MEDITS data prior to 2002, although existing in National institutes, was not sent in the 2014 DCF Data Call, and is thus not available for analysis;
- It should be noted that the Croatian *N. norvegicus* length data provided in the 2014 DCF data call for both landings and discards are reported in centimetres of total length (TL), rather than millimetres of carapace length (CL). In order to use these data for comparison with data from other countries which report length in terms of CL (mm), they need to be converted using an equation. Many of these are available for GSA 17, but they are area- and sex-specific. Not knowing where these LFDs come from means that we can only apply an averaged equation both in terms of area and sex. It would be desirable that length is measured in one standardised way (e.g. CL).

5.2.14.9 Working strategy and targets

In addition to the data issues outlined above (section 5.2.14.8), there are several other issues that need to be addressed if *N. norvegicus* stocks are to be assessed formally and “reliably” in GSA 17; these are:

- Data from the MEDITS scientific surveys should be carefully reanalysed to determine how realistic its representation of *N. norvegicus* stocks is and this should take into account factors such as time of the day and area; for example an exploratory analysis of MEDITS data using GLMs and GAMs would be helpful. Since UWTV data are available since 2009, an index comparison could be performed with MEDITS to see if the two surveys show similar internal consistency, trend and performance in an assessment model UWTV data are only available for the Pomo/Jabuka pit area; they should be used when assessing *N. norvegicus* in this area. In addition, should a formal, more precise and ongoing assessment of *N. norvegicus* be required for the entire GSA 17, then the source of fishery-independent data should be revisited. The alternatives could be two: 1) plan, fund and carry out an UWTV survey covering the whole GSA 17, not just the Pomo/Jabuka pit area; 2) consider *N. norvegicus* within the MEDITS survey as a separate species that requires special treatment; more specifically hauls should be carried out at dawn and dusk or during the night, depending on the area.

Given the issues outlined above and in section 5.2.14.8 as well as the availability of VMS, MEDITS and UWTV data and landings/catch data by sex for GSA 17, the operational procedure over the next year (i.e. 2015) could be as follows:

- Analysis of VMS data and cross-matching of these data with landings, catch, discard and LFD data from Italy and Croatia to obtain a separate datasets upon which to perform separate assessments of the two stock units in GSA 17 (Pomo/Jabuka pit and the rest);
- Use of VMS data to determine the additional catch if *N. norvegicus* were removed by vessels registered in GSA 18 or if vessels from GSA 17 fish in GSA 18;
- GLM/GAM or similar methods for CPUE standardization of MEDITS data taking into account its shortcomings with respect to *N. norvegicus* and dividing them by stock unit area;
- Analysis of UWTV data for use in the tuning of the stock assessment of *N. norvegicus* in the Pomo/Jabuka pit;
- Performance of an analytical assessment on separate areas within GSA 17, by sex, and using UWTV for tuning where possible. Given adequate data availability, alternative analytical methods (e.g. length-structured models, see section 5.2.14.7) could be explored;
- These more complex assessment models should be then compared against a simpler assessment which combine the entire GSA 17 and possibly also GSA 18, but in which spatial growth differences are accounted for, using spatially separate ALK to derive the catch at age matrix. The model results should be used to verify the differences in the models output between the different stock structure configurations.

This would result in the assessment(s) of the *N. norvegicus* stock unit(s) of GSA 17 by the end of 2015.

5.2.15 STOCK ASSESSMENT OF NORWAY LOBSTER IN GSA 18

5.2.15.1 Stock Identification

Nephrops norvegicus is a sedentary long-lived, slow growing lobster which inhabits burrows constructed in muddy substrates of the upper slope and its presence appears to be related with heterogeneity in the characteristics of the sediment as well as with variations in fishing effort. The species was recorded at depths from about 30 meters in the northern Adriatic Sea to 400 meters in the southern part of the Adriatic Sea (Marano et al., 1998). In the southern Adriatic, along the western (Italian) and eastern (Albanian) coasts, the settlements are not as dense as in northern part (Karlovac, 1953; Marano et al., 1998).

The geographic distribution of Norway lobster is highly discontinuous because heavily dependent upon sediment composition which should be muddy, preferably medium-grained (~ 40% of clay and silt; Farmer, 1975; Afonso-Dias, 1998; Bell et al., 2006). Importantly, there seems to be a stock-specificity to the relationship between burrow density and sediment composition which has been found to hold true over time (Campbell et al., 2009). This, added to the fact that *N. norvegicus* is a sedentary species (Chapman & Rice, 1970) with a relatively short larval phase (Dickey-Collas et al., 2000; Bell et al., 2006), means that this species is generally characterised by spatially segregated populations (or stocks) with little or no exchange between them (Bell et al., 2006). This heterogeneity in distribution is also present within smaller areas, giving rise to smaller “subopulations” or “stocklets” with different densities and life-history characteristics (Maynou & Sardà, 1997; Bell et al., 2006)

Lacking specific information on the stock identification of Norway lobster (*N. norvegicus*) in the Adriatic Sea, the stock was assumed in the boundaries of the whole GSA 18 (Fig. 5.2.15.2.1).

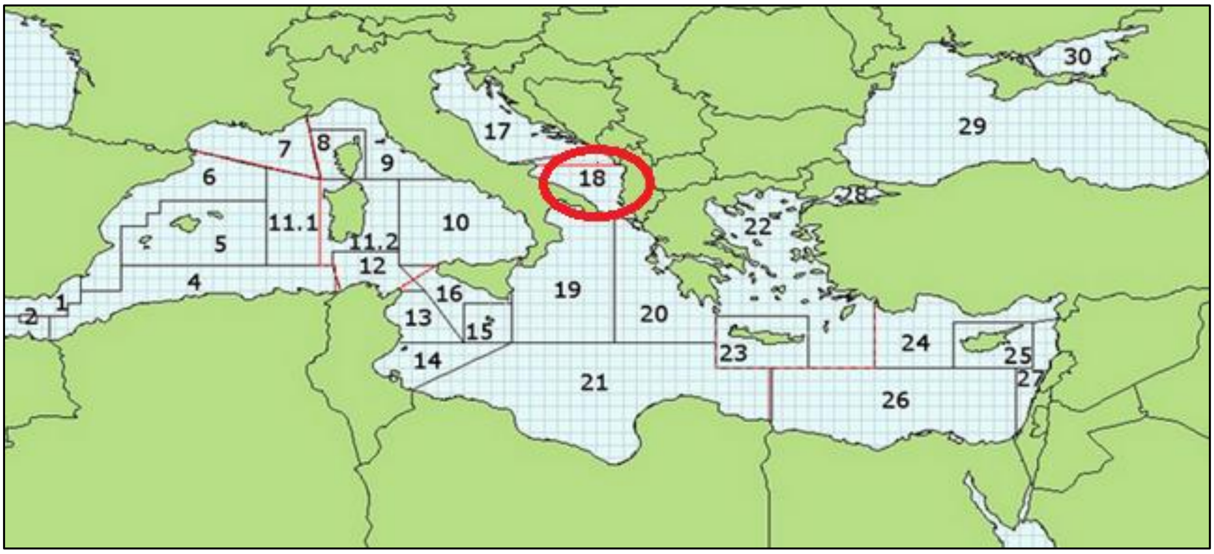


Fig. 5.2.15.2.1. Geographical location of GSA 18.

Total mortality has been found negatively correlated with the mean size obtained in different Mediterranean GSAs, although environmental influences at smaller spatial scale scale could play also an important role (Abellò *et al.*, 2002). Indeed, differences in growth have been highlighted for *N. norvegicus* from different habitats in the same geographical area (Central Adriatic) (Froglia and Gramitto, 1987) (see also 5.2.14).

5.2.15.2 Growth

In the DCF framework parameters were estimated from the analysis of LFDs and the following values were obtained: females CL_∞=61 mm; K=0.19; t_0= -0.5; males CL_∞=80 mm; K=0.17; t_0= -0.5. These estimates are comparable with the values obtained in the SAMED project (2002) in the same area. Parameters of the length-weight relationship were a=0.5749, b=3.1626 for sex combined (length in cm).
These parameters are comparable with the estimates from Marano et al., 1998.

5.2.15.3 Maturity

Studies on the maturity cycle of Norway lobster evidenced that the maturity process is completed from late-spring summer through autumn and the smallest ovigerous female had 23.5 mm carapace length. Records from literature report a length at first maturity (Lm_{50}) between 30.6 and 34.8 mm, depending on the year. These differences were probably due to the seasonal variations and different availability of the species to the gear.
In the Adriatic, *N. norvegicus* spawns once a year (Froglia and Gramitto, 1981). The proportion of females with mature ovaries peaks in spring or at the beginning of summer. Berried females were found in October and November (Orsi Relini et al., 1998), but some specimens can be present up to late spring. According to Karlovac (1953), Norway lobster larvae are present in the Adriatic plankton in late winter, from January to April.
The sex ratio in the catches changes through the year. The proportion of females is lower when they carry external eggs because they are less active and are more often hidden in burrows. On the other hand, this proportion increases and is higher in the mating period (Jukić, 1971; Froglia and Gramitto, 1981; Ungaro et al., 1999).
Data on the length at first sexual maturity highlight that at first maturity individuals are two (Froglia and Gramitto, 1981; 1987) or three years old (Orsi Relini et al., 1998).
In the southern Adriatic commercial catches of Norway lobster are taken on the same fishing grounds as pink shrimp and European hake (AA.VV. 2000; EU project 97/0066 – Medland).
The maturity ogive for females estimated within DCF was 24.2 mm CL and maturity range 2.1 mm as reported in figure 5.2.15.3.1. In this case females from stage 2b (i.e. MEDITS maturity scale) onwards were considered mature.
The sex ratio evidenced the prevalence of males in the higher size classes.

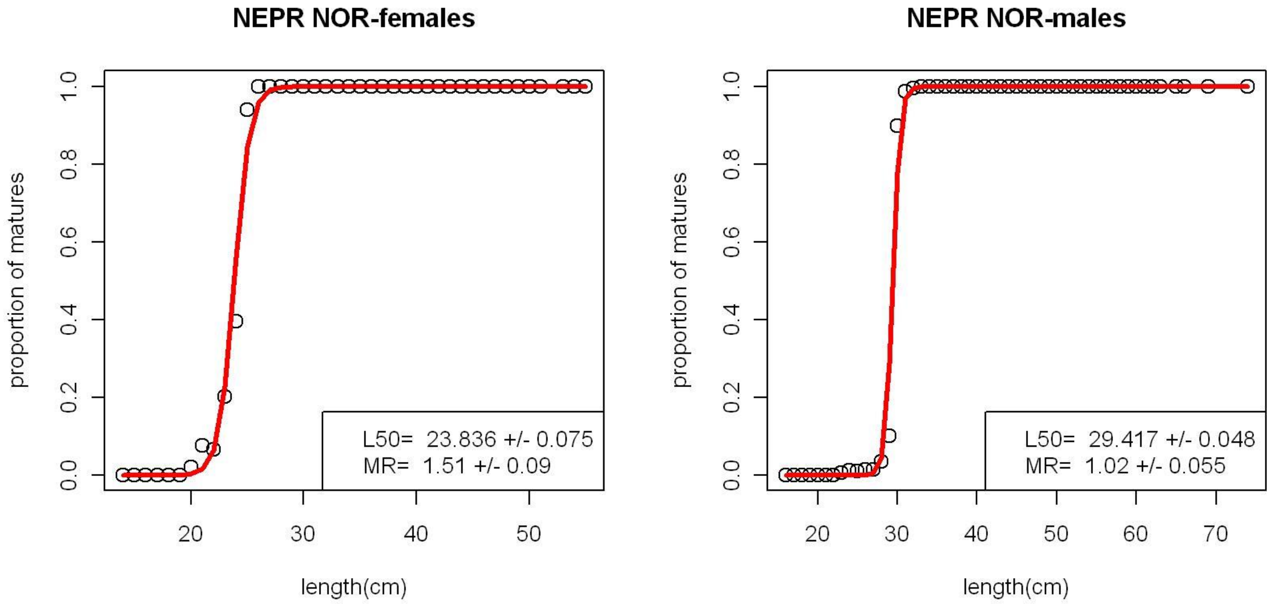


Fig. 5.2.15.3.1. Norway lobster in GSA 18. Maturity ogives of males and females.

5.2.15.4 Fisheries

5.2.15.4.1 General description of the fisheries

Norway lobster is only targeted by trawlers on offshore fishing grounds. Norway lobster usually occurs with other important commercial species as *M. merluccius*, *Illex coindetii*, *Eledone cirrhosa*, *Lophius* spp., *Lepidorhombus boscii* and *P. longirostris*.

5.2.15.4.2 Management regulations applicable in 2014

Management regulations are based on technical measures, closed number of fishing licenses for the fleet and area limitation (distance from the coast and depth). In order to limit the over-capacity of the fishing fleet, Italian fishing licenses have been fixed since the late 1980s and the fishing capacity has been gradually reduced. Other measures on which the management regulations are based are technical measures (mesh size), minimum landing sizes (EC 1967/06) and a seasonal fishing ban, that in southern Adriatic has been mandatory since the late 1980s. 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 zones (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) was established in 1989. In the former, only the professional small scale fishery using fixed nets and long-lines is allowed, from January 1st to June 30, while in the latter the trawling fishery is allowed from November 1st to March 31 and the small scale fishery is allowed all year round. A recreational fishery using no more than 5 hooks is allowed in both areas. Since June 2010, the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coast are also enforced.

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 MPAs 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.

5.2.15.4.3 *Catches*

Data from FISHSTAT FAO were available for both sides of GSA 18 for this species in the period 1970-2010 evidencing that catches in Montenegro are null whilst in Albania they are negligible (always less than 10 tons) by comparison with Italian catches (Fig. 5.2.15.4.3.1).

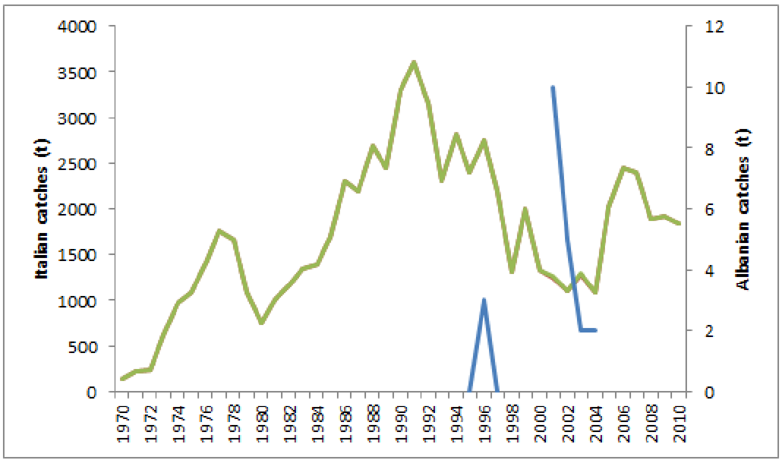


Fig. 5.2.15.4.3.1. Norway lobster in GSA 18. FAO-FISHSTAT data.

5.2.15.4.4 Landings

Available landings data are from DCF regulations. STECF EWG 14-19 received Italian landings data for GSA 18 by fisheries which are listed in Tab. 5.2.15.4.4.1.

In general, demersal trawlers account for the majority of the landings. Landings declined from 2007 to 2012 and increased in 2013.

Tab. 5.2.15.4.4.1. Norway lobster in GSA 18. Annual landings (tons) by fishery, from 2007 to 2013.

YEAR	GEAR	FISHERY	GSA	LANDINGS
2007	OTB	BOTH	18	1300
2008	OTB	BOTH	18	1003
2009	OTB	DEMSP	18	984
2009	OTB	MDDWSP	18	103
2010	OTB	DEMSP	18	812
2010	OTB	MDDWSP	18	206
2011	OTB	DEMSP	18	658

2011	OTB	MDDWSP	18	101
2012	OTB	DEMSP	18	410
2012	OTB	MDDWSP	18	48
2013	OTB	DEMSP	18	806
2013	OTB	MDDWSP	18	27

5.2.15.4.5 Discards

The proportion of the discards of Norway lobster in the GSA 18 is generally low (less than 5%). Discard data were available for the period 2009-2013. Considering the low amount of discards and that the collection of discard data was not carried out in DCF in 2007 and 2008, discard data were not used in the present assessment.

5.2.15.4.6 Fishing effort

The trends in fishing effort by year and major gear type in terms of nominal effort, GT*days and number vessels are listed in Tab. 5.2.15.4.6.1 and illustrated in figure 5.2.15.4.6.1. The fishing effort of trawlers, the major component of fishing in the area, is decreasing.

Tab. 5.2.15.4.6.1 Norway lobster in GSA 18. OTB Effort for GSA 18 by gear type, 2004-2013 as reported through the DCF official data call.

Year - Metier	Nominal effort	GT x days	N. vessels
2004	**14,451,460**	**2,510,980**	**2,403**
DEMSP	1,210,239	154,502	429
MDDWSP	13,241,221	2,356,478	1,974
2005	**13,550,061**	**2,354,637**	**2,217**
DEMSP	525,746	56,163	282
MDDWSP	13,024,315	2,298,474	1,935
2006	**14,744,610**	**2,662,179**	**2,650**
DEMSP	4,042,496	603,870	1,131
MDDWSP	10,702,114	2,058,309	1,519
2007	**12,840,209**	**2,294,240**	**2,442**
DEMSP	2,822,672	521,821	837
MDDWSP	10,017,537	1,772,419	1,605
2008	**11,575,103**	**2,056,032**	**1,758**
DEMSP	10,829,765	1,906,273	1,590
DWSP	131,456	29,784	27
MDDWSP	613,882	119,975	141
2009	**14,079,891**	**2,413,542**	**1,949**
DEMSP	12,468,201	2,125,323	1,682
DWSP	112,701	18,934	32
MDDWSP	1,498,989	269,285	235
2010	**11,856,268**	**2,068,044**	**1,177**
DEMSP	9,386,636	1,608,697	848
DWSP	124,777	21,524	42
MDDWSP	2,344,855	437,823	287
2011	**11,511,878**	**1,923,179**	**864**

DEMSP	10,061,608	1,630,015	708
DWSP	46,554	10,809	16
MDDWSP	1,403,716	282,355	140
2012	**9,821,959**	**1,668,749**	**1,057**
DEMSP	9,225,895	1,536,372	896
MDDWSP	596,064	132,377	161
2013	**10,511,626**	**1,994,855**	**997**
DEMSP	10,087,518	1,900,071	930
MDDWSP	424,108	94,784	67
Total	**124,943,065**	**21,946,437**	**17,514**

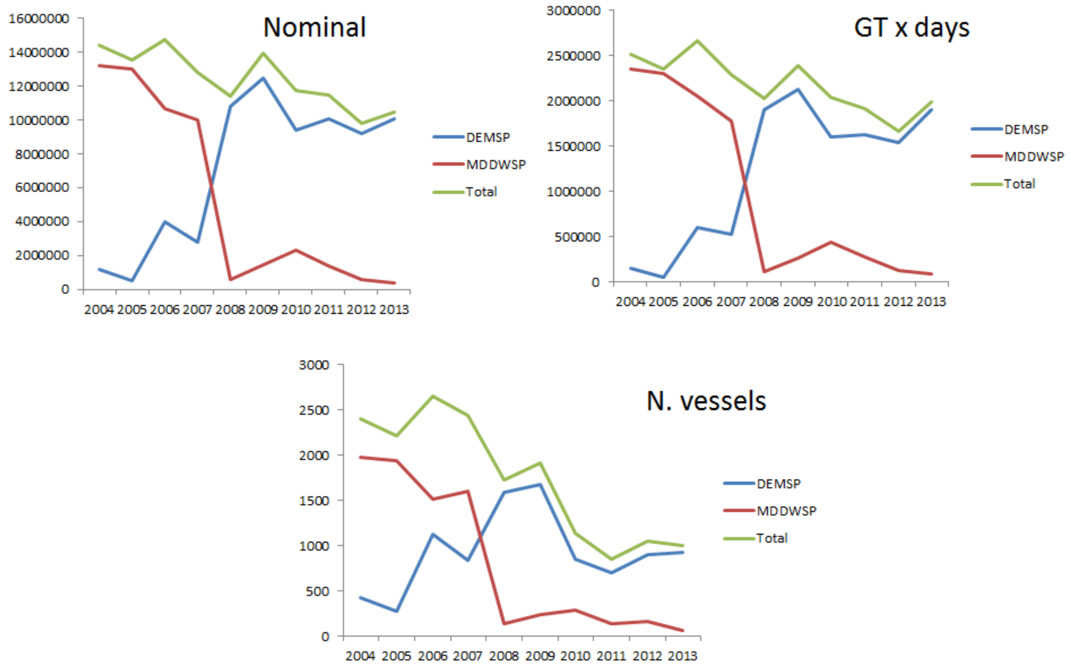


Fig. 5.2.15.4.6.1 Norway lobster in GSA 18. OTB Effort for GSA 18 by gear type, 2004-2013 as reported through the DCF official data call.

5.2.15.5 Scientific surveys

MEDITS

5.2.15.5.1 Methods

According to the MEDITS protocol (Bertrand et al., 2002), trawl surveys were carried out yearly (May-July), applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was used throughout the time series. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish and weight per surface unit) were standardised to square kilometre, using the swept area method.

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 18 the following number of hauls was reported per depth stratum (Tab 5.2.15.5.1.1).

Tab. 5.2.15.5.1.1. Number of MEDITS hauls per year and depth stratum in GSA 18, 1996-2013.

PROF MEDIA	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
10-50	18	17	17	17	17	18	12	12	11	11	11	11	12	12	12	12	12	12
51-100	24	25	25	26	25	24	20	19	21	20	21	20	22	20	20	20	20	20
101-200	32	33	33	32	33	33	31	32	31	32	31	32	33	30	31	31	31	31
201-500	19	18	18	19	18	18	13	13	13	13	13	13	12	14	13	13	13	13
501-800	19	19	19	18	19	19	14	14	14	14	14	14	11	14	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

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

5.2.15.5.2 Geographical distribution

Two main nursery areas were localized in the GSA Using GRUND survey data and geostatistical methods (Lembo, 2010): offshore Gargano promontory and in the southernmost part of the area using weighted inverse distance method (Fig. 5.2.15.5.2.1).

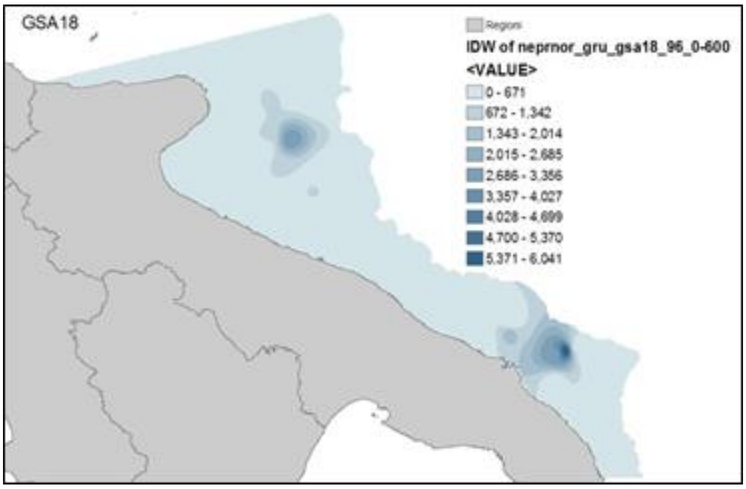


Fig. 5.2.15.5.2.1 Norway lobster in GSA 18. Geographical distribution patterns of nursery areas as estimated from GRUND data.

Using MEDITS survey data analysed in the framework of EU MEDISEH project (MAREA framework), three main spawning grounds were localized in GSA 18 in the southernmost part of the area using Ordinary Kriging method (Fig. 5.2.15.5.2.2).

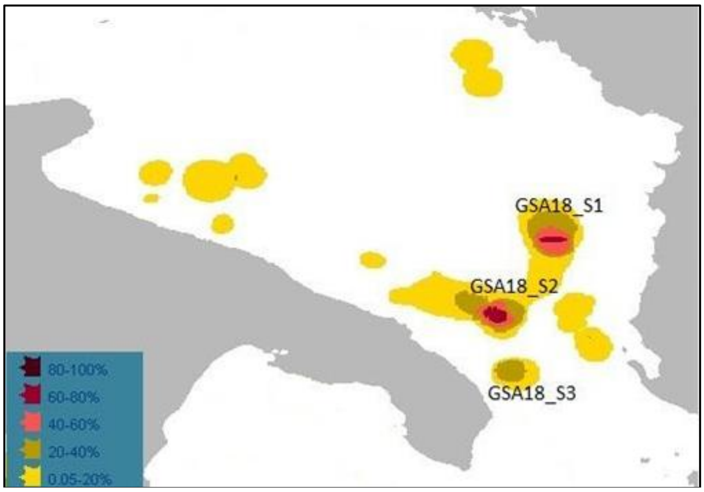


Fig. 5.2.15.5.2.2 Norway lobster in GSA 18. Geographical distribution patterns of spawners as estimated from GRUND data.

5.2.15.5.3 Trends in abundance and biomass

Fishery independent information regarding the state of Norway lobster in the whole GSA 18 was obtained from the international MEDITS survey.

Figure 5.2.15.5.3.1 displays the estimated trend of *N. norvegicus* abundance and biomass standardized to the square km in the GSA 18. The pattern is rather stable since 1997 to 2006; then there is a slight decrease in 2007 followed by a remarkable increase in 2009. After 2009, the abundance indices are decreasing at a level similar to those of the whole time series.

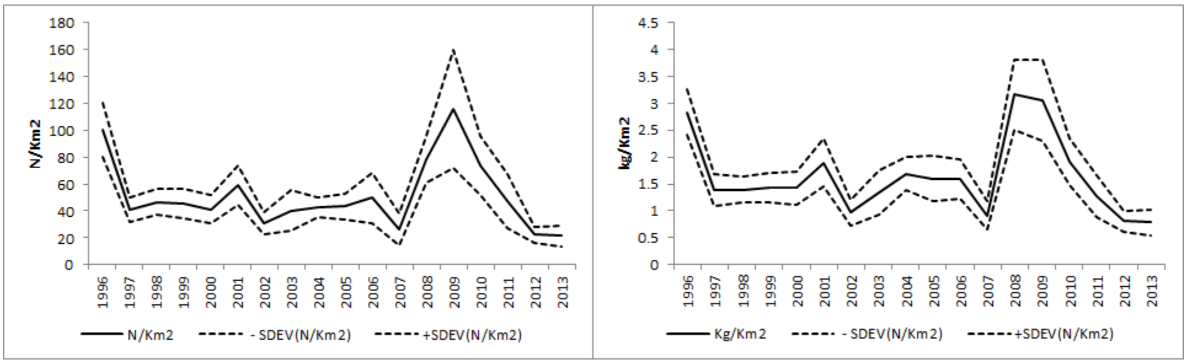


Fig. 5.2.15.5.3.1. Norway lobster in GSA 18. Abundance and biomass indices with confidence interval estimated from MEDITS in whole GSA 18 and standardized to the km^2.

5.2.15.5.4 Trends in abundance by length or age

The following Fig. 5.2.15.5.4.1 display the stratified abundance indices of GSA 18 in 1996-2013.

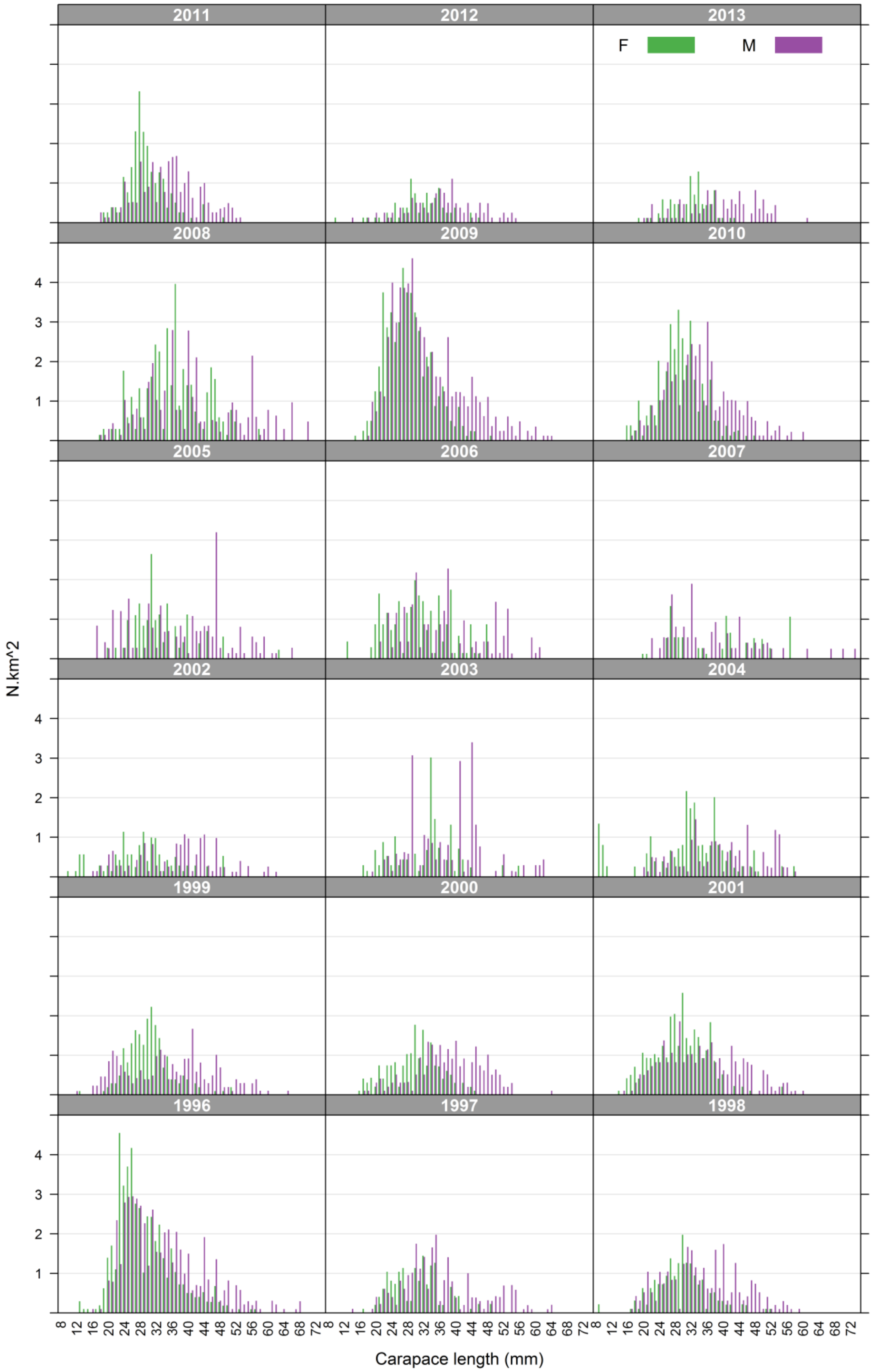


Fig. 5.2.15.5.4.1 Norway lobster in GSA 18. Stratified abundance indices by size, 1996-2013.

5.2.15.5.5 Trends in growth
No specific analyses were conducted during EWG-14-19.

5.2.15.5.6 Trends in maturity
No specific analyses were conducted during EWG-14-19.

5.2.15.6 Assessment of historic stock parameters
The assessment was performed for the western side of GSA 18 only in 2012 during the STECF-EWG 11-20, owing to a lack of landing data for the whole GSA 18. In the present meeting the assessment was performed for the whole area assuming (on average less than 4 tons in the last 10 years; Fig. 5.2.15.4.3.1) negligible catches from the eastern side Moreover, due the availability of a longer time series, XSA and SCAA approaches were utilised.

Methods: XSA

5.2.15.6.1 Justification Input parameters

Virtual Population Analysis is a deterministic algorithm to sequentially calculate a matrix of stock numbers at age and a matrix of fishing mortality rates at age given a matrix of catch at age and a matrix of natural mortality at age. The algorithm back-calculates previous stock sizes using catch at age data, current-year stock size estimates, and assumptions about fishing mortality relationships between age groups. The XSA (Shepherd 1992, Darby and Flatman 1994) implemented in R was performed aimed at the estimation of a vector of F at size, using data on total annual catches by size, including discard. The procedure does not define an object function, but is based on an iteration procedure of the functional type.

5.2.15.6.2 Input parameters
A sex-combined analysis was carried out using the growth parameters presented in section 5.2.15.3 to perform an age slicing for the landing and survey matrices (Tables 5.2.15.6.2.1-2).
Differently from the assumptions of STECF EWG 11-20, when a constant value of natural mortality M equal to 0.47 y^{-1} was estimated using Beverton & Holt Invariant method (Ragonese et al. 2006), in the present assessment an M vector calculated using the Prodbiom approach was utilized (0.42 at age 0, 0.24 at age 1, 0.20 at age 1, 0.19 at age 2, 0.18 at age 3, 0.17 at age 4, 0.17 at age 5, 0.16 at age 5, 0.16 at age 6 and 0.16 at age 7+), taking an average of the parameters presented in section 5.2.15.3. This M value is quite close to the values utilised in GSA 6 for the same species.
The same proportion of matures (0 at age 0, 0.058 at age 1, 0.827 at age 2 and for older ages 1) of the previous assessment (EWG 12-10) was also used.
The catch at age matrix estimated from the DCF data call presented ages from 0 to 17 (Fig. 5.2.15.6.2.1). Considering the low amount of catches observed in age 0 and in ages from 7 to 17, the matrix used in the assessment did not consider age 0 and a plus group from 7 was utilised. On the same basis the F_{bar} were estimated on ages from 1 to 6.

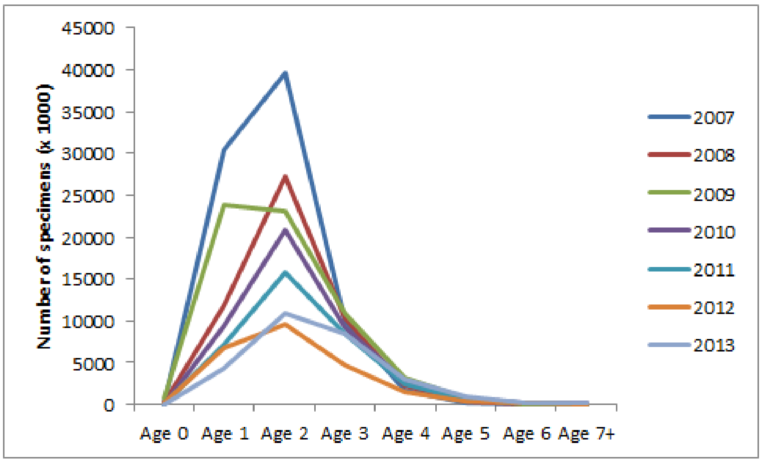


Fig. 5.2.15.6.2.1. Norway lobster in GSA 18. Catches by ages 2007-2013

Due to the absence of discard data by length in 2007 and 2008 and the fact that discards are generally negligible (i.e. less than 5% of the catches), the catch matrix used in XSA did not consider discarded specimens.
Moreover the SOP correction was not applied due to the good agreement between the real catches and the reconstructed ones.
Landing weights at age data were taken from the DCF data call 2014 (Table 5.2.15.6.1.2.3.).
The stock weight at age data were estimated using the growth parameters and L-W relationship reported in Section 5.2.15.2.
The proportion of F and M before spawning was set as 0.5.

Table 5.2.15.6.2.1. Norway lobster in GSA 18: landings at age (thousands).

Age	2007	2008	2009	2010	2011	2012	2013
1	28417.61	9786.61	14912.93	8782.86	6957.78	6373.57	4101.97
2	39600.79	27192.81	22753.11	20786.44	15836.09	9658.71	10898.35
3	9978.70	10420.91	10876.06	9258.38	8390.39	4639.80	8443.64
4	1731.93	2274.00	3125.32	2747.91	2502.06	1478.37	3079.96
5	251.44	433.79	722.87	862.77	632.39	431.00	925.49
6	85.61	81.44	92.39	254.60	198.54	135.22	292.67
7+	38.97	37.18	68.66	148.10	98.19	79.73	183.62

Table 5.2.15.6.2.2. Norway lobster in GSA 18: Abundance indices ($N \cdot km^{-2}$) at age from the MEDITS data.

Age	2007	2008	2009	2010	2011	2012	2013
1	3.25	4.82	29.85	11.89	5.28	2.06	1.73
2	7.29	13.20	46.45	27.38	19.61	6.17	4.75
3	4.43	18.44	22.31	20.95	14.81	7.56	7.63
4	2.98	11.74	10.37	9.13	5.17	4.20	4.83
5	1.84	7.89	3.86	2.13	1.82	1.25	2.28
6	1.87	5.26	1.77	1.24	0.53	0.72	0.31
7+	3.51	10.54	1.23	0.51	0.13	0.08	0.12

Table 5.2.14.6.2.3. Norway lobster in GSA 18. Mean weight at age in the landing (kg).

Age	2007	2008	2009	2010	2011	2012	2013
1	0.01	0.01	0.01	0.01	0.01	0.01	0.01
2	0.02	0.02	0.02	0.02	0.02	0.02	0.02
3	0.03	0.03	0.03	0.03	0.03	0.03	0.03
4	0.06	0.05	0.05	0.06	0.05	0.05	0.05
5	0.08	0.07	0.08	0.08	0.07	0.07	0.08
6	0.10	0.10	0.09	0.10	0.09	0.10	0.10
7+	0.08	0.11	0.12	0.16	0.11	0.11	0.14

Table 5.2.15.6.2.4. Norway lobster in GSA 18. Mean weight at age in the stock (kg).

Age	2007	2008	2009	2010	2011	2012	2013
1	0.01	0.01	0.01	0.01	0.01	0.01	0.01
2	0.02	0.02	0.02	0.02	0.02	0.02	0.02
3	0.03	0.03	0.03	0.03	0.03	0.03	0.03
4	0.05	0.05	0.05	0.05	0.05	0.05	0.05
5	0.07	0.07	0.07	0.07	0.07	0.07	0.07
6	0.17	0.17	0.17	0.17	0.17	0.17	0.17
7+	0.20	0.20	0.20	0.20	0.20	0.20	0.20

5.2.15.6.3 *Results*

The selection of the suitable parameters for the final XSA run was performed running four sensitivity analyses. The resulting SSB, fishing mortality and recruitment time series were plotted (Figures 5.2.15.6.3.1.-4).

The first sensitivity analysis was conducted using 4 different shrinkage weight assumptions (i.e. fse 0.5, 1, 1.5, 2). The final setting selected is a low value (0.5), considering the diagnostics and issues with the tuning fleet for this particular species as explained in Section 5.2.15.8 (Figure 5.2.15.6.3.1).

The second analysis was conducted to assess the effect of the age after which catchability is no longer estimated (i.e. qage assigning values ranging from 1 to 4). Considering the diagnostics, the final setting selected is a constant catchability for ages bigger than 4 (Figure 5.2.15.6.3.2).

The third analysis was conducted to assess the effect of shrinkage on the last ages (i.e. ranging from 3 to 6). Considering the diagnostics, the final setting selected is a shrinkage on the last 5 ages (Figure 5.2.15.6.3.3).

The fourth analysis was conducted to assess the effect of shrinkage on the last years (i.e. ranging from 3 to 6). Considering the diagnostics, the final setting selected is a shrinkage on the last 5 years (Figure 5.2.15.6.3.4).

The parameters finally retained for the final run are summarised in Table 5.2.15.6.3.1.

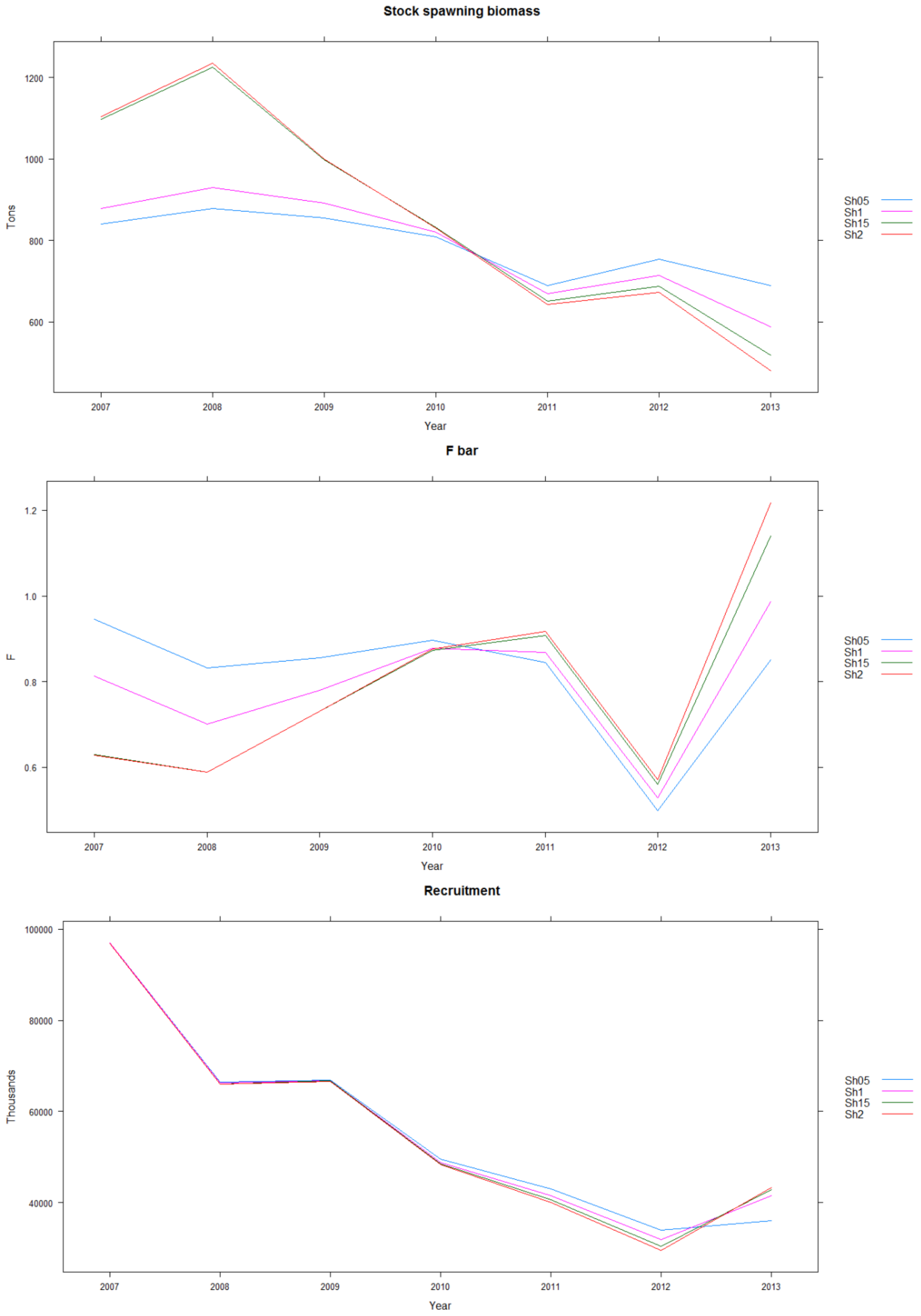


Figure 5.2.15.6.3.1. Norway lobster in GSA 18. Sensitivity analysis on shrinkage weight.

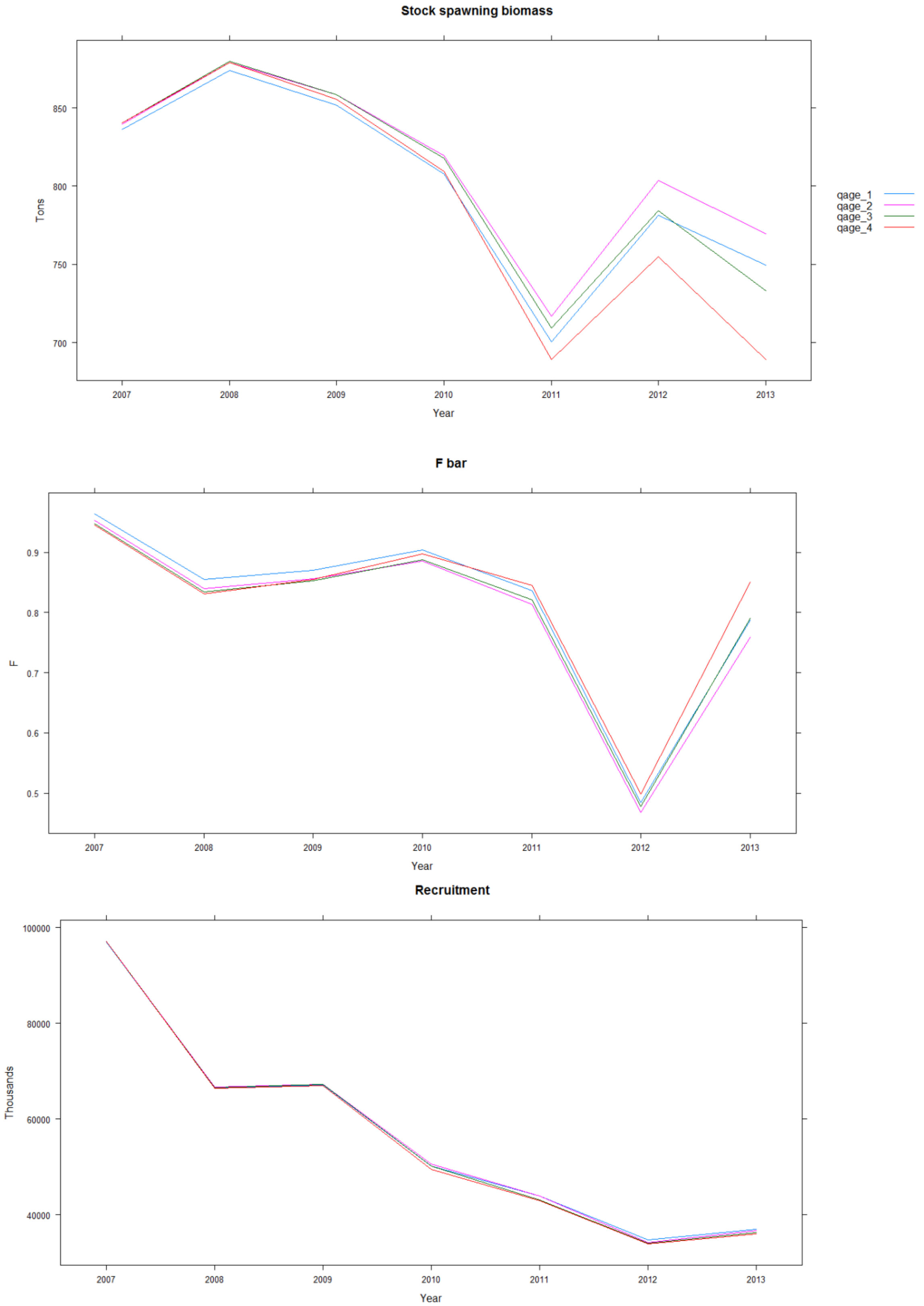


Figure 5.2.15.6.3.2. Norway lobster in GSA 18. Sensitivity analysis on catchability.

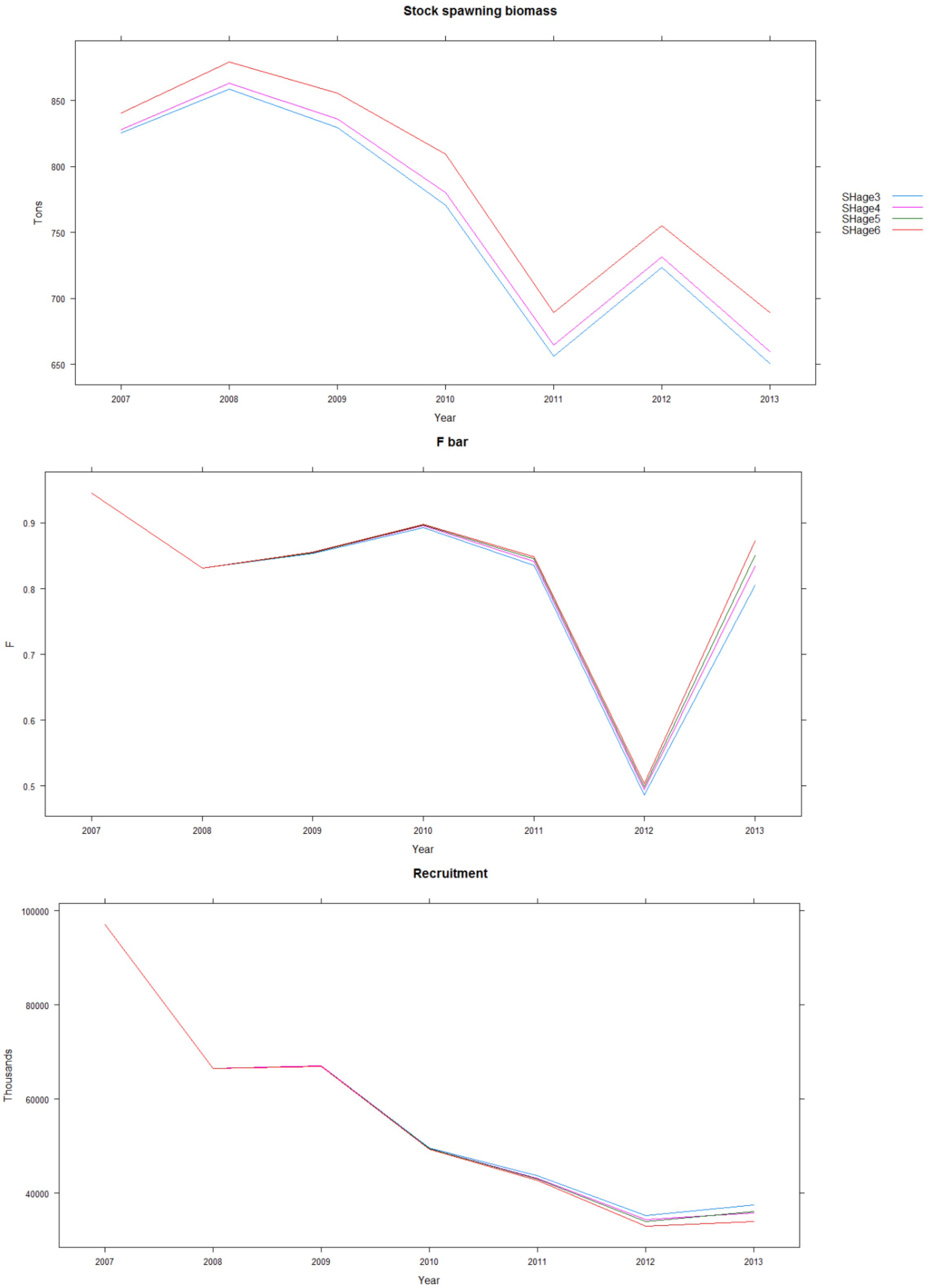


Figure 5.2.15.6.3.3. Norway lobster in GSA 18. Sensitivity analysis on shrinkage on the last ages.

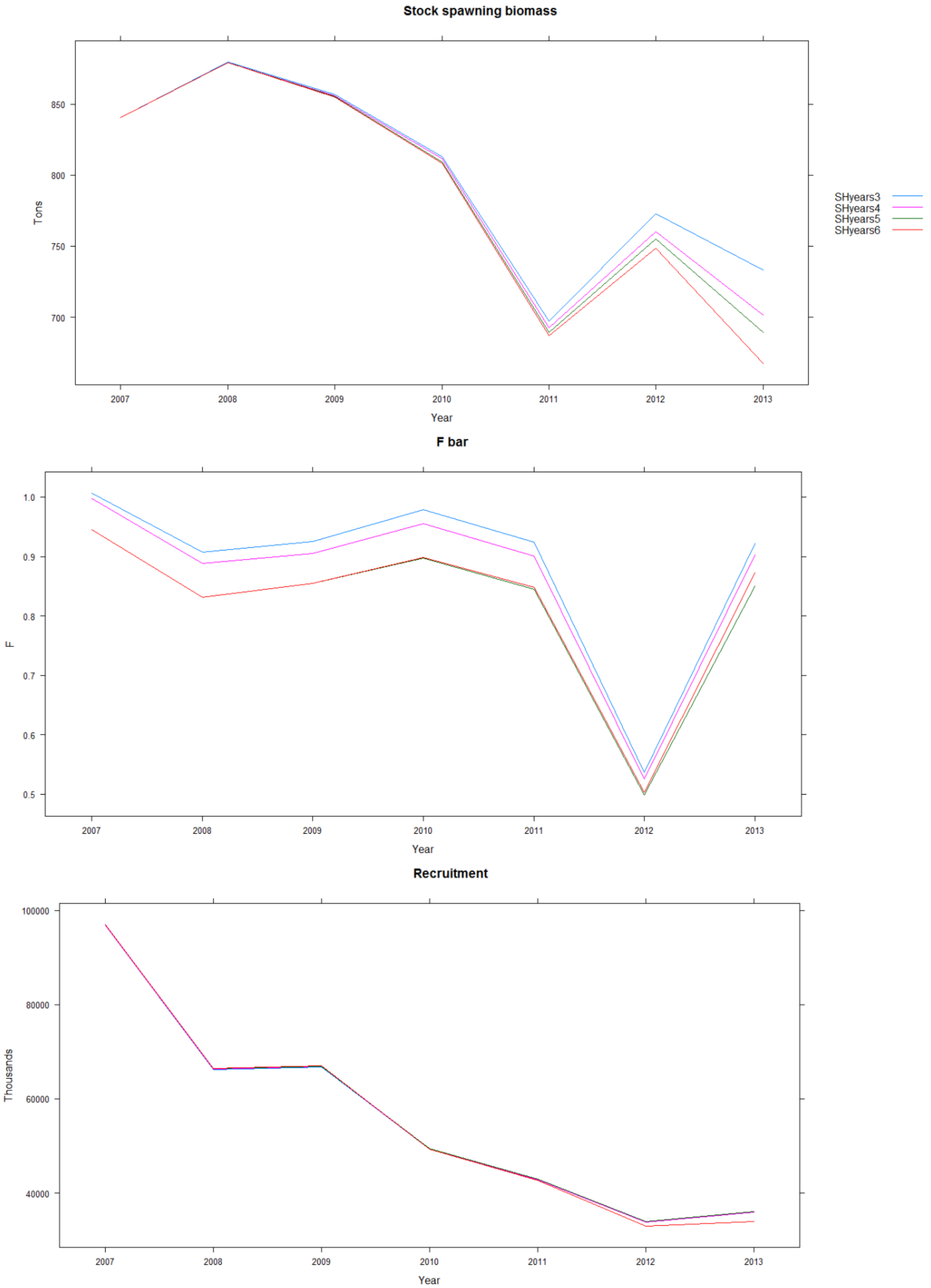


Figure 5.2.15.6.3.4. Norway lobster in GSA 18. Sensitivity analysis on shrinkage on the last years.

Table 5.2.15.6.3.1. Norway lobster in GSA 18. XSA settings.

Fse	shk.yrs	shk.ages	rage	qage
0.5	5	5	1	4

Moreover a retrospective analysis was conducted on recruitment, mean F and SSB (Figure 5.2.15.6.3.5) to ensure the robustness of the final estimates.

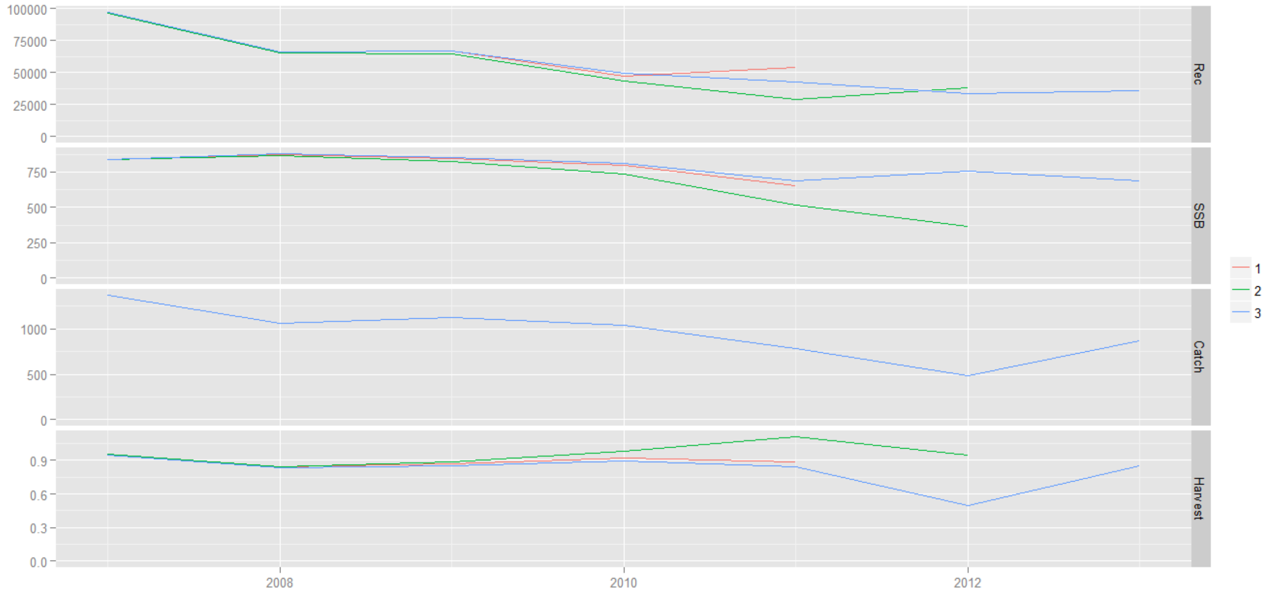


Figure 5.2.15.6.3.5. Norway lobster in GSA 18. Retrospective analysis (Recruitment, mean F and SSB).

The results of the assessment (Figure 5.2.15.6.3.6) show a decreasing trend of recruits and an oscillating trend in spawning stock biomass (SSB). The fishing mortality showed a minimum value in 2012 followed by the current Fbar1-6 of 0.85. The F values by age are shown in Figure 5.2.15.6.3.6. MEDITS log residuals (Figure 5.2.15.6.3.7) are quite low and no trend can be observed.

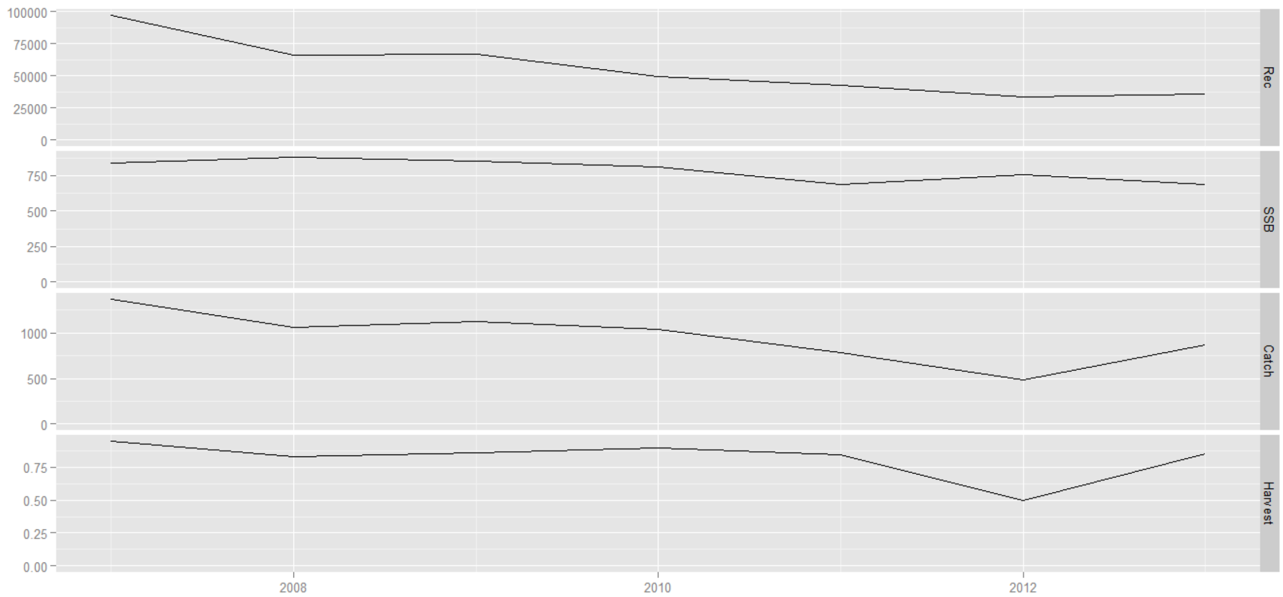


Figure 5.2.15.6.3.6 Norway lobster in GSA 18. XSA summary results: SSB and cath are in tonnes, recruitment in 1000s individuals.

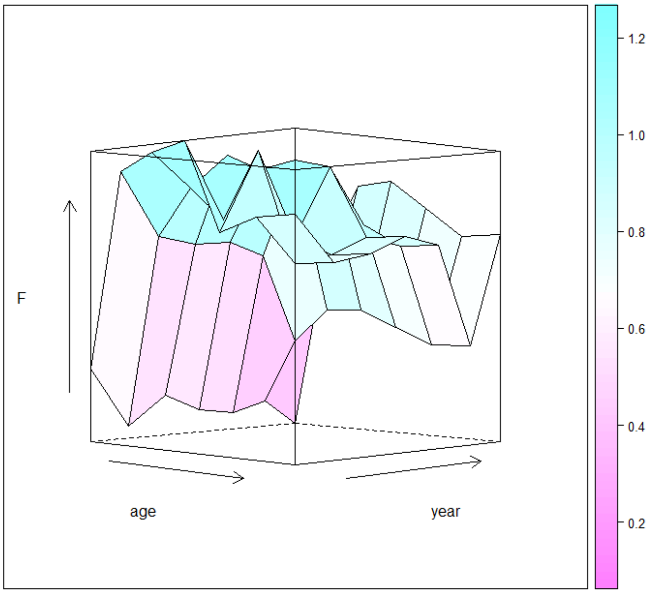


Figure 5.2.15.6.3.6 Norway lobster in GSA 18. XSA results: F values by ages.

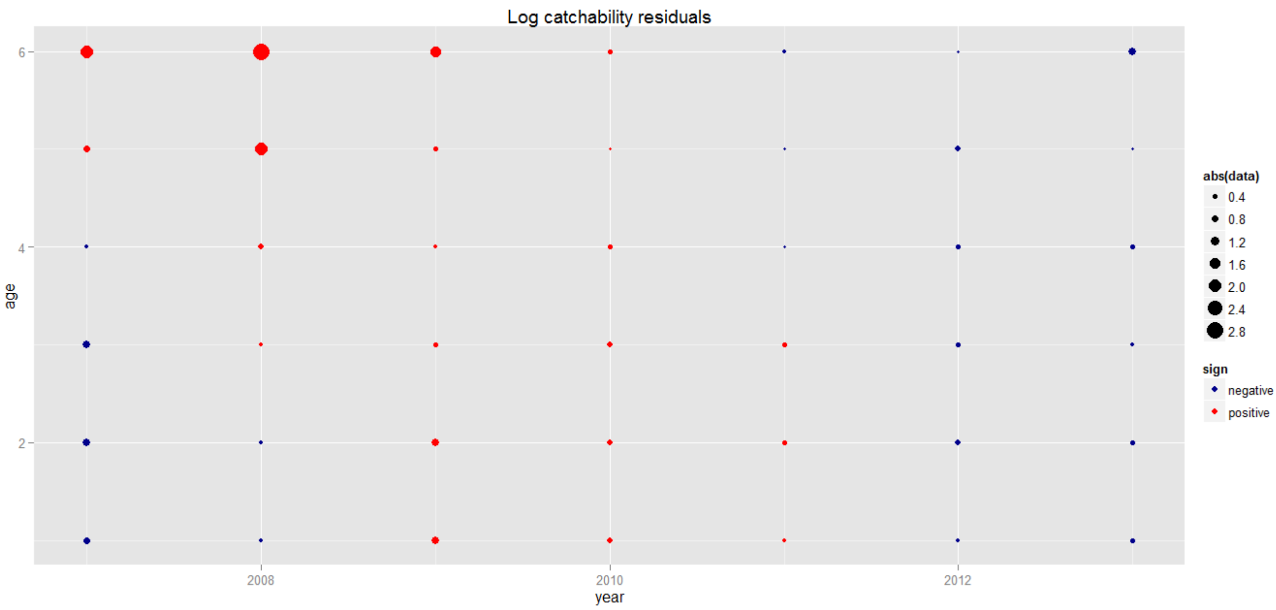


Figure 5.2.15.6.3.7 Norway lobster in GSA 18. XSA results: Log catchability residual plots (XSA) for the tuning fleet, MEDITS.

5.2.15.6.2 Method: a4a

5.2.15.6.2.1 Justification

STECF EWG 14-19 used the 'a4a' framework to run a variety of statistical catch at age models.

5.2.15.6.2.2 Input parameters

The input parameters are the same as those used for the XSA model for biological parameters, catch and abundance indices. The a4a statistical catch at age model requires the definition of a catchability model, a fishing mortality model and a stock recruitment model.

Table 5.2.15.6.2.2.1 summarizes the different types of models used. The stock-recruitment model was assumed to be year-dependent. We ran all possible combinations of these model formulations, resulting in 42 potential models.

Table 5.2.15.6.2.2.1 Norway lobster in GSA 18. Description of the different models used for the fishing mortality (fmodels), the catchability (qmodels) models ('a4aSCA' function in the a4a R package).

fmodel	**qmodel**
fmodel1 <- ~factor(age) + factor(year)	qmodel1 <- list(~factor(age))
fmodel2 <- ~s(age, k=3) + s(year,k=4)	qmodel2 <- list(~s(age, k=3))
fmodel3 <- ~te(age, year, k = c(3,4))	qmodel3 <- list(~s(age, k = 3) + s(pmax(year - age, 2008), k = 3) + s(year, k = 5))
fmodel4 <- ~factor(replace(age,age>3,3)) + factor(year)	qmodel4 <- list(~factor(replace(age,age>4,4)))
fmodel5 <- ~te(age, year, k = c(4, 6)) + s(year, k = 5, by = as.numeric(as.numeric(age == 1)))	qmodel5 <- list(~s(replace(age,age>4,4),k=3))
fmodel6 <- ~s(age, k = 4) + s(pmax(year - age, 2008), k = 8) + s(year, k = 8)	qmodel6 <- list(~s(replace(age,age>3,3),k=3))
fmodel7 <- ~s(replace(age,age>3,3),k=3) + factor(year)	

5.2.15.6.2.3 Results

Over the 42 potential models the best model was selected considering a sensitivity analysis (Fig. 5.2.15.6.2.3.1) and taking into account the AIC values (Table 5.2.15.6.2.3.1).

These 'best' model, model 16 (fmodel3 and qmodel2 in Table 5.2.15.6.2.3.1),gave results similar to XSA in terms of catch, SSB and fishing mortality but they gave lower estimates of recruitment (Fig. 5.2.15.6.2.3.2).

This general framework of testing a large number of models showed interesting potential to objectively assess this stock and test different hypotheses for selectivities. This would require further work and XSA was finally kept as the base-case model for the Norway lobster in GSA 18 stock assessment also taking into account the short time series analysed (2007-2013). The diagnostic of the best model are presented in Figures 5.2.15.6.2.3.3 - 5.

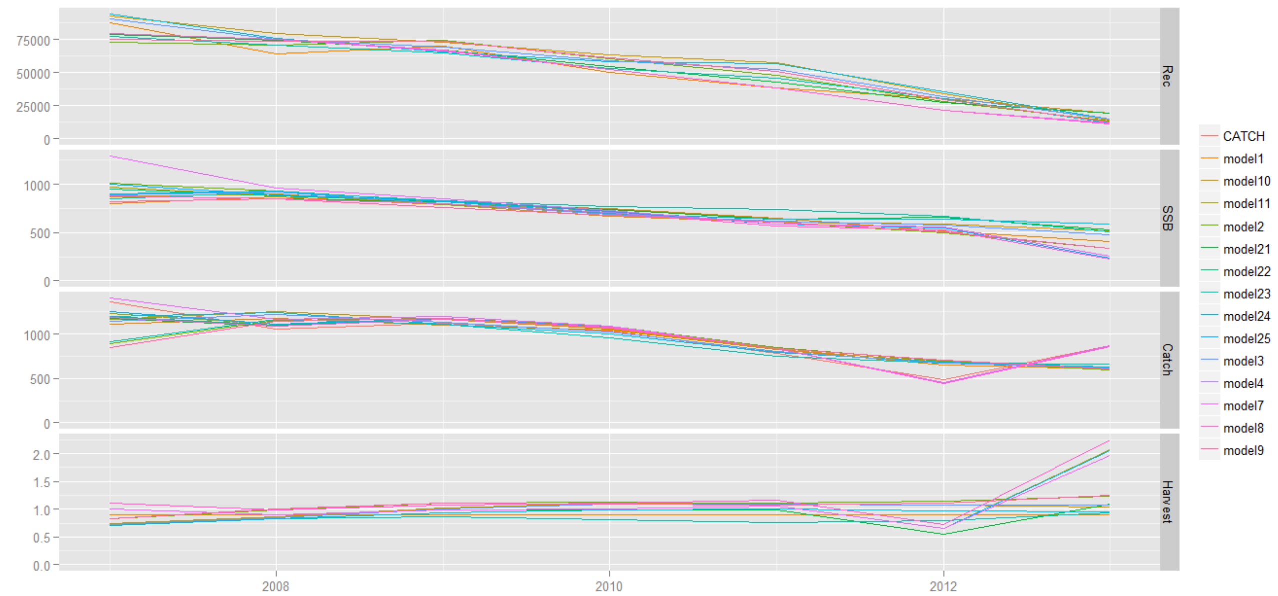


Figure 5.2.15.6.2.3.1. Norway lobster in GSA 18. SCAA results: Recruitment, SSB, Catch and F. Multiple models.

Table 5.2.15.6.2.3.1 Norway lobster in GSA 18. SCAA results: AIC values of each model.

Model N	AIC	Model N	AIC
1	182.81	23	221.37
2	220.31	24	203.97
3	202.04	25	112.73
4	110.8	28	112.73
7	110.8	29	118.34
8	113.62	30	219.45
9	218.97	31	202.45
10	196.88	32	111.04
11	107.08	33	111.04
15	184.1	34	125.48
16	**82.797**	35	221.44
17	152.39	37	211.56
18	88.171	38	120.13
21	88.171	42	120.13
22	120.06		

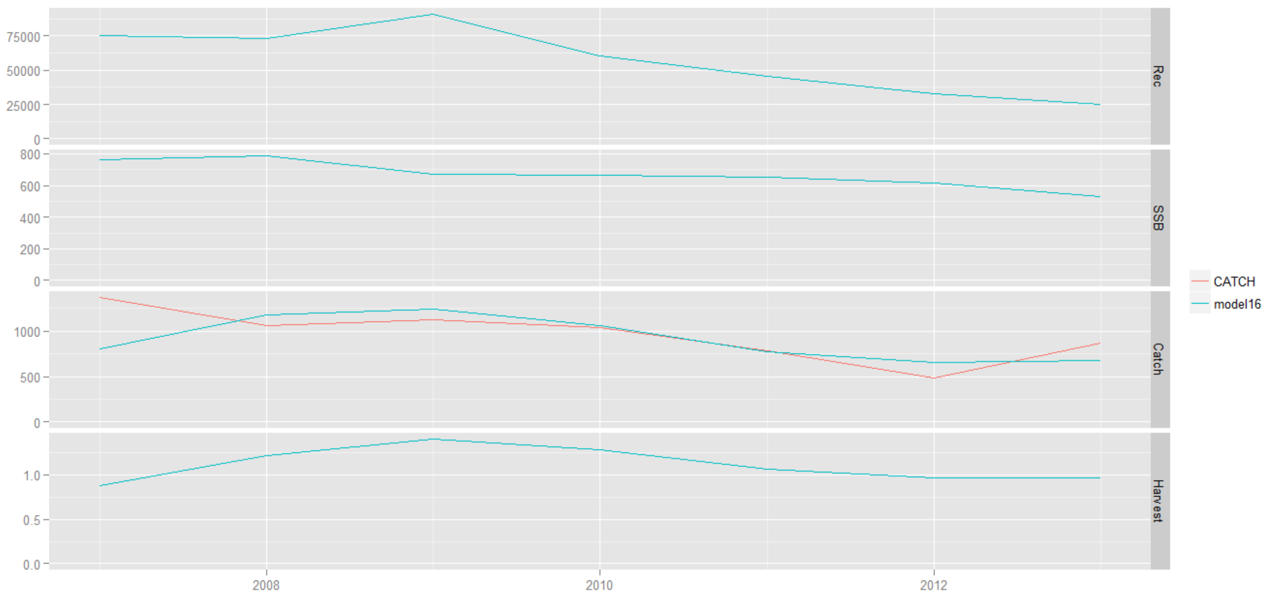


Figure 5.2.15.6.2.3.2. Norway lobster in GSA 18. SCAA results: Recruitment, SSB, Catch and F.

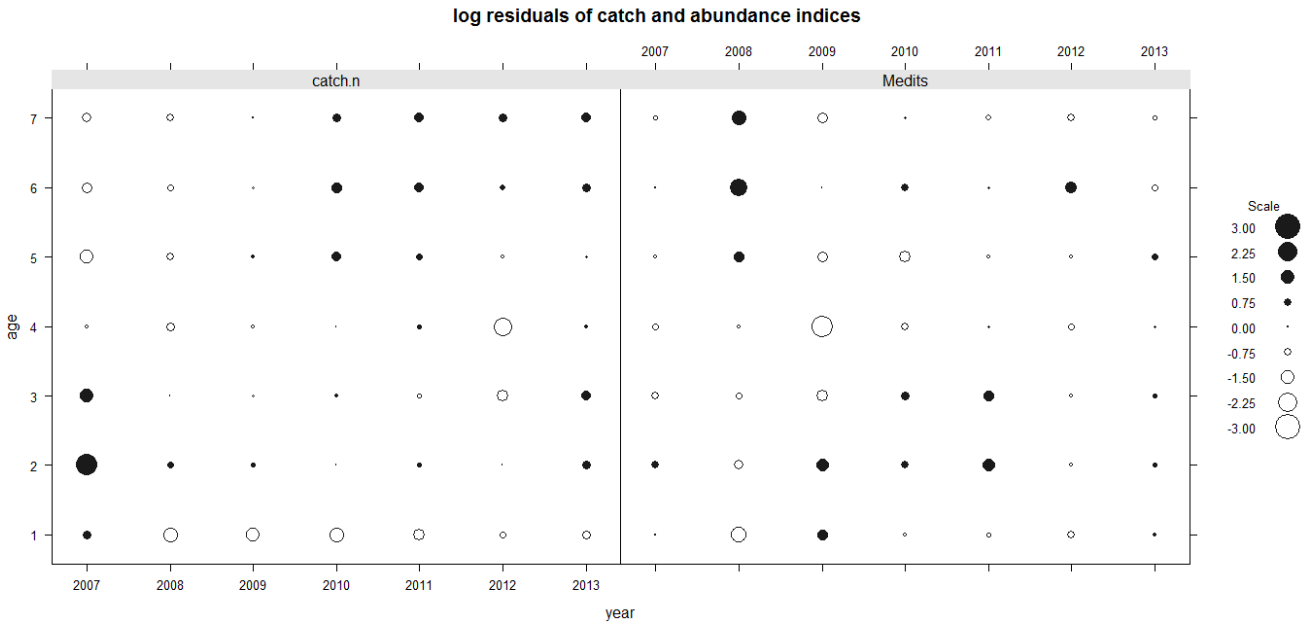


Figure 5.2.15.6.2.3.3. Norway lobster in GSA 18. SCAA diagnostics: Bubble plot residuals.

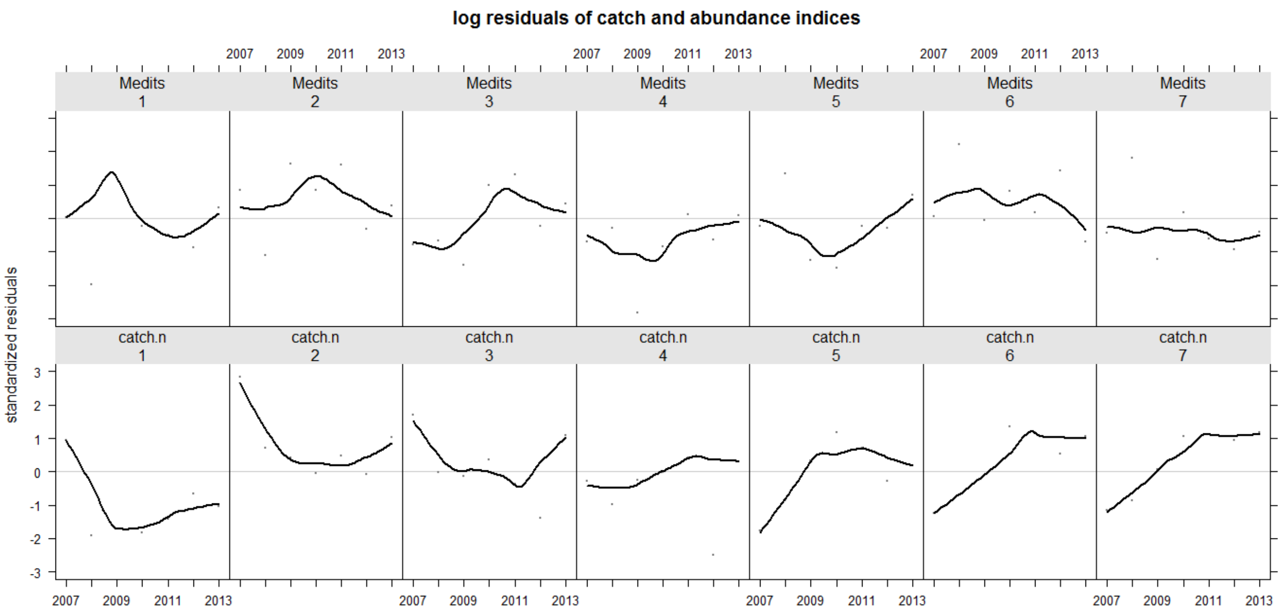


Figure 5.2.15.6.2.3.4 Norway lobster in GSA 18. SCAA diagnostics: residuals trends.

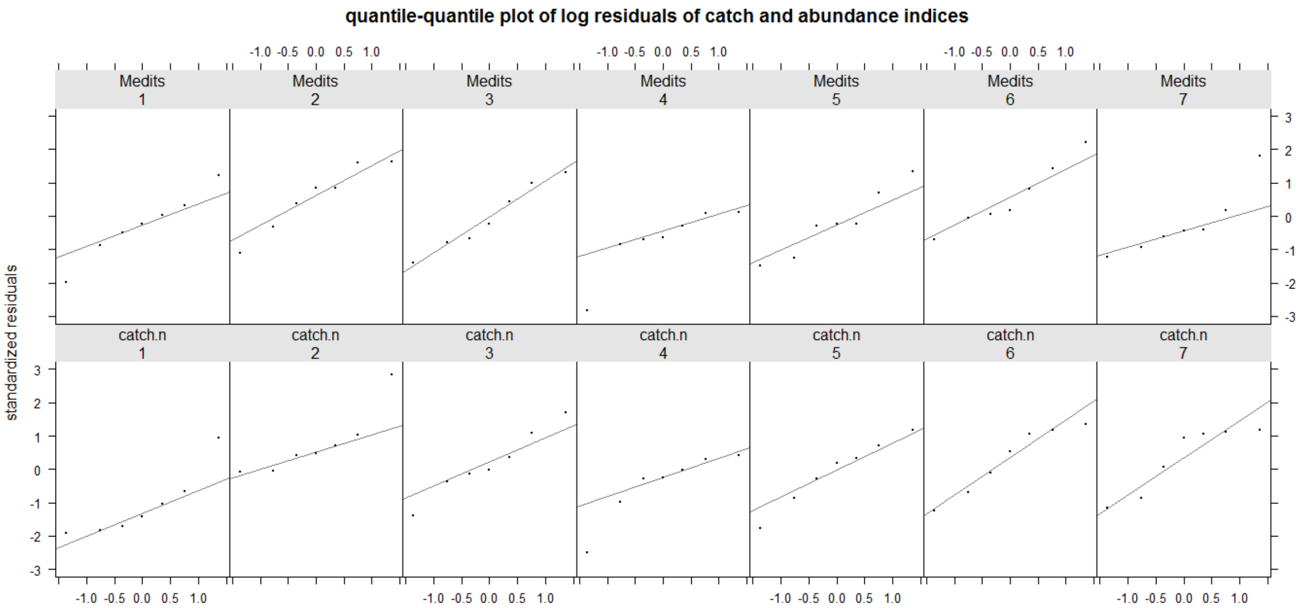


Figure 5.2.15.6.2.3.5 Norway lobster in GSA 18. SCAA diagnostics: q-q plots.

5.2.15.7 Long term prediction

5.2.15.7.1 *Justification*

Yield per recruit analysis was used (FLBRP) to calculate the reference point ($F_{0.1}$ as a proxy of FMSY) and the estimated reference fishing mortality (Fcurrent) from XSA.

5.2.15.7.2 *Results*

Yield per recruit output curves are illustrated in the Figure 5.2.15.7.2.1 while the main results of the analysis are reported in Table 5.2.15.7.2.1.

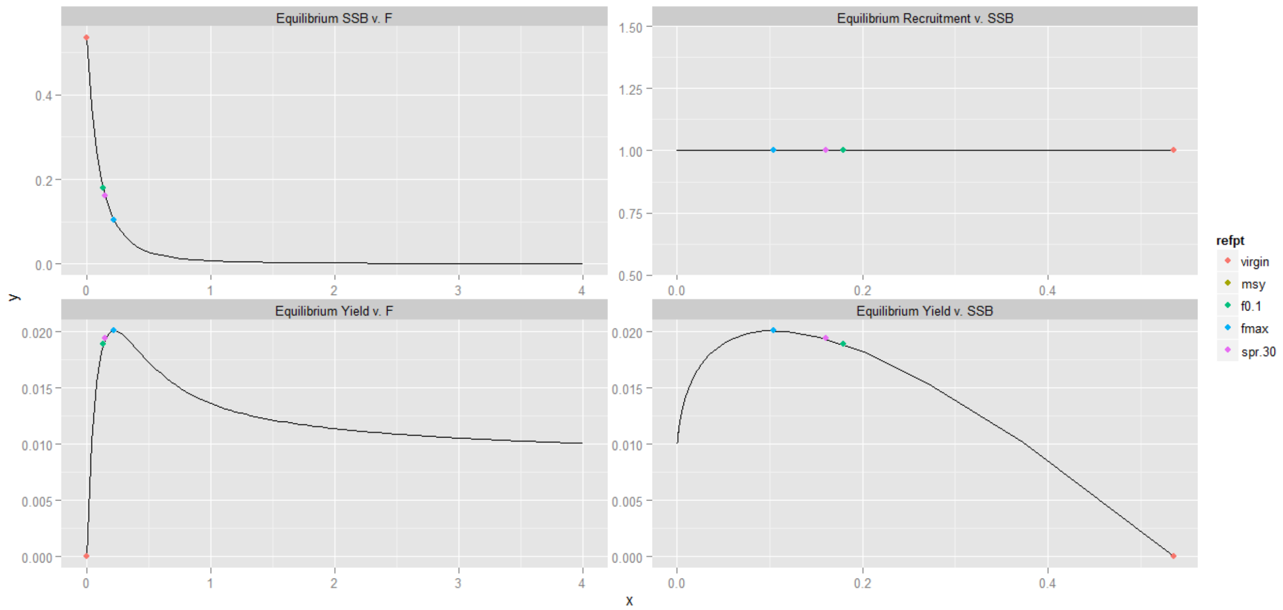


Figure 5.2.15.7.2.1. Norway lobster in GSA 18. YpR results.

Table 5.2.15.7.2.1 Norway lobster in GSA 18. YpR results.

	harvest	yield	ssb
virgin	0	0	0.54
f0.1	0.14	0.02	0.18
fmax	0.22	0.02	0.10

5.2.15.8 Data quality

Data from DCF data call issued in 2014 were used. A consistent sum of products compared to landings was observed (differences less than 5% for age data). In the period from 2009 to 2013 data were provided by year and metier, in 2007 and 2008 for fleet segment.

Discards data of the period 2009-2013 were available by metier and year. The proportion of the discards of Norway lobster in the GSA 18 is generally low (less than 5%).

Information on the 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.

It is important to mention that in the present format of DCF data call 2014 biological parameters (growth, maturity, etc) were absent as well as catch at age and catch at length data divided by sex (the current format requires the landing, discard at age and by length for sex combined). The age slicings by sex of catch and survey data were conducted using the raw data collected by the experts involved in DCF in GSA 18. They also provided data on maturity as well as on growth and L-W relationship parameters.

STECF EWG 14-19 stresses that, given the sexual dimorphism and difference in life history traits of male and female *N. norvegicus*, it is important to have access to this information in future data calls in order to improve the accuracy and precision of the evaluation of the stock status.

Data from the MEDITS scientific surveys should be carefully reanalysed to determine how realistic its representation of the Norway lobster stock is and this should take into account factors such as time of the day and area. The MEDITS survey as it is, is likely not to provide a good index of Norway lobster density owing to issues related to the species' burrowing behaviour, and diel and seasonal patterns of emergence which also vary among sexes (see section 5.2.14.4).

5.2.15.9 Scientific advice

During the period analysed, SSB and recruitment have declined and F has been much larger than FMSY.

5.2.15.10 Short term considerations

5.2.15.10.1 State of the stock size

In 2007-2013, the SSB was estimated to be between 879 and 689 t with levels estimated in 2012-2013 lower than levels calculated for 2007-2011. No precautionary biomass reference points were proposed for this stock. As a result, EWG 14-19 is unable to evaluate the status of the stock spawning biomass in respect to these.

5.2.15.10.2 State of recruitment

Recruitment ranged between 97 and 34 million in the period 2007-2013 with a decreasing trend over the analysed time series.

5.2.15.10.3 State of exploitation

The current F (0.85) is larger than F_{MSY} (0.14), which indicates that Norway lobster is exploited unsustainably. This result should be considered taking into account that the available time series is short compared to the life span of the species.

5.2.15.11 Management recommendations

STECF EWG 14-19 advise the relevant fleets' effort 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.

5.2.16 STOCK ASSESSMENT OF RED MULLET IN GSA 18

5.2.16.1 Stock Identification

Due to a lack of information on the structure of red mullet populations in the Adriatic Sea, this stock was assumed to be confined within the boundaries of the GSA 18 (Fig. 5.2.16.1.1).. Genetic studies conducted in the Adriatic (Garoia *et al*., 2004) evidenced a high genetic diversity, but such spatial genetic heterogeneity was not related to a geographic cline. However, the randomness of genetic differences among samples indicated that the Adriatic red mullet stock probably belongs to a single population unit. Nevertheless, individuals may group into local, genetically differentiated sub-populations. The observed genetic fragmentation in the Adriatic stock might be due to a reproductive success, survival rates or fishing pressure. In addition to the genetic considerations, indications presented by SGMED/ECA/RST-09-01 and based on correlation matrices of trawl-survey data in adjacent areas suggested that the spatial structure of red mullet population can be characterized by local differences.

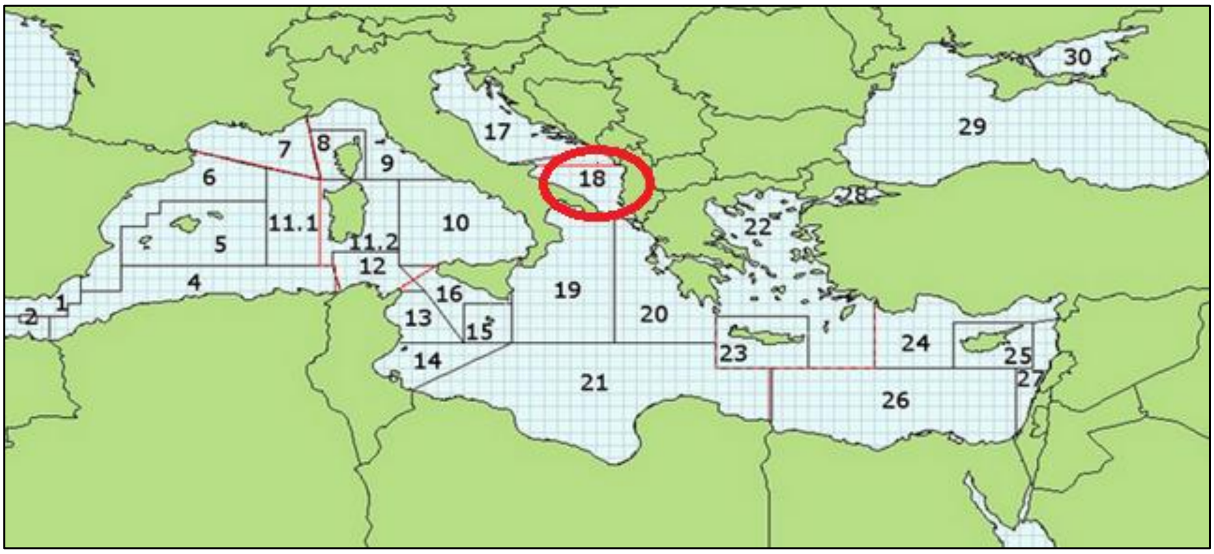


Fig. 5.2.16.1.1. Geographical location of GSA 18.

In the Adriatic Sea, red mullet spawns in late spring and summer, and according to Haidar (1970) the most intensive spawning occurs at depths of 60 to 70 m. After spawning, post larvae move towards shallower water (30-40 m) and then towards sandy coastal areas to become demersal at 4 cm TL. Later, they start their dispersion in deep waters towards sandy, muddy and gravel substrate (Relini *et al.*, 1999). Regarding the sex ratio males are generally prevailing up to 14-15 cm, while females are more frequent over 15-16 cm TL. The relative index of the population abundance is observed to decrease with depth. According to Haidar (1970) the main fish predators of juvenile and adult red mullet are *Lophius piscatorius*, *Raja clavata*, *Zeus faber* and *Merluccius merluccius*.

5.2.16.2 Growth

Literature data on the growth of red mullet in the Adriatic Sea show a high variability in growth between areas and time. According to the data reported in the AdriaMed website, asymptotic length for sex combined varies from 19.7 to 31.5 cm (range for females and males respectively: 26.2-34.5 cm and 17.8-27 cm), while the curvature parameter varies from 0.118 to 0.8 for both sexes combined (range for females and males respectively: 0.122-0.23; 0.184-0.282). Red mullet grows up to about 30 cm (around 0.5 kg), although the usual total length in catches varies from 10 to 20 cm. On average, females reach larger size than males and grow faster, which can be already noticed in the first year of their life (Haidar, 1970). Therefore, almost all largest specimens are females. According to recenty review (Bianchini and Ragonese, 2011) the life cycle lasts for 8 years with a faster growth rate in the firsts three years for both sexes. After the first three years, a reduction in growth is evident (age1=11.5.6-12.8 cm for males and females respectively, age2=14.8-17; age3=16.6-19.3; age8=20-24.5 cm). The growth parameters estimated by sex using the analysis of length frequency distributions of MEDITS data collected in the central-northern Adriatic area during the SAMED project (AAVV, 2002), were: females: L_∞=27 cm; K=0.396; t_0= -0.78; males: L_∞=23 cm; K=0.43; t_0= -0.80. Parameters of the length-weight relationship reported in literature for sexes combined are: a=0.008-0.0125, b=3.09-2.97 (Marano et al., 1998).

Estimates of growth parameters were achieved using otolith data collected within the Data collection framework (DCF) and analyzing length frequency distributions. The following VBGF parameters were estimated for sexes combined: L_∞=30 cm; K=0.4; t_0= -0.3. The parameters of the length-weight relationship estimated within the DCF for sexes combined were: a=0.008, b=3.11.

5.2.16.3 Maturity

According to Haidar (1970) females always have an annual reproduction cycle and reach sexual maturity in the first year of life at lengths around 12 cm. According to other literature sources, the size at first maturity for females is in the range 10-14 cm (AdriaMed website).

Using the data obtained in the DCF, the observed proportion of mature females (specimens belonging to the maturity stage 2 and onwards) by length class is reported below together with the maturity ogive estimated by a binomial GLM, which indicates a $L_{m50\%}$ of about 11.5 cm (±0.034 cm) and a maturity range ($MR=L_{m75\%}-L_{m25\%}$) of 0.88 ± 0.043 cm (Fig. 5.2.16.3.1).

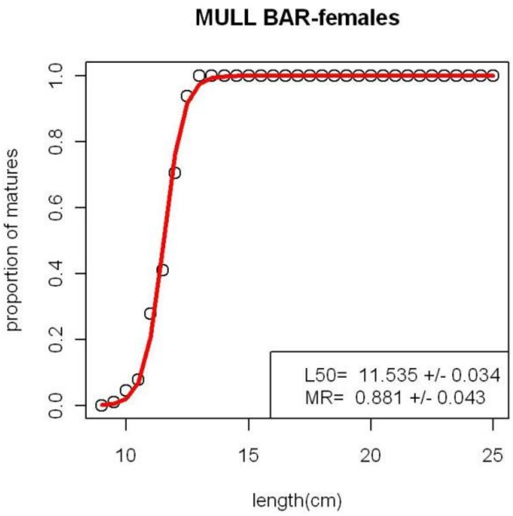


Figure 5.2.16.3.1. Red mullet in GSA 18. Female maturity ogive (MR indicates the difference Lm75%-Lm25%).

The sex ratio from DCF evidenced the prevalence of males in the size class from 9 to 15 cm while from 16 cm onwards the proportion of females was dominant Figure (5.2.16.3.2) .

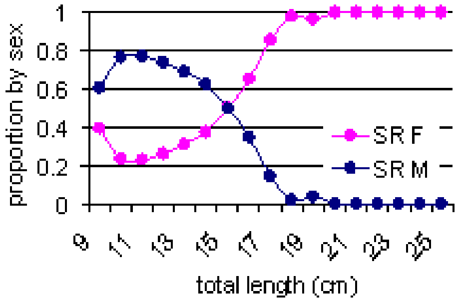


Figure 5.2.16.3.2. Red mullet in GSA 18. Sex ratio at length.

5.2.16.4 Fisheries

5.2.16.4.1 General description of the fisheries

Red mullet is mainly targeted by trawlers and to a much lesser extent by small scale fisheries using gill nets and trammel nets. Fishing grounds are located along the coasts of the whole GSA 18. Red mullet co-occurs with other important commercial species like Pagellus sp., Eledone sp., Octopus sp., *M. merluccius*, etc.

5.2.16.4.2 Management regulations applicable in 2014

In Italy 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 small scale fishery management regulations are based on technical measures related to the height and length of the gears as well as the mesh size opening, minimum landing sizes and number of fishing licenses for the fleet. 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 km2, between about 100 and 180 m depth), and in the vicinity of Tremiti Islands (115 km2 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 30th, 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 MPAs 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.

5.2.16.4.3 Catches

5.2.16.4.4 *Landings*

Available landing data collected under the DCF refer only to the western side of the GSA 18 and range from 2096 tons in 2012 to 532 tons in 2011, the latter being the lowest value observed in the time series (Fig. 5.2.16.4.4.1, Table 5.2.16.4.4.1). The majority of the reported landings of red mullet in all the years arise from trawlers Table 5.2.16.4.4.1. Gill nets and trammel nets represent about 7% of total catches in 2011, 0.34% in 2012 and 3.76% in 2013. Data from the eastern side of the GSA for the same period were not available from FAO-Fishstat.

However, the official data on the landings of the family Mullidae from the Eastern side are only available from the FAO-Fishstat for the period 2007 to 2011 in an aggregated form as 'mullets spp.' which could include also the Mullidae and Mugillidae species. It was suggested by the working group that the effects of taking the Eastern side production into account in the assessment should be explored by a sensitivity analysis. The analysis was performed with the assumption that the catch age structure on the Eastern side of the GSA was the same of the Western side. Three scenarios have been performed, assuming the Eastern landings to be the 5%, 10% and 20% of the Western side landings (Table 5.2.16.4.4.2, Fig. 5.2.16.4.4.1.1). The total landings decreased substantially in the period from 2007 to 2011, peaked in 2012 and decreased again in 2013, but to a point higher than the period 2008 - 2011.

Table 5.2.16.4.4.1. Red mullet in GSA 18. Annual landings (in tons) by major fishing techniques in the Western part of the GSA 18 (2007-2013).

WESTERN SIDE			
YEAR	**GEAR**	**FISHERY**	**LANDINGS (tonnes)**
2007	GNS	DEMF	119.77
2007	GTR	DEMSP	2.73
2007	OTB	-1	1679.6
2007 total			1802.1
2008	GNS	DEMF	41.83
2008	GTR	DEMSP	4.7
2008	OTB	-1	914.2
2008 total			960.73
2009	GNS	DEMF	75.87
2009	GTR	DEMSP	0.81
2009	OTB	DEMSP	920.58

Table 5.2.16.4.4.2. Red mullet in GSA 18. The estimated annual landings (in tons) in the Eastern side of the GSA 18 (2007-2013) tested in the sensitivity analysis.

	EASTERN SIDE LANDING SCENARIOS		
YEAR	**5%**	**10%**	**20%**
2007	90.10	180.21	360.42
2008	48.03	96.07	192.14
2009	51.55	103.09	206.19
2010	32.30	64.61	129.22
2011	26.59	53.17	106.34
2012	104.79	209.57	419.14
2013	62.49	124.98	249.96

2009	OTB	MDDWSP	33.71
2009 total			**1030.97**
2010	GNS	DEMF	43.97
2010	GTR	DEMSP	1.43
2010	OTB	DEMSP	524.85
2010	OTB	MDDWSP	75.85
2010 total			**646.1**
2011	GNS	DEMF	37.12
2011	GTR	DEMSP	0.4
2011	OTB	DEMSP	472
2011	OTB	MDDWSP	22.22
2011 total			**531.74**
2012	GNS	DEMF	7.12
2012	OTB	DEMSP	2079.55
2012	OTB	MDDWSP	9.06
2012 total			**2095.73**
2013	GNS	DEMF	47.03
2013	OTB	DEMSP	1195.02
2013	OTB	MDDWSP	7.76
2013 total			**1249.81**

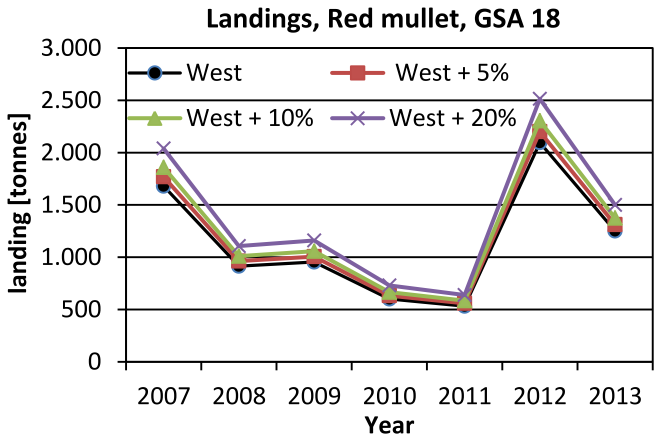


Fig. 5.2.16.4.4.1. Red mullet in GSA 18. Annual landings in tons in the Western part of the GSA 18 (2007-2013) and three tested scenarios of total landings for the GSA 18 reconstructed from the Western landings.

5.2.16.4.5 *Discards*

Discards data were available from DCF database for the Western side for the time period from 2009 to 2013. The proportion of the discards of red mullet in the GSA 18 was generally low (on average 5.84% of the total catch). An exceptional deviation from this trend was recorded in 2012 when the discard cumulated up to 17.16% of the total catch. The reason for this observation was a high recruitment in the same year, intercepted also by survey data.

Considering the exceptional amount of recruits in 2012, discard data were used in the analyses, to improve the consistency between fishery dependent and fishery independent information data.

Table 5.2.16.4.5.1. Red mullet in GSA 18. Total discard data in tons for red mullet in the Western part of the GSA 18 (2009 – 2013).

YEAR	DISCARD (tonnes)	RATIO discard/catch [%]
2009	14.73	1.52%
2010	35.01	5.51%
2011	19.30	3.50%
2012	434.05	17.16%
2013	19.44	1.53%
MEAN	104.51	5.84%

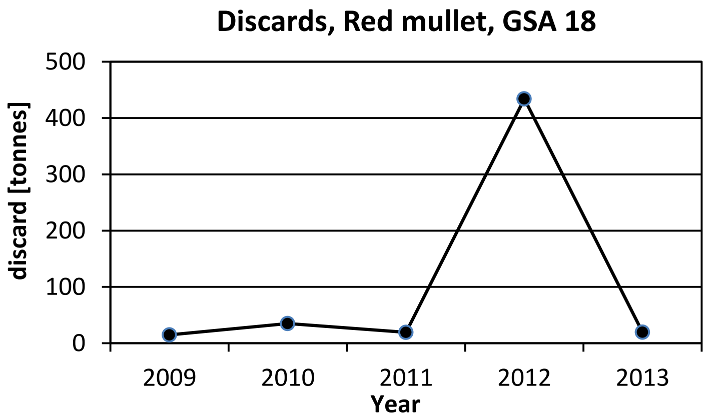


Table 5.2.16.4.5.1. Total annual discards in tonns for red mullet in the Western part of the GSA 18 (2009 – 2013).

5.2.16.4.6 Fishing effort

The trends in fishing effort for the Western side of the GSA by year and major gear type in terms of kW days at sea (nominal effort) as reported through the official DCF are presented in 5.2.16.4.6.1 and Figure 5.2.16.4.6.1. The bottom otter trawls of the DWSP fishery have been excluded from the table, since they only account for 1.57% of the total effort.

Table 5.2.16.4.6.1. Nominal effort (kW days at sea) for the Western side of GSA18 by gear and fishery type for the period 2004-2013, as reported through the DCF official data call. The total includes also DWSP fishery effort.

Fishery	**DEMSP**			**MDDWSP**	**TOTAL**
Gear	**GNS**	**GTR**	**OTB**	**OTB**	
2004	364,261.75	54,228.75	201,706.50	827,576.31	827,576.31
2005	508,965.25	103,033.40	87,624.33	1,085,359.58	1,085,359.58
2006	198,420.22	9,792.29	449,166.22	972,919.45	972,919.45
2007	160,059.63	40,563.38	256,606.55	834,794.75	834,794.75
2008	109,763.13	127,703.25	676,860.31	51,156.83	67,588.83
2009	126,065.13	79,190.13	779,262.56	124,915.75	153,091.00
2010	71,300.63	110,658.88	586,664.75	195,404.58	216,200.75
2011	56,368.25	97,216.88	628,850.50	116,976.33	132,494.33
2012	49,432.25	67,632.00	576,618.44	59,606.40	59,606.40
2013	97,219.75	30,079.00	630,469.88	60,586.86	60,586.86
TOTAL	145,758.36	75,163.10	552,037.31	464,368.97	1,257,112.89
Mean proportion	11.59%	5.98%	43.91%	36.94%	98.43%

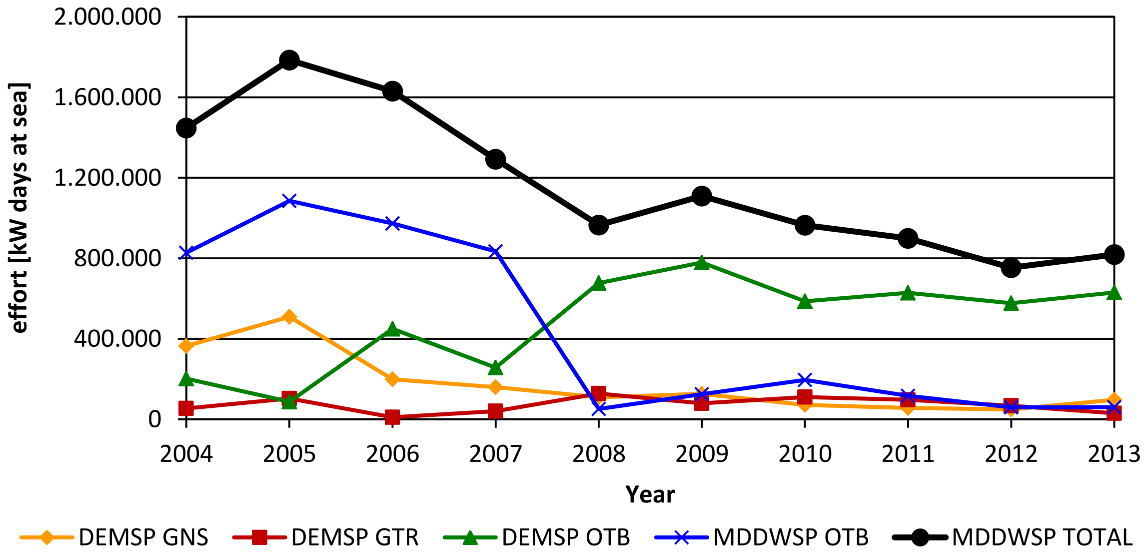


Figure 5.2.16.4.6.1. Nominal effort (kW days at sea) for the Western side of GSA 18 by gear and fishery type for the period 2004-2013, as reported through the DCF official data call.

The fishing effort of trawlers, which is the major component of fishing in the Western side, has decreased substantially since 2005. Hence, since 2008 the trawling effort of the DEMSP fishery remained constant and has been contributing the most to the catches.

5.2.16.5 Scientific surveys

MEDITS

5.2.16.5.1 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 calculated by ELASMOSTAT 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). In the GSA 18 the following number of hauls was reported per depth stratum (Table 5.2.16.5.1.1).

Table 1.2.16.5.1.1. Number of hauls per year and depth stratum in GSA 18, 1994-2013.

	YEAR									
Stratum	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
10-50	14	14	18	17	17	17	17	18	12	12
51-100	14	15	24	25	25	26	25	24	20	19
101-200	24	23	32	33	33	32	33	33	31	32
201-500	10	10	19	18	18	19	18	18	13	13
501-800	10	10	19	19	19	18	19	19	14	14
Total	72	72	112	112	112	112	112	112	90	90
	YEAR									
Stratum	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
10-50	11	11	11	11	12	12	12	12	12	12
51-100	21	20	21	20	22	20	20	20	20	20
101-200	31	32	31	32	33	30	31	31	31	31
201-500	13	13	13	13	12	14	13	13	13	13
501-800	14	14	14	14	11	14	14	14	14	14
Total	90	90	90	90	90	90	90	90	90	90

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches 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:

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

$$V(Y_{st}) = \Sigma (A_i^2 * s_i^2 / n_i) / A^2$$

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 ± 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.

5.2.16.5.2 Geographical distribution

The geographical distribution pattern of red mullet in the GSA 18 has been studied using trawl-survey data and 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). Results highlighted a patchy distribution of juveniles of red mullet mostly concentrated along the coast of the South Adriatic Sea within 50 m of depth. The areas showing the highest probability and persistency were detected from 1997 to 2002 using cut-offs of 5000 and 10000 n/km^2. In particular, the nursery areas were mainly distributed (probability of 0.8) along the Gargano peninsula and along the coasts off the area between Molfetta and Brindisi, within 50 m of depth.
Mapping of the red mullet nursery areas obtained applying the median indicator kriging technique is reported below in Figure 5.2.16.5.2.1.
Recent estimations carried out within MEDISEH EU project (MAREA framework) have confirmed the presence of important zone for recruits offshore Gargano promontory, while a smaller nursery was localised in front of Bari (5.2.16.5.2.2). Persistent spawning grounds were mainly identified in the eastern side, along the Albanian coasts at the latitude of Dürres (5.2.16.5.2.3), on muddy bottom with coastal terrigenous muds biocenosis (VTC). The main current is from south to north. Other nuclei were identified north of Vlora and along the coasts of Otranto on the west side.

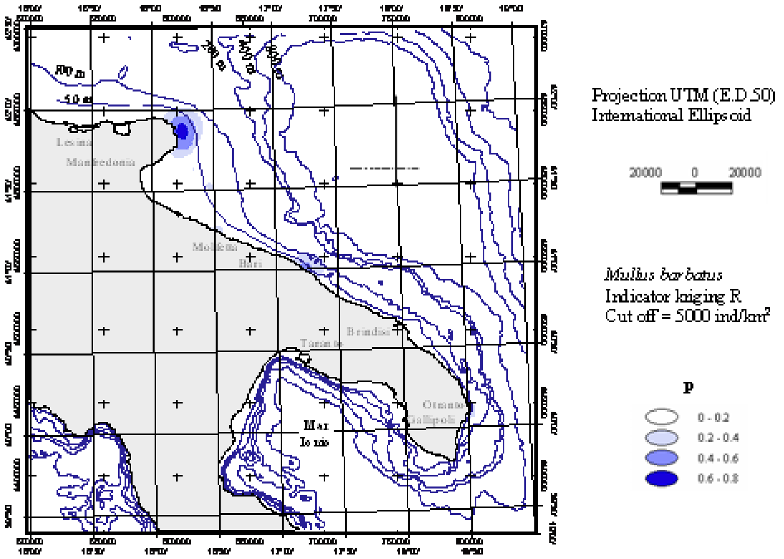


Figure 5.2.16.5.2.1. Red mullet in GSA 18. Geographical distribution patterns of nursery areas of along the western side of the GSA 18 (Progetto Nursery).

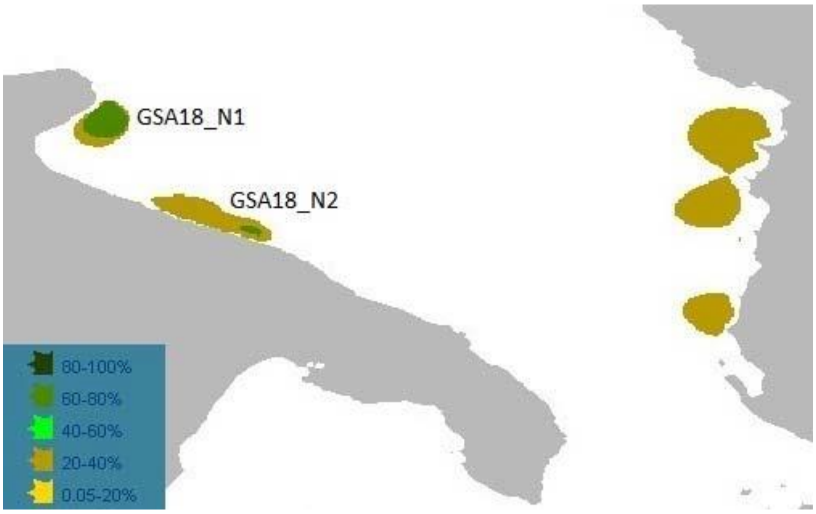


Figure 5.2.16.5.2.2. Red mullet in GSA 18. Geographical distribution patterns of nursery areas of red mullet of the GSA 18 (MEDISEH EU Project, Framework MARE/2009/5).

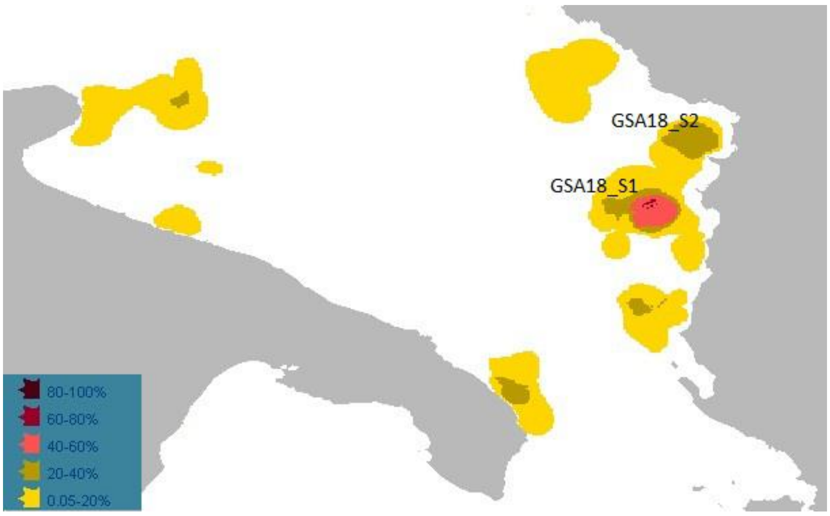
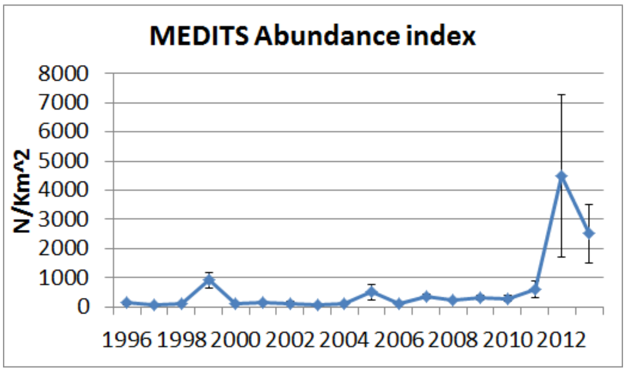


Figure 5.2.16.5.2.3. Red mullet in GSA 18. Geographical distribution patterns of spawning areas of red mullet in GSA18 (MEDISEH EU Project, Framework MARE/2009/5).

5.2.16.5.3 Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 18 was obtained from the international survey MEDITS. Figure 5.2.16.5.3.1 displays the estimated trend of red mullet abundance and biomass per square km in GSA 18. Both indices estimated from the MEDITS trawl survey show a highly variable pattern due to the sporadic presence of recruits in some years. Despite the noticed variability the estimated overall trend is increasing (Spearman rho abundance 0.635 and biomass 0.856) throughout the time series. There were 2 minor peaks in 1999 and 2005 observed and an very strong peak in abundance and biomass was observed in the years 2012.



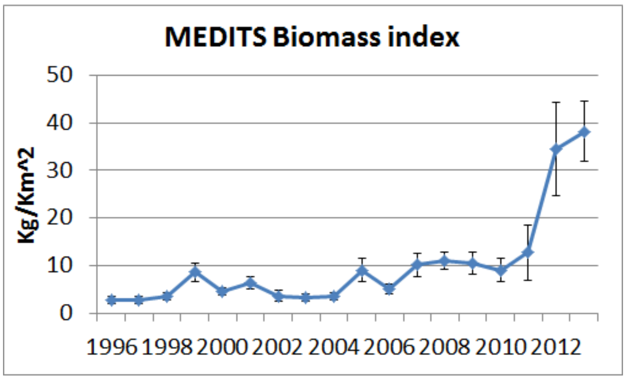
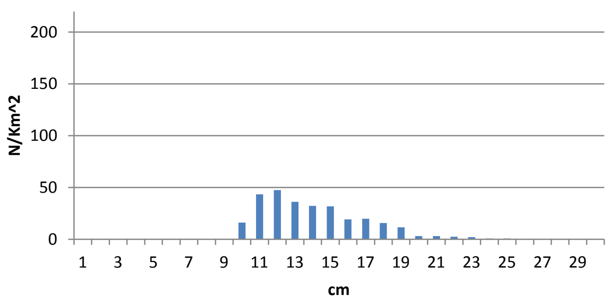


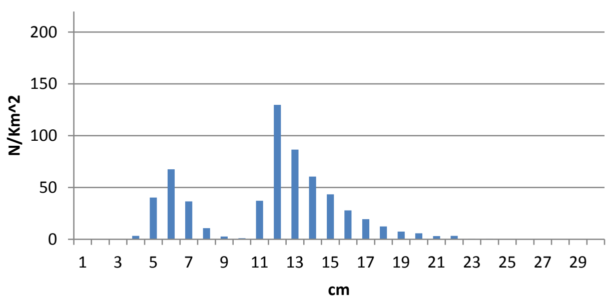
Figure 5.2.16.5.3.1. Red mullet in GSA 18. Abundance [N/km^2] and biomass [kg/ km^2] indices with standard deviation intervals estimated from the MEDITS data for the period 1996 to 2013.

5.2.16.5.4 Trends in abundance by length or age

2010

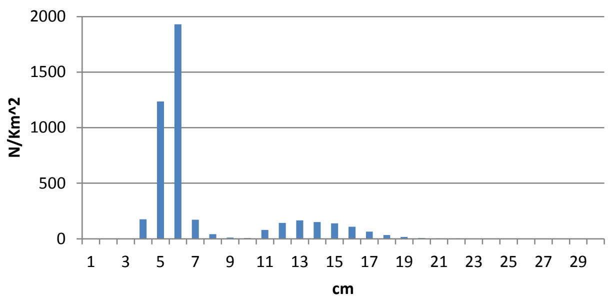


2011

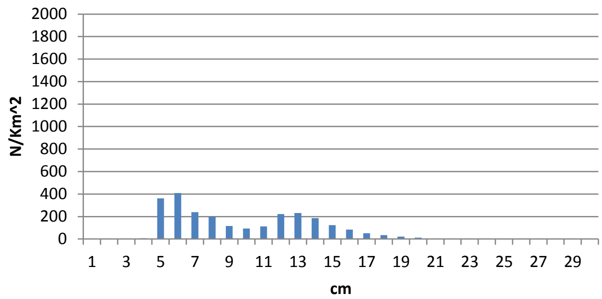


Error! Reference source not found. displays the stratified abundance indices by length for red mullet in GSA 18 estimated from the MEDITS data for the period 1996 – 2013 related to the whole area. The stratified abundance indices by length for red mullet in GSA 18 estimated from the MEDITS data for the years 2012 and 2013 are presented separately (Figure 5.2.16.5.4.2

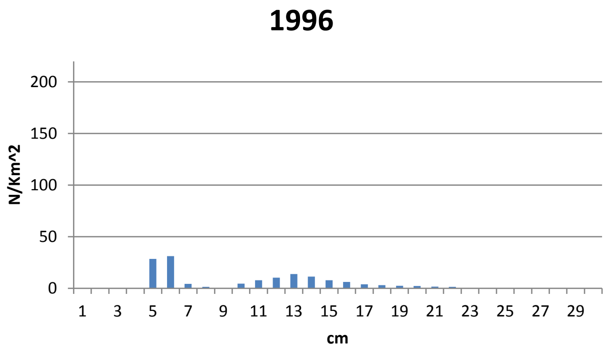
2012

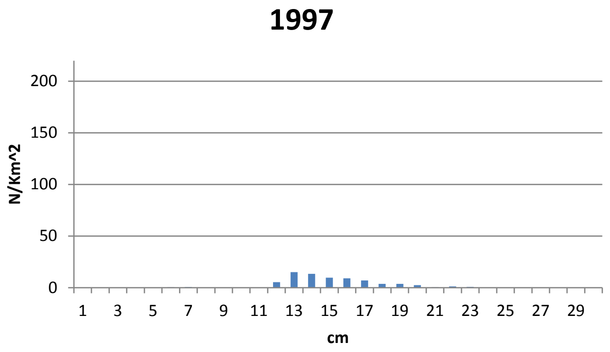


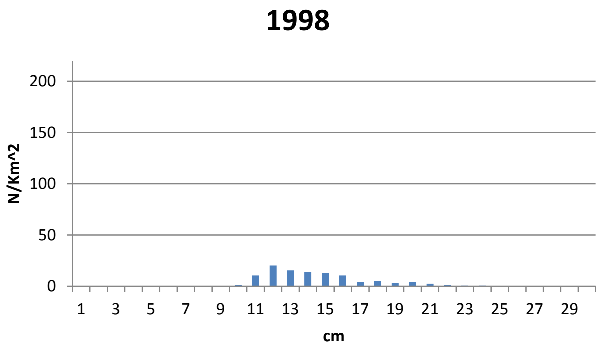
2013

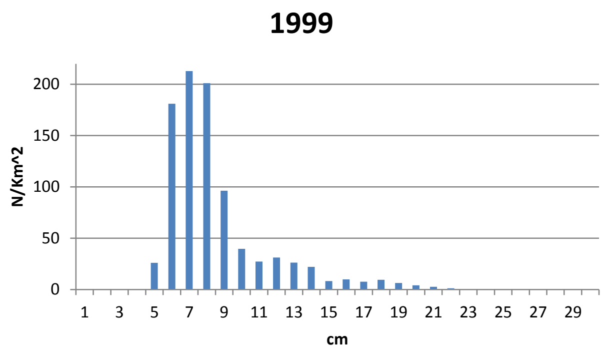


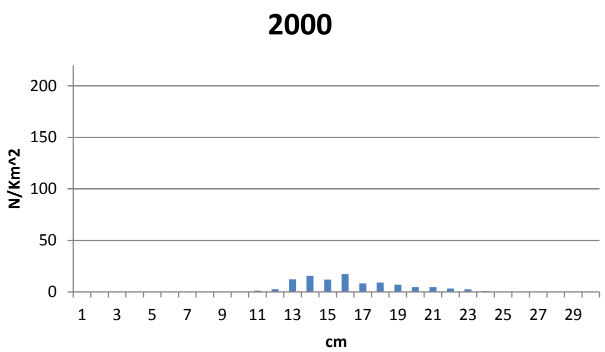
), because the high recruitment and consequently the high abundance indices required the use of a larger scale.

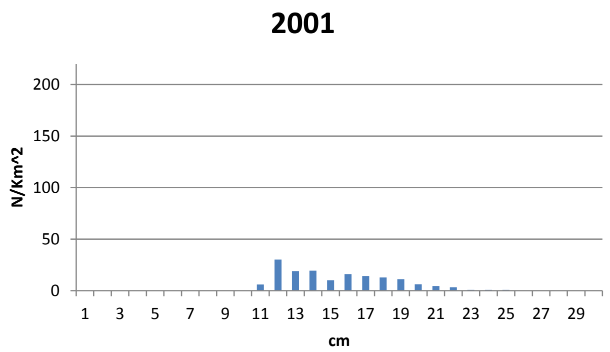


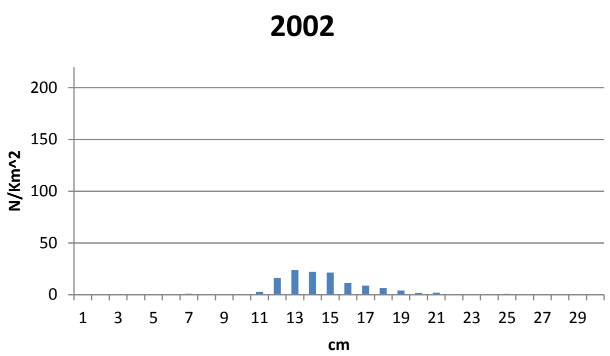


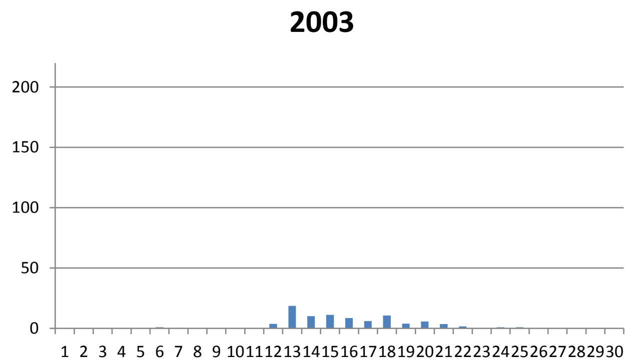


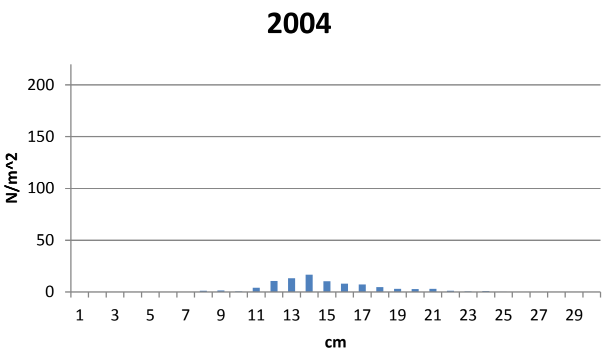


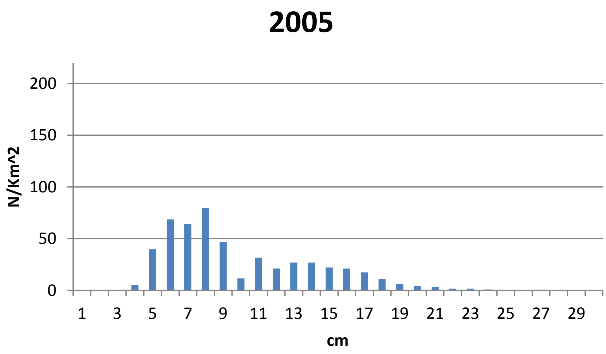


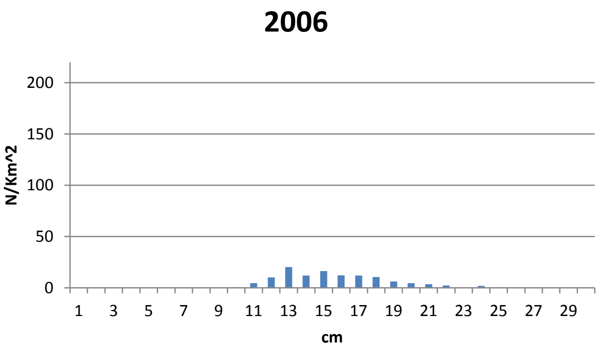


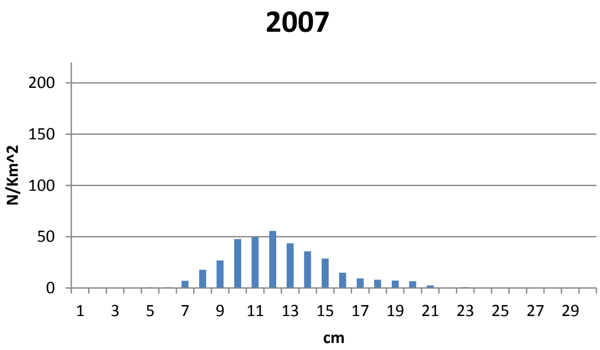


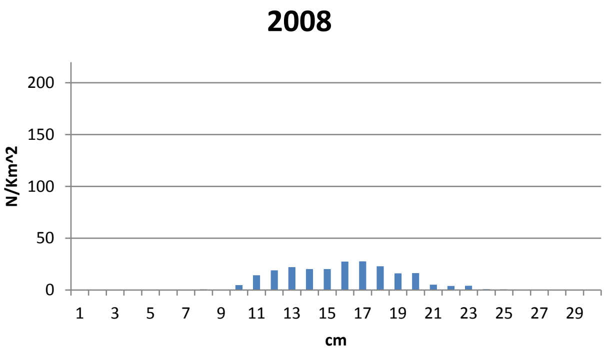


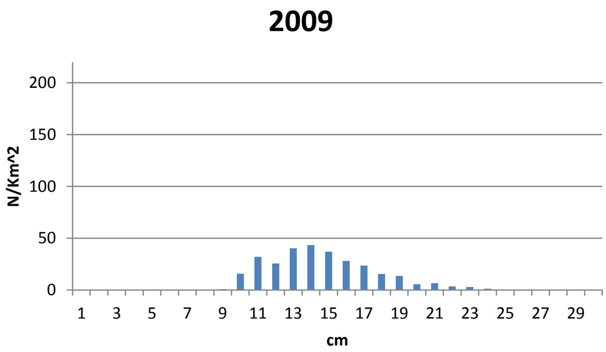

2004
N/m^2
0
50
100
150
200
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
cm


2005
N/Km^2
0
50
100
150
200
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
cm


2006
N/Km^2
0
50
100
150
200
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
cm


2007
N/Km^2
0
50
100
150
200
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
cm


2008
N/Km^2
0
50
100
150
200
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
cm


2009
N/Km^2
0
50
100
150
200
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
cm

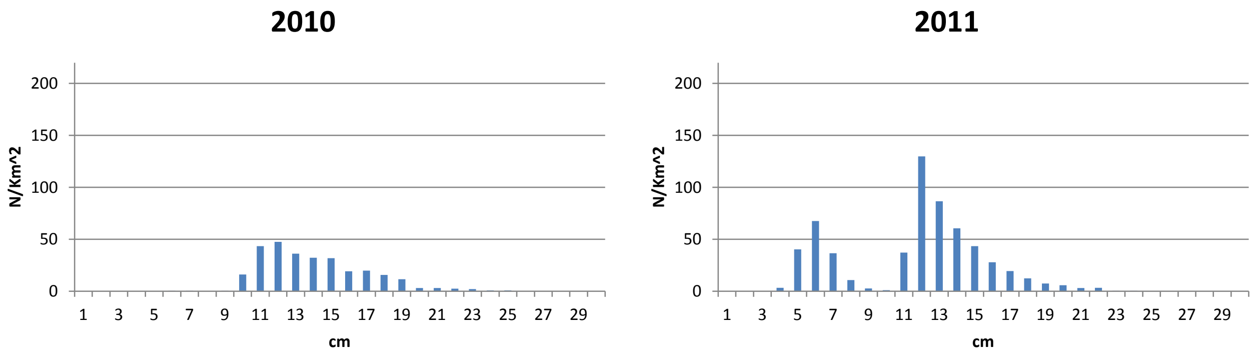


Figure 5.2.16.5.4.1. Red mullet in GSA 18. Stratified abundance indices by size estimated from the MEDITS survey data for the period 1996-2011.

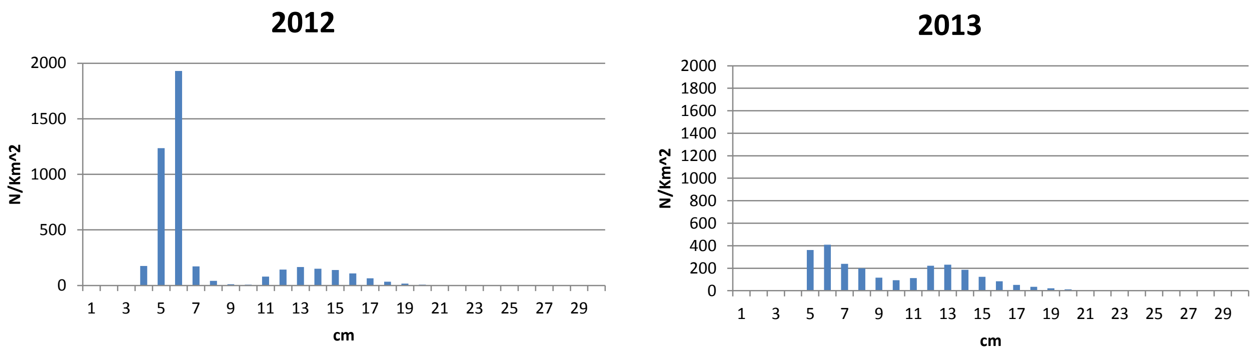


Figure 5.2.16.5.4.2. Red mullet in GSA 18. Stratified abundance indices by size estimated from the MEDITS survey data for the years 2012 and 2013.

5.2.16.5.5 Trends in growth

No analyses were conducted during EWG 14-19.

5.2.16.5.6 Trends in maturity

No analyses were conducted during EWG 14-19.

5.2.16.6 Assessment of historic stock parameters

5.2.16.6.1 Methods

XSA

5.2.16.6.2 Justification

The assessment of red mullet in GSA 18 has been performed during the STECF EWG in 2012 considering only the landing and only related to western side using XSA method because the time series covered at least one time the life span of the species.

Considering the exceptional amount of recruits in 2012, discard data were used during the STECF EWG 14-19 in the XSA analysis, to improve the consistency between fishery dependent and fishery independent information data.

5.2.16.6.3 Input parameters

In the last 2014 data call the data from 2007 to 2013 has been provided and this time series has been used to assess the stock using XSA method. For the assessment of red mullet stock in GSA 18 the DCF official data on the age structure and commercial catch has been used. The assessment was performed using the commercial data from the west side (landings and discard) and the survey indices on the whole area. Three different runs of XSA have been performed, assuming eastern side landings equal to 5%, 10% and 20% of the western side landings, in order to carry out a sensitivity analysis on this lacking information. The same age structure in the catch of western side has been assumed for the eastern side.

The western side discard in 2007 and 2008 has been reconstructed on the basis of the proportion on the discard ratio (Discard/Landing) of the years 2009-2011 applied to landing of 2007 and 2008. The age structure of nets in 2007, 2008, 2009, 2010 have been reconstructed on the basis of the LFDs of 2011 and the landings from IREPA source.
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 2013 have been used for the tuning.

The data used in the XSA analysis are shown in the tables below (Table 5.2.16.2.2.16.6.3.1-6) below.

Table 5.2.16.2.3.1. Red mullet in GSA 18. Catch at age in numbers by year used in the XSA.

Catch at age [N]	**5 %**			
Year	**age 0**	**age 1**	**age 2**	**age 3+**
2007	41,612.40	38,734.82	1,491.50	53.20
2008	16,797.61	24,629.66	452.53	31.31
2009	22,200.89	22,275.18	1,060.05	22.24
2010	21,464.62	13,886.62	307.06	26.37
2011	9,255.05	10,120.56	1,196.95	26.82
2012	129,857.40	42,463.99	1,494.39	11.24
2013	41,514.58	24,628.21	746.76	9.58
Catch at age [N]	**10 %**			
Year	**age 0**	**age 1**	**age 2**	**age 3+**
2007	43,273.88	40,572.17	1,562.52	55.73
2008	17,277.44	25,795.34	474.08	32.81
2009	23,177.66	23,333.65	1,110.53	23.30
2010	22,292.90	14,544.82	321.68	27.63
2011	9,639.23	10,600.42	1,253.95	28.09
2012	132,938.30	44,480.28	1,565.55	11.78
2013	43,405.42	25,799.89	782.32	10.04
Catch at age [N]	**20 %**			
Year	**age 0**	**age 1**	**age 2**	**age 3+**
2007	46,596.84	44,246.89	1,704.57	60.80
2008	18,237.09	28,126.71	517.18	35.79
2009	25,131.18	25,450.58	1,211.49	25.42
2010	23,949.45	15,861.21	350.93	30.14
2011	10,407.59	11,560.14	1,367.94	30.65
2012	139,100.12	48,512.87	1,707.87	12.85
2013	47,187.11	28,143.26	853.44	10.95

Table 5.2.16.3.3.2. Red mullet in GSA 18. Weights at age used in the XSA (used for the stock and the catch).

Weight at age in stock [kg]	**age 0**	**age 1**	**age 2**	**age 3+**
2007	0.005524	0.040751	0.096832	0.20177
2008	0.005524	0.040751	0.096832	0.20177
2008	0.005524	0.040751	0.096832	0.20177
2008	0.005524	0.040751	0.096832	0.20177
2008	0.005524	0.040751	0.096832	0.20177
2008	0.005524	0.040751	0.096832	0.20177
2008	0.005524	0.040751	0.096832	0.20177

Table 5.2.16.4.3.3. Red mullet in GSA 18. Indices from the MEDITS survey used in the XSA.

Survey indices [n/km^2]	**age 0**	**age 1**	**age 2**	**age 3+**
2007	192.03	185.15	14.31	1.16
2008	9.29	63.27	23.21	5.4
2009	2.01	70.07	20.06	7.27
2010	2.47	50.52	16.32	3.18
2011	308.37	39.9	12.56	1.98
2012	1620.44	105.73	19.08	3.06
2013	2891.81	844.13	33.42	3.75

Table 5.2.16.5.3.4. Red mullet in GSA 18. Proportion of mature at age used in the XSA.

Maturity			
Age 0	**age 1**	**age 2**	**age 3+**
0.16	0.92	1	1

Table 5.2.16.6.3.5. Red mullet in GSA 18. **Natural mortality at age used in the XSA.**

Natural mortality			
age 0	**age 1**	**age 2**	**age 3+**
1.03	0.71	0.65	0.62

Table 5.2.16.7.3.6. Red mullet in GSA 18. Growth parameters and length-weight relationship coefficient used in PRODBIOM.

Growth parameters	
Linf	30
K	0.4
t_0	-0.3
A	0.0083
B	3.1134

5.2.16.6.4 *Results*

The XSA run with the following settings has been performed:

- Catchability independent of size ages > 0;

- 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.

The log-catchability residuals are listed below (Figure 5.2.16.8.4.1 - 3).

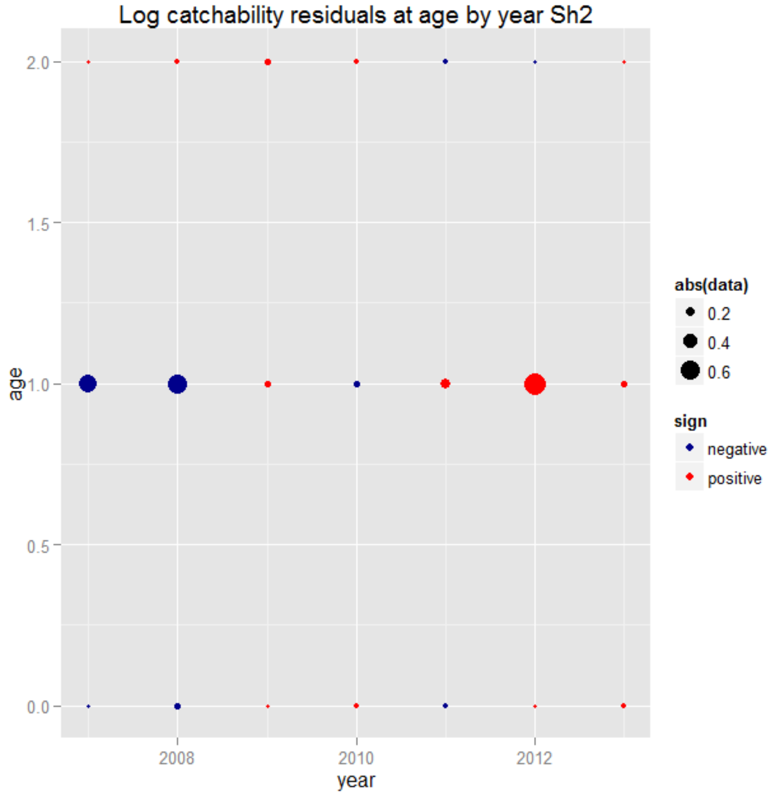


Figure 5.2.16.9.4.1. Red mullet in GSA 18. Log-catchability residuals of the XSA run for the 5% scenario.

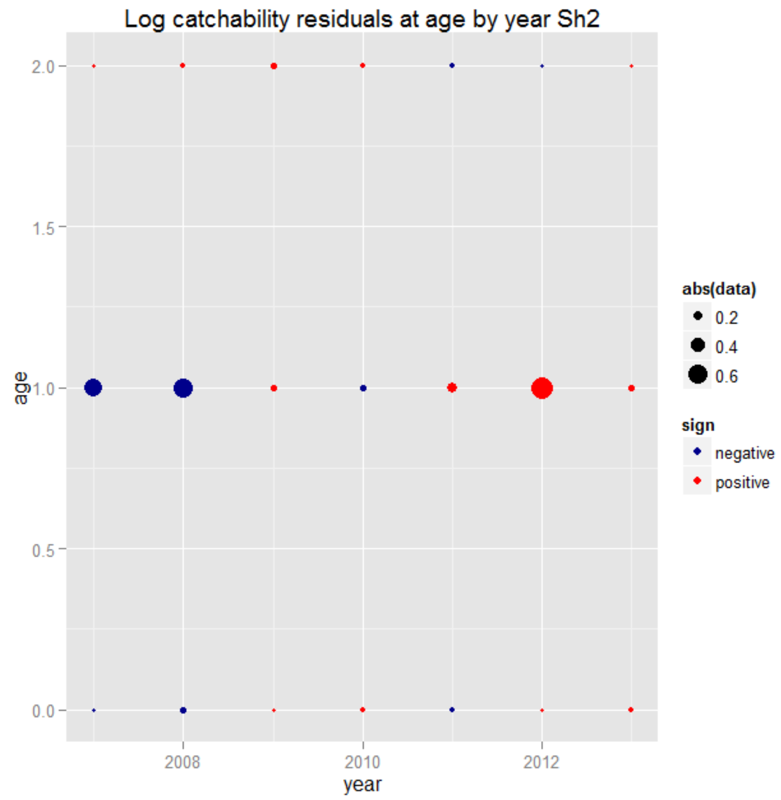


Figure 5.2.16.10.4.2. Red mullet in GSA 18. Log-catchability residuals of the XSA run for the 10% scenario.

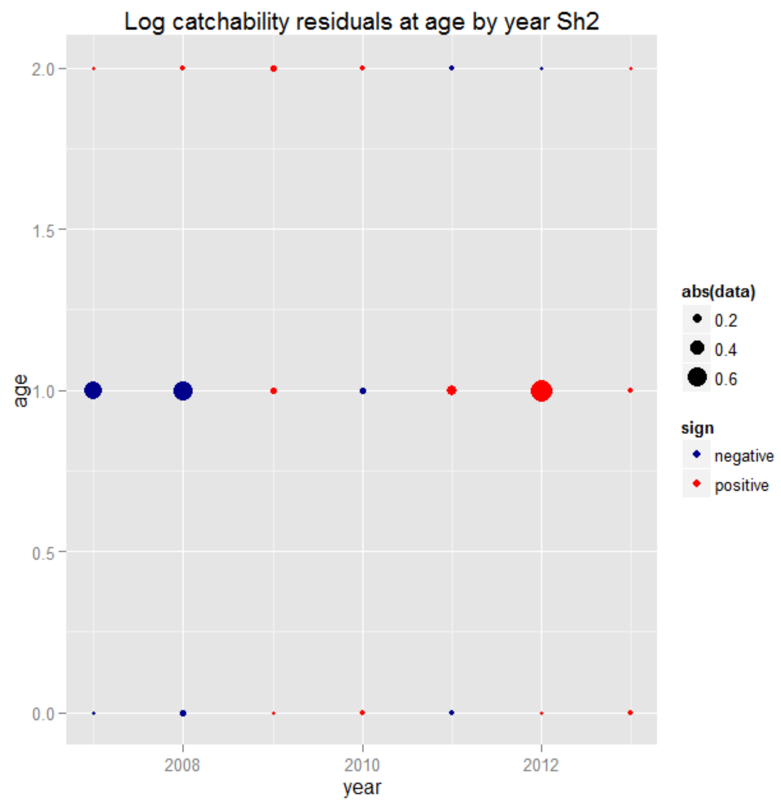


Figure 5.2.16.11.4.3. Red mullet in GSA 18. Log-catchability residuals of the XSA run for the 20% scenario.

The residuals are very similar for all the three tested scenarios (5%, 10% and 20%) and do not show any particular trend. The other results produced by XSA are presented below.

Table 5.2.16.12.4.1. Red mullet in GSA 18. Fishing mortality (Fbar(0-2)) by year estimated with XSA for the three tested scenarios.

F_{bar}(0-2)	2007	2008	2009	2010	2011	2012	2013
5 % scenario	1.3920	0.8157	1.1563	0.7557	0.6757	1.1807	0.4820
10 % scenario	1.3900	0.8140	1.1550	0.7543	0.6747	1.1753	0.4807
20 % scenario	1.3863	0.8107	1.1527	0.7517	0.6730	1.1650	0.4780

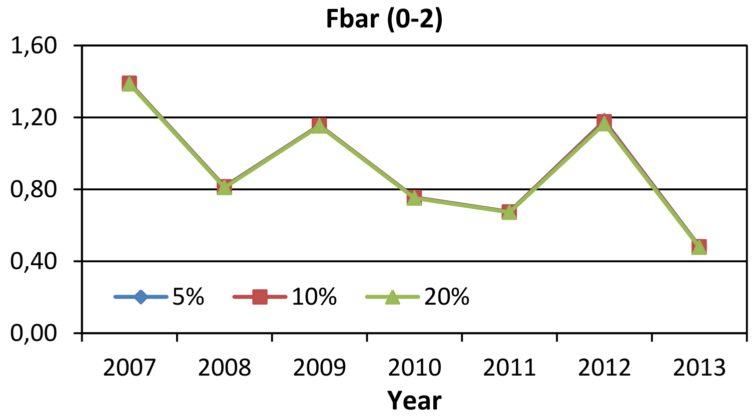


Figure 5.2.16.13.4.4. Red mullet in GSA 18. Fishing mortality (Fbar(0-2)) by year estimated with XSA for the three tested scenarios.

Table 5.2.16.14.4.2. Red mullet in GSA 18. Recruitment in numbers (thousands) by year estimated with XSA for the three tested scenarios.

Recruitment in numbers (thousands)	2007	2008	2009	2010	2011	2012	2013
5 % scenario	184,035	126,953	107,574	101,801	208,246	394,928	238,213
10 % scenario	192,248	132,467	112,560	106,356	218,072	409,147	249,038
20 % scenario	208,678	143,498	122,535	115,473	237,729	437,683	270,721

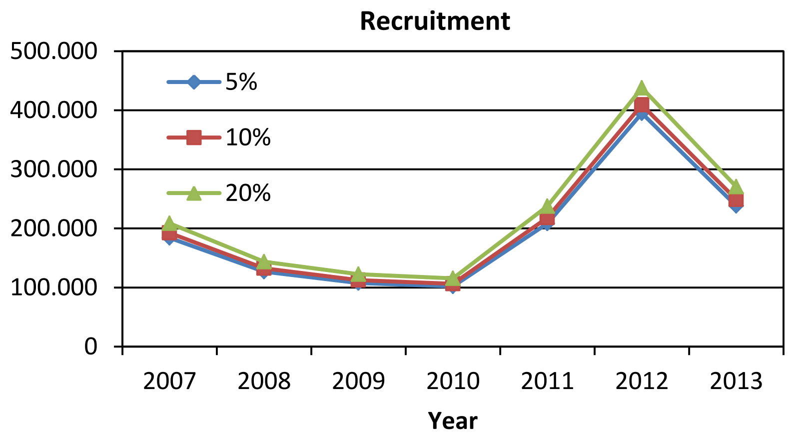


Figure 5.2.16.15.4.5. Red mullet in GSA 18. Recruitment in numbers (thousands) by year estimated with XSA for the three tested scenarios.

Table 5.2.16.16.4.3. Red mullet in GSA 18. Spawning stock biomass by year estimated with XSA for the three tested scenarios.

Spawning stock biomass	2007	2008	2009	2010	2011	2012	2013
5 % scenario	1,191.34	1,020.43	783.53	685.16	829.39	1,604.94	1,950.91
10 % scenario	1,248.38	1,069.30	821.26	717.96	869.46	1,680.96	2,050.94
20 % scenario	1,362.56	1,167.18	896.79	783.71	949.69	1,833.15	2,252.29

Because the results obtained with XSA method from all the three tested scenarios for red mullet in GSA 18 are very similar, EWG 14-19 agreed to present only the results from the 10% scenario (Figure 5.2.16.17.4.6). The results show a decreasing pattern in SSB since 2010 and then and increase until 2013 in all the tested scenarios. Recruitment shows an increase from 2010 until 2012 and then a decrease in 2013. The fishing mortality shows a global decrease from 2007 to 2013.

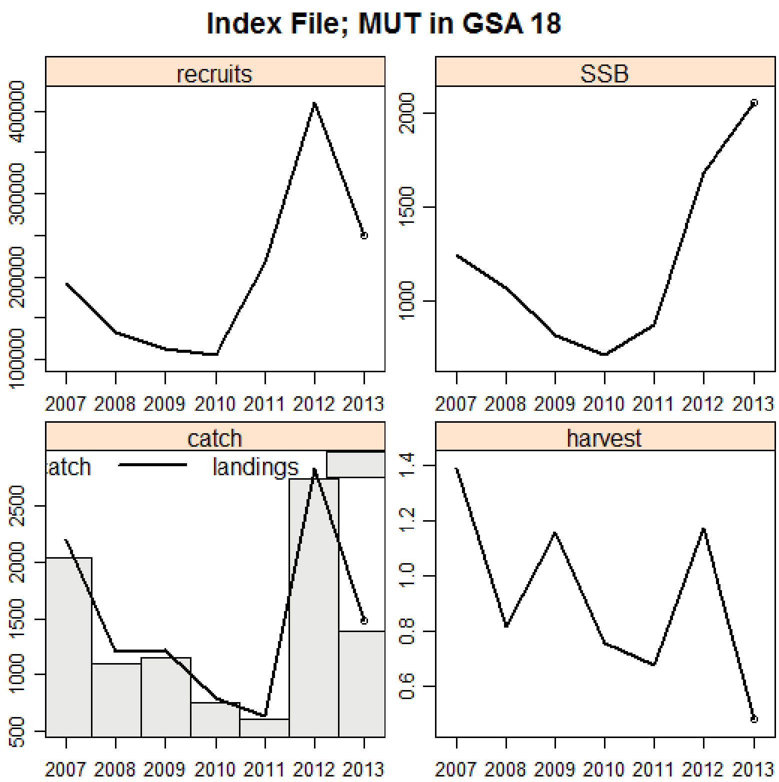


Figure 5.2.16.18.4.6. Recruitment, SSB, catch and harvest by year estimated with XSA for the 10% scenario.

The retrospective analysis have not showed any particular trend in all the tested scenarios (**Error! Reference source not found.**).

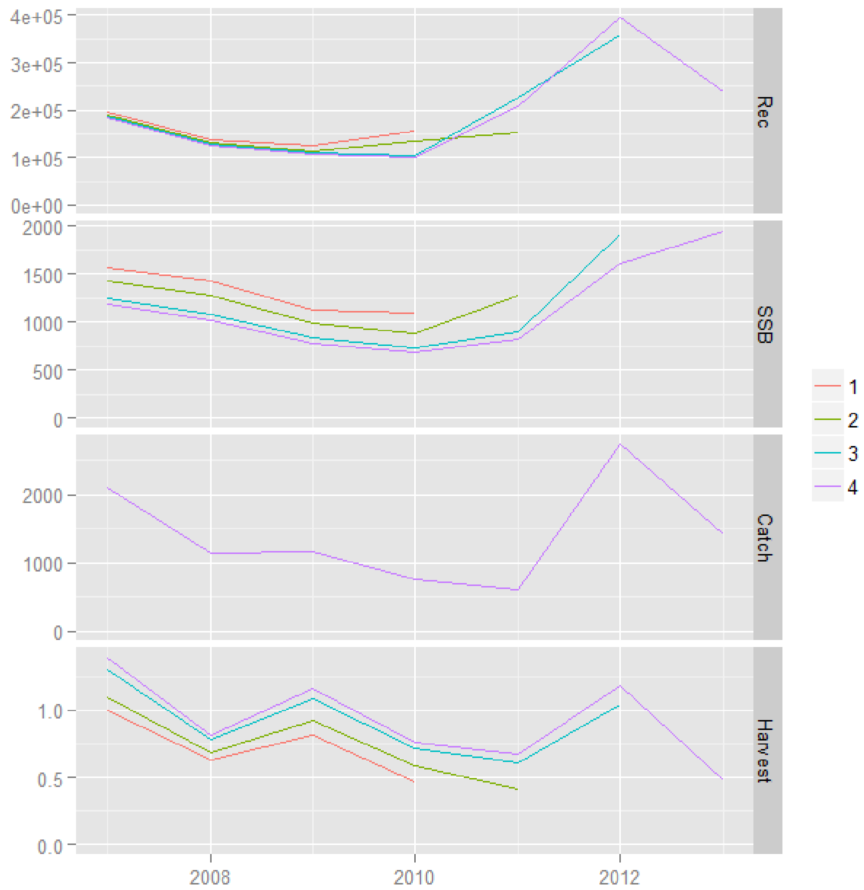


Figure 5.2.16.19.4.7. Red mullet in GSA 18. Retrospective analysis of the XSA for the 5% scenario.

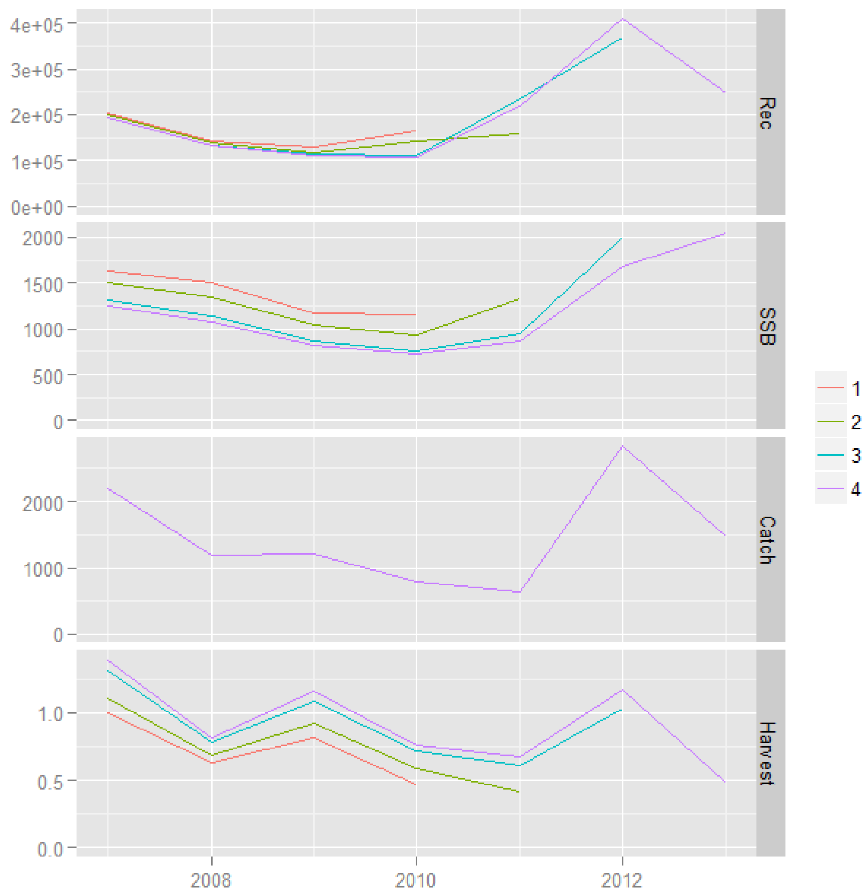


Figure 5.2.16.20.4.8. Red mullet in GSA 18. Retrospective analysis of the XSA for the 10% scenario.

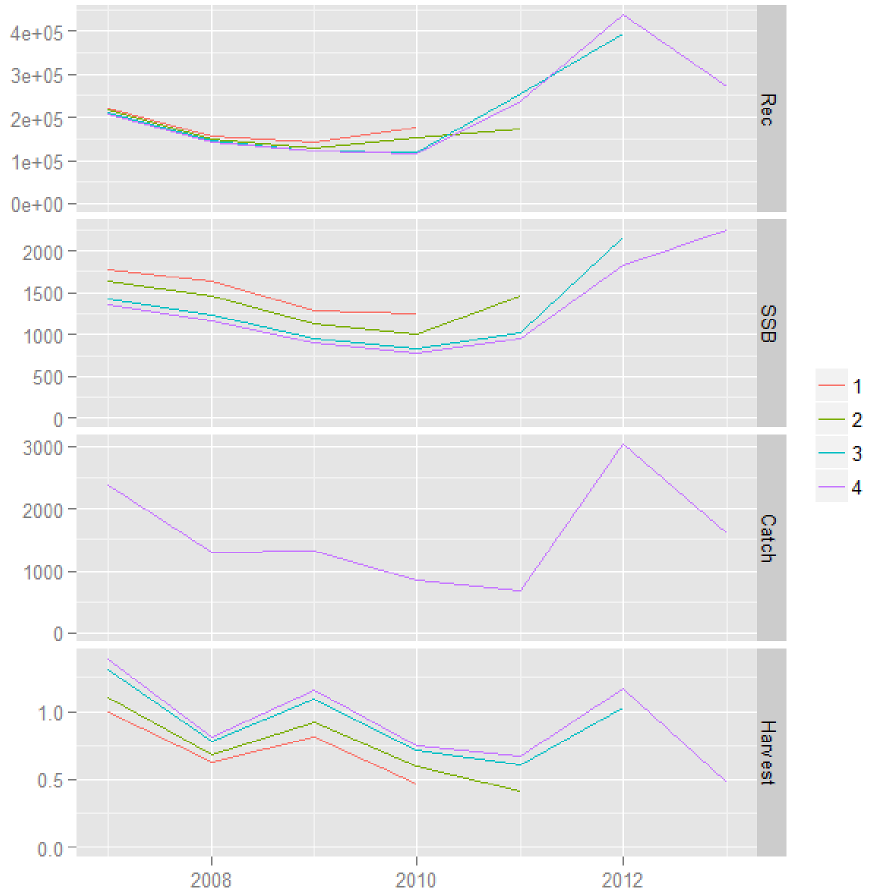


Figure 5.2.16.21.4.9. Red mullet in GSA 18. Retrospective analysis of the XSA for the 20% scenario.

METHOD 2: ALADYM

5.2.16.6.5 Justification

ALADYM model has been applied to the run chosen for the advice (10% Eastern landings scenario) also in order to answer to the ToR 3 of this meeting and provide a set of management scenarios by fleet as required.

In the ALADYM predictions the selectivity pattern defined in the ALADYM simulation for the three fleets have been assumed, that are logistic for the Western side trawlers and the Eastern fleet, and Gaussian for the nets fleet. These selectivity functions are different from the one assumed by XSA (logistic, not by fleet), used to derive the recruitment and F estimates for ALADYM parameterization. A more correct parameterization of ALADYM would have benefited of fleet based assessment (e.g. using fleet based assessment models), in order to use as input in ALADYM recruitment and the F estimates based on the selectivity for the three fleets. ALADYM approach has been performed to provide the short term predictions by fleet, that were not possible with the FLR short term forecast script.

5.2.16.6.5 Input parameters

In order to parameterize ALADYM model, the same growth parameters, length-weight relationship coefficients as for the XSA have been used, as well as the maturity parameters reported above. The same natural mortality vector estimated with Prodbiom method and used for XSA have been applied; the total mortality and the recruitment obtained as output from the XSA run related to the 10% Eastern landings scenario have been used to reconstruct the population at sea.

Three fleets have been considered in the simulations: Italian trawlers, Italian nets and Eastern side fleet. The selectivity parameters of the Italian fleets have been inferred on the basis of the observed DCF data, while the Eastern fleet selectivity has been assumed equal to the Western trawlers fleet. The selectivity of the Italian trawlers and the Eastern fleet have been assumed as a classical ogive with L50% equal to 7.5 cm and L75%-L25% equal to 1.8 until 2010. From 2011, with the enforcement of the increase in mesh size, the L50% has been set 9.5 cm. The selectivity of the nets fleet has been assumed to follow a normal distribution with mean 15 cm and standard deviation 5 cm. The discard for Italian trawlers have been modelled with a reverse ogive model with 7 cm of L50 until 2010 and 9 from 2011.

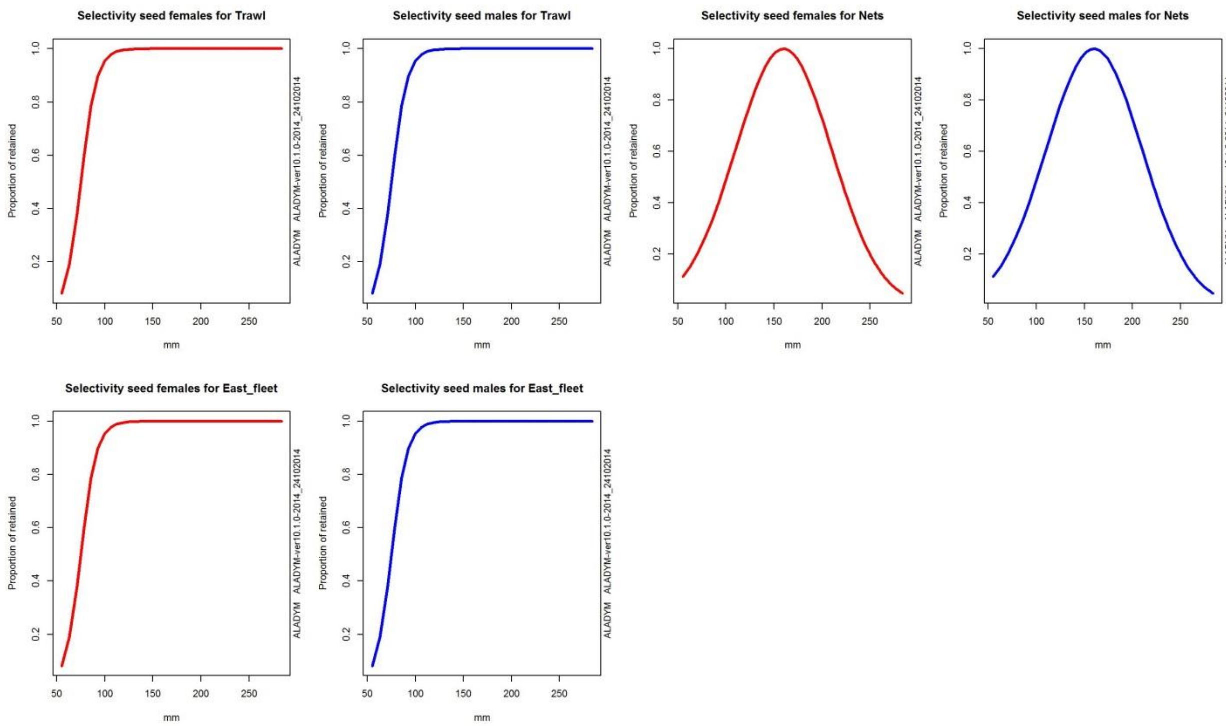
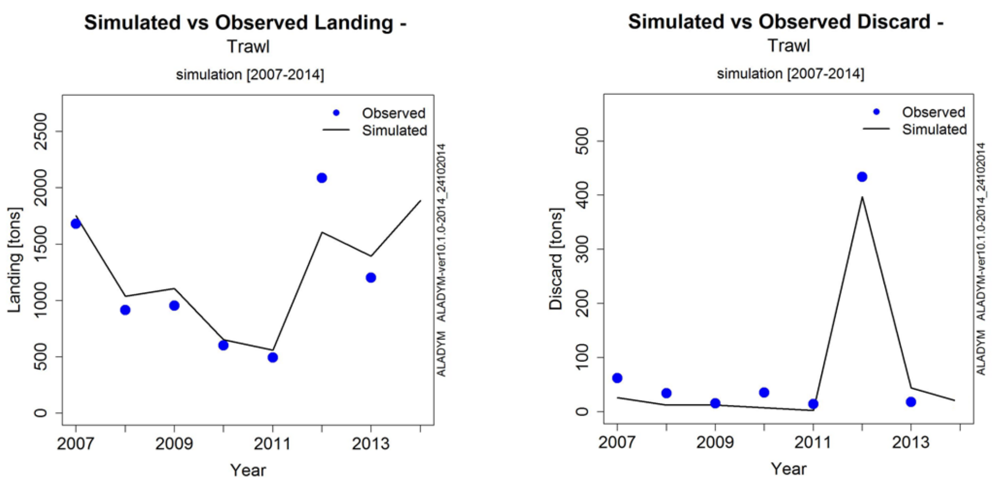


Figure 5.2.16.6.5.1. Red mullet in GSA 18. Selectivity used In ALADYM model by fleet.

5.2.16.6.6 *Results*

The fitting of ALADYM model has been considered satisfactory both for landing and discard of all the fleets, as well as the mean length in catches are reconstructed in a satisfactory way by the model.



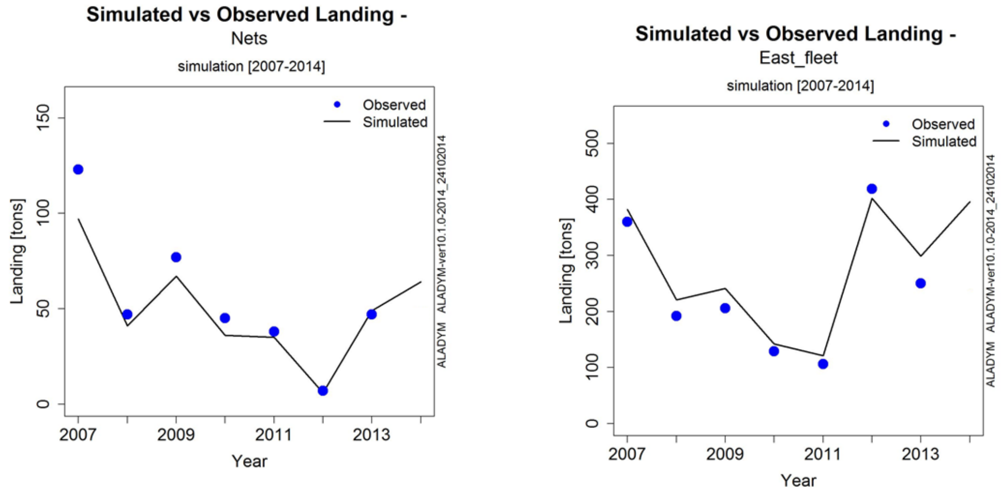


Figure 5.2.16.6.6.1. Red mullet in GSA 18. Comparison between landing and discard by fleet observed and simulated by ALADYM model.

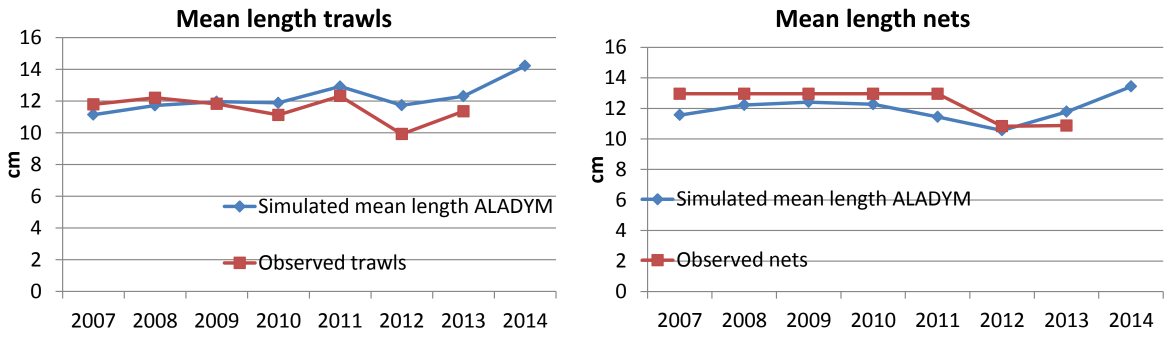


Figure 5.2.16.6.6.2. Red mullet in GSA 18. Comparison between mean length in catches observed and simulated by ALADYM model.

5.2.16.7 Long term prediction

5.2.16.7.1 *Justification*

Yield per recruit (YPR) analysis has been conducted using the package FLBRP on the XSA results, lacking a reliable stock-recruitment relationship due to the shortness of the time series. The same input parameters used for XSA have been used for the calculation of the reference point.

5.2.16.7.2 *Results*

The $F_{0.1}$ used as proxy of F_{MSY}, estimated by FLBR is 0.45. The reference point $F_{0.1}$ estimated by ALADYM model is 0.40.

5.2.16.8 Data quality

Data from DCF 2014 data call were used. Assessments were performed for the new submitted time series (2007-2013). A consistent sum of products compared with landing and discard was observed (difference less than 10%). Discards data from 2009 to 2013 were available. From 2009 to 2013 data were provided by year and metier, in 2007 and 2008 only at fleet segment level. Information on number of samples for landings, discards and catches, as well as the number of measurements by length for landings, discards and catches were also available.

5.2.16.9 Scientific advice

5.2.16.10 Short term considerations

5.2.16.10.1 State of the stock size

Survey indices and XSA indicate an increasing biomass in recent years.
However, EWG 14-19 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points.

5.2.16.10.2 State of recruitment

In 1999 and 2005 the MEDITS surveys indicated small peaks in recruitment; in 2012 a huge recruitment peak is present in the survey series and it is also showed by the XSA results.

5.2.16.10.3 State of exploitation

EWG 14-19 proposed $F_{0.1}$ = 0.45 as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the XSA and ALADYM analysis (current F corresponding to the F in the 2013 is around 0.48), the stock is considered exploited at levels close to sustainability.

5.2.16.10.4 Management recommendations

EWG 14-19 recommends the relevant fleets' effort 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. SHORT AND MEDIUM TERM FORECASTS

6.1 SHORT AND MEDIUM TERM PREDICTIONS FOR RED MULLET IN GSA 1

6.1.1 Short term prediction 2014-2016

6.1.1.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessments performed during EWG 14-19.

6.1.1.2 Input parameters

The input parameters were the same used for the XSA stock assessment and its results. An average of the last three years has been used for weight at age and maturity at age. For F at age it was used the $F_{bar1\text{-}2}$ in 2013.

6.1.1.3 Recruitment

Recruitment (age 0) for 2014 has been estimated from the population results as the geometric mean of the last 3 years (12385 thousand individuals).

6.1.1.4 Results

Table 6.1.1.4.1 – Short term forecast in different F scenarios computed for red mullet in GSA 1. Basis: F(2014) = $F_{bar1\text{-}2}$ 2013 = 1.31; R(2014) = geometric mean of the recruitment of the last 3 years; R = 12385 (thousands); SSB(2013) = 255 t, Catch (2013)= 130 t.

	Ffactor	Fbar	Catch_ 2015	Catch_ 2016	SSB_ 2016	Change_SSB_ 2015-2016(%)	Change_Catch_ 2013-2015(%)
zero catch	0	0	0.00	0.00	479.89	87.81	-100.00
F0.1	0.23	0.27	46.43	77.55	400.04	56.56	-64.29
status_ quo	1	1.31	138.39	134.42	249.76	-2.25	6.46
	0.1	0.13	21.73	40.64	442.29	73.10	-83.28
	0.2	0.26	41.12	70.44	409.06	60.09	-68.37
	0.3	0.39	58.44	92.02	379.69	48.60	-55.05
	0.4	0.52	73.92	107.39	353.72	38.43	-43.14
	0.5	0.65	87.77	118.10	330.74	29.44	-32.48
	0.6	0.78	100.18	125.31	310.40	21.48	-22.94
	0.7	0.92	111.31	129.94	292.40	14.43	-14.38
	0.8	1.05	121.31	132.68	276.44	8.19	-6.69
	0.9	1.18	130.30	134.04	262.30	2.66	0.23
	1.1	1.44	145.69	134.12	238.63	-6.61	12.07
	1.2	1.57	152.29	133.36	228.75	-10.48	17.14
	1.3	1.70	158.26	132.30	219.96	-13.91	21.73
	1.4	1.83	163.66	131.07	212.14	-16.97	25.89
	1.5	1.96	168.57	129.75	205.18	-19.70	29.67

	1.6	2.09	173.04	128.41	198.98	-22.13	33.11
	1.7	2.22	177.11	127.08	193.44	-24.29	36.24
	1.8	2.35	180.83	125.81	188.50	-26.23	39.10
	1.9	2.48	184.23	124.61	184.07	-27.96	41.72
	2	2.62	187.36	123.48	180.11	-29.51	44.12

6.1.2 Short term implications

A short term projection (Tab. 6.1.1.4.1) assuming an F_{stq} of 1.31 in 2013 and a recruitment of 12385 (thousand) individuals in 2014, shows that:

Fishing at the F_{stq} (1.31) from 2014 to 2016 would generate an increase of the catches of 6.5% in the period 2013-2015, while the spawning stock biomass would decrease by 2.3% between 2015-2016.

Fishing at $F_{0.1}$ (0.27) from 2014 to 2016 generates a decrease of the catch of 64.3% and a spawning stock biomass increase of 56.6% from 2015 to 2016.

Catches of red mullet in 2015 consistent with $F_{0.1}$ (0.27) should not exceed 46.4 tons.

6.1.2.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessments performed during EWG 14-19.

6.1.3 Medium term implications

The medium term projections were not conducted because no meaningful stock-recruitment relationship was found.

6.1.3.1 Method and justification

6.2 SHORT AND MEDIUM TERM PREDICTIONS FOR BLACK-BELLIED ANGLERFISH IN GSA 1

6.2.1 Short term prediction 2015-2017

No short term prediction was carried out for black-bellied anglefish in GSA 1 as a VIT was used for the assessment. See section 5.2.2 for details.

6.3 SHORT AND MEDIUM TERM PREDICTIONS FOR BLACK-BELLIED ANGLERFISH IN GSA 5

6.3.1 Short term prediction 2014-2016

6.3.1.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC, which takes into account the catch and landings in numbers and weight and the discards.

6.3.1.2 Input parameters

The same input parameters used in the XSA analysis shown above were used. Different scenarios of constant harvest strategy with F_{bar} calculated as the average of ages 1 to 3 and F status quo (F_{stq} = 0.838) were performed.

6.3.1.3 Recruitment

Recruitment (class 0) has been estimated from the population results from the geometric mean of the last three years 2011-2013 (141.086 thousands individuals) estimated with FLR.

6.3.1.4 Results

Table 6.3.1.4.1 – Short term forecast in different F scenarios computed for *Lophius budegassa* in GSA 5. Basis: F(2014) = mean(F_{bar}1-3 2011-2013)= 0.838; R(2013) = geometric mean of the recruitment of the last 3years; R = 141.086 (thousands); SSB(2013) = 8.167 t, Catch (2013)= 11.1 t.

Rationale	Ffactor	fbar	Catch 2015	Catch 2016	SSB 2016	Change SSB 2015-2016 (%)	Change Catch 2013-2015 (%)
zero catch	0.000	0.000	0.000	0.000	18.905	96.780	-100.000
High long-term yield (F0.1)	0.092	0.077	2.682	5.419	17.414	81.264	-75.839
Status quo	1.000	0.838	18.072	17.486	9.364	-2.533	62.815
Different scenarios	0.100	0.084	2.907	5.823	17.290	79.971	-73.813
	0.200	0.168	5.472	9.886	15.885	65.344	-50.706
	0.300	0.251	7.741	12.690	14.659	52.582	-30.258
	0.400	0.335	9.756	14.596	13.586	41.417	-12.110
	0.500	0.419	11.549	15.860	12.645	31.625	4.043
	0.600	0.503	13.149	16.667	11.818	23.013	18.461
	0.700	0.587	14.582	17.149	11.089	15.420	31.369
	0.800	0.670	15.868	17.404	10.444	8.707	42.958
	0.900	0.754	17.027	17.500	9.872	2.756	53.393
	1.000	0.838	18.072	17.486	9.364	-2.533	62.815
	1.100	0.922	19.019	17.399	8.911	-7.247	71.346
	1.200	1.005	19.879	17.263	8.506	-11.459	79.093
	1.300	1.089	20.662	17.098	8.144	-15.232	86.146
	1.400	1.173	21.377	16.916	7.818	-18.622	92.584
	1.500	1.257	22.031	16.726	7.525	-21.675	98.478
	1.600	1.341	22.631	16.535	7.260	-24.431	103.886
	1.700	1.424	23.184	16.346	7.020	-26.926	108.861
	1.800	1.508	23.693	16.163	6.803	-29.191	113.450
	1.900	1.592	24.164	15.987	6.605	-31.251	117.692

	2.000	1.676	24.600	15.820	6.424	-33.129	121.623

6.3.2 Short term implications

A short term projection (Table 6.3.1.4), assuming an Fstq of 0.838 in 2013 and a recruitment of 141.086 thousands individuals shows that:

Fishing at the Fstq (0.838) generates an increase of the catch of 62.8% from 2013 to 2015 along with an decrease of the spawning stock biomass of 2.59% from 2015 to 2016.

Fishing at F0.1 (0.077) generates a decrease of the catch of 75.84% from 2013 to 2015 and an increase of the spawning stock biomass of 81.26% from 2015 to 2016.

Catches of black bellied anglerfish in 2015 consistent with $F_{0.1}$ (0.077) should not exceed 2.7 tons.

6.3.2.1 Method and justification

6.3.3 Medium term implications

6.3.3.1 Method and justification

The medium term projections were not conducted because no meaningful stock-recruitment relationship was found.

6.4 SHORT AND MEDIUM TERM PREDICTIONS FOR NORWAY LOBSTER IN GSA 5

6.4.1 Short term prediction 2015-2017

No short term prediction was carried out for Norway lobster in GSA 5 as the retrospective patterns showed a lack of robustness in all the parameters analysed (SSB, R and F). See section 5.2.4 for details.

6.5 SHORT AND MEDIUM TERM PREDICTIONS FOR SARDINE IN GSA 6

6.5.1 Short term prediction 2015-2017

Short term predictions were implemented in R using the routines provided by JRC and based on the results of XSA- Assessment2 (see section 5.2.5.6.5)

6.5.1.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC, which takes into account the catch and landings in numbers and weight and the discards.

6.5.1.2 Input parameters

Input parameters were taken from Stock Assessment of sardine in GSA 6 (Assessment 2, section 5.2.5.6.5).

6.5.1.3 Recruitment

Recruitment (class 0) has been estimated from the population results from the geometric mean of the last three years (2011-2013).

6.5.1.4 Results

Table 6.5.1.4.1. Short term forecast for different F scenarios computed for *Sardina pilchardus* in GSA 6. Basis: F(2013)= 2.069; R(2014-2016): GM (2011-2013)= 27022 million); SSB(2013)= 31822 t; catch (2013)= 9734 t

	Ffactor	**Fbar**	**Catch_2015**	**Catch_2016**	**SSB_2016**	**Change_SSB_ 2015-2016(%)**	**Change_Catch_2 13-2015(%)**
zero catch	0	0	0	0	51842,0	29,5	-100
High long-term yield (F0.1)	0,2	0,347	4777,5	6881,7	47190,0	17,9	-50,9
Status quo	1	2,069	17620,8	14835,6	36163,1	-9,7	81,0
Different scenarios	0,1	0,207	2995,1	4673,3	48899,3	22,1	-69,2
	0,2	0,414	5565,1	7737,0	46445,8	16,0	-42,8
	0,3	0,621	7788,8	9798,0	44384,9	10,9	-20,0
	0,4	0,827	9729,0	11227,3	42639,7	6,5	0,0
	0,5	1,034	11435,7	12253,5	41149,9	2,8	17,5
	0,6	1,241	12948,8	13018,6	39867,5	-0,4	33,0
	0,7	1,448	14300,4	13612,1	38754,8	-3,2	46,9
	0,8	1,655	15516,4	14090,6	37781,6	-5,6	59,4
	0,9	1,862	16617,5	14490,5	36924,1	-7,8	70,7
	1,1	2,275	18540,1	15141,4	35483,3	-11,4	90,5
	1,2	2,482	19386,7	15418,3	34872,3	-12,9	99,2
	1,3	2,689	20169,9	15673,2	34320,2	-14,3	107,2
	1,4	2,896	20897,4	15911,1	33818,7	-15,5	114,7
	1,5	3,103	21575,6	16135,4	33361,2	-16,7	121,7
	1,6	3,310	22210,1	16348,3	32942,2	-17,7	128,2
	1,7	3,517	22805,2	16551,7	32557,2	-18,7	134,3
	1,8	3,723	23365,0	16746,8	32202,4	-19,6	140,0

	1,9	3,930	23892,8	16934,6	31874,5	-20,4	145,5
	2	4,137	24391,3	17115,9	31570,8	-21,1	150,6

6.5.2 Short term implications

A short term projection table (Table 6.5.1.4.1) assuming a statu-quo F of Fstq=2.069 in 2014 and a recruitment of 27022 million individuals shows that:

Increasing effort would produce increasing catches and decreasing SSB

Fishing at Fstq from 2014 to 2015 would produce an increase in catches of 81% with a decrease in SSB between 2015 and 2016 of -9.7 1.1%.

Fishing at $F_{0.1}$ (0.347) from 2014 to 2015 would generate a decrease of -50.9 % of the catches and an increase of 17.9 % in SSB.

Catches of sardine in 2015 consistent with $F_{0.1}$ (0.347) should not exceed 4777 tons.

6.5.2.1 Method and justification

6.5.3 Medium term implications

The medium term projections were not conducted because no meaningful stock-recruitment relationship was found.

6.5.3.1 Method and justification

6.6 SHORT AND MEDIUM TERM PREDICTIONS FOR ANCHOVY IN GSA 6

6.6.1 Short term prediction 2015-2017

No short term prediction was carried out for anchovy in GSA 6 as the assessment was not accepted. See section 5.2.6 for details.

6.7 SHORT AND MEDIUM TERM PREDICTIONS FOR BLACK-BELLIED ANGLERFISH IN GSA 6

6.7.1 Short term prediction 2014-2016

6.7.1.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessments performed during EWG 14-19.

6.7.1.2 Input parameters

The input parameters were the same used for the XSA stock assessment and its results. An average of the last three years has been used for weight at age, maturity at age and F at age.

6.7.1.3 Recruitment

Recruitment (age 0) has been estimated from the population results as the geometric mean of the last 3 years (11817.4 thousand individuals).

6.7.2 Outlook until 2016

Table 6.7.2.1. Black-bellied anglerfish in GSA 6. Short term forecast in different F scenarios.

Rationale	Ffactor	Fbar	Catch 2013	Catch 2014	Catch 2015	Catch 2016	SSB 2015	SSB 2016	Change SSB 2015-2016(%)	Change Catch 2013-2015(%)
Zero catch	0	0	1048.07	799.53	0	0	341.59	753.82	120.68	-100
High long term yield (F0.1)	0.13	0.14	1048.07	799.53	156.03	325.93	341.59	659.61	93.1	-85.11
Status quo	1	1.08	1048.07	799.53	711.98	778.46	341.59	346.17	1.34	-32.07
Different Scenarios	0.1	0.11	1048.07	799.53	123.42	265.53	341.59	679.1	98.8	-88.22
	0.2	0.22	1048.07	799.53	229.42	447.33	341.59	616.14	80.37	-78.11
	0.3	0.33	1048.07	799.53	321.03	571.31	341.59	562.65	64.71	-69.37
	0.4	0.43	1048.07	799.53	400.62	654.85	341.59	516.9	51.32	-61.78
	0.5	0.54	1048.07	799.53	470.12	709.9	341.59	477.56	39.8	-55.14
	0.6	0.65	1048.07	799.53	531.07	744.82	341.59	443.57	29.85	-49.33
	0.7	0.76	1048.07	799.53	584.75	765.49	341.59	414.08	21.22	-44.21
	0.8	0.87	1048.07	799.53	632.22	776.13	341.59	388.38	13.7	-39.68
	0.9	0.98	1048.07	799.53	674.39	779.73	341.59	365.9	7.12	-35.65
	1.1	1.19	1048.07	799.53	745.65	773.87	341.59	328.78	-3.75	-28.86
	1.2	1.3	1048.07	799.53	775.93	767.07	341.59	313.38	-8.26	-25.97
	1.3	1.41	1048.07	799.53	803.27	758.85	341.59	299.7	-12.26	-23.36
	1.4	1.52	1048.07	799.53	828.06	749.79	341.59	287.5	-15.83	-20.99
	1.5	1.63	1048.07	799.53	850.63	740.27	341.59	276.57	-19.04	-18.84
	1.6	1.73	1048.07	799.53	871.27	730.57	341.59	266.73	-21.92	-16.87
	1.7	1.84	1048.07	799.53	890.23	720.89	341.59	257.84	-24.52	-15.06
	1.8	1.95	1048.07	799.53	907.7	711.34	341.59	249.78	-26.88	-13.39
	1.9	2.06	1048.07	799.53	923.87	702.02	341.59	242.43	-29.03	-11.85
	2	2.17	1048.07	799.53	938.88	692.98	341.59	235.7	-31	-10.42

6.7.3 Short term implications

A short term projection (Table 6.7.2.1), assuming an F_{stq} of 1.08 in 2013 and a recruitment of 11817.4 thousand individuals, shows that:

Fishing at the F_{stq} (1.08) from 2014 to 2016 generates a decrease of the catch of 32.07 % and an increase of the spawning stock biomass of 1.34% from 2015 to 2016.

Fishing at $F_{0.1}$ (0.14) from 2014 to 2016 generates a decrease of the catch of 85.11% and a spawning stock biomass increase of 93.1 % from 2015 to 2016. The constant decrease of the catches is due to low recruitment.

Catches of black-bellied anglerfish in 2015 consistent with $F_{0.1}$ (0.14) should not exceed 156.03 tonnes.

6.7.3.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessments performed during EWG 14-19.

6.7.4 Medium term implications

6.7.4.1 Method and justification

Medium term was not conducted because no meaningful stock-recruitment relationship was estimated.

6.8 SHORT AND MEDIUM TERM PREDICTIONS FOR ANCHOVY IN GSA 7

6.8.1 Short term prediction 2015-2017

No short term prediction was carried out for anchovy in GSA 7 as the assessment was not accepted. See section 5.2.8 for details.

6.9 SHORT AND MEDIUM TERM PREDICTIONS FOR SARDINE IN GSA 7

6.9.1 Short term prediction 2015-2017

No short term prediction was carried out for sardine in GSA 7 as the assessment was not accepted. See section 5.2.9 for details.

6.10 SHORT AND MEDIUM TERM PREDICTIONS FOR SARDINE IN GSA 9

6.10.1 Short term prediction 2015-2017

No short term prediction was carried out for sardine in GSA 9 as the assessment was only considerate indicative of trends in SSB. See section 5.2.10 for details.

6.11 Short and medium term predictions for deep sea pink shrimp in GSA 9

6.11.1 Short term prediction 2014-2016

6.11.1.1 Input parameters

The input parameters were the same used for the XSA stock assessment and its results. Different scenarios, zero catch, harvest at reference point, Fstatus quo and a series of multiplier of Fstq were performed. Fstq=0.655 has been estimated as the geometric mean of the last three years 2011-2013 of Fbar values estimated with FLR.

6.11.1.2 Recruitment

Recruitment (class 0) has been estimated from the population results from the geometric mean (360522 thousands individuals).

6.11.2 Outlook until 2015

Table 6.11.2.1. Parapenaeus longirostris in GSA 9. Short term forecast in different F scenarios.

Basis: F(2014) = mean(Fbar1-3 2011-2013)= 0.655; R(2014) = geometric mean of the recruitment of the last 3years; R = 360522 (thousands); SSB(2014) = 965t, Catch (2013)= 605 t.

Rationale	Ffactor	Fbar	Catch 2015	Catch 2016	SSB 2016	Change SSB 2015-2016(%)	Change Catch 2013-2015(%)
Zero catch	0.000	0.000	0.000	0.000	1737.701	74.521	-100.000
High long term yield F(0.1)	1.069	0.700	691.231	686.205	986.753	-0.898	14.121
Status quo	1.000	0.655	663.377	670.383	1014.527	1.891	9.522
Different scenarios	0.100	0.065	97.281	130.631	1626.079	63.311	-83.939
	0.200	0.131	185.535	240.205	1526.131	53.273	-69.369
	0.300	0.196	265.738	332.119	1436.512	44.272	-56.127
	0.400	0.262	338.756	409.220	1356.039	36.190	-44.072
	0.500	0.327	405.355	473.889	1283.664	28.921	-33.077
	0.600	0.393	466.216	528.124	1218.465	22.373	-23.029
	0.700	0.458	521.942	573.597	1159.629	16.464	-13.829
	0.800	0.524	573.069	611.712	1106.438	11.122	-5.388
	0.900	0.589	620.073	643.645	1058.257	6.283	2.373
	1.100	0.720	703.358	692.754	974.752	-2.104	16.123
	1.200	0.786	740.349	711.452	938.496	-5.745	22.230
	1.300	0.851	774.648	727.063	905.373	-9.071	27.893
	1.400	0.917	806.522	740.075	875.041	-12.118	33.155
	1.500	0.982	836.206	750.902	847.198	-14.914	38.056
	1.600	1.048	863.912	759.889	821.577	-17.487	42.630
	1.700	1.113	889.827	767.329	797.942	-19.861	46.908
	1.800	1.179	914.120	773.465	776.083	-22.056	50.919
	1.900	1.244	936.941	778.505	755.813	-24.092	54.687
	2.000	1.310	958.425	782.621	736.970	-25.984	58.234

6.11.3 Short term implications

A short term projection (Table 6.11.2.1), assuming an Fstq of 0.655 in 2013 and a recruitment of 360522 thousands individuals show that:

Fishing at the Fstq (0.655) generates an increase of the catch of about 9% from 2013 to 2015 along with a increase of the spawning stock biomass of about 2% from 2015 to 2016.

Fishing at $F_{0.1}$ (0.7) generates an increase of the catch of about 14% from 2013 to 2015 and a decrease of the spawning stock biomass of about 1% from 2015 to 2016.

Catches of deep sea pink shrimp in 2015 consistent with $F_{0.1}$ (0.70) should not exceed 691 tons.

6.11.3.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessments performed during EWG14-19 for the years 2006–2013.

6.11.4 Medium term implications

6.11.4.1 Method and justification

The medium term projections were not conducted because no meaningful stock-recruitment relationship was found.

6.12 SHORT AND MEDIUM TERM PREDICTIONS FOR GIANT RED SHRIMP IN GSA 11

6.12.1 Short term prediction 2015-2017

No short term prediction was carried out for giant red shrimp in GSA 11 as the assessment was not accepted. See section 5.2.12 for details.

6.13 SHORT AND MEDIUM TERM PREDICTIONS FOR DEEP SEA PINK SHRIMP IN GSA 11

6.13.1 Short term prediction 2015-2017

No short term prediction was carried out for deep sea pink shrimp in GSA 11 as the assessment was not accepted. See section 5.2.13 for details.

6.14 SHORT AND MEDIUM TERM PREDICTIONS FOR NORWAY LOBSTER IN GSA 17

6.14.1 Short term prediction 2015-2017

No short term prediction was carried out for Norway lobster in GSA 17 as the assessment was not conducted. See section 5.2.14 for details.

6.15 SHORT AND MEDIUM TERM PREDICTIONS FOR NORWAY LOBSTER IN GSA 18

6.15.1 Short term prediction 2014-2016

6.15.1.1 Method and justification

A deterministic short term prediction for the period 2014 to 2016 was performed using an FLR routine, 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.

6.15.1.2 Input parameters

The input parameters were the same used for the XSA stock assessment and its results. An average of the last three years was 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.

6.15.1.3 Recruitment

Recruitment (class 1) in 2014 was estimated as the geometric mean (2011-2013), taken from XSA results = 37,641 (thousands).

6.15.1.4 Results

The scenarios of the short term projections are summarised in Table 6.15.1.4.1 .

Table 6.15.1.4.1 Norway lobster in GSA 18. Short-term forecast in different F scenarios.

Rationale	Ffactor	Fbar	Catch 2014	Catch 2015	Catch 2016	SSB 2015	SSB 2016	Change SSB 2015-2016 (%)	Change Catch 2013-2015 (%)
Zero catch	0	0.00	0.00	0.00	0.00	1199.83	2095.31	74.63	-100.00
F0.1	0.18	0.14	290.48	195.86	290.48	1107.70	1681.46	51.80	-77.50
Satus quo	1	0.61	665.70	675.35	665.70	847.03	821.37	-3.03	-22.41
Different scenarios	0.1	0.06	142.93	89.49	142.93	1158.55	1902.04	64.17	-89.72
	0.2	0.12	260.98	173.13	260.98	1118.74	1727.74	54.44	-80.11
	0.3	0.18	357.93	251.34	357.93	1080.34	1570.47	45.37	-71.13
	0.4	0.25	437.02	324.49	437.02	1043.31	1428.50	36.92	-62.72
	0.5	0.31	501.01	392.94	501.01	1007.58	1300.27	29.05	-54.86
	0.6	0.37	552.25	457.02	552.25	973.12	1184.40	21.71	-47.50
	0.7	0.43	592.75	517.03	592.75	939.88	1079.63	14.87	-40.60
	0.8	0.49	624.22	573.24	624.22	907.81	984.85	8.49	-34.14
	0.9	0.55	648.12	625.94	648.12	876.88	899.06	2.53	-28.09
	1.1	0.67	677.99	721.70	677.99	818.24	750.96	-8.22	-17.09
	1.2	0.74	685.92	765.21	685.92	790.45	687.12	-13.07	-12.09
	1.3	0.80	690.23	806.06	690.23	763.65	629.21	-17.61	-7.40
	1.4	0.86	691.57	844.44	691.57	737.78	576.63	-21.84	-2.99
	1.5	0.92	690.49	880.51	690.49	712.83	528.87	-25.81	1.16
	1.6	0.98	687.46	914.44	687.46	688.74	485.46	-29.52	5.05
	1.7	1.04	682.86	946.36	682.86	665.50	445.97	-32.99	8.72
	1.8	1.10	677.01	976.41	677.01	643.08	410.03	-36.24	12.17
	1.9	1.16	670.21	1004.71	670.21	621.43	377.31	-39.28	15.42
	2.0	1.23	662.67	1031.39	662.67	600.55	347.48	-42.14	18.49

6.15.2 Outlook until 2017

6.15.3 Short term implications

6.15.3.1 Method and justification

A short term projection table (Table 6.15.1.4.1) assuming a Fstq =0.61 in 2014 and a recruitment of 37,641 thousand.

The short term projection (Table 6.15.1.4.1), assuming an Fstq of 0.61 in 2013 and a recruitment of 37,641 (thousands) individuals shows that:

Fishing at the Fstq (0.61) generates a decrease in catch by 22% from 2013 to 2015 along with a decrease in the spawning stock biomass of 3% from 2015 to 2016.

Fishing at $F_{0.1}$ (0.14) generates a decrease in catch by 77 % from 2013 to 2015 and a spawning stock biomass increase by 55% from 2015 to 2016.

Catches of Norway lobster in 2015 consistent with $F_{0.1}$ (0.18) should not exceed 290 tons.

6.15.4 Medium term implications

6.15.4.1 Method and justification

The medium term projections were not conducted because no meaningful stock-recruitment relationship was found.

6.16 SHORT AND MEDIUM TERM PREDICTIONS FOR RED MULLET IN GSA 18

6.16.1 Short term prediction 2015-2017

6.16.1.1 Method and justification

Short and medium term predictions have been carried out using ALADYM simulation model (Lembo et al., 2009) in order to provide a set of management scenarios to achieve the reference point by fleet as required by the ToR 3 of this meeting.

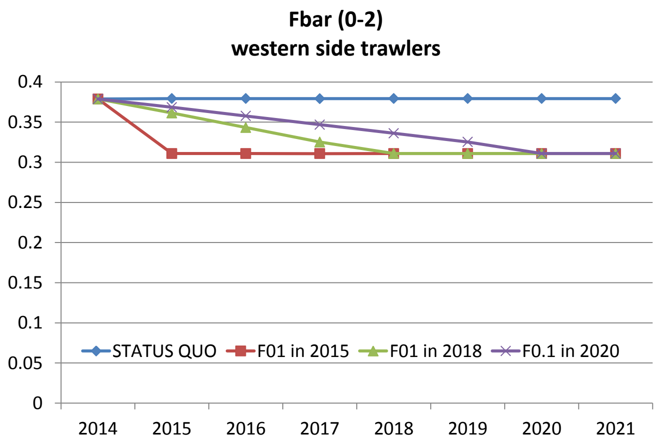
The short term predictions have been also carried out with the short term script developed within of the EWG, though in this case fleets/gears cannot be taken into account.

6.16.1.2 Input parameters

The same input used for XSA (10% Eastern landings scenario) and ALADYM runs have been used to simulate the following forecast scenarios with ALADYM model:

- Status quo;
- Reduction to F0.1 (=0.45) in 2015;
- Reduction to F0.1 (=0.45) in 2018;
- Reduction to F0.1 (=0.45) in 2020.

The reductions have been applied only to Western trawls and Eastern fleet, representing the nets less than the 10% of the landings (Fig. 6.16.1.2.1).



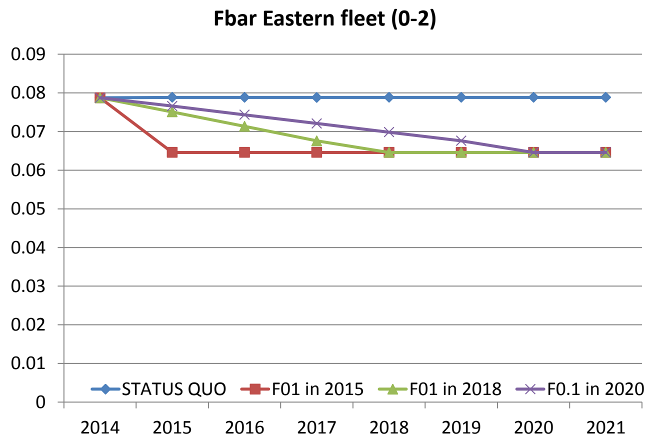


Figure 6.16.1.2.1. Scenarios simulated by ALADYM: reduction applied only on Eastern fleet nd Western trawls to reach the reference point $F_{0.1}$ in 2015, 2018 and 2020.

For the short term forecast script the results of XSA have been used. The F vector derived from XSA and used in the short term forecast is reported below.

F vector

	2007	2008	2009	2010	2011	2012	2013
0	0.473	0.246	0.423	0.432	0.077	0.785	0.345
1	2.294	1.966	2.304	1.549	0.95	2.12	0.803
2	1.403	0.23	0.738	0.282	0.997	0.621	0.294
3	1.403	0.23	0.738	0.282	0.997	0.621	0.294

Several scenarios with different harvest strategy were run, with F_{stq} (F_{bar} ages 0-2) assumed equal to the last year (=0.48).

Number at age in the stock (thousands)

	0	1	2	3
2007	192248	64356	2868	94
2008	132467	42778	3192	214
2009	112560	36968	2944	58
2010	106356	26336	1814	151
2011	218072	24650	2750	57
2012	409147	72094	4686	34
2013	249038	66638	4256	53

6.16.1.3 Recruitment

For both models a geometric mean of recruitment of the last three years (281 135 thousands) has been assumed. In order to evaluate the uncertainty on the landings and SSB, in ALADYM model a multiplicative noise on recruitment has been applied, characterized by a lognormal distribution with mean 0 and standard deviation 0.3.

6.16.1.4 Results

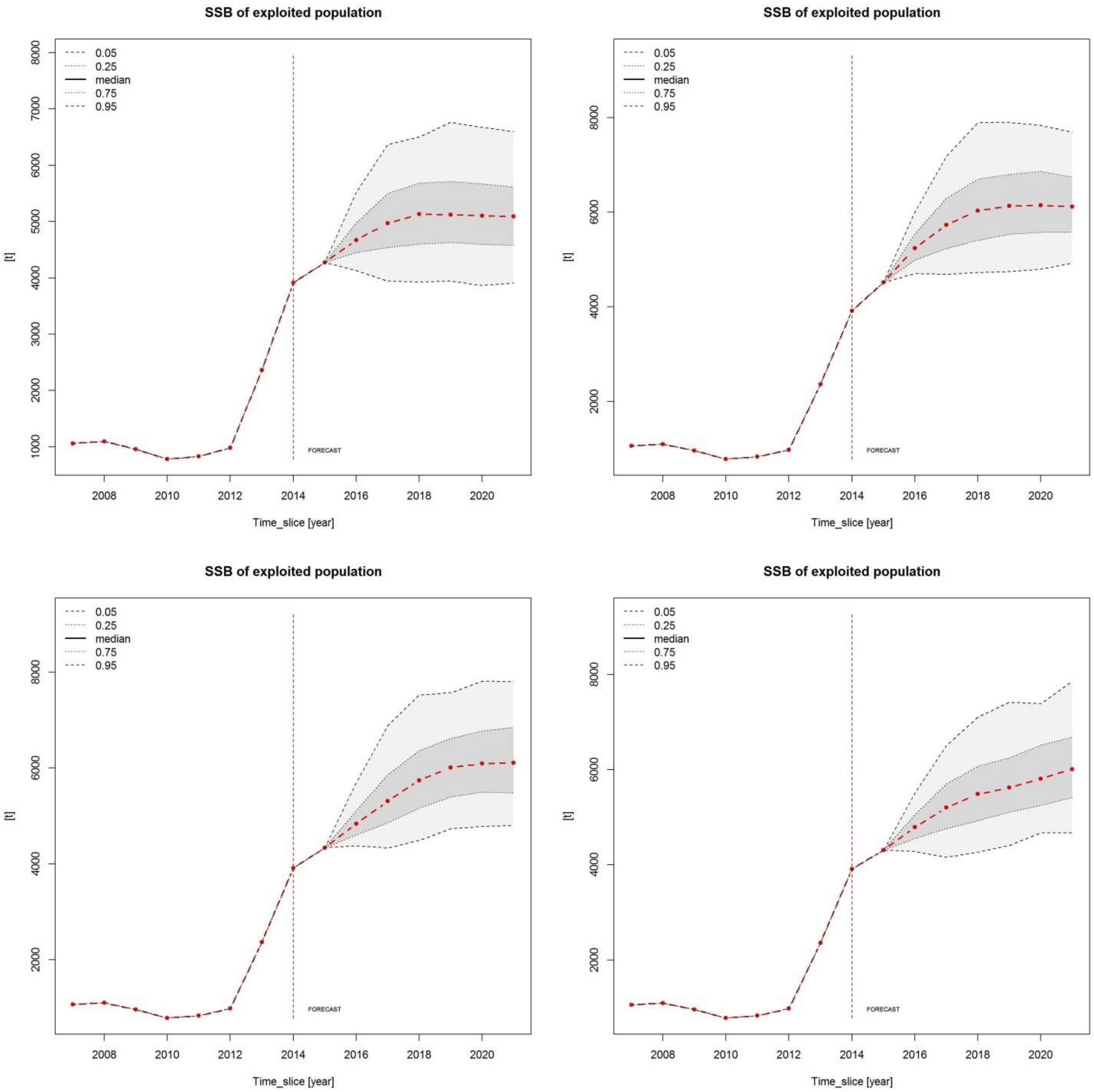


Figure 6.16.1.4.1. Scenarios simulated by ALADYM: trend in SSB associated to the four scenarios: status quo (topleft), reduction to reach the reference point $F_{0.1}$ in 2015 (topright), 2018 (bottomleft) and 2020 (bottomright).

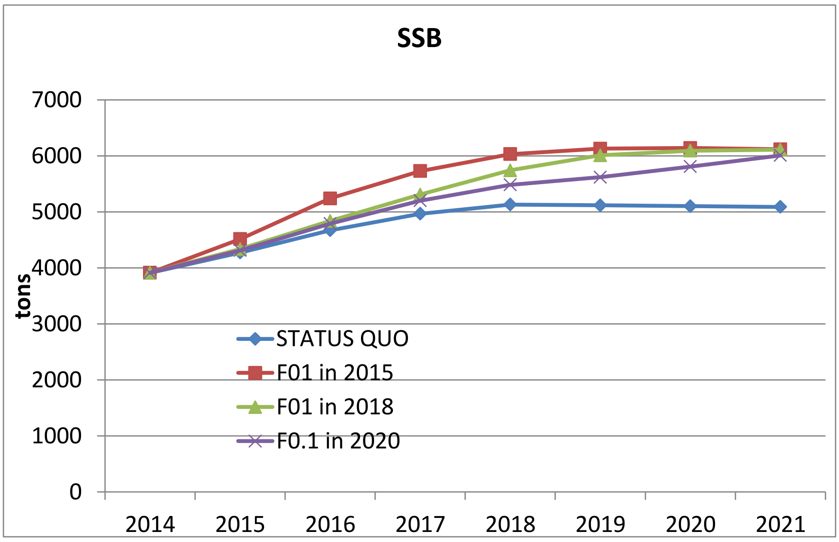
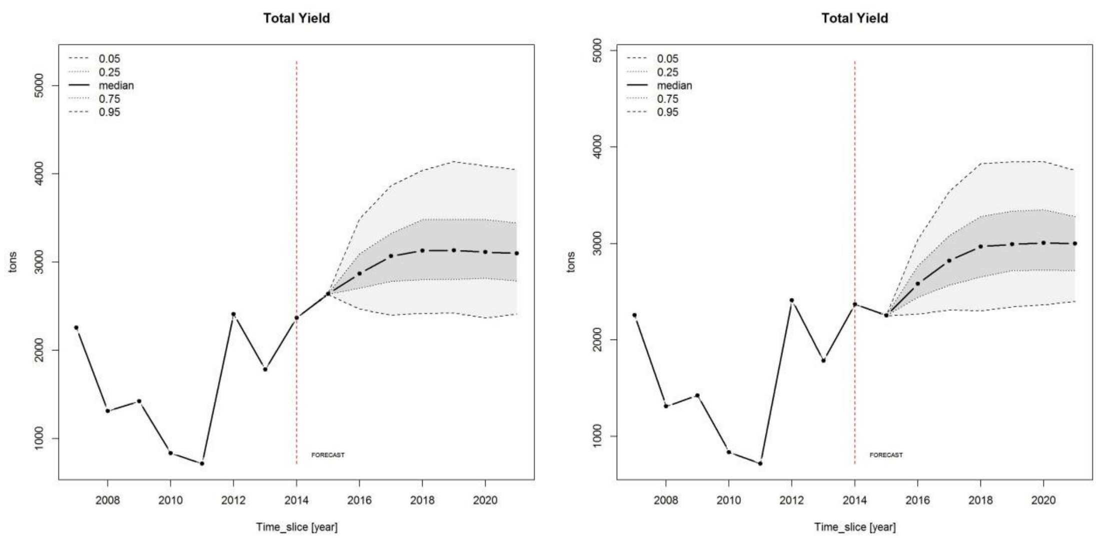


Figure 6.16.1.4.2. Scenarios simulated by ALADYM: trend in median SSB associated to the four scenarios: status quo, reduction to reach the reference point $F_{0.1}$ in 2015, 2018 and 2020.

The comparison of the results of ALADYM model (Figure 6.16.1.4.2-4) showed that:

- the reduction towards the F0.1 in 2015 would increase the SSB of 20.2 % respect to the status quo in 2021;
- the reduction towards the F0.1 in 2018 would increase the SSB of 20.1 % respect to the status quo in 2021;
- the reduction towards the F0.1 in 2020 would increase the SSB of 18.1 % respect to the status quo in 2021.



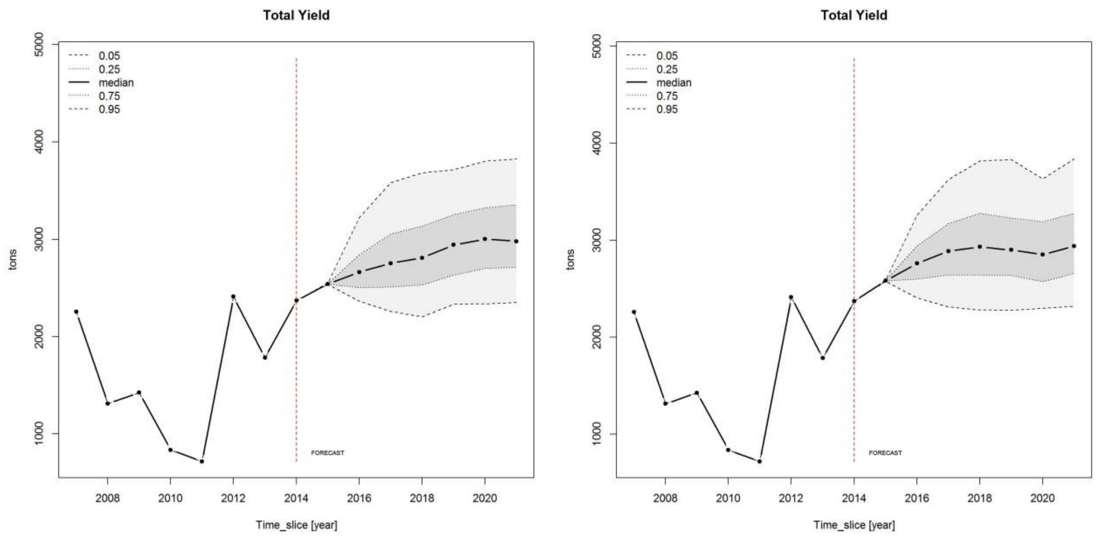


Figure 6.16.1.4.3. Scenarios simulated by ALADYM: trend in total landings associated to the four scenarios: status quo (topleft), reduction to reach the reference point $F_{0.1}$ in 2015 (topright), 2018 (bottomleft) and 2020 (bottomright).

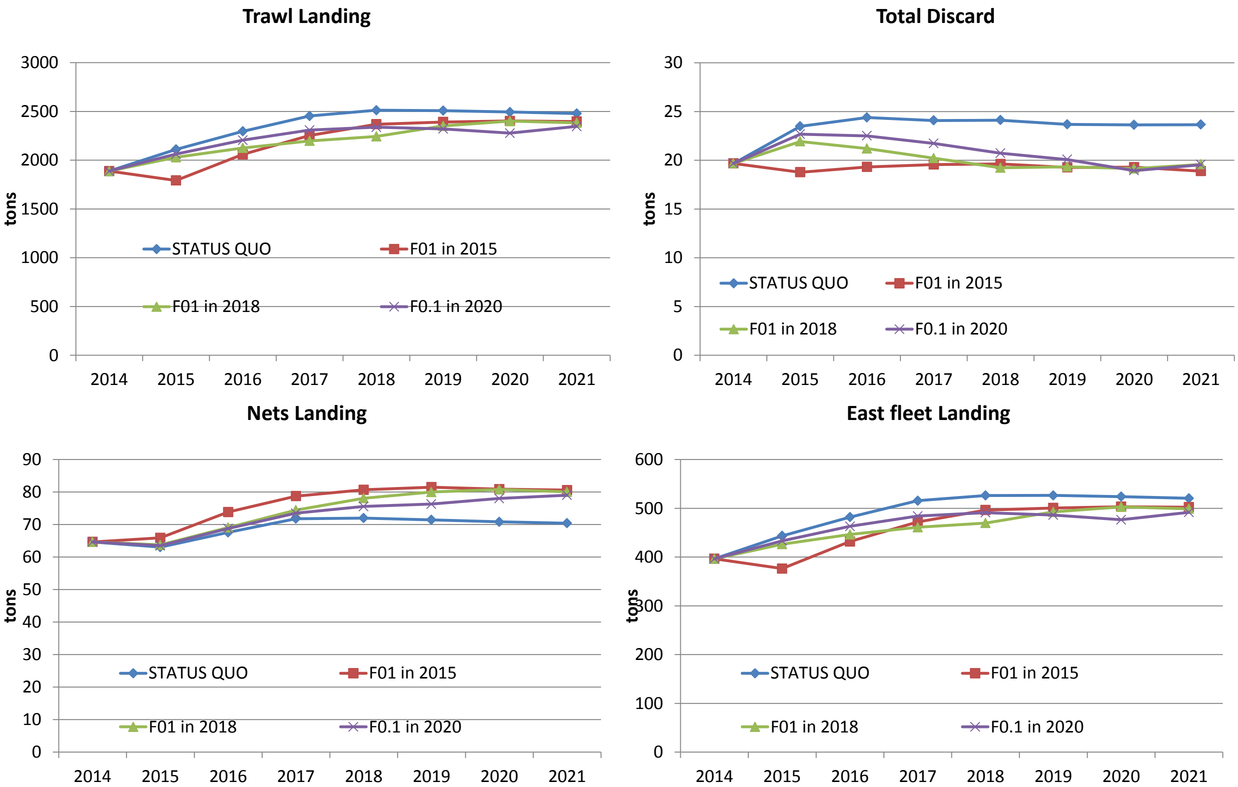


Figure 6.16.1.4.4. Scenarios simulated by ALADYM: trend in median landing by fleet associated to the three scenarios of reduction to reach the reference point $F_{0.1}$ in 2015, 2018 and 2020.

In terms of landings, ALADYM results showed that the scenario of achievement of $F_{0.1}$ in 2015 would produce a decrease in landings smaller than the scenario of reduction untile $F_{0.1}$ in 2020 on the total landings (Figure 6.16.1.4.4 and Table 6.16.1.4.1). Focusing on the different fleets, the same behaviour is showed by the landing of Western trawlers and of Eastern fleet, while the nets landings show for all the scenarios an increase in landings, that is higher in the scenario of achievement of $F_{0.1}$ in 2015.

For the three scenarios the decrease in discard for Western trawls ranges between 17.2 and 20.1% is shown by the model results.

Table 6.16.1.4.1 Percentage of change of total landings and by fleet segment evaluated in 2021 respect to status quo scenario.

% difference from SQ	Total_Landing	Landing_Trawl	Landing_Nets	Landing Eastern fleet
F01 in 2015	-2.9	-3.3	14.4	-3.5
F01 in 2018	-3.6	-3.8	13.7	-4.2
F0.1 in 2020	-4.8	-5.3	12.3	-5.5

Moreover the results of ALADYM model showed that:

- Fishing at the F_{stq} (0.48) from 2015 to 2016 generates an increase of the catch for 50.4 % and an increasing of the spawning stock biomass of 9.3 % from 2015 to 2016.

- Fishing at $F_{0.1}$ (0.45) for the same time (2015-2016) generates an increase of the catch of 28.4%, a total landing of 2350 tons and a spawning stock biomass increase of 16 % from 2015 to 2016.

A short term projection (Table 6.16.1.4.2) with the short term forecast script, assuming an F_{stq} of 0.48 in 2014 and a recruitment of 281 135 (thousands) individuals, shows that:

- Fishing at the F_{stq} (0.48) from 2015 to 2016 generates an increase of the catch for 37.5 % and an increasing of the spawning stock biomass of 9.7% from 2015 to 2016.

- Fishing at $F_{0.1}$ (0.45) for the same time (2015-2016) generates an increase of the catch of 30.53% and a spawning stock biomass increase of 12.74% from 2015 to 2016.

Table 6.16.1.4.22. Results of short term forecast for 22 different levels of F in 2015 and 2016. Catch (2013) = 1482 t. Catch (2014) = 1801 t. SSB (2014) = 2992 t. Recruitment = GM (2011-2013).

Ffactor	Fbar	Catch_2015	Catch_2016	SSB_2015	SSB_2016	Change_SSB_2015-2016(%)	Change_Catch_2013-2015(%)
0	0.00	0	0	4510	7796	72.84	-100.00
0.94	0.45	1935	2042	3886	4382	12.75	30.53
0.1	0.05	252	347	4438	7317	64.85	-83.02
0.2	0.10	491	654	4367	6870	57.30	-66.88
0.3	0.14	718	926	4298	6453	50.15	-51.53
0.4	0.19	935	1166	4230	6065	43.38	-36.93
0.5	0.24	1141	1377	4163	5703	36.98	-23.01
0.6	0.29	1338	1564	4098	5364	30.91	-9.75
0.7	0.34	1525	1728	4033	5048	25.16	2.89
0.8	0.38	1704	1873	3970	4753	19.72	14.96
0.9	0.43	1875	2000	3909	4478	14.56	26.48
1	0.48	2038	2111	3848	4220	9.66	37.48
1.1	0.53	2194	2208	3789	3979	5.02	48.01

Ffactor	Fbar	Catch_2015	Catch_2016	SSB_2015	SSB_2016	Change_SSB_2015-2016(%)	Change_Catch_2013-2015(%)
1.2	0.58	2343	2293	3730	3753	0.61	58.08
1.3	0.62	2486	2367	3673	3542	-3.57	67.72
1.4	0.67	2623	2431	3617	3344	-7.54	76.95
1.5	0.72	2754	2487	3562	3159	-11.31	85.80
1.6	0.77	2879	2535	3508	2985	-14.89	94.28
1.7	0.82	3000	2577	3455	2823	-18.30	102.43
1.8	0.87	3116	2612	3403	2670	-21.54	110.24
1.9	0.91	3227	2642	3352	2527	-24.61	117.75
2	0.96	3334	2668	3302	2392	-27.54	124.97

Being the results of the two models quite consistent among them, EWG 14-19 recommends that fishing mortality in 2015 should not exceed $F_{0.1}$= 0.45, corresponding to catches of 1935 t.

7. DATA QUALITY AND COMPLETENESS

The EWG was requested to:
"*Review the quality and completeness of all data resulting from the official Mediterranean DCF data call issued on April 2014. STECF-EWG 14-19 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 2014.*"

7.1 Data Overview

The main issues identified in the 2014 Data Call were described in detail in the previous EWG (STECF EWF 14-17 Mediterranean Stock Assessments part 1) as well as the JRC Science and Policy Report "DCF Data Call Coverage Report for the Mediterranean and Black Sea in 2014".

The data call issued on April 2014 had a second deadline for MEDITS survey data on the 12th of January 2015, just the week preceeding the EWG meeting. Data was uploaded by each country according to the following table:

Table 7.1.1. Timeline of data upload from Mediterranean Member States, data call **deadline of the 2h of January 2015**.

COUNTRY	First Upload	Last Upload
ITA	23 December 2014	23 January 2015
ESP	23 December 2014	23 December 2014
FRA	06 January 2015	09 January 2015
SVN	06 January 2015	08 January 2015
MLT	**No data submitted**	
CYP	**No data submitted**	
GRC	15 January 2015	21 January 2015
HRV	09 January 2015	12 January 2015

The overall 2014 Data Call performance of data coverage, timeliness and progress of submissions by member state and main table/variable can be visually evaluated on line in the following link:
https://visualise.jrc.ec.europa.eu/t/dcf/views/medbs_coverage/Coverage?:embed=y&:display_count=no.
More detailed information can be traced therein.

7.2 Stock Specific Data Issues

Red mullet in GSA 1

Fishing effort data values used in the assessments may be over- or under-estimated. Currently it is not possible to know the exact number of OTB vessels exerting their effort in GSA 1, due to the fact that the same boat can operate in different metiers during the same quarter.

Black-bellied anglerfish in GSA 1

The data submitted to the EWG 14-19 were of sufficient quality to perform a VPA on pseudo-cohorts at annual scale, but incomplete to perform a tuned VPA.

Black-bellied anglerfish in GSA 5

The data available were of sufficient quality to perform XSA. The data submitted to the EWG 14-19 were in general of good quality. Reported discards were negligible and this is acceptable, considering the important commercial value of this species in GSA 5.

Norway lobster in GSA 5

DCF information on catches, length and age frequency distributions were not available before 2009, as the species was not a target species in the DCR. Instead available information from IEO was used. Current format of the Data Call for the variable “number of boats” prevents the calculation of a total number of boats for OTB by year: as information is requested by metier and quarter, it is not possible to sum up this data, as the same boat during the same quarter can operate in more than one OTB metiers. MEDITS survey before 2007 was carried only in a small subarea of GSA 5 (circa 4 hauls per year in the south-western part of the area - Ibiza channel). The hauls carried out in this area are systematically excluded from the analysis for all the years.

Sardine in GSA 6

A first assessment (assessment1) was performed using as input the growth parameters estimated for sardine in GSA 6 (DCF 2008). The values of M vector calculated with these parameters and the method proposed by Gislason et al. (2010) were much higher than those estimated for sardine in other areas, for example in the Adriatic Sea. In addition, the species growth according to these parameters would be faster than that shown by the length distributions from the acoustic surveys in summer and late autumn. Thus, a second assessment (assessment 2) was performed using modified growth parameters and M vector calculated using a second set of growth parameters, with M values by age much higher and similar to those calculated for the Adriatic. The modification of the growth parameters was made by fixing Linf= 23.9 (DCF 2008) and using the Solver routine of Excel 2010 solution for the estimation of k, for different t0. The k value was chosen considering that the growth curve reproduced better the observed length frequencies from the acoustic surveys (younger ages) and coincided with original DCF (2008) growth curve in the older ages. The modified growth parameters reproduced better than the original set (DCF 2008) the younger ages when comparing the growth curve with the length distributions of sardine from the acoustic surveys, improved substantially the log catch curves and also moderately the residuals pattern and the retrospective. Based on these considerations, the Assessment2 (i.e. based on the modified growth parameters) was considered as the best one.

Anchovy in GSA 6

Discards data were not available, however they are considered negligible for this fishery. No other specific data issues were identified.

Black-bellied anglerfish in GSA 6

Fishing effort provided to EWG 14-19 were much higher than those submitted in previous meetings. For this reason, fishing effort data in the present report have been taken from the EWG 13-19 report. Discards data of 2008 to 2013 were available in catch, but there were no length frequencies of these discards so they were not included in the assessment. Spain made use of a derogation (Commission Regulation (EC) No 1581/2004) which does not oblige member states to collect detailed data for the discarded species under certain circumstances. Year 2003 was excluded from the assessment, because the length frequencies distribution of the landings data seemed to be truncated.

Anchovy in GSA 7

Discard data were not reported consistently along the 2003-2013 period, so that the assessments were conducted without taking discards into account (i.e., catches = landings). Effort: A time series (1993-2013) of effort was not available through the DCF tables. Therefore an estimation of the number of fishing days was obtained from IFREMER and used. However, some discrepancies were detected and the confidence in this time series was low.

Sardine in GSA 7

Discard data were not reported consistently during 2003-2013, so that the assessment was conducted without taking discards into account (i.e., catches equal to landings). No representative catch at length data was available in 2011. Indeed, 90% of the catches were made by purse seines and only 10% by pelagic trawl in 2011, while it had been the opposite before. Sampling was always concentrated on pelagic trawls and as a consequence it was rather small in 2011 and judged insufficient and non-representative of the catches.

Sardine in GSA 9

Although total landings and catch at age data were available for the period 2006-2013, corresponding survey abundance indexes for the same period were lacking which impeded to run a tuned VPA asssessment.

Deep Sea Pink Shrimp in GSA 9

No specific data issues were identified.

Giant Red Shrimp in GSA 11

Data available during EWG 14-19 for giant red shrimp were incomplete and rather inconsistent for several aspects that are listed and commented below.

> Landings: The official landings data were reported at different time scales (2005-2013 catch by age and 2011-2013 landings by length). Numbers-at-age appear inconsistent in 2005 and 2006 while the catch data appear to compose of only two and three age classes respectively (i.e. lack of big specimens).
>
> Discards: data seem unusual for giant red shrimp. They are reported in GSA11 for one year only and in high numbers. Probably a problem in the raising methods occurred.
>
> The recent data tables (2014 Data Call) were compared against older Data Call submissions. From the comparison of fisheries data landings at age, neither the total values nor the values by age reported in 2011 and 2012 during EWG 13-19 correspond to the data submitted this year (2014 Data Call). Differences were also found for landings at length. The latest information does not match with the old ones for years 2011 and 2012.

Deep Sea Pink Shrimp in GSA 11

Data available during EWG 14-19 for deep-sea pink shrimp were incomplete and rather inconsistent for several aspects that are listed and commented below:

> The official landings data were reported only for the period 2009-2013. In the past a more extended series of data was submitted in older Data Calls. Landings declined from a peak of about 550 t in 2005 to 21 t in 2013. The consistency of this trend in landings would need to be better explored. The composition in age (numbers-at-age) and length (numbers-at-length) of the landings were available for 2011-2013 and 2009-2013 respectively. It is not clear why the two datasets were not provided for the same time period. Moreover, numbers-at-age are not consistent with the numbers-at-length provided, in particular for the catch of the 0 group. No

catch of age 0 specimens was reported in catch-at-age data for 2011-2013 whereas these specimens appear in the numbers-at-age matrix. No discard data was provided.

Norway lobster in GSA 17

Croatian length data provided during the 2014 DCF data call for both landings and discards were reported in centimetres of total length (TL), rather than millimetres of carapace length (CL).
Other data issues can be traced in detail in the stock assessment section; however they pertain to the assumption of the existence of more than one stock in GSA 17.

Norway lobster in GSA 18

In the 2014 Data Call no biological parameters (growth, maturity, sex-ratio) were requested. As a result age slicing by sex of catch and survey data were conducted using the raw data collected by the experts involved in DCF in GSA 18. The experts also provided data on maturity as well as on growth and L-W relationship parameters. STECF EWG 14-19 stresses that it is important to have access to this information in future data calls in order to improve the accuracy and precision of the evaluation of the stock status.

Red mullet in GSA 18

No specific issues were identified except the lack of catch information from the Eastern side of the GSA 18. A sensitivity analysis with different level of assumed catches was perfomed indicating that the stok status is insensitive to the level of catches assumed for the Eastern side of the GSA 18.

8. UPDATE THE PROPOSED PRIORITY LIST FOR WHICH STOCK ASSESSMENT SHOULD BE PERFORMED IN EACH CALENDAR YEAR

The criteria set during the '2012 Assessment of Mediterranean Sea stocks part II (STECF EWG 13-05)' were used as the guiding rule for compiling an updated priority list of stocks to be performed in the upcoming years.
The criteria can be summarized as follows:

- *Selection criteria*
    - *Catch composition (major species ~ 80%)*
    - *Biological characteristics*
    - *Level of overfishing*
    - *Important commercial value*
    - *Threatened, need for conservation (red list, elasmo)*
    - *Species that never have been assessed (higher priority)*
- *Frequency of assessments*
    - *Frequent*
        - *Short living (small pelagics, cephalopods)*
        - *Stocks at critical exploitation status*
    - *Less frequent*
        - *Long living*
        - *Stocks sustainably exploited*

According to the aforementioned criteria, the following table 8.1 has been compiled in 2012 (STECF EWG 13-05). It can be identified that out of the 32 foreseen stocks to be assessed during 2014, only 18 were possible to be tackled. Non assessed stocks are indicated in red cells.

Table 8.1. Identification of stock priority list (as proposed in 2012 - STECF EWG 13-05).

GSA	CODE	Common name	*Species*	2013	2014	2015
1	PIL	Sardine	*Sardina pilchardus*	1		
1	ARA	Blue and red shrimp	*Aristeus antennatus*			1
1	HKE	Hake	*Merluccius merluccius*	1		1
1	DPS	Pink	*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	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	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	
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	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	Pink shrimp	*Parapenaeus longirostris*	1		
10	MTS	Spottail mantis	*Squilla mantis*		1	
10	MUT	Red mullet	*Mullus barbatus*		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	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	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	*Solea solea*	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	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*	1		
22+23	MUT	Red mullet	*Mullus barbatus*		1	
25	MUR	Striped red mullet	*Mullus surmuletus*		1	
25	MUT	Red mullet	*Mullus barbatus*		1	
TOTAL				**30**	**32**	**2**

Updating the above table of stock priority list for 2015-2019, took also into account two criteria not considered back in 2012:

- *Threatened, need for conservation (IUCN red list, sensitive elasmobranchs)*
    - *Squalus acanthias (DGS) - IUCN Red List*
    - *Raja clavata (RJC) - not in IUCN Red List; reatively high catches*
- *Stocks subject to multiannual plans (higher priority)*

Table 8.2. Identification of stock priority list for 2015-2019.

GSA	CODE	Common name	*Species*	2013	2015	2016	2017	2018	2019	Comments
1	PIL	Sardine	*Sardina pilchardus*	*	*	*	*	*	*	Absence of a reliable survey tuning index
1	ANE	Anchovy	*Engraulis encrasicolus*		*	*	*	*	*	Absence of a reliable survey tuning index
1	ARA	Blue and red shrimp	*Aristeus antennatus*		*			*		
1	HKE	Hake	*Merluccius merluccius*	*			*			
1	DPS	Pink shrimp	*Parapenaeus longirostris*	*					*	
5	ARA	Blue and red shrimp	*Aristeus antennatus*				*			This stock was assessed by GFCM WG demersal on Nov 2014 (so, although it was in the list of stocks to be assessed by EWG 14 19, it was replaced by another stock)
5	MUR	Striped red mullet	*Mullus surmuletus*	*		*				
5	HKE	Hake	*Merluccius merluccius*				*			This stock was assessed by GFCM WG on Nov 2014
5	DPS	Pink shrimp	*Parapenaeus longirostris*	*		*				
5	MUT	Red mullet	*Mullus barbatus*	*		*				
5	ANK	Black-bellied angler	*Lophius budegassa*					*		
5	CTC	Common cuttlefish	*Sepia officinalis*		*					
5	SKA	Thomback ray	Raja rays nei		*					Landings are only estimations, as this species is landed together with other Rajidae. Historical information available, so it would be possible to perform a production model for Raja spp.
6	PIL	Sardine	*Sardina pilchardus*		*	*	*	*	*	
6	HKE	Hake	*Merluccius merluccius*	*		*			*	
6	ANK	Black-bellied angler	*Lophius budegassa*					*		

6	DPS	Pink shrimp	*Parapenaeus longirostris*	*					*	Unbalanced spatial catches: Northern part of GSA6 realizes very low catches compared to the south GSA6
6	MUT	Red mullet	*Mullus barbatus*	*				*		
6	ARA	Blue and red shrimp	*Aristeus antennatus*			*			*	
6	ANE	Anchovy	*Engraulis encrasicolus*		*	*	*	*	*	
6	NEP	Norway lobster	*Nephrops norvegicus*				*			
6	MUR	Striped red mullet	*Mullus surmuletus*		*				*	
6	JAX	Jack and horse mackerels nei	*Trachurus spp.*				*			Horse mackerel reported landings may include different species (Trachurus spp). Unknown amount of discards. MEDITS & MEDIAS could be used as tuning indices.
7	PIL	Sardine	*Sardina pilchardus*	*	*	*	*	*	*	No analytical assessment are possible due to the recent low level of exploitation and to the demographic unbalance of the population
7	ANE	Anchovy	*Engraulis encrasicolus*		*	*	*	*	*	
7	HKE	Hake	*Merluccius merluccius*		*	*	*	*	*	This assessment should be updated every year, as there is a management plan for French trawlers based on it.
7	ANK	Black-bellied angler	*Lophius budegassa*						*	Problems with data: no biological parameters (no maturity ogive, no age data); no good independant fishery indices (doubts about correct species separation in the past in MEDITS)
7	MUT	Red mullet	*Mullus barbatus*						*	

7	SBG	Gilthead seabream	*Sparus aurata*				*			The stock assessment of seabream (Sparus aurata) and seabass (Dicentrarchus labrax) would be very welcome, however this is not to be envisaged before some years as the scientific basis is not ready yet: 1) 90% of the landings probably come from the small-scale fisheries, for which poor data is available; 2) Recreational fisheries are important , but neither biological sampling nor landings and effort estimates are available 3) no abundance index available 4) Biological parameters are poorly estimated for seabream, whereas almost no information is available for seabass. 5) stock units are not known 6) few sampling data for length structure are available, not fully representative 7) Spanish data : Gilthead seabream : only landings data (1-6 tons/year), no length information; Seabass : only landings data (1-3 tons/year), no length information
7	BSS	Sea bass	*Dicentrarchus labrax*				*			

8	NEP	Norway lobster	*Nephrops norvegicus*				*			never assessed
8	HKE	Hake	*Merluccius merluccius*		*					never assessed
8	MUR	Striped red mullet	*Mullus surmuletus*			*				never assessed
8	MUT	Red mullet	*Mullus barbatus*			*				never assessed
8	ARS	Giant red shrimp	*Aristaeomorpha foliacea*				*			never assessed
8	DPS	Pink shrimp	*Parapenaeus longirostris*					*		never assessed
9	PIL	Sardine	*Sardina pilchardus*	*			*			
9	HKE	Hake	*Merluccius merluccius*				*			
9	MUT	Red mullet	*Mullus barbatus*					*		
9	MUR	Striped red mullet	*Mullus surmuletus*		*					
9	DPS	Pink shrimp	*Parapenaeus longirostris*						*	
9	NEP	Norway lobster	*Nephrops norvegicus*						*	
9	ARS	Giant red shrimp	*Aristaeomorpha foliacea*	*		*				Ok DCF 2006-2013 and Medits data series 1994-2013
9	ANE	Anchovy	*Engraulis encrasicolus*		*			*		Only with Separable VPA approach because there are no fishery independent estimation of abundance at sea (MEDIAS Acoustic surveys)
9	ARA	Blue and red shrimp	*Aristeus antennatus*					*		
9	PAC	Common pandora	*Pagellus erythrinus*						*	
9	TGS	Caramote prawn	*Penaeus kerathurus*			*				Data available: DCF 2008-2013; No tuning data
										GENERAL COMMENT: no small pelagics
10	HKE	Hake	*Merluccius merluccius*	*		*			*	assessed during GFCM WGSAD session 2 (November 2014). The update of the assessment could be performed for 2016.
10	DPS	Pink shrimp	*Parapenaeus longirostris*	*		*			*	assessed during GFCM WGSAD session 2 (November 2014). The update of the assessment could be performed for 2016.

10	MUT	Red mullet	*Mullus barbatus*		*			*		assessed during GFCM WGSAD session 2 (November 2014)
10	ARS	Giant red shrimp	*Aristaeomorpha foliacea*		*			*		
10	ARA	Blue and red shrimp	*Aristeus antennatus*		*			*		update of the assessment
11	HKE	Hake	*Merluccius merluccius*	*		*				new GSAs 11.1 - 11.2. Future assessments may have to be conducted in two sub-areas
11	MUR	Striped red mullet	*Mullus surmuletus*	*				*		
11	MUT	Red mullet	*Mullus barbatus*	*			*			
11	ARS	Giant red shrimp	*Aristaeomorpha foliacea*		*				*	
11	DPS	Pink shrimp	*Parapenaeus longirostris*		*			*		
15+16										GENERAL
15+16	ANE	Anchovy	*Engraulis encrasicolus*		*				*	
15+16	PIL	Sardine	*Sardina pilchardus*		*				*	
15+16	ARA	Blue and red shrimp	*Aristeus antennatus*	*			*			
15+16	ARS	Giant red shrimp	*Aristaeomorpha foliacea*					*		Assessment cannot be carried out only for GSAs 15-16 since the landings come from vessels fishing over a wider area covering the whole Strait of Sicily (also GSAs 12-13-14).
15+16	PAC	Common Pandora	*Pagellus erythrinus*			*				
15+16	MUT	Red mullet	*Mullus barbatus*		*					
15+16	MUR	Striped red mullet	*Mullus surmuletus*	*		*			*	
15+16	RJC	Thornback ray	*Raja clavata*							relatively high catches
15+16	ANK	Black-bellied angler	*Lophius budegassa*			*				
15+16	BOG	Bogue	*Boops boops*				*			data available from 2011 onwards
12-16	ARS	Giant red shrimp	*Aristaeomorpha foliacea*			*				
12-16	DPS	Pink shrimp	*Parapenaeus longirostris*		*					This assessment will be presented at the GFCM WG in 2015
12-16	NEP	Norway lobster	*Nephrops norvegicus*	*		*				

12-16	HKE	Hake	*Merluccius merluccius*					*		The stock has been assessed in 2014 (GFCM) and will be re-assessed at the GFCM WG in 2015
17+18	ANE	Anchovy	*Engraulis encrasicolus*		*	*	*	*	*	Multiannual plan
17+18	PIL	Sardine	*Sardina pilchardus*	*	*	*	*	*	*	Multiannual plan
17	HKE	Hake	*Merluccius merluccius*				*			
17	MUT	Red mullet	*Mullus barbatus*					*		2014 assessement had a reference year of 2012
17	SOL	Common sole	*Solea solea*	*				*		
17	NEP	Norway lobster	*Nephrops norvegicus*			*			*	Probably more than one stock. Priority should be given for the 'Pomo pit' area stock, due to the fact that is exploited both by Italy and Croatia.
18	HKE	Hake	*Merluccius merluccius*	*			*			assessed during GFCM WGSAD session 2 (November 2014)
18	MUT	Red mullet	*Mullus barbatus*				*			
18	BOG	Bogue	*Boops boops*		*					
18	MTS	Spottail mantis	*Squilla mantis*					*		The update of the assessment could be performed (survey data by length only for 2012 and 2013. Only commercial LFDs could be used)
18	DPS	Pink shrimp	*Parapenaeus longirostris*				*			assessed during GFCM WGSAD session 2 (November 2014)
18	NEP	Norway lobster	*Nephrops norvegicus*			*			*	

19	DPS	Pink shrimp	*Parapenaeus longirostris*	*		*			*	assessed during GFCM WGSAD session 1 (reference year 2012). The update of the assessment can be performed.
19	ANE	Anchovy	*Engraulis encrasicolus*	*		*			*	The update of the assessment could be performed (survey data by length only for 2012 and 2013. Only commercial LFDs could be used)
19	HKE	Hake	*Merluccius merluccius*	*		*			*	The update of the assessment can be performed.
19	MUT	Red mullet	*Mullus barbatus*					*		assessed during GFCM WGSAD session 1 (reference year 2012). The update of the assessment can be performed.
19	ARS	Giant red shrimp	*Aristaeomorpha foliacea*		*			*		assessed during GFCM WGSAD session 2 (reference year 2013). The update of the assessment can be performed.
19	ARA	Blue and red shrimp	*Aristeus antennatus*		*			*		The assessment can be performed.
19	NEP	Norway lobster	*Nephrops norvegicus*				*			The assessment can be performed.
										GENERAL COMMENT: No data for 2009-2012 and most of 2013. No assessment seems feasible before 2015 for small pelagics and 2016 for demersal species.

20	ANE	Anchovy	*Engraulis encrasicolus*		*			*		In case of a multi-annual plan adoption, to be assessed annually
20	PIL	Sardine	*Sardina pilchardus*		*			*		In case of a multi-annual plan adoption, to be assessed annually
20	HKE	Hake	*Merluccius merluccius*			*			*	
20	DPS	Pink shrimp	*Parapenaeus longirostris*			*				
20	MUT	Red mullet	*Mullus barbatus*				*		*	
20	MUR	Striped red mullet	*Mullus surmuletus*				*			
20	NEP	Norway lobster	*Nephrops norvegicus*						*	
										GENERAL COMMENT: No data for 2009-2012 and most of 2013. No assessment seems feasible before 2015 for small pelagics and 2016 for demersal species.
22+23	ANE	Anchovy	*Engraulis encrasicolus*	*	*			*		In case of a multi-annual plan adoption, to be assessed annually
22+23	PIL	Sardine	*Sardina pilchardus*		*			*		In case of a multi-annual plan adoption, to be assessed annually
22+23	HKE	Hake	*Merluccius merluccius*	*		*			*	
22+23	DPS	Pink shrimp	*Parapenaeus longirostris*			*				
22+23	MUT	Red mullet	*Mullus barbatus*				*		*	
22+23	MUR	Striped red mullet	*Mullus surmuletus*				*			
22+23	NEP	Norway lobster	*Nephrops norvegicus*						*	
25	MUR	Striped red mullet	*Mullus surmuletus*				*			
25	MUT	Red mullet	*Mullus barbatus*				*			
25	BOG	Bogue	*Boops boops*		*			*		very high catches recently
TOTAL					**33**	**35**	**34**	**35**	**36**	

Additional to all the aforementioned stocks in Table 8.2, a list of many other stocks could potentialy become of insterest to a future EWG, however mostly the current lack of data deterred further consideration. A non-exhaustive list follows below:

GSA	CODE	Common name	Species
1	ANK	Black-bellied angler	*Lophius budegassa*
1	HOM	Horse mackerel	*Trachurus trachurus*
1	MUT	Red mullet	*Mullus barbatus*
1	NEP	Norway lobster	*Nephrops norvegicus*
1	OCC	Common octopus	*Octopus vulgaris*
1	PIL	Sardine	*Sardina pilchardus*
5	DGS	Spiny dogfish	*Squalus acanthias*
5	NEP	Norway lobster	*Nephrops norvegicus*
5	OCC	Common octopus	*Octopus vulgaris*
6	CTC	Common cuttlefish	*Sepia officinalis*
6	EOI	Horned octopus	*Eledone cirrhosa*
6	OCC	Common octopus	*Octopus vulgaris*
6	WHB	Blue whiting	*Micromesistius poutassou*
8	CTC	Common cuttlefish	*Sepia officinalis*
8	DEC	Common dentex	*Dentex dentex*
8	EOI	Horned octopus	*Eledone cirrhosa*
8	HOM	Horse mackerel	*Trachurus trachurus*
8	OCC	Common octopus	*Octopus vulgaris*
8	RJC	Thomback ray	*Raja clavata*
8	SCS	Scorpionfishes, rockfishes nei	*Scorpaena spp.*
8	SOL	Common sole	*Solea solea*
8	SWA	White seabream	*Diplodus sargus*
9	CTC	Common cuttlefish	*Sepia officinalis*
9	EOI	Horned octopus	*Eledone cirrhosa*
9	MTS	Spottail mantis squillids	*Squilla mantis*
9	RJC	Thomback ray	*Raja clavata*
9	SHO	Blackmouth catshark	*Galeus melastomus*
9	SYC	Small-spotted catshark	*Scyliorhinus canicula*
10	EOI	Horned octopus	*Eledone cirrhosa*
10	MTS	Spottail mantis	*Squilla mantis*
10	PAC	Common pandora	*Pagellus erythrinus*
11	CTC	Common cuttlefish	*Sepia officinalis*
11	EOI	Horned octopus	*Eledone cirrhosa*
11	OCC	Common octopus	*Octopus vulgaris*
11	RJC	Thomback ray	*Raja clavata*
17	CTC	Cuttlefish	*Sepia officinalis*
17	DGS	Spiny dogfish	*Squalus acanthias*
17	EDT	Horned octopus	*Eledone cirrhosa*
17	EOI	Musky octopus	*Eledone moscata*
17	JRS	Mediterranean starry ray	*Raja asterias*
17	MTS	Spottail mantis	*Squilla mantis*
17	SVE	Striped venus	*Chamelea gallina*
17	TGS	Caramote prawn	*Penaeus kerathurus*
17	RJC	Thornback ray	*Raja clavata*
18	EOI	Horned octopus	*Eledone cirrhosa*
19	EOI	Horned octopus	*Eledone cirrhosa*
19	MTS	Spottail mantis	*Squilla mantis*
20	CTC	Common cuttlefish	*Sepia officinalis*
20	PAC	Common Pandora	*Pagellus erythrinus*
20	SPC	Picarel	*Spicara smaris*
15+16	CTC	Common cuttlefish	*Sepia officinalis*
15+16	MAS	Chub mackerel	*Scomber japonicus*
15+16	OCC	Common octopus	*Octopus vulgaris*
15+16	RPG	Red porgy	*Pagrus pagrus*
15+16	RSE	Red scorpionfish	*Scorpaena scrofa*
15+16	SAA	Round sardinella	*Sardinella aurita*
15+16	SQR	European squid	*Loligo vulgaris*
22+23	ANK	Black-bellied angler	*Lophius budegassa*
22+23	BOG	Bogue	*Boops boops*
22+23	MAZ	Mackerel	*Scomber spp.*
22+23	OCC	Common octopus	*Octopus vulgaris*
22+23	PAC	Common pandora	*Pagellus erythrinus*
22+23	SPC	Picarel	*Spicara smaris*
4,5,11-16	DOL	Common dolphinfish	*Coryphaena hippurus*

9. DATA-LIMITED STOCK METHODS TO ASSESS THE STATUS OF CEPHALOPODS IN GSA 6

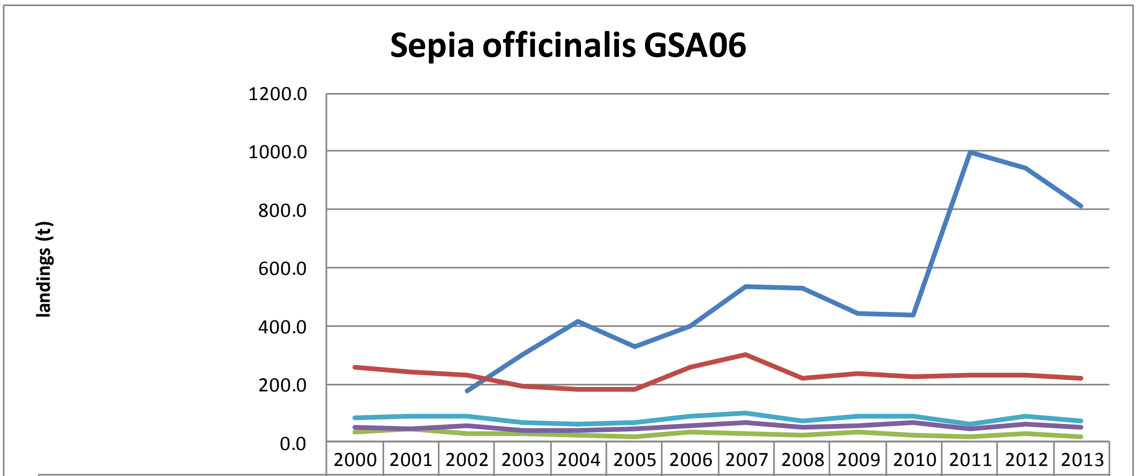
ToR 6 – Explore the possibilities to apply data-limited stock methods to assess the status of cephalopods and perform a preliminary assessment for some cephalopod species, with priority given to *Sepia officinalis, Eledone cirrhosa,* and *Illex coindetii* in GSA 6.

Rationale

The assessment of Mediterranean fisheries is often hampered by lack of complete data sets fulfilling the requirements of standard stock assessment models of the VPA family (Lleonart and Maynou 2003, Caddy 2009). In small scale Mediterranean fisheries, data is often not adequate for standard stock assessment methods because of incomplete monitoring, related both to the high diversity of small scale fisheries (in terms of fishing gears, as well as target species, Guyader et al. 2013) and the low quantity of production. Small scale fisheries have locally socioeconomic importance and the evaluation of its impact on coastal resources is necessary to help diagnose the status of these fisheries and take management initiatives leading to their sustainable exploitation. In this data-limited situation (Prince 2003) fisheries assessment methods alternative to the standard VPA family must be considered, making best use of whatever type of data is available (Caddy 2009).

Despite the lack of routine biological samplings, landings by species and fleet type and fishing effort are reported in most areas at high frequency (for instance, daily in Catalonia, northern half of GSA 6) for statistical or taxing purposes. These high frequency data, when collected over several years and combined with limited additional information on the biology of target species can be used for stock assessment purposes using depletion models. In multi-annual generalized depletion (MAGD) models (Roa-Ureta 2012; 2014) the classical assumptions of depletion of a closed population subject to direct proportionality between catch-per-unit-effort and abundance (Brodziak and Rosenberg 1993, MacAllister et al. 2004) are relaxed. When running at monthly scale, the regular annual pulses in abundance produced by the recruitment of a new cohort to the fishery can be used in MAGD models as prior information to the timing and magnitude of recurrent perturbations.

The MultiAnnual General Depletion Model of Roa-Ureta (2012, 2014) implemented in the R library CatDyn 1.0-5 was explored to produce a preliminary assessment of the cuttlefish *Sepia officinalis* in the Barcelona maritime district (comprising the ports of Arenys de Mar, Badalona, Barcelona and Vilanova i la Geltrú) in GSA 6. The total production of cuttlefish in this district represents 10% of total GSA 6 landings. Cuttlefish is caught by trammel netters (fleet segment GTR VL0612) and bottom trawlers (fleet segment OTB VL1224). Fig. 9.1 shows the evolution of landings in Catalonia and Barcelona district, total and by fleet segment. Note that the apparent increase in landings observed in the last 3 years in GSA 6 is simply due to the start of reporting of cuttlefish production by trammel netters to the JRC in the DCF. As shown in the figure, production by trammel netters is higher than production by otter trawl.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
landings GSA6 (t)			176.3	302.5	417.9	330.1	401.6	535.1	529.4	442.7	436.1	995.8	941.3	813.0
landings Catalonia(t)	258.0	240.0	230.7	195.0	181.6	181.8	256.4	301.0	222.3	238.8	222.6	230.2	231.5	219.9
landings OTB(t)	32.6	44.0	30.9	31.5	25.4	20.3	33.5	30.6	22.1	33.0	23.9	17.8	28.6	19.9
landings GTR(t)	52.2	44.5	58.5	38.0	39.3	45.6	55.0	68.8	52.3	58.8	66.8	46.3	61.4	51.0
total landings Barcelona (t)	84.8	88.5	89.4	69.5	64.7	65.9	88.5	99.4	74.4	91.8	90.7	64.2	90.1	71.0

Fig. 9.1. Landings of cuttlefish in GSA 6 (official DCF data submitted to JRC, 2014), Catalonia (northern half of GSA 6) and the Barcelona maritime district, total and separated by fishing gear (GTR: trammel net VL0612; OTB: bottom trawl VL1224).

The Multiannual General Depletion Model

Data source:

The daily landings of trammel netters (GTR VL0612) and the bottom trawlers (OTB1224) of the Barcelona Maritime District (comprising the ports of Arenys de Mar, Badalona, Barcelona and Vilanova i la Geltrú) were obtained from the Fishers' Association for the period 1 Jan. 2000 to 31 Dec. 2013 (14 complete years or 168 months). The vessels undertake daily fishing trips of 6 to 12 h, with compulsory return to their homeport to sell the catch in the fish auction of the Fishers' Association, and rest on Saturdays and Sundays. As shown in Fig. 9.2, the landings of cuttlefish *Sepia officinalis* are highly seasonal, with higher production in spring and summer by trammel netters and higher production in late winter by bottom trawlers. Note that cuttlefish landings and effort of trammel netters is higher than those of trawlers and that effort of bottom trawlers have been decreasing in the area, as elsewhere in the Mediterranean, due to fleet decommissioning programmes.

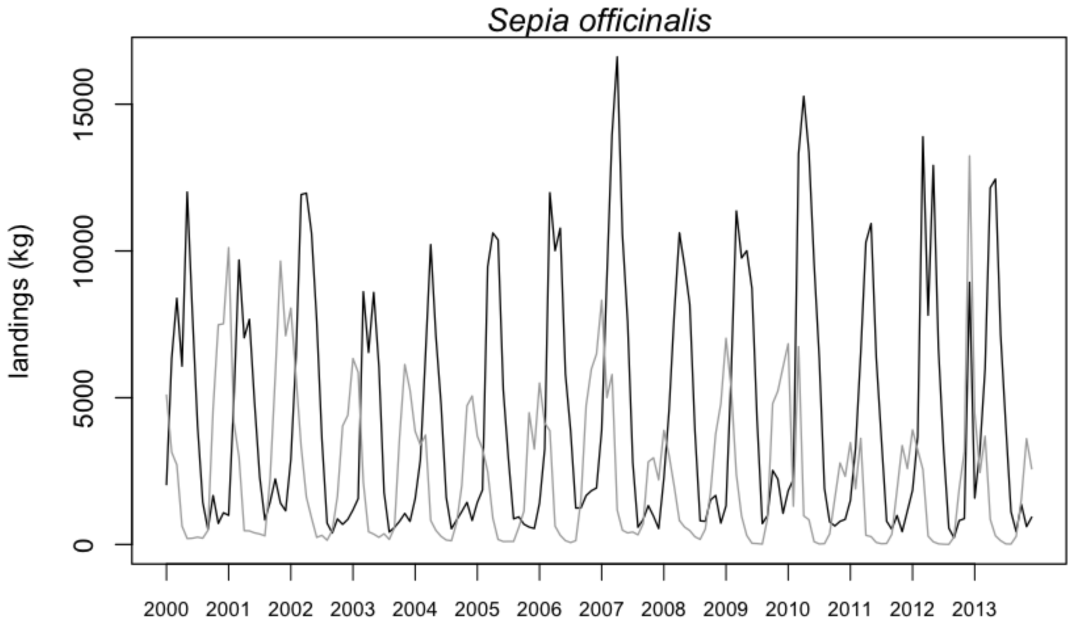


Fig. 9.2. Monhly landings of cuttlefish (*Sepia officinalis*) by trammel netters (black line, GTR VL0612) and bottom trawlers (grey line, OTB VL1224) in the maritime district of Barcelona (GSA 6).

The landings (kg) were aggregated at monthly scale. Fishing effort was measured as number of vessels x number of days per month in each fleet. Because no size frequency data is collected regularly for this fishery, the landings data set was complemented with frequency data obtained in the course of a biological sampling project ("Conflict" project, Ref. CGL2008-00047 of the Spanish National Research Plan) during 2009-2010. On board sampling of the entire catch of one trammel netter and one bottom trawler who collaborated voluntarily with the project was carried out 2-3 times per month (N =29 samples in the 12-month period), including length (mm ML for cuttlefish) and body weight measurements (g BW). The size and body weight frequencies are shown in Fig. 9.3.

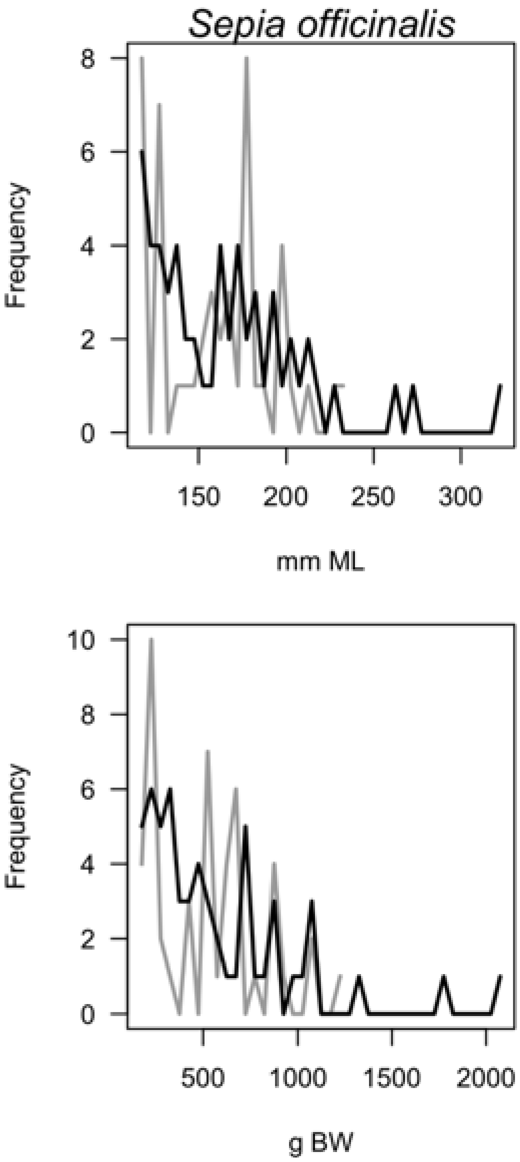


Fig. 9.3. Size (mm mantle length, ML, top) and body weigh (g) of cuttlefish sampled in 2009-2010 on board trammel netters (black line) and otter trawlers (grey line).

In generalized depletion models, catches are used as a time series of catch in number, while the landings database provides catch in weight. Body weight frequency data (Fig. 9.4) were used to transform catch in weight to catch in number, following Roa-Ureta (2014) Monte Carlo resampling procedure. The length frequencies of cuttlefish did not differ between the two sampling gears (cf. Belcari et al. 2002) and a common monthly body weight series was produced. The mean body size is lower in late summer and autumn, corresponding to the period of recruitment to the bottom (when they become more vulnerable to trawlers), while mean body size is higher in winter and beginning of spring, corresponding to the period of maturing individuals which come closer to the coast for reproduction (and become more vulnerable to trammel netters).

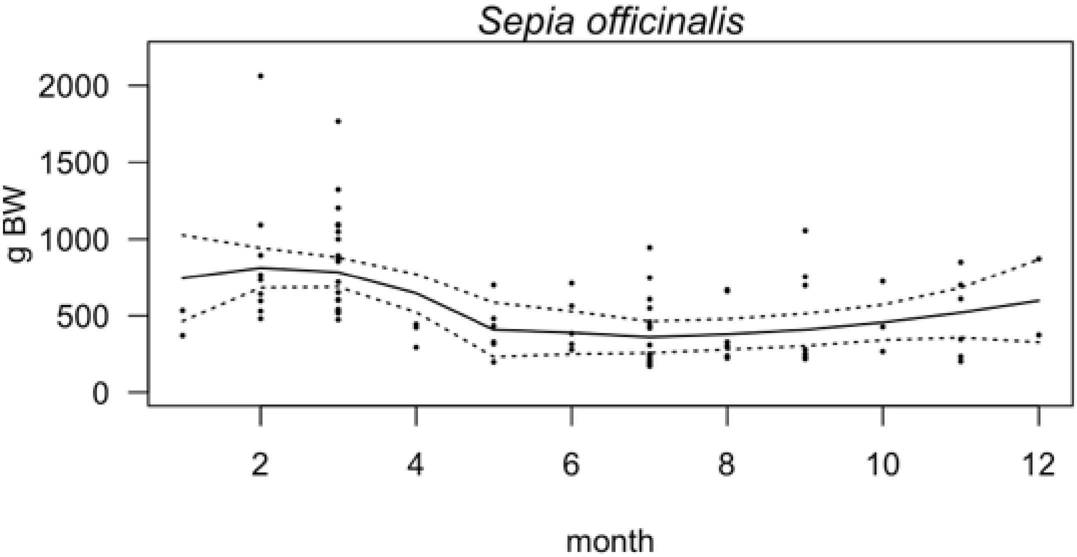


Fig. 9.4. Mean body weight of cuttlefish sampled (dots) and average monthly weight (continuous line) with 90% confidence intervals estimated through local interpolation (*loess* routine in R).

For *Sepia officinalis* a starting estimate of natural mortality was set at M=0.12 month^{-1} calculated, following Royer et al. (2006), who suggest a range of values from 0.05 month^{-1} to 0.15 month^{-1}.

Model

Generalized depletion models keep track of all fishing removals to estimate vulnerable biomass. In addition to fishing, natural mortality (M) contributes to deplete the population of each species (Chapman, 1974). For one species and one fleet, Chapman's depletion model is:

$$C_t = q\,E_t\left(N_0 e^{-Mt} - e^{-M/2}\left(\sum_{i=1}^{i=t-1} C_i e^{-M(t-i-1)}\right)\right)e^{-M/2} \qquad [1]$$

where C_t is catch in numbers at time $t=1...T$ (T=168 in the present study), q is a coefficient of catchability, E_t is fishing effort at time t, N_0 is the initial number of fish in the population, and M is the natural mortality.

In the multi-annual generalized depletion (MAGD) model (Roa-Ureta 2012, 2014), annual pulses of recruitment in an age-structured population are interpreted as perturbations that reset the depletion process. For a MAGD model running at monthly scale, the set of perturbations $\{R_j\}$ can happen in month p_j, where j is the number of perturbations (j=1, …, 14 years in the present case). Additionally, the MAGD model assumes that catchability q is possibly non-linearly related to fish abundance N:

$$q(N) = kN^{1-\beta} \qquad [2]$$

where k is a catchability factor, and β measures the response of catch-per-unit effort to fish abundance (β is 1 when catchability is proportional to abundance, β<1 when catchability varies less than population numbers (hyperstability) and β>1 when catchability varies more than population numbers (hyperdepletion) (Hilborn and Walters 1992). Furthermore, catches may be non-linearly related to fishing effort:

$$C_t(N,E) = q(N)E^{\alpha} f(N) \qquad [3]$$

where α is a proportionality parameter between fishing effort and catches that can account for nonlinear effects (Roa-Ureta 2014). Finally, the complete formulation of the MAGD model for one species and two fleets f is (Roa-Ureta 2014):

$$C_t = \sum_f k_f \, E_{f,t}^{\alpha_f} \left(N_0 e^{-Mt} - e^{-M/2} \left(\sum_{i=1}^{i=t-1} C_{f,i} e^{-M(t-i-1)} \right) + \sum_{j=1}^{j=J} R_{j,f} e^{-M(t-p_{j,f})} \right)^{\beta} e^{-M/2} \quad [4]$$

The number of parameters to estimate is 64 from 168 pairs of catch and effort observations. From the 64, the 14 x 2 parameters $p_{j,f}$ corresponding to the timing of the perturbations are relatively easy to estimate because peaks of recruitment to the fishery are easily identified in the observed catch series as spikes not explained by concurrent spikes in effort. The statistic for graphical display of the perturbations of catch spike S_t proposed by Roa-Ureta (2014) was used to establish stating estimate for the timing of the perturbations. The perturbations in the catch spike were selected from the set April-May-June for the trammel net fleet for both species and November-December-January-February for the bottom trawl fleets. These values were entered in the estimation algorithm as starting values of perturbation timings.

The remaining model parameters (36) were estimated by minimizing the likelihood function of difference between the observed catch series and the predicted catch series $\boldsymbol{L}(\theta, \{X_t, C_t\})$, assuming that catch in number at time step (month) is a random variable with random errors modelled as normal or lognormal distribution functions (Roa-Ureta, 2014).

The model estimation was performed with the R package CatDyn v. 1.0-5 (Roa-Ureta 2012, 2014), with the options CG (conjugate gradient optimization) and spg (spectral projected gradient. The function CatDynExp was used to graphically fine tune the initial values of certain parameters (N_0, R, p). Consistent estimation results were obtained when using $N_0 = R_j$ at starting values corresponding to 10 times the maximum observed catch value (approximately 15 000 individuals).

In addition to the model parameters, the CatDyn package provides also an estimate of population number and biomass vulnerable to the fishing gears. Vulnerable biomass was integrated at annual scale to assess the evolution of this statistic over time in the studied fisheries. Likewise, fishing mortality is a key quantity to assess the evolution over time of the exploitation rate and was calculated with the following relationship (based on eqs. 2 and 3 above):

$$F_j = k_j N^{1-\beta} E^{\alpha} \quad [5]$$

Stock assessment with the CG and spg configurations, under normal and lognormal error models yielded similar results, although the combination CG and lognormal error model had consistently lower AIC. The CV of some parameters could not always be computed with the spg algorithm (Table 9.1).

Table 9.1. Maximum Likelihood Estimates (MLE) parameters of the Multi Annual Depletion Model for *Sepia officinalis* in the Barcelona maritime district using lognormal error and the conjugate gradient (CG) algorithm.

Parameters	Timing	Year	month	MLEs.CG	CV.MLEs.CG	NGrad.CG
M				0.011	N/A	-8.442
N0				949.243	N/A	-4.069
P1.GTR	3	2000	3	284.362	N/A	-1.364
P2.GTR	15	2001	3	280.060	96.5	0.695
P3.GTR	28	2002	4	278.057	72.5	1.208
P4.GTR	42	2003	6	277.165	66.1	1.427
P5.GTR	50	2004	2	276.361	55.6	1.838
P6.GTR	64	2005	4	277.266	89.9	0.894

P7.GTR	76	2006	4	277.755	123.3	0.519
P8.GTR	88	2007	4	278.104	219.5	0.112
P9.GTR	100	2008	4	277.980	392.9	-0.006
P10.GTR	115	2009	7	277.896	292.6	0.006
P11.GTR	125	2010	5	277.020	107.8	0.639
P12.GTR	136	2011	4	277.585	123.3	0.501
P13.GTR	148	2012	4	278.560	249.1	0.09
P14.GTR	160	2013	4	279.100	178.5	0.249
k.GTR				1.02E-06	40.3	10.028
alpha.GTR				1.693	4.2	125.525
beta.GTR				0.719	8.5	60.2
P1.OTB	3	2000	3	388.056	N/A	-1.862
P2.OTB	13	2001	1	481.973	59.1	1.149
P3.OTB	24	2001	12	378.058	56.4	1.595
P4.OTB	36	2002	12	394.528	40.2	2.464
P5.OTB	48	2003	12	374.292	44.2	2.294
P6.OTB	60	2004	1	316.224	64.4	1.499
P7.OTB	75	2006	3	375.699	90.7	0.863
P8.OTB	81	2006	9	278.539	184.6	0.194
P9.OTB	98	2008	2	375.943	175.4	0.298
P10.OTB	108	2008	12	307.421	177.6	0.237
P11.OTB	120	2009	12	129.564	263.7	0.124
P12.OTB	132	2010	12	139.358	149	0.391
P13.OTB	144	2011	12	348.075	184.7	0.162
P14.OTB	157	2013	1	359.311	238.9	0.04
k.OTB				6.76E-05	62.7	3.167
alpha.OTB				1.422	3.5	-2.857
beta.OTB				0.399	18.7	14.898

Fig. 9.5. shows the results of the model fit (catch in numbers observed and predicted in the top left panel and diagnostics based on the model residuals in the remaining 3 panels). The diagnostics of the selected model (Table 9.1) show that the catches (in number) can be reasonably predicted by the model and that predictions are unbiased. However, high catches of bottom trawl are not successfully predicted by the model.

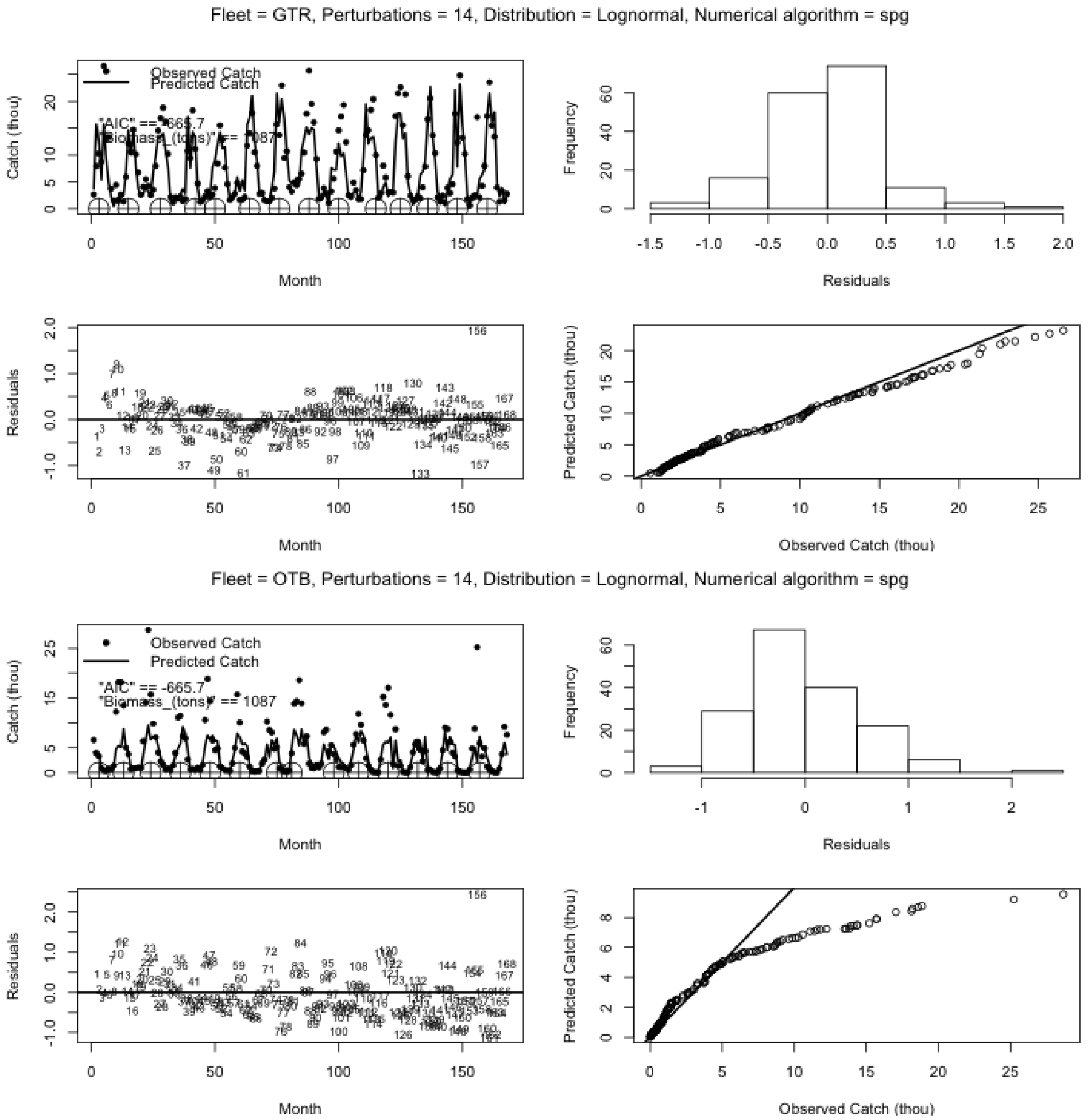


Fig. 9.5. Predicted and observed catch of *Sepia officinalis* in the Barcelona maritime district using the Multi Annual Depletion Model with lognormal error and the conjugate gradient (CG) algorithm. Top: trammel net (GTR); bottom: otter trawl (OTB).

The model parameters in Table 9.1 show an initial population of 0.949 million individuals, with regular annual recruitment pulses to the trammel net fishery generally in March or April of around 280,000 individuals, without a clear temporal trend. The recruits to the bottom trawl oscillated between 130 and 480 000 individuals, from year to year without trend. The timing of recruitment was in December for most years.

The evolution of the vulnerable biomass (Fig. 9.6) shows an increase in the last 10 years of the series, probably linked to a decrease in the fishing effort (and fishing mortality) by bottom trawlers.

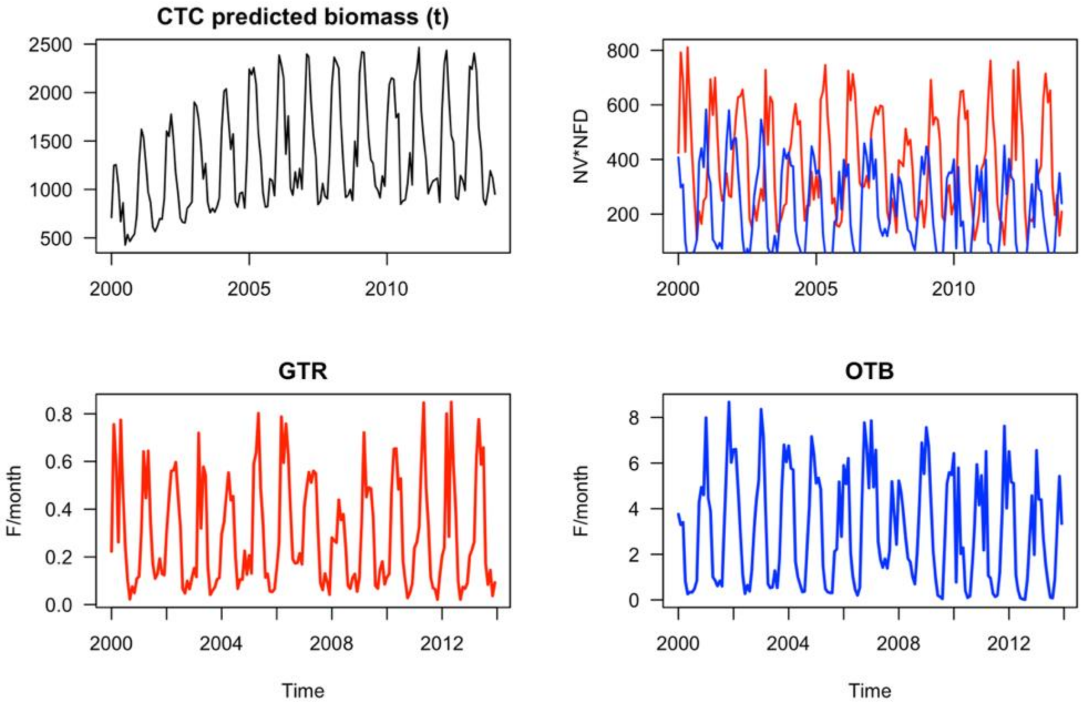


Fig. 9.6. Estimations of biomass (top left panel) and monthly fishing mortality (bottom panels) in *Sepia officinalis* in the Barcelona maritime district of GSA06. Top right panel shows the evolution of effort (measured in monthly number of vessel per days).

10. MSY VALUE OR RANGE OF VALUES AND SAFEGUARD POINTS, IN TERMS OF F AND STOCK BIOMASS, TO ADOPT A MULTIANNUAL MANAGEMENT PLAN FOR SMALL PELAGIC SPECIES IN THE NORTH ADRIATIC SEA

ToR 7

The EU has the intention to adopt a multiannual management plan for small pelagic species in the North Adriatic Sea. Discuss and propose the most scientifically sound MSY value or range of values and safeguard points, in terms of F and stock biomass.

10.1 State of the art

Two sets of reference points have been proposed for anchovy and sardine in GSA17: one inside the GFCM working group, and the other inside the STECF working group. The two sets differs due to the methodology and the rationale behind it.

The first approach, proposed inside the GFCM, is an empirical one, based on the estimated time series of biomass and on the empirical reference points (RP) proposed from Patterson's in 1992 for the exploitation rate (E). In particular, B_{lim} is defined as the lowest value of the time series from which a recovery has been observed. The threshold reference point (B_{pa}) is defined as a point at which the probability that the true value of the biomass would be below B_{lim} is lower than 5%: that roughly corresponds to B_{lim}*2.

The second approach has been developed from ICES and has been used in the STECF since 2012; the routine, named EqSim, provides MSY reference points based on the equilibrium distribution of stochastic projections. The biomass reference points need to be estimated empirically. In the past simulations, B_{lim} was set equal to a fraction of B_{max} for sardine ($B_{lim} = B_{pa}/1.4$; $B_{pa} = 0.4 * SSB_{max}$), while for anchovy was set equal to B_{loss}. Also, anchovy simulations were run excluding age 0 from the SSB estimates, since the inclusion of this age class was having an effect on the fitting, bringing all the observation outside the simulation confidence intervals: therefore the B_{lim} used has been scaled to the SSB without age 0, and is therefore much lower than the current SSB estimation.

The last assessment carried out for anchovy and sardine in GSA17 has been presented and accepted during the Working Group on Stock Assessment of Small Pelagic of the GFCM (even though has not yet been validated by the SAC): the results from this last assessment has been used for the simulations with the second approach (i.e. ICES).

First, a comparison between the two sets of reference points is carried out. Then, different simulations applying different options have been attempted.

10.2 Reference points comparison

Empirical RP defined for anchovy and sardine in GSA 17.

Table 10.23. Reference points for sardine and anchovy in GSA 17 derived using the empirical approach on the time series of biomass. The F corresponds to the average F of the ages 1-3 for anchovy, and ages 1-4 for sardine.

	Biomass	*F (corresponding to E=0.4)*
Anchovy	-	0.57 (E=1-3)
Sardine	62505	0.51 (E=1-4)

Table 10.24. Reference points for sardine and anchovy in GSA 17 derived using the EqSim routine during the STECF EWG 13-19. The F that maximize the catch has been used as a proxy for F_{MSY}. The B_{lim} for anchovy refers to the spawning stock biomass without Age 0.

	Biomass	*$F_{maxCatch}$ proxy for F_{msy}*
Anchovy	38791	0.38
Sardine	167383	0.46

10.3 Methodology tested

No stock recruitment relationship is evident for the two stocks therefore the only fitting possible is a hockey-stick. Due to the shape of the distribution, no breakpoints are evident. The methodology tested in this ToR is strongly influenced from the choice of B_{lim} and, in the case that a hockey-stick relationship is used, from its breakpoint (the point of the line where it flattened). Before running the simulations, and in order to define the scenarios to be tested, a series of considerations were done.
The first one concern the evidences of a regime shifts that interested the Adriatic in the late eighties (1987-1988). Conversi *et al.* (2010) extensively analyzed the abrupt change identifiable at the end of the 1980s, that involved both the physical and the biological system and that has been considered as a clear regime shift. This hypothesis finds its evidences in the pelagic community (as indicated by anchovies, but also jellies, plankton, mucilage, red tides) in the western and eastern Mediterranean basins, and it also involved Sea Surface Temperature, Sea Level Pressure and surface circulation. In particular, Grbec *et al*. (2002) observed that landings of different species changed synchronously in all ports around Italy and eastern Adriatic, and supported the idea that fishing effort alone could not explain changes in SSB. Another consideration refers to the instability of the SSB time series for anchovy: due to that, an attempt to estimate B_{lim} reference points from the minimum of the time series was done during the WG on small pelagics of the GFCM, but the estimated value was not accepted because of this instability (the minimum changed substantially from an assessment to the next with the addition of one year of data).

Recently, ICES carried out a workshop for the estimation of F_{MSY} for North Sea and Baltic Sea stocks, and provided a set of guidelines when using the EqSim routine (ICES, 2014) to estimate FMSY and the probability of SSB to fall below B_{lim}. Some of these guidelines have been followed in the present analysis. In particular:

- If recruitment appears to increase with SSB for all values of SSB observed, the breakpoint of the hockey-stick should be at the average of all observed SSBs.
- In the case of a stock lacking B_{lim} reference points, B_{lim} was derived as B_{pa}/1.4 for the stocks where B_{pa} was defined, $MSYB_{trigger}$/1.4 for the stocks where $MSYB_{trigger}$ was defined and B_{pa} was lacking, or as some other plausible value when both B_{pa} and $MSYB_{trigger}$ were lacking.
- The range of fishing mortalities compatible with an MSY approach to fishing were defined as the range of fishing mortalities leading to no less than 95% of MSY and which were precautionary in the sense that the probability of SSB falling below B_{lim} in a year in long term simulations with fixed F was ≤5%. The ranges were produced by first estimating the range of fishing mortalities leading to no less than 95% of MSY ($FMSY_{lower}$ and $FMSY_{upper}$). This range was then compared with the estimated $F_{P.05}$ (value of corresponding to 5% probability of SSB<B_{lim}). Where the estimated $FMSY_{upper}$ exceeded the estimated $F_{P.05}$, $FMSY_{upper}$ was specified as $F_{P.05}$. Where the estimated F_{MSY} exceeded the estimated $F_{P.05}$, F_{MSY} and $FMSY_{upper}$

were both specified as $F_{P.05}$ and $FMSY_{lower}$ redefined as the lower fishing mortality providing 95% of the yield at $F_{P.05}$ ($F_{P.05}$ lower).

Given the above considerations, 9 scenarios per each species have been tested. These scenarios varies among each others for: i) the calculation of the breakpoint for the hockey-stick relationship, ii) the choice of B_{lim} and iii) the choice of the time series used for the analysis (Table 10.3).

Table 10.25. Summary of the tested scenarios for anchovy and sardine in GSA 17.

Scenarios	Breakpoint	B_{lim}	Time series
1	Mean(SSB)	$B_{lim}=B_{pa}/1.4$ $B_{pa}=max(SSB)*0.4$ (the same approach has been used for the previous estimations of B_{lim} inside STECF for the same stocks)	Long time series (1975-2013)
2	Mean(SSB)	$B_{lim} = B_{loss}$	Long Time series (1975-2013)
3	Mean(SSB)	B_{lim} = mean(SSB)/1.4 (approach used in ICES)	Long Time series (1975-2013)
4	Mean(SSB)	$B_{lim}=B_{pa}/1.4$ $B_{pa}=SSB_{max}*0.4$ (the same approach has been used for the previous estimations of B_{lim} inside STECF for the same stocks)	Short time series (after regime shifts, 1989-2013)
5	Mean(SSB)	$B_{lim} = B_{loss}$	Short time series (after regime shifts, 1989-2013)
6	Mean(SSB)	B_{lim} = mean(SSB)/1.4 (approach used in ICES)	Short time series (after regime shifts, 1989-2013)
7	$SSB_{max}*0.7$	$B_{lim}=B_{pa}/1.4$ $B_{pa}=SSB_{max}*0.4$ (the same approach has been used for the previous estimations of B_{lim} inside STECF for the same stocks)	Long Time series (1975-2013)
8	$SSB_{max}*0.7$	$B_{lim} = B_{loss}$	Long Time series (1975-2013)
9	$SSB_{max}*0.7$	B_{lim} = mean(SSB)/1.4 (approach used in ICES)	Long Time series (1975-2013)

An assessment error of F equal to 0.25 and an autocorrelation in assessment error of 0.3 has been used in the simulations.

10.4 Results

For both species the models are not able to accurately fit the observations, with several points outside the confidence intervals drawn from the simulations (Figures 10.1-10.18). The situation improves a little (mainly for anchovy) when only the shorter time series is used (data from 1989 to

2013). Also, the confidence intervals for the estimated F_{MSY} for sardine are skewed to the left, being the CI for the upper boundary much higher than the mean value. The main output of the simulations are shown in the plots below for both species. The dots represents the observed values, respect to different simulated levels of F (x axis) from 0 to 1. The $F_{P.05}$ is shown as a red straight line.

Sardine

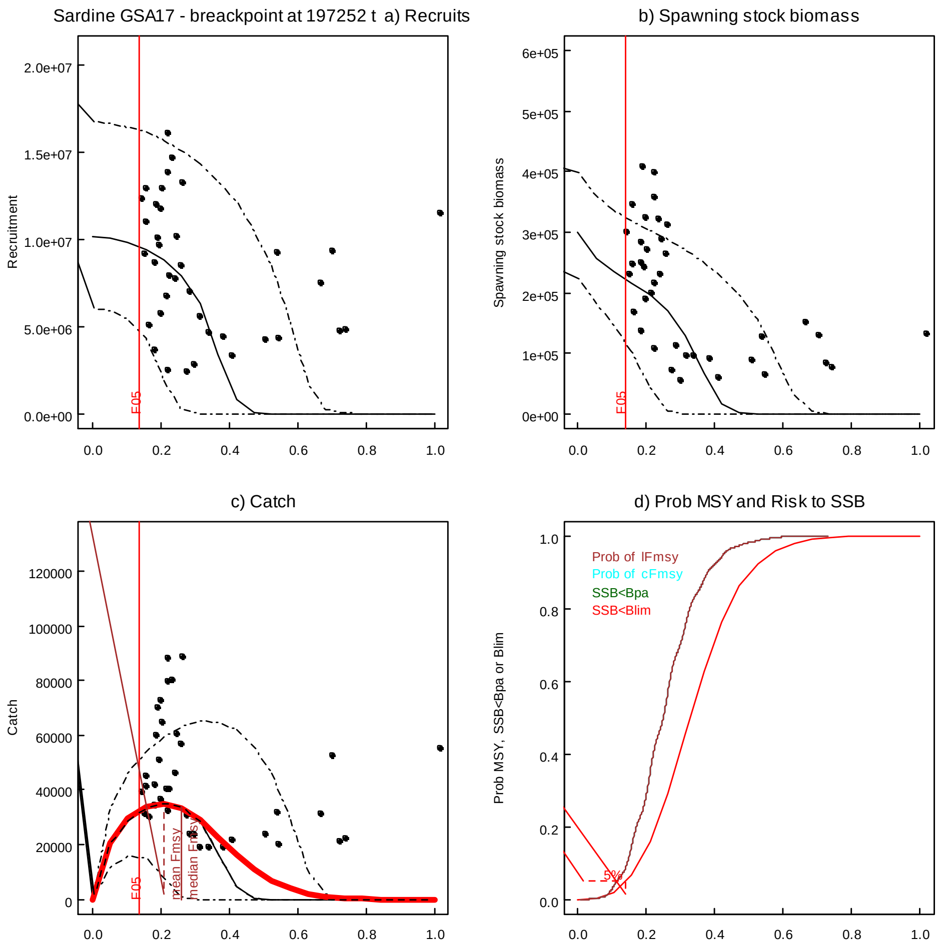


Figure 10.1. Scenario 1 EqSim summary plot for sardine in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

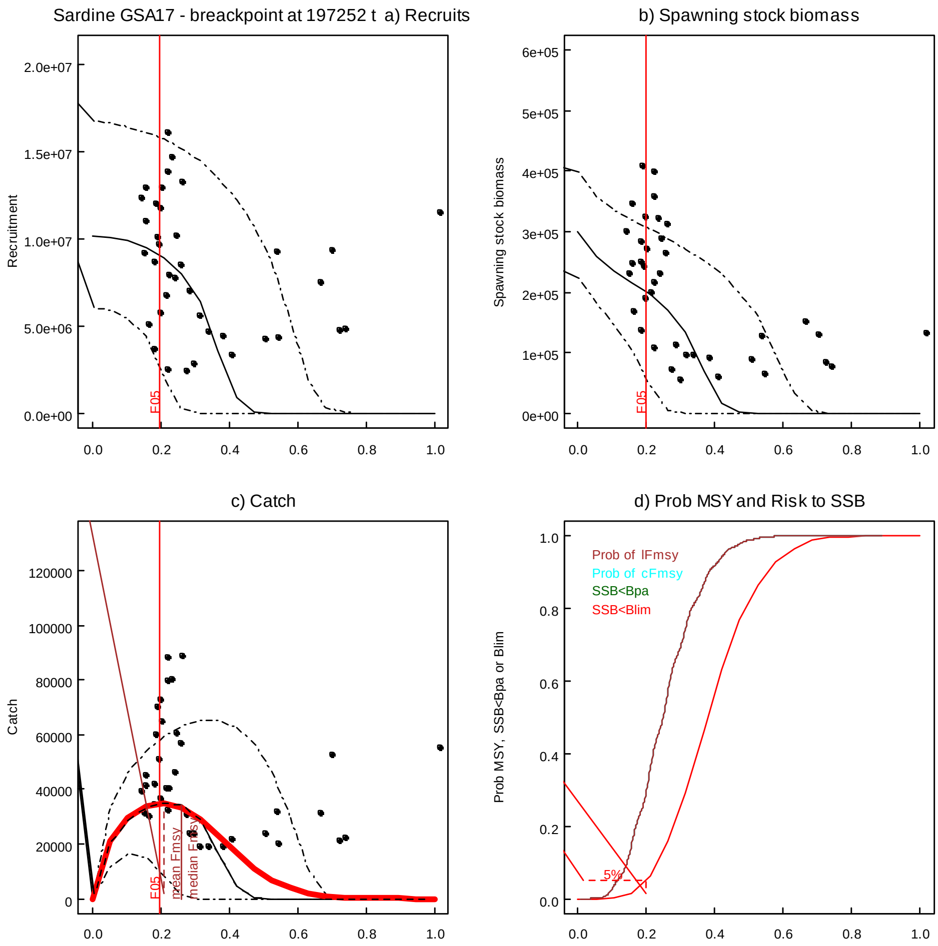


Figure 10.2. Scenario 2 EqSim summary plot for sardine in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

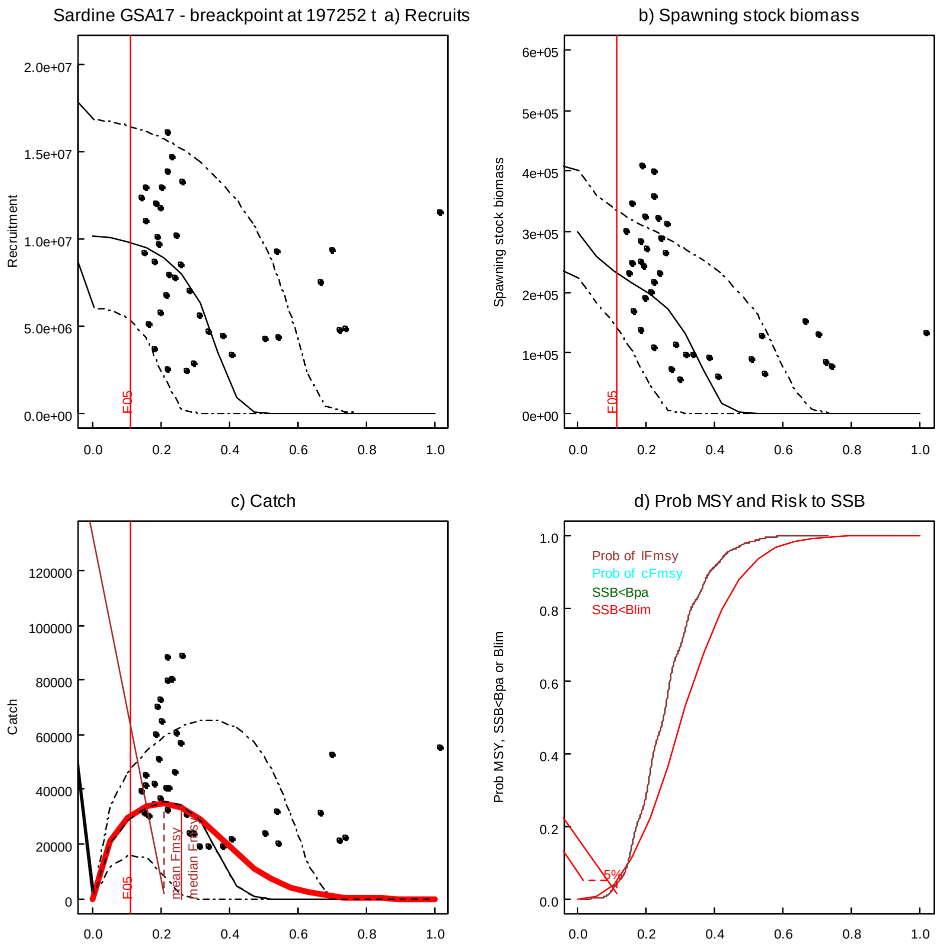


Figure 10.3. Scenario 3 EqSim summary plot for sardine in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

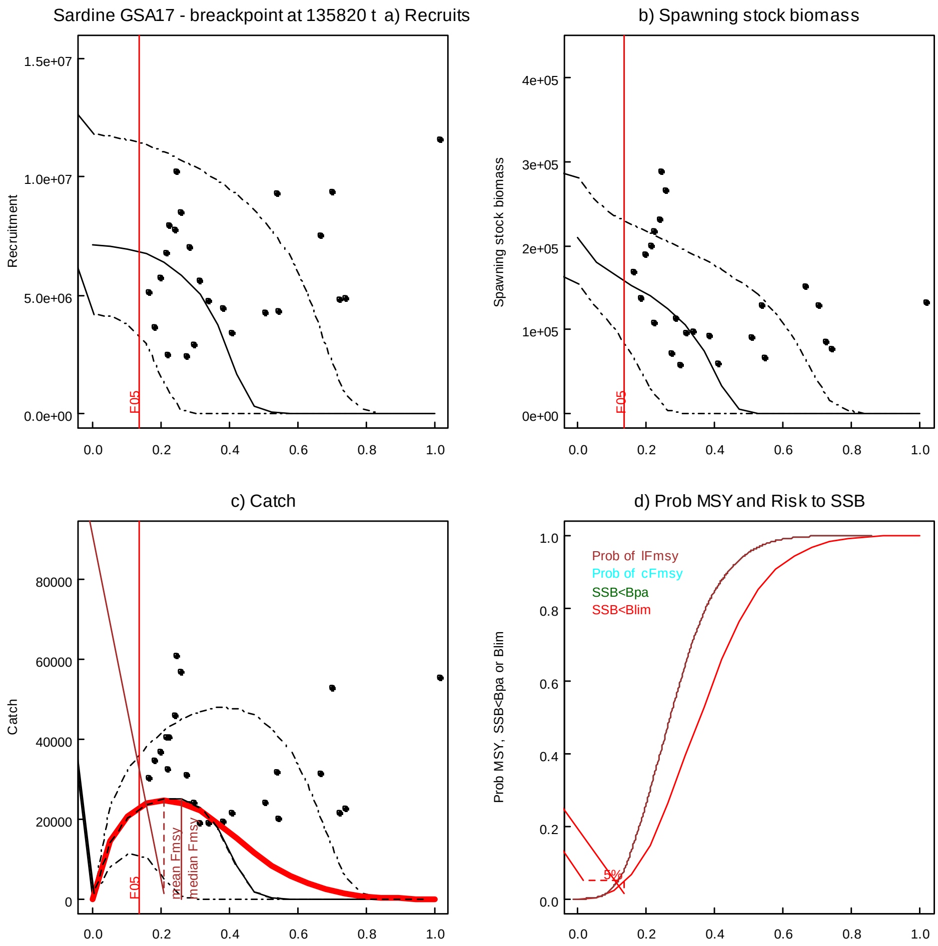


Figure 10.4. Scenario 4 EqSim summary plot for sardine in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

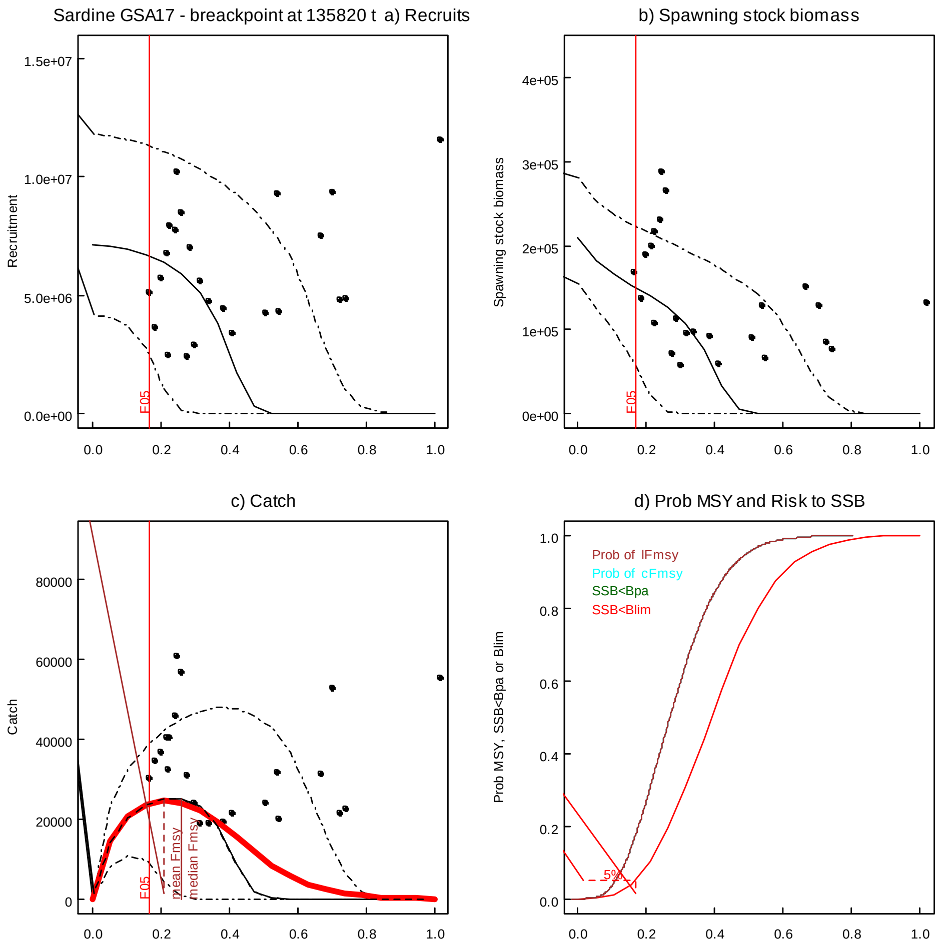


Figure 10.5. Scenario 5 EqSim summary plot for sardine in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

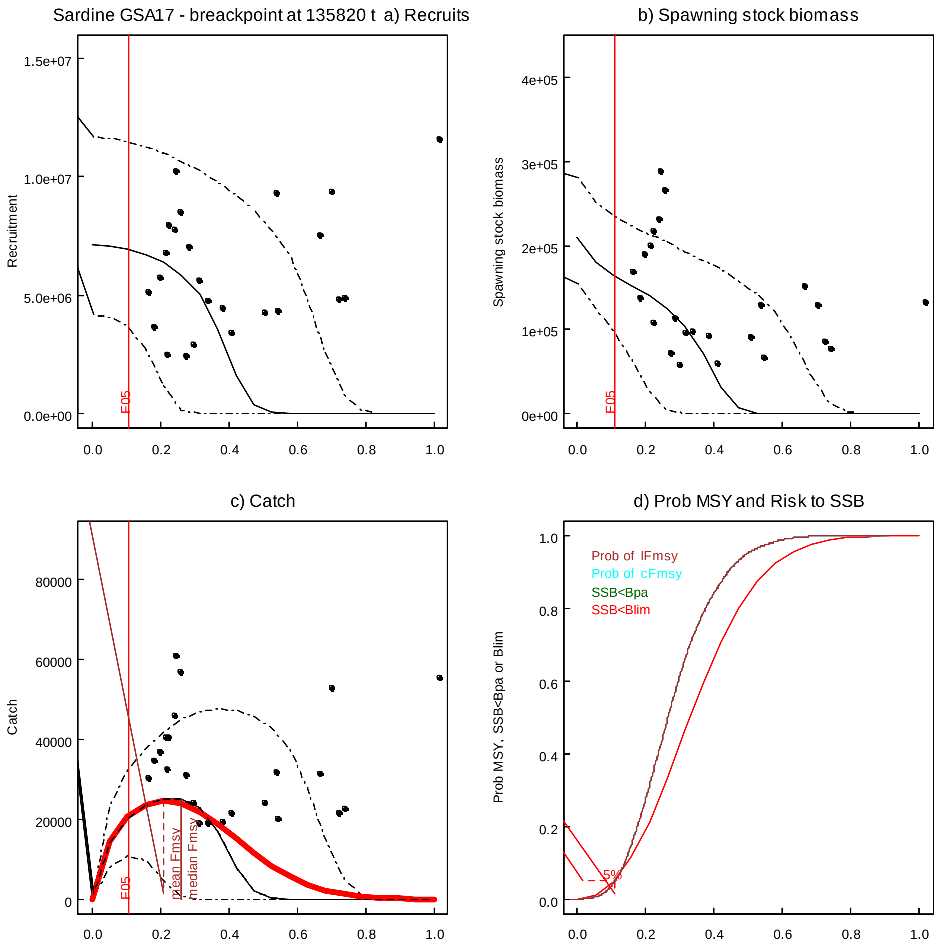


Figure 10.6. Scenario 6 EqSim summary plot for sardine in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

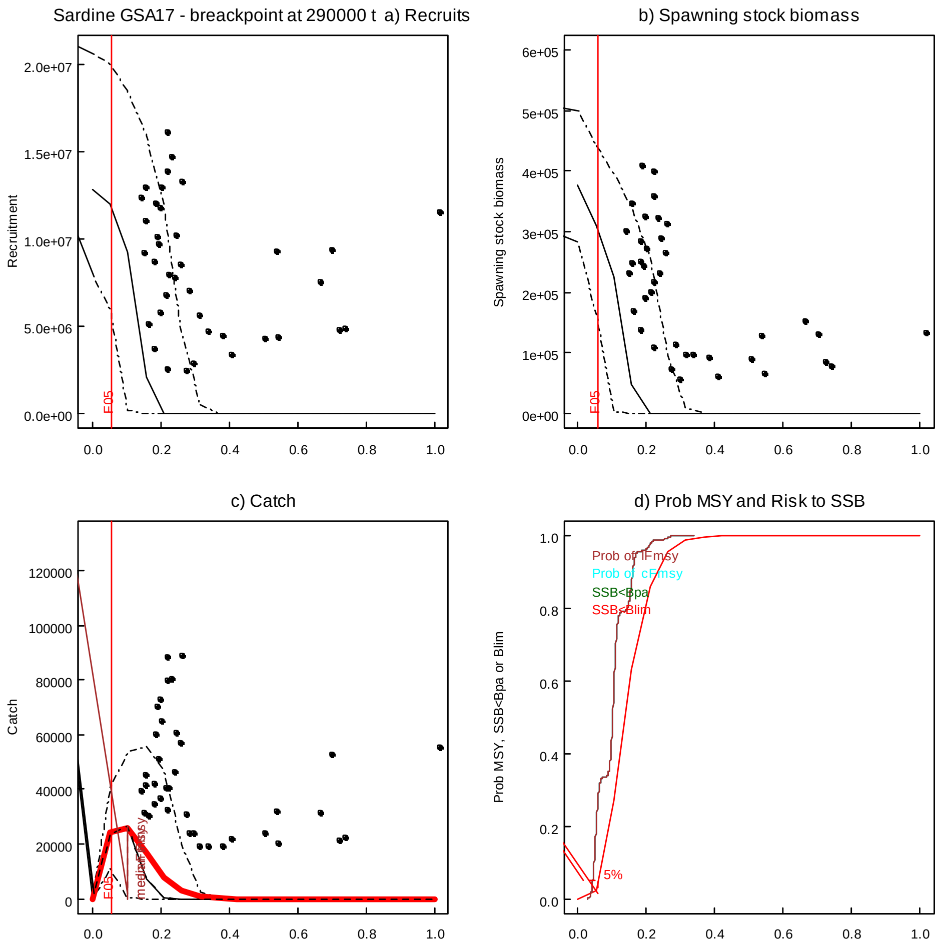


Figure 10.7. Scenario 7 EqSim summary plot for sardine in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

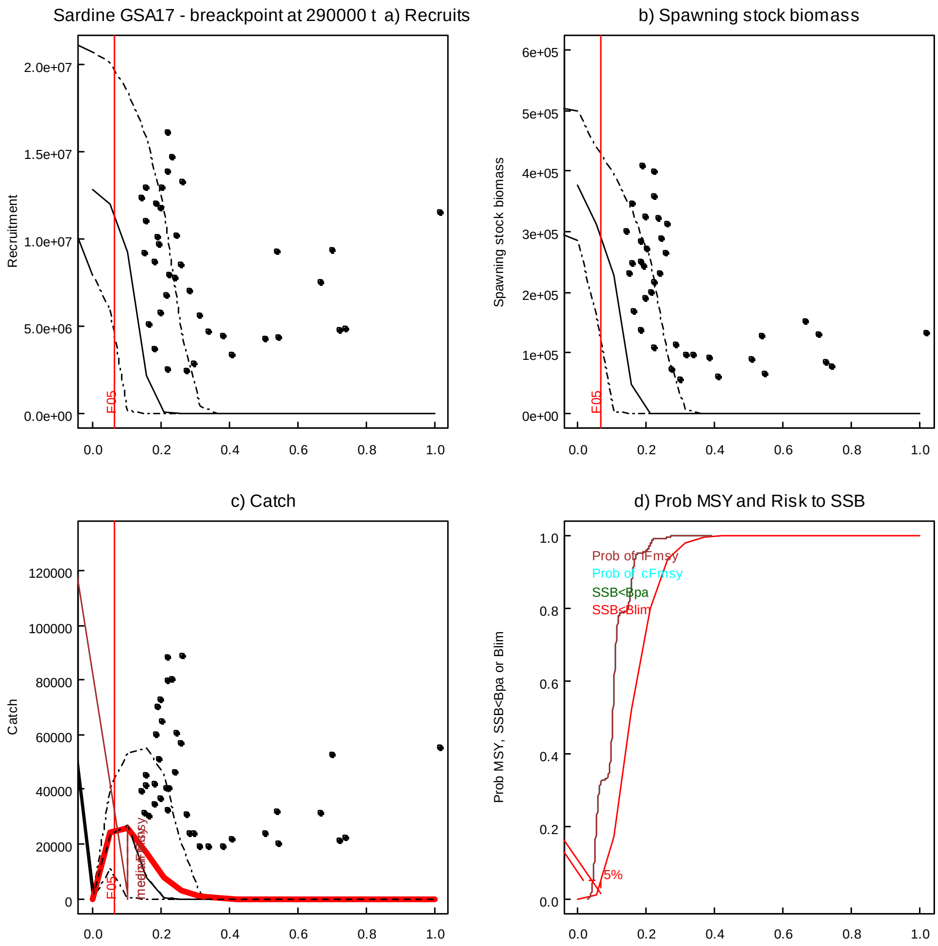


Figure 10.8. Scenario 8 EqSim summary plot for sardine in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

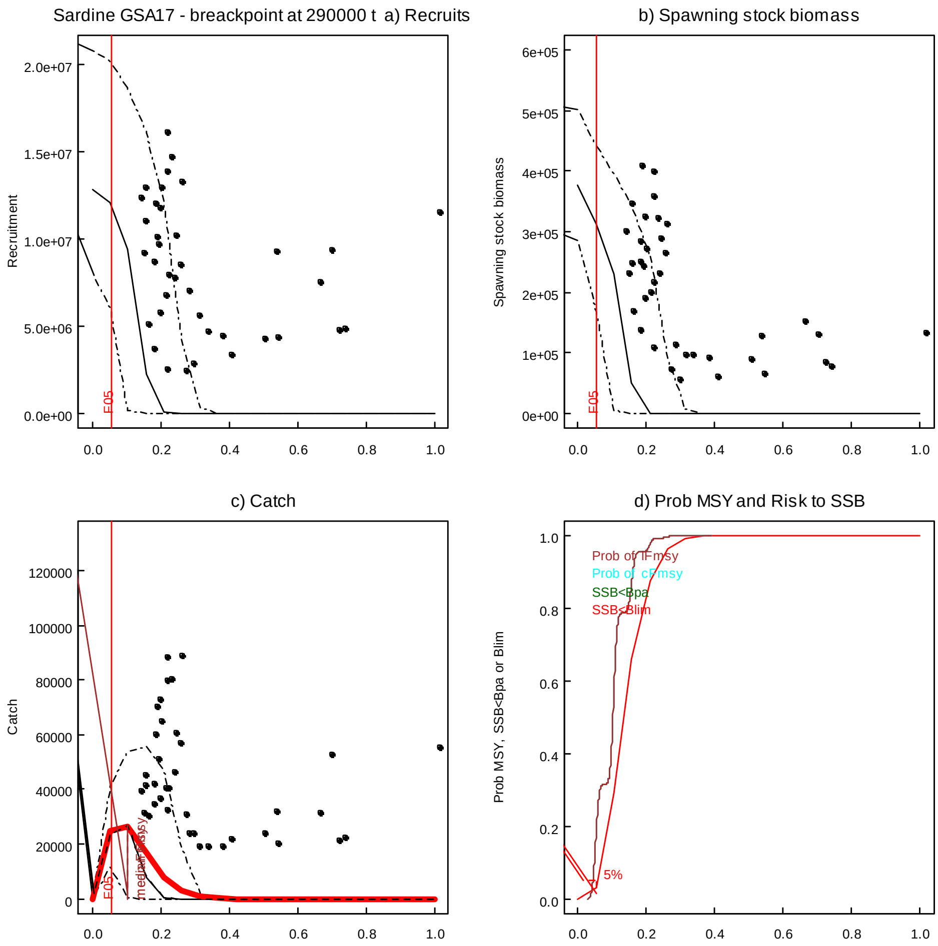


Figure 10.9. Scenario 9 EqSim summary plot for sardine in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

Anchovy

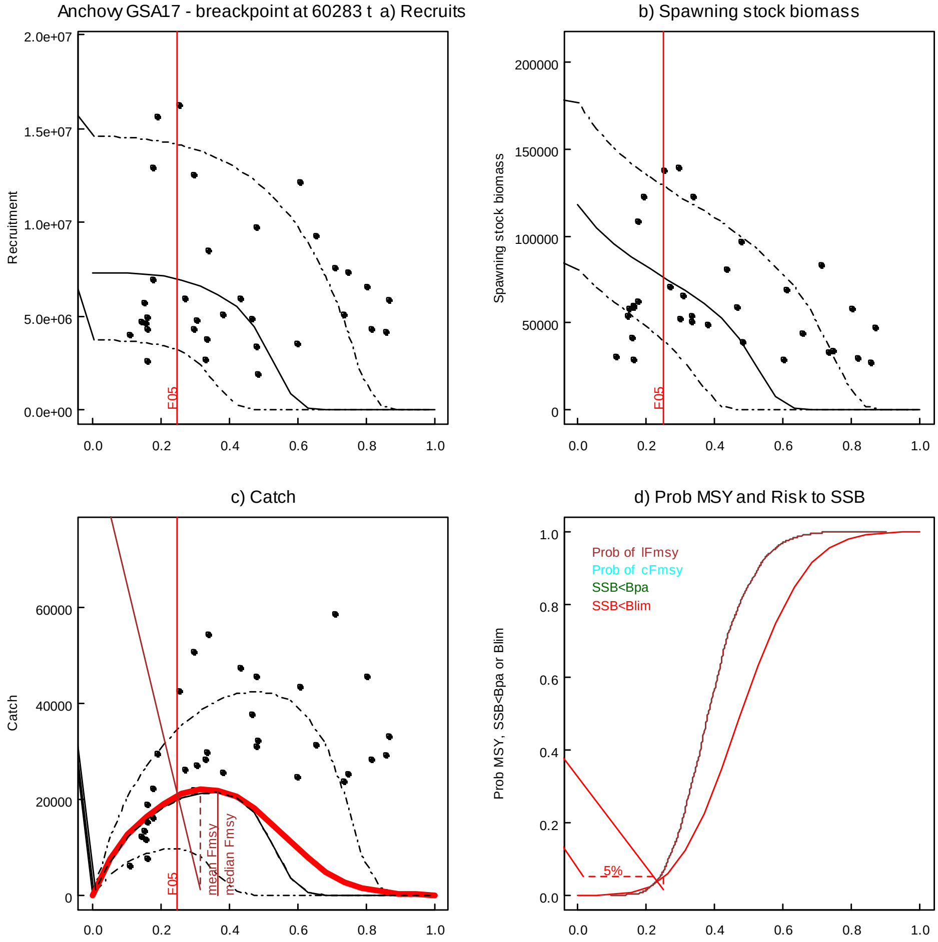


Figure 10.10. Scenario 1 EqSim summary plot for anchovy in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

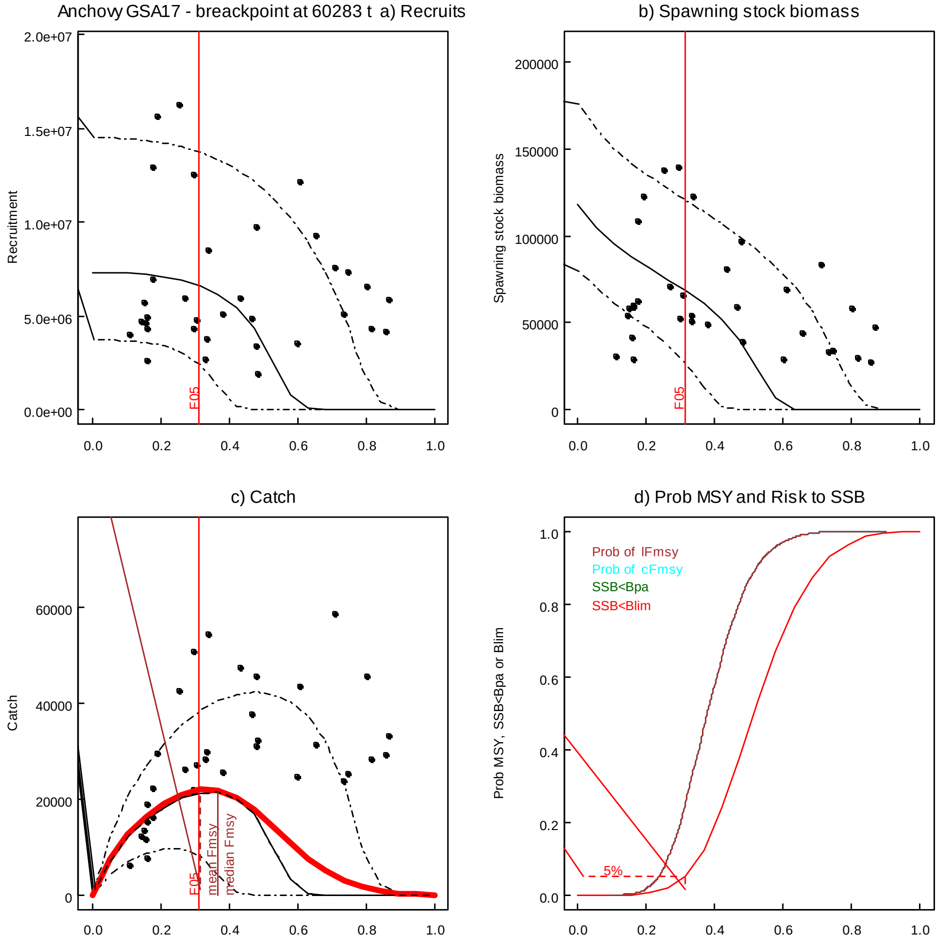


Figure 10.11. Scenario 2 EqSim summary plot for anchovy in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

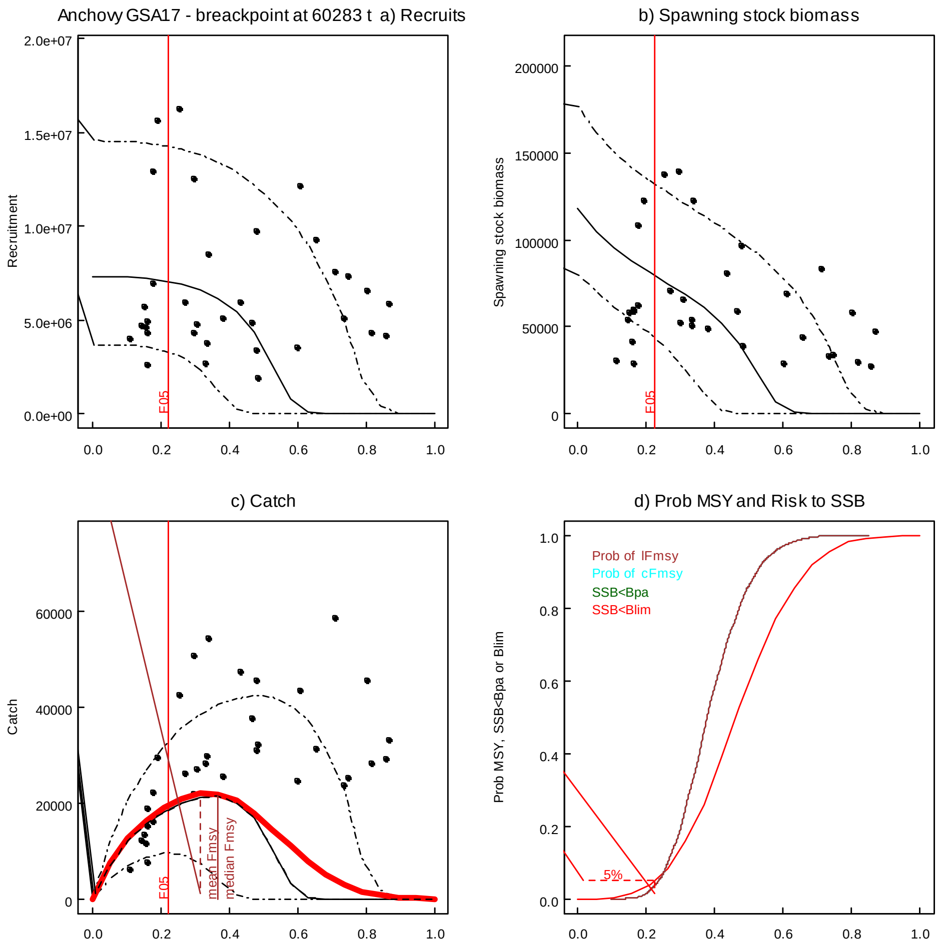


Figure 10.12. Scenario 3 EqSim summary plot for anchovy in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

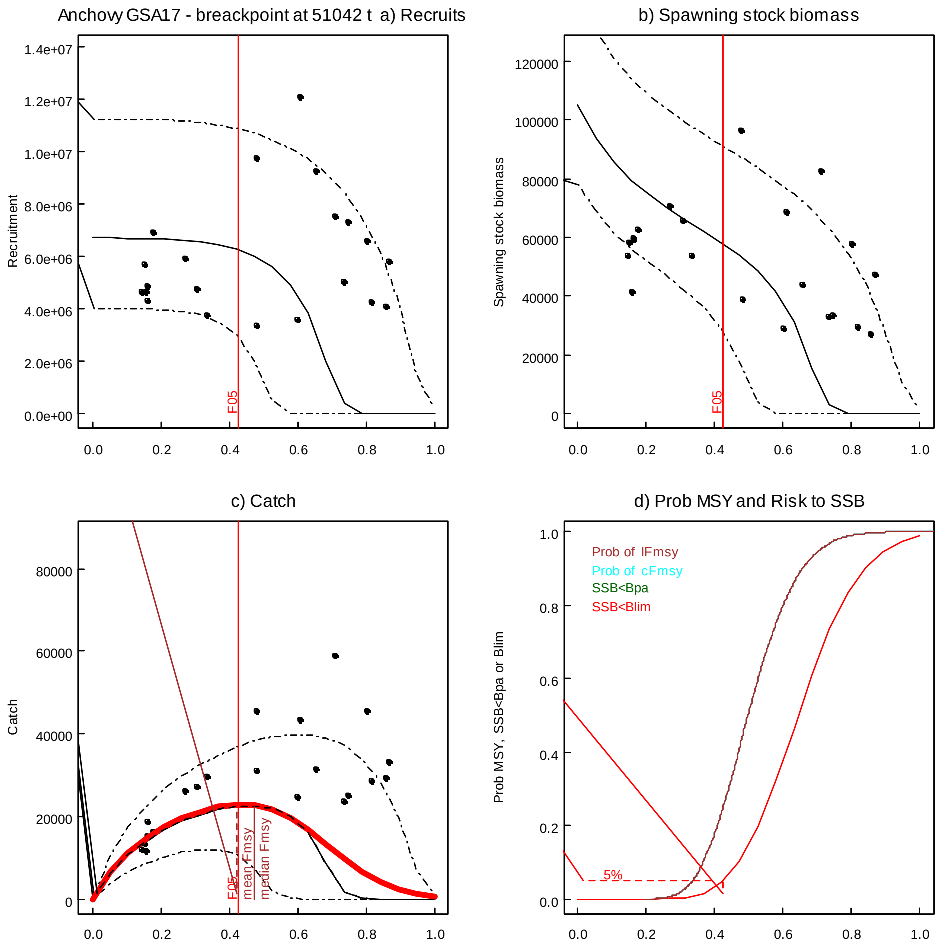


Figure 10.13. Scenario 4 EqSim summary plot for anchovy in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

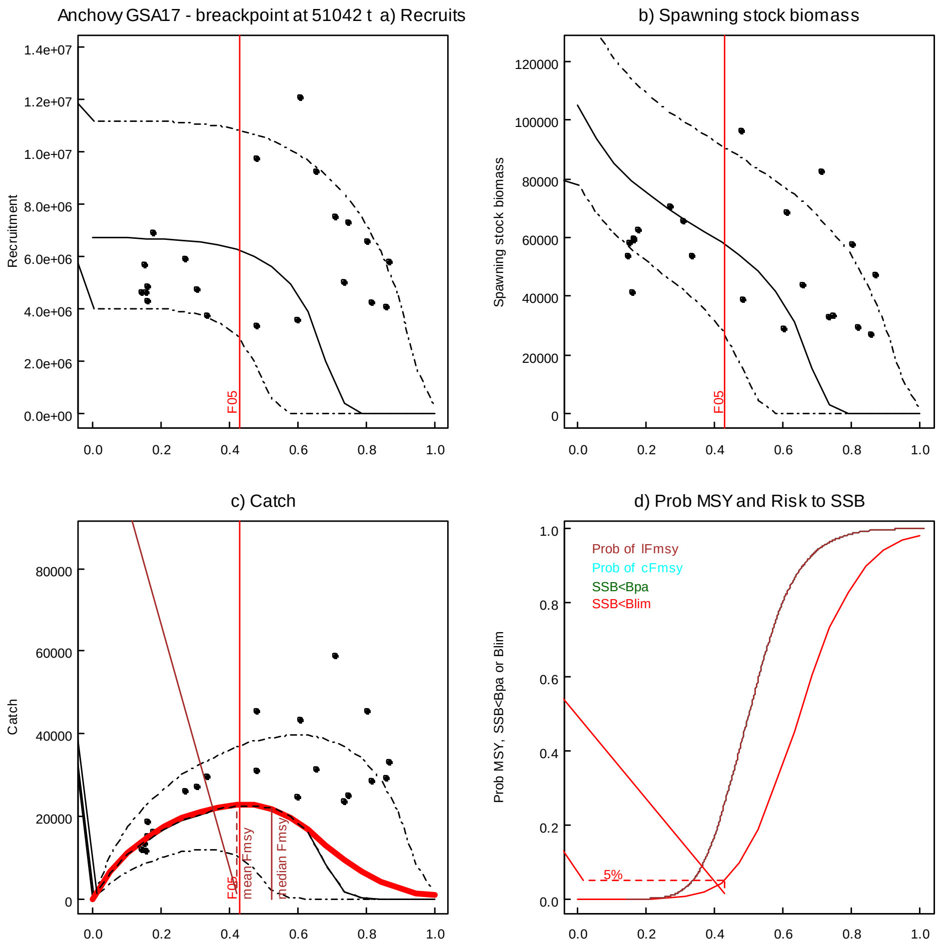


Figure 10.14. Scenario 5 EqSim summary plot for anchovy in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

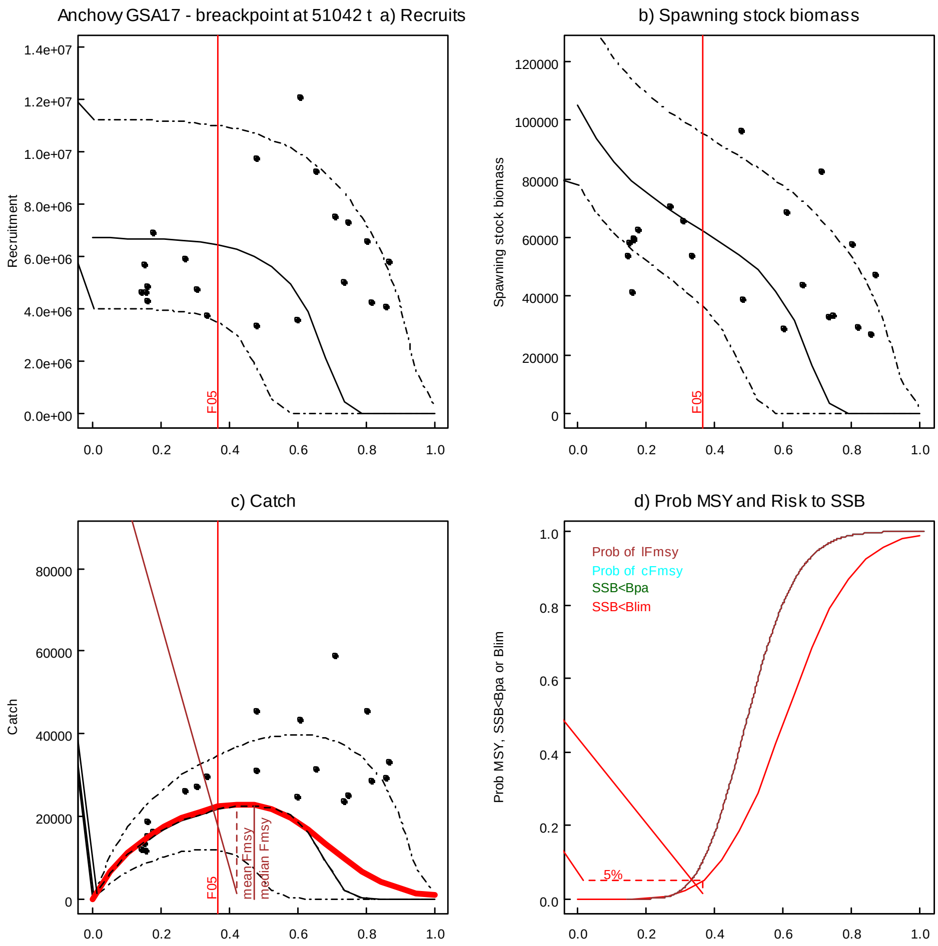


Figure 10.15. Scenario 6 EqSim summary plot for anchovy in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

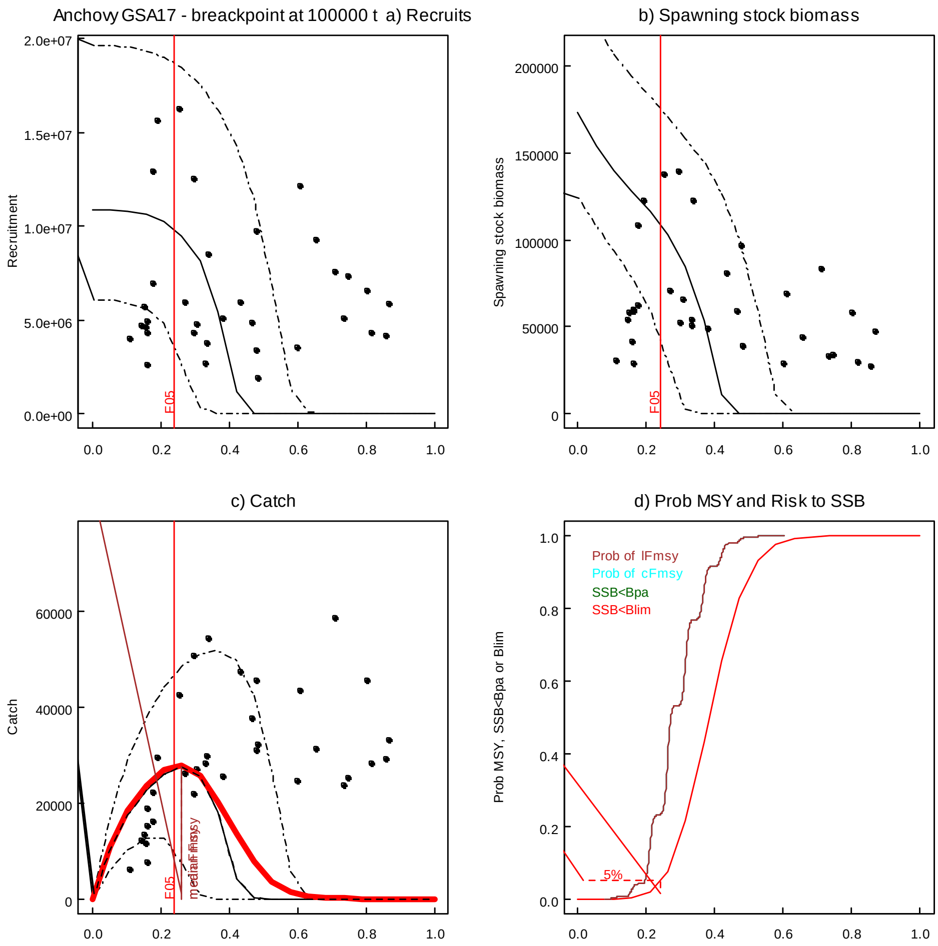


Figure 10.16. Scenario 7 EqSim summary plot for anchovy in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

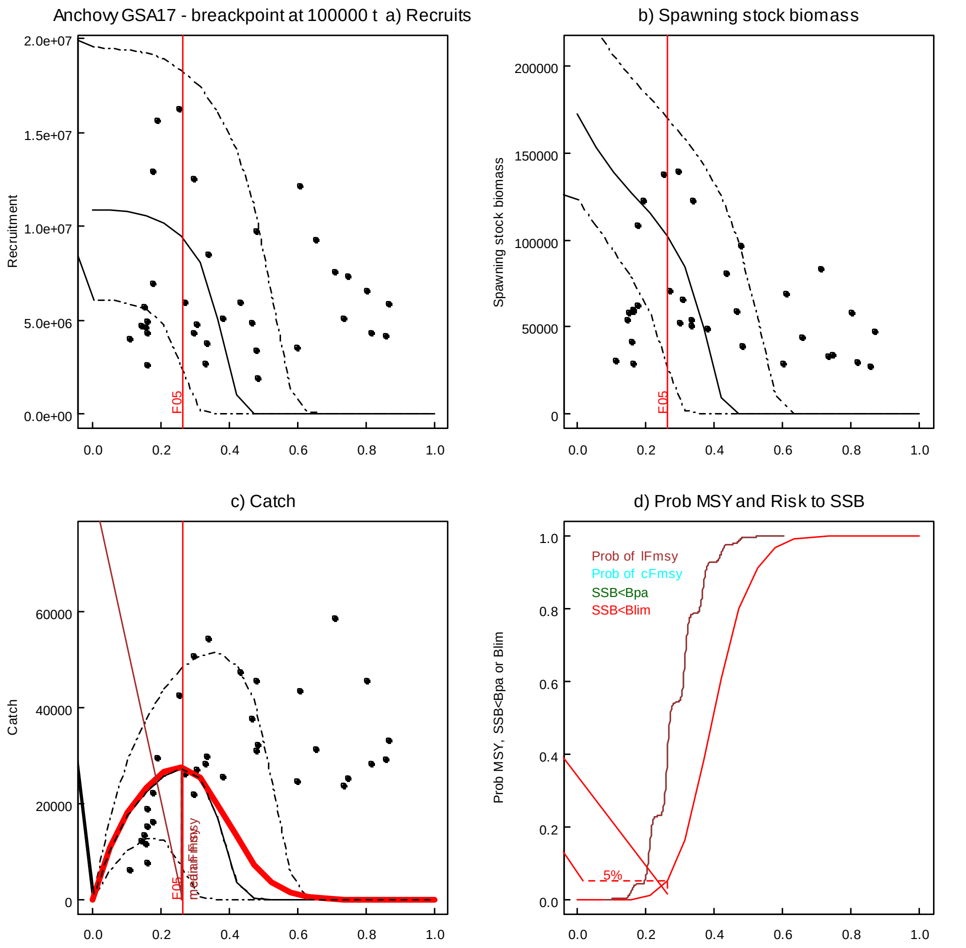


Figure 10.17. Scenario 8 EqSim summary plot for anchovy in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

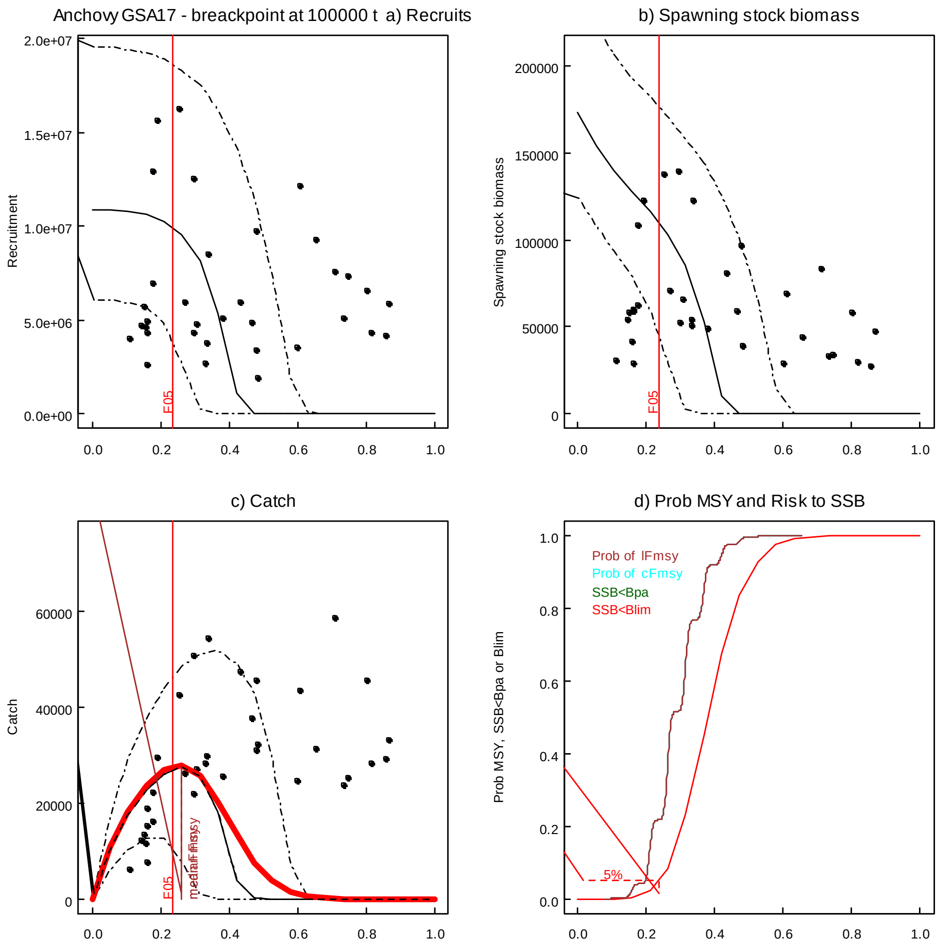


Figure 10.18. Scenario 9 EqSim summary plot for anchovy in GSA 17. Panels a-c: historic values (dots) median (solid black line) and 90% intervals (dotted black) recruitment, SSB and landings for exploitation at fixed values of F. In panel c mean landings are shown as well (red line). Panel d shows the probability of SSB falling below B_{lim} (red) and the cumulative distribution of F_{MSY} based on yield as landings and catch (brown, the two lines overlap).

Table 10.4: Reference points for sardine in GSA 17 estimated for the 9 scenarios. Flower is the lower bound estimated for F_{MSY}. If the $F_{P.05}$ is lower than F_{MSY}, then $F_{P.05}$ is used as FMSY. In the case of sardine, this implies that in all scenarios $F_{P.05}$ is considered as a proxy of F_{MSY} and F_{lower} exists for only 3 of the 9 scenarios analysed here.

Sardine				
Scenarios	$F_{P.05}$	F_{lower}	F_{MSY}	B_{lim}
1	0.139	-	0.139	117011
2	0.198	0.159	0.198	56794
3	0.113	-	0.113	140894
4	0.137	-	0.137	82316
5	0.168	0.167	0.168	56794
6	0.108	-	0.108	97014
7	0.059	-	0.059	117011
8	0.066	0.061	0.066	56794
9	0.057	-	0.057	140894

Table 10.5: Reference points of anchovy in GSA 17 estimated for the 9 scenarios. Flower is the lower bound estimated for F_{MSY}. If the $F_{P.05}$ is lower than F_{MSY}, then $F_{P.05}$ is used as F_{MSY}. In the case of anchovy, this implies that in all scenarios, $F_{P.05}$ is considered as a proxy of F_{MSY} and F_{lower} exists in all scenarios except 1 and 3. The B_{lim} corresponding to the total SSB (i.e. including age 0) is shown as well.

Anchovy					
Scenarios	$F_{P.05}$	F_{lower}	F_{MSY}	B_{lim}	B_{lim} (scaled to total SSB)
1	0.249	-	0.249	39756	135299
2	0.314	0.270	0.314	26891	95658
3	0.225	-	0.225	43059	142513
4	0.426	0.360	0.426	27571	92109
5	0.429	0.360	0.429	26891	105046
6	0.366	0.360	0.366	36458	126575
7	0.240	0.213	0.240	39756	135299
8	0.263	0.211	0.263	26891	95658
9	0.236	0.214	0.236	43059	142513

10.5 Conclusions

The approach used has the advantage that involves considerations on risk analysis and it is currently considered the most appropriate approach by ICES (ICES 2014). However, some shortcomings have been highlighted, such as its dependence on the choice of B_{lim} and on the time series used. A feature that has been highlighted also by the simulations made by ICES was the fact that for short living species (as sardine and anchovy) F_{MSY} is generally dictated by $F_{P0.5}$ and thus by the choice of B_{lim}. ICES did consider that this is not an artefact of the approach but a real feature of short living species possibly linked to the shape of the SR curve and also to the variability in R and the fact that the SSB of short living species is concentrated in few age classes. Thus, if the objective of a management plan is to, at the same time, maximize catches in the long term and minimize the risk of the SSB to go below B_{lim}, then $F_{P0.5}$ (Tables 10.4 and 10.5) should be applied for sardine and anchovy in GSA 17.

Thus the choice of F_{MSY} levels would heavily depend on the choice of B_{lim} and, for anchovy, also on the choice of the time series used.

It should be noted that the stock recruitment relationships of anchovy and sardine in GSA 17 are uncertain, as the assessment outputs suffers from (for details see GFCM-SCSA, 2014):

- Errors in landings data, in particular concerning the old part of the time series, which is to be revised in the next months.
- Age reading inconsistencies between the western and the eastern part of the Adriatic, that mostly affect age 0 and 1 of sardine, that also should be revised in the following months.

A GFCM benchmark assessment is planned for November 2015, to overcome issues with the data and to allow a more robust estimation of the stock status. If a new assessment is developed in the next months then the simulations made here need to be rerun for both stocks. On the basis of all the considerations above, EWG 14-19 could not agree on which scenario shoud be used to derive the F_{MSY} values for anchovy and sardine in GSA 17. The discussion focused on the length of the time series (i.e. 1975-2013 or 1989-2013) and on the methodology used to derive B_{lim}, on which EWG 14-19 did not reach consensus.

11. REFERENCES

AA.VV. 2000. Mediterranean Landings Pilot Project (MEDLAND). E.U. project n°97/0066. (1998-2000). Final Report.

AA.VV. (2008) Status of deep-sea red shrimps in the Central and Eastern Mediterranean Sea, Final Report. Project Ref FISH/2004/03-32

Abella A., Caddy J.F., Serena F., 1997. Do natural mortality and availability decline with age? An alternative yield paradigm for juvenile fisheries, illustrated by the hake Merluccius merluccius fishery in the Mediterranean. IFREMER Aquatic Living Resources. 10: 257-269.

Afonso-Dias M., 1998. Variability of *N. norvegicus* (L.) populations in Scottish waters in relation to the sediment characteristics of the seabed. PhD thesis, University of Aberdeen. 282 pp.

Aguzzi J., Sardà F., 2008. A history of recent advancements on *N. norvegicus* behavioral and physiological rhythms. Reviews in Fish Biology and Fisheries, 18: 235–248

Aguzzi J., Bahamon N., Marotta L., 2009a. The influence of light availability and predatory behaviour of the decapod crustacean *N. norvegicus* on the activity rhythms of continental margin prey decapods. Marine Ecology, 30: 366–375.

Aguzzi J., Puig P., Company J.B., 2009b. Hydrodynamic, non-photic modulation of biorhythms in the Norway lobster, *N. norvegicus* (L.). Deep-Sea Research I 56: 366–373.

Ardizzone G.D., Gravina M.F., Belluscio A., Schintu P. (1990). Depth size distribution pattern of Parapenaeus longirostris (Lucas, 1846) (Decapoda) in the Central Mediterranean Sea. Jour. Crust. Biol., 10 (1): 139 -147.

Ardizzone G.D., Corsi F. (Editors). (1997). Atlas of Italian Demersal Fishery Resources. Trawl Surveys 1985-1987. *Biol. Mar. Medit* **4** (2): 568 pp.

Atkinson, R.J.A., Naylor, E., 1976. An endogenous activity rhythm and the rhythmicity of catches of *N. norvegicus*. Journal of Experimental Marine Biology and Ecology, 25: 95-108.

Belcari P., Sartor P., Sánchez P., Demestre M., Tsangridis A., Leondarakis P., Lefkaditou E., Papaconstantinou C. 2002. Exploitation patterns of the cuttlefish, *Sepia officinalis* (Cephalopoda, Sepiidae), in the Mediterranean Sea. Bull. Mar. Sci. 71: 187-196.

Bell M.C., Redant F. and Tuck I., 2007. *N. norvegicus* Species. In: Phillips, B.F. (ed.), Lobsters : biology, management, aquaculture, and fisheries, pp. 412-461. Blackwell Publishing, Oxford.

Bertrand J.A., de Sola L.G., Papaconstantinou C., Relini G. and Souplet A. (2002) The general specifications of the MEDITS surveys. Scientia Marina, 66: 9-17.

Bertrand J.A., L. Gil de Sola, C. Papaconstantinou, G. Relini, Y. A. Souplet., 2002a. The general specifications of the MEDITS surveys. Sci. Mar., 66(Suppl. 2): 9-17.

Biagi F., Sartor P., Ardizzone G. D., Belcari P., Belluscio A., Serena F. – 2002 – Analysis of demersal assemblages off the Tuscany and Latium coasts (North-Western Mediterranean). – Scientia Marina, vol. 66 (suppl. 2), pp. 233-242.

Bianchini M.L. and Ragonese S. 2011. Establishing length–at–age references in the red mullet, Mullus barbatus L. 1758 (Pisces, Mullidae), a case study for growth assessments in the Mediterranean Geographical Sub–Areas (GSA), Mediterranean Marine Science, 12(2): 316–332.

Bitetto I., Carpi P., Martiradonna A., 2014. GL-Met 2014 (Working Group of the SIBM on the Methodology applied to DCF at national level. GLM - GAM modelling for MEDITS abundance indices standardization.

Brodziak J. K. T., Rosenberg, A. A. 1993. A method to assess squid fisheries in the north-west Atlantic. ICES J. Mar. Sci. 50: 187–194.

Caddy J. F. 2009. Practical issues in choosing a framework for resource assessment and management of Mediterranean and Black Sea fisheries. Med. Mar. Sci. 10: 83-119.

Campbell N., Dobby H., Bailey N., 2009. Investigating and mitigating uncertainties in the assessment of Scottish *N. norvegicus* populations using simulated underwater television data. ICES Journal of Marine Science: Journal du Conseil, 66:646-55

Cartes, J.E., Fanelli, E., Kapiris, K., Bayhan, Y.K., Ligas, A., López-Pérez, C., Murenu, M., Papiol, V., Rumolo, P., and Scarcella, G. (2014). Spatial variability in the trophic ecology and biology of the deep-sea shrimp Aristaeomorpha foliacea in the Mediterranean Sea. Deep Sea Research Part I: Oceanographic Research Papers 87, 1–13.

Cau A., Sabatini A., Murenu M., Follesa M. C., Cuccu D. (1994). Considerazioni sullo stato di sfruttamento delle risorse demersali (Mari di Saerdegna). Atti Seminario sulla regolazione dello sforzo di pesca. Biol. Mar. Medit., 1(2), 67-76.

Cetinić P., 1999. Istraživanje kompetitivnih odnosa između ribolova pridnenim povlačnom povlačnom mrežom (koćom), vršama za lov škampa i jednostrukim mrežema stajačicama za lov oslića u velebitskom kanalu, s posebnim osvrtom na populaciju škampa i oslića. IOF, Split, 53 pp.

Chapman C.J., 1980. Ecology of juvenile and adult *N. norvegicus*. In: The Biology and Management of Lobsters, Volume II – Ecology and Management, (eds J.S. Cobb & B.F. Phillips), Academic Press, New York, pp. 143-178.

Chapman C.J., Rice A.L., 1971. Some direct observations on the ecology and behaviour of the Norway lobster *N. norvegicus*. Marine Biology, 10: 321–329.

Chapman D.G., 1974. Estimation of population size and sustainable yield of sei whales in the Antarctic. Rep. Int. Whal. Comm. 24: 82-90.

Cochran, W. G., 1953. Sampling techniques. John Wiley & Sons Inc. New York: 1-330, 143 p.

Colloca F., Cardinale M., Belluscio A., Ardizzone G. (2003) - Pattern of distribution and diversity of demersal assemblages in the central Mediterranean Sea. Estuar. Coast. Shelf Sci., 56: 469-480.

Colloca F., Carpenteri P., Balestri E., Ardizzone G.D. (2004) - A critical habitat for Mediterranean fish resources: shelf-break areas with Leptometra phalangium (Echinodermata: Crinoidea). Mar. Biol., 145: 1129-1142

Conversi A, Fonda Umani S, Peluso T, Molinero JC, Santojanni A, et al. (2010) The Mediterranean Sea Regime Shift at the End of the 1980s, and Intriguing Parallelisms with Other European Basins. *PLoS ONE* 5(5): e10633. doi:10.1371/journal.pone.0010633

Darby, C. D., and Flatman, S. 1994. Virtual population analysis: Version 3.1 (Windows/DOS) User Guide. MAFF Directorate of Fisheries Research IT Report 1. 85 pp.

de Figueiredo M.J., 1984. Attempts to estimate growth and natural mortality of *N. norvegicus* off the Portuguese coast. ICES CM 1984/K:28 (mimeo).

de Ranieri S., Belcari P., Bertolini D., Biagi F., Chiericoni V., Cognetti A.G., Mori M., Nannini N., Reale B., Rocca V., Sartor P., Sbrana M. (1997). - Reclutamento di alcune specie ittiche demersali nel mar Tirreno settentrionale. *Biol. Mar. Medit*, **4** (1): 237-243.

Dickey-Collas M., McQuaid N., Armstrong M.J., Allen M., Briggs R.P., 2000. Temperature-dependent stage durations of Irish Sea *N. norvegicus* larvae. Journal of Plankton Research 22:749-60

Dobby, H., Hillary R., 2008. CASE STUDY 4A: Sensitivity testing of a length-based approach to Nephrops stock assessment using FLR. EFIMAS Project Workpackage 4, pp. 1-43.

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.

EU Mediseh-Mediterranean Sensitive Habitats (2013). Edited by Giannoulaki M., A. Belluscio, F. Colloca, S. Fraschetti, M. Scardi, C. Smith, P. Panayotidis, V. Valavanis M.T. Spedicato. DG MARE Specific Contract SI2.600741, Final Report, 557 p

Farmer A.S.D., 1974. Reproduction in *N. norvegicus* (Decapoda: Nephropidae). Journal of Zoology 174:161-83

Froglia C. 1972. Osservazioni sulle variazioni di cattura dello scampo, *N. norvegicus* (L.) in riferimento all'etologia ed alla biologia della specie. Quaderni del Laboratorio di Tecnologia della Pesca Ancona 1: 83-99

Froglia C., Gramitto M.E., 1979. An estimate of the fecundity of Norway lobster (*N. norvegicus*) in the Adriatic Sea. Rapp. Comm. int. Mer Medit., 25/26 (4): 227-229.

Froglia C., Gramitto M.E., 1981. Summary of biological parameters on the Norway lobster, *N. norvegicus* (L.), in the Adriatic. FAO Fisheries Report, 253: 165-178.

Froglia C., Gramitto M.E., 1988. An estimate of growth and mortality parameters for Norway lobster (*N. norvegicus)* in the Central Adriatic Sea. FAO Fisheries Report, 394: 189-203.

Froglia C., Gramitto, M.E., 1986. Diurnal changes in fishery resources catchability by bottom trawl in the Adriatic Sea. FAO Fisheries Report, 345: 111–118.

Froglia, C., Gramitto, M. E. (1981) Summary of biological parameters on the Norway lobster, Nephrops norvegicus (L.), in the Adriatic. FAO Fish. Rep., (253): 165 – 178.

Froglia, C. and M.E. Gramitto.- 1987. An estimate of growth and mortality parameters for Norway lobster (*Nephrops norvegicus*) in the central Adriatic Sea. FAO Fish.Rep., 394: 189-204.

Gabriel, W.L., Sissenwine, M.P., Overholtz, W.J., 1989. Analysis of spawning stock biomass per recruit: an example for Georges Bank Haddock. N. Am. J. Fish. Manage. 9, 383–391.

Ganias K., Somarakis S., Caragitsou E., Koutsikopoulos C., Machias A., Theodorou A. (2001) - Differential egg production of sardine off the central Hellenic coasts in December 1999. *Rapp. Comm. Int. Mer. Médit.,* **36**: 268.

Garoia F., Guarniero, I., Piccinetti, C. & Tinti, F. (2004) First Microsatellite Loci of Red Mullet (*Mullus barbatus*) and their Application to Genetic Structure Analysis of Adriatic Shared Stock. Marine Biotechnology, 6 (5):446-452.

GFCM-SCSA, 2014. Report of the General fisheries commission for the Mediterranean scientific advisory committee (GFCM), Sub-Committee for Stock Assessment (SCSA), Working Group on Stock Assessment of Small Pelagic Species (WGSASP), Rome, 24-27 November 2014. 39pp.

Gislason H., Daan N., Rice J. C., & Pope J. G. 2010. Size, growth, temperature and the natural mortality of marine fish. *Fish and Fisheries* **11**(2), 149–158. doi:10.1111/j.1467-2979.2009.00350.x

Gramitto M.E., 1998. Molt pattern identification through gastrolisth examination on *N. norvegicus* (L.) in the Mediterranean Sea. Scientia Marina 62: 17-23

Gramitto M.E., Froglia C., 1980. Osservazioni sul potenziale reproduttivo dello scampo (*N. norvegicus*) in Adriatico. Memorie di Biologia Marina e di Oceanografia, 10 (Suppl.): 213-218

Grbec B,Dulcic J,Morovic M (2002) Long-term changes in landings of small pelagic fish in the eastern Adriatic–possible influence of climate oscillations over the Northern Hemisphere. *Clim Res* 20: 241–252.

Grosslein M. P. and A. Laurec. (1982) Etudes par chalutage demersal: planification, conduite des operations et analyse des resultats. COPACE/PACE Series 81: 22 pp.

Guijarro B. & Massuti E. (2006) Selectivity of diamond- and square-mesh codends in the deepwater crustacean trawl fishery off the Balearic Islands (western Mediterranean). ICES Journal of Marine Science, 63, 52-67.

Guijarro B., González N., Rubio V. and Massutí E. Population dynamics, biology and state of exploitation of the Norway lobster (*Nephrops norvegicus*) in the Balearic Islands. (2013) Rapport du Commission Internationale de la Mer Méditerranée. Comm. Int. Mer Médit, 40, 2013. 40th CIESM Congress. Marsella (Francia), octubre 2013.

Guyader O., Berthou P., Koutsikopoulos C., Alban F., Demanèche S., Gaspar M.B., Eschbaum R., Fahy E., Tully O., Reynal L., Curtil O., Frangoudes K., Maynou F. 2013. Small scale fisheries in Europe: A comparative analysis based on a selection of case studies. Fish. Res. 140, 1-13. doi:10.1016/j.fishres.2012.11.008

Haidar, Z. (1970) L'oecologie du rouget (Mullus barbatus L.) en Adriatique orientale. Acta Adriat., 14 (1): 1-94.

Hillborn R., Walters C. J. 1992. Quantitative Fisheries Stock Assessment. Chapman & Hall, London.

ICES, 2003. Report of the Working Group on Nephrops Stocks. ICES CM 2003/ACFM:18.

ICES, 2009. Report of the Benchmark Workshop on Nephrops (WKNEPH), 2–6 March 2009, Aberdeen, UK. ICES CM 2009/ACOM:33. 156 pp.

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

ICES, 2013. Report of the Benchmark Workshop on Nephrops Stocks (WKNEPH), 25 February–1 March 2013, Lysekil, Sweden. ICES CM 2013/ACOM:45. 230 pp.

ICES. 2014. Report of the Joint ICES-MYFISH Workshop to consider the basis for FMSY ranges for all stocks (WKMSYREF3) , 17–21 November 2014, Charlottenlund, Denmark. ICES CM 2014/ACOM:64. 147 pp.

IMBC, UMBSM, and IRPEM, 1994. *N. norvegicus*: stock variability and assessment in relation to fishing pressure and environmental factors. Final Report to the European Commission, Contract XIV-1/MED/91/003. 84 pp. þ Figures and Appendices.

JRC, 2015. DCF Data Call Coverage Report for the Mediterranean and Black Sea in 2014 . EUR 27112. Luxembourg (Luxembourg): Publications Office of the European Union; 2015. JRC94670. ISBN 978-92-79-45675-6, ISSN 1831-9424, DOI: 10.2788/243980.

Jukić, S. (1971) Studies on the population and catchabilltiy of Norway lobster in the central Adriatic. FAO Stud. Rev., 48: 27-52.

Karlovac, O. (1953) An ecological study of Nephrops norvegicus (L) of the high Adriatic. Izv. rep. Rib.biol. Eksp."Hvar" 1948-49, 5(2C): 1-50.

Lembo G., Abella, A., Fiorentino, F., Martino S., and Spedicato, M.-T. 2009. ALADYM: an age and length-based single species simulator for exploring alternative management strategies. Aquatic Living Resources, 22, 233–241.

Lembo G. (coord.) (2010) – Identificazione spazio-temporale delle aree di concentrazione dei giovanili delle principali specie demersali e localizzazione geografica di aree di nursery nei mari italiani - NURSERY. Relazione Finale (VI Piano Triennale - Completamento del programma nazionale di ricerca), Società Italiana di Biologia Marina – S.I.B.M., Genova: pag. 1-119.

Lleonart, J. & J. Salat. 1992. VIT. Programa de análisis de pesquerías. Inf. Técn. Sci, Mar., 168-169: 116 pp

Lleonart J. and Salat J., 1992. VIT Programa de analisis de Pesquerias. Inf. Tec. Sci. Mar., 168-169.

Lleonart J., Maynou F. 2003. Fish stock assessment in the Mediterranean: state of the art. Sci. Mar. 67(Suppl. 1): 37-49.

Lorenzen K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. *Journal of fish biology* **49**(4), 627-642

Mantovani B., Scali V., 1992. Allozyme characterization of the Norway lobster, *N. norvegicus*, of two Adriatic trawling grounds. Acta Adriat 33: 209-213.

Marano, G., Marsan R., Pastorelli A.M., Vaccarella R., 1998. Areale di distribuzione e pesca dello scampo, *N. norvegicus* (L.), nelle acque del basso Adriatico. Biologia marina Mediterranea, 5 (2): 284-292.

Marano, G., Ungaro, N., Marano, C.A., Marsan, R. (1998) La ricerca sulle risorse demersali del bacino Adriatico sud-occidentale (anni 1985-97): sintesi dei risultati. Biol. Mar. Medit., 5 (3): 109-119.

Marrs S.J., Tuck I.D., Arneri E., La Mesa M., Atkinson R.J.A., et al., 2002. Technical improvements in the assessment of Scot.tish *N. norvegicus* and Adriatic clam fisheries. Final Report EC Study Contract 97/0100.

Martinelli M., Morello E.B., Isajlović I., Belardinelli A., Lucchetti A., Santojanni A., Atkinson R.J.A., Vrgoc N., Arneri E., 2013. Towed underwater television towards the quantification of Norway lobster, squat lobsters and sea pens in the Adriatic Sea. Acta Adriatica, 54: 3 – 12.

Massutí E. and Reñones O. (2005) Demersal resource assemblages in the trawl fishing grounds off the Balearic Islands (western Mediterranean). Scientia Marina, 69 (1): 167-181.

Maynou F, Sardà F., 1997. *N. norvegicus* population and morphometrical characteristics in relation to substrate heterogeneity. Fisheries Research 30: 139-49

McAllister M. K., Hill S. L., Agnew D. J., Kirkwood G. P., Beddington J. R. 2004. A Bayesian hierarchical formulation of the DeLury stock assessment model for abundance estimation of Falkland Islands' squid (*Loligo gahi*). Can. J. Fish. Aquat. Sci. 61: 1048-1059.

Mediterranean Sensitive Habitats (2013). Eds. Giannoulaki M., A. Belluscio, F. Colloca, S. Fraschetti, M. Scardi, C. Smith, P. Panayotidis, V. Valavanis M.T. Spedicato. DG MARE Specific Contract SI2.600741, Final Report, 557 p.

MEDSUDMED (2004) - Report of the MedSudMed Expert Consultation on Small Pelagic Fishes: Stock Identification and Oceanographic Processes Influencing their Abundance and Distribution. GCP/RER/010/ITA/MSM-TD-05. MedSudMed Technical Documents, 5: 132 pp.

Morello E.B., Froglia C., Atkinson R.J.A. 2007. Underwater television as a fishery-independent method for stock assessment of Norway lobster, *N. norvegicus*, in the central Adriatic Sea (Italy). ICES Journal of Marine Science, 64: 1116 – 1123.

Morello E.B., Arneri E. (2009) - Anchovy and sardine in the Adriatic Sea: an ecological review. *Oceanogr. Mar. Biol. Annu. Rev.,* **47**: 209-245.

Mori M., Biagi F., De Ranieri S. (1994). Reproductive biology of Aristaeomorpha foliacea in the Southern Tuscany archipelago (Central Tyrrhenian Sea). N.R.T-I.T.T.P., Special Publication, 3: 31-32.

Mori M., Sbrana M., de Ranieri S. – 2000a – Reproductive biology of female *Parapenaeus longirostris* (Crustacea, Decapoda, Penaeidae) in the northern Tyrrhenian Sea (western Mediterranean). Atti Soc. Tosc. Sci. Nat. Mem., serie B. 107: 1-6.

Mori M., Sartor P., Biagi F. – 2000b – Diet of adult females of Parapenaeus longirostris (Crustacea, Decapoda) in the northern Tyrrhenian Sea (Western Medterranean). – Atti Soc. Tosc. Sci. Nat. Mem. Serie B., vol. 107, pp. 7-10.

Mura M., Campisi S., Cau A. (1992). Osservazioni sulla biologia riproduttiva negli aristeidi demersali del Mediterraneo centro-occidentale. Oebalia, 17 (2): 75-80.

Mura M., Orrù F., Cau A. (1997). Osservazioni sull'accrescimento di individui in fase preriproduttiva di Aristeus antennatus e Aristaeomorpha foliacea. Biol. Mar. Medit., 4 (1): 254-261.

Murenu, M., M. Muntoni and A. Cau 2010 - Spatial characterization of fishing areas and fleet dynamics in the Central Mediterranean: GIS application to test VMS usefulness. In: Nishida T, Kailola PJ and Caton AE (eds) The Fourth Symposium on GIS/Spatial analysis in fishery and aquatic sciences, Vol 4: 381-398.

Mužinić R. (1954) - Contribution à l'étude de l'oecologie de la sardine (*Sardina pilchardus* Walb.) dans l'Adriatique orientale. *Acta Adriat.,* 5: 1-219.

Mužinić R. (1973) - Migrations of adult sardines in the central Adriatic. *Neth. J. Sea. Res.,* **7**: 19-30.

Naylor E., Atkinson R.J.A., 1976. Rhythmic behaviour of *N. norvegicus* and some other marine crustaceans. In Perspectives in Experimental Biology, pp. 135–143. Ed. by P. Spencer. Davies Pergamon Press, Oxford.

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

Orsi Relini L., Zamboni A., Fiorentino F., Massi D., 1998. Reproductive patterns in Norway lobster *N. norvegicus* (L.), (Crustacea Decapoda Nephropidae) of different Mediterranean areas. Scientia Marina 62: 25-41

Ospina-Alvarez A., Parada C., & Palomera I. 2012. Vertical migration effects on the dispersion and recruitment of European anchovy larvae: From spawning to nursery areas. Ecological Modelling 231, 65-79.

Palmer M., Quetglas A., Guijarro B., Moranta J., Ordines F. & Massuti E. (2009) Performance of artificial neural networks and discriminant analysis in predicting fishing tactics from multispecific fisheries. Canadian Journal of Fisheries and Aquatic Sciences, 66, 224-237.

Patterson, K. (1992). Fisheries for small pelagic species: an empirical approach to management targets. Review of Fish Biology and Fisheries, 2: 321-338.

Pauly, D. (1980). On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. J. Cons. Int. Explor. Mer, 39 (3): 175-192.

Perdichizzi Anna, Pirrera Laura, Micale Valeria, Muglia Ugo, and Rinelli Paola (2012) A Histological Study of Ovarian Development in the Giant Red Shrimp Aristaeomorpha foliacea (Crustacea: Decapoda: Aristeidae) from the Southern Tyrrhenian Sea (WesternMediterranean). The ScientificWorld Journal, Volume 2012, Article ID 289608,doi:10.1100/2012/289608

Prince, J. 2003. The barefoot ecologist goes fishing. Fish and Fisheries 4: 359-370.

Quetglas A., Guijarro B., Ordines F. and Massutí E. (2012) Stock boundaries for fisheries assessment and management in the Mediterranean: the Balearic Islands as a case study. Scientia Marina, 76(1): 17-28.

Ragonese S., Bianchini M.L. (1995). Size at sexual maturity in red shrimp females, Aristaeomorpha foliacea, from the Sicilian Channel (Mediterranean Sea). Crustaceana, 68 (1): 73-82.

Ragonese S., Andreoli M.G., Bono G., Giusto G.B., Rizzo P., Sinacori G., 2004. Overview of the available biological information on demersal resources of the Strait of Sicily. MedSudMed Technical Documents 2: 67-74.

Ragonese S., Abella A., Fiorentino F., Spedicato M.T. 2006. Metodi per la stima del tasso istantaneo di mortalità naturale (M) nella scienza alieutica con particolare riferimento alla realtà mediterranea. Biol. Mar. Medit., 13 (3): 151 pp.

Ratz, H.J, Cheilari, A and Lleonart, J. On the performance of fish stock parameters derived from VIT pseudo-cohort analysis. sci. maR., 74(1), march 2010, 155-162. issn 0214-8358 doi: 10.3989/scimar.2010.74n1155.

Reale B., Sartor P., Ligas A., Viva C., Bertolini D., de Ranieri S., Belcari P. (2005) – Demersal species assemblage on the Leptometra phalangium (J. Müller, 1841) (Echinodermata; Crinoidea) bottoms of the Northern Tyrrhenian Sea. Biol. Mar. Mediterr., 12 (1): 571-574.

Relini, G., Bertrand, J., Zamboni, A. (eds.) (1999) Synthesis of the knowledge on bottom fishery resources in Central Mediterranean (Italy and Corsica). Biol. Mar. Medit., 6 (suppl. 1).

Roa-Ureta R.H. 2012. Modeling in-season pulses of recruitment and hyperstability- hyperdepletion in the *Loligo gahi* fishery around the Falkland Islands with generalized depletion models. ICES J. Mar. Sci. 69: 1403-1415.

Roa-Ureta R.H. 2104. Stock assessment of the Spanish mackerel (*Scomberomorus commerson*) in Saudi waters of the Arabian Gulf with generalized depletion models under data-limited conditions. Fish. Res. http://dx.doi.org/10.1016/j.fishres.2014.08.014

Royer J., Pierce G. J., Foucher E., Robin J. P. 2006. The English Channel stock of *Sepia officinalis*: Modelling variability in abundance and impact of the fishery. Fish. Res. 78: 96-106.

Russo T., Parisi A., Cataudella S., 2011. New insights in interpolating fishing t acks from VMS data for different métiers. Fisheries Research, 108: 184–194.

Sbrana M., Viva C., Belcari P. – 2006 - Fishery of the deep-water rose shrimp Parapenaeus longirostris (Lucas, 1846) (Crustacea: Decapoda) in the northern Tyrrhenian Sea (western Mediterranean). Hydrobiology. Vol. 184, 2006, pp 135-144

Samed, 2002. Stock Assessment in the MEDiterranean. European Commission – DG XIV, Project 99/047 – Final Report. Scientific, Technical and Economic Committee for Fisheries. Assessment of Mediterranean Sea stocks -part 2 (STECF-11-14).

Sampedro, P., Saínza, M. and V. Trujillo (2005). A simple tool to calculate biological parameters' uncertainty. Working Document in Workshop on Sampling Design for Fisheries Data (Pasajes, 2005).

Santojanni A., Angelini S., Belardinelli A., Carpi P., Cingolani N., Colella S., Croci C., Donato F., Martinelli M., Panfili M., 2012. Final report CAMPBIOL project: national program for the collection of halieutic data (Reg. CE 199/2008).

Saraux C., Fromentin J.M., Bigot J.L., Bourdeix J.H., Morfin M., Roos D., VanBeveren E. & Bez N. Spatial structure and distribution of small pelagic fish in the NorthWestern Mediterranean Sea. *PLoS One* 9(11): e111211.

Šarčević M., 1992. Ocjena obimnosti i biološke razine dopuštenog iskorištavanja populacije škampa (*N. norvegicus*) u Jabučkoj kotlini. Master thesis. Sveučilište u Zagrebu. 72 p.

Sardà F., Lleonart J., Cartes J.E., 1998. An analysis of the population dynamics of *N. norvegicus* (L.) in the Mediterranean Sea. Scientia Marina, 62 (Suppl.1): 135-143.

Sardà, Aguzzi 2011. A review of burrow counting as an alternative to other typical methods of assessment of Norway lobster populations. Rev Fish Biol Fisheries (2012) 22:409–422.

Sartor P., Sbrana M., Reale B., Belcari P. – 2003 – Impact of the deep sea trawl fishery on demersal communities of the Northern Tyrrhenian Sea (Western Mediterranean). – J. Northw. Atl. Fish. Sci., vol. 31, pp. 275-284.

Saville A., 1977. Survey methods of appraising fishery resources. FAO Fish. Tech. Pap., 171: 1-76.

SGMED-12-10 (2012). Report of the Scientific, Technical and Economic Committee for Fisheries of Mediterranean Sea stocks – Part 1 (STECF-12-10). EUR 25602 EN – Joint Research Centre – Institute for the Protection and Security of the Citizen. 498 pp.

Simmonds J. & MacLennan D. 2005. Fisheries Acoustics, Theory and Practice, 2nd edn. Oxford: Blackwell Publishing, 437 pp.

Sinovčić G. (1983) - Fecundity of sardine, *Sardina pilchardus* (Walb.) from the central Adriatic. *Nova Thalassia*, **6**: 351-363.

Sinovčić G. (1984) - Summary of biological parameters of sardine, Sardina pilchardus (Walb.), from the Central Adriatic. FAO Fish. Rep., 290:147-148.

Sinovčić G. (2000) - Responsible exploitation of the sardine, Sardina pilchardus (Walb.), population in the coastal region of the eastern Adriatic. Periodicum Biologorum, 102: 47-54.

Sinovčić G., Zorica B., Franicevic M., Cikes KEC V. (2003) - First sexual maturity of sardine, Sardina pilchardus (Walb.) in the eastern Adriatic Sea. Periodicum Biologorum, 105: 401-404.

Spedicato M.T., Lembo G., Carbonara P., Silecchia T. (1994). Biological parameters and dynamics of Aristaeomorpha foliacea in Southern Tyrrhenian Sea. In: M. L. Bianchini and S. Ragonese, S. (eds.), Life Cycles and Fisheries of the Deep-water Red Shrimps Aristaeomorpha foliacea and Aristeus antennatus. N.T.R. - I.T.P.P. Spec. Publ., 3: 35-36.

Tuck I.D., Atkinson R.J.A., Chapman C.J., 2000. Population biology of the Norway lobster, *N. norvegicus* (L.) in the Firth of Clyde, Scotland. II: fecundity and size at onset of sexual maturity. ICES Journal of Marine Science 57: 1227-39

Tuck I.D., Chapman C.J., Atkinson R.J.A., 1997a. Population biology of the Norway lobster, *N. norvegicus* (L.) in the Firth of Clyde, Scotland. I. Growth and density. ICES Journal of Marine Science, 54: 125-135.

Ungaro, N., Marano, G., Marsan, R., Pastorelli, A.M., (1999) On the reproduction of Nephrops norvegicus (L.) in the Southern Adriatic Sea (Mediterranean Sea): sex ratio, maturity length and potential fecundity. Crustacean Issues, 12: 553-561.

Van Beveren E., Bonhommeau S., Fromentin, J.M., Bigot J.L., Bourdeix J.H., Brosset P., Roos D. & Saraux C. 2014. Rapid changes in growth, condition, size and age of small pelagic fish in the Mediterranean. *Marine Biology* 161: 1809-1822.

Vrgoć N., Arneri E., Jukić Peladić S., Krstulović Š., Mannini P., Marčeta B., Osmani K., et al., 2004. Review of current knowledge on shared demersal stocks of the Adriatic Sea. AdriaMed Technical Documents, 12. 91 pp.

White R.G., Hill A.E., Jones D.A., 1988. Distribution of *N. norvegicus* (L.) larvae in the western Irish Sea: an example of advective control on recruitment. Journal of Plankton Research 10: 735-47

12. CONTACT DETAILS OF STECF MEMBERS AND EWG-14-19 LIST OF PARTICIPANTS

Information on STECF members and invited experts' affiliations is displayed for information only. In some instances the details given below for STECF members may differ from that provided in Commission COMMISSION DECISION of 27 October 2010 on the appointment of members of the STECF (2010/C 292/04) as some members' employment details may have changed or have been subject to organisational changes in their main place of employment. In any case, as outlined in Article 13 of the Commission Decision (2005/629/EU and 2010/74/EU) on STECF, Members of the STECF, invited experts, and JRC experts shall act independently of Member States or stakeholders. In the context of the STECF work, the committee members and other experts do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members and invited experts make declarations of commitment (yearly for STECF members) to act independently in the public interest of the European Union. STECF members and experts also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: http://stecf.jrc.ec.europa.eu/adm-declarations

STECF members:

Name	Address[1]	Tel.	Email
STECF members			
Abella, J. Alvaro (vice-chair)	ARPAT – AREA MARE Agenzia Regionale per la Protezione Ambientale della Toscana Articolazione Funzionale RIBM Risorse Ittiche e Biodiversità Marina Via Marradi 114, 57126 Livorno – Italia	Tel. 0039-0555-3206956	alvarojuan.abella@arpat.toscana.it
Andersen, Jesper Levring (vice-chair)	Department of Food and Resource Economics (IFRO) Section for Environment and Natural Resources University of Copenhagen Rolighedsvej 25 1958 Frederiksberg Denmark	Tel.dir.: +45 35 28 68 92	jla@ifro.ku.dk
Bailey, Nicholas	Fisheries Research Services Marine Laboratory, P.O Box 101 375 Victoria Road, Torry Aberdeen AB11 9DB UK	Tel: +44 (0)1224 876544 Direct: +44 (0)1224 295398 Fax: +44 (0)1224 295511	baileyn@marlab.ac.uk n.bailey@marlab.ac.uk
Bertignac, Michel	Laboratoire de Biologie Halieutique IFREMER Centre de Brest BP 70 - 29280 Plouzane, France	tel : +33 (0)2 98 22 45 25 - fax : +33 (0)2 98 22 46 53	michel.bertignac@ifremer.fr
Cardinale, Massimiliano	Föreningsgatan 45, 330 Lysekil, Sweden	Tel: +46 523 18750	massimiliano.cardinale@slu.se
Curtis, Hazel	Sea Fish Industry Authority 18 Logie Mill Logie Green Road Edinburgh EH7 4HS	Tel: +44 (0)131 558 3331 Fax: +44 (0)131 558 1442	H_Curtis@seafish.co.uk
Delaney, Alyne	Innovative Fisheries Management, -an Aalborg University Research Centre, Postboks 104, 9850 Hirtshals, Denmark	Tel.: +45 9940 3694	ad@ifm.aau.dk
Daskalov, Georgi	Laboratory of Marine Ecology, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences	Tel.: +359 52 646892	gmdaskalov@yahoo.co.uk

Name	Address[1]	Tel.	Email
STECF members			
Döring, Ralf	Thünen Bundesforschungsinstitut, für Ländliche Räume, Wald und Fischerei, Institut für Seefischerei - AG Fischereiökonomie, Palmaille 9, D-22767 Hamburg, Germany	Tel.: 040 38905-185 Fax.: 040 38905-263	ralf.doering@ti.bund.de
Gascuel, Didier	AGROCAMPUS OUEST 65 Route de Saint Brieuc, bat.4 CS 84215, F-35042 RENNES Cedex France	Tel:+33(0)2.23.48.55.3 4 Fax: +33(0)2.23.48.55.35	Didier.Gascuel@agrocampus-ouest.fr
Graham, Norman (chair)	Marine Institute, Fisheries Science Services (FSS), Rinville, Oranmore, Co. Galway, Ireland	Tel: + 353(0) 91 87200	norman.graham@marine.ie
Garcia Rodriguez, Mariano	Instituto Español de Oceanografía, Servicios Centrales, Corazón de María 8, 28002, Madrid, Spain		Mariano.Garcia@md.ieo.es
Gustavsson, Tore Karl-Erik	Independent Consultant, Göteborg, Sweden		tore.gustavsson@hotmail.com
Jennings, Simon	CEFAS Lowestoft Laboratory, Pakefield Road, Lowestoft Suffolk, UK NR33 0HT	Tel.: +44 1502562244 Fax: +44 1502513865	simon.jennings@cefas.co.uk
Kenny, Andrew	CEFAS Lowestoft Laboratory, Pakefield Road, Lowestoft Suffolk, UK NR33 0HT	Tel.: +44 1502562244 Fax: +44 1502513865	andrew.kenny@cefas.co.uk
Kraak, Sarah	University College Cork Based at: Marine Institute, Rinville, Oranmore, Co Galway, Ireland	Tel: +353 (0)91 387392 Fax +353 (0)91 387201	Sarah.kraak@marine.ie
Kuikka, Sakari	University of Helsinki, Department of Environmental Sciences, P.O. Box 65 (Viikinkaari 1), FI-00014 University of Helsinki, FINLAND	Tel.: +358 50 3309233 Fax. +358-9-191 58754	skuikka@mappi.helsinki.fi
Martin, Paloma	CSIC Instituto de Ciencias del Mar PasseigMarítim, 37-49 08003 Barcelona Spain	Tel: 34.93.2309500 direct line : 34.93.2309552 Fax: 34.93.2309555	paloma@icm.csic.es
Malvarosa, Loretta	NISEA S.c.a.r.l.		malvarosa@nisea.eu
Murua, Hilario	AZTI - Tecnalia / Unidad de Investigación Marina, Herrera kaia portualdea z/g 20110 Pasaia (Gipuzkoa), Spain	Tel: 0034 667174433 Fax: 94 6572555	hmurua@azti.es
Nord, Jenny	The Swedish Agency of Marine and Water Management (SwAM)	Tel. 0046 76 140 140 3	Jenny.nord@havochvatten.se
Nowakowski, Piotr	Maritime University of Szczecin. – Faculty of Food Science and Fisheries, Department of Fishing Technique, Szczecin		npfgd@poczta.onet.pl
Prelezzo, Raul	AZTI - Tecnalia / Unidad de Investigación Marina Txatxarramendi Ugartea z/g 48395 Sukarrieta (Bizkaia), Spain	Tel: 94 6029400 Ext: 406- Fax: 94 6870006	rprellezo@suk.azti.es
Sala, Antonello	Fishing Technology Unit National Research Council (CNR) Institute of Marine Sciences (ISMAR) - Fisheries Section Largo Fiera della Pesca, 1 60125 Ancona - Italy	Tel: +39 071 2078841 Fax: +39 071 55313	a.sala@ismar.cnr.it
Scarcella, Giuseppe	Environmental Management Unit National Research Council (CNR) Institute of Marine Sciences (ISMAR) - Fisheries Section Largo Fiera della Pesca, 1 60125 Ancona - ITaly	Tel: +39 071 2078846 Fax: +39 071 55313	g.scarcella@ismar.cnr.it

Name	Address[1]	Tel.	Email
STECF members			
Somarakis, Stylianos	Department of Biology University of Crete VassilikaVouton P.O. Box 2208 71409 Heraklion Crete Greece	Tel.: +30 2610 394065, +30 6936566764	somarak@biology.uoc.gr
Stransky, Christoph	Thünen Institute [TI-SF] Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Sea Fisheries, Palmaille 9, D-22767 Hamburg, Germany	Tel. +49 40 38905-228 Fax: +49 40 38905-263	christoph.stransky@ti.bund.de
Theret, Francois	Scapêche 17 Bd Abbé Le Cam 56100 Lorient France		ftheret@comata.com
Ulrich, Clara	DTU Aqua, National Institute of Aquatic Resources, Technical University of Denmark, Charlottenlund Slot, JægersborgAllé 1, 2920 Charlottenlund, Denmark		cu@aqua.dtu.dk
Vanhee, Willy	ILVO - Institute for Agricultural and Fisheries Research Unit Animal Sciences - Fisheries Ankerstraat 1, B-8400 Oostende, Belgium	Tel 00-32-59-34-22-55 Fax 00-32-59-33-06-29	willy.vanhee@ilvo.vlaanderen.be
van Oostenbrugge, Hans	LandbouwEconomishInstituut-LEI, Fisheries Section, Burg. Patijnlaan 19 P.O.Box 29703 2502 LS The Hague The Netherlands	Tel:+31 (0)70 3358239 Fax: +31 (0)70 3615624	Hans.vanOostenbrugge@wur.Nl

EWG-14-19 participants:

STECF members			
Name	**Address**	**Tel.**	**Email**
Cardinale, Massimiliano (Chair)	Swedish University Föreningsgatan, 45, 330 Lysekil, Sweden	Tel. +46 523 18750	massimiliano.cardinale@slu.se
Abella, J. Alvaro	ARPAT – AREA MARE, Agenzia Regionale per la Protezione Ambientale della Toscana Articolazione Funzionale RIBM Risorse Ittiche e Biodiversità Marina Via Marradi 114, 57126 Livorno – Italia	Tel. 0039-0555-3206956	alvarojuan.abella@arpat.toscana.it
Martin, Paloma	CSIC Instituto de Ciencias del Mar PasseigMarítim, 37-49 08003 Barcelona Spain	Tel: 34.93.2309500 direct line : 34.93.2309552 Fax: 34.93.2309555	paloma@icm.csic.es
Scarcella, Giuseppe	Environmental Management Unit National Research Council (CNR) Institute of Marine Sciences (ISMAR) - Fisheries Section Largo Fiera della Pesca, 1 60125 Ancona - ITaly	Tel: +39 071 2078846 Fax: +39 071 55313	g.scarcella@ismar.cnr.it

Invited experts			
Name	**Address**	**Tel.**	**Email**
Bitetto, Isabella	COISPA Tecnologia & Ricerca, via dei trulli 18, 70126, Bari, Italy	Tel. +39 080 5433596	bitetto@coispa.it
Carpi, Piera	National Research Council (CNR) ISMAR Largo Fiera della Pesca 60100 Ancona, Italy	Tel. +39071207881 Fax +39071207881	piera.carpi@an.ismar.cnr.it
Colloca, Francesco	University of Rome "laSapienza2 V.le dell'Università, 32 185, Rome, Italy	Tel.+390649914763 Fax +39064958259	francesco.colloca@uniroma1.it
Guijarro, Beatriz	Spanish Institute of oceanography Apt. 291	Tel. +34971133739 Fax +34971404945	beatriz@ba.ieo.es

	7015 Palma de Mallorca Spain		
Mannini, Alessandro	University of Genoa - DISTAV. Corso Europa, 26 zip code 16132, Italy	Tel.+390103538036 Fax +39010357888	Alessandro.Mannini@unige.it
Maynou, Francesc	Institut de Ciències del Mar CSIC, Psg Marítim de la Barceloneta 37-49, 8003, Barcelona, Spain	Tel. +34932309500	maynouf@icm.csic.es
Morello, Elisabetta	CNR-ISMAR, LARGO FIERA DELLA PESCA 2, 60125, Ancona Italy	Tel. +393394746671	betullla.morello@an.ismar.cnr.it
Murenu, Matteo	University of Cagliari (DBAE) Viale Poetto,1 09126 Cagliari, Italy	Tel. +390706758017 Fax +390706758022	mmurenu@unica.it
Orio, Alessandro	Swedish University of Agricultural Sciences, 5, Turistgatan, 45330, Lysekil, Sweden	Tel. +46104784067	alessandro.orio@slu.se
Pengal, Polona	Fisheries Research Institute of Slovenia, Spodnje Gameljne 61a, 1211, Ljubljana-Šmartno, Slovenia	Tel. +386 31 885953	polona.pengal@zzrs.si
Pérez Gil, José Luis	IEO - Spanish Institute of Oceanography, Puerto pesquero S/N, 29640, Fuengirola (Málaga), Spain	Tel. +34 952197124	joseluis.perez@ma.ieo.es
Quetglas, Antoni	Spanish Institute of Oceanography, Apt. 291, 7015, Palma de Mallorca, Spain	Tel. +34971401561	toni.quetglas@ba.ieo.es
Recasens, Laura	Institut Ciències Mar Barcelona (ICM-CSIC) Passeig Marítim 37-49 8191 Barcelona Spain	Tel. +3493 2309563 Fax. +3493 2309555	laura@icm.csic.es
Saraux, Claire	IFREMER, av Jean Monnet, 34200, Sète, France	Tel. +33 (0) 4 99 57 2 50	claire.saraux@ifremer.fr
Sbrana, Mario	Centro Intruniversitario di Biologia Marina Viale Nazario Sauro 4 57128 Livorno, Italy	Tel.+390586260723 Fax.+390586260723	msbrana@cibm.it
Torres, Pedro	Instituto Español de Oceanografia, Puerto Pesquero s/n, 29640, Fuengirola, Spain	Tel. +34952197124	pedro.torres@ma.ieo.es

JRC experts

Name	Address	Telephone no.	Email
Damalas, Dimitrios	Joint Research Centre (IPSC) Maritime Affairs Unit Via E. Fermi, 2749 21027 Ispra (Varese), Italy	Tel.+390332789677 Fax+390332789658	dimitrios.damalas@jrc.ec.europa.eu
Osio, Giacomo Chato	Joint Research Centre (IPSC) Maritime Affairs Unit Via E. Fermi, 2749 21027 Ispra (Varese), Italy	Tel.+390332785948 Fax+390332789658	giacomo-chato.osio@jrc.ec.europa.eu

European Commission

Name	Address	Telephone no.	Email
Perez Perera, Amanda	DG MARE, D2, Rue Joseph II 99/Josef II-straat 99 1000 Brussels	+32 229-59785	Amanda.PEREZ-PERERA@ec.europa.eu

Observers:

None

13. List of Background Documents

Background documents are published on the meeting's web site on: http://stecf.jrc.ec.europa.eu/web/stecf/ewg1419

List of background documents:

1. EWG-14-19 – Doc 1 - Declarations of invited and JRC experts (see also section 10 of this report – List of participants)

European Commission

EUR 27221 EN – Joint Research Centre – Institute for the Protection and Security of the Citizen
Title: Scientific, Technical and Economic Committee for Fisheries. Mediterranean Fisheries Assessments Part 2 (STECF-15-06).

Authors:

STECF members:
Graham, N., J., Abella, J. A., Andersen, J., Bailey, N., Bertignac, M., Cardinale, M., Curtis, H., Daskalov, G., Delaney, A., Döring, R., Garcia Rodriguez, M., Gascuel, D., Gustavsson, T., Jennings, S., Kenny, A., Kraak, S., Kuikka, S., Malvarosa, L., Martin, P., Murua, H., Nord, J., Nowakowski, P., Prellezo, R., Sala, A., Scarcella, G., Somarakis, S., Stransky, C., Theret, F., Ulrich, C., Vanhee, W. & Van Oostenbrugge, H.

EWG-14-19 members:
Cardinale, M. (Chair), Abella, J.A., Martin, P., Scarcella, G., Bitetto, I., Carpi, P., Colloca, F., Guijarro, B., Mannini, A., Maynou, F., Morello, E., Murenu, M., Orio, A., Pengal, P., Pérez Gil, J.L., Quetglas, A., Recasens, L., Saraux, C., Sbrana, M., Torres, P.

JRC experts:
Damalas, D., Osio, G.C.

Luxembourg: Publications Office of the European Union

2015 – 396 pp. – 21 x 29.7 cm

EUR – Scientific and Technical Research series – ISSN 1831-9424 (online), ISSN 1018-5593 (print)

ISBN 978-92-79-48047-8
doi:10.2788/20044

LB-NA-27221-EN-N

STECF

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.

JRC Mission

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

Serving society
Stimulating innovation
Supporting legislation

doi:10.2788/20044

ISBN 978-92-79-48047-8

Publications Office