JRC Scientific and Technical Reports

# Scientific, Technical and Economic Committee for Fisheries (STECF)

# Report of the SGMED-09-03 Working Group on the Mediterranean Part II

**14-18 DECEMBER 2009, Barza d'Ispra (VA), ITALY**

**Edited by Massimiliano Cardinale, Anna Cheilari & Hans-Joachim Rätz**

EUR 24372 EN - 2010

JRC
EUROPEAN COMMISSION

ipsc
Institute for the Protection and Security of the Citizen

The mission of the Institute for the Protection and Security of the Citizen (IPSC) is to provide research results and to support EU policy-makers in their effort towards global security and towards protection of European citizens from accidents, deliberate attacks, fraud and illegal actions against EU policies

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.

European Commission
Joint Research Centre
Institute for the Protection and Security of the Citizen

**Contact information**
Address: TP 051, 21027 Ispra (VA), Italy
E-mail: stecf-secretariat@jrc.ec.europa.eu
Tel.: 0039 0332 789343
Fax: 0039 0332 789658

https://stecf.jrc.ec.europa.eu/home
http://ipsc.jrc.ec.europa.eu/
http://www.jrc.ec.europa.eu/



JRC 58587

EUR 24372 EN
ISBN 978-92-79-15798-1
ISSN 1018-5593
DOI 10.2788/9336

Luxembourg: Office for Official Publications of the European Communities



*Printed in Italy*

## TABLE OF CONTENTS

**SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)**

# STECF COMMENTS ON THE REPORT OF THE SGMED-09-03 WORKING GROUP ON THE MEDITERRANEAN PART II

## Barza d'Ispra (VA), Italy, 14-18th December 2009

**STECF UNDERTOOK THE REVIEW DURING THE PLENARY MEETING**

**HELD IN NORWICH 26-30 APRIL 2010**

## 1. BACKGROUND

The European Community is expected to establish long-term management plans (LTMP) for relevant Mediterranean demersal and small pelagic fisheries, based on the precautionary approach and adaptive management in taking measures designed to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimise the impact of fishing activities on marine ecosystems.

STECF can play an important role in focusing greater contributions for European scientists towards stocks and fisheries assessment, in identifying a common scientific framework regarding specific analyses to advise on Community plans, to be then channeled into or completed by the GFCM working groups.

STECF was requested at its 2007 November plenary session to set up an operational work programme for 2008, beginning in the 1st quarter of 2008, with a view to update the status of the main demersal stocks and evaluate the exploitation levels with respect to their biological and economic production potentials and the sustainability of the stock by using both trawl surveys and commercial catch/landing data as collected through the Community Data Collection regulation N° 1543/2000 as well as other scientific information collected at national level.

The work of STECF's subgroup on Mediterranean continued in 2009 with a dedicated workshop in Murcia, Spain, 2-6 March 2009, the SGMED-09-01 meeting on advice reviews for 2009 for sprat and turbot in the Black Sea in Ranco, Italy, 23-27 March 2009, the report of SGMED-09-02 part I on the historic assessments and management advice regarding historic status of Mediterranean stocks and the present report of SGMED-09-03 part II on short term (2009-2011) and medium term predictions (2009-2018) of stock size and catches under various management options.

## 2. TERMS OF REFERENCE

Terms of reference for the STECF/SGMED-09-03 meeting (14-18/12/2009) were defined as follows:

a) Provide short term and medium term forecasts of stock biomass and yield for the stocks assessed during the SGMED-09-02 meeting in June for the species listed below, under different management options with a view to evaluate the consequences fishing effort/mortality changes on equivalent time scale, by fleets where possible:

- Sardine (*Sardina pilchardus*)

- Anchovy (*Engraulis encrasicolus*)
- European hake (*Merluccius merluccius*)
- Red mullet (*Mullus barbatus*)
- Deep water rose shrimp (*Parapenaeus longirostris*)
- Red shrimp (*Aristeus antennatus*)
- Giant red shrimp (*Aristaeomorpha foliacea*)
- Norway lobster (*Nephrops norvegicus*)
- Common Sole (*Solea solea*)

b) Advise on stock-size dependent harvesting strategies and slope-based approaches decision control rules to avoid risk situations for the stocks while ensuring high fisheries productivity, taking into account the recommendations of the SGMED-09-02 meeting in June and the following STECF comments. Such advice should consider mixed fisheries effects and ecosystem approach to fisheries management.

c) Identify any needs for management measures required to safeguard the production potentials of the stocks assessed.

d) Review the applicability and fully document all applied methodologies for the projections and determination of alternative management approaches.

e) Fully document the data used and their origin for the projections and determination of the proposed biological reference points.

f) Provide and review marine population and community indicators.

g) Based on the "Survey of existing bio-economic models" under Studies and Pilot Projects for carrying out the Common Fisheries Policy No FISH/2007/07 and data made available by MS, review existing bio-economic models for producing advice on possible short-term and long-term economic consequences of the selected harvesting strategies. Evaluate the possibility to use existing bioeconomic models for comparing the proposed harvesting strategies with long-term economic profitability (MEY) of the main fisheries exploiting the assessed stocks.

h) Discrepancies in estimates of growth parameters for several demersal and small pelagic stocks which are likely to be attributed more to differences in methods used to estimate mean length at age and interpretation of ring patterns on otoliths than to genuine differences on growth patterns have been noted by SGMED. STECF has advised to organize a specific workshop on improving ageing accuracy and reduce uncertainty. Define the specific ToR for a methodological workshop to be held in 2011 with the aim of improving the precision and accuracy of individual ageing of exploited stocks as a prerequisite to age-based stock assessments. Such ToR should be forwarded to PGMed or ICES PGCCDBS before March 2010 for review and possible endorsement. This work could also be useful for further methodological standardization in the multilateral framework as also underlined in paragraph 104 of the 33° GFCM report.

i) Suggest adjustments and provide guidance on data needs and quality, on methods and on interpretations, so that SGMED work can further progress in 2010 towards the goals of the overall mandate given to STECF, focusing its attention, in particular, on the various stocks of the following species, which are either included in Appendix VII of the Commission Decision (2008/949/EC) for the Mediterranean and the Black Sea or specifically regulated under the Mediterranean Regulation (Council Regulation (EC) No 1967/2006): European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), Striped red mullet (*Mullus surmuletus*) blue whiting (*Micromesistius poutassou*), common Pandora (*Pagellus erythrinus*), Blackspot seabream (*Pagellus bogaraveo*), Axillary seabream (*Pagellus acarne*), Common sole (*Solea solea*), Horse mackerel (*Trachurus trachurus*), Mediterranean horse mackerel (*Trachurus mediterraneus*), Greater forkbeard (*Phycis blennoides*), Poor cod (*Trisopterus minutus*), Sargo breams (*Diplodus spp.*), Picarel (*Spicara smaris*), Bogue (*Boops boops*), Sea bass (*Dicentrarchus labrax*), Anglerfish (*Lophius piscatorius*), Black-bellied angler (*Lophius budegassa*), Gilthead seabream (*Sparus aurata*), tub gurnard (*Trigla lucerna*), grey gurnard (*Eutrigla gurnardus*), grey mullets (*Mugilidae*), Mackerel (*Scomber spp.*), Common dolphinfish (*Coryphaena hippurus*), Sardine (*Sardina pilchardus*), Anchovy (*Engraulis encrasicolus*), Sprat (*Sprattus sprattus*), Deep-water rose shrimp (*Parapenaeus longirostris*), Norway lobster (*Nephrops norvegicus*), Red shrimp (*Aristeus antennatus*), Giant red shrimp (*Aristaeomorpha foliacea*), caramote prawn (*Penaeus kerathurus*), spottail mantis squillids (*Squilla mantis*), Atlantic bonito (*Sarda sarda*).

k) for each species listed above, provide the following information needed for the different variables of the official data calls:

- length type, length class and length range
- age class interval and age range

l) Additional Term of Reference

The assessment of the status of small pelagic stocks in the Adriatic has been completely changed at the GFCM-SCSA meeting in Malaga on 2 December 2009 last. SGMED is requested to evaluate this new assessment and comment as adequate also in respect to its advice already expressed by SGMED-09-02 of June 2009 last.

SGMED is also requested to:

- evaluate possible consequences on the biological reference points as advised by STECF at the November plenary session

- run the short term forecast taking into account both the previous and most recent assessments for both sardine and anchovy.

## 3. STECF OBSERVATIONS

No specific observations were formulated.

## 4. STECF COMMENTS AND CONCLUSIONS

With the aim of establishing the scientific evidence required to support development of long-term management plans for selected fisheries in the Mediterranean, consistent with the objectives of the Common Fisheries Policy, and to strengthen the Community's scientific input to the work of GFCM, the Commission made a number of requests to STECF.

STECF notes that SGMED 09-03 was able to answer exhaustively to all TORs, with only one exception due to time constraints. In accordance to the ToR, the SGMED 09-03 report deals mainly with the short and medium term forecasts for demersal and small pelagic Mediterranean stocks. Deterministic short and medium term forecasts for stock size and landings under various management scenarios were delivered. Fisheries management advice was provided considering the proposed management reference points $F_{0.1}$ and $F_{msy}$ as applicable.

STECF endorses the calculated forecasts for 2 stocks of anchovy, 2 of sardine, 5 of European hake, 4 of red mullet, 3 of deepwater shrimp and only one for red shrimp, giant red shrimp, Norway lobster, and common sole, respectively. For all of them SGMED-09-02 had previously concluded on analytical assessments and advice regarding stock status and exploitation. All applied methodologies for the short and medium term forecast projections were fully documented as well as the data used and their origin. The layout of the short and medium term forecast was designed to allow scientists and managers to review in a consistent way the data underlying the outputs and the specific issues encountered during the short and medium term forecast, as well as the assumptions made and the management advice. The assessments confirmed the results of the analyses conducted in the previous SGMED meetings, showing a general condition of overfishing for most of the stocks. As for most of the stocks assessed current exploitation rates are larger or much larger than any level of fishing mortality associated with high and sustainable long term yields. Reductions in the catches and fishing mortality are needed in the short term for most of the assessed Mediterranean stocks to improve stock status. Following reductions of fishing mortality and catches in the short term, in the long term improvements in terms of stock status and catches are expected.

STECF welcomes the efforts undertaken by SGMED to improve the quality of stock assessments and recommends increasing the number of stocks to be assessed in each area. STECF recommends the quality and availability of relevant stock assessment data should be further improved and differences in biological parameters used in the different GSAs for the same species being explained or harmonised.

STECF acknowledges the use of bio-economic models for the assessment of the short and medium-term economic consequences of changes in F. They were based on the "Survey of Existing Bio-economic Models" under Studies and Pilot Projects for carrying out the Common Fisheries Policy No FISH/2007/07 and data made available by MS. Existing bio-economic models were used for producing advice on possible short-term and long-term economic consequences of the selected harvesting strategies. The analyses were performed for bottom trawl fisheries in GSA6 and 10. STECF encourages the SGMED group to extend such exercise to other stocks.

STECF notes that SGMED 09-03 identified serious discrepancies between the catches declared to various scientific and Regional Fisheries Management Organizations (ICES, STECF, GFCM, ICCAT, etc.). In particular, significant discrepancies in the average catches of the period 2005-2007, which was used as the reference period by the last RCM Med & BS (6th Regional Coordination Meeting for the Mediterranean and the Black Sea, Venice 13-16 October 2009) for planning and evaluation of the sampling intensity under the provisions of the DCF. STECF recommends that discrepancies in national catch declarations be cross-checked and corrected as a matter of urgency.

**SGMED-09-03 WORKING GROUP REPORT THE MEDITERRANEAN PART II**

**Barza d'Ispra (VA), Italy, 14-18 December 2009**

## 1. EXECUTIVE SUMMARY AND RECOMMENDATIONS

With the aim of establishing the scientific evidence required to support development of long-term management plans for selected fisheries in the Mediterranean, consistent with the objectives of the Common Fisheries Policy, and to strengthen the Community's scientific input to the work of GFCM, the Commission made a number of requests to STECF. The Terms of Reference (TORs) for SGMED-09-03 were extensive and are listed in section 2.1 below.

SGMED 09-03 was able to answer exhaustively to all TORs, with the exception of TOR f. SGMED 09-03 report deals mainly with the short and medium term forecasts for Mediterranean stocks. Deterministic short and medium term forecast for stock size and exploitation, including predicted landings and stock advice, were delivered and long term forecasts provided in order to allow assessments of the stock against established management reference points $F_{0.1}$ and $F_{msy}$.

During the meeting, short and medium term forecast for 20 demersal and small pelagic species/GSA combinations were conducted (ToR a-c) (Table 1.1). The species were anchovy, sardine, European hake, red mullet, deepwater pink shrimp, red shrimp, giant red shrimp, Norway lobster and sole. The assessed GSA covered geographical sub-areas (GSA) from western part of the Mediterranean to Cyprus in the east. Short and medium term forecast were supported by a DCR data call as defined during a previous meeting of SGMED. The layout of the short and medium term forecast was designed to allow scientists and managers to revise in a consistent way the data underlying the outputs and the specific issues encountered during the short and medium term forecast, and review the assumptions made and the management advice. The report includes short and medium term forecast sheets for stocks of anchovy (2), sardine (2), European hake (5), red mullet (4), deepwater shrimp (3), red shrimp (1), giant red shrimp (1), Norway lobster (1) and sole (1) for which SGMED-09-02 concluded on definitive assessments and gave advice (Tables 1.2 and 1.3).

**TORs a-c**: The assessment confirmed the results of the analyses already conducted in the previous SGMED, showing a general condition of overfishing for most of the stocks (Table 1.4). The stock status was evaluated against F reference points and in this context $F_{0.1}$ was considered as the most reliable proxy of $F_{msy}$. As for most of the stocks assessed current exploitation rates are larger or much larger than any level of fishing mortality associated with long term sustainable targets, reductions in the catches are needed in the short term for most of the Mediterranean stocks. However, available analyses shows that following reductions of fishing mortality and catches in the short term, long term gain are possible both in terms of catches, improvement of the stock status and its size structure.

**TORs d-e**: All applied methodologies for the short and medium term forecast projections were fully document as well as the data used and their origin. Short and medium term forecast were conducted using R scripts and details of the scripts are available at the STECF web site.

**TORs g**: Based on the "Survey of existing bio-economic models" under Studies and Pilot Projects for carrying out the Common Fisheries Policy No FISH/2007/07 and data made available by MS, existing bio-economic models were used for producing advice on possible short-term and long-term economic consequences of the selected harvesting strategies. The analyses shows that financial profits of the GSA 06 trawl fleet are negative at present and are likely to remain negative under any harvesting strategy. However, harvesting strategies aiming at reducing fishing mortality by 25%, 50% or 75% would allow decreasing the losses of the trawl fleet in the long-term. Naturally, these F-reduction scenarios would imply additional financial losses in the short-term (2009-2011) but it is undoubt that the trawl fishery in GSA 06 needs urgent attention to strongly reduce fishing mortality in order to ensure its viability in the long-term.

Economic indicators for the GSA 07 trawl fleet in 2008 show negative profits, but the bioeconomic simulation analysis predicts positive profits under any harvesting strategy in the short- and long-term. This result is directly related to the high catches of hake obtained from the strong recruitment of 2008 and by projecting high constant recruitment in the future. Given the strong dependency of the results of the simulations for GSA 07 trawl on the high recruitment of hake in 2008 and the uncertainty of projecting future recruitment of this species into the future, it is advised to reduce F to $F_{0.1}$ for GSA 07 trawl fishery in order to reduce risks in the long term.

**TORs h**: The TORs for a methodological workshop for improving the precision and accuracy of individual ageing of exploited stocks were defined and agreed by the SGMED and included in the report. The methodological workshop will be held in 2011 and TORs should be forwarded to PGMed or ICES PGCCDBS before March 2010 for review and possible endorsement. Also, detailed TORs for a workshop for the standardization of MEDITS survey indices to estimate trends in stocks and to prepare input files for assessment was proposed by SGMED. The involvement of the FLR Team would be crucial to tailor the scripts. In addition given the mixed levels of scientist proficiency with R, specific training should be given to scientists attending SGMED.

**TORs i**: SGMED-09-03 was requested to evaluate the quality of data used in stock assessment, including the total catch by species by GSA and MS. A table with total catch by species and by MS for the species included in the TORs provided to STECF/SGMED-09-03 and for those included in the DCR/DCF was created. SGMED-09-03 noticed serious discrepancies between the catches declared to various fora and, in particular, with respect to the average of the period 2005-2007, that was used as the reference value by the last RCM Med & BS (6th Regional Coordination Meeting for the Mediterranean and the Black Sea, Venice 13-16 October 2009) for planning and evaluation of the sampling intensity. SGMED-09-03 strongly recommends that individuated discrepancies are cross-checked and corrected as a matter of urgency.

Table 1.1. Summary of the species and GSA areas for which analyses were performed.

| **Species/GSA Area** | **5** | **6** | **7** | **9** | **10** | **11** | **15&16** | **16** | **17** | **22** | **25** | **27** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Merluccius merluccius* | X | X | X | X | X | | | | | | | |
| *Mullus barbatus* | | | X | X | | X | | | | | X | |
| *Parapenaeus longirostris* | | X | | X | | | | X | | | | |
| *Engraulis encrasicolus* | | | | | | | | X | | X | | |
| *Sardina pilchardus* | | | | | | | | X | | X | | |
| *Solea solea* | | | | | | | | | X | | | |
| *Aristeus antennatus* | | X | | | | | | | | | | |
| *Aristaeomorpha foliacea* | | | | | | | X | | | | | |
| *Nephrops norvegicus* | | | | X | | | | | | | | |

Table 1.2. Change (in %) of the catch for the period 2008-2011, for the different stocks, if fishing at $F_{stq}$ and at $F_{0.1}$ or E=0.4 (in parenthesis).

| **Species/GSA Area** | **5** | **6** | **7** | **9** | **10** | **11** | **15+16** | **17** | **22** | **25** |
|---|---|---|---|---|---|---|---|---|---|---|
| *Merluccius merluccius* | -38.5 (-69) | +329 (-42) | +134 (+69) | +5 (-162) | -7 (-49) | | | | | |
| *Mullus barbatus* | | | -5 (-33) | +74 (+21) | | -24 (-75) | | | | +1 (-64) |
| *Parapenaeus longirostris* | | +65 | | +39 (+58) | | | | | | |
| *Engraulis encrasicolus* | | | | | | | | | -22 (+25) | |
| *Sardina pilchardus* | | | | | | | | | +8 (-28) | |
| *Solea solea* | | | | | | | | +15 (-60) | | |
| *Aristeus antennatus* | | -25 (-79) | | | | | | | | |
| *Aristaeomorpha foliacea* | | | | | | | -10.5 (-49) | | | |
| *Nephrops norvegicus* | | | | -4 (-61.5) | | | | | | |

Table 1.3. Change (in %) of the SSB for the period 2010-2011, for the different stocks, if fishing at $F_{stq}$ and at $F_{0.1}$ or E=0.4 (in parenthesis).

| **Species/GSA Area** | **5** | **6** | **7** | **9** | **10** | **11** | **15+16** | **17** | **22** | **25** |
|---|---|---|---|---|---|---|---|---|---|---|
| *Merluccius merluccius* | -19 (+77) | -1.5 (+387) | +35 (+53) | -8 (+119) | -4 (+16) | | | | | |
| *Mullus barbatus* | | | -7 (+14) | -10 (+8) | | -1.5 (+51) | | | | +0.5 (+40) |
| *Parapenaeus longirostris* | | +9 | | -4 (-8) | | | | | | |
| *Engraulis encrasicolus* | | | | | | | | | -12 (-25) | |
| *Sardina pilchardus* | | | | | | | | | -1 (+11) | |
| *Solea solea* | | | | | | | | -0.3 (+179) | | |
| *Aristeus antennatus* | | -2 (+123) | | | | | | | | |
| *Aristaeomorpha foliacea* | | | | | | | -0.4 (+45) | | | |
| *Nephrops norvegicus* | | | | +0.5 (+28) | | | | | | |

Table 1.4. State of the exploitation (O: overexploited, S: sustainable exploited) by species and GSA areas for which short term projections were performed during SGMED 09-03.

| **Species/GSA Area** | **5** | **6** | **7** | **9** | **10** | **11** | **15&16** | **16** | **17** | **22** | **25** | **27** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Merluccius merluccius* | O | O | O | O | O | | | | | | | |
| *Mullus barbatus* | | | O | O | | O | | | | | O | |
| *Parapenaeus longirostris* | | | | S | | | | | | | | |
| *Engraulis encrasicolus* | | | | | | | | O | | S | | |
| *Sardina pilchardus* | | | | | | | | S | | O | | |
| *Solea solea* | | | | | | | | | O | | | |
| *Aristeus antennatus* | | O | | | | | | | | | | |
| *Aristaeomorpha foliacea* | | | | | | | O | | | | | |
| *Nephrops norvegicus* | | | | O | | | | | | | | |

## 2. INTRODUCTION

The European Community is expected to establish long-term management plans (LTMP) for relevant Mediterranean demersal and small pelagic fisheries, based on the precautionary approach and adaptive management in taking measures designed to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimise the impact of fishing activities on marine ecosystems.

STECF can play an important role in focusing greater contributions for European scientists towards stocks and fisheries assessment, in identifying a common scientific framework regarding specific analyses to advise on Community plans, to be then channeled into or completed by the GFCM working groups.

STECF was requested at its November plenary session to set up an operational work programme for 2008, beginning in the 1$^{st}$ quarter of 2008, with a view to update the status of the main demersal stocks and evaluate the exploitation levels with respect to their biological and economic production potentials and the sustainability of the stock by using both trawl surveys and commercial catch/landing data as collected through the Community Data Collection regulation N° 1543/2000 as well as other scientific information collected at national level.

To address the requests, the STECF Subgroup on the Mediterranean (SGMED-09-03) for demersal and small pelagic stocks met in Barza d'Ispra (VA), Italy, from 14-18$^{th}$ December 2009. The meeting was opened at 9:00 am on the 14$^{th}$, and closed at 16:00 on the 18$^{th}$. The meeting built upon the work performed during SGMED meetings conducted during 2008 and 2009 to pursue the Commission's requests, in particular upon the work of SGMED 09-02, 8-12 June 2009. During the latest SGMED 09-02 meeting, assessments of trends in historic stock parameters were completed. Such information was taken up by SGMED 09-03 in order to estimate short and medium term projections of stock size and catches for various management options.

Observations to the official data call by DG MARE, data deliveries and data deficiencies are reported in section 3. Experts' presentations related to the ToRs are summarized in section 4. SGMED 09-03 provides in the present report specific stock (by species and GSAs) predictions of stock size, fishing mortality and catches in short term (2009-2011) and medium term (2009-2018) under different management scenarios. These are given in section 5 of this report in the ordering of stocks equal to the previous SGMED 09-02 report and cover ToRs a-e. The methods used (ToR d) are described in detail in Appendix 5 to this report. SGMED 09-03 responses to the remaining ToRs f-k and to the additional ad hoc ToR l are outlined in section 6.

### 2.1. Terms of Reference for SGMED-09-03

The overall terms of reference for the SGMED meetings are listed in Appendix 1. Terms of reference for the STECF/SGMED-09-03 meeting (14-18/12/2009) were defined as follows:

a) Provide short term and medium term forecasts of stock biomass and yield for the stocks assessed during the SGMED-09-02 meeting in June for the species listed below, under different management options with a view to evaluate the consequences fishing effort/mortality changes on equivalent time scale, by fleets where possible:

- Sardine (*Sardina pilchardus*)
- Anchovy (*Engraulis encrasicolus*)
- European hake (*Merluccius merluccius*)

- Red mullet (*Mullus barbatus*)

- Deep water rose shrimp (*Parapenaeus longirostris*)

- Red shrimp (*Aristeus antennatus*)

- Giant red shrimp (*Aristaeomorpha foliacea*)

- Norway lobster (*Nephrops norvegicus*)

- Common Sole (*Solea solea*)

b) Advise on stock-size dependent harvesting strategies and slope-based approaches decision control rules to avoid risk situations for the stocks while ensuring high fisheries productivity, taking into account the recommendations of the SGMED-09-02 meeting in June and the following STECF comments. Such advice should consider mixed fisheries effects and ecosystem approach to fisheries management.

c) Identify any needs for management measures required to safeguard the production potentials of the stocks assessed.

d) Review the applicability and fully document all applied methodologies for the projections and determination of alternative management approaches.

e) Fully document the data used and their origin for the projections and determination of the proposed biological reference points.

f) Provide and review marine population and community indicators.

g) Based on the "Survey of existing bio-economic models" under Studies and Pilot Projects for carrying out the Common Fisheries Policy No FISH/2007/07 and data made available by MS, review existing bio-economic models for producing advice on possible short-term and long-term economic consequences of the selected harvesting strategies. Evaluate the possibility to use existing bioeconomic models for comparing the proposed harvesting strategies with long-term economic profitability (MEY) of the main fisheries exploiting the assessed stocks.

h) Discrepancies in estimates of growth parameters for several demersal and small pelagic stocks which are likely to be attributed more to differences in methods used to estimate mean length at age and interpretation of ring patterns on otoliths than to genuine differences on growth patterns have been noted by SGMED. STECF has advised to organize a specific workshop on improving ageing accuracy and reduce uncertainty. Define the specific ToR for a methodological workshop to be held in 2011 with the aim of improving the precision and accuracy of individual ageing of exploited stocks as a prerequisite to age-based stock assessments. Such ToR should be forwarded to PGMed or ICES PGCCDBS before March 2010 for review and possible endorsement. This work could also be useful for further methodological standardization in the multilateral framework as also underlined in paragraph 104 of the 33° GFCM report.

i) Suggest adjustments and provide guidance on data needs and quality, on methods and on interpretations, so that SGMED work can further progress in 2010 towards the goals of the overall mandate given to STECF, focusing its attention, in particular, on the various stocks of the following species, which are either included in Appendix VII of the Commission Decision (2008/949/EC) for the Mediterranean and the Black Sea or specifically regulated under the Mediterranean Regulation (Council Regulation (EC) No 1967/2006): European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), Striped red mullet (*Mullus surmuletus*) blue whiting (*Micromesistius poutassou*), common Pandora (*Pagellus erythrinus*), Blackspot seabream (*Pagellus bogaraveo*), Axillary seabream (*Pagellus acarne*), Common sole (*Solea solea*), Horse mackerel (*Trachurus trachurus*), Mediterranean horse mackerel (*Trachurus mediterraneus*), Greater forkbeard (*Phycis blennoides*), Poor cod (*Trisopterus minutus*), Sargo breams (*Diplodus spp.*), Picarel (*Spicara smaris*), Bogue (*Boops boops*), Sea bass (*Dicentrarchus labrax*), Anglerfish (*Lophius piscatorius*), Black-bellied angler (*Lophius budegassa*), Gilthead seabream (*Sparus aurata*), tub gurnard (*Trigla lucerna*), grey gurnard (*Eutrigla gurnardus*), grey mullets (*Mugilidae*), Mackerel (*Scomber spp.*), Common dolphinfish (*Coryphaena hippurus*), Sardine (*Sardina pilchardus*), Anchovy (*Engraulis encrasicolus*), Sprat (*Sprattus sprattus*), Deep-water rose shrimp (*Parapenaeus longirostris*), Norway lobster (*Nephrops norvegicus*), Red shrimp (*Aristeus antennatus*), Giant red shrimp (*Aristaeomorpha foliacea*), caramote prawn (*Penaeus kerathurus*), spottail mantis squillids (*Squilla mantis*), Atlantic bonito (*Sarda sarda*).

k) for each species listed above, provide the following information needed for the different variables of the official data calls:

- length type, length class and length range

- age class interval and age range

l) Additional Term of Reference

The assessment of the status of small pelagic stocks in the Adriatic has been completely changed at the GFCM-SCSA meeting in Malaga on 2 December 2009 last. SGMED is requested to evaluate this new assessment and comment as adequate also in respect to its advice already expressed by SGMED-09-02 of June 2009 last.

SGMED is also requested to:

- evaluate possible consequences on the biological reference points as advised by STECF at the November plenary session

- run the short term forecast taking into account both the previous and most recent assessments for both sardine and anchovy.

## 2.2. Participants

The full list of participants at SGMED-09-03 is presented in Appendix 2.

## 3. SUMMARY OF DATA PROVIDED FOR THE MEDITERRANEAN THROUGH THE DCF CALL

### 3.1. Data call and delivery

On the 20th of May 2009 DG MARE launched an official call for data on landings, catches, length and age compositions, fishing effort, trawl and hydroacoustic surveys in the Mediterranean Sea. Member states were invited to provide, as soon as possible and no alter than 8 June 2009, data to the Commission and to the scientists that would attend the forthcoming STECF-SGMED-09-02 meeting. Further data on more stocks and on the 2009 surveys were expected to be uploaded before 24 November 2009 to be available to the SGMED-09-03 meeting.

An overview of the data provided to the SGMED-09-03 meeting by country is presented in Table 3.1.

In 2009, SGMED-09-02 experienced significant difficulties in the timing of the DCF data call and the data deliveries by Member States. For the second delivery date, mainly data from the scientific surveys were provided by the member states. However, some member states managed to update the fisheries data with information on more species.

In addition, some national data deliveries hardly met minimum standards requested in the data call regarding deadlines, inconsistent codification and units of data. This caused extra work and intersessional cooperation on all levels from data receipt, quality checking, data access and evaluation. SGMED recommends appropriate time be allowed for such processing of data. In addition and in accordance with the provivions of the DCF to allow appropriate data preparation by Member States, SGMED recommends future data calls be issued at least 2 months in advance of assessment meetings.

### 3.2. Data review and observed deficiencies

SGMED 09-03 identified the following data inconsistencies:

Red mullet in GSA 11: The landings appear incompletely reported as the very limited fraction of the passive gears segments (hooks,. lines and nets) seems to be unrealistic,. given that the fishing effort of the small scale fishery (DCR data) is almost as high as the effort of the trawlers. Furthermore, discarding is very low and the length range of red mullet size in the discard is expected to be less wide than those reported in the official data (i.e. 6-17 cm).

Hake in GSA 06 and 07: The landings were incompletely reported by fleet. Reporting the landings by fleet is important in species such as hake where the SSB is mainly caught by gillnets and longlines, whereas juveniles are mainly caught by trawlers. In the case of Spain, no data from GSA 07 were available from the data call. When a species is exploited by different fishing gears and fleets from different countries, as hake in GSA 07, it is necessary that each Member State involved in the fishery submits all the relevant information. The reported hake landings for GSA 06, 05 and 01 only covered bottom trawl. In GSA 06 hake is also targeted by longlines and gillnets.

Several GSAs: When countries report landings by fleet, there are still some errors in the data that need to be corrected. For example, in some few cases (Malta and Italy), *Mullus surmuletus* and *Sardina pilchardus* are reported to be caught by longlines, which is practically impossible taking into account the biology and feeding behaviour of the species. Similarly, anchovy is said sometimes to be caught by traps (e.g. Italy), which is also practically impossible. These errors need to be corrected since in some cases it is important to conduct the analyses by fleet.

During SGMED-09-03, discrepancies between the MEDITS data set available to the SGMED for GSA 17 and data presented on SCSA (Malaga, 2009) have been noted. These discrepancies need to be clarified as soon as possible, through contacts with the National correspondents.

Table 3.1. Overview of data provided by country from the DCR call for SGMED-09-03until 14/12/2009 (Black color indicates submitted or updated data for the second delivery date, red color indicates data submitted during the first data delivery deadline, in June).

| REQUESTED FILES | FILENAME | DESCRIPTION | CYPRUS | | FRANCE | | GREECE | | ITALY | | MALTA | SLOVENIA | | SPAIN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fisheries Data** | | | | | | | | no deep water shrimp data, 2007 no data | | | | | only ANE PIL | |
| FILE_1 | M01_MED_LAN | LANDINGS | 2005-08 | MUT, HKE | 2002-08 | | 2003-08 | | 2002-08 | 2004-08 other species | 2005-08 | 2006-07 | | 2002-08 |
| FILE_2 | M02_MED_EFF | EFFORT | 2005-08 | | 2003-08 | | 2003-08 | | 2002-07 | | 2005-08 | 2006-08 | only days | |
| FILE_3 | M03_MED_LAN_LEN | LENGTH_DISTRIBUTION_LANDINGS | 2005-08 | MUT | 2002-08 | | 2003-08 | | 2002-08 | 2006-08 other species | 2003-08 | 2006-08 | | 2002-08 |
| FILE_4 | M04_MED_LAN_AGE | AGE_DISTRIBUTION_LANDINGS | 2005-08 | MUT | 2002-08 | ANE, PIL | 2003-08 | only ANE, PIL | 2002-08 | 2006-08 other species | | | | 2002-08 |
| FILE_5 | M05_MED_MAT | MATURITY_AT_LENGTH | 2006-08 | MUT | 2003-08 | ANE, PIL | | | 2002-08 | | 2003-08 | 2006-08 | | 2002-08 |
| FILE_6 | M06_MED_GRO | GROWTH_PARAMETERS | 2006-08 | MUT | 2002-08 | ANE, PIL, MUR, SBG, MUT, HKE | 2003-08 | | 2002-08 | 2006-08 other species | 2003-08 | 2006-08 | | 2002-08 |
| FILE_7 | M07_MED_SEX | SEX_RATIO | 2006-08 | MUT | 1994-2009 | | 2003-08 | | 2002-08 | 2008 other species | 2002-08 | 2006-08 | | 2002-08 |
| FILE_8 | M08_MED_DIS | DISCARDS | 2006-08 | MUT, HKE | 2003-08 | ANE, PIL, MUT, HKE | | | 2005-08 | GSA 9,10,11,16,19<br>data only for DPS, HKE, MUT | | 2007-08 | | 2002-08 |
| FILE_9 | M09_MED_DIS_LEN | LENGTH_DISTRIBUTION_DISCARDS | 2008 | MUT | 2003-08 | ANE, PIL, MUT, HKE, HMM, HOM | | | 2005-08 | GSA 9,11, 19<br>data only for HKE, MUT | | 2007-08 | | 2005, 2008 |
| **Survey Data** | | | | | | | | | | | | | | |
| FILE_10 | M10_MED_TA | MEDITS_TA | 2005-2009 | | 1994-2009 | | 1994-2008 | no data for 2002, 2007 | 1994-2009 | (GSA17 2002-09, GSA18 1996-2009) | 2003-08 | 1996-09 | -2006 the survey was continued in 2007 and the data are put together | 1994-2009 |
| FILE_11 | M11_MED_TB | MEDITS_TB | 2005-2009 | | 1994-2009 | | 1994-2008 | no data for 2002, 2007 | 1994-2009 | (GSA17 2002-09, GSA18 1996-2009) | 2003-08 | 1996-09 | -2006 | 1994-2009 |
| FILE_12 | M12_MED_TC | MEDITS_TC | 2005-2009 | | 1994-2009 | | 1994-2008 | no data for 2002, 2007 | 1994-2009 | (GSA17 2002-09, GSA18 1996-2009) | 2003-08 | 1996-09 | -2006 | 1994-2009 |
| FILE_13 | M13_MED_SP_LEN | | | | 1998-2008 | | 2003-08 | no data 2007 | 2009 | GSA 16 | | | | 2002-2009 |
| FILE_14 | M13_MED_SP_AGE | | | | 2002-08 | -2004 | 2003-08 | no data 2007 | 2009 | GSA 16 | | | | 2002-2009 |
| FILE_15 | M13_MED_SP_MAT | | | | 2005-08 | | | | | | | | | 2002-2009 |
| **Economic** | | | | | | | | | | | | | | |
| FILE_16 | CAPACITY | | 2005-07 | | 2002-07 | | | | 2002-07 | | 2006-08 | 2006-07 | | |
| FILE_17 | EMPLOYMENT | | 2005-07 | | 2005-07 | | | | 2002-07 | | 2006 | 2006-07 | | |
| FILE_18 | REVENUES | | 2005-07 | | 2005-07 | | | | 2002-07 | | 2005-06 | 2007 | | |
| FILE_19 | FINANCIAL POSITION | | 2005 | | 2005-07 | | | | 2002-07 | | NO DATA | 2006-07 | | |
| FILE_20 | PRICE | | 2005-07 | | 2002-07 | | | | 2002-03 | | 2005-08 | 2006-07 | | |

### 3.3. Data provision policy

Working Group members were reminded that data collected under the DCF call and supplied to SGMED-09-03 for all GSAs could not be used outside the meeting. Requests will be made to relevant country contacts to allow the data to be stored by the EU to enable future assessments under the auspices of SGMED or related groups to be performed without the need to produce further DCF calls.

## 4. ABSTRACTS OF WORKING DOCUMENTS (WD)

### 4.1. WD 1: Effect of the current fishing regime on the structure and productivity of Mediterranean stocks: hake as a case study

By Francesco Colloca & Massimiliano Cardinale

We revised the current status of hake stocks in the Mediterranean Sea comparing the current productivity in different GSA in terms of yield, length composition and biomass at the sea, with the productivity of the same stocks under two different simulated fishing regimes:

- $F_{01}$ scenario;
- F at $L_{opt}$ scenario.

$F_{0.1}$ aims for fishing stocks at the maximum sustainable yield (European Commission, 2006) and it is in line with directives agreed under the framework of the Johannesburg convention. F at $L_{opt}$ is an alternative regime proposed by Froese *et al*., (2008) where the same catch as obtained under the $F_{0.1}$ regime is taken after growth in weight and cohort biomass have reached their maximum (Beverton and Holt, 1957). Fishing at $L_{opt}$ allows the stock to express its full growth potential as well as accounting the objective of the Ecosystem Based approach to Fisheries Management (EBFM). This implies combining single species management targets (i.e. exploiting stocks at maximum sustainable yield) with specific goals as maintaining or restore an healthy trophic structure (community size structure) and community diversity.

We used population parameters and exploitation rates data included into working group reports of SGMED and GFCM-SCSA. The results shows that current yield for hake Mediterranean stocks is 2-7 times lower than the yield obtained under a $F_{0.1}$ or F at $L_{opt}$ exploitation regime. Also, current F determines a population with a truncated size distribution while F at $L_{opt}$ allows exploiting the stock at the MSY and rebuilding its un-fished population structure.

### 4.2. WD 2: Review of assessment of anchovy and sardine in GSA 17

By Vjekoslav Ticina

A comparison between VPA stock assessments of anchovy and sardine stocks in GSA 17 previously reviewed by SGMED-09-02, and improved assessments recently presented to GFCM-SAC-SCSA in Malaga, 2009 (Source: http://151.1.154.86/GfcmWebSite/SAC/SCSA/2009/docs.html) and carried out within framework of FAO AdriaMed Project, were presented. Differences in input data (i.e. improved data sets), new tuning series used (new acoustic stock estimates), as well as use of natural mortality vector calculated by Gislason's equation in accordance with SGMED-09-01 advice were highlighted and new assessments outputs were presented and discussed. Furthermore, there were proposed several suggestions for further improvements, in the near future such as: use of $L_{inf}$ as adviced by SGMED-09-01, inclusion of all data from fisheries exploiting small pelagics fish stocks in assessment (i.e. data on fry fisheries estimated from

SARDONE Project), combine GSA 17 and GSA18 (i.e. entire stock distribution area), as well as to use MEDIAS survey data from the Eastern part of the Adriatic Sea.

### 4.3. WD 3: Coincidence between trends in MEDITS biomass indices and landings of selected demersal Mediterranean stocks and its potential use for data validation and short term predictions

By Anna Cheilari & Hans-Joachim Rätz

Inconsistencies between the data series of survey biomass indices and landings usually form the basis of conflicting stock status perceptions of fishermen and scientists. Annual landings and survey biomass indices (2002-2008) are found correlated (r>0.5) for 2 Mediterranean hake stocks (by GSAs) out of 15 provisionally assessed. Also 2 out of 14 red mullet stocks, 6 out of 13 pink shrimp, 3 out of 9 blue and red shrimp, 4 out of 8 giant red shrimp stocks and 3 out of 13 Norway lobster stocks show close and positive correlations between annual landings and survey indices. Lacking coincidence indicate either that the survey results don't reflect the changes in stock abundance or that the fisheries data are doubtful. The inconsistencies between the data series of survey biomass indices and landings should be explored in detail in order to support the dialog between scientists and stakeholders.

The significant regressions between the survey biomass indices of hake, red mullet, pink shrimp, blue and red shrimp, giant red shrimp and Norway lobster in certain GSAs and the annual landings of the following year should be used to provide some quantitative guidance to the fisheries managers and stakeholders about likely developments of landings in the present and the near future years. The need of in-season information about MEDITS biomass indices in order to provide short term outlook regarding the likely range of landing possibilities under the option of status quo fishing effort in data poor situations and to validate results of age structured model results is underlined. The consequence for the optimum timing of future SGMED sub-group meetings is discussed.

### 4.4. WD 4: Improvement of the ICA stock assessment of sardine in GSA 22

By Marianna Giannoulaki

Improved assessment presented and endorsed by the SGMED-03-09 was based on the same methodology and assumptions that were applied in the sardine assessment applied during SGMED-02-09. Furthermore, ICA was based on commercial catch data (2000-2008) and biomass estimates from acoustic surveys over the period 2003-2006 and 2008 were used as tuning indices. Sardine data concerned annual sardine landings, annual sardine catch at age data (2000-2008), mean weights at age, maturity at age and the results of acoustic surveys as presented in SGMED-03-09. The abundance at age and the weight at age in the catch has been re-estimated as the interpretation of ring patterns on otoliths for the landings data from 2000-2008 has been revised by the Hellenic Centre for Marine. Similarly, the abundance at age and the weight at age in the stock has been re-estimated as the interpretation of ring patterns on otoliths for survey data from 2003-2008 has been revised by the Hellenic Centre for Marine Research.

Concerning natural mortality values, the same natural mortality values that were applied in SGMED-02-09 estimated per age group but constant for all years based on ProBiom (Abella *et al.*, 1997) was applied. New abundances per age groups for the landings and the stock as well as mean weight per age group in the landings and the stock are presented in the updated summary sheet. The graphical diagnostics of the model generally indicated good model fit. Residual plots for recent years showed no strong deviations from separability. SSQ plot (possibly indicated some degree of inconsistency between the model and the indices (minima not fairly close to each other on x-axis, Needle (2000)) but the model fit was considerably inproved compared to the assessment applied in the SGMED-02-09. Improvement was apparent in terms of reduction of the residuals, the estimation of the catchability of the surveys, SSQ plot and CVs which around 20%

indicating good model fit (Needle 2000). Furthermore, estimation of the recruitment in the terminal year 2008 which was overestimated in the pervious assessment was re-estimated into a lower, more realistic level. The output of the improved assessment is presented in the updated summary sheet.

Based on ICA results, the mean fishing mortality (averaged over ages 1 to 3) was highly variable but showed a clear decreasing trend since 2006, amounting approximating 0.8 in 2008. The mean F/Z has declined from 2003 reaching the value of 0.51 which is over the exploitation reference points (E<0.4, Patterson 1992) suggested by SGMED for small pelagics. Given the current high exploitation rates, SGMED recommends that fishing mortality should be reduced towards F/Z= 0.4 in order to promote stock recovery and avoid future loss in stock productivity and landings. Sardine stock should be monitored on an annual basis. The management of the sardine fishery requires mixed fisheries implications to be considered, mainly with anchovy.

# 5. ToRs A-E: Stock specific short and medium term predictions of stock parameters and catches

## 5.1. European hake (*Merluccius merluccius*) in GSA 5

### *5.1.1. Short term prediction 2009-2011*

#### 5.1.1.1. Method and justification

A deterministic short term prediction for 2009 to 2011 was performed using the EXCEL workbook provided by JRC IPSC (H.-J. Rätz), which take into account the catch and landings in numbers and weight and the discards, and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994) stock assessment presented at the 11th Session of Sub-Committee on Stock Assessment (SCSA) of the GFCM (Málaga, Spain, 30 Nov- Dec 2009; http://151.1.154.86/GfcmWebSite/SAC/SCSA/2009/StockAssessmentForms/SCSA_2009_HKE_GSA05_IEO.pdf).

#### 5.1.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the hake stock in GSA 5:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|---|
| 2005-2008 | Prop. Matures | 0 | 0.05 | 0.56 | 0.89 | 0.98 | 1 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5+ | Mean 0-4 |
|---|---|---|---|---|---|---|---|---|
| 2005-2008 | M | 1 | 0.70 | 0.50 | 0.40 | 0.40 | 0.40 | 0.60 |

*F vector*

| F | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| 2005 | 0.15 | 1.08 | 0.80 | 1.29 | 0.80 | 0.80 |
| 2006 | 0.26 | 1.38 | 1.07 | 0.73 | 0.93 | 0.93 |
| 2007 | 0.03 | 1.03 | 1.47 | 0.94 | 0.98 | 0.98 |
| 2008 | 0.17 | 1.14 | 0.96 | 1.15 | 1.03 | 1.03 |

*Weight-at-age in the stock*

| Mean weight in stock (kg) | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| 2005-2008 | 0.016 | 0.065 | 0.203 | 0.438 | 0.777 | 1.377 |

*Weight-at-age in the catch*

| Mean weight in catch (kg) | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| 2005-2008 | 0.016 | 0.065 | 0.203 | 0.438 | 0.777 | 1.377 |

*Number at age in the catch*

| Catch at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| 2005 | 353 | 806 | 129 | 39 | 4 | 2 |
| 2006 | 353 | 1016 | 173 | 35 | 6 | 2 |
| 2007 | 30 | 477 | 166 | 35 | 13 | 6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2008 | 183 | 442 | 103 | 21 | 9 | 8 |

*Number at age in the stock*

| Stock at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| 2005 | 3150 | 1539 | 295 | 68 | 9 | 5 |
| 2006 | 1921 | 1709 | 331 | 84 | 12 | 5 |
| 2007 | 1332 | 932 | 271 | 72 | 25 | 12 |
| 2008 | 1501 | 817 | 210 | 39 | 18 | 16 |

Different scenarios of constant harvest strategy with reduction of the mean F ($F_{bar}$ ages 1-3) calculated as the average ages 1 to 3 in 2008 was used and defined as F status quo ($F_{stq}$ = 1.08)

*Stock recruitment*

Recruitment (class 0) has been estimated as the geometric mean of the class 0 estimated from 1980 to 2008.

5.1.1.3. Results

**Short-term implications**

A short term projection (Table 5.1.1.3.1), assuming an $F_{stq}$ of 1.08 in 2009 and a recruitment of 1916 (thousand) individuals, shows that:

- Fishing at the $F_{stq}$ (1.08) generates a decrease of the catch of 38% from 2008 to 2011 along with a decrease of the spawning stock biomass of 19% from 2010 to 2011.

- Fishing at $F_{0.1}$ (0.23) for the same time frame (2008-2011) generates a decrease of the catch for 69% in 2011 and a spawning stock biomass increase by 77% from 2010 to 2011.

**Outlook until 2011**

Table 5.1.1.3.1 – Short term forecast in different F scenarios computed for hake in GSA 5.

Basis: F(2009) = mean($F_{bar}$0-2 2008); Catch (2009): 69 t; R(2009) = GM(1980–2008) = 1916 (thousands); F (2009) = 1.08; SSB(2010) = 43 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2008-2011 (%) |
|---|---|---|---|---|---|---|---|
| zero catch | 0.00 | 0.0 | 0 | 0 | 95 | 120.9 | -100 |
| High long-term yield ($F_{0.1}$) | 0.23 | 0.25 | 17 | 24 | 172 | 76.7 | -68.6 |
| Status quo | 1.08 | 1.0 | 52 | 47 | 35 | -18.6 | -38.5 |
| Different scenarios | 0.1083 | 0.1 | 7 | 14 | 95 | 102.3 | -81.7 |
| | 0.2165 | 0.2 | 16 | 23 | 87 | 81.4 | -69.9 |
| | 0.3248 | 0.3 | 20 | 29 | 78 | 62.8 | -62.0 |
| | 0.4330 | 0.4 | 25 | 35 | 70 | 46.5 | -54.2 |
| | 0.5413 | 0.5 | 33 | 39 | 63 | 32.6 | -49.0 |
| | 0.6496 | 0.6 | 36 | 43 | 57 | 20.9 | -43.7 |
| | 0.7579 | 0.7 | 41 | 45 | 52 | 9.3 | -41.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.8661 | 0.8 | 44 | 44 | 47 | -2.3 | -42.4 |
| | 0.9744 | 0.9 | 49 | 47 | 42 | -11.6 | -38.5 |
| | 1.0826 | 1.1 | 52 | 44 | 31 | -27.9 | -42.4 |
| | 1.1909 | 1.2 | 54 | 46 | 28 | -34.9 | -39.8 |
| | 1.2992 | 1.3 | 57 | 45 | 27 | -37.2 | -41.1 |
| | 1.4074 | 1.4 | 59 | 44 | 24 | -44.2 | -42.4 |
| | 1.5157 | 1.5 | 61 | 43 | 22 | -48.8 | -43.7 |

Weights in t.

**Data consistency**

These results should be taken carefully as the data used correspond only to trawl catches, which comprise only young individuals. This gear is the only one which catches hake in the GSA05, so the absence of other sources of information prevents the input of large individuals (i.e. spawners) in the model.

## 5.2. European hake (*Merluccius merluccius*) in GSA 6

### *5.2.1.Short term prediction 2009-2011*

#### 5.2.1.1. Method and justification

A deterministic short term prediction for 2009 to 2011 was performed using the EXCEL workbook provided by JRC IPSC (H.-J. Rätz) which take into account the catch and landings in numbers and weight and the discards, and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994) stock assessment performed during SGMED-09-02.

#### 5.2.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the hake stock in GSA 6:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|---|
| 2008 | Prop. Matures | 0 | 0.15 | 0.82 | 0.98 | 0.99 | 1 | 1 | 1 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ | Mean 0-4 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2008 | M | 1.43 | 0.68 | 0.47 | 0.42 | 0.39 | 0.37 | 0.36 | 0.35 | 0.68 |

*F vector*

| F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2008 | 0.98 | 2.15 | 1.54 | 1.70 | 1.30 | 0.58 | 1.45 | 1.47 |

*Weight-at-age in the stock*

| Mean weight in stock (kg) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2008 | 0.02 | 0.117 | 0.453 | 1.149 | 1.752 | 2.791 | 3.773 | 4.332 |

*Weight-at-age in the catch*

| Mean weight in catch (kg) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2008 | 0.02 | 0.117 | 0.453 | 1.149 | 1.752 | 2.791 | 3.773 | 4.332 |

*Number at age in the catch*

| Catch at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2008 | 56035 | 17421 | 1279 | 187 | 33 | 3 | 0.3 | 0.1 |

*Number at age in the stock*

| Numbers at age in the stock (thousands) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2008 | 183396 | 27750 | 2061 | 281 | 56 | 8 | 0 | 1 |

Different scenarios of constant harvest strategy with reduction of the mean F ($F_{bar}$ ages 0-4) calculated as the average ages 0 to 4 in 2008 was used and defined as F status quo ($F_{sq}$ = 1.53).

*Stock recruitment*

Recruitment (class 0) has been estimated as the geometric mean from 1995 to 2008 (from XSA done in SGMED-09-02; this assessment regards bottom trawl exclusively).

5.2.1.3. Results

**Short-term implications**

A short term projection (Table 5.2.1.3.1), assuming an $F_{stq}$ of 1.53 in 2009 and a recruitment of 346360 (thousand) individuals, shows that:

- Fishing at the $F_{stq}$ (1.53) from 2008 to 2010 would generate an increase of the catches of 330% in 2010, while the spawning stock biomass would remain at similar level (decrease of -1.5 % from 2010 to 2011).

- Fishing at $F_{0.1}$ (0.16) from 2008 to 2010 generates a decrease of the catches of -42 % in 2010 and a spawning stock biomass increase by 387% from 2010 to 2011.

**Outlook until 2011**

Table 5.2.1.3.1 – Short term forecast in different F scenarios computed for hake in GSA 6.

Basis: F(2009) = mean($F_{bar}$1-4 2008); R(2009) = GM(1995-2008) = 346360 (thousands); F (2009) = 1.53; SSB(2010) = 3462 t; landings(2009)= 8195 t; landings(2008)= 3494 t.

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2008-2010 (%) |
|---|---|---|---|---|---|---|---|
| zero catch | 0.00 | 0 | 0 | 0 | 29275 | 5198.4 | -100 |
| High long-term yield ($F_{0.1}$) | 0.16 | 0.104 | 2024 | 3403 | 16864 | 387.1 | -42.1 |
| Status quo | 1.53 | 1 | 14987 | 5529 | 8003 | -1.5 | 328.9 |
| Different scenarios | 0.15 | 0.1 | 2776 | 4737 | 23936 | 471.0 | -20.5 |
| | 0.31 | 0.2 | 5117 | 7501 | 19592 | 367.4 | 46.5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.46 | 0.3 | 7111 | 8987 | 16054 | 283.0 | 103.5 |
| | 0.61 | 0.4 | 8801 | 9643 | 13166 | 214.1 | 151.9 |
| | 0..77 | 0.5 | 10244 | 9789 | 10815 | 158.0 | 193.2 |
| | 0.92 | 0.6 | 11487 | 9635 | 8896 | 112.2 | 228.8 |
| | 1.07 | 0.7 | 12554 | 9304 | 7327 | 74.8 | 259.3 |
| | 1.23 | 0.8 | 13479 | 8884 | 6038 | 44.0 | 285.8 |
| | 1.38 | 0.9 | 14282 | 8441 | 4988 | 19.0 | 308.8 |
| | 1.69 | 1.1 | 15608 | 7593 | 3417 | -18.5 | 346.7 |
| | 1.84 | 1.2 | 16152 | 7218 | 2839 | -32.3 | 362.3 |
| | 1..99 | 1.3 | 16637 | 6883 | 2360 | -43.7 | 376.2 |
| | 2.15 | 1.4 | 17067 | 6590 | 1967 | -53.1 | 388.5 |
| | 2.30 | 1.5 | 17452 | 6333 | 1644 | -60.8 | 399.5 |

Weights in t.

**Data consistency**

To assess stocks which are simultaneously exploited by different fishing gears and fleets all relevant data should be available to SGMED. For hake in GSA06 only bottom trawl data were available (no data from longline nor gillnet available).

Thus, results should be taken with caution because only bottom trawl data have been considered (in GSA06, hake is fished also with gillnet and longline, which target the larger individuals of the population). Therefore, in this case, a decrease in fishing effort immediately appears reflected as an increase in SSB, which is not the case, since part of SSB is fished by the artisanal fleet.

## 5.3. European hake (*Merluccius merluccius*) in GSA 7

### *5.3.1.Short term prediction 2009-2011*

#### 5.3.1.1. Method and justification

A deterministic short term prediction for 2009 to 2011 was performed using the EXCEL workbook provided by JRC IPSC (H.-J. Rätz) which take into account the catch and landings in numbers and weight and the discards, and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994) stock assessment presented at the 11th Session of Sub-Committee on Stock Assessment (SCSA) of the GFCM (Málaga, Spain, 30 Nov- Dec 2009; http://151.1.154.86/GfcmWebSite/SAC/SCSA/2009/StockAssessmentForms/SCSA_2009_HKE_GSA07_IFREMER_IEO.pdf). We considered total landings (all gears combined) and fleet specific landings.

#### 5.3.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the hake stock in GSA 7:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|---|
| 2005-2008 | Prop. Matures | 0 | 0.03 | 0.77 | 0.99 | 1 | 1 | 1 | 1 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ | Mean 0-4 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2005-2008 | M | 0.68 | 0.47 | 0.30 | 0.22 | 0.19 | 0.17 | 0.16 | 0.14 | 0.37 |

*F vector*

| F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2005 | 0.47 | 0.53 | 0.46 | 0.36 | 0.34 | 0.29 | 0.16 | 0.16 |
| 2006 | 0.27 | 0.46 | 0.60 | 0.56 | 0.39 | 0.36 | 0.68 | 0.68 |
| 2007 | 0.18 | 0.65 | 0.52 | 0.45 | 0.36 | 0.28 | 0.48 | 0.48 |
| 2008 | 0.21 | 0.51 | 0.41 | 0.35 | 0.25 | 0.23 | 0.35 | 0.35 |

*Weight-at-age in the stock*

| Mean weight in stock (kg) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2005-2008 | 0.047 | 0.184 | 0.575 | 1.106 | 1.654 | 2.309 | 2.777 | 3.454 |

*Weight-at-age in the catch*

| Mean weight in catch (kg) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2005-2008 | 0.047 | 0.184 | 0.575 | 1.106 | 1.654 | 2.309 | 2.777 | 3.454 |

*Number at age in the catch*

| Catch at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2005 | 9224 | 3350 | 854 | 228 | 45 | 8 | 3 | 1 |
| 2006 | 4940 | 2909 | 1083 | 318 | 86 | 17 | 6 | 3 |
| 2007 | 6462 | 3839 | 1014 | 245 | 64 | 22 | 8 | 3 |
| 2008 | 22347 | 8529 | 662 | 162 | 32 | 13 | 4 | 3 |

*Number at age in the stock*

| Stock at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2005 | 34788 | 11411 | 3244 | 1049 | 220 | 44 | 30 | 13 |
| 2006 | 29203 | 11059 | 3397 | 1035 | 369 | 79 | 17 | 9 |
| 2007 | 54083 | 11279 | 3532 | 943 | 298 | 126 | 28 | 12 |
| 2008 | 112418 | 22800 | 2982 | 1068 | 303 | 106 | 48 | 34 |

Different scenarios of constant harvest strategy with reduction of the mean F ($F_{bar}$ ages 1-4) calculated as the average ages 1 to 4 in 2008 was used and defined as F status quo ($F_{stq}$ = 0.38).

*Stock recruitment*

Recruitment (class 0) has been estimated as the geometric mean of values observed between 1998 and 2008.

### 5.3.1.3. Results

**Short-term implications**

A short term projection (Table 5.3.1.3.1), assuming an $F_{stq}$ of 0.38 in 2009 and a recruitment of 50280 (thousand) individuals, shows that:

- Fishing at the $F_{stq}$ (0.38) generates an increase of the catch of 134% from 2008 to 2010 along with an increase of the spawning stock biomass of 35 % from 2010 to 2011.

- Fishing at $F_{0.1}$ (0.26) generates an increase of the catch of 69% from 2008 to 2010 and a spawning stock biomass increase by 53% from 2010 to 2011.

- It is worth noting that even with an increase of F by a factor of 1.5, an increase of the SSB (by 10%) is projected for 2011. This can be explained by the strength of year classes 2007 and 2008, which is shown from XSA analyses and is also observed in trawl landings in 2008 and MEDITS data (which mainly catches the 0-group). These forecasts are, however, limited by the current low levels of the SSB, which will increase the uincertainty of the predictions.

**Outlook until 2011 All fleets combined (Spanish and French bottom trawl, Spanish longline, French gillnet).**

Table 5.3.1.3.1 – Short term forecast in different F scenarios computed for hake in GSA 7. (All fleets combined: Spanish and French bottom trawl, Spanish longline, French gillnet).

Basis: F(2009) = mean($F_{bar}$1-4 2008); R(2009) = GM(1998–2008) = 50280 (thousands); F (2009) = 0.38; SSB(2010) = 11826t; Catch(2009)= 4304 t.

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2008-2010 (%) |
|---|---|---|---|---|---|---|---|
| zero catch | 0.00 | 0.0 | 0 | 0 | 23921 | 102 | -100 |
| High long-term yield ($F_{0.1}$) | 0.26 | 0.68 | 3888 | 4815 | 18084 | 53 | 69 |
| Status quo | 0.38 | 1.0 | 5374 | 5962 | 15909 | 35 | 134 |
| Different scenarios | 0.04 | 0.1 | 635 | 962 | 22960 | 94 | -72 |
| | 0.08 | 0.2 | 1243 | 1824 | 22037 | 86 | -46 |
| | 0.11 | 0.3 | 1827 | 2594 | 21150 | 79 | -20 |
| | 0.15 | 0.4 | 2393 | 3278 | 20305 | 72 | 4 |
| | 0.19 | 0.5 | 2939 | 3880 | 19493 | 65 | 28 |
| | 0.23 | 0.6 | 3466 | 4413 | 18719 | 58 | 51 |
| | 0.27 | 0.7 | 3969 | 4884 | 17968 | 52 | 73 |
| | 0.30 | 0.8 | 4454 | 5294 | 17252 | 46 | 94 |
| | 0.34 | 0.9 | 4923 | 5654 | 16566 | 40 | 114 |
| | 0.42 | 1.1 | 5810 | 6226 | 15276 | 29 | 153 |
| | 0.46 | 1.2 | 6228 | 6454 | 14672 | 24 | 171 |
| | 0.49 | 1.3 | 6632 | 6639 | 14090 | 19 | 189 |
| | 0.53 | 1.4 | 7024 | 6800 | 13534 | 14 | 206 |
| | 0.57 | 1.5 | 7402 | 6926 | 12999 | 10 | 222 |

Weights in t.

**Outlook until 2011 Fleet specific (fleet 1: bottom trawl, and fleet 2:longline+gillnet)**

- Bottom trawl targets mainly juveniles while gillnet and longline target the adult population.
- Input data for the estimation of F by fleet are catch-at-age by fleet and mean weight-at-age by fleet.
- The increase of longline and gillnet landings (spawners) is particularly observed in 2011 when the strong year classes 2007 and 2008 become fully available to these fleets.

Table 5.3.1.3.2 Basis for the short term forecast for hake in GSA 07 for 2009, considering trawls and gillnet – longline separately.

| 2009 | | | | | Trawlers | Gillnet & longline |
|---|---|---|---|---|---|---|
| F-factor | Reference F | Stock biomass (t) | SSB (t) | Landings (t) | landings (t) | landings (t) |
| 1.00 | 0.38 | 15521 | 5051 | 4233 | 3713 | 520 |

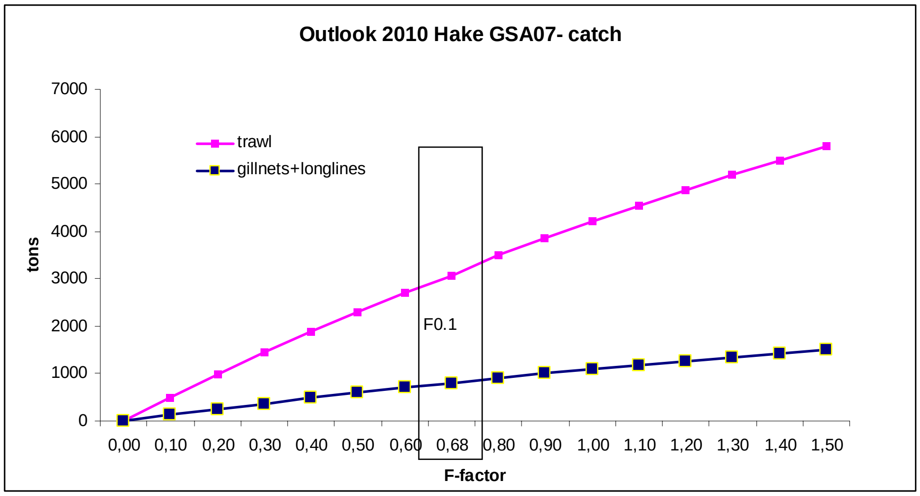



Fig. 5.3.1.3.1. Projected landings in 2010 of hake in GSA 7 by fleet as fishing mortality increases.

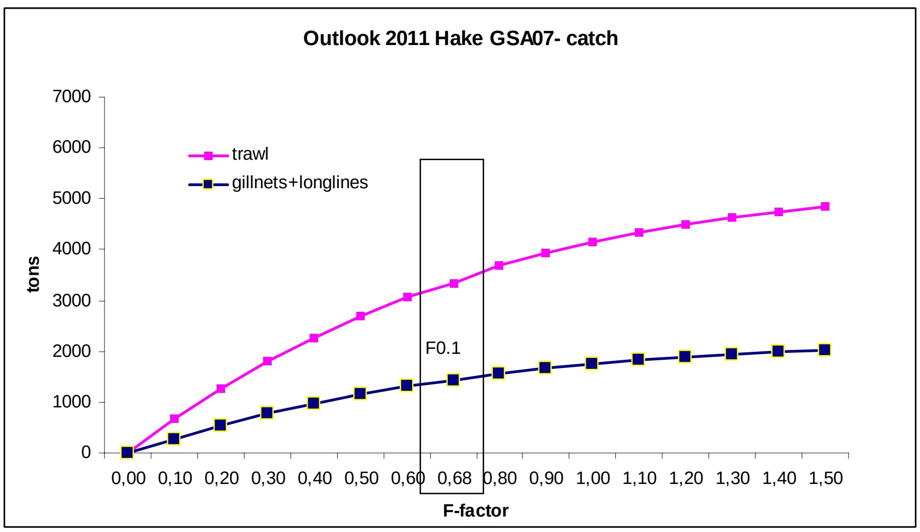



Fig. 5.3.1.3.2. Projected landings in 2011 of hake in GSA 7 by fleet as fishing mortality increases.

Table 5.3.1.3.3. Outlook for 2010-2011 for hake in GSA 7, by fleet.

| | | 2010 | | 2011 | | 2011 | |
|---|---|---|---|---|---|---|---|
| F-factor | reference F | Trawlers landings (t) | Gill nets & longlines landings (t) | Trawlers landings (t) | Gill nets & longlines landings (t) | Total Biomass (t) | SSB (t) |
| 0.0 | 0 | 0 | 0 | 0 | 0 | 32694 | 23921 |
| 0.1 | 0.04 | 496 | 126 | 664 | 264 | 31545 | 22960 |
| 0.2 | 0.08 | 977 | 248 | 1265 | 547 | 30443 | 22037 |
| 0.3 | 0.11 | 1438 | 367 | 1797 | 773 | 29385 | 21153 |
| 0.4 | 0.15 | 1884 | 484 | 2272 | 976 | 28370 | 20305 |
| 0.5 | 0.19 | 2308 | 592 | 2693 | 1157 | 27393 | 19493 |

|  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
| 0.6 | 0.23 | 2716 | 701 | 3062 | 1314 | 26461 | 18718 |
| 0.7 | 0.26 | 3053 | 786 | 3341 | 1429 | 25699 | 18085 |
| 0.8 | 0.30 | 3492 | 901 | 3680 | 1570 | 24697 | 17252 |
| 0.9 | 0.34 | 3857 | 999 | 3929 | 1674 | 23869 | 16566 |
| 1.0 | 0.38 | 4213 | 1093 | 4147 | 1762 | 23076 | 15909 |
| 1.1 | 0.42 | 4551 | 1181 | 4334 | 1836 | 22311 | 15276 |
| 1.2 | 0.46 | 4879 | 1271 | 4497 | 1898 | 21578 | 14672 |
| 1.3 | 0.49 | 5194 | 1349 | 4629 | 1947 | 20872 | 14090 |
| 1.4 | 0.53 | 5498 | 1432 | 4746 | 1989 | 20197 | 13534 |
| 1.5 | 0.57 | 5788 | 1513 | 4842 | 2021 | 19546 | 12999 |

### *5.3.2.Short term prediction 2009-2010 (based on landings and MEDITS indices)*

#### 5.3.2.1. Method and justification

SGMED 09-03 notes that there is no data available to formulate any age-structured production model to predict stock size and landings and discards in short term (2009-2011). However, based on a significant and positive regression between the MEDITS survey biomass indices 2001-2007 and landings the consecutive years 2002-2008, SGMED predicted the landings in 2009 and 2010 when survey biomass indices were available (WD 3 in section 4.3). This approach should theoretically provide quantitative landings forecasts under the straightforward presumptions that both independent series

- represent few, mainly juvenile age groups (ages 0 and 1),
- the fishing effort in the various GSAs has not drastically changed and
- there are no constrains on landings.

SGMED 09-03 emphasizes that the results of such quantitative approach should be interpreted only as an imprecise approximation of future landings under status quo conditions and should be rather interpreted in a qualitative sense, given the high confidence intervals usually associated with such survey indices, and the potential bias related to official landings declarations.

#### 5.3.2.2. Input parameters

The trends in MEDITS survey biomass indices 2001-2009 and the respective reported annual landings 2002-2008 (through the DCF data call) are given in the Table 5.3.2.2.1 below. The estimated landings in 2009 and 2010 are based on the regression between MEDITS biomass indices in year y and the landings in year y+1 as given in the following section.

Table 5.3.2.2.1 of MEDITS survey biomass indices and landings by year. Estimated landing in 2009 and 2010 are in bold italics.

|  | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| MEDITS biomass index (kg) | 4.258 | 7.644 | 4.078 | 2.836 | 2.142 | 2.067 | 5.276 | 16.949 | 6.958 |  |
| Lanings (t) |  | 2345 | 2277 | 1117 | 1249 | 1311 | 1445 | 2009 | ***4075*** | ***2220*** |

#### 5.3.2.3. Results

The correlation and regression parameters between the biomass index from MEDITS in year y and the landings in year y+1are given below.

For 2009, the landings in 2009 are indicated to be the highest since 2002, like estimated in deterministic forecast. The following decrease in landings estimated for 2010 is due to the fact that the survey catches almost exclusively 0 group fish.

Table 5.3.2.3.1. Correlation and regression parameters between MEDITS biomass indices (kg) in year y and annual landings (t) in year y+1.

| slope | intercept | r | r2 |
|---|---|---|---|
| 185.6182 | 928.4596 | 0.711215 | 0.505826 |

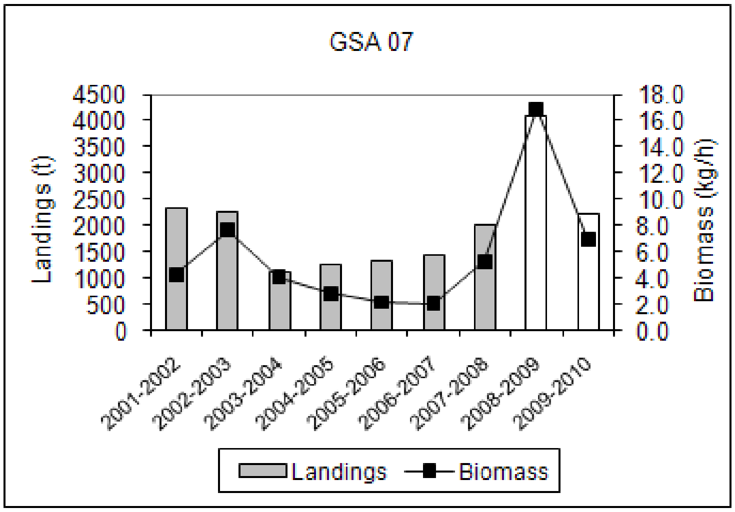



Fig. 5.3.2.3.1 Projection of annual landings in 2009 and 2010 based on the relationship between the MEDITS survey index in year y and the landings in year y+1.

### *5.3.3.Further observations comparing landings and MEDITS indices*

These two series of annual landings and the MEDITS biomass index, that is, high biomass observed during MEDITS surveys in the Gulf of Lions correspond to high annual trawl landings. However, as the MEDITS survey mostly catches the 0 group while trawl landings consist mainly of age classes 0 and 1, then the relationship can be weak in those years like 2009 when great numbers of age 1 are found in the fishing area (resulting from strong recruitment in 2008, as shown by MEDITS). 2009 trawl landings data have been estimated from VPA.

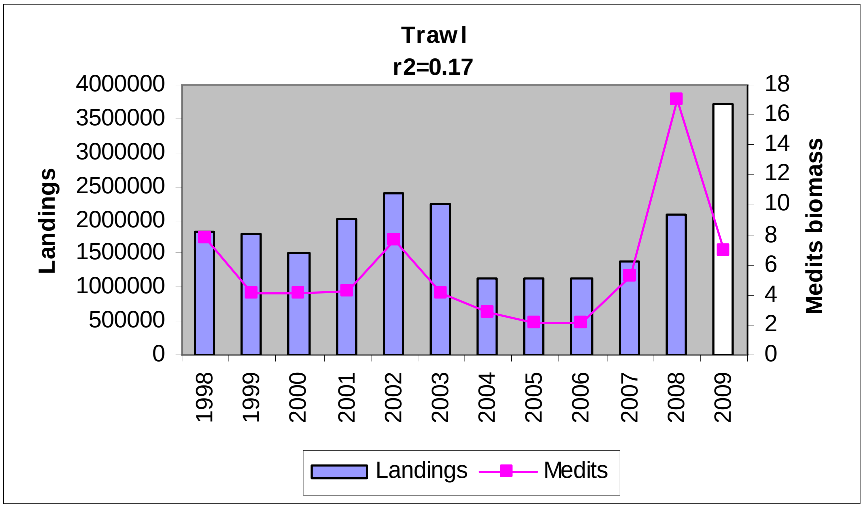


Fig. 5.3.3.1 Relation between the annual landings and the Medits index in the same year.

*Evolution of trawl landings and gillnet+longline landings*

- Current (2008) gillnets and longline landings (which consists mostly of adults) are among the lowest observed during 1998-2008, which is in accordance with the low current levels of SSB

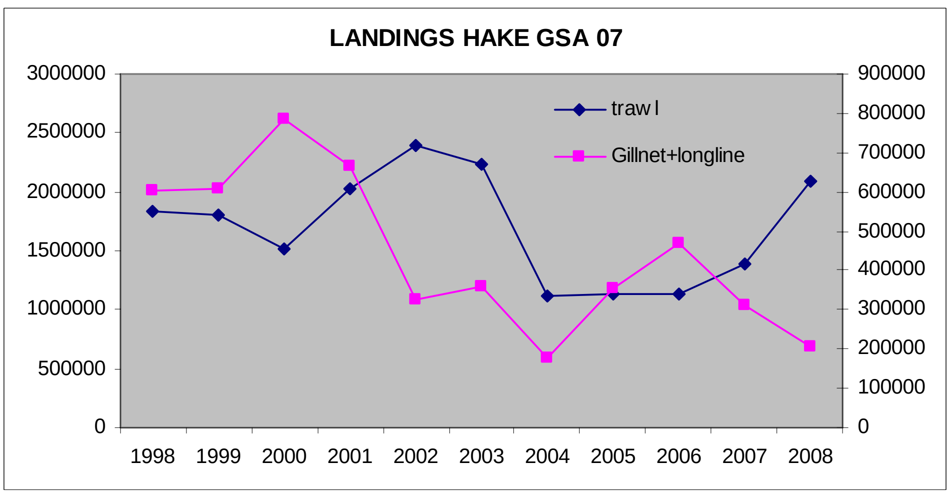


Fig. 5.3.3.2 Trends in gillnet+longline and trawl landings (t) (1998-2008).

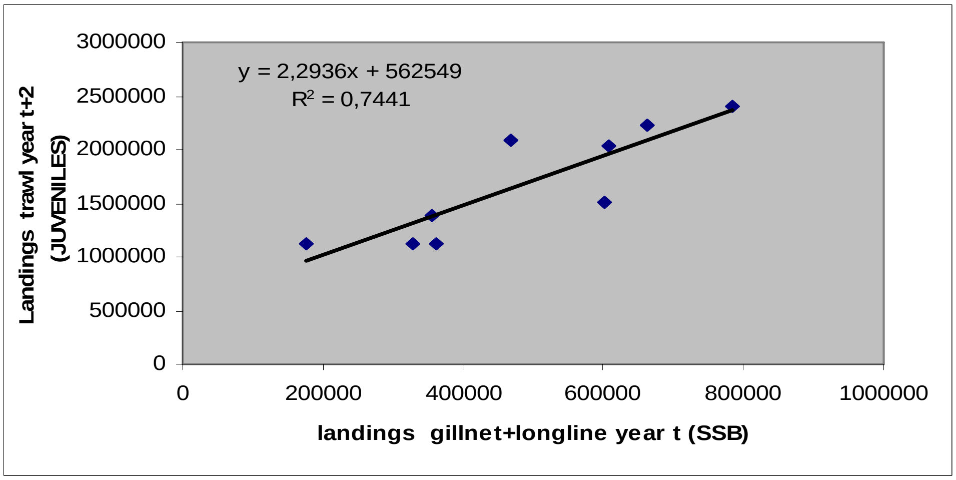



Fig. 5.3.3.3 Relationship between gillnet+longline landings (adults) in a given year(t) and trawl landings (juveniles) two years later (1998-2008).

We can predict trawl landings from the gillnets and longline landings two years before. This can be used as a simple forecasting measure in case VPA analyses are not available or are not robust for this stock.

**Data consistency**

Reporting the landings by fleet it is important in species such as hake where adults are mainly caught by gillnets and longlines, whereas juveniles are mainly caught by trawlers. The assessment of hake in GSA07 by fleet was only possible because one expert attending SGMED-09-03 made the data available. In the case of Spain, no data from GSA 07 were available. Spain reported hake landings for GSA 06, 05 and 01, and only for bottom trawl. Therefore, for those cases when a species is exploited by different fishing gears and fleets from different countries, it is necessary each Member State involved in the fishery under study submits all the relevant information.

## 5.4. European hake (*Merluccius merluccius*) in GSA 9

### *5.4.1.Short term prediction 2009-2011*

#### 5.4.1.1. Method and justification

Short term prediction for 2009 to 2011 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of Length Cohort Analysis (LCA) carried out on 2006, 2007, 2008 catch data collected under DCR.

#### 5.4.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of hake in GSA 9:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| 2006-2008 | Prop. Matures | 0 | 0.21 | 0.9 | 1.0 | 1.0 | 1.0 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2006-2008 | M | 1.3 | 0.6 | 0.46 | 0.41 | 0.3 | 0.2 |

*F vector*

| F | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 2006 | 1.62 | 1.95 | 0.89 | 0.52 | 0.33 | 0.17 |
| 2007 | 1.25 | 1.96 | 0.66 | 0.24 | 0.15 | 0.04 |
| 2008 | 1.35 | 2.18 | 0.77 | 0.43 | 0.11 | 0.10 |

*Weight-at-age in the stock*

| Mean weight in stock (kg) | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 2006 | 0.01 | 0.14 | 0.61 | 1.37 | 2.30 | 3.31 |
| 2007 | 0.01 | 0.13 | 0.60 | 1.36 | 2.28 | 3.28 |
| 2008 | 0.01 | 0.12 | 0.60 | 1.35 | 2.29 | 3.29 |

*Weight-at-age in the catch*

| Mean weight in catch (kg) | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 2006 | 0.01 | 0.14 | 0.61 | 1.37 | 2.30 | 3.31 |
| 2007 | 0.01 | 0.13 | 0.60 | 1.36 | 2.28 | 3.28 |
| 2008 | 0.01 | 0.12 | 0.60 | 1.35 | 2.29 | 3.29 |

*Number at age in the catch*

| Catch at age in numbers | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 2006 | 39706441 | 3404234 | 207063 | 47225 | 17216 | 6350 |
| 2007 | 52288585 | 7115854 | 369969 | 65369 | 27726 | 6026 |
| 2008 | 11571004 | 6996734 | 246999 | 53012 | 12553 | 3498 |

*Number at age in the stock*

| Stock numbers at age | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 2006 | 71244252 | 4734172 | 392227 | 124689 | 65045 | 42530 |
| 2007 | 140335373 | 10948816 | 887664 | 342555 | 221312 | 156108 |
| 2008 | 139546784 | 10004953 | 551825 | 184255 | 102753 | 82925 |

Maturity was estimated as the mean of the last 3 years. M was calculated using the ProBiom method.

5.4.1.3. Results

**Short-term implications**

A short term projection (Table 5.4.1.3.1), assuming an $F_{stq}$ of 1.12 ($F_{1-3}$) in 2009 and a recruitment of 99.7(millions) individuals, shows that:

- Fishing at the $F_{stq}$ (1.12) from 2010 to 2011 will generate an increase of the catches of 5.2% in 2011 and a decrease of the spawning stock biomass of 7.6%.

- Fishing at $F_{0.1}$ (0.22), which corresponds to an 80% reduction of the current F, is expected to generate a decrease of the catch in the short term (about 162% in 2011) and a spawning stock biomass increase of 119% from the year 2010 to 2011.

- A start of rebuilding of SSB should be achieved through a 20% reduction of the $F_{stq}$ (F from 1.12 to 0.90).

**Outlook until 2011**

Table 5.4.1.3.1 – Short term forecast in different F scenarios computed for hake in GSA 9.

Basis: F(2009) = mean($F_{bar}$2006–2008); Catch stq (2009) = 1520 t; R(2009) = GM(2005–2008) = 99.7(millions); F (2009) = 1.12; SSB(2010) = 1390 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change in catch 2010-2011 (%) |
|---|---|---|---|---|---|---|---|
| zero catch | 0 | 0.0 | 0 | 0 | 3967 | 185.4 | 0.0 |
| High long-term yield ($F_{0.1}$) | 0.22 | 0.2 | 376 | 986 | 3041 | 118.8 | -162.2 |
| Status quo | 1.12 | 1.0 | 1204 | 1141 | 1284 | -7.6 | 5.2 |
| Different scenarios | 0.11 | 0.1 | 201 | 611 | 3455 | 148.6 | -204.0 |
| | 0.34 | 0.3 | 529 | 1201 | 2664 | 91.7 | -127.0 |
| | 0.45 | 0.4 | 663 | 1309 | 2360 | 69.8 | -97.4 |
| | 0.56 | 0.5 | 781 | 1347 | 2102 | 51.2 | -72.5 |
| | 0.67 | 0.6 | 886 | 1340 | 1883 | 35.5 | -51.2 |
| | 0.78 | 0.7 | 979 | 1306 | 1697 | 22.1 | -33.4 |
| | 0.90 | 0.8 | 1062 | 1257 | 1538 | 10.6 | -18.4 |
| | 1.01 | 0.9 | 1137 | 1200 | 1401 | 0.8 | -5.5 |
| | 1.12 | 1.1 | 1204 | 1141 | 1182 | -14.9 | 5.2 |
| | 1.23 | 1.2 | 1265 | 1083 | 1094 | -21.3 | 14.4 |
| | 1.35 | 1.3 | 1321 | 1028 | 1017 | -26.8 | 22.2 |
| | 1.46 | 1.4 | 1371 | 977 | 949 | -31.7 | 28.7 |
| | 1.57 | 1.5 | 1418 | 931 | 890 | -36.0 | 34.3 |
| | 1.68 | 1.6 | 1461 | 890 | 837 | -39.8 | 39.1 |
| | 1.79 | 1.7 | 1500 | 853 | 791 | -43.1 | 43.1 |
| | 1.91 | 1.8 | 1537 | 821 | 749 | -46.1 | 46.6 |
| | 2.02 | 1.9 | 1571 | 792 | 712 | -48.8 | 49.6 |
| | 2.13 | 2.0 | 1603 | 767 | 678 | -51.2 | 52.2 |

## 5.5. European hake (*Merluccius merluccius*) in GSA 10

### *5.5.1.Short term prediction 2009-2011*

#### 5.5.1.1. Method and justification

Short term predictions for 2010 and 2011 were implemented in the age-length based dynamic model Aladym (Lembo *et al.*, 2009). The predictions were based on the results of the stock assessment carried out for *M. merluccius* in the GSA 10 in the framework of SGMED-09-02, which was based on a combination of Surba, Aladym and Yield analyses.

### 5.5.1.2. Input parameters

The input parameters used for the short term projections were from the assessment carried out in the SGMED-09-02, to which the reader should refer for further details. A summary of the parameters used to initialize the model is reported in the tables 5.5.1.2.1 - 5.5.1.2.4.

Table 5.5.1.2.1. Hake in GSA 10. Growth parameters.

| **Parameter** | **Distribution** | **Min** | **Max** | **Mean** | **Std.** |
|---|---|---|---|---|---|
| Male $t_0$ [years] | | -0.45 | -0.35 | -0.4 | |
| Female $t_0$ [years] | | -0.45 | -0.35 | -0.4 | |
| Male K [$years^{-1}$] | Normal | 0.20 | 0.30 | 0.25 | 0.07 |
| Female K [$years^{-1}$] | Normal | 0.130 | 0.140 | 0.135 | 0.01 |
| Male $L_\infty$ [mm] | Normal | 500 | 510 | 520 | 14.14 |
| Female $L_\infty$ [mm] | Normal | 970 | 990 | 980 | 14.14 |

The following parameters of the length-weight relationship were used for both sexes (length in mm and weight in grams) a=0.000002139; b=3.22.

Table 5.5.1.2.2. Hake in GSA 10. Maturity ogives parameters.

| **Parameter** | **Distribution** | **Min** | **Max** |
|---|---|---|---|
| Female L50% [mm] | Uniform | 29 | 32 |
| Female L75%L25% [mm] | Uniform | 20 | 21 |

*Mortality rates*

Table 5.5.1.2.3. Hake in GSA 10. Mortality rates.

| **Age** | **0** | **1** | **2** | **3** | **4** | **5+** |
|---|---|---|---|---|---|---|
| M | 0.85 | 0.46 | 0.37 | 0.33 | 0.31 | 0.29 |

Table 5.5.1.2.4. Hake in GSA 10. Total mortality rates.

| **Year** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
|---|---|---|---|---|---|---|---|---|
| Z | 1.51 | 1.56 | 1.62 | 1.42 | 1.43 | 1.56 | 1.74 | 1.71 |
| **Year** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| Z | 1.40 | 1.46 | 1.58 | 1.50 | 1.68 | 1.69 | 1.69 | 1.68 |

Sex ratio was set as 0.5.

*Stock recruitment relationship*

The recruitment used for the short term projections was estimated as the geometric mean of values estimated from 1994 to 2008. The number of individuals was set at 59322 (thousands). The variability around the estimated recruitment was set at 10% from a uniform distribution and monthly recruitment pulses were simulated by splitting the proportion of offspring entering the stock by month with a peak in January-March.

*Selection parameters of fleet gear*

Selectivity of the fleet was simulated using an ogive (Lc=12cm; selection range 3 cm) coupled with a de-selection ogive with 50% de-selection size at 38 cm and a de-selection range of 7 cm (Abella *et al*., 1997).

Different scenarios of constant harvest strategy with a reduction of the mean F calculated on the last 3 years ($F_{bar}$ 2006-2008) was used and defined as F status quo ($F_{stq}$=0.56)

### 5.5.1.3. Results

**Short-term implications**

A short term projection (Table 5.5.1.3.1), assuming an $F_{stq}$ of 0.56 in 2009 and a constant recruitment of 59322 (thousands) individuals, shows that:

- Fishing at the $F_{stq}$ (0.56) from 2008 to 2010 generates a decrease of the catches of 7.4 % in 2010 and a decrease of the spawning stock biomass of 4.1% from the year 2010 to 2011.

- Fishing at $F_{0.1}$ (0.244) in the same time period (2008-2010) generates a decrease of the catch of 49.4% in 2010 and a spawning stock biomass increase of 16.1% from the year 2010 to 2011.

- A 30% reduction of the $F_{stq}$ (F=0.39) generates a decrease of catch of 27.2% in 2010 and a spawning stock biomass increase of 4.5 % from the year 2010 to 2011.

The short term analysis evidenced that fishing around the status quo will not contribute to the increase of catches, whilst will erode the spawning stock biomass.

**Outlook until 2011**

Table 5.5.1.3.1 – Short term forecast in different F scenarios computed for hake in GSA 10.

Basis: F(2009) = mean($F_{bar}$ 2006–2008); R(2009) = GM(1994–2008) = 59322 (thousands); F (2009) = 0.56; SSB(2010) =1593 t;

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2008-2010 (%) |
|---|---|---|---|---|---|---|---|
| zero catch | 0.00 | 0.00 | 0 | 0 | 2601 | 48.4 | -100.00 |
| High long-term yield ($F_{0.1}$) | 0.24 | 0.44 | 612 | 953 | 1944 | 16.1 | -49.4 |
| Status quo | 0.56 | 1.00 | 1122 | 1061 | 1526 | -4.1 | -7.4 |
| Different scenarios | 0.06 | 0.10 | 158 | 324 | 2412 | 39.1 | -86.9 |
| | 0.11 | 0.20 | 290 | 553 | 2267 | 32.1 | -76.1 |
| | 0.17 | 0.30 | 408 | 728 | 2144 | 25.9 | -66.3 |
| | 0.22 | 0.40 | 516 | 858 | 2037 | 20.7 | -57.4 |
| | 0.28 | 0.50 | 657 | 989 | 1903 | 14.1 | -45.7 |
| | 0.34 | 0.60 | 815 | 1079 | 1765 | 7.2 | -32.7 |
| | 0.39 | 0.70 | 882 | 1098 | 1709 | 4.5 | -27.2 |
| | 0.45 | 0.80 | 997 | 1102 | 1618 | 0.1 | -17.7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.50 | 0.90 | 1069 | 1085 | 1565 | -2.3 | -11.8 |
| | 0.56 | 1.00 | 1122 | 1061 | 1526 | -4.1 | -7.4 |
| | 0.62 | 1.10 | 1225 | 988 | 1455 | -7.3 | 1.1 |
| | 0.67 | 1.20 | 1274 | 937 | 1423 | -8.7 | 5.0 |
| | 0.73 | 1.30 | 1312 | 887 | 1398 | -9.7 | 8.2 |
| | 0.78 | 1.40 | 1343 | 839 | 1377 | -10.5 | 10.7 |
| | 0.84 | 1.50 | 1366 | 795 | 1361 | -11.1 | 12.7 |
| | 0.90 | 1.60 | 1381 | 764 | 1351 | -11.4 | 13.9 |
| | 0.95 | 1.70 | 1405 | 701 | 1332 | -12.0 | 15.9 |
| | 1.01 | 1.80 | 1414 | 670 | 1323 | -12.2 | 16.7 |
| | 1.06 | 1.90 | 1424 | 629 | 1313 | -12.4 | 17.4 |
| | 1.12 | 2.00 | 1429 | 595 | 1305 | -12.6 | 17.9 |

Weights in t.

### *5.5.2. Medium term prediction*

#### 5.5.2.1. Method and justification

A medium term prediction from 2009 to 2019 was implemented in Aladym (Lembo *et al.,* 2009). The predictions were based on the results of the stock assessment carried out during SGMED-09-02, which was based on a combination of Surba, Aladym and Yield analyses. Predictions were based on $F_{bar}$ 2006-2008 (0.56), and run assuming a gradual decrease of F towards the $F_{0.1}$ in 10 years.

#### 5.5.2.2. Input parameters

The same parameters used for the short term forecasts were applied, in addition the mortality was gradually reduced of 7% year by year until the value of $F_{0.1}$ was reached in 2019 (Fig. 5.5.2.2.1).

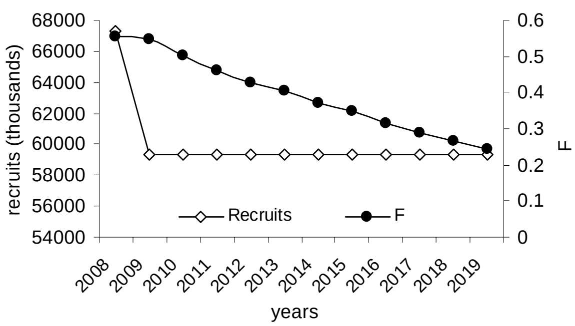
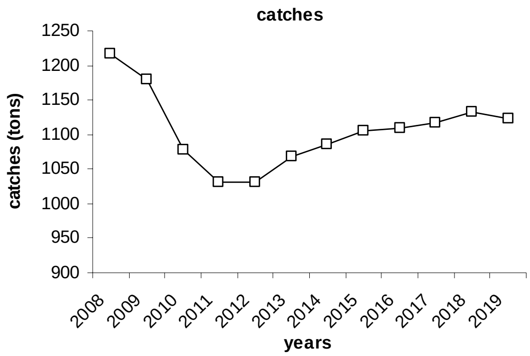



Fig. 5.5.2.2.1. Fishing mortality and recruitment vectors for the medium term prediction.

Results were compared with the status quo as set in the short-term analysis for the year 2008.

#### 5.5.2.3. Results

In the Figure. 5.5.2.3.1 the catches and SSB from 2008 to 2019 are reported considering a constant reduction of the $F_{stq}$ of around 7% each year from 2010 to 2019. The decrease in fishing mortality determines a considerable increase of the SSB, that was around 103% in 2019. This stock recovery was achieved without affecting the amount of the catches in the medium term with catches that were at the end (2019) about -7.7% of the those reported in 2008.



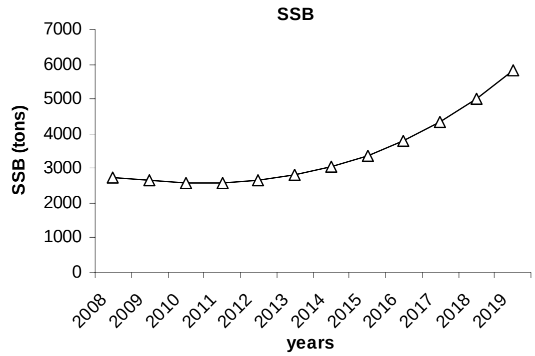




Fig. 5.5.2.3.1. Catches and spawning stock biomass predicted in the medium term analysis. Last value corresponds to $F_{0.1}$ value.

## 5.6. Red mullet (*Mullus barbatus*) in GSA 7

### *5.6.1.Short term prediction 2009-2011*

#### 5.6.1.1. Method and justification

A deterministic short term prediction for 2009 to 2011 was performed using the EXCEL workbook provided by JRC IPSC (H.-J. Rätz) which take into account the catch and landings in numbers and weight and the discards, and based on the results of pseudo-cohort 2004-2008 stock assessment (LCA and Y/R; VIT software) presented at the 11th Session of Sub-Committee on Stock Assessment (SCSA) of the GFCM (Málaga, Spain, 30 Nov- Dec 2009; http://151.1.154.86/GfcmWebSite/SAC/SCSA/2009/StockAssessmentForms/SCSA_2009_MUT_GSA07_IFREMER_IEO.pdf).

#### 5.6.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the red mullet stock in GSA 7:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|---|
| 2004-2008 | Prop. Matures | 0.17 | 0.61 | 0.89 | 0.96 | 0.98 | 0.99 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5+ | Mean 0-4 |
|---|---|---|---|---|---|---|---|---|
| 2004-2008 | M | 0.64 | 0.43 | 0.27 | 0.18 | 0.15 | 0.12 | 0.33 |

*F vector*

| F | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| 2004-2008 | 0.09 | 1.00 | 0.96 | 0.60 | 0.32 | 0.25 |

*Weight-at-age in the stock*

| Mean weight in stock (kg) | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| 2004-2008 | 0.005 | 0.027 | 0.063 | 0.099 | 0.130 | 0.153 |

*Weight-at-age in the catch*

| Mean weight in catch (kg) | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| 2004-2008 | 0.005 | 0.027 | 0.063 | 0.099 | 0.130 | 0.153 |

*Number at age in the catch*

| Catch at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| Mean 2004-2008 | 822 | 3466 | 857 | 190 | 52 | 27 |

*Number at age in the stock*

| Stock at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| Mean 2004-2008 | 13443 | 6504 | 1552 | 454 | 207 | 30 |

Different scenarios of constant harvest strategy with $F_{bar}$ calculated as the average of ages 1 to 3 ($F_{bar}$ ages 1-3) and F status quo ($F_{stq}$ = 0.86) were performed.

*Stock recruitment*

Recruitment (class 0) has been estimated from the population results from the 2008 data 9obtained from VIT) and Z using the survivor equation.

5.6.1.3. Results

A short term projection (Table 5.6.1.3.1), assuming an $F_{stq}$ of 0.38 in 2009 and a recruitment of 8419 (thousands) individuals, shows that:

- Fishing at the $F_{stq}$ (0.86) generates a decrease of the catch of -5% from 2008 to 2010 along with a decrease of the spawning stock biomass of -7% from 2010 to 2011.

- Fishing at $F_{0.1}$ (0.53) generates a decrease of the catch of -33% from 2008 to 2010 and an increase of the spawning stock biomass of 14% from 2010 to 2011.

**Outlook until 2011**

Table 5.6.1.3.1 – Short term forecast in different F scenarios computed for red mullet in GSA 7.

Basis: F(2009) = mean($F_{bar}$1-3 2008); R(2009) = calculated using the survivor equation from the 2008 data and considering Z from VIT; R = 8419 (thousands); F (2009) = 0.86; SSB(2010) = 219 t, Catch (2009)= 147 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2008-2010 (%) |
|---|---|---|---|---|---|---|---|
| zero catch | 0.00 | 0.0 | 0 | 0 | 379 | 73.1 | |
| High long-term yield ($F_{0.1}$) | 0.53 | 0.62 | 89 | 103 | 254 | 14 | -33 |
| Status quo | 0.86 | 1.0 | 126 | 119 | 205 | -7 | -5 |
| Different scenarios | 0.09 | 0.1 | 17 | 27 | 353 | 38 | -87 |
| | 0.17 | 0.2 | 35 | 50 | 331 | 34 | -74 |
| | 0.26 | 0.3 | 49 | 68 | 311 | 30 | -63 |
| | 0.34 | 0.4 | 62 | 80 | 292 | 25 | -53 |
| | 0.43 | 0.5 | 75 | 92 | 272 | 19 | -44 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.51 | 0.6 | 87 | 101 | 257 | 14 | -33 |
| | 0.60 | 0.7 | 97 | 108 | 242 | 10 | -27 |
| | 0.68 | 0.8 | 108 | 113 | 229 | 4 | -19 |
| | 0.77 | 0.9 | 117 | 116 | 217 | -1 | -12 |
| | 0.94 | 1.1 | 135 | 121 | 194 | -13 | 2 |
| | 1.03 | 1.2 | 141 | 121 | 184 | -19 | 6 |
| | 1.11 | 1.3 | 148 | 123 | 176 | -24 | 11 |
| | 1.20 | 1.4 | 154 | 122 | 167 | -31 | 16 |
| | 1.28 | 1.5 | 161 | 121 | 161 | -36 | 21 |

**Data consistency**

No particular issue was identified with data quality and data consistency.

## 5.7. Red mullet (*Mullus barbatus*) in GSA 9

### *5.7.1.Short term prediction 2009-2011*

#### 5.7.1.1. Method and justification

Short term prediction for 2009 and 2010 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of Length Cohort Analysis (LCA) carried out on 2006, 2007, 2008 catch data collected under DCR.

#### 5.7.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of red mullet in GSA 9:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| 2006-2008 | Prop. Matures | 0.0 | 1.0 | 1.0 | 1.0 | 1.0 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| 2006-2008 | M | 1.30 | 0.79 | 0.62 | 0.54 | 0.40 |

*F vector*

| F | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 2006 | 0.13 | 0.67 | 0.75 | 0.74 | 0.80 |
| 2007 | 0.20 | 1.61 | 1.14 | 0.73 | 0.80 |
| 2008 | 0.25 | 1.05 | 0.60 | 0.69 | 0.85 |

*Weight-at-age in the stock*

| Mean weight in stock (kg) | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 2006 | 0.0047 | 0.0414 | 0.0938 | 0.1325 | 0.1553 |
| 2007 | 0.0046 | 0.0379 | 0.0925 | 0.1325 | 0.1553 |
| 2008 | 0.0045 | 0.0399 | 0.0943 | 0.1326 | 0.1553 |

*Weight-at-age in the catch*

| Mean weight in catch (kg) | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 2006 | 0.0047 | 0.0414 | 0.0938 | 0.1325 | 0.1553 |
| 2007 | 0.0047 | 0.0414 | 0.0938 | 0.1325 | 0.1553 |
| 2008 | 0.0047 | 0.0414 | 0.0938 | 0.1325 | 0.1553 |

*Number at age in the catch*

| Catch at age in numbers | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 2006 | 5903534 | 18368054 | 3034567 | 466033 | 101254 |
| 2007 | 7080112 | 15902835 | 927187 | 40918 | 10214 |
| 2008 | 17427273 | 18649823 | 507581 | 138832 | 75558 |

*Number at age in the stock*

| Stock numbers at age | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 2006 | 317192676 | 102178227 | 23414732 | 6043295 | 1742760 |
| 2007 | 125822328 | 37797746 | 3406639 | 599031 | 175793 |
| 2008 | 213658632 | 61066119 | 9567133 | 2891773 | 882488 |

Maturity, was estimated as the mean of the last 3 years. M was calculated using the ProBiom method.

5.7.1.3. Results

A short term projection (Table 5.7.1.3.1), assuming an $F_{stq}$ of 0.79 ($F_{1\text{-}3}$) in 2009 and a recruitment of 164 millions individuals, shows that:

- Fishing at the $F_{stq}$ from year 2008 to 2010 generates an increases in catch of 74.4% and a decrease in SSB of 10.2%.

- Fishing at $F_{0.1}$ (0.49) generates an increase in both catches (20.9%) from 2008 to 2010 and spawning stock biomass (8.0%) between 2010 and 2011.

- A 30% reduction of the $F_{stq}$ (F = 0.55) generates an increase of catch for 33% in 2010 and a spawning stock biomass increase of 4% from the year 2010 to 2011.

A 30% reduction of $F_{stq}$ generates a more or less stable situation where the catches and SSB gradually increase.

**Outlook until 2011**

Table 5.7.1.3.1 – Short term forecast in different F scenarios computed for red mullet in GSA 9.

Basis: F(2009) = mean($F_{bar}$2006–2008); R(2009) = GM(2006–2008) = 164 (millions); F (2009) = 0.79; SSB(2010) = 3645 t; Catch (2009) = 2070 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2008-2010 (%) |
|---|---|---|---|---|---|---|---|
| Zero catch | 0.00 | 0.00 | 0 | 0 | 5455 | 49.6 | -100.0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| High long term yield ($F_{01}$) | 0.49 | 0.62 | 1125 | 1217 | 3937 | 8.0 | 20.9 |
| Status quo | 0.79 | 1.00 | 1623 | 1475 | 3275 | -10.2 | 74.4 |
| Different scenarios | 0.08 | 0.10 | 213 | 300 | 5166 | 41.7 | -77.1 |
| | 0.16 | 0.20 | 413 | 551 | 4895 | 34.3 | -55.6 |
| | 0.24 | 0.30 | 600 | 760 | 4643 | 27.4 | -35.5 |
| | 0.32 | 0.40 | 775 | 934 | 4406 | 20.9 | -16.7 |
| | 0.39 | 0.50 | 940 | 1077 | 4186 | 14.8 | 1.0 |
| | 0.47 | 0.60 | 1094 | 1195 | 3979 | 9.1 | 17.6 |
| | 0.55 | 0.70 | 1239 | 1290 | 3785 | 3.8 | 33.2 |
| | 0.63 | 0.80 | 1375 | 1367 | 3604 | -1.1 | 47.8 |
| | 0.71 | 0.90 | 1503 | 1428 | 3434 | -5.8 | 61.5 |
| | 0.87 | 1.10 | 1736 | 1511 | 3125 | -14.3 | 86.6 |
| | 0.95 | 1.20 | 1843 | 1537 | 2985 | -18.1 | 98.1 |
| | 1.03 | 1.30 | 1943 | 1555 | 2853 | -21.7 | 108.8 |
| | 1.10 | 1.40 | 2038 | 1566 | 2729 | -25.1 | 119.0 |
| | 1.18 | 1.50 | 2127 | 1571 | 2612 | -28.3 | 128.6 |
| | 1.26 | 1.60 | 2211 | 1571 | 2502 | -31.4 | 137.6 |
| | 1.34 | 1.70 | 2290 | 1568 | 2399 | -34.2 | 146.1 |
| | 1.42 | 1.80 | 2365 | 1561 | 2301 | -36.9 | 154.2 |
| | 1.50 | 1.90 | 2436 | 1552 | 2209 | -39.4 | 161.8 |
| | 1.58 | 2.00 | 2503 | 1541 | 2123 | -41.8 | 169.0 |

There were no special problems regarding the data quality and availability.

## 5.8. Red mullet (*Mullus barbatus*) in GSA 11

### *5.8.1. Short term prediction 2009-2011*

#### 5.8.1.1. Method and justification

Short term predictions for 2010 and 2011 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment that was applied for red mullet stock in GSA 11 in the framework of the SGMED-09-02 using the VIT software (Lleonart and Salat, 1992).

#### 5.8.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the red mullet in GSA 11:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 |
|---|---|---|---|---|---|
| 2006-2007 | Prop. Matures | 0.43 | 0.63 | 0.83 | 0.91 |

| PERIOD | Age | 0 | 1 | 2 | 3 |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 2006-2007 | M | 1.30 | 0.41 | 0.27 | 0.23 |

*F vector*

| PERIOD | Age | 0 | 1 | 2 | 3 |
|---|---|---|---|---|---|
| 2006-2007 | F | 0.03 | 1.06 | 1.45 | 0.38 |

*Weight-at-age in the stock*

| Mean weight in stock | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| Kg | 0.0007 | 0.0036 | 0.0081 | 0.0130 |

*Weight-at-age in the catch*

| Mean weight in stock | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| Kg | 0.0007 | 0.0036 | 0.0081 | 0.0130 |

*Number at age in the catch*

| Catch at age in numbers (thousands) | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| | 4267 | 45786 | 13149 | 976 |

*Number at age in the stock*

| Stock at age in numbers (thousands) | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| | 220071 | 82379 | 19054 | 3442 |

Maturity. weight-at-age in the stock and weight-at-age in the catch were estimated as the mean of the 2006 and 2007. F and M before spawning were considered the same as the one considered in the VPA.

For the projections, the mean F ($F_{bar}$ ages 1-3). calculated for the period 2006-2007, was defined as F status quo ($F_{stq}$ = 0.96). Different scenarios of constant harvest strategy were used.

*Stock recruitment*

The recruitment used for the short term projection derived from the results of the stock numbers provided by the VIT results of the age 0+ group.

5.8.1.3. Results

A short term projection (Table 5.8.1.3.1) assuming an $F_{stq}$ of 0.96 and a recruitment of 220 (millions) individuals, shows that:

- Fishing at the $F_{stq}$ (0.96) from 2008 to 2010 generates a decrease of the catch of 24.4% in 2010 and a decrease of the spawning stock biomass of 1.5% from 2010 to 2011.

- Fishing at $F_{0.1}$ (0.22) for the same time frame (2008-2010) generates a decrease of the catches of 75.3% in 2010 and an increase of the spawning stock biomass of 50.6% from 2010 to 2011.

- A 20% reduction of the $F_{stq}$ (0.77) generates a decrease of the catches of 34.1% in 2010 and a spawning stock biomass increase of 8.1% from 2010 to 2011.

**Outlook until 2011**

Table 5.8.1.3.1 – Short term forecast in different F scenarios computed for red mullet in GSA 11.

Basis: F(2009)= mean ($F_{bar}$ 2006-2007); R(2009) = 220 (millions); F(2009) = 0.96; SSB(2010) = 358 t; Catch (2009) = 218 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2008-2010 (%) |
|---|---|---|---|---|---|---|---|
| zero catch | 0.00 | 0.00 | 0 | 0 | 643 | 76.9 | -100.0 |
| High long-term yield ($F_{0.1}$) | 0.22 | 0.23 | 71 | 112 | 548 | 50.6 | -75.3 |
| Status quo | 0.96 | 1 | 218 | 217 | 358 | -1.5 | -24.4 |
| Different scenarios | 0.10 | 0.10 | 33 | 58 | 598 | 64.5 | -88.4 |
| | 0.19 | 0.20 | 63 | 101 | 558 | 53.5 | -78.1 |
| | 0.29 | 0.30 | 90 | 135 | 522 | 43.6 | -68.7 |
| | 0.39 | 0.40 | 115 | 159 | 490 | 34.8 | -60.3 |
| | 0.48 | 0.50 | 136 | 178 | 462 | 27.0 | -52.7 |
| | 0.58 | 0.60 | 156 | 192 | 436 | 20.0 | -45.9 |
| | 0.67 | 0.70 | 174 | 202 | 414 | 13.7 | -39.7 |
| | 0.77 | 0.80 | 190 | 209 | 393 | 8.1 | -34.1 |
| | 0.87 | 0.90 | 205 | 213 | 375 | 3.0 | -29.0 |
| | 1.06 | 1.10 | 230 | 219 | 343 | -5.6 | -20.2 |
| | 1.16 | 1.20 | 242 | 220 | 330 | -9.2 | -16.3 |
| | 1.25 | 1.30 | 252 | 220 | 318 | -12.5 | -12.8 |
| | 1.35 | 1.40 | 261 | 220 | 307 | -15.5 | -9.6 |
| | 1.45 | 1.50 | 269 | 219 | 298 | -18.2 | -6.7 |
| | 1.54 | 1.60 | 277 | 219 | 289 | -20.6 | -4.0 |
| | 1.64 | 1.70 | 284 | 218 | 281 | -22.8 | -1.5 |
| | 1.73 | 1.80 | 291 | 217 | 274 | -24.8 | 0.8 |
| | 1.83 | 1.90 | 297 | 216 | 267 | -26.6 | 2.9 |
| | 1.93 | 2.00 | 303 | 215 | 261 | -28.3 | 4.8 |

## 5.9. Red mullet (*Mullus barbatus*) in GSA 25

### *5.9.1. Short term prediction 2009-2011*

#### 5.9.1.1. Method and justification

Short term predictions for 2009 and 2010 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the VPA analysis (running the classic catch equation - Gulland 1965) stock assessment that was applied for red mullet stock in GSA 25 in the framework of the SGMED-09-02 using the VIT software (Lleonart and Salat, 1992).

#### 5.9.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of he red mullet in GSA 25:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| 2005-2008 | Prop. Matures | 0.47 | 0.90 | 0.94 | 1 | 1 | 1 | 1 | 1 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| 2005-2008 | M | 0.26 | 0.12 | 0.1 | 0.09 | 0.08 | 0.08 | 0.08 | 0.08 |

*F vector*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| 2005-2008 | F | 0.01 | 0.49 | 1.27 | 0.75 | 0.77 | 0.61 | 0.33 | 0.30 |

*Weight-at-age in the stock*

| Mean weight in stock | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Kg | 0.015 | 0.028 | 0.043 | 0.061 | 0.079 | 0.097 | 0.113 | 0.128 |

*Weight-at-age in the catch*

| Mean weight in stock | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Kg | 0.015 | 0.028 | 0.043 | 0.061 | 0.079 | 0.097 | 0.113 | 0.128 |

*Number at age in the catch*

| Catch at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| | 16110 | 416092 | 422403 | 78817 | 34826 | 12690 | 3947 | 2402 |

*Number at age in the stock*

| Stock at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| | 1482146 | 1128709 | 611365 | 155651 | 67348 | 28886 | 14525 | 9625 |

For the projection the mean F ($F_{bar}$ ages 1-3), F status quo ($F_{stq}$ = 0.84) was defined as the average of the period 2005-2008. Different scenarios of constant harvest strategy with changes in $F_{stq}$ were used.

*Stock recruitment*

The recruitment used for the short term projections was derived from the VIT results of the age 0+ group.

5.9.1.3. Results

A short term projection (Table 5.9.1.3.1), assuming an $F_{stq}$ of 0.84, shows that:

- Fishing at the $F_{stq}$ (0.84) from 2008 to 2010 generates an equilibrium situation, where the catches increase is minimal, namely only 0.9% in 2010 and the spawning stock biomass from the year 2010 to 2011 increases by 0.5%.

- Fishing at $F_{0.1}$ (0.22) from 2008 to 2010 generates a decrease of the catches of 64.4% in 2010 and a spawning stock biomass increase of 39.8% from 2010 to 2011.

**Outlook until 2011**

Table 5.9.1.3.1 – Short term forecast in different F scenarios computed for red mullet in GSA 25.

Basis: F(2009)= mean ($F_{bar}$ 2005-2008); R(2009) = 1,482 (millions); F(2009) = 0.84; SSB(2010) = 84 t; Catch (2009) = 40 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2008-2010 (%) |
|---|---|---|---|---|---|---|---|
| zero catch | 0.00 | 0 | 0 | 0 | 138 | 61.5 | -100.0 |
| High long-term yield ($F_{0.1}$) | 0.22 | 0.26 | 14 | 21 | 119 | 39.8 | -64.4 |
| Status quo | 0.84 | 1 | 40 | 40 | 86 | 0.5 | 0.9 |
| Different scenarios | 0.08 | 0.1 | 6 | 10 | 130 | 52.7 | -85.5 |
| | 0.17 | 0.2 | 11 | 17 | 124 | 44.6 | -72.2 |
| | 0.25 | 0.3 | 16 | 23 | 117 | 37.2 | -60.1 |
| | 0.33 | 0.4 | 20 | 28 | 111 | 30.5 | -49.0 |
| | 0.42 | 0.5 | 24 | 31 | 106 | 24.3 | -38.8 |
| | 0.50 | 0.6 | 28 | 34 | 101 | 18.7 | -29.5 |
| | 0.59 | 0.7 | 31 | 36 | 97 | 13.5 | -20.9 |
| | 0.67 | 0.8 | 35 | 38 | 93 | 8.8 | -13.0 |
| | 0.75 | 0.9 | 37 | 39 | 89 | 4.5 | -5.8 |
| | 0.92 | 1.1 | 42 | 41 | 83 | -3.2 | 7.1 |
| | 1.00 | 1.2 | 45 | 41 | 80 | -6.6 | 12.8 |
| | 1.09 | 1.3 | 47 | 41 | 77 | -9.7 | 18.1 |
| | 1.17 | 1.4 | 49 | 41 | 75 | -12.6 | 23.0 |
| | 1.25 | 1.5 | 51 | 41 | 72 | -15.3 | 27.5 |
| | 1.34 | 1.6 | 52 | 41 | 70 | -17.8 | 31.8 |
| | 1.42 | 1.7 | 54 | 41 | 68 | -20.1 | 35.7 |
| | 1.51 | 1.8 | 55 | 40 | 66 | -22.3 | 39.4 |
| | 1.59 | 1.9 | 57 | 40 | 65 | -24.3 | 42.8 |
| | 1.67 | 2 | 58 | 40 | 63 | -26.1 | 46.0 |

Weights in t.

There were no particular problems regarding the data quality and availability.

## 5.10. Pink shrimp (*Parapenaeus longirostris*) in GSA 6

### *5.10.1. Short term prediction 2009-2011*

#### 5.10.1.1. Method and justification

A deterministic short term prediction for 2009 to 2011 was performed using the EXCEL workbook provided by JRC IPSC (H.-J. Rätz) which take into account the catch and landings in numbers and weight and the discards, and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994) stock assessment performed during SGMED-09-02.

#### 5.10.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the pink shrimp stock in GSA 6:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2008 | Prop. Matures | 0.00 | 0.13 | 0.50 | 0.79 | 0.90 | 0.97 | 1 | 1 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|---|
| 2008 | M | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 |

*F vector*

| F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2008 | 0.00 | 0.05 | 0.49 | 0.47 | 0.36 | 0.38 | 0.96 | 0.50 |

*Weight-at-age in the stock*

| Mean weight in stock (kg) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2008 | 0.001 | 0.006 | 0.010 | 0.017 | 0.022 | 0.028 | 0.031 | 0.036 |

*Weight-at-age in the catch*

| Mean weight in catch (kg) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2008 | 0.001 | 0.006 | 0.010 | 0.017 | 0.022 | 0.028 | 0.031 | 0.036 |

*Number at age in the catch*

| Catch at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2008 | 0 | 913 | 1855 | 296 | 70 | 13 | 5 | 4.2 |

*Number at age in the stock*

| Numbers at age in the stock (thousands) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2008 | 202213 | 36192 | 8879 | 1483 | 429 | 75 | 14 | 2 |

Different scenarios of constant harvest strategy with reduction of the mean F ($F_{bar}$ ages 2-5) calculated as the average ages 2 to 5 in 2008 was used and defined as F status quo ($F_{stq}$ = 0.43).

*Stock recruitment*

From SGMED 09-02, recruits (aged 0 individuals) were estimated to have declined from 2002 to 2005as for SSB and continued to be very low in 2006-2007. However, in 2008, recruitment increased significantly and appears to be at the level of the 2003 value. Such increased recruitment has the potential to contribute to a recovery of the spawning stock in short time. In this forecast, recruitment of 2008 was used for 2009, as MEDITS trend showed again high values of recruitment for 2009, even higher than for 2008.

#### 5.10.1.3.Results

A short term projection (Table 5.10.1.3.1), assuming an $F_{stq}$ of 0.43 in 2009 and a recruitment of 202213 (thousands) individuals, shows that:

- Fishing at the $F_{stq}$ (0.43) from 2008 to 2010 generates an increase of the catch for 64.6% in 2010 and an increase of the spawning stock biomass for 8.9% from the year 2010 to 2011.

- No limit or target reference points were estimated as SGMED 09-02 was unable to fully evaluate the exploitation status. Fishing mortalities displayed a high variation.

**Outlook until 2011**

Table 5.10.1.3.1 – Short term forecast in different F scenarios computed for pink shrimp in GSA 6.

Basis: F(2009) = (F2008); R(2009) = R(2008) =202213 (thousands); F(2009) = 0.43; SSB(2010) =158 t; Catch (2009) = 39 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2008-2010 (%) |
|---|---|---|---|---|---|---|---|
| zero catch | 0.0 | 0.0 | 0 | 0 | 204 | 29.1 | -100.0 |
| High long-term yield ($F_{0.1}$) | - | - | - | - | - | - | - |
| Status quo | 0.43 | 1.0 | 54 | 57 | 172 | 8.9 | 64.6 |
| Different scenarios | 0.04 | 0.10 | 6 | 8 | 199 | 25.9 | -81.7 |
| | 0.09 | 0.20 | 13 | 15 | 196 | 24.1 | -60.4 |
| | 0.13 | 0.30 | 18 | 22 | 193 | 22.2 | -45.1 |
| | 0.17 | 0.40 | 24 | 28 | 189 | 19.6 | -26.8 |
| | 0.21 | 0.50 | 30 | 34 | 186 | 17.7 | -8.5 |
| | 0.26 | 0.60 | 35 | 39 | 182 | 15.2 | 6.7 |
| | 0.30 | 0.70 | 40 | 45 | 180 | 13.9 | 22.0 |
| | 0.34 | 0.80 | 45 | 50 | 178 | 12.7 | 37.2 |
| | 0.38 | 0.90 | 49 | 53 | 174 | 10.1 | 49.4 |
| | 0.47 | 1.10 | 58 | 62 | 168 | 6.3 | 76.8 |
| | 0.51 | 1.20 | 63 | 65 | 167 | 5.7 | 92.1 |
| | 0.55 | 1.30 | 67 | 69 | 164 | 3.8 | 104.3 |
| | 0.60 | 1.40 | 71 | 72 | 161 | 1.9 | 116.5 |
| | 0.64 | 1.50 | 76 | 76 | 160 | 1.3 | 131.7 |

Weights in t.

**Data consistency**

No particular issue was identified with data quality and data consistency.

## 5.11. Pink shrimp (*Parapenaeus longirostris*) in GSA 9

### *5.11.1. Short term prediction 2009-2011*

#### 5.11.1.1. Method and justification

Short term predictions for 2009 and 2010 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of Length Cohort Analysis (LCA) carried out on 2006, 2007, 2008 catch data collected under DCR.

#### 5.11.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the pink shrimp stock in GSA9:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| 2006-2008 | Prop. Matures | 0.3 | 0.8 | 1.0 | 1.0 | 1.0 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| 2006-2008 | M | 1.2 | 0.78 | 0.76 | 0.65 | 0.50 |

*F vector*

| F | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 2006 | 0.002 | 0.17 | 0.38 | 0.16 | 0.21 |
| 2007 | 0.011 | 0.43 | 0.79 | 0.43 | 0.33 |
| 2008 | 0.019 | 0.26 | 0.30 | 0.13 | 0.18 |

*Weight-at-age in the stock*

| Mean weight in stock (kg) | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 2006 | 0.0015 | 0.0092 | 0.0175 | 0.0236 | 0.0296 |
| 2007 | 0.0015 | 0.0091 | 0.0174 | 0.0234 | 0.0304 |
| 2008 | 0.0015 | 0.0091 | 0.0174 | 0.0234 | 0.0296 |

*Weight-at-age in the catch*

| Mean weight in catch (kg) | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 2006 | 0.0015 | 0.0092 | 0.0175 | 0.0236 | 0.0296 |
| 2007 | 0.0015 | 0.0090 | 0.0173 | 0.0235 | 0.0296 |
| 2008 | 0.0015 | 0.0092 | 0.0176 | 0.0236 | 0.0296 |

*Number at age in the catch*

| Catch at age in numbers | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 2006 | 393585 | 15457648 | 12364102 | 2063212 | 467362 |
| 2007 | 835361 | 10825035 | 5211325 | 792357 | 332509 |
| 2008 | 2430147 | 11852261 | 5072217 | 912313 | 951795 |

*Number at age in the stock*

| Stock numbers at age | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 2006 | 395096539 | 145109172 | 54335829 | 19015553 | 15575208 |
| 2007 | 126664886 | 46090736 | 13310165 | 3094906 | 1781014 |
| 2008 | 214615676 | 77478737 | 26609500 | 10016203 | 8513642 |

Maturity, was estimated as the mean of the last 3 years. M was calculated using the ProBiom method.

#### 5.11.1.3.Results

A short term projection (Table 5.11.1.3.1), assuming an $F_{stq}$ of 0.59 in 2009 and a recruitment of 165 millions individuals, shows that:

- Fishing at the $F_{stq}$ from 2008 to 2011 generates an increases in catch of 39.3 % and a decrease in SSB of 3.8%.

- Fishing at F0.1 (0.7) for the same time frame (2008-2011) generates an icrease in the catches of 58.2% and a decrease of spawning stock biomass of 7.8% from 2010 to 2011.

- A 20% reduction of the Fstq (F = 0.47) generates an increase of catches of 16.4% in 2010 and a spawning stock biomass increase of 1.2% from the year 2010 to 2011.

A 20% reduction of F generates a more or less stable situation where both the catches and SSB gradually increase.

**Outlook until 2011**

Table 5.11.1.3.1 – Short term forecast in different F scenarios computed for pink shrimp in GSA 9.

Basis: F(2009) = mean($F_{bar}$ 2006–2008); R(2009) = GM(2005–2008) = 165 (millions); F (2009) = 0.59; SSB(2010) = 1165 t; Catch (2009) = 410 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2011 -2010 (%) | Change Catch 2010 -2008 (%) |
|---|---|---|---|---|---|---|---|
| Zero catch | 0.00 | 0.00 | 0 | 0 | 1477 | 26.8 | -100.0 |
| High long term yield ($F_{01}$) | 0.70 | 1.18 | 397 | 364 | 1074 | -7.8 | 58.2 |
| Status quo | 0.59 | 1.00 | 349 | 336 | 1120 | -3.8 | 39.3 |
| Different scenarios | 0.06 | 0.10 | 43 | 55 | 1433 | 23.0 | -82.9 |
| | 0.12 | 0.20 | 84 | 104 | 1390 | 19.4 | -66.7 |
| | 0.18 | 0.30 | 123 | 147 | 1350 | 15.9 | -51.2 |
| | 0.24 | 0.40 | 160 | 185 | 1312 | 12.7 | -36.4 |
| | 0.30 | 0.50 | 195 | 218 | 1276 | 9.6 | -22.2 |
| | 0.36 | 0.60 | 229 | 248 | 1242 | 6.6 | -8.8 |
| | 0.42 | 0.70 | 261 | 275 | 1209 | 3.8 | 4.1 |
| | 0.47 | 0.80 | 292 | 298 | 1178 | 1.2 | 16.4 |
| | 0.53 | 0.90 | 321 | 318 | 1149 | -1.4 | 28.1 |
| | 0.65 | 1.10 | 376 | 352 | 1094 | -6.1 | 50.1 |
| | 0.71 | 1.20 | 402 | 366 | 1068 | -8.3 | 60.3 |
| | 0.77 | 1.30 | 427 | 379 | 1044 | -10.3 | 70.1 |
| | 0.83 | 1.40 | 450 | 390 | 1021 | -12.3 | 79.5 |
| | 0.89 | 1.50 | 473 | 399 | 999 | -14.2 | 88.5 |
| | 0.95 | 1.60 | 494 | 408 | 978 | -16.0 | 97.1 |
| | 1.01 | 1.70 | 515 | 415 | 958 | -17.7 | 105.4 |
| | 1.07 | 1.80 | 535 | 422 | 939 | -19.3 | 113.3 |
| | 1.13 | 1.90 | 554 | 427 | 921 | -20.9 | 120.9 |
| | 1.19 | 2.00 | 572 | 432 | 904 | -22.4 | 128.2 |

There were no special problems regarding the data quality and availability.

## 5.12. Pink shrimp (*Parapenaeus longirostris*) in GSA 16

### *5.12.1. Short term prediction 2009-2011*

#### 5.12.1.1. Method and justification

SGMED 09-03 notes that there is no data available to formulate any age-structured production model to predict stock size and landings and discards in short term (2009-2011) for pink shrimp in GSA 16. However, based on a significant and positive regression between the MEDITS survey biomass indices 2001-2007 and landings the consecutive years 2002-2008, SGMED predicted the landings in 2009 and 2010 when survey biomass indices were available. This approach should theoretically provide quantitative landings forecasts under the straightforward presumptions that both independent series:

- represent few, mainly juvenile age groups (ages 0 and 1),
- the fishing effort in the various GSAs has not drastically changed and
- there are no constrains on landings.

SGMED 09-03 emphasizes that the results of such quantitative approach should be interpreted only as an imprecise approximation of future landings under status quo conditions and should be rather interpreted in a qualitative sense, given the high confidence intervals usually associated with such survey indices, and the potential bias related to official landings declarations.

#### 5.12.1.2. Input parameters

The trends in MEDITS survey biomass indices 2001-2009 and the respective reported annual landings 2002-2008 (through the DCF data call) are given in the Table 5.12.1.2.1 below. The estimated landings in 2009 and 2010 are based on the regression between MEDITS biomass indices in year y and the landings in year y+1 as given in the following section.

Table 5.12.1.2.1 of MEDITS survey biomass indices and annual landings by year of pink shrimp in GSA 16. Landings in 2009 and 2010 are projected (bold).

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| MEDITS biomass index (kg/h) | 1.479 | 0.496 | 0.784 | 1.910 | 1.312 | 0.701 | 0.598 | 1.308 | 2.741 | n/a |
| Landings (t) | n/a | 7583 | 7466 | 6665 | 8584 | 8456 | 5966 | 5941 | **7662** | **9928** |

#### 5.12.1.3. Results

The correlation and regression parameters between the biomass index from MEDITS in year y and the landings in year y+1 are given below (Table 5.12.1.3.1).

Table 5.12.1.3.1. Correlation and regression parameters from a linear regression between MEDITS survey biomass in year y (kg/h) and the annual landings (t) in year y+1.

| slope | intercept | r | r^2 |
|---|---|---|---|
| 1582.138 | 5591.48 | 0.77 | 0.60 |

The resulting landings are listed in Table 5.12.1.2.1 and illustrated as blank bars in Figure 5.12.1.3.1.

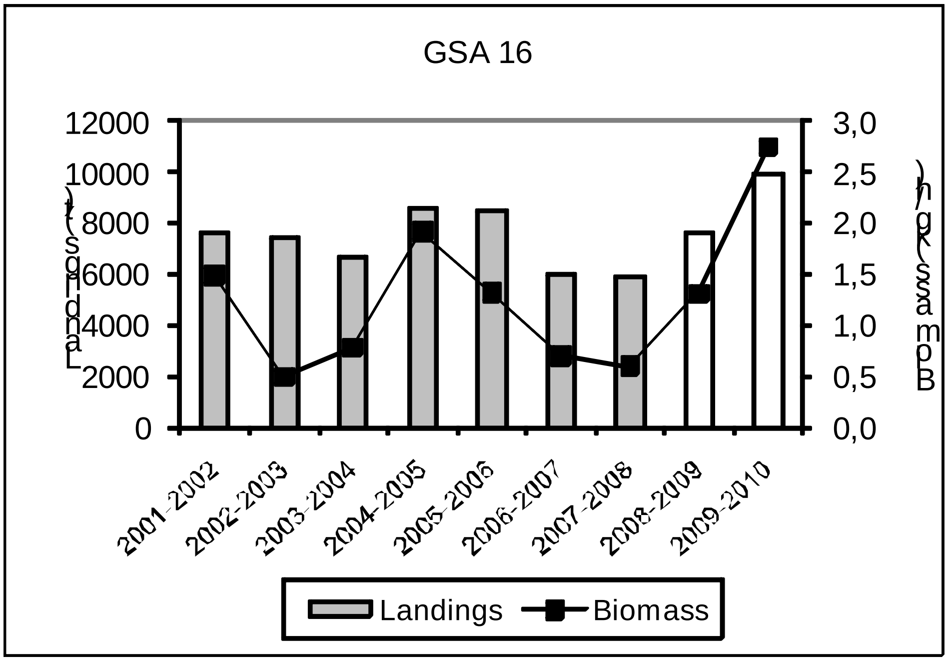



Fig. 5.12.1.3.1. Coincidence between biomass indices derived from MEDITS surveys in a given year and landings of pink shrimp in the following year by GSA 16, 2001-2010. Correlation and linear regression parameters are listed in Table 5.12.1.3.1. Landings in 2009-2010 are estimated from linear regression and illustrated as blank bars.

The projected landings for 2009 are slightly increased as compared to 2006-2007 but range at the average level of about 7,500 t. Based on the highest survey index of the series since 2001 observed in 2009, the landings in 2010 are assessed to be increased further to about 10,000 t. SGMED notes that the results of the short term forecast are considered as representative of a status quo fishing scenario (same exploitation rate in 2009-2010 as estimated for 2007 for both GSAs 15 and 16). This exploitation rate is considered not sustainable (overfishing in relation to $F_{0.1}$, report of SGMED 08-04). As the forecast is subject to largely unknown uncertainty in the input variables, SGMED recommends to interpret the results rather in a qualitative sense.

## 5.13. Anchovy (*Engraulis encrasicolus*) in GSA 16

### *5.13.1. Short term prediction 2009-2011*

#### 5.13.1.1. Method and justification

SGMED 09-03 notes that there is no data available to formulate any age-structured production model to predict stock size and landings and discards in short term (2009-2011). Further, the attempt to apply the approach used for sardine in the same area (GSA 16), based on the exploration of the relationship between the acoustic survey biomass estimates 1998-2007 and landings in the consecutive years 1999-2008 was not successful for the anchovy stock, as the two series were found to be largely unrelated ($r=0.17$; $F_{1,8} = 0.25$, $p=0.63$). This was an expected result, as the acoustic surveys are carried out in June-July, and thus do not include the effect of the annual recruitment on the stock biomass.

#### 5.13.1.2. Input parameters

Hydroacoustic survey biomass trends 1998-2007 and annual landings 1999-2008.

5.13.1.3. Results

None as no forecast analyses are presented.

## 5.14. Anchovy (*Engraulis encrasicolus*) in GSA 22

### *5.14.1. Short term prediction 2009-2011*

5.14.1.1. Method and justification

Short term predictions for 2009 and 2010 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the Integrated Catch at Age (ICA, Patterson 1998) stock assessment that was applied for anchovy stock in GSA 22 in the framework of the SGMED-09-02 using the FLICA FLR library.

5.14.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the anchovy stock in GSA 22:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| 2000-2008 | Prop. Matures | 0 | 0.4 | 0.98 | 1.0 | 1.0 | 1.0 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| 2000-2008 | M | 1.5 | 1 | 0.74 | 0.66 | 0.62 | 0.6 |

*F vector*

| F | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 2000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 2001 | 0.187 | 0.141 | 0.116 | 0.194 | 0.194 | 0.147 |
| 2002 | 1.149 | 0.743 | 0.614 | 1.021 | 1.023 | 0.77 |
| 2003 | 1.502 | 0.270 | 0.222 | 0.370 | 0.371 | 0.281 |
| 2004 | 0.836 | 0.297 | 0.245 | 0.408 | 0.409 | 0.309 |
| 2005 | 0.836 | 0.297 | 0.245 | 0.408 | 0.409 | 0.309 |
| 2006 | 0.001 | 0.001 | 0.000 | 0.001 | 0.001 | 0.001 |
| 2007 | 0.187 | 0.141 | 0.116 | 0.194 | 0.194 | 0.147 |
| 2008 | 1.149 | 0.743 | 0.614 | 1.021 | 1.023 | 0.774 |

*Weight-at-age in the stock*

| Mean weight in stock | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| kg | 0.002 | 0.008 | 0.017 | 0.022 | 0.023 | 0.038 |

*Weight-at-age in the catch*

| Mean weight in catch | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| kg | 0.01 | 0.014 | 0.015 | 0.018 | 0.022 | 0.036 |

*Number at age in the catch*

| Catch at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 2000 | 8859 | 287419 | 357849 | 27449 | 2160 | 1000 |
| 2001 | 14506 | 286470 | 297203 | 19457 | 1000 | 1000 |
| 2002 | 9803 | 304095 | 328428 | 23198 | 1269 | 1000 |
| 2003 | 4676 | 348900 | 513289 | 41899 | 3881 | 1000 |
| 2004 | 16315 | 342761 | 521446 | 57843 | 8527 | 1000 |
| 2005 | 14523 | 498088 | 591543 | 43454 | 3003 | 1000 |
| 2006 | 21930 | 766824 | 863957 | 57795 | 6472 | 1000 |
| 2007 | 46515 | 731249 | 782267 | 58787 | 5727 | 1000 |
| 2008 | 75828 | 892863 | 866883 | 64421 | 2531 | 1000 |

*Number at age in the stock*

| Stock at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 2000 | 14703508 | 2624164 | 692792.8 | 44639.6 | 4903.3 | 2252.7 |
| 2001 | 16976772 | 3276980 | 800638.1 | 104666.4 | 5134.4 | 5090.9 |
| 2002 | 14070858 | 3784188 | 1046578 | 181528 | 41295.5 | 6031.1 |
| 2003 | 17650840 | 3137004 | 1238748 | 270175.3 | 75075.2 | 3885.6 |
| 2004 | 25331475 | 3932952 | 950404.1 | 212799.6 | 96382.9 | 3878.7 |
| 2005 | 39394147 | 5644330 | 1191051 | 162907.8 | 75854.1 | 4914.8 |
| 2006 | 36555089 | 8780740 | 1792161 | 261883.4 | 63562.3 | 4575.6 |
| 2007 | 55134126 | 8147186 | 2752777 | 368540.3 | 99727.6 | 5403.7 |
| 2008 | 24376863 | 12290429 | 2626277 | 655405.3 | 148008.3 | 6292.2 |

Maturity, weight-at-age in the stock and weight-at-age in the catch were estimated as the mean of the last 3 years. F and M before spawning were considered the same as the one considered in the ICA. Different scenarios of constant harvest strategy with reduction of the mean F ($F_{bar}$ ages 1-3) calculated on the last 3 years, but scaled to the $F_{bar}$ (age 1-3) of 2008 in order to account for the recent decreasing trend in the fishing mortality pattern.

*Stock recruitment*

The recruitment used for the short term projection was estimated as the geometric mean from 2000-2007. The recruitment in 2008 was not considered reliable because:

1) No survey took place in 2009 that could confirm the ICA estimated high recruitment of 2008.
2) No information on landings was available for 2009 in order to confirm the estimated high recruitment of 2008.
3) It is known that stock assessment models estimate recruitment by summing all fish from a cohort taking into account fishing and natural mortality. Therefore, the recruitment estimate is the population that would have existed in order to generate the observed catches. However, since the recruitment of the last year results from a cohort that is still contributing to the catch, this often results into an overestimation of the last year’s recruitment.

#### 5.14.1.3.Results

A short term projection (Table 5.14.1.3.1), assuming an $F_{stq}$ of 0.303 in 2009 and a recruitment of 24376863 (thousand) individuals, shows that:

- Fishing at the $F_{stq}$ (0.303) between 2008 to 2010 generates a decrease in the catch of 22% in 2010 and a decrease of the spawning stock biomass of 12% from the year 2010 to 2011.
- Reducing F of 30% of the $F_{stq}$ (0.210) results into a 48% decrease of the catches in 2010 and a decrease in spawning stock biomass of 5% from the year 2010 to 2011.
- Fishing at $F_{stq}$*2 (0.610) for the same time frame (2008-2010) generates an 25% increase in the catches in 2010 and a decrease in spawning stock biomass of 25% from the year 2010 to 2011.

The reference point of E (0.4) as suggested by Patterson (1998) and endorsed by SGMED-09-02 was used in order to comment the short terms implications of the different exploitation scenarios (see Table 5.14.1.3.1).

**Outlook until 2011**

Table 5.14.1.3.1 – Short term forecast in different F scenarios computed for anchovy in GSA 22.

Basis: F(2009) = mean(F2006–2008) scaled to 2008 = 0.303; R(2009) = GM(2000–2007) = 24376863 (thousands); Landings(2009) = 28393 ton and $F_{stq}$(2009) = 0.303; SSB(2011) = 44826 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | E 2010 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2009-2010 (%) |
|---|---|---|---|---|---|---|---|---|
| zero catch | 0 | 0 | 0 | 0 | 0 | 62759 | 10.2 | -100.0 |
| Status quo | 0.303 | 1.1 | 20197 | 19186 | 0.28 | 43432 | -12.1 | -22.4 |
| Different scenarios | 0.00 | 0.0 | 0 | 0 | 0.00 | 62759 | 10.3 | -100.0 |
| | 0.03 | 0.1 | 2142 | 2338 | 0.04 | 60579 | 7.8 | -91.8 |
| | 0.06 | 0.2 | 4215 | 4531 | 0.07 | 58497 | 5.5 | -83.8 |
| | 0.09 | 0.3 | 6221 | 6590 | 0.10 | 56508 | 3.3 | -76.1 |
| | 0.12 | 0.4 | 8163 | 8524 | 0.13 | 54608 | 1.1 | -68.7 |
| | 0.15 | 0.5 | 10044 | 10341 | 0.16 | 52791 | -1.0 | -61.4 |
| | 0.18 | 0.6 | 11867 | 12048 | 0.18 | 51054 | -3.0 | -54.4 |
| | 0.21 | 0.7 | 13635 | 13654 | 0.20 | 49393 | -5.0 | -47.7 |
| | 0.24 | 0.8 | 15350 | 15164 | 0.22 | 47804 | -6.9 | -41.1 |
| | 0.27 | 0.9 | 17014 | 16586 | 0.24 | 46283 | -8.7 | -34.7 |
| | 0.30 | 1.0 | 18629 | 17925 | 0.26 | 44827 | -10.4 | -28.5 |
| | 0.33 | 1.1 | 20198 | 19186 | 0.28 | 43432 | -12.1 | -22.5 |
| | 0.36 | 1.2 | 21722 | 20375 | 0.29 | 42096 | -13.8 | -16.6 |
| | 0.39 | 1.3 | 23204 | 21496 | 0.31 | 40817 | -15.3 | -10.9 |
| | 0.42 | 1.4 | 24645 | 22554 | 0.32 | 39590 | -16.9 | -5.4 |
| | 0.45 | 1.5 | 26047 | 23553 | 0.34 | 38414 | -18.3 | 0.0 |
| | 0.49 | 1.6 | 27412 | 24497 | 0.35 | 37286 | -19.7 | 5.2 |
| | 0.52 | 1.7 | 28741 | 25389 | 0.36 | 36204 | -21.1 | 10.4 |
| | 0.55 | 1.8 | 30035 | 26233 | 0.37 | 35166 | -22.4 | 15.3 |
| | 0.58 | 1.9 | 31296 | 27031 | 0.38 | 34170 | -23.7 | 20.2 |
| | 0.61 | 2.0 | 32526 | 27788 | 0.40 | 33213 | -25.0 | 24.9 |

Weights in ‘000t.

[1)] SSB 2011 relative to SSB 2010. SSB estimates refer to the middle of the year.

2) Landings 2010 relative to Landings 2009.

This short term prediction relies on the ICA assessment for anchovy in GSA 22 but it is based only on data derived from the Greek part of the GSA 22. The inclusion in the Input data of the Turkish landings data, the total catches as well as the length and age structure of the Turkish catches from GSA 22 will likely ensure the reduction of possible bias in the estimates derived from the current stock assessment.

### *5.14.2. Medium term prediction*

#### 5.14.2.1. Method and justification

Medium term predictions for a 10 years period were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the Integrated Catch at Age (ICA, Patterson 1998) stock assessment applied using the FLICA- FLR library. The predictions were conducted assuming an increase in F towards the F (E0.4) in 2010 as the stock is harvested below the reference point E(0.4) suggested by Patterson (1998) and endorsed by SGMED-09-02. The stock-recruitment relationship used was based on the Ricker model for the estimated SSB from 2000 to 2007. Runs were made with 500 simulations, using a log-normally distributed recruitment noise with a mean of 1 and a standard deviation of 0.3.

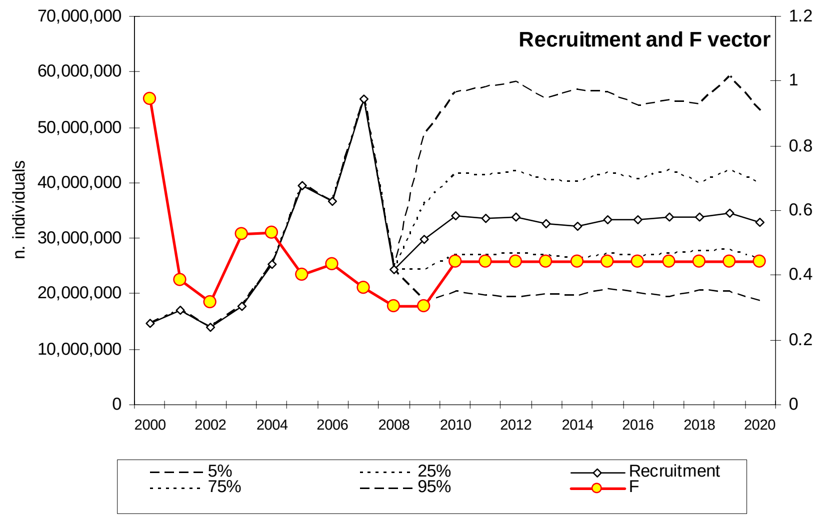
#### 5.14.2.2. Input parameters

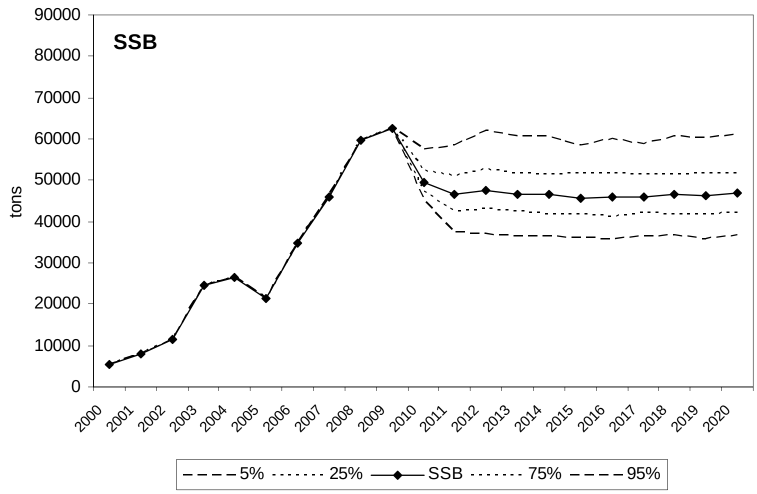
The input parameters were the same as the ones used in the short term forecast.

#### 5.14.2.3. Results

In Figure 5.14.2.3.1, 5$^{th}$, 25$^{th}$, 50$^{th}$, 75$^{th}$ and 95$^{th}$ percentile are showed for the SSB, recruitment and catches from 2000 to 2020, considering an increase of the $F_{stq}$ of around 30% F(0.44) for 2010 in order to obtain an F(E0.4) and remain at this level for the projected period.

Under the aforementioned assumptions, the model predicts a slight increase in the recruitment. The SSB remains around 47000 t, with an increase in the catches to approximately 29000 t.



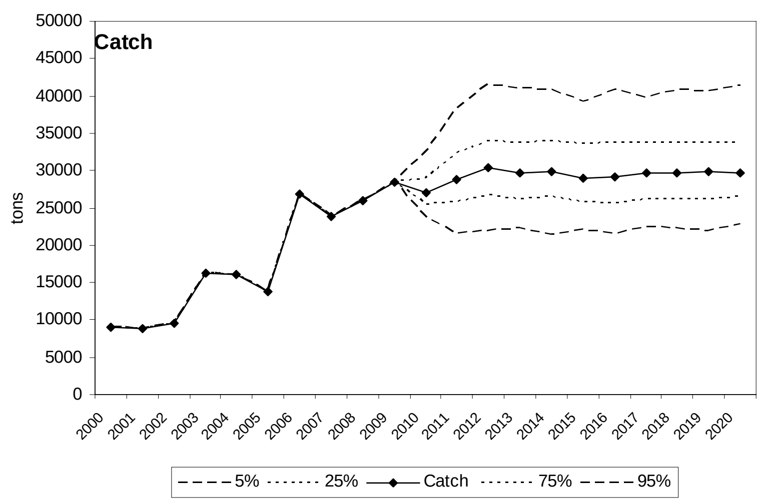




Fig. 5.14.2.3.1 – Outputs of the medium term forecast computed for anchovy in GSA 22.

This medium term prediction relies on the ICA assessment for anchovy in GSA 22 but it is based only on data derived from the Greek part of the GSA 22. The inclusion of the Turkish landings data and the length and age structure of the Turkish catches from GSA 22 will likely improve the estimates derived from the current stock assessment.

## 5.15. Sardine (*Sardina pilchardus*) in GSA 16

### *5.15.1. Short term prediction 2009-2011*

#### 5.15.1.1. Method and justification

SGMED 09-03 notes that there is no data available to formulate any age-structured model to predict stock size, landings and discards in the short or medium term. However, based on a positive regression observed between the acoustic survey biomass estimates during 1998-2007 and landings in the consecutive years (1999-2008; r=0.58; $F_{1,8} = 4.09$, p=0.08), SGMED was able to predict the landings in 2009 and 2010 based on the available survey biomass estimates in the previous years (2008 and 2009). This approach should theoretically provide quantitative landings forecasts under the straightforward presumptions that:

- both independent series represent few, mainly juvenile age groups (ages 0 and 1),
- the fishing effort in the GSA has not drastically changed and
- there are no constrains on landings.

SGMED 09-03 emphasizes that the results of such quantitative approach should be interpreted only as an imprecise approximation of future landings under status quo conditions and should be rather interpreted in a qualitative sense, given the relatively high confidence intervals usually associated with such survey biomass estimates, the potential bias related to official landings declarations and the uncertainty in the relationship between survey and landings estimates.

#### 5.15.1.1. Input parameters

The trends in acoustic survey biomass estimates during 1998-2007 and the respective annual landings during 1999-2008 for GSA 16 (as evaluated from census data collected in Sciacca, the main landing port for small pelagics in the area, and their relative importance compared total landings in GSA16) are given in the Table 5.15.1.1.1. Landings from the DCR/DCF data call were not used because of the shorter time series and because the amount of sardine landings for years before 2006 are considered to be underestimated as in this period landings from pelagic trawlers based in Sciacca port were not yet considered into the sampling framework of DCR. It is also worth noting that reported DCR/DCF landings data for the more recent years (from 2006 onward) are comparable with the estimates of GSA16 landings based on census data collected in Sciacca port (the difference between the two sources of information is less than 10% on average over the period 2006-2008).

The estimated landings in 2009 and 2010 are based on the regression between acoustic biomass estimates in year t and the landings in year t+1 as given in the following section.

Table 5.15.1.1.1. Acoustic survey biomass estimates and landings by year used for the regression analysis.

| Year | Biomass estimates (t, year t) | Landings (t, year t+1) |
|---|---|---|
| 1998 | 20000 | 1850 |
| 1999 | 33700 | 3119 |
| 2000 | 36370 | 2484 |
| 2001 | 10054 | 2430 |

| | | |
|---|---|---|
| 2002 | 6000 | 1739 |
| 2003 | 9510 | 2011 |
| 2004 | 17960 | 1798 |
| 2005 | 21219 | 1856 |
| 2006 | 10220 | 1585 |
| 2007 | 11043 | 2448 |

### 5.15.1.2.Results

The correlation and regression parameters between the biomass estimate from acoustic surveys in year y and the landings in year y+1 are given below.

Table 5.12.1.2.1.

| intercept | slope | r | $r^2$ |
|---|---|---|---|
| 1667.6 | 0.026 | 0.58 | 0.34 |

The resulting landings are illustrated as blank bars in Figure 5.12.1.2.1.

Table 5.12.1.2.2.

| year | Estimated landings (t) |
|---|---|
| 2009 | 1988 |
| 2010 | 1879 |

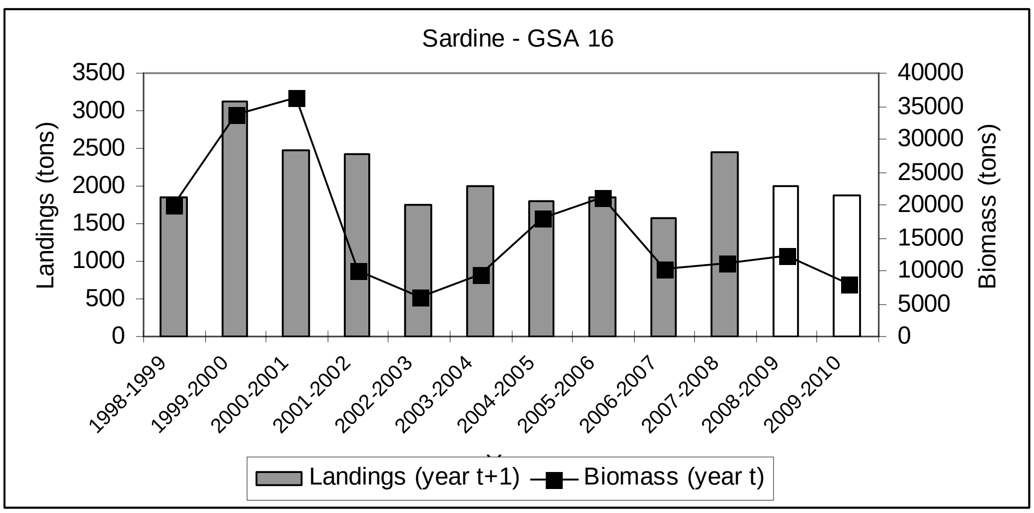



Figure 5.12.1.2.1. Biomass estimates derived from acoustic surveys in a given year and landings of sardine in the following year in GSAs 16. Correlation and linear regression parameters are listed in Table 5.12.1.2.1. Landings in 2009-2010 are estimated from linear regressions and illustrated as blank bars.

The estimated landings in 2009 and 2010 are close to the median value over the period 1999-2008 (1933 t). The estimated landings in 2009 and 2010 evidence a decreasing trend respect to 2008 (the corresponding reduction is -19% for 2009 and -23% for 2010). In addition, biomass estimates for year 2009 (about 8000 t) is relatively low compared to the median of the biomass estimates over the period 1998-2007 (14500 t) and even lower when compared to the average biomass over the same period (17600 t).

The results of the short term forecast are considered as representative of a status quo fishing scenario (same exploitation rate in 2009-2010 as estimated for 2008). This exploitation rate is considered sustainable (report of SGMED 09-02).

## 5.16. Sardine (*Sardina pilchardus*) in GSA 22

### *5.16.1. Short term prediction 2009-2011*

#### 5.16.1.1. Method and justification

Short term predictions for 2009 and 2010 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of an improved Integrated Catch at Age (ICA, Patterson 1998) stock assessment analysis that was presented and accepted for the sardine stock in GSA 22 by the SGMED-09-02 using the FLICA FLR library. The input and the results of this improved stock assessment are included in the Appendix of the current report.

#### 5.16.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the sardine stock in GSA 22:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| 2000-2008 | Prop. Matures | 0 | 0.4 | 1.0 | 1.0 | 1.0 | 1.0 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| 2000-2008 | M | 1.5 | 0.96 | 0.69 | 0.61 | 0.57 | 0.55 |

*F vector*

| F | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 2000 | 0.00 | 0.01 | 0.03 | 0.00 | 0.00 | 0.01 |
| 2001 | 0.58 | 1.15 | 0.82 | 0.63 | 0.52 | 0.70 |
| 2002 | 1.47 | 1.04 | 1.37 | 1.19 | 0.99 | 1.32 |
| 2003 | 1.99 | 2.12 | 0.29 | 1.16 | 0.96 | 1.29 |
| 2004 | 0.33 | 0.38 | 0.23 | 0.25 | 0.21 | 0.28 |
| 2005 | 0.33 | 0.38 | 0.23 | 0.25 | 0.21 | 0.28 |
| 2006 | 0.00 | 0.01 | 0.03 | 0.00 | 0.00 | 0.01 |
| 2007 | 0.58 | 1.15 | 0.82 | 0.63 | 0.52 | 0.70 |
| 2008 | 1.47 | 1.04 | 1.37 | 1.19 | 0.99 | 1.32 |

*Weight-at-age in the stock*

| Mean weight in stock | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| kg | 0.0055 | 0.0177 | 0.021 | 0.0271 | 0.0343 | 0.1 |

*Weight-at-age in the catch*

| Mean weight in catch | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| kg | 0.0041 | 0.5214 | 0.9812 | 0.958 | 0.208 | 0.2086 |

*Number at age in the catch*

| Catch at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 2000 | 11667 | 37520 | 51717 | 21500 | 20239 | 6181 |
| 2001 | 551371 | 713226 | 443184 | 295889 | 286649 | 418858 |
| 2002 | 207846 | 199767 | 105728 | 90330 | 84203 | 159655 |
| 2003 | 36580 | 28760 | 13667 | 12886 | 11966 | 28900 |
| 2004 | 1624 | 940 | 406 | 505 | 443 | 1194 |
| 2005 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| 2006 | 11667 | 37520 | 51717 | 21500 | 20239 | 6181 |
| 2007 | 551371 | 713226 | 443184 | 295889 | 286649 | 418858 |
| 2008 | 207846 | 199767 | 105728 | 90330 | 84203 | 159655 |

*Number at age in the stock*

| Stock at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 2000 | 6713358 | 1872753 | 344829.2 | 51615.8 | 7547.7 | 4608.1 |
| 2001 | 5279912 | 1492928 | 402958.6 | 39638.3 | 3829.3 | 4039.4 |
| 2002 | 4007557 | 1161970 | 181856.9 | 71156.2 | 2592.3 | 6329.6 |
| 2003 | 4025375 | 871993.2 | 196892 | 23066.5 | 28887.2 | 5741.4 |
| 2004 | 5095284 | 893735.1 | 177196 | 29979 | 3913.3 | 6801.4 |
| 2005 | 5394085 | 1132247 | 202483.3 | 33108.3 | 6211.2 | 5251.2 |
| 2006 | 4416555 | 1196992 | 215119 | 27165.9 | 4964.1 | 4911.5 |
| 2007 | 7828961 | 979642.7 | 215100.9 | 25989.6 | 3677 | 5575.4 |
| 2008 | 5210637 | 1737937 | 194880.8 | 31466.2 | 4240.2 | 6840.8 |

Maturity, weight-at-age in the stock and weight-at-age in the catch was estimated as the mean of the last 3 years. F and M before spawning were considered the same as used in ICA.

Different scenarios of constant harvest strategy with reduction of the mean F ($F_{bar}$ ages 1-3) calculated as the average of the last 3 years, but scaled to the F of 2008 in order to account for the recent decreasing trend in the fishing mortality pattern.

*Stock recruitment*

The recruitment used for the short term projection was estimated as the geometric mean from 2000-2007. The recruitment in 2008 was not considered reliable because:

4) No survey took place in 2009 that could confirm the ICA estimated high recruitment of 2008.
5) No information on landings was available for 2009 in order to confirm the estimated high recruitment of 2008.
6) It is known that stock assessment models estimate recruitment by summing all fish from a cohort taking into account fishing and natural mortality. Therefore, the recruitment estimate is the population that would have existed in order to generate the observed catches. However, since the recruitment of the last year results from a cohort that is still contributing to the catch, this often results into an overestimation of the last year recruitment.

#### 5.16.1.3. Results

A short term projection (Table 5.16.1.3.1), assuming an $F_{stq}$ of 0.82 in 2009 and a constant recruitment of 5210637 (thousands) individuals, shows that:

- Fishing at the $F_{stq}$ (0.82) from 2008 to 2010 generates an increase in the catches of 8% in 2010 and a spawning stock biomass decrease of 1.1% from 2010 to 2011.
- Fishing with a 30% reduction of F (0.57) from 2008 to 2010 generates a decrease in the catches of 18% in 2010 and a spawning stock biomass increase of 8% from 2010 to 2011.

The precautionary reference point of E(0.4) as suggested by Patterson (1998) and endorsed by SGMED-09-02 was used in order to comment the short terms implications of the different exploitation scenarios.

According to the short term predictions results, a 60% decrease of the $F_{stq}$ (F=0.49) will maintain the sardine landings at 7169 t for 2010 and allow the stock to be exploited sustainably, based on the reference point E(0.4).

### Outlook until 2011

Table 5.16.1.3.1 – Short term forecast in different F scenarios computed for sardine in GSA 22.

Basis: F(2009) = mean(F2006–2008) scaled to 2008 = 0.8202; R(2009) = GM(2000–2007) = 5210637 (thousands); Landings(2009) = 11730 t and $F_{stq}$ (2009) = 0.82; SSB(2011) = 9250 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | E 2010 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2009-2010 (%) |
|---|---|---|---|---|---|---|---|---|
| zero catch | 0 | 0 | 0 | 0 | 0 | 17207.55 | 39.4 | -100.0 |
| Status quo | 0.82 | 1 | 10757 | 10479 | 0.52 | 9250 | -1.1 | 8.3 |
| Different scenarios | 0.00 | 0 | 0 | 0 | 0.00 | 17208 | 39.4 | -100.0 |
| | 0.08 | 0.1 | 1378 | 1736 | 0.10 | 16041 | 33.7 | -86.1 |
| | 0.16 | 0.2 | 2676 | 3253 | 0.19 | 14981 | 28.4 | -73.1 |
| | 0.25 | 0.3 | 3899 | 4584 | 0.25 | 14017 | 23.5 | -60.7 |
| | 0.33 | 0.4 | 5052 | 5754 | 0.31 | 13139 | 19.0 | -49.1 |
| | 0.41 | 0.5 | 6141 | 6787 | 0.36 | 12339 | 14.9 | -38.2 |
| | 0.49 | 0.6 | 7170 | 7702 | 0.40 | 11608 | 11.2 | -27.8 |
| | 0.57 | 0.7 | 8142 | 8516 | 0.43 | 10939 | 7.7 | -18.0 |
| | 0.66 | 0.8 | 9062 | 9242 | 0.46 | 10327 | 4.5 | -8.8 |
| | 0.74 | 0.9 | 9932 | 9894 | 0.49 | 9766 | 1.6 | 0.0 |
| | 0.82 | 1 | 10757 | 10480 | 0.52 | 9251 | -1.2 | 8.3 |
| | 0.90 | 1.1 | 11539 | 11010 | 0.54 | 8777 | -3.6 | 16.2 |
| | 0.98 | 1.2 | 12281 | 11492 | 0.56 | 8340 | -5.9 | 23.7 |
| | 1.07 | 1.3 | 12986 | 11931 | 0.58 | 7937 | -8.0 | 30.8 |
| | 1.15 | 1.4 | 13655 | 12333 | 0.59 | 7565 | -9.9 | 37.5 |
| | 1.23 | 1.5 | 14292 | 12702 | 0.61 | 7221 | -11.7 | 43.9 |
| | 1.31 | 1.6 | 14897 | 13044 | 0.62 | 6902 | -13.3 | 50.0 |
| | 1.39 | 1.7 | 15474 | 13360 | 0.64 | 6605 | -14.8 | 55.8 |
| | 1.48 | 1.8 | 16023 | 13655 | 0.65 | 6329 | -16.2 | 61.4 |
| | 1.56 | 1.9 | 16547 | 13930 | 0.66 | 6073 | -17.4 | 66.6 |

Weights in ‘000t.

1) SSB 2011 relative to SSB 2010. SSB is estimated at the middle of the year.

2) Landings 2010 relative to Landing 2009.

This short term prediction relies on the ICA assessment for sardine in GSA 22 but it is based only on data derived from the Greek part of the GSA 22. The inclusion of the Turkish landings data and the length and age structure of the Turkish catches from GSA 22 will likely improve the estimates derived from the current stock assessment.

### *5.16.2. Medium term prediction*

#### 5.16.2.1. Method and justification

Medium term predictions for a 10 years period were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the Integrated Catch at Age (ICA, Patterson 1998) stock assessment applied using the FLICA- FLR library. The predictions were conducted assuming a decrease in F towards the F(E0.4) in 2015, based on the reference point E(0.4) suggested by Patterson (1998) and endorsed by SGMED-09-02. The stock-recruitment relationship used was based on the Ricker model for the estimated SSB from 2000 to 2007. Runs were made with 500 simulations, using a log-normally distributed recruitment noise with a mean of 1 and a standard deviation of 0.3.

#### 5.16.2.2. Input parameters

The input parameters were the same as the ones used in the short term forecast.

#### 5.16.2.3. Results

In Figure 5.16.2.3.1, $5^{th}$, $25^{th}$, $50^{th}$, $75^{th}$ and $95^{th}$ percentile are showed for the SSB, recruitment and catches from 2000 to 2020, considering a decrease of the $F_{stq}$ of around 30% F(0.63) for 2015 in order to obtain an F(E0.4) and remain at this level for the rest of the projected period.

Under the aforementioned assumptions, the model predicts a stable recruitment for the whole period. The SSB remains around 12000 t, with a smaller increase in the catches between 9000 to 10000 t. In addition, under this scenario an increase in the mean individual weight after 2015 has been predicted (data not shown).

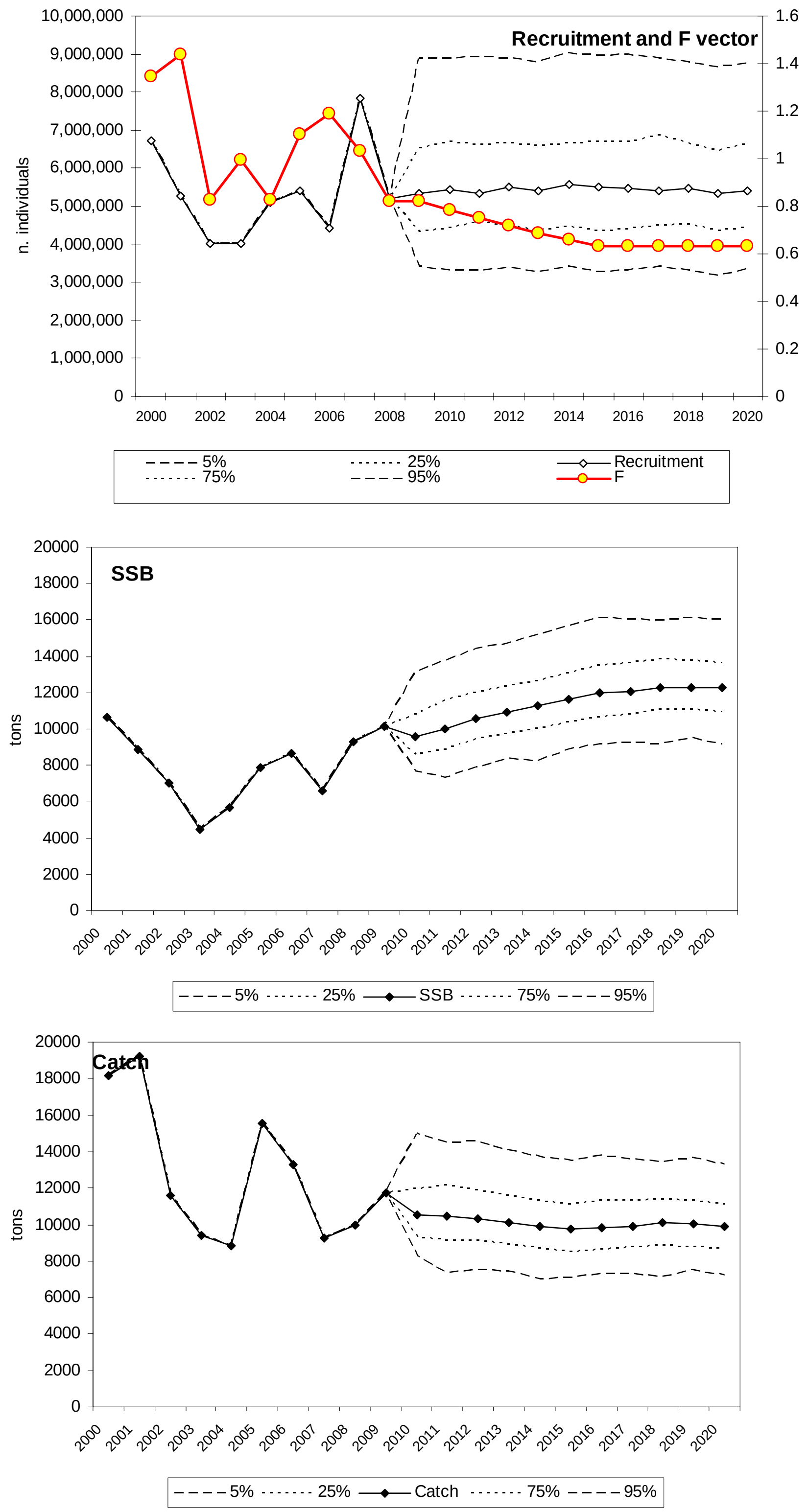



Fig. 5.16.2.3.1 – Outputs of the medium term forecast computed for sardine in GSA 22.

This short term prediction relies on the ICA assessment for sardine in GSA 22 but it is based only on data derived from the Greek part of the GSA 22. The inclusion of the Turkish landings data and the length and age structure of the Turkish catches from GSA 22 will likely improve the estimates derived from the current stock assessment.

## 5.17. Common sole (*Solea solea*) in GSA 17

### *5.17.1. Short term prediction 2009-2011*

#### 5.17.1.1. Method and justification

Short term prediction for 2009 and 2010 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994) stock assessment that was conducted in the framework of the SGMED-09-02 using the VPA Lowestoft software suite.

#### 5.17.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the common sole in GSA 17:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|---|
| 2005-2008 | Prop. Matures | 0 | 0.25 | 0.75 | 1 | 1 | 1 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5+ | Mean 0-4 |
|---|---|---|---|---|---|---|---|---|
| 2005-2008 | M | 0.69 | 0.34 | 0.27 | 0.25 | 0.23 | 0.22 | 0.39 |

*F vector*

| F | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| 2005 | 0.07 | 1.78 | 2.48 | 1.60 | 1.48 | 1.48 |
| 2006 | 0.10 | 1.87 | 1.82 | 1.23 | 1.25 | 1.25 |
| 2007 | 0.11 | 1.61 | 1.91 | 1.35 | 1.26 | 1.26 |
| 2008 | 0.17 | 1.76 | 2.08 | 1.37 | 1.37 | 1.37 |

*Weight-at-age in the stock*

| Mean weight in stock | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| kg | 0.012 | 0.058 | 0.155 | 0.258 | 0.345 | 0.519 |

*Weight-at-age in the catch*

| Mean weight in catch | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| kg | 0.012 | 0.058 | 0.155 | 0.258 | 0.345 | 0.519 |

*Number at age in the catch*

| Catch at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| 2005 | 2190 | 12910 | 3120 | 138 | 11 | 8 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2006 | 2629 | 15151 | 1637 | 159 | 20 | 10 |
| 2007 | 3813 | 11205 | 1768 | 186 | 38 | 14 |
| 2008 | 5779 | 15675 | 1830 | 181 | 39 | 14 |

*Number at age in the stock*

| Stock at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| 2005 | 53322 | 18306 | 3858 | 193 | 16 | 11 |
| 2006 | 43063 | 21139 | 2214 | 251 | 31 | 15 |
| 2007 | 58650 | 16512 | 2351 | 280 | 59 | 21 |
| 2008 | 57227 | 22338 | 2370 | 271 | 58 | 20 |

Different scenarios of constant harvest strategy with reduction of the mean F ($F_{bar}$ ages 0-4) calculated as the average of the last 3 years was used and defined as F status quo (Fstq = 1.28).

*Stock recruitment*

The recruitment used for the short term projection was estimated as the geometric mean from 2006-2008.

5.17.1.3.Results

A short term projection (Table 5.17.1.3.1), assuming an $F_{stq}$ of 1.28 in 2009 and a constant recruitment of 52479 (thousands) individuals, shows that:

- Fishing at the $F_{stq}$ (1.28) from the year 2008 to 2010 generates an increase of the catches of 14.7% in 2010 and a decrease of the spawning stock biomass of 0.3 % from the year 2010 to 2011.
- Fishing at $F_{0.1}$ (0.26) from 2008 to 2010 generates a decrease of the catch of 60.3% in 2010 and a spawning stock biomass increase of 179.4% from 2010 to 2011.
- A 30% reduction of the $F_{stq}$ (F = 0.90) generates a decrease of the catches of 3.6% in 2010 and a spawning stock biomass increase of 40.9% from 2010 to 2011.

The last scenario clearly indicates that a 30% reduction of F generates minimal reduction of catches in 2010 in comparison with 2008, while it predicts a large increase (40%) of the SSB from 2010 to 2011.

**Outlook until 2011**

Table 5.17.1.3.1 – Short term forecast in different F scenarios computed for the common sole in GSA 17

Basis: F(2009) = mean($F_{bar}$2006–2008); R(2009) = GM(2005–2008) = 52479 (thousands); F (2009) = 1.28; SSB(2010) = 790 t; Landings(2009)= 1472 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2008-2010 (%) |
|---|---|---|---|---|---|---|---|
| zero catch | 0.00 | 0 | 0 | 0 | 3006 | 280.7 | -100.0 |
| High long-term yield ($F_{0.1}$) | 0.26 | 0.203 | 511 | 1008.3 | 2206 | 179.4 | -60.3 |
| Status quo | 1.28 | 1 | 1474 | 1468 | 788 | -0.3 | 14.7 |
| Different scenarios | 0.13 | 0.1 | 273 | 609 | 2576 | 226.2 | -78.8 |
| | 0.26 | 0.2 | 505 | 1000 | 2215 | 180.5 | -60.7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.38 | 0.3 | 702 | 1244 | 1912 | 142.1 | -45.4 |
| | 0.51 | 0.4 | 870 | 1390 | 1657 | 109.9 | -32.4 |
| | 0.64 | 0.5 | 1013 | 1469 | 1444 | 82.8 | -21.3 |
| | 0.77 | 0.6 | 1135 | 1506 | 1264 | 60.1 | -11.7 |
| | 0.90 | 0.7 | 1240 | 1516 | 1113 | 40.9 | -3.6 |
| | 1.03 | 0.8 | 1330 | 1508 | 986 | 24.8 | 3.4 |
| | 1.15 | 0.9 | 1407 | 1491 | 878 | 11.2 | 9.4 |
| | 1.41 | 1.1 | 1533 | 1442 | 711 | -10.0 | 19.2 |
| | 1.54 | 1.2 | 1583 | 1416 | 646 | -18.2 | 23.1 |
| | 1.67 | 1.3 | 1627 | 1390 | 591 | -25.1 | 26.5 |
| | 1.80 | 1.4 | 1666 | 1366 | 545 | -31.0 | 29.5 |
| | 1.92 | 1.5 | 1700 | 1343 | 505 | -36.1 | 32.2 |
| | 2.05 | 1.6 | 1730 | 1322 | 471 | -40.4 | 34.5 |
| | 2.18 | 1.7 | 1757 | 1302 | 442 | -44.1 | 36.6 |
| | 2.31 | 1.8 | 1781 | 1284 | 417 | -47.2 | 38.5 |
| | 2.44 | 1.9 | 1802 | 1268 | 395 | -50.0 | 40.1 |
| | 2.57 | 2 | 1821 | 1252 | 377 | -52.3 | 41.6 |

Weights in t.

### *5.17.2. Medium term prediction*

#### 5.17.2.1. Method and justification

Medium term prediction from 2009 to 2020 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994) stock assessment that was applied for common sole stock in GSA 17 in the framework of the SGMED-09-02 using the VPA Lowestoft software suite. The program used in the Medium term projections (10 years) were assuming a decreasing trend of the $F_{stq}$ toward the $F_{0.1}$ in 10 years. The stock-recruitment relationship used geometric mean recruitment over the observed SSB range from 2006 to 2008. Runs were made with 500 simulations per run to try projecting with stochastic recruitment, multiplying the recruitment by log-normally distributed noise with a mean of 1 and a standard deviation of 0.3.

#### 5.17.2.2. Input parameters

The maturity ogive, the natural mortality, the numbers of individuals and weight-at-age for the stock and for the catch were the same used in the short term forecast.

#### 5.17.2.3. Results

In fig. 5.17.2.3.1, the $5^{th}$, $25^{th}$, $50^{th}$, $75^{th}$ and $95^{th}$ percentile are showed for the SSB, recruitment and catches in t from 2005 to 2020, considering a constant reduction of the $F_{stq}$ of around 14% each year from 2010 to 2020.

It is interesting that the decreasing fishing mortality determine a clear increase of the SSB not affecting the amount of the catches in a medium term.

At the moment the fishing activity is conducted in a not rationale sense, considering that the catches could be constant in the medium term with a large decreasing of the fishing mortality.

Data used in the present assessment (XSA) and in the short and medium term forecast have been compared with the official data collected in Italy in the framework of the Data Collection Regulation. The sampling regarding the age and the length structures of the landings did not provide useful data for 2007 and 2008. As regarding the total landings (Table 5.17.2.3.1), there is a high level of similarity comparing the official DCR data and the data collected in the framework of other projects used in the present assessment. The most important difference (753 t) has been observed only in the last year (2008), likely due to the underestimation of the "rapido" trawl fishing activity in the DCR data. The Slovenian data were not available in the period the assessment was performed, however, considering relatively low amount, they should not change the results of the assessment. At present, data on sole are not available from the Croatian part; because sole is considered under the "mixed flatfish" category in the Croatian fishery statistics. However, landings of around 200 t of *Solea solea* per year have been suggested, mainly caught by small scale fisheries. Therefore this value was used in the present assessment. As for age structure of *Solea solea* in the eastern part of Adriatic sea, the data collected during the SoleMon survey carried out in the area close to the Croatian coast, were used.

Table 5.17.2.3.1 – Landings of common sole from GSA 17.

| | **2005** | **2006** | **2007** | **2008** |
|---|---|---|---|---|
| DCR Italian landings | 1662 | 1891 | 1492 | 1231 |
| SGMED landings* | 1867 | 1808 | 1473 | 1984 |
| Slovenian landings | 6.4 | 5.6 | 8.3 | 6.2 |
| Croatian landings* | 200 | 200 | 200 | 200 |

*used in the present assessment

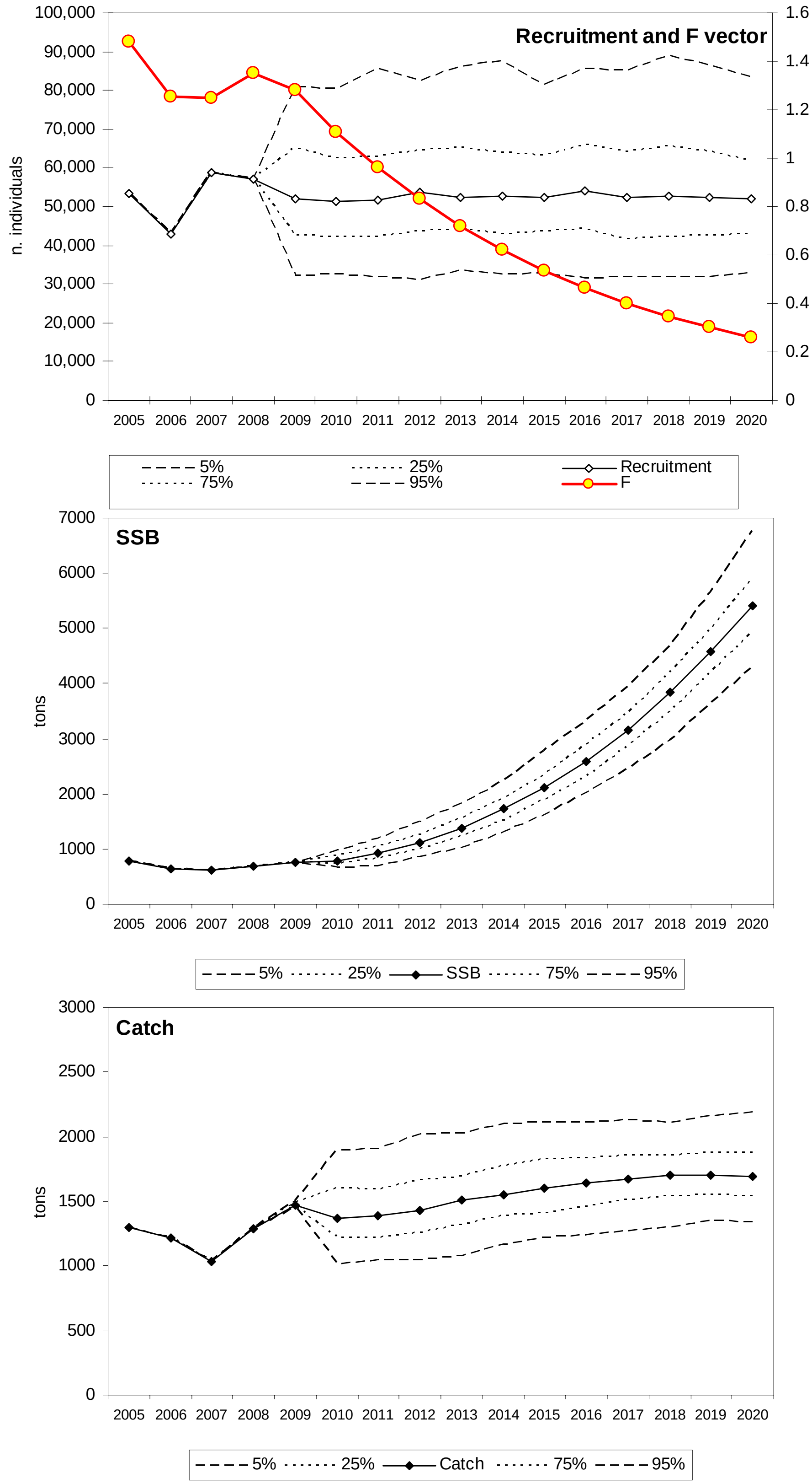



Fig. 5.17.2.3.1– Outputs of the medium term forecast computed for the common sole in GSA 17.

## 5.18. Blue and red shrimp (*Aristeus antennatus*) in GSA 6

### *5.18.1. Short term prediction 2009-2011*

#### 5.18.1.1. Method and justification

A deterministic short term prediction for 2009 to 2011 was performed using the EXCEL workbook provided by JRC IPSC (H.-J. Rätz) which take into account the catch and landings in numbers and weight and the discards, and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994) stock assessment performed during SGMED-09-02.

#### 5.18.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the blue and red shrimp stock in GSA 6:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4+ |
|---|---|---|---|---|---|---|
| 2008 | Prop. Matures | 0.08 | 0.77 | 1 | 1 | 1 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4+ |
|---|---|---|---|---|---|---|
| 2008 | M | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |

*F vector*

| F | 0 | 1 | 2 | 3 | 4+ |
|---|---|---|---|---|---|
| 2008 | 0.15 | 2.14 | 1.48 | 1.41 | 1.42 |

*Weight-at-age in the stock*

| Mean weight in stock (kg) | 0 | 1 | 2 | 3 | 4+ |
|---|---|---|---|---|---|
| 2008 | 0.005 | 0.009 | 0.028 | 0.046 | 0.061 |

*Weight-at-age in the catch*

| Mean weight in catch (kg) | 0 | 1 | 2 | 3 | 4+ |
|---|---|---|---|---|---|
| 2008 | 0.005 | 0.009 | 0.028 | 0.046 | 0.061 |

*Number at age in the catch*

| Catch at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4+ |
|---|---|---|---|---|---|
| 2008 | 9796 | 39672 | 3859 | 808 | 41 |

*Number at age in the stock*

| Numbers at age in the stock (thousands) | 0 | 1 | 2 | 3 | 4+ |
|---|---|---|---|---|---|
| 2008 | 91043 | 56306 | 6251 | 1338 | 316 |

Different scenarios of constant harvest strategy with reduction of the mean F ($F_{bar}$ ages 1-4) calculated as the average ages 1 to 4 in 2008 was used and defined as F status quo ($F_{sq}$ = 1.61)

*Stock recruitment*

Recruitment (class 0) has been estimated as the geometric mean of values in 2006-2008.

5.18.1.3. Results

A short term projection (Table 5.18.1.3.1), assuming an $F_{stq}$ of 1.61 in 2009 and a recruitment of 88322 (thousands) individuals, shows that:

- Fishing at the $F_{stq}$ (1.61) from 2008 to 2010 generates a decrease of the catches of 25.4% in 2010 and a decrease of the spawning stock biomass of 1.8% from the year 2010 to 2011.
- Fishing at $F_{0.1}$ (0.25) from 2008 to 2010 generates a decrease of the catches of 79.3% in 2010 and a spawning stock biomass increase of 123.2% from the year 2010 to 2011.
- $F_{0.1}$ used came from GFCM assessment from 2007 (estimated by Y/R) as this information was not available in SGMED-09-02 report.

**Outlook until 2011**

Table 5.18.1.3.1 – Short term forecast in different F scenarios computed for blue and red shrimp in GSA 6.

Basis: F(2009) = (F2008); R(2009) = GM(2006–2008) = 88322 (thousands); F(2009) = 1.61; SSB(2010) = 1022 t; Catch (2009) = 506 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2008-2010 (%) |
|---|---|---|---|---|---|---|---|
| zero catch | 0.00 | 0.00 | 0 | 0 | 1426 | 117.9 | -100.0 |
| High long-term yield ($F_{0.1}$) | 0.25 | 0.15 | 132 | 243 | 1145 | 123.2 | -79.3 |
| Status quo | 1.61 | 1.00 | 476 | 470 | 504 | -1.8 | -25.4 |
| Different scenarios | 0.16 | 0.10 | 90 | 173 | 1235 | 140.7 | -85.9 |
| | 0.32 | 0.20 | 165 | 288 | 1079 | 110.3 | -74.1 |
| | 0.48 | 0.30 | 227 | 364 | 951 | 85.4 | -64.4 |
| | 0.65 | 0.40 | 282 | 412 | 846 | 64.9 | -55.8 |
| | 0.81 | 0.50 | 328 | 440 | 760 | 48.1 | -48.6 |
| | 0.97 | 0.60 | 366 | 458 | 686 | 33.7 | -42.6 |
| | 1.13 | 0.70 | 400 | 467 | 628 | 22.4 | -37.3 |
| | 1.29 | 0.80 | 429 | 470 | 580 | 13.1 | -32.8 |
| | 1.45 | 0.90 | 454 | 472 | 539 | 5.1 | -28.8 |
| | 1.78 | 1.10 | 496 | 468 | 475 | -7.4 | -22.3 |
| | 1.94 | 1.20 | 513 | 466 | 452 | -11.9 | -19.6 |
| | 2.10 | 1.30 | 528 | 464 | 431 | -16.0 | -17.2 |
| | 2.26 | 1.40 | 542 | 459 | 412 | -19.7 | -15.0 |
| | 2.42 | 1.50 | 555 | 456 | 398 | -22.4 | -13.0 |

Weights in t.

**Data consistency**

No particular issue was identified with data quality and data consistency.

## 5.19. Giant red shrimp (*Aristaeomorpha foliacea*) in GSAs 15 and 16

### *5.19.1. Short term prediction 2009-2011*

#### 5.19.1.1. Method and justification

Short term prediction for 2010 and 2011 was implemented in the age-length based dynamic model Aladym (Lembo *et al*., 2009). The predictions were based on the results of the stock assessment carried out for *A. foliacea* in GSAs 15 and 16 in the framework of SGMED-09-02, which was based on a combination of SURBA and VIT analyses. Predictions were based on $F_{bar}$ 2006-2008 (0.78), and run for F factor scenarios from 0 to 2 of $F_{stq}$, with increments of 0.1. In addition, a scenario was run with $F_{0.1}$ (0.3).

#### 5.19.1.2. Input parameters

The input parameters used for the short term projection were taken from the assessment carried out in the framework of SGMED-09-02, to which the reader is referred for a detailed description.

*Growth parameters*

Table 5.19.1.2.1. Giant red shrimp von Bertalanffy growth parameters.

| Parameter | Distribution | Min | Max | Mean | Std. |
|---|---|---|---|---|---|
| Male $t_0$ [years] | n/a | -0.22 | -0.18 | -0.20 | n/a |
| Female $t_0$ [years] | n/a | -0.22 | -0.18 | -0.20 | n/a |
| Male K [$years^{-1}$] | Normal | 0.630 | 0.770 | 0.700 | 0.099 |
| Female K [$years^{-1}$] | Normal | 0.549 | 0.670 | 0.610 | 0.086 |
| Male $L_\infty$ [mm] | Normal | 37.80 | 46.20 | 42.00 | 5.94 |
| Female $L_\infty$ [mm] | Normal | 62.10 | 75.90 | 69.00 | 9.76 |

*Length-weight relationship*

Table 5.19.1.2.2. Giant red shrimp length weight relationship.

| Parameter | a | b |
|---|---|---|
| **Males** | 0.001 | 2.745 |
| **Females** | 0.0013 | 2.636 |

*Maturity ogive parameters*

Table 5.19.1.2.3. Giant red shrimp maturity ogive parameters.

| Parameter | Distribution | Min | Max | Mean | Std. |
|---|---|---|---|---|---|
| Male $L_{50\%}$ [mm] | Uniform | 26.00 | 28.00 | n/a | n/a |
| Male $L_{75\%}L_{25\%}$ [mm] | Uniform | 3.00 | 4.00 | n/a | n/a |
| Female $L_{50\%}$ [mm] | Uniform | 36.50 | 37.50 | n/a | n/a |
| Female $L_{75\%}L_{25\%}$ [mm] | Uniform | 3.00 | 4.00 | n/a | n/a |

*Natural mortality rates*

Table 5.19.1.2.4. Giant red shrimp natural mortality rates.

| Age | 0 | 1 | 2 | 3 | 4 | 5+ | Constant M |
|---|---|---|---|---|---|---|---|
| M Females | 0.62 | 0.30 | 0.23 | 0.19 | 0.17 | 0.16 | 0.40 |
| M Males | 0.60 | 0.28 | 0.21 | 0.18 | 0.16 | 0.15 | 0.40 |

*Fishing mortality rates*

Table 5.19.1.2.5. Giant red shrimp total mortality rates.

| Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|
| Z | 1.20 | 1.21 | 1.21 | 1.24 | 1.17 | 1.21 | 1.17 | 1.18 |

*Stock recruitment relationship*

Table 5.19.1.2.6. Giant red shrimp stock recruitment relationship.

| Year | Recruitment |
|---|---|
| 2002 | 210116705 |
| 2003 | 141828776 |
| 2004 | 199610870 |
| 2005 | 204863788 |
| 2006 | 147600000 |
| 2007 | 190600000 |
| 2008 | 125600000 |
| 2009 -2010 | 152311594 |

The recruitment used for the short term projection was estimated as the geometric mean of the recruitment estimates from 2006-2008. Sex ratio was set as 0.5, and the variability around the offspring generated from the recruitment vector was set to 0.1. The latter was generated from a uniform distribution. To simulate monthly recruitment pulses, the proportions of offspring entering the stock per month were set as follows: January-February: 0; March: 0.1; April: 0.2; May: 0.3; June: 0.2; July: 0.1; August: 0.1; September-December: 0.

*Selection parameters of fleet gear*

Fleet gear selections parameters were set according to a trawler ogive, with $L_{50\%}$ = 18 mm and $L_{75\%-25\%}$ = 6 mm. Values were taken from Ragonese *et al.* (1994) , who carried out a study of the selectivity and the coefficient of retention of trawl nets used for giant red shrimp in the Sicilian Channel.

### 5.19.1.3. Results

A short term projection (Table 5.19.1.3.1), assuming an $F_{stq}$ of 0.78 in 2009 and a recruitment of 152 (million) individuals in 2009-2011, show that:

- Fishing at the $F_{stq}$ (0.78) from 2008 to 2010 generates a decrease of the catches of 10.5% in 2010 and a decrease of the spawning stock biomass of 0.4% from the year 2010 to 2011.

- Fishing at $F_{0.1}$ (0.30) from 2008 to 2010 generates a decrease of the catch of 49.3% in 2010 and a spawning stock biomass increase of 45.2 % from the year 2010 to 2011.

**Outlook until 2011**

Table 5.19.1.3.1 – Short term forecast in different F scenarios computed for giant red shrimp in GSAs 15 and 16.

Basis: F(2009) = mean ($F_{bar}$2006–2008); R(2009) = GM(2006–2008) = 152311594; F(2009) = 0.78; SSB(2010) = 653 t; Catch (2009) = 1116 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2008-2010 (%) |
|---|---|---|---|---|---|---|---|
| zero catch | 0 | 0 | 0 | 0 | 2182 | 100 | -100 |
| High long-term yield ($F_{0.1}$) | 0.30 | 0.39 | 606 | 832 | 1244 | 45.2 | -49.3 |
| Status quo | 0.78 | 1.0 | 1070 | 1073 | 651 | -0.4 | -10.5 |
| Different scenarios | 0.08 | 0.1 | 304 | 487 | 1690 | 73 | -75 |
| | 0.16 | 0.2 | 422 | 638 | 1511 | 62.3 | -64.7 |
| | 0.23 | 0.3 | 517 | 745 | 1371 | 53.5 | -56.7 |
| | 0.31 | 0.4 | 619 | 843 | 1227 | 44.0 | -48.3 |
| | 0.39 | 0.5 | 712 | 918 | 1099 | 35.2 | -40.5 |
| | 0.47 | 0.6 | 797 | 975 | 986 | 26.9 | -33.3 |
| | 0.55 | 0.7 | 876 | 1016 | 885 | 19.2 | -26.7 |
| | 0.62 | 0.8 | 940 | 1042 | 805 | 12.8 | -21.4 |
| | 0.70 | 0.9 | 1008 | 1062 | 724 | 6.0 | -15.7 |
| | 0.86 | 1.1 | 1127 | 1076 | 586 | -6.3 | -5.7 |
| | 0.94 | 1.2 | 1180 | 1074 | 528 | -11.9 | -1.3 |
| | 1.01 | 1.3 | 1223 | 1069 | 482 | -16.5 | 2.2 |
| | 1.09 | 1.4 | 1268 | 1059 | 435 | -21.5 | 6.0 |
| | 1.17 | 1.5 | 1309 | 1046 | 392 | -26.1 | 9.5 |
| | 1.25 | 1.6 | 1347 | 1030 | 354 | -30.5 | 12.6 |
| | 1.33 | 1.7 | 1382 | 1013 | 320 | -34.5 | 15.6 |
| | 1.40 | 1.8 | 1410 | 997 | 294 | -37.9 | 17.9 |
| | 1.48 | 1.9 | 1440 | 978 | 266 | -41.5 | 20.4 |
| | 1.56 | 2.0 | 1467 | 959 | 241 | -44.9 | 22.7 |

Weights in t

The above table is based on Aladym projections since catch at age data was not available for *A. foliacea* from GSA 15. There were no other problems regarding the data quality and availability.

### *5.19.2. Medium term prediction*

#### 5.19.2.1. Method and justification

A medium term prediction from 2009 to 2020 was implemented in Aladym (Lembo *et al*., 2009). The predictions were based on the results of the stock assessment carried out for *A. foliacea* in GSA 15&16 in the framework of SGMED-09-02, which was based on a combination of SURBA and VIT analyses. Predictions were based on $F_{bar}$ 2006-2008 (0.78), and run assuming a decreasing trend of $F_{stq}$ towards the $F_{0.1}$ in 10 years.

5.19.2.2. Input parameters

All input parameters were the same as those used in the short term forecast except for Z values of the simulated years, which are given below.

Table 5.19.2.2.1. Z values for a simulated reduction of giant red shrimp fishing mortality rates from $F_{stq}$ to $F_{0.1}$ from 2010 – 2020.

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Z | 1.14 | 1.09 | 1.05 | 1.01 | 0.96 | 0.92 | 0.87 | 0.83 | 0.79 | 0.74 | 0.70 |

5.19.2.3. Results

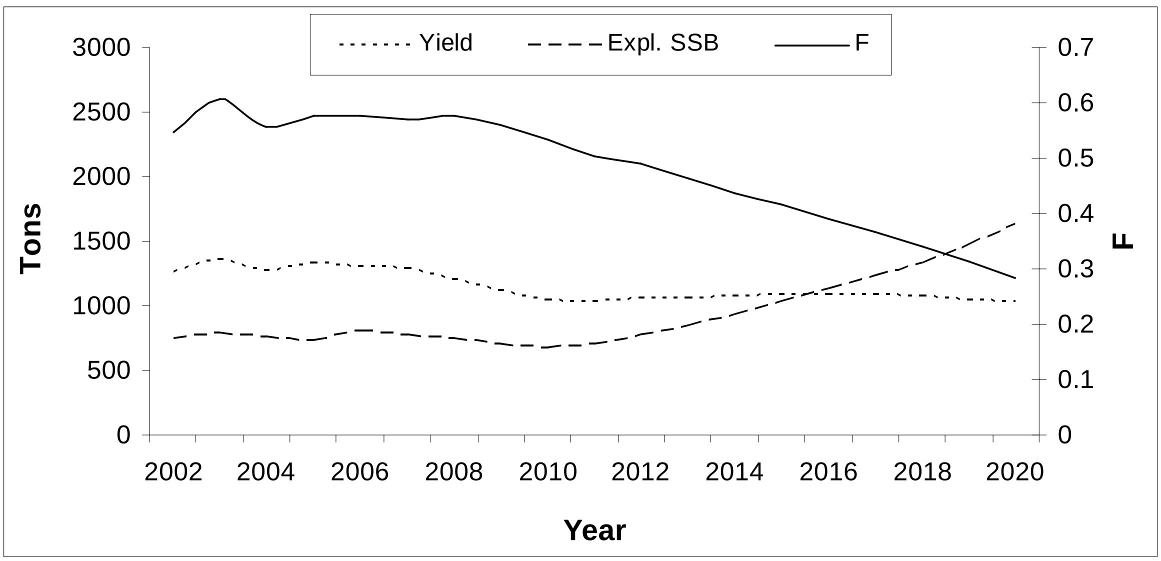



Fig. 5.19.2.3.1. Changes in giant red shrimp yield and exploited spawning stock biomass as F is gradually reduced from $F_{stq}$ (0.78) in 2009 to $F_{0.1}$ (0.30) in 2020.

Based on the medium term predictions of giant red shrimp stock dynamics, a gradual decline in fishing mortality rates would result in a gradual increase in spawning stock biomass: decreasing total mortality by 39% would result in an increase of the spawning stock biomass by 144%. Catches on the other hand would only decline marginally, by 14% from 2009 to 2020, if fishing mortality rates were decreased towards $F_{0.1}$.

## 5.20. Norway lobster (*Nephrops norvegicus*) in GSA 9

### *5.20.1. Short term prediction 2009-2011*

5.20.1.1. Method and justification

Short term predictions for 2009 and 2010 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of Length Cohort Analysis (LCA) carried out on 2006, 2007, 2008 catch data collected under DCR.

### 5.20.1.1. Input parameters

The following data have been used to derive the input data for the short term projection of Norway lobster in the GSA 9:

*Maturity and M vectors*

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2006-2008 | Prop. Matures | 0 | 0.2 | 0.5 | 0.9 | 1 | 1 | 1 | 1 | 1 | 1 |

| PERIOD | Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2006-2008 | M | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |

*F vector*

| F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 0.001 | 0.10 | 0.44 | 0.27 | 0.23 | 0.35 | 0.24 | 0.10 | 0.13 | 0.11 |
| 2007 | 0.01 | 0.10 | 0.24 | 0.23 | 0.23 | 0.49 | 1.02 | 1.10 | 0.22 | 0.21 |
| 2008 | 0.01 | 0.12 | 0.31 | 0.42 | 0.38 | 0.28 | 0.76 | 0.52 | 0.61 | 0.22 |

*Weight-at-age in the stock*

| Mean weight in stock (kg) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 0.0026 | 0.0094 | 0.0202 | 0.0351 | 0.0520 | 0.0697 | 0.0879 | 0.1055 | 0.1219 | 0.1370 |
| 2007 | 0.0026 | 0.0094 | 0.0205 | 0.0351 | 0.0520 | 0.0695 | 0.0868 | 0.1042 | 0.1218 | 0.1560 |
| 2008 | 0.0027 | 0.0098 | 0.0219 | 0.0380 | 0.0570 | 0.0775 | 0.0973 | 0.1178 | 0.1367 | 0.1770 |

*Weight-at-age in the catch*

| Mean weight in catch (kg) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 0.0026 | 0.0094 | 0.0202 | 0.0351 | 0.0520 | 0.0697 | 0.0879 | 0.1055 | 0.1219 | 0.1600 |
| 2007 | 0.0009 | 0.0055 | 0.0148 | 0.0281 | 0.0442 | 0.0618 | 0.0799 | 0.0977 | 0.1146 | 0.1500 |
| 2008 | 0.0027 | 0.0098 | 0.0219 | 0.0380 | 0.0570 | 0.0775 | 0.0973 | 0.1178 | 0.1367 | 0.1770 |

*Number at age in the catch*

| Catch at age in numbers (thousands) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 45 | 1959 | 4634 | 1326 | 588 | 457 | 156 | 38 | 29 | 14 |
| 2007 | 174 | 1820 | 2421 | 1250 | 654 | 664 | 457 | 116 | 8 | 10 |
| 2008 | 181 | 1688 | 2493 | 1571 | 644 | 225 | 254 | 60 | 27 | 11 |

*Number at age in the stock*

| Stock numbers at age (thousands) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 38559 | 25810 | 15713 | 6818 | 3502 | 1873 | 888 | 469 | 284 | 167 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2007 | 33996 | 22646 | 13705 | 7233 | 3840 | 2046 | 840 | 204 | 46 | 44 |
| 2008 | 28195 | 18752 | 11203 | 5503 | 2429 | 1111 | 564 | 176 | 70 | 44 |

Maturity was estimated as the mean of the last 3 years. A fixed M value (0.4) was used.

### 5.20.1.2. Results

A short term predictions (Table 5.20.1.2.1), assuming an $F_{stq}$ of 0.60 ($F_{2\text{-}8}$) in 2009 and a recruitment of 31 millions individuals shows that:

- Fishing at the $F_{stq}$ (0.60) from 2008 to 2011 is expected to produce a decrease of the catches of 3.9% in 2010 and an increase of the spawning stock biomass of 0.5 % from 2010 to 2011.

- Fishing at $F_{0.1}$ (0.21) generates a short term decrease of the catches of 61.5% in 2010 and a spawning stock biomass increase of 27.9% from 2010 to 2011.

- A 10% reduction of the $F_{stq}$ (F = 0.54) generates a decrease of the catches of 11.7% in 2010 and a spawning stock biomass increase of 4.2% from 2010 to 2011.

**Outlook until 2011**

Table 5.20.1.3.1 – Short term forecast in different F scenarios computed for Norway lobster in GSA 9.

Basis: F(2009) = mean(Fbar2006–2008); R(2009) = GM(2005–2008) = 31 (millions) individuals; F (2009) = 0.6; SSB(2010) = 554 t; Catch (2009) = 220 t

| Rationale | F scenario | F factor | Catch 2010 | Catch 2011 | SSB 2011 | Change SSB 2010-2011 (%) | Change Catch 2008-2010 (%) |
|---|---|---|---|---|---|---|---|
| zero catch | 0.00 | 0.0 | 0 | 0 | 811 | 46.5 | -100.0 |
| High long-tem yield ($F_{0.1}$) | 0.21 | 0.3 | 86 | 110 | 708 | 27.9 | -61.5 |
| Status quo | 0.60 | 1.0 | 214 | 220 | 557 | 0.5 | -3.9 |
| Different scenarios | 0.06 | 0.1 | 26 | 37 | 780 | 40.8 | -88.3 |
| | 0.12 | 0.2 | 51 | 69 | 750 | 35.4 | -77.2 |
| | 0.18 | 0.3 | 75 | 97 | 722 | 30.3 | -66.5 |
| | 0.24 | 0.4 | 97 | 123 | 695 | 25.4 | -56.4 |
| | 0.30 | 0.5 | 119 | 145 | 669 | 20.8 | -46.6 |
| | 0.36 | 0.6 | 140 | 164 | 644 | 16.3 | -37.3 |
| | 0.42 | 0.7 | 160 | 181 | 621 | 12.1 | -28.4 |
| | 0.48 | 0.8 | 179 | 196 | 598 | 8.0 | -19.9 |
| | 0.54 | 0.9 | 197 | 209 | 577 | 4.2 | -11.7 |
| | 0.66 | 1.1 | 231 | 230 | 537 | -3.0 | 3.6 |
| | 0.72 | 1.2 | 247 | 238 | 518 | -6.4 | 10.8 |
| | 0.78 | 1.3 | 262 | 246 | 501 | -9.6 | 17.7 |
| | 0.84 | 1.4 | 277 | 252 | 484 | -12.7 | 24.3 |
| | 0.90 | 1.5 | 291 | 257 | 467 | -15.6 | 30.7 |
| | 0.96 | 1.6 | 305 | 261 | 452 | -18.4 | 36.8 |
| | 1.02 | 1.7 | 318 | 265 | 437 | -21.1 | 42.6 |
| | 1.08 | 1.8 | 330 | 268 | 423 | -23.7 | 48.3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1.14 | 1.9 | 343 | 270 | 409 | -26.2 | 53.7 |
| | 1.21 | 2.0 | 354 | 272 | 396 | -28.5 | 58.9 |

There were no special problems regarding the data quality and availability. However F values have been scaled on the 2008 value in order to account for the recent decreasing trend in recruitment.

# 6. TORS F-K AND THE ADDITIONAL AD HOC TOR L

## 6.1. ToR f: Marine population and community indicators

Given the workload SGMED 09-03 assigned the task to ‘provide and review marine population and community indicators’ a secondary priority. Due to time constraints, SGMED was unable to address this ToR.

As a pre-requisite for the outstanding assessment of marine population and community indicators SGMED 09-03 recommends to hold a specific workshop to elaborate a basis for an improved use of scientific survey data.

**Workshop for the development and testing of trawl survey index standardization procedures with R**

The assessments made by SURBA or by means of tuned VPA are run on un-standardized data of abundance derived from MEDITS surveys. STECF in 2009 considered that an ad-hoc working group should be convened to develop and test R scripts aimed to standardise MEDITS time series used into stock assessment of Mediterranean resources. In addition, the performance and estimates of SURBA assessments and tuned VPA derived from standardized and un-standardized data should be compared. Thus, STECF recommended that such an ad-hoc working group should convene in February 2010 and deal specifically with the above mentioned tasks.

SGMED currently has assessed the status of 9 species in 22 Mediterranean GSA’s and will expand the number of species over the next years (as defined in the TOR’s of SGMED 09-03). The workload for scientists attending SGMED and preparing assessments is high and will increase rapidly. Thus, it is high priority to provide the scientists involved efficient and fast tools to allow automation and standardized replication of assessments and graphical outputs. Currently, the R platform is becoming the standard tool for statistical analysis as well as implementation of fisheries models using FLR or other packages. Adopting R and developing SGMED specific scripts to manage and standardize data and run statistical and assessment models will enhance the productivity of SGMED working groups.

In this perspective, different timelines are foreseeable: A first step will be focusing on the standardization of MEDITS survey indices to estimate trends in stocks and to prepare input files for assessment.

TORs

1. Develop R scripts to import, merge and select species specific data from MEDITS database.

2. Develop R scripts to run GLM/GAM models on the imported MEDITS data to derive stock specific standardized yearly trends of CPUE (biomass/area) and numbers at length and at age to be used into SURBA and tuned VPA. Those scripts should also produce detailed model diagnostics to assess best performing type of models, link function, family distribution and predictors.

3. Develop R scripts to perform age slicing to transform numbers at length in numbers at age to be exported in a SURBA ready format.

The involvement of the FLR Team would be crucial to tailor the scripts. In addition given the mixed levels of scientist proficiency with R, specific training should be given to scientists attending SGMED.

## 6.2. ToR g: Case studies of short-term and long-term economic consequences of selected harvesting strategies

APPLICATION OF THE MEFISTO BIOECONOMIC MODEL TO PRODUCE ADVICE ON SHORT- AND LONG-TERM CONSEQUENCES OF SELECTED HARVESTING STRATEGIES ON NW MEDITERRANEAN TRAWL FISHERIES (GSA06 AND GSA07)

The bioeconomic projection of the trawl fishery in GSA06 and GSA07 was performed with the bioeconomic model MEFISTO ("Mediterranean FIsheries Simulation Tool", fully documented in Lleonart *et al*., 2003), downloadable from www.mefisto.info. MEFISTO is a multi-species, multi-fleet model with technical interactions, with one or more fleets competing for a pool of fishery resources. The model comprises two interacting sub-models, one defining the population dynamics of the stock and the other defining the vessel dynamics. For the stock sub-model, MEFISTO follows the general formulation of a fully age-structured model describing the biology of the "main" or target species for which assessment data is available. In our analyses European hake (*Merluccius merluccius*) is a target species in both GSA trawl fleets, while *Aristeus antennatus* and *Parapenaeus longirostris* are target species in GSA06, and *Mullus barbatus* in GSA07. The model treats the production of secondary or "by-catch" species as an empirically estimated function of the main species, because no biological assessments are available for secondary species, although they may contribute significantly to the total revenues of the vessels.

The economic submodel built-in MEFISTO is a standard revenue minus costs submodel with endogenous effort dynamics at the vessel level (Lleonart *et al*., 2003; Maynou *et al*., 2006). For the present application the endogenous effort-allocation dynamics of MEFISTO was not used. The cost structure in the model includes trade costs, fuel costs, labour costs, fixed and depreciation costs, opportunity costs and financial costs. Note that in Mediterranean fisheries labour costs are a share of the revenues minus common costs (fuel and other daily costs are met by the owner and the crew). Hence, even maintaining the same fishing effort, when catches increase and revenues are higher, costs will also increase, because labour and trade costs increase.

The biological assessments ("input data") used in the accompanying analyses were produced during the June 2009 SGMED meeting for GSA06 and have been complemented for GSA07 by assessments delivered to the SCSA GFCM by the French-Spanish working group.

The economic input data was based on the Annual Economic Report of the European fishing fleet (Anderson and Guillén, 2009) for Spain and economic data supplied by France to the June SGMED meeting. In both cases the reference fleet was the trawl segment 12-24 m. Economic official data cannot be transposed directly to the MEFISTO model and some assumptions have to be made to calculate the necessary parameters for this model. For instance, the costs and revenues of a fleet are related to the entire set of species caught, not only to the 2 or 3 target species modeled here, and an empirical relationship between catch of the main species and total catch was introduced (based on data for Catalonia trawl fisheries, the northernmost fishery in GSA06 and having many economic structural similarities to GSA07 trawl fisheries). The economic analysis further assumes that i) the opportunity cost interest is set at 3%, ii) the economic life of a trawl vessel is 20 years (depreciation of capital corresponding to a 5% annual rate), and iii) fish price is constant over time, and independent of the catch level/landings.

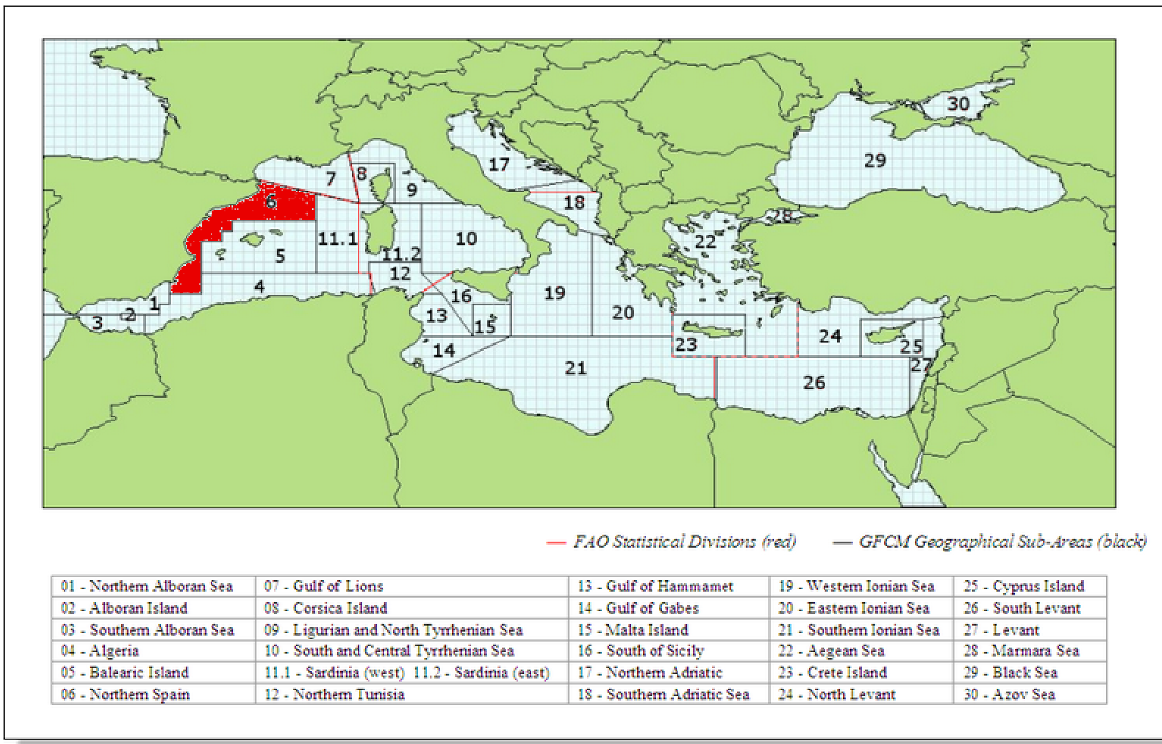
The bioeconomic analyses consisted in the projection of the initial bioeconomic data, using 2008 as base year, for the period 2009-2019, with 1000 iterations for each scenario or harvesting strategy. The simulation scenarios where built around variations on the present ("status quo") fishing mortality ($F_{sq}$), implying that a management strategy can simultaneously increase or decrease fishing mortality across all target species by the same proportion. The proposed harvesting strategies imply reducing fishing mortality to 25%, 50%, 75% or 90% of present (2008) levels or increasing fishing mortality by 25% or 50%, i.e.:

Fsq·0.25
Fsq·0.50

Fsq·0.75
Fsq·0.90
Fsq·1.25
Fsq·1.50

Due to the limited knowledge on the recruitment dynamics of the species considered, future recruitments for each species were modeled as a lognormal distribution of the mean that corresponds to the geometric mean of the 3 most recent years (2006-2008) and standard deviation corresponding to the square root of the variance of the observed recruitment series, when available. Assuming a randomly varying recruitment around a constant signal is a strong assumption, especially for hake in GSA06, where a clearly decreasing trend in recruitment is observed for the last 15 years. Instead, for hake in GSA07 a very high recruitment was observed in 2008 (corresponding to around twice the historical observed levels), which results in very high catches of this species in the short-term. It is very important to note that the outcome of the simulations is very much affected by the recruitment models used and, given the very poor knowledge on recruitment dynamics of Mediterranean fish stocks, the results should be interpreted with caution.

### *6.2.1. Bioeconomic analysis of GSA06 ("Northern Spain") trawl fleet*




Three main species considered were European hake (*Merluccius merluccius*), blue-and-red shrimp (*Aristeus antennatus*) and pink shrimp (*Parapenaeus longirostris*).

| 2008 | Catch (t) |
|---|---|
| *Merluccius merluccius* | 3494 |
| *Aristeus antennatus* | 638 |
| *Parapenaeus longirostris* | 33 |

The bioeconomic model follows a fully age-structured model for the biology of main species (for which assessment data is available: *M. merluccius*, *A. antennatus* and *P. longirostris*) and treats the production of

secondary (by-catch) species as an empirically estimated function of main species, because no biological parameters are available for secondary species although they contribute significantly to the total revenues of the vessels. In the case of GSA06 trawlers, the 3 species of the biological submodel account for 15% of the catch and 25% of the value.
The trawl fleet in GSA06 is composed of 647 trawlers (parameterized with economic data for the trawl 12-24 m segment). The economic submodel applied here is standard revenue minus costs submodel, while the endogenous effort-allocation dynamics of MEFISTO was not used. The cost structure in the model includes trade costs, fuel costs, labour costs, fixed and depreciation costs, opportunity costs and financial costs. Note that in Mediterranean fisheries labour costs are a share of the revenues minus common costs (fuel and other daily costs are met by the owner and the crew). Hence, even maintaining the same fishing effort, when catches increase and revenues are higher, costs will also increase, because labour and trade costs increase.

#### 6.2.1.1. Biological data

The necessary input data required for the starting year (2008) of the simulation are shown in the following tables.

Table 6.2.1.1.1 Allometric and growth curve parameters

| a | b | $L_{inf}$ | k | $t_0$ | Ncoh | Stock |
|---|---|---|---|---|---|---|
| 0.0069 | 3.030 | 106.70 | 0.20 | 0.00 | 8 | Hake |
| 0.0024 | 2.464 | 77.00 | 0.38 | -0.07 | 5 | Blue-and-red shrimp |
| 0.0019 | 2.611 | 45.00 | 0.39 | -0.10 | 8 | Pink shrimp |

Table 6.2.1.1.2 Stock number, maturity (Mat), natural mortality (M) and fishing mortality (F) at age.

| **Stock** | **Age** | **Number** | Mat | M | **F** |
|---|---|---|---|---|---|
| Hake | 0 | 183396000 | 0.00 | 1.43 | 0.98 |
| Hake | 1 | 27750293 | 0.14 | 0.68 | 2.14 |
| Hake | 2 | 2060515 | 0.81 | 0.47 | 1.54 |
| Hake | 3 | 281245 | 0.98 | 0.41 | 1.70 |
| Hake | 4 | 55712 | 0.99 | 0.38 | 1.29 |
| Hake | 5 | 7698 | 1.00 | 0.37 | 0.57 |
| Hake | 6 | 470 | 1.00 | 0.36 | 1.44 |
| Hake | 7 | 1414 | 1.00 | 0.35 | 1.44 |
| Blue-and-red shrimp | 0 | 91043000 | 0.07 | 0.45 | 0.14 |
| Blue-and-red shrimp | 1 | 56306815 | 0.76 | 0.45 | 2.14 |
| Blue-and-red shrimp | 2 | 6251376 | 0.99 | 0.45 | 1.48 |
| Blue-and-red shrimp | 3 | 1338533 | 1.00 | 0.45 | 1.41 |
| Blue-and-red shrimp | 4 | 316322 | 1.00 | 0.45 | 1.41 |
| Pink shrimp | 0 | 202213000 | 0.00 | 1.25 | 0.00 |
| Pink shrimp | 1 | 36191859 | 0.13 | 1.25 | 0.04 |
| Pink shrimp | 2 | 8878734 | 0.50 | 1.25 | 0.49 |
| Pink shrimp | 3 | 1482615 | 0.78 | 1.25 | 0.46 |
| Pink shrimp | 4 | 429194 | 0.90 | 1.25 | 0.36 |
| Pink shrimp | 5 | 75455 | 0.97 | 1.25 | 0.38 |
| Pink shrimp | 6 | 13884 | 1.00 | 1.25 | 0.96 |
| Pink shrimp | 7 | 1516 | 1.00 | 1.25 | 0.50 |

Table 6.2.1.1.3 Recruitment (mean number of individuals and standard deviation of a lognormal distribution).

| Stock | $N_0$ |
|---|---|
| Hake | 231,683,667 (sd=0.400) |
| Blue-and-red shrimp | 88,321,667 (sd=0.275) |
| Pink shrimp | 147,060,667 (sd=0.450) |

These biological data were calculated from the corresponding assessments performed during SGMED-09-02.

#### 6.2.1.2. Economic data

Spain did not report economic data for 2008; thus data from the Annual Economic Report (Anderson and Guillén, 2009) have been used, referring to 2007.

Here we assumed that:

- The opportunity cost interest is set at a 3%.
- It is estimated that the economic life of a vessel is 20 years. Thus, the depreciation of the vessel is established at a 5% annual rate.
- It is assumed that fish price is constant over time, and independent of the level of andings. The landings from this area represent only about the 20% of the total seafood consumption in the area (most of the seafood consumed is imported from other parts of Spain, especially from the north, or from other countries). Thus, it is reasonable to assume that fish price will no be greatly affected by local landings, but rather set by the imports. Normally, imports of fish are stable over time, as well as their prices. In this context, seafood prices are expected to remain constant or increase at the inflation rate level just as the input costs. Thus, the assumptions of constant fish prices are reasonable in the context of this bioeconomic projection.

Economic data reported in Anderson and Guillén (2009) and official DCR cannot be transposed directly to the MEFISTO model and some assumptions have to be made to calculate the necessary parameters. For instance, the costs and revenues of a fleet are related to the entire set of species caught, not only to the 3 species modelled here, and an empirical relationship between catch of the main species and total catch was introduced (based on data for Catalonia trawl fisheries that represents about 50% of the volume of GSA06 trawl fisheries).

Table 6.2.1.2.1 Economic and technical parameters:

| | |
|---|---|
| Number of fishing days per year | 220 |
| Commercial (or trade) cost | 16% |
| Fuel price | 0.57 € / l |
| Opportunity cost | 3% |
| Financial cost | 5% |
| Capital | 456,152,263 € |
| Gross tonnage | 32,460 GT |
| Fuel consumption | 709,112 l / d |
| Crew size | 2,309 FTE |
| Other daily costs | 104.44 € / d / boat |

| | |
|---|---|
| Annual costs | 46,602,298 € |
| Percentage of annual fixed costs | 51% |
| Percentage of annual depreciation costs | 49% |
| Unit price of hake | 7.80 € / kg |
| Unit price of blue-and-red shrimp | 30 € / kg |
| Unit price of pink shrimp | 15 € / kg |

Additionally, we assumed opportunity and constant fleet capital in the simulations. This assumption implies no internal investment in the fleet, which is reasonable considering the negative profits observed in recent years, and no external investment (i.e., absence of national or Community subsidies).

#### 6.2.1.3. Simulation conditions

The simultaneous forward projections of the 3 stocks and 1 fleet were performed for the period 2009-2019, with 1000 iterations for each scenario. Simulation scenarios were established with reference to the present fishing mortality ($F_{sq}$):

Fsq·0.25
Fsq·0.50
Fsq·0.75
Fsq·0.90
Fsq·1.25
Fsq·1.50

#### 6.2.1.4. Critical assumptions / limitations

For the 3 species, future recruitment was modelled as a lognormal distribution with the mean equal to the geometric mean of the last 3 years (2006-2008) and standard deviation corresponding to the variability observed in the historical data series (see table *Recruitment* above).

For hake the historical data series of recruitment runs from 1995 to 2008, while for the two crustaceans it ranges from 2002 to 2008. Assuming a randomly varying recruitment around a constant value is a strong assumption, especially for hake where a clearly decreasing trend in recruitment is observed during the last 15 years (Fig. 6.2.1.4.1). This clearly decreasing trend in recruitment implies that, for hake, catch and SSB projections under all scenarios are optimistic. On the other hand, for *Aristeus antennatus*, recruitment has been increasing linearly over the last 6 years in GSA06 (Fig. 6.2.1.4.2), suggesting that the projections carried out here may be overly pessimistic. The modelled recruitment of *Parapenaeus longirostris* is well within the historical average, except for a large recruitment peak in the very first year of the time series (Fig. 6.2.1.4.3). However, considering the relatively low importance of the catches of this species in the area, the impact on the simulation results of incorrect parameterization of this species is relatively low.

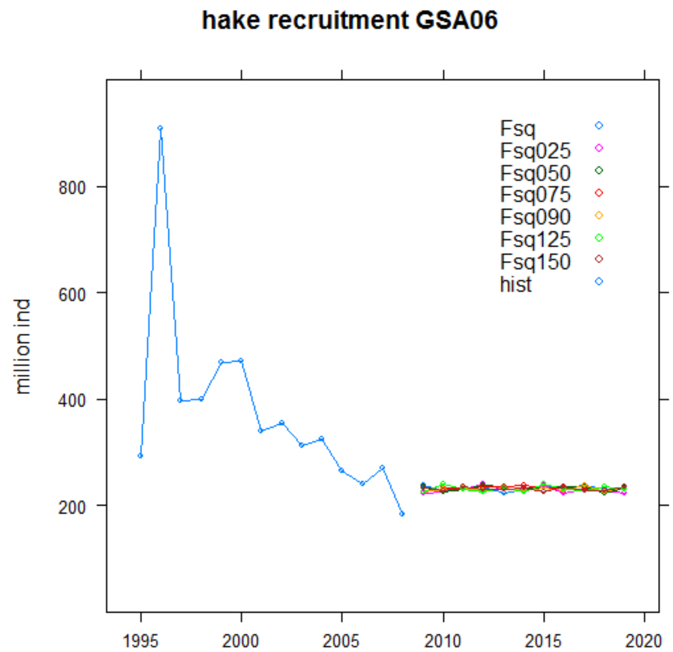



Fig. 6.2.1.4.1. Historical and projected series of Hake recruitment (*Merluccius merluccius*) under the assumption of constant recruitment around the geometric mean of the last 3 years (2006-2008) and variability following a lognormal distribution with sd=0.40 (confidence intervals not shown)

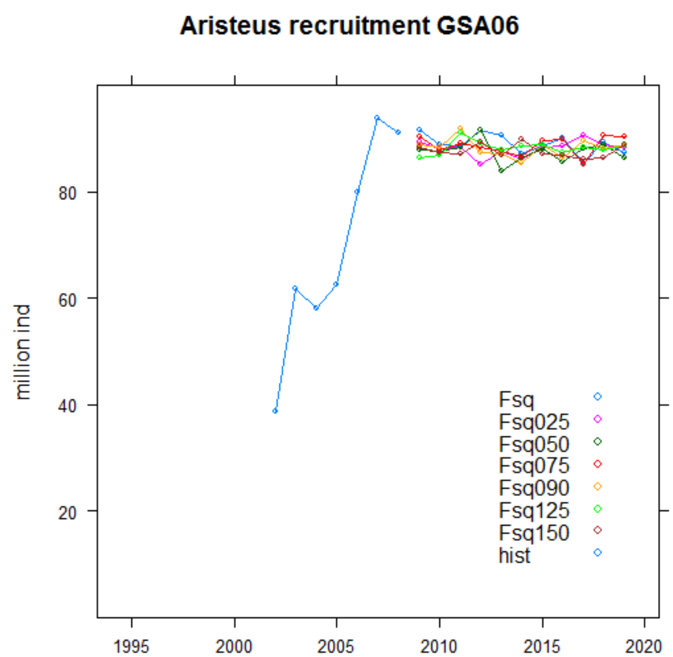



Fig. 6.2.1.4.2. Historical and projected series of Blue-and-red shrimp recruitment (*Aristeus antennatus*) under the assumption of constant recruitment around the geometric mean of the last 3 years (2006-2008) and variability following a lognormal distribution with sd=0.275 (confidence intervals not shown)

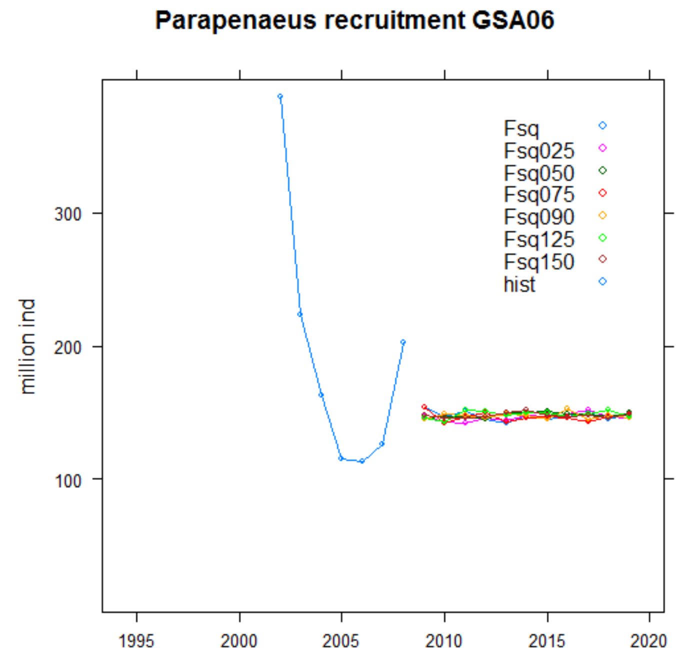



Fig. 6.2.1.4.3. Historical and projected series of Pink shrimp recruitment (*Parapenaeus longirostris*) under the assumption of constant recruitment around the geometric mean of the last 3 years (2006-2008) and variability following a lognormal distribution with sd=0.475 (confidence intervals not shown)

### 6.2.1.5. Results

The simulation results showed here allow for a simultaneous analysis of the short, medium and long-term trends. Summary statistics for the short-term are given in Annexes 1-4, while medium and long-term results can be inspected visually from the figures below.

Catches of hake in the years 2009-2011 are projected to be lower than historical levels (Fig. 6.2.1.5.1). For any scenarios implying a reduction in F, the catch reduction would be important (down by 50% approximately). A strong reduction of fishing mortality ($F_{sq}$·0.25 and $F_{sq}$·0.50) would ensure higher catches than historical levels in the medium and long term, while moderate F-reductions ($F_{sq}$·0.75 and $F_{sq}$·0.90) would do no more than keeping catches around historical levels. Maintaining the status quo or increasing fishing mortality would imply decreasing yields in the medium and long-term. It is important to note that to maintain hake catches at historical levels in the long term (around 4000 t for GSA06), an immediate reduction of fishing mortality of at least 75% of the 2008 levels should be applied.

Catches of blue-and-red shrimp in the mid- to long-term under any management scenario are projected to be within the historical range (Fig. 6.2.1.5.2). However, all scenarios implying a reduction of F would result in decreasing catches in the short term and high catches in the long term.

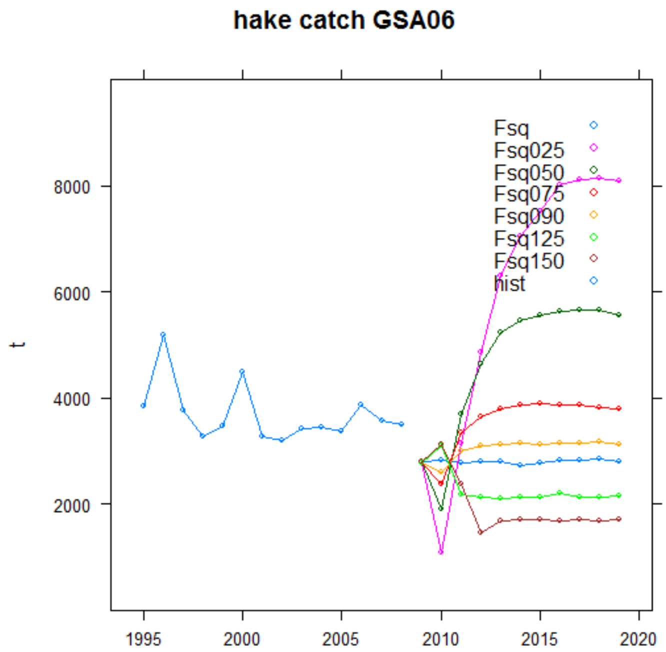



Fig. 6.2.1.5.1. Projected catches of hake (*Merluccius merluccius*) under different management scenarios. The reported catches of hake for the period 1995-2008 are shown also for comparison (confidence intervals not shown).

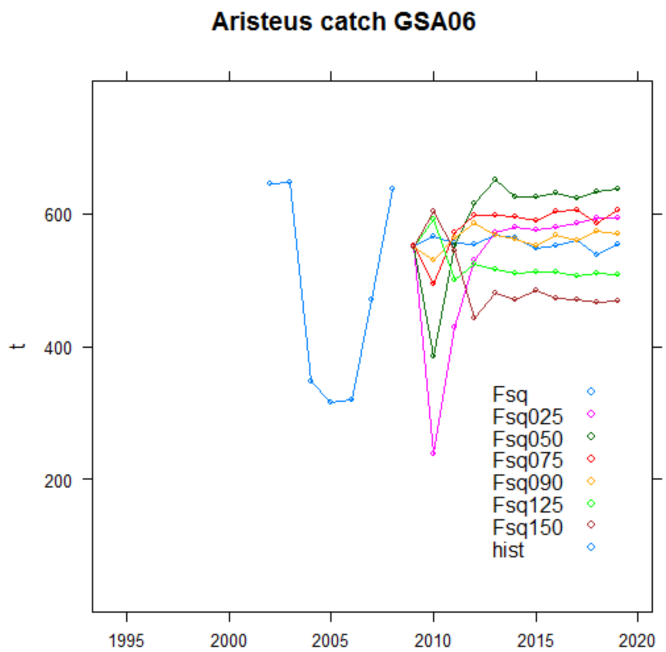



Fig. 6.2.1.5.2. Projected catches of blue-and-red shrimp (*Aristeus antennatus*) under different management scenarios. The reported catches for the period 2002-2008 are shown also for comparison (confidence intervals not shown).

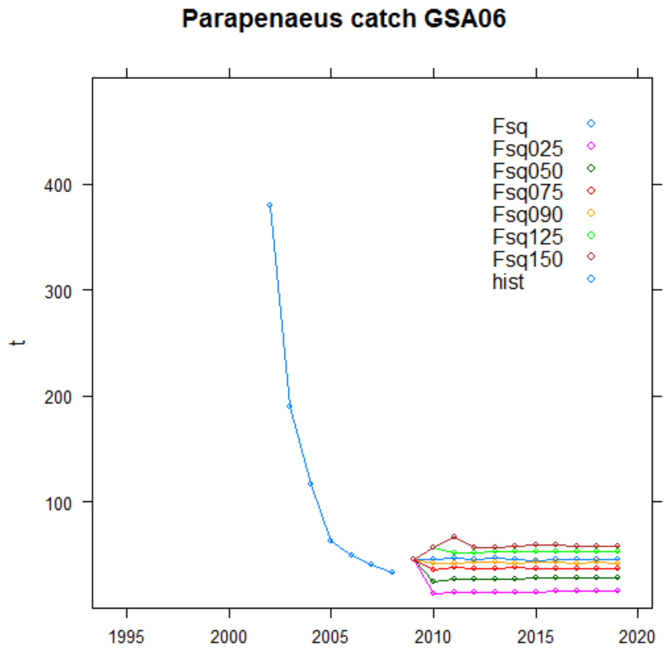



Fig. 6.2.1.5.3. Projected catches of pink shrimp (*Parapenaeus longirostris*) under different management scenarios. The reported catches for the period 2002-2008 are shown also for comparison (confidence intervals not shown).

All management scenarios forecast a reduction of SSB for the 3 species in the short term (Figs. 6.2.1.5.4-6.2.1.5.7). Only the most conservative scenarios ($F_{sq}$·0.25, $F_{sq}$·0.50) would allow recovery of SSB to historical or higher levels; any other management scenarios would keep SSB at very low levels (under the current assumptions of constant recruitment and uncoupling between SSB and R).

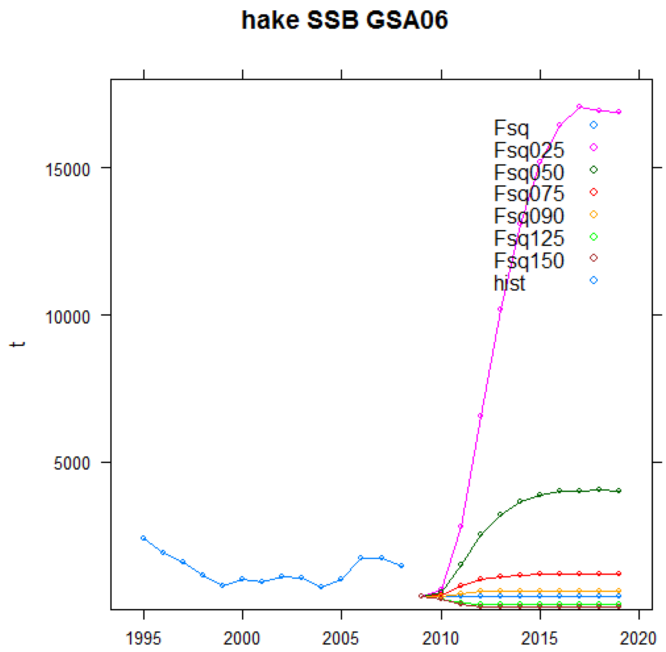



Fig. 6.2.1.5.4. Projected Spawning Stock Biomass of hake (*Merluccius merluccius*) under different management scenarios. The reported SSB of hake for the period 1995-2008 is shown also for comparison (confidence intervals not shown).

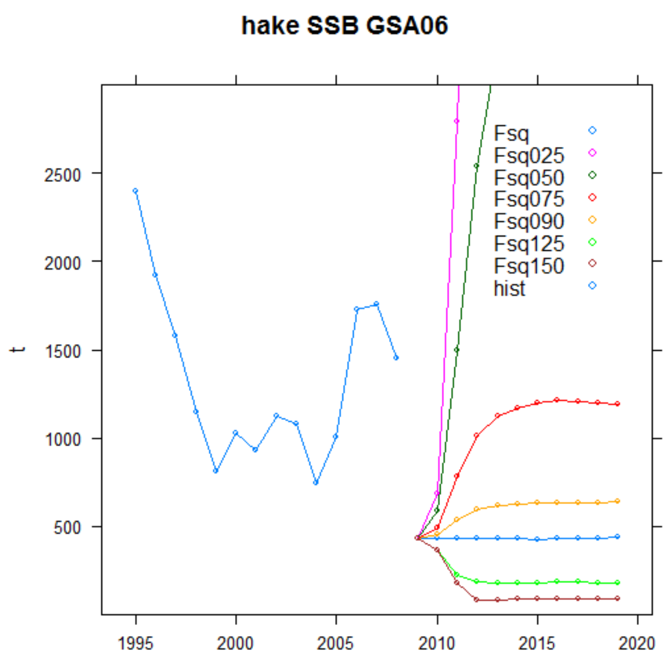



Fig. 6.2.1.5.5. Detail of Fig. 6.2.1.5.4 to better appreciate SSB projections of Hake under different scenarios.

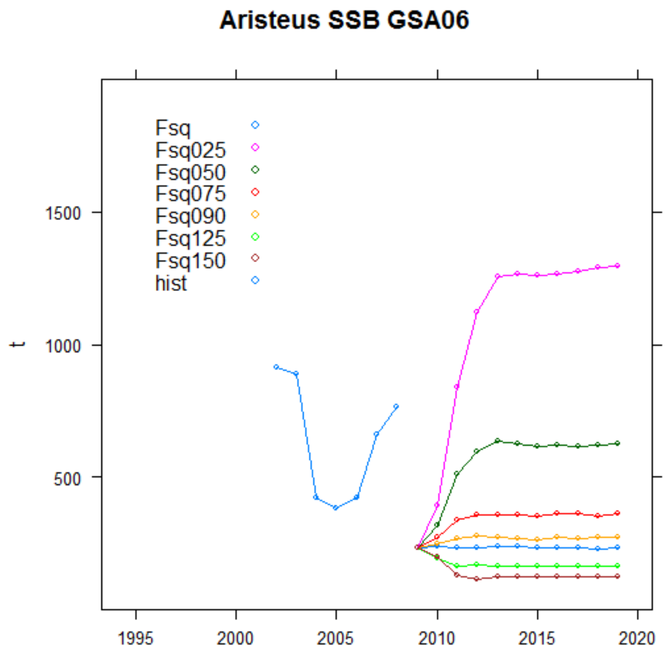



Fig. 6.2.1.5.6. Projected Spawning Stock Biomass of blue-and-red shrimp (*Aristeus antennatus*) under different management scenarios. The reported SSB for the period 2002-2008 is shown also for comparison (confidence intervals not shown).

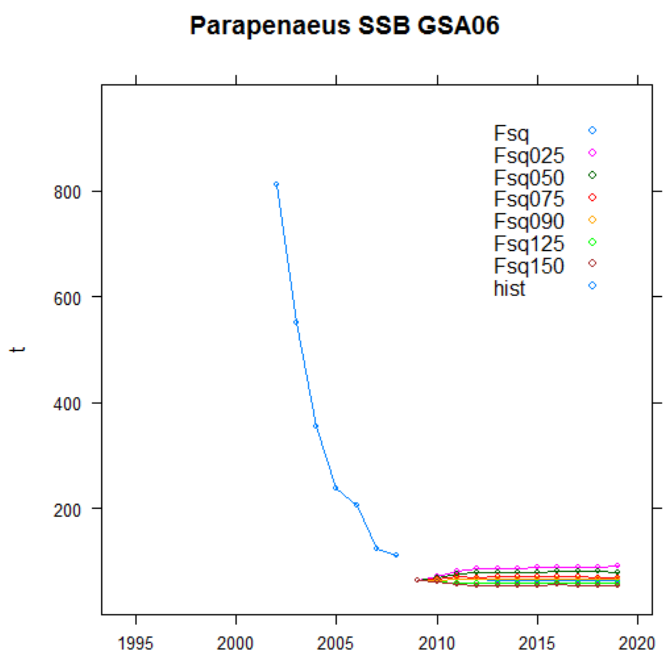



Fig. 6.2.1.5.7. Projected Spawning Stock Biomass of pink shrimp (*Parapenaeus longirostris*) under different management scenarios. The reported SSB for the period 2002-2008 is shown also for comparison (confidence intervals not shown).

### 6.2.1.6. Economic indicators

Two indicators were selected for analysis: Profits and Return on Investment, defined as:

RoI = (Profits / Capital) · 100

Note that both indicators are negative at present and will remain so for the near future, regardless of the management scenario. It should be also noted that even if the overall profits for the fleet are negative, some vessels may actually have positive profits. This is confirmed by field observations and bieconomic projections performed with trawl fleets in a few ports of GSA06 and GSA07 (Lleonart *et al*., 2003; Maynou *et al.*, 2006). Moreover, these profits are financial profits, in the sense that they account for the opportunity costs. The opportunity cost interest was estimated to be 3%. This is equivalent to the return of a risk-free investment. Concerning the RoI figure, it can be seen that the level of losses (negative profits) is very low between 0.2 and 0 % for all scenarios simulated. Thus, fishermen are obtaining losses from a financial point of view; but disregard the opportunity costs, the RoI would turn into profits between the 2.8 and 3%. The capital invested in the vessels can be considered a sunk cost, because it is not common to buy and sell vessels in the second hand market. Hence, the investment decision is something that is done once and for all. It is very difficult to change the investment except through leaving the fishery. Moreover, sometimes, the investment was not totally paid by the fishermen. All these considerations imply that vessel owners in the Mediterranean (usually the owner is also the skipper) do not take into account the opportunity cost, at least on the short term.

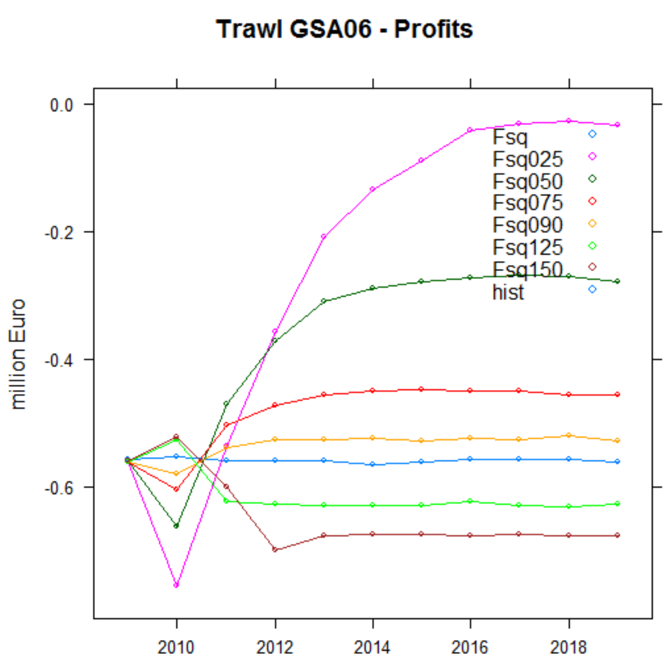



Fig. 6.2.1.6.1. Projection of fleet profits from 2009 to 2019 under different management scenarios.

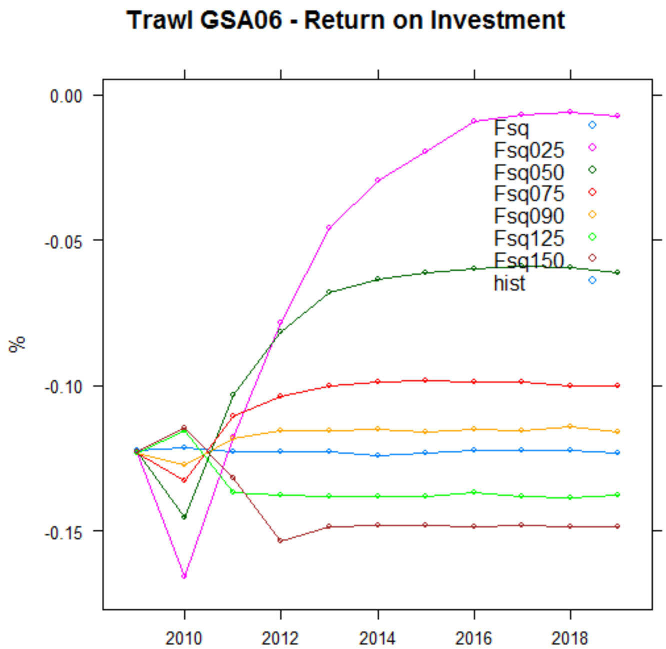



Fig. 6.2.1.6.2. Projection of fleet Return on Investment from 2009 to 2019 under different management scenarios.

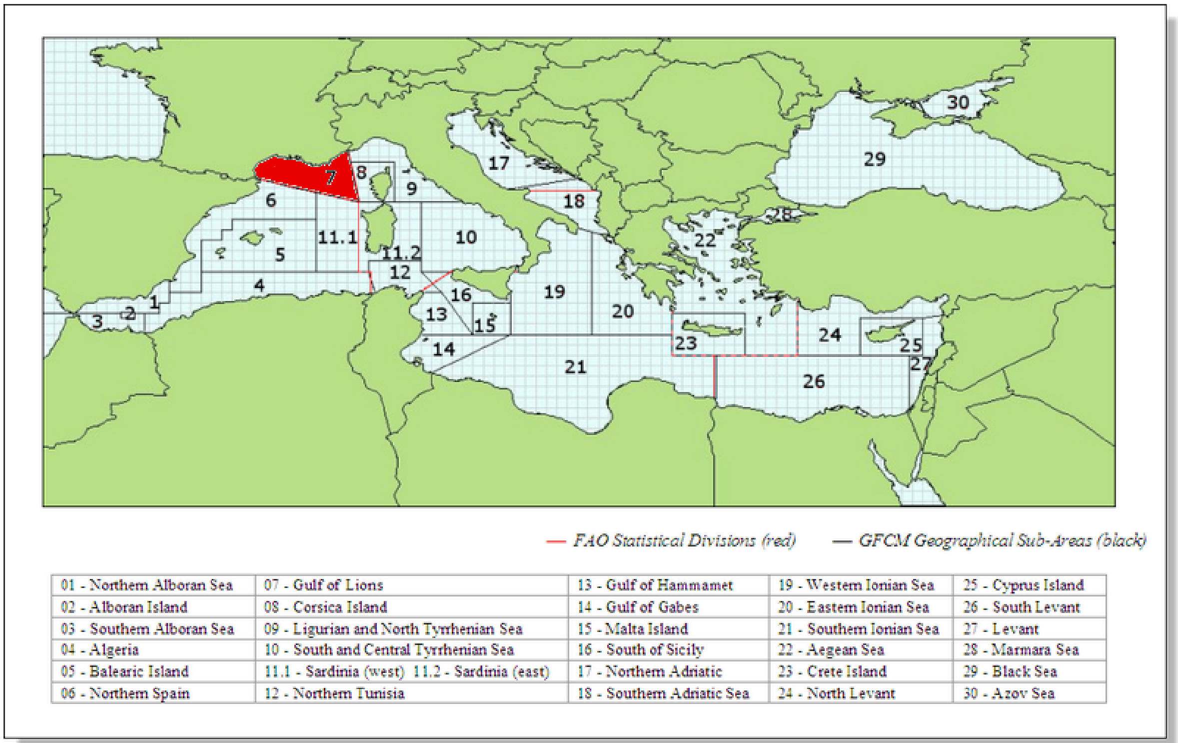
### 6.2.1.7. Conclusions

The results of the accompanying simulation analysis show that:

1) For GSA06 catches of hake are projected to be lower in the short-term (2009-2011) than catches observed in the period 1995-2008. Only very strong fishing mortality reduction strategies (namely, $F_{sq}\cdot 0.25$ and $F_{sq}\cdot 0.50$) would, in the long term, allow for increasing catches to higher levels than those observed in the historical period. Reducing $F_{sq}$ by 75% would allow maintaining catches at the historical levels while any other harvesting strategy (including maintaining the status quo) would result in lower catches in the short and long term.
2) The SSB of hake in GSA06 would only increase above reasonably safe levels by a strong reduction in fishing mortality ($F_{sq}\cdot 0.25$ and $F_{sq}\cdot 0.50$). Any other harvesting strategy would result in a further decrease of SSB.
3) Catches of *Aristeus antennatus* in GSA06 have varied strongly over the historical period (2002-2008) and all harvesting strategies would produce catches around the historical mean. However, reducing F will result in a strong decrease in catches in the short-term, especially $F_{sq}\cdot 0.25$ and $F_{sq}\cdot 0.50$. However, these management strategies would ensure sustained high catches in the mid and long-term
4) The SSB of *A. antennatus* in GSA06 is predicted to be lower than the SSB observed in the historical period under all harvesting strategies, both in the short- and long-term. Only a strong reduction in F ($F_{sq}\cdot 0.25$) would allow to rebuild SSB in the long-term.
5) Catches and SSB of *P. longirostris* in GSA06 have been decreasing steadily from 2002 to 2008, with present catches and SSB around 10% of the maximum observed catches. Under the assumption of constant recruitment, no harvesting strategy would allow to increase catches and/or SSB significantly.
6) Financial profits of the GSA06 trawl fleet are negative at present and are likely to remain negative under any harvesting strategy. However, harvesting strategies aiming at reducing fishing mortality by 25%, 50% or 75% would allow decreasing the losses of the trawl fleet in the long-term. Naturally, these F-reduction scenarios would imply additional financial losses in the short-term (2009-2011).

In summary, the trawl fishery in GSA06 needs urgent attention to strongly reduce fishing mortality in order to ensure its viability in the long-term.

### *6.2.2. Bioeconomic analysis of GSA07 ("Gulf of Lions") trawl fleet*




Two main species, for which population parameters are available and which constitute the main target species of this fleet, are considered: European hake (*Merluccius merluccius*) and red mullet (*Mullus barbatus*).

| 2008 | Catch (t) |
|---|---|
| *Merluccius merluccius* | 2297 |
| *Mullus barbatus* | 150 |

The bioeconomic model follows a fully age-structured model for the biology of main species for which assessment data is available, in this case: *M. merluccius* and *M. barbatus.* The model treats the production of secondary (by-catch) species as an empirically estimated function of the main species, because no biological parameters are available for secondary species although they contribute significantly to the total revenues of the fleet. The two species considered in the biological submodel account for 12% of the catch and 20% of the value of GSA07 trawlers.

The GSA07 trawl fleet is composed of 78 trawlers (parameterized with French economic data for the trawl 12-24 m segment). The economic submodel applied here is a standard revenue minus costs submodel, where the endogenous effort-allocation dynamics of MEFISTO not used. The cost structure in the model includes trade costs, fuel costs, labour costs, fixed and depreciation costs, opportunity costs and financial costs. Note that in Mediterranean fisheries labour costs are a share of the revenues minus common costs (fuel and other daily costs are met by the owner and the crew). Hence, maintaining the same fishing effort, when catches increase and revenues are higher, will also increase the general costs as labour and trade costs increase.

### 6.2.2.1. Biological data

The necessary input data required for the first year of simulation (2008) are shown in the following tables.

Table 6.2.2.1.1 Allometric and growth curve parameters.

| A | b | $L_{inf}$ | k | $t_0$ | Ncoh | Stock |
|---|---|---|---|---|---|---|
| 0.0069 | 3.0300 | 86.75 | 0.23 | -0.36 | 8 | Hake |

Table 6.2.2.1.2 Stock number, maturity (Mat), natural mortality (M) and fishing mortality (F) at age.

| Stock | Age | Number | Mat | M | F |
|---|---|---|---|---|---|
| Hake | 0 | 112,418,000 | 0.00 | 0.68 | 0.32 |
| Hake | 1 | 22,800,000 | 0.03 | 0.47 | 0.74 |
| Hake | 2 | 2,982,000 | 0.77 | 0.30 | 0.37 |
| Hake | 3 | 1,068,000 | 0.99 | 0.22 | 0.24 |
| Hake | 4 | 303,000 | 1.00 | 0.19 | 0.16 |
| Hake | 5 | 106,000 | 1.00 | 0.17 | 0.19 |
| Hake | 6 | 48,000 | 1.00 | 0.16 | 0.11 |
| Hake | 7 | 34,000 | 1.00 | 0.14 | 0.11 |
| Red mullet | 0 | 13,443,147 | 0.16 | 0.64 | 0.07 |
| Red mullet | 1 | 6,504,076 | 0.61 | 0.54 | 0.88 |
| Red mullet | 2 | 1,552,192 | 0.88 | 0.45 | 0.77 |
| Red mullet | 3 | 453,855 | 0.95 | 0.32 | 0.46 |
| Red mullet | 4 | 207,241 | 0.97 | 0.22 | 0.24 |
| Red mullet | 5 | 130,176 | 0.99 | 0.20 | 0.16 |

Table 6.2.2.1.3 Recruitment (geometric mean (2006-2008) number of individuals and standard deviation of the lognormal distribution).

| Stock | Type | Recr | k | epsilon |
|---|---|---|---|---|
| Hake | 0 | 56,204,967 | 1 | 0.40 |
| Red mullet | 0 | 13443147.3 | 1 | 0.30 |

These biological data are calculated from the corresponding assessments performed by the French-Spanish Working Group, using XSA for hake (presented at the Izmir 2008 SCSA of the GFCM) and VIT for red mullet (provided by the French-Spanish Working Group).

### 6.2.2.2. Economic data

French economic data for 2007 are available to the SGMED from the economic database submitted by each country. The economic analysis assumes that:

- The opportunity cost interest is set at 3%.
- The economic life of a vessel is 20 years. Thus, the depreciation of the vessel is established at a 5% annual rate.
- Fish price is constant over time and independent of the landings level.

Economic official data cannot be transposed directly to the MEFISTO model and some assumptions have to be made to calculate the necessary parameters. For instance, the costs and revenues of a fleet are related to the entire set of species caught, not only to the two species modelled here and an empirical relationship between catch of the main species and total catch was introduced (based on data for Catalonia trawl fisheries, the northernmost fishery in GSA06 and having many economic structural similarities to GSA07 trawl fisheries).

Table 6.2.2.2.1 Economic and technical parameters:

| | |
|---|---|
| Number of fishing days per year | 220 |
| Commercial (or trade) cost | 16% |
| Fuel price | 0.57 € / l |
| Opportunity cost | 3% |
| Financial cost | 5% |
| Capital | 43,826,555 € |
| Gross tonnage | 527,234 GT |
| Fuel consumption | 131,235 l / d |
| Crew size | 347 FTE |
| Other daily costs | 50 € / d / boat |
| Annual costs | 5,777,080 € |
| Percentage of annual fixed costs | 62% |
| Percentage of annual depreciation costs | 38% |
| Unit price of hake | 5.42 € / kg |
| Unit price of red mullet | 6.06 € / kg |

Additionally, we assumed opportunity and constant fleet capital throughout the simulation. This assumption implies no internal investment in the fleet and no external investment (i.e., absence of national or Community subsidies).

### 6.2.2.3. Simulation conditions

The simultaneous projections of the two stocks and one fleet were performed for the period 2009-2019, with 1000 iterations for each scenario. Simulation scenarios were established with reference to the present fishing mortality ($F_{sq}$):

$F_{sq}$·0.25
$F_{sq}$·0.50
$F_{sq}$·0.75
$F_{sq}$·0.90
$F_{sq}$·1.25
$F_{sq}$·1.50

### 6.2.2.4. Critical assumptions and limitations

For the 2 species, future recruitment was modelled as a lognormal distribution with mean equal to the geometric mean of the last 3 years (2006-2008) and standard deviation corresponding to the variability observed in the historical time series (see table *Recruitment* above).

For hake, the historical data series of recruitment runs from 1998 to 2008, while for red mullet no information before 2008 is available. Assuming a randomly varying recruitment around a constant signal is a strong assumption (Fig. 6.2.2.4.1), but in the case of hake in GSA07 the future assumed recruitment levels are well within the historical observed values. In the case of red mullet, no past information is available on recruitment and the value for 2008 is projected forwards with a SD of 0.30 (Fig. 6.2.2.4.2). Considering the relatively low importance of catches of this red mullet in the area, the impact on the simulation results of incorrect parameterization of this species is relatively low.

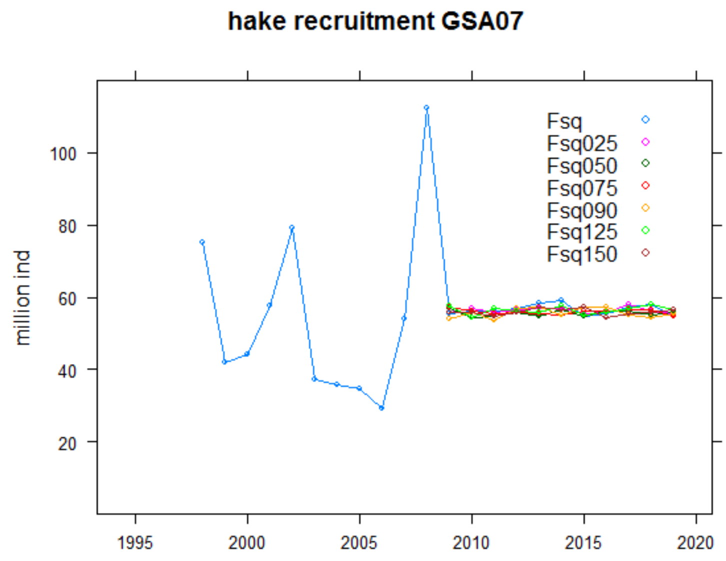



Fig. 6.2.2.4.1. Historical and projected series of Hake recruitment (*Merluccius merluccius*) under the assumption of constant recruitment around the geometric mean of the last 3 years (2006-2008) and variability following a lognormal distribution with sd=0.40 (confidence intervals not shown).

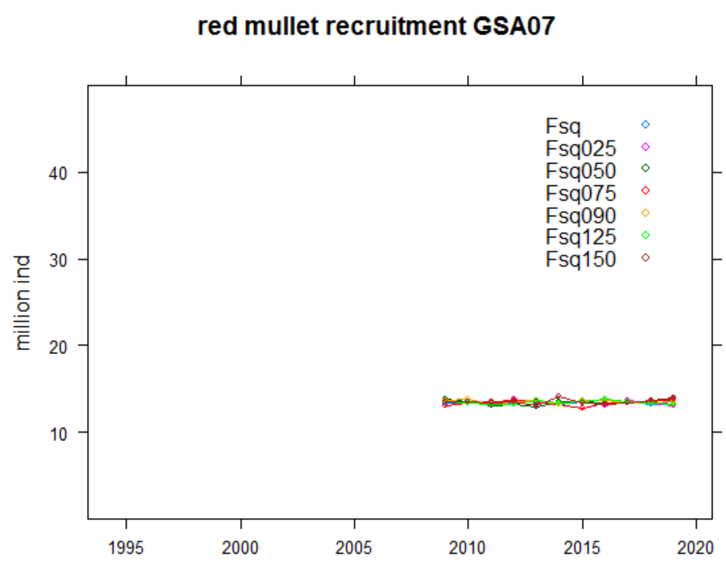



Fig. 6.2.2.4.2. Historical and projected series of Red mullet recruitment (*Mullus barbatus*) under the assumption of constant recruitment around the value of the most recent year (2008) and variability following a lognormal distribution with sd=0.30 (confidence intervals not shown).

6.2.2.5. Results

The simulation results showed here allow for a simultaneous analysis of the short, medium and long-term trends. Summary statistics for the short-term are given in Annexes 5-7, while medium and long-term results can be inspected visually from the figures below.

Catches of hake in the years 2009-2011 are projected to be much higher than historical levels (Fig. 6.2.2.5.1). This is the result of the high recruitment (double than the historical mean over the period 1998-2008) observed for 2008, which would results in catches of 5078 t for 2009 under current fishing levels ($F_{sq}$). For F-reduction scenarios ($F_{sq}$·0.25 and $F_{sq}$·0.75 and $F_{sq}$·0.90), the catch reduction would be large (down by 50% approximately), but catches will still remain within historically observed values. A strong reduction of fishing mortality ($F_{sq}$·0.25 and $F_{sq}$·0.50) would ensure higher catches than historical levels in the medium and long term, while moderate F-reductions ($F_{sq}$·0.75 and $F_{sq}$·0.90) would do no more than keep catches around historical levels. Maintaining the status quo or increasing fishing mortality would imply decreasing yields in the medium and long-term. Due to the assumption of constant recruitment around the geometric mean of the last 3 years and the high pulse of recruitment observed in 2008, the population is projected to be able to sustain higher catches than historical levels under the range of fishing mortalities tested here ($F_{sq}$·0.25 and $F_{sq}$·1.50) in the mid and long term.

Catches of red mullet in the short term (2009-2011) would decrease under F-reduction scenarios, while they would increase under F-increasing scenarios. In the mid- to long-term, catches are projected to be lower than 2008 catches under any management scenario (Fig. 6.2.2.5.2) and with F-reduction scenarios of $F_{sq}$·0.25 and $F_{sq}$·0.50 they would be much lower than the 2008 values.

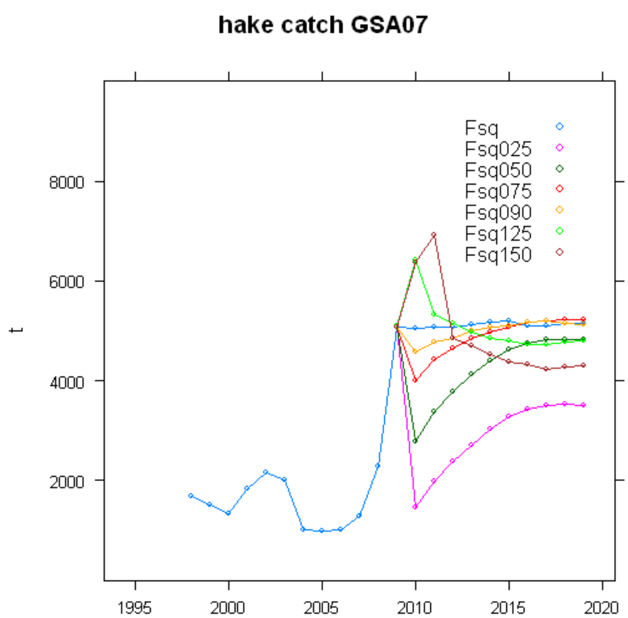



Fig. 6.2.2.5.1. Projected catches of hake (Merluccius merluccius) under different management scenarios. The reported catches for the period 1998-2008 are shown also for comparison (confidence intervals not shown).

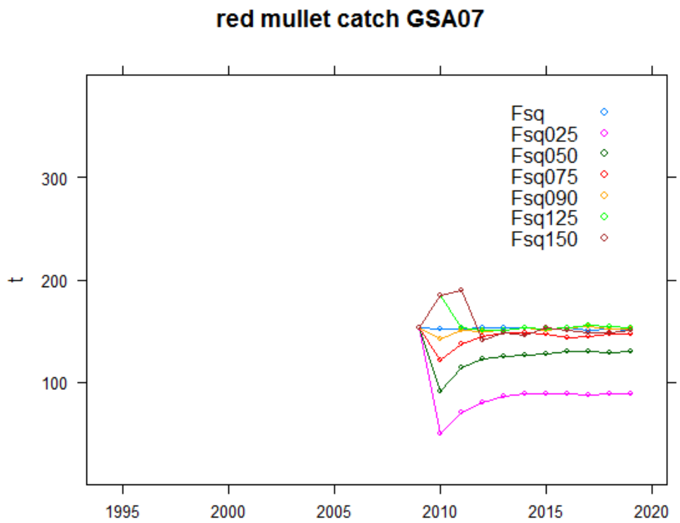



Fig. 6.2.2.5.2. Projected catches of red mullet (*Mullus barbatus*) under different management scenarios. (confidence intervals not shown).

Due to the high recruitment observed in 2008, the Spawning Stock Biomass (SSB) is projected to be much higher (2-3 times) in the short term (2009-2011) than in the historical range of observed values (Fig. 6.2.2.5.3). Maintaining or reducing F would results in high to very high SSB in the mid and long term, and even increasing F to 1.25 or 1.50 times the $F_{sq}$ would result in higher SSB than historical levels (Fig. 6.2.2.5.3). For red mullet, due to the absence of historical data, it is difficult to assess the quality of the results, but it is apparent from Fig. 6.2.2.5.4 that a decrease of F would be beneficial to the stock both in the short and long term. Conversely, an increase in F would result in SSB lower than present (2008).

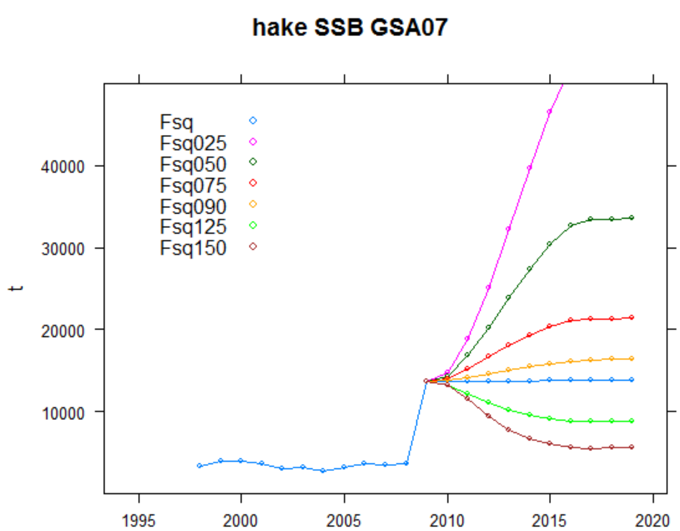



Fig. 6.2.2.5.3. Projected Spawning Stock Biomass of hake (*Merluccius merluccius*) under different management scenarios. The reported SSB for the period 1998-2008 is shown also for comparison (confidence intervals not shown).

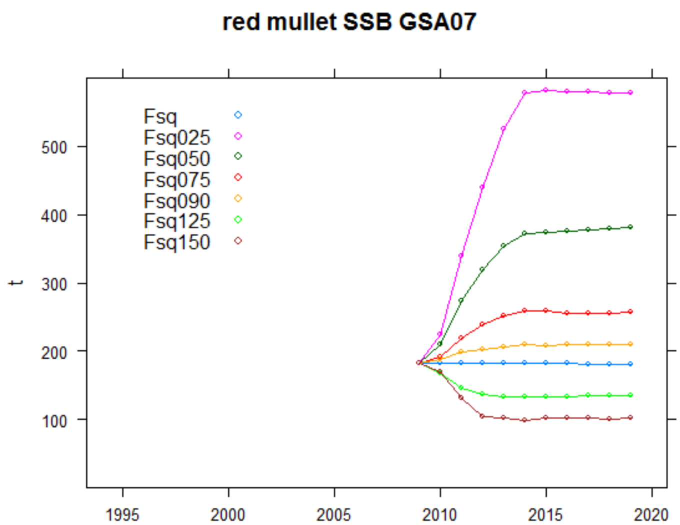



Fig. 6.2.2.5.4. Projected Spawning Stock Biomass of red mullet (*Mullus barbatus*) under different management scenarios (confidence intervals not shown).

### 6.2.2.6. Economic indicators

Two indicators were selected for analysis: Profits and Return on Investment, defined as:

RoI = (Profits / Capital) * 100

Profits of the French trawl fleet would be positive and around 1.1 M€ / yr in 2009. Projecting the favourable present productivity conditions (exceptionally high recruitment in 2008) under different F-management scenarios (Fig. 6.2.2.6.1) shows that:

- In the short-term (2009-2011), increasing F ($F_{sq}$·1.25 and $F_{sq}$·1.50) would result in higher profits, but these would go down to levels lower than present in the mid and long term.
- Decreasing F strongly ($F_{sq}$·0.25 and $F_{sq}$·0.50) would produce lower profits in the short and mid term and profits would not recover to present (2008) levels even in the long term (2019). Decreasing F to 75 or 90% of present values ($F_{sq}$·0.75 and $F_{sq}$·0.90) would allow to produce profits of similar levels than present.

These profits must be considered financial profits, in the sense that they account for the opportunity costs. The opportunity costs interest was estimated to be 3%. This is equivalent to the return of a risk-free investment. The RoI is mostly below 3% (except in the short term for scenarios of increasing F: Fsq125 and Fsq150), the opportunity cost (Fig. 6.2.2.6.2). The capital invested in the vessels can be considered a sunk cost because it is not common to buy and sell vessels in the second hand market. Hence, the investment decision is something that is done once and for all. It is very difficult to change the investment, except through leaving the fishery. Moreover, sometimes, the investment was not totally paid by the fishermen. All these considerations imply that vessel owners in the Mediterranean (usually the owner is also the skipper) do not take into account the opportunity cost, at least on the short term.

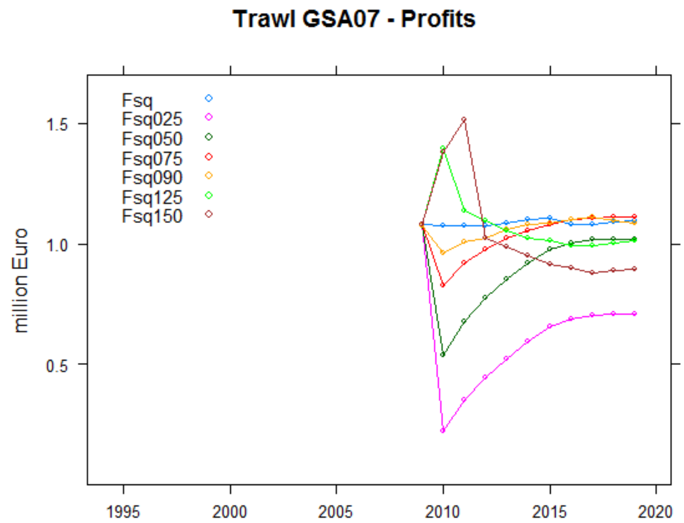



Fig. 6.2.2.6.1. Projection of fleet profits from 2009 to 2019 under different management scenarios.

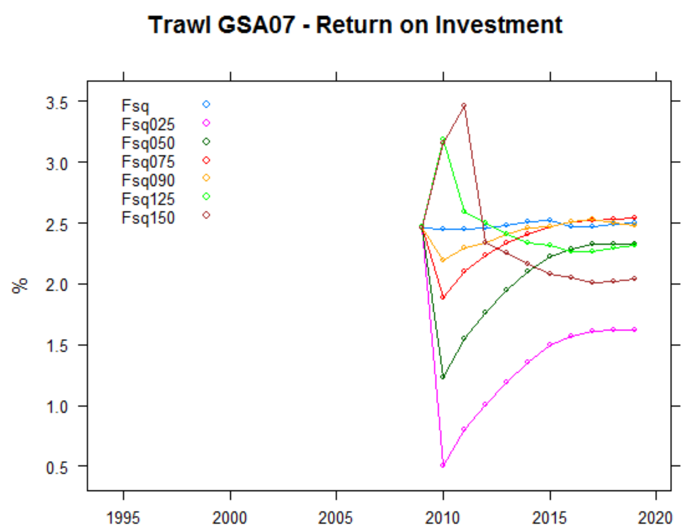



Fig. . 6.2.2.6.2. Projection of fleet Return on Investment from 2009 to 2019 under different management scenarios.

### 6.2.2.7. Conclusions

The results of the accompanying simulation analysis show that:

1) Catches of hake in GSA07 are predicted to be high under any harvesting strategy due to the high recruitment observed in 2008. Maintaining the status quo or decreasing F would allow for catches in line with those observed in the historical period or higher in the short and long-term. Increasing F would allow obtaining even higher catches in the short-term, but high catches would only be ensured in the long-term if recruitment levels remain high, which is uncertain.
2) SSB of hake in GSA07 is also projected to be higher than historical levels under any F-reduction

scenarios or maintaining the status quo, both in the short- and long-term, but again this depends strongly on future high recruitment.

3) For red mullet in GSA07 there are no historical reference baselines, but catches could be sustained at 2008 levels by harvesting strategies $F_{sq}$·075 or higher. However, increasing F to 125% or 150% would ensure higher catches than present but only in the short-term.
4) Similarly, for SSB of red mullet in GSA07 there are no historical data. SSB equal or higher than present could be attained by maintaining the status quo or reducing fishing mortality.
5) Economic indicators for the GSA07 trawl fleet in 2008 show negative profits, but the bioeconomic simulation analysis predicts positive profits under any harvesting strategy in the short- and long-term. This result is directly related to the high catches of hake obtained from the strong recruitment of 2008 and by projecting high constant recruitment in the future.
6) Given the strong dependency of the results of the simulations for GSA07 trawl on the high recruitment of hake in 2008 and the uncertainty of projecting future recruitment of this species into the future, SGMED 09-03 is not in the position to provide precise economic advice on future fishing strategies. However, SGMED 08-04 assessed the stock as being overexploited in comparison with Fmsy and thus SGMED 09-03 concludes that reductions in fishing effort implies less risk and higher stability in medium term.

## 6.3. ToR h: Methodological workshop to be held in 2011 with the aim of improving the precision and accuracy of individual ageing of exploited stocks

SGMED 09-03 recommends a workshop for the improvement of the precision and accuracy of individual ageing of exploited Mediterranean stocks (Table 6.3.1) to be held in 2011 with the following ToRs:

Proposed TORs

- ✓ Review the state of the art of the current ageing procedures, taking into account the results of recent workshops held in the framework of DCR and ICES
- ✓ Review the sample processing techniques for age reading used by different laboratories and initiate the standardisation process to improve the quality (i.e. accuracy and precision) of age-readings
- ✓ Undertake and evaluate the results from comparative age readings for precision, bias, and accuracy.
- ✓ Review age reading validation techniques
- ✓ Test the precision, bias and accuracy of age estimates through complementary validation methods (daily increment reading in 0 group, marginal increment reading, mark and recapture, length frequency distributions, etc.)
- ✓ Agree on and recommend the most appropriate techniques to be applied
- ✓ Develop otolith exchange programmes among different laboratories

Also, other structures could be taken into account for age reading in molluscs and elasmobranchs (e.g. shells, statoliths, vertebrae, spines), that are among the most valuable or endangered species in the Mediterranean Sea. For species with no hard structures as crustaceans, for which direct ageing is unfeasible, it is necessary to reach a general consensus regarding the data requirements and a set of approaches based on the analysis of size frequency distributions to be implemented as an alternative method for growth parameters estimation.

Table 6.3.1 Species list and contact persons.

| Species | GSAs | Contact persons |
|---|---|---|
| *Merluccius merluccius* | 5; 6; 7; 9; 10; 16; 17; 18 | Pierluigi Carbonara / Maria Teresa Spedicato / Fabio Fiorentino |
| *Mullus barbatus* | 7; 9; 10; 11; 16; 17; 18; 25 | Pierluigi Carbonara / Maria Teresa Spedicato / Fabio Fiorentino |
| *Solea solea* | 17; 18 | Giuseppe Scarcella |
| *Engraulis encrasicolus* | 16; 17; 18; 19; 22 | Mario La Mesa / Marianna Giannoulaki / Gualtiero Basilone |
| *Sardina pilchardus* | 16; 17; 18; 19; 22 | Mario La Mesa / Marianna Giannoulaki / Gualtiero Basilone |
| *Parapenaeus longirostris* | 6; 9; 16 | Carlo Froglia / Alvaro Abella / Fabio Fiorentino |
| *Aristeus antennatus* | 6; 10; 15 | Alvaro Abella / Maria Teresa Spedicato |
| *Aristaeomorpha foliacea* | 6; 10; 15; 16; 18 | Alvaro Abella / Maria Teresa Spedicato / Fabio Fiorentino |
| *Nephrops norvegicus* | 9; 17; 18 | Carlo Froglia / Alvaro Abella / M.E. Gramitto |

## 6.4. ToR i and k: Suggestions regarding a workplan of SGMED in 2010 and respective data needs

### *6.4.1.Ranking of species importance*

As concerns the future work of SGMED, the species included in the TORs of STECF and SGMED-09-03 were ranked with the purpose to identify priorities for the future assessment to be conducted for the Mediterranean species (excluding the Black Sea).

For the ranking exercise, SGMED-09-03 decided to take into account the priorities established by the two RFMOs concerned (GFCM and ICCAT), the existence of specific EC Regulations for single species or fishery, the total catch level in the period 2005-2007 (it was agreed to consider only the FAO catches, because of the availability of the full series and for the discrepancies noticed in catch reporting between Mediterranean RCM and FAO Production statistics), the trend in reported catches in the period 2002-2007 and the list of assessments already available from GFCM/SAC and STECF/SGMED working groups.

The ranking values have been attributed according to the following table:

Table 6.4.1.1 Species ranking values

| | Ranking values | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| Priority species (GFCM) | no | yes | | |
| Priority species (ICCAT) | no | yes | | |
| EC regulated | no | yes | | |
| Included in the EC DCR/DCF | no | | | yes |

| | | | | |
|---|---|---|---|---|
| Total catch level 2005-2007 in tons (FAO) | nd | <5,000 | 5,000/10,000 | >10,000 |
| 5-year 2003-2007 catch trend (FAO) | nd | positive(+) | stable (=) | negative(-) |
| Species/GSA assessments (GFCM+SGMED) | | >3 | 1-3 | 0 |

Due to the complexity of the various possible other components (i.e.: the number of assessments in the same GSA, the total value of the landings, the ecosystem component, the conservation status and others), SGMED-09-03 decided to limit the entry of the ranking to the agreed variables in this first attempt.

The ranking is provided in a table by species (or genus, when only the genus or the family was included in the EC DCF). The highest value should give an useful indication for the priorities to be used for future STECF/SGMED assessment. Obviously, future assessment will strongly depend on the availability of the necessary scientific data. The table is provided on the following page (Table 6.4.1.2).

Table 6.4.1.2. Information regarding importance of exploited species for future SGMED assessments and advice. The importance is quantified under the "Ranking field". The ranking is explained in the text of the previous page.

| | | Ranking values by category: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1, 0 | 1, 0 | 1, 0 | 3, 0 | 3, 2, 1 | 3, 2, 1 | | 3, 2, 1 | | |
| | | ORIGINAL PRIORITY | | EC | CATCHES | FAO CATCHES 05-07 | | ASSESSMENTS | GFCM | SGMED | |
| *Latin name* | English name | GFCM | ICCAT | REGULATED | 2005-2007 | tons | 5y trend | *Species* | GSA | GSA | Ranking |
| *Boops boops* | Bogue | 1 | | | 11687 | 8130.7 | + | *Boops boops* | 22 | | 9 |
| *Coryphaena hippurus* | Dolphinfish | 1 | 1 | 1 | 2659 | 2964.7 | + | *Coryphaena hippurus* | | | 11 |
| *Dicentrarchus labrax* | Sea bass | | | 1 | 586 | 1584.3 | - | *Dicentrarchus labrax* | | | 11 |
| *Diplodus* spp. | Sargo breams | | | 1 | nd | 3620 | + | *Diplodus* spp. | 12, 13, 14 | | 5 |
| *Engraulis encrasicolus* | Anchovy | 1 | | 1 | 94053 | 90145.3 | + | *Engraulis encrasicolus* | 1, 3, 6, 7, 16, 17, 18, 22 | 16, 17, 22 | 10 |
| *Eutrigla gurnardus* | Grey gurnard | | | | 485 | 17 | + | *Eutrigla gurnardus* | | | 8 |
| | Gurnards, searobins nei * | | | | | 2355.7 | - | | | | |
| *Lophius budegassa* | Black-bellied angler * | 1 | | | 5127 | 0 | nd | *Lophius budegassa* | 6 | | 7 |
| *Lophius piscatorius* | Anglerfish * | | | | 1072 | 5358.7 | + | *Lophius piscatorius* | | | 6 |
| *Merluccius merluccius* | European hake | 1 | | 1 | 32681 | 26301.3 | + | *Merluccius merluccius* | 1, 3, 5, 6, 7, 9,10, 15, 20, 22 | 6, 9, 10, 11 | 10 |
| *Micromesistius poutassou* | Blue whiting | 1 | | | 7678 | 8975.3 | + | *Micromesistius poutassou* | | | 10 |
| Mugillidae | Grey mullets | | | | 3385 | 3748.7 | - | Mugillidae | | | 10 |
| *Mullus barbatus* | Red mullet * | 1 | | 1 | 14926 | 13765 | + | *Mullus barbatus* | 1, 3, 5, 6,7, 9, 11, 22, 23,25 | 9, 25 | 10 |
| *Mullus surmuletus* | Striped red mullet * | 1 | | 1 | 6595 | 6267.7 | + | *Mullus surmuletus* | 5, 12, 13, 14 | | 9 |
| *Pagellus acarne* | Axillary seabream | | | 1 | nd | 120 | - | *Pagellus acarne* | | | 8 |
| *Pagellus bogaraveo* | Blackspot seabream | 1 | | 1 | nd | 12.7 | - | *Pagellus bogaraveo* | 3 | | 8 |
| *Pagellus erythrinus* | Common pandora | 1 | | 1 | 3411 | 4463.7 | + | *Pagellus erythrinus* | 9 | | 9 |
| *Phycis blennoides* | Greater forkbeard | | | | nd | 452.3 | + | *Phycis blennoides* | | | 5 |
| *Sarda sarda* | Atlantic bonito | 1 | 1 | | 3252 | 3046 | = | *Sarda sarda* | | | 11 |
| *Sardina pilchardus* | Sardine (European pilchard) | 1 | | 1 | 71155 | 68505 | = | *Sardina pilchardus* | 1, 3, 6, 7, 16, 17, 18, 20, 22 | 16, 17, 22 | 10 |
| *Solea solea* | Common sole | 1 | | 1 | 3927 | 3912.7 | = | *Solea solea* | 17, 14 | 17 | 10 |
| *Sparus aurata* | Gilthead seabream | | | 1 | 661 | 1600.7 | - | *Sparus aurata* | | | 11 |
| *Spicara smaris* | Picarel | | | | 7245 | 5968.3 | + | *Spicara smaris* | 22 | | 8 |
| *Sprattus sprattus* | European Sprat | 1 | | | 4 | 330.3 | - | *Sprattus sprattus* | 17 | | 9 |
| *Scomber* spp. | Mackerels* | 1 | | 1 | 15374 | 8796.3 | + | *Scomber* spp. | 3 | | 10 |
| *Trachurus mediterraneus* | Mediterranean horse mackerel * | 1 | | 1 | 781 | 2992.3 | + | *Trachurus mediterraneus* | | | 10 |
| *Trachurus trachurus* | Atlantic horse mackerel * | 1 | | 1 | 19631 | 600.7 | - | *Trachurus trachurus* | 3, 22 | | 11 |
| | Jack and horse mackerel nei * | | | | nd | 16162.3 | + | | | | |
| *Trigla lucerna* | Tub gurnard | | | | 457 | 26.7 | - | *Trigla lucerna* | | | 10 |
| *Trisopterus minutus* | Poor cod | | | | nd | 2775.3 | + | *Trisopterus minutus* | | | 5 |
| *CRUSTACEANS* | | | | | | | | *CRUSTACEANS* | | | |
| *Aristaeomorpha foliacea* | Giant red shrimp * | 1 | | | 2387 | 0 | nd | *Aristaeomorpha foliacea* | 15,16,11 | 15, 16 | 7 |
| *Aristeus antennatus* | Red shrimps (Blue and red shrimp) * | 1 | | | 1645 | 918.7 | = | *Aristeus antennatus* | 1, 5, 6, 16, 17 | 6 | 8 |
| *Nephrops norvegicus* | Norway lobster | 1 | | 1 | 5630 | 5444.3 | + | *Nephrops norvegicus* | 5, 6, 9 | 9 | 10 |
| *Parapenaeus longirostris* | Deep-water rose shrimp | 1 | | 1 | 15713 | 11992 | + | *Parapenaeus longirostris* | 3, 6 | 6, 9 | 11 |
| *Melicerthus keraturus* | Caramote prawn | | | | 3579 | 3983.7 | + | *Penaeus keraturus* | | | 8 |
| *Squilla mantis* | Spottail | | | | 6957 | 7672.7 | + | *Squilla mantis* | | | 9 |
| | * species possibly mixed up in the catch statistics | | | | | | | | | | |

### 6.4.2. Discrepancies in total catch by species reported by each Member State

SGMED-09-03 was requested to evaluate the quality of data used in stock assessments, including the total catch by species by GSA and MS. A table with total catch by species and by Member State (MS) for the species included in the TORs provided to STECF/SGMED-09-03 and for those included in the DCR/DCF was created.

SGMED-09-03 noticed serious discrepancies between the catches declared to various fora and, in particular, with respect to the average of the period 2005-2007, that was used as the reference value by the last RCM Med & BS (6th Regional Coordination Meeting for the Mediterranean and the Black Sea, Venice 13-16 October 2009) for planning and evaluation of the sampling intensity.

SGMED-09-03 stressed the high relevance of the table included in the RCM meeting in page 95 of its report, which was adopted by the 3rd PGMed 2009 as the "Common Template on Landing Data". This table (average landing values –in tons- for each species and for each Mediterranean MS – 2005-2007) constitutes the base for the calculation of each MS share in landings, the base for the exemptions from sampling landings and biological variables and, finally, for the calculation of the EC contribution to each MS within the DCF. Furthermore, total catches are necessary data for stock assessments.

After the enforcement of the DCR and the following DCF, total catch figures must be always coherent, should be more reliable and mostly the same in all international data banks dealing with the list of species included in the DCF. SGMED-09-03 noticed that this is not the case, that many discrepancies of various levels exist and that these discrepancies might bias the results of sample planning and assessment working groups.

SGMED-09-03 carried out a cross check of the data by species (or, when it was relevant according to the DCR appendix XIII or DCF appendix VII, by genus or family) between the PGMed/RCM Med&BS table, the FAO/FISHSTAT capture production data bank and the ICCAT Task I data bank, to assess coherences or discrepancies by MS and in total EU Mediterranean catches.

The results are shown on Table 6.4.2.2. It is clear that discrepancies exist for most of the species and MS concerned and some of these are very relevant and must be clarified. SGMED-09-03 emphasises that the comparison between the PGMed/RCM Med&BS table and the FAO/FISHSTAT table is difficult for some species, because of inconsistent categorizations, which are listed in the following Table 6.4.2.1:

Table 6.4.2.1 Inconsistent categorizations of species

| DCR/DCF species | FAO-FISHSTAT Capture Production name |
|---|---|
| *Scomber* spp. | Atlantic mackerel+Chub mackerel+Mackerels nei+Scomber mackerels |
| *Trachurus mediterraneus* | Mediterranean horse mackerel+Atlantic horse mackerel+(Jack and horse mackerels*) |
| *Dicentrarchus labrax* | European seabass+Seabasses nei |
| *Diplodus* spp. | Black seabream+Saddler seabream+White seabream+Sargo breams nei |
| *Lophius budegassa* | Blackbellied angler (possibly included in the undefined anglers) |
| *Lophius piscatorius* | Angler (=Monk)+Monkfishes nei |
| *Mullus barbatus* | Red mullet+surmullets(=Red mullets) nei |
| *Mullus surmuletus* | Surmullet |
| *Pagellus erythrinus* | Common pandora+Pandoras nei |
| *Psetta maxima* | Turbot+Turbot nei |
| *Raja clavata* & *Raja miraletus* | No catches by species. We used Raja rays ney+Rays and skates nei+Raya, stingrays, mantes nei |
| *Sepia officinalis* | Cuttlefish+Cuttlefish, bobtail squids nei |
| Venerupis+Veneridae | Clams etc. nei+venus clams nei |

*this category includes also Scombers

Some discrepancies might be caused by the group categories used by FAO Capture Production statistics (although matching the various species possibly included in the various grouping categories, discrepancies are still existing), others minor discrepancies might be explained by the rounding of partial data sets, others are very difficult to explain and should be better explored and rapidly clarified.

In the case of the large pelagic species included in the table it is very difficult to understand how data can be different among the RCM, the ICCAT and the FAO sets, because of the validation of data at the EC level after the submission by MS. This is particularly the case of the bluefin tuna data: according to the RCM/PGMed table, it seems that the criteria followed in reporting the data was different by MS: most of the MS reported total catches, while France maybe reported only landings in France. Furthermore, the total figure is obviously far from the total figure reported in ICCAT and FAO.

SGMED-09-03 also noticed that some species are included in some MS and are not present in other MS, even if the same fishing activity exists. This might be explained by a lot of factors (markets, small landings, etc.), but it should be investigate if the various figures are fully reliable or not. SGMED-09-03, noticing that this discrepancy issue was also noted in SGRN-09-03 but not formally included in the SGRN-09-03 report, strongly recommends that individuated discrepancies are cross-checked and corrected as a matter of urgency.

Table 6.4.2.2 Comparison of landing (t) statistics from various sources by species or species group and Member State, 2005-2007.

| | | Cyprus | | France | | Greece | | Italy | | Malta | | Slovenia | | Spain | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Latin name* | English name | RCM | FAO | RCM | FAO | RCM | FAO | RCM | FAO | RCM | FAO | RCM | FAO | RCM | FAO | TOT RCM | TOT ICCAT | TOT FAO |
| *Anguilla anguilla* | Common eel | 0 | 0 | 2 | 2 | 6 | 16 | 0 | 33 | 0 | | 0 | 0 | 1 | 23.7 | 9.0 | | 74.7 |
| *Boops boops* | Bogue | 233 | 233.7 | 135 | 133.7 | 7964 | 4066 | 3199 | 3327.3 | 24 | 20.3 | 2 | 2 | 128 | 347.7 | 11687.2 | | 8130.7 |
| *Coryphaena hippurus* | Dolphinfish | 0 | 0 | 0 | 0 | 4 | 0 | 2247 | 2336.7 | 383 | 427.3 | 0 | 0 | 25 | 200.7 | 2658.7 | | 2964.7 |
| *Coryphaena aequiselis* | Dolphinfish | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | | 0 |
| *Dicentrarchus labrax* | Sea bass | 8 | 8 | 267 | 269 | 145 | 956 | 110 | 166.3 | 0 | 0.5 | 1 | 1 | 55 | 184 | 586.1 | | 1584.3 |
| *Diplodus* spp. | Sargo breams | na | 50.3 | na | 100 | na | 760 | na | 2188.1 | na | 7 | na | 2.3 | na | 519.7 | na | | 3620 |
| *Engraulis encrasicolus* | European anchovy | 0 | 0.5 | 2939 | 2948.3 | 20481 | 13833.3 | 66730 | 68583.7 | 0 | 0 | 409 | 418.3 | 3494 | 4361.7 | 94052.7 | | 90145.3 |
| *Eutrigla gurnardus* | Grey gurnard | 0 | 0 | 17 | 17 | 0 | 0 | 462 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 485.4 | | 17 |
| | Gurnards, searobins nei | na | 0 | na | 60.7 | na | 135.7 | na | 1663 | na | 2.7 | na | 0.7 | na | 493 | na | | 2355.7 |
| *Lophius budegassa* | Black-bellied angler * | 0 | 0 | 3870 | 0 | 2578 | 0 | 997 | 0 | 1 | 0 | 0 | 0 | 1165 | 0 | 5126.8 | | |
| *Lophius piscatorius* | Anglerfish * | 0 | 0 | 0 | 389 | | 1265.3 | 1072 | 2150.7 | 0 | 0.3 | 0 | 0 | 0 | 1553.3 | 1071.7 | | 5358.7 |
| *Merluccius merluccius* | European hake | 25 | 25.3 | 1116 | 1127.3 | 12386 | 4619 | 15578 | 16201.3 | 7 | 7 | 4 | 4 | 3563 | 4317.3 | 32681.3 | | 26301.3 |
| *Micromesistius poutassou* | Blue whiting | 0 | 0 | 23 | 23 | 400 | 1224 | 1458 | 1516.7 | 0 | 0 | 3 | 2.3 | 5793 | 6209.3 | 7677.6 | | 8975.3 |
| Mugillidae | Grey mullets | 3 | 0 | 338 | 333 | 141 | 0 | 2825 | 2938.7 | 0 | 0.3 | 12 | 11 | 66 | 465.7 | 3384.9 | | 3748.7 |
| *Mullus barbatus* | Red mullet * | 50 | 68.4 | 211 | 218.3 | 4048 | 2027.3 | 9014 | 9374.7 | 9 | 13.3 | 4 | 4 | 1590 | 2059 | 14926.0 | | 13765 |
| *Mullus surmuletus* | Striped red mullet * | 132 | 112.7 | 0 | 0 | 2458 | 1380 | 3912 | 4068 | 4 | 0 | 0 | 0 | 0 | 707 | 6505.1 | | 6267.7 |
| *Pagellus acarne* | Axillary seabream | na | 6.3 | na | 110.7 | na | 0 | na | 0 | na | 3 | na | 0 | na | 0 | na | | 120 |
| *Pagellus bogaraveo* | Blackspot seabream | na | 5.7 | na | 7 | na | 0 | na | 0 | na | 0 | na | 0 | na | 0 | na | | 12.7 |
| *Pagellus erythrinus* | Common pandora | 25 | 23 | 111 | 115 | 1487 | 542 | 1585 | 2241 | 5 | 3.7 | 5 | 4.3 | 193 | 1534.7 | 3411.1 | | 4463.7 |
| *Phycis blennoides* | Greater forkbeard | na | 0 | na | 4 | na | 0 | na | 68 | na | 1.7 | na | 0 | na | 378.7 | na | | 452.3 |
| *Psetta massima* | Turbot | 0 | 0 | 12 | 11.7 | 0 | 66.7 | 0 | 791 | 0 | 0 | 0 | 0.3 | 5 | 6.7 | 17.3 | | 876.3 |
| *Raja clavata* | Thornback ray * | 0 | 0 | 15 | 15.3 | 378 | 336.3 | 357 | 0 | 6 | 0 | 0 | 0 | 1 | 0 | 757.0 | | 351.7 |
| *Raja milareltus* | Brown ray * | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 111 | 0 | 151.1 | | 0 |
| | Rays nei* | na | 0 | na | 53.3 | na | 200.7 | na | 1068.7 | na | 7.7 | na | 0 | na | 337.7 | na | | 1168 |
| *Sarda sarda* | Atlantic bonito | 4 | 2.3 | 10 | 5 | 1316 | 1119.3 | 1524 | 452 | 7 | 0.7 | 1 | 0 | 391 | 391.7 | 3252.0 | 1971 | 3046 |
| *Sardina pilchardus* | Sardine (European pilchard) | 7 | | 10983 | | 20388 | | 13126 | | 1 | | 273 | | 26376 | | 71154.8 | | 68505 |
| Selachii | Shark-like Selachii | 19 | | 9 | | 636 | | 1704 | | 22 | | 2 | | 184 | | 2575.4 | | |
| *Solea vulgaris* | Common sole | 0 | 0 | 178 | 180.3 | 1460 | 1115.7 | 2231 | 2373 | 0 | 0.5 | 7 | 7 | 50 | 236.7 | 3927.3 | | 3912.7 |
| *Squalus acanthias* | Piked dogfish | 0 | | 2 | | 0 | | 0 | | 0 | | | | 10 | | 11.9 | | |
| *Sparus aurata* | Gilthead seabream | 6 | 6 | 307 | 317.7 | 101 | 220.3 | 0 | 330.7 | 2 | 0.7 | 3 | 3.3 | 242 | 772 | 661.2 | | 1600.7 |
| *Spicara smaris* | Picarel | 269 | 263 | 7 | 7.3 | 4816 | 3232.7 | 2048 | 2129.7 | 5 | 2.7 | 5 | 5 | 94 | 328 | 7245.1 | | 5968.3 |
| *Sprattus sprattus* | European Sprat | 0 | 0 | 0 | 0 | 0 | 182.7 | 0 | 114.3 | 0 | 0 | 0 | 30.7 | 4 | 2.7 | 4.3 | | 330.3 |
| *Tetrapturus belone* + Istiophoridae | Spearfish | 0 | | 0 | | 0 | | 150 | | 2 | | 0 | | 0 | | 152.5 | 0 | nd |
| *Thunnus alalunga* | Albacore | 538 | 548 | 0 | 0.7 | 236 | 490.3 | 3680 | 3043.7 | 10 | 5.3 | 0 | | 362 | 361.7 | 4926.6 | 4449.7 | 5052.7 |
| *Thunnus thynnus* | Bluefin tuna | 80 | 86.6 | 24 | 8819.3 | 159 | 285.7 | 4364 | 4367.3 | 305 | 314.3 | 0 | 0 | 2764 | 2620.7 | 7996.0 | 16493.9 | nd |
| *Scomber* spp. | Mackerels * | 1 | 1 | 1382 | 1358 | 4148 | 3797.7 | 3480 | 3619.3 | 13 | 10.7 | 11 | 9.7 | 6339 | 9201 | 15374.4 | | 17997.3 |
| *Trachurus mediterraneus* | Mediterranean horse mackerel * | 12 | 0 | 0 | 0 | 0 | 2992.3 | 762 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 780.6 | | 2992.3 |
| *Trachurus trachurus* | Atlantic horse mackerel * | 0 | nd | 534 | nd | 7047 | 593.3 | 4334 | nd | 0 | nd | 7 | 7.3 | 7708 | 0 | 19630.5 | | 6007 |
| | Jack and horse mackerel nei * | nd | 12 | nd | 526.7 | nd | nd | nd | 5455.3 | nd | 5 | nd | 7 | nd | 10156.3 | na | | 16162.3 |
| *Trigla lucerna* | Tub gurnard | 0 | | 26 | 26.7 | 81 | 0 | 341 | 0 | 4 | 0 | 0 | 0 | 4 | 0 | 457.3 | | 26.7 |
| *Trisopterus minutus* | Poor cod | na | 0 | na | 692.3 | na | 0 | na | 1031 | na | 0 | na | 1.3 | na | 1050.7 | na | | 2775.3 |
| *Xiphias gladius* | Swordfish | 54 | 54.3 | 9 | 4.7 | 1192 | 1568.3 | 7202 | 7202 | 229 | 271.3 | 0 | | 620 | 1355 | 9305.2 | 10455.6 | 10558 |
| CRUSTACEANS | | | | | | | | | | | | | | | | | | |
| *Aristaeomorpha foliacea* | Giant red shrimp (Blue and red shirmp) * | 0 | 0 | 1 | 0 | 0 | 0 | 2361 | 0 | 23 | 0 | 0 | 0 | 1 | 0 | 2387.0 | | 0 |
| *Aristeus antennatus* | Red shrimps * | 0 | 0 | 0 | 0 | 0 | 0 | 845 | 0 | 0 | 0 | 0 | 0 | 799 | 918.7 | 1644.6 | | 918.7 |
| *Nephrops norvegicus* | Norway lobster | 0 | 0 | 1 | 0.3 | 1007 | 462.7 | 4239 | 4460.7 | 1 | 0.3 | 0 | 0 | 332 | 520.3 | 5630.1 | | 5444.3 |
| *Parapenaeus longirostris* | Deep-water rose shrimp | 3 | 3.3 | 1 | 0.3 | 4206 | 0 | 11369 | 11824.3 | 8 | 8 | 0 | 0 | 126 | 161.3 | 15713.3 | | 11992 |
| *Melicerthus keraturus* | Caramote prawn | 0 | 0 | 2 | 1.7 | 2832 | 3146.3 | 575 | 586.7 | 0 | 0 | 0 | 0 | 170 | 249 | 3578.9 | | 3983.7 |
| *Squilla mantis* | Spottail | 0 | 0 | 34 | 35 | 116 | 0 | 6520 | 6780 | 0 | 0 | 5 | 4.7 | 283 | 853 | 6957.3 | | 7272.7 |
| MOLLUSCS | | | | | | | | | | | | | | | | | | |
| *Elenone cyrrhosa* | Curled octopus | 0 | 0 | 1498 | 0 | 1005 | 0 | 2693 | 0 | 0 | 0 | 0 | 0 | 157 | 0 | 5622.3 | | 0 |
| *Eledone moschata* | Musky octopus | 0 | 0 | 0 | 0 | 0 | 0 | 4543 | 0 | 0 | 0 | 31 | 0 | 0 | 0 | 4573.2 | | 0 |
| *Octopus vulgaris* | Common octopus | 137 | 0 | 0 | 1511.3 | 4853 | 2284.7 | 3817 | 3969.7 | 35 | 0 | 0 | 33 | 1827 | 0 | 10668.4 | | 7798.7 |
| | Octopuses, etc. nei | na | 137 | na | 0 | na | 975.3 | na | 0 | na | 12.7 | na | 0 | na | 5613 | na | | 6738 |
| *Illex* spp. and *Todarodes* spp. | Shortfin and European flying Squids | 0 | 0 | 48 | 0 | 1721 | 0 | 4077 | 0 | 0 | 0 | 0 | 0 | 103 | 133 | 5981.8 | | 133 |
| *Loligo vulgaris* | European squid | 24 | 0 | 294 | 0 | 1072 | 0 | 1915 | 0 | 0 | 0 | 9 | 0 | 271 | 0 | 3494.1 | | 0 |
| *Sepia officinalis* | Common cuttlefish | 41 | 55 | 102 | 104 | 3553 | 1824 | 9490 | 11251.7 | 11 | 5.7 | 32 | 32.7 | 320 | 1143.7 | 13548.8 | | 14416.7 |
| *Veneridae* | Venus clams | 0 | 0 | 0 | 1002.3 | 0 | 0 | 24316 | 0 | 0 | 0 | 0 | 0 | 6 | 290.3 | 24321.8 | | 1292.7 |

* species possibly mixed up in the catch statistics

## 6.5. Additional ad hoc ToR l: Review of the updated assessments of the status of small pelagic stocks in the Adriatic (GSA 17)

SGMED noticed the results of the updated and revised assessments of anchovy and sardine in GSA 17 presented in Malaga to GFCM-SAC in December 2009. SGMED welcomed the new assessment approaches for both stocks now based on improved data input, such as fleet specific catch-at-age matrixes, compilation of fishery independent survey results and consideration of the recommendations made by STECF regarding used biological parameters.

SGMED was unable to review the assessment results or any conclusions drawn from them as SGMED had no access to the input and output data used and the diagnostics of the assessment models. Therefore, SGMED reiterates its recommendation that all input and output data as well as model diagnostics of historic stock assessments and predictions should be reported in a table format for small pelagic stocks in the Adriatic (GSA 17) as well as for any other assessed stock. This should be considered as a standard procedure in order to allow for a transparent and complete review process of the assessment and forecast information.

# 7. References


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. Aquat. Living Resourc. 22: 233-241.

Abella A., Caddy J. and Serena F. (1997). Do natural mortality and availability decline with age? An alternative yield paradigm for juvenile fisheries, illustrated by the hake *Merluccius merluccius* in the Mediterranean. Aquat. Living Resour., 10: 257-269.

Lleonart, J. and Salat, J. (1992). VIT. Programa de análisis de pesquerías. *Inf. Técn. Sci, Mar.,* 168-169: 116 pp.

Patterson K.R. (1998). Integrated catch-at-age analysis, v.1.4. Aberdeen, Marine Laboratory.

Darby C.D. and Flatman S. (1994). Virtual Population Analysis: version 3.1 (Windows/Dos) user guide. Information Technology Series, MAFF Directorate of Fisheries Research, Lowestoft, 1: 85 pp.

Ragonese, S., Bianchini, L., Di Stefano, L., Bertolino, F. and Campagnuolo, S. (1994) Study of the selectivity and assessment of the coefficient of retention of the trawl nets used for red shrimp fishing in the Sicilian Channel (Central Mediterranean Sea). European Community – DG XIV, Project: MED92/010. Final Report: 89 pp + annexes.

Anderson, J. and Guillén, J. (2009). The 2009 Annual Economic Report on the European fishing fleet. JRC Scientific and Technical Reports, EC.

Lleonart, J., F. Maynou, L. Recasens and Franquesa R. (2003). A bioeconomic model for Mediterranean Fisheries, the hake off Catalonia (Western Mediterranean) as a case study. Scientia Marina 67 (suppl. 1): 337-351. In: Fisheries stock assessments and predictions: Integrating relevant knowledge, Ø. Ulltang, G. Blom [eds.]

Maynou, F., F. Sardà, S. Tudela and Demestre M. (2006). Management strategies for red shrimp (*Aristeus antennatus*) fisheries in the Catalan sea (NW) Mediterranean based on bioeconomic simulation analysis. Aquatic Living Resources, 19(2): 161-171.

## 8. APPENDIX 1. SGMED OVERALL TERMS OF REFERENCE

The European Community is expected to establish long-term management plans (LTMP) for relevant Mediterranean demersal and small pelagic fisheries based on precautionary approach and adaptive management in taking measures designed to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimise the impact of fishing activities on marine eco-systems.

The plans shall include conservation reference points such as targets against which measuring the recovery to or the maintenance of stocks within safe biological limits for fisheries exploiting stocks at/or within safe biological limits (e.g. population size and/or long-term yields and/or fishing mortality rate and/or stability of catches). The management plans shall be drawn up on the basis of the precautionary approach to fisheries management and take account of limit reference points as identified by scientists. The quantitative scientific assessment should provide sufficiently precise and accurate biological and economic indicators and reference points to allow also for an adaptive management of fisheries.

Stating clearly how stocks and fisheries will be assessed and how decision will be taken is fundamental for proper and effective implementation of management plans as well as for transparency and consultations with stakeholders.

Demersal and small pelagic stocks and fisheries in the Mediterranean are evaluated both at national and GFCM level; however these evaluations are often not recurring, are spatially restricted to only some GFCM geographical sub-areas (see attached reference map), covering only partially the overall spatial range where Community fishing fleets and stocks are distributed, and address only few stocks out of several that may be exploited in the same fisheries. Limited attention is also given to technical interactions between different fishing gears exploiting the same stocks.

A limited, although fundamental, scientific contribution of EU fishery scientists to the GFCM assessment process is increasingly affecting the capacity of this regional fisheries management organization to identify harvesting strategies and control rules and to adopt precautionary and adaptive fisheries management measures based on scientific advice.

Anyhow, GFCM and most of the riparian countries consider that management measures to control the exploitation rate and fishing effort, complemented by technical measures, are the most adequate approach for multi-species and multiple-gears Mediterranean fisheries.

Nevertheless, provided that scientific advice underlines to do so, also output measures may be conceivable to manage fisheries particularly for both small pelagic and benthic fish stocks.

Coherence and certain level of harmonization between Community and multilateral framework measures are advisable for effective conservation measures and to enhance responsible management supported by all concerned Parties and stakeholders in the Mediterranean.

STECF can play an important role in focusing greater contributions of European scientists towards stocks and fisheries assessment, in identifying a common scientific framework regarding specific analyses to advise on Community plans and to be then channeled into or completed by the GFCM working groups[1].

STECF was requested at its November plenary session to set up an operational work-programme for 2008, beginning in the 1st quarter of 2008, with a view to update the status of the main demersal stocks and evaluate the exploitation levels with respect to their biological and economic production potentials and the sustainability of the stock by using both trawl surveys and commercial catch/landing data as collected through the Community Data Collection regulation N° 1543/2000 as well as other scientific information collected at national level.

---

[1] STECF is requested to take into account the GFCM stock assessment forms as available at the web site http://www.gfcm.org/fishery/nems/36406/en

Within this work-programme STECF is also requested to provide its advice on the status of the main small pelagic stocks and to evaluate the exploitation levels with respect to their biological and economic production potentials and the sustainability of the stock by using both echo and/or DEPM surveys and commercial catch/landing data as collected through the Community Data Collection regulation N° 1543/2000 as well as other scientific information collected at national level.

STECF should take into consideration the data that Member States have been collecting on a regular basis both via monitoring fishing activities and carrying out direct surveys[2]. STECF, in replying at the following terms of reference, should also take into consideration chapter 7 of the 26th STECF Plenary session of 5-9 November 2007[3], as well as the report of the STECF working group on balance between fishing capacity and fishing opportunities[4].

STECF shall contribute to identify and setup an advisory framework regarding low risk adaptive management by identifying and using appropriate risk assessment methods in order to understand where we stand with respect to sustainable exploitation of ecologically and economically important stocks and what additional management actions need to be taken.

On the basis of the STECF advice the Commission will launch official data calls to EU Member States requesting submission of data collected under the Community Data Collection regulation N° 1543/2000.

STECF is requested in particular:

- to advice whether the data availability may allow the development of a precautionary conceptual framework within which develop specific harvesting strategies and decision control rules for an adaptive management of demersal and small pelagic fisheries in the Mediterranean;

- to set up a conceptual, methodological and operational assessment framework which will allow STECF to carry out in a standardized way both stocks assessment analyses and detailed reviews of assessments done by other scientific bodies in the Mediterranean. The selected assessment methods shall allow estimating indicators for measuring the current status of demersal and small pelagic fisheries and stocks, the sustainability of the exploitation and to measure progress towards higher fishing productivity (MSY or other proxy) with respect to precautionary technical/biological reference points relating to MSY or other yield-based reference points, to low risk of stock collapse and to maintaining the reproductive capacity of the stocks;

- to set up a conceptual, methodological and operational assessment framework which will allow STECF to identify economic indicators and reference points compatible with economic profitability of the main fisheries while ensuring sustainable exploitation of the stocks in the Mediterranean;

- to indicate whether age/length-based VPA or statistical catch-at –age/length methods are adequate modelling tools to estimate precautionary indicators and reference points measuring the current status and future development of multispecies/multigears Mediterranean fisheries. STECF shall also provide a conceptual and operational framework to use, if advisable, these methods for demersal and small pelagic Mediterranean fisheries;

- to identify adequate empirical modelling approaches that are adequate to estimate precautionary indicators and reference points measuring the current status and future development of multispecies/multigears Mediterranean fisheries. STECF shall also provide a conceptual and operational framework to use, if advisable, these methods for demersal and small pelagic Mediterranean fisheries;

---

[2] Council Regulation (EC) No **1343/2007** of 13 November 2007 amending Regulation (EC) No 1543/2000 establishing a Community framework for the collection and management of the data needed to conduct the common fisheries policy

Commission Regulation (EC) No **1581/2004** of 27 August 2004 amending Regulation (EC) No 1639/2001 establishing the minimum and extended Community programmes for the collection of data in the fisheries sector and laying down detailed rules for the application of Council Regulation (EC) No 1543/2000

[3] http://stecf.jrc.ec.europa.eu/38

[4] Report of the STECF Working Group on The Balance between Capacity and Exploitation SGRST-SGECA-07-05 Working group convened in the margin of SGECA-SGRST-SGECA-07-02 (Review of Scientific advice II), 22-26th Oct 2007. Evaluated and endorsed at the November plenary session.

- to identify the decision-making support modelling tools that are adequate for the Mediterranean fisheries and that will produce outputs that support sustainable use of fishery resources recognizing the need for a precautionary framework in the face of uncertainty and that may allow to provide projections of alternative scenarios for short-medium and long term management guidance;

- to provide either a qualitative or quantitative understanding of the level of precision and accuracy attached to the estimation of indicators and reference points through the different modelling tools;

- to identify which decision-making support modelling tools may help in setting up stock-size dependent harvesting strategies and respective decision control rules;

- to provide information on the data and standardised format needed for each of the decision-making support modelling tool which will be used to launch official data calls under the DCR n° 1543/2000. STECF should also indicate criteria to ensure quality cross- checks of the data received upon the calls.

# 9. APPENDIX 2. SGMED-09-03 PARTICIPANTS LIST

| Name | Address | Telephone no. | Email |
|---|---|---|---|
| **STECF members** | | | |
| Abella, J. Alvaro | Agenzia Regionale Protezione Ambiente della Toscana<br>Via Marradi 114<br>57126, Livorno<br>Italy | Tel. +390586263456<br>Fax+390586263477 | a.abella@arpat.toscana.it |
| Cardinale Massimiliano | IMR<br>Föreningsgatan 28<br>45 330 Lysekil<br>Sweden | Tel.+46730342209 | massimiliano.cardinale@fiskeriverket.se |
| Di Natale Antonio | AQUASTUDIO Research Institute<br>Via Trapani, 6<br>98121, Messina<br>Italy | Tel. +39090 346408<br>Fax +30090 364560 | adinatale@acquariodigenova.it |
| Martin Paloma | CSIC Instituto de Ciencias del Mar<br>Passeig Maritim 37-49<br>08003, Barcelona<br>Spain | Tel. +3493 2309552<br>Fax+3493 2309555 | paloma@icm.csic.es |

| Name | Address | Telephone no. | Email |
|---|---|---|---|
| **Invited experts** | | | |
| Colloca Francesco | University of Rome "la Sapienza"<br>V.le dell'Università, 32<br>00185, Rome<br>Italy | Tel.+39 649914763<br>Fax+39 064958259 | francesco.colloca@uniroma1.it |
| Giannoulaki Marianna | Hellenic Centre for Marine Research<br>Former American Base,<br>Gournes PO BOX 2214<br>GR71003, Iraklion<br>Greece | Tel.+302810337831<br>Fax+302810337822 | marianna@her.hcmr.gr |
| Guijarro Beatriz | Instituto Español de Oceanografia<br>Moll de Ponent s/n POBox 291<br>7080 Palma<br>Spain | Tel.+ 34971133739<br>Fax+ 34971404945 | beatriz@ba.ieo.es |

| Name | Address | Telephone no. | Email |
|---|---|---|---|
| **Invited experts** | | | |
| Jenko Klavdija | University of Massachusetts Dartmouth, School of Marine Science and Technology,<br>200 Mill Rd,<br>Suite 325,<br>Fairhaven, MA | Tel.+1 508 9106393<br>Fax+1 508 9106396 | kjenko@umassd.edu |
| Knittweis Leyla | Malta Centre for Fisheries Science<br>Fort San Lucjan<br>BBG 1283<br>Marsaxlokk<br>Malta | Tel. +35622293312<br>Fax +35621659380 | leyla.knittweis@gov.mt |
| Lloret Josep | University of Girona<br>Faculty of Sciences, Campus Montilivi<br>E-17071 Girona<br>Spain | Tel. + 34679322265<br>Fax +34 972418150 | josep.lloret@udg.edu |
| Maynou Francesc | Institut de Ciències del Mar CSIC<br>Psg Marítim de la Barceloneta 37-49<br>8003, Barcelona<br>Spain | Tel. +34932309500<br>Fax +34932309500 | maynouf@icm.csic.es |
| Murenu Matteo | University of Cagliari (DBAE)<br>Viale Poetto,1<br>09126, Cagliari<br>Italy | Tel.+390706758017<br>Fax +390706758022 | mmurenu@unica.it |
| Osio Giacomo Chato | University of New Hampshire<br>39 College Rd<br>3824, Durham<br>United States | Tel. +<br>Fax + | c.osio@unh.edu |
| Patti Bernardo | IAMC-CNR<br>via L.Vaccara, 61<br>91026, Mazara del Vallo<br>Italy | Tel. +390923948966<br>Fax +390923906634 | bernardo.patti@cnr.it |
| Pilling Graham | Cefas<br>Pakefield Rd<br>NR33 0HT<br>Lowestoft<br>United Kingdom | Tel. +44 1502 527730<br>Fax + | graham.pilling@cefas.co.uk |
| Scarcella Giuseppe | National Research Council (CNR)<br>L.go Fiera della Pesca<br>60100 Ancona<br>Italy | Tel.+ 390712078846<br>Fax+3907155313 | g.scarcella@ismar.cnr.it |

| Name | Address | Telephone no. | Email |
|---|---|---|---|
| **Invited experts** | | | |
| Scott Finlay | Cefas<br>Pakefield Rd<br>NR33 0HT<br>Lowestoft<br>United Kingdom | Tel. +44 (0)1502562244<br>Fax+ | finlay.scott@cefas.co.uk |
| Spedicato Maria Teresa | COISPA<br>via Dei Trulli 18<br>70126, Bari<br>Italy | Tel.+390805433596<br>Fax+390805433586 | spedicato@coispa.it |
| Ticina Vjekoslav | Institute of Oceanography and Fisheries<br>Set. I. Mestrovica 63<br>21000, Split<br>Croatia | Tel. + 38521408000<br>Fax+ 38521358650 | ticina@izor.hr |

| Name | Address | Telephone no. | Email |
|---|---|---|---|
| **JRC Experts** | | | |
| Cheilari Anna | Joint Research Centre (IPSC)<br>Maritime Affairs Unit<br>Via E. Fermi, 2749<br>21027 Ispra (Varese)<br>Italy | Tel.+390332783034<br>Fax+390332789658 | anna.cheilari@jrc.ec.europa.eu |
| Guillen Garcia Jordi | Joint Research Centre (IPSC)<br>Maritime Affairs Unit<br>Via E. Fermi, 2749<br>21027 Ispra (Varese)<br>Italy | Tel.+390332785383<br>Fax+390332789658 | jordi.guillen@jrc.ec.europa.eu |
| Rätz Hans-Joachim | Joint Research Centre (IPSC)<br>Maritime Affairs Unit<br>Via E. Fermi, 2749<br>21027 Ispra (Varese)<br>Italy | Tel.+390332786073<br>Fax+390332789658 | hans-joachim.raetz@jrc.ec.europa.eu |

| Name | Address | Telephone no. | Email |
|---|---|---|---|
| **European Commission** | | | |
| Biagi Franco | DG Maritime Affairs and Fisheries<br>Mediterranean & Black Sea Directorate, Unit D.2.<br>Rue Joseph II, 99<br>J-99 02/055<br>1042 Bruxelles<br>Belgium | Tel.+3222994104 | franco.biagi@ec.europa.eu |
| **STECF Secretariat** | | | |

| Name | Address | Telephone no. | Email |
|---|---|---|---|
| Rätz Hans-Joachim | Joint Research Centre (IPSC) | Tel.+390332786073<br>Fax+390332789658 | hans-joachim.raetz@jrc.ec.europa.eu |
| Cheilari Anna | Joint Research Centre (IPSC) | Tel.+390332783034<br>Fax+390332789658 | anna.cheilari@jrc.ec.europa.eu |

## 10. APPENDIX 3. FLEET SEGMENTATION IN THE MEDITERRANEAN SEA
(copied from SGMED-08-01 report).

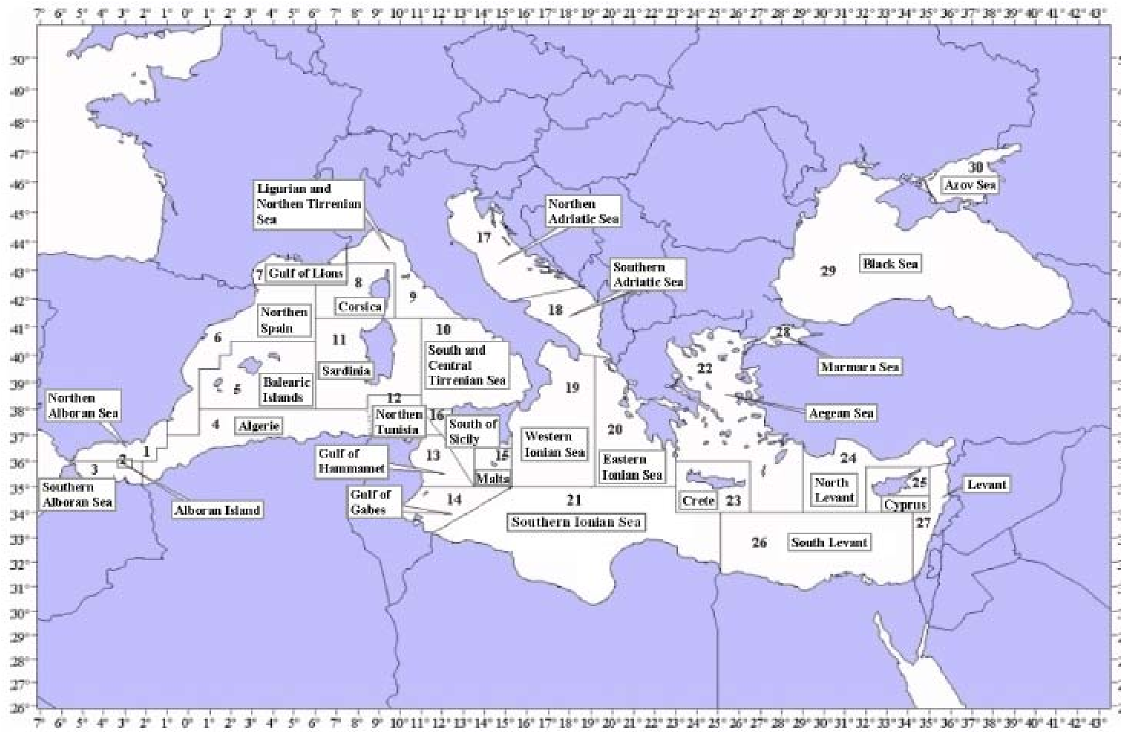
| Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 | LOA classes | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Activity | Gear classes | Gear groups | Gear type | Target assemblage | Mesh size and other selective devices | < 6 | 6-12 | 12-18 | 18-24 | 24-40 | > 40 |
| Fishing activity | Dredges | Dredges | Boat dredge [DRB] | Molluscs | (a) | | | | | | |
| | Trawls | Bottom trawls | Bottom otter trawl [OTB] | Demersal species | (a) | | | | | | |
| | | | | Deep water species (b) | (a) | | | | | | |
| | | | | Mixed demersal species and deep water species (b) | (a) | | | | | | |
| | | | Multi-rig otter trawl [OTT] | Demersal species | (a) | | | | | | |
| | | | Bottom pair trawl [PTB] | Demersal species | (a) | | | | | | |
| | | | Beam trawl [TBB] | Demersal species | (a) | | | | | | |
| | | Pelagic trawls | Midwater otter trawl [OTM] | Mixed demersal and pelagic species | (a) | | | | | | |
| | | | Pelagic pair trawl [PTM] | Small pelagic fish | (a) | | | | | | |
| | Hooks and Lines | Rods and Lines | Hand and Pole lines [LHP] [LHM] | Finfish | (a) | | | | | | |
| | | | | Cephalopods | (a) | | | | | | |
| | | | Trolling lines [LTL] | Large pelagic fish | (a) | | | | | | |
| | | Longlines | Drifting longlines [LLD] | Large pelagic fish | (a) | | | | | | |
| | | | Set longlines [LLS] | Demersal fish | (a) | | | | | | |
| | Traps | Traps | Pots and Traps [FPO] | Demersal species | (a) | | | | | | |
| | | | Fyke nets [FYK] | Catadromous species | (a) | | | | | | |
| | | | | Demersal species | (a) | | | | | | |
| | | | Stationary uncovered pound nets [FPN] | Large pelagic fish | (a) | | | | | | |
| | Nets | Nets | Trammel net [GTR] | Demersal species | (a) | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Set gillnet [GNS] | Small and large pelagic fish | (a) | | | | | | |
| | | | | Demersal species | (a) | | | | | | |
| | | | Driftnet [GND] | Small pelagic fish | (a) | | | | | | |
| | | | | Demersal fish | (a) | | | | | | |
| | Seines | Surrounding nets | Purse seine [PS] | Small pelagic fish | (a) | | | | | | |
| | | | | Large pelagic fish | (a) | | | | | | |
| | | | Lampara nets [LA] | Small and large pelagic fish | (a) | | | | | | |
| | | Seines | Fly shooting seine [SSC] | Demersal species | (a) | | | | | | |
| | | | Anchored seine [SDN] | Demersal species | (a) | | | | | | |
| | | | Pair seine [SPR] | Demersal species | (a) | | | | | | |
| | | | Beach and boat seine [SB] [SV] | Demersal species | (a) | | | | | | |
| | Other gear | Other gear | Glass eel fishing | Glass eel | (a) | | | | | | |
| | Misc. (Specify) | Misc. (Specify) | | | (a) | | | | | | |
| Other activity than fishing | | | | Other activity than fishing | | | | | | | |
| Inactive | | | | Inactive | | | | | | | |
| Recreational fisheries (non registered vessels or no vessels) | | | | To be specified | Not applicable | All vessel classes (if any) combined | | | | | |

(a) Not spelled out in DCR but defined with reference to relevant EU Regulation(s)

(b) Refering only to red shrimps *Aristaeomorpha foliacea* and *Aristeus antennatus*, species not included in the definition of deep sea species given by Council Regulation (EC) 2347/2002.

## 11. APPENDIX 4. GFCM GSAs



## 12. APPENDIX 5. METHODS USED TO PERFORM SHORT TERM AND MEDIUM TERM PREDICTIONS

### 1. FLR scripts for the short and medium term forecast

Three scripts were developed to enable SGMED projections to be performed in the FLR framework:

- script 1 (“load_stock_example.r” and “load_stock_VIT output example.r”) loads the stock assessment results and input file time series (e.g. XSA) or single year input (e.g. VIT) necessary for the projection method as an ‘FLStock’, one of the basic structures used by the FLR framework.

- script 2 (“project_example_cod_Fscenarios with plot.r” and “project_VIT output example_Fscenarios with plot.r”) takes the resulting FLStock, and with user input to set the necessary parameters, performs a short term (3 year) projection of the stock under alternative future scenarios of fishing mortality, from zero to twice the $F_{status\ quo}$ level, as well as at the $F_{0.1}$ or other established reference level. A table is automatically produced displaying key outputs of interest to managers for each future scenario run.

- Script 3 (“medium_term_forecast_v2.r”) takes the FLStock resulting from script 1 and performs a medium term projection. The basic assumption for this projection was to reach $F_{0.1}$ or other established reference level by either 2015 or 2020, assuming a proportional annual decrease in F from $F_{current}$ to $F_{0.1}$ or other established reference level over that period. Future recruitment was modelled as the geometric mean of historical recruitments, with inter-annual variability modelled as a lognormal CV at a level set by the user.

The scripts will be made available on the STECF events homepage under the SGMED 09-03 site for the purpose of documentation and dissemination.

### 2. EXCEL and VISUAL BASIC short and medium term forecast

An EXCEL workbook to perform short term forecasts was made available by JRC-IPSC FishReg (H.-J. Rätz). Inputs can be edited by hand, and the results are formatted as a standard management option table. The only changes to be done by the user are the cell ranges to correctly estimate the mean fishing mortality (Freference) in all three prediction years (intermediate year, year to be regulated and the year following that year).

An EXCEL workbook to perform medium term forecasts (management strategy or harvest control rule evaluation) was made available by JRC-IPSC FishReg (H.-J. Rätz). Inputs can be edited by hand, which will be used by a VISUAL BASIC code to compute and illustrate the results. This allows random variation of the input parameters as well as bias to account for retrospective assessment bias (over- or underestimations) as well as assumed implementation errors.

## 13. Appendix 6. Stock specific Outlooks and parameters used in the Bio-Economic Modelling

### Short-term implications

**ANNEX 1**

*Merluccius merluccius* GSA06

*Outlook for 2010*

Basis:
F(2009) = 1.39, mean vector of F estimated for 2008 by VPA (SGMED-09-02)
R(2009) = GM(2006–2008) = 223 millions
Landings (2009) = 2809 t
Discards (2009) = 0
SSB (2009) = 429 t

| Rationale | Landings 2010 | Basis | F total (2010) | Catch (2010) | SSB (2011) | % SSB change | % Landings change |
|---|---|---|---|---|---|---|---|
| Status quo | 1099 | $F_{sq} \cdot 0.25$ | 0.34 | 1099 | 2792 | 308% | -60% |
| | 1908 | $F_{sq} \cdot 0.50$ | 0.69 | 1908 | 1497 | 156% | -32% |
| | 2382 | $F_{sq} \cdot 0.75$ | 1.04 | 2382 | 779 | 58% | -15% |
| | 2611 | $F_{sq} \cdot 0.90$ | 1.25 | 2611 | 537 | 19% | -7% |
| | 2839 | $F_{sq}$ | 1.39 | 2839 | 434 | 0.3% | 1% |
| | 3095 | $F_{sq} \cdot 1.25$ | 1.74 | 3095 | 220 | -39% | 10% |
| | 3114 | $F_{sq} \cdot 1.50$ | 1.80 | 3114 | 177 | -51% | 11% |

Weights in t.
1) SSB 2011 relative to SSB in 2010
2) Landings 2010 relative to landings in 2009.

**Short-term implications**

**ANNEX 2**

*Aristeus antennatus* GSA06

*Outlook for 2010*

Basis:
F(2009) = 1.31, mean vector of F estimated for 2008 by VPA (SGMED-09-02)
R(2009) = GM(2006–2008) = 91 millions
Landings (2009) = 551 t
Discards (2009) = 0
SSB (2009) = 231.23 t

| **Rationale** | **Landings 2010** | **Basis** | **F total (2010)** | **Catch (2010)** | **SSB (2011)** | **% SSB change** | **% Landings change** |
|---|---|---|---|---|---|---|---|
| Status quo | 238 | $F_{sq} \cdot 0.25$ | 0.32 | 238 | 837 | 114% | -56% |
| | 385 | $F_{sq} \cdot 0.50$ | 0.65 | 384 | 509 | 59% | -30% |
| | 494 | $F_{sq} \cdot 0.75$ | 0.98 | 493 | 335 | 22% | -10% |
| | 530 | $F_{sq} \cdot 0.90$ | 1.18 | 530 | 266 | 8% | -3% |
| | 567 | $F_{sq}$ | 1.31 | 566 | 233 | -1% | 2% |
| | 592 | $F_{sq} \cdot 1.25$ | 1.64 | 592 | 161 | -16% | 7% |
| | 603 | $F_{sq} \cdot 1.50$ | 1.71 | 603 | 130 | -33% | 9% |

Weights in t.
1) SSB 2011 relative to SSB in 2010
2) Landings 2010 relative to Landings in 2009.

**Short-term implications**

## ANNEX 3

*Parapenaeus longirostris* GSA06

*Outlook for 2010*

Basis:
F(2009) = 0.40, mean vector of F estimated for 2008 by VPA (SGMED-09-02)
R(2009) = GM(2006–2008) = 154 millions.
Landings (2009) = 46 t
Discards (2009) = 0
SSB (2009) = 64 t

| **Rationale** | **Landings 2010** | **Basis** | **F total (2010)** | **Catch (2010)** | **SSB (2011)** | **% SSB change** | **% Landings change** |
|---|---|---|---|---|---|---|---|
| Status quo | 12.91 | $F_{sq}$·0.25 | 0.10 | 12 | 82 | 15% | -71% |
| | 24.74 | $F_{sq}$·0.50 | 0.20 | 24 | 75 | 9% | -45% |
| | 35.84 | $F_{sq}$·0.75 | 0.30 | 35 | 70 | 5% | -21% |
| | 41.70 | $F_{sq}$·0.90 | 0.36 | 41 | 66 | 2% | -8% |
| | 45.93 | $F_{sq}$ | 0.40 | 45 | 65 | 1% | 1% |
| | 56.62 | $F_{sq}$·1.25 | 0.52 | 56 | 58 | -5% | 23% |
| | 56.72 | $F_{sq}$·1.50 | 0.68 | 56 | 55 | -9% | 24% |

Weights in t.
[1)] SSB 2011 relative to SSB in 2010
[2)] Landings 2010 relative to landings in 2009.

**Short-term implications**

**ANNEX 4**

Trawl fleet GSA06

*Outlook for 2010*

Basis:
Profits (2009): -557,765 €
RoI (2009): -0.12%

| Rationale | Basis | Profits € (2010) | RoI (2010) | Profits change | RoI change |
|---|---|---|---|---|---|
| **Status quo** | $F_{sq}$·0.25 | -755,786 | -0.17 | -35% | -35% |
| | $F_{sq}$·0.50 | -662,494 | -0.15 | -18% | -18% |
| | $F_{sq}$·0.75 | -605,677 | -0.13 | -8% | -8% |
| | $F_{sq}$·0.90 | -579,621 | -0.13 | -3% | -3% |
| | $F_{sq}$ | -553,695 | -0.12 | 1% | 1% |
| | $F_{sq}$·1.25 | -525,613 | -0.12 | 5% | 5% |
| | $F_{sq}$·1.50 | -522,792 | -0.11 | 6% | 6% |

**Short-term implications**

**ANNEX 5**

*Merluccius merluccius* GSA07

*Outlook for 2010*

Basis:
F(2008): 0.28
R(2008): 56 millions
Landings (2008): 2297 t
Discards(2008): 0
SSB(2008): 3612 t

| Rationale | Landings 2010 | Basis | F total (2010) | Catch (2010) | SSB (2011) | %SSB change | %Landings change |
|---|---|---|---|---|---|---|---|
| **Status quo** | 1461.15 | $F_{sq} \cdot 0.25$ | 0.07 | 1461 | 18809 | 420% | -36% |
| | 2793.67 | $F_{sq} \cdot 0.50$ | 0.14 | 2793 | 16889 | 367% | 21% |
| | 4012.19 | $F_{sq} \cdot 0.75$ | 0.21 | 4012 | 15196 | 320% | 74% |
| | 4588.97 | $F_{sq} \cdot 0.90$ | 0.25 | 4588 | 14163 | 292% | 99% |
| | 5056.34 | $F_{sq}$ | 0.28 | 5056 | 13656 | 278% | 120% |
| | 6415.90 | $F_{sq} \cdot 1.25$ | 0.37 | 6415 | 12143 | 236% | 179% |
| | 6359.68 | $F_{sq} \cdot 1.50$ | 0.50 | 6359 | 11555 | 219% | 176% |

Weights in t.
1) SSB 2011 relative to SSB in 2008
2) Landings 2010 relative to Landings in 2008.

**Short-term implications**

**ANNEX 6**

*Mullus barbatus* GSA07

*Outlook for 2010*

Basis:
F(2008): 0.43
R(2008): 13 millions
Landings(2008): 153 t
Discards(2008): 0
SSB(2008): 183 t

| Rationale | Landings 2010 | Basis | F total (2010) | Catch (2010) | SSB (2011) | % SSB change | % Landings change |
|---|---|---|---|---|---|---|---|
| **Status quo** | 49.11 | $F_{sq}$·0.25 | 0.11 | 49 | 338 | 84% | -67% |
| | 90.61 | $F_{sq}$·0.50 | 0.22 | 90 | 273 | 49% | -40% |
| | 121.94 | $F_{sq}$·0.75 | 0.33 | 121 | 218 | 19% | -20% |
| | 142.79 | $F_{sq}$·0.90 | 0.39 | 142 | 198 | 8% | -6% |
| | 151.94 | $F_{sq}$ | 0.43 | 151 | 181 | -1% | -1% |
| | 185.26 | $F_{sq}$·1.25 | 0.58 | 185 | 145 | -20% | 21% |
| | 185.32 | $F_{sq}$·1.50 | 0.65 | 185 | 130 | -28% | 21% |

Weights in t.

1) SSB 2011 relative to SSB in 2008

2) Landings 2010 relative to Landings in 2008.

**Short-term implications**

**ANNEX 7**

Trawl fleet GSA07

*Outlook for 2010*

Basis:
Profits (2009): 1,079,457 €
RoI (2009): 2.46%

| Rationale | Basis | Profits € (2010) | RoI (2010) | Profits change | RoI change |
|---|---|---|---|---|---|
| **Status quo** | $F_{sq} \cdot 0.25$ | 222,177 | 0.51% | -79% | -79% |
| | $F_{sq} \cdot 0.50$ | 537,767 | 1.23% | -50% | -50% |
| | $F_{sq} \cdot 0.75$ | 826,251 | 1.89% | -23% | -23% |
| | $F_{sq} \cdot 0.90$ | 962,900 | 2.20% | -10% | -10% |
| | $F_{sq}$ | 1,073,502 | 2.45% | -1% | -1% |
| | $F_{sq} \cdot 1.25$ | 1,395,352 | 3.18% | 29% | 29% |
| | $F_{sq} \cdot 1.50$ | 1,382,064 | 3.15% | 28% | 28% |

## 14. ANNEX-EXPERT DECLARATIONS

Declarations of invited experts are published on the STECF web site on https://stecf.jrc.ec.europa.eu/home together with the final report.

European Commission

**EUR** 24372 EN **– Joint Research Centre – Institute for the Protection and Security of the Citizen**
Title: Scientific, Technical and Economic Committee for Fisheries. Report of the SGMED-09-03 Working Group on the Mediterranean Part II.
Author(s): Cardinale M., Abella A., Colloca F., Di Natale A., Giannoulaki M., Guijarro B., Jenko K., Knittweis L., Lloret J., Martin P., Maynou F., Murenu M., Osio G.C., Patti B., Pilling, G., Scarcella G., Scott F., Spedicato M.T., Ticina V., Rätz H.-J., Guillen J., Cheilari A.
Luxembourg: Office for Official Publications of the European Communities
2010 – 137 pp. – 21 x 29.7 cm
EUR – Scientific and Technical Research series – ISSN 1018-5593
ISBN 978-92-79-15798-1
DOI 10.2788/9336

**Abstract**

SGMED-09-03 meeting was held on 14-18 December 2009 in Barza d' Ispra (Italy). The report provides specific stock (by species and GSAs) predictions of stock size, fishing mortality and catches in short term (2009-2011) and medium term (2009-2018) under different management scenarios, for the main demersal and small pelagic Mediterranean stocks. STECF reviewed the report during its Plenary meeting on 26-30 April 2010 in Norwich.

**How to obtain EU publications**

Our priced publications are available from EU Bookshop (http://bookshop.europa.eu), where you can place an order with the sales agent of your choice.

The Publications Office has a worldwide network of sales agents. You can obtain their contact details by sending a fax to (352) 29 29-42758.

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

EUROPEAN COMMISSION

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.

LB-NA-24372-EN-N



Publications Office
Publications.eu.int

ISBN 978-92-79-15798-1
9 789279 157981