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Scientific, Technical and Economic Committee for Fisheries (STECF)

Report of the SGMED-09-02 Working Group on the Mediterranean Part I

8-12 JUNE 2009, Villasimius, Sardinia, ITALY

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SCIENTIFIC, TECHNICAL AND ECONOMIC

COMMITTEE FOR FISHERIES (STECF)

STECF COMMENTS ON THE REPORT OF THE SGMED-09-02 WORKING GROUP ON THE MEDITERRANEAN PART I Villasimius, Sardinia, Italy, 8-12th June 2009

STECF UNDERTOOK THE REVIEW DURING THE PLENARY MEETING

HELD IN BRUSSEL 9-13 NOVEMBER 2009

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, and the present report of SGMED-09-02 part I on the historic assessments and management advice regarding historic status of Mediterranean stocks. During the forthcoming meeting SGMED-09-03 will be dealing mainly with short and medium term forecasts of stock size and landings of Mediterranean stocks under different management options.

2. Terms of reference

Terms of reference for the STECF/SGMED-09-02 meeting (8-12/6/2009) were defined as follows:

a) Update and assess the status and trends of the stocks by all relevant GSAs, or, if the case, by bigger areas merging adjacent GSAs, in the Mediterranean Sea, taking into account the recommendations of the SGMED workshop in March and the following STECF comments. Advise on the status of the exploited stocks of the species listed below, with respect to high yields harvesting strategies and to maintain their reproductive capacity and ensure a low risk.

- Sardine (*Sardina pilchardus*)
- Anchovy (*Engraulis encrasicolus*)
- European hake (*Merluccius merluccius*)
- Red mullet (*Mullus barbatus*)
- Deep-water rose shrimp (*Parapenaeus longirostris*)

- Other species out of the list given to STECF and recalled both under point i) of the ToRs for SGMED 09 03 and in tables 1 and 2 of the data call

b) Assess the status and trends of the stocks by all relevant GSAs, or, if the case, by bigger areas merging adjacent GSAs, in the Mediterranean Sea. Advise on the status of the following exploited stocks of the species listed below, with respect to high yields harvesting strategies and to maintain their reproductive capacity and ensure a low risk.

- Red shrimp (*Aristeus antennatus*)
- Giant red shrimp (*Aristaeomorpha foliacea*)
- Norway lobster (*Nephrops norvegicus*)
- Other species out of the list given to STECF and recalled both under point i) of the ToRs for SGMED 09 03 and in tables 1 and 2 of the data call

c) Review and propose biological reference points related to high yields and low risk of fishery collapse in long term of each of the stocks assessed.

SPECIFIC QUESTIONS UNDER POINT C)

- advice whether 300 tonnes for deep water rose shrimp and 2200 tonnes for hake may be considered as adequate minimum biological acceptable level (MBAL= Blim) in GSA 6 or in any other more appropriate spatial aggregation of adjacent GSAs; otherwise advice on which values could be used to this end.

- advice whether 1200 tonnes for deep water rose shrimp and 4000 tonnes for hake, which correspond to the long-term average over the last 8 and 16 years respectively, may be considered as precautionary biomass reference point (=Bpa) in GSA 6 or in any other more appropriate GSA spatial aggregation of adjacent GSAs; otherwise advice on which values could be used to this end.

- advice whether $F \leq 0.2$ per year on appropriate age groups can be considered as an adequate Fpa both for hake and deep water rose shrimp in GSA 6 or in any other more appropriate GSA spatial aggregation of adjacent GSAs.

- advice whether the exploitation rate $E \leq 0.4$ per year on appropriate age groups is an adequate precautionary reference point both for anchovy and sardine stocks in all GSAs; otherwise advice on likely value to be used to this end.

- advice whether 50000 tonnes may be considered as adequate minimum biological acceptable levels (MBAL= Blim) both for anchovy and sardine stocks in GSA 17; otherwise advice on which values could be used to this end.

- advice whether 300000 tonnes for sardine and 80000 tonnes for anchovy may be considered as precautionary biomass reference point (=Bpa) in GSA 17; otherwise advice on which values could be used to this end.

d) Update and assess historic and recent trends (capacity, technological creep, nominal fishing effort) in the major fisheries by GSAs or, if the case, by bigger areas merging adjacent GSAs exploiting the stocks assessed. The trends should be interpreted in light of management regulations applicable to them.

e) Review the applicability and fully document all applied methodologies for the assessments and determination of the proposed biological reference points.

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

g) To review proposed methodologies to standardize the MEDITS and GRUND surveys time series to account for unbalanced sampling designs and appropriate data distributions. Specific work has been initiated in this regard.

h) Investigate the requirements for reorganising the MEDITS database that result from the recommendations of STECF for combining some GSAs for some species.

i) 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, develop specific case studies for Mediterranean fisheries (e.g. anchovy, sardine and Nephrops), and advise 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 (to be continued in SGMED-09-03).

j) With a view to enhance the number of stocks jointly assessed on the spot at the forthcoming GFCM-SAC working groups, either within one or by merging more than one adjacent GFCM-GSAs, identify for each selected assessment methodology the data needs, data format and start data-sets preparatory work.

k) - PROTECTION OF JUVENILES AND SPAWNING AGGREGATIONS:

1) Provide relevant information on spatial and temporal distribution of seasonal or persistent juveniles aggregations and provide scientific elements indicating that possible protection of these areas may allow to control and reduce the overall fishing mortality on the stock and further improve the exploitation pattern with a view to increase the yield.

2) Provide relevant information on fishing gear selectivity (mesh size/shape, twine thickness, hanging ratio, hook size, hook shape, etc.) with a view to further improve the exploitation pattern, reduce the fishing mortality on juveniles and increase the yield.

3) Provide relevant information on spatial and temporal distribution of seasonal or persistent aggregations of spawners and provide scientific elements indicating that possible protection of these areas may reduce the risk of stock collapse and maintain the reproductive capacity of the exploited stocks.

TABLES 1 and 2 of the Data Call

SGMED is requested to provide for each species listed below the following information needed for the different variables of the data calls:

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

TABLE 1: Additional species as included in the data collection regulations and for which Member States are invited to provide relevant data before 24 November 2009.

Species common name	Species scientific name	FAO CODE
1. Bogue	*Boops boops*	BOG
2. Common dolphinfish	*Coryphaena hippurus*	DOL
3. Sea bass	*Dicentrarchus labrax*	BSS
4. Grey gurnard	*Eutrigla gurnardus*	GUG
5. Black-bellied angler	*Lophius budegassa*	ANK
6. Anglerfish	*Lophius piscatorius*	MON
7. Blue whiting	*Micromesistius poutassou*	WHB
8. Grey mullets (Mugilidae)	Mugilidae	MUL
9. Striped red mullet	*Mullus surmuletus*	MUR
10. Common Pandora	*Pagellus erythrinus*	PAC
11. Caramote prawn	*Penaeus kerathurus*	TGS
12. Mackerel	*Scomber* spp.	MAZ
13. Common sole	*Solea solea (=Solea vulgaris*)	SOL
14. Gilthead seabream	*Sparus aurata*	SBG
15. Picarel	*Spicara smaris*	SPC
16. Spottail mantis squillids	*Squilla mantis*	MTS
17. Mediterranean horse mackerel	*Trachurus mediterraneus*	HMM
18. Horse mackerel	*Trachurus trachurus*	HOM
19. Tub gurnard	*Trigla lucerna (=Chelidonichthys lucerna)*	GUU

TABLE 2: Additional species not included in the data collection regulations and for which <u>interested Member States</u> are invited to provide relevant data before 24 November 2009.

Species common name	Species scientific name	FAO CODE
1. Sargo breams	*Diplodus* spp.	SRG
2. Axillary seabream	*Pagellus acarne*	SBA
3. Blackspot seabream	*Pagellus bogaraveo*	SBR
4. Greater forkbeard	*Phycis blennoides*	GFB
5. Poor cod	*Trisopterus minutus*	POD

3. STECF OBSERVATIONS

STECF concludes that overall the SGMED framework has so far represented an excellent forum to support stock assessment and advice within the region and built the foundations upon which assessment work can be successfully undertaken. The meetings in 2008 and 2009 also allowed the standardization of procedures for data collection and analysis within the region. In order to ensure that this is continued, the Working Group suggests that inter-sessional workshops or training courses be pursued to expand the number of scientists fully able to undertake assessments within the Mediterranean region.

STECF notes that the working group SGMED 09-02 was able exhaustively address all TORs. The SGMED 09-02 report deals mainly with the assessment of historic and recent trends in stock parameters (stock size, recruitment and exploitation) and relevant scientific advice. Where applicable, long-term forecasts are provided in order to allow assessments of the stock against proposed management reference points F0.1, Fmax and FMSY. In this context F0.1 was considered as the most reliable proxy of FMSY. For most of the stocks assessed, current exploitation rates are estimated larger or much larger than any level of fishing mortality that is associated with high long-term sustainable targets. STECF endorses such conclusion. STECF notes that deterministic short and medium term forecast of landings and stock size and related management advice will be delivered through the forthcoming SGMED 09-03 meeting in December 2009.

STECF supports SGMED 09-02 reiteration that recovery plans should be developed and established with urgency in order to achieve advised effort reductions and those recovery plans should be enforced until the stocks are proved to be exploited consistently with the sustainable targets. The development of recovery plans needs to consider catches of other species in a mixed fishery context and should be socio-economically evaluated.

STECF endorses the SGMED recommendations regarding its future working procedures. The stocks to be assessed within each working group should be clearly identified by the TORs prior to the meeting, rather than being faced with an open list of potential assessments and with experts facing ad hoc decisions on which stock to assess. Also, the data call should cover the needs to fulfill the TORs rather than having to undertake additional analyses at the meeting. In this context, SGMED considers a reasonable approach would be to attempt no more than 25 stock assessments over the 2-weekly working group meetings scheduled for future years. SGMED considers that a system, whereby each stock is assessed every 2 or 3 years, could represent an achievable working arrangement. This will also allow SGMED to conduct a more careful examination of the quality of input data and dedicate more time to a discussion of the observed trends and provision of advice.

Furthermore, SGMED-09-02 recommends the stock assessments should be continued in 2010 within two meetings. SGMED considers that a maximum of 10-15 selected stocks should be assessed in each meeting, which should also include predictions of catch and biomass under different management scenarios in the short-term for the assessed stocks.

4. STECF COMMENTS AND CONCLUSIONS

ToR a-b: STECF notes that during the meeting, data compilations and assessments of 59 demersal and small pelagic species/GSA combinations were conducted (ToR a-b). The species were anchovy, sardine, European hake, red mullet, deepwater pink shrimp, blue and red shrimp, giant red shrimp, Norway lobster and sole. The assessed stocks covered geographical sub-areas (GSA) from western part of the Mediterranean to Cyprus in the east. Those assessments were supported by a DCR data call as defined during a previous meeting of SGMED (SGMED 09-01; Murcia, 2-6 March 2009) and followed procedures agreed at SGMED 09-01. The layout of the assessments was designed to allow scientists and managers to review in a consistent way the data underlying the assessments outputs and the specific issues encountered during the assessment, and review the assumptions made and the management advice. The report includes summary sheets for stocks of anchovy (3), sardine (3), European hake (4), red mullet (2), pink shrimp (2), blue and red shrimp (1), giant red shrimp (1), Norway lobster (1) and sole (1) for which SGMED-09-02 concluded on definitive assessments and provided advice. STECF endorses the assessments and results obtained by SGMED 09-02.

STECF notes that a total of 13 stocks (out of 18 for which an advice was given) were considered overfished in accordance to the proposed reference points. No particular regional patterns of stock developments and exploitation emerged, while the only stocks that are exploited sustainably are the stocks of sardine, anchovy and pink shrimp. The assessment confirmed the results of the analyses conducted in the previous 2008 meetings of SGMED, showing a general state of overfishing for most of the stocks, especially for hake and red shrimps, with an exception for some of the pelagic stocks.

ToR c: After a general discussion on candidate reference points applied in fisheries management of Mediterranean fish and shellfish stocks, SGMED recommends that high priority should be given to exploitation indicators (fishing mortality) and the appropriate levels to achieve high sustainable long-term yield. Considering data availability and the recent political agreements (UN, 2002) and EU communications (Council Conclusions 2007), SGMED recommends the application of F_{MSY} (maximum sustainable yield), with $F_{0.1}$ derived from Yield per Recruit analysis as the appropriate proxy in cases where data are lacking or there is uncertainty (Kell and Fromentin, 2007). In contrast, state indicators of stock size in terms of biomass are rather difficult to interpret, as decreases in biomass below reference levels such as B_{lim} (biomass of all adult specimens at the level of impaired recruitment) and B_{pa} (precautionary reference of the biomass of all adult specimens including uncertainty) can be due to many ecological effects in addition to fishery impacts. In addition, the shortness of the assessment time series for most of the Mediterranean stocks and the lack of appropriate historical data, impede the establishment of biomass reference points. In the light of the fact that the actual stock size cannot be directly controlled through fisheries management, SGMED recommends stock biomass reference points be given lower priority in the management of Mediterranean fisheries (finfish and shellfish) than exploitation indicators. SGMED further recommends that levels of fishing mortality F_{MSY} or its proxy $F_{0.1}$ should rather be interpreted and applied as management targets than any category boundaries, accounting also for uncertainty. Therefore, SGMED considers that emphasis should been given to exploitation rates rather than level of biomass. STECF agrees with SGMED 09-02.

STECF endorses the SGMED recommendations regarding fisheries management reference points for European hake in GSA 6. STECF **recommends** that F=0.16 ($F_{0.1}$) be adopted as the reference point for fishery management. SGMED is not in the position to estimate or propose adequate limit (B_{lim}) or precautionary (B_{pa}) biomass reference points given the data available due to the shortage of the time series and the limited stock dynamics it covers. The time series indicates that the stock has always been below the proposed B_{lim}=2,200t and B_{pa}=4,000t. SGMED notes that the recent stock size is estimated at a much lower level and thus recommends as an interim measure, the proposed biomass reference points of B_{lim} and B_{pa} be adopted as biomass reference points. Those values may be revised in future when more information becomes available.

STECF endorses the SGMED recommendations regarding fisheries management reference points for pink shrimp in GSA 6. SGMED is not in the position to estimate and propose appropriate management targets of fishing mortality or biomass reference points due to the shortage of the time series and the extreme stock dynamics it covers. SGMED notes that the proposed $F \leq 0.2$ is much lower than the current exploitation of $F = 0.5$ for ages 2-5. In the light of the management advice of SGMED to reduce F in order to allow the stock to rebuild, SGMED recommends that as an interim measure $F \leq 0.2$ be adopted as the reference point for fishery management. This value might be revised in the future when more information becomes available. After a continuous decline in spawning stock biomass, the 2008 SSB is estimated to amount to 111 t, the lowest level observed since 2002. STECF notes that this level is much lower than the proposed management references of B_{lim}=300t and B_{pa}=1,200t, respectively. Given the management advice of SGMED to allow the stock to recover, STECF **recommends** the proposed state reference points of B_{lim} and B_{pa} be adopted as biomass reference points. Those values might be revised in the future when more information becomes available.

STECF endorses the SGMED recommendations regarding the appropriateness of the exploitation rate $E \leq 0.4$ for anchovy and sardine stocks in the Mediterranean Sea as a sustainable fisheries management reference point consistent with high long-term yield. SGMED concludes that the short-term responses of the assessed anchovy and sardine stocks to recent exploitation rates indicate that an exploitation rate in the order of $E \leq 0.4$ might be consistent with the management goal of high long-term yields, taking into account the dynamic of the stocks. SGMED underlines that limited area and temporal coverage of the available stock assessments impede any quantification of risk related to this statement. As such, the expressed indication regarding Mediterranean small pelagic stocks is in agreement with empirical findings of Patterson (1992), who has proposed this exploitation level.

SGMED recommends the application of the proposed exploitation rate $E \leq 0.4$ as management threshold for stocks of anchovy and sardine in the Mediterranean Sea. This value might be revised in the future when more information becomes available.

STECF endorses the SGMED recommendations regarding the biomass reference points for anchovy in GSA 17. SGMED bases its recommendations regarding the proposed biomass reference points of B_{lim}=50,000t and B_{pa}=80,000 t on a revised stock assessment accounting for natural mortality rates as advised during the SGMED workshop in Murcia, 2-6 March 2009. The visual inspection of the scatter plot of recruitment versus spawning stock biomass clearly indicates that recruitment is impaired at stock sizes below 50,000t. Thus, SGMED recommends that B_{lim}=50,000t be adopted for the stock of anchovy in GSA 17. According to FAO recommendations (Cadima, 2003), B_{pa} should be in the range of 1.39*B_{lim} - 1.64*B_{lim}, accounting for uncertainty in the estimations of fishing mortality. Such factors would determine B_{pa} being in the range of 70,000t - 82,000t. Thus, SGMED recommends that B_{pa}=80,000t be adopted for the stock of anchovy in GSA 17.

STECF endorses the SGMED recommendations regarding the biomass reference points for sardine in GSA 17. SGMED bases its recommendations regarding the proposed biomass reference points of B_{lim}=50,000t and B_{pa}=300,000 t on a revised stock assessment accounting for natural mortality rates as advised during the SGMED workshop in Murcia, 2-6 March 2009. The visual inspection of the scatter plot of recruitment versus spawning stock biomass clearly indicates that recruitment is impaired at stock sizes below 180,000t. Thus, SGMED recommends adopting B_{lim}=180,000t for the stock of sardine in GSA 17. According to FAO recommendations (Cadima, 2003), B_{pa} should be in the range of 1.39*B_{lim} - 1.64*B_{lim}, accounting for uncertainty in the estimations of fishing mortality. Such factors would determine B_{pa} being in the range of 250,000t-295,000t. Thus, SGMED recommends B_{pa}=270,000t for the stock of sardine in GSA 17.

TOR d: STECF notes that SGMED 09-02 compiled a data set of fishing effort trends in accordance to the DCR data call issued in 2009. The fleet specific effort trends are also listed in the respective stock specific assessment sections of the SGMED report. No general conclusions were drawn from these data.

ToR e and f: STECF acknowledges that SGMED 09-02 compiled and listed relevant data and methods used for stock assessments and associated biological reference points for management. However, STECF requests that such documentation is continued and further improved in future meetings of SGMED.

ToR g and h: STECF notes that SGMED has provided specific advice on how to undertake standardization of MEDITS and GRUND surveys and that a more structured approach is needed. STECF supports the SGMED recommendation noting that this particular issue would best be solved by convening an ad-hoc working group to develop and test species-specific R script to be applied to standardize MEDITS and GRUND time series for use as quantitative fishery-independent information in stock assessments.

ToR i: STECF endorses the recommendation by SGMED 09-02 that the bio-economic models MEFISTO and/or BIRDMOD should be used in future studies to simulate the effects of the management measures of Mediterranean fisheries and evaluate the models' outcomes. Such work is planned for the forthcoming meeting SGMED 09-03.

ToR k: STECF acknowledges that SGMED 09-02 compiled an extensive amount of information and analyses regarding the definition of the areas of aggregation and persistence of juveniles and, partially, also of spawners in several GSAs and stocks. STECF endorses the use of the index of persistence as estimated for example in Colloca et al. (2009) as a robust method to define such areas and verify their persistency. If this task is to be continued, STECF advises to address it by mean of a specific data call and a dedicated working group under the STECF framework.

SGMED-09-02 WORKING GROUP REPORT THE MEDITERRANEAN PART I

Villasimius, Sardinia, Italy, 8-12 June 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-09-02 were extensive and are listed in section 2.1.

Due to time and human resources constraints, the working group was able to answer exhaustively to all TORs, except TORs e, f, h and j. SGMED 09-02 report deals mainly with the assessment of historic and recent trends in stock parameters (stock size, recruitment and exploitation) and relevant scientific advice. Deterministic short and medium term forecast for stock size and exploitation, including predicted landings and stock advice, will be delivered through the forthcoming SGMED 09-03 meeting in December 2009. Where applicable, long term forecasts are provided in order to allow assessments of the stock against established management reference points $F_{0.1}$, F_{max} and F_{msy}.

During the meeting, data compilations and assessments of 59 demersal and small pelagic species/GSA combinations were conducted (ToR a-b). The species were anchovy, sardine, European hake, red mullet, deepwater pink shrimp, red shrimp, giant red shrim, Norway lobster and sole. The assessed GSA covered stocks from western part of the Mediterranean to Cyprus in the east. Those assessments were supported by a DCR data call as defined during a previous meeting of SGMED (SGMED 09-01; Murcia, 2-6 March 2009) and followed procedures agreed at SGMED 09-01. The layout of the assessments was designed to allow scientists and managers to revise in a consistent way the data underlying the assessments outputs and the specific issues encountered during the assessment, and review the assumptions made and the management advice. The report includes summary sheets for stocks of anchovy (3), sardine (3), European hake (4), red mullet (2), deepwater shrimp (2), 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.

A total of 13 stocks (out of 18 for which an advice was given) were considered overfished in accordance to the proposed reference points. No particular regional patterns of stock developments and exploitation emerged, while the only stocks that are exploited sustainably are some of the sardine and anchovy stocks.

The assessment confirmed the results of the analyses already conducted in the previous SGMED 08-03 and 04, showing a general condition of overfishing for most of the stocks, especially for hake and red shrimps, with exception of some of the pelagic stocks. 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}. For most of the stocks assessed, current exploitation rates are larger or much larger than any level of fishing mortality that is associated with high long term sustainable targets.

Concerning TOR c, reference points in terms of both exploitation rates and biomass were given for all the stocks concerned. SGMED recommends the application of $F_{0.1}$ derived from Yield per Recruit analysis as the appropriate proxy of F_{msy} (maximum sustainable yield) in case of data lack or uncertainty (Kell and Fromentin, 2007). On the other hand, state indicators of stock size in terms of biomass are rather difficult to interpret, as changes in biomass in relation to reference levels such as B_{lim} and B_{pa}. Also, the shortness of the time series for most of the Mediterranean stocks, the fact that landings are regarded as uncertain and also the lack of historical data, impede the establishment of such biomass reference points. Therefore, SGMED consider that emphasis should been given on exploitation rates rather than level of biomass. SGMED also recommends that any exploitation targets should be applied within an adaptive management framework of multiannual plans. In the specific case ot TORc, SGMED did not apply any analytical approach to comment on appropriate fisheries management reference points regarding biomass indicators as B_{lim} or B_{pa} but bases its comments on visual inspection of relationships between recruitment and spawning stock size.

For TOR d, SGMED concludes that there is no evidence of a general decline in fishing capacity of the Mediterranean fleets although this might be also the result of changes in the classification system (i.e., from polyvalent to a specific gear type).

Concerning TOR h, specific advice has been given on how to conduct standardization of MEDITS and GRUND surveys but SGMED considers that a more structured approach is needed. Thus, SGMED recommends that this particular issue would be solved with an ad-hoc working group to develop and test species specific R script that should be used to standardise MEDITS and GRUND time series of the different GSAs to be used in stock assessment as quantitative fishery independent information.

For TOR i, the bio-economic models MEFISTO and BIRDMOD were used to evaluate possible short-term and long-term biological and economic consequences of specific management options for Mediterranean fisheries. SGMED recommends that the bio-economic models MEFISTO and/or BIRDMOD, using ad-hoc biological and economic data of selected case studies, should be used in future studies to simulate the effects of the management measures of Mediterranean fisheries and evaluate the models outcomes.

Concerning TOR k, SGMED recognise that an extensive amount of information and analysis is now available to define and quantify the areas of aggregation and persistence of juveniles and, partially, also spawners for several GSAs and stocks. SGMED consider that index of persistence as estimated for example in Colloca *et al.* (2009) can be used as a robust method to define such areas and verify that they are constant during time. This work should be addressed by a specific working group under the STECF framework.

SGMED reiterates that recovery plans should be developed and established with urgency in order to achieve advised effort reductions and those recovery plans should be enforced until the stocks are proved to be exploited consistently with the sustainability targets. The development of recovery plans needs to consider catches of other species in a mixed fishery context and should be socio-economically evaluated.

SGMED also recommends that stocks to be assessed within each working group should be clearly identified by the TORs prior to the meeting, rather than allowing an open list with experts chosing which stock to deal just at the meeting. Also, the data call should cover the needs to fullfill the TORs rather than allows for any kind of analyses at the meeting. In this context, SGMED considers reasonable that no more than 25 stock are assessed within 2 weeks of the two working groups scheduled for future years. SGMED considers that a rotation system, with each stock assessed every 2 or 3 years (similar to the ICES benchmark system), could represent a reasonable compromise. This will also allow SGMED to conduct a more carefull examination of the quality of input data and dedicate more time to the discussion of the observed trends and advice within the group.

Futhermore, SGMED-09-02 recommends the stock assessments should be continued in 2010 within two meetings. SGEMD considers that a maximum of 10-15 selected stocks should be assessed in each meeting, that should also include predictions of catch and biomass under different management scenarios in the short term for the assessed stocks.

Overall the SGMED framework has so far represented an excellent forum to support stock assessment and advice within the region and built the foundations upon which assessment work can be successfully undertaken. The meeting also allowed the standardisation of procedures for data collection and analysis within the region. In order to ensure that this is continued, the Working Group suggests that inter-sessional workshops or training courses be pursued to expand the number of scientists fully able to undertake assessments within the Mediterranean region.

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 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.

To address the requests, the STECF Subgroup on the Mediterranean (SGMED-09-02) for demersal and pelagic stocks met in Villasimius, Sardinia, Italy, from 8-12th June 2009. The meeting was opened at 15:00 on the 8th, and closed at 17:00 on the 12th. The meeting built upon the work performed during SGMED meetings conducted during 2008 and 2009 to pursue the Commission's requests.

In accordance with the ToR given in the following chapter, the present report is structured in 3 main parts. The first part consists of the stock specific (species and area) summary sheets of the various assessments concluded by SGMED 09-02, the second part covers SGMED 09-02 responses to the specific questions, and the third part documents the various assessments in detail with the raw data (where available), methods applied and results.

2.1. Terms of Reference for SGMED-09-02

The overall terms of reference for the SGMED meetings are listed in Appendix 1. The specific terms of reference for SGMED-09-02 were:

STECF SGMED-09-02 Subgroup for Mediterranean is requested to:

a) Update and assess the status and trends of the stocks by all relevant GSAs, or, if the case, by bigger areas merging adjacent GSAs, in the Mediterranean Sea, taking into account the recommendations of the SGMED workshop in March and the following STECF comments. Advise on the status of the exploited stocks of the species listed below, with respect to high yields harvesting strategies and to maintain their reproductive capacity and ensure a low risk.

- Sardine (*Sardina pilchardus*)
- Anchovy (*Engraulis encrasicolus*)
- European hake (*Merluccius merluccius*)
- Red mullet (*Mullus barbatus*)
- Deep-water rose shrimp (*Parapenaeus longirostris*)
- Other species out of the list given to STECF and recalled both under point i) of the ToRs for SGMED 09 03 and in tables 1 and 2 of the data call

b) Assess the status and trends of the stocks by all relevant GSAs, or, if the case, by bigger areas merging adjacent GSAs, in the Mediterranean Sea. Advise on the status of the following exploited stocks of the species listed below, with respect to high yields harvesting strategies and to maintain their reproductive capacity and ensure a low risk.

- Red shrimp (*Aristeus antennatus*)
- Giant red shrimp (*Aristaeomorpha foliacea*)
- Norway lobster (*Nephrops norvegicus*)
- Other species out of the list given to STECF and recalled both under point i) of the ToRs for SGMED 09 03 and in tables 1 and 2 of the data call

c) Review and propose biological reference points related to high yields and low risk of fishery collapse in long term of each of the stocks assessed.

SPECIFIC QUESTIONS UNDER POINT C)

- advice whether 300 tonnes for deep water rose shrimp and 2200 tonnes for hake may be considered as adequate minimum biological acceptable level (MBAL= Blim) in GSA 6 or in any other more appropriate spatial aggregation of adjacent GSAs; otherwise advice on which values could be used to this end.

- advice whether 1200 tonnes for deep water rose shrimp and 4000 tonnes for hake, which correspond to the long-term average over the last 8 and 16 years respetively, may be considered as precautionary biomass reference point (=Bpa) in GSA 6 or in any other more appropriate GSA spatial aggregation of adjacent GSAs; otherwise advice on which values could be used to this end.

- advice whether $F \leq 0.2$ per year on appropriate age groups can be considered as an adequate Fpa both for hake and deep water rose shrimp in GSA 6 or in any other more appropriate GSA spatial aggregation of adjacent GSAs.

- advice whether the exploitation rate $E \leq 0.4$ per year on appropriate age groups is an adequate precautionary reference point both for anchovy and sardine stocks in all GSAs; otherwise advice on likely value to be used to this end.

- advice whether 50000 tonnes may be considered as adequate minimum biological acceptable levels (MBAL= Blim) both for anchovy and sardine stocks in GSA 17; otherwise advice on which values could be used to this end.

- advice whether 300000 tonnes for sardine and 80000 tonnes for anchovy may be considered as precautionary biomass reference point (=Bpa) in GSA 17; otherwise advice on which values could be used to this end.

d) Update and assess historic and recent trends (capacity, technological creep, nominal fishing effort) in the major fisheries by GSAs or, if the case, by bigger areas merging adjacent GSAs exploiting the stocks assessed. The trends should be interpreted in light of management regulations applicable to them.

e) Review the applicability and fully document all applied methodologies for the assessments and determination of the proposed biological reference points.

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

g) To review proposed methodologies to standardize the MEDITS and GRUND surveys time series to account for unbalanced sampling designs and appropriate data distributions. Specific work has been initiated in this regard.

h) Investigate the requirements for reorganising the MEDITS database that result from the recommendations of STECF for combining some GSAs for some species.

i) 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, develop specific case studies for Mediterranean fisheries (e.g. anchovy, sardine and Nephrops), and advise 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 (to be continued in SGMED-09-03).

j) With a view to enhance the number of stocks jointly assessed on the spot at the forthcoming GFCM-SAC working groups, either within one or by merging more than one adjacent GFCM-GSAs, identify for each selected assessment methodology the data needs, data format and start data-sets preparatory work.

k) - PROTECTION OF JUVENILES AND SPAWNING AGGREGATIONS:

1) Provide relevant information on spatial and temporal distribution of seasonal or persistent juveniles aggregations and provide scientific elements indicating that possible protection of these areas may allow to control and reduce the overall fishing mortality on the stock and further improve the exploitation pattern with a view to increase the yield.

2) Provide relevant information on fishing gear selectivity (mesh size/shape, twine thickness, hanging ratio, hook size, hook shape, etc.) with a view to further improve the exploitation pattern, reduce the fishing mortality on juveniles and increase the yield.

3) Provide relevant information on spatial and temporal distribution of seasonal or persistent aggregations of spawners and provide scientific elements indicating that possible protection of these areas may reduce the risk of stock collapse and maintain the reproductive capacity of the exploited stocks.

2.2. Participants

The full list of participants at SGMED-09-02 is presented in Appendix 2.

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

A summary of the data provided to the SGMED-09-02 meeting by country is presented in Table 3.1.

Details of the total landing, discards and effort data by species, GSA, fishing technique and years successfully obtained through the DCF call is presented in Appendix 3.

In 2009, SGMED-09-02 experienced significant difficulties in the timing of the DCF data call and the data deliveries by Member States, although the recommended data call was prepared by the workshop SGMED 09-01 and reviewed by STECF during its spring plenary session in April 2009. In addition, many 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.

Table 3.1. Overview of data provided by country from the first DCR call for SGMED-09-02 (all stocks).

REQUESTED FILES	**FILENAME**	**DESCRIPTION**	**CYPRUS**		**FRANCE**		**GREECE**		**ITALY**		**MALTA**	**SLOVENIA**		**SPAIN**	
Fisheries Data					only ANE, PIL, MUT, HKE		no data 2002, 2007					only ANE PIL			
FILE_1	M01_MED_LAN	LANDINGS	2005-08	MUT, HKE	2002-08		2003-08		2002-08		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		2003-08	2006-08		2002-08	
FILE_4	M04_MED_LAN_AGE	AGE_DISTRIBUTION_LANDINGS	2005-08	MUT	2002-08	no data HKE			2002-08					2002-08	
FILE_5	M05_MED_MAT	MATURITY_AT_LENGTH	2006-08	MUT	2005-08				2002-08		2003-08	2006-08		2002-08	
FILE_6	M06_MED_GRO	GROWTH_PARAMETERS	2006-08	MUT	2002-08		2003-08	only ANE, PIL	2002-08		2003-08	2006-08		2002-08	
FILE_7	M07_MED_SEX	SEX_RATIO	2006-08	MUT	2002-08		2003-08		2002-08		2002-08	2006-08		2002-08	
FILE_8	M08_MED_DIS	DISCARDS	2006-08	MUT, HKE	2003-08				2005-08	GSA 9,10,11,16,19		2007-08		2002-08	
										data only for DPS, HKE, MUT					
FILE_9	M09_MED_DIS_LEN	LENGTH_DISTRIBUTION_DISCARDS	2008	MUT	2003-08				2005-08	GSA 9,11, 19		2007-08		2005, 2008	
										data only for HKE, MUT					
Survey Data															
FILE_10	M10_MED_TA	MEDITS_TA	2005-08		1994-08		1994-08		1994-08	(GSA17 2002-08, GSA18 1996-2008)	2003-08	1996-08		1994-2008	
FILE_11	M11_MED_TB	MEDITS_TB	2005-08		1994-08		1994-08		1994-08	(GSA17 2002-08, GSA18 1996-2008)	2003-08	1996-08		1994-2008	
FILE_12	M12_MED_TC	MEDITS_TC	2005-08		1994-08		1994-08		1994-08	(GSA17 2002-08, GSA18 1996-2008)	2003-08	1996-08		1994-2008	2002-06 no data
FILE_13	M13_MED_SP_LEN				1994-08		2003-08							2002-08	
FILE_14	M13_MED_SP_AGE				2002-08	No data 2004	2003-08							2002-08	
FILE_15	M13_MED_SP_MAT				2005-08	only ANE								2002-08	
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			2006-07			
FILE_20	PRICE		2005-07		2002-07				2002-03		2005-08	2006-07			

4. DATA PROVISION POLICY

Working Group members were reminded that data collected under the DCF call and supplied to SGMED-09-02 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.

5. WORKING DOCUMENTS

5.1. Working document 1: Recent changes of small pelagics fish abundance as detected in the eastern part of GSA 17 by acoustic surveys

by Vjekoslav Ticina

The presentation described recent changes (2003-2008) in small pelagic fish abundance in the eastern part of GSA 17 (Adriatic Sea), as detected by acoustic surveys (PELMON). Directly measured acoustic indices of fish abundance (S_A or NASC, m^2/nm^2) were averaged over the survey area (i.e. Croatian territorial waters and protected ecological-fishery zone), and the values compared over 6-year period. With aim to detect changes in fish abundance in the given period, linear trend analyses were performed for anchovy, sardine and both species together. Correlation coefficients for all respective trend lines were calculated and tested for significance. Due to large annual changes in abundance of anchovy and sardine, in all cases (anchovy, sardine, anchovy plus sardine) it was found that no significant correlation exists ($p>0.05$) between trend lines and abundance data. Despite a positive trend in abundance calculated for both species together, due to non-significant correlation, as well as lack of acoustic data from western part of GSA 17 (MEDIAS area) during SGMED-09-02 meeting, the group was not able to make a conclusion about positive nor negative recent changes in small pelagic fish abundance in the GSA 17. Also, as it was mentioned in previous SGMED meetings, the situation detected in eastern part of GSA 17 can be different from situation in its western part.

5.2. Working document 2: The use of acoustics in identifying small pelagics' juvenile habitat in the Mediterranean

by Giannoulaki Marianna *et al.*

Acoustic and satellite environmental data as well as bathymetry data were used to model the presence of sardine juveniles, *Sardina pilchardus*, during early summer as well as anchovy juveniles, *Engraulis encrasicolus*, during autumn and winter, in the Mediterranean Sea. Acoustic data recorded with a 38 kHz split beam echosounder from the Aegean Sea (Eastern Mediterranean), the Adriatic Sea and the Gulf of Lions (Western Mediterranean) has been analyzed for this purpose. Satellite data were used as proxies to infer spatial variations of environmental factors and assess possible ecological relationships. Generalized Additive Models (GAMs) were used for modelling and subsequently applied in a predictive mode to identify those regions in the study areas and the entire Mediterranean basin that could support juveniles’ presence. Model results were evaluated with the estimation of Receiver Operating Characteristic (ROC)-plots. Mapping the estimated environmental conditions indicated areas that generally agree with the known distribution grounds of anchovy and sardine juveniles. Such habitat maps that are based on species-environment relations could indicate suitable areas that can consistently support juveniles’ presence and might be useful to fisheries management and conservation.

5.3. Working document 3: *Rapido* trawl survey for *Solea solea* and other shared benthic species in the GSA 17

by Giuseppe Scarcella

The common sole *Solea solea* (Linnaeus, 1758) is one of the most important valuable species in the FAO GFCM area, which provides for 13% of the word overall catches of this species. Around 22% of the GFCM area landings comes from the Adriatic Sea, especially the northern and central basins (GSA 17) representing an important spawning and aggregation area for sole. Taking into consideration the importance of sole in GSA 17 and the lack of scientific data for sustainable managing the stock, the SoleMon project was initiated in 2005. The aims of the project are to provide a stock assessment of *S. solea* through surveys at sea, carried out by the *rapido* trawl, and analysis of landings of the fleets catching the common sole either as target species (*rapido* trawl and set nets) or as a portion of a multi-species catch (otter trawl). The spatial distribution of the entire population, recruits and spawning females of *S. solea* is also studied. Moreover the survey at sea provides information on trends and spatial distribution of other benthic shared resources (e.g. *Sepia officinalis, Pecten jacobaeus, Melicerthus kerathurus, Squilla mantis, Chelidonichthys lucerna*). The project involves CNR – ISMAR Ancona (Italy), ISPRA Chioggia (Italy), IOF Split (Croatia) and FRIS Ljubliana (Slovenia) and has been financed by MIPAF in 2005-2006 and ADRIAMED in 2007-2008. Considering the results presented at the GFCM meetings since 2005, it can be concluded that the rapido trawl survey is a very efficient tool for providing useful data for the stock assessment, spatial distribution of sole and other benthic species and management advice. It is suggested that the survey is considered to be co-founded within the Data Collection Framework.

5.4. Working document 4: Spawning grounds of the European anchovy *Engraulis encrasicolus* in the Strait of Sicily (GSA 16) and relationships with hydrographic surface circulation

by B. Patti *et al.*

Some aspects of the effects of the hydrographic circulation on the reproductive strategy of the European anchovy (*Engraulis encrasicolus*, L. 1758) population off the southern coast of Sicily were investigated, using information from satellite SST data and anchovy egg horizontal distributions. Ichthyoplanktonic data used in this study were collected during summer oceanographic surveys carried out from 1997 to 2006. The general circulation pattern is locally controlled by the motion of the Modified Atlantic Water, the Atlantic Ionian Stream (AIS). During summer the water mass advected by the AIS to the south of Sicily is fresher and also warmer than the surrounding waters north of it at the same depth. This characteristic permits to use temperature as a tracer to depict the AIS trajectory. The year to year variability of AIS path, inferred from SST data, while establishing different environmental conditions along the southern coast of Sicily, appeared to be able to affect the spawning strategy of anchovy, which has preference for warm waters. Namely, the analysis of available information permitted to identify correlation patterns between standardized SST and the location of major spawning grounds, with some important exceptions suggesting that, occasionally, environmental factors other than temperature may control spawning behaviour.

5.5. Working document 5: Data on hake nurseries in the Gulf of Lions (GSA 7)

by H. Farrugio *et al.*

During the European project *Données sur la distribution des principales espèces commerciales du golfe du Lion (et plus particulièrement des groupes 0 et 1*), distribution maps of the juveniles of hake and other 12 species exploited in the gulf of Lions have been estimated. The data used came from three trawl surveys conducted by IFREMER in 1988on the continental shelf between 10 and 250 m depth, sampling in the main fish markets and on board professional fishing boats. Indices of abundance in number of fish per hectar and by depth stratum were calculated using the Pennington & Gryslein (1978) method and the results have been mapped for the three periods of observations, February, June and November. This work shows that the highest abundance (62%) of the 0-group was observed in June, while they were less abundant in November

(36%) and almost absent in February. The 0-group hake was mainly caught on the external border of the continental shelf, in the vicinity of the top of the slope canyons. For the present SGMED working group the available data on juvenile hakes (0 group) coming from the MEDITS surveys in the gulf of Lions for the period 1998 to 2008 have been preliminary analysed by a group of IEO/IFREMER French and Spanish scientists. For each of the 11 years, standardized indices of abundance of age 0 individuals have been calculated. The SURFER software was used to create contour maps showing their distribution. An attempt was made to apply the kriging methodology, but unfortunately, except for the data of the year 1998, it was not possible to obtain a suitable variograms. Hence, the contour maps were finally created by applying the inverse distance to a power method. A great variability was observed in the abundance of the age 0 group, however the geographic pattern of recruitment appears to be fairly constant throughout the time series analysed. This pattern is even clearer by combining the data coming from the whole series of MEDITS surveys. The map obtained in this way shows that in June, the hake recruits are mainly concentrated in the eastern part of the Gulf of Lions, along the external border of the continental shelf, in the vicinity of the top of the slope canyons where a Fishery Restricted Area has been established in 2009 by the GFCM in order to protect the large spawners living there.

5.6. Working document 6: Estimation of natural mortality and redefinition of current divisions of GSA for stock assessment

By Alvero Abella

In the ToRs of the Murcia meeting, it was posed the problem of the choice of methods allowing the estimation of natural mortality rates. It was stressed the need of considering as a preferred choice those that assume declining vectors of M at age or at size. The assumption of a constant value is likely to provide, in the case of the Mediterranean fisheries, a wrong perception of the stocks status with consequences on management. It was recommended, when available data make it feasible, to use two approaches that allow defining a decreasing M at size vector, namely the Gislason et al (2005) model, based on growth parameters and the Abella et al (1997) model, based on considerations on biomass and production (see details in the final SGMED 09-01 report). The group also suggested that other approaches could be used in the case scientists were not confident with the estimates of parameters needed for the use of the above mentioned approaches. In this case, the different choice must be justified. During the SGMED meeting there was also addressed the problem of the definition of the current divisions of GSAs for stock assessment. Most of the GSAs definitions approved by GFCM were more based on political considerations than biological knowledge. It was presented a paper as a base of discussion that analysed the trends in abundance observed in each GSA for a selected number of species and checking on consistence of these trends among neighbouring GSAs. Results of the analysis were considered useful for helping on decisions related to the convenience of merging neighbouring GSAs. The merging of neighbouring GSAs might be taken under consideration as an attempt of improving the reliability of stock assessments and may imply the definition of different units of management. It was stressed that the need to merge GSAs may be species-specific and may depend on the spatial scale of some biological phenomena as migrations, spawning and nursery areas, oceanography as well as on spatial dynamics of fleets. Proposals of mergings are included in the final report of the Murcia meeting.

5.7. Working document 7: Nursey localization of some key demersal species in the GSA 10, 18 and 19.

by M.T. Spedicato

Nursery area of relevant demersal species (hake, deep water rose shrimp) were localised in the central-southern Tyrrhenian Sea (GSA 10), in the south Adriatic (GSA 18) and in the western Ionian Sea (GSA 19) in the framework of a research project conducted at national level. Juveniles were identified analysing the length frequency distribution of trawl survey data and cut-off size used to split the LFD of each species into juvenile and adult components. Geo-referenced abundance indices were used to assess the spatial distribution of juveniles, applying geostatistical methods and kriging techniques. Structural analysis was conducted and the more common variogram model fitted to the data was the exponential and spherical ones with ranges generally describing a structure at small spatial scale. Localization of the nurseries was obtained by Indicator

Kriging that allows interpreting the localization in terms of probability, after defining cut-off thresholds based on the ranking of the cumulative abundance and the number of hauls. Maps of the modelled nurseries were then analysed throughout the time to estimate the persistence of the localization. The applied techniques was based on the averaging of the probability contours when these were higher than 0.6. In the southern Tyrrhenian sea nursery of hake and deep water rose shrimp were localised off Ischia Island, in the Napoli and Salerno Gulf and offshore Cape Bonifati (Calabria coasts), whilst persistent nuclei for the same species were located along the Gargano promontory and off Capo Santa Maria di Leuca in the GSA 18 and 19, respectively.

5.8. Working document 8: Nursey localization of demersal species in the italian GSAs

by M. Murenu

A national project conducted by SIBM was devoted to analyze the recruitment of the demersal species economically most relevant (*Eledone cirrhosa, Merluccius merluccius, Mullus barbatus, Nephrops norvegicus, Parapenaeus longirostris, Phycis blennoides*) in all the italian GSAs. In few GSAs other important species were considered (*Aristaeomorpha foliacea, Illex coindetii, Loligo vulgaris, Pagellus erythrinus*). A geostatistical approach is used to define the main nursery areas of demersal resources and define their persistence by means of direct estimation of fish densities. Data collected during trawl surveys carried out in the 7 Italian GSAs in the late-spring and autumn from 1994 to 2006 were analysed to locate aggregation of 0 group individuals (recruits) and check their stability by means of geo-spatial methods and common criteria. Juveniles were identified analysing the length frequency distribution of trawl survey data and cut-off size used to split the LFD of each species into juvenile and adult components. Juveniles geo-referenced abundance indices were afterwards used to assess their spatial distribution, applying geostatistical methods and kriging techniques. Localization of the nurseries was obtained by Indicator Kriging that allows interpreting the localization in terms of probability, after defining cut-off thresholds based on the ranking of the cumulative abundance and the number of hauls. As a case study of the project results for the European Hake are reported in Murenu *et al.* (submitted paper). Although a certain degree of variability in extension and shape of areas with high concentrations of hake recruits was observed over the years in each GSA, the results of persistence analysis showed a considerable stability in their location. Most of the nursery areas are located inside the territorial waters with the notable exception of those of the GSAs 16, 17, and 18. In these GSAs the percentage of the recruitment area which falls in international waters ranges from 86 % in the GSA 17 to 100% in the GSA 18.

6. SGMED 09-02 RESPONSES TO SPECIAL QUESTIONS OF TOR C, D, G, I AND K

6.1. c) Review and propose biological reference points related to high yields and low risk of fishery collapse in long term of each of the stocks assessed.

SGMED considers the establishment of management reference points crucial to achieve high sustainable long term yield of Mediterranean fish and shellfish stocks in the short and medium term. Within its mandate, STECF can endorse management reference points as proposed by its subgroup SGMED. After a general discussion on candidate reference points applied in fisheries management of Mediterranean fish and shellfish stocks, SGMED recommends that high priority should be given to exploitation indicators (fishing mortality) and its appropriate levels to achieve high sustainable long term yield. Considering data availability and the recent political agreements (UN, 2002) and EU communications (Council Conclusions 2007), SGMED recommends the application of F_{msy} (maximum sustainable yield), with $F_{0.1}$ derived from Yield per Recruit analysis as the appropriate proxy in case of data lack or uncertainty (Kell and Fromentin, 2007). Contrarily, state indicators of stock size in terms of biomass are rather difficult to interpret, as decreases in biomass below reference levels such as B_{lim} (biomass of all adult specimens at the level of impaired recruitment) and B_{pa} (precautionary reference of the biomass of all adult specimens including uncertainty) can be due to many ecological effects in addition to the fishery impact. Also, the shortness of the assessment time series for most of the Mediterranean stocks and the lack of historical data, impede the establishment of biomass reference points. In the light of the fact that the actual stock size cannot be directly controlled through fisheries management, SGMED recommends stock biomass reference points be given less priority in fisheries management of Mediterranean fish and shellfish stocks than exploitation indicators. SGMED further recommends that levels of fishing mortality F_{msy} or its proxy $F_{0.1}$ should rather be interpreted and applied as management targets than any category boundaries, accounting also for uncertainty. Given the limited but best data and stock assessment results available, SGMED recommends such targets being applied within an adaptive management framework of multiannual plans.

SGMED did not apply any analytical approach to comment on appropriate fisheries management reference points regarding state indicators B_{lim} or B_{pa} but bases its comments on visual inspection of relationships between recruitment and spawning stock size. Proposed fisheries management reference points regarding exploitation indicators are commented in relation to estimated F_{msy}, $F_{0.1}$ values and evaluations of the stock response to different levels of exploitation.

6.1.1. European hake (Merluccius merluccius) in GSA 6

SGMED recommends that the proposed $F \leq 0.2$ reference point can be interpreted as a management target. SGMED bases its recommendation of a revised stock assessment accounting for the fast growth hypothesis. Such revised stock assessment is presented in this report in section 8.4. SGMED notes that F_{max}=0.23 and $F_{0.1}$ = 0.17 (ages 2-4) are within the range of the proposed value. Thus, SGMED recommends the establishment of $F \leq 0.2$ as a management target. SGMED notes that the age range 2-4 does not cover ages 0 and 1, which contributed to most of the landings. SGMED recommends that the reference ages of the mean fishing mortality and the reference points be revised to 1-4 in order to include the youngest age groups.

SGMED is not in the position to estimate or propose adequate limit (B_{lim}) or precautionary (B_{pa}) biomass reference points given the data available. Major scientific concerns arise from the shortage of the time series and the limited stock dynamics it covers. The time series hardly covers the proposed B_{lim}=2,200t and B_{pa}=4,000t. SGMED notes that the recent stock size is estimated at a much lower level and thus recommends the proposed biomass reference points of B_{lim} and B_{pa} be established as biomass reference points. Those values might be revised in the future when more information becomes available.

6.1.2. Deep water rose shrimp (Parapenaeus longirostris) in GSA 6

SGMED is not in the position to estimate and propose appropriate management targets of fishing mortality or biomass reference points. Major scientific concerns arise from the shortage of the time series and the extreme stock dynamics it covers. SGMED notes that the proposed $F \leq 0.2$ is much lower than the current exploitation of $F = 0.5$ for ages 2-5. In the light of the management advice of SGMED to reduce F in order to allow the stock to rebuild, SGMED recommends that $F \leq 0.2$ be established as a management target and a proxy for F_{msy}. This value might be revised in the future when more information becomes available.

After a continuous decline stock biomass in 2008 is estimated to amount to 111 t, the lowest level observed since 2002. STECF notes that this level is much lower than the proposed management references of B_{lim}=300t and B_{pa}=1,200t, respectively. Given the management advice of SGMED to allow the stock to recover, SGMED recommends the proposed state reference points of B_{lim} and B_{pa} be established as biomass reference points. Those values might be revised in the future when more information becomes available.

6.1.3. Appropriateness of exploitation rate $E \leq 0.4$ for anchovy (Engraulis encrasicolus) and sardine (Sardina pilchardus) in the Mediterranean Sea

SGMED notes that stock productivity may differ between stocks in various regions of the Mediterranean Sea. Furthermore, stock productivity may also change over time. Neither the spatial nor the temporal coverage of stock assessments of anchovy and sardine in the Mediterranean Sea can provide a definitive answer regarding the appropriateness of an $E \leq 0.4$. However, SGMED summarized the stocks of anchovy and sardine assessed and compared the stock trends with the current and historical exploitation rates.

The following table (Tab. 6.1.3.1) lists recruitment and the stock size in comparison with the estimated exploitation rates of the 5 stocks of each species anchovy and sardine assessed. Only the stocks of anchovy and sardine in GSA 17 have historical time series of stock size and exploitation extending to periods before 2000. 5 out of 6 stocks exploited at $E \geq 0.5$ are in a reduced or low status of SSB or recruitment, with Sardine in GSA 22 being the only exception where both recruitment and SSB are either high or recovering, respectively. All the remaining 4 stocks with $E < 0.5$ display a medium, recovering, recovered or even high stock size. Only sardine in GSA 01 displays a poor recruitment at $E < 0.5$. However, the conclusions drawn from a comparison of long term stock responses to $E > 0.4$ in GSA 17 of anchovy and sardine stock are conflicting. Both stocks have undergone continuously declining trends with an exploitation rate in excess of 0.4 for anchovy and an exploitation rate of less than 0.4 for sardine.

SGMED concludes that the short term responses of the assessed anchovy and sardine stocks to recent exploitation rates indicate that an exploitation rate in the order of $E \leq 0.4$ might be consistent with the management goal of high long term yields, taking into account the dynamic of the stocks. SGMED underlines that limited area and temporal coverage of the available stock assessments impede any quantification of risk related to this statement. As such, the expressed indication regarding Mediterranean small pelagic stocks is in agreement with empirical findings of Patterson (1992), who has proposed this exploitation level. SGMED recommends the application of the proposed exploitation rate $E \leq 0.4$ as management target for stocks of anchovy and sardine in the Mediterranean Sea. This value might be revised in the future when more information becomes available.

Tab. 6.1.3.1. Recent and historic status of the stock parameters spawning stock biomass (SSB) and recruitment (R) in comparison with assessed exploitation rates E.

Stock	recent E	recent R	recent SSB	historic E	historic SSB
Anchovy GSA 01	0.74	low	low		
Anchovy GSA 06	0.78	low	low		
Anchovy GSA 16	0.64	unknown	low		
Anchovy GSA 17	0.45	recovered	recovered	E>0.4	declining
Anchovy GSA 22	0.30	high	high		
Sardine GSA 01	0.48	reduced	med		
Sardine GSA 06	0.71	reduced	reduced		
Sardine GSA 16	0.22	unknown	recovering		
Sardine GSA 17	0.50	low	low	E<0.4	declining
Sardine GSA 22	0.50	high	recovering		

6.1.4. Biomass reference points for Anchovy (Engraulis encrasicolus) in GSA 17

SGMED bases its recommendations regarding the proposed biomass reference points of B_{lim}=50,000t and B_{pa}=80,000 t on a revised stock assessment accounting for natural mortality rates as advised during the SGMED workshop in Murcia, 2-6 March 2009. Such revised stock assessment is presented in this report in section 8.42.

The visual inspection of the scatter plot of recruitment versus spawning stock biomass clearly indicates that recruitment is impaired at stock sizes below 50,000t. Thus, SGMED recommends establishing B_{lim}=50,000t for the stock of anchovy in GSA 17.

According to FAO recommendations (Cadima, 2003), B_{pa} should be in the range of 1.39*B_{lim} - 1.64*B_{lim}, accounting for uncertainty in the estimations of fishing mortality. Such factors would determine B_{pa} being in the range of 70,000t-82,000t. Thus, SGMED recommends establishing B_{pa}=80,000t for the stock of anchovy in GSA 17.

6.1.5. Biomass reference points for Sardine (Sardina pilchardus) in GSA 17

SGMED bases its recommendations regarding the proposed biomass reference points of B_{lim}=50,000t and B_{pa}=300,000 t on a revised stock assessment accounting for natural mortality rates as advised during the SGMED workshop in Murcia, 2-6 March 2009. Such revised stock assessment is presented in this report in section 8.45.

The visual inspection of the scatter plot of recruitment versus spawning stock biomass clearly indicates that recruitment is impaired at stock sizes below 180,000t. Thus, SGMED recommends establishing B_{lim}=180,000t for the stock of sardine in GSA 17.

According to FAO recommendations (Cadima, 2003), B_{pa} should be in the range of 1.39*B_{lim} - 1.64*B_{lim}, accounting for uncertainty in the estimations of fishing mortality. Such factors would determine B_{pa} being in the range of 250,000t-295,000t. Thus, SGMED recommends establishing B_{pa}=270,000t for the stock of sardine in GSA 17.

6.2. d) update and assess historic and recent trends (capacity, technological creeping, nominal fishing effort) in the major fisheries by GSAs or, if the case, by bigger areas merging adjacent GSAs exploiting the stocks assessed. The trends should be interpreted in light of management regulations applicable to them

Fleet specific trends in fishing effort are given under the stock specific assessments in section 8 by area.

Cyprus

Data are available for the period 2005-2007 by fleet segment and for the period 2005-2008 for the effort, and possibly concerns GSA 25. The complete set of information (number of vessels, kw, GT, age, days, kw/day and GT/day) is available by gear. Previous data were not available at the meeting.

Demersal trawlers

There is a decreasing trend either in number of vessels or capacity (GT and kw) or effort (days, kw*day and GT*day) in the segment 12-24 m. No other segments are present.

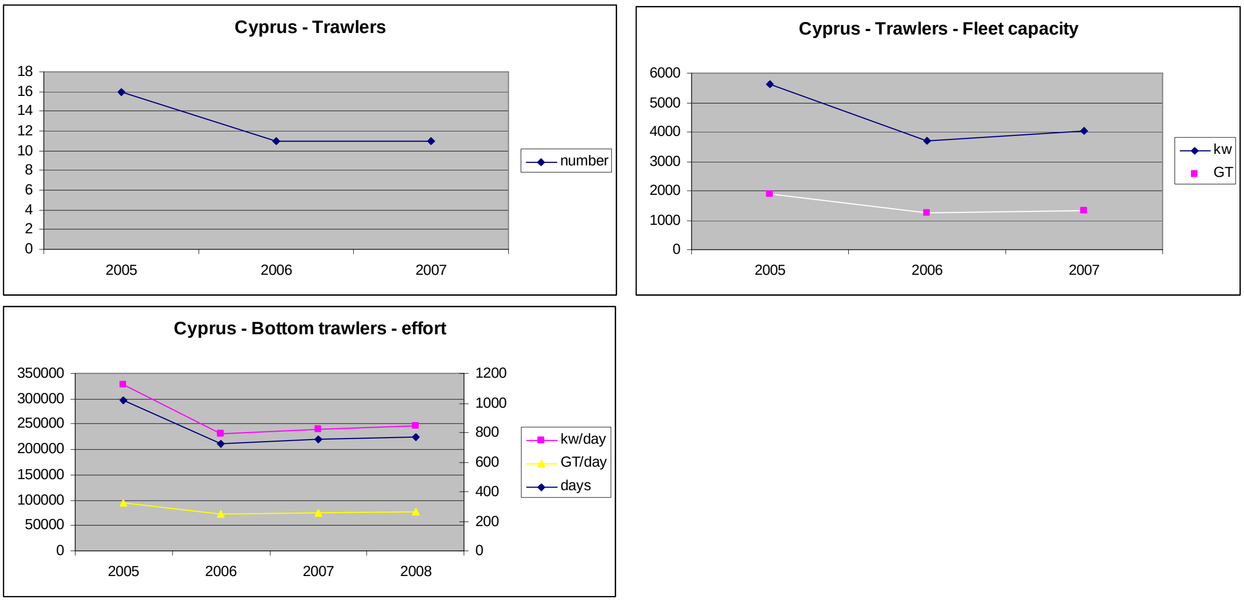


Fig. 6.2.1 Trends in Cyprian fleet specific effort.

Purse seiners

According to the data, only one purse seiner was active in 2005 (GT 51; kw 270). This vessel become inactive in 2006 and was possibly dismissed in 2007.

France

Fleet characteristics (number of vessels, GT and kw) and effort data (fishing days, kw*day and GT*day) are available for the period 2003-2008 by gear and for GSA 7. The number of vessels and data concerning the purse-seine sector were not provided by MS. Previous data and data from GSA 8 were not available at the meeting.

Bottom trawlers (OTB - GSA 7)

There is a clear decreasing trend for all the fleet parameters and also for the number of fishing days and the kw*day, while GT*day shows a slight decreasing trend. Data are concerning mostly the fleet segment 12-24 m.

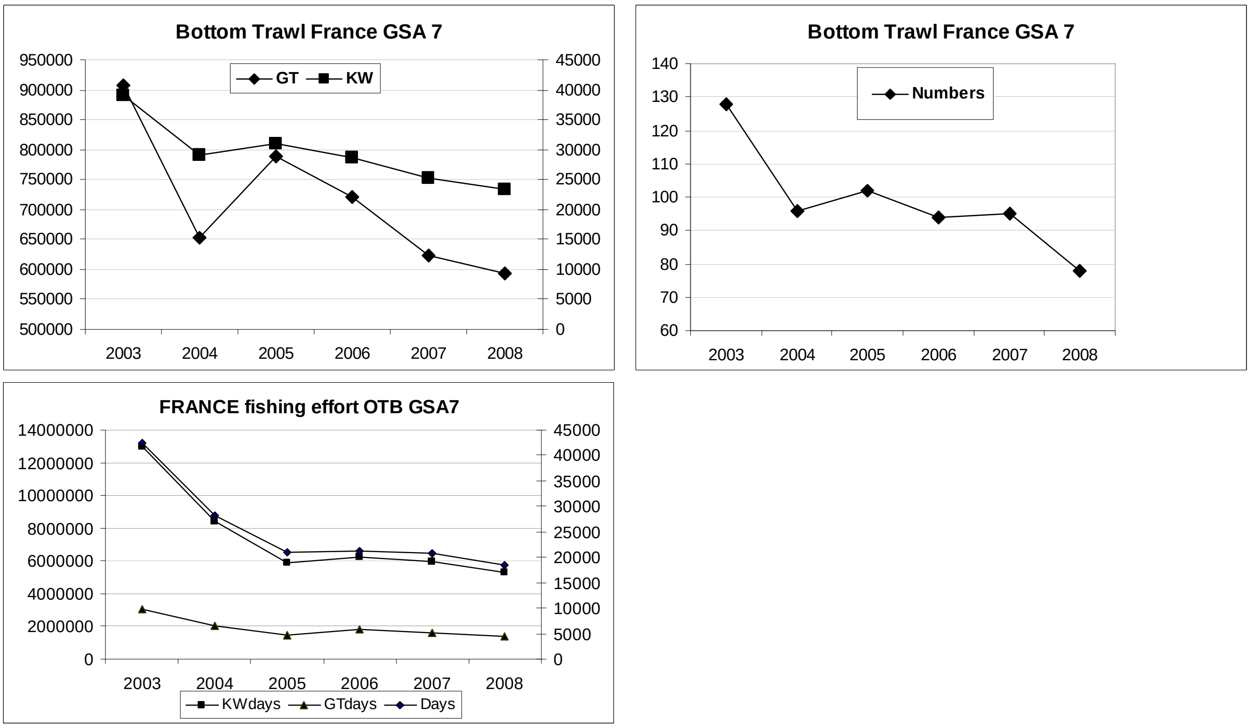


Fig. 6.2.2 Trends in French fleet specific effort.

<u>Pelagic trawlers</u> (OTM – GSA 7)

As concerns the fleet data, all the trends show a remarkable increase. On the opposite, there is a clear decreasing trend for the number of fishing days and the kw*day, while GT*day shows only a slight decreasing trend. Data are concerning mostly the fleet segment 12-24 m.

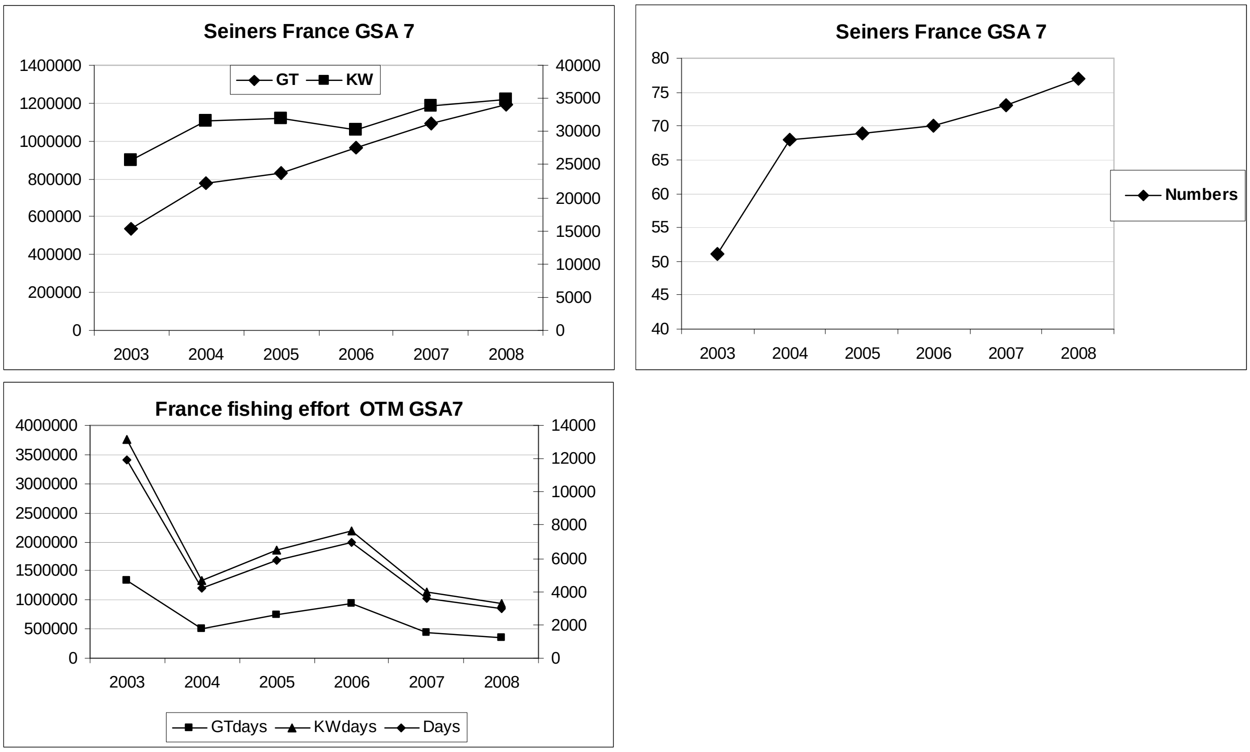


Fig. 6.2.3 Trends in French fleet specific effort.

Greece

No fleet or capacity data have been submitted by Greece at the meeting. Data used in SGMED-08-03 are here included. They concerns only fleets exploiting the European hake in GSA 20, 22 and 23, by all gear and fleet segments, with the historical trends.

<u>Fleets exploiting the European hake in GSA 20:</u> The available capacity indicators (number of vessels and GT) show declining trends over the period 1991-2007.

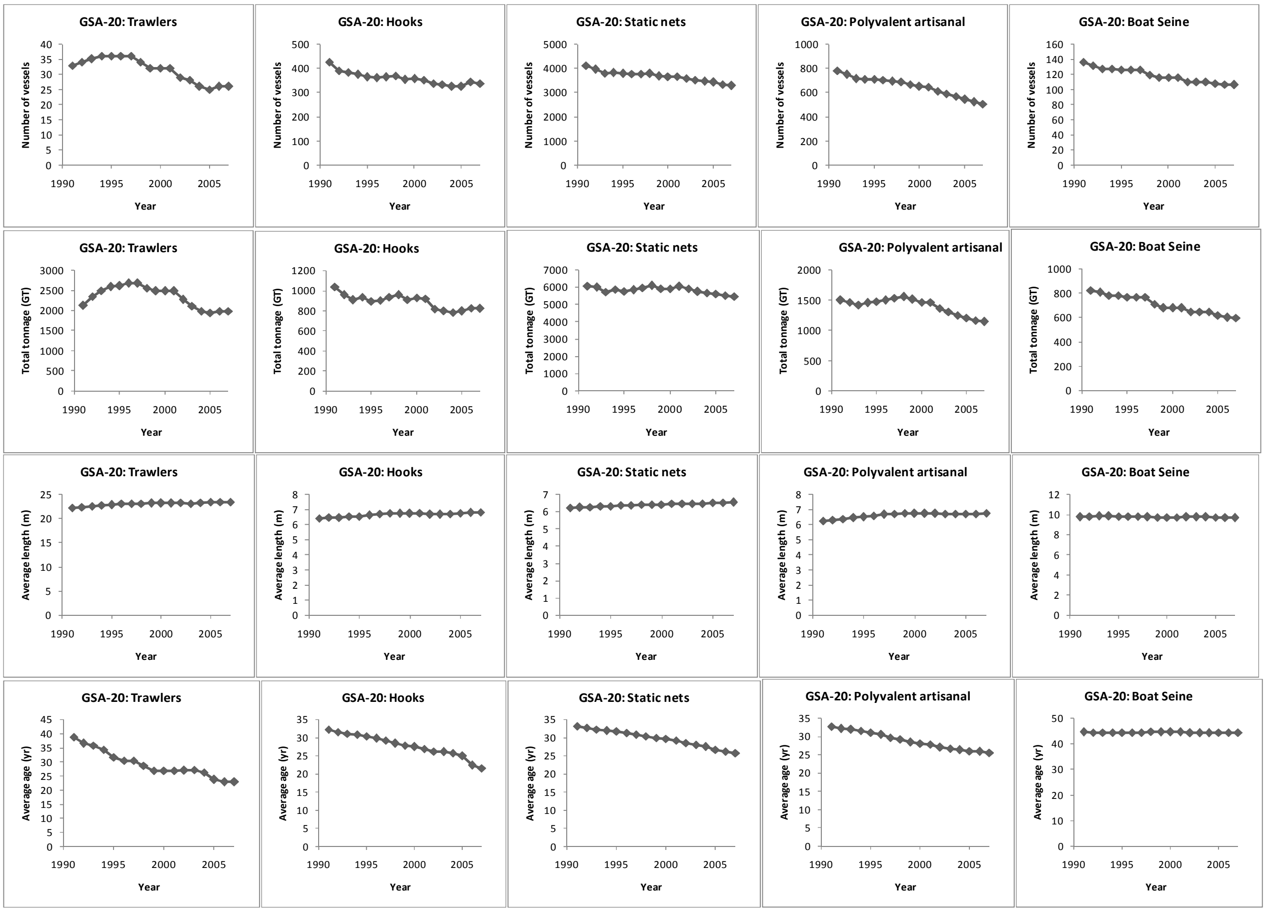


Fig. 6.2.4 Trends in Greek fleet specific effort.

Fleets exploiting the European hake in GSA 22: The available capacity indicators (number of vessels and GT) show declining trends over the period 1991-2007, with the exception of the GT for trawlers.

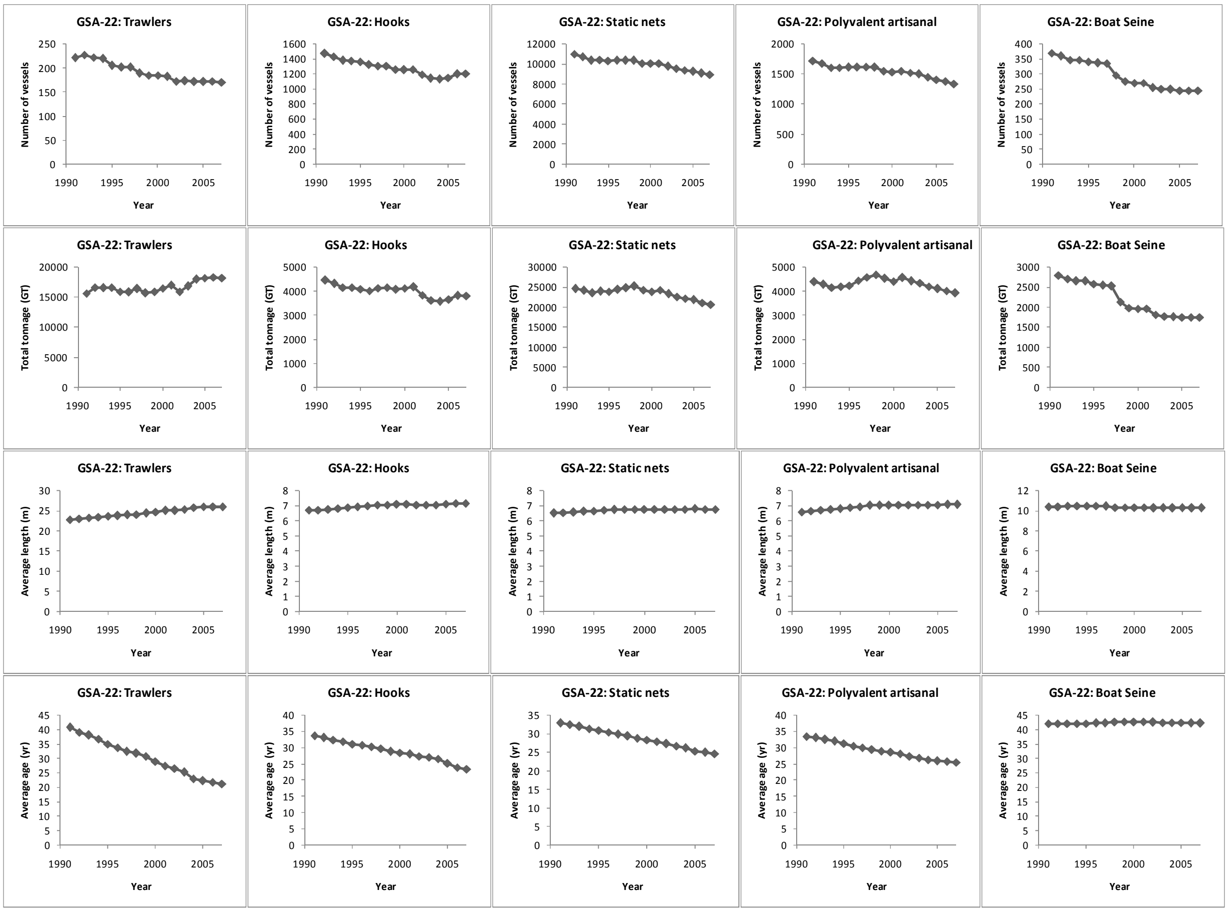


Fig. 6.2.5 Trends in Greek fleet specific effort.

Fleets exploiting the European hake in GSA 23: The available capacity indicators (number of vessels and GT) show declining trends over the period 1991-2007, except for the set nets, which show an increasing trend.

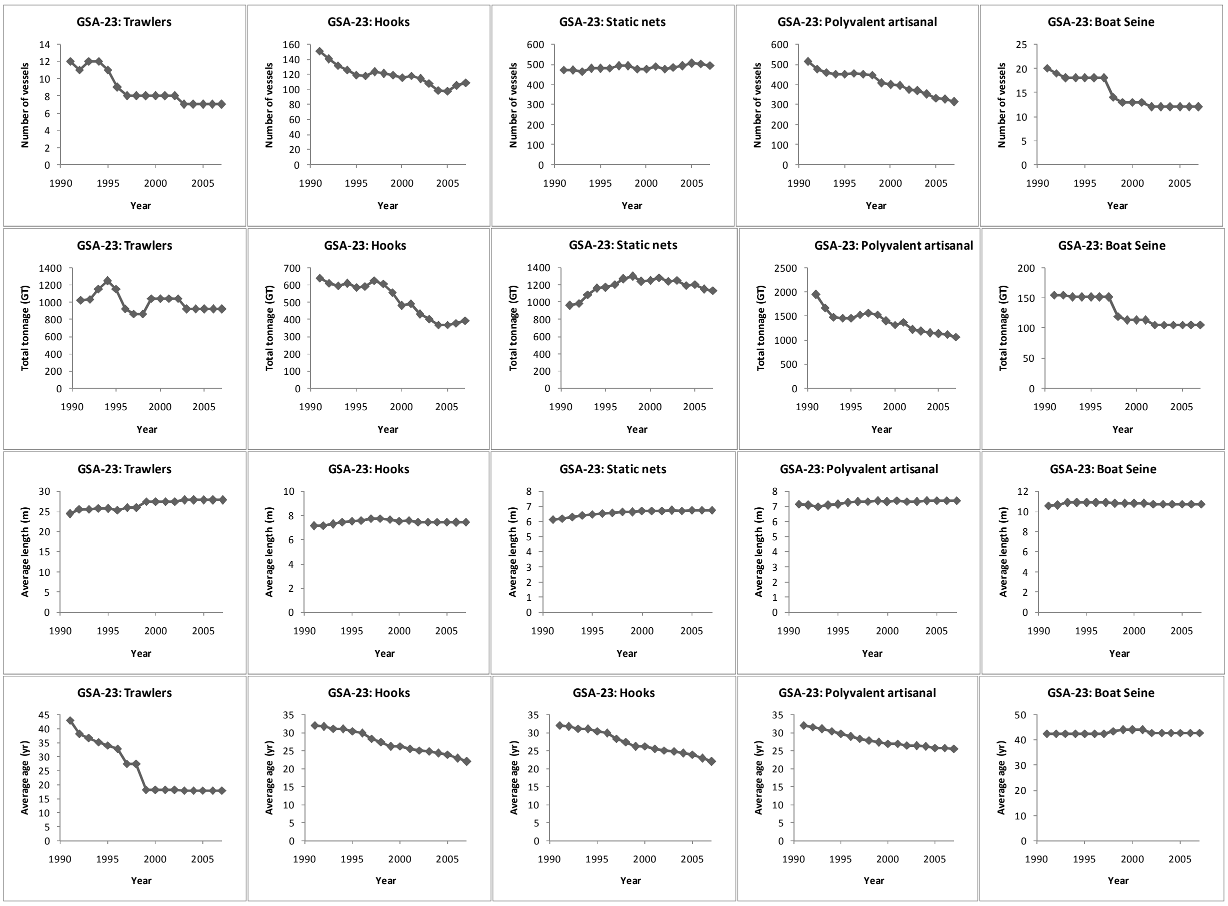


Fig. 6.2.6 Trends in Greek fleet specific effort.

Italy

Data are available for the period 2002-2007 by fleet segment and by GSA. The complete set of information (number of vessels, kw, GT, age, days, kw*days and GT*days) is available by gear. Trends are possibly affected by the gear classification adopted, which moved several polyvalent vessels to trawlers or to other segments. Previous historical data were not available at the meeting. Due to the number of variables, data on fishing effort are not showed in graphs in this synthesis.

Demersal trawlers (number of vessels by length segment and GSA):
GSA 9 –There is a slight increasing trend in the segment 0-12 m and an increasing trend in the segment 12-24 m.
GSA 10 – There is an increasing trend in the segment 12-24 m.
GSA 11 – There is an increasing trend in the segment 12-24 m and a decreasing trend for the segment 24-40 m.

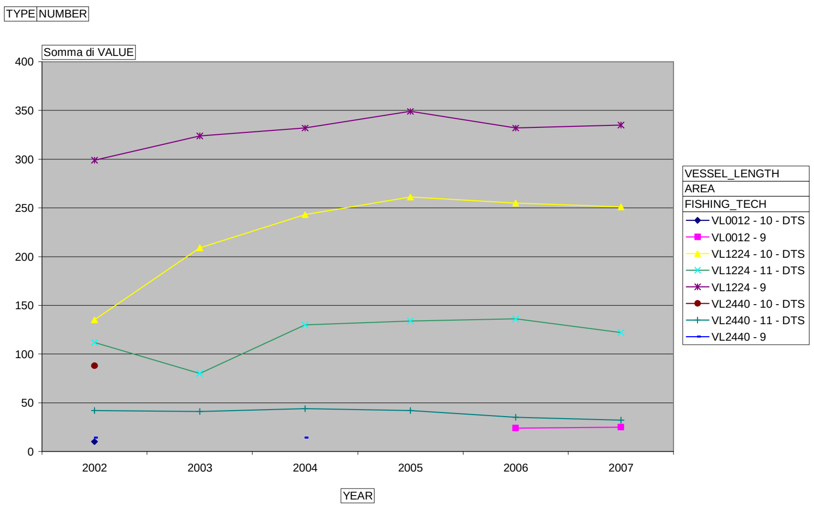


Fig. 6.2.7 Trends in Italian fleet specific effort.

GSA 16 – There is an increasing trend in the segment 12-24 m and stability in the segment 24-40 m.

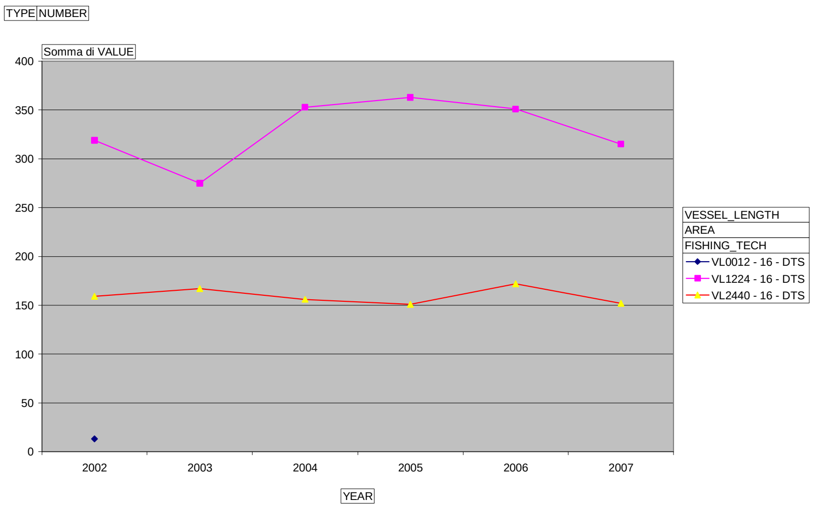


Fig. 6.2.8 Trends in Italian fleet specific effort.

GSA 17 – There is a slight increasing trend in the segment 0-12 m and a decreasing trend in the segments 12-24 m and 24-40 m.

GSA 18 – There is stability in the segment 12-24 m and a decreasing trend in the segments 0-12 m and 24-40 m.

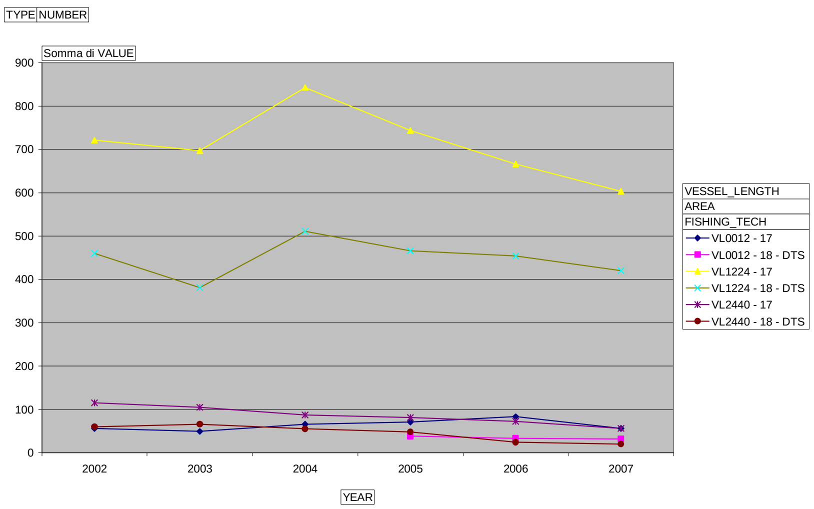


Fig. 6.2.9 Trends in Italian fleet specific effort.

GSA 19 – There is an increasing trend in the segment 12-24 m.

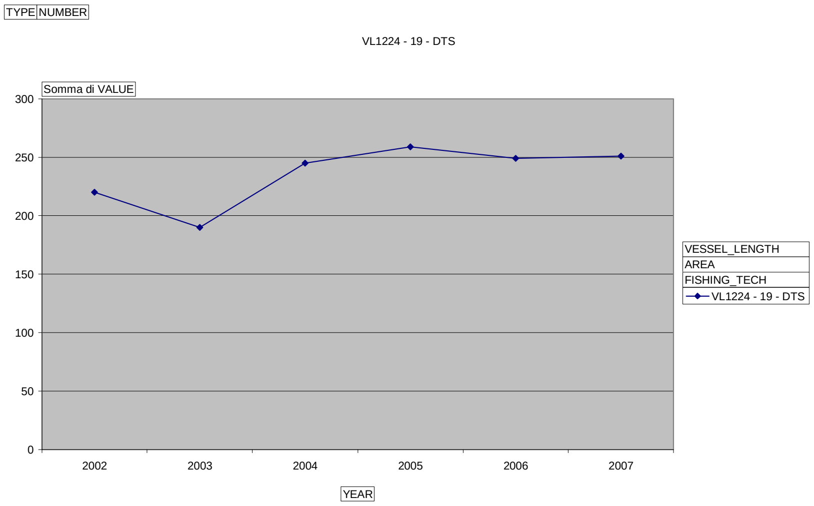


Fig. 6.2.10 Trends in Italian fleet specific effort.

<u>Demersal trawlers</u> (kw by length segment and by GSA)

GSA 9 – There is a stability in the segment 0-12 m and increasing trend in the segment 12-24 m.
GSA 10 – There is an increasing trend in the segment 12-24 m.
GSA 11 – There is an increasing trend in the segment 12-24 m and a decreasing trend in the segment 24-40 m.

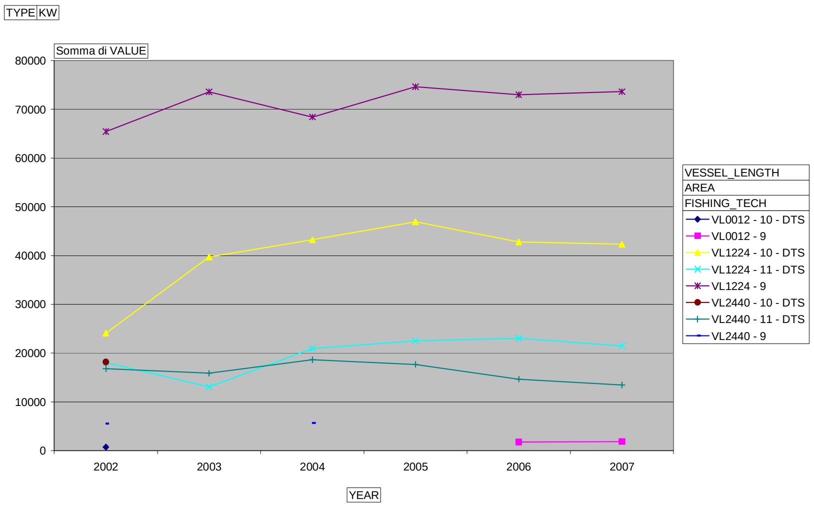


Fig. 6.2.11 Trends in Italian fleet specific effort.

GSA 16 – There is an increasing trend in the segment 12-24 m and stability in the segment 24-40 m.

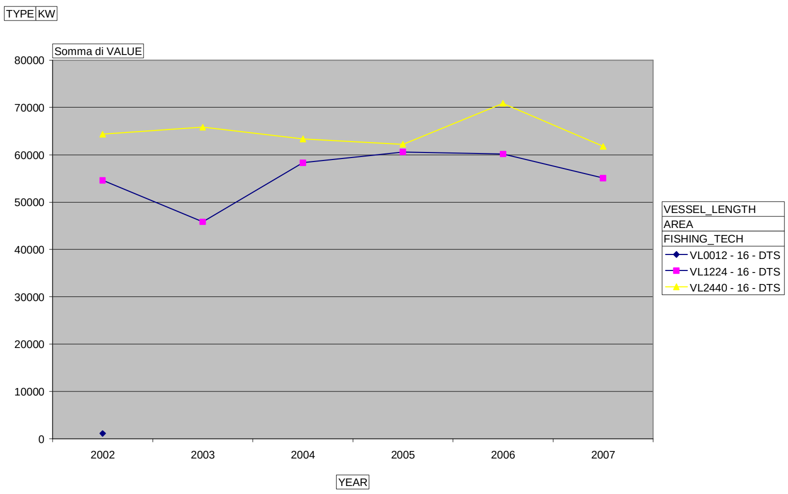


Fig. 6.2.12 Trends in Italian fleet specific effort.

GSA 17 – There is a slight increasing trend in the segment 0-12 m and a decreasing trend in the segments 12-24 m and 24-40 m.
GSA 18 – There is a slight decrease in the segment 0-12 m, an increasing trend in the segment 12-24 m and a strong decreasing trend in the segment 24-40 m.

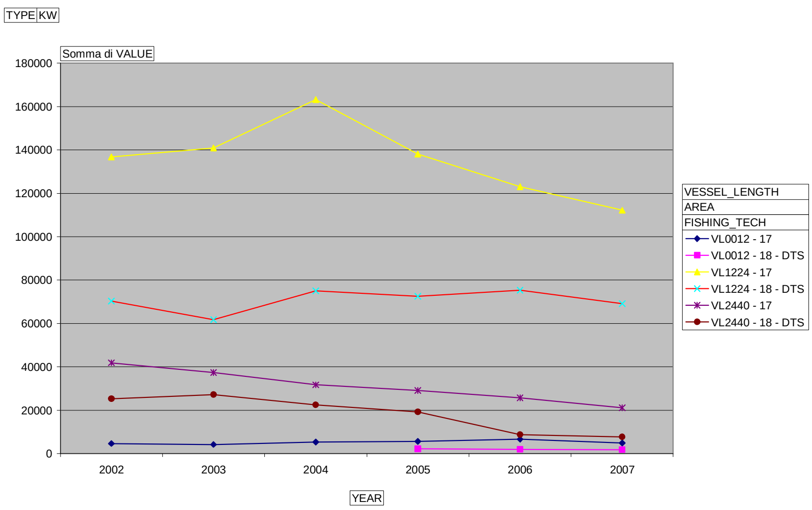


Fig. 6.2.13 Trends in Italian fleet specific effort.

GSA 19 – There is an increasing trend in the segment 12-24 m.

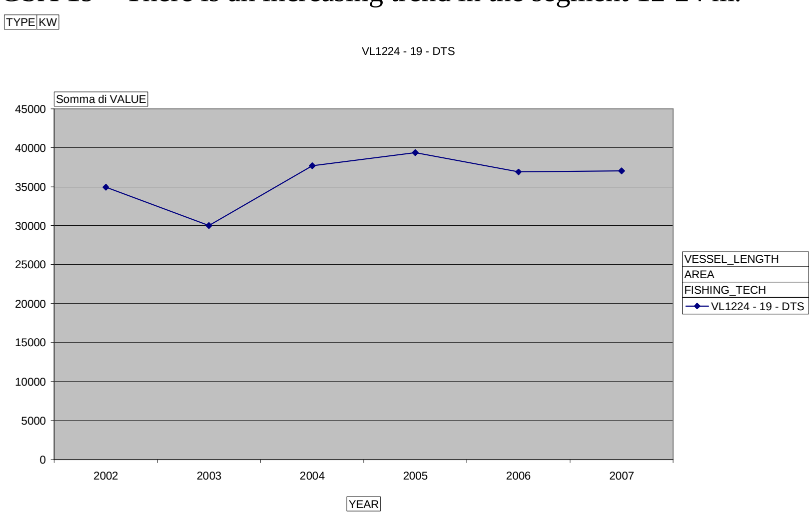


Fig. 6.2.14 Trends in Italian fleet specific effort.

Purse-seiners (number of vessels by length segment and by GSA):
GSA 9 –There is an increasing trend in the segment 12-24 m, while the segment 24-40 m was present only in 2002.
GSA 10 – There is an increasing trend in the segment 12-24 m, while the segment 24-40 m disappeared in 2003.
GSA 11 – Vessels (12-24 m) were present only in 2005.

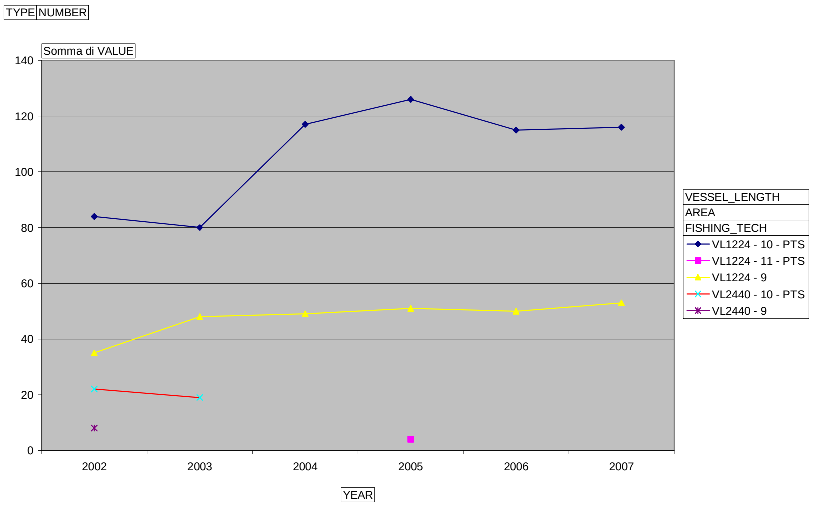


Fig. 6.2.15 Trends in Italian fleet specific effort.

GSA 16 – There is a decreasing trend in the segment 12-24 m, while the segment 24-40 m disappeared in 2003.

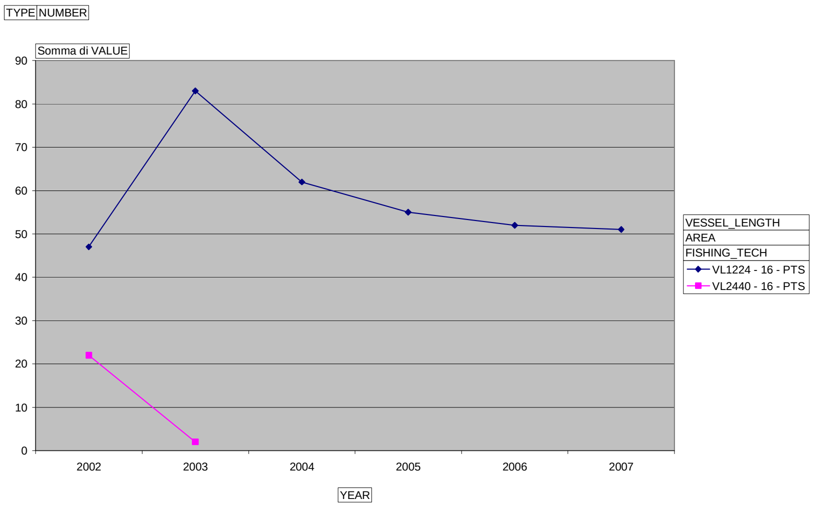


Fig. 6.2.16 Trends in Italian fleet specific effort.

GSA 17 – There is an increasing trend in the segment 12-24 m and a decreasing trend in the segment 24-40 m.
GSA 18 – There is an increasing in the segment 24-40 m, while the vessels belonging to the segment 12-24 m appear only in 2002 and 2005.

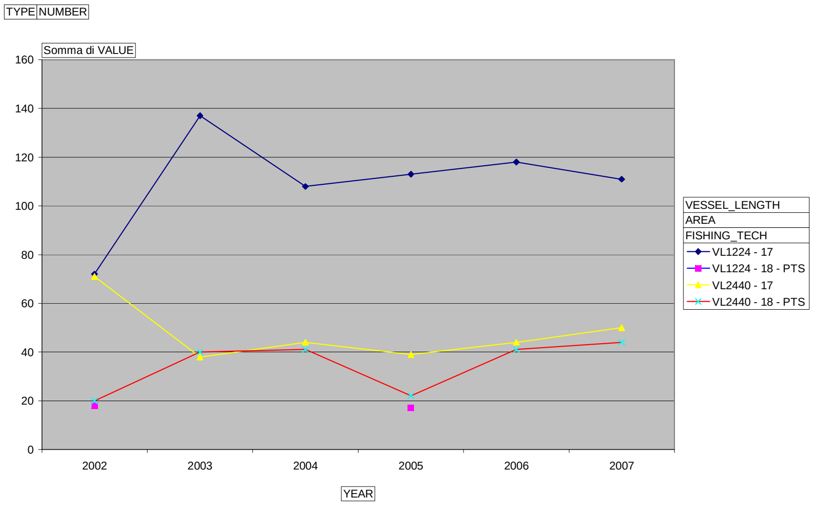


Fig. 6.2.17 Trends in Italian fleet specific effort.

GSA 19 – There is a decreasing trend in the segment 12-24 m, while vessels in the segment 24-40m appear only in 2003.

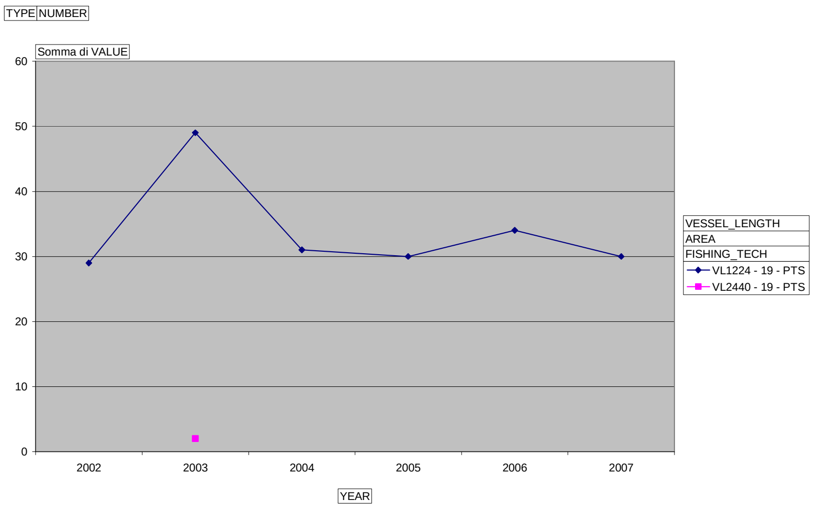


Fig. 6.2.18 Trends in Italian fleet specific effort.

<u>Purse seiners</u> (kw by length segment and by GSA):
GSA 9 – There is an increasing trend in the segment 12-24 m, while vessels in the segment 24-40 m appear only in 2002.
GSA 10 – There is an increasing trend in the segment 12-24 m, while vessels in the segment 24-40 m appear only in 2002 and 2003.
GSA 11 – There are vessels in the segment 12-24 m only in 2005.

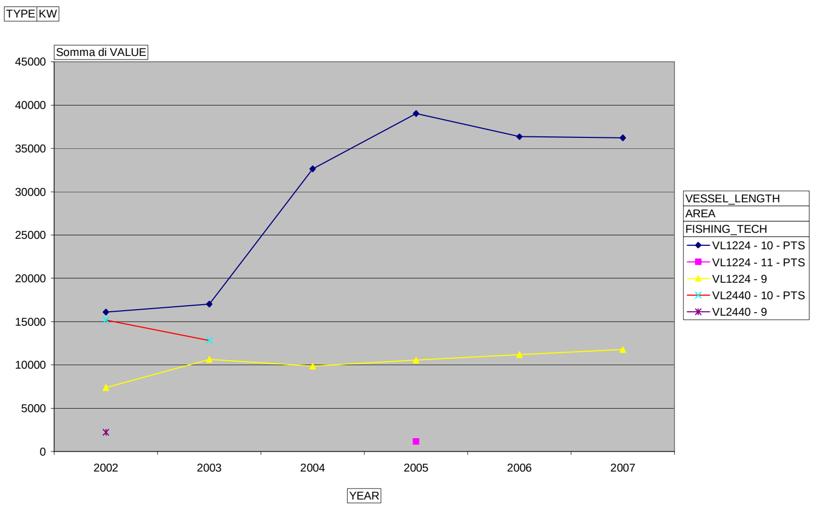


Fig. 6.2.19 Trends in Italian fleet specific effort.

GSA 16 – There is a slight increasing trend in the segment 12-24 m, while vessels in the segment 24-40 m appear only in 2002 and 2003.

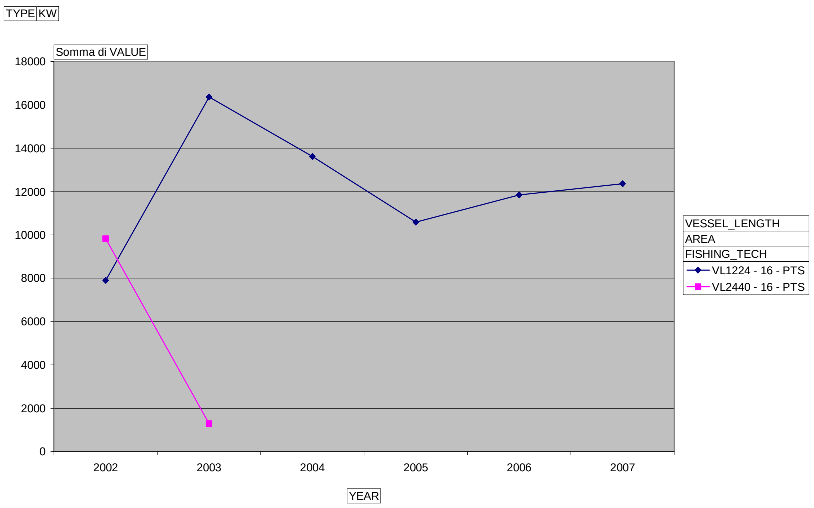


Fig. 6.2.20 Trends in Italian fleet specific effort.

GSA 17 – There is an increasing trend in the segment 12-24 m and a decreasing trend in the segment 24-40 m.

GSA 18 – There is an increasing trend in the segment 24-40 m, while the vessels belonging to the segment 12-24 m appear only in 2002 and 2005.

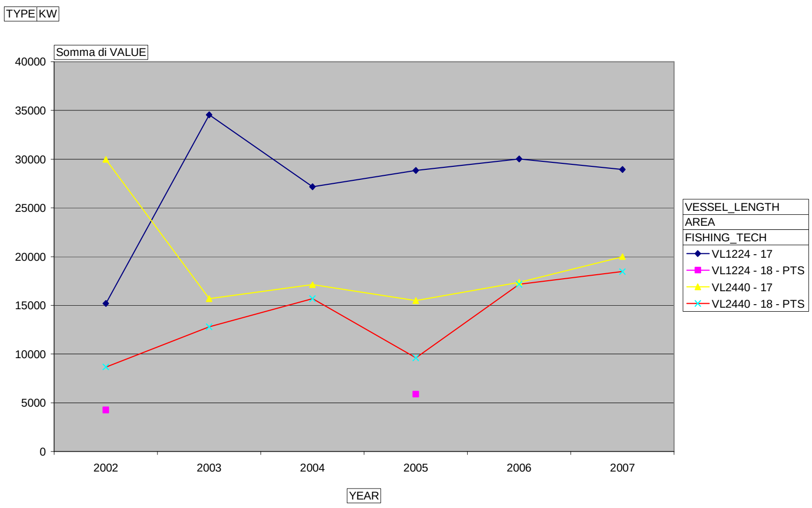


Fig. 6.2.21 Trends in Italian fleet specific effort.

GSA 19 – There is a decreasing trend in the segment 12-24 m, while vessels in the segment 24-40 appear only in 2003.

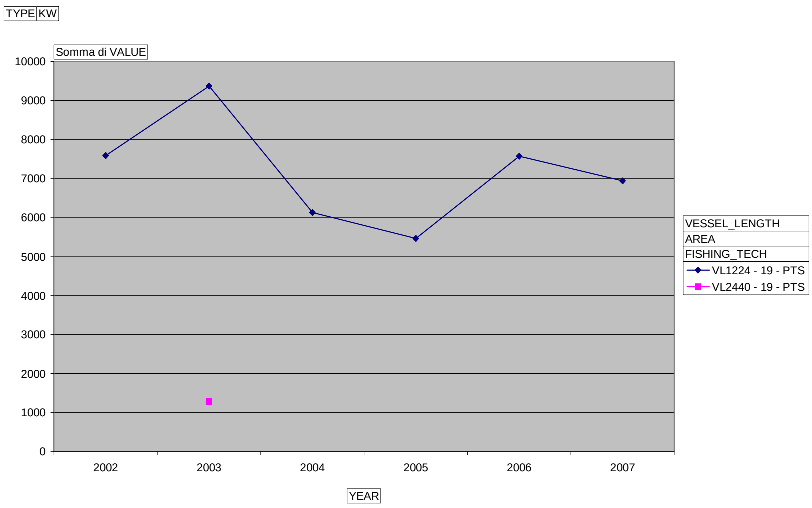


Fig. 6.2.22 Trends in Italian fleet specific effort.

Malta

Capacity data (days, kw*days and GT*days) from 2005 to 2008, by segment, have been provided for the meeting. The data are related to GSA 15.

Bottom trawlers (OTB)

The data related to the bottom trawlers (OTB) are concerning two segments (18-24 m and 24-40 m), but disaggregated data on the number of vessels are available only for 2008. All data show increasing trends over the period considered.

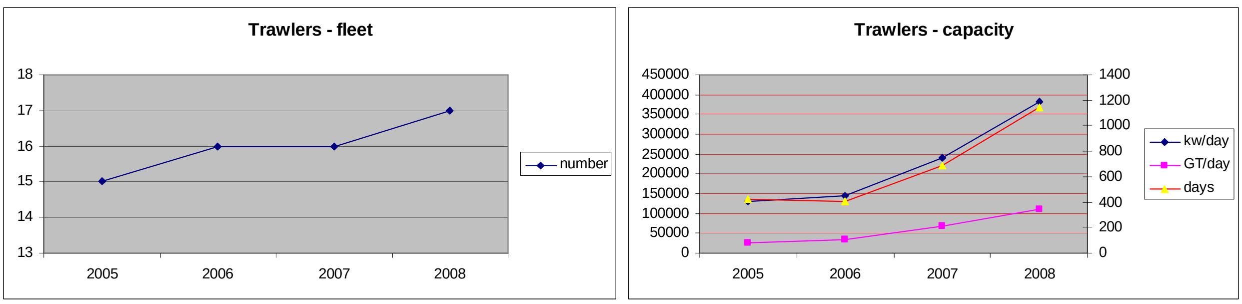


Fig. 6.2.23 Trends in Maltesean fleet specific effort.

Other bottom trawlers (TBB)
The capacity table provided by Malta includes this new category only in 2008, with two segments (0-12 m and 12-24 m). There are no data on the related fleet.

Purse-seiners (LA)
Capacity data on purse seiners (Lampara) targeting small pelagics are available for the period 2006-2008, but no information on the fleet is available. Data are showing a decreasing trend over the short period taken into account.

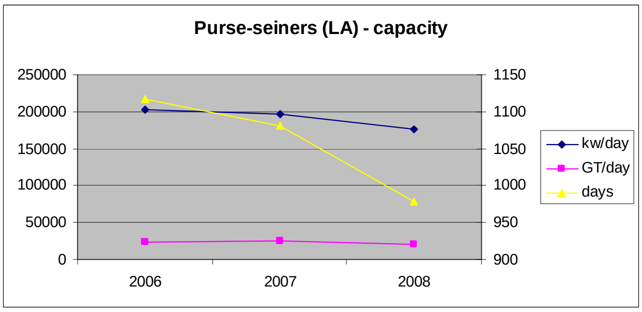


Fig. 6.2.24 Trends in Maltesean fleet specific effort.

Other surrounding nets (PS) for small pelagics.
The capacity table provided by Malta includes this new category only in 2008, with two segments (0-12 m and 12-24 m). There are no data on the related fleet.

Slovenia
Fleet data (number of vessels, GT and kw by segment) have been provided for the period 2006-2007, while data on fishing days have been provided for the period 2006-2008 but only for purse-seiners by segment. It is supposed that data are related to GSA 17.

Bottom trawlers (DTS)
Data on bottom trawlers are available by segment, but they are here presented in total by year. All trends are increasing in the two years available and this is due to the higher number (+2) of larger trawlers (12-24 m).

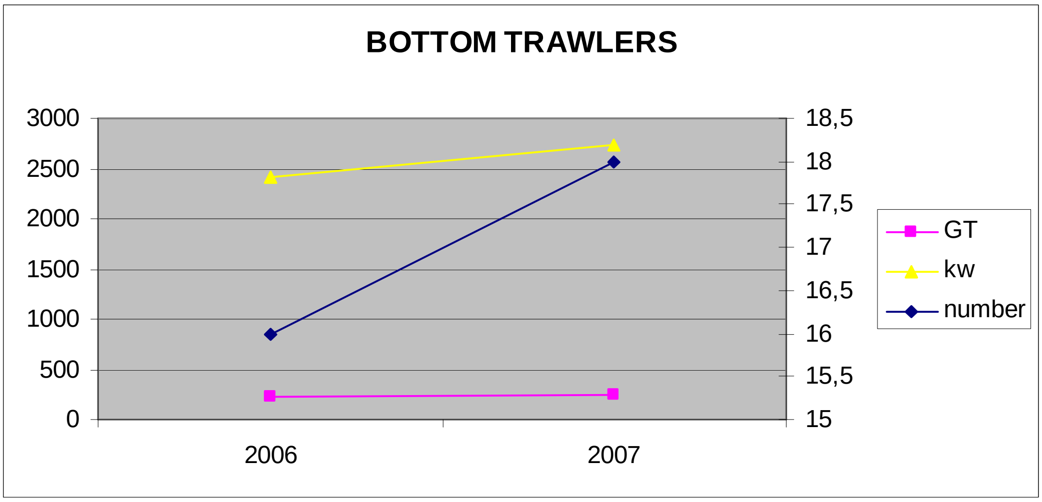


Fig. 6.2.25 Trends in Slovenian fleet specific effort.

Small pelagic fishery (PTS)

Data on purse seiners are partly confusing, due to the lack of fleet data for 2008 and to the use of different codes for the effort data. As a matter of fact, fleet data are referred to PTS for all segments in 2006 and 2007, while effort data are referred to PS for the segments 0-12 m and 12-24 m and to PTM for the segment 24-40 m for the period 2006-2008. Effort data for 2008 cannot be correlated to any reference fleet data. In this situation, it is difficult to define and understand trends: the fleet decreased in 2007 (- 1 vessel in the segment 0-12 m), but data on 2008 are not available; kw and GT are stable in 2006 and 2007, but data on 2008 are again not available, while the total number of fishing days is slightly decreasing over the period 2006-2008.

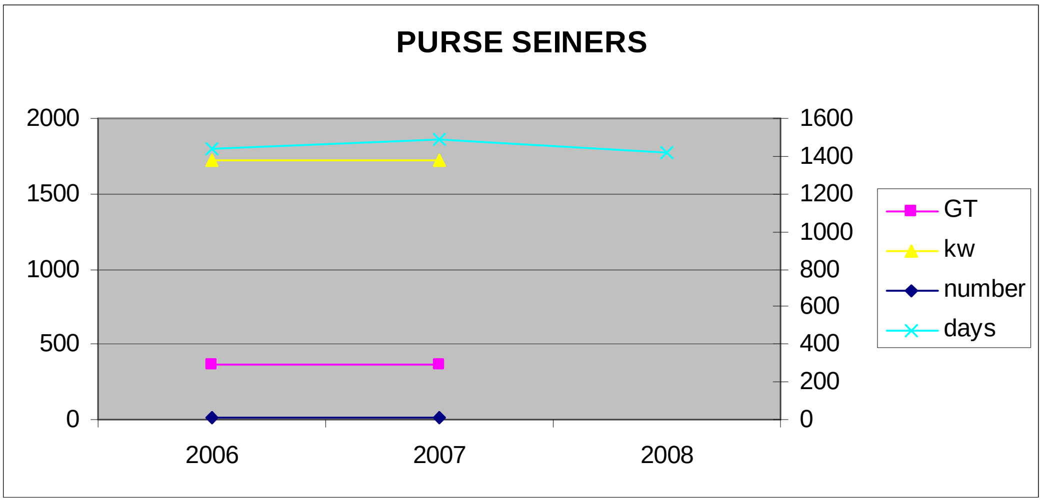


Fig. 6.2.26 Trends in Slovenian fleet specific effort.

Spain

No data have been provided by Spain for the meeting. Fleet data have been provided by the experts during the meeting, for the fleets in GSA 1 and 6. No data are available for GSA 2 and 5, or for capacity or effort in all the GSAs.

<u>Bottom trawlers</u> (GSA 1 and GSA 6)

The few data available for GSA 1 (2005-2007) show a slightly increasing trend of the fleet. The historical trend of the fleet in GSA 6 (1998-2007) shows a clear decreasing trend.

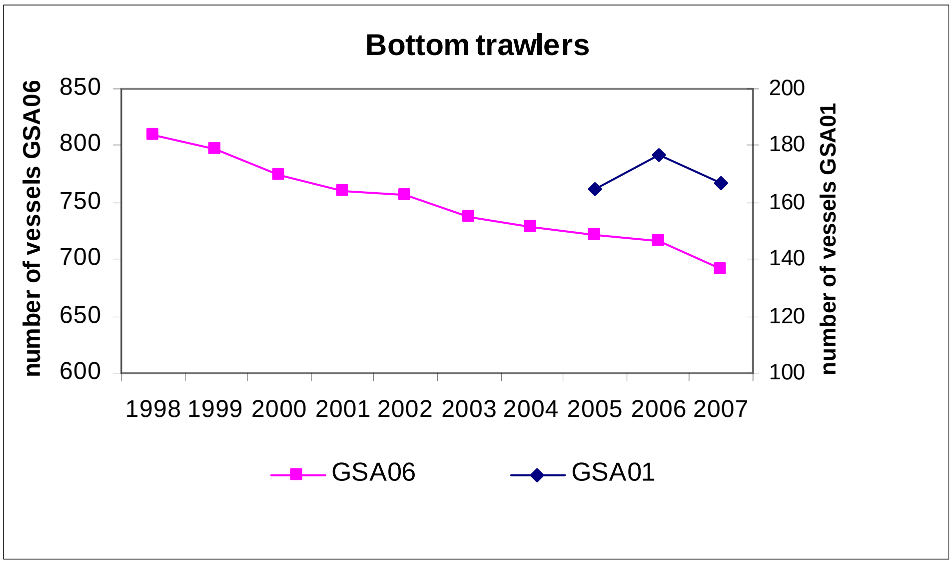


Fig. 6.2.27 Trends in Spanish fleet specific effort.

<u>Purse seiners</u> (GSA 1 and GSA 6)

The historical trends of the fleets in GSA 1 and GSA 6 (1998-2007, with a hole in 1999) shows a clear decreasing trend during the period analysed.

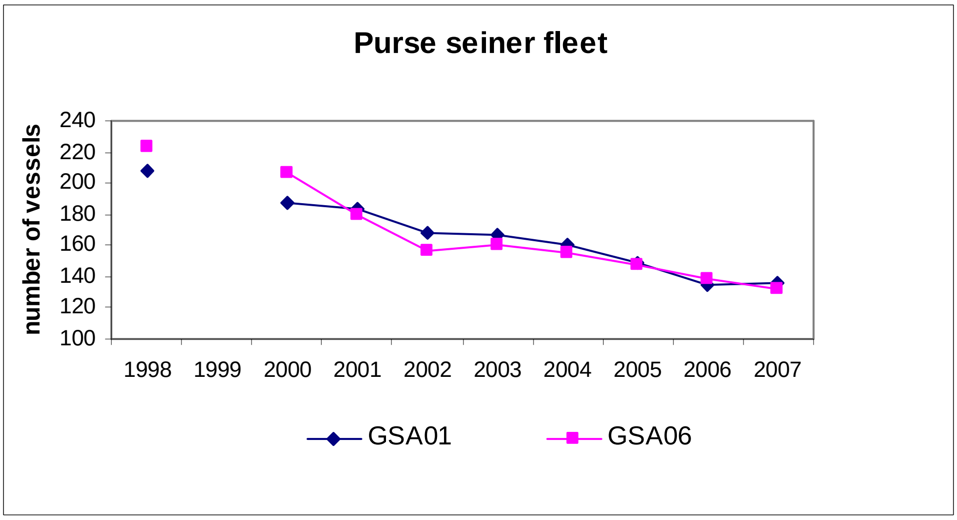


Fig. 6.2.28 Trends in Spanish fleet specific effort.

SGMED conclusions and recommendations:

The following Table 6.2.1 summarises the data presented in the document by GSA and MS concerned, for the major fisheries analysed. For bottom trawlers, trends are equally positive and negative, with data missing in several GSAs. For purse seiners, trends are again equally positive and negative, with a majority of GSAs were data are not available.

SGMED concludes that there is no evidence of a general decline in fishing capacity of the Mediterranean fleets. However, this might be also the result of changes in the classification system (i.e: from polyvalent to a specific gear type).

Table 6.2.1 Overview on effort trends observed over recent years as plotted in the figures above, by country and GSA.

				TREND											
				Bottom trawlers				Pelagic trawlers				Purse seiners for small pelagics			
MS	GSA	series	source	no.	kw	GT	E/Day	no.	kw	GT	E/Day	no.	kw	GT	E/Day
Spain	1	2005-2007	E	+	nd	nd	nd					nd	nd	nd	nd
Spain	2		MS	nd	nd	nd	nd					nd	nd	nd	nd
Spain	5		MS	nd	nd	nd	nd					nd	nd	nd	nd
Spain	6	1998-2007	E	-	nd	nd	nd					-	nd	nd	nd
France	7	2003-2008	MS	-	-	-	-	+	+	+	-	nd	nd	nd	nd
France	8		MS	nd	nd	nd	nd					nd	nd	nd	nd
Italy	9	2002-2007	MS	+	+	a	a					+	+	a	a
Italy	10	2002-2007	MS	+	+	a	a					+	+	a	a
Italy	11	2002-2007	MS	+	+	a	a					na	na	na	na
Malta	15	2005-2008	MS/E	+	na	na	+					nd	nd	nd	na
Italy	16	2002-2007	MS	+	+	a	a					-	-	a	a
Italy	17	2002-2007	MS	-	-	a	a					+	+	a	a
Slovenia	17	2006-2008	MS	+	+	+	nd					-	=	=	-
Italy	18	2002-2007	MS	-	-	a	a					+	+	a	a
Italy	19	2002-2007	MS	+	+	a	a					-	-	a	a
Greece	20	1991-2007	E	-	nd	-	nd					nd	nd	nd	nd
Greece	22	1991-2007	E	-	nd	+	nd					nd	nd	nd	nd
Greece	23	1991-2007	E	-	nd	-	nd					nd	nd	nd	nd
Cyprus	25	2005-2007	MS	-	-	-	-					-	-	-	-

legenda: **MS** Member State; **E** Experts; **-** negative trend; **+** positive trend; **=** stability; **nd** -no data available; **na** -non applicable; **a** -data available but not plotted.

From the above reported data, it is also evident that it is essential to improve the data collection system for the fleet information. Several MS did not provide the relevant data on fleets, capacity and effort (required under the economic section), while updated information is often missing. Data provided are often incomplete and sometimes are inconsistent. It should be essential to revise the available data series trying to provide coherence between the previous DCR data and the new DCF data otherwise it will be impossible to define trends of the basic fleet parameters. Reported data on fleets are not always usable and their utility for stock assessments and management purposes appears questionable, even if it is reasonable to assume that reliable data are available at national level in all MS.

6.3. g) Review of proposed methodologies to standardize the MEDITS and GRUND surveys time series to account for unbalanced sampling designs and appropriate data distributions. Specific work has been initiated in this regard.

Main General Points

Issues and importance of CPUE data

CPUE data can be generated from commercial data as catch/fishing day/boat/area, or from survey as catch/swept area/area/strata. CPUE's are the easiest data to collect and analyze, however the analysis of this data can generate various types of errors. The factors that can make CPUE's non representative of stock biomass are: unaccounted changes in catchability over time, changes in fish spatial distribution and availability (a), changes in fishing behavioural responses that would affect a and cause hyperdepletion or hyperstability of the CPUE time series (Hilborn and Walters, 1992). These are all sources of errors and biases that can be generated by modeling CPUEs under varying catchability (q) and a. The bias can propagate as errors in the estimation of stock biomass indices and thus in the stock assessment.

Generalized Linear Models (GLM) (MacCullagh and Nelder 1999), Generalized Additive Models (GAM) (Hastie and Tibshirani, 1990) and Generalized Mixed Models (GLMM) (Venables and Dichmont, 2004) are powerful tool for standardizing CPUEs and to build robust stock indices. In addition if year is treated as a factor, the time effect will be the best estimate of the abundance trend (Hilborn and Walters, 1992, Stefánsson, 1996). However, if there are effects, such as gear modification or others, that affect the catchability but are unquantifiable in the model, the GLM/GAM/GLMM models will ascribe those effects to change in abundance rather than gear (Hilborn and Walters, 1992). Therefore, the use of CPUE data must be conducted very carefully, considering the temporal and spatial development of fishing or survey spatial/temporal stratification.

Need and advantages of standardization

The risk associated with building stock assessments on “raw” catch rates from either survey or commercial data have been known for many years and various methods to standardise catch and effort data have been developed. Fishery data are well known to be highly variable and noisy, thus a wide range of methodologies are applied to improve experimental design and data analysis. Although this group of methods were revealed successful in respect to the need to provide unbiased indices of abundance, one of their major difficulties is related to the high occurrence of low values or zeros. This kind of data represented a real challenge for scientists and statisticians mining some of the main assumptions on which Gaussian models rely. These data are generally referred as zero-inflated distributed and an array of different approaches has been developed in the last years for working with them. The problem of zero inflated data is particularly true for species with very rare occurrence such as some elasmobranchs or in the case the indices of abundance are estimated by year classes (i.e. that it is usually the case for indices used for tuning of VPA type of models) which greatly reduces the numbers of non- zero tows (Stefánsson, 1996).
The GLM/GAM/GLMM models has the advantage over the stratified analysis that the underlying spatial pattern of the fish density can be modeled explicitly, an aspect ignored by the stratified analysis. Also, data from all years of the survey can be analyzed at once and data from incomplete surveys can be included.

Survey data standardization (MEDITS, GRUND)

Distribution and link function

GLM/GAM/GLMM models extend the framework of classical (normal-based) linear models to allow the error distribution to be any member of the exponential dispersion family. According to the type of data different distributions and relative link functions need to be chosen.

- If the interest is to model the density (numbers of individuals), e.g. discrete data, a Poisson, Binomial, Negative binomial distribution among the others can be used. More specifically depending on the number of zero’s in the data some distributions are more appropriate than others.

- If abundance data (kg), e.g. continuous data, is modelled a Gaussian, LogNormal, Gamma, Negative binomial and quasi-poisson distributions among the others can be used.

The link function, which relates the linear predictor to the mean, needs to be chosen depending on the error distribution and the type of data.

Swept area

The swept area estimation is an essential parameter that needs to be as accurate as possible as it used to scale fish abundance or density. The swept area enters into the regression model as the part of the modelled CPUE index and either as an offset parameter or as a predictor depending on whether the estimate is very accurate or not. Setting swept area as a model offset in a GLM/GAM/GLMM models are equivalent to setting it's regression coefficient equal to 1 (MacCullagh and Nelder, 1999) and this is commonly used in survey standardization (Helser et al., 2004; Gutiérrez et al., 2008).

Zero inflation

There are different methods to deal with zero inflated data. Within GLM's the simplest way to deal with zeros is the transformation of the CPUE (by addition of 1 or a small number to the zero catch), however this approach has been widely criticized as it can yield biased estimates. Alternatively the use of the negative binomial error structure to model the predicted catch also avoids the need to adjust the observed catch values (Campbell, 2004). For situations with even more inflated data, the Delta method can be used (Lo et al., 1992; Stefánsson,, 1996). This is based on the product of fitted values from two GLM/GAM/GLMM models. The index combines year effects from a binomial GLM/GAM/GLMM models that estimates the probability, p, of a positive observation, and a second GLM/GAM/GLMM models that estimates the mean, μ, conditioned on a positive observation. The final Delta GLM/GAM/GLMM models abundance index is the product of the year effects from the two models, pμ.

Thus, within GLM/GAM/GLMM models to address zero inflation the following method can be adopted:

1. presence/absence (1,0) are firstly modeled as a binary process using the binomial distribution. Model predictions Pij (where i and j are geographical coordinates) indicate the probability of finding a certain species at a particular location
2. fish density (n km-2) is modeled using a negative binomial distribution (or any other appropriate distribution for the data) to obtain the model predictions Dij.
3. Final overall predictions Yij are obtained by multiplying the results of the previous two model fit: Yij = Pij * Dij

Environmental data

Environmental variables as explanatory covariates can be used to separate the variation in the catch rates per tow into that due to inter-annual variation in population size and that due to differences in the environmental variables (Brynjarsdottir and Stefansson, 2004)

Spatial and Temporal data correlation

A common problem with fisheries data is autocorrelation at a temporal and spatial level. Regression models such as GLM's and GAM's assume data independence and therefore when dealing with CPUE data this assumption is violated if not dealt with explicitly. As a consequence data exhibiting the autocorrelation of time series and spatial processes are excluded although there are some ways to relax such assumptions as using quasi-likelihood estimation (MacCullagh and Nelder, 1999). To deal with spatial correlation in GLM's the use of Spatial-GLM's resolves the spatial bias and yields unbiased indices (Nishida and Chen, 2004). To account for the spatial correlation effect in GAMs and get a more accurate estimate of the significance of the terms, the p-values were computed using a wild bootstrap approach (Davison and Hinkley, 1997). Specifically, for a given fitted model: (1) the residuals were extracted, (2) rescaled, to have the same variance as the estimated scale parameter of the model, (3) their signs randomly inverted before being (4) used as a response variable in a model (having the same set of covariates as the original model). Steps 3–4 are repeated usually 1000 times.

Working procedure for MEDITS standardization in R

1. Select species of interest
2. Merge MEDITS TA with either TB or TC files for all years available
3. Code season, mean depth, environmental variables, etc.
4. Transform latitude and longitude in UTM system
5. Calculate swept area
6. Subset for biomass or abundance as response
7. If abundance is selected divide in age classes or not
8. Assess the degree of zero inflation to decide which method to use
9. Chose modelling framework (GLM, GAM, GLMM) and initial error distribution and link function
10. Example of a GLM model script for hake in R:

GLM(individuals MERLMER/swep area~year+season+lat+lon+ depth+offset=(swept), family="Gaussian"(link=log), na.action=na.remove)

11. Compare different models checking term significance, AIC, GCV and others and residuals fits using ANOVA tests and other diagnostics
12. Plot fits over years to visualize temporal trends and add confidence intervals

GRUND

In Italian waters the GRUND is an important source of survey information that ranges over the period 1985 to present. This survey in most GSA's charters commercial vessels with un-standardized nets and there have been frequent gear/vessels changes over time within the same GSAs. An exception is the GSA 15 and 16 where the same net and boat have been used consistently until summer 2008. The standardization of the GRUND survey indices is extremely important to build unbiased indices of abundance/density. The critical point is the fact that fishing power and catchability have changed at each gear change thus introducing a potential bias. That is that likely fishing equipment has undergone technological creeping over the 25 years and the fishing power has increased. This could potentially mask stock declines unless it is accounted for. Standardizing for increased fishing power is difficult unless an inter-calibration is performed. One inter-calibration experiment has been carried out in 1999 (Lembo 1999) between the vessels of all the Italian GSA's. In this context some correcting coefficients had been estimated and could be revised using a methodological approach. The inter-calibration is however a one point in time that is valid only for the boats that participated at the time. Prior and posterior gear change within GSA has no inter-calibration coefficient. One possibility is jointly fitting a GLM/GLMM/GAM to GRUND and MEDITS data from 1994 onward, in the same areas. Such model would estimate survey effect and estimate the changes in catchability at each gear change in the GRUND survey using as a reference the MEDITS which is assumed to have remained constant over time.

MEDITS intercalibration

In the MEDITS survey the same net is used on vessels ranging from small trawlers to oceanographic vessels. While still untested, this has likely an effect on catchability and survey data. As SGMED is exploring the possibility of doing assessments on merged GSA's, understanding how the MEDITS net performs on different types of vessels is very important. Within data standardization effort, the performance of different vessels should be investigated. If mayor differences between GSA's emerge, the MEDITS steering committee should address it.

Commercial CPUE Standardization

Standardizing commercial CPUE's entails the same steps as for survey data with some further complications and risks of bias than with survey CPUEs. The main problems are the estimation of fishing time/effort, fishing area, fishing strategy and change in fishing power and technological creep over time. Fishing time/effort needs to be known with accuracy as it is used to build the CPUE and can be used as an offset parameter. In some areas there are only daily fishing trips and others multiple day trips. Fishing area should be available for standardization of the CPUE as if there are unaccounted shifts of fishing pattern or of the stock distribution the CPUEs tend to be biased. For this reason the interaction between year and geographical information should be modelled. In a multi-species fishery as in the Mediterranean, identifying the fishing strategy is important for the standardization. PCA approaches are used routinely (Sbrana et al., 2003; Maynou et al., 2004) to identify the different metiers and quantify the amount of effort directed towards a single specie (or group of species). Target fishery can lead to overestimated CPUE's if fishermen are able to find fish aggregations, like for the North Sea cod, while non-target fisheries tend to be less biased (Maynou et al., 2003). In the standardization process once year, month and geographical information are used as predictors a choice needs to be made regarding the use of fleet technical characteristics as covariates. In some cases only vessel ID is used as a covariate (Bataille and Quinn, 2004) or others vessel technical details can be used such as HP/Kw, GRT/GT and vessel Length. Depending on how much variance is explained by either set of predictors or the correlation between them, one can use either or combine all the predictors in the CPUE standardization.

SGMED conclusions and recommendations

The current SURBA assessments models made using MEDITS time series or VPA tuned with MEDITS time series are run on un-standardized data of abundance biomass or year class strength. SGMED consider that this particular aspect would require an ad-hoc working group to develop and test species specific R script that would be used by the different GSA to standardise MEDITS time series used into stock assessment. In addition the performance and estimates of SURBA assessments and VPA should be compared when the models that are run with standardized or un-standardized data. Thus, SGMED recommends that such ad-hoc working group should convene next year and deal specifically with this task.

6.4. i) 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, develop specific case studies for Mediterranean fisheries (e.g. anchovy, sardine and Nephrops), and advise 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 (to be continued in SGMED-09-03).

The final report "Survey of existing bioeconomic models" by Prellezo et al. (2009) contains a review of the technical characteristics of bioeconomic models developed in Europe. According to the technical characteristics of the models reviewed, this working group is asked to select the model(s) most likely to be applicable to Mediterranean fisheries, using stock assessments (made during STECF/SGMED meetings, which will provide the biological information) and the economic data provided by the fisheries Data Collection Regulation (DCR). The models reviewed by Prellezo et al. (2009) were:

EIAA, TEMAS, MOSES, BEMMFISH[1], BIRDMOD (with Aladym), MEFISTO, AHF-EFIMAS[2], EMMFID, SRRMCF, COBAS, ECOCORP, ECONMULT and FLR-EFIMAS[2].

We followed the same assessment criteria employed by Prellezo et al. (2009):
- Model orientation: If the model is output or input driven (i.e., quota based fishery or effort based management).
- If it is a simulation (what if) or an optimization model (what's best).
- Characteristics of the economic and biological modules and the links between them.
- Data requirements: Biological and economic modules initializations. We have paid particular attention to the model requirements of stocks assessments and also analyzed data requirements in relation to whether the DCR provides sufficient information for each model.
- The output format and in particular the bioeconomic indicators that each model produces.

In the context of Mediterranean fisheries and to answer to the ToR of the STECF/SGMED-09-02, we selected those simulation models that are input driven, and based on age-structured populations. This reduces the number of applicable models to: BIRDMOD (with Aladym) and MEFISTO. The toolbox FLR can be used to develop *adhoc* bioeconomic fisheries models, and has been used in the context of the EFIMAS

1 BEMMFISH is the acronym of a multi-species, multi-fleet bioeconomic simulation model developed by Árnason & Koholka in the context of the BEMMFISH project, but this model should not be confused with the project.

2 FLR continues to be developed beyond the project EFIMAS

project in 3 Mediterranean case studies, but there is no sufficient expertise within the working group to apply FLR modelling tools to produce advice to STECF at present, although it would certainly be interesting to explore FLR in the near future.

BIRDMOD with Aladym[3]:
BIRDMOD is a bio-economic multi-species and multi-gear simulation model. The main objective of the model is to measure the effects of different management policies from a biological, economic and social point of view. These are mainly based on fishing effort restrictions, but also technical and economic measures, such as variations in gear selectivity and introduction of taxes and subsidies. It is an analytical model composed by four modules and structured into three different dimensions. The managerial, biological, economic and that of state variation are the modules considered. The dimensions taken into account are the temporal dimension, technical dimension related to the fleet and the structural dimension related to the species. The model simulates the sector evolution over the number of years specified by users. The final output is represented by the historical series simulated for the variables included in the logical-conceptual pattern of the model. Some references and applications: Accadia and Spagnolo (2006), Lembo et al. (2009).

Biological sub-model:
Aladym uses classical age-length models with (trawl) survey derived population parameters and indices (i.e. recruitment) as primary information. It can predict catches although does not use fishery-dependent information. It can be used as a single-stock, single-fleet (trawl) simulation model. It accounts for sex differences in biological growth parameters and works at monthly time steps. It allows including stochasticity in some biological parameters. Basic biological parameters needed are: von Bertalanffy Growth Function parameters, a-b parameters of the length-weight relationship, Selection parameters of the fleet, maturity ogives, S/R parameters or vectors of offspring, sex-ratio, total and natural mortality, the latter as a point value or a vector. Also initial “guesstimates” for recruitment are necessary to start the model. Aladym can assist in building up different scenarios.

Economic sub-model:
The BIRDMOD economic sub-model is structured by fleet segment. This produces simulations by constant time intervals equal to a year. The main elements of the economic box are prices and costs functions. Two potential functional forms can be used to simulate price dynamics. Prices by fleet segment and species can be assumed as constant or a function of landings. Landings can be identified either with the production of the single fleet segment or the aggregate production of the reference market. The costs considered for each fishing system are broken down as follows: variable costs, fixed costs, labour costs, and interests and amortizations. On the basis of the structure of the economic account adopted, variable costs are subdivided into three components: cost of fuel and lubricant, commercial, and others variable costs. The first and the third are considered as a function of the total fishing days, whilst the commercial costs are estimated as a function of the aggregate landings. The fixed costs, subdivided into maintenance and other fixed costs, are estimated as a function of the gross tonnage. Finally, labour cost is calculated as a quota of the difference between revenues and variable costs.

Output: The final output is composed of the historical series simulated for the biological and economic variables included in the logical-conceptual pattern of the model, and several population indicators. This is reported in the following table:

3 Note that the Aladym version reviewed here is the latest: Lembo et al. (2009), *Aquatic Living Resources*, vol(22).

BIRDMOD model output			
By area and by fleet segment	**By area and by species**	**By area, by species and by length class**	**By area, by fleet segment and by species**
Net Profit Landings Landings per unit of GRT CPUE Total tonnage Total effort Average days at sea Revenues Average price	Biomass in number Biomass in weight Average SSB	Biomass in number Biomass in weight SSB	Landings Revenues Prices

MEFISTO

It is a fully integrated bio-economic simulation model, allowing simulating alternative management scenarios (technical measures, such as effort or selectivity changes, or economic measures such as subsidies or changing in fuel price). It is a multi-stock and multi-fleet model, incorporating technical interactions. It uses a linear or non-linear relationship between main (or target) species and secondary (or commercial bycatch) species. It uses a very detailed economic model at the vessel level (but can be easily adapted to work at fleet level, given that the economic data provided by DCR are aggregated at fleet level).

Some references and applications are: Lleonart et al. (2003), Maynou et al. (2006), Merino et al. (2007), Silvestri and Maynou (2009).

Biological sub-model:

MEFISTO uses classical age-structured models. It can simulate any number of main species and fleets and works at a yearly step. It can include stochasticity in the S/R function. Basic biological parameters needed: von Bertalanffy Growth Function parameters, a-b parameters of the length-weight relationship, Selection ogives, maturity ogives, S/R parameters (optionally, by default: constant recruitment). Abundance and fishing mortality of each cohort of each main stock must be provided and can be derived from annual assessments, such as those performed by this working group.

Economic submodel:

The economic submodel is hierarchically organized around the basic unit of vessel. A collection of vessels practicing the same fishery (~métier) are aggregated in a fleet object. Each vessel may have different technical characteristics, different costs, etc. but common parameters are entered at the fleet level (e.g., number of fishing days at sea, fuel price, etc.) The model allows computing the net profits over each simulation cycle (year) for each vessel. Depending on the net profits each vessel will allocate its effort or catchability level at the following iteration, depending on some pre-programmed behavioral rules.

Output: the standard set of indicators are: mean biomass, mean spawning stock biomass, number of recruits, stock averaged fishing mortality, catches by stock or fleet, effort, catchability, capital, number of boats, profits, total revenues and total costs. The value of each model's state variable can also be examined.

Comparing MEFISTO and BIRDMOD

The biological simulation box in MEFISTO and BIRDMOD are very similar in the sense that they follow standard age-structured biological models. But the steps followed to obtain the biological parameterization are fundamentally different: MEFISTO directly incorporates biological data from standard VPA-type assessment, while BIRDMOD is based on the Aladym biological simulation model. The Aladym model makes use of fishery-independent data, while MEFISTO uses only fishery-dependent data. In this sense, BIRDMOD and MEFISTO can be applied in a complementary and non-exclusive manner. One of the main differences between BIRDMOD and MEFISTO comes from the dimensions used to analyze the fleet. BIRDMOD (and the FLR-EFIMAS models for Mediterranean fisheries) perform simulations at level of fleet segment, while MEFISTO can produce projections for each vessel in the fleet. Fleet behaviour is then simulated following two different approaches. The Fisherman module in MEFISTO simulates the entry-exit and investment decisions for each vessel based on the profit generated in the past by the vessel. The State variation box in BIRDMOD (and FLR-EFIMAS models) simulates changes in the number of vessels and average days at sea by fleet segment based on the total profits realized by the fleet segment in the past.

Operational aspects: BIRDMOD (with Aladym) and FLR are based on the command-based R computer language. They can be run on any operating system. MEFISTO is a standalone, menu-driven, freeware program for Windows. Some participants in this working group have ample experience in running these programs.

Applicability to case studies

The two selected bioeconomic models -or any other that can be specifically built using e.g. the FLR toolbox- can be applied to case studies fulfilling the following conditions:

- A case study is defined by a group of fleets (or fleet segments) catching a pool of target species in a given GSA.
- Assessment data should exist for at least the main 3-4 target species making a strong proportion of the catches of the group of fleets analyzed
- Complete economic data should exist for the group of fleets selected.

As Mediterranean fisheries are generally multi-species and multi-fleet, biological and economic consequences of management strategies should be evaluated taking into account a pool of species and a set of fleet segments. The bio-economic models MEFISTO and BIRDMOD, developed for Mediterranean fisheries, are able to simulate the effects of management policies on a set of target species and fleet segments. The combination of species and fleet segments in a specific area identifies a case study. Therefore, a prior identification of case studies is needed to define data requirement and produce simulations. A minimum data series of 2-3 years of assessment and economic data is required to meaningfully estimate the biological or economic parameters of the bio-economic models considered. Working in less than ideal cases may be feasible, but the results obtained need to be taken with extreme care when producing advice.

Data required by MEFISTO against data that should be available for a particular stock, provided by assessment groups (biological) and DCR (economic)

Biological parameters	
a-b parameters of the Length-Weight relationship	generally available
Linf, k, t0 parameters of the vBGF	generally available
Population numbers	derived from VPA assessment
Maturity ogive	generally available
Natural mortality	generally available
S/R parameters	optional
Fishing mortality	derived from VPA assessment

Fleet parameters		
Number of vessels	DCR	worksheet CAPACITY
decommission price per GT	optional	
Owner's Share	DCR: can be derived from CREWCOST and INCOME	worksheet REV_COST_FUEL
Catchability function parameters	optional	
Fishing time (hours, days)	can be assumed 365	
daily ice cost	DCR: not available, can be derived from VARCOST or pooled with these costs	worksheet REV_COST_FUEL
Commercial cost	DCR: not available, can be derived from VARCOST or pooled with these costs	worksheet REV_COST_FUEL
Maximum bank credit	optional	
fuel price	DCR: can be derived from FUELCOST and FUELCONS	worksheet REV_COST_FUEL
Opportunity cost	DCR: can be derived from CAPCOST	worksheet REV_COST_FUEL
Financial cost	available from country's central bank	
Fleet capital	DCR	worksheet FINANCIALPOSITION
GT	DCR	worksheet CAPACITY
credit	DCR: can be derived from BORROWING	worksheet FINANCIALPOSITION
daily fuel consumption	DCR: can be derived from FUELCOST and FUELCONS	
crew size	DCR	worksheet EMPLOYMENT
other daily costs	DCR: not available, can be derived from VARCOST or pooled with these costs	worksheet REV_COST_FUEL

Annual costs (fixed)	FIXEDCOST	worksheet REV_COST_FUEL
Annual costs (variable)	VARCOST	worksheet REV_COST_FUEL
target species price	DCR	worksheet PRICE
Functional relationship between main and secondary species: type and parameters	should be estimated from external data sources or VALUE in worksheet price	worksheet PRICE, in part
Price of secondary species	should be estimated from external data sources or VALUE in worksheet price	worksheet PRICE, in part

Economic data required by BIRDMOD compared with available data by DCR

BIRDMOD economic data	**DCR data**	**Comments**
Number of vessels	Y: NUMBER	By fleet segment and area
GT	Y: GT	By fleet segment and area
Number of days at sea	Y: DAYS	By fleet segment and area
Number of people employed	Y: FTE	By fleet segment and area
Landings in weight by species and by fishing technique	Y: LW	By fishing technique, area and species. Landings should be available for the most relevant species in terms of landing value.
Price by species and by fleet segment	Y: LIVE	By fleet segment, area and species. Landings should be available for the most relevant species in terms of landing value.
Crew share	Y: CREWCOST	By fleet segment and area
Commercial costs	Y: VARCOST*	By fleet segment and area. These costs are included in variable costs.
Fuel costs	Y: FUELCOST	By fleet segment and area
Other variable costs	Y: VARCOST*	By fleet segment and area. These costs are included in variable costs.
Fixed costs	Y: FIXEDCOST	By fleet segment and area
Depreciation and interest	Y: CAPCOST	By fleet segment and area

Economic parameters to be estimated to simulate management scenarios by BIRDMOD

Parameters	**Estimation**
Price flexibility coefficient by species, fleet segment and area	To be estimated on time series data
Flexibility coefficient of the average days in comparison with the profits by fleet segment and area	To be estimated on time series data
Flexibility coefficient of the overall GRT in comparison with the profits by fleet segment and area	To be estimated on time series data
Costs parameters	To be estimated on time series data

Both bio-economic models can be run by using the data collected under DCR. The aim of MEFISTO and BIRDMOD is to simulate the implementation of specific management options for a case study and evaluate the biological and economic outcomes in the short and long run. Management options should be defined in terms of input or technical restrictions. In particular, input restrictions are related to reductions in nominal fishing effort (reduction of days at sea or number of vessels) for a specific fleet segment. The following steps are needed for using a bio-economic model in the next SGMED meeting:

1. Definition of case studies based on:
    a. Identification of the fishery (e.g., “demersal fishery in GSA x” or “pelagic fishery in GSA y”);
    b. Identification of the fleet segments involved in that fishery (e.g., “bottom trawlers 12-24m”, “purse seine 24-40m”);
    c. Identification of the most relevant target species for each fleet segment involved in terms of revenues (e.g., “European hake”, “Striped mullet”, “Sardine”);
2. For each case study, definition of a set of management measures to be simulated (e.g., “reduction of 20% in days at sea for bottom trawlers 12-24m”);
3. Collection of the relevant biological and economic data (as reported above) to be used in the bio-economic model (at least 2-3 years data) for each case study defined.

SGMED conclusions and recommendations

In order to test the bio-economic models MEFISTO and BIRDMOD in evaluating possible short-term and long-term biological and economic consequences of specific management options for Mediterranean fisheries, the following is recommended:
Define a set of Mediterranean case studies by identifying the fishery (e.g., “demersal fishery in GSA x” or “pelagic fishery in GSA y”), the fleet segments involved in that fishery (e.g., “bottom trawlers 12-24m”, “purse seine 24-40m”), and the most relevant target species in terms of revenues for each fleet segment involved (e.g., “European hake”, “Striped mullet”, “Sardine”). For each case study, define a set of management measures to be simulated (e.g., “reduction of 20% in days at sea for bottom trawlers 12-24m”). By using the bio-economic models MEFISTO and/or BIRDMOD with the biological and economic data to be provided for the SGMED-09-03 meeting, simulate the effects of the management measures defined and evaluate the models outcomes.

6.5. k) Protection of Juveniles and Spawning Aggregations

6.5.1. Provide relevant information on spatial and temporal distribution of seasonal or persistent juveniles’ aggregations and provide scientific elements indicating that possible protection of these areas may allow to control and reduce the overall fishing mortality on the stock and further improve the exploitation pattern with a view to increase the yield.

BACKGROUND

The implementation of management measures aimed at reducing the effects of fishing on juveniles and their habitats requires the spatial identification of nurseries. Usually, any area where juveniles occur in relatively high densities has been considered as a nursery (Dahlgren et al. 2006) but without providing a clear definition. Some recent attempts to establish a definition of nurseries within a general conservation framework have been developed mainly for coastal species. Beck et al. (2001) defined a nursery as a habitat that, compared to other habitats on a per-unit-area basis, gives a greater contribution to the adult population of a given species; Dahlgren et al. (2006) introduced the concept of Effective Juvenile Habitats, referring to habitats that make a greater than average overall contribution to the adult population. Many authors agree that the most effective way of assessing the importance of a specific habitat in terms of juvenile production is to directly measure the movement of individuals from juvenile habitats to the adult population (Beck et al. 2001, Gillanders et al. 2003).

A possible alternative approach to the use of connectivity measures to identify and evaluate nursery role is to use the spatial abundance of juvenile fish and the persistence over time of density hot-spots. This approach is based on the assumption that the average contribution to the adult population can be expected to be higher for nurseries with higher juvenile density and higher spatio-temporal stability (Colloca et al., 2009). In fact, maintenance of a population depends on successful recruitment of young fish to nursery areas and from nursery areas back to the parent population (Hinckley et al. 2001). The location of nursery areas is therefore an integral component of the adaptation of marine fish life cycles to their environments.

In this context, the stability of a density hot-spot of fish juveniles in a given area can be assumed to be indirect evidence of the importance of that area to the recruitment success of the population. Furthermore, the temporal persistence of the characteristics of an area is a fundamental prerequisite for its inclusion in a conservation network, as commonly considered in terrestrial ecosystems (Early et al. 2008). The same approach defined for juveniles can be used also for the identification of spawning grounds using survey data of spatial distribution of mature specimens.

The identification of nurseries and spawning grounds would need to be completed with an evaluation of the potential effect of protection of these areas on the stock. A first evaluation can be obtained considering the proportion of fish included into the identified nurseries or spawning areas.

METHODS

The approach suggested for identification of nursery and spawning aggregation requires the use of temporal series of maps of density or biomass hot-spot that can be obtained with different geostatistical approaches applied to survey data. The estimation of the temporal persistence of each hot spot can be obtained measuring the relative persistence of the cell *i* as an annual nursery (Fiorentino et al. 2003). Let $\delta_{ikj} = 1$ if the grid cell *i* is included in a nursery in year *j* and in survey *k*, and $\delta_{ikj} = 0$ otherwise. A persistence index *Ii* can be computed as follows:

$$Ii = \frac{1}{n}\sum_{k=1}^{n} \mathrm{d}_{ij}$$

where *n* is the number of surveys considered. *Ii* ranges between 0 (cell *i* never included in an annual nursery area) and 1 (cell *i* always included in an annual nursery area) for each cell in the study area. Alternatively, and when geostatistical techniques as indicator kriging are applied, an average of the probability can be used contouring the areas where the level is higher than 60%, especially where the geometry and/or the sample allocation make for example the ordinary kriging estimates poor (smoothing effects).

Different conservation scenarios can be evaluated using different levels of *Ii*, the area occupied by nurseries and the proportion of hake recruits included in the nurseries can be calculated. For instance in the case of hake in the GSA 9 highly persistent nurseries (*Ii* > 80%) covered 5.3% of the study area and included on average 39.2% of recruits (proportion calculated over the entire study period). Nurseries occurring in at least 60 to 80% of surveys included 12.4% of the whole area and 65.6% of recruits (Colloca et al., 2009).

This can be used to maximize the amount of protected fish (juveniles or spawners) and, at the same time, minimize the area closed to fisheries and therefore the impact on the fleet. A cumulative relative abundance of juveniles can be plotted against proportion of area covered by nurseries according to different persistence level (Fig. 6.5.1.1).

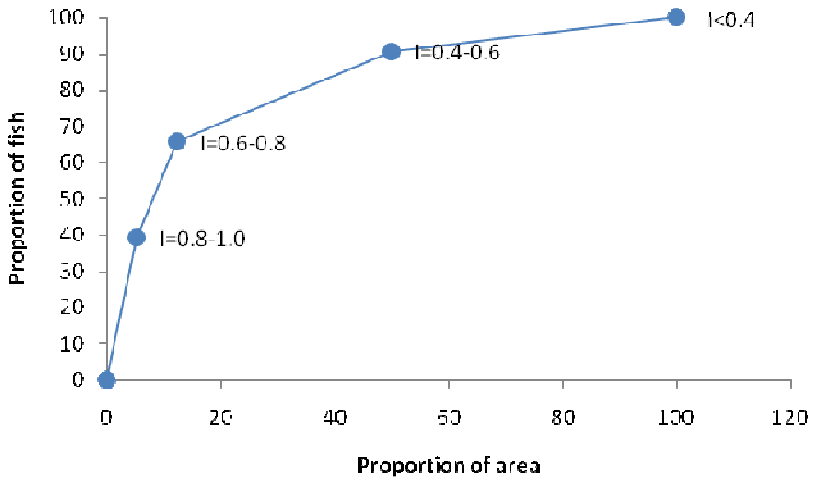


Fig. 6.5.1.1. Proportion of juvenile hake within GSA 9 nursery areas in relation to proportion of area covered by nursery areas according to different level of temporal persistence.

EXAMPLE OF CONSEQUENCES OF REDUCTION OF FISHING PRESURE ON NURSERY GROUNDS

In order to enhance the value of the fishery and to increase the reproductive output, limitations related to effort and a legal minimum size limit was gradually enforced since 1995 for a group of species (EC regulation 1626/94), with an improvement of control since the year 2000. Available data proceeding from trawl surveys and commercial catch allowed the monitoring of the evolution of the European hake before and during the process of enforcement of the legal size (Abella et al, 2005). Reconstructed size structure of the catch and at sea and time series of abundance and catch rates of the commercial fleet were analyzed. The mentioned legal restrictions conditioned the behavior of the fishing fleets targeting demersal resources, and related to hake, they produced a drastic reduction of the fishing pressure on the nursery grounds.

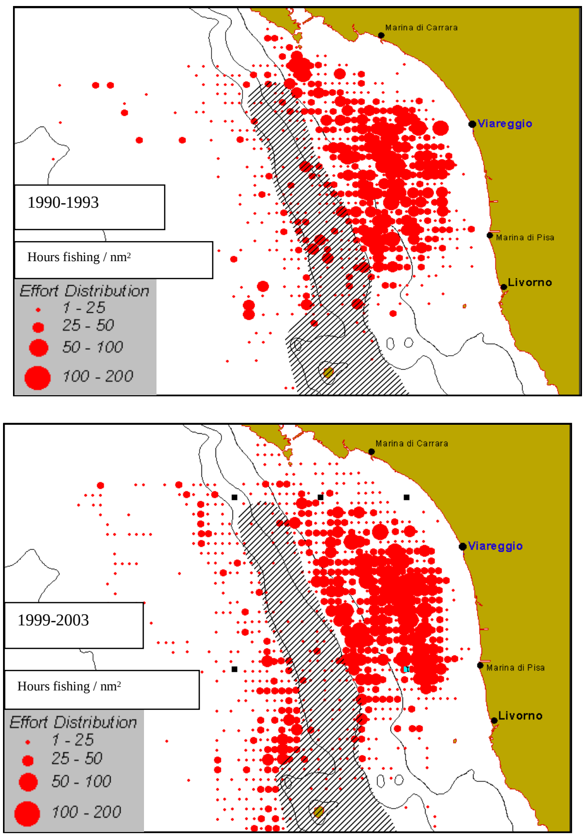


Fig. 6.5.1.2 Distribution of fishing effort showing a reduction of fishing pressure on nursery areas (shaded zones)

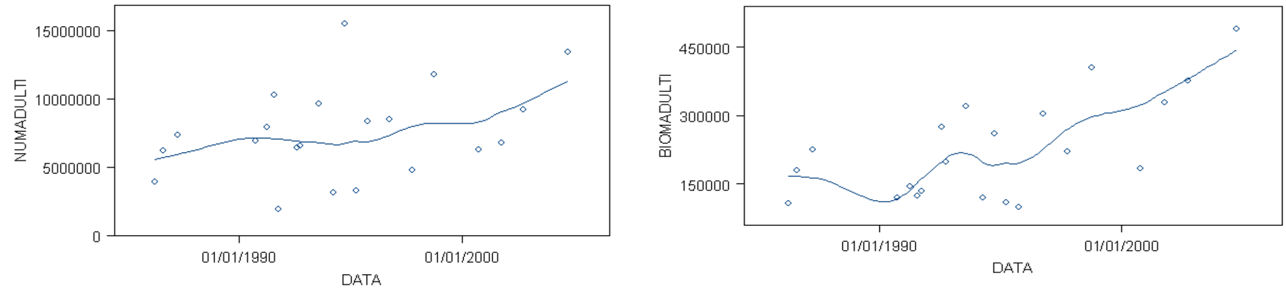
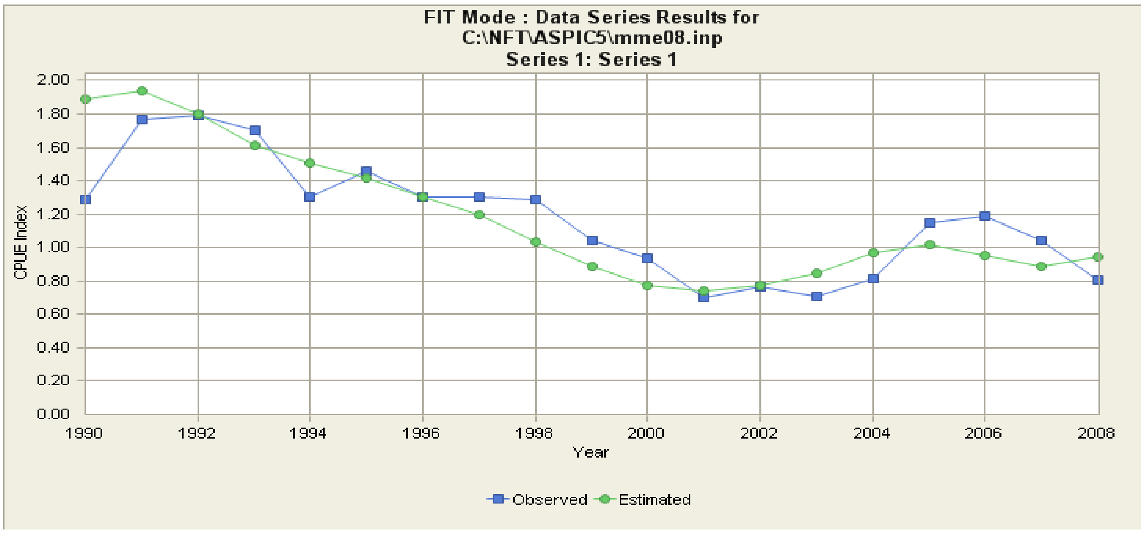


Fig. 6.5.1.3. Trends in numbers at sea and biomass in the Southern Ligurian from trawl surveys. Standardized numbers at sea in the different years from trawl surveys shows a clear increase in numbers in the more recent years



STATUS OF KNOWLEDGE

Western Mediterranean

A European project: *Impact of fishery and environment on hake recruitment in Northwestern Mediterranean.* EU Contract FAIR CT-97-3522 (1998-2000) (Lleonart, coord. 2001) was devoted to analyze the hake recruitment. A number of specific results were published for Gulf of Lions, Catalonia and North Tyrrhenian Sea.

During the European project, *Données sur la distribution des principales espèces commerciales du golfe du Lion (et plus particulièrement des groupes 0 et 1*, in Campillo, 1999) distribution maps of the juveniles of hake and other 12 species exploited in the gulf of Lions were estimated. The data used came from three IFREMER trawl surveys on the continental shelf between 10 and 250 m depth, together with sampling in the main fish markets and on board professional fishing boats. Indices of abundance in number of fish per ha and by depth stratum were calculated using the Pennington & Grosslein (1978) method to assess the stratified random trawl surveys and the results have been hand mapped for the 3 periods of observations.: February, June and November 1988.

Results shows that the highest abundance (62%) of the juvenile hake (0 group) was observed in June while recruits were less abundant in November (36%) and near zero in February. Juvenile hakes were mainly caught on the external border of the continental shelf, in the vicinity of the top of the slope canyons.

For the present SGMED working group the available data on juvenile hakes coming from the MEDITS surveys in the gulf of Lions for the period 1998 to 2008 have been preliminary analysed by a group of IEO/IFREMER French and Spanish scientists. For each of the 11 years standardized indices of abundance have been calculated. Except for the data of the year 1988, it was not possible to obtain a suitable variogram to apply the kriging method, so the maps have been established by using the SURFER software.

By combining the data coming from the whole series a map has been established which shows that in June, during the MEDITS surveys, the hake recruits are mainly concentrated in the eastern part of the gulf of Lions on the external border of the continental shelf, in the vicinity of the top of the slope canyons where a Fishery Restricted Area have been adopted in 2009 by the GFCM in order to protect the spawners in this area.

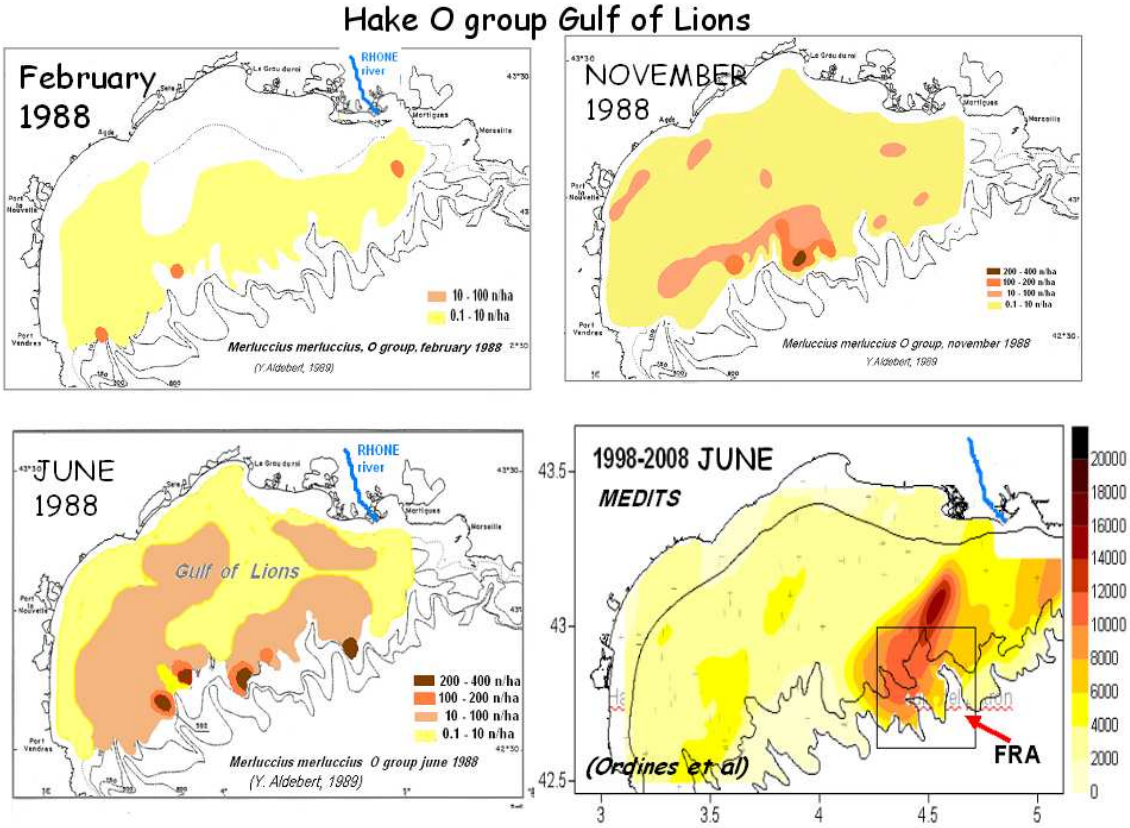


Fig. 6.5.1.4.

Spanish waters

The provision of information for the geographical distribution of demersal species (nursery and feeding areas) in the Mediterranean Sea is a strong recommendation of the GFCM. Mapping with trawl survey results (MEDITS_ES 2001-2005) requires the use of spatial analysis. The data used was the density (number by haul) and biomass (kg by haul), length and geographical position. Nursery areas of different species have been identified and their spatial dimension estimated. The importance of closing these areas for juvenile protection has also been highlighted, but there has been less understanding of the need to protect spawning stocks in areas where juvenile fisheries are predominant (Fiorentino *et al*., 2006).

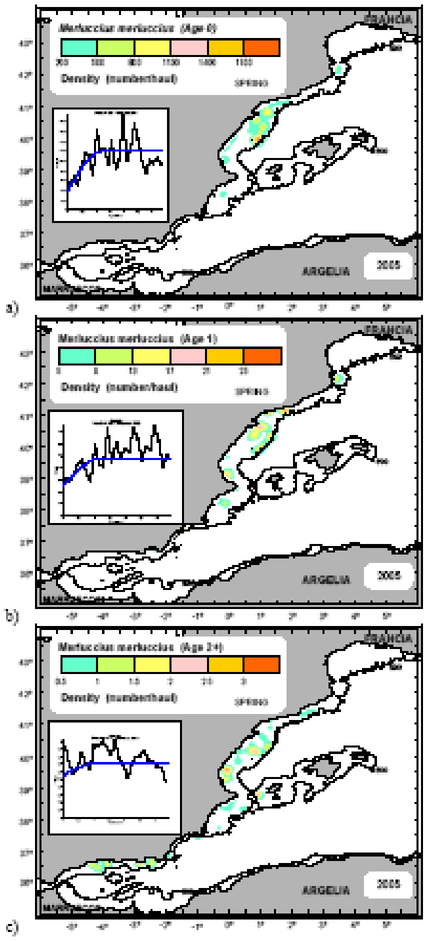


Figure 8.

Fig. 6.5.1.5.

Catalonia

Maynou *et al*. (2003) studied the patterns of seasonal variability in hake recruitment by means of quarterly surveys conducted over the shelf and the upper slope of the Catalan coast (50–350m depth), with the aims of establishing the areas where hake recruitment is important throughout the year, and determining the environmental factors of the sea-floor characterizing the habitat of hake recruits. In addition to sampling juvenile hake, we sampled its trophic resource (mainly suprabenthos and zooplankton) with a Macer-GIROQ sledge sampler, to determine the characteristics of the sediment: temperature, redox potential, organic matter contents, carbonate contents and grain size. Hake juveniles were found between 60 and 160 m depth in autumn and winter, while in spring and summer their depth range extended down to 300 m depth. A multiple analysis of variance (MANOVA) model with interactions was used to partition the variability in hake recruits density. Season and depth stratum were the main factors accounting for the variability in hake recruitment. Well-defined nursery areas were apparent between 68 and 168 m depth, but the density in well-defined nursery areas was not different from the density in occasional nursery areas. Some sediment variables (redox potential and organic matter contents) were statistically different in nursery areas and in occasional nursery areas, indicating that juvenile hake recruit on bottoms where food resources are enhanced. The vagile macrofauna (mainly mysids and euphausiids), which constitute the main trophic resource of juvenile hake, did not overlap spatially with the main nursery areas, as they were found in higher concentrations over the 200m depth isobath. This suggests that juvenile hake and their main food resource are spatially uncoupled, at least during daytime, when both sets of samples were obtained. Establishing nursery areas for heavily exploited stocks such as hake in the Catalan sea are a valuable tool for fisheries management.

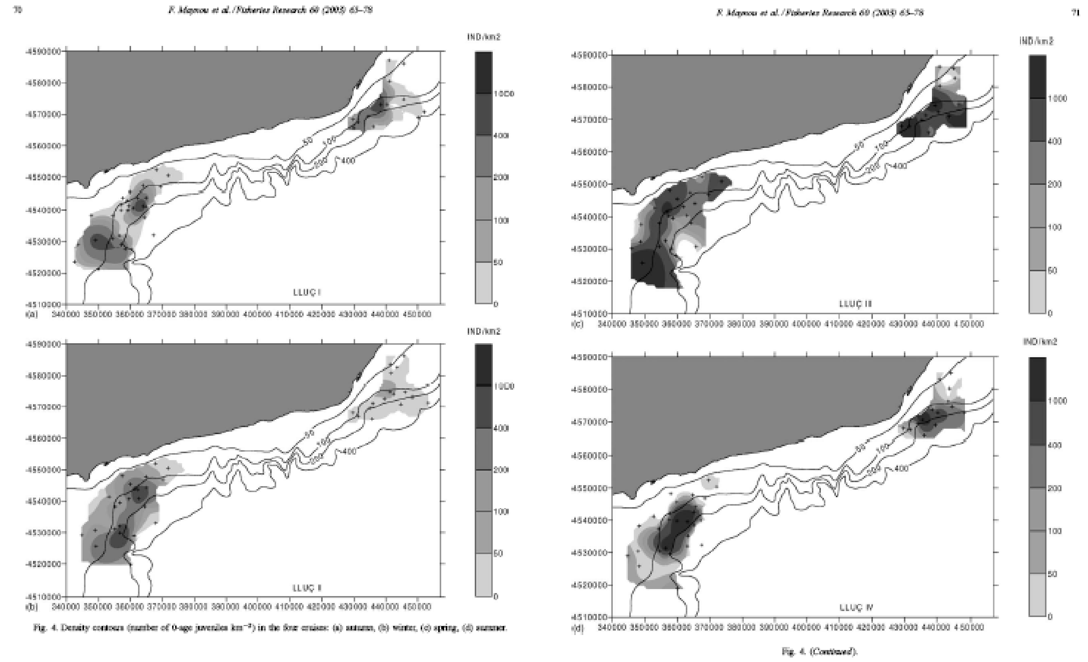


Fig. 6.5.1.6.

Sicily channel

Fiorentino et al. (2003). Aspects of the recruitment of hake (*Merluccius merluccius* L., 1758) and greater fork beard (*Phycis blennoides* Brunnich, 1768) in the Strait of Sicily (Central Mediterranean) are presented. Data were collected from 1994 to 1999 during the international bottom trawl survey program MEDITS. In view of the available literature on juvenile growth of these two species in the Mediterranean area, a length-based criterion was adopted to separate fish belonging to the 0 group (recruits). Recruit density indices (n/km2) by haul were calculated based upon the likely variability of recruit growth among years and used to study abundance variability and spatial pattern of recruitment and to identify the main nursery areas. Although there was inter-annual variability, two stable areas for *M. merluccius* were identified on the eastern side of the Adventure Bank and the Malta Bank at depths ranging between 100 and 200 m. The main nursery areas for *P. blennoides* were deeper (from 200 to 400 m) and two stable nursery areas were identified on the western and eastern side of the Adventure Bank; other nurseries were found in the easternmost part of the Strait in 1998 and 1999. Recruitments of the two species were significantly correlated, with the strongest recruitment occurring in 1998 and 1999 for each species.

A. Abella et al. / Journal of Marine Systems 71 (2008) 279–295 285

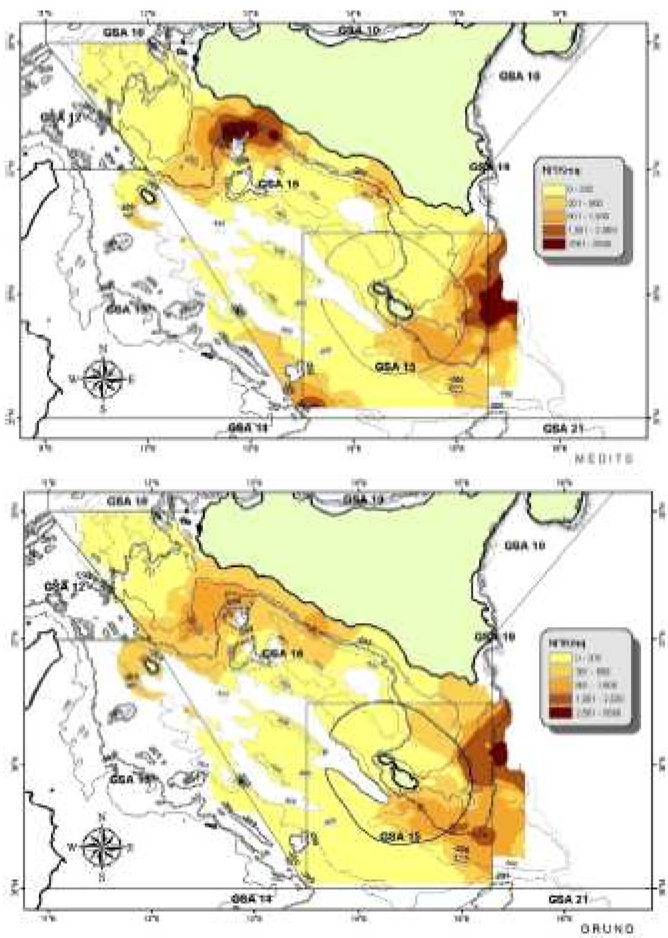


Fig. 6. Mean pattern of highest concentration of YOY's in the Strait of Sicily in Spring (MEDITS surveys at the top) and Autumn (GRUND surveys at the bottom).

Fig. 6.5.1.7. Mean pattern of highest concentration of YOY's in the Strait of Sicily in Spring (MEDITS surveys at the top) and Autumn (GRUND surveys at the bottom).

Fiorentino *et al*. (2006) present the results of a spatial analysis by life stage of hake (*Merluccius merluccius*, L., 1758) in the Strait of Sicily (Central Mediterranean. The general spatial pattern in the whole region of investigation showed that hake occurs at any life stage in two distinct geographical areas, the Adventure and Malta Banks, well separated by a wide area where hake abundance is very scanty. Specifically, two areas where young of the year are highly and almost exclusively concentrated (nurseries) were identified on the eastern sides of both the Adventure Bank and Malta Bank respectively, at depths ranging mainly between 100 and 200m. The position of concentration areas of juveniles suggests their spreading from nurseries towards the shallower bottoms on both the Adventure and Malta Banks. As regards, mature females the highest abundances were found in two areas, sited up stream and west of the nurseries on both Banks. Overall, it appears that while young of the year and females occupy discrete grounds, differing both for bathymetry and bottom type, juvenile concentration areas are large and show partial overlap with those of the other life stages.

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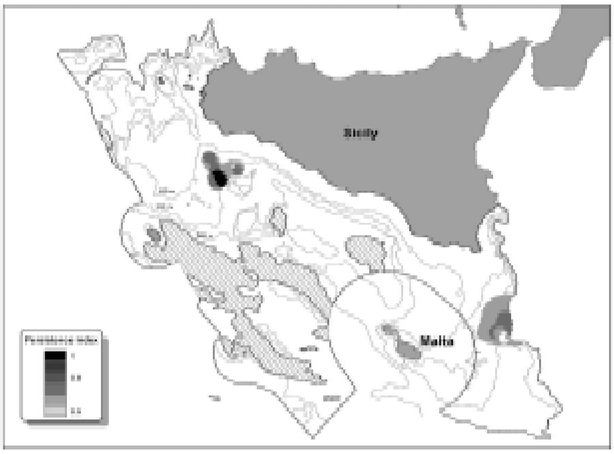


Figure 7. Areas showing stable presence of *M. merluccius* recruits throughout the examined period. The index of persistence ranges between 0 and 1, where 1 indicates stable nursery and 0 complete lack of nursery. Visualization was restricted to persistence index of 0.5 or more.

Fig. 6.5.1.8.

Malta

Trawl survey data gathered around the Maltese Islands during the MEDITS project in 2003-2008 were analysed for *Merluccius merluccius*, *Mullus barbatus*, *Mullus surmuletus*, *Parapenaeus longirostris, Nephrops norvegicus* and *Aristaemorpha foliacea* (Knittweis & Dimech, 2009). Abundance and biomass indices were calculated, and maps of the distribution of immature individuals plotted in order to reveal the location of nursery sites. Data for *M. merluccius*, *M. barbatus*, *M. surmuletus* and *N. norvegicus* was analysed for the years 2003-2008, data for *P. longirostris* and *A. foliacea* was analysed for 2003-2007. Nursery areas were defined as those areas where individuals which had not reached maturity were concentrated. Data sets normalized in order to identify zones of high concentration regardless of interannual variability in abundance indices. This was done by scaling data between the observed maximum and minimum values (after Garofalo *et al*. 2004). Distribution maps based on pooled data of all abundance indices for all years combined were produced, using inverse distance weighting interpolation, a method which uses a distance weighted average of data points to calculate grid cell values.

Results revealed that recruits of the species *M. merluccius, M. barbatus, M. surmuletus* and *P. longirostris* were concentrated to the east/north-east of the Maltese Islands, in the vicinity of the Malta Bank. The distribution of immature individuals of *N. norvegicus* and *A. foliacea* was found to be patchier, with sites distributed throughout the deeper waters lying to the west / northwest of the Maltese Islands (see figures below).

A. *Merluccius merluccius*

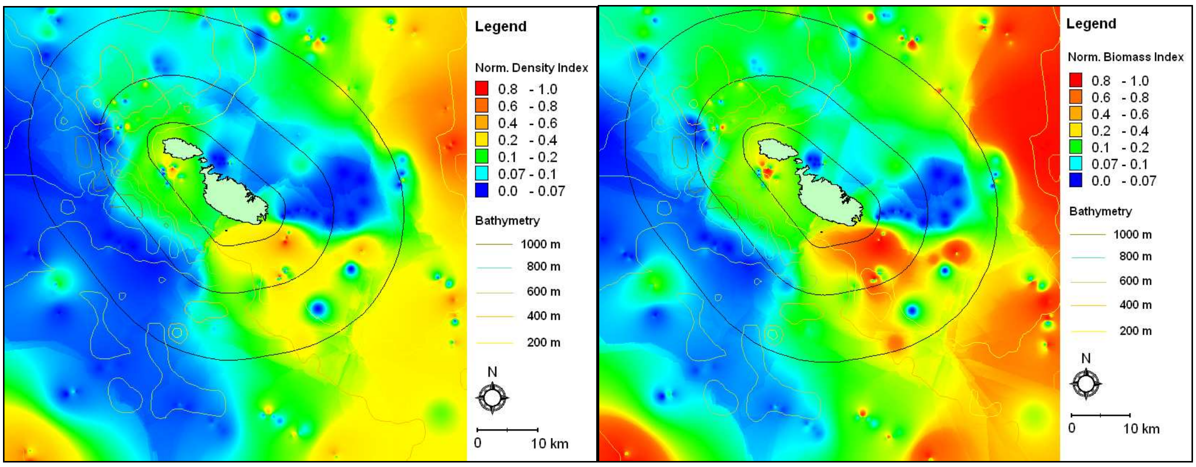


Fig. 6.5.1.9. Density and biomass indices, immature *M. merluccius.*

B. *Mullus barbatus*

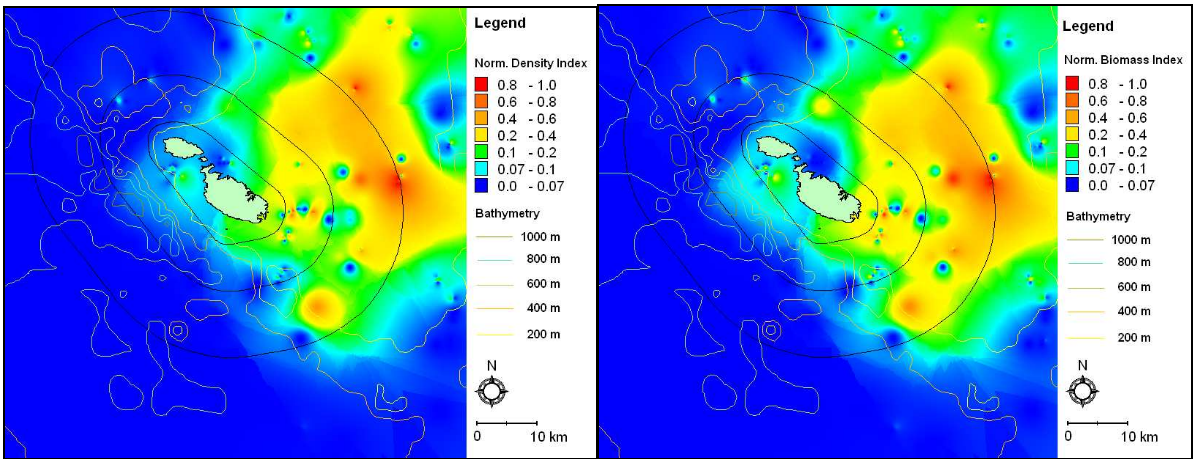


Fig. 6.5.1.10. Density and biomass indices, immature *M. barbatus.*

C. *Mullus surmuletus*

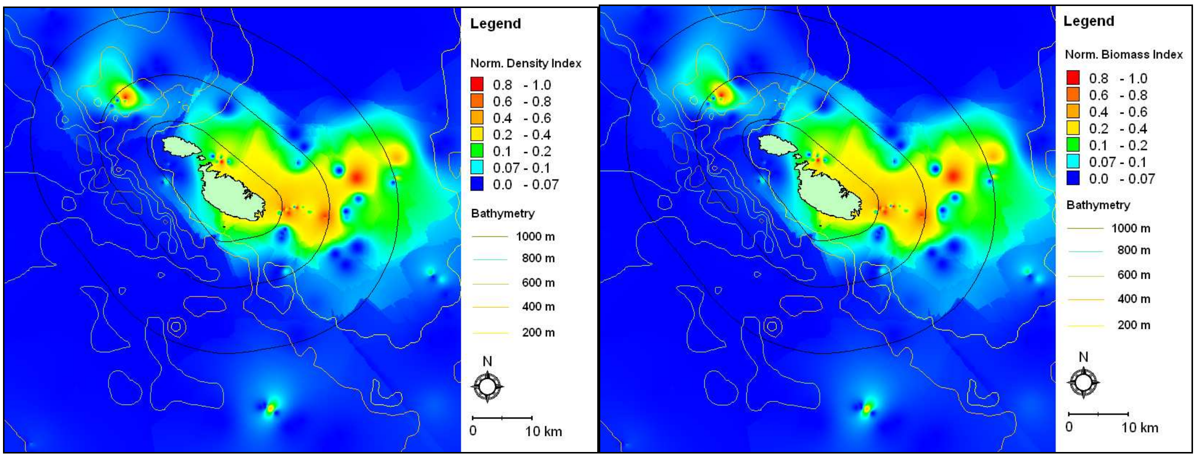


Fig. 6.5.1.11. Density and biomass indices, immature *M. surmuletus.*

D. *Parapenaeus longirostris*

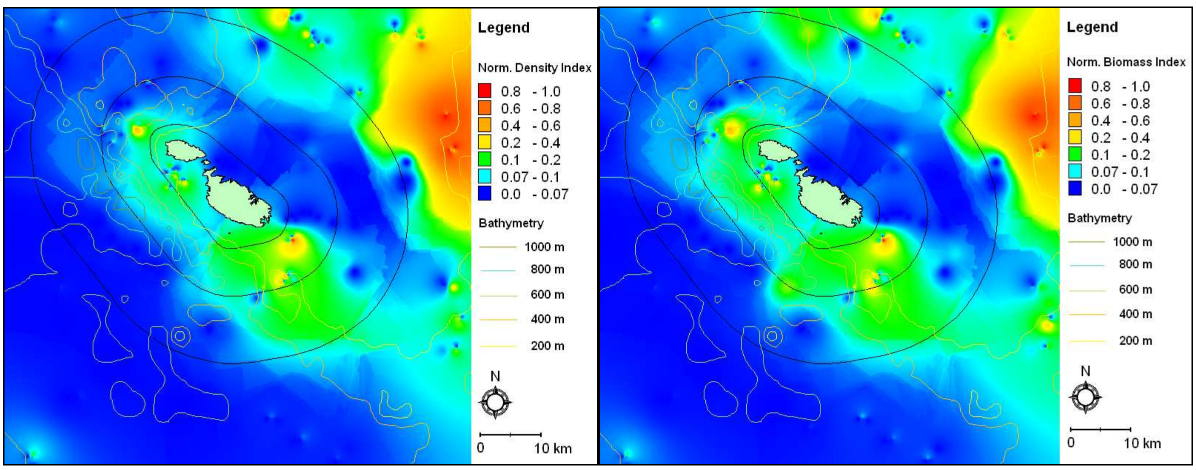


Fig. 6.5.1.12. Density and biomass indices immature *P. longirostris.*

E. *Nephrops norvegicus*

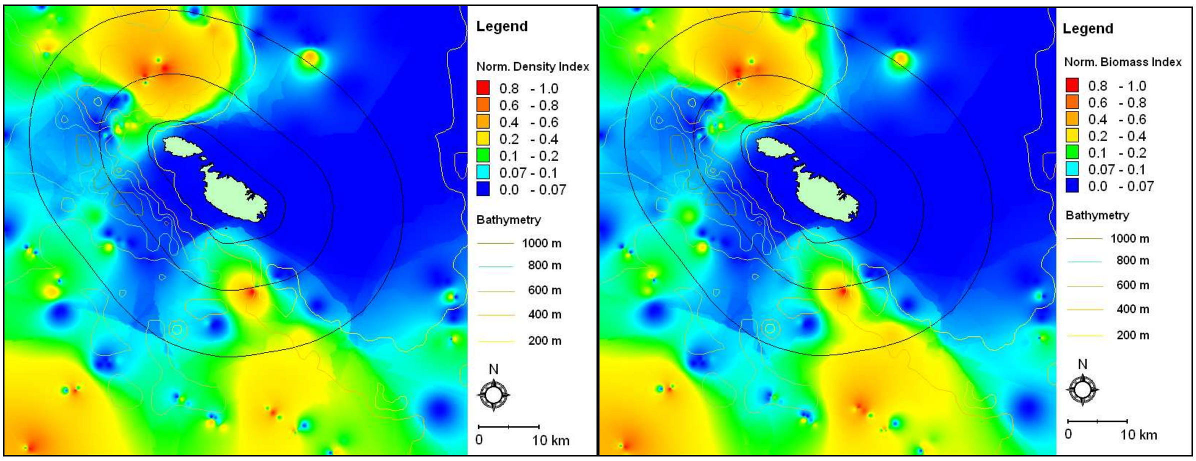


Fig. 6.5.1.13. Density and biomass indices, immature *N. norvegicus.*

F. *Aristaemorpha foliacea*

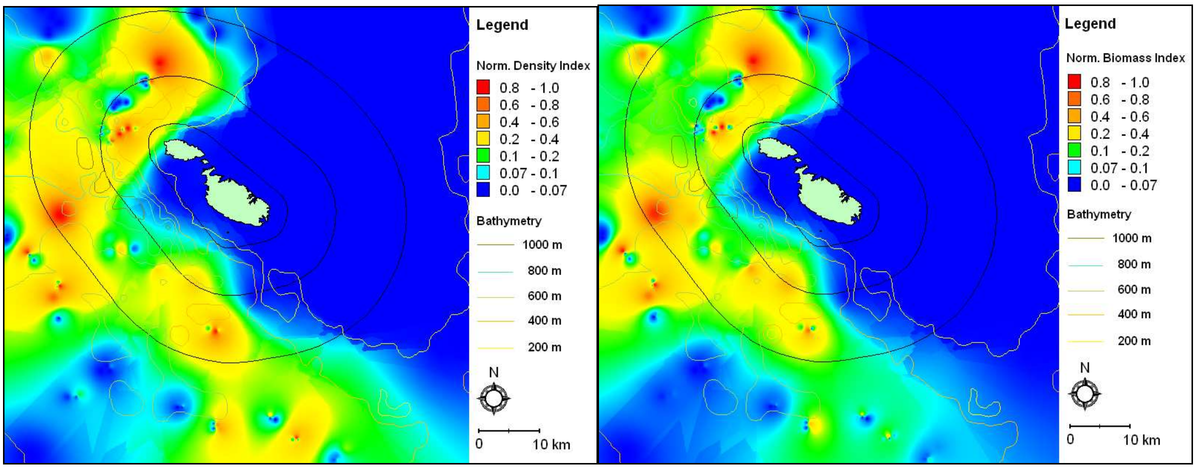


Fig. 6.5.1.14. Density and biomass indices, immature *A. foliacea.*

The presence of *M. merluccius*, *M. barbatus*, *M. surmuletus* and *P. longirostris* recruits in the vicinity of the Malta Bank may be explained by local oceanographic features. In particular the presence of a cyclonic current between Adventure Bank and Malta Bank, and a permanent thermal front on the eastern edge of Malta Bank (MEDSUDMED, 2007, 2008) have in previous studies been suggested to explain the distribution of juvenile *M. merluccius* (Fiorentino *et al.* 2003; Abella *et al.* 2008; MEDSUDMED 2007), *M. barbatus* (GAROFALO et al. 2004; MEDSUDMED 2007) and *P. longirostris* (MEDSUDMED 2007). The fact that a number of sites with high densities of immature individuals were found close to the border of GSA 15 indicates that the vulnerable habitats of the demersal species studied overlap with adjacent GSAs. Indeed, it has previously been suggested that Maltese fishing stocks are at least partly sustained by young individuals transported by currents from adjacent GSAs, and that stocks are shared with neighbouring jurisdictions (Garofalo *et al.* 2004; MEDSUDMED 2007, 2008). It follows that a spatial analysis of nursery sites throughout the entire Central Mediterranean, ideally in combination with regional scale oceanographic data, is necessary to fully understand the observed patterns. Notwithstanding the underlying causes, and the precise nature of stock boundaries in the study area, the area to the northeast of Malta in the vicinity of Malta Bank has been suggested a priority site for potential future fisheries closures based on these results.

Tyrrhenian - Ligurian Sea

Abella et al. (2009) explores the relationships between the spatial patterns of the distribution of the young hakes of the year (YOY) and the oceanographical features in two areas of the Central Mediterranean (the

Ligurian Sea and the Strait of Sicily), characterized by the occurrence of straits and channels. Comparative and correlative approaches were used to investigate coupling between biological and physical patterns. Density indices of the YOY were derived from annual trawl surveys from 1994 to 2004 in spring and autumn. Mean patterns of the YOY distributions were compared with the mesoscale oceanographical features reported in literature. No evident trends in recruitment strength were found in both areas. Inter-annual variability in YOY abundance in the Ligurian Sea was higher than in the Strait of Sicily. The location of nursery grounds in the study areas coincides with zones of relatively higher production, where upwelling and other enrichment processes regularly occur. The presence of predictable eddies and the frontal systems play a major role in the localization of nursery areas in the Strait of Sicily, maintaining their stable position throughout the years. The strongest transport of southern waters from the Tyrrhenian to the Ligurian Sea, due to the East Corsica Current, which is negatively correlated to winter North Atlantic Oscillation, is associated with the highest abundance of hake recruits in the nurseries of the Northern Ligurian Sea.

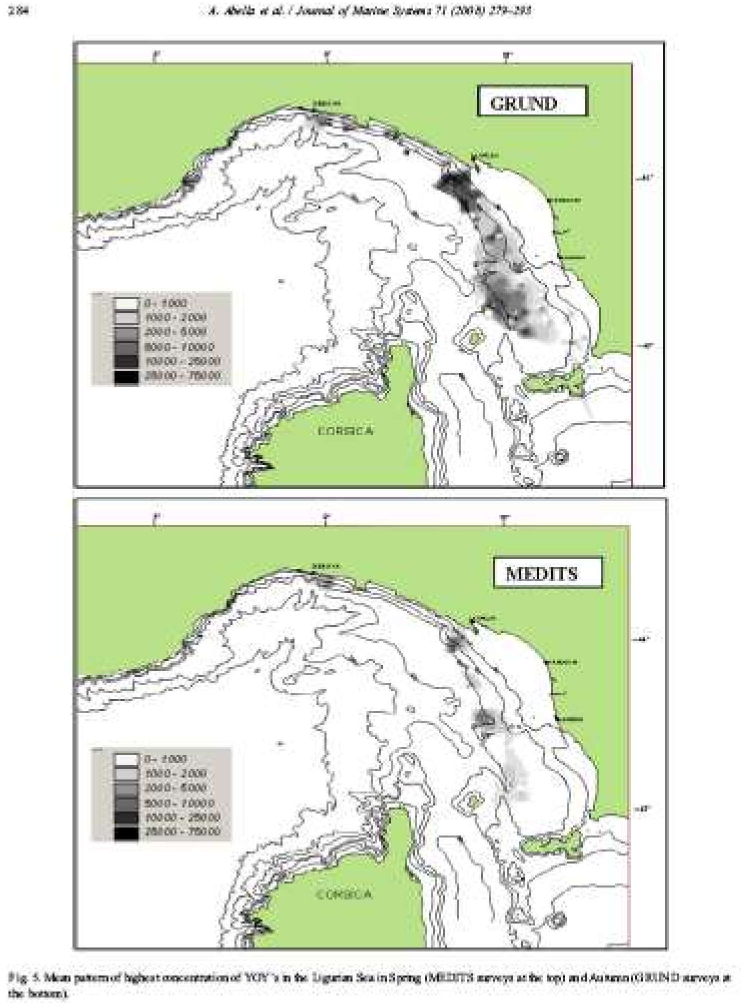


Fig. 6.5.1.15. Mean pattern of highest concentration of YOY's in the Ligurian Sea in Spring (MEDITS surveys at the top) and Autumn (GRUND surveys at the bottom).

Colloca *et al.* (2009) proposed a 3-step methodological approach to identify and classify fish nurseries for fisheries management purposes. We applied our approach to juvenile European hake *Merluccius merluccius* in the central Mediterranean Sea. Time series of trawl-survey fish-density data were used to map juvenile hake distribution with Bayesian kriging, while geostatistical aggregation curves were used to find density hot-spots. Persistence measures were adopted to identify nurseries on the basis of their spatio-temporal persistence. We found that areas with a high density of juvenile hake showed a high temporal persistence on both a seasonal and annual basis, with the most persistent nursery areas covering about 5% of the study areas while including about 39% of hake recruitment (averaged over 10 years). We believe the persistence of these areas is indirect evidence of their importance to the productivity of the population, with many potentially important implications for fisheries management. The approach that we developed to identify hake nurseries can be applied to different species and life stages to improve knowledge of the role of habitat for populations and communities.

Nursery areas of deep sea pink shrimp have been identified in the GSA 9 using the same approach used for hake (Nursery project, MIPAAF). Recruits (CL< 20 mm) are patchily distributed around the shelf-break with denser and persistent nurseries in the southern part of the GSA (Tyrrhenian Sea). These nurseries overlapped largely with hake nurseries.

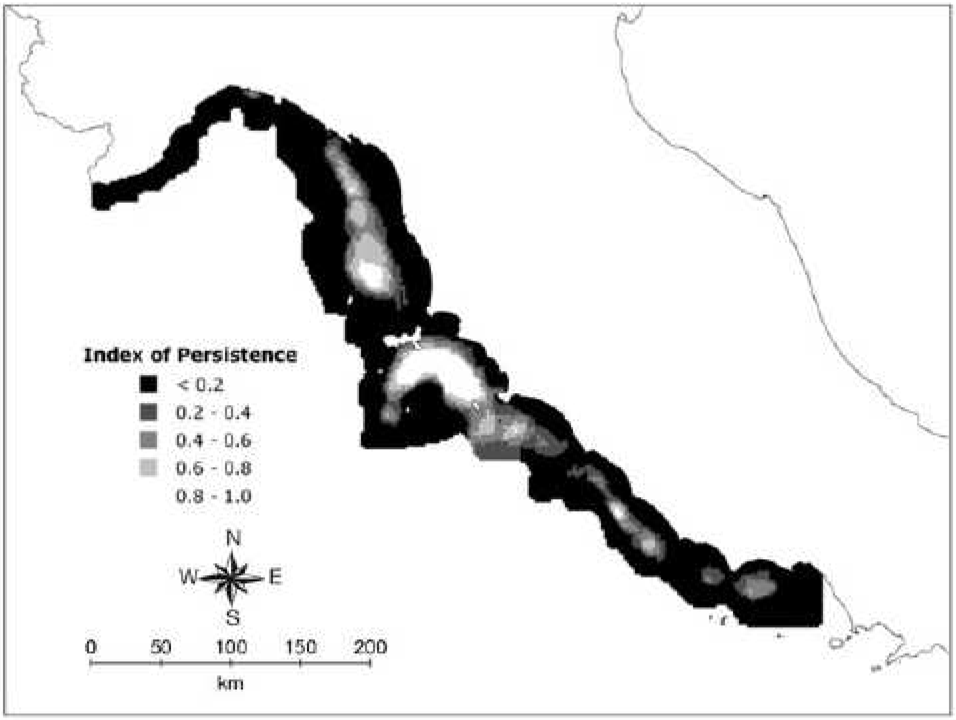


Fig. 6.5.1.16. Temporal persistence of the estimated nurseries of Merluccius merluccius in the period 1994 to 2005 based on GRUND and MEDITS surveys

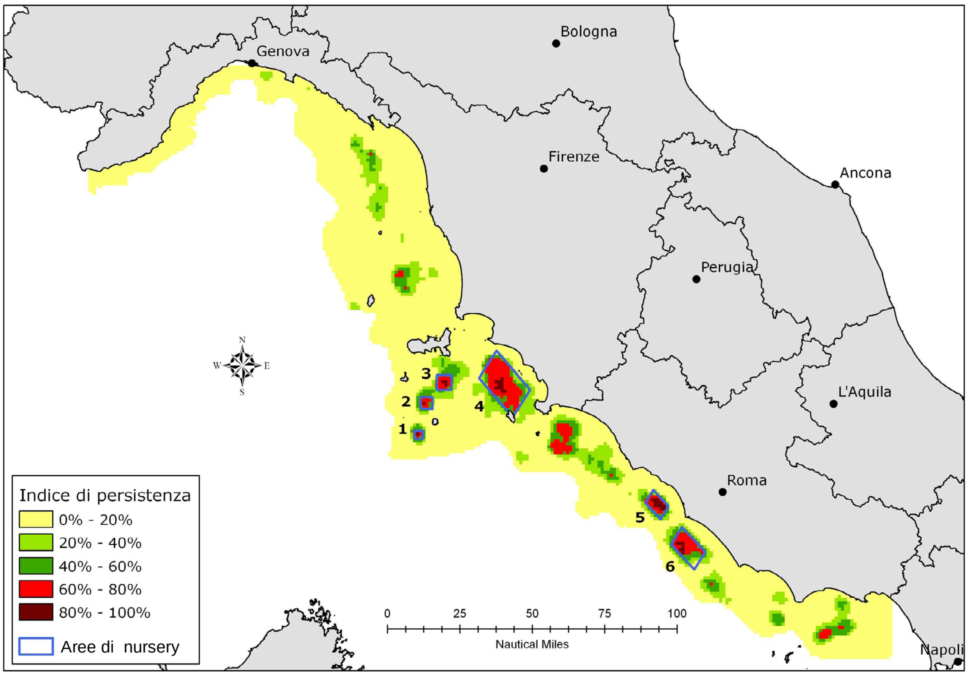


Fig. 6.5.1.17. Temporal persistence of the estimated nurseries of *Parapenaeus longirostris* in the period 1994 to 2005 based on GRUND and MEDITS surveys

Aegean Sea

Karlou-Riga & Varkitzi (2002) analysed nursery areas in the Aegean Sea. Samplings were carried out with chartered trawler and beach seiner monthly in the Saronikos Gulf (September 1998 to August 1999) and bimonthly in the Cyclades islands (September 1999 to August 2000) in order to identify sites of juvenile concentrations. Juveniles of hake in the Saronikos Gulf were observed throughout the year, whereas these juveniles favorite mainly the outer part of the Gulf. The number of sites when juveniles occurs increases progressively form January to June, and decrease afterwards. In the Cyclades islands juveniles of hake are disperse. Although they do not show any dependence on depth, they prefer areas rich in nutrients. Juveniles of striped mullet (*Mullus surmuletus*) are also caught by beach seiner in the Cyclades islands from May to August. Due to the occurrence of juveniles in the catch of beach seiners mainly during spring, the fishing season for this gear has recently decreased.

Juveniles of picarel (*Spicara smaris*) and bogue (*Boops boops*) caught by beach seiner were not observed in the Saronikos Gulf during the open fishing season (October-May) except for bogue caught during October. On the contrary juveniles of these species, caught by beach seiner as well, were observed in the Cyclades islands during late spring and spring respectively. The time difference between the two areas when juveniles occur is due to different time of spawning the last related with the seawater temperature. In the Saronikos Gulf juveniles of Mediterranean horse mackerel (*Trachurus mediterraneus*) caught by beach seiner and of horse mackerel (*Trachurus trachurus*) caught by trawler were observed during October and May (open fishing season) respectively. Trawler in the Cyclades islands did not catch juveniles of small pelagics. Due to the occurrence of juveniles in the catch of beach seiners mainly during spring, the fishing season for this gear has recently decreased.

Sole nursery area in northern and central Adriatic Sea

The spatial distribution of *Solea solea* was evaluated throughout yearly *rapido* trawl surveys (2005-2008) carried out in fall in the central and northern Adriatic Sea. Age class 0+ aggregated inshore, mostly in the area close to the Po river mouth and along the Italian coast. Age class 1+ gradually migrated off-shore and adults concentrated in the deepest waters located at South West from Istria peninsula. The age classes were estimated on the base of a slicing carried out by LFDA 5.0 utilizing growth parameters of sole estimated through the length frequency distributions obtained from surveys. L_{inf} (39.60 cm) was computed by the Powell-Wetherall method (Powell, 1979; Wetherall, 1986) and used to estimate K (0.44) and t_0 (-0.46).

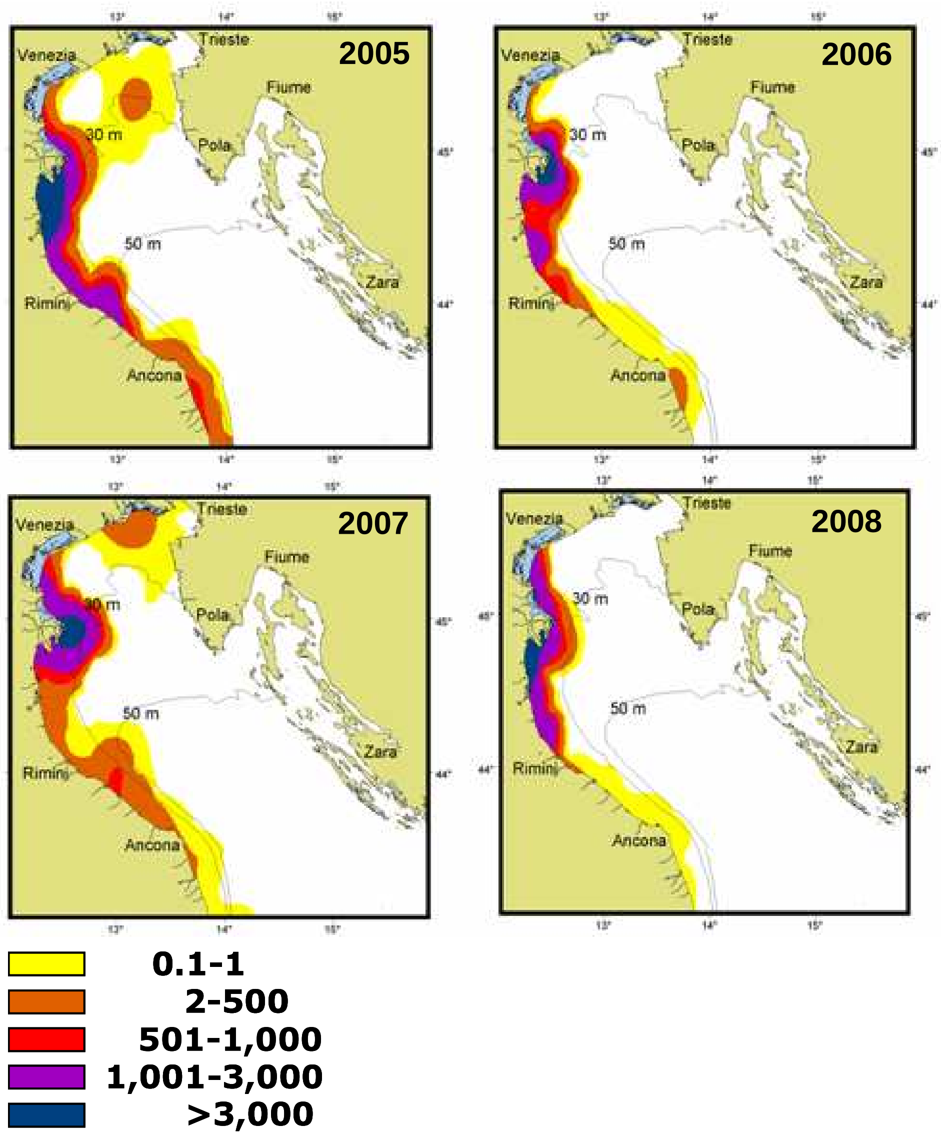


Fig. 6.5.1.18. Abundance indeces (ind. km^{-2}) for *Solea solea* interpolated using Kriging.

Southern Tyrrhenian Sea

In the southern Tyrrhenian Sea the studies on the spatial distribution of *Merluccius merluccius* and *Parapaeneus longirostris* juvenile were initiated using MEDITS trawl survey data and applying geostatistical methods (Lembo et al., 1998; 2000a; 2000b). Recruits and area of their concentration were identified using arbitrary thresholds for, size and density. As the time series were short the spatial localization was accomplished by tools as co-kriging, using a secondary auxiliary variable (generally depth) or the same variable in two different times, thus trying to identify the persistence of juvenile aggregation. Spatial analyses evidenced the presence of nurseries of hake off Ischia Island and in the Napoli Gulf as regards hake, whilst these same locations and a third area off Capo Bonifati (Calabria coasts) were the sites where also *P. longirostis* nurseries were localised. Recently an analysis using the indicator kriging, thus giving the maps to be also interpreted in terms of the probability to find a nursery was conducted along the Italian seas within a research project. The possibility to investigating a longer time series allowed to analyse the persistence of the nursery identified in each survey and year. Maps reporting the main results are in the figure below and show the presence of other two nuclei off Salerno Gulf and Capo Bonifati, besides those identified in the past.

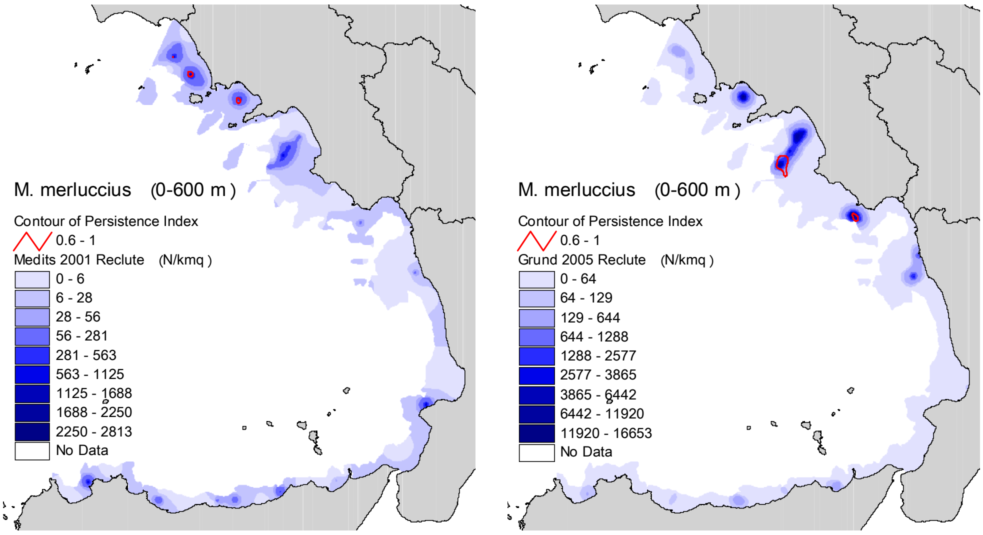


Fig. 6.5.1.19. Nursery of hake with the persistence along time.

South Adriatic and western Ionian Sea

The spatial pattern of the nursery areas of red mullet (*Mullus barbatus*), hake (*Merluccius merluccius*) (Linnaeus, 1758) and deep-water rose shrimp (*Parapenaeus longirostris*) (Lucas, 1846) was studied in the South Adriatic and North Ionian Seas (Eastern-Central Mediterranean) applying geostatistical techniques and data from time series trawl surveys conducted in the area. The analysed variables were: R (number of recruits/km^2) and n/tot (fraction of recruits on the total sampled population). The structural analysis showed a spatial pattern of both variables characterized by continuity on a small scale. Predictions of nursery area localization with probability of finding recruits at different threshold values were obtained through median indicator kriging. For the red mullet the nurseries were mainly identified in the South Adriatic Sea off the Gargano peninsula and between Molfetta and Monopoli within 50 m in depth. The main concentration of hake juveniles were found to be between 100-200 m in depth along the Gargano peninsula and between Otranto and Santa Maria di Leuca, where a nursery of deep-water rose shrimp was also detected. An overlapping depth, between 100 and 200 m, was identified for hake and deep-water rose shrimp nurseries.

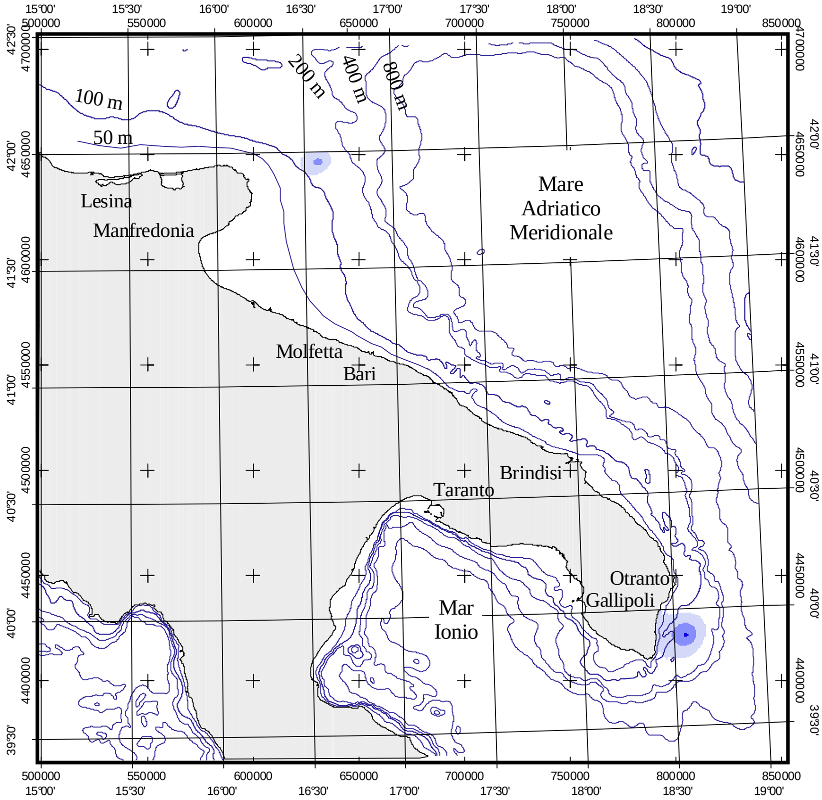


Fig. 6.5.1.20. Nursery of hake in the GSA 18 and 19 located with a threshold of 4000 ind/km^2

Sardinia

With the aim to identify the main nursery areas for the Sardinian grounds geo-referenced abundance indices of autumn (GRUND) and spring (MEDIT) scientific bottom trawl survey were analysed. Standardized (km^2) LFD were processed by means of the Bhattacharya method in order to identify the first modal component which be referred to the recruits (0^+ group). Once the cohorts features were identified, the cut-off to isolate recruits was calculated and recruits by haul were estimated as all individuals whose TL is less than the average length + 1 standard deviation. Juveniles indices were then used to model the spatial distribution applying geostatistical methods and kriging techniques.

Before building the geostatistical model the exploratory data analysis was carried out. The Indicator Kriging was applied to locate the sites where number of recruits exceeded, at a given probability, a conditioned threshold value (75th percentile of the cumulative abundance). The temporal persistence of high density patches of recruits was then evaluated by means of an index of spatial persistence.

As shown in the figures below, results revealed that recruits of the species *E. cirrhosa*, *M. merluccius*, *M. barbatus* and *P. blennoides* were stably concentrated to the west of the Sardinian Islands. *P. blennoides* showed high and persistent concentrations in deep waters (more than 200m) of the south-west Sardinian shores. In the southern portion of the Island, in the coastal Carloforte waters and in the Gulf of Cagliari was found the presence of nursery areas stable in time for the species *M. barbatus*. The distribution of immature individuals of *M. merluccius* showed high and persistent concentrations in the shelf break.

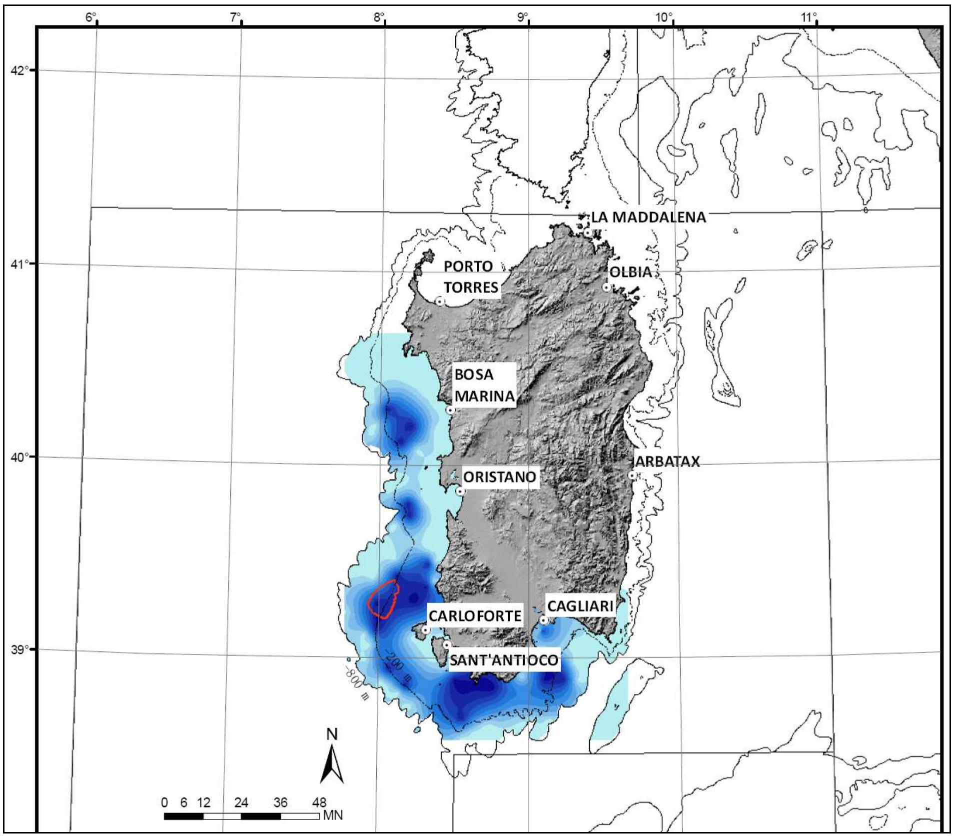


Fig. 6.5.1.21. Nursery of *Eledone cirrhosa* with the persistence along time.

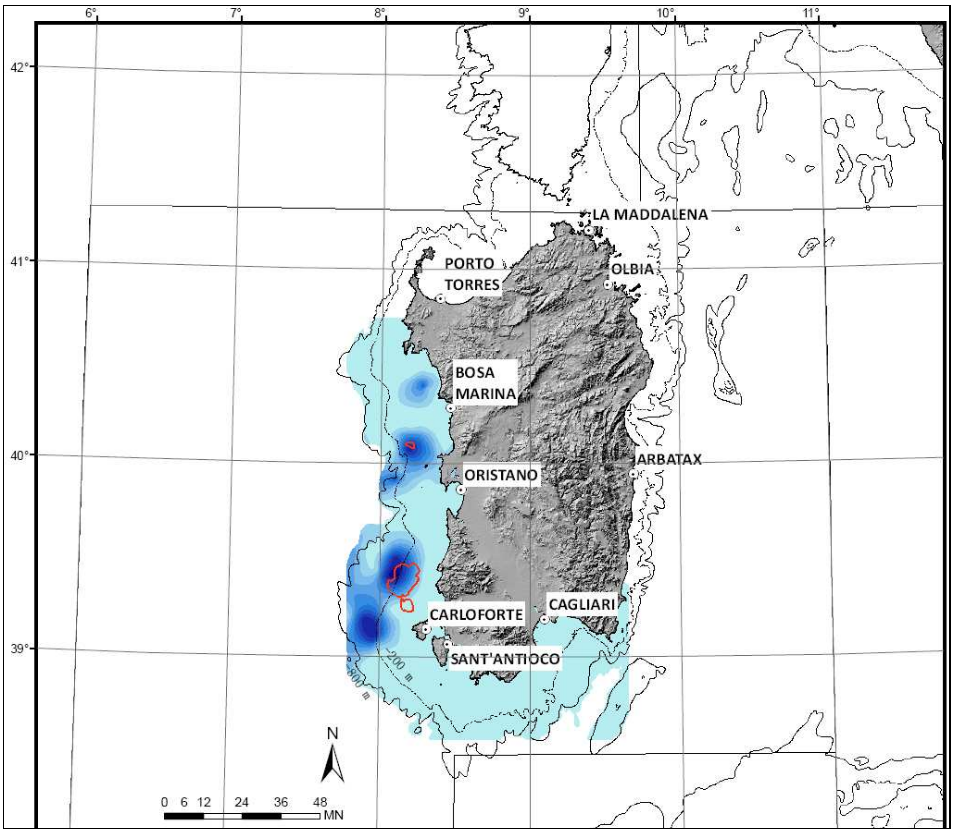


Fig. 6.5.1.22. Nursery of *Merluccius merluccius* with the persistence along time.

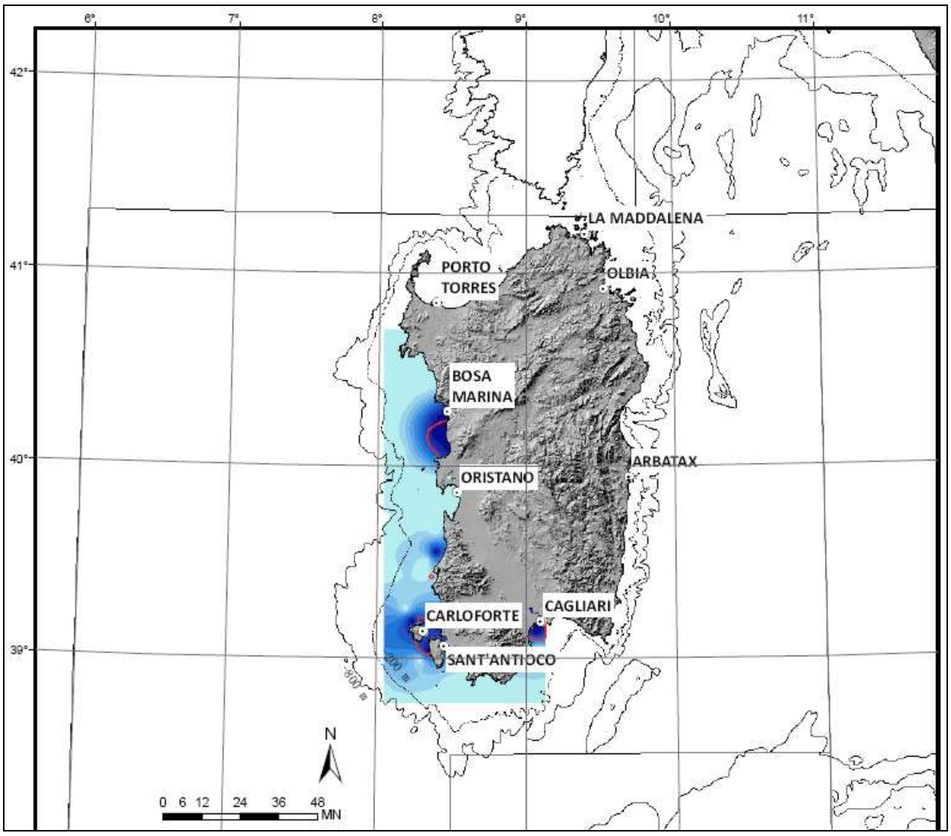


Fig. 6.5.1.23. Nursery of *Mullus barbatus* with the persistence along time.

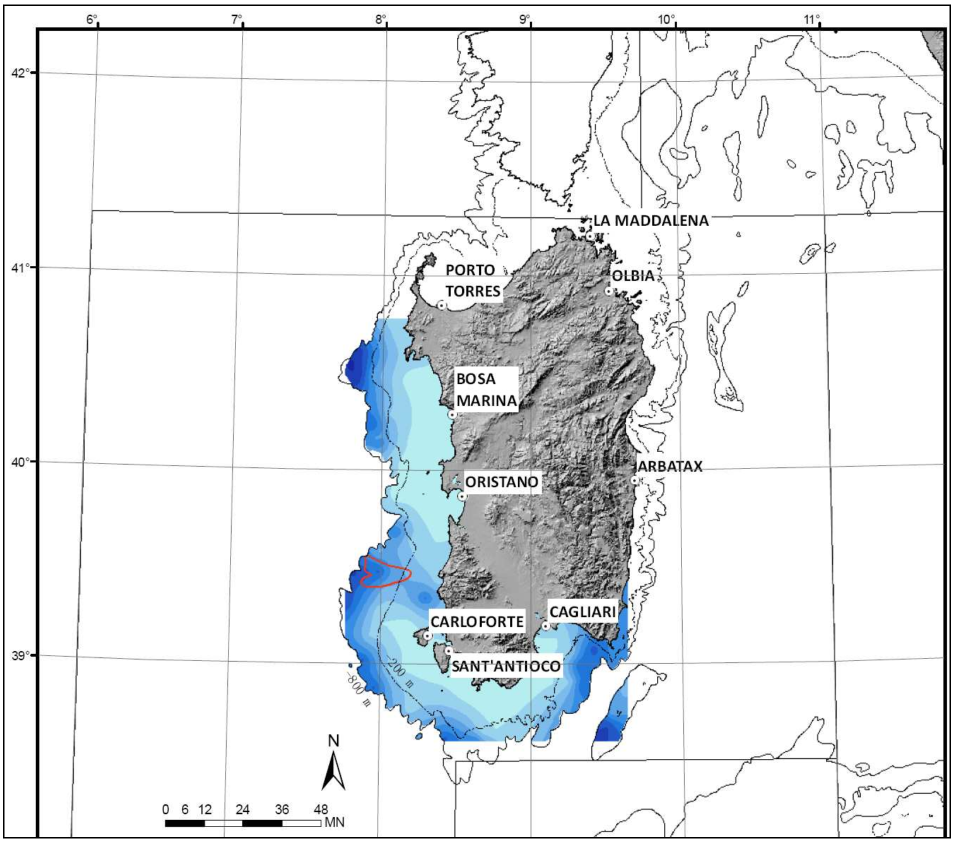


Fig. 6.5.1.24. Nursery of *Phycis blennoides* with the persistence along time.

SMALL PELAGICS NURSERY HABITATS FROM ACOUSTIC SURVEYS

BACKGROUND

An alternative approach has been applied to map the Essential Fish Habitat (as "those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity defined in the Magnuson- Stevens Fishery Conservation and Management Act in 1996) of small pelagic fish based on spatial analysis and GIS techniques (Valavanis et al., 2008). Within this framework the potential Fish Habitat of anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*) has been modeled (Bellido et al., 2008; Giannoulaki et al., 2008) using data from acoustic surveys and satellite environmental data. The nursery habitat of sardine has been also addressed based on data from northern Aegean Sea (Tsagarakis et al., 2008). Similarly, the potential spawning habitat of anchovy (*Engraulis encrasicolus*) and round sardinella (*Sardinella aurita*) has been modeled based on data from ichthyoplankton surveys in northern Aegean Sea (Schismenou et al., 2008). This approach is based on modeling the presence of a certain species (i.e. presence of adults, juveniles, or eggs) with environmental satellite data as well as bathymetry data that are used as proxies to infer spatial variations of environmental factors in order to identify those areas that could be suitable to support the presence of the species (Planque et al., 2007) and subsequently obtain probability maps that correspond to suitable environmental conditions.

Similarly, to the previous approach the stability of high probability areas that could support the presence of small pelagic fish juveniles in a given area can be assumed to be indirect evidence of the importance of that area to the recruitment success of the population. The same approach defined for juveniles can be used also for the identification of spawning grounds using survey data of the spatial distribution of eggs.

METHODS

The suggested approach for the identification of nursery areas requires the use of presence/absence acoustic data referring to small pelagic fish juveniles as well as environmental satellite data and bathymetry data in order to estimate a habitat distribution model (Guisan & Zimmerman 2000; Planque et al 2007). The principle of this approach is based on the examination of the influence of oceanographic key parameters on the distribution and biology of the juveniles of small pelagic fish. Within this framework an ongoing European project titled "SARDONE *Improving assessment and management of small pelagics in the Mediterranean"* aims at the development of a series of tools which will enable a better understanding, stock assessment and fishery management of small pelagic fish resources (anchovy and sardine) of the Mediterranean. Within the scope of the project is to detect nursery areas, develop echo-surveys for the estimation of the recruitment strength and to fill the gap in knowledge on the ecology of late larvae and juveniles. Three major small pelagic stocks and fisheries i.e. the NW Mediterranean, the Adriatic and the Aegean have been chosen for this purpose.

Specifically, within the framework of the SARDONE project the relationships between the spatial patterns of the presence/absence of sardine juveniles in June (Aegean Sea) and in July (Gulf of Lions) have been modeled along with satellite environmental data as well as bathymetry data. Furthermore, the spatial patterns of the presence/absence of anchovy juveniles in September have been modeled in a similar way. Acoustic data recorded with a 38 kHz split beam echosounder from the northern Aegean Sea (2004-2006), the Adriatic Sea (2004-2008) and the Gulf of Lions (2003-2006) have been analyzed for this purpose. Sardine and anchovy juveniles' echoes discrimination was based on the characteristic echogram shape of the schools and the catch composition of pelagic trawling held in the surveyed area (MacLennan & Simmonds, 1992). Satellite data included mean monthly values of sea surface temperature, sea surface chlorophyll concentration, Photosynthetically Active Radiation, sea surface salinity distribution and sea level anomaly (Giannoulaki et al., 2008). Statistical modelling was applied using Generalized Additive Models (GAMs, Hastie & Tibshirani 1990, Wood 2006) following the same methodology as described in Giannoulaki et al., 2008; Schismenou et al., 2008).

For this purpose three different GAM models (each one representing different area and sampling period) were estimated, using pooled data from all years for the specific area and period, in order to ensure potentiality and calibration of the model over a wider range of environmental conditions (Planque et al., 2007). The probability of the occurrence of suitable environmental conditions for sardine/anchovy juveniles' presence was estimated and mapped. The model performance was evaluated with the AUC criterion (Elith et al, 2008). Similarly to the approach used in demersal species, we believe that the persistence of these areas is indirect evidence of their importance to the productivity of the population, with many potentially important implications for fisheries management. The approach that we developed to identify sardine and anchovy nurseries can be applied to different species and life stages to improve knowledge of the role of habitat for populations and communities.

STATUS OF KNOWLEDGE

Preliminary results of the SARDONE project concerning the detection of anchovy and sardine juveniles in the Mediterranean have been recently presented in the ICES WGFAST that was held in Ancona during May 2009 and are shown below.

Gulf of Lions

Within the SARDONE presence/ absence data of sardine *(Sardina pilchardus)* juveniles from acoustic surveys (2003-2006) held in the Gulf of Lions (GSA 7) during July have been used. The methodology used is the one already described and the final GAM model selected included bathymetry, sea surface temperature, sea level anomaly as well as chlorophyll concentration explaining almost 50% of the total deviance. The probability of the occurrence of suitable environmental conditions for sardine juveniles' presence was estimated and mapped. The model was evaluated with the AUC criterion (Elith et al, 2008) and indicated good model performance (AUC >0.75).

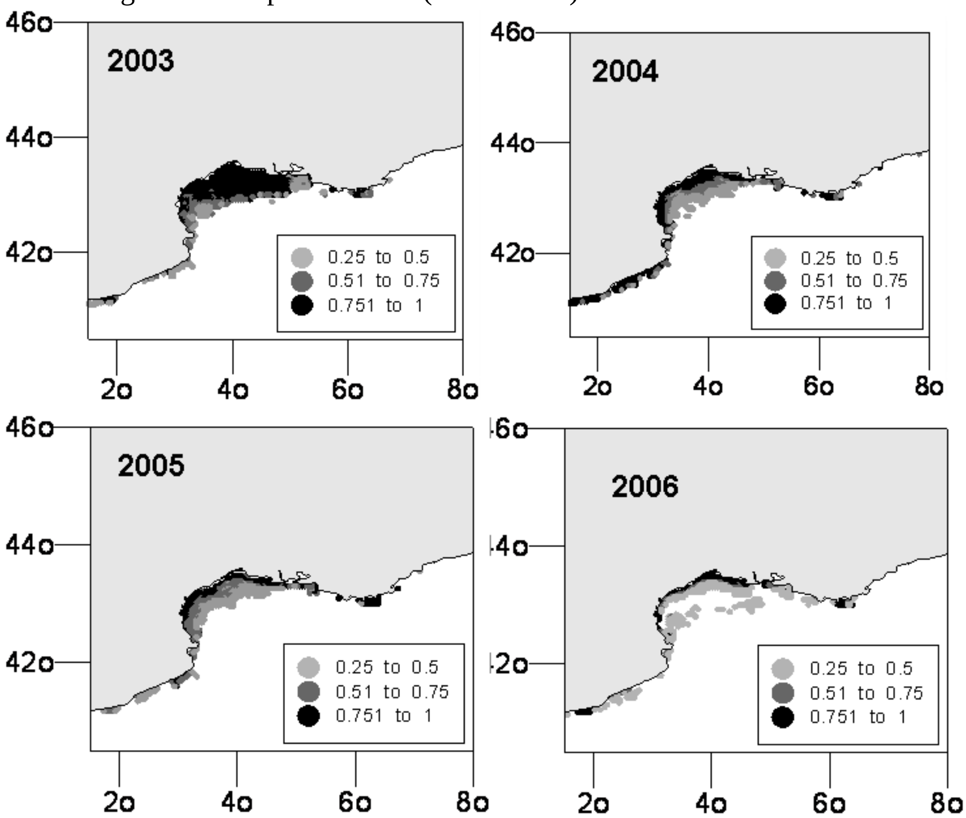


Fig. 6.5.1.25. Map of areas representing sardine juveniles potential habitat in the Gulf of Lions during July based on the GAM model. Gray scale indicates the probability of suitable areas for nursery grounds.

The indicated nursery areas consist shallow waters (<70m bottom depth), warmer waters in respect to the available temperature values, associated with high productivity values. These results should be considered as preliminary since SARDONE is an ongoing project. In addition, the probability threshold that defines an area as "nursery hot-spot" of sardine juveniles as well as the temporal persistency of this nursery area should be examined, in order to consider it as indirect evidence of the importance of that area to the recruitment success of the sardine population and use these maps for management and conservation purposes.

Adriatic Sea

Within the SARDONE presence/ absence data of anchovy *(Engraulis encrasicolus)* juveniles from acoustic surveys (2004-2008) held in the western part of the Adriatic Sea (GSA 17) during September have been used. The methodology used is the one already described and the final GAM model selected included bathymetry, sea surface temperature, sea level anomaly as well as chlorophyll concentration explaining 40% of the overall deviance. The probability of the occurrence of suitable environmental conditions for anchovy juveniles' presence was estimated and mapped. The model was evaluated with the AUC criterion (Elith et al, 2008) and indicated good model performance (AUC >0.75).

The indicated nursery areas consist shallow waters (<65m bottom depth) associated with waters of lower temperatures compared to the available ones. These results should be considered as preliminary since SARDONE is an ongoing project. Within the framework of the specific project work concerning the anchovy juveniles habitat during the winter period remains to be done. In addition, the probability threshold that defines an area as "nursery hot-spot" of anchovy juveniles as well as the temporal persistency of this nursery area should be examined, in order to consider it as indirect evidence of the importance of that area to the recruitment success of the anchovy population and use these maps for management and conservation purposes.

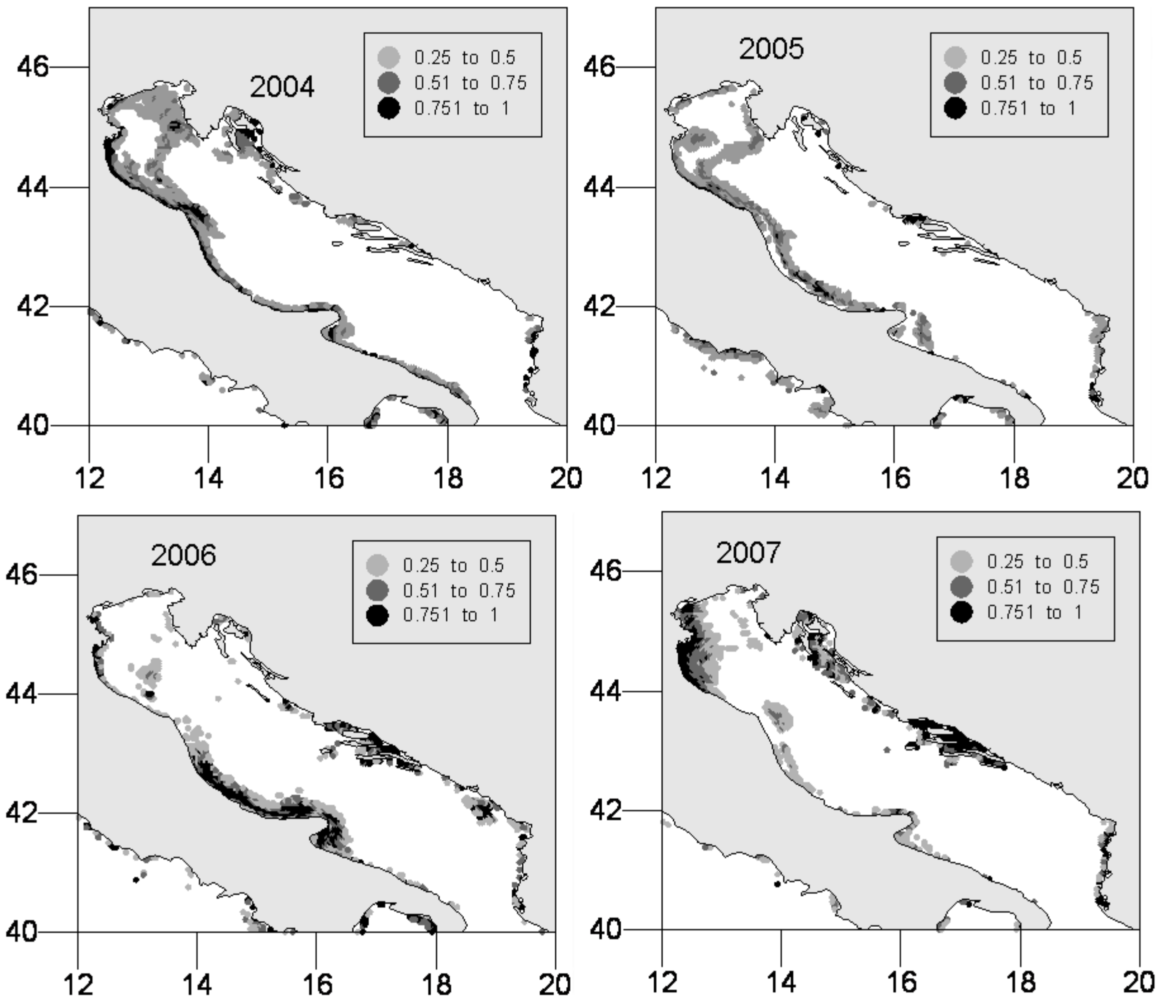


Fig. 6.5.1.26. Map of areas representing sardine juveniles potential habitat in the Adriatic Sea during September based on the GAM model. Gray scale is the probability of suitable areas for nursery grounds.

Aegean Sea

Within the SARDONE presence/ absence data of sardine *(Sardina pilchardus)* juveniles from acoustic surveys (2004-2006) held in northern Aegean Sea (GSA 22) during June have been used. The methodology used is the one already described and the final GAM model selected included bathymetry, photosynthetic active radiation, sea level anomaly as well as chlorophyll concentration explaining 55.5% of the total deviance. The probability of the occurrence of suitable environmental conditions for sardine juveniles' presence was estimated and mapped. The model was evaluated with the AUC criterion (Elith et al, 2008) and indicated good model performance (AUC >0.75).

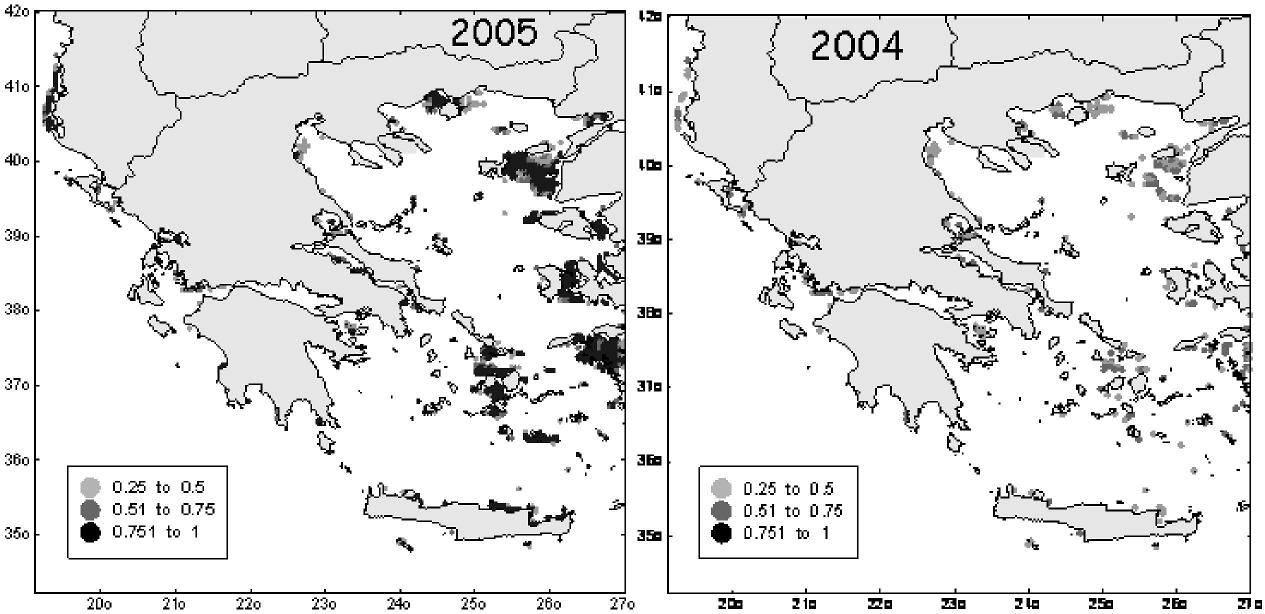


Fig. 6.5.1.27. Map of areas representing sardine juveniles potential habitat in Greek waters during June based on the GAM model from the northern Aegean Sea. Gray scale is the probability of suitable areas for nursery grounds.

The indicated nursery areas consist shallow areas (<70m bottom depth) associated with waters of high productivity. These results should be considered as preliminary since SARDONE is an ongoing project. In addition, the probability threshold that defines an area as a "nursery hot-spot" of sardine juveniles as well as the temporal persistency of this nursery area should be examined.

Tsagarakis *et al.* 2008 explores the relationships between the spatial patterns of the distribution of sardine juveniles in northern Aegean Sea (GSA 22) using data from experimental pelagic hauls that were held within acoustic surveys in the northern Aegean Sea (June 2003–2006). The presence of sardine juveniles was modelled using multivariate techniques and satellite environmental data as well as bathymetry data. Regions characterized by those environmental conditions that are likely to support increased presence of juvenile sardine were mapped.

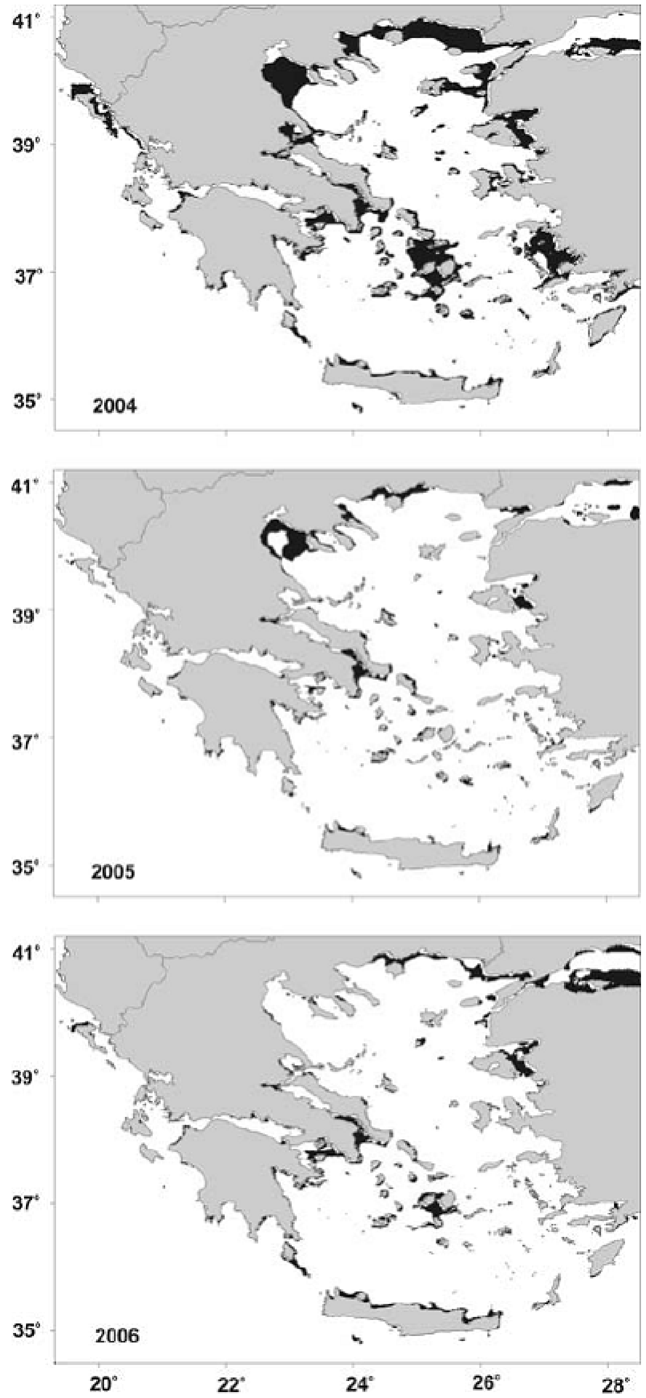


Fig. 6.5.1.28. Geographic distribution of regions classified as ‘‘juvenile’’ areas within the Greek Seas, for June 2004–2006 based on Tsagarakis et al. 2008.

Again, comparison of the maps obtained with the two different approaches and the temporal persistency of the areas that are characterised as nurseries should be examined, in order to assume it as indirect evidence of the importance of that area to the recruitment success of the sardine population and use these maps for management and conservation purposes.

6.5.2. Provide relevant information on fishing gear selectivity (mesh size/shape, twine thickness, hanging ratio, hook size, hook shape, etc.) with a view to further improve the exploitation pattern, reduce the fishing mortality on juveniles and increase the yield.

No information or analysis was provided during the SGMED.

6.5.3. Provide relevant information on spatial and temporal distribution of seasonal or persistent aggregations of spawners and provide scientific elements indicating that possible protection of these areas may reduce the risk of stock collapse and maintain the reproductive capacity of the exploited stocks.

Gulf of Lions slope

Part of the fishing fleets of northern Catalonia (Spain, NW Mediterranean) and Sète (France) exploit the fishing resources of the Gulf of Lions. This is a relatively well known fishery, with its main target species being hake (*Merluccius merluccius*), which is exploited using trawlnets (both countries), longlines (Spain) and gillnets (France). Since the first Franco-Spanish joint assessment of hake (Aldebert *et al*., 1993), longer data series and more sophisticated procedures (i.e. from LCA at the beginning to XSA the last assessment) have been carried out. In the SCSA sessions up to four (2001, 2003, 2005, 2006) and point to heavy growth overexploitation and likely recruitment overexploitation. Despite the heavy fishing pressure on all classes and the evidences of overfishing (both growth and recruitment), historical series of catches appear to be rather stable. The remaining spawning fraction of the hake stock appears to be limited to the most inaccessible areas on the continental slope of the Gulf of Lions, where it is only lightly exploited. Its preservation from full commercial exploitation is considered vital for avoiding the intensification of recruitment overexploitation and the associated collapse of the fishery. The character of lightly exploited refuges was confirmed by a series of experimental trawl cruises carried out in 2007 (Massutí et al. 2008).

As consequence a Fishery Restricted Area (FRA) proposal was submitted to the SCMEE of GFCM, which was endorsed by SCMEE (GFCM, 2008a) and SAC (GFCM, 2008b) and approved by the Commission (GFCM, 2009) with some modifications (Recommendation GFCM/33/2009/1: On the establishment of a fisheries restricted area in the Gulf of Lions to protect spawning aggregations and deep sea sensitive habitats).

The current proposal reveals key findings of a study carried out in the Gulf of Lions, in which results indicate that the continental slope of the Eastern Gulf of Lions acts as a refuge for large spawners of several commercially important species, including *Merluccius merluccius*, *Aristeus antennatus*, *Nephrops norvegicus, Lophius piscatorius, Micromesistius poutassou, Lepidopus caudatus, Trachurus trachurus and other species*

Based on this finding, and with fishing activities expected to shift to areas further out on the continental shelf in future years due to the dismal state of stocks closer the shore, the current proposal suggests that a fisheries restricted area be established on the continental slope of the Eastern Gulf of Lions in order to protect one of the last refuges for large spawning adults of hake and other important fish species. The suggested management measure would be to prohibit any kind of demersal fishing, towed or not, including trawl gears, bottom and midwater longlines, bottom nets (gillnets, trammel nets) and traps in the proposed zone. This measure is expected to result in major socio-economic benefits, since preserving the area would preserve the source of recruits supporting the current demersal fishery in the Gulf of Lions and even further south, in Northern Catalonia.

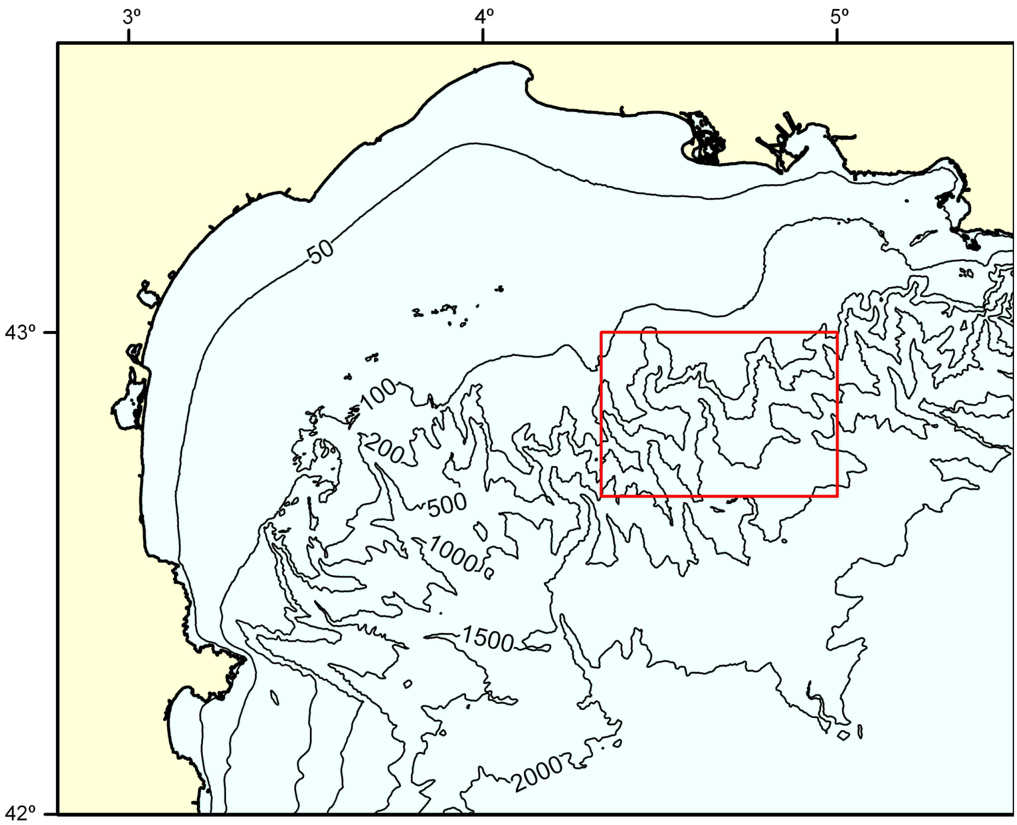


Fig. 6.5.3.1.

Spawning Sites in Central Mediterranean – Malta, GSA 15

Trawl survey data gathered around the Maltese Islands during the MEDITS project in 2003-2008 were analysed for *Merluccius merluccius*, *Mullus barbatus*, *Mullus surmuletus*, *Parapenaeus longirostris*, *Nephrops norvegicus* and *Aristaemorpha foliacea* (Knittweis & Dimech 2009). Abundance and biomass indices were calculated, and maps of the distribution of mature individuals plotted using MapInfo in order to reveal the location of spawning sites. Data for for *M. merluccius*, *M. barbatus*, *M. surmuletus* and *N. norvegicus* was analysed for the years 2003-2008, data for *P. longirostris* and *A. foliacea* was analysed for 2003-2007. Data sets were normalized in order to identify zones of high concentration regardless of interannual variabilities in abundance indices. This was done by scaling data between the observed maximum and minimum values (after Garofalo et al. 2004). Distribution maps based on pooled data of all abundance indices for all years combined were produced, using inverse distance weighting interpolation, a method which uses a distance weighted average of data points to calculate grid cell values.

Results revealed that spawners of the species *M. merluccius*, *M. barbatus*, *M. surmuletus* and *P. longirostris* were concentrated to the east / north-east of the Maltese Islands, in the vicinity of the Malta Bank. The distribution of mature individuals of *N. norvegicus* and *A. foliacea* was found to be patchier, with sites distributed throughout the deeper waters lying to the west / northwest of the Maltese Islands (see Figures 1-12 below).

A. ***Merluccius merluccius***

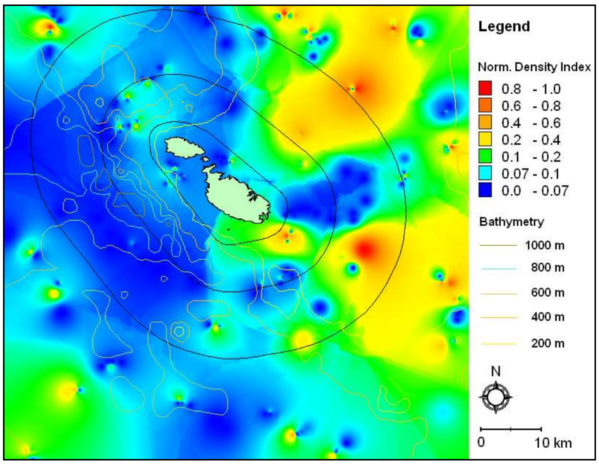


Fig. 6.5.3.2. Density indices, mature *M. merluccius*.

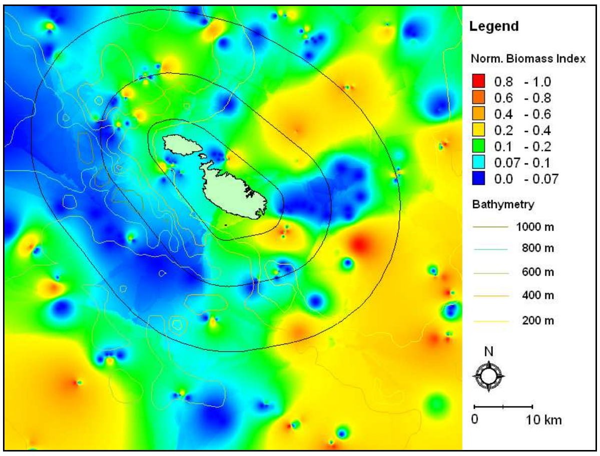


Fig. 6.5.3.3. Biomass indices, mature *M. merluccius*.

B. Mullus barbatus

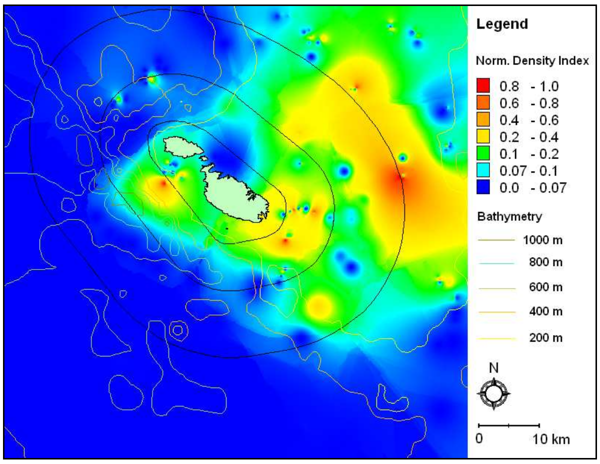


Fig. 6.5.3.4. Density indices, mature *M. barbatus*.

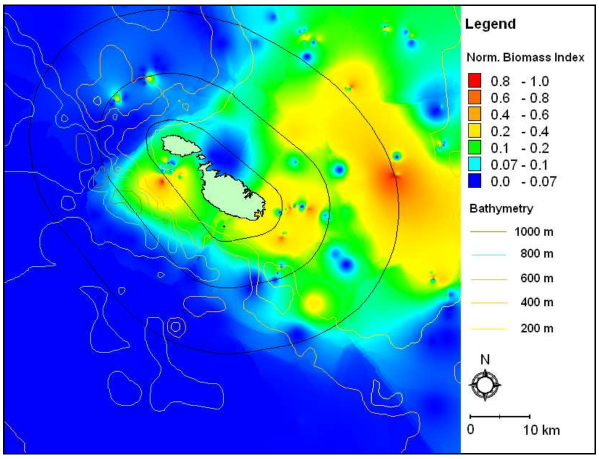


Fig. 6.5.3.5. Biomass indices, mature *M. barbatus.*

C. Mullus surmuletus

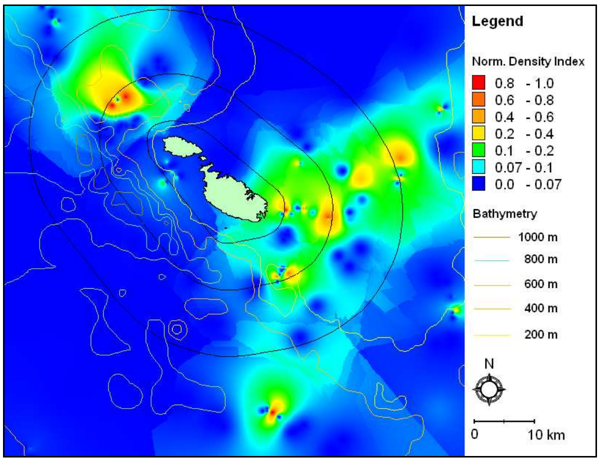


Fig. 6.5.3.6. Density indices, mature *M. surmuletus.*

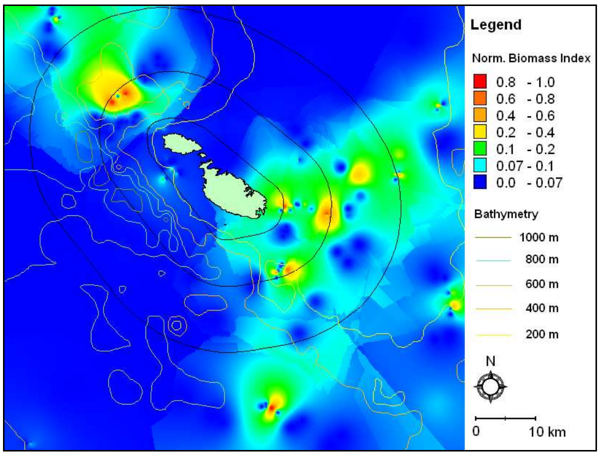


Fig. 6.5.3.7. Biomass indices, mature M. surmuletus.

D. Parapenaeus longirostris

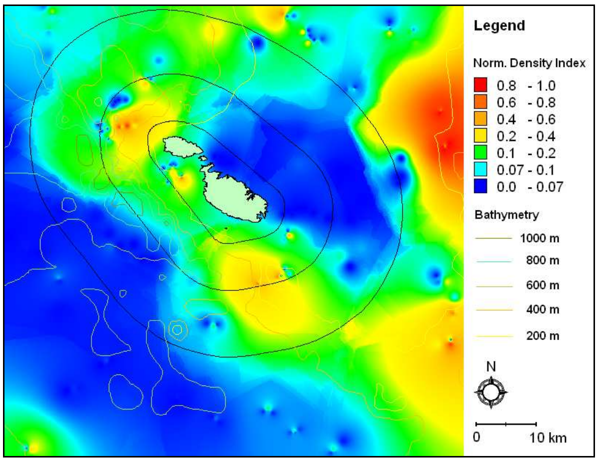


Fig. 6.5.3.8. Density indices, mature *P. longirostris*.

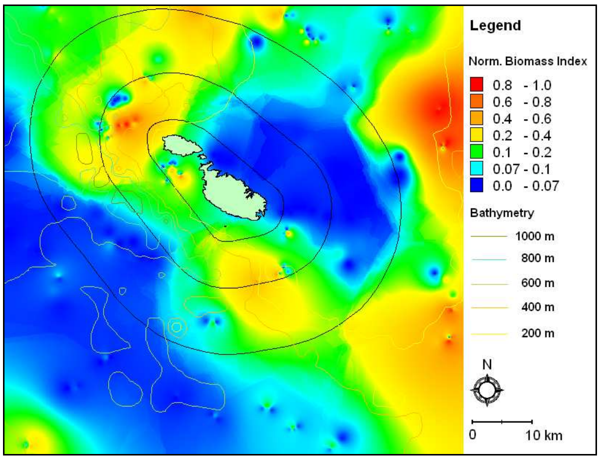


Fig. 6.5.3.9. Biomass indices, mature *P. longirostris.*

E. Nephrops norvegicus

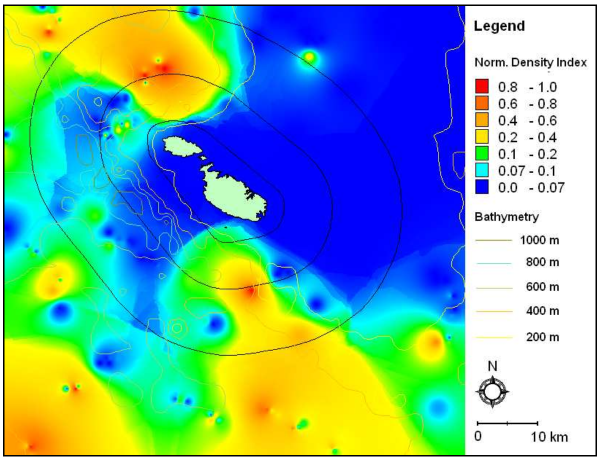


Fig. 6.5.3.10. Density indices, mature *N. norvegicus.*

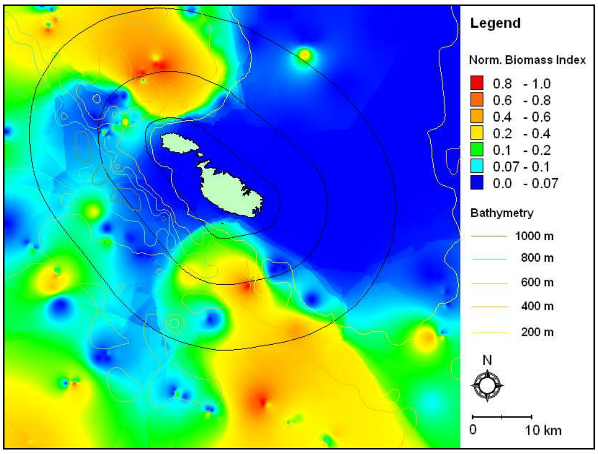


Fig. 6.5.3.11. Biomass indices, mature *N. norvegicus.*

G. *Aristaemorpha foliacea*

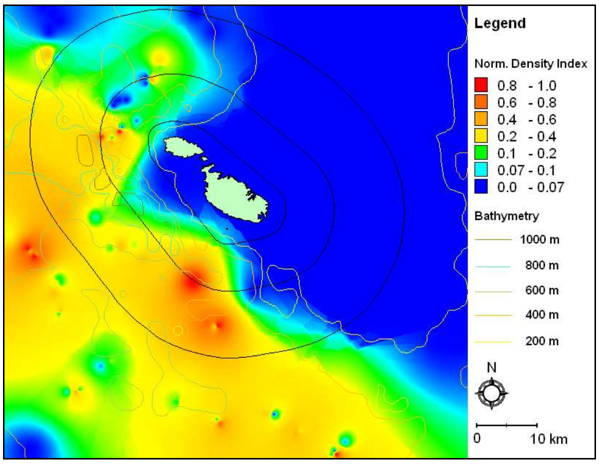


Fig. 6.5.3.12. Density indices, mature *A. foliacea.*

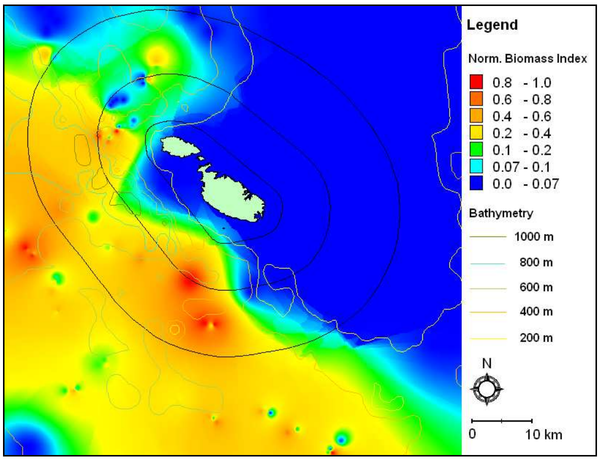


Fig. 6.5.3.13. Biomass indices, mature *A. foliacea.*

Small pelagics spawning grounds in Aegean Sea (GSA 22)

Schismenou et al. (2008) explored the relationships between the spatial patterns of the distribution of eggs and larvae of anchovy and round sardinella in Aegean Sea (GSA 22) and attempted to map the potential spawning habitat of anchovy and round sardinella in Aegean Sea. The term ‘‘potential spawning habitat,’’ (PSH) has been recently defined by Planque *et al.* (2007). It is used to describe the areas where the environmental conditions are suitable for spawning, i.e., the broad geographical area that could support the spawning activity of a species, defined by environmental conditions and the preferred ranges for spawning.

To estimate the PSH for anchovy and round sardinella, the presence/absence egg data from DEPM (Daily Egg Production Method) surveys in the northern Aegean Sea (June 2003–2006, Somarakis et al., 2007) was modeled with satellite environmental data using Generalized Additive Models (GAMs). The probability of the occurrence of suitable environmental conditions for spawning was estimated and mapped. The model performance was evaluated with the AUC criterion (Elith et al, 2008).

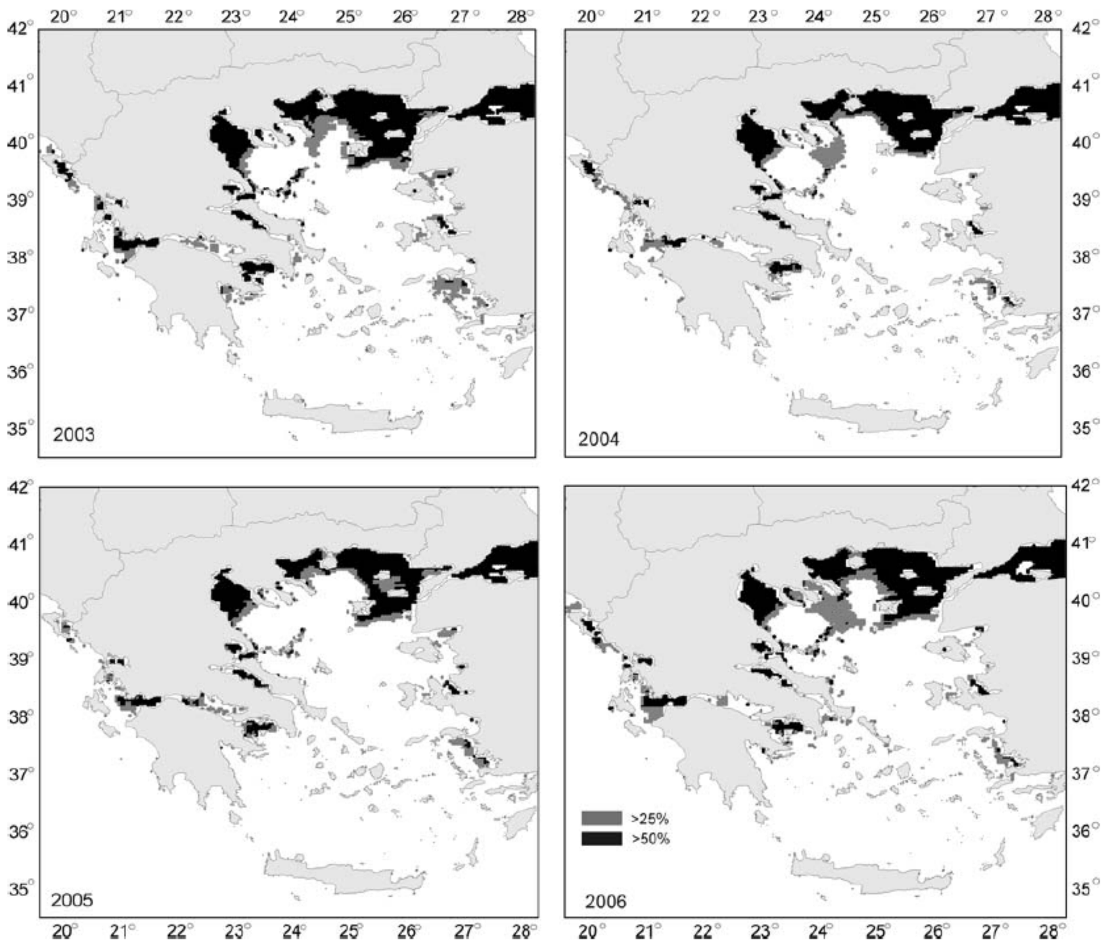


Fig. 6.5.3.14. Map of areas representing anchovy potential spawning habitat in Greek waters based on the GAM model from the northern Aegean Sea. Gray color:[25%; black color:[50% probability of suitable areas for spawning.

More specifically, in the Greek Seas the main spawning areas for anchovy were shown in the northern Aegean Sea, which is in agreement with the observed distribution patterns of eggs and data from previous surveys (Somarakis *et al.*, 2004; Somarakis, 2005; Somarakis *et al.*, 2006). The North Aegean Sea is largely influenced by the Black Sea Water and river runoffs exhibiting characteristics that are favorable for anchovy spawning (Somarakis *et al.*, 2002a; Somarakis & Nikolioudakis, 2007). Other smaller spawning grounds were also predicted by the model in the central Ionian and Aegean Seas, which match well survey results of July 1998 and June 1999 in this area (Somarakis *et al.*, 2002b; Somarakis *et al.*, 2006). The temporal persistency of these areas should be examined, in order to assume it as indirect evidence of the importance of that area to the spawning success of anchovy population and use these maps for management and conservation purposes.

SGMED conclusions and recommendations

SGMED recognise that an extensive amount of information and analysis is now available to define and quantify the areas of aggregation and persistence of juveniles and, partially, also spawners for several GSAs and stock. SGMED consider that index of persistence as estimated for example in Colloca *et al.* (2009) can be used as a robust method to define such areas and verify that they are constant during time. For example, the index of persistence has been already calculated for GSA 9 and 11. SGMED recommends that the estimation of the index of persistence should be performed also for the other areas and species where spatial information about the yearly distribution of juveniles and adults are available. This work could be addressed by a specific working group under the STECF framework.

7. STOCK SUMMARY SHEETS

SGMED 09-02 provides summary sheets (short versions of the important information from the assessment sections of this report) only in cases where exploitation rates are estimated analytically and respective fisheries management advice could be formulated.

Unlike the 2008 report of SGMED 08-04, the summary sheets provided in this report of SGMED 09-02 deal with assessment of historic and recent trends in stock parameters (stock size, recruitment and exploitation) and relevant scientific advice only. Deterministic short and medium term for such parameters including landings and relevant scientific advice will we delivered through the forthcoming SGMED 09-03 meeting in the fourth quarter of 2009. However, long term forecasts are provided in order to allow stock status reviews with regard to the estimated management reference points $F_{0.1}$, F_{max} and F_{msy}.

Where assessments and respective summary sheets could not be updated due to lack of data or expertise present at the meeting, a short reference to last year's report of SGMED 08-04 is provided.

7.1. Hake in GSA 06

Species common name:	European hake
Species scientific name:	*Merluccius merluccius*
Geographical Sub-area(s) GSA(s):	GSA 06

Most recent state of the stock

- State of the adult abundance and biomass:

Since 2006, SSB has increased from historical lows and varies slightly above average since then. SSB is estimated to about 1,500 t in 2008. SGMED 09-02 notes that this level of SSB is significantly below the proposed B_{lim}=2,200 t and B_{pa}=4,000 t.

- State of the juvenile (recruits):

Recruitment has been low in recent years and has decreased to the lowest level observed in 2008.

- State of exploitation:

SGMED 09-02 recommends F≤0.2 as target management reference point (basis $F_{0.1}$).
Fishing mortality has fluctuated without a trend at 1.6 (F_{bar} 0-2), or 1.5 for F_{bar} for ages 2 to 4. Comparing such estimates with $F_{0.1}$=0.16 and F_{max}=0.23, it can be concluded that the resource is heavily over-exploited, with future catches Being highly dependent on incoming recruitment.

The continued low abundance of adult fish in the surveyed population and landings indicate a very high exploitation pattern far in excess of those achieving high yields and low risk of fisheries collapse.

- Source of data and methods:

MEDITS surveys and official landings and biological data as collected within the DCR framework were used for the assessment.

The state of exploitation was assessed for the period 1995-2008 by means of a VPA Separable, tuned with standardised CPUE from abundance indices from trawl survey (MEDITS). Analysis was carried out applying the Extended Survivor Analysis (XSA) method (Lowestoft suite; Darby and Flatman, 1994) over the period 1995-2008. In addition, a yield-per-recruit (Y/R) analysis (VIT program; Lleonart and Salat, 1992) was applied on the mean pseudo-cohorts 1995-2008 for the GFCM geographical sub-area Northern Spain (GSA-06). Both methods were performed from size composition of trawl catches (obtained from on board and on port monthly sampling) and official landings, transforming length data to age data by slicing (L2AGE program).

Growth parameters used were those from Garcia-Rodriguez (2002) over otolith readings and length distributions analysis (L_{inf}= 106.7; K 0.20; t_0= 0.0028), and length-weight relationship and maturity ogive from García Rodriguez and Esteban (1995). The size composition of commercial landings were obtained by monthly length samplings carried out in one of the sampling ports used for the present assessment (Santa Pola) during the 1995-2008 period. Landings and effort data were obtained combining different sources, such as Official Landings provided by Autonomous Community, and from the Information and Sampling Network of the Spanish Oceanographic Institute (IEO). In this assessment, a new set of parameters (fast growth hypothesis) were considered and a natural mortality vector (PROBIOM, Caddy and Abella, 1999) was applied. SGMED-09-02 notes that the set of growth parameters used in the assessment were different to those used the year before, and the recommendation made last year regarding the use of parameters representing “fast growth hypothesis” has been followed.

Outlook and management advice

SGMED recommends the relevant fleets’ effort to be reduced until fishing mortality is below or at the proposed level $F_{0.1}$, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches consistent with the effort reductions should be estimated.

Short and medium term scenarios:
Will be conducted and delivered by SGMED 09-03 (14-18 December 2009).

Fisheries

Exploitation is based on very young age classes, mainly 0 and 1 year old individuals, with immature fish dominating the landings.
During last years, the annual landings of this species were around 3,500 tons in the whole GSA. From official data, the total trawl fleet of the whole geographical sub-area 06 (Northern Spain) is made up by 647 boats: on average, 47 TRB, 58 GT and 297 HP. Some of these units (smaller vessels) operate almost exclusively on the continental shelf (targeted at red mullet, octopus, hake and sea breams), others (bigger vessels) operate almost exclusively on the continental slope (targeting decapod crustaceans) and the rest can operate indistinctly on the continental shelf and slope fishing grounds, depending on the season, the weather conditions and also economic factors (e.g. landings price). The percentages of these trawl fleet segments have been estimated around 30, 40 and 30% of the boats, respectively.

Year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
GSA 6 Landings (t)	3850	5187	3770	3286	3462	4497	3269
Effort (days)	127167	106778	124183	113978	84966	67922	50553
Year	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
GSA 6 Landings (t)	3195	3411	3441	3363	3876	3572	3494
Effort (days)	92026	120049	104004	123302	106015	108879	92877

Precautionary and target management reference points or levels

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

$F_{0.1}$ (0-2)=0.16	target reference, sex combined
F_{msy} (age range)	
F_{mean} (age range)=	
Z_{msy} (age range)=	
Z_{mean} (age range)=	
B_{pa} (spawning stock) ≥ 4,000 t	
B_{lim} (spawning stock) ≥ 2,200 t	

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

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

Comments on assessment

During the STECF 09-06, an assessment on Hake from GSA 06 was performed. Official data were not sent on time, but the expert provided a copy of some of the data. Files dealing with official landings and effort were not available. Consequently data on landings and effort for 2008, were derived from the series.

Terminal Fs derived using XSA (With F shrinkage)							
	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 2- 4
	Age 0						
1995	293785	8080	2397	3850	1.6065	0.9998	1.0149
1996	908556	10813	1920	5187	2.7021	1.0203	1.2574
1997	396054	7367	1581	3770	2.3852	1.0001	1.4311
1998	398448	6669	1148	3286	2.863	0.9847	1.6672
1999	467937	7646	814	3462	4.2525	0.9898	1.6597
2000	472647	9220	1024	4497	4.3916	1.0035	2.2839
2001	340506	6860	928	3269	3.5223	1.0071	1.1704
2002	353803	6675	1122	3195	2.848	0.997	1.4808
2003	311571	7230	1077	3411	3.1663	0.9824	2.09
2004	323751	7742	743	3441	4.6336	0.9877	1.2667
2005	264061	7369	1005	3363	3.3462	0.9842	1.0389
2006	240848	10038	1725	3876	2.2466	1.4416	1.3285
2007	270807	8251	1757	3572	2.0327	0.9452	1.5273
2008	183396	7207	1455	3494	2.4011	0.8691	1.5121
Mean	373298	7940	1335	3691	3.0284		1.4806

7.2. Hake in GSA 09

Species common name:	European hake
Species scientific name:	*Merluccius merluccius* (L., 1758)
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

SSB is likely to amout to 5-10% of the SSB at Fmsy. STECF SGMED-09-02 underlines that this conclusion could be influenced by the observed exploitation patterns in the surveys and fisheries, which almost exclusively represent the juvenile part of the stock.

- State of the juveniles (recruits):

In recent years recruitment has varied without a clear trend.

- State of exploitation:

SGMED 09-02 recommends F=0.2 as target management reference point (basis $F_{0.1}$).
The stock appears to be heavily overexploited and F needs a consistent reduction from the current F of 1.2-1.7 (SURBA and VIT estimates) towards the candidate reference points for long term sustainability based on F between 0.2-0.4 ($F_{0.1}$-F_{max}). However, considering the high productivity in terms of incoming year classes, this stock has the potential to recover quickly if F is reduced towards $F_{0.1}$.
The continued lack of older fish in the surveyed population indicates exploitation rates far beyond those considered consistent with high yields and low risk. This fact, on the other hand, may reduce the risk of fisheries collapse.

- Source of data and methods:

Data coming from MEDITS (1994-2008) and GRUND (1994-2004) trawl surveys were used to estimate relative SSB and F with Surba. Data coming from DCR (size distribution of landings for trawl and gillnet data on trawl discards for 2006) for the period 2006-2008 were used to run LCA analyses.

The following parameters were used both for SURBA and VIT analyses:

Growth parameters (Von Bertalanffy)
$L\infty$ = 104 (cm, total length); k = 0.2; $t_{0=}$ - 0.03
L*W: a = 0.006657; b=3.028
M vector Age_1=1.3, Age_2=0.6, Age_3=0.46, Age_4=0.41, Age_5=0.3 (ProBiom)
q(age 1+) = 0.8, q(age 2+) = 1.0, q(age 3+)=0.7, q(age 4+)=0.7, q(age 5+)=0.7
Length at maturity (L_{50}) = 30 cm total length (sex combined)

Outlook and management advice

SGMED recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed level $F_{0.1}$, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches consistent with the effort reductions should be estimated.

Short and medium term scenarios:
Will be conducted and delivered by SGMED 09-03 (14-18 December 2009).

Fisheries

Hake is the demersal species providing the highest landings and incomes in the GSA 0 9. About 90% of landings of hake are due to bottom trawl vessels; the remaining fraction is caught by artisanal vessels using set nets, in particular gillnets. Hake trawl fishery exploits a highly diversified species assemblage: horned octopus (*Eledone cirrhosa*), poor cod (*Trisopterus minutus capelanus*), squids (*Illex coindetii*), are among the most important species in the by catch. The trawl fleet of GSA 09 at the end of 2007 accounted for 360 vessels. The main trawl fleets of GSA 09 are present in the following continental harbours: Viareggio, Livorno, Porto Santo Stefano (Tuscany), Fiumicino, Terracina, Gaeta (Latium). The fishing capacity of the GSA 09 has shown in these last 20 years a progressive decrease; from 1996 to 2006 the number of bottom trawlers of GSA9 decreased of about 30%. Consequently also fishing effort decreased, even though in a lesser extent, in this period. In the last five years the total landings of hake of GSA 09 fluctuated between 1,000 to about 2,300 tons. In 2008 the landing was 1,329 tons.

Landings (t) by year and major gear types, 2002-2008 as reported through DCR.

AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
9	ITA	DTS	508	1148	540	1040	1180	1026	914
9	ITA	HOK			1	2	38		5.06
9	ITA	PGP	154	659	626	858	1112	727	410
9	ITA	PMP	236	258	16	19			
9	ITA	PTS	7	15	12				
			905	2080	1195	1919	2330	1753	

Trend in fishing effort (days, GT*days, kW*days, TSL*days) by major gear types, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	9	ITA	DRB	1856	3332	2660	2635	3182	2177
DAYS	9	ITA	DTS	62616	63331	64870	65657	63141	61710
DAYS	9	ITA	HOK			2568	1921	1821	
DAYS	9	ITA	PGP	212455	182159	196758	189052	183435	175888
DAYS	9	ITA	PMP	52193	75479	16960	6655		
DAYS	9	ITA	PTS	5453	6242	4728	4739	5242	5160
GT*DAYS	9	ITA	DRB			24050	23915	28878	20772
GT*DAYS	9	ITA	DTS			2410544	2448143	2325295	2289820
GT*DAYS	9	ITA	HOK			22784	16701	13580	
GT*DAYS	9	ITA	PGP			521225	493611	507794	485784
GT*DAYS	9	ITA	PMP			62599	24894		
GT*DAYS	9	ITA	PTS			143490	162480	200226	194754
KW*DAYS	9	ITA	DRB	187147	335521	268423	265359	320437	225526
KW*DAYS	9	ITA	DTS	14583556	14671042	14130070	14265309	13484321	13096031
KW*DAYS	9	ITA	HOK			376470	275809	262696	
KW*DAYS	9	ITA	PGP	6504001	6925653	7060573	6946213	7399313	7300451
KW*DAYS	9	ITA	PMP	4715565	4051809	984241	396631		
KW*DAYS	9	ITA	PTS	1312412	1333245	947166	1013627	1174295	1151346
TSLDAYS	9	ITA	DRB	15733	28362				
TSLDAYS	9	ITA	DTS	2154256	2147750				
TSLDAYS	9	ITA	PGP	624182	650560				
TSLDAYS	9	ITA	PMP	382454	382992				
TSLDAYS	9	ITA	PTS	193726	181590				

Due to large concentration of hake juveniles in GSA 09, trawl landings are traditionally dominated by small sized specimens; they are basically composed by age groups 0+ and 1+. Gillnet fishery lands mostly age 2 and age 3 fish. High quantities of small size hake are routinely discarded, especially in summer and on fishing grounds located near the main nursery areas of the species. About 450 tons of hake discards were estimated in 2006 for the trawl fishery in GSA 09. Due to the introduction of the EU Regulations on MLS, a progressive increase of the size at which 50% of the specimens caught was discarded has been observed in the last ten years.

Limit and target management reference points or levels

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

$F_{0.1}$ (age1-5) = 0.22	target
F_{max} (age 1-5) = 0.35	
F_{msy} (age range) =	
B_{msy} (spawning stock) =	
B_{pa} (B_{lim}, spawning stock) =	

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

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

Comments on assessment

GRUND data prior to 1994 should be standardised and used within this assessment.

7.3. Hake in GSA 10

Species common name:	European hake
Species scientific name:	*Merluccius merluccius* (L., 1758)
Geographical Sub-area(s) GSA(s):	GSA 10

Most recent state of the stock

- State of the adult abundance and biomass:

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. However, recent values are among the highest observed since 1994. The hindcasting approach using Aladym model shows that the SSB was continuously decreasing. A similar pattern shows also the spawning potential ratio that was in the range 6 and 4% from 1994 and 2008. SGMED-09-02 is unable to interpret such different trends and thus unable to advice on the state of the spawning stock size, in particular due to a lack of a estimated management reference points.

- State of the juvenile (recruits):

Recent recruitment since 2006 appears to be above average.

- State of exploitation:

SGMED 09-02 proposes $F \leq 0.24$ as target management reference point (basis $F_{0.1)}$.
Given the results of the present analysis, the stock appears overexploited. Considering the level of F estimated in 2008 by Aladym, i.e. 0.55, the stock appears overfished and a reduction of 55% would be necessary to reach $F_{0.1}$ (0.244).

- Source of data and methods:

The data used in the analyses were from trawl surveys (time series of MEDITS and GRUND surveys from 1994 to 2008 and from 1994 to 2006 respectively) and from the effort and landings. The analyses on the population were conducted using SURBA and ALADYM models in a complementary way. The following growth parameters were used to split the LFD for the SURBA analyses and to parameterize Aladym model as well as Yield software: L_∞=97.9 cm, K=0.135, t_0= -0.4; males: L_∞=50.8 cm, K=0.25, t_0= -0.4; length-weight relationship: a=0.00355, b=3.2. Size at first maturity was varying around 32 cm (maturity range 2 cm). Estimates of total mortality and recruitment from SURBA were used to feed Aladym model, re-estimating the total and fishing mortality.

Outlook and management advice

SGMED recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed level $F_{0.1}$, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches consistent with the effort reductions should be estimated.

Short and medium term scenarios:
Will be conducted and delivered by SGMED 09-03 (14-18 December 2009).

Fisheries

Available landing data are from DCR regulations and range from 1012 tons of 2002 to 1,544 t in 2006, being the lowest value of 393 tons registered in 2006. Landings were rising from 2002 to 2006 and then were decreasing to1,122 tons in 2008. The whole fishing effort (kw·days) of fishing segments (2002-2004) or métier (2005-2007) related with hake capture in the GSA 10 shows a decreasing from 2002 till now, with trawlers almost stable and slightly decreasing in the last 3 years and small scale fishery decreasing from 2002 to 2007.

Table of fishing effort by fleet for longest time series available.

Sum od EF				
YEAR	AREA	TYPE	FISHING_TECH	Total
2002	10	KWDAYS	DTS	7344089
			PGP	6440217
			PMP	12686947
			PTS	2631242
2002 Total				29102495
2003	10	KWDAYS	DTS	7231486
			PGP	7222145
			PMP	8003452
			PTS	2930380
2003 Total				25387463
2004	10	KWDAYS	DTS	7883881
			HOK	1654352
			PGP	7056306
			PMP	3588004
			PTS	2308589
2004 Totale				22491133

Sum of EF				
YEAR	TYPE	FT_LVL4	FT_LVL5	Total
2005	KW*DAYS	GNS	Demersal species	4354162
		LLS	Demersal fish	1852150
		OTB	Deep water species (b)	1405828
			Demersal species	1610275
			Mixed demersal species and deep water species (b)	5086660
2005 Total				14309075
2006	KW*DAYS	GNS	Demersal species	2457132
		LLS	Demersal fish	1289606
		OTB	Deep water species (b)	910667
			Demersal species	2677321
			Mixed demersal species and deep water species (b)	3356430
2006 Total				10691156
2007	KW*DAYS	GNS	Demersal species	1743047
		LLS	Demersal fish	1194311
		OTB	Deep water species (b)	1258898
			Demersal species	3095793
			Mixed demersal species and deep water species (b)	2527698
	KW*DAYS Totale			9819747
2007 Total				9819747

Annual landings (t) by fishing technique, 2002-2008.

Sum of Weight (tons)		FISHING_TECH				
YEAR	SPECIES	DTS	PTS	PGP	PMP	Total
2002	HKE	515.30	26.50	224.80	245.60	1012.30
2003	HKE	425.10	21.30	328.50	321.70	1096.70

Sum of Weight (tons)		FT_LVL4					
YEAR		OTB	GNS	GTR	LLS	SB-SV	Total
2004	HKE	487.20	382.90	202.20	266.40		1338.60
2005	HKE	623.80	293.80	297.40	269.70		1484.70
2006	HKE	761.30	343.00	152.10	287.70		1544.10
2007	HKE	640.70	219.80	167.90	240.20		1268.70
2008	HKE	500.60	319.30	67.60	233.90	1.40	1122.80

Precautionary and target management reference points or levels

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

$F_{0.1}$ (equilibrium) = 0.24	
F_{max} (age range) = 0.42	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

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

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

7.4. Hake in GSA 11

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

Most recent state of the stock

- State of the adult abundance and biomass:

SGMED-09-02 could not estimate the absolute levels of stock abundance. Survey abundance (n/km²) and biomass (kg/km²) indices do not indicate a significant trend. The stock SSB is more variable over the last decade. No biomass reference points have been proposed for this stock. As a result, SGMED is unable to evaluate the status of the stock with respect to biomass.

- State of the juvenile (recruits):

SGMED-09-02 could not estimate the absolute levels of recruitment. Relative indices estimated by SURBA indicated very high fluctuations of recruitment in the period 1994-2008, without a clear temporal pattern.

- State of exploitation:

SGEMD 09-02 recommends $F \leq 0.17$ as target management reference point (basis $F_{0.1}$).
The reference points ($F_{0.1}$ and F_{max}) estimated for this species using the Yield software were 0.17 and 0.25, respectively. SGMED notes that the current F (F_{1-3}=1.0-2.3) is far in excess of the proposed target reference point $F_{0.1}$ and also exeeds F_{max}. Assuming similar selection patters of the survey and the commercial fishery, SGMED concludes that the stock is heavily overfished.

- Source of data and methods:

The SURBA software program was used to analyse the MEDITS time series and to estimate relative SSB and F. Data coming from DCR (size distribution of landings for trawl) for the period 2006-2007 were used to run stock analyses.

The following parameters were used both for SURBA and VIT analyses:

VBGF	L_∞=97.15 cm, K=0.165, t_0= -0.03
L*W relationship	a = 0.004, b= 3.156
M vector	Age_1=1.11, Age_2=0.51, Age_3=0.40, Age_4=0.35, Age_5=0.33
Catchability (q)	q_1 = 0.9, q_{2-3} = 1.0, q_4=0.75, q_5=0.55
Length at maturity (L50)	36 cm (sex combined)

Outlook and management advice

SGMED recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed level $F_{0.1}$, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches consistent with the effort reductions should be estimated.

Short and medium term scenarios:
Will be conducted and delivered by SGMED 09-03 (14-18 December 2009).

Fisheries

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

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

At the end of 2006 the trawl fleet of GSA11 accounted for 157 vessels (11.7% of the overall Sardinian fishery fleet). The main trawl fleets of GSA11 are present in the following harbors: Cagliari, Alghero, Porto Torres, La Caletta, Sant'antioco, Oristano, Alghero and Arbatax. The fishing capacity of the GSA trawl fleet has shown in these last 15 years remarkable changes. From 1994 to 2004 a general increase in the number of vessels and by the replacement of the old, low tonnage wooden boats by larger steel boats. In the latest years the effort shows a peak in 2005. In the last five years the total landings of hake of GSA 11 fluctuated between 592 to about 768 tons, with a consistent drop (-25% of the mean) in the last year.

Italian landings (t) by year and major gear types, 2002-2007 as reported through DCR.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
HKE	11	ITA	DTS	167	592	597	768	595	447
HKE	11	ITA	PGP	4	26	114	160	229	103
HKE	11	ITA	PMP	190	279				
Sum			Total	361	897	711	928	824	550

Trend in fishing effort (days, GT*days, kW*days) for Italy by major gear types, 2004-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2004	2005	2006	2007
DAYS	11	ITA	DTS	28840	31993	26532	27374
DAYS	11	ITA	PGP	165945	151720	156269	155243
DAYS	11	ITA	PMP				
GT*DAYS	11	ITA	DTS	1598912	1881952	1437559	1486500
GT*DAYS	11	ITA	PGP	501550	484820	493411	495670
KW*DAYS	11	ITA	DTS	6711626	7736040	6017232	6340429
KW*DAYS	11	ITA	PGP	7105771	6996350	7234881	7398923

Limit and target management reference points or levels

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

$F_{0.1}$ (age 1-5)=0.17	target
F_{max} (age 1-5)=0.25	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

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

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

Comments on the assessment

GRUND data should be standardised and used in the assessment.

7.5. Red mullet in GSA 09

Species common name:	Red mullet
Species scientific name:	*Mullus barbatus*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

The index of stock abundance from GRUND survey shows high variability throughout the time series, but no trend is observed. The index of abundance from MEDITS survey, that approximates a spawning stock biomass index (mostly represented by mature fish), suggests an increasing trend from 1994 to 2008. High inter-annual variation is observed from 2002 to 2008. The current spawning stock biomass roughly estimated through simulations with LCA outputs and yield-per-recruit analysis is assumed to be lower than 20% of the pristine one. Such surviving rate of spawners, is considered very low for ensuring the stock self-renewal.

- State of the juvenile (recruits):

Recruitment shows a slight increasing trend, especially in the most recent years.

- State of exploitation:

SGMED 09-02 proposes $F \leq 0.58$ as target management reference point (basis F_{MSY}).
Quite consistent estimates of the current fishing mortality were obtained with 3 alternative approaches (F2008 = 0.85 with ASPIC, F2006-2008=0.97 with LCA) all of them higher than the values recently estimated for the limit reference points F_{MSY}=0.58 and its proxy $F_{0.1}$ =0.49 as well as with a previous biomass dynamics model based on trawl surveys time series of Z and biomass index, that provided a F_{MSY} rate of 0.59 (SGMED-08-03). The stock is considered overexploited. The size of first capture is too low (growth overfishing) and an increase in yield can be expected in the case a reduction of fishing effort do occur and/or more selective gears are used. It is advisable to avoid the illegal fishing within the 3 miles zone from the base line as well as the landing of undersized individuals in order to decrease fishing pressure on juveniles.

- Source of data and methods:

Data used derive from trawl surveys on size composition and abundance indices and on landings by size/age and direct fishing effort from commercial catch assessement surveys. LCA with data from 2008 was used for the estimation of the *F* vector, using catches from trawlers and small scale fisheries. Yield per recruit analysis was used for the definition of F_{max} and $F_{0.1}$. A dynamic Biomass Production model (ASPIC) using both a time series from 1994 and 2008 of catch and effort of commercial vessels proceeding from two of the main ports (Viareggio and Porto Santo Stefano) and an abundance index derived from trawl surveys for the same time interval allowed to estimate F_{MSY}, *q* for each fishery, B_{MSY}, f_{MSY}, and a value of *F* for each year along the time series. SURBA was also used for deriving *F* estimates by year and other features.

The parameters used: Linf=29, K=0.6, to=-0.1 L/W relationship a=0.00053 b=3.12; An M vector (age1=1.30, age2 0.79, age 3 0.62, age 4= 0.54) and a weighted mean value of M of 0.8

Outlook and management advice

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

Short and medium term scenarios:
Will be conducted and delivered by SGMED 09-03 (14-18 December 2009).

Fisheries

The species is caught as a part of a species mix that constitutes the target of the trawlers operating near shore. The main species caught in GSA 09 are *Squilla mantis, Sepia officinalis, Trigla lucerna, Merluccius merluccius, Mullus barbatus, Gobius niger*. The species is mainly caught in late summer-beginnings of autumn, when juveniles are highly concentrated near shore. Age of first capture is of about 7 cm. Catch is mainly composed by age 0 individuals while the older age classes are poorly represented in the catch. Catch rates increased along the analysed period and considering that no dramatic changes occurred on effort allocation nor on other aspects of fishing behaviour in the analysed years, this increase has to be attributed to an enhancement in biomass. Even if catch within the coastal 3 miles stripe is forbidden, illegal fishing do occur considering the high value that small-sized individuals have in the area.

Total catches GSA9 of Mullus barbatus

YEAR	Bottom trawls	Longlines	MISCELANEOUS	Nets	Seines
2004	521.09		2.30	59.85	0.00
2005	684.00			30.82	0.05
2006	1033.19		0.45	16.43	
2007	1087.41			8.63	
2008	716.25	0.02		11.16	
Total (tons)	4041.94	0.02	2.75	126.90	0.05

Total landings and directed fishing effort for *M. barbatus* in 2 ports of GSA 09.

	P.Santo Stefano		Viareggio	
	days	catch	hours	catch
1994	1928	39029	78375	69650
1995	2250	27357	75240	71326
1996	2320	33643	74195	74663
1997	2137	34715	73150	85110
1998	2626	30091	71060	104051
1999	2454	33161	71060	141873
2000	2354	46063	70015	154654
2001	1532	48069	67925	170953
2002	1174	40993	66880	163647
2003	1448	51027	65835	143018
2004	1591	46048	64790	142679
2005	1475	39844	63745	140381
2006	1629	69955	63556	150826
2007	1550	62735	62632	119807
2008	1423	50117	61726	181412

Precautionary and target management reference points or levels

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

$F_{0.1}$ (all exploited ages) = 0.49	from Y/R
F_{max} (all exploited ages) = 0.62	from Y/R
F_{msy} (all exploited ages) = 0.58	target, from catch and effort with ASPIC
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

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

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

7.6. Red mullet in GSA 25

Species common name:	Red mullet
Species scientific name:	*Mullus barbatus*
Geographical Sub-area(s) GSA(s):	GSA 25

Most recent state of the stock

- State of the adult abundance and biomass:

In the absence of proposed or agreed precautionary refernce points SGMED 09-02 is unable to fully evaluate the status of the spawning stock size. In the current stock assessment no trend in the spawning stock biomass is evident.

- State of the juvenile (recruits):

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment as no trend in recruitment is evident.

- State of exploitation:

SGMED recommends $F_{0.1}$ of ages 1-3=0.22 as an approximation of F_{msy} ($F \leq 0.22$) and thus as the target management reference of sustainable exploitation.

The estimated reference points of $F_{0.1}$ (0.22) and F_{max} (0.34), in relation with the estimated value of $F_{bar\ (1\text{-}3)}$ (=0.84), sugggest an overexploitation state of the stock.

- Source of data and methods:

The present assessment was performed by means of VPA analysis, using a mean pseudo-cohort from catch-at-age data for the period of 2005-2008. A Yield per Recruit (Y/R) Analysis was also performed for the estimation of F_{max} and $F_{0.1}$. The VIT software (Lleonart and Salat, 1992) was used for both analyses. Catch-at-age data derived from landings for each fishing gear exploiting the stock (bottom otter trawl and trammel net), and discards data from bottom otter trawl.
An M vector was used as estimated by PROBIOM. The biological data used were collected within the framework of the Cyprus National Data Collection Programme and submitted under the 2009 Spring Official EC Data Call.
All data required under the 2009 Spring Official EC Data Call were available during the meeting.

Outlook and management advice

SGMED 09-02 recommends a reduction in fishing effort of the relevant fleets until sustainable levels of fishing effort are achieved ($F \leq 0.22$). This shoud be done by means of a multi-annual management plan taking into account mixed fisheries implications. Catches consistent with the effort reductions should be estimated.

Short and medium term scenarios:
Will be conducted and delivered by SGMED 09-03 (14-18 December 2009).

Fisheries

Red mullet in GSA 25 is exploited with other demersal species by the bottom otter trawlers and the artisanal fleet using trammel nets. The main species caught with *M. barbatus* are: *Spicara* spp. (mostly *S. smaris*), *Boops boops*, *M. surmuletus*, *Pagellus erythrinus* and cephalopods (*Octopus vulgaris*, *Loligo vulgaris* and *Sepia officinalis*). The artisanal (inshore) fishery catches also relatively large quantities of *Diplodus* spp, *Sparisoma cretense* and *Siganus* spp. The average percentage of *M. barbatus* in the overall landings of the bottom trawl and artisanal fishery, for the period 2005-2008, was 7% and 2% respectively.

Figure 7.6.1 provides the official landings of *M. barbatus* in GSA 25 by fishing gear, for the years 1985-2008. The figure presents a declining trend in the landings from both gears, mostly from the trammel nets. For the same period, the overall LPUE by fishing fleet (all gears combined for the artisanal fishery) is provided in Figure 7.6.2. LPUE of both fleets show a declining trend until 2006; since then, LPUE for the artisanal seems to be stable, while for the bottom trawl fishery LPUE in 2007 reached the highest value of the time period. It is noted that since 2006 the number of licensed bottom trawlers operating in GSA 25 has been reduced by 50% (from 8 to 4).

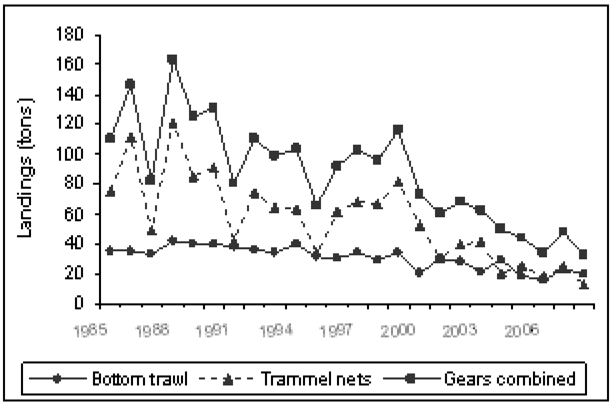


Fig. 7.6.1 Landings of *M. barbatus* in GSA 25 by fishing fleet for the period 1985-2008.

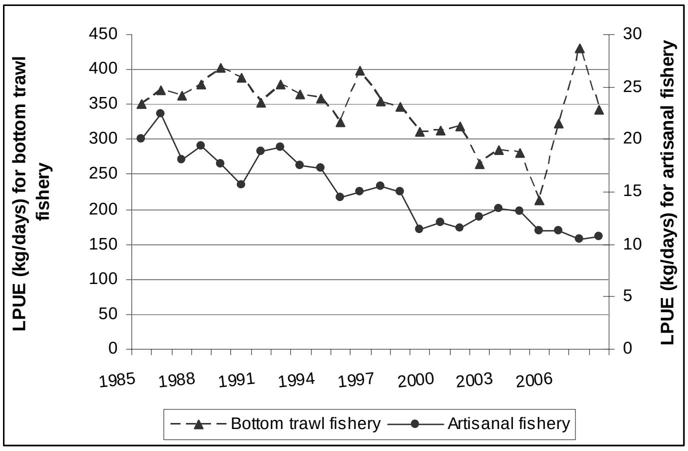


Fig. 7.6.2 Overall LPUE in GSA 25 by fishing fleet for the period 1985-2008.

Precautionary and target management reference points or levels

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

$F_{0.1}$ (1-3)=	0.22
F_{max} (1-3)=	0.34
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

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

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

7.7. Pink shrimp in GSA 06

Species common name:	Deepwater pink shrimp
Species scientific name:	*Parapenaeus longirostris*
Geographical Sub-area(s) GSA(s):	GSA 06

Most recent state of the stock

- State of the adult abundance and biomass:

Since 2002, SSB, with an average for the whole period of 342 t, declined rapidly and continuously to the lowest value observed in 2008 (111 t) which represents only 8% of that observed in 2002. SGMED notes that the MEDITS survey abundance index shows a very high peak in abundance in the 1999-2001 period, which represents the start of the assessment period. Prior to 1999, abundance levels were comparable to those seen in the 2002-2008 period. SGMED notes that the level of 111 t is much lower than the proposed management references of B_{lim}=300 t and B_{pa}=1,200 t, respectively. The stock is therefore considered not having its full reproductive capacity.

- State of the juvenile (recruits):

Recruits (aged 0 individuals) were estimated to have declined from 2002 to 2005 in the same pattern as 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.

- State of exploitation:

SGMED recommends that $F \leq 0.2$ be established as a management target and a proxy for F_{msy}.
Fishing mortality over ages 2-5 displays a high variation with an average value of F=0.5. SGMED 09-02 considers the stock being subject to overfishing.

- Source of data and methods:

The state of exploitation was assessed for the period 2002-2008 by means of a VPA Separable, tuned with standardised CPUE from abundance indices from trawl survey (MEDITS). Analysis was carried out applying the Extended Survivor Analysis (XSA) method (Lowestoft suite; Darby and Flatman, 1994) over the period 2002-2008. In addition, a yield-per-recruit (Y/R) analysis (VIT program; Lleonart and Salat, 1992) was applied on the mean pseudo-cohorts 2002-2008 for the GFCM geographical sub-area Northern Spain (GSA-06). Both methods were performed from size composition of trawl catches (obtained from on board and on port monthly sampling) and official landings, transforming length data to age data by slicing (L2AGE program).

The parameters of the size-weight relationship used in this assessment (García Rodriguez et al., 2009) are similar to those calculated by other authors, (Ribeiro-Cascalho & Arrobas, 1987; Sobrino, 1998; Tosunoglu et al., 2007). The estimates made for the VBGF parameters (García Rodriguez et al., 2009) show that, although the L_∞ values were similar, the values for the growth rate (K) calculated in this study are lower than those presented by other authors both for the Mediterranean (Ardizzone *et al*., 1990; D'Ongia *et al*., 1998) and for the Atlantic (Ribeiro-Cascalho, 1988; Sobrino, 1998), The size composition of commercial landings were obtained by monthly length samplings carried out both in one of the ports (Santa Pola) as well as on board samplings, during the 2002-2008 period. Landings and effort data were obtained combining different sources, such as Official Landings provided by Autonomous Community, and from the Information and Sampling Network of the Spanish Oceanographic Institute (IEO).

Outlook and management advice

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

Short and medium term scenarios:
Will be conducted and delivered by SGMED 09-03 (14-18 December 2009).

Fisheries
Deep-water pink shrimp (*Parapenaeus longirostris*) is one of the most important crustacean species for the trawl fisheries developed along the GFCM geographical sub-area Northern Spain (GSA 06). This resource is an important component of commercial landings in some ports of the Mediterranean Northern Spain and occasionally target species of the trawl fleet, composed by around 600 vessels, and especially by 260 vessels which operate on the upper slope. During the last years, a sharp increase in landings was observed, starting in 1998 and reaching the maximum value in 2000, followed by a decreasing trend during the period 2001-2008. In 2008 the annual landings of this species amounts 33 tons in the whole area, which it has been the lowest value of the historical series.

Fishing effort has reduced from 50,000 days in 2000 to 13,000 in 2006, with a slight increase in 2007 and 2008 to 18,000. SGMED notes that the fishing effort below only includes vessels that have landed pink shrimp in the given years.

Year	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
GSA 6 Landings (t)	380.0	190.0	117.0	63.0	49.1	41.0	32.8
Effort (days)	38466	27519	23052	16133	12942	18812	18039

Limit and target management reference points or levels

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

$F_{0.1}$ (age range)=	Sex combined, age groups
F_{msy} (age range)≤ 0.2	Proxy
F_{mean} (age range)=	
Z_{msy} (age range)=	
Z_{mean} (age range)=	
B_{pa} (spawning stock) = 1,200 t	
B_{lim} (spawning stock = 300 t	

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

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

Comments on assessment
SGMED-09-02 suggested the use of seasonal VPA models for assessment of short lived crustaceans.
During the STECF 09-02, an assessment on deepwater pink shrimp from GSA 06 was performed. Official data were not sent on time, but the expert provided a copy of some of the data. Files dealing with official landings and effort were not available. Consequently data on landings and effort for 2008, were derived from the series.

7.8. Pink shrimp in GSA 09

Species common name:	Deepwater pink shrimp
Species scientific name:	*Parapenaeus longirostris*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

A new assessment was performed assuming a different natural mortality vector calculated using the ProdBiom routine. SGMED was unable to estimate the absolute stock size. Since 1998, SSB shows a high variation without a clear trend. As no precautionary level for the stock of deep-sea pink shrimp in GSA 09 is proposed or agreed, SGMED cannot evaluate the stock status in relation the precautionary approach.

- State of the juveniles (recruits):

Recent recruitment in 2004-2006 is indicated to be above average.

- State of exploitation:

SGMED proposed F≤0.7 as target management reference point (basis $F_{0.1}$).
SGMED's advice relies on the VIT analysis and considers the stock being harvested sustainably, as $F_{1\text{-}3}$ was estimated to range among 0.5-0.6 for the period 2006-2008.

- Source of data and methods:

Time series of survey data were used (MEDITS: 1994-2008; GRUND: 1994-2007) to investigate trends in abundance and F with SURBA. Length cohort analysis was used on 2006 and 2007 DCR data.
The following parameters were used both for SURBA and VIT analyses:

• **Growth**
L∞ = 43.5 mm carapace length
K = 0.6
to = 0
• **Length-Weight relationhips**
a = 0.00686
b = 2.24
• **Natural mortality**
Mvector = 1.0 (age 1), 0.78 (age 2), 0.69 (age 3), 0.65 (age 4)
• **Length-at-maturity (L50)**
L50 = 24 mm
Lc100 = 20 mm

Outlook and management advice

Given the current uncertainty in F estimates, SGMED recommends the relevant fleet effort to not be increased, in order to avoid future low stock productivity and landings. Any management measure should consider the mixed nature of the fisheries exploiting the stock.

Short and medium term scenarios:
Will be conducted and delivered by SGMED 09-03 (14-18 December 2009).

Fisheries

The species is exploited by trawl fleet mostly on muddy bottoms from 150 to 500 m depth. Annual trawl landings increased from 160 tons in 2002 to 450 tons in 2006, decreasing to 220 tons in 2007 and 254 tons in 2008.

Annual landings (t) by fishing technique in GSA 09.

SPECIES	COUNTRY	FT_LV4	2002	2003	2004	2005	2006	2007	2008
DPS	ITA	DTS	133	308	367	430	462	215	253
DPS	ITA	PGP		3	8	1		2	1
DPS	ITA	PMP	19	12					
DPS	ITA	PTS	9		1				
SUM	ITA		161	323	376	431	462	217	254

A total of 9 tons of discards, composed by individuals smaller than 20 mm carapace length, was estimated in 2006 (approx. 2% of total landings). Trawl landings showed a marked difference in the length composition between 2006 and 2007. Proportion of juveniles (0+) increased in 2007 landing. The total trawl fleet of GSA 09 at the end of 2006 accounted for 361 vessels. Deep sea pink shrimp is mostly exploited in the southern part of the GSA9 (fleets of Porto Santo Stefano Porto Ercole, Fiumicino, Terracina and Gaeta. The fishing capacity of the GSA 09 has shown in the last 20 years a progressive decrease. From 1996 to 2006 the number of bottom trawlers of GSA 09 decreased of about 30%. Also fishing effort decreased, even though in a lesser extent, in this period.

Trends in annual fishing effort by fishing technique deployed in GSA 09, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	9	ITA	DRB	1856	3332	2660	2635	3182	2177
DAYS	9	ITA	DTS	62616	63331	64870	65657	63141	61710
DAYS	9	ITA	HOK			2568	1921	1821	
DAYS	9	ITA	PGP	212455	182159	196758	189052	183435	175888
DAYS	9	ITA	PMP	52193	75479	16960	6655		
DAYS	9	ITA	PTS	5453	6242	4728	4739	5242	5160
GT*DAYS	9	ITA	DRB			24050	23915	28878	20772
GT*DAYS	9	ITA	DTS			2410544	2448143	2325295	2289820
GT*DAYS	9	ITA	HOK			22784	16701	13580	
GT*DAYS	9	ITA	PGP			521225	493611	507794	485784
GT*DAYS	9	ITA	PMP			62599	24894		
GT*DAYS	9	ITA	PTS			143490	162480	200226	194754
KW*DAYS	9	ITA	DRB	187147	335520	268423	265359	320437	225526
KW*DAYS	9	ITA	DTS	14583556	14671042	14130070	14265309	13484321	13096031
KW*DAYS	9	ITA	HOK			376470	275809	262696	
KW*DAYS	9	ITA	PGP	6504001	6925653	7060573	6946213	7399313	7300451
KW*DAYS	9	ITA	PMP	4715565	4051809	984241	396631		
KW*DAYS	9	ITA	PTS	1312412	1333245	947166	1013627	1174295	1151346

Precautionary and target management reference points or levels

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

$F_{0.1}$ (1-3) = 0.7	Proxy
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

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

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

7.9. Anchovy in GSA 16

Species common name:	Anchovy
Species scientific name:	*Engraulis encrasicolus*
Geographical Sub-area(s) GSA(s):	GSA 16 – South of Sicily

Most recent state of the stock

- State of the adult abundance and biomass:

Biomass estimates of total population obtained by hydro-acoustic surveys for anchovy in GSA 16 show a decreasing trend over the last years. The 2008 estimate is the lowest value of the series and represents approximately just one-tenth of the maximum recorded value. However, in the absence of proposed or agreed references, SGMED-09-02 is unable to fully evaluate the state of the stock and provide any scientific advice in relation to them.

- State of the juvenile (recruits):

No recruitment data were provided by this assessment.

- State of exploitation:

SGMED 09-02 recommends the exploitation rate $E \leq 0.4$ as target management reference point.
The high and increasing yearly exploitation rates, as estimated by the ratio between total landings and biomass, indicates high fishing mortality levels. If this estimate of exploitation rate can be considered as equivalent to F/Z estimate obtained from the fitting of standard stock assessment models, the current exploitation (0.64) is higher than the suggested reference point. The fishing mortality level corresponding to $F/Z=0.64$ is $F=1.17$, if $M=0.66$ is estimated with Pauly (1980) empirical equation. Thus, the stock is considered to be overexploited.

- Source of data and methods:

Census data for catch and effort data were obtained from census information (on deck interviews) in Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA16), accounting for about 2/3 of total landings in GSA 16. Acoustic data were used for fish biomass evaluations. Natural mortality was set at 0.66, estimate obtained with Pauly (1980) empirical equations. An attempt to fit a surplus production (logistic) model to the available data series (catch-effort and acoustic biomass estimates) was also done by means of ASPIC (Prager, 1994), but results were not mentioned in this document as the basic assumption about the proportionality between CPUE and biomass was not fulfilled.

Outlook and management advice

Given the very low biomass for three consecutive years (2006, 2007 and 2008) and the current high exploitation rates, 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.

Taking into account that fishing effort was relatively stable in last decade, whereas CPUE trend was even increasing, results would suggest that also environmental factors are important to explain the variability on yearly recruitment success. However, the stock biomass did not recover from the 2006 "collapse" in biomass (-69% from July 2005 to June 2006), and even further decreased (-53%) in 2008. This fact, along with the quite high and increasing level of exploitation rates experienced over the last years, also suggests questioning about the sustainability of current levels of fishing effort. In addition, possible negative effects on the stock could result from pressure of other fishing gears on larval stages.

A warning on the fishing of larval stages (locally named *bianchetto*) is also relevant for anchovy population if derogation of the fishing ban, normally operated for GSA 16 in wintertime, is postponed after the start of the anchovy spawning season, even though more data and investigation are needed in order to estimate the possible impact of this fishing activity on the exploited populations

Short and medium term scenarios:
Will be conducted and delivered by SGMED 09-03 (14-18 December 2009).

Fisheries

In Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA16), accounting for about 2/3 of total landings in GSA 16, two operational units (OU) are presently active, purse seiners and pelagic pair trawlers. The fleet in GSA16 is composed by about 50 units (17 purse seiners and 30 pelagic pair trawlers were counted up in a census carried out in December 2006). In both OUs, anchovy represents the main target species due to the higher market price.

Average anchovy landings over the last decade (1997-2008) were about 1,600 metric tons, with large inter-annual fluctuations. Total effort was slightly increasing over the same period.

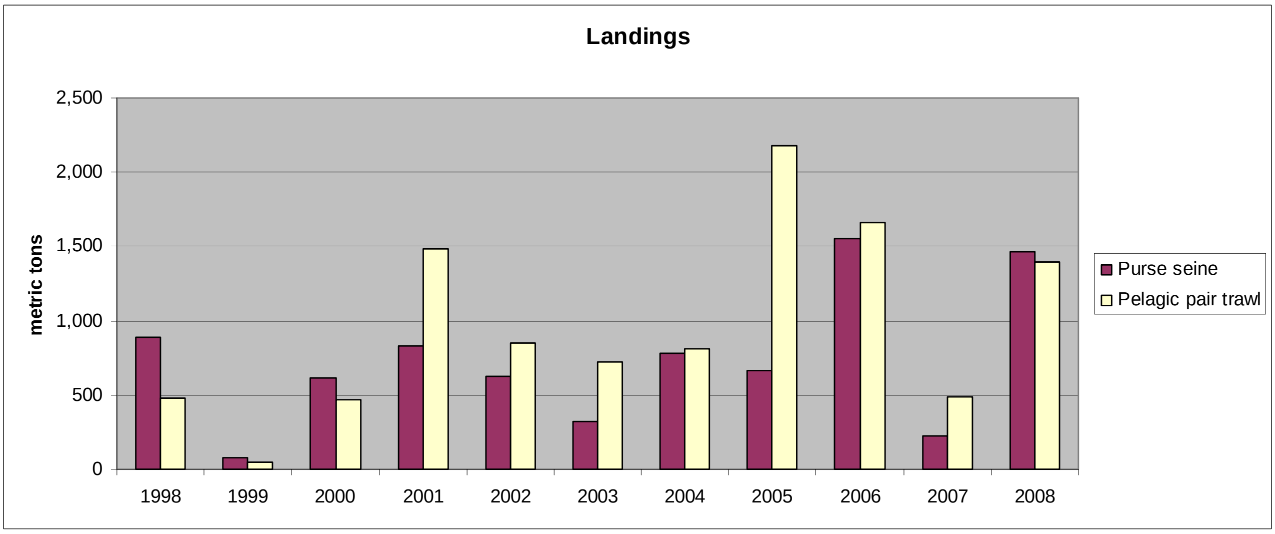


Fig. 7.9.1 Anchovy landings over the last decade (1998-2008) by fleet segment

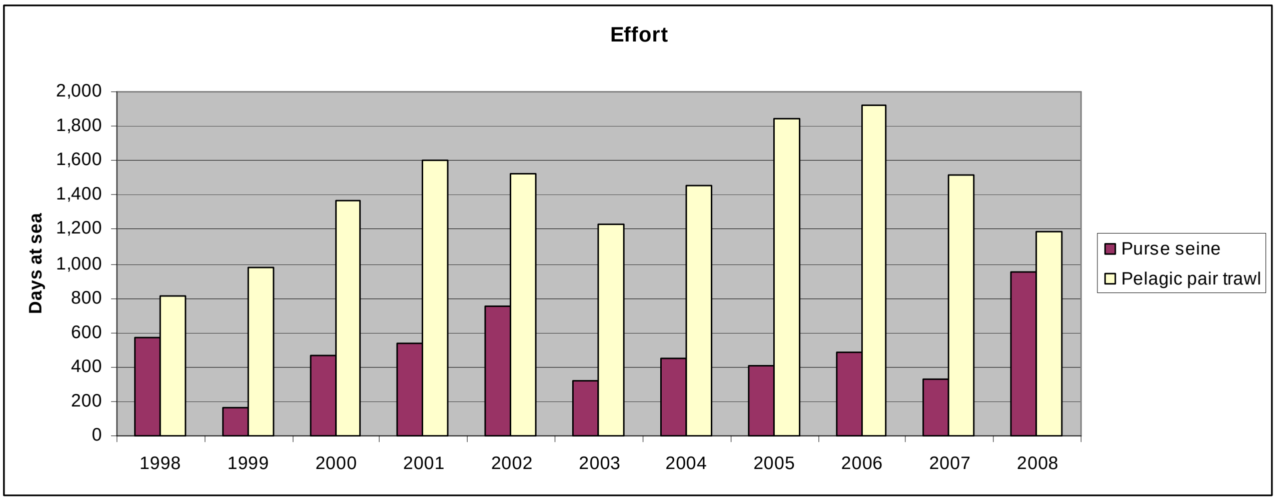


Fig. 7.9.2 Total effort over the last decade (1998-2008) by fleet segment

Limit and target management reference points or levels

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

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	
E_{msy} (F/Z, F age range 0-3)= 0.4	proxy

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

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

7.10. Anchovy in GSA 17

Species common name:	Anchovy
Species scientific name:	*Engraulis encrasicolus*
Geographical Sub-area(s) GSA(s):	GSA 17

Most recent state of the stock

SGMED 09-02 has modified the assessment carried out last year in accordance with its recommendations regarding natural mortality to be applied (Murcia workshop of SGMED 09-01, 2-6 March 2009). No update with 2008 catch data was conducted.

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

SGMED 09-02 recommends Bpa=80,000 t and Blim=50,000 t be defined as precautionary management reference points.
After a drastic decline the stock reached its minimum in the late 1980s and recovered thereafter to about 130,000 t in 2007. The stock is considered to having its full reproductive capacity.

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

SGMED 09-02 estimates recent recruitment to be at an average level.

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

SGMED recommends the application of the proposed exploitation rate $E \leq 0.4$ as management target for stocks of anchovy and sardine in the Mediterranean Sea. This value might be revised in the future when more information becomes available.
SGMED 09-02 estimated the most recent exploitation rates in 2005-2007 as at or slightly below the proposed sustainable level. As such, the stock is considered sustainably harvested.

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

The assessment of this stock was carried out by means of Virtual Population Analysis (VPA), using catch data collected for Italy, Slovenia and Croatia, from 1975 to 2007. Split-year data were used assuming the first of June as the birth date of anchovy. The annual natural mortality rates were derived from Probiom software, according to the first SGMED meeting of 2009 (Tab. 1). The values of von Bertalanffy parameters Linf = 16.15 , k = 0.40 , t0 = -2.04 and length-weight parameters a = 0.0025 , b = 3.37 were used into the calculations of the M at age vectors and were derived from DCR (biological sampling of landing data, GSA 17, year 2007).

Outlook and management advice

SGMED 09-02 recommends to maintain the effort constant and to determine consistent catches. Technical interactions regarding the fisheries targeting the sardine stock in GSA 17 need to be taken into account when managing the anchovy fisheries.

- <u>Short, medium and long term scenarios:</u>

Projections of stock status were not performed.

Fisheries

Mid-water trawlers and purse seiners. In 2007, the Italian fleet was composed of about 130 (65 pairs) pelagic trawlers (*volante*) mainly operating from Trieste to Ancona (average GRT 43, average engine power 290 kW) and about 45 purse seiners attracting fish with light (*lampara*), operating in the Gulf of Trieste (24 small *lampara*, average GRT 9, average engine power 110 kW) and in the Central Adriatic (21 big *lampara*, average GRT 97, average engine power 390 kW). In 2007, the Slovenian fleet was composed of 1 pelagic trawler pair and 7 purse seiners; no updated data are available for the Croatian fleet.

The main fraction of the total catch has been usually taken by the Italian fleet but, in recent years, the fraction relative to the fleets of the eastern part of the GSA 17 has increased.

Limit and target management reference points or levels

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

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (spawning stock) ≥ 80,000 t	Proxy
B_{lim} (spawning stock) ≥ 50,000 t	Proxy
E_{lim} (F/Z, F age range 0-3) ≤ 0.4	Proxy

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

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

Comments on the assessment

SGMED notes that there was no information presented during the meeting regarding the fry fishery within GSA 17. The catches of fry fishery are believed to be negligible in this GSA by CNR-ISMAR-SPM Fish Population Dynamics Unit. Fry fishery may be more important in GSA 18 and an ongoing EU funded project (SARDONE) will allow to evaluate if this fishery has an impact also on the stock in GSA 17.

Inclusion of all catch data for anchovy in GSA 17 should be ensured.

Explore the possibility to include acoustic survey data carried out in the eastern part of GSA 17 as a tuning fleet within the assessment.

7.11. Anchovy in GSA 22

Species common name:	Anchovy
Species scientific name:	*Engraulis encrasicolus*
Geographical Sub-area(s) GSA(s):	GSA 22

Most recent state of the stock

- State of the adult abundance and biomass:

Given the short length of the time series, SGMED is unable to precisely estimate the absolute levels of stock abundance and biomass. Survey indices and VPA analyses indicate that average total biomass and SSB increased since 2005 to 2008. Biomass limit reference points have not been estimated for this stock, and hence advice relative to these cannot be provided by SGMED in respect to those.

- State of the juvenile (recruits):

ICA model estimates suggest an increase in recruitment since 2004, with a pronounced increase in 2008. However the model predicts a decrease in the population abundance at age 0 for 2009 to the 2006 abundance level.

- State of exploitation:

SGMED recommends the application of the proposed exploitation rate $E \leq 0.4$ as management target for stocks of anchovy and sardine in the Mediterranean Sea. This value might be revised in the future when more information becomes available.

Based on ICA results, the mean E=F/Z (F averaged over ages 1 to 3) has fluctuated around 0.36 and since 2004 has been below the empirical level of sustainability suggested as target exploitation level for this stock.Thus, the stock is considered to be exploited sustainably.

- Source of data and methods:

This assessment is based on fishery independent surveys information as well as on Integrated Catch at Age (ICA) analysis model. Specifically, acoustic surveys estimations were used for Total Biomass estimates and DEPM surveys for the estimation of SSB. ICA assessment method uses separable virtual population analysis (VPA) with weighted tuning indices. The application of ICA was based on commercial catch data (2000-2008) and as tuning indices were used the biomass estimates from acoustic surveys and the Daily Egg Production Method (DEPM) estimates over the period 2003-2008 but with a gap for 2007. Anchovy data were comprised of annual anchovy landings, annual anchovy catch at age data (2000-2008), mean weights at age, maturity at age at age and the results of acoustic and DEPM surveys. Since, acoustics and DEPM are being applied at the same time and with the same research vessel acoustic estimates were used as an index for the numbers at age of the population and DEPM estimates as stock spawning biomass estimates. Different natural mortality were applied per age group but constant for all years based on ProBiom (Abella *et al.*, 1997) as recommended in the report of the SG-ECA/RST/MED 09-01. This method of the estimation of the natural mortality is consistent with the methodology used in GSAs 5, 6 and 17 for small pelagics.

Natural mortality values applied for anchovy stock in GSA 22.

Age0	Age1	Age2	Age3	Age4
1.5	1	0.74	0.66	0.62

Reference age for the fishery was age group 2, as fully exploited and fully recruited. The age groups 0, 4 and 5 were underweighted in the analysis based on their percentage in the catch. Age 1 was also underweighted in the acoustic surveys (0.5). Catchability for the DEPM index is assumed as absolute indicator of biomass and linear catchability relationship is assumed for the acoustic surveys.

Outlook and management advice

Taking the empirical level as a reference point for sustainable exploitation, the stock is considered to be exploited sustainably. Increased fishing is not expected to result in increased landings in the long term. SGMED 09-02 recommends not to increase the effort and to determine consistent catches. Technical interactions regarding the fisheries targeting the sardine stock in GSA 22 need to be taken into account when managing the anchovy fisheries.

For precautionary reasons the possibility of changing the closed period should be examined. Since the purse seine fishery is a multispecies fishery targeting both anchovy and sardine, a shift of the closed period (present: mid December to end of February) towards the recruitment period of anchovy (e.g. October to December) / or the recruitment period of sardine (e.g. February to April) could be suggested. This approach has the potential to improve the selectivity of the fishery, and thus provide higher potential catch in the long term.

- Short, medium and long term scenarios:

Projections of stock status were not performed.

Fisheries

In GSA 22 (Greek part) anchovy is almost exclusively exploited by the purse seine fleet. Pelagic trawls are banned and benthic trawls are allowed to fish small pelagics in percentages less than 5% of their total catch. Regarding the regulations enforced they concern a closed period from the mid December till the end of February and technical measures such as minimum distance from shore, gear and mesh size, engine, GT. There is a minimum landing size at 9 cm.

Anchovy landings showed an increasing trend towards 2008 Anchovy reported landings have showed an increasing trend since 2002, comprising 24,480 tons in 2008. Information regarding the age and length distribution of sardine landings prior to 2003 is based on the Hellenic Centre of Marine Research data collection system.

Data of the fishing effort (Days at Sea) and the landings per vessel class indicate that small vessels (12-24 m) (Tables below) are mainly responsible for anchovy catches (>70% of anchovy catches).

Table of anchovy landings (in t) in GSA 22 per vessel size for 2003 to 2006 and 2008 concerning the purse seine fleet in Greek waters. Since there was no Data Collection Program in Greece in 2007, data concerning this year are estimations of the Hellenic Centre for Marine Research based on data from other research projects that were held in GSA 22.

Year	PS 12-24 m	PS 24-40 m
2003	12507	1495
2004	12222	3877
2005	11073	5274
2006	16121	6190
2007	14875	6625
2008	18188	6293

Discards values are less than 1%, reaching approximately 0.06% data for GSA 22.

Table of fishing effort in GSA 22 per vessel size for 2003 to 2008 concerning the purse seine fleet in Greek waters. GRT=Gross tonnage, KW=engine horsepower.

Year	PS 12-24 m	PS 24-40 m	PS 12-24 m	PS 24-40 m	PS 12-24 m	PS 24-40 m
	Days at Sea	**Days at Sea**	**Days at Sea x GRT**	**Days at Sea x GRT**	**Days at Sea x KW**	**Days at Sea x KW**
2003	41539	2942	1767398	230726	8709727	679624
2004	39783	3989	1620847	366709	8111571	1029410
2005	42520	5690	1753346	542120	8123673	1532790
2006	37255	5619	1568893	539146	7386042	1606608
2008	35090	4938	1457212	473121	6898061	1335582

Limit and target management reference points or levels

No reference points concerning biomass can be suggested at this point due to the small time series of data available. E_{msy} should be set as the fishing mortality that assures exploitation rate below the empirical level of E<0.4 (Patterson 1992).

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

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
E (F/Z, age range 1-3) ≤ 0.4	Proxy
B_{msy} (spawning stock)=	
B_{lim} (spawning stock)=	

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

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

The summary output of the ICA model.

Year	Recruits	Total Biomass (tonnes)	Spawning Biomass (tonnes)	Landings (tonnes)	Yield/SSB ratio	F 1-3	SoP (%)
2000	14710880	86826	5558	9762	1.7563	0.9375	107
2001	16896880	101009	8197	8232	1.0042	0.3792	93
2002	14589360	95152	11709	8549	0.7301	0.3157	89
2003	18070210	157771	24857	14002	0.5633	0.5177	86
2004	26547200	150349	27244	16099	0.5909	0.5209	99
2005	35474340	107727	22233	16347	0.7352	0.3897	118
2006	35635540	157404	34296	22311	0.6505	0.445	83
2007	48426060	195413	43140	21500	0.4984	0.3687	90
2008	1.63E+08	402348	53918	24480	0.454	0.3316	93

Discards were also included within this assessment representing however only 0.06 % of total landings.

7.12. Sardine in GSA 16

Species common name:	Sardine
Species scientific name:	*Sardina pilchardus*
Geographical Sub-area(s) GSA(s):	GSA 16 – South of Sicily

Most recent state of the stock

- State of the adult abundance and biomass:

Biomass estimates of the total population obtained by hydro-acoustic surveys for sardine in GSA 16 show that the recent stock level is well below the average value over the last decade. However, in the absence of proposed or agreed references, SGMED-09-02 is unable to fully evaluate the state of the stock and provide any scientific advice in relation to them.

- State of the juvenile (recruits):

Data not available.

- State of exploitation:

SGMED recommends the application of the proposed exploitation rate E ≤ 0.4 as management target for stocks of anchovy and sardine in the Mediterranean Sea. This value might be revised in the future when more information becomes available.

Annual exploitation rates, as estimated by the ratio between total landings and biomass, indicates relatively low fishing mortality during the last decade. If this estimate of exploitation rate can be considered as equivalent to F/Z estimate obtained from the fitting of standard stock assessment models, the current exploitation rate (0.22) and even all the previous available estimates are lower than the reference point suggested by Patterson (1992) and confirmed by SGMED 09-02 in this report (section 6.1.3). The fishing mortality level corresponding to F/Z=0.22 is F=0.14, if M=0.51, estimated with Pauly (1980) empirical equation, is assumed.

Using the exploitation rate as a target reference point, the stock of sardine in GSA 16 is considered as being sustainably exploited.

- Source of data and methods:

Census data for catch and effort data were obtained from census information (on deck interviews) in Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA16), accounting for about 2/3 of total landings in GSA 16. Acoustic data were used for fish biomass evaluations. Natural mortality was set at 0.51, estimate obtained with Pauly (1980) empirical equations. An attempt to fit a surplus production (logistic) model to the available data series (Catch-effort and acoustic biomass estimates) was also done by means of ASPIC software ver. 5.33 (Prager, 1994), but results were not mentioned in this document, mainly due to their quite high variability depending on the adopted parameter starting guesses in the estimation procedure.

Outlook and management advice

Given that biomass was quite low for three consecutive years (2006, 2007 and 2008) and that the exploitation rate of sardine was occasionally moderate over the last decade, SGMED recommends the relevant fleet effort should not be allowed to increase in order to avoid future loss in stock productivity and landings. However, as the small pelagic fishery is generally multispecies, any enforcement about fishing effort for anchovy stock (see management advice for anchovy in GSA 16) would also have effects on sardine. In addition, due to the low level of the anchovy stock, measures should be taken to prevent a shift of effort from anchovy to sardine.

Taking into account that fishing effort was relatively stable in the last decade, results would suggest that also environmental factors are important to explain the variability on yearly recruitment success. However, the stock did not recover from the 2006 "collapse" in biomass (-52% from July 2005 to June 2006), and this fact, along with the moderate exploitation rates experienced over the last decade and the decreasing trend in landings, also suggests questioning about the sustainability of current levels of fishing effort. In addition, possible negative effects on these populations could results from pressure of other fishing gears on larval stages.

A warning on the fishing of larval stages (locally named *bianchetto*) is relevant, taking into account that in the past years derogation of the fishing ban was normally operated in wintertime, i.e. during the sardine spawning season, even though more data and investigation are needed in order to estimate the possible impact of this fishing activity on the exploited populations.

- Short, medium and long term scenarios

Projections of stock status were not performed.

Fisheries

In Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16, two operational units (OU) are presently active, purse seiners and pelagic pair trawlers. The fleet in GSA 16 is composed by about 50 units (17 purse seiners and 30 pelagic pair trawlers were counted up in a census carried out in December 2006). In both OUs, anchovy represents the main target species due to the higher market price.

Average sardine landings over the last decade (1997-2008) were about 1,500 metric tons, with a general decreasing trend. Total effort was slightly increasing over the same period.

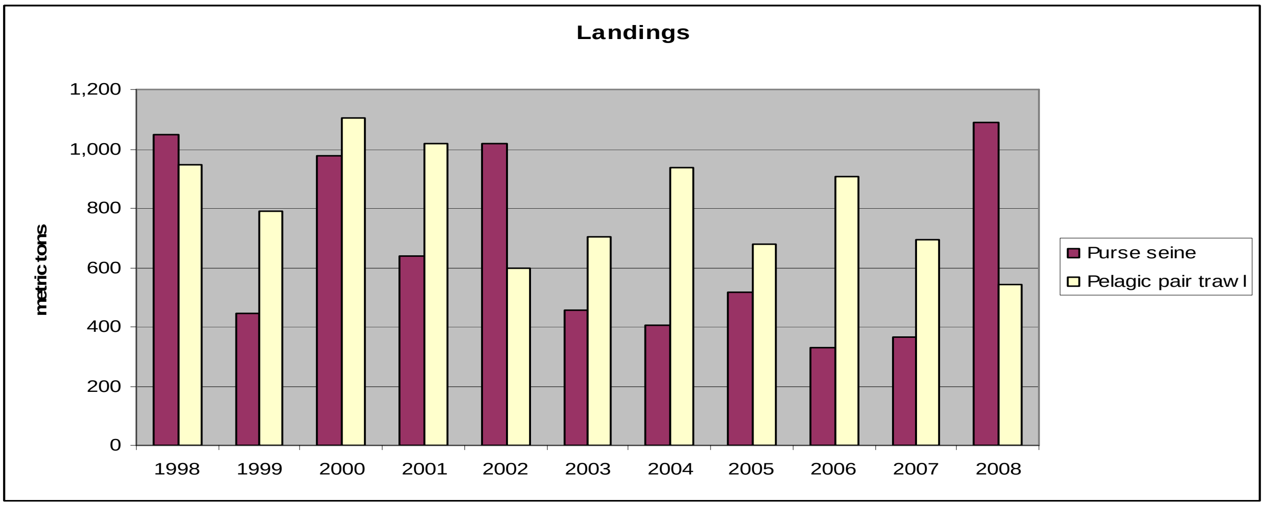


Fig. 7.12.1 Sardine landings over the last decade (1998-2008) by fleet segment

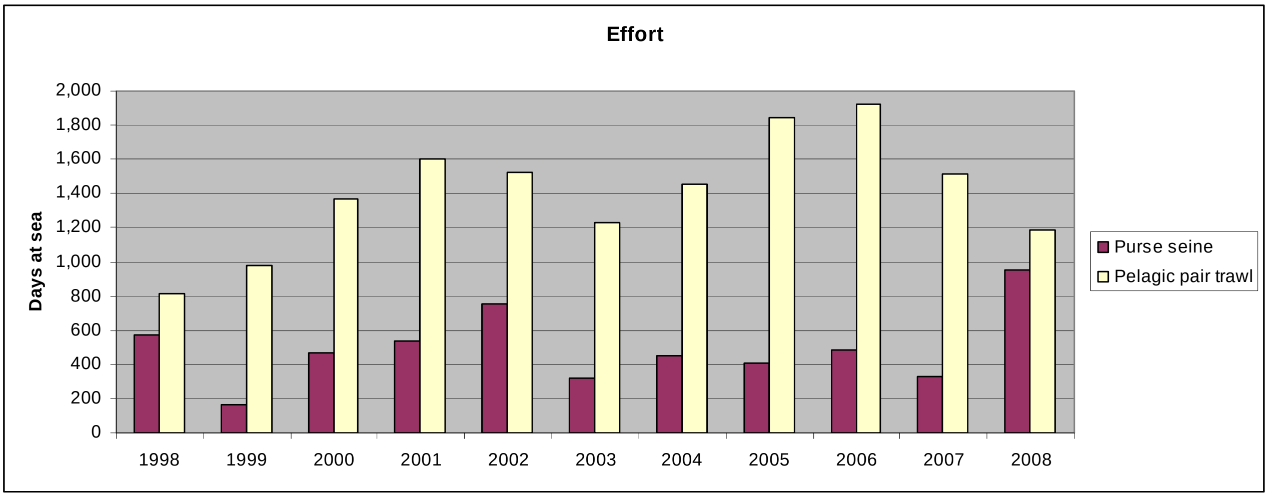


Fig. 7.12.2 Trend in fishing effort by major gear types, 1998-2008.

Limit and target management reference points or levels

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

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	
E (F/Z, F age range 0-3) $\leq$ 0.4	Proxy

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

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

7.13. Sardine in GSA 17

Species common name:	Sardine
Species scientific name:	*Sardina pilchardus*
Geographical Sub-area(s) GSA(s):	GSA 17

Most recent state of the stock

SGMED 09-02 has modified the assessment carried out last year in accordance with its recommendations regarding natural mortality to be applied (Murcia workshop of SGMED 09-01, 2-6 March 2009). No update assessment with 2008 catch data was conducted.

- State of the adult abundance and biomass:

SGMED 09-02 recommends B_{pa}=270,000 t and B_{lim}=180,000 t be defined as precautionary management reference points.

The average stock biomass estimated by VPA was 440,000 tonnes in 1975-2007 and 90,000 tonnes in 2005-2007. Spawning stock biomass showed the lowest levels just in recent years.
SGMED 09-02 considers the stock status of sardine in GSA 17 being far below its reproductive capacity.

In September 2004 there was a point estimate of abundance in the eastern part of GSA17: 213,332 tons. SGMED did not have the opportunity to verify this point estimate.

- State of the juvenile (recruits):

Since the mid 1995, recruitment remained significantly below the average recruitment.

- State of exploitation:

SGMED recommends the application of the proposed exploitation rate $E \leq 0.4$ as management target for stocks of anchovy and sardine in the Mediterranean Sea. This value might be revised in the future when more information becomes available.

SGMED 09-02 considers the stock of sardine to be over-exploited, as the estimated E almost continuously exceeds 0.4 since 1998.

- Source of data and methods:

The assessment of this stock was carried out by means of Virtual Population Analysis (VPA), using catch data collected for Italy, Slovenia and Croatia, from 1975 to 2007. Natural mortality was estimated by the Probiom model. The Laurec-Shepherd tuning of VPA was performed using an abundance index series derived from echo-surveys carried out in the western part of the GSA 17.

In 2009, VPA was also carried out using vectors of natural mortality rate at age, i.e. not constant over age as in the stock assessment of 2008. They were derived from Probiom software and Gislason's method, according to the first SGMED meeting of 2009. The values of von Bertalanffy parameters Linf = 18.783, k = 0.379, t0 = -2.302 and length-weight parameters a = 0.0095, b = 2.94 were used into the calculations of the M at age vectors and were derived from DCR (biological sampling of landing data, GSA 17, year 2007).

Outlook and management advice

SGMED 09-02 recommends recovering the stock biomass in order to increase stock productivity. Fishing mortality should be reduced until fishing mortality is below F/Z=0.4 in order to allow future recruitment contributing to stock recovery. In order to decrease the fishing mortality, SGMED 09-02 advises to reduce fishing effort by means of a multiannual management plan and consistent catches should be determined. The management of the sardine fisheries in GSA 17 needs to account for multi-species effects, mainly the interaction with anchovy.

- Short, medium and long term scenarios:

Projections of stock status were not performed.

Fisheries

In 2007, the Italian fleet was composed of about 130 (65 pairs) pelagic trawlers (*volante*) mainly operating from Trieste to Ancona (average GRT 43, average engine power 290 kW) and about 45 purse seiners attracting fish with light (*lampara*), operating in the Gulf of Trieste (24 small *lampara*, average GRT 9, average engine power 110 kW) and in the Central Adriatic (21 big *lampara*, average GRT 97, average engine power 390 kW). In 2007, the Slovenian fleet was composed of 1 pelagic trawler pair and 7 purse seiners; no updated data are available for the Croatian fleet.

The fractions of the total catch due to the fleets of the Italy and Slovenia-Croatia were quite similar, but the latter one accounted increased in recent years.

Limit and target management reference points or levels

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

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (spawning stock)= 270,000 t	
B_{lim} (spawning stock= 180,000 t	
E_{lim} (F/Z, F age range 0-5) ≤ 0.4	Proxy

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

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

Comments on the assessment

Inclusion of all catch data for sardine in GSA17 should be ensured.

Explore the possibility to include acoustic survey data carried out in the eastern part of GSA17 as a tuning fleet in the assessment.

SGMED notes that there was no information presented during the meeting regarding the fry fishery within GSA 17. The catches of fry fishery are believed to be negligible in this GSA by CNR-ISMAR-SPM Fish Population Dynamics Unit. Fry fishery may be more important in GSA 18 and an ongoing EU funded project (SARDONE) will allow to evaluate if this fishery has an impact also on the stock in GSA 17.

The natural mortality rate was taken as fixed over ages and years. Trials with a vector of natural mortality rates at age could be done in the future. Abundance data from echo-surveys carried out also in the eastern part of the GSA 17 could be useful.

7.14. Sardine in GSA 22

Species common name:	Sardine
Species scientific name:	*Sardina pilchardus*
Geographical Sub-area(s) GSA(s):	GSA 22

Most recent state of the stock

- State of the adult abundance and biomass:

The results of the short time series of data do not allow concluding on reference points of B_{lim} or B_{pa}. In the absence of proposed or agreed references, SGMED-09-02 is unable to fully evaluate the state of the stock and provide scientific advice.
Results of the Integrated Catch at Age analysis indicated an increasing trend in total biomass and SSB showing a slight recovery of SSB to 20,000 t in 2008 from the low 2003-2004 estimates of 7,000 t.

- State of the juvenile (recruits):

ICA model estimates showed above average recruitment since 2007, with a very high peak in 2008.

- State of exploitation:

SGMED recommends the application of the proposed exploitation rate $E \leq 0.4$ as management target for stocks of anchovy and sardine in the Mediterranean Sea. This value might be revised in the future when more information becomes available.
Based on ICA results, the mean fishing mortality (averaged over ages 1 to 3) showed a clear decreasing trend, and has remained below 0.75 since 2004. The mean F/Z has declined from 2003 but remains above the suggested level of sustainability ($E\leq0.4$) for this stock. Taking the empirical level as a reference point for sustainable exploitation, the stock is considered to be overexploited.

- Source of data and methods:

This assessment is based on fishery independent surveys information as well as on Integrated Catch at Age (ICA) analysis model. Acoustic surveys estimations were used for Total Biomass estimates. ICA assessment method uses separable virtual population analysis (VPA) with weighted tuning indices. The application of ICA was based on commercial catch data (2000-2008) and as tuning indices were used the biomass estimates from acoustic surveys estimates over the period 2003-2008 with a gap in 2007, as no acoustic survey data were available for this year. Sardine data were comprised of annual sardine landings, annual sardine catch at age data (2000-2008), mean weights at age, maturity at age at age and the results of acoustic surveys. Different natural mortality were applied per age group but constant for all years based on ProdBiom (Abella *et al.*, 1997) as recommended in the report of the SG-ECA/RST/MED 09-01. This method of the estimation of the natural mortality is consistent with the methodology used in GSAs 5, 6 and 17 for small pelagics.

Natural mortality values applied for sardine stock in GSA 22.

Age0	Age1	Age2	Age3	Age4
1.5	0.95	0.69	0.61	0.57

Reference age for the fishery was age group 2, as fully exploited and fully recruited. The age groups 0, 4 and 5 were underweighted in the analysis based on their percentage in the catch. Age 1 was also underweighted in the acoustic surveys (0.5). Linear catchability relationship assumed for the acoustic surveys. Discards were also included within this assessment representing however only 0.3 % of total landings.

Y/R analyses were performed but were not considered reliable due to its flat-topped shape.

Outlook and management advice

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.

In order to decrease the fishing mortality, SGMED 09-02 advises to reduce fishing effort by means of a multiannual management plan and consistent catches should be determined. The management of the sardine fisheries in GSA 22 needs to account for multi-species effects, mainly the interaction with anchovy.

For precautionary reasons the possibility of changing the closed period should be examined. Since the purse seine fishery is a multispecies fishery targeting both anchovy and sardine, a shift of the closed period (present: mid December to end of February) towards the recruitment period of anchovy (e.g. October to December) / or the recruitment period of sardine (e.g. February to April) could be suggested. This approach has the potential to improve the selectivity of the fishery, and thus provide higher potential catch in the long term.

- Short, medium and long term scenarios:

Not performed.

Fisheries

In GSA 22 (Greek part) sardine is almost exclusively exploited by the purse seine fleet. Pelagic trawls are banned and benthic trawls are allowed to fish small pelagics in percentages less than 5% of their total catch. Regarding the regulations enforced they concern a closed period from the mid December till the end of February and technical measures such as minimum distance from shore, gear and mesh size, engine, GT. There is a minimum landing size at 11 cm.

Sardine landings showed high variability indicating a decreasing trend since 2005 to 2008, comprising approximately 9700 tons in 2008. Information regarding the age and length distribution of sardine landings prior to 2003 is based on the Hellenic Centre of Marine Research data collection system.

Data of the fishing effort (Days at Sea) and the landings per vessel class indicate that small vessels (12-24 m) (Tables below) are mainly responsible for sardine catches (> 88% of the total catches). The purse seine fishery is considered a mixed fishery, where sardine, anchovy and other species are caught.

Table of sardine landings (in t) in GSA 22 per vessel size for 2003 to 2006 and 2008 concerning the purse seine fleet in Greek waters derived from data provided to DCR call. Since there was no Data Collection Program in Greece in 2007, data concerning this year are estimations of the Hellenic Centre for Marine Research based on data from other research projects that were held in GSA 22. Discards were also included within this assessment representing however only 0.3 % of total landings.

Year	PS 12-24 m	PS 24-40 m
2003	7158	634
2004	7267	902
2005	12159	1468
2006	11618	1166
2007	6603	1948
2008	7704	1447

Discards values are less than 1%, reaching approximately 0.3% data for GSA 22.

Table of fishing effort in GSA 22 per vessel size for 2003 to 2008 concerning the purse seine fleet in Greek waters. GRT=Gross tonnage, KW=engine horsepower.

Year	PS 12-24 m	PS 24-40 m	PS 12-24 m	PS 24-40 m	PS 12-24 m	PS 24-40 m
	Days at Sea	**Days at Sea**	**Days at Sea x GRT**	**Days at Sea x GRT**	**Days at Sea x KW**	**Days at Sea x KW**
2003	41539	2942	1767398	230726	8709727	679624
2004	39783	3989	1620847	366709	8111571	1029410
2005	42520	5690	1753346	542120	8123673	1532790
2006	37255	5619	1568893	539146	7386042	1606608
2008	35090	4938	1457212	473121	6898061	1335582

Limit and target management reference points or levels

No reference points concerning biomass can be suggested at this point. F_{max} and $F_{0.1}$ are overestimated so precautionary the F_{pa} is suggestd to be set as the fishing mortality that assures exploitation rate below the empirical level for stock decline (E<0.4, Patterson 1992) for small pelagic.

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

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
E (F/Z, age range 1-3) ≤ 0.4	Proxy
B_{msy} (spawning stock)=	
B_{lim} (spawning stock)=	

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

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

The summary output of the ICA model.

Year	Recruits	Total Biomass (tonnes)	Spawning Biomass (tonnes)	Landings (tonnes)	Yield/SSB ratio	F1-3	SoP (%)
2000	7490250	85387	18221	18075	0.9919	1.3089	98
2001	5467110	65165	14033	19115	1.3621	1.4154	103
2002	4904990	48089	9355	11483	1.2274	0.9666	101
2003	7587190	45438	6747	8260	1.2242	1.5292	100
2004	6337230	48632	7199	8660	1.2029	0.8638	102
2005	5992080	62234	13426	14444	1.0758	0.9041	97
2006	8108220	70919	12558	12984	1.0339	1.2249	98
2007	16265580	99256	12851	9064	0.7053	1.0055	97
2008	1,02E+08	418026	20630	9700	0.4702	0.6379	96

7.15. Sole in GSA 17

Species common name:	Sole
Species scientific name:	*Solea solea*
Geographical Sub-area GSA:	GSA 17

Most recent state of the stock

- State of the adult abundance and biomass:

SGMED 09-02 is unable to fully evaluate the stock status due to a lack of precautionary management reference points.
After the minimum value observed in 2005 the SSB was constant in 2006 and 2007 and increased in 2008.

- State of the juvenile (recruits):

Recruitment varied without any trend in the years 2005-2008, reaching a minimum in 2006. The value estimated in 2008 was similar to that of 2007.

- State of exploitation:

SGMED 09-02 recommends $F \leq 0.26$ as a target management reference point for sustainable exploitation related to high long term yield (basis $F_{0.1}$).

Exploitation decreased from 2005 to 2006, was constant in 2006-2007 and increased in 2008. The most recent estimate of fishing mortality (F_{0-4}) is F=1.35. With $F_{0.1}$=0.26 and F_{max} =0.46, the stock is considered being subject to overexploitation.

- Source of data and methods:

This assessment is based on VPA (XSA) methods. VPA Lowestoft software suite (Darby and Flatman 1994) was used and XSA was the assessment method. A separable VPA (Pope and Sheperd, 1982) was also run as exploratory analysis for this stock. In addition, a yield-per-recruit (Y/R) analysis was carried out (Yield program; Branch et al., 2000).

Data used for XSA:

- Landings at age from 2005-2008 from all fishing harbours of GSA 17.
- Biological sampling 2005-2006 for Maturity at age and Length-Weight relationships.
- M vector, estimated using PROBIOM.
- Tuning data from *rapido* trawl surveys and commercial fleet of Rimini for years 2005 to 2008.

Data derived from a regional project (SoleMon) founded by MIPAF and ADRIAMED. Catch data were obtained from on board observations and auction documents of the principal markets of the Italian coast. Length data were transformed to age data by slicing (LFDA 5.0) using the parameters estimated by length-frequency distributions from surveys (L_{inf}: 39.6 cm; k: 0.44 y^{-1}; t_0: -0.46 y). Discard of *S. solea* is negligible (also damaged specimens are sold at a lower price), information on the level of mis-reporting for this stock has been provided in the framework of the SoleMon project. Italian *rapido* trawlers exploit this resource providing more than 80% of landings. Sole is also a target species of the Italian and Croatian set netters, while it represents an accessory species for otter trawlers.

The stock was also assessed by SURBA methods. Both XSA and SURBA methods gave the same perception of the state of the stock.

Outlook and management advice

SGMED recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed level $F_{0.1}$, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches consistent with the effort reductions should be estimated.

A reduction of fishing pressure, especially by *rapido* trawling, would be recommended, also taking into account that the exploitation is mainly orientated towards juveniles and the success of recruitment is strictly related to environmental conditions. Hence, in the case of both increasing fishing effort and yearly bad recruitment there could be a high risk of stock depletion. A two-months closure for rapido trawling inside 11 km offshore along the Italian coast, after the biological fishing ban (August), would be advisable to reduce the portion of juvenilespecimens in the catches.

For the same reason, specific studies on rapido trawl selectivity are necessary. In fact, it is not sure that the adoption of a larger mesh size would correspond to a decrease of juvenile catches, considering that the mesh opening currently used by the Italian rapido trawlers is larger (48 mm or more) than the legal one. The same uncertanty regards the adoption of square mesh. SSB increased over the 4 years, maybe because in late fall - winter the main spawning area is only partially exploited by the Croatian set netters and Italian fleets. The safeguard of such area (identified by the *rapido* trawl survey) to prevent a possible future exploitation might be crucial for the sustainability of the Adriatic sole stock. Finally, a set of specific management rules for *rapido* trawl fishery would be advisable (e.g.: size and number of gears, mesh size, towing speed).

Short and medium term scenarios:
Will be conducted and delivered by SGMED 09-03 (14-18 December 2009).

Fisheries

The Italian fleets exploit this resource with *rapido* trawl and set nets (gill nets and trammel nets), while only trammel net is used in the countries of the eastern coast. Sole is an accessory species for otter trawling. More than 90% of catches come from the Italian side. Landings fluctuated between 1,000 and 2,300 t in the period 1996-2006 (data source: FAO-FishStat and IREPA-SISTAN time series). The fishing effort applied by the Italian *rapido* trawlers gradually increased from 1996 to 2005, and slightly decreased in the last years.

Brief description of trends:
Exploitation is based on young age classes, mainly 1 and 2 year old individuals, with immature fraction dominating the landings. In the last years, the annual landings of this species were around 2184 tons in the overall GSA. From SoleMon project data, the overall Italian fleet exploiting sole in the GSA 17 is made up by around 1,300 vessels. Otter and rapido trawlers carry out their activity all year round, with the only exception of the fishing ban (end of July – beginning of September), while set netters show a seasonal activity (spring-fall). The fishing grounds exploited by rapido trawlers extend from 5.5 km from the shoreline to 50-60 m depth, while otter trawlers carry out their activity in the overall area, except for the Croatian waters. Set netters operate in the shallower waters usually close to the fishing harbours.

Year	**2005**	**2006**	**2007**	**2008**
GSA17Landings (t)	2067	2008	1673	2184
Effort (days)	152,182	122,669	108,830	116,860

Precautionary and target management reference points or levels

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

$F_{0.1}$ (Y/R, sexes combined, ages 0-4) ≤ 0.26	Proxy for target
F_{max} (Y/R, sexes combined)= 0.46	0.46
Z_{max} (Y/R, sexes combined)=	
Z_{mean} (0-4, sexes combined)=	

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

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

7.16. Blue and red shrimp in GSA 06

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

Most recent state of the stock

- State of the adult abundance and biomass:

SGMED-09-02 cannot fully evaluate the state of the spawning stock relative to precautionary reference points, as these have not been proposed or defined.
Since 2002, SSB, with an average for the whole period of 637 mt, declined rapidly from 2002 to 2004 reaching the lowest value (384 t) observed in 2002-2008 which represents a 25% of that observed in 2002. Thereafter, SSB is estimated to increase until 2008 almost to the level seen in the beginning of the assessed time period.

- State of the juvenile (recruits):

Recruits (aged 0 individuals) were estimated to increase significantly from 2003 to 2007 and remain high in 2008.

- State of exploitation:

The lack of a target management reference point for exploitation causes SGMED-09-02 being unable to fully evaluate the state of exploitation. Mean fishing mortality from 2002 to 2008 varied without a clear trend between 0.8 and 1.3. The highest value is observed in 2008.

- Source of data and methods:

The state of exploitation was assessed for the period 2002-2008 by means of a VPA Separable, tuned with standardised CPUE from abundance indices from trawl survey (MEDITS). Analysis was carried out applying the Extended Survivor Analysis (XSA) method (Lowestoft suite; Darby and Flatman, 1994) over the period 2002-2008. In addition, a yield-per-recruit (Y/R) analysis (VIT program; Lleonart and Salat, 1992) was applied on the mean pseudo-cohorts 2002-2008 for the GFCM geographical sub-area Northern Spain (GSA-06). Both methods were performed from size composition of trawl catches (obtained from on board and on port monthly sampling) and official landings, transforming length data to age data by slicing (L2AGE program). The parameters of the size-weight relationship used in this assessment (García Rodriguez et al., 2003) are similar to those calculated by other authors (a= 0.0024; b= 2.464) (Ribeiro-Cascalho & Arrobas, 1987). The estimates made for the VBGF parameters (García Rodriguez et al., 2003) show also similar values ($L\infty$= 77; K= 0.38; t0=-0.065).

The size composition of commercial landings were obtained by monthly length samplings carried out both in one of the ports (Santa Pola) as well as on board samplings, during the 2002-2008 period. Landings and effort data were obtained combining different sources, such as Official Landings provided by Autonomous Community, and from the Information and Sampling Network of the Spanish Oceanographic Institute (IEO).

Outlook and management advice

SGMED has no basis to provide specific managment advice. Management of the fisheries of blue and red shrimp need to consider the mixed fisheries interactions.

- Short and medium term scenarios:

Will be conducted and delivered by SGMED 09-03 (14-18 December 2009).

Fisheries

Red shrimp (*Aristeus antennatus*) is one of the most important crustacean species for the trawl fisheries developed along the GFCM geographical sub-area Northern Spain (GSA 06). This resource is an important component of commercial landings in some ports of the Mediterranean Northern Spain, and is a target species of a specific trawl fleet. Updated information on landings and effort has been done on annual basis (2002-2008). Throughout the time series landings fluctuated between 300 and 650 tonnes, with an average of c.a. 500 tonnes. The red shrimp has a wide bathymetric distribution, between 80 and 3300 m depth (Sardà et al., 2005), and some areas may constitute a reservoir for the resource since they are located a long way from ports and in deeper zones up to 1000 m. Females predominate in the landings nearly 80% of the total. Discards of the red shrimp are null. The number of harbours with red shrimp fleets is 14 for the whole area. Exploitation is based on very young age classes, mainly 1 and 0 year old individuals, indicating a dependence on recruitments.

Fishing effort has reduced from 20,000 days in 2002 to 9,000 in 2006, with a increase thereafter, reaching the 23,000 in 2008. SGMED notes that the fishing effort below only includes vessels that have landed pink shrimp in the given years.

Year	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
GSA 6 Landings (t)	645	647	347	316	320	470	638
Effort (days)	20874	26688	15152	14890	8942	17695	23718

Limit and target management reference points or levels

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

$F_{0.1}$ (age range)=	
F_{msy} (age range)=	
F_{mean} (age range)=	
Z_{msy} (age range)=	
Z_{mean} (age range)=	

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

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

Comments on assessment

During the SGMED-09-02, an assessment on red shrimp from GSA 06 was performed. Official data were not received on time, but the expert provided a copy of some of the data. Files dealing with official landings and effort were not available. Consequently data on landings and effort for 2008 were derived from the series.

A yield per Recruit analysis should be undertaken during the upcoming meeting of SGMED 09-03 (14-18 December 2009).

7.17. Giant red shrimp in GSAs 15 and 16

Species common name:	Giant red shrimp
Species scientific name:	*Aristaeomorpha foliacea*
Geographical Sub-area(s) GSA(s):	GSAs 15 and 16

Most recent state of the stock

- State of the adult abundance and biomass:

SGMED-09-02 cannot fully evaluate the state of the SSB due to the lack of precautionary management references.
SGMED-09-02 estimated the absolute levels of stock abundance in 2006, 2007 and 2008 using the VIT approach on length structure of Sicilian trawlers which catch about 98% of the total yield in the area. Mean total biomass ranges between 1,721 t (2008) and 1,883 t (2006), the SSB representing about 75% of the total stock biomass.
Survey indices (MEDITS) combining GSAs indicate the stock to vary without an evident trend in the last year (2002-2008), although SSB reached its highest level in 2008 compared with the last 6 years. Considering only the GSA 16, where the time series is longer (1994-2008), SSB remained at a low level since 2001.

- State of the juvenile (recruits):

Absolute estimate of recruitment (18-22 mm CL) from VIT ranged between 63 (2008) and 95 (2007) millions of recruits. A low variability in recruitment indices derived from SURBA was observed when combining GSA data from 2002 to 2007, with the exception of sudden fall in recruit density observed in 2006 both in GSAs 15 and 16. The stability of recruitment indices in the last years is also confirmed by the analysis of the longer series from GSA 16.

- State of exploitation:

SGMED-09-02 proposes $F \leq 0.35$ (average if both applied methods) as target management reference point of exploitation consistent with high long term yield (basis $F_{0.1}$).
The giant red shrimp in the Northern sector of the Strait of Sicily is considered overfished since the current fishing mortality is significantly higher than both $F_{0.1}$ and F_{max}.

- Source of data and methods:

Data derived both from indirect (fisheries monitoring) and direct (scientific surveys) sources. Stock status was assessed by using Y and SSB per recruit analysis with package VIT and Yield on females, which reach larger size and represents more than 60% of the landing in weight. Current F was assessed with steady state VPA with VIT by length and by age on LFD of 2006, 2007 and 2008 landings. Further estimations of F, SSB and recruitment indices derived from The SURBA software program was used to analyse the MEDITS time series. Biological parameters used were: K=0.61; Linf = 68.9 cm; t_0 = -0.2. M-at-age vector (PROBIOM sheet): 0.62; 0.30; 0.23; 0.19; 0.17; 0.16. q vector = estimate: q(Age0)=0.4; q(Age1+)=1.0; q(Age2+)=1.0; q(Age3+);tq(Age4+)=1.0. F_{max} and $F_{0.1}$ was estimated by VIT, with vector M by size (PROBIOM sheet) and Yield package (2000 runs) with scalar M=0 .42.

Outlook and management advice

SGMED recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed $F_{0.1}$ level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches consistent with the effort reductions should be estimated.

SGMED-09-02 noted that the Italian government is adopting a management plan, in which a reduction of fishing mortality of 25% is planned within 2013. SGMED-08-04 was informed that medium term management plan for 2008-2013 has been agreed for Italian trawlers catching hake in GSA 15 and 16.

The effect of 5 different management scenarios considered by the Italian Management Fishery Plans were

- a fleet reduction of 25% of the current capacity obtained in two steps. The first (12.5%) from 2008 to 2010, and the second (12.5%) from 2011 to 2013;
- trawling ban of 45 days per year between January and March (targeted to deep water pink shrimp fishery which is the main commercial species in the GSA 15 and 16);
- changing the mesh opening in the cod-end from the 40 mm to 50 mm (diamond) from 2010;
- the above three measures combined; and
- maintaining the status quo.

Although designed mainly for deep water pink shrimps, the adoption of the management measures of the IFMP is expected to improve also the stock status of giant red shrimp in the area.

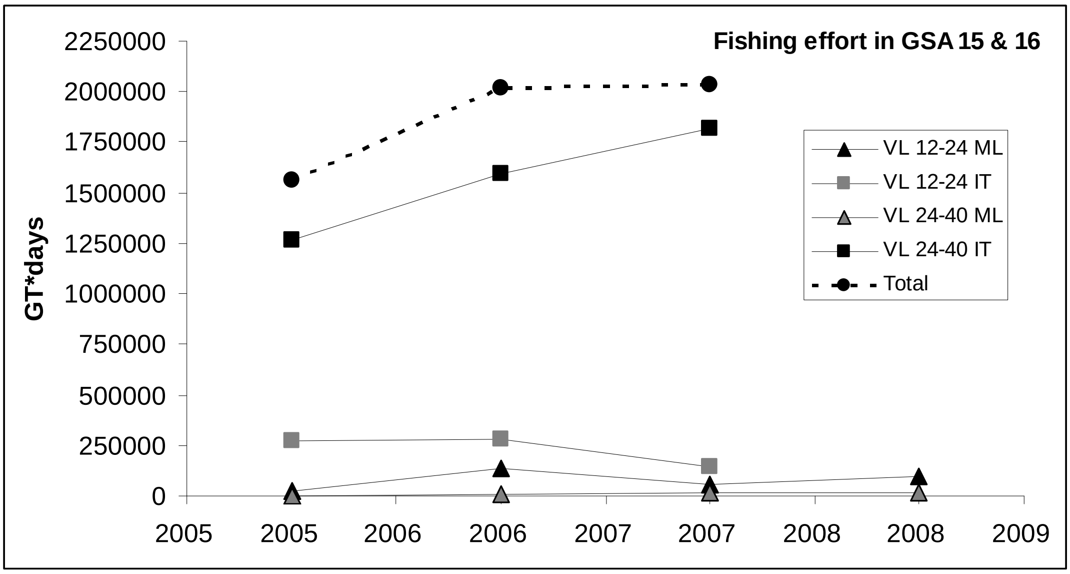
Short and medium term scenarios:
Will be conducted and delivered by SGMED 09-03 (14-18 December 2009).

Fisheries

Brief description of trends:
The giant red shrimps is a relevant target species of the Sicilian and Maltese trawlers and is caught on the slope ground during all year round, but landing peaks are observed in summer. Yield of the Italian trawlers in 2006 was about 1883 t decreasing to 1721 t in 2008. The Maltese trawlers landed 25 t in 2006 and 34 t in 2007. *A.foliacea* is fished exclusively by otter trawl, mainly in the central –eastern side of the Strait of Sicily, whereas in the western side it is substitute by the red shrimp, *Aristeus antennatus* Due to reduction of catch rate since 2004 some distant trawlers based in Mazara del Vallo, which is the main fleet in the area, move to the eastern Mediterranean (Aegean and Levant Sea) to fish red shrimps.

Landings (t) by year and major gear types, 2005-2008 as reported through DCR

Species	Area	Country	Fleet	2005	2006	2007	2008
ARS	15	Malta	OTB	17	26	34	27
ARS	16	Italy	OTB	1270	1424	1540	1260
ARS	15&b 16	Italy	OTB	1287	1450	1574	1287



Fishing effort in terms of GT*days of trawlers targeted to demersal deep water species in GSA 15 and 16.

Precautionary and target management reference points or levels

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

$F_{0.1}$ (1-3) = 0.35	proxy
F_{max} (1-3) = 0.50	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

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

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

7.18. Norway lobster in GSA 09

Species common name:	Norway lobster
Species scientific name:	*Nephrops norvegicus* (L., 1758)
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

SGMED-09-02 cannot fully evaluate the state of the SSB due to a lack of precautionary management reference points.
Relative spawning stock biomass (SSB) indices derived from MEDITS (1994-2008) and GRUND (1994-2006) showed a fluctuating trend in the spawning stock biomass (SSB). An increase in SSB occurred in recent years (2005-08, MEDITS survey).

- State of the juveniles (recruits):

Recruitment (age groups 1+ and 2+) showed a significant increasing trend since 1994.

- State of exploitation:

The reference points ($F_{0.1}$ and F_{max}) estimated for this species using the Yield software were 0.21 and 0.36 (median values), respectively. Recent values of F_{3-7} obtained on commercial data with LCA (VIT) were: 0.32 (2006), 0.30 (2007), 0.36 (2008). Similar F_{3-7} values were obtained from MEDITS data using Surba (0.36 in 2006 and 0.33 in 2007) which indicates that the stock is currently fully exploited or lightly overexploited.

SGMED-09-02 proposes the $F \leq 0.21$ as target management reference point for sustainable exploitation consistent with high long term yield (basis $F_{0.1}$).
Recent values of F_{3-7} obtained on commercial data with LCA (VIT) and using SURBA indicate that the stock is currently overexploited.

- Source of data and methods:

Data coming from MEDITS (1994-2008) and GRUND (1994-2006) trawl surveys were used to estimate relative SSB and F with Surba. DCR data (size distribution of trawl landings 2006-2008) were used to estimate F at age, absolute abundance at age with VIT (LCA analysis).

The following parameters were used both for SURBA and VIT analyses:

Growth parameters (Von Bertalanffy)
$L\infty$ = 74 (mm, carapace length); k = 0.17; $t_{0=}$ 0
L*W: a = 0.0005; b=3.04
M = 0.4 constant from 3-7 age classes (from ProdBiom)
q = 1
Length at maturity (L_{50}) = 29 mm total length (sex combined)

Outlook and management advice

SGMED recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed $F_{0.1}$ level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches consistent with the effort reductions should be estimated.

Short and medium term scenarios:
Will be conducted and delivered by SGMED 09-03 (14-18 December 2009).

Fisheries

Norway lobster is one of the most important commercial species in the GSA as total annual landing value. All the landing is due to bottom trawl vessels exploiting slope muddy bottoms mainly between 300 and 500 m depth.
Catch of vessels targeting Norway lobster is composed of a mix of both commercial (hake, deep-sea pink shrimp, horned octopus (*Eledone cirrhosa*), squids (*Todaropsis eblanae*)), and non-commercial species.
The trawl fleet of GSA 09 at the end of 2007 accounted for 360 trawlers. To date about 80-100 trawlers are involved in this fishery.
In the last five years the total landings of Norway lobster of GSA 09 fluctuated between 248 (2005) to 228 tons (2008).

Landings (t) by year and major gear types, 2002-2007 as reported through DCR.

YEAR	2005	2006	2007	2008
DTS		247.96	260.55	227.67
GNS		0.09		0.06
Traps				0.05
Total		248.05	260.55	227.79

Trend in fishing effort (days, GT*days, kW*days, TSL*days) by major gear types, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	9	ITA	DRB	1856	3332	2660	2635	3182	2177
DAYS	9	ITA	DTS	62616	63331	64870	65657	63141	61710
DAYS	9	ITA	HOK			2568	1921	1821	
DAYS	9	ITA	PGP	212455	182159	196758	189052	183435	175888
DAYS	9	ITA	PMP	52193	75479	16960	6655		
DAYS	9	ITA	PTS	5453	6242	4728	4739	5242	5160
GT*DAYS	9	ITA	DRB			24050	23915	28878	20772
GT*DAYS	9	ITA	DTS			2410544	2448143	2325295	2289820
GT*DAYS	9	ITA	HOK			22784	16701	13580	
GT*DAYS	9	ITA	PGP			521225	493611	507794	485784
GT*DAYS	9	ITA	PMP			62599	24894		
GT*DAYS	9	ITA	PTS			143490	162480	200226	194754
KW*DAYS	9	ITA	DRB	187147	335521	268423	265359	320437	225526
KW*DAYS	9	ITA	DTS	14583556	14671042	14130070	14265309	13484321	13096031
KW*DAYS	9	ITA	HOK			376470	275809	262696	
KW*DAYS	9	ITA	PGP	6504001	6925653	7060573	6946213	7399313	7300451
KW*DAYS	9	ITA	PMP	4715565	4051809	984241	396631		
KW*DAYS	9	ITA	PTS	1312412	1333245	947166	1013627	1174295	1151346
TSLDAYS	9	ITA	DRB	15733	28362				
TSLDAYS	9	ITA	DTS	2154256	2147750				
TSLDAYS	9	ITA	PGP	624182	650560				
TSLDAYS	9	ITA	PMP	382454	382992				
TSLDAYS	9	ITA	PTS	193726	181590				

The catch is mainly composed by adult individuals over the size-at-maturity and discarding of specimens under MLS (20 mm CL) is negligible.

Limit and target management reference points or levels

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

$F_{0.1}$ (age 2-7) = 0.21	Proxy of target
F_{max} (age 2-7) = 0.36	
F_{msy} (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

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

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

Comments on assessment

GRUND data prior to 1994 should be standardised and used within this assessment. MEDITS survey data does not allow the calculation of length-at-maturity because the survey period (late spring-early summer) does not cover the spawning season (autumn-winter). Recent increase in SSB and recruitment seems poorly correlated with fishing mortality. This may suggest that other factors can be affecting the stock dynamics during recent years.

8. STOCK ASSESSMENTS REVIEWED OR CONDUCTED

8.1. Introductory notes

SGMED-09-02 presents the following stock assessment approaches in an agreed and consistent format in order to allow scientists and fisheries managers a quick review of all information provided, the methods used and the assessment results.

Constrained by data availability and the fact, that the framework of SGMED has just been created in 2008, not all the assessments presented are considered final. SGMED will continue to improve and update the assessments in the future, especially where data or scientific advice with respect to target and limit references of stock size and exploitaiton is lacking.

The assessments are largely based on data obtained through the DCR and an official call issued in 2009 for fisheries and scientific survey data, also covering data collected during national programmes or projects co-funded by the EU-Commission. SGMED was often unable to verify the origin or quality of the data used in the assessment but will continue its effort to validate the data through expert knowledge and transparent presentation of the data.

In some assessments, SGMED applied a number of different approaches in order to verify the assessment results. The assessment tools applied are CPUE analyses from surveys, hydro-acoustic surveys, daily egg productions, virtual population analyses (XSA or ICA) calibrated with survey or commercial data on stock abundance, pseudo-cohort analyses (VIT) and various dynamic production models under equilibrium (YpR) or non-equilibrium conditions (ALADYM, ASPIC).

Unlike the 2008 report of SGMED 08-04, this SGMED 09-02 report deals with assessment of historic and recent trends in stock parameters (stock size, recruitment and exploitation) and relevant scientific advice only. Deterministic short and medium term for such parameters including stock size, landings and relevant scientific advice will we delivered through the forthcoming SGMED 09-03 meeting in the fourth quarter of 2009.

8.2. Stock assessment of hake in GSA 01

8.2.1. Stock identification and biological features

8.2.1.1. Stock Identification

The delimitation of the hake stock in GSA01 is considered unknown. Likely connections with hake in GSA06 may exist, because of the continuity of shelf. Large exchanges with the south Alborán Sea (GSA03) are believed insignificant.

8.2.1.2. Growth

Two growth parameter sets were considered: fast and slow. Also different values were used for males and females. They are shown in Table 8.2.1.2.1.

Tab. 8.2.1.2.1. Two sets of growth parameters (v. Bertalanffy) by sex for hake in GSA 01.

	Fast growth Females	Fast growth Males	Slow growth Females	Slow growth Males	Units
Linf	100.7	72.8	100.7	72.8	cm
K	0.248	0.298	0.124	0.149	$year^{-1}$
t0	-0.35	-0.383	-0.35	-0.383	year
a	0.0069	0.0069	0.0069	0.0069	gr
b	3.03	3.03	3.03	3.03	
M	0.18	0.22	0.18	0.22	$year^{-1}$

8.2.1.3. Maturity

Fig. 8.2.1.3.1 shows the maturity at length ogive for female hake in GSAs 01, 05 and 06. The more recent years indicate significant reduction in size at maturation.

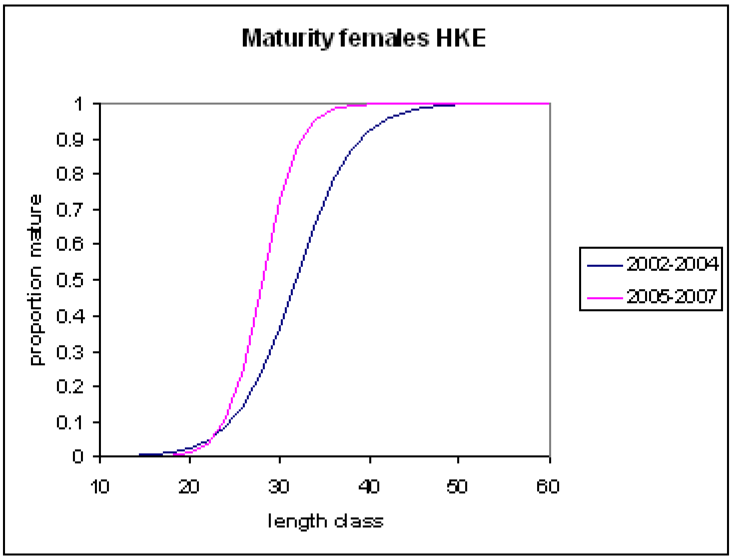
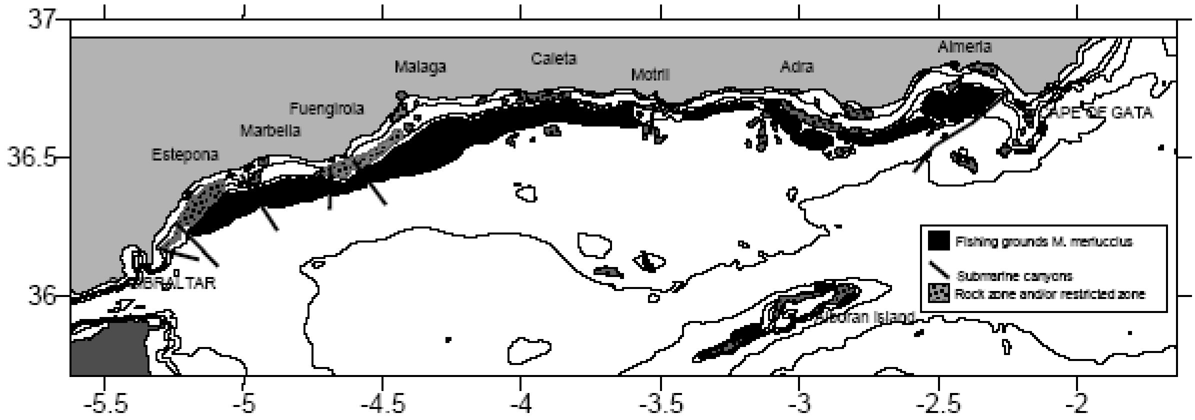


Fig. 8.2.1.3.1 Maturity ogives for female hake in GSAs 01, 05 and 06.

8.2.2. Fisheries

8.2.2.1. General description of fisheries

Hake is one of the most important target species for the trawl fisheries in GSA 01. It is exploited in all trawlable areas from Gibraltar straight to Cape of Gata, including the deep-bottom fishing grounds about GSA 02. Commonly small hakes are caught in shallow waters about 50 m to 300 m depth, whereas adults reach the maximum depths exploited (800 m), associated with the red shrimp (*Aristeus antennatus*) fishery.



Fishing grounds M. Merluccius in GSA 1 **(*Source: I.E.O.*)**

Fig. 8.2.2.1.1 Fishing grounds of hake in GSA 01. Countries: only Spain

8.2.2.2. Management regulations applicable in 2008 and 2009

No information was documented.

8.2.2.3. Catches

8.2.2.3.1. Landings

Tab. 8.2.2.3.1.1 shows the trend in reported landings taken by trawlers (Spain only). The data were reported to SGMED-09-02 through the Data collection regulation and are listed in Table A3.1 of Appendix 3.

Tab. 8.2.2.3.1.1 Annual hake landings (t) by Spanish trawlers.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
HKE	1	ESP	OTB	353	201	374	208	212	220	242

Annual lengths of landings were reported to SGMED-09-02 only for 2005-2008 and are shown in Fig. 8.2.2.3.1.2.

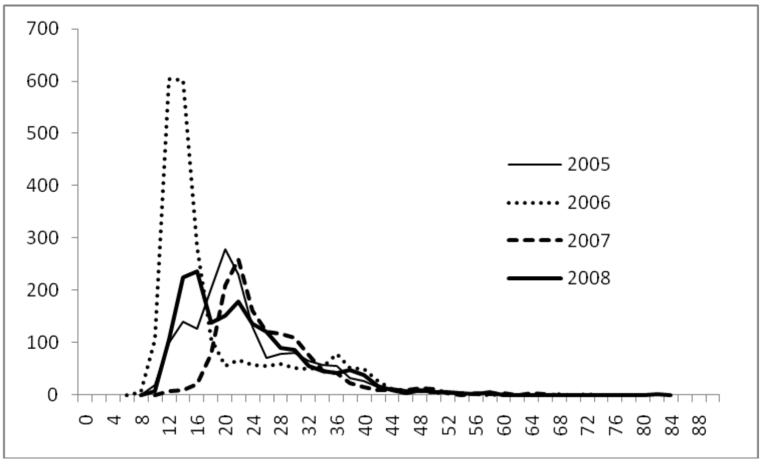


Fig. 8.2.2.3.1.2 Annual size composition of hake landings (thousands) by Spanish trawlers, 2005-2008.

8.2.2.3.2. Discards

SGMED-09-02 received discard data only for 2005 and 2008. A total of 6 tons discarded in 2005 and 16 tons for 2008 (2.9% and 6.6% of the landings, respectively). The data were compiled and reported through the Data collection regulation and are listed in Table A3.9 of Appendix 3.

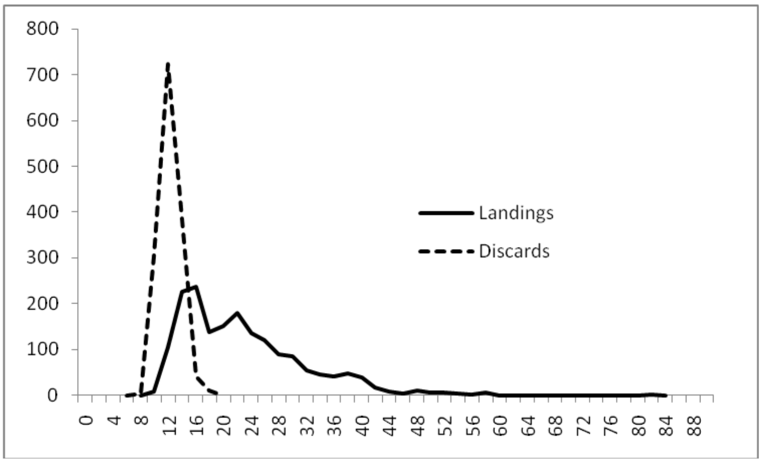


Fig. 8.2.2.3.2.1 Annual size composition of hake landings and discards (thousands) by Spanish trawlers, in 2008.

8.2.2.3.3. Fishing effort

No effort data were reported to SGMED-09-02 through the DCF data call for Spain.

8.2.3.Scientific surveys

8.2.3.1. Medits

8.2.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were calculated. In GSA 01 the following number of hauls were reported per depth stratum (s. Tab. 8.2.3.1.1.1)

Tab. 8.2.3.1.1.1. Number of hauls per year and depth stratum in GSA 01, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA01_010-050	3	1	2	2	2	2	2	3	3	3	3	2	3	3	4
GSA01_050-100	6	4	5	6	5	7	6	5	6	10	7	7	6	6	6
GSA01_100-200	3	3	3	5	5	5	5	5	8	6	5	6	5	6	6
GSA01_200-500	7	9	11	10	8	11	12	10	11	11	13	11	12	11	11
GSA01_500-800	6	10	13	10	13	12	10	13	15	14	13	11	15	10	9

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = $Yst \pm t(\text{student distribution}) * V(Yst) / n$

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

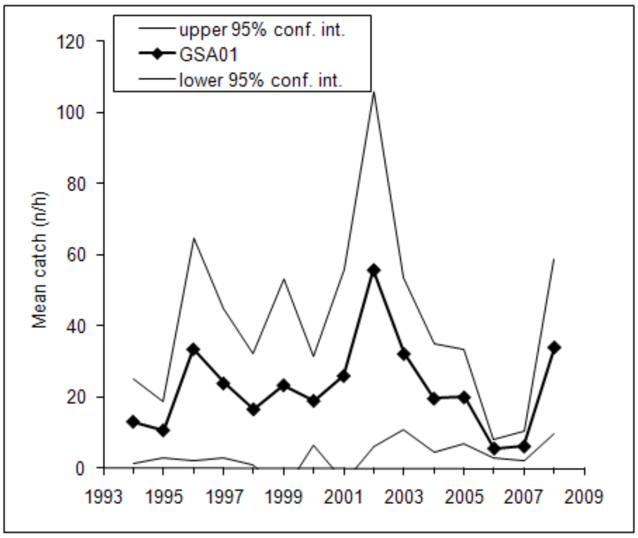
Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.2.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.2.3.1.3. *Trends in abundance and biomass*

Fishery independent information regarding the state of the hake in GSA 01 was derived from the international survey Medits. Figure 7.2.3.1.3.1 displays the estimated trend in hake abundance and biomass for the GSA 01.
It can be seen in the following figures, that the Medits indices for hake in GSA 01 do not follow the general increasing trend but appear to having recently increased from a very low to an average level estimated since 1994 (Fig. 8.2.3.1.3.1). The analyses of Medits indices are considered preliminary.



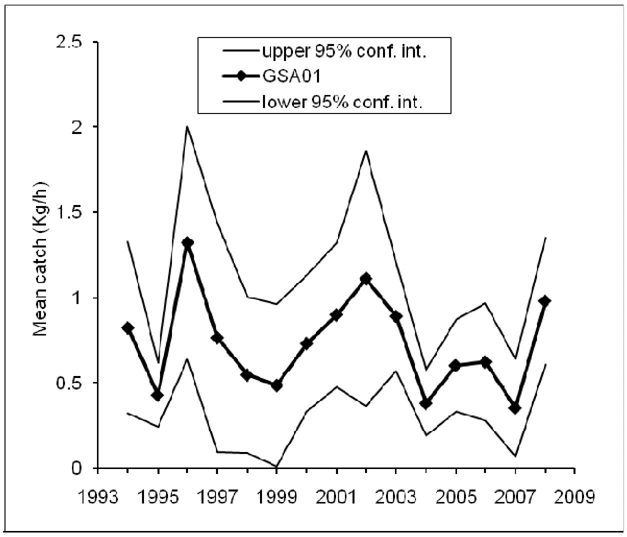


Fig. 8.2.3.1.3.1. Abundance and biomass indices of hake in GSA 01.

8.2.3.1.4. *Trends in abundance by length or age*

The following Fig. 8.2.3.1.4.1 and 2 display the stratified abundance indices of GSA 01 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

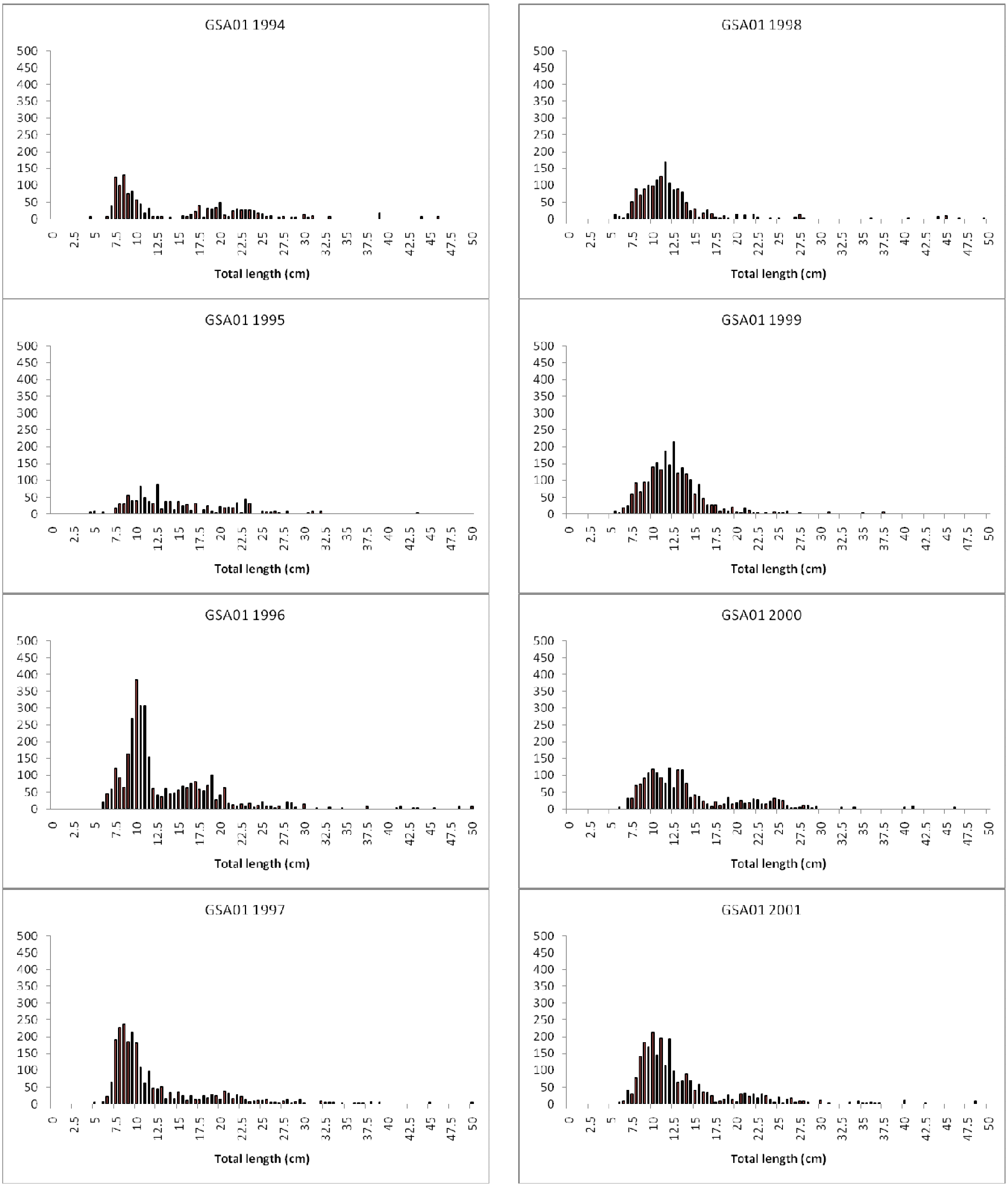


Fig. 8.2.3.1.4.1 Stratified abundance indices by size, 1994-2001.

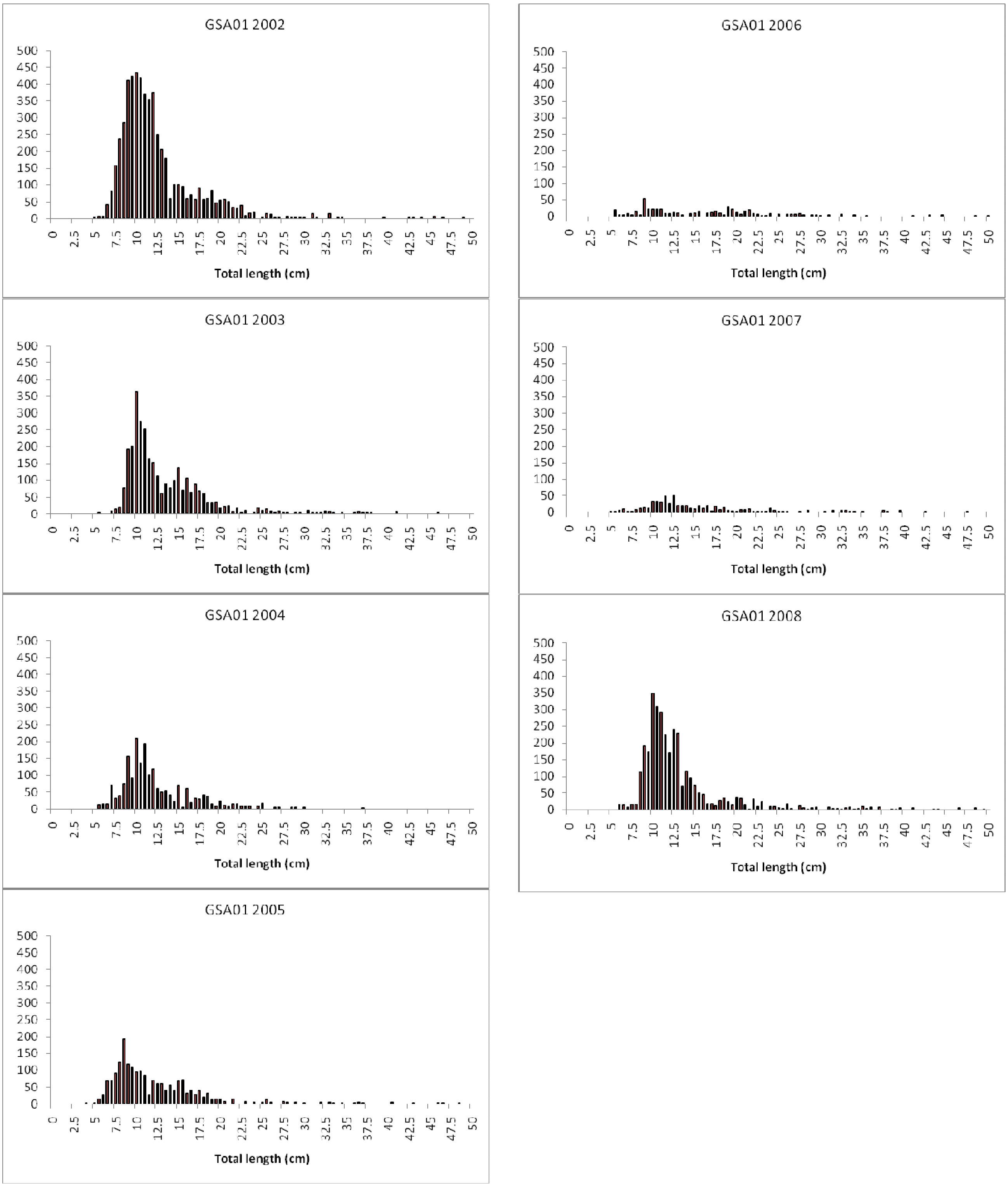


Fig. 8.2.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.2.3.1.5. Trends in growth

No analyses were conducted.

8.2.3.1.6. Trends in maturity

No analyses were conducted

8.2.4. Assessment of historic stock parameters

SGMED 09-02 did not undertake any analytical assessment of hake in GSA 01. Last year's assessment using SURBA and VIT can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.2.5. Long term prediction

8.2.5.1. Justification

No forecast analyses were conducted.

8.2.5.2. Input parameters

No forecast analyses were conducted.

8.2.5.3. Results

No forecast analyses were conducted.

8.2.6. Scientific advice

8.2.6.1. Short term considerations

8.2.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.2.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.2.6.1.3. State of exploitation

SGMED cannot estimate recent or historic exploitation rates. No proposed or agreed reference points were available to SGMED to identify stock status.

8.3. Stock assessment of hake in GSA 05

8.3.1.Stock identification and biological features

8.3.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.3.1.2. Growth

No information was documented during SGMED-09-02.

8.3.1.3. Maturity

No information was documented during SGMED-09-02.

8.3.2.Fisheries

8.3.2.1. General description of fisheries

STECF in 2007 (stock review part II) noted that the trawl fishery off Mallorca is developed by around 40 vessels, corresponding to about 72% of the total trawl fleet of the Balearic Islands (GFCM GSA 05). The total annual landings are approximately 1,400 tonnes, representing around 90% of the total catch of GSA 05. The European hake (*Merluccius merluccius*) is a target species for this fishery, mainly exploited on the deep shelf and upper slope, with annual landings oscillating between 50 and 190 t during the last decades.

8.3.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.3.2.3. Catches

8.3.2.3.1. Landings

Tab 8.3.2.3.1.1 shows the trend in reported landings taken by trawlers (Spain only). The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.1 of Appendix 3. Since 2002 the annual landings varied between 40 and 100 t.

Tab. 8.3.2.3.1.1 Annual hake landings (t) by Spanish trawlers.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
HKE	5	ESP	OTB	91	44	57	86	102	72	68

8.3.2.3.2. Discards

Reported discards through the DCF data call to SGMED-09-02 varied among 5 and 10 t annually during 2002 to 2008. The data are listed in Table A3.9 of Appendix 3.

8.3.2.3.3. Fishing effort

No effort data were reported to SGMED-09-02 through the DCF data call for Spain.

8.3.3.Scientific surveys

8.3.3.1. Medits

8.3.3.1.1. Methods

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 05 the following number of hauls were reported per depth stratum (s. Tab. 8.3.3.1.1.1)

Tab. 8.3.3.1.1.1. Number of hauls per year and depth stratum in GSA 05, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA05_050-100														8	7
GSA05_100-200		1				1		1			1		1	5	5
GSA05_200-500		4	2	2	2	1		5	2		2	2	4	6	5
GSA05_500-800	1	5	3	2	2	3	1	2	2		2	2	2	1	6

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.3.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.3.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 05 was derived from the international survey Medits. Figure 8.3.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 05.

The few hauls may indicate a general increasing trend in both abundance and biomass since 1994. The analyses of Medits indices are considered preliminary.

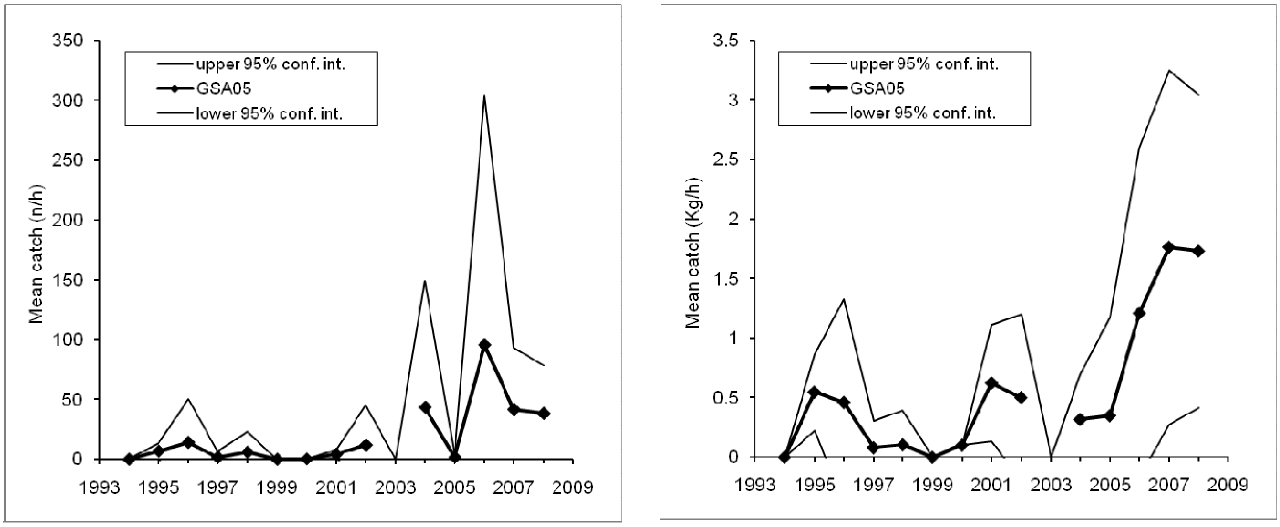


Fig. 8.3.3.1.3.1 Abundance and biomass indices of hake in GSA 05.

8.3.3.1.4. Trends in abundance by length or age

The following Fig. 8.3.3.1.4.1 and 2 display the stratified abundance indices of GSA 05 in 1995-2004 and 2005-2008. These size compositions are considered preliminary.

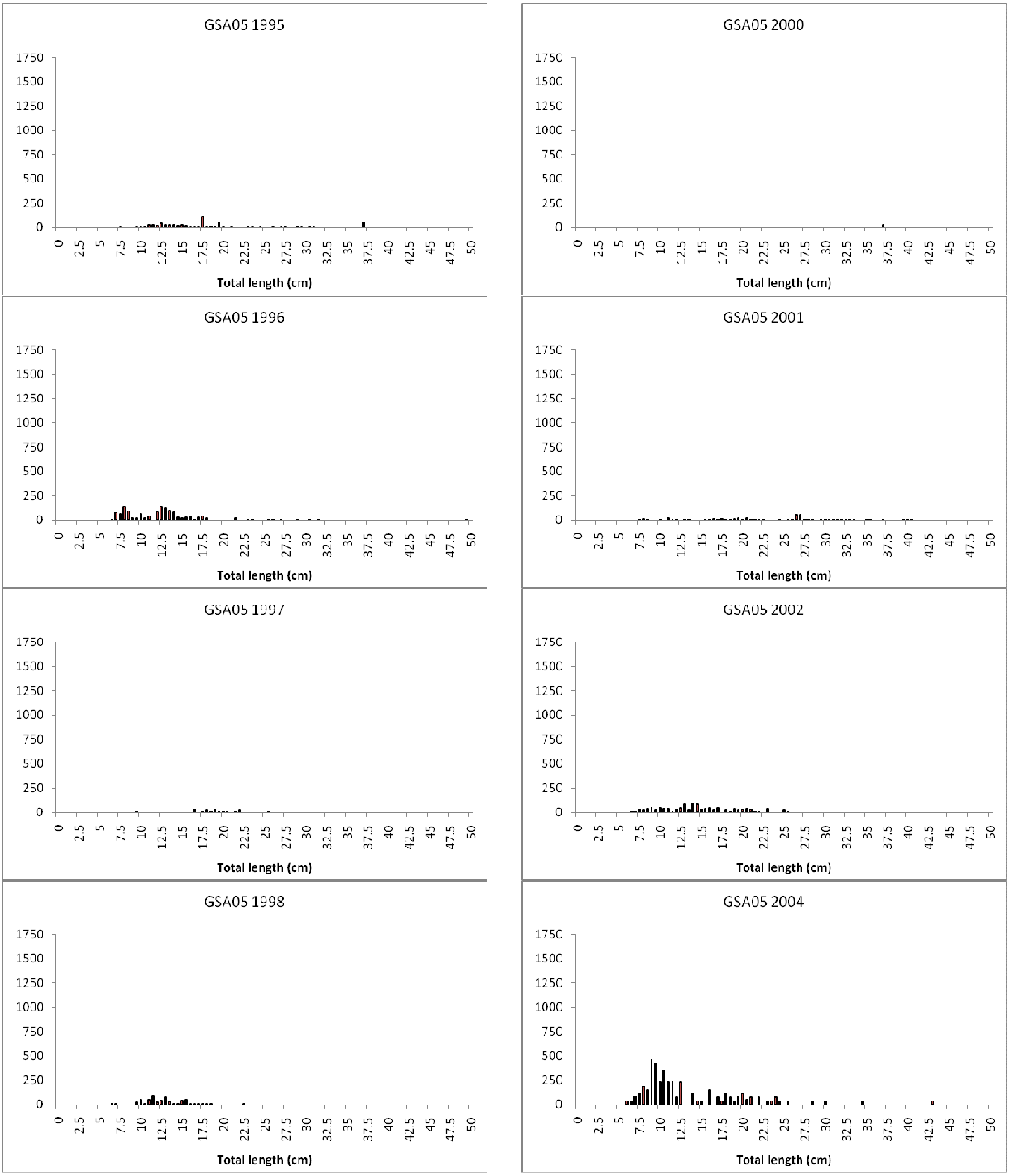


Fig. 8.3.3.1.4.1 Stratified abundance indices by size, 1995-2004.

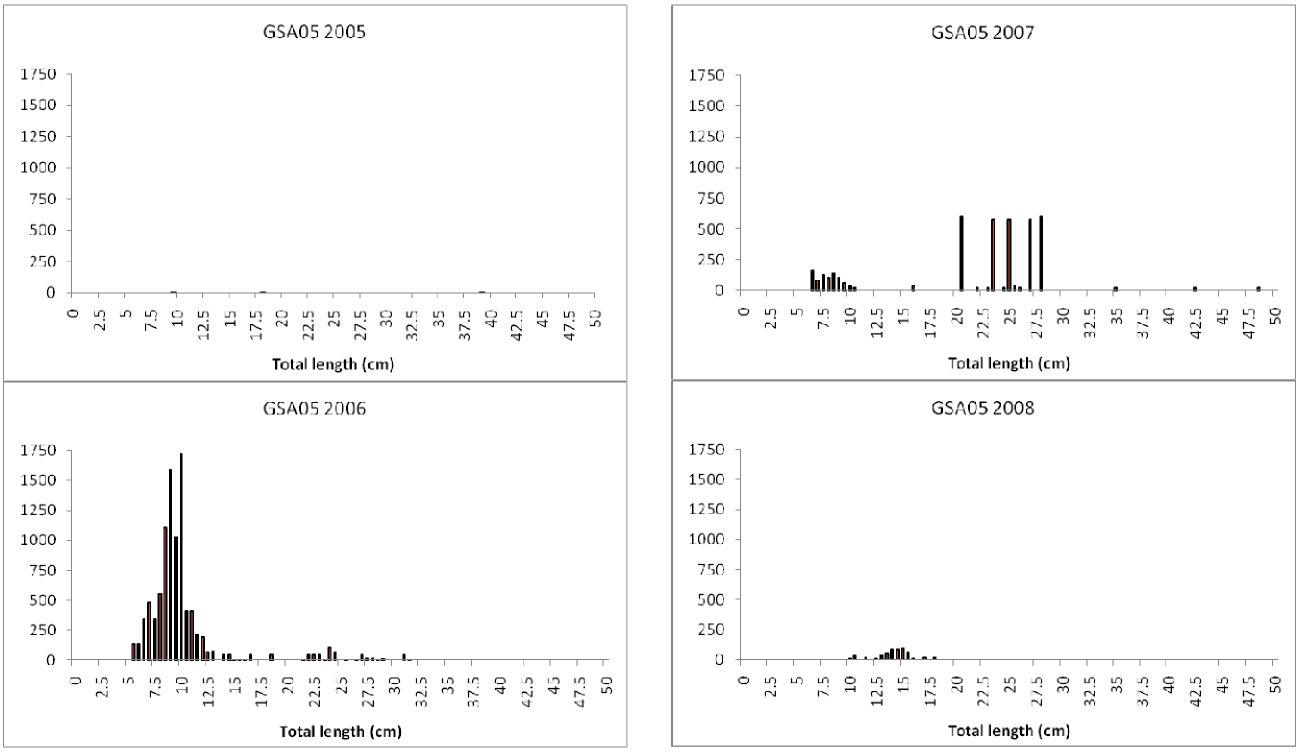


Fig. 8.3.3.1.4.2 Stratified abundance indices by size, 2005-2008.

8.3.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.3.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.3.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment. It was noted that hake in GSA 05 was assessed in 2007 and presented to SCSA/SAC/GFCM. This assessment can be viewed at:

http://www.gfcm.org/ for GSA05 open Doc05-HKE0508Gui.xls

8.3.5. Long term prediction

8.3.5.1. Justification

No forecast analyses were conducted.

8.3.5.2. Input parameters

No forecast analyses were conducted.

8.3.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 05.

8.3.6.Scientific advice

8.3.6.1. Short term considerations

8.3.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

SGMED-09-02 noted that the hake ‘population’ of GSA 05 is unlikely to be independent from that of the adjacent GSA 06. SGMED therefore recommends exploring the alternative of merging data from GSA 05 and GSA 06 and perfoming a single assessment for both GSAs together.

8.3.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.3.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.4. Stock assessment of hake in GSA 06

8.4.1.Stock identification and biological features

8.4.1.1. Stock Identification

No information was documented.

8.4.1.2. Growth

SGMED-09-02 notes that the set of growth parameters used in the assessment were different to those used the year before, and the recommendation made last year on the use of a set more agreed with the “fast growth hypothesis” has been followed. Growth parameters used were those from Garcia-Rodriguez (2002) over otolith readings and length distributions analysis (Linf= 106.7; K= 0.20; t0= 0.0028), and length-weight relationship (a= 0.0048; b= 3.12) from García Rodriguez & Esteban (1995).

8.4.1.3. Maturity

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

Age class	0	1	2	3	4	5	6	7
Maturity ratio	0	0.312	1	1	1	1	1	1

8.4.2.Fisheries

8.4.2.1. General description of fisheries

STECF in 2007 (stock review part II) noted that hake (*Merluccius merluccius*) is one of the most important target species for the trawl fisheries carried out by around 647 vessels in the Northern Spain (GSA 06) with an average of 47 TRB, 58 GT and 297 HP. Some of these units (smaller vessels) operate almost exclusively on the continental shelf (targeted at red mullet, octopus, hake and sea breams), others (bigger vessels) operate almost exclusively on the continental slope (targeted at decapod crustaceans) and the rest can operate indistinctly on the continental shelf and slope fishing grounds, depending on the season, the weather conditions and also economic factors (e.g. landings price). The percentage of these trawl fleet segments has been estimated around 30, 40 and 30% of the boats, respectively. In the last years, the annual landings of this species, which are mainly composed by juveniles living on the continental shelf, the annual landings of this species were around 3800 tons in the whole GSA.

8.4.2.2. Management regulations applicable in 2008 and 2009

No information was documented.

8.4.2.3. Catches

8.4.2.3.1. Landings

Fig. 8.4.2.3.1.1 shows the trend in reported landings taken by trawlers (Spain only). The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.1 of Appendix 3. The annual landings show an a stable trend, with some oscillations.

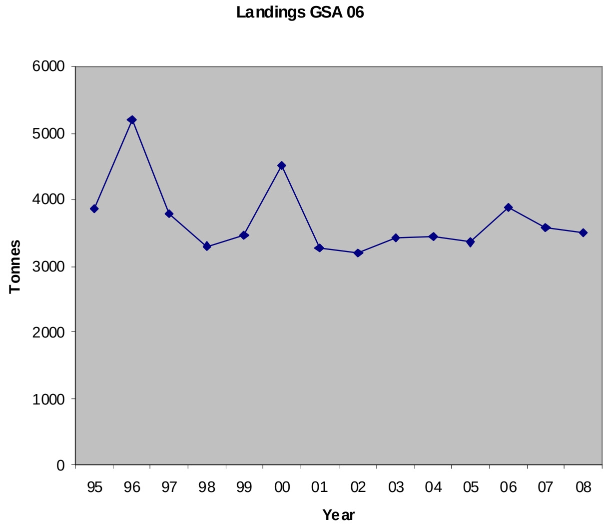


Fig. 8.4.2.3.1.1 Annual hake landings (t) by Spanish trawlers.

Tab. 8.4.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.1 of Appendix 3. Since 2002 the annual landings fluctuated around an average of 3 500 t. The landings were only taken by demersal otter trawls.

Tab. 8.4.2.3.1.1 Annual landings (t) by fishing technique in GSA 06.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
HKE	6	ESP	OTB	3195	3411	3441	3363	3864	3701	3494

8.4.2.3.2. Discards

Reported discards through the DCR data call to SGMED-09-02 amount 80 t in 2005. The data are listed in Table A3.9 of Appendix 3.

8.4.2.3.3. Fishing effort

SGMED-09-02 did not receive fishing effort data for GSA 06. STECF (stock review part II in 2007) noted that the trawl fishery off northern Spain (GSA 06) is carried out by around 647 vessels.

8.4.3. Scientific surveys

8.4.3.1. MEDITS

8.4.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 06 the following number of hauls were reported per depth stratum (s. Tab. 8.4.3.1.1.1).

Tab. 8.4.3.1.1.1. Number of hauls per year and depth stratum in GSA 06, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA06_010-050	7	8	7	8	7	8	9	8	11	9	9	11	12	6	8
GSA06_050-100	21	28	27	26	28	30	30	31	36	39	31	32	34	40	43
GSA06_100-200	11	19	17	15	13	17	19	20	20	21	17	18	19	24	30
GSA06_200-500	10	13	10	12	7	13	12	16	17	18	16	15	18	18	19
GSA06_500-800	7	8	9	7	4	9	6	8	7	11	11	8	10	15	14

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.4.3.1.2. Geographical distribution patterns

No specific analyses were conducted.

8.4.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 06 was derived from the international survey Medits. Figure 8.4.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 06.

The hauls indicate a general increasing trend in both abundance and biomass since 1996, except for the most recent years 2007 and 2008, when the indices suddenly decreased to the lowest level observed.

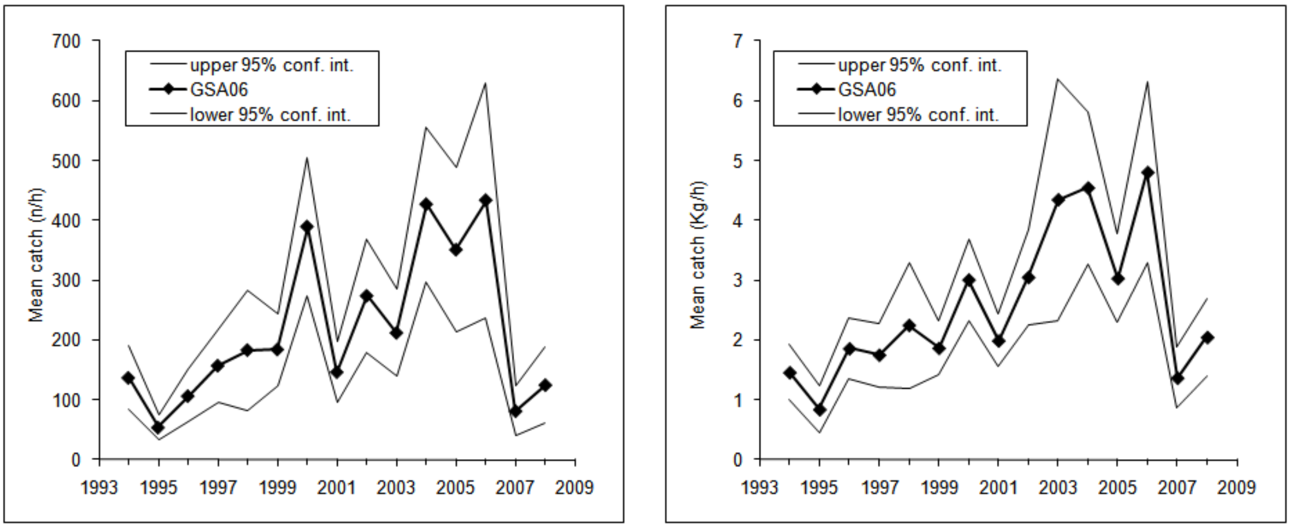


Fig. 8.4.3.1.3.1 Abundance and biomass indices of hake in GSA 06.

8.4.3.1.4. Trends in abundance by length or age

The following Fig. 8.4.3.1.4.1 and 2 display the stratified abundance indices of GSA 06 in 1994-2001 and 2002-2008.

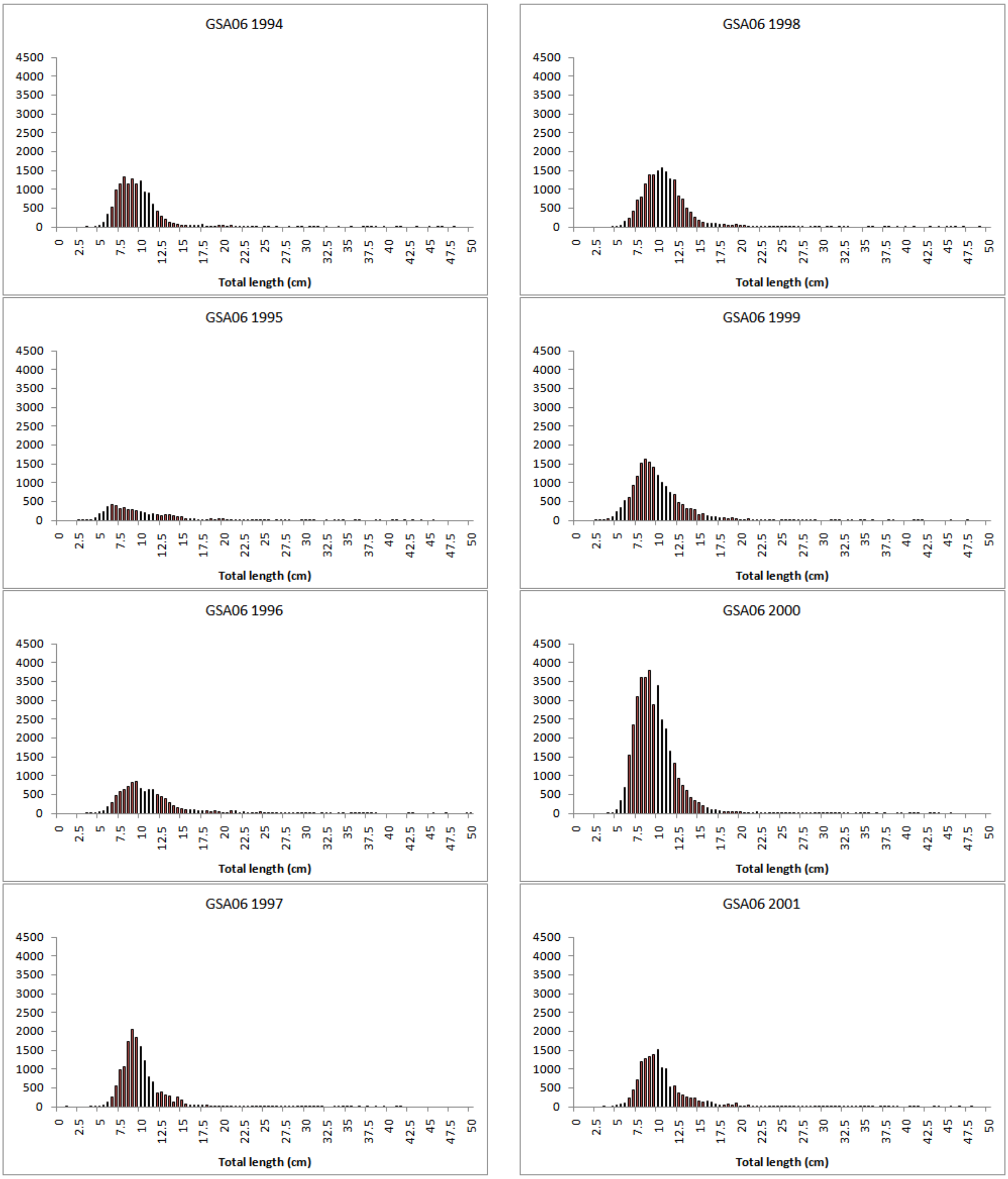


Fig. 8.4.3.1.4.1 Stratified abundance indices by size, 1994-2001.

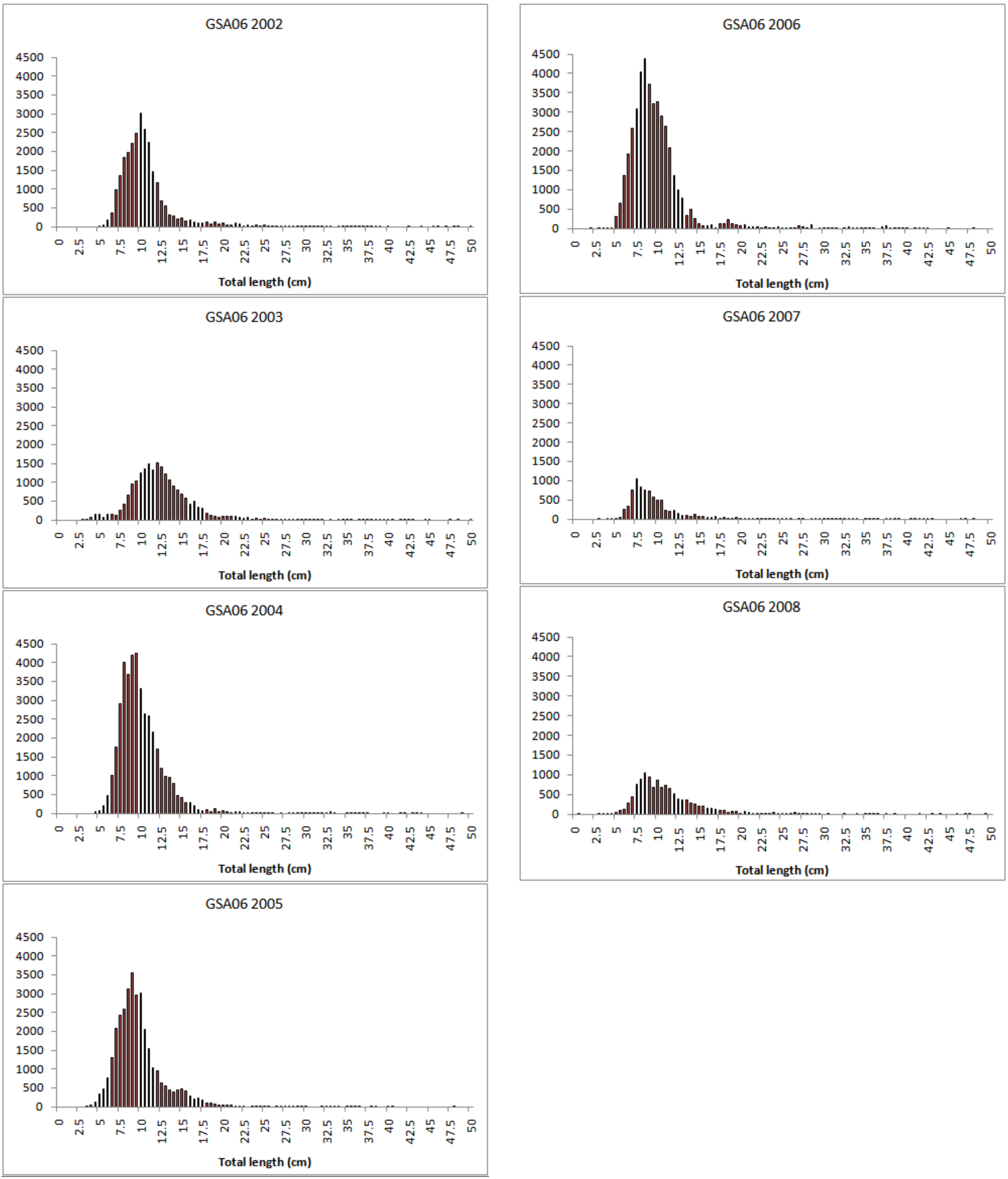


Fig. 8.4.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.4.3.1.5. Trends in growth

No analyses were conducted.

8.4.3.1.6. Trends in maturity

No analyses were conducted.

8.4.4.Assessment of historic stock parameters

During the SGMED-09-02, an assessment on hake from GSA 06 was performed. There was no official effort data available.

8.4.4.1.1. Method 1: XSA

8.4.4.1.2. Justification

An XSA was performed calibrated with fishery independent survey abundance indices.

8.4.4.1.3. Input parameters

The following Table 8.4.4.1.3.1 lists the input parameters to the XSA, i.e. catch at age, weight at age, matutity at age, natural mortality at age and the tuning series at age (MEDITS).

Table 8.4.1.1.3.1 The input parameters to the XSA, i.e. catch at age, weight at age, matutity at age, natural mortality at age and the tuning series at age (MEDITS).

Hake GSA 06							Catch at age							
Age class	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	116256	406832	169348	166681	186806	195509	136607	140324	113370	116713	93502.8	73585.8	75489.4	56035
1	10091.8	7321.7	10765.4	7144.2	7812.7	12431.3	10087	8454.5	10323.7	11537.6	12269.1	8704.7	12406.5	17420.7
2	1428.9	816.2	943.7	955.4	570.1	956.9	895.5	972.9	874.3	423.1	767.8	706.2	1677.1	1278.9
3	331.5	226.9	220.9	138.2	120.4	75.8	54.4	124.5	147.7	87	65.3	156.7	242.9	186.6
4	84.9	126.6	54.2	40	13.8	9.5	1	8.5	30.5	7.9	0.4	6.4	25.9	33.3
5	3.2	26	20.8	11.8	2	3.1	1.4	0.4	0.8	1.4	0.4	1.3	0.4	2.8
6	0.3	3.5	10.4	0.3	0	3.2	0	0.3	0.3	0.3	0.3	1.8	5.6	0.3
7+	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.6	1.4	0.1

							Weight at age (kg)							
Age class	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	0.013	0.008	0.01	0.011	0.012	0.013	0.012	0.011	0.015	0.016	0.016	0.017	0.017	0.02
1	0.11	0.114	0.109	0.108	0.103	0.109	0.114	0.124	0.108	0.114	0.123	0.104	0.111	0.117
2	0.48	0.48	0.484	0.488	0.504	0.486	0.437	0.471	0.493	0.439	0.44	0.459	0.463	0.453
3	1.124	1.23	1.106	1.114	1.104	1.062	1.09	1.104	1.131	1.108	1.08	1.025	1.097	1.149
4	1.902	1.908	1.854	1.996	1.76	1.822	1.608	1.665	1.795	1.695	1.996	1.954	1.781	1.752
5	2.445	2.673	2.995	2.583	3.125	3.125	2.865	2.88	2.609	2.895	2.88	2.523	2.88	2.791
6	3.773	3.431	3.692	3.773	4.322	3.695	4.322	3.773	3.773	3.773	3.773	4.234	4.008	3.773
7+	4.322	4.322	4.322	4.322	4.322	4.322	4.322	4.322	4.322	4.322	4.322	4.322	4.322	4.322

Age class	Maturity at age	Age clas:	Natural mortality
0	0	0	1.43276
1	0.14533	1	0.68255
2	0.81758	2	0.4721
3	0.98386	3	0.41722
4	1	4	0.38889
5	1	5	0.3727
6	1	6	0.36164
7+	1	7+	0.35395

							Tunning parameters (MEDITS)							
Age class	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	1.6595	6.3385	8.2977	8.5748	7.5039	13.7547	6.4184	8.5738	12.5825	16.6934	13.0631	18.7995	4.9477	8.3646
1	1.2746	3.9825	4.3534	1.8703	2.2258	2.4913	3.1234	4.7249	5.9544	5.0772	3.4079	9.0916	2.8417	3.4108
2	0.3807	1.3448	1.5544	1.1375	1.1305	1.501	1.7562	1.7672	2.6743	3.323	1.1701	5.566	1.5009	0.6964
3	0.2413	1.0028	0.0001	0.1687	0.2086	0.0169	0.2199	0.786	0.3337	0.9488	0.2107	0.3787	0.7323	0.7657
4	0.1763	0.0001	2.727	0.0001	0.2265	0.0001	0.3482	0.0001	0.217	0.0001	0.0001	0.5345	0.0935	0.2285
5	0.0001	0.0214	3.185	0.0001	0.0001	0.0001	0.1726	0.0001	0.2084	0.0001	0.0001	0.0761	0.0001	0.0001
6	0.0001	0.7478	0.7478	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

8.4.4.1.4. Results including sensitivity analyses

The following Table 8.4.4.1.4.1 lists the fishing mortality at age as estimated by XSA.

Table 8.4.4.1.4.1 Fishing mortality at age.

Table 8	Fishing mortality (F) at age														
YEAI	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	FBA
AGE															
0	1.661	2.4842	2.0817	1.9402	1.6993	1.8756	1.7217	1.6707	1.3658	1.3392	1.2904	0.9819	0.8454	0.982	0.9365
1	1.6919	1.4844	1.8174	1.9141	1.6318	1.9423	1.7194	1.7077	2.457	1.9341	1.9136	1.2248	1.664	2.1466	1.6785
2	1.3184	1.0167	1.5298	1.6877	1.7245	2.2767	1.4554	1.5469	1.7835	1.5091	1.2089	0.8974	1.7421	1.5415	1.3937
3	0.8772	1.1335	1.3654	1.751	2.0124	3.1256	1.4938	1.2473	2.0839	1.463	1.8847	1.379	1.5127	1.7004	1.5307
4	0.8489	1.6219	1.3981	1.5629	1.2423	1.4494	0.5618	1.6483	2.4026	0.828	0.0231	1.7093	1.3271	1.2945	1.4436
5	0.3703	0.9145	3.7677	3.5384	0.3231	1.6602	1.2147	0.5821	0.8633	1.1247	0.1004	0.1178	0.5343	0.5767	0.4096
6	1.0396	1.23	1.9921	2.1236	0	2.1274	0	1.3202	1.9324	1.3554	1.0306	1.1581	1.5034	1.4465	1.3693
+gp	1.0396	1.23	1.9921	2.1236	0	2.1274	0	1.3202	1.9324	1.3554	1.0306	1.1581	1.5034	1.4465	
0 FBAR	1.0149	1.2574	1.4311	1.6672	1.6597	2.2839	1.1704	1.4808	2.09	1.2667	1.0389	1.3285	1.5273	1.5121	
FBAR 0-2	1.5571	1.6618	1.8096	1.8473	1.6852	2.0315	1.6322	1.6418	1.8688	1.5941	1.4710	1.0347	1.4172	1.5567	

The following Table 8.4.4.1.4.2 provides the summary of stock parmeters as estimated by XSA.

Table 8.4.4.1.4.2 Summary of stock parmeters as estimated by XSA.

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 2- 4	FBAR 0-2
	Age 0							
1995	293785	8080	2397	3850	1.6065	0.9998	1.0149	1.557
1996	908556	10813	1920	5187	2.7021	1.0203	1.2574	1.662
1997	396054	7367	1581	3770	2.3852	1.0001	1.4311	1.810
1998	398448	6669	1148	3286	2.863	0.9847	1.6672	1.847
1999	467937	7646	814	3462	4.2525	0.9898	1.6597	1.685
2000	472647	9220	1024	4497	4.3916	1.0035	2.2839	2.032
2001	340506	6860	928	3269	3.5223	1.0071	1.1704	1.632
2002	353803	6675	1122	3195	2.848	0.997	1.4808	1.642
2003	311571	7230	1077	3411	3.1663	0.9824	2.09	1.869
2004	323751	7742	743	3441	4.6336	0.9877	1.2667	1.594
2005	264061	7369	1005	3363	3.3462	0.9842	1.0389	1.471
2006	240848	10038	1725	3876	2.2466	1.4416	1.3285	1.035
2007	270807	8251	1757	3572	2.0327	0.9452	1.5273	1.417
2008	183396	7207	1455	3494	2.4011	0.8691	1.5121	1.557
Arith.								
Mean	373298	7940	1335	3691	3.0284		1.4806	1.6292

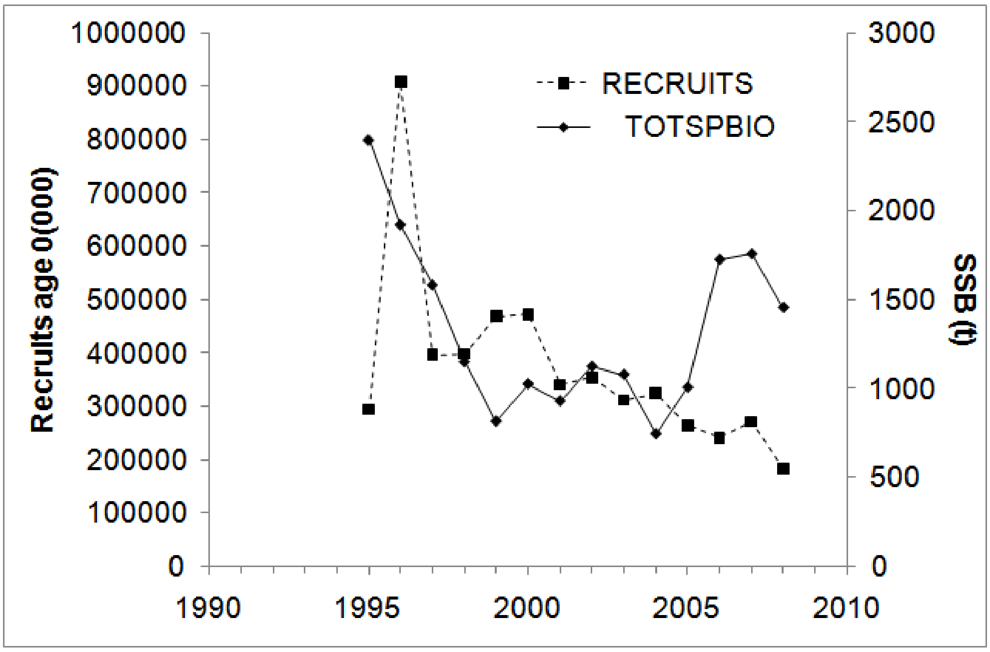


Fig. 8.4.4.1.4.1 Trends in spawning stock SSB and recruits at age 0.

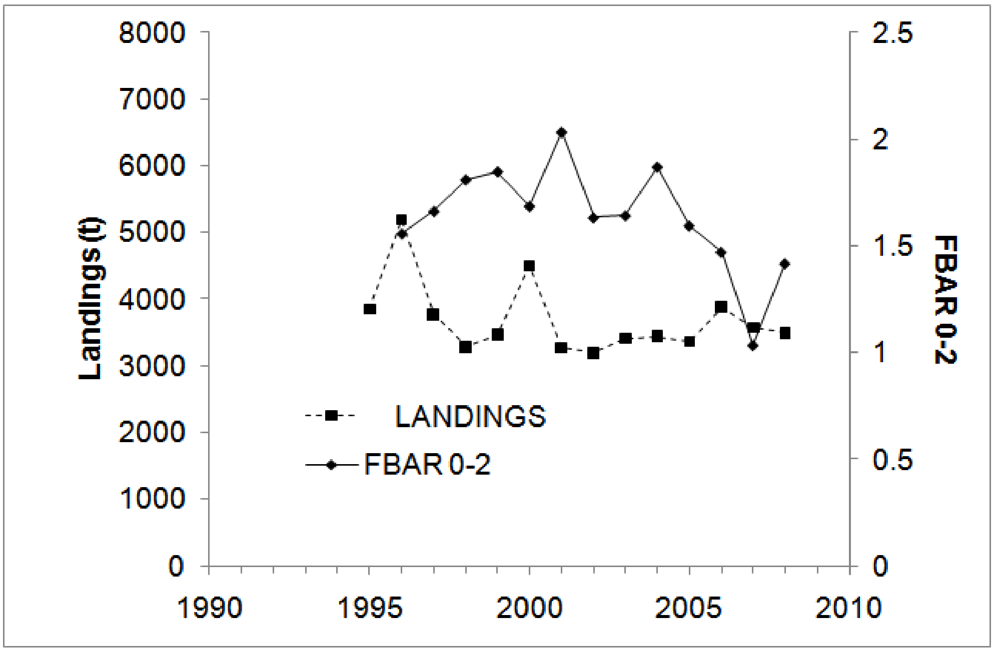


Fig. 8.4.4.1.4.2 Trends in landings and mean fishing mortality over ages 0-2.

Fishing mortality has fluctuated without trend in the average of 1.6 (Fbar 0-2), or 1.5 for Fbar from 2 to 4 age classes. Those values are high, but consistent with “fast growth hypothesis and a mean M = 0.43. The exploitation is concentrated on very low age classes, mainly 0 and 1.

8.4.5.Long term prediction

8.4.5.1. Justification

No forecast analyses were conducted.

8.4.5.2. Input parameters

No forecast analyses were conducted.

8.4.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 06.

8.4.6.Scientific advice

8.4.6.1. Short term considerations

8.4.6.1.1. State of the spawning stock size

Since 2006, SSB has increased from historical lows and varies slighty above average since then.

8.4.6.1.2. State of recruitment

Recruitment has been low in recent years and has decreased to the lowest level observed in 2008.

8.4.6.1.3. State of exploitation

Fishing mortality has fluctuated without a trend at 1.6 (Fbar 0-2), or 1.5 for Fbar for ages 2 to 4. Comparing such estimates with $F_{0.1}$ = 0.16 and F_{max} = 0.23, it can be concluded that the resource is heavily over-exploited, with a high dependence on incoming recruitment.

The continued low abundance of adult fish in the surveyed population and landings indicate a very high exploitation pattern far in excess of those achieving high yields and low risk of fisheries collapse.

8.5. Stock assessment of hake in GSA 07

8.5.1.Stock identification and biological features

8.5.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.5.1.2. Growth

No information was documented during SGMED-09-02.

8.5.1.3. Maturity

No information was documented during SGMED-09-02.

8.5.2.Fisheries

8.5.2.1. General description of fisheries

STECF in 2007 (stock review part II) noted that hake (*Merluccius merluccius*) is one of the most important demersal target species of commercial fisheries in the Gulf of Lions (GFCM GSA 7). In this area, hake is exploited by French trawl, French gillnet, Spanish trawl and Spanish long-line. Around 250 boats are involved in the fishery. According to the official statistics the total annual landings decreased from 2,751 t in 2003 to 1,341 t in 2004 (this was mainly due to the decrease of the French trawlers landings (from 2,024 t to 1,023 t) and of the Spanish trawlers landings (from 207 t to 101 t).

8.5.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.5.2.3. Catches

8.5.2.3.1. Landings

SGMED-09-02 received French landings data for GSA 07 which are listed in Tab. 8.5.2.3.1.1. Otter trawls dominate the landings which in 2008 have increase to previous levels, after a major decrease in 2004 by about half. The data are listed in Table A3.1 of Appendix 3.

No Spanish data for GSA 07 were provided.

Table 8.5.2.3.1.1 French landings (t) by year and major gear types, 2002-2008 as reported through DCF.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
HKE	7	FRA	GNS	177	248	99	255	299	168	111
HKE	7	FRA	LLS	5						
HKE	7	FRA	OTB	2163	2029	1018	995	1011	1277	1898

8.5.2.3.2. Discards

Reported discards through the DCF data call to SGMED-09-02 are listed in Table A3.9 of Appendix 3.However, some values regarding French discards data for bottom trawl appear unreasonable.

8.5.2.3.3. Fishing effort

STECF (stock review part II in 2007) noted that about 250 boats from France and Spain are engaged in the fishery. The trends in fishing effort by year and major gear type is listed in Tab. 8.5.2.3.3.1 only in terms of kW*days.

No Spanish effort data for GSA 07 were provided.

Tab. 8.5.2.3.3.1 Trend in fishing effort (kW*days) for France by major gear types, 2003-2008. No values were reported for 2002.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
kW*days	7	FRA	DRB		701658	498937	1446390	1474302	838511	503036
kW*days	7	FRA	FPO		543235	362280	332514	1039964	803688	384117
kW*days	7	FRA	FYK		439690	918434	633578	383108	438750	358399
kW*days	7	FRA	GNF		2846442	3221150	4273917	4580080	4743557	4085999
kW*days	7	FRA	GNS		896281	869433	749969	307954	458826	116992
kW*days	7	FRA	GTR		2381824	2734374	3335217	5657420	4661238	3519840
kW*days	7	FRA	LA.		671916		131612	170907	144068	128347
kW*days	7	FRA	LLS		919296	662464	634850	1014367	795610	806093
kW*days	7	FRA	MIS		881266	754958	569204	1927473	1093578	1102514
kW*days	7	FRA	OTB		12970505	8450443	5870844	6219184	5938674	5277458
kW*days	7	FRA	OTM		3766550	1330992	1864890	2193060	1144433	931468
kW*days	7	FRA	SB-		272065	145083	60475	364747	291432	304153

8.5.3.Scientific surveys

8.5.3.1. Medits

8.5.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 07 the following number of hauls was reported per depth stratum (s. Tab. 8.5.3.1.1.1).

Tab. 8.5.3.1.1.1. Number of hauls per year and depth stratum in GSA 07, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA07_010-050	12	12	12	15	12	12	12	12	12	13	12	12	12	15	12
GSA07_050-100	32	32	32	38	39	33	33	33	32	38	31	31	33	31	25
GSA07_100-200	10	9	9	9	9	9	10	9	9	10	13	11	10	10	7
GSA07_200-500	6	6	5	6	5	5	6	6	5	5	5	5	5	5	4
GSA07_500-800	8	7	5	5	4	5	6	5	4	5	6	5	6	5	5

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

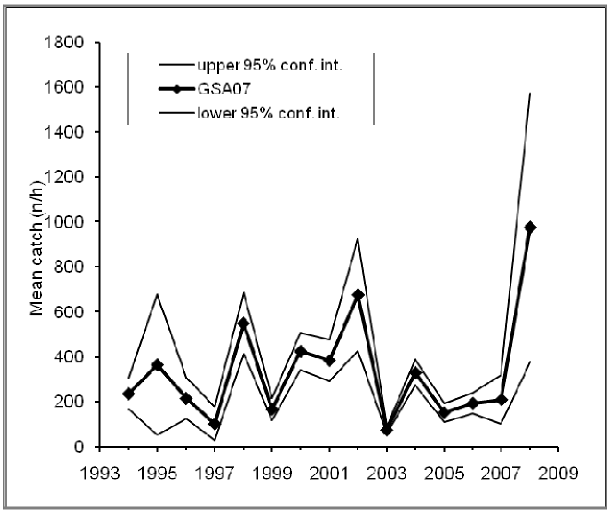
8.5.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.5.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 07 was derived from the international survey Medits. Figure 8.5.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 07.

The estimated abundance and biomass indices do not reveal any significant trends since 1994. However, the recent abundance indices since 2005 appear low. In 2008 the highest values have been observed. The analyses of Medits indices are considered preliminary.



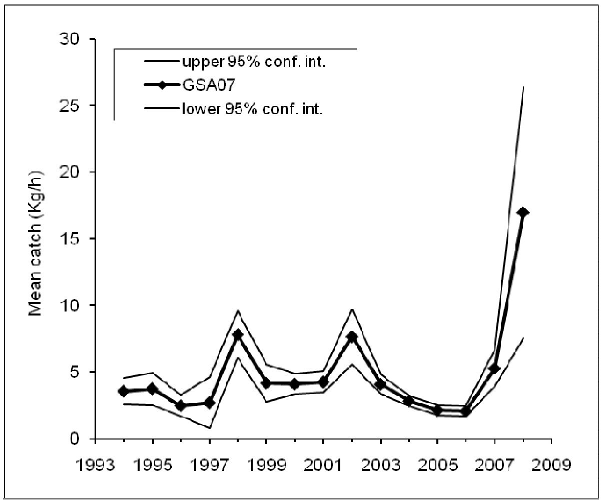


Fig. 8.5.3.1.3.1 Abundance and biomass indices of hake in GSA 07.

8.5.3.1.4. Trends in abundance by length or age

The following Fig. 8.5.3.1.4.1 and 2 display the stratified abundance indices of GSA 07 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

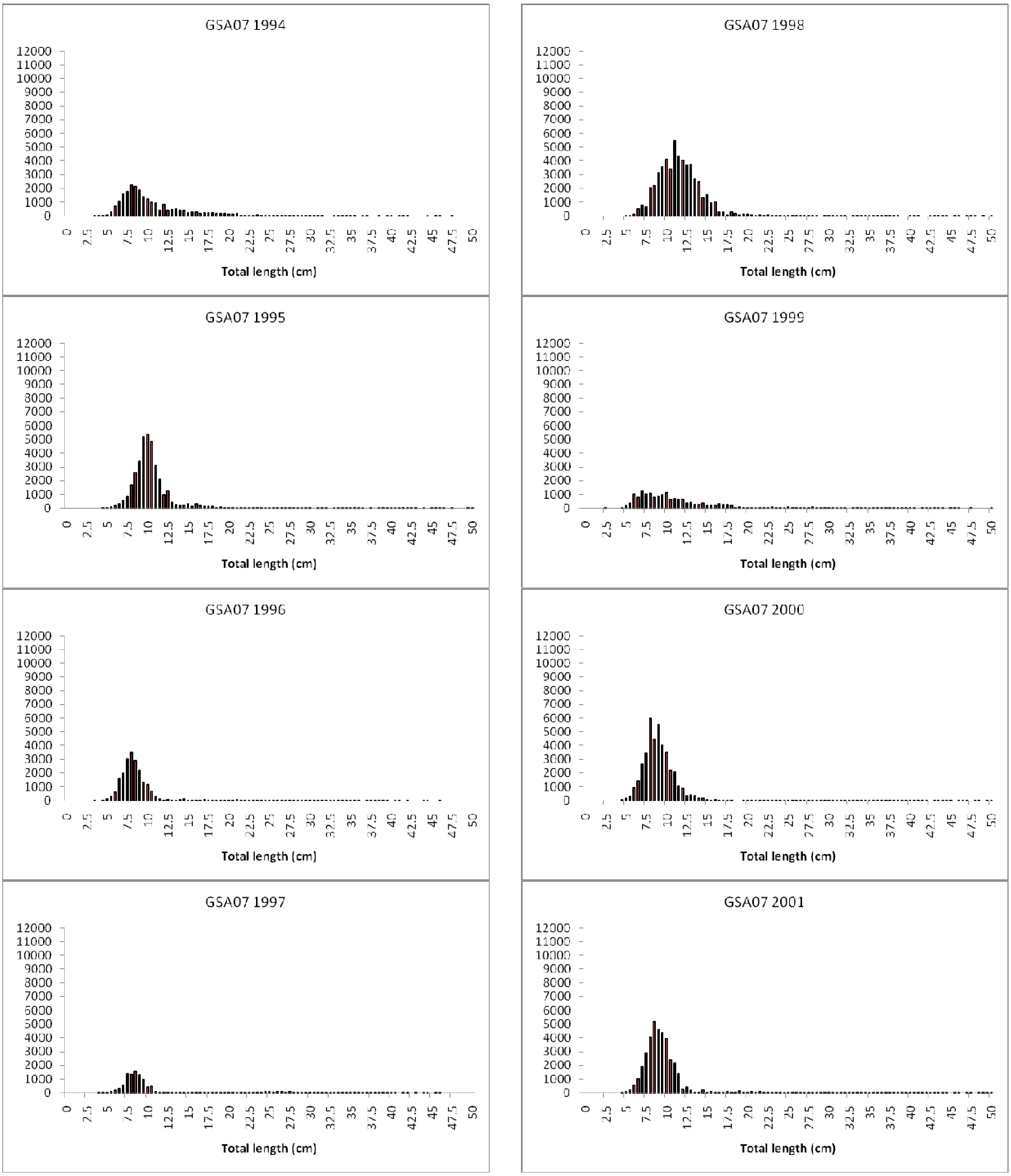


Fig. 8.5.3.1.4.1 Stratified abundance indices by size, 1994-2001.

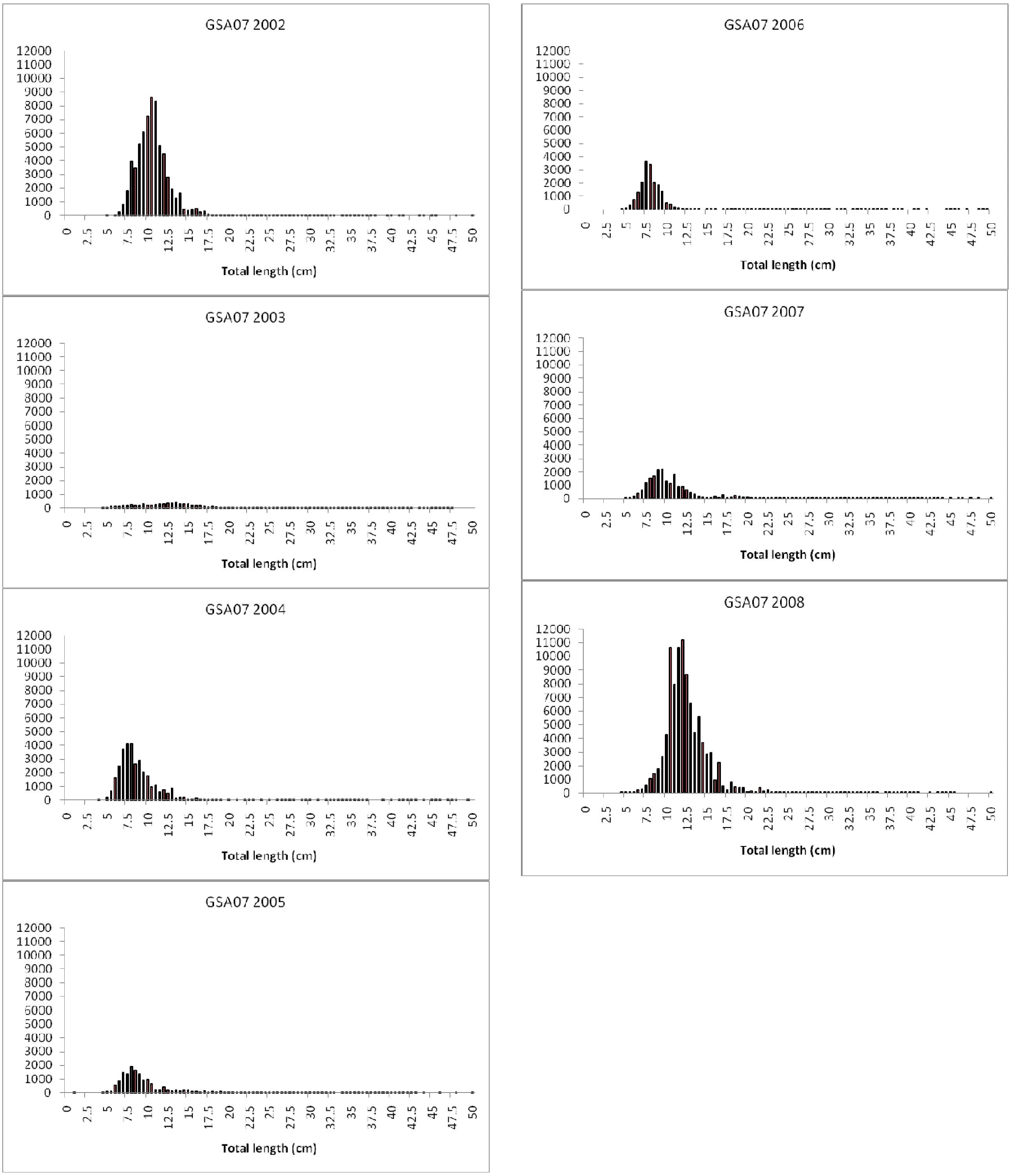


Fig. 8.5.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.5.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.5.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.5.4.Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.5.5.Long term prediction

8.5.5.1. Justification

No forecast analyses were conducted.

8.5.5.2. Input parameters

No forecast analyses were conducted.

8.5.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 07.

8.5.6.Scientific advice

8.5.6.1. Short term considerations

8.5.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.5.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.5.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.6. Stock assessment of hake in GSA 08

8.6.1. Stock identification and biological features

8.6.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.6.1.2. Growth

No information was documented during SGMED-09-02.

8.6.1.3. Maturity

No information was documented during SGMED-09-02.

8.6.2. Fisheries

8.6.2.1. General description of fisheries

No information was documented during SGMED-09-02.

8.6.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.6.2.3. Catches

8.6.2.3.1. Landings

No information was documented during SGMED-09-02.

8.6.2.3.2. Discards

No information was documented during SGMED-09-02.

8.6.2.3.3. Fishing effort

No information was documented during SGMED-09-02.

8.6.3. Scientific surveys

8.6.3.1. Medits

8.6.3.1.1. Methods

Based on the DCF data call, abundance and biomass indices were recalculated. SGMED-09-02 notes that the reported Medits data in GSA 08 only cover the eastern coast of Corsica. In GSA 08 the following number of hauls was reported per depth stratum (s. Tab. 8.6.3.1.1.1).

Tab. 8.6.3.1.1.1. Number of hauls per year and depth stratum in GSA 08, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA08_010-050	4														
GSA08_050-100	6	5	8	4	8	7	5	5		6	6	8	8	5	7
GSA08_100-200	3	5	6	2	5	5	5	5	1	5	5	5	5	4	5
GSA08_200-500	10	11	12	8	12	10	11	10		10	11	11	11	10	12
GSA08_500-800	6	5	4	4	5	6	5	5		4	5	5	5	5	5

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.6.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.6.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 08 was derived from the international survey Medits. SGMED-9-02 notes that the reported Medits data in GSA 08 only cover the eastern coast of Corsica. Figure 8.6.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 08.

The estimated abundance and biomass indices do not reveal any significant trends since 1994. However, the recent abundance and biomass indices since 2006 appear high but are subject to high variation (uncertainty). The analyses of Medits indices are considered preliminary.

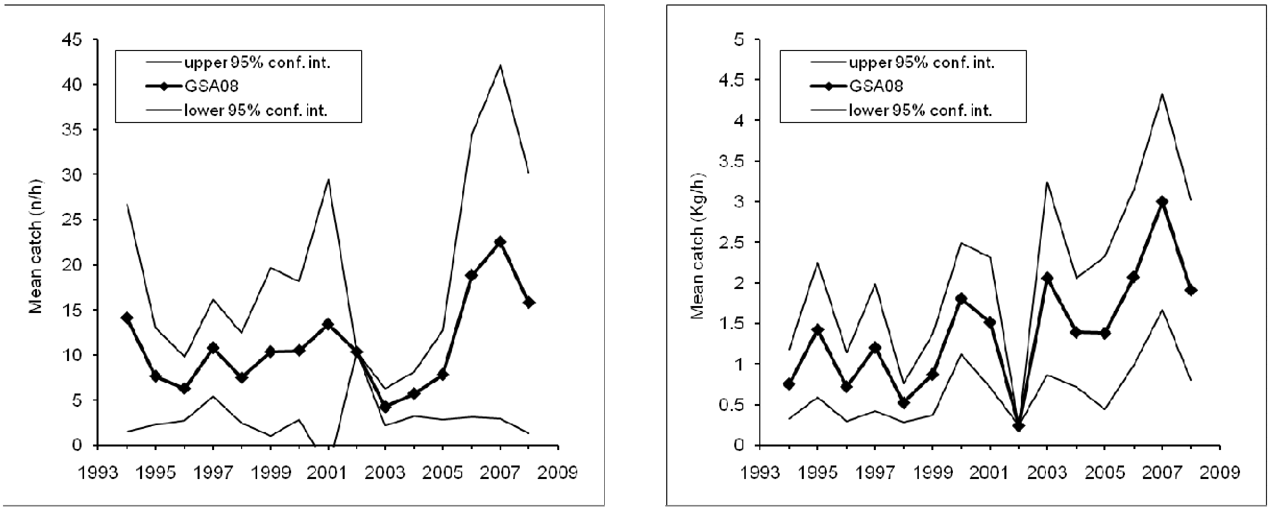


Fig. 8.6.3.1.3.1 Abundance and biomass indices of hake in GSA 08.

8.6.3.1.4. Trends in abundance by length or age

The following Fig. 8.6.3.1.4.1 and 2 display the stratified abundance indices of GSA 08 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

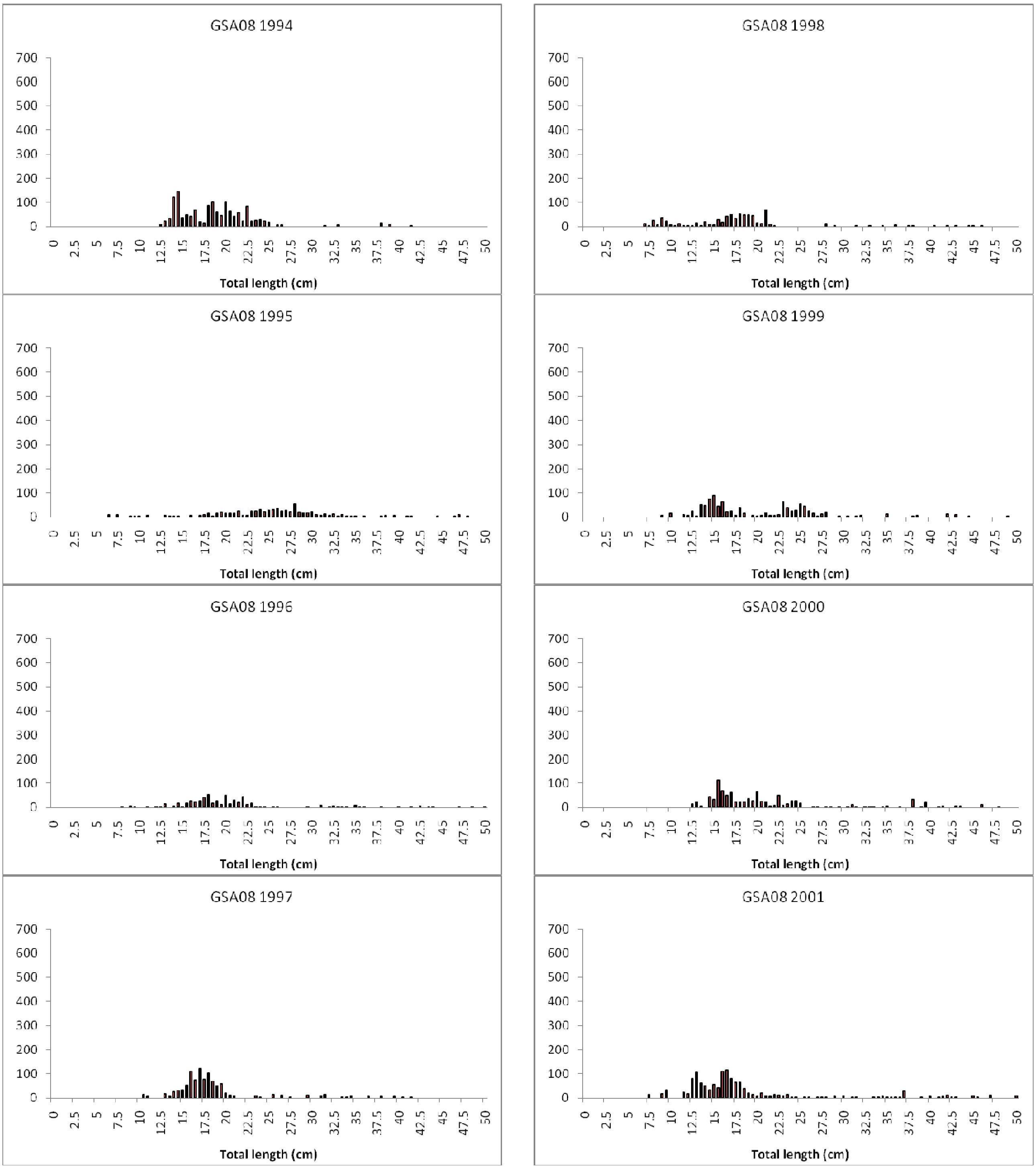


Fig. 8.6.3.1.4.1 Stratified abundance indices by size, 1994-2001.

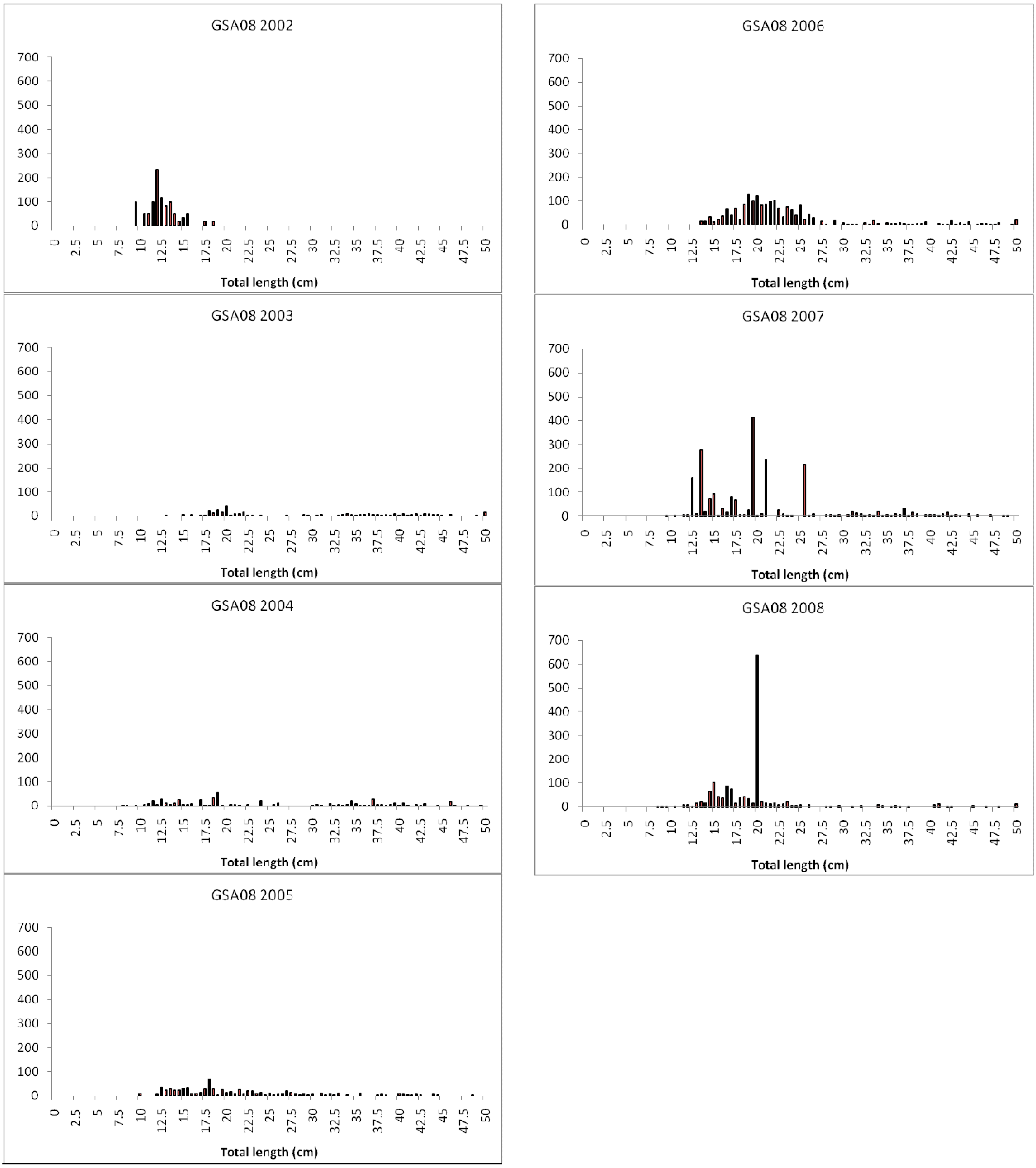


Fig. 8.6.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.6.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.6.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.6.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.6.5. Long term prediction

8.6.5.1. Justification

No forecast analyses were conducted.

8.6.5.2. Input parameters

No forecast analyses were conducted.

8.6.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 08.

8.6.6. Scientific advice

8.6.6.1. Short term considerations

8.6.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.6.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.6.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.7. Stock assessment of hake in GSA 09

8.7.1.Stock identification and biological features

8.7.1.1. Stock Identification

Due to a lack of information about the structure of hake population in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries.

Hake is distributed in the whole area between 10 and 800 m depth (Biagi et al., 2002; Colloca et al., 2003). Recruits peak in abundance between 150 and 250 m depth over the continental shelf-break and appear to move slightly deeper when they reach 10-cm total length. Crinoid (*Leptometra phalangium*) bottoms over the shelf-break are the main settlement habitat for hake in the area (Colloca *et al*., 2004, 2006; Reale *et al*., 2005). Migration from nurseries takes place when juveniles attained a critical size between 13 and 15.5 cm TL (Bartolino et al., 2008a). Maturing hakes (15-35 cm TL) persist on the continental shelf with a preference for water of 70–100 m depth, while larger hakes can be found in a larger depth range from the shelf to the upper slope. Juveniles show a patchy distribution with some main density hot spots (i.e. nurseries areas) showing a high spatio-temporal persistence (Abella *et al*., 2005; Colloca *et al*., 2006, Jona Lasinio *et al*., 2007; Colloca *et al*., 2008) (Fig. 8.7.1.1.1) in areas with frontal terms and other oceanographic structures that can enhance larval retention (Abella *et al*., 2008).

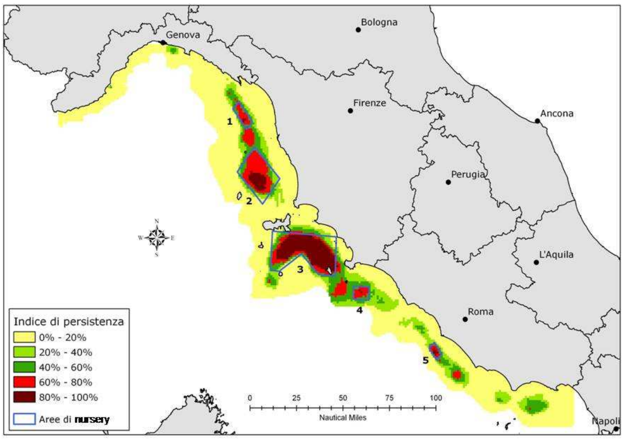
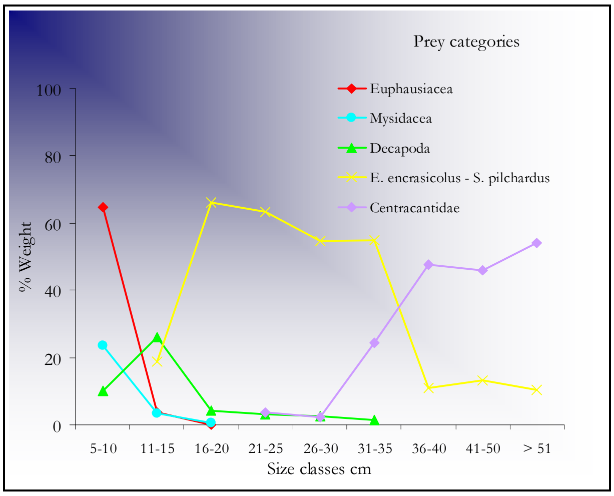


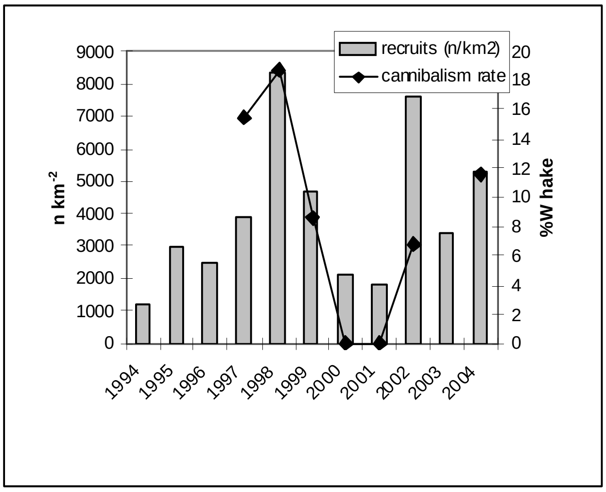
Fig 8.7.1.1.1 Temporal persistence of hake nurseries calculated from MEDITS and GRUND time-series density maps (1994-2005) of juveniles.

Although hakes are demersal fish feeding typically upon fast-moving pelagic preys while ambushed in the water column (Alheit and Pitcher, 1995). There is evidence that hakes feed in mid-water or at the surface during night-time, undertaking daily vertical migrations (Orsi-Relini *et al*., 1989, Carpentieri *et al*., 2008) which are more intense for juveniles. In GSA 09 many different studies are available on hake diet. Results from stomach data collected in the 1996-2001 period can be found in Sartor et al. (2003a) and Carpentieri et al. (2005). Hake diet shifts from euphausids and mysiids, consumed by smaller hake (<16 cm TL), to fishes consumed by larger hake.

Before the transition to the complete ichthyophagous phase (TL> 36 cm) hake shows more generalized feeding habits where decapods, benthic (Gobiidae, *Callionymus* spp.,) and necktonic fish (*S. pilchardus*, *E. encrasicolus*) dominated the diet, whereas cephalopods had a lower incidence (Fig. 8.7.1.1.2).



A)



B)

Fig. 8.7.1.1.2 A) Hake diet composition in GSA 09 by size class (from Carpentieri *et al.*, 2005). B) Relationships between recruitment and cannibalism rate (proportion by weight, %W, of hake in hake stomachs).

Estimation of cannibalism rate has been provided for the southern part of the GSA (Latium, EU Because project). Cannibalism increased with size and can be considered significant for hakes between 30 and 40 cm TL (up to 20% by weight in diet) and seems to relate closely to hake recruitment density and level of spatial overlapping.

Consumption rate has been estimated for juveniles and piscivorous hakes. Daily consumption of juveniles, calculated in proportion of body weight (%BW), varied between 5 (July) and 5.9 % BW (Carpentieri et al., 2008). The estimated relative daily consumption for hake between 14 and 40 cm, estimated using a bioenergetic approach (EU Because project) TL was between 2.9 and 2.3 BW%.

8.7.1.2. Growth

Juvenile growth rate was estimated to be about 1.5 cm.month^{-1} using daily growth increments on otoliths (Belcari et al., 2006). According to this growth rate, hake reaches an average length of about 18 cm TL at the end of the first year. According to these observations, the growth of hake in the GSA 09 seems to follow the pattern estimated in the NW Mediterranean (Garcia-Rodriguez and Esteban, 2002) adopting the hypothesis that two rings are laid down on otoliths each year. This new interpretation of otolith ring patterns returns a growth rate (L_∞ = 103.9, K/year = 0.212, t_0 =0.031) almost double than that assumed in the past.

As showed in the Fig. 8.7.1.2.1, cohorts obtained through age slicing of LFDS MEDITS data according to fast growth parameters, can be consistently followed during time, while a less reliable pattern was obtained using parametersconform to the slow growth hypothesis.

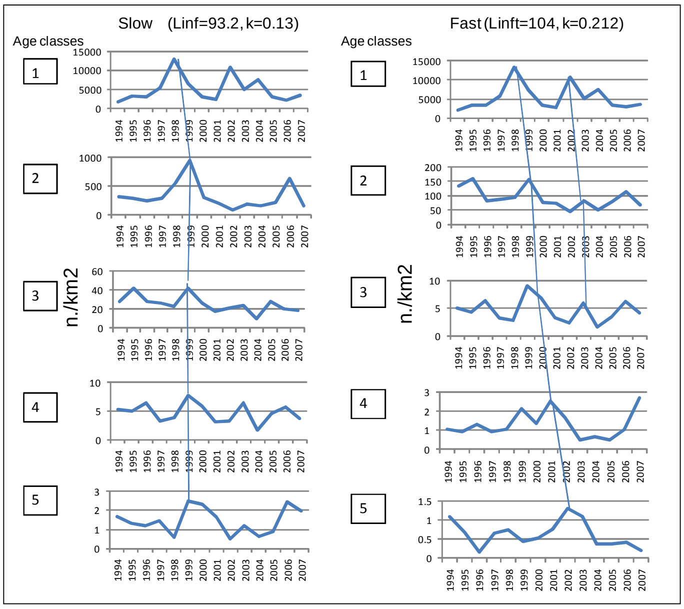


Fig. 8.7.1.2.1 Trends in abundance of age classes obtained using age slicing according to two different sets of growth parameters on MEDITS data.

8.7.1.3. Maturity

The catchability of hake spawners to the Mediterranean trawl nets is rather limited. Either the distribution of adults which are more abundant on deeper or untrawable grounds, or the ability of larger fish to avoid capture have been claimed as causes of the observed extremely reduced catch of adult hake by trawlers in the Mediterranean (Abella *et al.*, 1997). Also during trawl surveys (MEDITS and GRUND) the catch rate of mature specimens was very low, reducing the possibility of use trawl survey data to explore patterns in gonad development as well as the relationships between growth rate and maturation processes.

Large size hake are targets of a specifically targeted gillnet fishery carried out by several vessels working in the southern part (northern and central Tyrrhenian Sea) of the GSA 09 (Sartor *et al.*, 2001a).

Reproductive biology and fecundity of hake have been studied in northern Tyrrhenian Sea (Biagi *et al.*, 1995; Nannini *et al.*, 2001; Recasens *et al.*, 2008) by monthly samplings of adults caught by trawling and gillnets.

Females in advanced maturity stages, spawning and partial post-spawning are present all year round, but reproductive activity is concentrated from January to May, with two peaks of spawning in February and May. The presence of hake spawners seems to be more concentrated in the southern part of GSA 09.

Female length at first maturity was estimated at 35 cm TL in northern Tyrrhenian Sea (Recasens *et al.*, 2008). This value is consistent with the observations obtained from trawl surveys over the Latium (Colloca, pers. comm.) reporting first maturity from 31 to 37 cm TL for females and from 21 to 25 cm TL for males.

Batch fecundity was about 200 eggs per gonad-free female gram, with asynchronous oocyte development (Recasens *et al.*, 2008).

8.7.2.Fisheries

8.7.2.1. General description of fisheries

Hake is among the most important component of bottom trawlers targeting a species complex and is the demersal species providing the highest landings and incomes for the GSA 09. The analysis of available information suggests that about 90% of landings of hake are obtained by bottom trawl vessels; the remaining fraction is provided by artisanal vessels using set nets, in particular gillnets.

The trawl fleet of GSA 09 at the end of 2006 accounted for 361 vessels (Tab. 8.7.2.1.1).

The main trawl fleets of GSA 09 are present in the following continental harbours: Viareggio, Livorno, Porto Santo Stefano (Tuscany), Fiumicino, Terracina, Gaeta (Latium).

Tab. 8.7.2.1.1 Technical characteristics of the trawl fleet of GSA 09.

N. of boats	361
GT	13.191
kW	75.514
Mean GT	36.5
Mean kW	209.2

As concerns fishing activity, the majority of bottom trawlers of GSA 09 operate daily fishing trips with only some vessels staying out for two-three days and especially in summer.

Hake fishing grounds comprise all the soft bottoms of continental shelves and the upper part of continental slope. Fishing pressure shows some geographical differences inside the GSA 09 according to the consistency of the fleets and the characteristics of the bottoms.

The artisanal fleets, according to the last official data (end of 2006), accounted for 1,309 vessels that operate in several harbours along the continental and insular coasts. Of these, about 50 vessels, mainly located in some harbors of the GSA 09 (e.g. Marina di Campo, Ponza, Porto Santo Stefano), utilize gillnets and target medium and large-sized hakes (larger than 25 cm TL) especially from winter to summer.

8.7.2.2. Management regulations applicable in 2009

- Fishing closure for trawling: 45 days in late summer (not every year have been enforced)
- Minimum landing sizes: EC regulation 1967/2006: 20 cm TL for hake.
- Cod end mesh size of trawl nets: 40 mm (stretched, diamond meshes) till 30/05/2010. From 1/6/2010 the existing nets will be replaced with a cod end with 40 mm (stretched) square meshes or a cod end with 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.
- Two small No Take Zones (“Zone di Tutela Biologica”, ZTB) are present inside the GSA 09; one off the Giglio Island (50 km^2, northern Tyrrhenian Sea) another off Gaeta, (125 km^2, central Tyrrhenian Sea). Bottom fishing was not allowed in the two ZTB. A recent regulation of the Italian Ministry of Agricultural, Food and Forestry Policies established that fishing activities can be carried out in these two areas from July 1st to December 31st.

8.7.2.3. Catches

8.7.2.3.1. Landings

In the last seven years the total landings of hake of GSA 09 fluctuated between 1,000 to about 2,300 tons (Fig. 8.7.2.3.1.1).

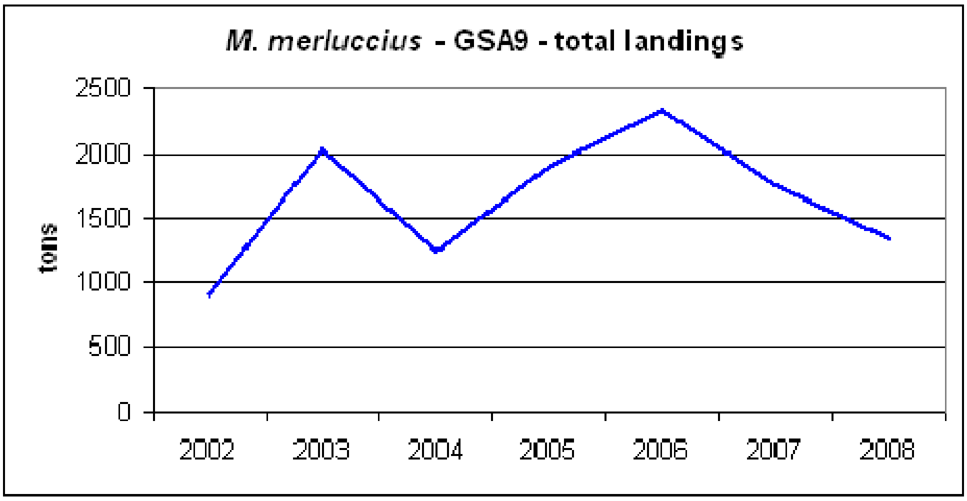


Fig. 8.7.2.3.1.1 Landings of hake (all gears) in the GSA 09, from 2002 to 2008 (DCR official data).

Due to huge concentration of hake juveniles in GSA 09, trawl landings were traditionally dominated by small sized specimens; they are basically composed by 0+ and 1+ age class individuals. Gillnet fishery lands mostly 2+ and 3+ fishes, as shown, as an example, by the two following histograms (Fig. 8.7.2.3.1.2).

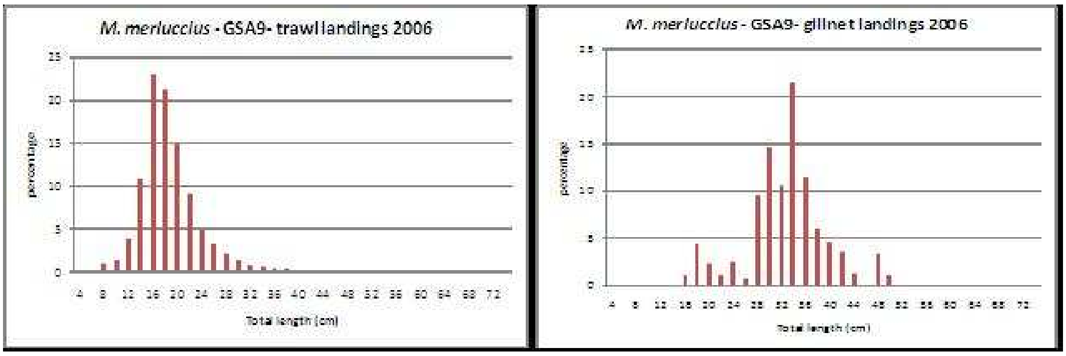


Fig. 8.7.2.3.1.2 Size structure of the landings of hake provided in 2006 by otter trawling and by set nets in the GSA 09 (DCR official data).

The following Table 8.7.2.3.1.1 lists the landings data of Hake in GSA 09 coming from the Data Collection Regulation, by major gear types.

According to the STECF-SGMED-09-02 scientist's knowledge, DCR landing data for GSA 09 give an overstimation of the amount derived from the set nets. This aspect underlines both the need of some improvements of the data collection, paying particular attention to the sampling design and the importance of a routinely check made by experts of the official data.

Table 8.7.2.3.1.1 Landings (t) by year and major gear types, 2002-2008 as reported through DCF. Figures for 2002 and 2003 are obviously wrong. Data are listed in Table A3.1 in Appendix 3.

AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
9	ITA	DTS	508	1148	540	1040	1180	1026	914
9	ITA	HOK			1	2	38		5.06
9	ITA	PGP	154	659	626	858	1112	727	410
9	ITA	PMP	236	258	16	19			
9	ITA	PTS	7	15	12				
			905	2080	1195	1919	2330	1753	

8.7.2.3.2. *Discards*

Several EU and national projects carried out in GSA 09 highlighted the problem of discard of hake by trawl fisheries. High quantities of small sized hakes are routinely discarded, especially in summer and on the fishing grounds located near the main nursery areas of the species (Fig. 8.7.2.3.2.1).

Due to the introduction of the EU Regulations on MLS a progressive increase of the size at which 50% of the specimens caught was discarded has been observed in these last years: from about 11 cm TL in 1995 (Sartor *et al*., 2001b), to about 17 cm TL in 2006 (De Ranieri, 2007). In the last years this size is even increasing (Sartor, pers. obs.) This phenomenon might be also explained with the reduction of the fishing pressure on the nursery areas of this species.

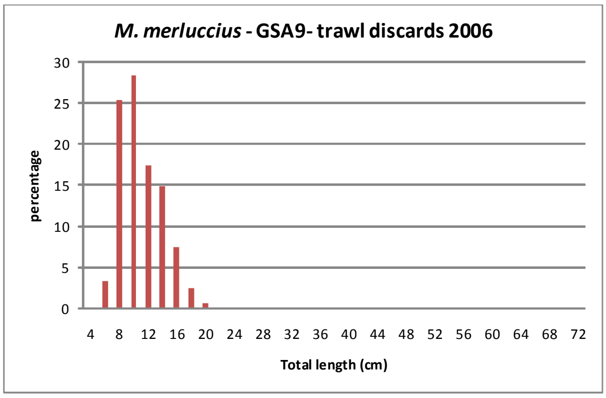


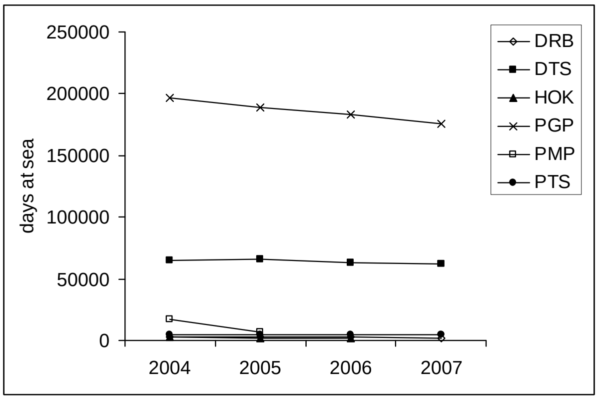
Fig. 8.7.2.3.2.1 Size structure of the hake discarded by the trawl fleets operating in the GSA 09 in 2006 (DCR official data).

Reported discards through the DCR data call to SGMED-09-02 amount 467 t in 2006 for trawlers. The data are listed in Table A3.9 of Appendix 3.

8.7.2.3.3. *Fishing effort*

The fishing capacity of the GSA 09 has shown in these last 20 years a progressive decrease; from 1996 to 2006 the number of bottom trawlers of GSA 09 decreased of about 30%.

The total fishing days carried out by all the GSA 09 trawlers varied from about 65,000 in 2004 to about 63,000 in 2006 (Fig. 8.7.2.3.3.1), a little decrease of the mean number of fishing days/year per vessel was observed in this period, from 187 to 177.



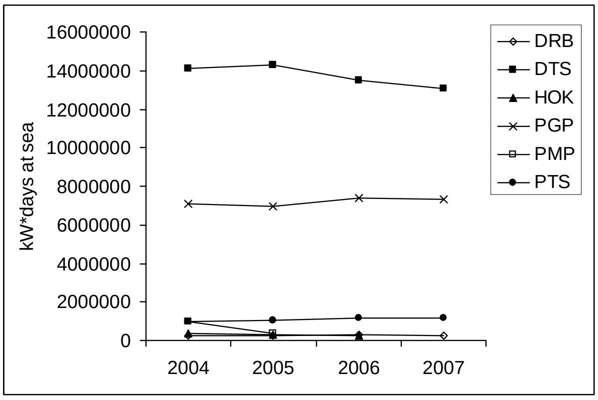


Fig. 8.7.2.3.3.1 Effort trends (days and kW*days) by major fleets, 2004-2007. The data are listed below and in Tables A3.10 and A3.12 of Appendix 3.

Tab. 8.7.2.3.3.1 Effort trends (kW*days) by major fleets as reported through DCF, 2002-2007 (no data available in 2008), s. Tab. A3.10-12 of Appendix 3.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
kW*days	9	ITA	DTS	14583556	14671042	14130070				
KW*DAYS	9	ITA	FPO					1448	15787	
KW*DAYS	9	ITA	GND				273248	223990	146786	
KW*DAYS	9	ITA	GNS				3668438	2989348	3630165	
KW*DAYS	9	ITA	GTR				3392406	3459956	2528382	
kW*days	9	ITA	HOK			376470				
KW*DAYS	9	ITA	LLD				653659	816400	453585	
KW*DAYS	9	ITA	LLS				426713	357010	99478	
KW*DAYS	9	ITA	LTL					6081	2128	
KW*DAYS	9	ITA	MIS				352334	80944		
KW*DAYS	9	ITA	OTB				14351906	12112028	12809257	
kW*days	9	ITA	PGP	6504001	6925653	7060573				
kW*days	9	ITA	PMP	4715565	4051809	984241				
KW*DAYS	9	ITA	PS				1097509	934012	922193	
KW*DAYS	9	ITA	PTM					4671		
kW*days	9	ITA	PTS	1312412	1333245	947166				
KW*DAYS	9	ITA	SB-SV				950710	751142	550250	
SUM				27115534	26981749	23498520	25166923	21737030	21158011	

8.7.3.Scientific surveys

8.7.3.1. MEDITS

8.7.3.1.1. Methods

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 09 the following number of hauls were reported per depth stratum (s. Tab. 8.7.3.1.1.1).

Tab. 8.7.3.1.1.1. Number of hauls per year and depth stratum in GSA 09, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA09_010-050	19	18	18	18	19	18	18	18	13	13	13	14	13	13	13
GSA09_050-100	19	20	18	19	18	19	20	20	15	15	15	14	16	16	13
GSA09_100-200	35	35	36	35	35	35	34	34	26	27	26	27	25	26	28
GSA09_200-500	32	33	33	36	32	36	37	35	27	27	27	28	29	33	30
GSA09_500-800	31	30	32	28	30	28	27	29	24	22	21	20	20	17	18

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

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

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

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

Where:
- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.7.3.1.2. Geographical distribution patterns

According to recent studies (Orsi Relini et al., 2002), the density of hake recruits concentrations in nursery areas in GSA 09 is by far higher than that of the other GSAs of the western Mediterranean and, probably, also of the other Mediterranean GSAs (Fig. 8.7.3.1.2.1).

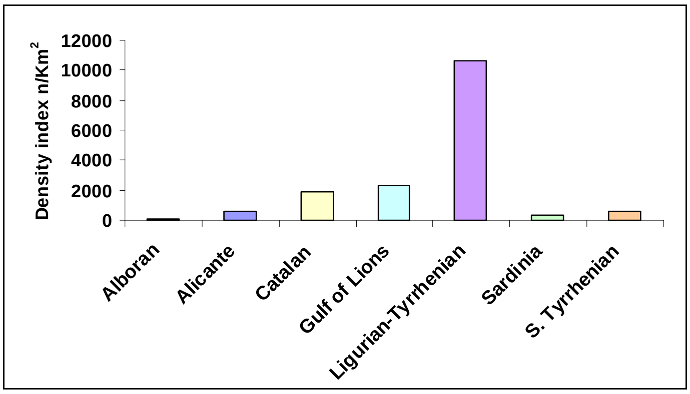


Fig. 8.7.3.1.2.1 MEDITS density indices of the hake recruits (<12 cm TL) obtained in different Mediterranean GSAs (from Orsi-Relini et al., 2002, modified).

Generalized additive models were developed to investigate hake recruitment dynamics in the Tyrrhenian Sea in relation to spawner abundance and selected key oceanographic variables. Thermal anomalies in summer, characterized by high peaks in water temperature, revealed a negative effect on the abundance of recruits in autumn, probably due to a reduction in hake egg and larval survival rate. Recruitment was reduced when elevated sea-surface temperatures were coupled with lower levels of water circulation. Enhanced spring primary production, related to late winter low temperatures could affect water mass productivity in the following months, thus influencing spring recruitment. In the central Tyrrhenian a dome-shaped relationship between wind mixing in early spring and recruitment could be interpreted as an "optimal environmental window" in which intermediate water mixing level played a positive role in phytoplankton displacement, larval feeding rate and appropriate larval drift (Bartolino *et al*., 2008b) (Fig. 8.7.3.1.2.2).

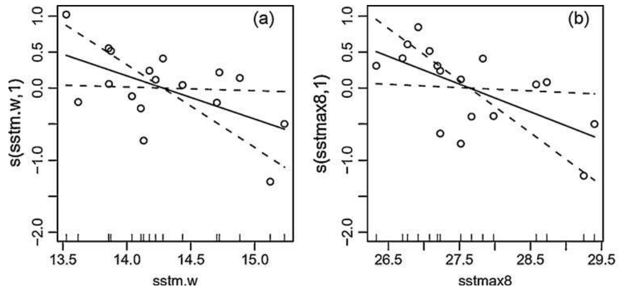


Fig. 8.7.3.1.2.2 Effects of: (a) sstm.w, (b) sstmax8 and (c) wmix4 on hake recruitment in the central Tyrrhenian (from Bartolino et al., 2007).

The temporal trend in spatial distribution of hake > 26 cm TL showed a clear reduction of distribution area, particularly in the Tyrrhenian part of the GSA (GRUND data, Fig. 8.7.3.1.2.3).

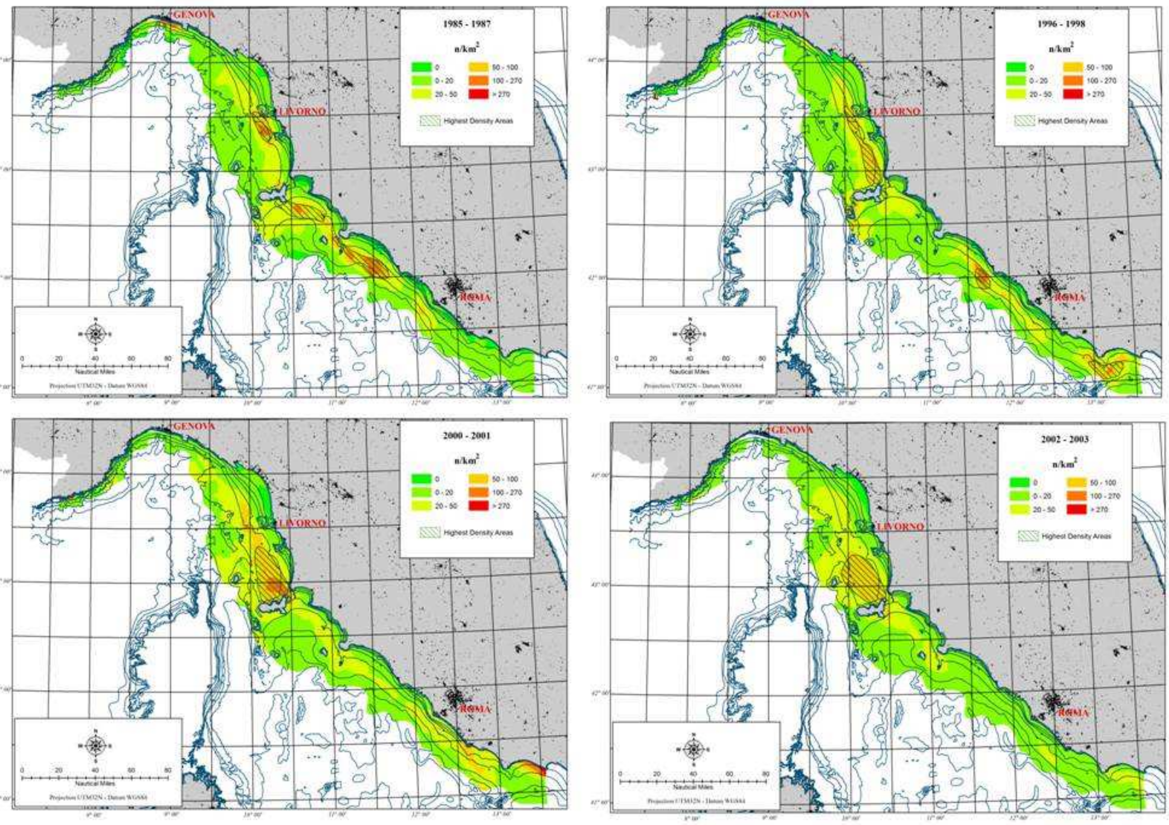


Fig. 8.7.3.1.2.3 Distribution of hakes larger than 26 cm TL in 1985-87, 1996-98, 2000-01, 2002-03.

8.7.3.1.3. Trends in abundance and biomass

The national GRUND trawl survey (Relini, 1998) has been performed out along the Italian coasts in addition to MEDITS. It has been carried out since 1985, with some years lacking (1988, 1989 and 1999, 2007). Sampling is random stratified, except in the period 1990-93 where a different sampling design, based on transects, was applied. Locations of stations were selected randomly within each stratum in the period 1985-87, while starting from 1996, the same stations were sampled the following years. Therefore from 1994 in Italy two trawl surveys are regularly carried out each year: MEDITS, in spring, and GRUND, in autumn. The two surveys provide integrate pictures on different seasons, allowing to monitor the most important biological events (recruitment, spawning) for the majority of the demersal species.

Figure 8.7.3.1.3.1 shows the density and biomass indices of hake obtained from 1994 to 2008; no evident trends are present.

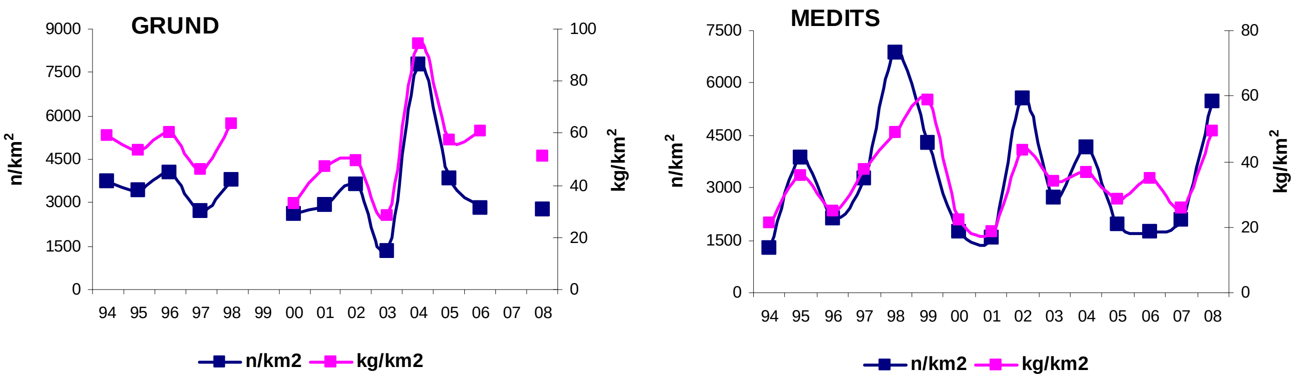


Fig. 8.7.3.1.3.1 Density and biomass indices of hake according to the GRUND and MEDITS surveys.

Figure 8.7.3.1.3.2 displays the re-estimated trend in hake abundance and biomass in GSA 09 (kg/h) based on the MEDITS DCR data call. Both MEDITS trends presented are similar without any long term trend.

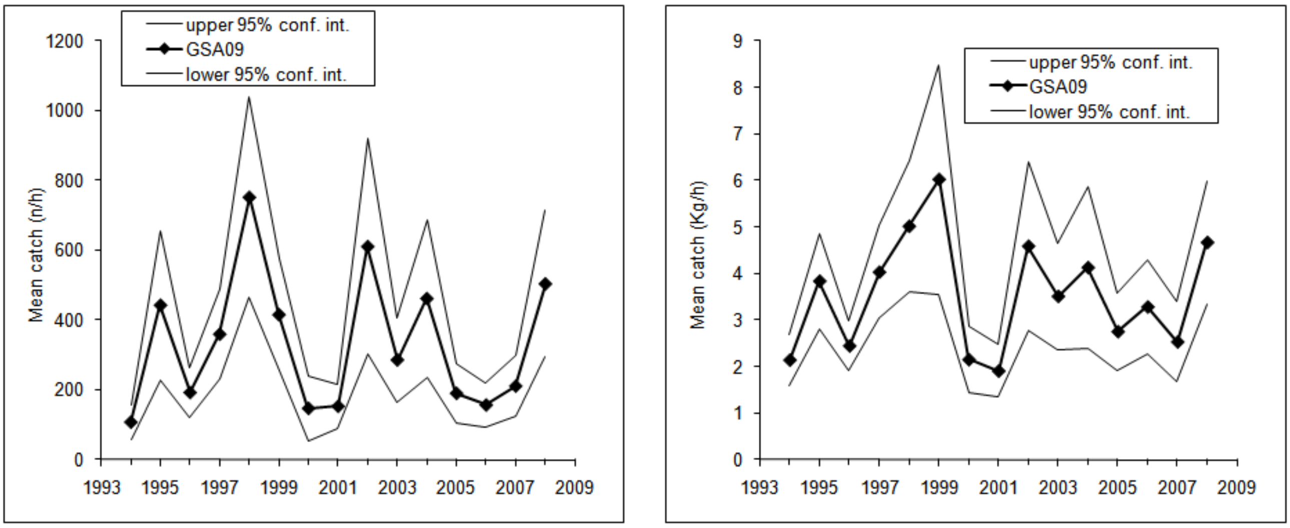


Fig. 8.7.3.1.3.2 Abundance and biomass indices of hake in GSA 09.

8.7.3.1.4. Trends in abundance by length or age

The following Fig. 8.7.3.1.4.1 and 2 display the stratified abundance indices of GSA 09 in 1994-2001 and 2002-2008.

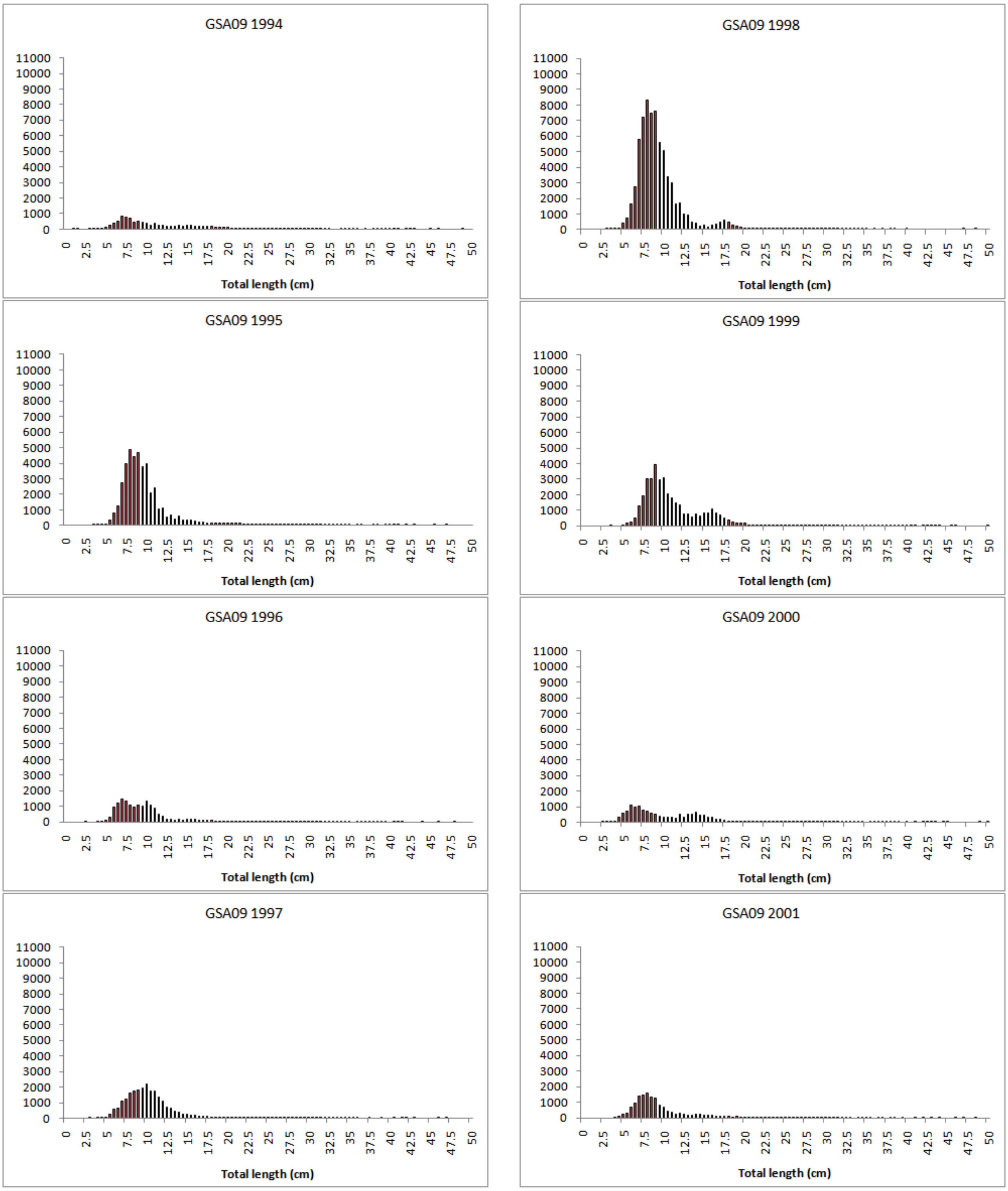


Fig. 8.7.3.1.4.1 Stratified abundance indices by size, 1994-2001.

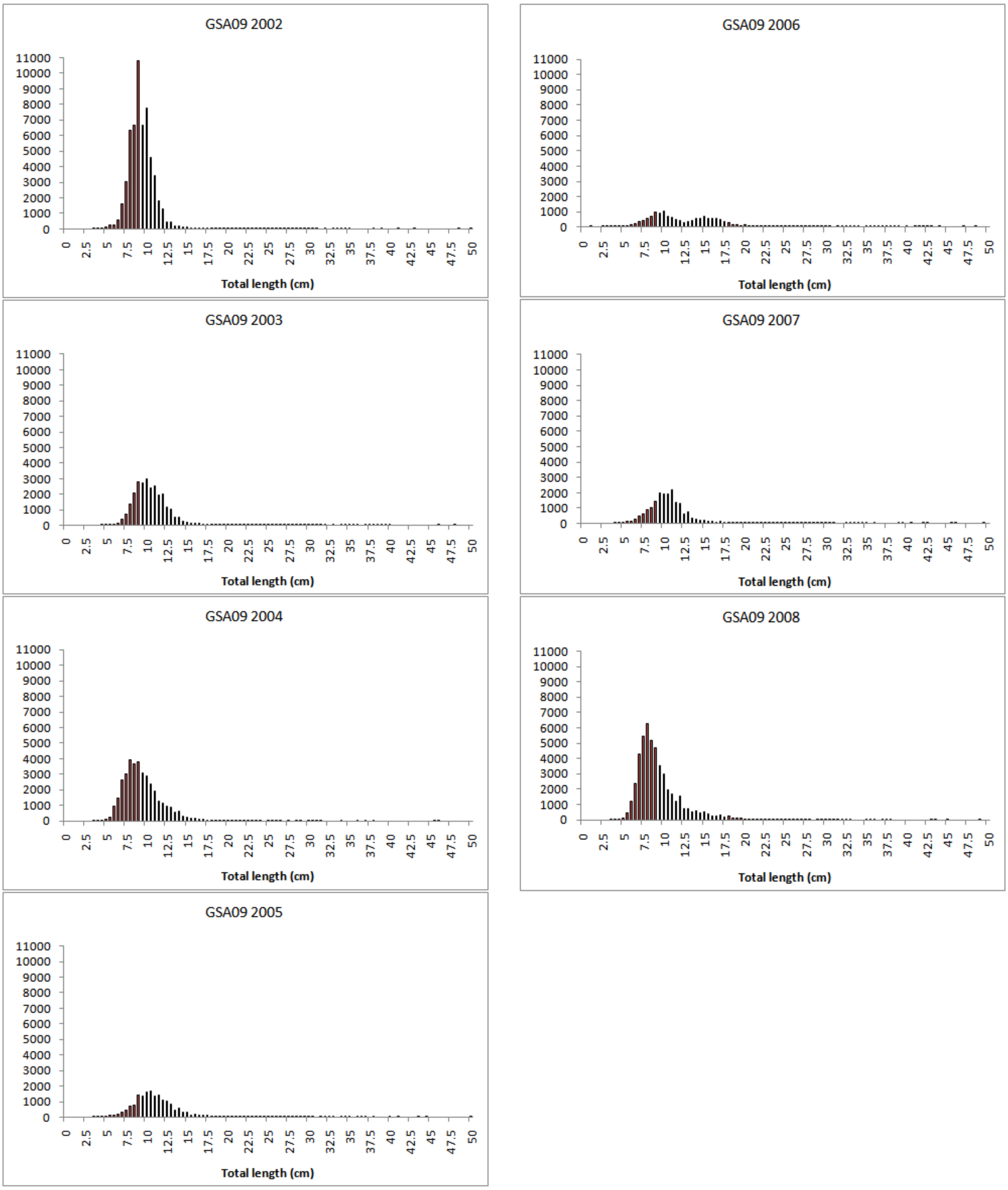


Fig. 8.7.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.7.3.1.5. Trends in growth

No analyses were conducted.

8.7.3.1.6. Trends in maturity

No analyses were conducted.

8.7.4. Assessment of historic stock parameters

Due to its importance as demersal resource, hake has been object of several assessments in the GSA 09 (Reale *et al*., 1995; Fiorentino et al., 1996; Ardizzone *et al*., 1998; Abella *et al*., 1999; 2007; Colloca *et al*., 2000). These results are published and regularly updated in the GFCM SAC sheets. The assessments, often performed with different approaches in different periods or in different subareas of the GSA 09, showed substantially convergent results.

The hake in the GSA 09 seems to be in a "chronic" overexploitation, as shown by the results of the analytical models (reference points as F_{max}, $F_{0.1}$ and SSB_{curr}/SSB_0). Also the production models based on total mortality provided total mortality estimates greater than the mortality corresponding to the maximum biological production (ZMBP).

A growth overfishing situation was detected, with excessive fishing mortality on 0+ and 1+ age classes. The values of the SSB_{curr}/SSB_0 ratio are always lower than 0.1.

As concern the STECF-SGMED-09-02, two new assessments were produced. The main results are presented below.

8.7.4.1. Method 1: Trends in LPUE

As concerns the Landings per Unit of Effort, quite long time series are available for some important fleets operating in this GSA 09.

8.7.4.1.1. Justification

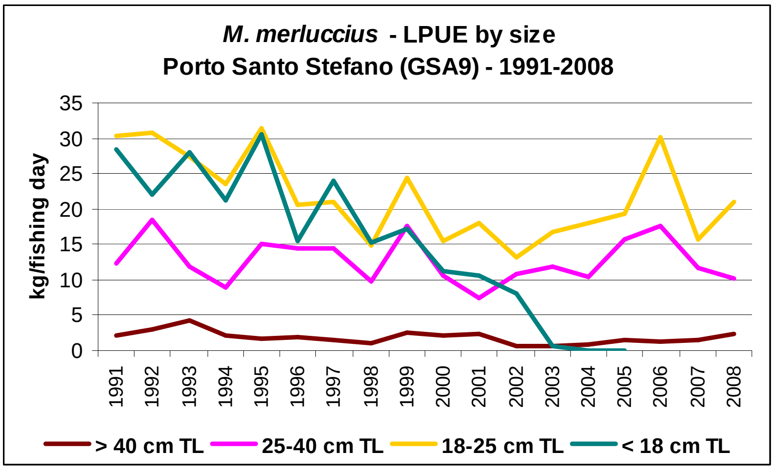
Trends in LPUE may provide insight into trends in stock size. SGMED-09-02 recommends that technological creep should be considered when trends in LPUE are interpreted.

8.7.4.1.2. Input parameters

These data come from independent monitoring activities performed by the research institutes working in the GSA.

8.7.4.1.3. Results

As an example, the LPUE evolution in the period 1991-2008 is reported in Fig. 8.7.4.1.3.1. LPUE showed a continuous decreasing trend till 2004 while LPUE remained substantially stable in the last four years. The decrease in LPUE is mainly due to a change in fishing pattern experienced by the local fleets: the progressive disappearance of the smallest specimens from the landings is the effect of the introduction of the EU Regulations (1626/94 and 1967/06) concerning MLS (20 cm TL for hake). Also a progressive reduction of fishing pressure on the nursery areas is occurring in the last years, especially on the northern fishing grounds of GSA 09.



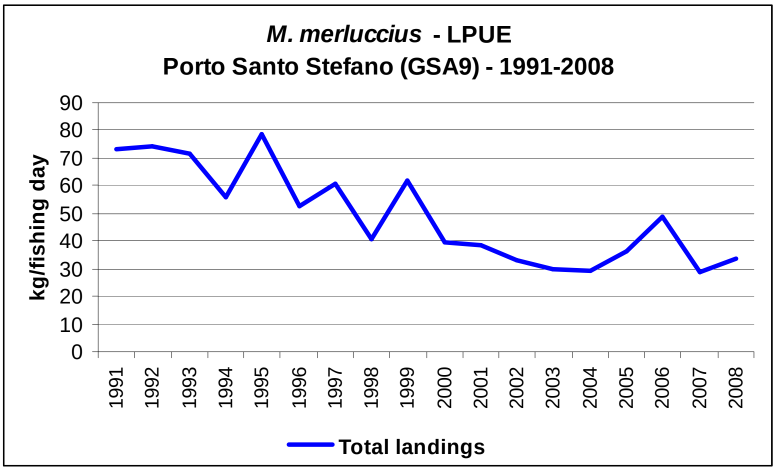


Fig. 8.7.4.1.3.1 Hake LPUE of the Porto Santo Stefano trawl fleet (1991-2008); above: LPUE by size class; below: total LPUE

8.7.4.2. Method 2: SURBA

8.7.4.2.1. Justification

The relatively long time series of data available from the GRUND and MEDITS surveys provided the most useful data sets for analysis. The survey-based stock assessment approach SURBA (Needle, 2003) was used both on MEDITS (1994-2007) and GRUND (1994-2004) data of the hake of GSA 09.

8.7.4.2.2. Input parameters

The following set of parameters was adopted:

Growth parameters (Von Bertalanffy)
L_∞ = 104 (mm, length)
K = 0.2
t_0 = - 0.03
L*W
a = 0.006657
b = 3.028
Natural mortality

M vector Age_1=1.3 , Age_2=0.6, Age_3=0.46, Age_4=0.41, Age_5=0.3
Catchability (q)
q(age 0+) = 0.8, q(age 1+) = 1.0, q(age 2+)=0.7, q(age3+)=0.7, q(age 4+)=0.7
Length at maturity (L50)
L50 = 30 cm
Length of first capture (Lc)
Lc = 12 cm

Tab. 8.7.4.2.2.1 Input parameters used for the SURBA model.

MEDITS

Abundance indices

	Age				
Year	0	1	2	3	4 plus
1994	2062.6	132.4	5	1.1	1.1
1995	3446.2	159.5	4.3	0.9	0.7
1996	3366.3	80.9	6.3	1.3	0.2
1997	5753.5	86.4	3.3	0.9	0.7
1998	13371.3	94.8	2.9	1	0.7
1999	7441.3	156.7	9	2.2	0.4
2000	3371	75.3	6.8	1.4	0.5
2001	2663.1	73.8	3.3	2.5	0.7
2002	10864.1	44.7	2.3	1.7	1.3
2003	5153	82	6	0.5	1.1
2004	7590.5	51.1	1.6	0.6	0.4
2005	3278.9	79.3	3.4	0.5	0.4
2006	2865	114	6.2	1.1	0.4
2007	3559.8	69.1	4.2	2.7	0.2
2008	8529	94.8	3.6	1	1.1

Proportion of mature

	0	1	2	3	4 plus
1994	0	0.012	0.96	1	1
1995	0	0.012	0.92	1	1
1996	0	0.029	0.9	1	1
1997	0	0.02	0.94	1	1
1998	0	0.017	0.89	1	1
1999	0	0.015	0.92	1	1
2000	0	0.026	0.92	1	1
2001	0	0.018	0.96	1	1
2002	0	0.028	0.97	1	1
2003	0	0.025	0.93	1	1
2004	0	0.012	0.9	1	1
2005	0	0.027	0.92	1	1
2006	0	0.021	0.93	1	1
2007	0	0.021	0.93	1	1
2008	0	0.019	0.96	1	1

Mean weight

	0	1	2	3	4 plus
1994	0.00821	0.08569	0.49789	1.24384	3.26085
1995	0.00642	0.09093	0.49083	1.20488	3.03094
1996	0.00648	0.10256	0.45216	1.45539	2.12216
1997	0.00718	0.09718	0.51897	1.33968	2.91788
1998	0.00537	0.09101	0.48922	1.50861	2.63007
1999	0.00933	0.09007	0.45094	1.29203	2.03558
2000	0.00786	0.10492	0.47502	1.15342	2.13631
2001	0.00597	0.09352	0.58	1.18013	2.83928
2002	0.00491	0.11447	0.51342	1.33502	2.52247
2003	0.00734	0.10004	0.50867	1.26864	2.50939
2004	0.0055	0.0868	0.49082	1.34498	2.23332
2005	0.00866	0.10099	0.44792	1.05234	3.44714
2006	0.01326	0.08804	0.50521	1.28601	3.30746
2007	0.00736	0.09644	0.55926	1.22497	1.81089
2008	0.00736	0.09644	0.55926	1.22497	1.81089

GRUND

Abundance indices

	Age				
Year	3	4	5	6	7 plus
1994	4079.4	111.5	6.5	0.1	0.3
1995	3586.1	132	3.2	0.6	0.3
1996	3930	157.9	4.5	1.1	0.6
1997	2729.1	119.9	4	0.9	0.7
1998	3894.3	122.9	4.4	0.7	0.3
1999	3265.3	103.9	5	0.6	0.5
2000	2636.3	84.9	5.6	0.6	0.7
2001	3254.5	126.2	4	0.8	0.4
2002	3901	107.8	3.9	0.8	0.5
2003	1243.5	102.7	4.4	0.7	0.7
2004	7859.5	110.5	3.3	0.9	0.6

Proportion of mature

	0	1	2	3	4 plus
1994	0	0	0.012	0.96	1
1995	0	0.012	0.92	1	1
1996	0	0.029	0.9	1	1
1997	0	0.02	0.94	1	1
1998	0	0.017	0.89	1	1
1999	0	0.015	0.92	1	1
2000	0	0.026	0.92	1	1
2001	0	0.018	0.96	1	1
2002	0	0.028	0.97	1	1
2003	0	0.025	0.93	1	1
2004	0	0.012	0.9	1	1

Mean weight

	0	1	2	3	4 plus
1994	0.013	0.113	0.461	0.875	1.794
1995	0.013	0.112	0.488	0.912	2.885
1996	0.012	0.108	0.454	1.051	1.834
1997	0.013	0.114	0.42	1.095	1.954
1998	0.015	0.105	0.438	1.021	1.952
1999	0.012	0.11	0.449	1.026	1.919
2000	0.009	0.116	0.458	1.032	1.904
2001	0.012	0.112	0.438	1.108	2.359
2002	0.011	0.111	0.445	1.06	2.118
2003	0.015	0.117	0.42	0.986	1.596
2004	0.011	0.112	0.447	1.113	2.245

8.7.4.2.3. Results

The two surveys gave a similar picture for F_{1-3} which shows a clear increasing trend (MEDITS, $p<0.01$) from 0.8 (1994) to 1.6 (2008). Relative SSB decreased significantly (MEDITS, $p<0.01$). Recruitment fluctuated from year to year without a clear temporal pattern during MEDITS. The largest year classes were observed in 1998 and 2008. GRUND showed a more constant pattern in recruitment with the lowest value in 2003 and a high peak in 2004 (Fig. 8.7.4.2.3.1).

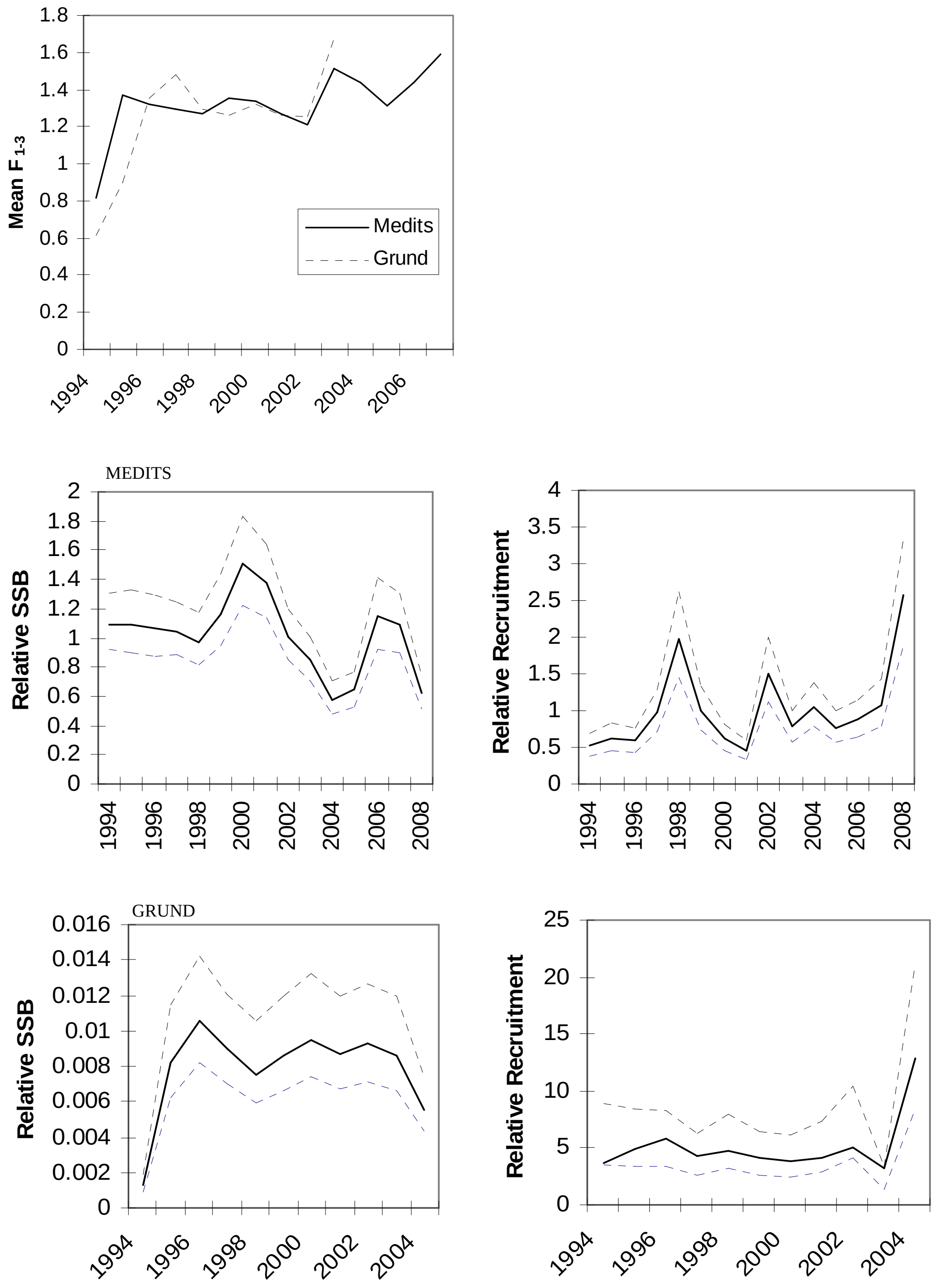
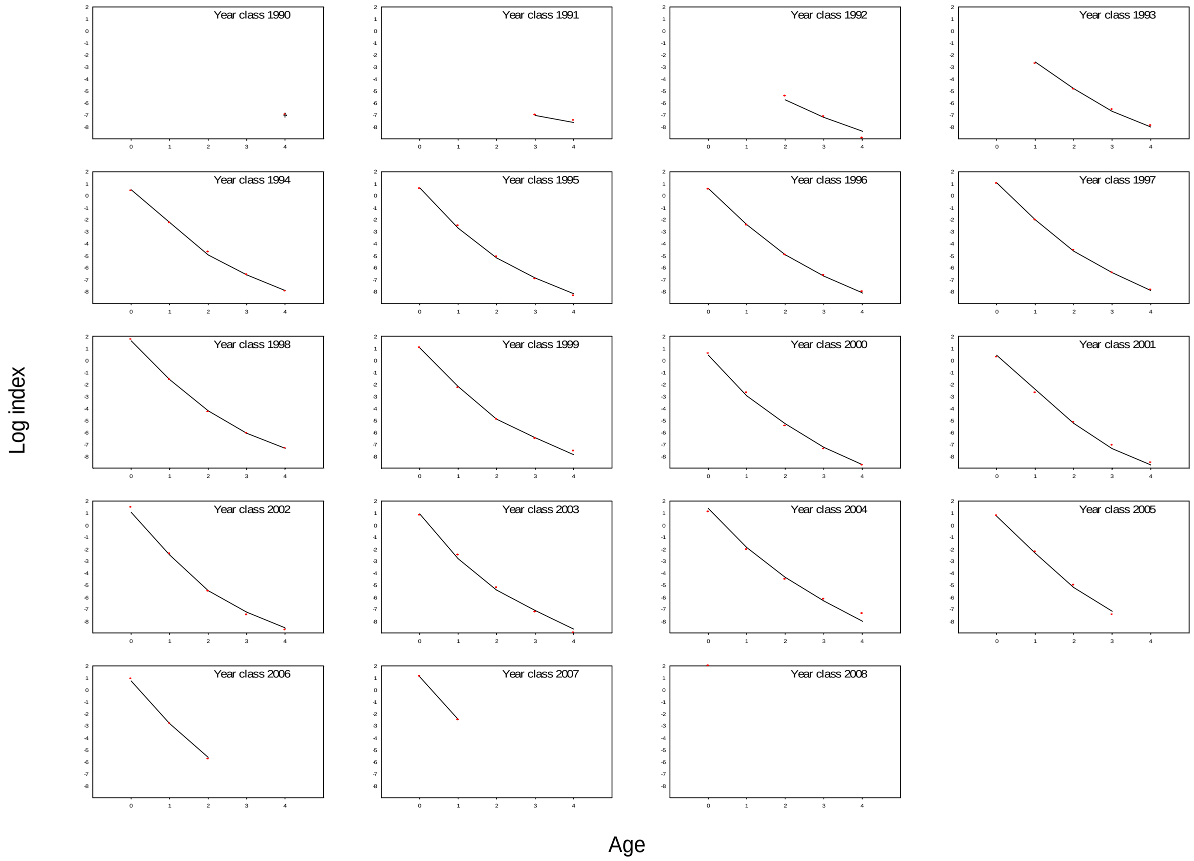


Fig. 8.7.4.2.3.1 MEDITS and GRUND surveys. Estimated trend in F, relative SSB and recruitment using SURBA. 50th percentile of bootstrapped runs (solid line) and 5% and 95% percentiles of bootsrapped runs (dashed lines).

Model diagnostics are shown in the following Fig. 8.7.4.2.3.2 and Fig. 8.7.4.2.3.3.



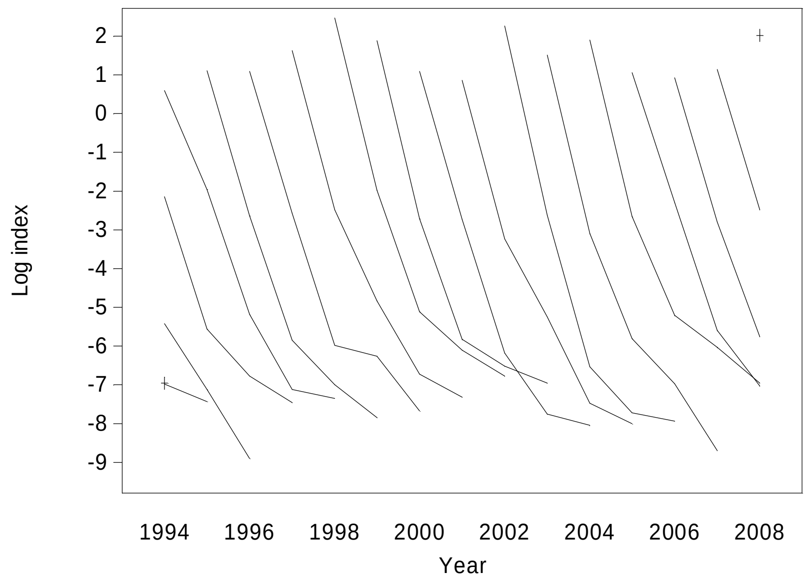


Fig. 8.7.4.2.3.2. Model diagnostic for Surba model in the GSA 09. A) Comparison between observed (points) and fitted (lines) of MEDITS survey abundance indices, for each year. B) Log survey abundance indices by cohort. Each line represents the log index abundance of a particular cohort throughout its life.

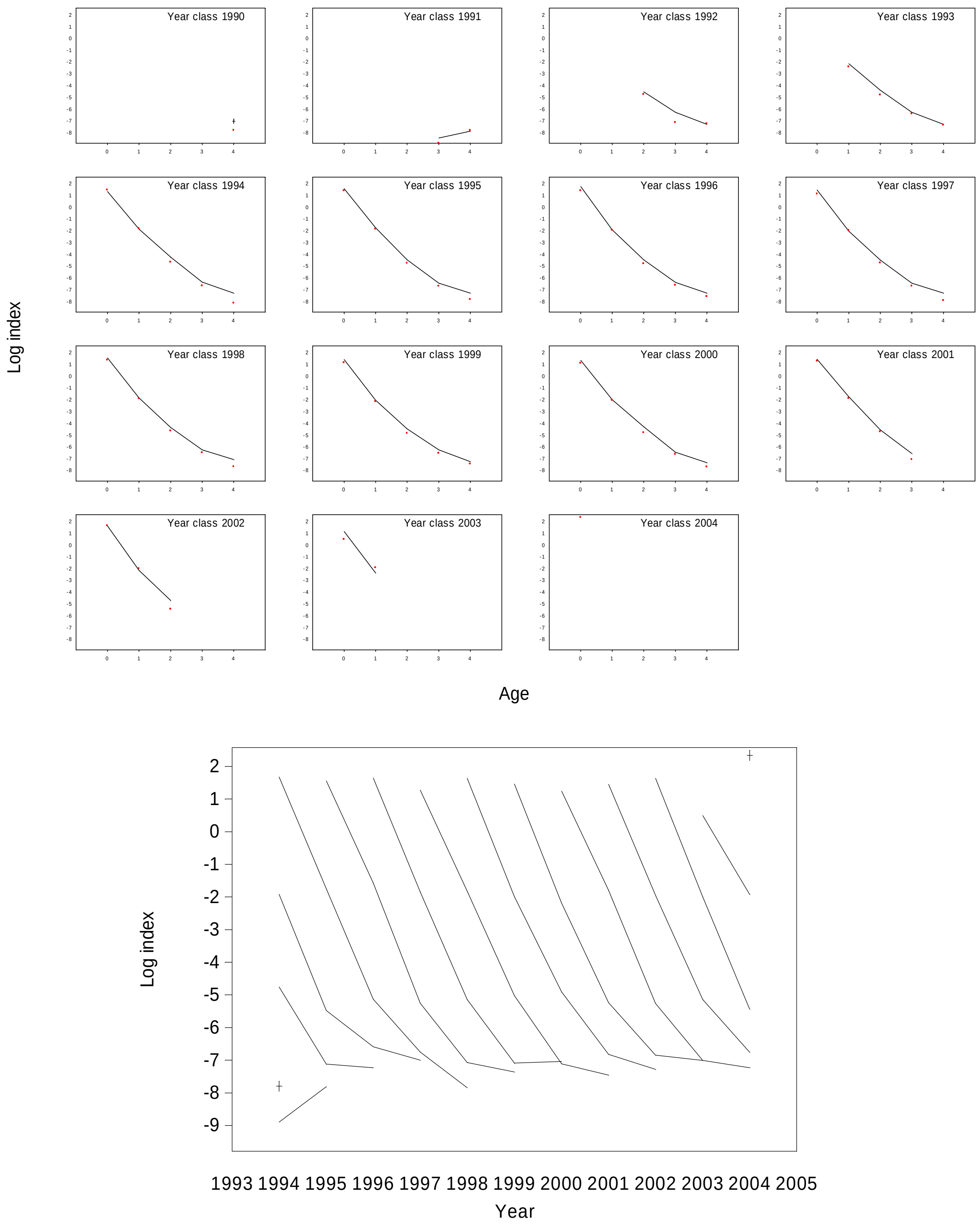


Fig. 8.7.4.2.3.3. Model diagnostic for Surba model in the GSA 09. A) Comparison between observed (points) and fitted (lines) of GRUND survey abundance indices, for each year. B) Log survey abundance indices by cohort. Each line represents the log index abundance of a particular cohort throughout its life.

8.7.4.3. Method 3: LCA on DCR data

8.7.4.3.1. Justification

Assessment was performed using an LCA (VIT software, Lleonart and Salat, 1997) on an annual pseudocohort (year 2006 and 2008).

8.7.4.3.2. Input parameters

Data coming from DCR contained, for GSA 0 9, information on hake landings and the respective size/age structure for the period 2005-2008; discard size structure was also available but only for 2006. Such data were available for the two main fishing gears exploiting hake in GSA 09: trawling and set nets (gillnets). Anyway, the short data series did not allow the use of VPA models.

LCA was performed using VIT software on data of the years 2006 and 2008. For 2006, landing data were “corrected” including the available information on discard. Fig. 8.7.4.3.2.1 shows the size frequency distributions of the landings and discards, by gear.

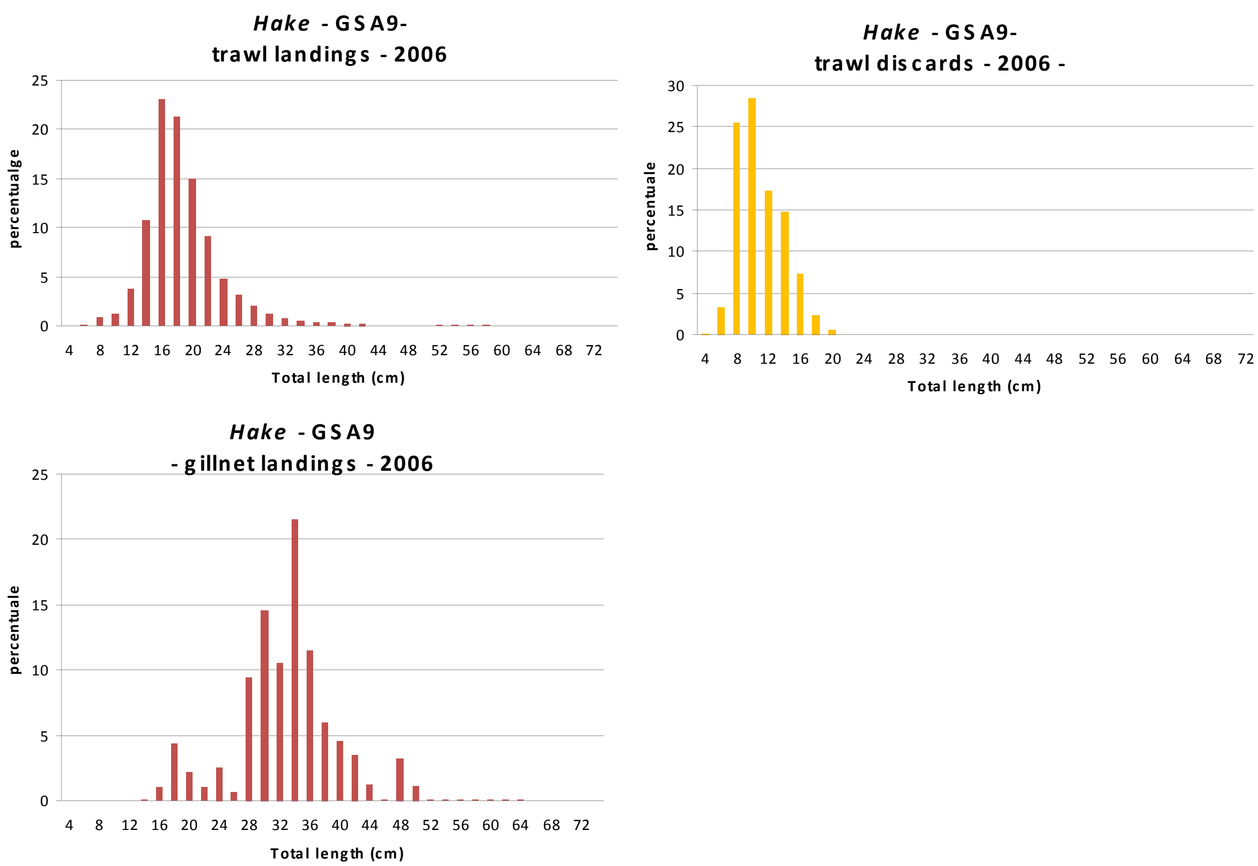


Fig. 8.7.4.3.2.1. Length frequency distributions of the *M. merluccius* landings and discards in 2006 in the GSA 09.

Tab. 8.7.4.3.2.1 shows the input data concerning 2006. The used parameters were the same of the SURBA analysis, including the same M-vector and the same maturity ogive.

Tab. 8.7.4.3.2.1. Input data for LCA of the European hake in GSA 09.

	Data are in percentage	
Total length (CM)	BOTTOM TRAWL Landings + discards	GILLNETS Landings
4	0.0595	0.0000
6	2.6588	0.0000
8	20.4007	0.0000
10	22.8540	0.0000
12	14.5735	0.0000
14	14.0674	0.0638
16	10.6385	1.0094
18	6.2978	4.3835
20	3.5836	2.2102
22	1.8927	1.0732
24	0.9992	2.5426
26	0.6632	0.7016
28	0.4215	9.4687
30	0.2611	14.6433
32	0.1472	10.6057
34	0.1039	21.5582
36	0.0793	11.5010
38	0.0712	5.9670
40	0.0535	4.5749
42	0.0467	3.4882
44	0.0101	1.2645
46	0.0053	0.0638
48	0.0045	3.2331
50	0.0017	1.1370
52	0.0369	0.0638
54	0.0164	0.1276
56	0.0164	0.1276
58	0.0164	0.0638
60	0.0113	0.1276
62	0.0078	0.0801
64	0.0078	0.0801
66	0.0078	0.0401
68	0.0037	0.0010
70	0.0078	0.0000
72	0.0036	0.0000

	BOTTOM TRAWL	GILLNETS
LANDINGS (tons)	1180	131
	BOTTOM TRAWL	
DISCARDS	465	

According to the STECF-SGMED-09-02 scientist's knowledge, DCR landing data for GSA 09 have been adjusted concerning to the contribution of artisanal fishery to the total catch. DCR data gave a proportion of about 60% for trawling and about 40% for set nets. An overestimation of the set nets was detected, so the percentage contribution of set nets was reduced to a more realistic value of 10%, taking into account the expert's knowledge of the GSA 09 fisheries. This aspect underlines both the need of some improvements of the data collection, paying particular attention to the sampling design and the importance of a routinely check made by experts of the official data.

8.7.4.3.3. Results

The general results of LCA highlight an exploitation focused on young age classes, mainly 0+ and 1+, reflecting a growth overfishing state.
As concerns 2006 data a mean value of F(1-3) of 1.24 was estimated, while for the 2008 data a value of 1.53 was obtained.
Fig. 8.7.4.3.3.1 shows, as an example, the results of 2006.

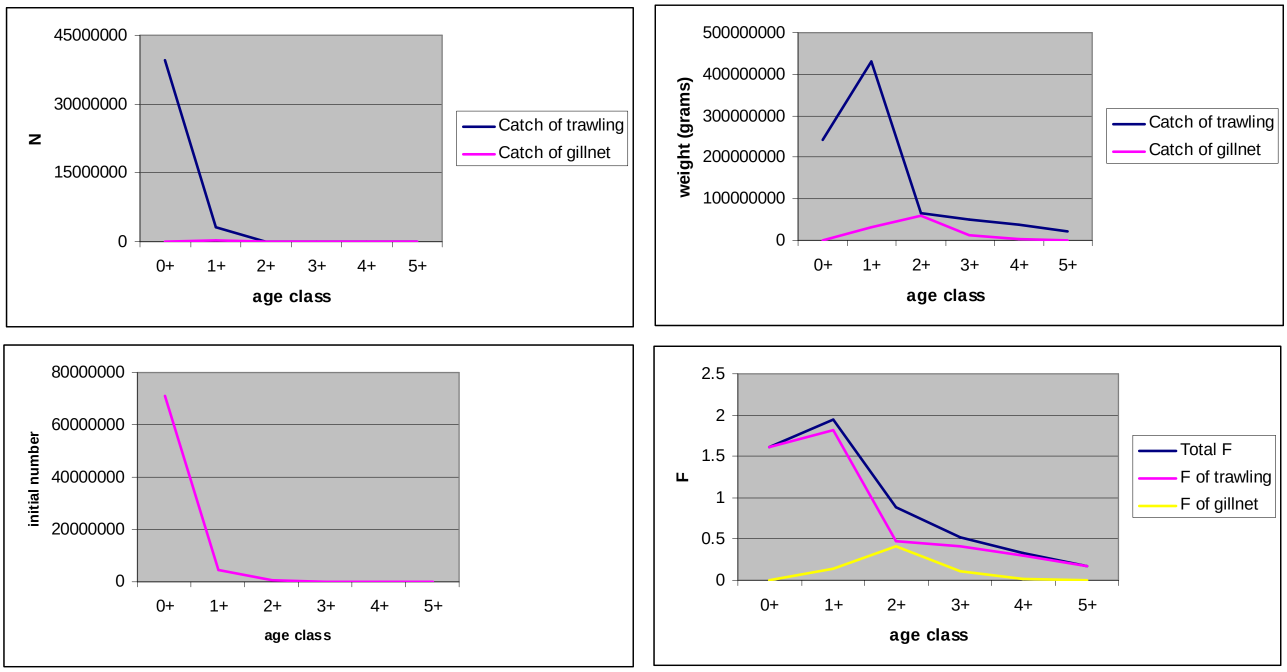


Fig. 8.7.4.3.3.1. LCA outputs: catch in numbers, catch in weight, numbers-at-age and fishing mortality at age of *M. merluccius* in the GSA 09 (2006 data).

8.7.5.Long term prediction

8.7.5.1. Justification

Equilibrium YPR reference points for the stock estimated through the Yield software (Hoggarth *et al.*, 2006) were assessed.

Further YPR analyses were conducted based on the VIT (pseudocohort) results.

8.7.5.2. Input parameters

Equilibrium YPR reference points for the stock were estimated through the Yield software (Hoggarth *et al.*, 2006) assuming recruitment fluctuating randomly around a constant value and 20% uncertainty in input parameters.
The second YPR analyses used the results of VIT (pseudocohort) as inputs.
The used parameters were the same of the SURBA and LCA analyses given above.

8.7.5.3. Results

Yield software quantified uncertainty by repeatedly selecting a set of biological and fishery parameters by sampling from the probability distributions for uncertain parameters set by the user, and then calculating the quantities of interest. In this sampling, it is assumed that each of the uncertain parameters are independently distributed, even though for some biological parameters, this assumption is almost certainly incorrect (Hoggarth *et al*., 2006). F_{max} and F_{ref} , this latter corresponding to F at SSB/initial SSB = 0.30, were assumed as limiting reference points. $F_{0.1}$ was assumed as target reference point. The probability distributions of the three RPs showed a considerable variations (Fig. 8.7.5.3.1). The following mean values were obtained: F_{max} = 0.35; $F_{0.1}$= 0.22 and F_{ref} = 0.28. The maximum predicted values were respectively 0.59 (F_{max}), 0.36 (F_{01}) and 0.41 (F_{ref}). RPs suggest an overfishing situation for the stock considering current F about six times higher than the limit and target RPs F.

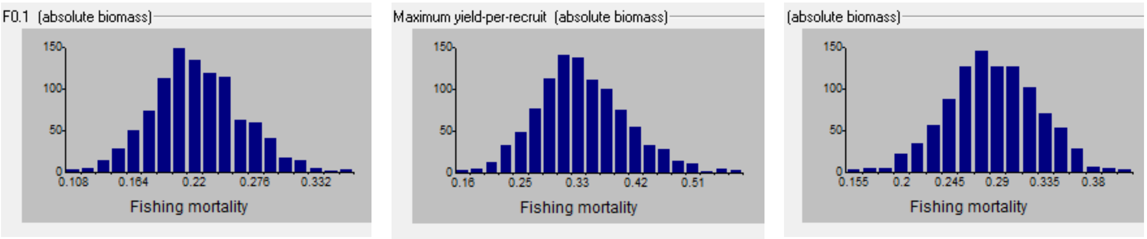


Fig. 8.7.5.3.1 Probability distribution of hake RPs in the GSA9 obtained using the Yield software (age groups 1-5).

Fig. 8.7.5.3.2. shows the YPR analysis performed with VIT software with DCR data of 2006. A similar picture was obtained with 2008 data. With the forecasting routine of VIT, due to the fact of the use of a M vector declining with age, a higher value of F_{max} and $F_{0.1}$ can be obtained and a better exploitation status of the stock is derived, even though still high regarding the mentioned F reference values.

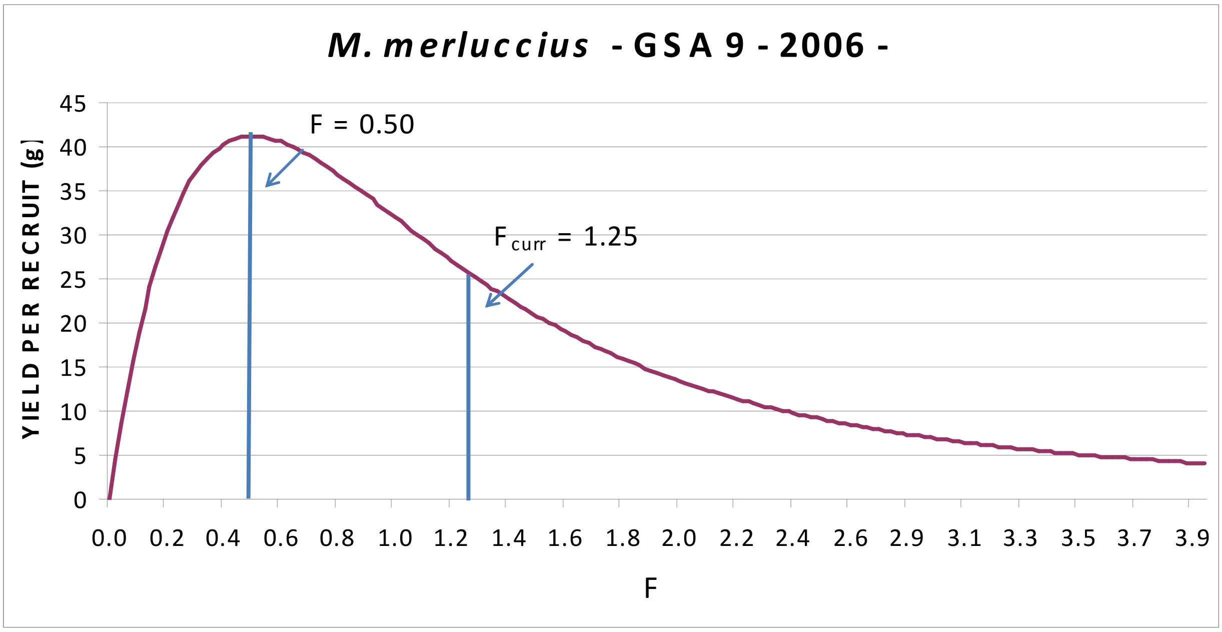


Fig. 8.7.5.3.2 Y/R curves from VIT analyses. F values (age groups 1-5) are also shown.

8.7.6.Scientific advice

8.7.6.1. Short term considerations

8.7.6.1.1. State of the spawning stock size

From the above reported analyses, SSB is likely to amout to 5-10% of the SSB at F_{msy}. STECF SGMED-09-02 underlines that this conclusion could be influenced by the observed exploitation patterns in the surveys and fisheries, which almost exclusively represent the juvenile part of the stock.

8.7.6.1.2. State of recruitment

In recent years recruitment has varied without a clear trend.

8.7.6.1.3. State of exploitation

The stock appears to be heavily overexploited and F needs a consistent reduction from the current F of 1.2-1.7 (SURBA and VIT estimates) towards the candidate reference points for long term sustainability based on F around $F_{0.1}$ (0.2). However, considering the high productivity in terms of incoming year classes, this stock has the potential to recover quickly if F is reduced towards F_{msy}.
The continued lack of older fish in the surveyed population indicates exploitation rates far beyond those considered consistent with high yields and low risk. This fact, on the other hand, may reduce the risk of fisheries collapse.
An improvement of the estimates of catchability of adults is needed to better estimate the stock dynamics and to assess the likely impact of fishing activity on this stock

8.8. Stock assessment of hake in GSA 10

8.8.1.Stock identification and biological features

8.8.1.1. Stock Identification

The stock of European hake was assumed in the boundaries of the whole GSA 10, lacking specific information on stock identification. *M. merluccius* is with red mullet and deep-water rose shrimp a key species of fishing assemblages in the central-southern Tyrrhenian Sea (GSA 10). It is generally also ranked among species with higher abundance indices in the trawl surveys (e.g. Spedicato et al. 2003). It is a long lived fish mainly exploited by trawlers, especially on the continental shelves of the Gulfs (e.g. Gaeta, Salerno, Palermo) but also by artisanal fishers using fixed gears (gillnets, bottom long-line).

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

8.8.1.2. Growth

Estimates of growth parameters were achieved during the Samed project (Anonymous, 2002). The approach was based on the analysis of length frequency distributions and the following von Bertalanffy parameters were estimated by sex: females L_∞=74.2 cm; K=0.178; t_0= -0.20; males: L_∞=46.3cm; K=0.285; t_0= -0.20.
In the DCR framework the growth has been studied ageing fish by otolith readings using the whole sagitta and thin sections for older individuals. Length frequency distributions were also analyzed using techniques as Batthacharya for separation of modal components. The observed maximum length of European hake was 83 cm for females and 45.5 cm for males both registered during the biological samplings (bottom long-lines). The following estimates of von Bertalanffy growth parameters for each sex were obtained from average length at age using an iterative non-liner procedure that minimises the sum of the square differences between observed and expected values (excel): females: L_∞=97.9 cm, K=0.135, t_0= -0.4; males: L_∞=50.8 cm, K=0.25, t_0= -0.4. Parameters of the length-weight relationship estimated were a=0.00350, b=3.2 for females and a=0.0086, b=3.215 for males, for length expressed in cm.

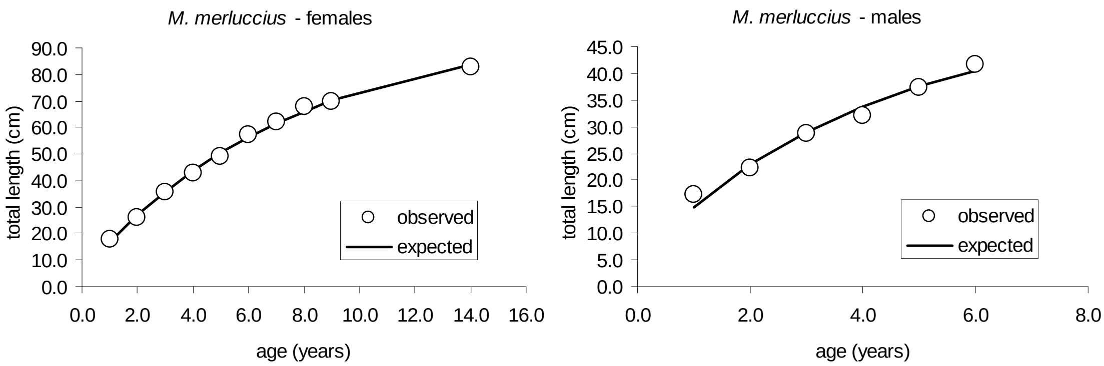
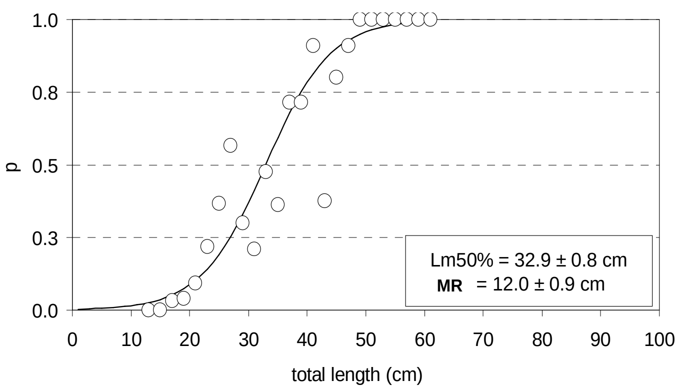


Fig. 8.8.1.2.1. V. Bertalanffy growth functions for female and male of hake in the GSA 10.

8.8.1.3. Maturity

A proxy of size at first maturity as estimated in the Samed project (Anonymous, 2002) using the average length at stage 2 (females with gonads at developing stage) indicates an average length of about 30 cm. According to the data obtained in the DCR, the proportion of mature females (fish belonging to the maturity stage 2 onwards) by length class is reported in the table below together with the estimated maturity ogive which indicates a $L_{m50\%}$ of about 33 cm (±0.8 cm).



TL (cm)	Proportion of mature	TL (cm)	Proportion of mature
15	0.000	33	0.476
17	0.032	35	0.364
19	0.041	37	0.714
21	0.092	39	0.714
23	0.217	41	0.909
25	0.367	43	0.375
27	0.565	45	0.800
29	0.300	47	0.909
31	0.211	49	1.000

Fig. 8.8.1.3.1 Maturity ogive and proportions of mature female of hake in the GSA 10 (MR indicates the difference $Lm_{75\%}$-$Lm_{25\%}$).

8.8.2.Fisheries

8.8.2.1. General description of fisheries

European hake is mostly targeted by trawlers, but also by small scale fisheries using nets and bottom long-lines. Fishing grounds are located along the coasts of the whole GSA offshore 50 m depth or 3 miles from the coast. Catches from trawlers are from a depth range between 50-60 and 500 m and hake occurs with other important commercial species as *Illex coindetii*, *M. barbatus*, *P. longirostris*, *Eledone* spp., *Todaropsis eblanae*, *Lophius* spp., *Pagellus* spp., *P. blennoides*, *N. norvegicus*.

8.8.2.2. Management regulations applicable in 2009

Management regulations are based on technical measures closed number of fishing licenses for the fleet and area limitation (distance from the coast and depth). In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late eighties. After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity is implemented. Along northern Sicily coasts two main Gulfs (Patti and Castellammare) have been closed to the trawl fishery up 200 m depth, since 1990. Two closed areas were also established in 2004 along the mainland, in front of Sorrento peninsula (Napoli Gulf) and Amantea (Calabrian coasts), although these protected area mainly cover the distribution of coastal species. Other measures on which the management regulations are based regard technical measures (mesh size) and minimum landing sizes (EC 1967/06). In the GSA 10 the fishing ban has not been mandatory along the time, and from one year to the other it was adopted on a voluntary basis by fishers.

8.8.2.3. Catches

8.8.2.3.1. Landings

Available landing data are from DCR regulations. SGMED-09-02 received Italian landings data for GSA 10 by major fishing gears which are listed in Tab. 8.8.2.3.1.1. The fishing segments DTS, LLS, PGP, PMP and PTS indicate respectively trawler, long-lines, small scale fishery (nets), polyvalent, and pair trawl. Since 2002, landings of hake increased from 1,013 t to 1,544 t in 2006 and decreased to 1,122 t in 2008 (Fig. 8.8.2.3.1.1). The data are listed in Table A3.1 of Appendix 3. Most part of the landings of hake is from trawlers and nets.

Tab. 8.8.2.3.1.1. Annual landings (t) by major gear type, 2002-2008.

Sum of Weight (tons)		FISHING_TECH					
YEAR	SPECIES	DTS	PTS	PGP	PMP		Total
2002	HKE	515.30	26.50	224.80	245.60		1012.30
2003	HKE	425.10	21.30	328.50	321.70		1096.70

Sum of Weight (tons)		FT_LVL4					
YEAR		OTB	GNS	GTR	LLS	SB-SV	Total
2004	HKE	487.20	382.90	202.20	266.40		1338.60
2005	HKE	623.80	293.80	297.40	269.70		1484.70
2006	HKE	761.30	343.00	152.10	287.70		1544.10
2007	HKE	640.70	219.80	167.90	240.20		1268.70
2008	HKE	500.60	319.30	67.60	233.90	1.40	1122.80

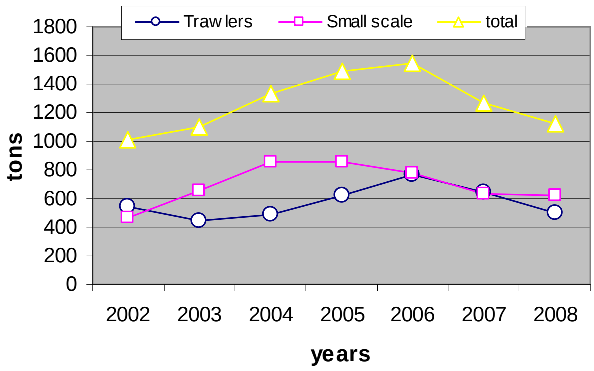


Fig. 8.8.2.3.1.1 Landings (t) by year and major gear types, 2002-2008 as reported through DCR in the GSA 10.

8.8.2.3.2. Discards

The discards of hake in the GSA 10 are assessed to be low. About 5 and 6 tons of discards in 2005 and 2006 were reported to SGMED-09-02 (Tab. A3.9 of Appendix 3).

8.8.2.3.3. Fishing effort

The trends in fishing effort by year and major gear type is listed in Tab. 8.8.2.3.3.1 and shown in Fig. 8.8.2.3.3.1 in terms of kW*days. The fishing segments DTS, HOK, PGP, PMP and PTS indicate respectively trawlers, long-lines, small scale fishery (nets), polyvalent, and pair trawl. The fishing effort in kW*days of the trawlers seems almost stable, whilst that of the fishing segments and métiers forming the aggregation of the small scale fishery is decreasing. As a result the whole pattern is decreasing.

Tab. 8.8.2.3.3.1 Trend in fishing effort (kW*days) for GSA 10 by major gear types, 2002-2007. No data are available for 2008.

Sum od EF				
YEAR	AREA	TYPE	FISHING_TECH	Total
2002	10	KWDAYS	DTS	7344089
			PGP	6440217
			PMP	12686947
			PTS	2631242
2002 Total				29102495
2003	10	KWDAYS	DTS	7231486
			PGP	7222145
			PMP	8003452
			PTS	2930380
2003 Total				25387463
2004	10	KWDAYS	DTS	7883881
			HOK	1654352
			PGP	7056306
			PMP	3588004
			PTS	2308589
2004 Totale				22491133

Sum of EF				
YEAR	TYPE	FT_LVL4	FT_LVL5	Total
2005	KW*DAYS	GNS	Demersal species	4354162
		LLS	Demersal fish	1852150
		OTB	Deep water species (b)	1405828
			Demersal species	1610275
			Mixed demersal species and deep water species (b)	5086660
2005 Total				14309075
2006	KW*DAYS	GNS	Demersal species	2457132
		LLS	Demersal fish	1289606
		OTB	Deep water species (b)	910667
			Demersal species	2677321
			Mixed demersal species and deep water species (b)	3356430
2006 Total				10691156
2007	KW*DAYS	GNS	Demersal species	1743047
		LLS	Demersal fish	1194311
		OTB	Deep water species (b)	1258898
			Demersal species	3095793
			Mixed demersal species and deep water species (b)	2527698
	KW*DAYS Totale			9819747
2007 Total				9819747

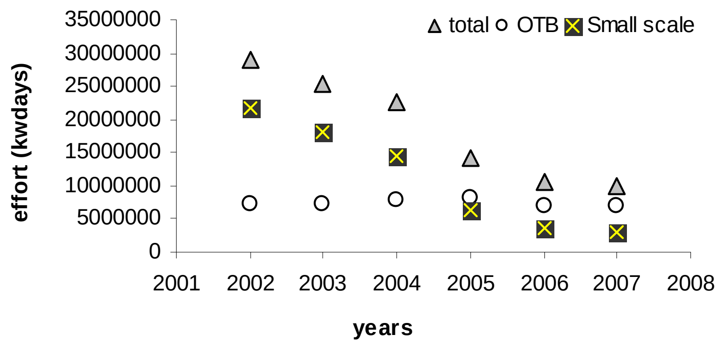


Fig. 8.8.2.3.3.1 Trend in fishing effort (kW*days) for GSA 10 by major gear types, 2002-2007.

8.8.3.Scientific surveys

8.8.3.1. Medits

8.8.3.1.1. Methods

According to the MEDITS protocol (Bertrand *et al*., 2002), trawl surveys were yearly (May-July) carried out, applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish per surface unit) were standardised to square kilometre, using the swept area method.

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 10 the following number of hauls was reported per depth stratum (s. Tab. 8.8.3.1.1.1).

Tab. 8.8.3.1.1.1. Number of hauls per year and depth stratum in GSA 10, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA10_010-050	9	10	10	10	10	10	10	10	9	9	9	9	9	9	9
GSA10_050-100	12	12	12	12	12	12	12	12	10	10	10	10	10	10	10
GSA10_100-200	20	20	20	20	20	20	20	20	17	17	17	17	17	17	17
GSA10_200-500	26	27	26	26	27	26	26	28	22	22	22	22	22	22	22
GSA10_500-800	31	30	31	31	31	30	31	29	26	27	26	26	26	26	26

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al*. 2004).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.8.3.1.2. Geographical distribution patterns

The geographical distribution pattern of European hake has been studied in the area using trawl-survey data and the geostatistical methods. In these studies both the total abundance indices (Lembo et al., 1998a) and the abundance indices of recruits were analysed (Lembo *et al*., 1998b, 2000). The higher concentration of recruits in the GSA 10 were localised in the northern side (Gulfs of Napoli and Gaeta).
On average, considering the analyzed distributions (years 1994-2005), the recruits are individual smaller than 12.3 cm (±1.41). These individual are belonging to the age 0 group.
More recent analyses performed in project at national scale confirmed the presence of important zone for recruits in the northernmost part of the GSA, although sites with a high probability of locating a nursery appeared also along the coasts of southern part of the mainland and North Sicily. From Grund data (autumn survey) the higher abundance of recruits were instead localised in the central part of the GSA, along the mainland coasts. Persistence of the nursery areas along the time was estimated from the indicator kriging. Further details and maps are given in the section of this report dedicated to the nursery.

8.8.3.2. GRUND

8.8.3.2.1. Methods

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

8.8.3.2.2. Geographical distribution patterns

Mapping of the hake recruits obtained applying the indicator krigging technique with contouring that represents probability (in percentage) is reported in the Nursery section of this report.

8.8.3.2.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 10 was derived from the international survey MEDITS. Figure 8.8.3.2.3.1 displays the estimated trend of hake abundance and biomass in GSA 10. Indices from Medits trawl-surveys show an increasing pattern in the last years, although variability is high (Fig. 8.8.3.2.3.1).

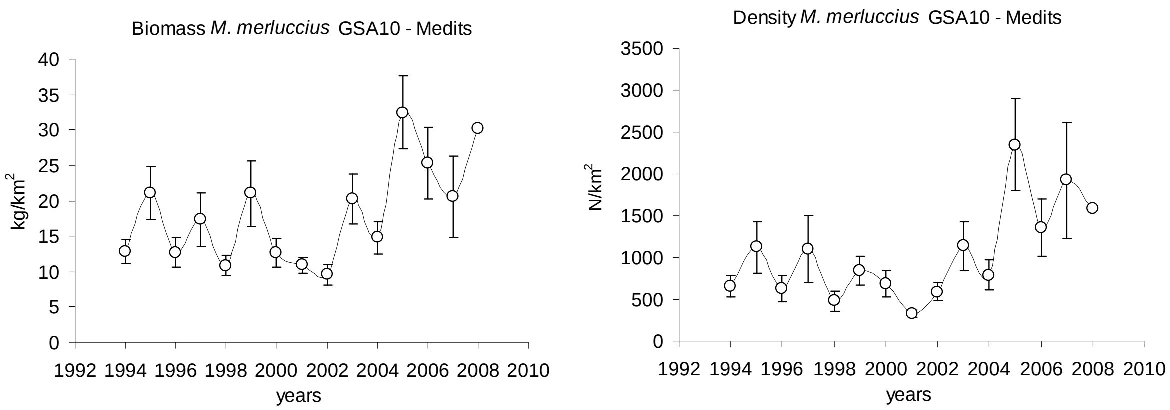


Fig. 8.8.3.2.3.1 Trends in survey abundance and biomass (mean and standard deviation) derived from Medits.

The re-estimated abundance and biomass indices (Figure 8.8.3.2.3.2) also reveal increasing trends since 2002. However, the recent high abundance and biomass indices are subject to high uncertainty.

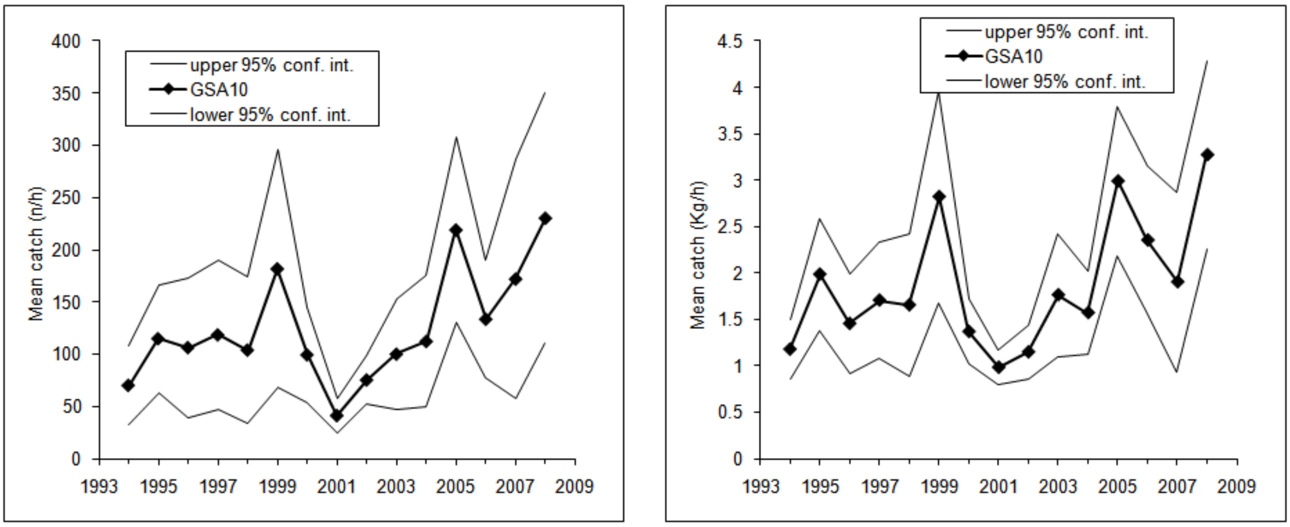


Fig. 8.8.3.2.3.2 Abundance and biomass indices of hake in GSA 10.

Trends derived from the GRUND surveys are shown in Fig. 8.8.3.2.3.3. Abundance indices were significantly increasing ($p<0.05$ on ln-transformed data), as well as recruitment indices (Fig. 8.8.3.2.3.3) while biomass indices were almost stationary.

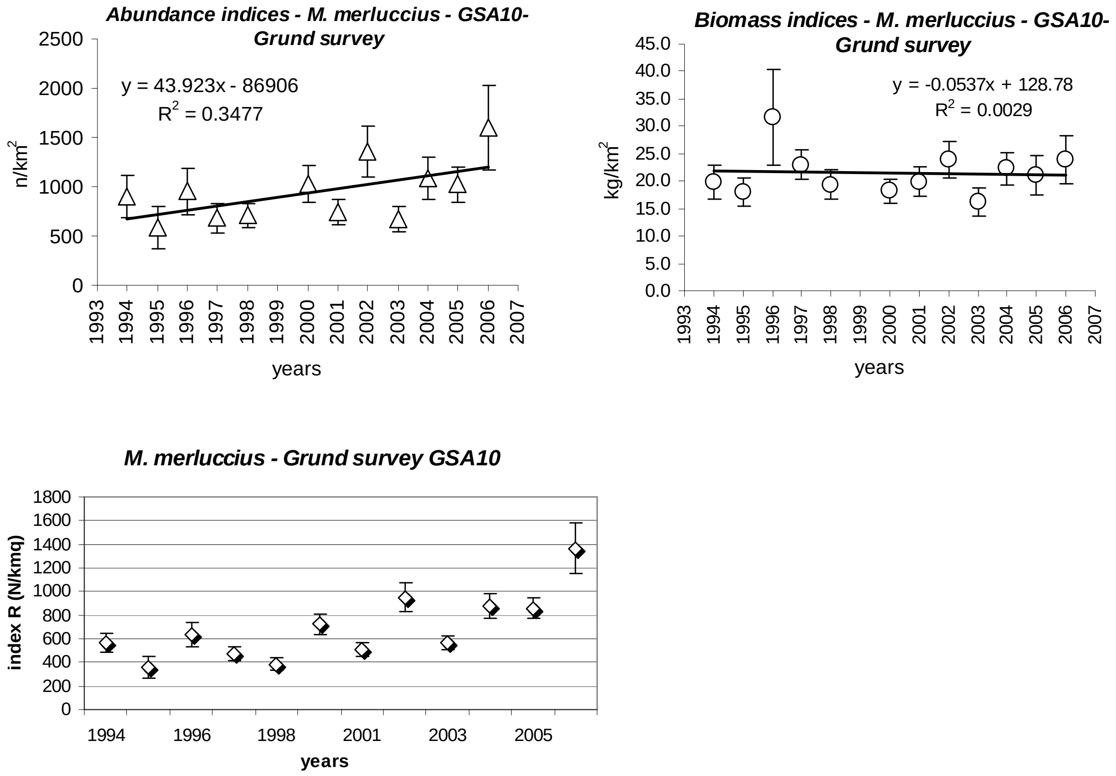


Fig. 8.8.3.2.3.3. Abundance and biomass indices of hake in GSA 10 derived from Grund surveys. Recruitment indices (N/km^2) with standard deviation are also reported.

8.8.3.2.4. Trends in abundance by length or age

No trend in the mean length was observed in Medits survey (Fig. 8.8.3.2.4.1), nor at the third quantile lengths, as obtained from the length structures of Grund time series from 1994 to 2006 (Fig. 8.8.3.2.4.2).

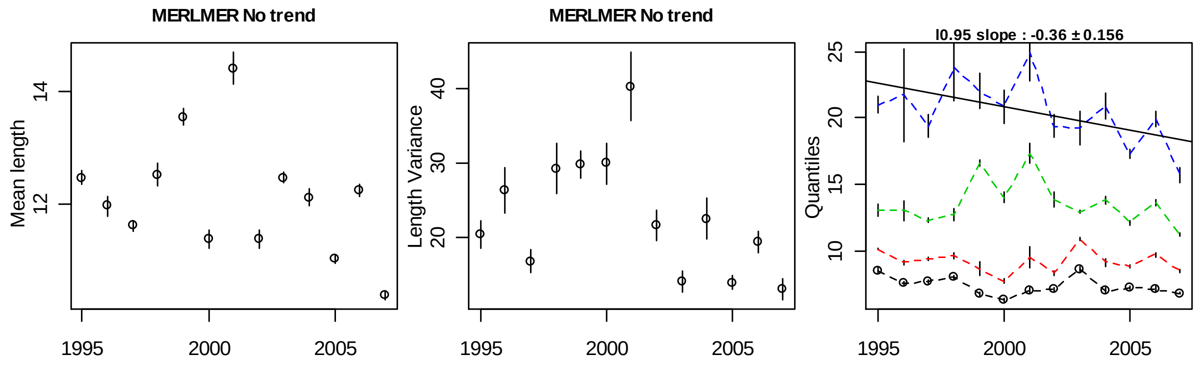


Fig. 8.8.3.2.4.1 Mean length, variance and quantiles derived from the Medits length compositions in 1995-2007.

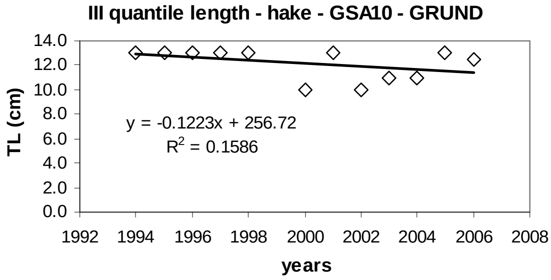


Fig. 8.8.3.2.4.2 III Quantile derived from the GRUND length structures in 1994-2006.

The following Fig. 8.8.3.2.4.3 and 4 display the stratified abundance indices of GSA 10 in 1994-2001 and 2002-2008.

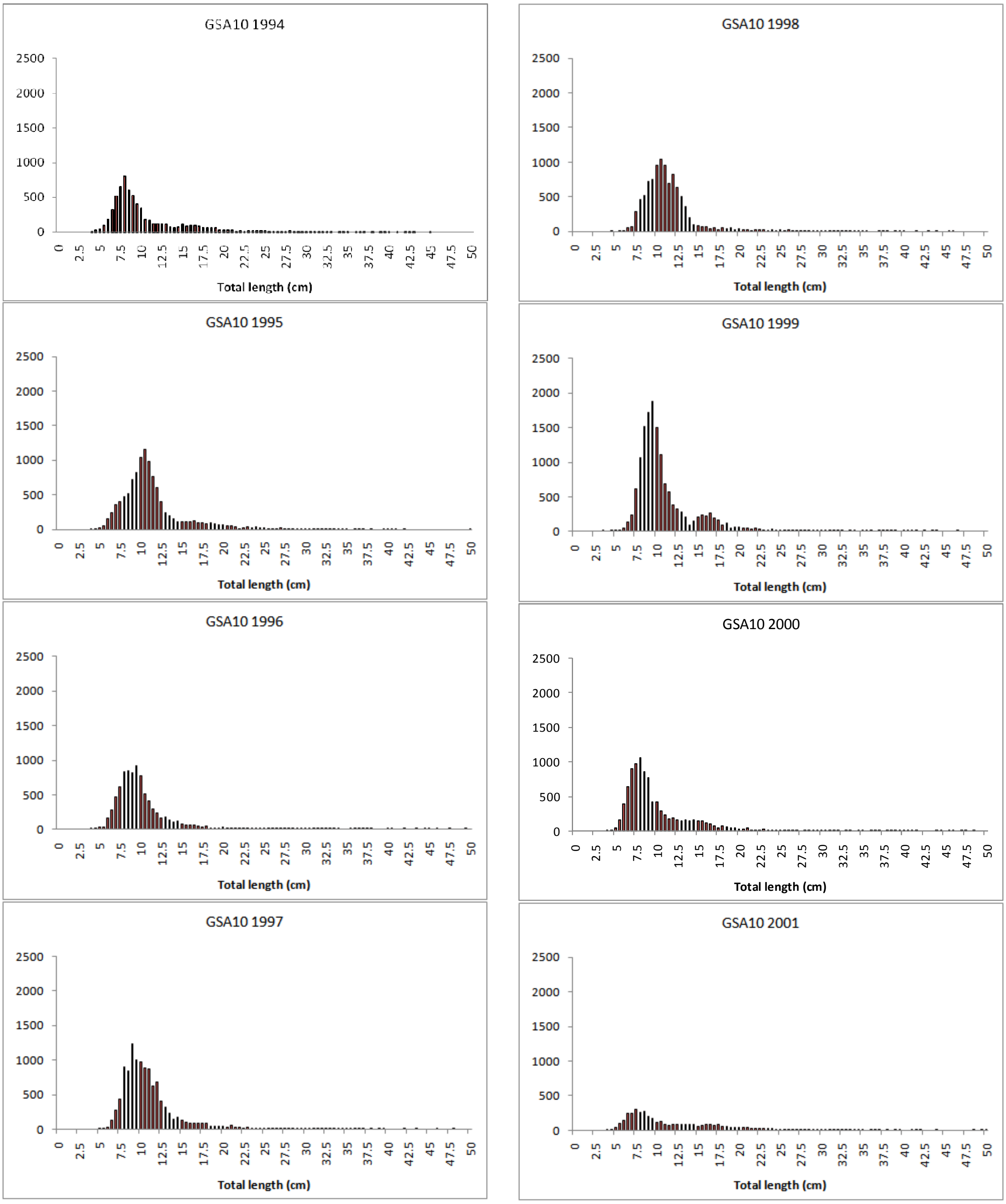


Fig. 7.8.3.2.4.3 Stratified abundance indices by size, 1994-2001.

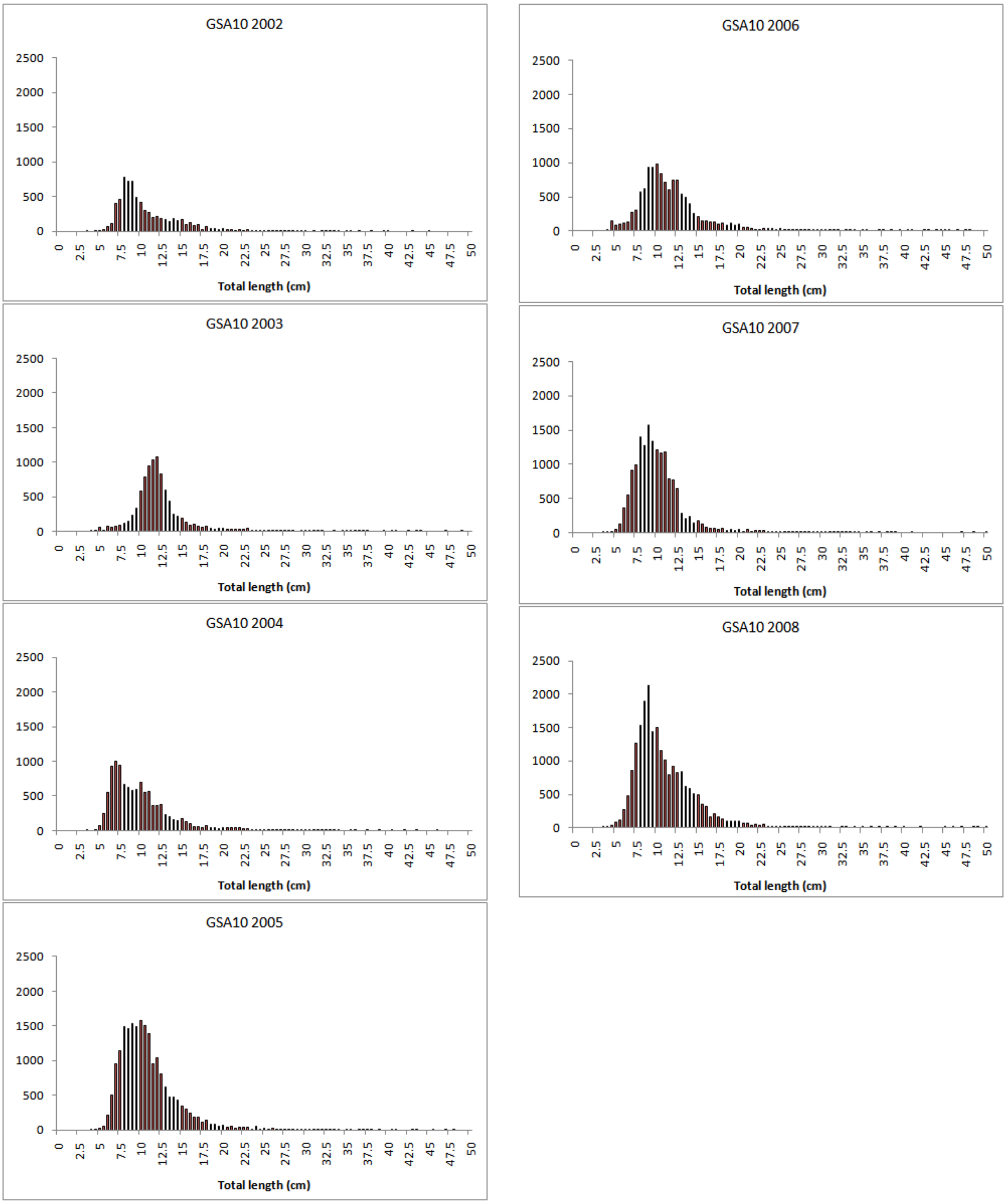


Fig. 8.8.3.2.4.4 Stratified abundance indices by size, 2002-2008.

8.8.3.2.5. Trends in growth

No analyses were conducted.

8.8.3.2.6. Trends in maturity

No analyses were conducted.

8.8.4.Assessment of historic stock parameters

8.8.4.1. Method 1: Surba

8.8.4.1.1. Justification

Surba software was applied to both MEDITS and GRUND abundance estimates as described above.

8.8.4.1.2. Input parameters

The following growth parameters were used to split the LFD for the Surba analyses and to parameterize the Aladym model as well as Yield software: L_∞=97.9 cm, K=0.135, t_0= -0.4; males: L_∞=50.8 cm, K=0.25, t_0= -0.4; length-weight relationship: a=0.00355, b=3.22 for sex combined. Size at first maturity was put varying around 32 cm (maturity range 2 cm), according to the maturity ogive derived in the area. Estimates of total mortality and recruitment from Surba were used to feed Aladym model, which routines re-estimated the total and fishing mortality using the whole information on the population parameters and exploitation pattern. The recruitment estimated by Surba was raised to the GSA area accounting for the q parameter adopted in the model parameterization for the first age group.

8.8.4.1.3. Results

Estimates of total mortality for sex combined from Surba were as follows:

Year	Original			Smoothed
	SSB	Z	SSB	Z
1994	1.208	1.536	1.153	1.508
1995	0.965	1.634	1.046	1.558
1996	1.202	1.81	1.035	1.623
1997	0.707	1.497	0.936	1.417
1998	0.888	1.096	0.954	1.432
1999	1.38	1.976	1.27	1.556
2000	1.21	1.731	1.174	1.737
2001	0.872	1.844	0.894	1.705
2002	0.544	1.078	0.682	1.402
2003	0.933	2.223	0.716	1.46
2004	0.725	1.327	0.926	1.579
2005	1.122	1.68	0.983	1.499
2006	0.968	2.253	1.065	1.675
2007	0.75	1.017	1.16	1.688
2008	1.526	NA	1.004	NA

An average of the last two years was used for 2008.

The following vector of natural mortality estimated by Prodbiom method was applied in both models.

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

The following q parameters were used to set Surba

q	0.9	1	1	0.75	0.5	0.5

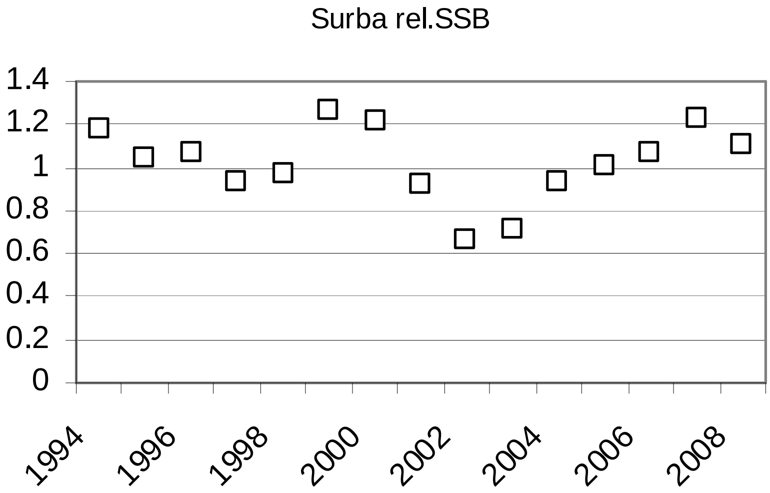


Fig. 8.8.4.1.3.1 Relative estimates of SSB from Surba, 1994-2008.

The abundance indices from trawl surveys showed an increasing pattern as well as those estimated using Surba, as showed in the figure below.

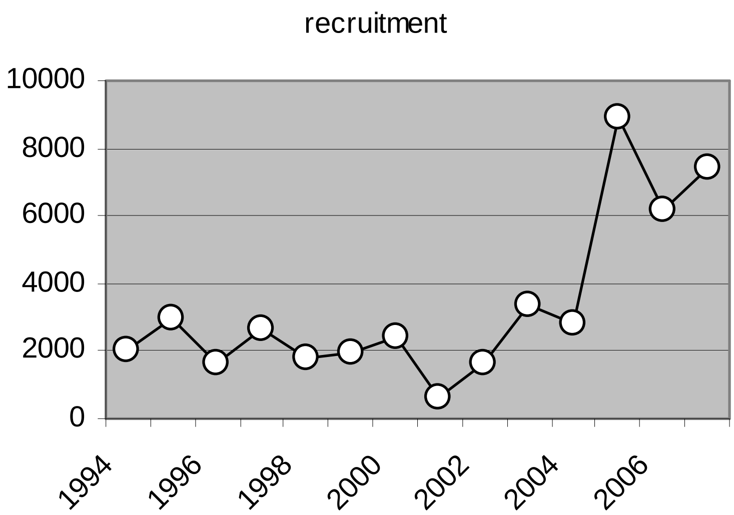


Fig. 8.8.4.1.3.2 Relative estimates of recruits from Surba, 1994-2008.

Other relevant results are showed in the following Fig. 8.8.4.1.3.3.

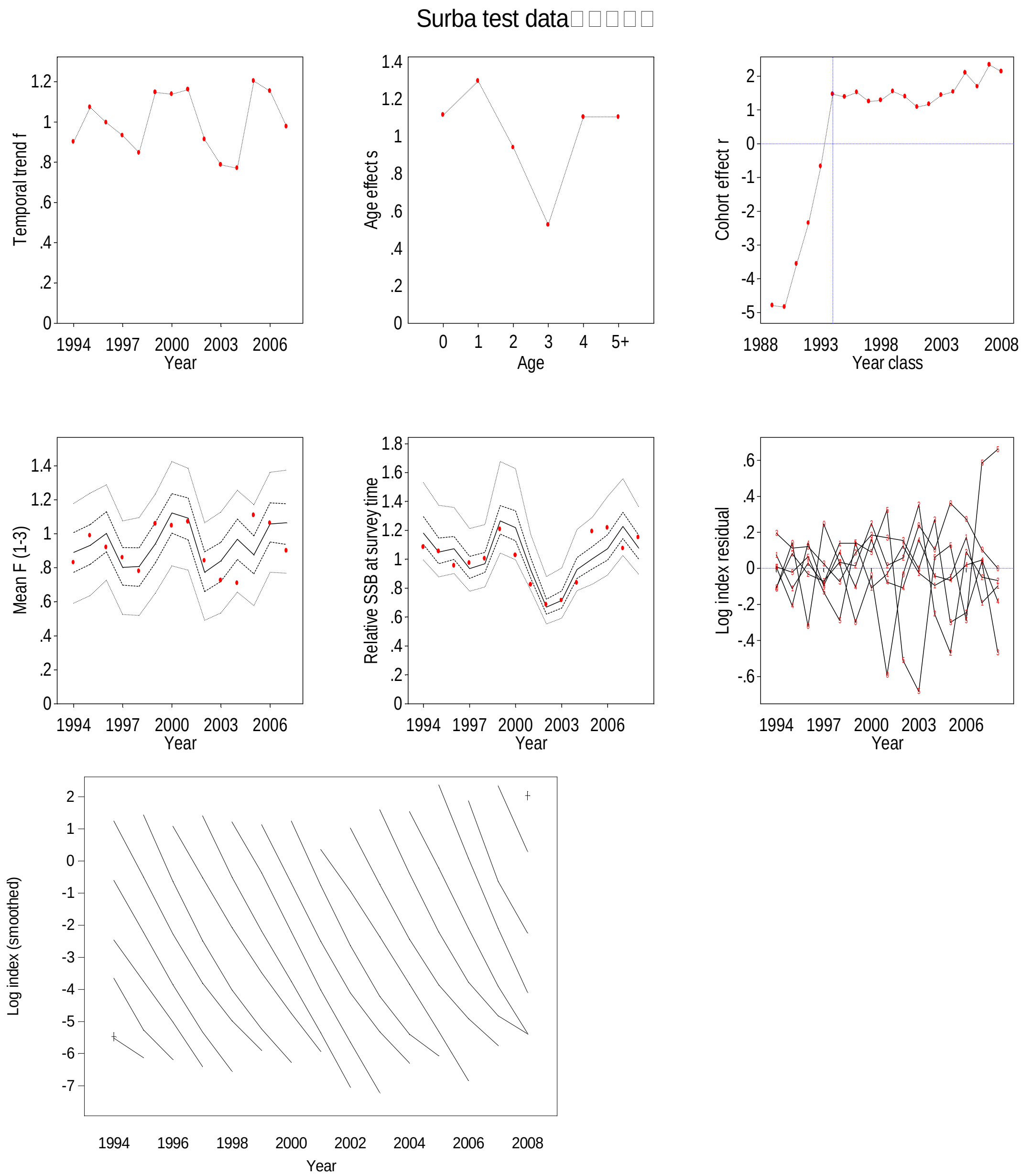


Fig. 8.8.4.1.3.3. Trends in various stock parameters as estimated by SURBA.

8.8.4.2. Method 2: Aladym

8.8.4.2.1. Justification

Aladym software was applied to both MEDITS and GRUND abundance estimates as described above.

8.8.4.2.2. Input parameters

The following growth parameters were used to split the LFD for the Surba analyses and to parameterize the Aladym model as well as Yield software: L_∞=97.9 cm, K=0.135, t_0= -0.4; males: L_∞=50.8 cm, K=0.25, t_0= -0.4; length-weight relationship: a=0.00355, b=3.22 for sex combined. Size at first maturity was put varying around 32 cm (maturity range 2 cm), according to the maturity ogive derived in the area. Estimates of total mortality and recruitment from Surba were used to feed Aladym model, which routines re-estimated the total and fishing mortality using the whole information on the population parameters and exploitation pattern. The recruitment estimated by Surba was raised to the GSA area accounting for the q parameter adopted in the model parameterization for the first age group.

In Aladym spawning was considered to occur along the year with peaks in winter and late spring that means peaks of recruitment occurring in spring and autumn months. The ratio between the month and the average year landing was used to tune the fishing mortality coefficient in Aladym. This was done for 2004-2006 and assumed similar in the previous and successive years. Selectivity of the fleet was simulated using an ogive (Lc=12cm; selection range 3 cm) coupled with a deselection ogive with 50% deselection size at 38 cm and a deselection range of 7 cm (Abella *et al.*, 1997).

8.8.4.2.3. Results

Outcomes from Aladym converged with the Z estimates of Surba and yield simulated using Aladym well approximated the observed ones.

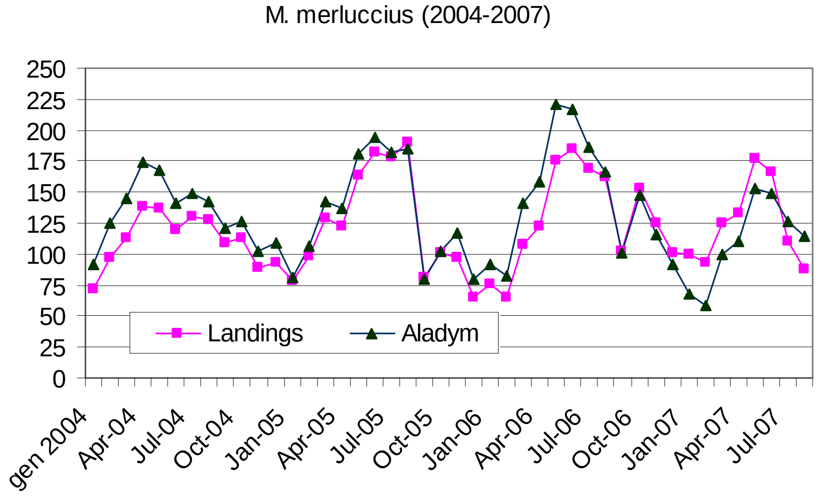


Fig. 8.8.4.2.3.1 Trend in landings and landings simulated by Aladym.

The state of the stock in relation to reference points was estimated using the software YIELD in an equilibrium condition using a point estimate of natural mortality of 0.35.

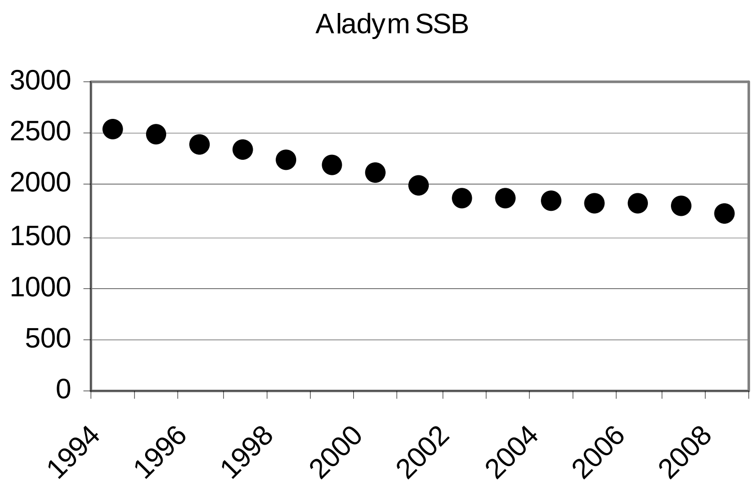


Fig. 8.8.4.2.3.2 Trend in SSB in tons from Aladym simulations, 1994-2008.

Estimates of total mortality from SURBA and Aladym were converging, also a similar pattern was observed for the fishing mortality with difference in levels due to the age range considered.

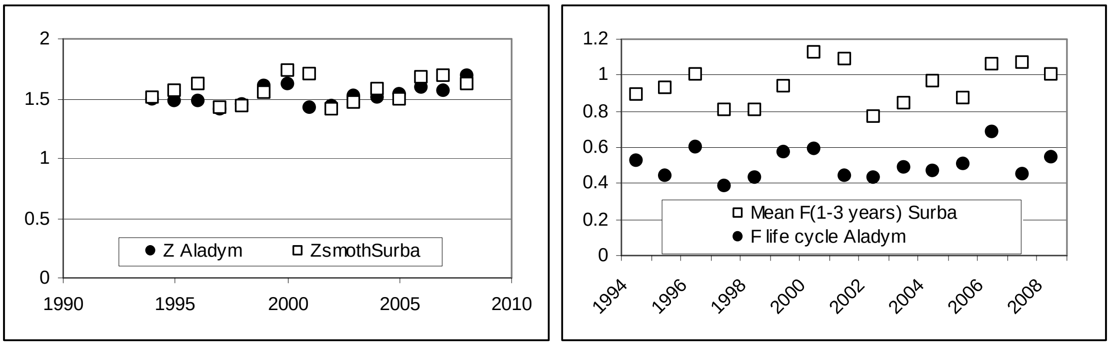


Fig. 8.8.4.2.3.3. Comparison of Z and F estimates as derived from SURBA and Aladym.

8.8.5.Long term prediction

8.8.5.1. Justification

A yield per recruit analyses was conducted using the Yield software.

8.8.5.2. Input parameters

Like used in the Surba and Aladym assessments described above.

8.8.5.3. Results

Table 8.8.5.3.1 lists the reference points estimated from the yield per recruit analysis.

Table 8.8.5.3.1. Fisheries management reference values derived from yield per recruit analysis.

Equilibrium "Yield results"	F	Y/R	B/R	SSB/R
F(0.1)	0.244	0.615	2.643	1.619
F(Max)	0.419	0.659	0.824	1.691
F(Current)	0.548	0.645	0.5	1.27

8.8.6.Scientific advice

8.8.6.1. Short term considerations

8.8.6.1.1. State of the spawning stock size

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. However, recent values are among the highest observed since 1994.
The hindcasting approach using Aladym model shows that the SSB was continously decreasing. A similar pattern shows also the spawning potential ratio that was in the range 6 and 4% from 1994 and 2008.

SGMED-09-02 is unable to interprete such different trends and thus unable to advice on the state of the spawning stock size, in particular due to a lack of a estimated management reference points.

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

8.8.6.1.2. State of recruitment

Recent recruitment since 2006 appears to be above average.

8.8.6.1.3. State of exploitation

Given the results of the present analysis, the stock appears overexploited. Considering the level of F estimated in 2008 by Aladym, i.e. 0.55, the stock appears overfished and a reduction of 55% would be necessary to reach $F_{0.1}$ (0.244).

8.9. Stock assessment of hake in GSA 11

8.9.1.Stock identification and biological features

8.9.1.1. Stock Identification

This stock is assumed to be confined within the GSA boundaries, where it is distributed between 30 and 650 m of depth, with a peak in abundance (due to high number of recruits) over the continental shelf-break (between 150 and 250 m depth). The stock is mainly exploited by the local fishing fleet, although seasonally and occasionally some other Italian fleet use to fish in some areas. Spawning is taking place almost all year around, with a peak during winter –spring.

Juveniles showed a patchy distribution with some main density hot spots (nurseries) showing a high spatio-temporal persistence (Murenu *et al.*, 2007) in western areas.

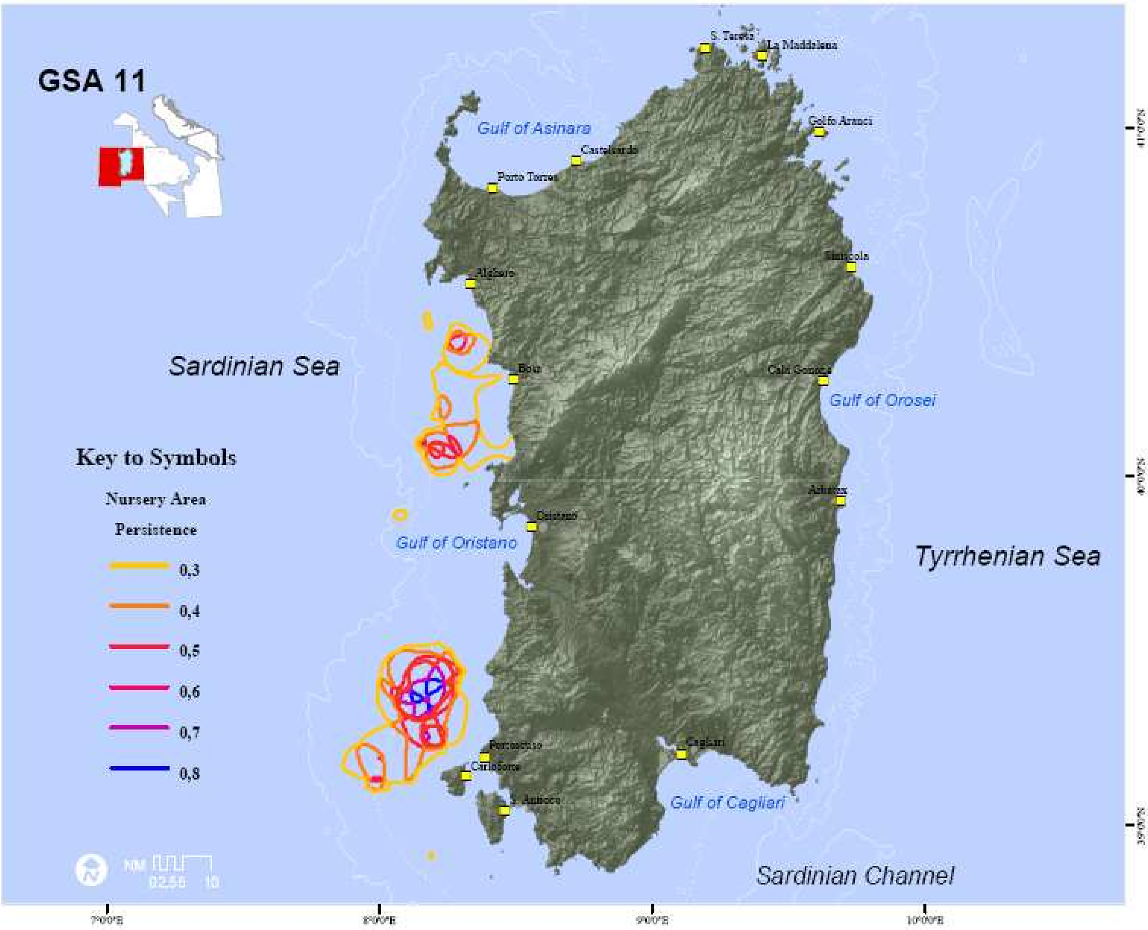


Fig. 8.9.1.1.1 Temporal persistence of hake nurseries calculated from data survey time-series density maps (1994-2006) of juveniles.

8.9.1.2. Growth

Data coming from LFDA hake showed a slow growth pattern both in male and female (Samed, 2002). A slower growth pattern for the GSA 11 hake population comes from otolith readings (DCR, 2008). New Von Bertalanffy Growth Function parameters have been calculated and used within this assessment. This is much in line with recent evidences that suggest a fast growing pattern hypothesis for hake either in the Western Mediterranean (Garcia-Rodriguez and Esteban, 2002; Jadaud *et al*., 2006; Piñeiro *et al*., 2007) or in the Bay of Biscay (De Pontual *et al*., 2003).

8.9.1.3. Maturity

Due to the well-known limited trawl nets catchability of hake spawners, the catch rate of mature specimens during the MEDITS survey was very low thus influencing the analysis to identify the pattern in gonad development as well as the growth rate and maturation processes relationship. The logistic model detect female length at first maturity at 36 cm. Although spawning off Sardinian coast (GSA 11) occurs nearly all over the year (Jan. to Sept.) the maturity peak is usually observed in winter (Feb.-May).

8.9.2.Fisheries

8.9.2.1. General description of fisheries

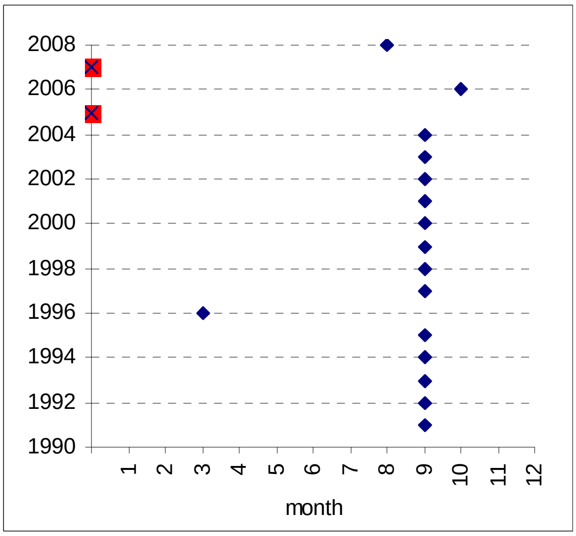
STECF in 2007 (stock review part II) noted that hake is one of the most important commercial species in the Sardinian seas. In this area, the biology and population dynamics have been studied intensively in the past fifteen years.
Although hake is not a target of a specific fishery, such as deep red shrimp, it is the third species in terms of biomass landed in GSA 11 (Murenu M., pers. com.). In the GSA 11 hake is caught exclusively by a mixed bottom trawl fishery at depth between 50 and 600 m. No gillnet or longline fleets target on this species. Although different nets are used in shallow, mid and deep water ("terra" mainly targeting Mullus spp., "mezzo fondo" targeting fish and "fondale" net targeting deep shrimp) the main trawl used is an "Italian trawl net" type with a low vertical opening (max up to 1.5 m). The dimensions change in relation to the trawlers engine power.
Important by catch species are horned octopus, squids, poor cod, shortnose greeneye, greater forkbeard and deep-water pink shrimp.

Detailed maps of the trawlers fishing-grounds are reported in Murenu *et al*. (2006). Most of the GSA effort is concentrated within a relative short radius around the major fishing ports (Cagliari, Alghero, Porto Torres, La Caletta, Sant'antioco, Oristano, Alghero). However some big trawlers seasonally move in different fishing grounds far from the usual ports.

From 1994 to 2004, in GSA 11, the trawl fleet remarkably changed. The change mostly consisted of a general increase in the number of vessels and by the replacement of the old, low tonnage wooden boats by larger steel boats. For the entire GSA an increase of 85% for boats >70 Tons class occurred. A decrease of 20% for the smaller boats (<30 GRT) was also observed.

8.9.2.2. Management regulations applicable in 2008 and 2009

As in other areas of the Mediterranean, the stock management is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area closures), and minimum landing sizes (EC 1967/06).
Two small closed areas were also established along the mainland (west and east coast respectively), although these are defined to mainly protect Norwegian lobster. Since 1991, a fishing closure for 45 trawling days has been enforced (month and year are reported on the following figure) almost every year. Red points means no closing measure adopted).



Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

8.9.2.3. Catches

8.9.2.3.1. Landings

SGMED-09-02 received Italian landings data for GSA 11 by major fishing gears which are listed in Tab. 8.9.2.3.1.1. Since 2002, landings increased from 360 t to 930 t in 2005 and decreased to 340 t in 2008 (Fig. 8.9.2.3.1.1). Landings are dominated by demersal trawl fisheries (DTS, OTB and partially PMP). The data are listed in Table A3.1 of Appendix 3.

Tab. 8.9.2.3.1.1 Landings (t) by year and major gear types, 2002-2008 as reported through DCR.

FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DTS	167	592					
GNS			32	60	8	37	22
GTR			81	101	206	63	29
LLS			1	2	16	8	10
OTB			597	765	594	442	279
PGP	4	26					
PMP	190	279					
total landings (all gears)	361	897	711	928	824	550	340

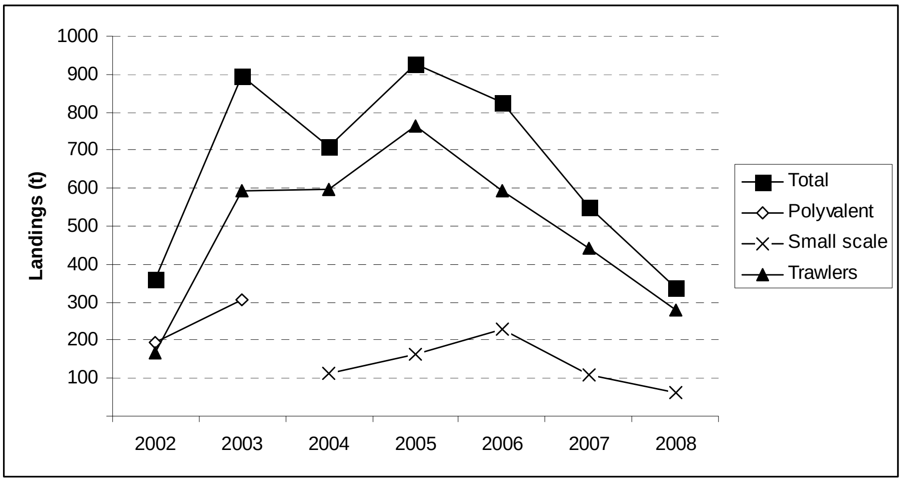


Fig. 8.9.2.3.1.1 Landings (t) by year and major gear types, 2002-2007 as reported through DCR.

8.9.2.3.2. Discards

Discards reported to SGMED-09-02 sum 15 t and 63 t in 2005 (long-lines) and 2006 (trawlers) respectively. The data are listed in Table A3.9 of Appendix 3.

8.9.2.3.3. Fishing effort

The trends in fishing effort by year and major gear type is listed in Tab. 8.9.2.3.3.1 and shown in Fig. 8.9.2.3.3.1 in terms of kW*days.
Taking into account that landing of hake are mostly from trawler and trawl net are one of the gears for the polyvalent segments, the trend of fishing effort by trawler would be read as stable, i.e. matching the same pattern of the total fishing effort.

Tab. 8.9.2.3.3.1 Trend in fishing effort (kW*days) for Italy by major gear types, 2002-2007. No values were reported for 2008.

FT_LVL4	2002	2003	2004	2005	2006	2007
FPO				79031	824017	1387022
FYK						13055
GND						11713
GNS				1007963	236313	781402
GTR				6358014	6476994	4393484
LHP-LHM				769	70523	122621
LLD				284297	480411	952876
LLS				832709	1159412	1054615
LTL					12388	1622
OTB				7679721	5879355	5957347
DTS	3679604	4652647	6711626			
PGP	2865738	5099814	7105771			
PMP	7159338	3245118				
total	13704680	12997579	13817397	16242504	15139413	14675757

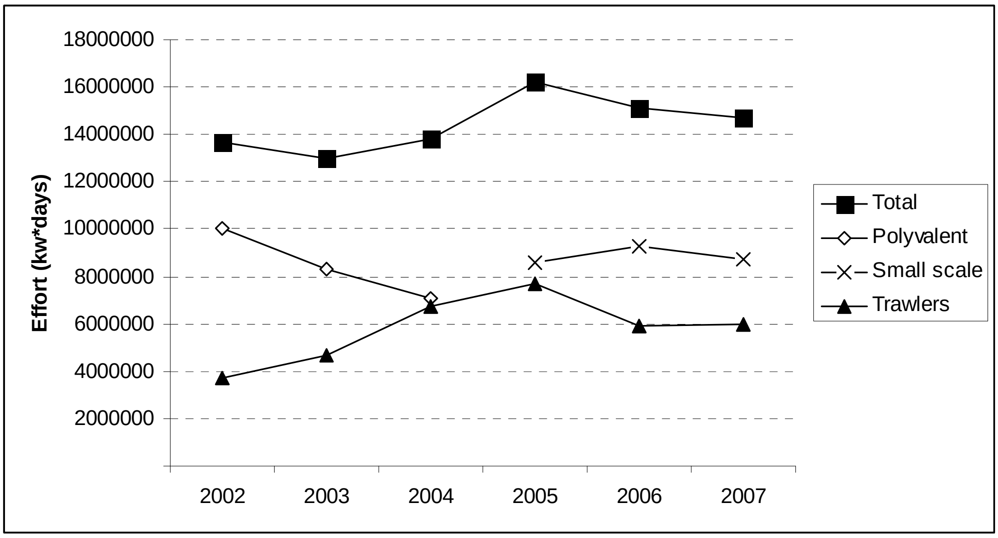


Fig. 8.9.2.3.3.1 Trend in fishing effort (kW*days) for the Italian fleet by major gear types, 2002-2007.

8.9.3.Scientific surveys

8.9.3.1. MEDITS

8.9.3.1.1. Methods

Since 1994 the Medits trawl surveys have been yearly carried out between May and July (except in 2007). According to the MEDITS protocol (Relini, 2000; Bertand *et al.*, 2002) a stratified random sampling design with allocation of hauls proportional to depth strata extension (depth strata: 10–50 m, 51–100 m, 101–200 m, 201–500 m, 501–800 m) was adopted. A specific gear (GOC 73, with a 20 mm stretched mesh size in the cod-end) was always used following the instruction stated and reported in Dremière and Fiorentini (1996).

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 11 the following number of hauls was reported per depth stratum (s. Tab. 8.9.3.1.1.1).

Tab. 8.9.3.1.1.1. Number of hauls per year and depth stratum in GSA 11, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA11_010-050	17	19	21	21	21	21	19	18	20	18	17	17	19	19	17
GSA11_050-100	27	21	22	22	20	22	22	24	19	19	18	21	18	20	19
GSA11_100-200	22	23	30	31	31	30	31	30	24	24	24	24	24	24	22
GSA11_200-500	35	29	29	26	25	27	24	25	20	24	21	20	20	20	21
GSA11_500-800	23	16	21	25	25	24	27	26	16	14	15	14	16	17	16

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).
The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

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

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

Where:

- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.9.3.1.2. Geographical distribution patterns

The spatial structure of European hake has been described by modelling the spatial correlation structure of the abundance indices through geostatistical techniques (i.e. kriging). In different studies either total abundance index or abundances of recruits and adults were analysed (Murenu *et al*., 2007).
On average, considering the analyzed distributions (years 1994-2005), the recruits are individual smaller than 12.3 cm (±1.41). These individual are belonging to the age 0 group. Persistence of the nursery areas along the years was studied by applying indicator kriging technique (Journel 1983, Goovaerts, 1997) to abundance estimations of recruits (Murenu *et al*., 2008). Main results and maps are reported in the "nursery section" of this report.

8.9.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 11 was derived from the international survey MEDITS. Figure 8.9.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 11.

The estimated abundance and biomass indices since 2000 show high variation without any trend.

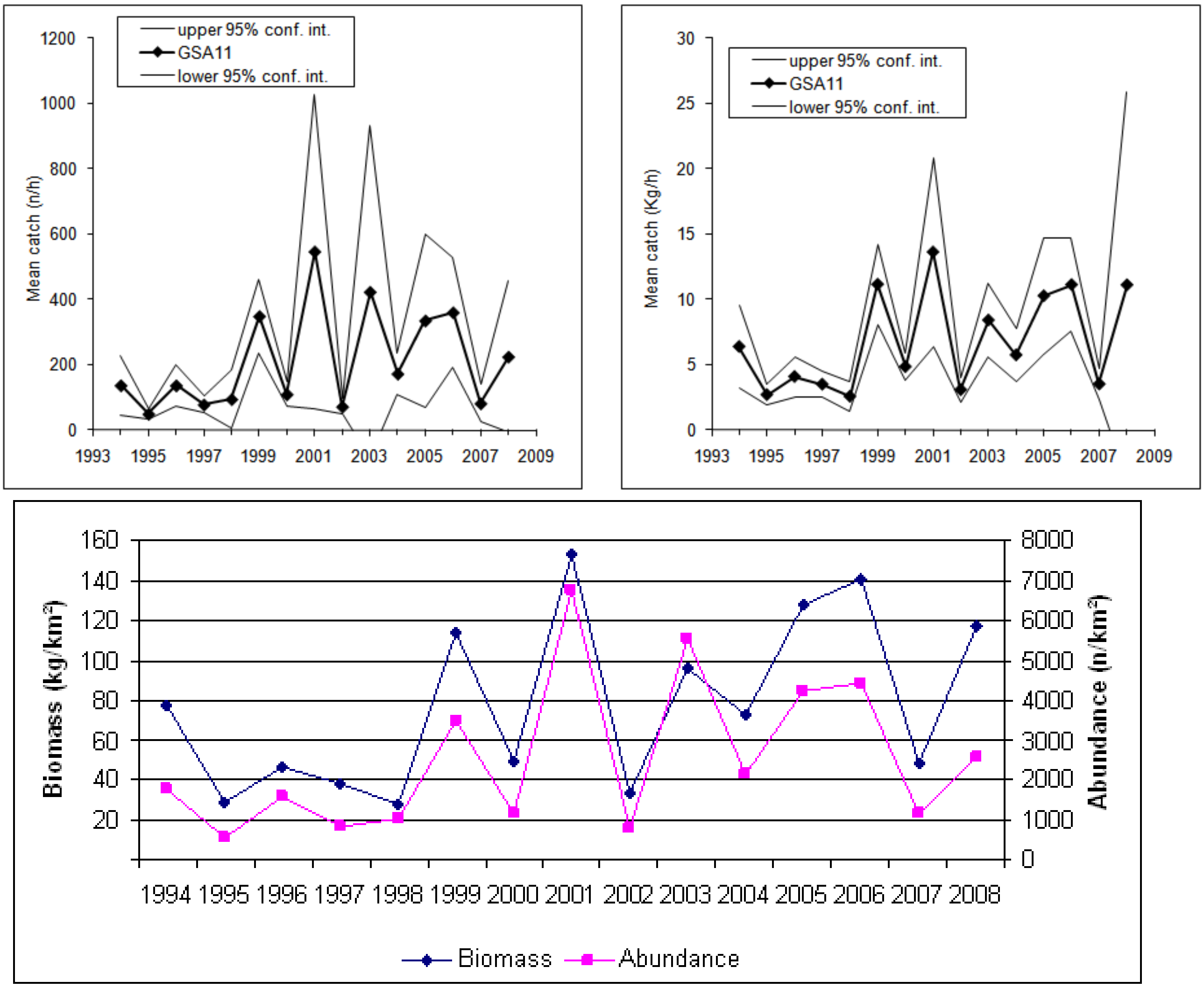


Fig. 8.9.3.1.3.1 Abundance and biomass indices of hake in GSA 11.

8.9.3.1.4. Trends in abundance by length or age

The following Fig. 8.9.3.1.4.1 and 2 display the stratified abundance indices of GSA 11 in 1994-2001 and 2002-2008 respectively.

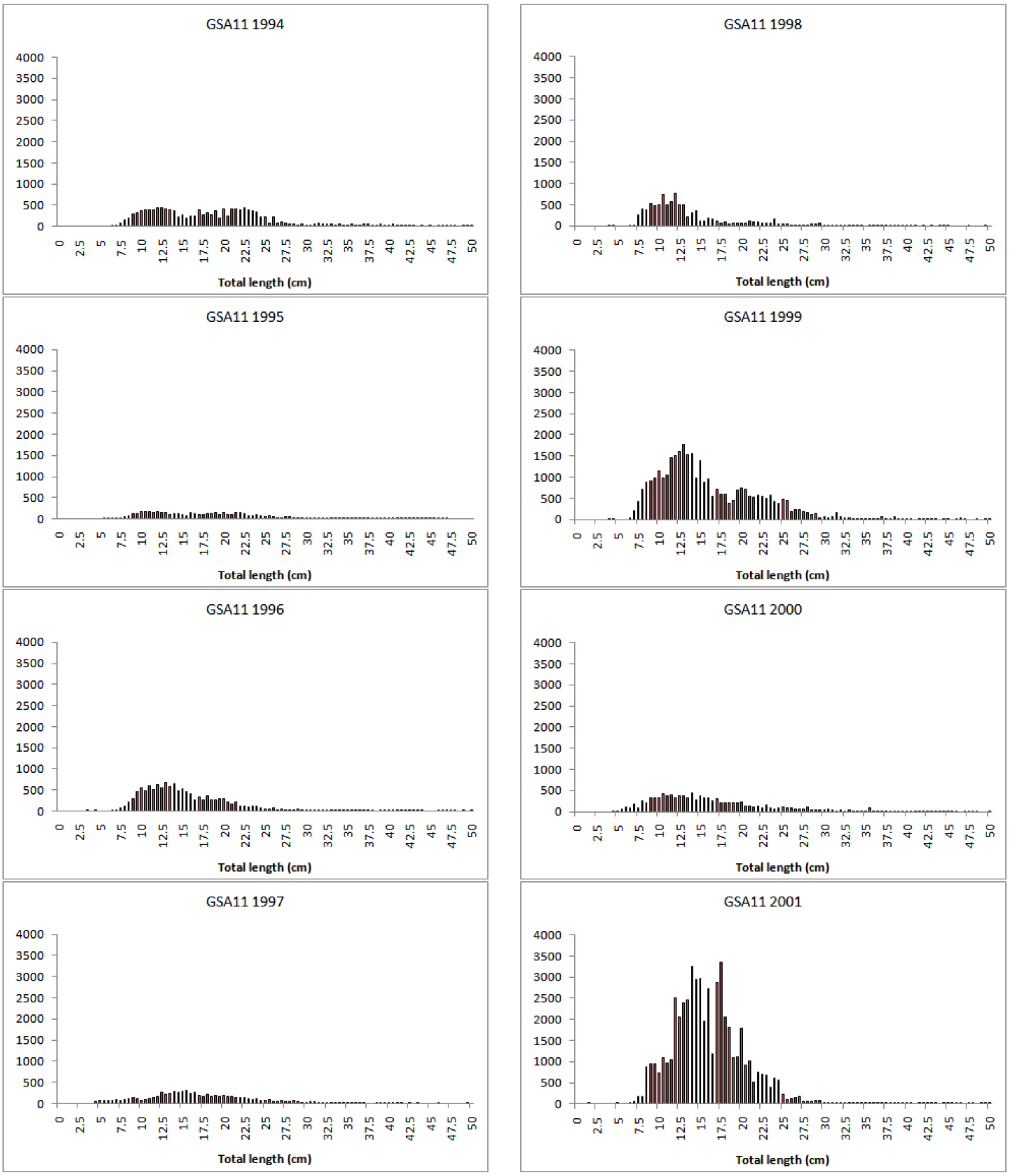


Fig. 8.9.3.1.4.1 Stratified abundance indices by size, 1994-2001.

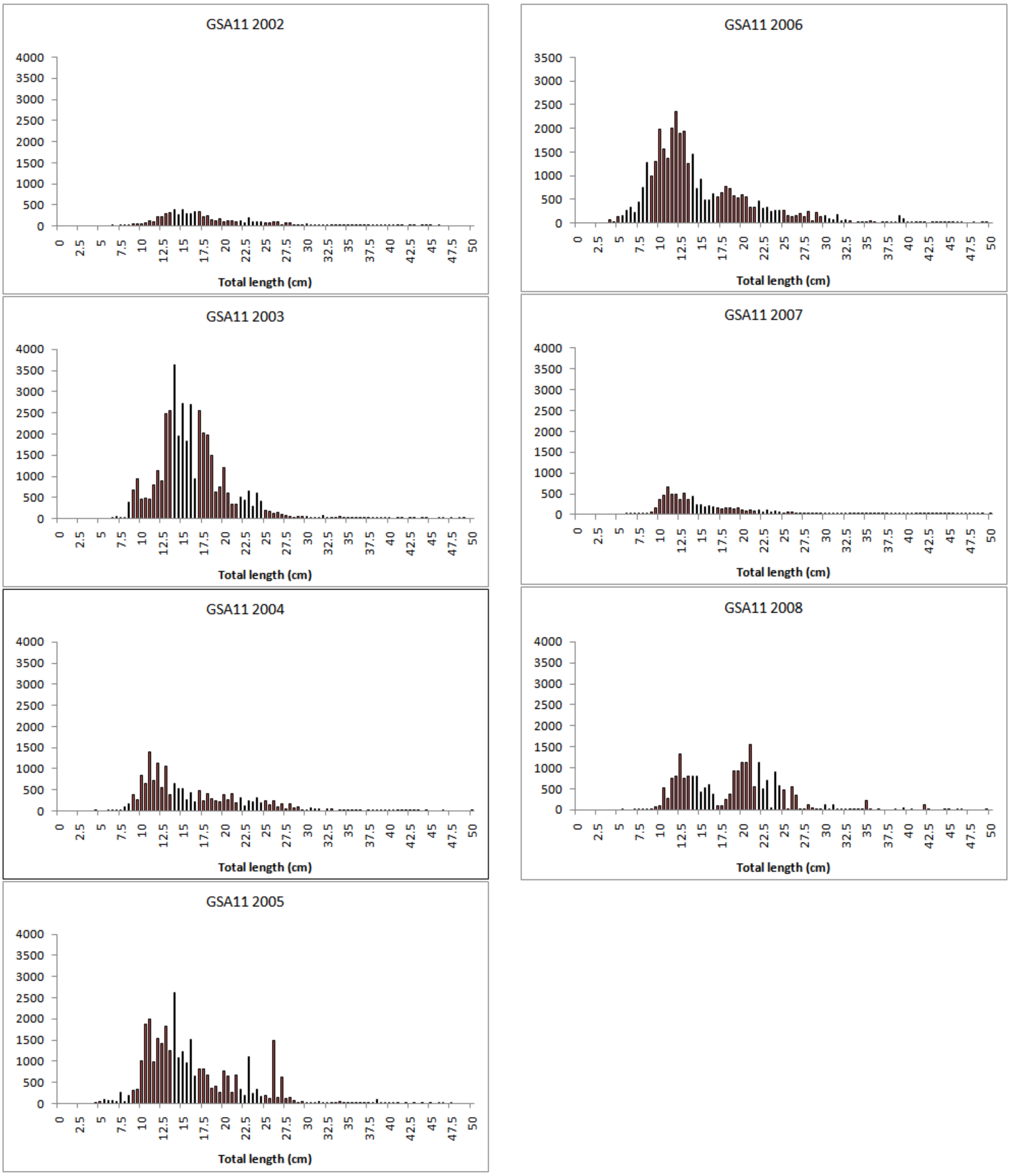


Fig. 8.9.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.9.3.1.5. Trends in growth

No analyses were conducted.

8.9.3.1.6. Trends in maturity

No analyses were conducted.

8.9.4. Assessment of historic stock parameters

8.9.4.1. Method 1: SURBA

8.9.4.1.1. Justification

The SURBA analyses was applied to the MEDITS survey estimates.

8.9.4.1.2. Input parameters

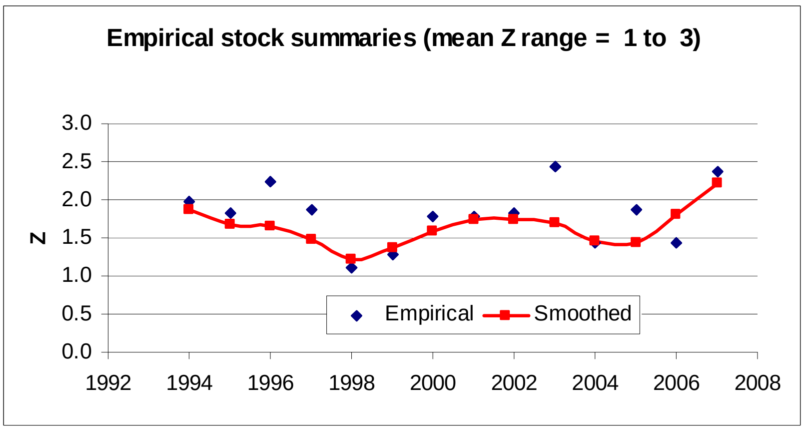
Data from trawl surveys (time series of Medits from 1994 to 2008) and effort and landings data from DCR have been used for the analysis. The SURBA software package (Needle, 2003) lets to take advantage of the trawl surveys data time series available from the Medits research program. Using the software the evolution of fishing mortality rates of hake in the GSA 11 was reconstruct starting from the analysis of the length frequency distribution (LFD).
The LFDs were converted in numbers by age group using the subroutine “age slicing” as implemented in the software package LFDA (Kirkwood *et al*., 2001). Moreover the VBGF parameters used to split the LFD are: L_∞=97.15 cm, K=0.165, t_0= 0.03.
According to the Prodbiom approach by Caddy and Abella (1999), a vectorial natural mortality at age was computed for the stock analysis (Tab. 8.9.4.1.2.1).
Guess estimates of catchability by age are given in Tab. 8.9.4.1.2.1.

Tab. 8.9.4.1.2.1 Input parameters used in the SURBA analysis (sex combined) in the (GSA11).

VBGF	L_∞=97.15 cm, K=0.165, t_0= -0.03
M vector	Age_1=1.11 , Age_2=0.51, Age_3=0.40, Age_4=0.35, Age_5=0.33
Catchability (q)	q_1 = 0.9, $q_{2\text{-}3}$ = 1.0, q_4=0.75, q_5=0.55
Length at maturity (L_{50})	36 cm (sex combined)

8.9.4.1.3. Results

Estimates of total mortality for sex combined from Surba were as follows:



Year	Original SSB	Z	Smoothed SSB	Z
1994	1.243	1.979	1.155	1.872
1995	1.04	1.828	1.008	1.672
1996	0.909	2.244	0.918	1.644
1997	0.745	1.878	0.782	1.47
1998	0.636	1.117	0.775	1.221
1999	0.992	1.289	1.034	1.361
2000	1.434	1.787	1.275	1.58
2001	1.034	1.785	1.105	1.734
2002	1.017	1.834	0.949	1.741
2003	0.974	2.43	0.792	1.692
2004	0.597	1.429	0.794	1.451
2005	1.149	1.862	1.143	1.438
2006	1.192	1.438	1.488	1.812
2007	1.449	2.361	1.163	2.228
2008	0.591	NA	0.617	NA

Fig. 8.9.4.1.3.1 Total mortalities estimated by SURBA using trawl surveys age composition (MEDITS).

Trends in estimated fishing mortalities are plotted in Fig. 8.9.4.1.3.2.

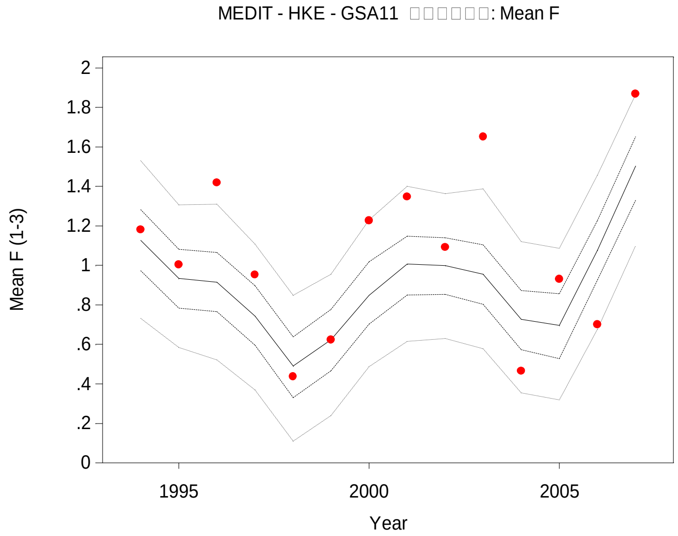
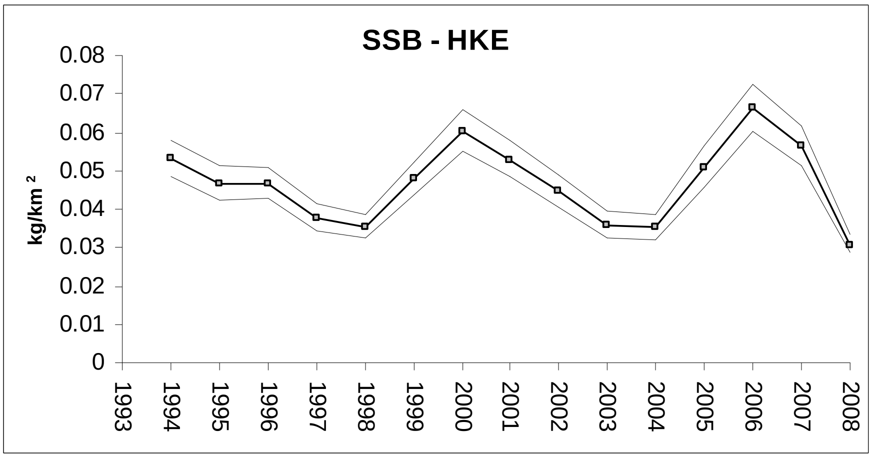


Fig. 8.9.4.1.3.2 Fishing mortalities estimated by SURBA using trawl surveys age composition (MEDITS).



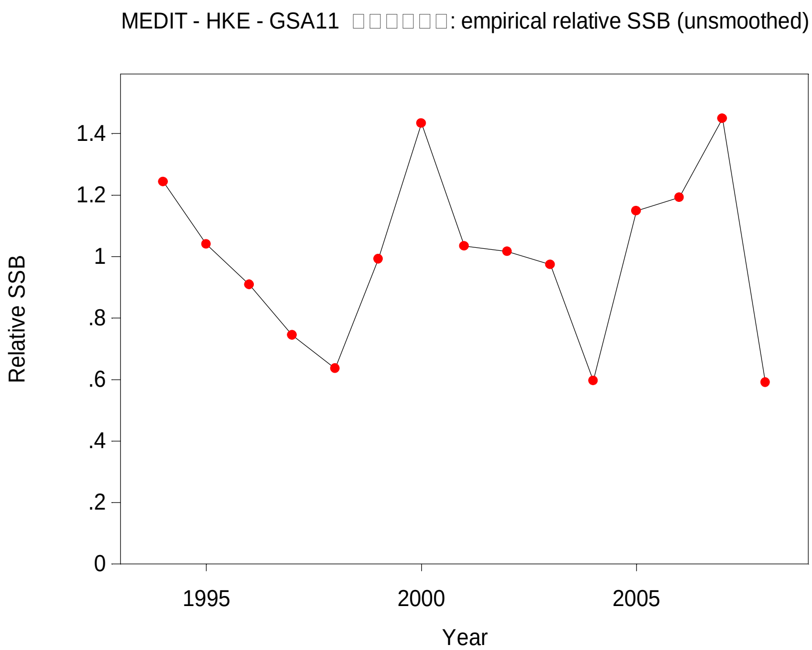


Fig. 8.9.4.1.3.3 SSB trend estimated by SURBA using trawl surveys age composition (MEDITS).

Relative indices estimated by SURBA indicated very high fluctuations of recruitment in the period 1994-2008, without a clear temporal pattern.

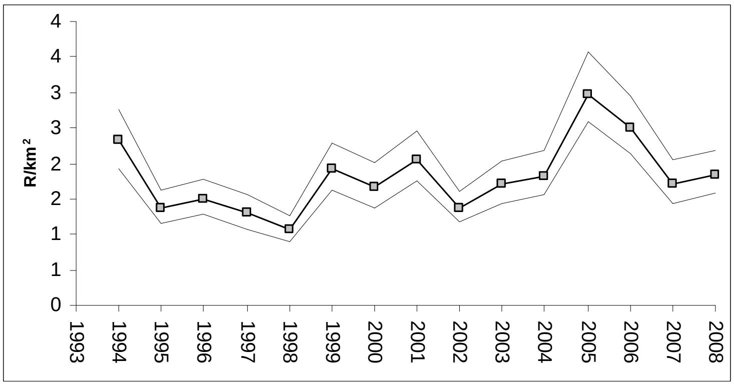


Fig. 8.9.4.1.3.4 Recruitment trend estimated by SURBA using trawl surveys age composition (MEDITS).

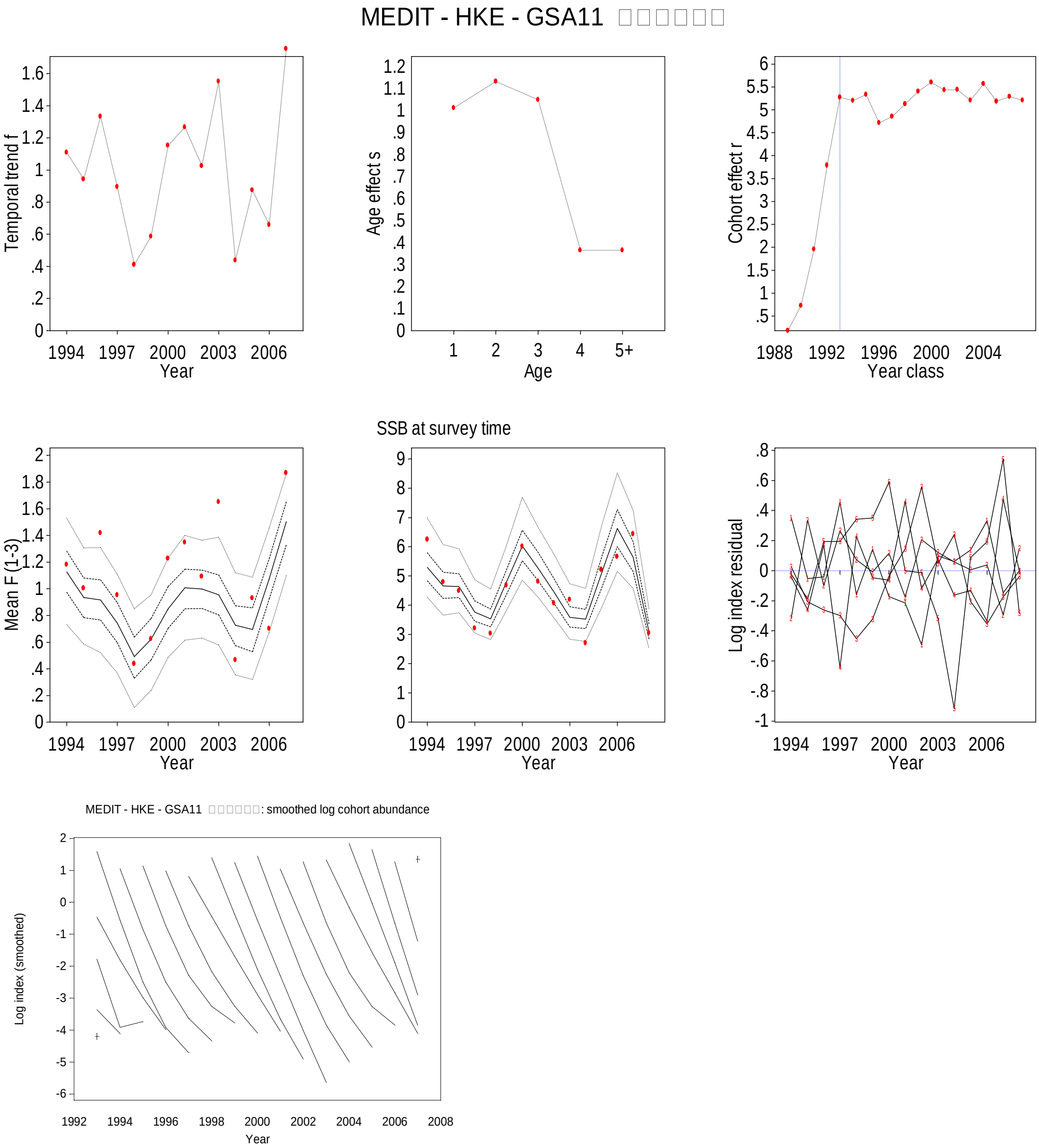


Fig. 8.9.4.1.3.5 Estimates of stock parameters derived from SURBA.

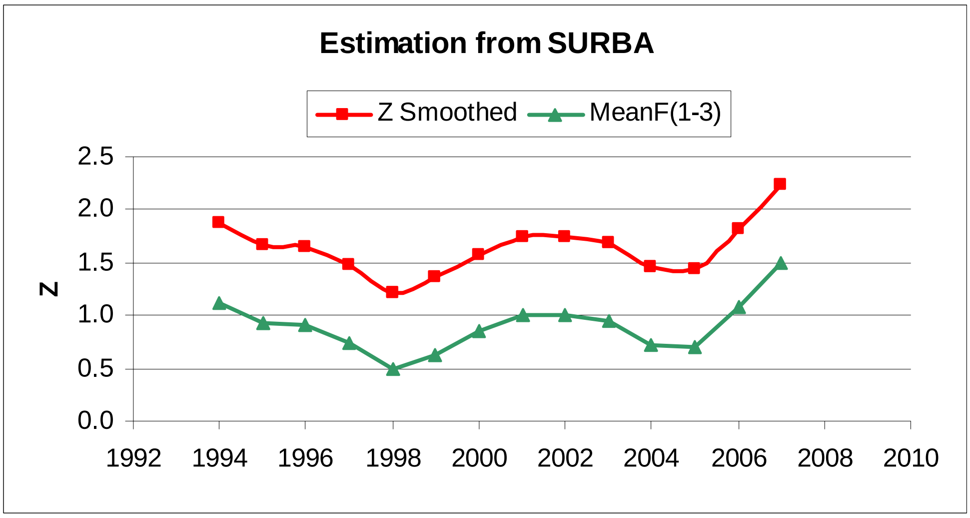


Fig. 8.9.4.1.3.6 Estimates of total and fishing mortality from SURBA.

Estimates of total and fishing mortality from SURBA showed a similar oscillatory pattern, increasing in the last years.

8.9.5.Long term prediction

8.9.5.1. Justification

State of the stock in relation to reference points was estimated using Yield software (Hoggarth et al., 2006).

8.9.5.2. Input parameters

See chapter 8.9.4.1.2.

8.9.5.3. Results

$F_{0.1}$ was assumed as target reference point. F_{max} and F_{ref} were considered as limit reference points. F_{ref} match to F where the ratio SSB/initial SSB is equal to 0.30. The following mean values were obtained: F_{max} = 0.25; $F_{0.1}$= 0.17 and F_{ref} = 0.21.

8.9.6.Scientific advice

8.9.6.1. Short term considerations

8.9.6.1.1. State of the spawning stock size

SGMED-09-02 could not estimate the absolute levels of stock abundance. Survey abundance (n/km²) and biomass (kg/km²) indices do not indicate a significant trend. The stock SSB is more variable over the last decade.

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

8.9.6.1.2. State of recruitment

SGMED-09-02 could not estimate the absolute levels of recruitment. Relative indices estimated by SURBA indicated very high fluctuations of recruitment in the period 1994-2008, without a clear temporal pattern.

8.9.6.1.3. State of exploitation

Trends in the average fishing mortality over ages 1 to 3 derived from MEDITS surveys ranged from 1 to 2.3, with the highest value observed in the last year. SGMED notes that the current F is far in excess of the proposed target reference point $F_{0.1}$. Assuming similar selection patters of the survey and the commercial fishery, SGMED concludes that the stock is heavily overfished.

8.10. Stock assessment of hake in GSAs 15 and 16

8.10.1. Stock identification and biological features

8.10.1.1. Stock Identification

The stock structure of hake in the Strait of Sicily is not well known. Levi *et al*. (1994) compared the growth of *M. merluccius* in Mediterranean and found quite a similar pattern in individuals from the Northern side of the Strait of Sicily (GSAs 15 and 16) and those caught in the Gulf of Gabes (GSA 14). Lo Brutto *et al*. (1998) have also found no evident of genetic subdivisions or significant differences in allelic frequencies, between samples near Sicily and those from the mid-line. More recently Levi *et al*. (2004) applied electrophoretic, morphometric and growth analyses to test the hypothesis of the existence of a unique stock of hake in the Sicily channel, which includes part of the North African continental shelf off the Tunisian coast and the shelf off the southern Sicilian coast. Although the level of genetic variation detected at five selected sampling sites was very low, morphometric analyses and otolith readings revealed some significant differences at phenotypic level, mainly in females. On the basis of the spatial distribution of spawning and nursery areas compared with the current patterns in the Strait of Sicily, Camilleri *et al*., (in press) believed the existence of genetic exchange between hake sub-populations inhabiting GSAs 15 and 16. In consequence it was decided to perform a common assessment for hake in GSA 15 and 16.

Despite very small specimens of 3.5 cm TL (Sinacori G., pers. com.) were caught during fine mesh trawl surveys, hake is considered fully recruited to grounds at 10 cm TL (SAMED, 2002). Differently to other areas of the Mediterranean, where two main recruitment pulses are known (Orsi Relini *et al*., 2002), the analysis of the length frequency distribution through year suggest that in GSA 15 and 16 recruits reach grounds all year round (SAMED, 2002).

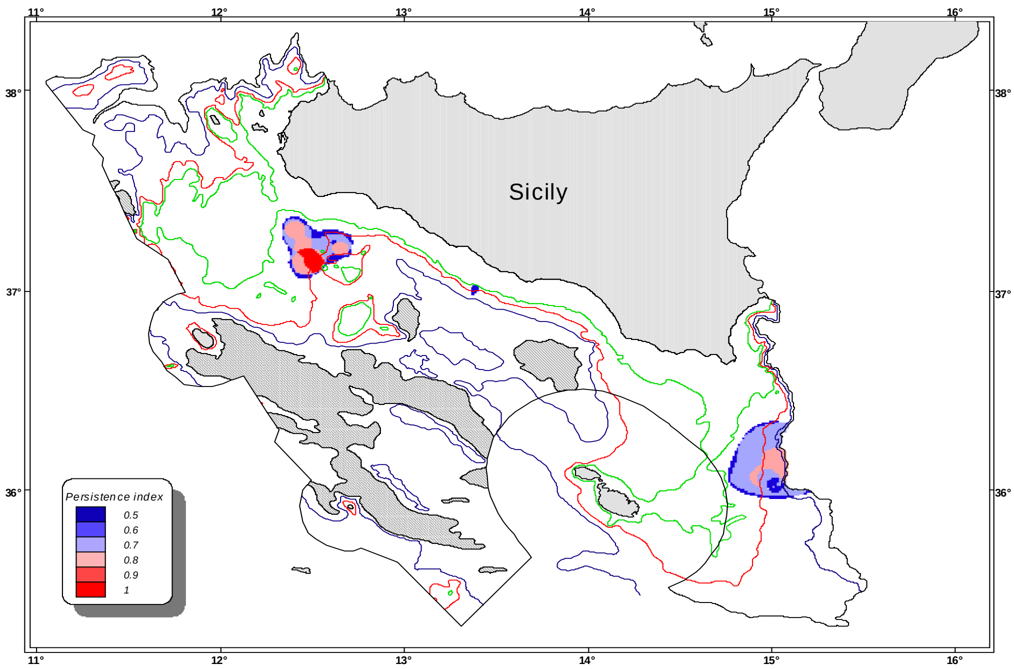


Fig. 8.10.1.1.1 Areas showing stable presence of recruits of *M. merluccius* between 1994 and 1999 in GSA 15 and 16, excluding the Maltese Fisheries Management Zone (FMZ). The index of persistence ranges between 0 and 1, where 1 indicates stable nursery and 0 absence of nursery (modified from Fiorentino *et al*., 2003b).

In the northern sector of the Strait of Sicily (GSA 15 and 16), although some inter-annual variability in the nurseries distribution was evident, two stable areas for hake were identified, which are related with the presence of meso-scale oceanographical processes. These nurseries were located on the eastern side of the Adventure and Malta banks, between 100 and 200 m depth (Fig. 8.10.1.1.1).

On the basis of trawl surveys carried out in the northern side of the Strait (GSA 15 & 16) sex ratio is around 0.5 between 12 and 24 cm TL, while females prevail on males mainly at larger sizes (SR≥0.90 after 36 cm TL) (SAMED, 2002). In GSA 16 sex ratio shows a significant decrease (r_s=-0.673) with time, showing a reduction of females in the population since 1994 (Fiorentino *et al*., 2005).

A study by Andaloro *et al*., (1985) in the Strait of Sicily found that hake's diet varied according to size. Smallest fish of 4.5-12 cm TL feed mainly on Euphausiacea. Decapods are the main preys of hake between 13 and 24 cm TL, while fish is the preferred food of individuals larger than 25 cm TL. Similar feeding behaviour that varied with size has also been observed for other areas in the Mediterranean (see Colloca, 1999).

8.10.1.2.Growth

Considering the northern sector of the Strait of Sicily (GSA 15 and 16) the observed maximum length is 88 cm TL in females (Fiorentino *et al*., 2003a) and 53 cm TL in males (Sinacori G., pers. com.). According to Fiorentino *et al*. (2003a), the maximum estimated age in years in the exploited standing stock, resulted to be 15 years. This was established by thin section otolith lectures of largest females collected in trawl surveys for over 15 years. On the basis of comparison of results produced by different methods to estimate natural mortality (Chen & Watanabe; Beverton & Holt Invariants, Alagaraya), M=0.34 in females and M=0.43 in males were proposed as reference values for stock assessment purposes (SAMED, 2002).

With the exception of Andaloro *et al*. (1985), hake showed similar growth patterns in populations inhabiting the Strait of Sicily and the adjacent seas. Excluding the values given by Andaloro *et al*. (1985), the mean growth rates per month during the first two years range between 0.92 and 1.1 cm in females and 0.86 and 1.0 cm in males. These rates are compatible with those reported for juvenile hake in the Mediterranean by Fiorentino *et al*. (2000). The growth parameters were reported in Table 7.10.1.2.1.

Tab. 8.10.1.2.1 Von Bertalanffy growth function (cm;y) and length-weight relationship (cm;g) parameters in GSA 16.

	Sex	Linf	K	t_0	a	b
CNR_IAMC; 2007	Females	81.54	0.15	-0.08	0.0043	3.1525
	Males	53.58	0.22	-0.13	0.0049	3.1028

8.10.1.3.Maturity

Although spawning off Tunisia (GSA 12) occurs all over the year, Bouhlel (1973) reported three maturity peaks, in summer, winter and spring depending to the size of females. The largest females (LT> 40 cm) spawn mainly in spring, while the smallest (29<TL<39 cm) have two main spawning peaks one in summer and another one in winter. Bouaziz *et al*. (1998), studied samples from Bou-Ismail (GSA 4), reported that the spawning season runs throughout the whole year, even if a peak in summer is evident. According to Levi (1991), in GSA 15 and 16 mature specimens were collected both in autumn (November) and winter (February). Information on the northern sector of the Strait of Sicily (GSA 16) show that outer shelf on the western side of Adventure Bank might be a relevant spawning area (Fiorentino *et al*., 2006). According to literature spawning should occur in the outer shelf-upper slope. Aggregation of mature adults was reported between 100 and 200 m in the Gulf of Tunis (Bouhlel, 1973).
The parameters of maturity ogive were: L50% of 35.6 cm TL and 0.29 the corresponding slope in females, L50% of 24.6 cm TL and 0.23the corresponding slope in males (CNR_IAMC, 2007).

8.10.2. Fisheries

8.10.2.1. General description of fisheries

Although hake is not a target of a specific fishery, such as deep water pink shrimp and striped mullet, it is the third species in terms of biomass which is landed in GSA 16 (Fiorentino *et al*., 2005). Hake is caught by trawling in a wide depth range (50-500 m) together with other important species such as *Nephrops norvegicus*, *Parapenaeus longirostris*, *Eledone* spp., *Illex coindetii*, *Todaropsis eblanae*, *Lophius* spp., *Mullus* spp., *Pagellus* spp., *Zeus faber*, *Raja* spp. among others. In the northern sector of the Strait of Sicily (GSA 15 and 16) although hake is fished by long lines and gill-net (Gangitano *et al*., 2007) more than 95% of the catches are obtained by bottom trawling.

A rough delimitation of the most important commercial macro-areas for a large part of the Strait of Sicily is reported in Andaloro (1996). Main fishing-grounds, species caught, fishing periods and other relevant information of the Mazara distant trawl fleet fishing for hake in the Strait of Sicily are reported in Fiorentino *et al*. (2007). Very detailed maps of the trawling grounds for Maltese Fisheries Management Zone (FMZ), including a wide part of GSA 15 are available (Camilleri *et al*., in press). Most of the Maltese effort of bottom longlining and trammel netting is concentrated within a short radius around the major fishing ports with large areas being slightly exploited (Camilleri *et al*., in press).

The Italian and Maltese trawlers operating in the Strait of Sicily use the same typology of trawl net called "Italian trawl net". Although some differences in material between the net used in shallow waters ("banco" net, mainly targeted to shelf fish and cephalopods) and that employed in deeper ones ("fondale" net, mainly targeted to deep water crustaceans) exist, the Italian trawl net is characterized by a low vertical opening (up to 1.5 m) with dimensions changing with engine power (Fiorentino *et al*., 2003a).

8.10.2.2. Management regulations applicable in 2008 and 2009

At present there are no formal management objectives for hake fisheries in the Strait of Sicily. As in other areas of the Mediterranean, the stock management is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area closures), and minimum landing sizes (EC 1967/06).

In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late eighties. After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity is occurring. Furthermore from 1987 to 2005 a 30-45 days stopping of fishing activities was enforced each year, although in different ways, in order to reduce fishing effort. However this measure is considered less effective in order to protect hake juveniles. In Malta the trawling fleet has been stable since the early 2000 with 16 trawlers having a license to fish. Unfortunately in 2008 due to a reduction in capacity of other fleets 8 new trawl licenses will be issued that will increase the trawl capacity for Malta by 50%.

The new regulation EC 1967 of 21 December 2006 fixed a minimum mesh size of 40 mm for bottom trawling of EU fishing vessels (Italian and Maltese trawlers). The mesh has to be modified in square 40 mm or diamond 50 mm after July 2008, however derogations are possible up to 2010.

A further and more effective improvement in the exploitation pattern of hake might be obtained through an integrative technical measure having a similar effect to the increasing of mesh size, i.e. the protection of hake nurseries. Differently from red mullet, whose nurseries are in the already protected bottoms within three nautical miles from the coast, the location of hake nurseries are on discrete off-shore areas on the outer shelf (100-200 m) and in international waters making the possibility of protecting the nursery areas a difficult task especially with respect to enforcement (see Fig. 8.10.1.1.1).

It must be outlined the existence in the Strait of Sicily of the Maltese FMZ which extends up to 25 nautical miles from baselines around the Maltese islands, where fisheries are specifically managed on the basis of capacity control (EC 813/04; EC 1967/06).

The access of Community vessels to the waters and resources in the FMZ is regulated as follows:
(a) fishing within the management zone is limited to fishing vessels smaller than 12 metres overall length using other than towed gears and;
(b) the total fishing effort of those vessels, expressed in terms of the overall fishing capacity, does not exceed the average level observed in 2000-2001 that corresponds to 1 950 vessels with an overall engine power and tonnage of 83 000 kW and 4 035 GT respectively.

Trawlers not exceeding an overall length of 24 metres are authorised to fish in certain areas within the management zone. The overall fishing capacity of the trawlers allowed to operate in the management zone must not exceed the ceiling of 4 800 kW and the fishing capacity of any trawler authorised to operate at a depth of less than 200 metres must not exceed 185 kW. Trawlers fishing in the management zone hold a special fishing permit in accordance with Article 7 of Regulation (EC) No 1627/94 and are included in a list containing their external marking and vessel's Community fleet register number (CFR) to be provided to the Commission annually by the Member States concerned.

8.10.2.3.Catches

8.10.2.3.1. Landings

The most recent Italian and Maltese data were collected within the framework of the DCR. Available information is considered feasible by the experts attending the working group. Andreoli *et al*. (1995) estimated yield of hake landed by trawling with 1-2 day trip of commercial fisheries of southern coasts of Sicily (GSA 15 and 16) in the middle eighties. Between April 1985 and March 1986 landing was about 1440 tons; the next year it amounted to 1,238 tons.

Tab. 8.10.2.3.1.1 Landings (t) of hake by fishing technique by the Sicilian (ITA) and Maltese (MLT) fleets (DTS = demersal trawl; HOK = gears using hooks; PGP = polyvalent passive gears; PMP = combining mobile and passive gears; PTS = pelagic trawl). Landings data provided for the years 2002 and 2003, must have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
HKE	15	MLT	[LHP] [LHM]				0			
HKE	15	MLT	FPO				0			
HKE	15	MLT	GNS				0			
HKE	15	MLT	GTR				1	0	0	0
HKE	15	MLT	LLD				0			
HKE	15	MLT	LLS				2	1	2	1
HKE	15	MLT	LTL				0	0		0
HKE	15	MLT	OTB				4	5	6	1
HKE	15	MLT	Other				0			
HKE	15	MLT	TBB							0
HKE	16	ITA	DTS	1716292	1960135					
HKE	16	ITA	GTR				46	6	83	16
HKE	16	ITA	LLS			0	23	22	36	12
HKE	16	ITA	OTB			1949	1720	1598	1599	1367
HKE	16	ITA	OTM							0
HKE	16	ITA	PGP	91753	11820					
HKE	16	ITA	PMP	51884	23321					

Considering that overall yield of trawling was about 9,666 tons in 2006 and 8,052 tons in 2007, hake landings representing about 14-15% of total yield in the area. On the basis of 2008 data, about 98% of Sicilian landings are due to trawling (Table 8.10.2.3.1.1). Furthermore, hake yield corresponded to less than 10% of the whole demersal landing of Sicilian fisheries in the Strait of Sicily. To note that landings of hake in the Sicilian ports do not derive solely from GSA 16 but from GSA 15 and 16 with some catches also from other GSAs in the Strait of Sicily.

The Maltese hake yield decreased from 10 t in 1985 to about 1 t in 1992; the following years it fluctuated around 5 t. This reduction could be partially explained by the reduction in the amount of trawlers during the 1980s and a change in target species of the remaining trawlers, which fished mainly for red shrimps from the mid nineties onwards.

Total annual landings are shown in Fig. 8.10.2.3.1.1 IREPA source. The data as reported through the DCF data call are listed in Table A3.1 of Appendix 3.

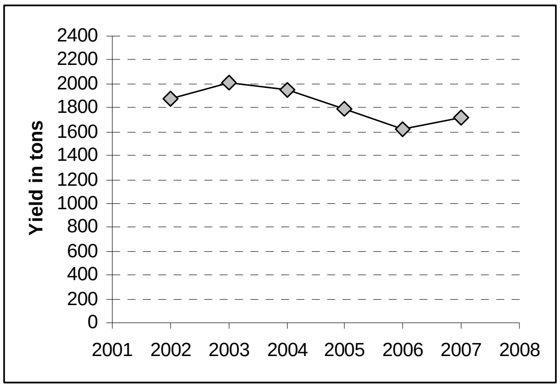


Fig. 8.10.2.3.1.1 The Italian hake yield in GSA 15 and 16 (IREPA source).

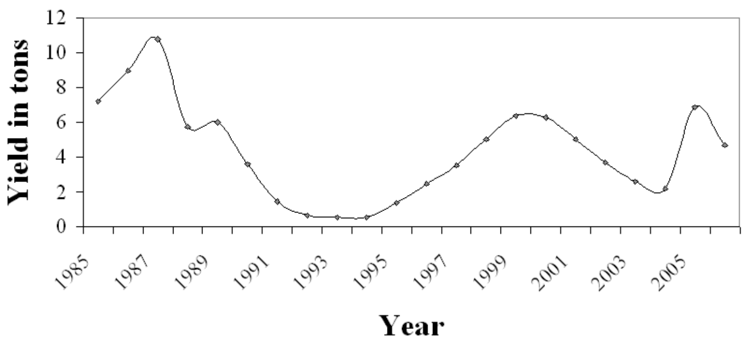


Fig. 8.10.2.3.1.2 The Maltese hake yield (GSA 15; all gears combined).

As the length compositions of landing concerns, information is available only for the Sicilian vessels. Data were considered representative since the 3rd quarter of 2005, when a sampling scheme allowing a realistic raising of the sampled catches to the total ones was adopted (SIBM, 2005).

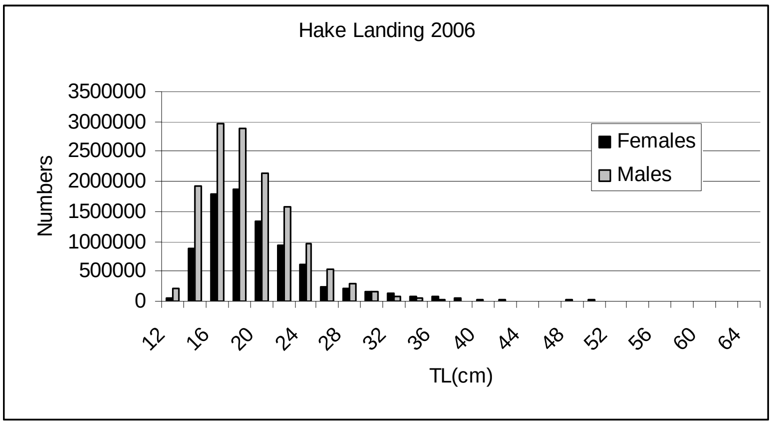


Fig. 8.10.2.3.1.3 Yearly length structure of hake landings by sex in absolute numbers of Sicilian trawlers in 2006 (GSA 15 and 16).

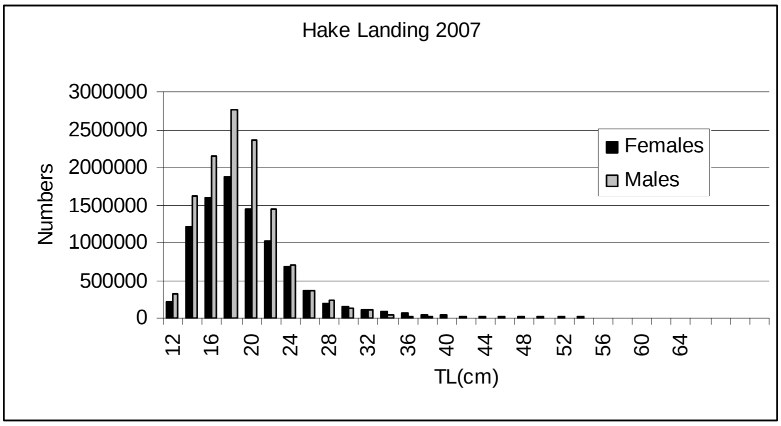


Fig. 8.10.2.3.1.4 Yearly length structure of hake landings by sex in absolute numbers of Sicilian trawlers in 2007 (GSA 15 and 16).

8.10.2.3.2. Discards

In the late nineties Sicilian trawlers fishing off-shore (15 – 25 days of trip) had higher discard rates of hake (86% in number and 31% in weight) than the inshore trawlers (1-2 days trips) (32% in number and 9% in weight) (Anon., 2000). For distant fisheries the first modal group (10-12 cm) in the catches was totally discarded. This is due to the intensive use of the working time and the space in the cold cellar for high prised crustaceans. Conversely trawlers operating in coastal waters tend to reduce the discarded fraction to the smallest specimens of the first age group present in the catches.

More recent data, collected within the framework of DCR, showed that discarded fraction of undersized hakes by Sicilian trawlers seems to decrease (13% in number and 3% in weight in 2006), amounting to about 48 tons in 2008. The mean size of the discarded hakes varies according to the season. During 2006 the length at 50% discard of the Sicilian trawlers ranged between 12.9 (summer and autumn) and 15.0 (spring) cm TL, being 13.5 cm TL the yearly value (Gancitano V., pers. comm.).

Annual discards are listed in Table A3.9 of Appendix 3.

8.10.2.3.3. Fishing effort

The trend in fishing effort by year and major gear type is listed in Tab. 8.10.2.3.3.1. The data are listed in Tables A3.10-A3.12 of Appendix 3.

Tab. 8.10.2.3.3.1 Trend in annual effort (days at sea, GT*days, kW*days) by country and gears in GSAs 15 and 16, 2002-2008.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	15	MLT	[FPO]							596
DAYS	15	MLT	[GNS]				51			78
DAYS	15	MLT	[GTR]				200	152	320	244
DAYS	15	MLT	[LA]					1116	1096	978
DAYS	15	MLT	[LHP] [LHM]				157			337
DAYS	15	MLT	[LLD]				3164		2827	3264
DAYS	15	MLT	[LLS]				1197	1466	1624	2104
DAYS	15	MLT	[LTL]				263	142		
DAYS	15	MLT	[OTB]				421	404	688	1149
DAYS	15	MLT	[PS]							216
DAYS	15	MLT	[SB] [SV]						59	36
DAYS	15	MLT	[TBB]							10
DAYS	15	MLT	Other gear				64			163
DAYS	16	ITA	DTS	87300	76233	81853				
DAYS	16	ITA	FPO				18	20	28	
DAYS	16	ITA	GND				6717	6218	7547	
DAYS	16	ITA	GTR				78429	52961	50840	
DAYS	16	ITA	HOK			14856				
DAYS	16	ITA	LHP-LHM				1363	3695	4674	
DAYS	16	ITA	LLD				5759	6397	8493	
DAYS	16	ITA	LLS				16424	22888	19638	
DAYS	16	ITA	LTL				300	408		
DAYS	16	ITA	MIS				262			
DAYS	16	ITA	OTB				83124	84674	82261	
DAYS	16	ITA	OTM				756	1540	1471	
DAYS	16	ITA	PGP	146019	118660	118425				
DAYS	16	ITA	PMP	26655	34956	6939				
DAYS	16	ITA	PS				1612	2066	1971	
DAYS	16	ITA	PTM				1204	3746	4193	
DAYS	16	ITA	PTS	8778	8568	4899				
GT*DAYS	15	MLT	[FPO]							2061
GT*DAYS	15	MLT	[GNS]				135			175
GT*DAYS	15	MLT	[GTR]				1174	477	1023	570
GT*DAYS	15	MLT	[LA]					23999	29596	20678
GT*DAYS	15	MLT	[LHP] [LHM]				486			968
GT*DAYS	15	MLT	[LLD]				82011		60606	58322
GT*DAYS	15	MLT	[LLS]				16866	18866	18072	16220
GT*DAYS	15	MLT	[LTL]				2539	639		
GT*DAYS	15	MLT	[OTB]				24878	34527	69268	109332
GT*DAYS	15	MLT	[PS]							9036
GT*DAYS	15	MLT	[SB] [SV]						139	71
GT*DAYS	15	MLT	[TBB]							214
GT*DAYS	15	MLT	Other gear				226			400
GT*days	16	ITA	DTS	6739948	6175213	6673029				
GT*DAYS	16	ITA	FPO				531	939	2962	
GT*DAYS	16	ITA	GND				51767	68581	70266	
GT*DAYS	16	ITA	GTR				183252	139048	146474	
GT*days	16	ITA	HOK			764595				
GT*DAYS	16	ITA	LHP-LHM				2757	7752	9603	
GT*DAYS	16	ITA	LLD				377485	290622	351965	
GT*DAYS	16	ITA	LLS				40376	41294	51455	
GT*DAYS	16	ITA	LTL				600	815		
GT*DAYS	16	ITA	MIS				1630			
GT*DAYS	16	ITA	OTB				7064255	7088706	6994494	
GT*DAYS	16	ITA	OTM				65935	141508	135199	
GT*days	16	ITA	PGP	410857	732725	249032				
GT*days	16	ITA	PMP	375921	418892	20134				
GT*DAYS	16	ITA	PS				101266	114791	95754	
GT*DAYS	16	ITA	PTM				57807	197450	225837	
GT*days	16	ITA	PTS	585964	327460	224188				

Tab. 8.10.2.3.3.1 Continue.

GT*days	16	ITA	PGP	410857	732725	249032				
GT*days	16	ITA	PMP	375921	418892	20134				
GT*DAYS	16	ITA	PS				101266	114791	95754	
GT*DAYS	16	ITA	PTM				57807	197450	225837	
GT*days	16	ITA	PTS	585964	327460	224188				
KW*DAYS	15	MLT	[FPO]							50771
KW*DAYS	15	MLT	[GNS]				2121			4379
KW*DAYS	15	MLT	[GTR]				13889	8391	20724	14361
KW*DAYS	15	MLT	[LA]					203361	208456	175644
KW*DAYS	15	MLT	[LHP] [LHM]				6757			19368
KW*DAYS	15	MLT	[LLD]				554562		449900	502339
KW*DAYS	15	MLT	[LLS]				140846	159692	160914	210146
KW*DAYS	15	MLT	[LTL]				26318	10210		
KW*DAYS	15	MLT	[OTB]				129838	143909	240858	382542
KW*DAYS	15	MLT	[PS]							55823
KW*DAYS	15	MLT	[SB] [SV]						2507	1334
KW*DAYS	15	MLT	[TBB]							1785
KW*DAYS	15	MLT	Other gear				3394			6355
kW*days	16	ITA	DTS	23952310	20951845	21381964				
KW*DAYS	16	ITA	FPO				2602	4116	16280	
KW*DAYS	16	ITA	GND				484488	565283	560624	
KW*DAYS	16	ITA	GTR				2436223	1675235	1779917	
kW*days	16	ITA	HOK			3153486				
KW*DAYS	16	ITA	LHP-LHM				147929	332833	329113	
KW*DAYS	16	ITA	LLD				1102509	1319225	1938868	
KW*DAYS	16	ITA	LLS				812348	751898	805197	
KW*DAYS	16	ITA	LTL				2401	3260		
KW*DAYS	16	ITA	MIS				18900			
KW*DAYS	16	ITA	OTB				22936088	23764571	22757302	
KW*DAYS	16	ITA	OTM				159014	315468	300311	
kW*days	16	ITA	PGP	3133993	4603457	2691324				
kW*days	16	ITA	PMP	2792612	2761842	223470				
KW*DAYS	16	ITA	PS				444087	520717	459314	
KW*DAYS	16	ITA	PTM				280234	712936	862918	
kW*days	16	ITA	PTS	2510582	1750128	962786				

8.10.3.Scientific surveys

8.10.3.1.Medits

8.10.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSAs 15 and 16 the following number of hauls was reported per depth stratum (s. Tab. 8.10.3.1.1.1).

Tab. 8.10.3.1.1.1. Number of hauls per year and depth stratum in GSAs 15 and 16, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA15_010-050									1	3	6	1	1		
GSA15_050-100									6	13	10	5	5	12	6
GSA15_100-200									12	33	33	13	13	12	12
GSA15_200-500									9	26	23	9	9	4	9
GSA15_500-800									18	40	39	17	16	18	17
GSA16_010-050	4	4	4	4	4	4	4	4	7	7	7	10	10	11	11
GSA16_050-100	9	8	8	8	8	8	7	8	11	12	12	20	22	23	23
GSA16_100-200	4	4	4	4	5	5	6	5	11	10	11	20	19	21	21
GSA16_200-500	10	11	11	12	11	11	11	11	19	18	27	37	31	27	27
GSA16_500-800	10	14	14	13	14	14	14	14	20	20	21	33	33	38	38

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

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

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

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

Where:

- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.10.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.10.3.1.3. Trends in abundance and biomass

The trend in abundance and biomass as re-estimated by SGMED-09-02 are shown in Figures 8.10.3.1.3.4 and 8.10.3.1.3.5 for GSAs 15 and 16. While the trend in GSA 15 is quite short, recent abundance and biomass indices (2005-2008) in GSA 16 appear at the highest level observed since 1994. Such analyses of Medits indices are considered preliminary.

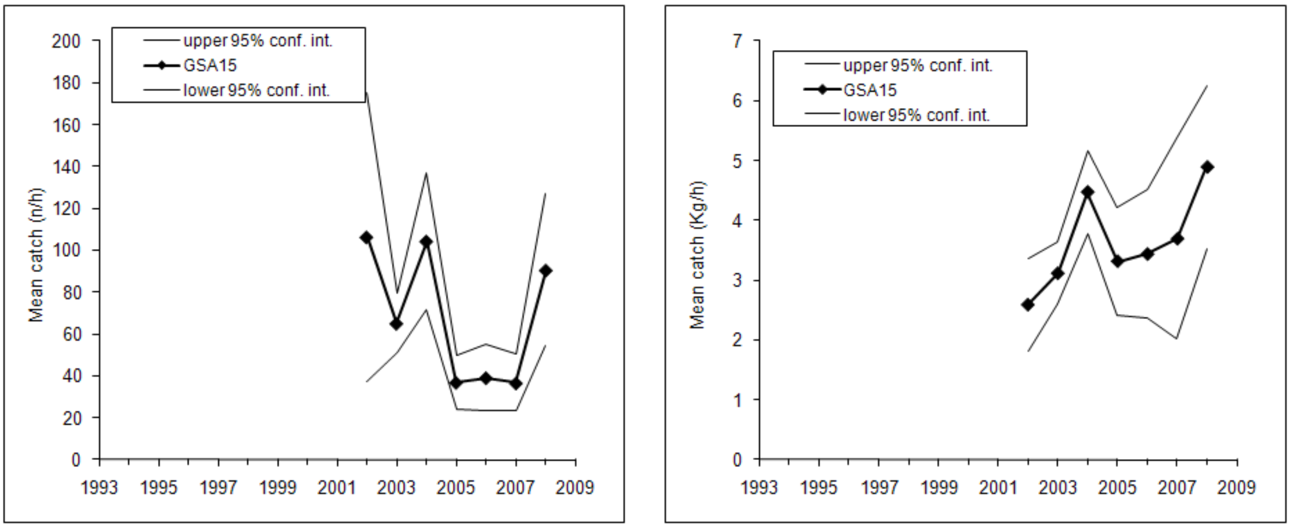


Fig. 8.10.3.1.3.4 Abundance and biomass indices of hake in GSA 15.

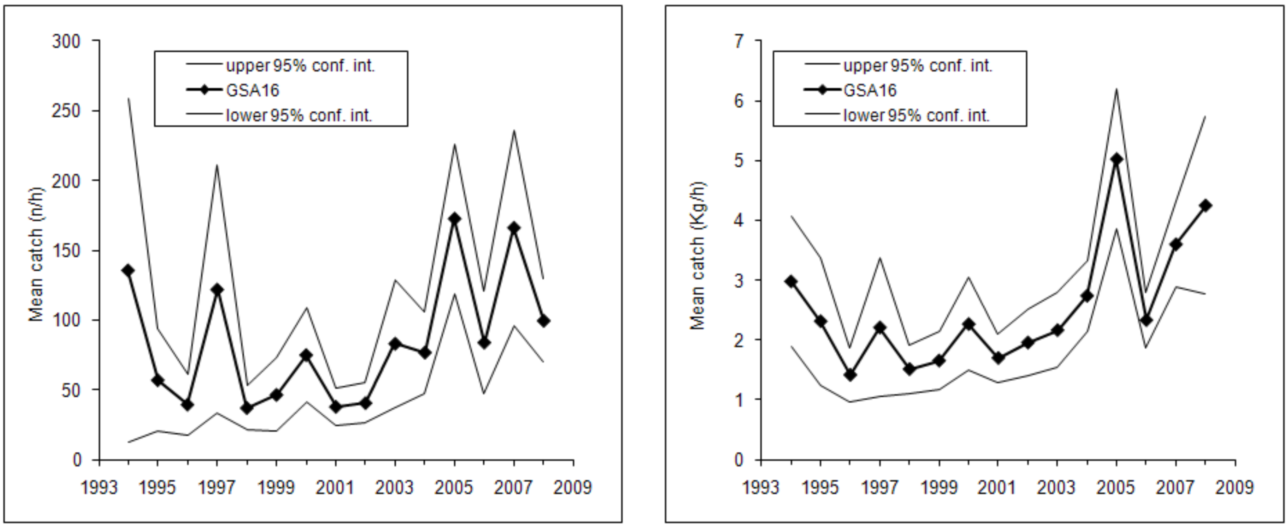


Fig. 8.10.3.1.3.5 Abundance and biomass indices of hake in GSA 16.

8.10.3.1.4. Trends in abundance by length or age

The following Fig. 8.10.3.1.4.1 displays the stratified abundance indices of GSA 15 in 2002-2008. These size compositions are considered preliminary.

The Figures 8.10.3.1.4.2 and 7.10.3.1.4.3 display the stratified abundance indices of GSA 16 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

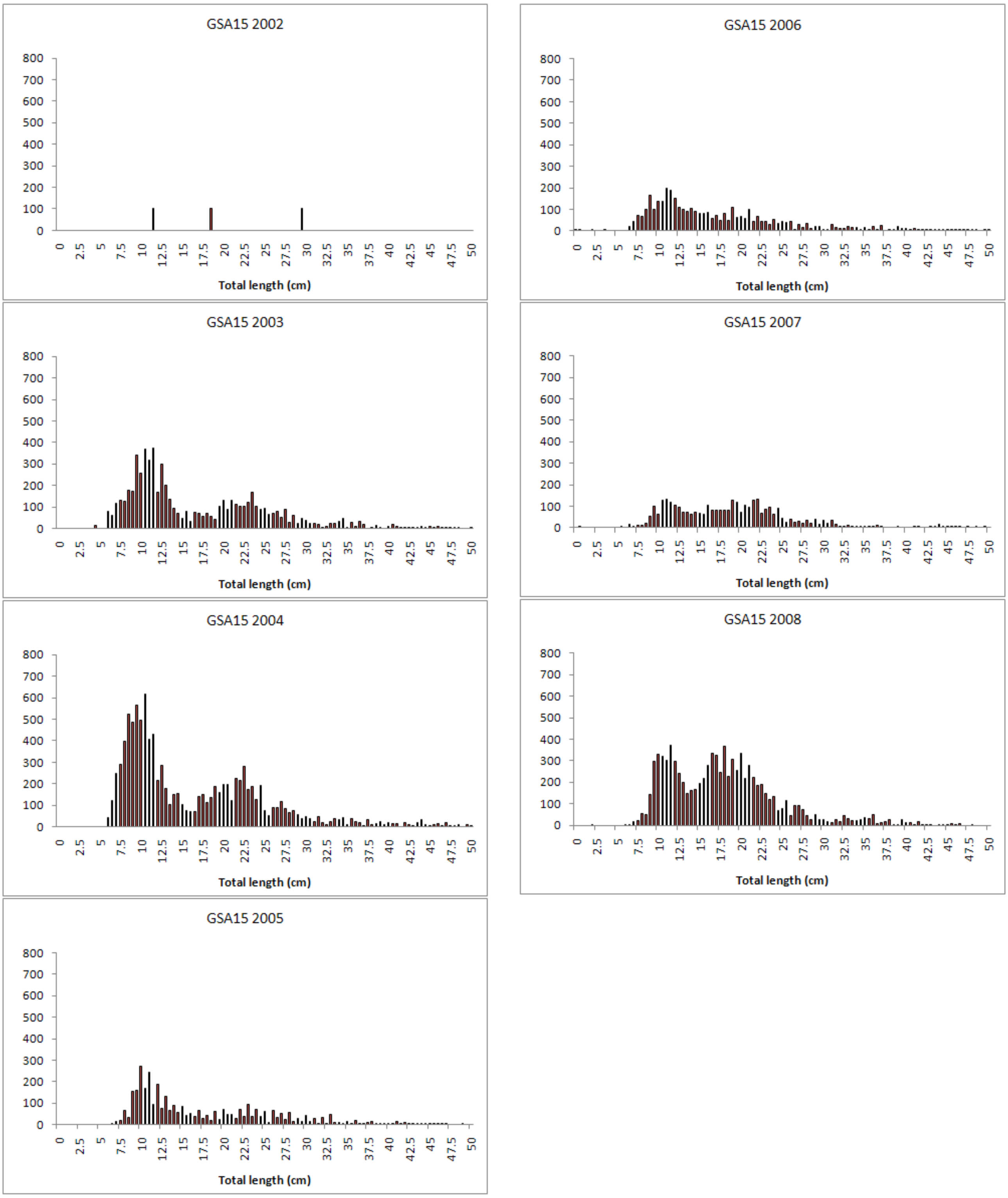


Fig. 8.10.3.1.4.1 Stratified abundance indices by size in GSA 15, 2002-2008.

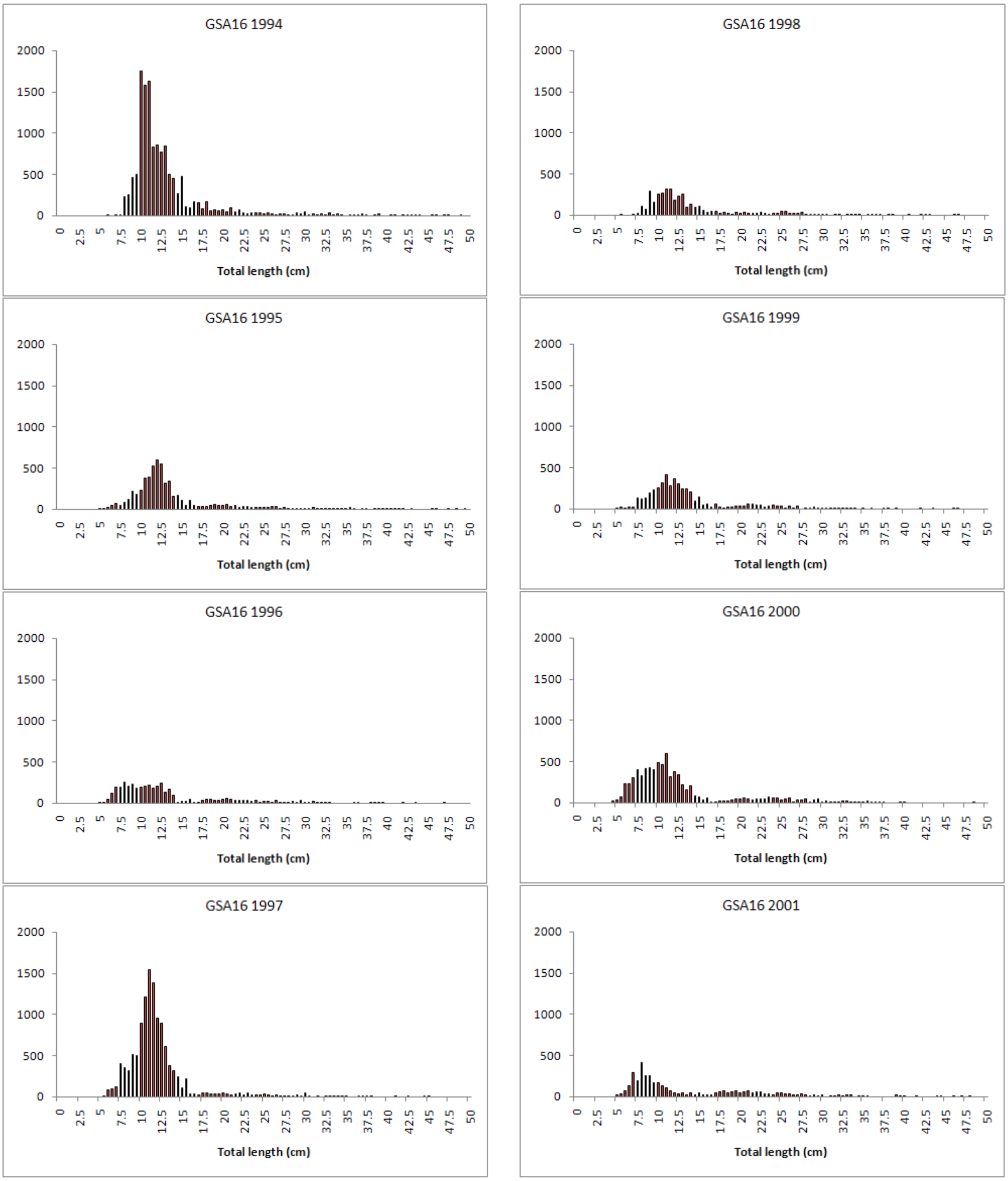


Fig. 8.10.3.1.4.2 Stratified abundance indices by size in GSA 16, 1994-2001.

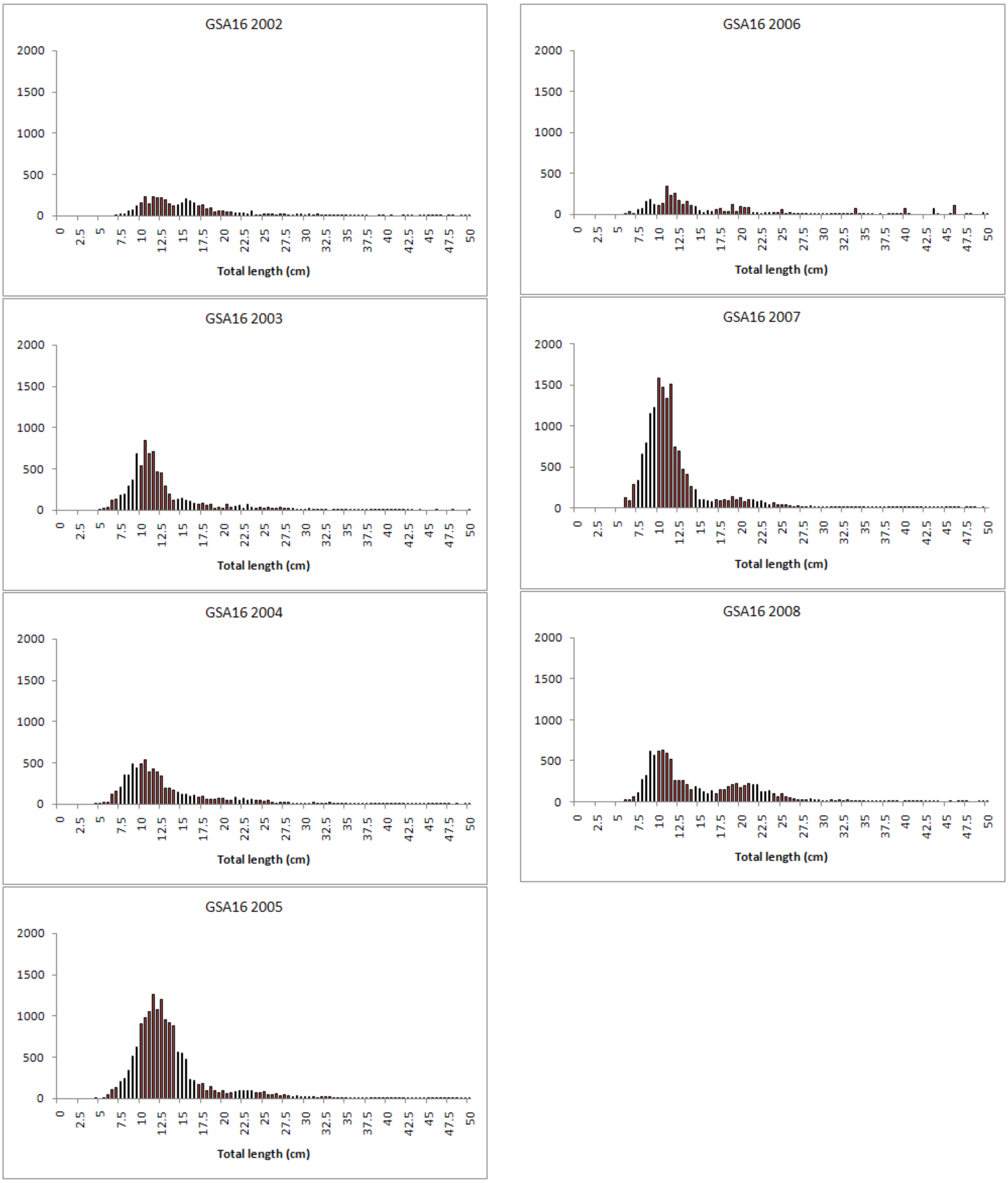


Fig. 8.10.3.1.4.3 Stratified abundance indices by size in GSA 16, 2002-2008.

8.10.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.10.3.1.6. Trends in maturity

No analyses were conducted during SGMED--09-02.

8.10.4. Assessment of historic stock parameters

SGMED 09-02 did not undertake any analytical assessment of hake in GSAs 15 and 16. Last year's assessments using Trends in LPUE, SURBA and VIT can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.10.5. Long term prediction

8.10.5.1. Justification

No forecast analyses were conducted.

8.10.5.2. Input parameters

No forecast analyses were conducted.

8.10.5.3. Results

Given the state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSAs 15 and 16.

8.10.6. Scientific advice

8.10.6.1. Short term considerations

8.10.6.1.1. State of the spawning stock size

The last updated information regarding the state of spawning stock for hake in GSAs 15 and 16 can be found in the last year's report of SGMED-08-04 working group (Cardinale et al., 2008).

8.10.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.10.6.1.3. State of exploitation

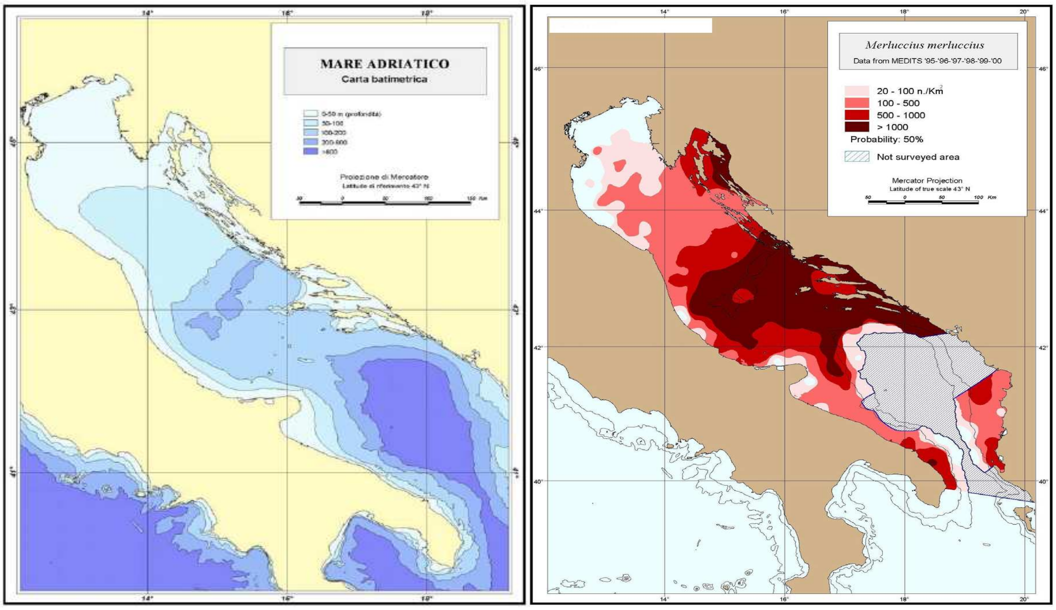
The last updated information regarding the state of exploitation for hake in GSAs 15 and 16 can be found in the last year's report of SGMED-08-04 working group (Cardinale et al., 2008).

8.11. Stock assessment of hake in GSA 17

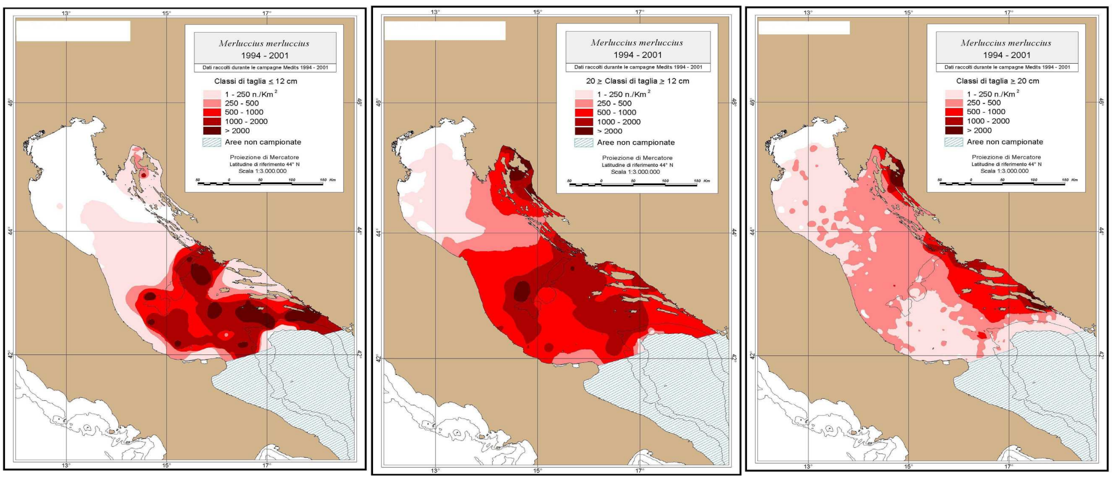
8.11.1.Stock identification and biological features

8.11.1.1.Stock Identification

The distribution of hake (*Merluccius merluccius*) in GSA 17, in spring-summer, is shown in the maps below, imported from Sabatella and Piccinetti (2004). The picture on the left provides details on the depth, increasing with darker colour (0-50, 50-100, 100-200, 200-800, > 800 m). The picture on the right displays the hake densities at sea from MEDITS trawl survey in the second half of the 1990s, expressed as number of individuals per square kilometre. In the GSA 17, higher densities are observed in the southern part and at depths between 100 and 200 m.



In the subsequent three maps, again imported from Sabatella and Piccinetti (2004), densities at sea are plotted taking into account different length ranges (increasing in the maps from left to right). In particular, individuals with length lower than 12 cm are concentrated in the southern part of the GSA 17. The individuals with length between 12 and 20 cm display the same pattern but are more diffuse; the same holds true for the individuals with length higher than 20 cm, but they are more abundant on the eastern side of Adriatic.



Spawning of hake occurs throughout the year with two peaks in winter and summer. Earliest spawning occurs in winter in deeper waters, up to 200 m, in the Pomo/Jabuka Pit (where the greatest depths in GSA 17 are observed). In the summer period, spawning occurs in shallower waters. Nursery areas are located close just to the Pomo/Jabuka Pit (Vrgoc *et al*., 2004).

8.11.1.2.Growth

No information was documented during SGMED-09-02.

8.11.1.3.Maturity

A reasonable value of length at the first sexual maturity for hake, in the GSA 17, is between 23 and 33 cm for females and between 20 and 28 cm for males, as reported by Zupanovic and Jardas (1986) (mentioned in Vrgoc *et al.,* 2004).

The summary of the values of length at the first sexual maturity estimated for the Adriatic Sea was imported from Vrgoc *et al.* (2004), as follows.

Author	Sex	L_m (cm)
Zei, 1949	M	22-30
Županović, 1968;	M	20-28
	F	26-33
Županović and Jardas, 1986	M	20-28
	F	23-33
Ungaro *et al*., 1993	M+F	25-30
Cetinić *et al*., 1999	M+F (Velebit Channel)	24

In conclusion, a meaningful percentage of caught hake has a length below the values of sexual maturity. This is a further reason for caution in managing this stock.

8.11.2.Fisheries

8.11.2.1.General description of fisheries

The fisheries for hake are one of the most important in the GSA 17. Fishing grounds mostly correspond to the distribution of the stock (SEC (2002) 1374).

8.11.2.2.Management regulations applicable in 2008 and 2009

According to Regulation (EC) 1967/2006 the minimum legal length for fishery is, for hake, equal to 20 cm.

8.11.2.3.Catches

8.11.2.3.1. Landings

On the basis of data collected for Italy through DCR from 2002 to 2008 (Tab. 8.11.2.3.1.1), landings are due, mainly, to bottom otter trawlers, which account for over 90% of the total. The data are listed in Table A3.1 of Appendix 3.

Tab. 8.11.2.3.1.1. Hake landings in GSA 17 by fishing technique, 2002-2008. Landings data provided for the years 2002 and 2003, probably have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
HKE	17	ITA	DRB	55639						
HKE	17	ITA	DTS	2338500	2386560					
HKE	17	ITA	GNS			17	39	50	26	32
HKE	17	ITA	GTR			2	6	4	2	3
HKE	17	ITA	OTB			2938	3421	4102	3525	3037
HKE	17	ITA	OTM					1		
HKE	17	ITA	PGP	1092	7027					
HKE	17	ITA	PMP	216073	179211					
HKE	17	ITA	PTM			1	0	1	0	
HKE	17	ITA	PTS	26130	33126					
HKE	17	ITA	TBB			88	142	237	212	105

Moreover, according to the FAO statistics (ftp://ftp.fao.org/fi/stat/windows/fishplus/gfcm.zip), in the northern and central Adriatic Sea, the annual landings of hake (see the figure below) in the 1980s and 1990s were estimated at around 2,000-4,000 t, with some peaks over 5,000 tonnes. A decreasing trend occurred from 1993 to 2000.

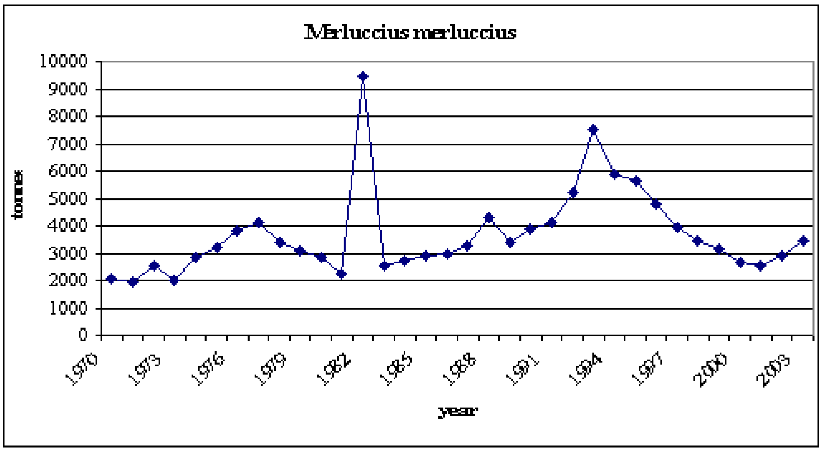


Fig. 8.11.2.3.1.1 FAO landing statistics 1970-2003.

8.11.2.3.2. Discards

No discards were reported to SGMED-09-02 through the DCR data call.

8.11.2.3.3. Fishing effort

Table 8.11.2.3.3.1 reveals an overall decreasing trend in effort of the major bottom otter trawl fleet.

Tab. 8.11.2.3.3.1. Trend in annual effort (days at sea, GT*days, kW*days) by country and gears in GSA 17, 2002-2008.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	17	ITA	DRB	58297	69126	64120	53905	55592	61072	
DAYS	17	ITA	DTS	124529	125106	134776				
DAYS	17	ITA	FPO				57270	75621	72165	
DAYS	17	ITA	FYK				16763	26395	33769	
DAYS	17	ITA	GND				1933	391	184	
DAYS	17	ITA	GNS				124822	104855	90594	
DAYS	17	ITA	GTR				17367	15132	17108	
DAYS	17	ITA	HOK			641				
DAYS	17	ITA	LLD				961	391	637	
DAYS	17	ITA	LLS					20	18	
DAYS	17	ITA	MIS				37020	17371	9020	
DAYS	17	ITA	OTB				129874	105577	94257	
DAYS	17	ITA	OTM				702	1044		
DAYS	17	ITA	PGP	335599	272040	287886				
DAYS	17	ITA	PMP	96386	98110	15512				
DAYS	17	ITA	PS				2702	2596	4037	
DAYS	17	ITA	PTM				16714	18236	17053	
DAYS	17	ITA	PTS	23522	25649	23387				
DAYS	17	ITA	TBB			12395	11382	15729	16246	
DAYS	17	SVN	PS					840	766	925
DAYS	17	SVN	PTM					556	669	489
GT*days	17	ITA	DRB	610984	724702	858864	701785	751815	886404	
GT*days	17	ITA	DTS	4521393	4459910	5624744				
GT*DAYS	17	ITA	FPO				129755	173844	155713	
GT*DAYS	17	ITA	FYK				21213	48049	62095	
GT*DAYS	17	ITA	GND				20395	4854	3540	
GT*DAYS	17	ITA	GNS				232491	192464	141092	
GT*DAYS	17	ITA	GTR				59566	55663	67511	
GT*days	17	ITA	HOK			9492				
GT*DAYS	17	ITA	LLD				15878	9200	12818	
GT*DAYS	17	ITA	LLS					39	35	
GT*DAYS	17	ITA	MIS				100776	38408	12101	
GT*DAYS	17	ITA	OTB				5488069	4273375	3993908	
GT*DAYS	17	ITA	OTM				1696	2995		
GT*days	17	ITA	PGP	631665	551556	518165				
GT*days	17	ITA	PMP	660337	545482	73495				
GT*DAYS	17	ITA	PS				87381	125919	228375	
GT*DAYS	17	ITA	PTM				1388235	1638485	1609761	
GT*days	17	ITA	PTS	1349466	1277088	1516671				
GT*days	17	ITA	TBB			673656	730413	1081644	1021605	
kW*days	17	ITA	DRB	6381241	7517860	6982982	5954396	6173978	6713642	
kW*days	17	ITA	DTS	27568094	27486393	26771813				
KW*DAYS	17	ITA	FPO				3599417	4907498	4431128	
KW*DAYS	17	ITA	FYK				850518	1383490	1518073	
KW*DAYS	17	ITA	GND				219617	53220	36434	
KW*DAYS	17	ITA	GNS				4556942	3978580	2419608	
KW*DAYS	17	ITA	GTR				977664	861488	1018946	
kW*days	17	ITA	HOK			153794				
KW*DAYS	17	ITA	LLD				188429	92528	134508	
KW*DAYS	17	ITA	LLS					1051	904	
KW*DAYS	17	ITA	MIS				2729814	1063909	288624	
KW*DAYS	17	ITA	OTB				25773719	20565276	19174064	
KW*DAYS	17	ITA	OTM				13347	20352		
kW*days	17	ITA	PGP	9297244	7646003	9120053				
kW*days	17	ITA	PMP	7989134	7039902	1072033				
KW*DAYS	17	ITA	PS				638587	718994	1270590	
KW*DAYS	17	ITA	PTM				6268640	6392893	6298871	
kW*days	17	ITA	PTS	7841347	7636049	6955633				
kW*days	17	ITA	TBB			3419642	3642104	5144016	5038186	

8.11.3.Scientific surveys

8.11.3.1.Medits

8.11.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 17 the following number of hauls was reported per depth stratum (s. Tab. 8.11.3.1.1.1).

Tab. 8.11.3.1.1.1. Number of hauls per year and depth stratum in GSA 17, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA17_010-050			2	2	2	2	2	2	62	47	51	63	49	60	53
GSA17_050-100									54	36	37	62	38	38	37
GSA17_100-200									50	27	23	43	22	24	23
GSA17_200-500									9	7	5	7	5	5	5
GSA17_500-800									1	1					

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = $Yst \pm t(\text{student distribution}) * V(Yst) / n$

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

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

frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.11.3.1.2. Geographical distribution patterns

See section 8.11.1.1.

8.11.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 17 was derived from the international survey Medits. Figure 8.11.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 17.

The analyses of Medits indices are considered preliminary.

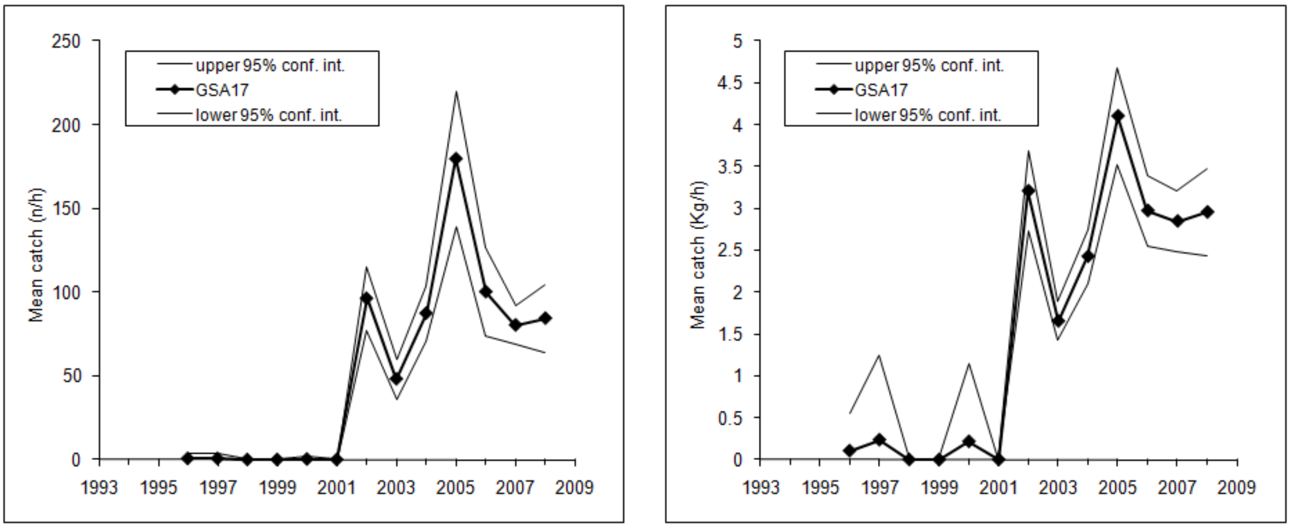


Fig. 8.11.3.1.3.1 Abundance and biomass indices of hake in GSA 17.

8.11.3.1.4. Trends in abundance by length or age

The following Fig. 8.11.3.1.4.1 displays the stratified abundance indices of GSA 17 in 2002-2008. These size compositions are considered preliminary.

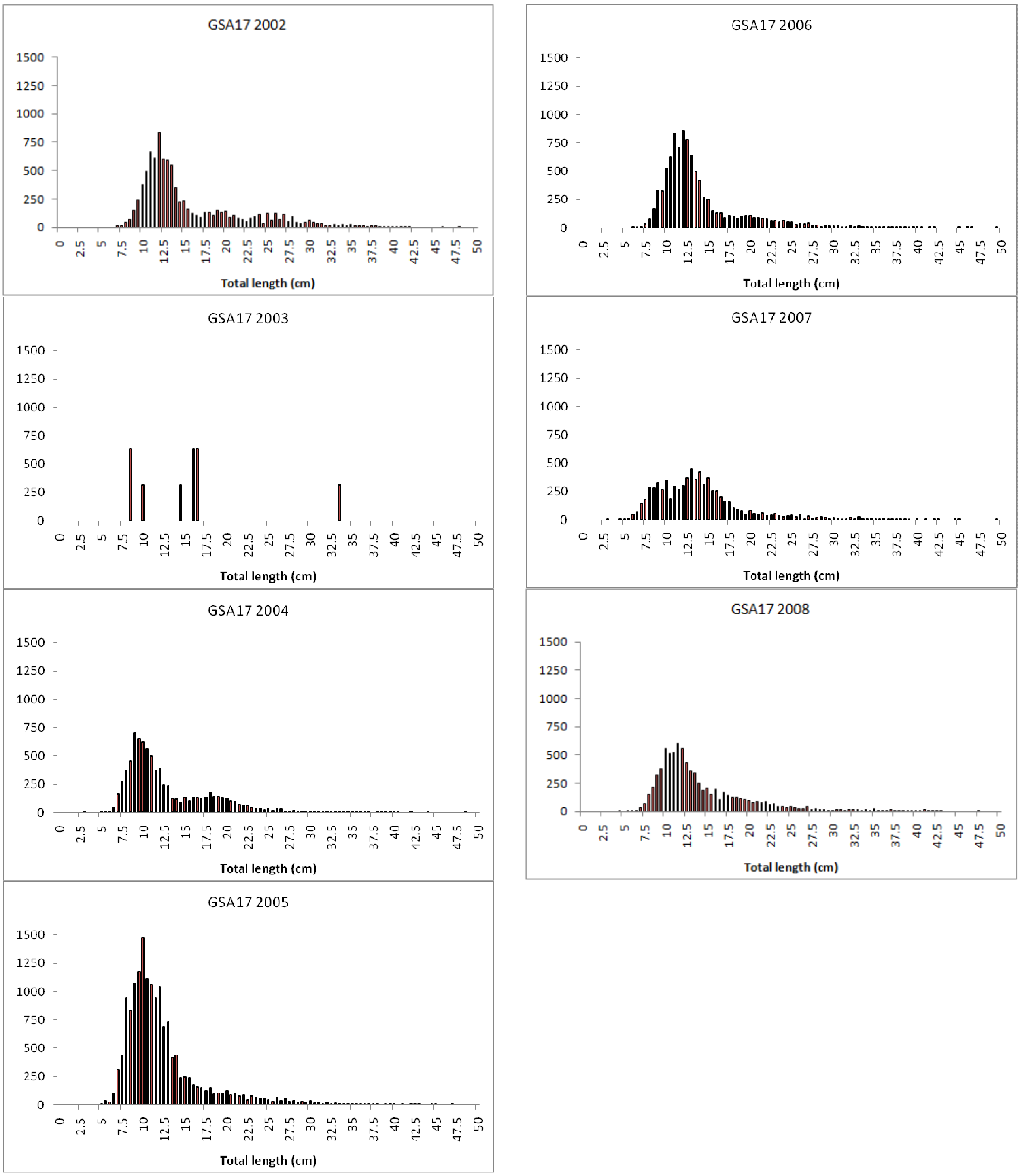


Fig. 8.11.3.1.4.1 Stratified abundance indices by size, 2002-2008.

8.11.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.11.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.11.4.Assessment of historic stock parameters

SGMED 09-02 did not undertake any analytical assessment of hake in GSA 17. Last year's preliminary assessment using Length Cohort Analysis (LCA) can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.11.5.Long term prediction

8.11.5.1.Justification

No forecast analyses were conducted.

8.11.5.2.Input parameters

No forecast analyses were conducted.

8.11.5.3.Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 17.

8.11.6.Scientific advice

8.11.6.1.Short term considerations

8.11.6.1.1. State of the spawning stock size

The average stock biomass estimated by LCA in 2006-2007 was around 4,000 tonnes. Without any biomass reference proposed or agreed, SGMED-09-02 is unable to fully evalute the state of the stock size.

8.11.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.11.6.1.3. State of exploitation

Without any biomass reference proposed or agreed, SGMED-09-02 is unable to fully evaluate the state of the exploitation.

8.12. Stock assessment of hake in GSA 18

8.12.1.Stock identification and biological features

8.12.1.1.Stock Identification

No information was documented during SGMED-09-02.

8.12.1.2.Growth

No information was documented during SGMED-09-02.

8.12.1.3.Maturity

No information was documented during SGMED-09-02.

8.12.2.Fisheries

8.12.2.1.General description of fisheries

STECF (stock review part II in 2007) noted that *Merluccius merluccius* is one of the most important species in the Geographical Sub Area 18 representing more than 20% of landings from trawlers. Trawling represents the most important fishery activity in the southern Adriatic Sea and a yearly catch of around 30,000 tonnes could be estimated for the last decades. Demersal species catches are landed on the western side (Italian coast) and the eastern side (Albanian coast), with an approximate percentage of 97% and 3%, respectively. Trawling is the most important fishery activity on the whole area (about 900 boats, 60% of total number of fishing vessels; 85% of gross tonnage). The Mediterranean hake is also caught by off-shore bottom long-lines, but these gears are utilised by a low number of boats (less than 5% of the whole South-western Adriatic fleet).

8.12.2.2.Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.12.2.3.Catches

8.12.2.3.1. Landings

SGMED-09-02 received the following information about hake landings in GSA 18 through the official DCR data call (Tab. 8.12.2.3.1.1). The landings are listed in Tab. A3.1 of Appendix 3. Landings by demersal trawlers dominate by far.

Tab. 8.12.2.3.1.1 Hake landings in GSA 18 by fishing technique, 2002-2008. Landings data provided for the years 2002 and 2003, probably have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
HKE	18	ITA	DTS	2005806	2899137					
HKE	18	ITA	GNS			19	38	31	19	15
HKE	18	ITA	GTR			21	18	26	18	42
HKE	18	ITA	LLS			233	454	837	620	551
HKE	18	ITA	MIS						0	
HKE	18	ITA	OTB			2932	3275	4613	3497	3643
HKE	18	ITA	PGP	26247	198611					
HKE	18	ITA	PMP	277090	1353022					
HKE	18	ITA	PTM			0				

8.12.2.3.2. Discards

No information was documented during SGMED-09-02.

8.12.2.3.3. Fishing effort

Tab. 8.12.2.3.3.1 lists the fishing effort reported to SGMED-09-02 through the DCR data call. The overview is given in Tab. A3.10-A3.12 of Appendix 3 to this report.

Tab. 8.12.2.3.3.1 Fishing effort in different units by fishing technique deployed in GSA 18, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	18	ITA	DRB	11081	5890	3865	6083	7723	8158	
DAYS	18	ITA	DTS	85424	71203	80259				
DAYS	18	ITA	GNS				41046	44570	31727	
DAYS	18	ITA	GTR				26899	29749	22260	
DAYS	18	ITA	HOK			1799				
DAYS	18	ITA	LHP-LHM					30		
DAYS	18	ITA	LLD				1207	580	371	
DAYS	18	ITA	LLS				18676	20819	16620	
DAYS	18	ITA	MIS				2446	872	49	
DAYS	18	ITA	OTB				82436	85956	70678	
DAYS	18	ITA	PGP	110621	63332	67232				
DAYS	18	ITA	PMP	53475	35980	3667				
DAYS	18	ITA	PS				1382	915	1014	
DAYS	18	ITA	PTM				2447	4006	4558	
DAYS	18	ITA	PTS	4140	4526	4679				
GT*days	18	ITA	DRB	101523	53962	41347	58156	78840	83726	
GT*days	18	ITA	DTS	2648217	2309802	2568868				
GT*DAYS	18	ITA	GNS				81222	103569	61647	
GT*DAYS	18	ITA	GTR				52099	34536	40270	
GT*days	18	ITA	HOK			27800				
GT*DAYS	18	ITA	LHP-LHM					30		
GT*DAYS	18	ITA	LLD				14253	5477	4533	
GT*DAYS	18	ITA	LLS				68422	77823	66105	
GT*DAYS	18	ITA	MIS				5104	4206	103	
GT*DAYS	18	ITA	OTB				2522892	2649998	2225039	
GT*days	18	ITA	PGP	262823	150987	120701				
GT*days	18	ITA	PMP	655187	416888	40920				
GT*DAYS	18	ITA	PS				166872	111889	125116	
GT*DAYS	18	ITA	PTM				181912	391845	506393	
GT*days	18	ITA	PTS	278115	270956	369876				
kW*days	18	ITA	DRB	1100225	584801	381968	613628	792317	848774	
kW*days	18	ITA	DTS	17112022	14530793	14369490				
KW*DAYS	18	ITA	GNS				1448541	1515067	1067720	
KW*DAYS	18	ITA	GTR				402155	144123	312140	
kW*days	18	ITA	HOK			284535				
KW*DAYS	18	ITA	LHP-LHM					1364		
KW*DAYS	18	ITA	LLD				147964	53215	35447	
KW*DAYS	18	ITA	LLS				920272	819044	652678	
KW*DAYS	18	ITA	MIS				17234	32782	1933	
KW*DAYS	18	ITA	OTB				14372055	14808415	12562033	
kW*days	18	ITA	PGP	1722336	1002933	1180371				
kW*days	18	ITA	PMP	7277279	4416994	351689				
KW*DAYS	18	ITA	PS				619543	466158	597297	
KW*DAYS	18	ITA	PTM				1069744	1436018	1773275	
kW*days	18	ITA	PTS	1480945	1464793	1842716				

8.12.3.Scientific surveys

8.12.3.1.Medits

8.12.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 18 the following number of hauls was reported per depth stratum (s. Tab. 8.12.3.1.1.1).

Tab. 8.12.3.1.1.1. Number of hauls per year and depth stratum in GSA 18, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA18_010-050	14	15	15	14	14	14	14	15	13	13	12	9	10	11	10
GSA18_050-100	14	14	14	15	15	15	15	14	21	21	23	16	15	15	14
GSA18_100-200	24	23	23	23	23	23	23	23	34	31	32	25	25	23	22
GSA18_200-500	10	10	10	10	10	10	10	10	15	15	16	10	10	9	8
GSA18_500-800	10	10	10	10	10	10	10	10	14	14	14	7	7	7	5

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

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

aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.12.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.12.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 18 was derived from the international survey Medits. Figure 8.12.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 08.

The estimated abundance and biomass indices do not reveal any significant trends since 1995 until 2003, increased to the highest values in 2005 and dropped sharply to the lowest level of the time series in 2007. The analyses of Medits indices are considered preliminary.

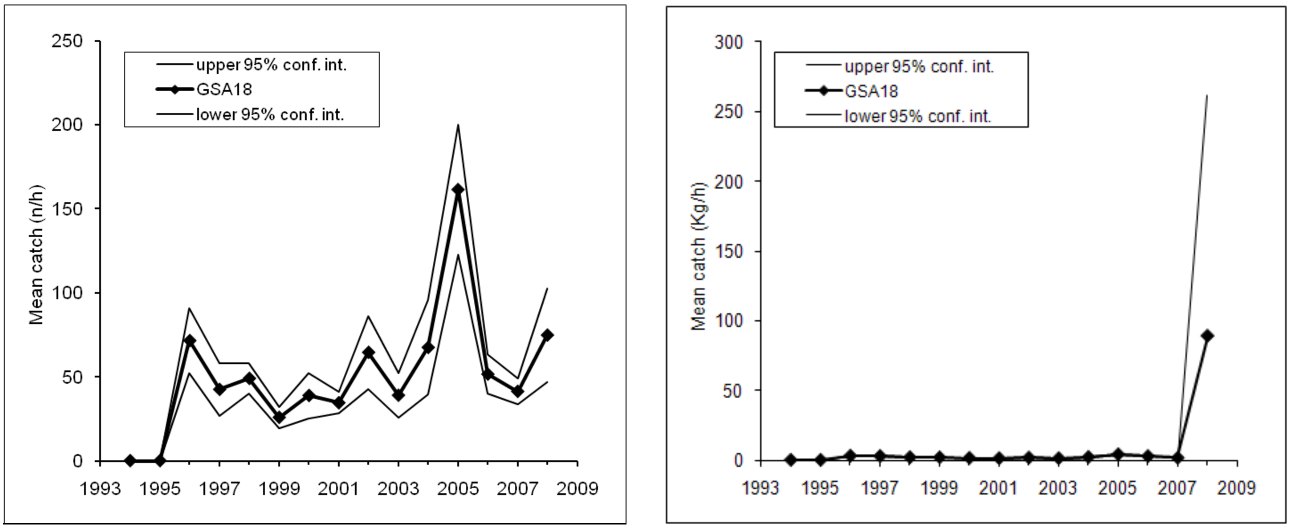


Fig. 8.12.3.1.3.1 Abundance and biomass indices of hake in GSA 18.

8.12.3.1.4. Trends in abundance by length or age

The following Fig. 8.12.3.1.4.1 and 2 display the stratified abundance indices of GSA 18 in 1996-2003 and 2004-2008. These size compositions are considered preliminary.

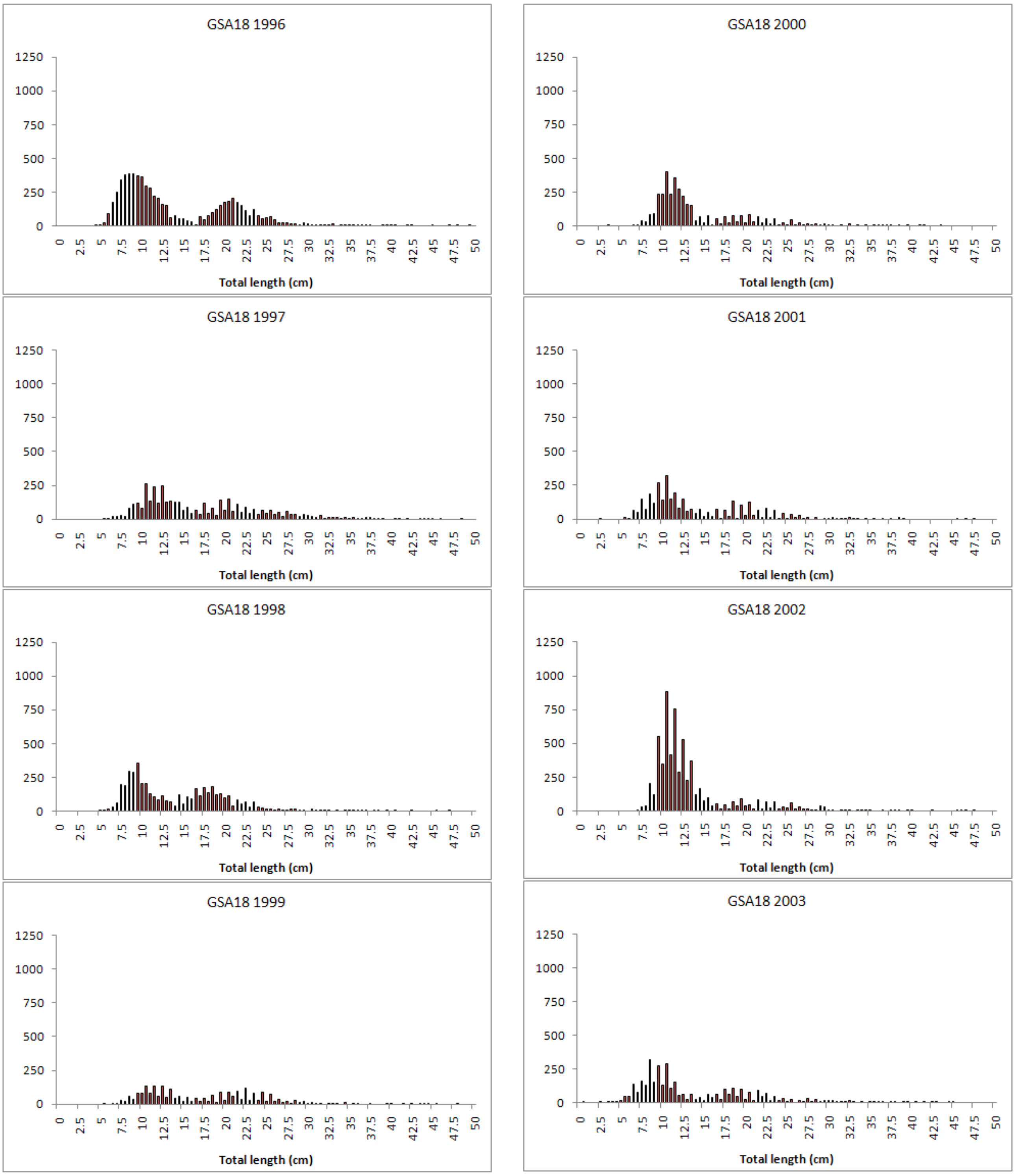


Fig. 8.12.3.1.4.1 Stratified abundance indices by size, 1996-2003.

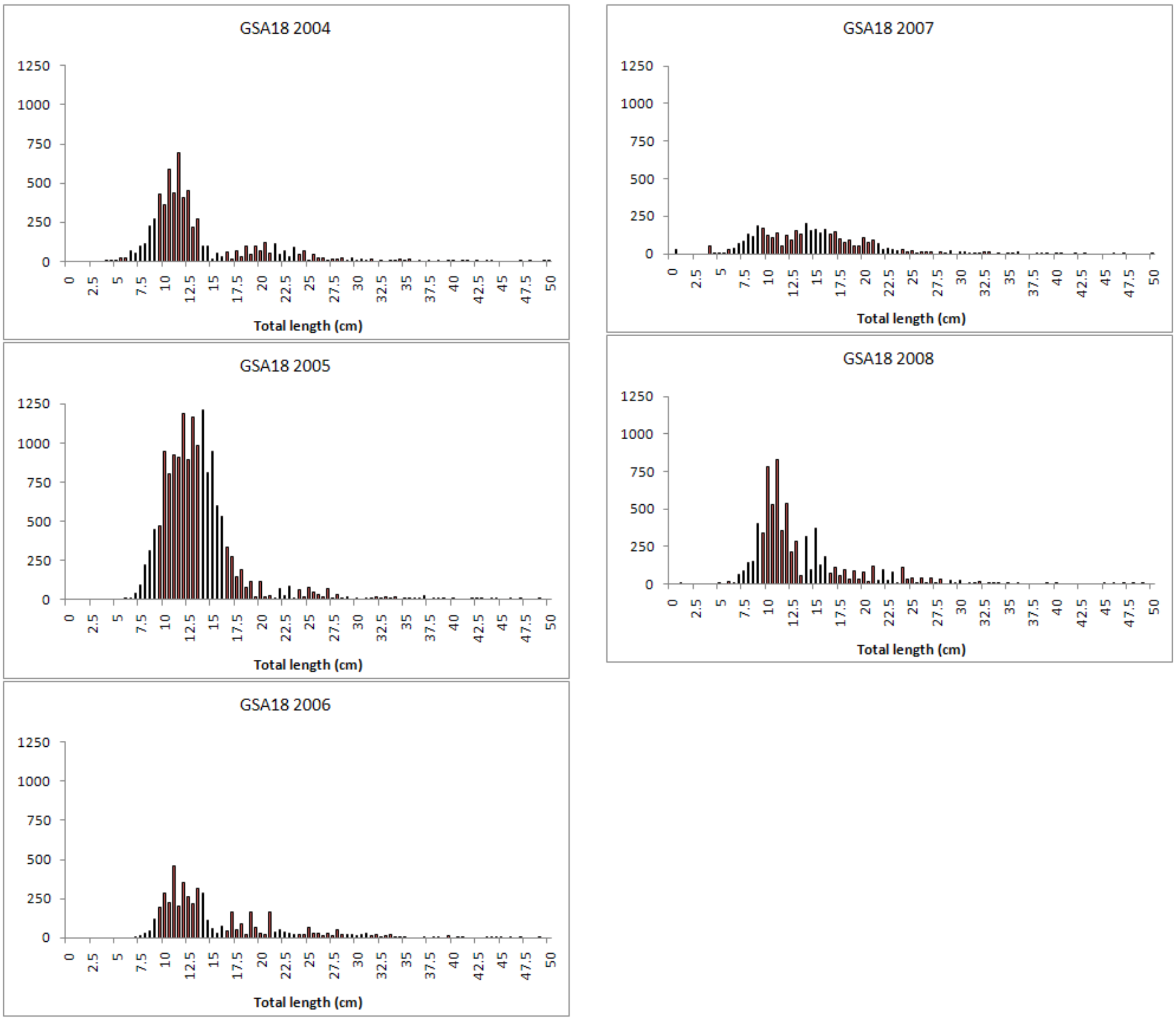


Fig. 8.12.3.1.4.2 Stratified abundance indices by size, 2004-2008.

8.12.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.12.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.12.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.12.5. Long term prediction

8.12.5.1. Justification

No forecast analyses were conducted.

8.12.5.2. Input parameters

No forecast analyses were conducted.

8.12.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 18.

8.12.6. Scientific advice

8.12.6.1. Short term considerations

8.12.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.12.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.12.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.13. Stock assessment of hake in GSA 19

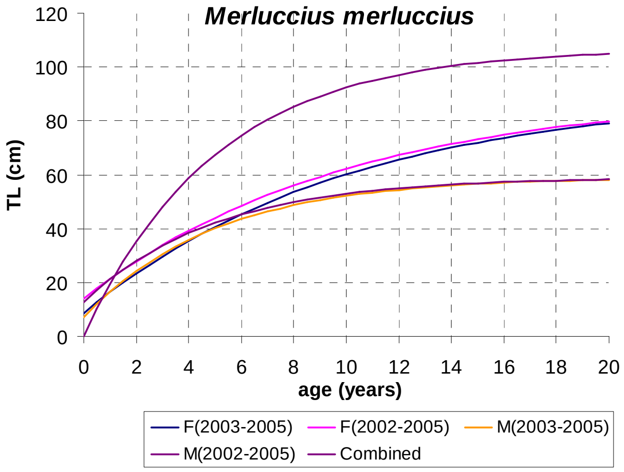
8.13.1.Stock identification and biological features

8.13.1.1.Stock Identification

No information was documented during SGMED-09-02.

8.13.1.2.Growth

Three sets of data on growth parameters were submitted, for females (F) and males (M) separately, estimated by otolith reading. Since the assessment was done for males and females combined, the growth parameters used were those proposed by García-Rodríguez and Esteban (2002), estimated by otolith reading and length frequency analysis, which correspond to the “fast growth” hypothesis, in line with the recommendations of SGMED in previous meetings. These growth parameters were used in the assessment of hake in GSA 19.
Three sets of data on the paramenters of the length-weight relationship were submitted, for females and males separately, and one set for both sexes combined, which were those used in the assessment.



		a	b
2003-2005	F	0,0036	3,100
2008	F	0,0047	3,134
2002-2005	F	0,0036	3,100
2003-2005	M	0,004	3,100
2008	M	0,0045	3,150
2002-2005	M	0,004	3,100
2008	C	0,0048	3,129

Fig. 8.13.1.2.1 V. Bertalanffy growth functions and parameters by sex.

8.13.1.3.Maturity

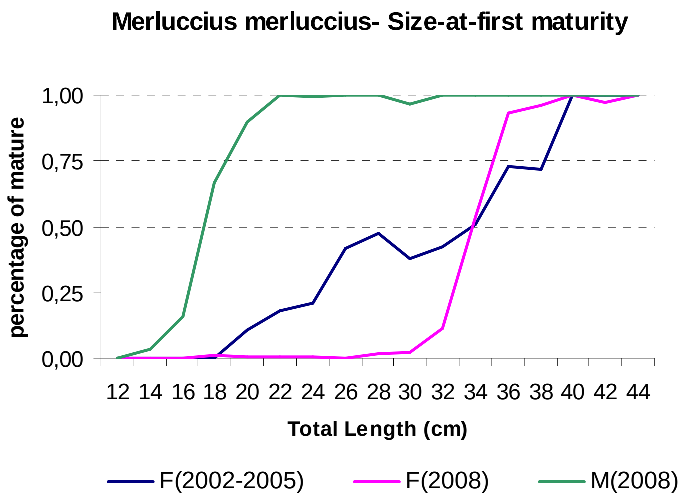


Fig. 8.13.1.3.1 Maturity ogives by sex.

Three sets of data on the percentage of mature individuals by size and sex, two for females and one for males, were submitted to SGMED-09-02. According to these sets, size-at-first-maturity (50% of individual mature, L_{50}) would be around 18 cm TL for males and 34 cm TL for females. The observed L_{50} for females is similar to that determined in other Mediterranean areas.

8.13.2.Fisheries

8.13.2.1.General description of fisheries

STECF (stock review part II in 2007) noted that *Merluccius merluccius* is one of the most important species in the GSA 19, considering both the amount of catch and the commercial value. It is fished with different strategies and gears (bottom trawling and long-line). In the year 2004 the landings in the Ionian area were detected around 850 tonnes (IREPA data). The main fisheries operating in GSA 19 are from Gallipoli, Taranto, Schiavonea and Crotone. The fishing pressure varies between fisheries and fishing grounds. No new documentation on the hake fishery in GSA19 was submitted to SGMED-09-02.

8.13.2.2.Management regulations applicable in 2008 and 2009

No information was documented.

8.13.2.3.Catches

8.13.2.3.1. Landings

Since 2002 until 2006, landings as provided to SGMED-09-02 through the DCR data call, varied between 1,300 and 1,600 t. In 2007 and 2008, landings dropped significantly regarding the period 2002-2006 (Tab. 8.13.2.3.1.1). The data are listed in Tab. A3.1 of Appendix 3. Demersal otter trawls (OTB) appear the major fishing gear at present. Current landings are similar to those in 2002 and 2003, although the current OTB fishing effort is much higher than in 2002 and 2003. Landings by nets were much higher during 2002-2003, when the fishing effort of this fishing technique was much higher than at present (see Tab. 8.13.2.3.3.1).

Tab. 8.13.2.3.1.1 Hake landings in GSA 19 by fishing technique, 2002-2008.

landings	2002	2003	2004	2005	2006	2007	2008
OTB	688	668	852	1077	1330	572	635
NETS	653	845	308	123	218	257	206
LONGLINE			139	72	81	54	39
PURSE SEINE	15	1					
ALL	1356	1514	1299	1272	1629	883	879

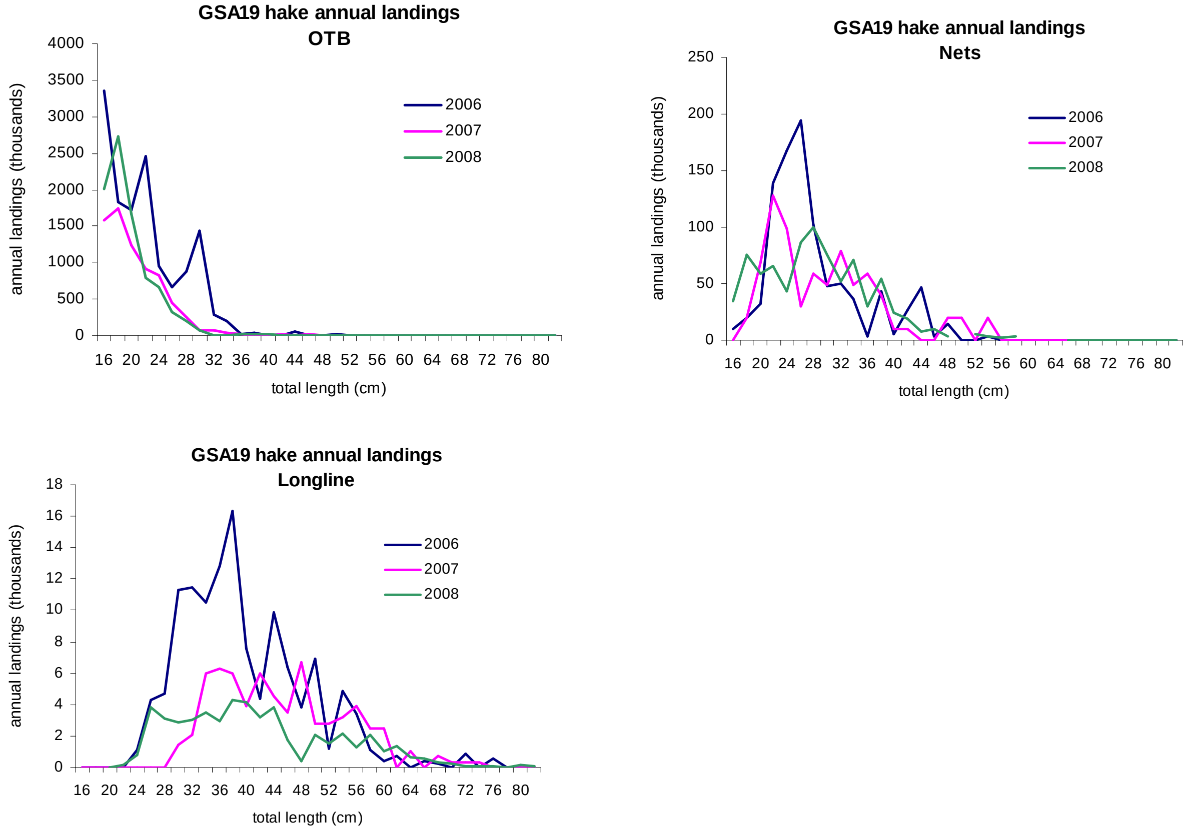


Fig. 8.13.2.3.1.1 Size frequency distributions, by fishing technique, 2006-2008.

By far, highest landings in number correspond to bottom otter trawl, most of them made up of immature individuals. The smallest landed recorded size class is 16 cm TL. Gillnets fish immature and mature individuals, while long lining landings correspond to mature individuals (Data submitted to SGMED-09-02).

8.13.2.3.2. Discards

Discards reported to SGMED-09-02 amount to 10 t in 2006, estimated for demersal otter trawls only. Discards as obtained through the DCR data call are listed in Table A3.9 of Appendix 3. No data on discards were reported for 2008. No data on the hake discards size distribution were available to SGMED-09-02.
Hake discard was less than 10% in weght so, according to the national protocol, the length distributions were not presented in the data.

8.13.2.3.3. Fishing effort

Tab. 8.13.2.3.3.1 lists the fishing effort reported to SGMED-09-02 through the DCR data call. The overview is given in Tab. A3.10-3.12 of Appendix 3 to this report. The dominant demersal otter trawl fleet increased in effort since 2002.

Tab. 8.13.2.3.3.1 Fishing effort in different units by fishing technique deployed in GSA 19, 2002-2007. No data are available for 2008.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	19	ITA	DRB				1318	3384	3998	
DAYS	19	ITA	DTS	31381	31586	37234				
DAYS	19	ITA	FPO				3189	2925	2473	
DAYS	19	ITA	GND				29731	20736	13328	
DAYS	19	ITA	GNS				49840	83590	73806	
DAYS	19	ITA	GTR				70390	53842	29510	
DAYS	19	ITA	HOK			39190				
DAYS	19	ITA	LHP-LHM				6539	5653	4829	
DAYS	19	ITA	LLD				21034	27841	20451	
DAYS	19	ITA	LLS				19503	12450	14608	
DAYS	19	ITA	LTL				2853	2862	371	
DAYS	19	ITA	MIS				1162	19	168	
DAYS	19	ITA	OTB				41760	45465	39604	
DAYS	19	ITA	PGP	233718	254881	225109				
DAYS	19	ITA	PMP	100208	122225	20325				
DAYS	19	ITA	PS				11984	9365	6768	
DAYS	19	ITA	PTM					150		
DAYS	19	ITA	PTS	3458	7302	6605				
DAYS	19	ITA	SB-SV				19427	24848	20184	
GT*DAYS	19	ITA	DRB				1318	3384	5019	
GT*days	19	ITA	DTS	580641	581841	782163				
GT*DAYS	19	ITA	FPO				3189	3500	2633	
GT*DAYS	19	ITA	GND				143652	144284	119326	
GT*DAYS	19	ITA	GNS				90354	121741	116633	
GT*DAYS	19	ITA	GTR				168879	123220	85068	
GT*days	19	ITA	HOK			1015534				
GT*DAYS	19	ITA	LHP-LHM				6746	9985	5233	
GT*DAYS	19	ITA	LLD				1107106	810180	779709	
GT*DAYS	19	ITA	LLS				60709	48454	58917	
GT*DAYS	19	ITA	LTL				14316	17178	1683	
GT*DAYS	19	ITA	MIS				2246	207	2688	
GT*DAYS	19	ITA	OTB				745886	677976	571825	
GT*days	19	ITA	PGP	602573	1113240	473727				
GT*days	19	ITA	PMP	1379166	1015437	111129				
GT*DAYS	19	ITA	PS				159697	125312	103153	
GT*DAYS	19	ITA	PTM					1646		
GT*days	19	ITA	PTS	188356	320037	195882				
GT*DAYS	19	ITA	SB-SV				42997	64370	50261	
KW*DAYS	19	ITA	DRB				7389	15175	36099	
kW*days	19	ITA	DTS	5125805	5002396	5802023				
KW*DAYS	19	ITA	FPO				57394	57121	56482	
KW*DAYS	19	ITA	GND				1185580	1388194	1130531	
KW*DAYS	19	ITA	GNS				1046673	1475918	1510335	
KW*DAYS	19	ITA	GTR				1818750	1347016	928503	
kW*days	19	ITA	HOK			6809150				
KW*DAYS	19	ITA	LHP-LHM				29910	160904	36015	
KW*DAYS	19	ITA	LLD				6607539	4495795	4304257	
KW*DAYS	19	ITA	LLS				724710	541247	670291	
KW*DAYS	19	ITA	LTL				159527	177770	20433	
KW*DAYS	19	ITA	MIS				26652	1760	16129	
KW*DAYS	19	ITA	OTB				6256653	6868746	5888163	
kW*days	19	ITA	PGP	4669873	9192254	4881153				
kW*days	19	ITA	PMP	13116917	9143878	1188078				
KW*DAYS	19	ITA	PS				1376127	942578	783035	
KW*DAYS	19	ITA	PTM					12646		
kW*days	19	ITA	PTS	978457	1629677	1105203				
KW*DAYS	19	ITA	SB-SV				510273	699325	584069	

(DTS= Demersal Trawl; HOK= longline; PGP= nets; PMP= nets; PTS= purse seine)

8.13.3.Scientific surveys

8.13.3.1.MEDITS

8.13.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 19 the following number of hauls was reported per depth stratum (s. Tab. 8.13.3.1.1.1).

Tab. 8.13.3.1.1.1. Number of hauls per year and depth stratum in GSA 19, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA19_010-050	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9
GSA19_050-100	7	8	8	8	8	8	8	8	8	8	8	8	8	9	8
GSA19_100-200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11
GSA19_200-500	16	15	15	15	15	15	15	15	21	21	14	15	14	14	14
GSA19_500-800	31	32	32	32	32	32	32	32	29	29	29	28	29	29	29

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

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

aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

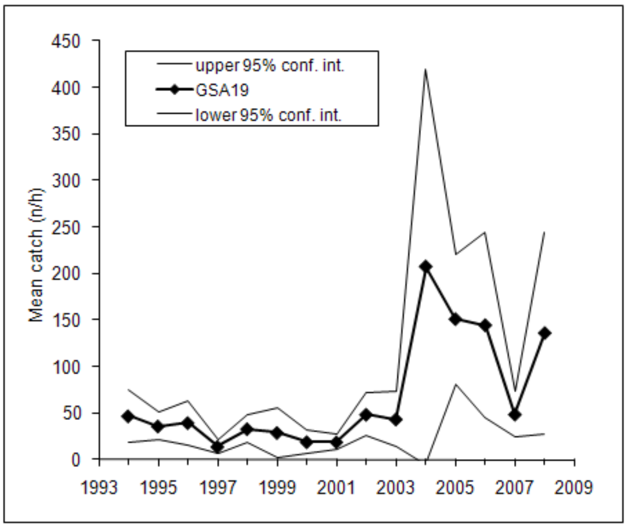
8.13.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.13.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 19 was derived from the international survey MEDITS. Figure 8.13.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 19.

The time series of estimated abundance and biomass indices reveals a significant increase in stock size since 2004.



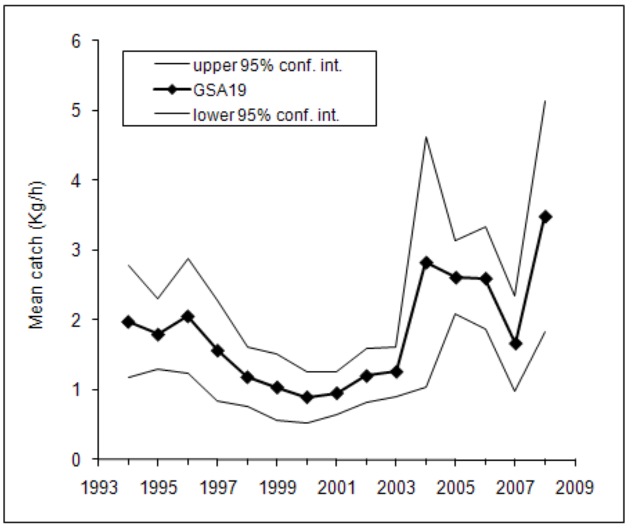


Fig. 8.13.3.1.3.1 Abundance and biomass indices of hake in GSA 19.

8.13.3.1.4. Trends in abundance by length or age

The following Fig. 8.13.3.1.4.1 and 2 display the stratified abundance indices of GSA 19 in 1994-2001 and 2002-2008, respectively. These size compositions are considered preliminary.

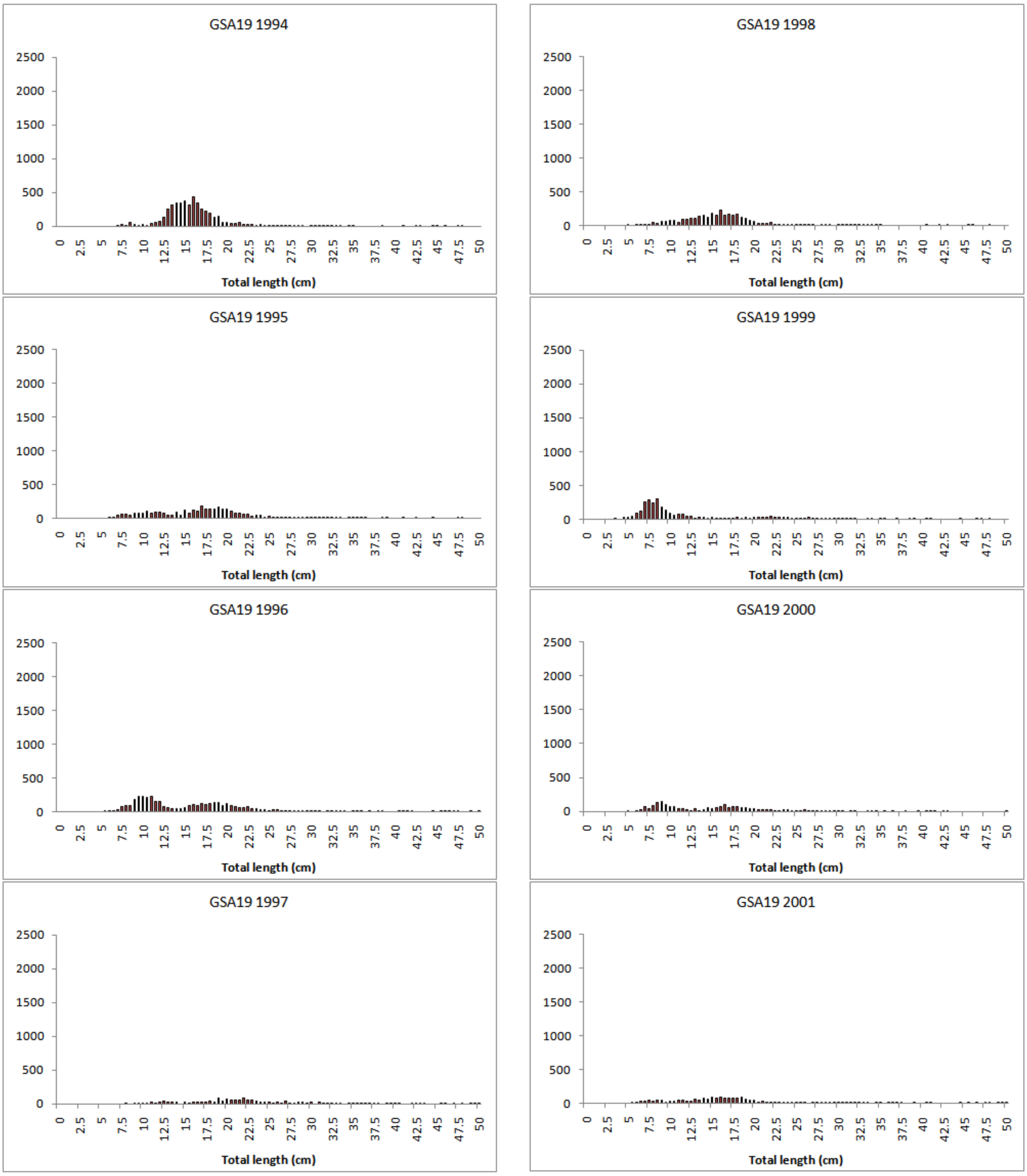


Fig. 8.13.3.1.4.1 Stratified abundance indices by size, 1994-2001.

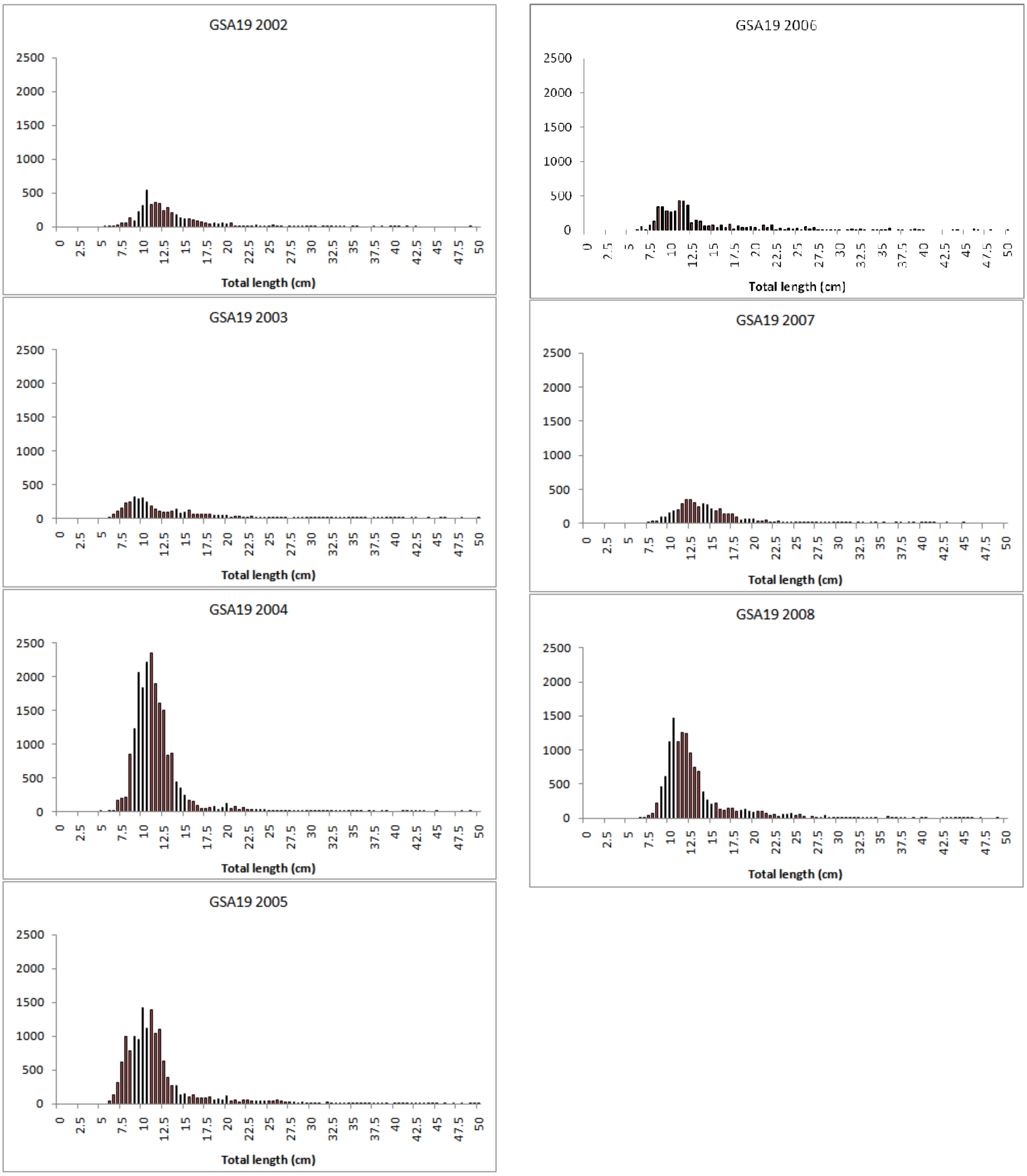


Fig. 8.13.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.13.3.1.5. Trends in growth

No analyses were conducted.

8.13.3.1.6. Trends in maturity

No analyses were conducted.

8.13.4.Assessment of historic stock parameters

8.13.4.1.Method 1: VIT

8.13.4.1.1. Justification

VPA analysis was performed using VIT program (Lleonart and Salat, 1992) using as input data the mean pseudo-cohort for the period 2006-2008 to provide a general overview of the current state of exploitation of hake in GSA 19.

8.13.4.1.2. Input Data

Size distribution data were available only for 2006-2008. VIT was performed using as input size distribution by fishing technique the corresponding "mean" pseudo- cohort for the period 2006-2008, estimated from the annual length distribution of landings. In any case, according to the landings and effort data in Tab. 8.13.2.3.1.1 and Tab. 8.13.2.3.3.1, the hake fishery does not appear to be in equilibrium.

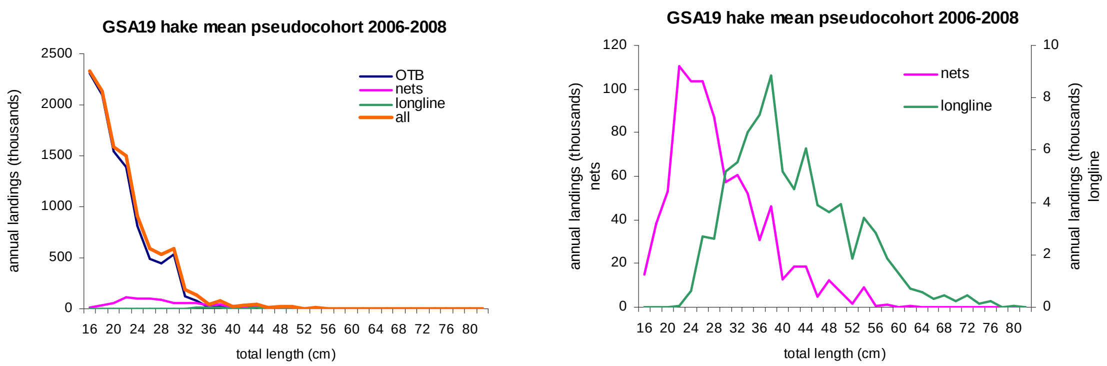


Fig. 8.13.4.1.2.1 Size compositions of landings by gears.

The size distribution of the total landings is very similar to that of bottom trawl and consists mostly of <30cm TL individuals. The size distribution of gillnets and longline landings are also presented separately, to show the different size-ranges exploited by each gear. Since the smallest landed size is 16cm TL, and also considering the size distribution obtained by OTB, this species should be discarded although data on discards were not available.
About the observed landed sizes by fishing technique, gillnets (assumed to be both trammel net and gillnet) and longline landings overlap over a wide size range. The mode of the nets landings (around 24-28 cm TL) and that of long line (around 40 cm TL) are smaller than those reported for gillnets and longline in other Mediterranean areas.
Some inconsistencies were observed between the annual size distributions by gear and the landings expressed in weight.

Growth parameters were taken from García-Rodríguez and Esteban (2002); length-weight relationship parameters and maturity ogive for females were submitted to SGMED 09-02; and M Vector by age was estimated using PROBIOM (Caddy and Abella, 1999). M_{mean} as estimated from PROBIOM is 0.43. Weight at length and maturity at length were transformed into ages during the analysis.

Tab. 8.13.4.1.2.1 VIT Input parameters.

Lin	k	to	a	b
106,8	0,2	0,0028	0,0048	3,1285

number of classes, by length	34
number of fishing gears	3
lower limit of the first class	16
class interval	2
plus group	no

class number	2006-2008 OTB	2006-2008 nets	2006-2008 long line	GSA19 Fem Maturity
1	2315,47	14,71	0,00	0,00
2	2099,61	38,41	0,00	0,01
3	1541,17	53,18	0,01	0,01
4	1384,94	110,70	0,04	0,01
5	811,91	103,36	0,63	0,01
6	484,92	103,43	2,70	0,00
7	445,58	87,14	2,62	0,01
8	529,10	57,48	5,19	0,02
9	122,33	60,37	5,55	0,11
10	79,87	52,09	6,69	0,54
11	11,54	31,04	7,35	0,93
12	22,79	45,99	8,85	0,96
13	5,24	12,97	5,19	1,00
14	7,61	18,58	4,50	0,97
15	16,75	18,38	6,07	1,00
16	3,69	4,71	3,87	1,00
17	1,70	12,36	3,65	1,00
18	7,24	6,65	3,95	1,00
19	0,99	1,75	1,86	1,00
20	0,85	8,83	3,40	1,00
21	0,00	0,76	2,83	1,00
22	0,85	1,07	1,86	1,00
23	0,00	0,07	1,28	1,00
24	1,48	0,69	0,70	1,00
25	0,99	0,07	0,57	1,00
26	0,00	0,00	0,30	1,00
27	0,67	0,00	0,44	1,00
28	0,00	0,00	0,20	1,00
29	0,00	0,00	0,46	1,00
30	0,00	0,00	0,14	1,00
31	0,00	0,00	0,21	1,00
32	0,00	0,00	0,00	1,00
33	0,00	0,00	0,04	1,00
34	0,00	0,00	0,02	1,00

8.13.4.1.3. Results including sensitivity analyses

This is the first assessment of hake in GSA19. All results refer to the landed range of lengths/ages. Results show that, although longline and nets target big-sized hakes, exploitation is concentrated on recruits, age classes 0 and 1. Accordingly, the exploitation rate is very high and Y/R for nets and long line are very low. Also, F must be even higher than that shown in results, since no data on discards were used as input for the analysis but discard is know to occur. In fact, bottom trawl landings in 2007 and 2008 were much lower than in the previous years, while trawl fishing effort did not decrease.

Taking into account the input data used in the assessment (2006-2008 mean pseudo- cohort, no discards data, which means F values are underestimated) and that the data on fishing effort and landing do not correspond to a situation of equilibrium, these results are to be considered only as preliminary, and no management advice can be provided.

All results refer to the current state of exploitation.

Tab. 8.13.4.1.3.1 VIT assessment results.

	Total	Bottom trawl	Nets	Long line
Catch mean age (year)	1,159	1,149	1,151	2,599
Catch mean length (TL cm)	21,966	21,83	21,82	42,438
Mean F	1,173	0,653	0,207	0,314
Total catch (t)	1130,4	845,5	227,0	57,9

B/R	SSB/R	Y/R	Y/R Bottom trawl	Y/R Nets	Y/R Long line
35,536	10,476	86,524	64,718	17,376	4,43

---	Critical age	Critica length
Current stock	1,151	22
Virgin stock	2,343	40
Total Biomass balance (D):	1422332271,89	
---	Biomass	Percentage
Recruitment	372554720	26,19
Growth	1049777552	73,81
Natural death	291945322	20,53
Fishing	1130386950	79,47
R/B(mean)	63,37	
D/B(mean)	241,93	
B(max)/B(mean)	78,05	
B(max)/D	32,26	
Mean Mortality rate (Z)	1,369	
Mean Mortality rate (F)	1,105	

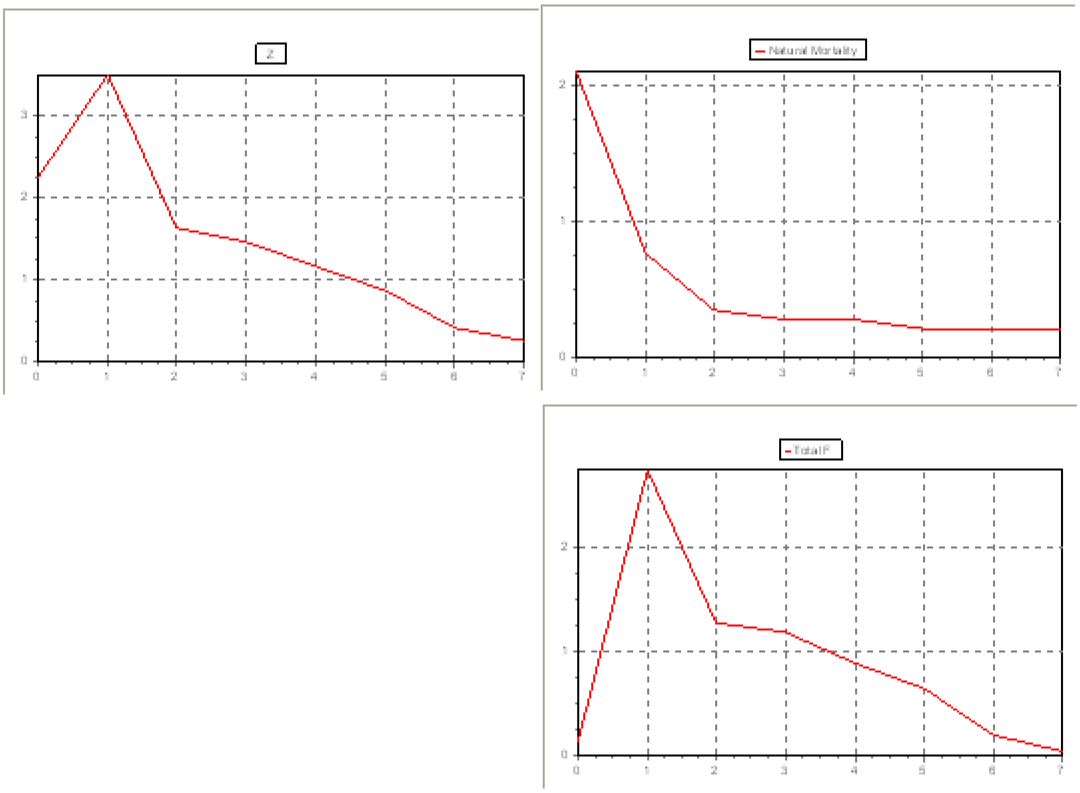


Fig. 8.13.4.1.3.1 VIT assessment results. GSA 19. *Merluccius merluccius*. Mortality rates: total (Z), natural (M), fishing (F)- bottom trawl, nets and longline combined.

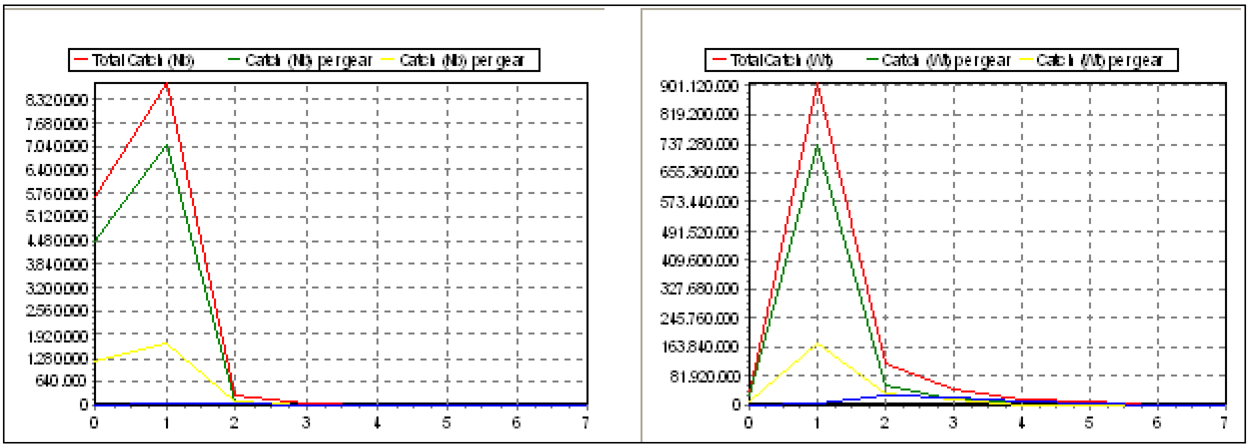


Fig. 8.13.4.1.3.2 VIT assessment results. GSA 19. *Merluccius merluccius.* VPA results, using VIT. Landings by fishing technique and age, in numbers (left) and weight (right). (red: total; green:bottom trawl; yellow: nets; blue: longline).

8.13.5.Long term prediction

8.13.5.1.Justification

Yield per recruit analysis was performed, although, from data on landings and fishing effort during 2006-2008 and in the previous years, equilibrium conditions cannot be assumed. Thus, this analysis is presented only to provide a general overview of the exploitation of hake in GSA 19, and cannot be taken as a proposal for advice.

8.13.5.2. Input parameters

Input data are the exploitation pattern resulting for VPA (VIT) and its population parameters.

8.13.5.3. Results

Overall results of the yield per recruit analysis are given below.

Table 8.13.5.3.1. YpR results: column factor (x axis in the figure below), indicates the level of fishing effort regarding the current effort which would correspond to $F_{(0,1)}$, to the maximum Y/R for each gear, and for the three gears combined, as well as the current situation (Factor=1) and the situation in case the effort level was twice the current effort (Factor= 2).

___	Factor	Y/R	B/R	SSB	Y/R OTB	Y/R NETS	Y/R L-LINE
F(0)	0	0	5,626,754	5,478,943	0	0	0
F(0.1)	0,15	252,575	2,013,164	1,907,635	108,730	37,949	105,896
Max L-Line	0,16	252,575	2,013,164	1,907,635	108,730	37,949	105,896
Max(all)	0,2	259,034	1,544,636	1,447,754	115,567	40,343	103,124
Max NETS	0,25	253,653	1,116,485	1,029,197	118,423	41,175	94,055
Max OTB	0,26	251,428	1,047,292	961,776	118,462	41,133	91,833
	1	86,524	35,536	10,476	64,718	17,376	4,430
	2	53,153	10,025	0,16	42,130	10,916	0,106

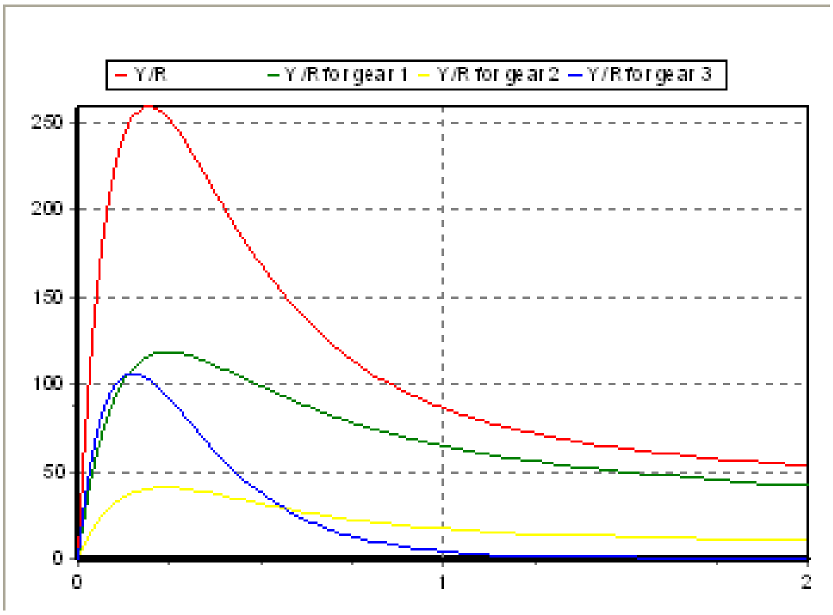


Fig. 8.13.5.3.1. GSA 19. *Merluccius merluccius*. Yield per recruit results (current effort= 1; red: total; green: bottom trawl; yellow: nets; blue: longline).

Yield per recruit results suggest a clear situation of overexploitation, for the three different fishing techniques targeting hake in GSA19. F_{max} (F corresponding to the highest Y/R) is in all cases well below the current effort.

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 19.

8.13.6.Scientific advice

8.13.6.1.Short term considerations

8.13.6.1.1. State of the spawning stock size

Survey results indicate a recent increase in stock abundance. However, due to the data deficiencies in the assessment and the lack of estimated limit or target management reference points, SGMED-09-02 is unable to fully review the status of the spawing stock.

8.13.6.1.2. State of recruitment

Survey results indicate a recent increase in stock abundance. Recent recruitment appears above average.

8.13.6.1.3. State of exploitation

Due to the data deficiencies in the assessment and the lack of estimated limit or target management reference points, SGMED-09-02 is unable to fully review the status of the exploitation. However, the persistent lack of older fish in the surveyed population and catches indicate high exploitation rates far in access of any sustainable level.

8.14. Stock assessment of hake in GSA 20

8.14.1.Stock identification and biological features

8.14.1.1.Stock Identification

Hake is one of the most important fish stocks in GSA 20 for bottom trawlers, nets (mainly gill nets) and longlines. The stock is distributed in depth between 50-600 m, with a peak in abundance in depths between 200 and 300 m. The stock is exploited almost exclusively by the Greek fishing fleet. Spawning takes place all year around, with a peak during winter – spring.

8.14.1.2.Growth

No information was documented during SGMED-09-02.

8.14.1.3.Maturity

No information was documented during SGMED-09-02.

8.14.2.Fisheries

8.14.2.1.General description of fisheries

Hake mainly lives on muddy substrates in depths between 50-600 m. The main landing port in the area is the port of Patra. Other important landing ports are in Igoumenitsa, Kerkyra, Preveza, Killini and Kalamata.

The bottom trawl fishery in Greece is a mixed fishery, operating 24hr per day. Bottom trawl fishing targeting hake, is taking place mainly during the day in muddy bottoms in depths 80-400 m (approximately). The mesh size of the cod end of bottom trawls is 40 mm. Apart from hake, important target species are shrimps, anglerfish, blue whiting, megrims, picarel and red mullet.

The gill nets are setting in the morning and are hauling the next day in depth from 80-300 m. The mesh size used is about 48 to 64 mm. The fishery is carried out mainly during summer when bottom trawl fishery is closed. Long line fishery for hake is taking place in deeper waters down to 500 m mainly during summer. Fishing is taking place during the day. The size of the hook is No 6-8. Gillnet and especially longline fisheries have a relatively greater species and size selectivity. The main by catch species in the gill net fishery is horse mackerel.

Due to the selectivity of each gear the length composition differs significantly. The catch from bottom trawls consists mainly of small individuals (hake with lengths between 6 and 18 cm are ~75% of the catch by number). The catch of gill nets comprises mainly of specimens with lengths between 20 and 40 cm, while longliners catch relatively large fish.

8.14.2.2.Management regulations applicable in 2008 and 2009

RD 917/1966 is the principal law regulating the operation of trawlers. Although this law is still in effect, it has been superseded by EC Regulation 1626/1994, and its replacement Regulation 1967/2006. The main restrictions established by Greek and European legislation are:

(1) establishment of a total exclusion zone one and a half mile from the coastline of the mainland and the islands,

(2) a total fishing ban from the 1st of June till the end of September,
(3) establishment of a total exclusion zone which is: either a zone three miles from the coastal line or a zone shallower than 50 m,
(4) minimum cod-end mesh size is 40 mm (EC regulation 1967/2006); from 1 July 2008, the net shall be replaced by a square-meshed net of 40 mm at the cod-end or, at the duly justified request of the shipowner, by a diamond meshed net of 50 mm.

Additional restrictions exist for bottom trawling in specific areas: in Amvrakikos Gulf and some parts of the Korinthiakos Gulf and the Ionian Sea, trawling is prohibited all year around, while in Patraikos Gulf trawling is prohibited from the 1st of March till the end of November.

The operation of the bottom set nets is subject to the following main restrictions:
(1) the maximum total length of the trammel net is 6000 m.
(2) the minimum mesh size opening is 16 mm.
(3) monofilament or twine diameter of the net should not exceed 0.5 mm.
(4) the maximum drop of a combined trammel and gill net should not exceed 10 m and the length of combined nets should not exceed 2,500 m.

8.14.2.3.Catches

8.14.2.3.1. Landings

Estimation of landings was based on random sampling in 66 sampling stations (ports) in GSA 20. Sampling was conducted on a monthly basis at each sampling station, where a sufficient number of vessels from each fleet segment and gear type was randomly selected and landings by species recorded. Based on these data, average landings per fishing day, by species and for each fishing gear were estimated. Based on total effort estimations, sampled data were raised to the whole fleet to estimate total landings by species, fleet segment, fishing gear, and GSA.

Tab. 8.14.2.3.1.1 shows the trend in reported landings taken by major gear types. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.1 of Appendix 3.

Tab. 8.14.2.3.1.1 Greek landings (t) by year and major gear types, 2002-2008 as reported through DCF.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
HKE	20	GRC	FPO							4
HKE	20	GRC	GTR		1445	3112	3404	2768		2545
HKE	20	GRC	LLS							286
HKE	20	GRC	OTB		308	404	516	754		459
HKE	20	GRC	PS			1				
HKE	20	GRC	SB		12	4	1			

8.14.2.3.2. Discards

No discards data were reported to SGMED-09-02 through the DCF data call for Greece.

8.14.2.3.3. Fishing effort

Estimation of effort was based on interviews conducted with random sampling in 30 sampling stations (ports) in GSA 20. Sampling was conducted on a monthly basis at each sampling station, where a sufficient number of vessels from each fleet segment and gear type were randomly selected and effort was recorded. In addition, all fishing vessels present in the sampling stations were categorized as full-time, part-time, occasionally fishing, or inactive and the proportion of the year when they were active was estimated. Based on this information, sampled data were raised to the whole fleet to estimate total effort per fleet segment, fishing gear, and GSA. Should be noted that the estimated effort do not refer to the effective effort targeting to hake but to the entire effort of each fleet segment. This is very important for the long lines and gill nets because the effort targeting hake is much smaller than the effort of the fleets.

Tab. 8.14.2.3.3.2 lists the fishing effort reported to SGMED-09-02 through the DCR data call. The overview is given in Tab. A3.10-3.12 of Appendix 3 to this report.

Tab. 8.14.2.3.3.2 Fishing effort in different units by fishing technique deployed in GSA 20, 2003-2008.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	20	GRC	GTR		838891	749522	777934	688042		574268
DAYS	20	GRC	LLS		1212	6333	3843	11810		99755
DAYS	20	GRC	OTB		7810	7296	6279	6682		6753
DAYS	20	GRC	PS		5386	4646	6132	5559		5197
DAYS	20	GRC	SB		13429	11118	10883	11363		12774
GT*DAYS	20	GRC	GTR		3338474	2974825	2949967	2509455		2264227
GT*DAYS	20	GRC	LLS		9110	43698	26517	81492		396520
GT*DAYS	20	GRC	OTB		574443	580133	435054	565011		534692
GT*DAYS	20	GRC	PS		105429	123580	230265	189582		155249
GT*DAYS	20	GRC	SB		83099	65507	58441	57058		75249
KW*DAYS	20	GRC	GTR		33001422	25547517	24809229	19460968		18504513
KW*DAYS	20	GRC	LLS		125676	698284	423729	1302215		3486777
KW*DAYS	20	GRC	OTB		2374841	2359179	1729664	2024955		1800736
KW*DAYS	20	GRC	PS		725384	874064	747375	626335		615159
KW*DAYS	20	GRC	SB		863066	697644	604098	623628		807597

8.14.3.Scientific surveys

8.14.3.1.Medits

8.14.3.1.1. Methods

Tables TA, TB, TC were provided according to the MEDITS protocol. The MEDITS survey was carried out in GSA 20 every summer from 1994 to 20068, except in 2002 because of administrative problems. For similar reasons, no MEDITS survey was conducted in Greece in 2007. During 1994 and 1995 the survey in GSA 20 was carried out in a small number of stations (12 and 15). The number of stations kept increasing and in 1998 was more than doubled (32 stations). The survey vessel changed in 1998. Due to these changes in the survey design, caution is needed when investigating the trends of relevant indicators in the MEDITS time series. More details on methodology and trends on selected indicators may be found in MEDITS (2007).

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 20 the following number of hauls was reported per depth stratum (s. Tab. 8.14.3.1.1.1).

Tab. 8.14.3.1.1.1. Number of hauls per year and depth stratum in GSA 20, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA20_010-050	2	2	2	2	4	4	3	3		3	3	3	3		3
GSA20_050-100	3	4	8	7	11	10	11	10		10	10	10	9		10
GSA20_100-200	2	3	4	2	5	6	5	6		6	6	5	6		6
GSA20_200-500	2	3	4	4	7	7	7	8		8	9	8	8		7
GSA20_500-800	3	3	4	3	5	5	5	5		5	4	5	4		6

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.14.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.14.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 20 was derived from the international survey Medits. Figure 8.14.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 20.

The estimated abundance and biomass indices reveal a significantly increased level of stock size since 2003. However, the recent abundance and biomass indices are subject to high variation (uncertainty). The analyses of Medits indices are considered preliminary.

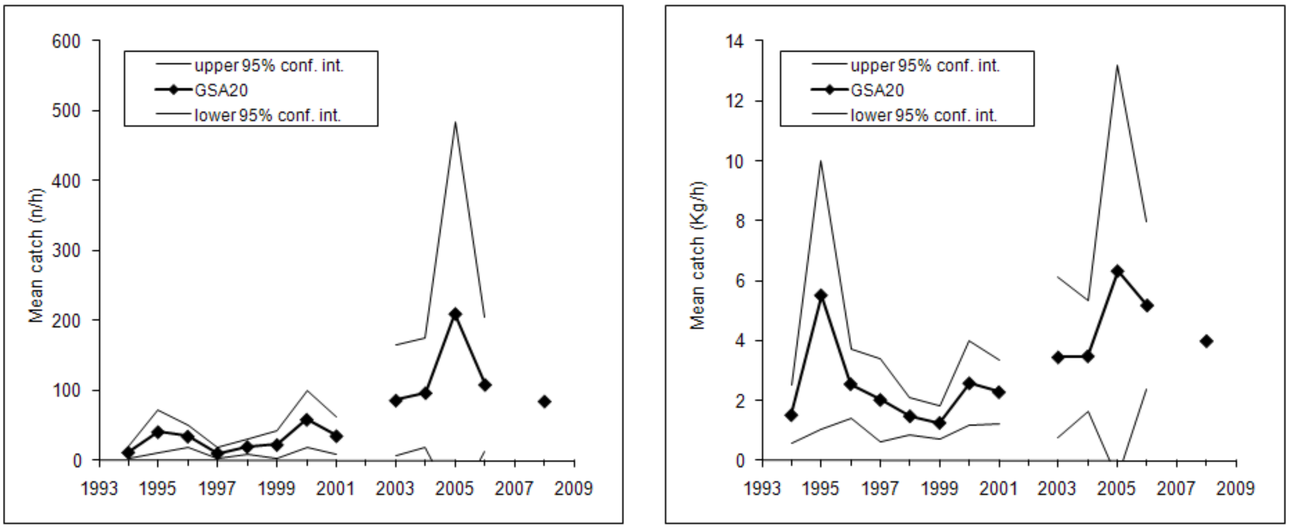


Fig. 8.14.3.1.3.1 Abundance and biomass indices of hake in GSA 20.

8.14.3.1.4. Trends in abundance by length or age

The following Fig. 8.14.3.1.4.1 and 2 display the stratified abundance indices of GSA 20 in 1994-2001 and 2003-2008. These size compositions are considered preliminary.

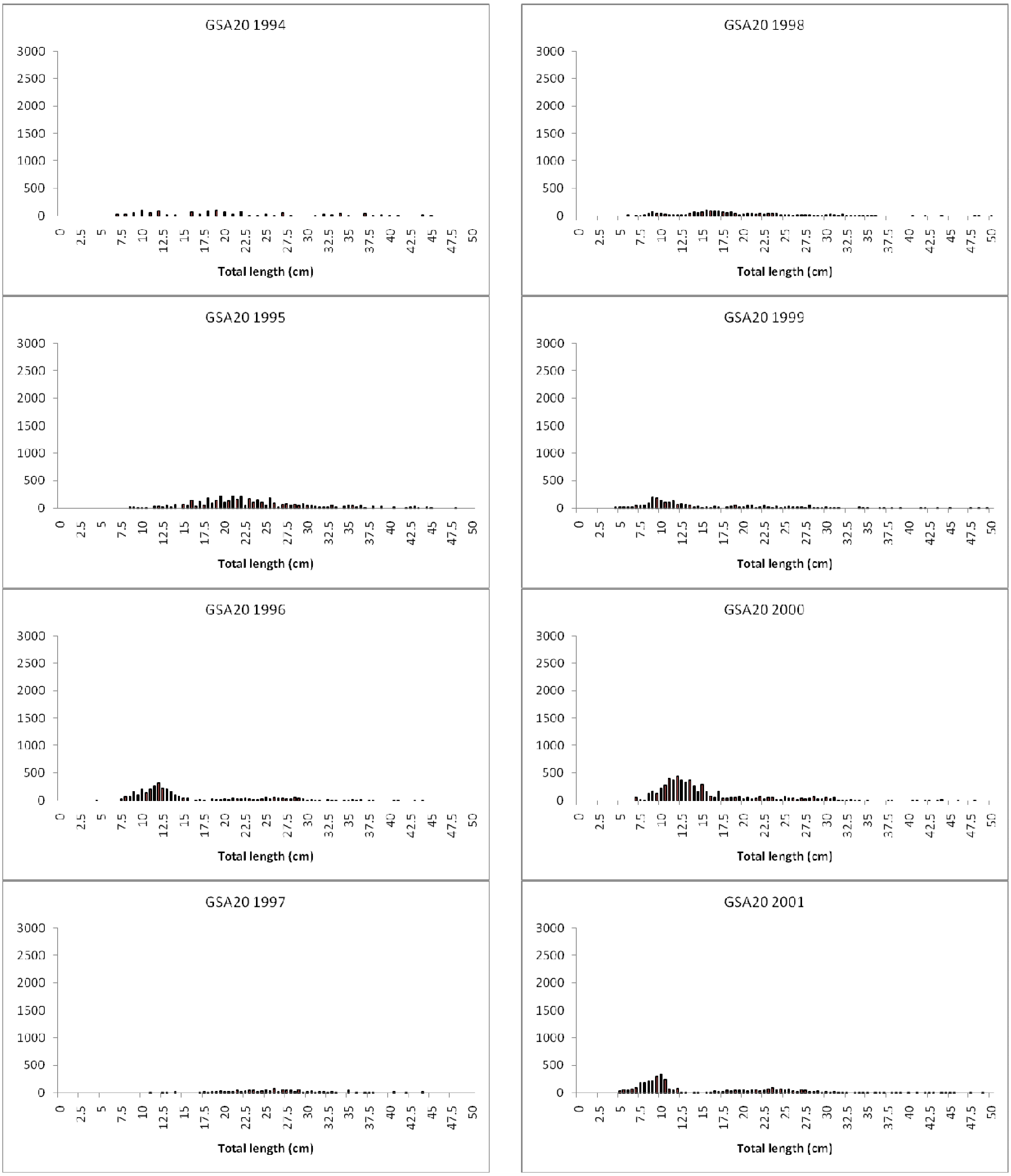


Fig. 8.14.3.1.4.1 Stratified abundance indices by size, 1994-2001.

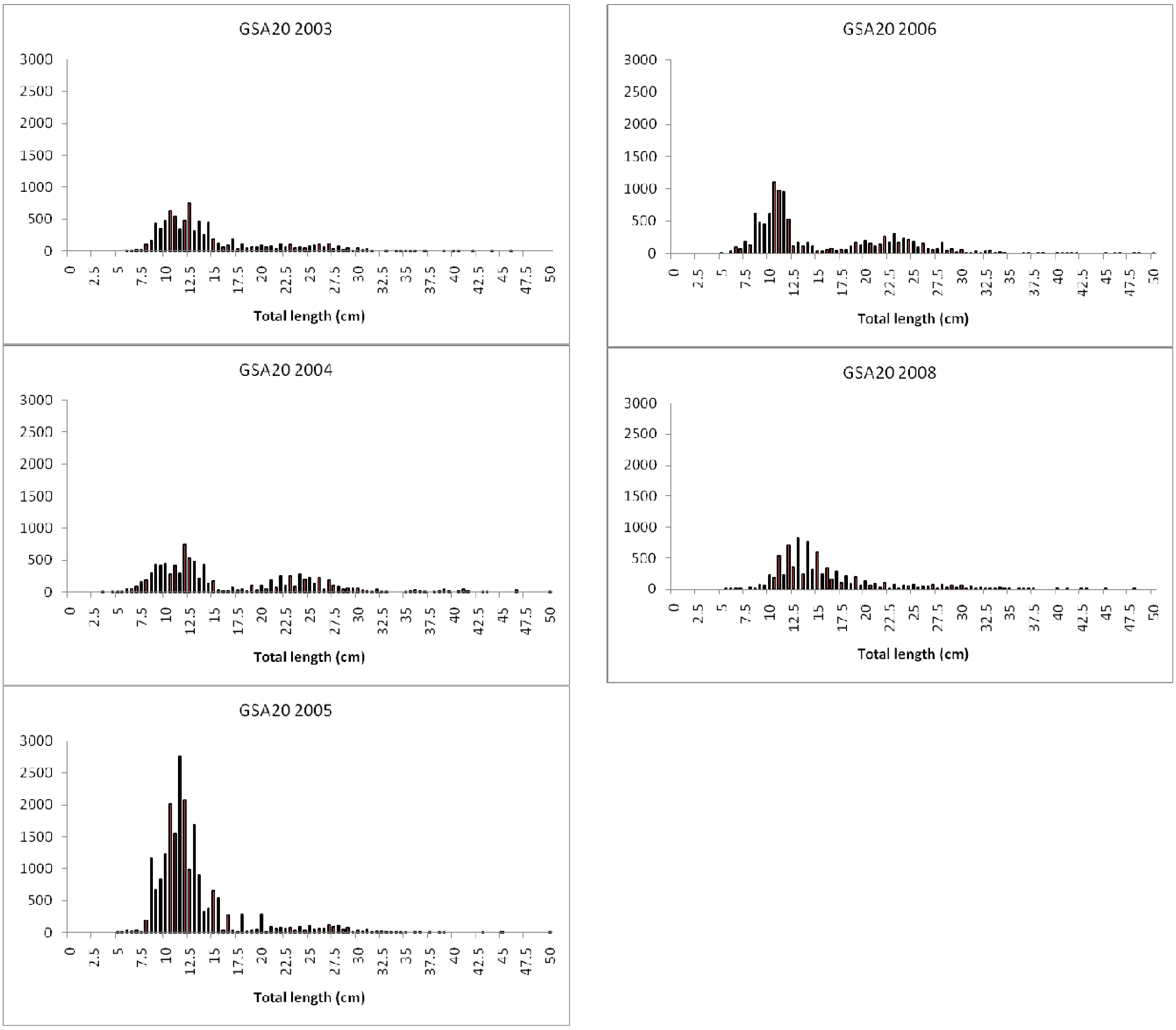


Fig. 8.14.3.1.4.2 Stratified abundance indices by size, 2003-2008.

8.14.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.14.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.14.4.Assessment of historic stock parameters

SGMED 09-02 did not undertake any analytical assessment of hake in GSA 20. Last year's preliminary assessment using SURBA can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.14.5.Long term prediction

8.14.5.1.Justification

No forecast analyses were conducted.

8.14.5.2.Input parameters

No forecast analyses were conducted.

8.14.5.3.Results

No forecast analyses were conducted.

8.14.6.Scientific advice

8.14.6.1.Short term considerations

8.14.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.14.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.14.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.15. Stock assessment of hake in GSAs 22 and 23 combined

8.15.1.Stock identification and biological features

8.15.1.1.Stock Identification

Hake is one of the most important fish stocks in GSAs 22-23 for bottom trawlers, nets (mainly gillnets) and longlines. The stock is distributed in depth between 50-600 m, with a peak in abundance in depths between 200 and 300 m. The stock is exploited by the Greek fishing fleet in the National Greek waters and by the Greek and Turkish fleet in the international waters. Spawning is taking place all year around, with a peak during winter - spring.

8.15.1.2.Growth

No information was documented during SGMED-09-02.

8.15.1.3.Maturity

No information was documented during SGMED-09-02.

8.15.2.Fisheries

8.15.2.1.General description of fisheries

Hake mainly lives on muddy substrates in depths between 50-600 m. The main landing ports in the GSAs 22-23 are the port of Pireus, Thessaloniki, Kavala, Alexandroupolis, Volos, Chalkida and Chios.

The bottom trawl fishery in Greece is a mixed fishery, operating 24hr per day. Bottom trawl fishing targeting hake, is taking place mainly during the day in muddy bottoms in depths 80-400 m (approximately). Especially for the offshore fisheries in the international waters, the duration of the trip could be up to 3 days. The mesh size of the cod end of bottom trawls is 40 mm. Important bycatch species are shrimps, anglerfish, blue whiting, Norway lobster, megrims, picarel and red mullet.

The gill nets are setting in the morning and are hauling the next day in depth from 80-300 m. The mesh size used is about 48 to 64 mm. The fishery is carried out mainly during summer when bottom trawl fishery is closed. Long line fishery for hake is taking place in deeper waters down to 500 m mainly during summer. Fishing is taking place during the day. The size of the hook is No 6-8. Gillnet and especially longline fisheries have a relatively greater species and size selectivity. The main by catch species in the gill net fishery is horse mackerel.

Due to the selectivity of each gear the length composition differs significantly. The catch from bottom trawls consists mainly of small individuals (hake with lengths between 6 and 18 cm are ~75% of the catch). The catch of gillnets comprises mainly of specimens with lengths between 20 and 40 cm, while longliners catch relatively larger fish.

8.15.2.2.Management regulations applicable in 2008 and 2009

The most important measures for managing bottom trawl or net fisheries in Greece have been described in the section 8.14.2.2.

8.15.2.3.Catches

8.15.2.3.1. Landings

Estimation of landings was based on random sampling in 127 sampling stations (ports) in GSA 22-23. Sampling was conducted on a monthly basis at each sampling station, where a sufficient number of vessels from each fleet segment and gear type was randomly selected and landings by species recorded. Based on these data, average landings per fishing day, by species and for each fishing gear were estimated. Based on total effort estimations, sampled data were raised to the whole fleet to estimate total landings by species, fleet segment, fishing gear, and GSA

Tab. 8.15.2.3.1.1 shows the trend in reported landings taken by major gear types. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.1 of Appendix 3.

Tab. 8.15.2.3.1.1 Greek landings (t) by year and major gear types, 2002-2008 as reported through DCF.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
HKE	22+23	GRC	FPO							0
HKE	22+23	GRC	GTR		2507	4039	4649	5229		2612
HKE	22+23	GRC	LLS		22	16	90			747
HKE	22+23	GRC	OTB		2444	3572	3857	3835		3793
HKE	22+23	GRC	PS		0	3				
HKE	22+23	GRC	SB		13	5	7	15		8

8.15.2.3.2. Discards

No discards data were reported to SGMED-09-02 through the DCF data call for Greece.

8.15.2.3.3. Fishing effort

Estimation of effort was based on interviews conducted with random sampling in 127 sampling stations (ports) in GSA 22-23. Sampling was conducted on a monthly basis at each sampling station, where a sufficient number of vessels from each fleet segment and gear type were randomly selected and effort was recorded. In addition, all fishing vessels present in the sampling stations were categorized as full-time, part-time, occasionally fishing, or inactive, and the proportion of the year they were active was estimated. Based on this information, sampled data were raised to the whole fleet to estimate total effort per fleet segment, fishing gear, and GSA. Should be noted that the estimated effort do not refer to the effective effort targeting to hake but to the entire effort of each fleet segment. This is very important for the long lines and gill nets because the effort targeting hake is much smaller than the effort of the fleets.

Tab. 8.15.2.3.3.1 lists the fishing effort reported to SGMED-09-02 through the DCR data call. The overview is given in Tab. A3.10-3.12 of Appendix 3 to this report.

Tab. 8.15.2.3.3.1 Fishing effort in different units by fishing technique deployed in GSAs 22 and 23, 2003-2008.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	22+23	GRC	GTR		2078058	1908626	1993815	1914951		1374948
DAYS	22+23	GRC	LLS		20905	41155	41568	51501		302098
DAYS	22+23	GRC	OTB		52536	53381	56580	53367		51855
DAYS	22+23	GRC	PS		44481	43772	48211	42874		40029
DAYS	22+23	GRC	SB		36266	31987	33200	30098		25138
GT*DAYS	22+23	GRC	GTR		8567144	8034837	7939836	7571041		5309125
GT*DAYS	22+23	GRC	LLS		332005	577572	603419	780138		1244484
GT*DAYS	22+23	GRC	OTB		4927349	4972085	5553804	5556446		5355704
GT*DAYS	22+23	GRC	PS		1998124	1987556	2295466	2108039		1930332
GT*DAYS	22+23	GRC	SB		294896	269645	276265	257271		214985
KW*DAYS	22+23	GRC	GTR		68845607	70633794	70746878	66780942		50244080
KW*DAYS	22+23	GRC	LLS		1888201	4977272	2715667	3848302		7914684
KW*DAYS	22+23	GRC	OTB		15792715	15874762	17730748	16424382		16013057
KW*DAYS	22+23	GRC	PS		9389351	9140980	9656463	8992650		8233643
KW*DAYS	22+23	GRC	SB		2775797	2206815	2193550	2022231		1774864

8.15.3. Scientific surveys

8.15.3.1. Medits

8.15.3.1.1. Methods

Tables TA, TB, TC were provided according to the MEDITS protocol. The MEDITS survey was carried out in GSAs 22-23 every summer from 1994 to 2006, except in 2002 because of administrative problems. For similar reasons, no MEDITS survey was conducted in Greece in 2007. In GSA 22 and 23, the number of stations was 98 in 1994 and gradually increased to 146 in 1996 and onwards. During the first two years (1994, 1995) the survey was conducted by two scientific teams from two institutes but with the same vessel. From 1996 three scientific teams were involved. During 1996 and 1997 two commercial vessels were used, and three vessels from 1998. Due to these changes in the survey design, caution is needed when investigating the trends of relevant indicators in the MEDITS time series. More details on methodology and trends on selected indicators may be found in MEDITS (2007).

Based on the DCR data call, abundance and biomass indices were recalculated. In GSAs 22 and 23 the following number of hauls was reported per depth stratum (s. Tab. 8.15.3.1.1.1).

Tab. 8.15.3.1.1.1. Number of hauls per year and depth stratum in GSAs 22 and 23, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA22+23_010-050	10	10	11	10	13	12	13	13		13	13	14	14		13
GSA22+23_050-100	19	21	22	28	24	26	21	25		25	23	24	24		27
GSA22+23_100-200	19	26	38	36	36	33	38	35		36	43	41	41		40
GSA22+23_200-500	32	35	45	50	51	54	50	48		51	53	52	52		52
GSA22+23_500-800	18	13	19	22	22	21	20	17		17	17	17	17		17

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.15.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.15.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSAs 22 and 23 was derived from the international survey Medits. Fig. 8.15.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSAs 22 and 23.

The estimated abundance and biomass indices do not reveal any significant trends since 1994. However, the recent abundance and biomass indices in 2006 appear high but are subject to high variation (uncertainty). The analyses of Medits indices are considered preliminary.

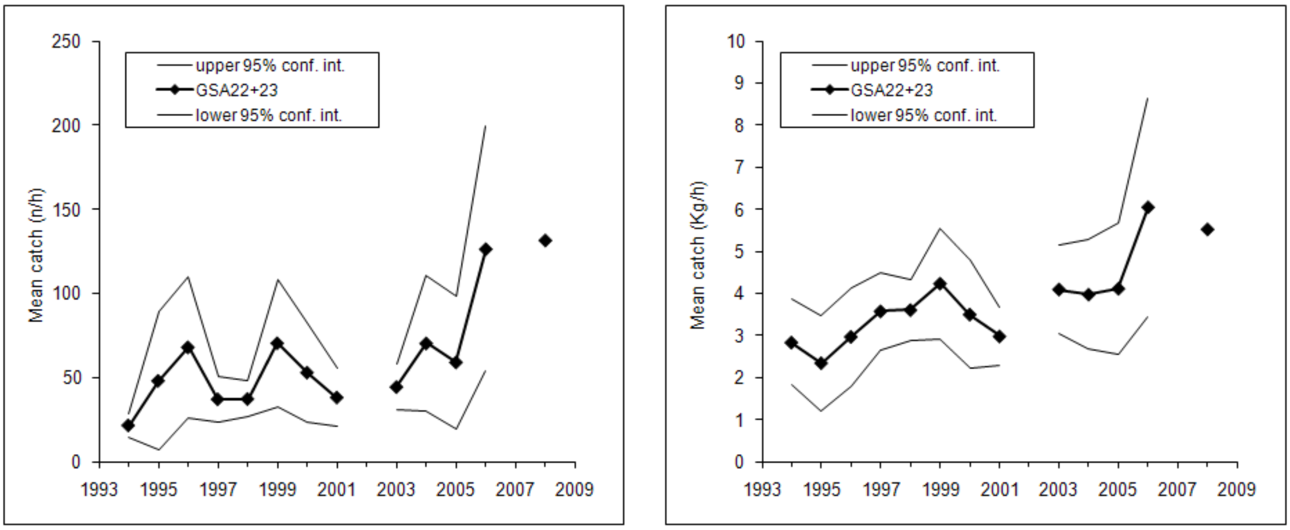


Fig. 8.15.3.1.3.1 Abundance and biomass indices of hake in GSAs 22 and 23.

8.15.3.1.4. Trends in abundance by length or age

The following Fig. 8.15.3.1.4.1 and 2 display the stratified abundance indices of GSAs 22and 23 combined in 1994-2001 and 2003-2008. These size compositions are considered preliminary.

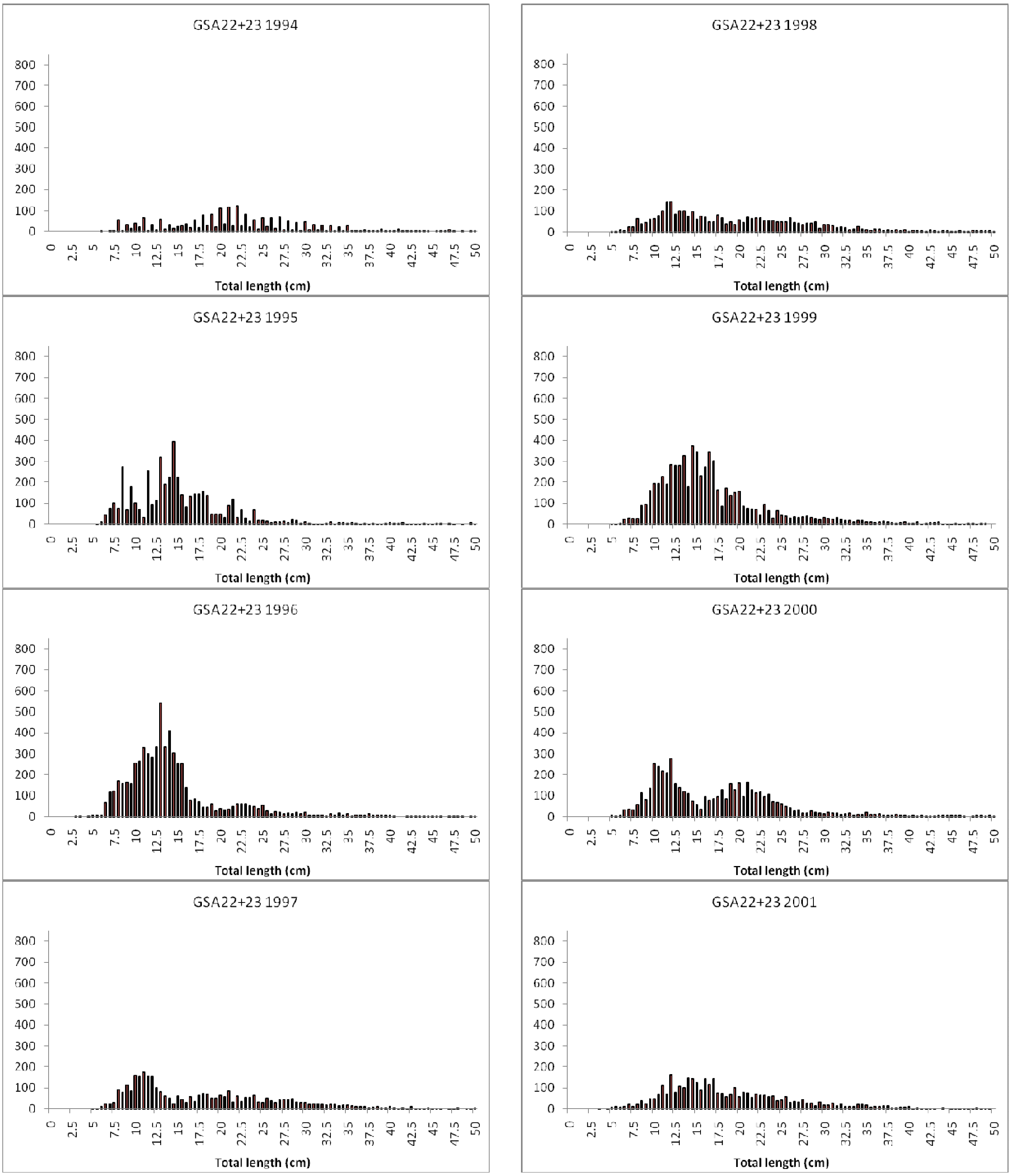


Fig. 8.15.3.1.4.1 Stratified abundance indices by size, 1994-2001.

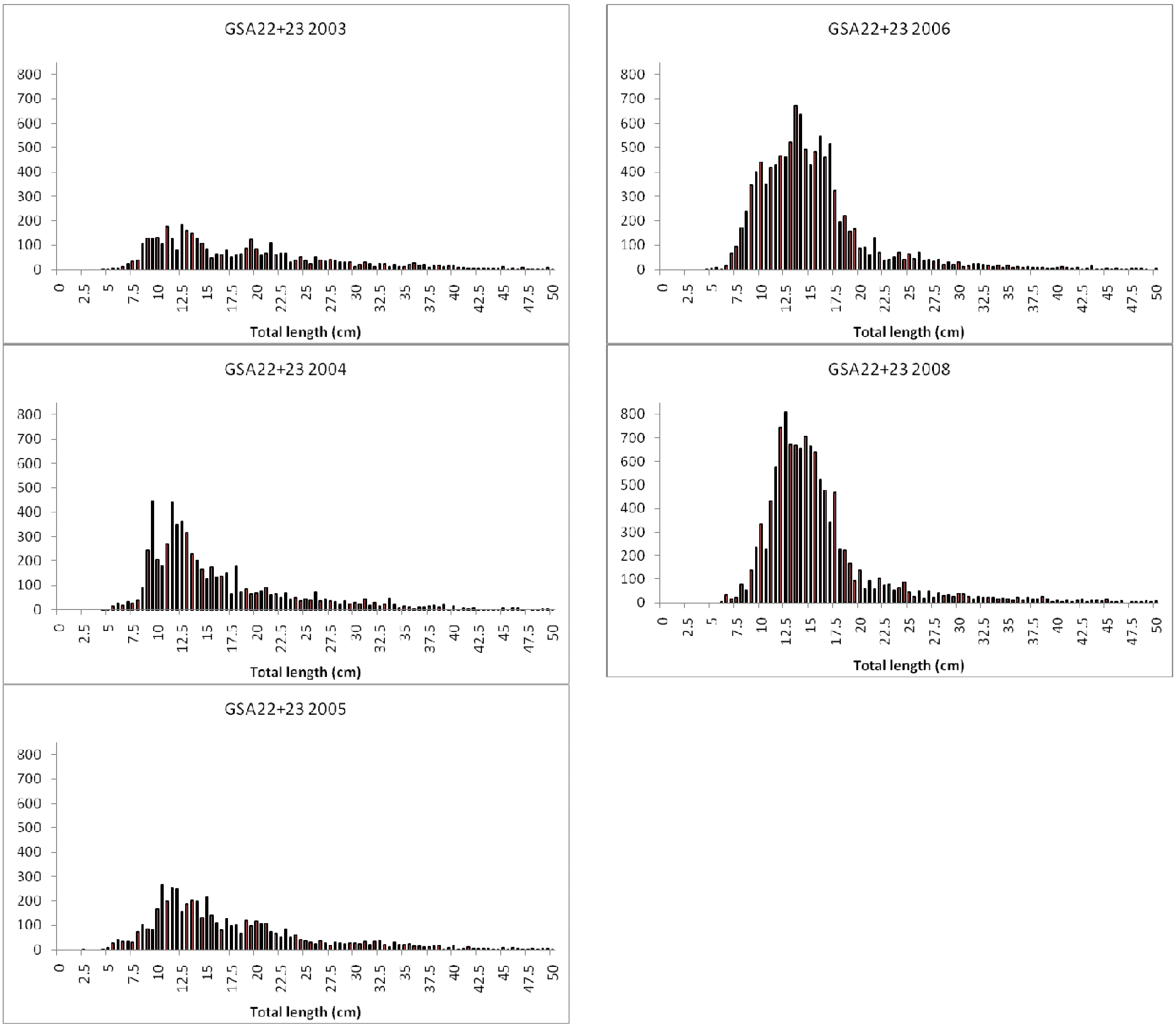


Fig. 8.15.3.1.4.2 Stratified abundance indices by size, 2003-2008.

8.15.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.15.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.15.4. Assessment of historic stock parameters

SGMED 09-02 did not undertake any analytical assessment of hake in GSAs 22 and 23. Last year's preliminary assessment using SURBA can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.15.5. Long term prediction

8.15.5.1. Justification

No forecast analyses were conducted.

8.15.5.2. Input parameters

No forecast analyses were conducted.

8.15.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSAs 22 and 23.

8.15.6. Scientific advice

SGMED-09-02 considers all analyses presented to assess the status of hake in GSAs 22 and 23 as preliminary and not suitable to provide sound scientific advice.

8.15.6.1. Short term considerations

8.15.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.15.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.15.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.16. Stock assessment of red mullet in GSA 01

8.16.1. Stock identification and biological features

8.16.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.16.1.2. Growth

No information was documented during SGMED-09-02.

8.16.1.3. Maturity

No information was documented during SGMED-09-02.

8.16.2. Fisheries

8.16.2.1. General description of fisheries

STECF (second stock review in 2007) notes that this species mainly appears in the mixed catches of bottom trawlers operating in sandy areas, being also caught with set gears, in particular trammel-nets and gillnets. Catch data are incomplete. Red mullets (*Mullus barbatus* and *Mullus surmuletus*) are one of the most important target species for the trawl fisheries. In the GSA 01 there are 142 trawlers that land over 150 t by year.

8.16.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.16.2.3. Catches

8.16.2.3.1. Landings

Landings data were reported to SGMED-09-02 through the Data collection regulation and are listed in Table A3.2 of Appendix 3. Only landings by otter trawlers are considered, which increased from 68 t in 2002 to 113 t in 2008.

Table 8.16.2.3.1.1 Annual landings (t) by fishing technique as reported to SGMED-09-02 through the DCR data call.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
MUT	1	ESP	OTB	68	81	109	94	109	138	113

8.16.2.3.2. Discards

No information was documented during SGMED-09-02.

8.16.2.3.3. Fishing effort

Fishing effort data are listed in Appendix 3, Tables A3.10-3.12.

8.16.3. Scientific surveys

8.16.3.1. Medits

8.16.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 01 the following number of hauls were reported per depth stratum (s. Tab. 8.16.3.1.1.1).

Tab. 8.16.3.1.1.1. Number of hauls per year and depth stratum in GSA 01, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA01_010-050	3	1	2	2	2	2	2	3	3	3	3	2	3	3	4
GSA01_050-100	6	4	5	6	5	7	6	5	6	10	7	7	6	6	6
GSA01_100-200	3	3	3	5	5	5	5	5	8	6	5	6	5	6	6
GSA01_200-500	7	9	11	10	8	11	12	10	11	11	13	11	12	11	11
GSA01_500-800	6	10	13	10	13	12	10	13	15	14	13	11	15	10	9

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

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

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

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

Where:
- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.16.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.16.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 01 was derived from the international survey Medits. Figure 8.16.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 01.

The estimated abundance and biomass indices do not reveal any significant trends since 1994. However, the recent abundance and biomass indices since 2006 appear high but are subject to high variation (uncertainty). The analyses of Medits indices are considered preliminary.

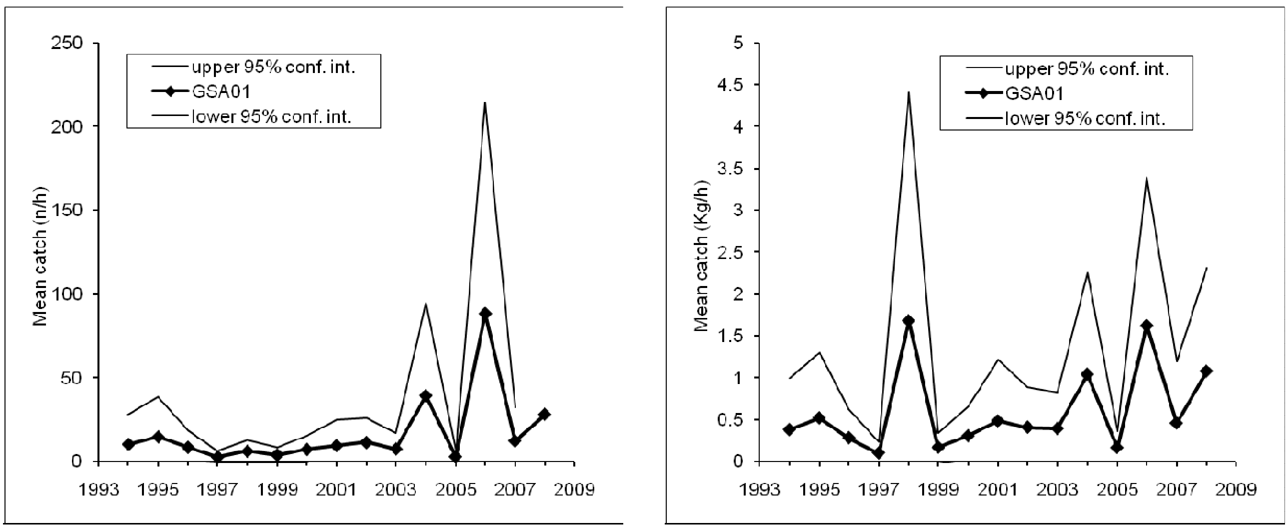


Fig. 8.16.3.1.3.1 Abundance and biomass indices of red mullet in GSA 01.

8.16.3.1.4. Trends in abundance by length or age

The following Fig. 8.6.3.1.4.1 and 2 display the stratified abundance indices of GSA 01 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

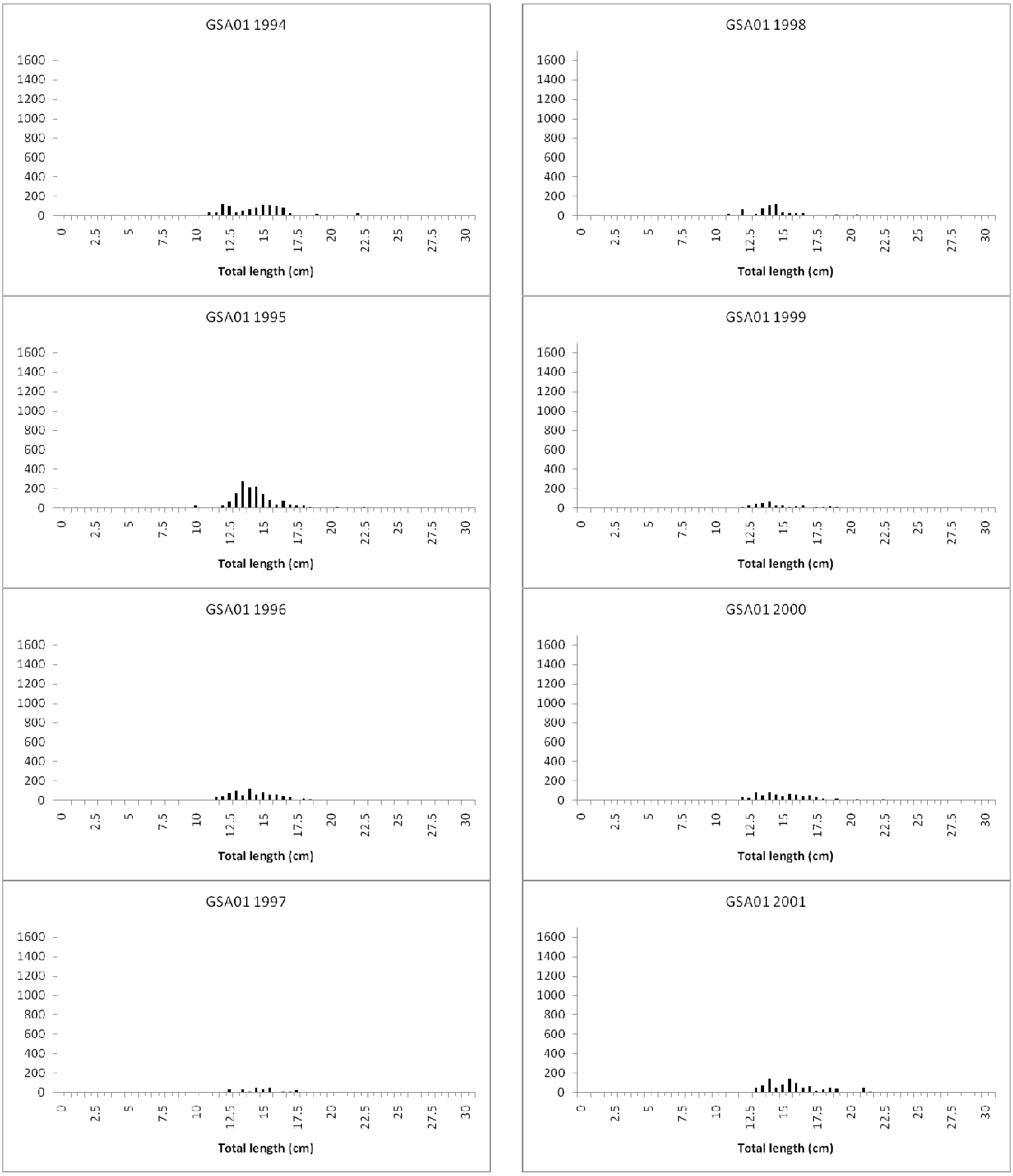


Fig. 8.16.3.1.4.1 Stratified abundance indices by size, 1994-2001.

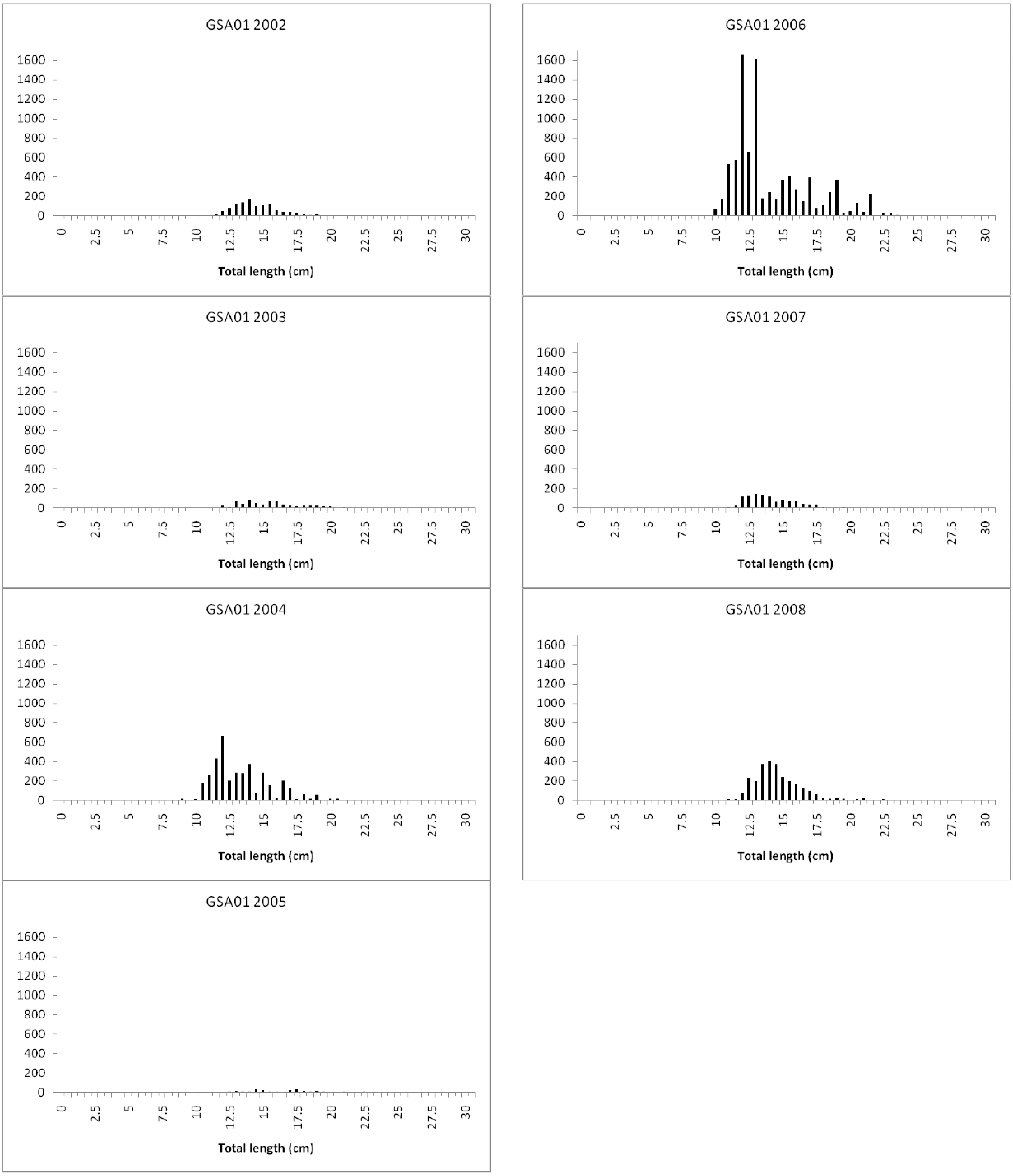


Fig. 8.16.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.16.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.16.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.16.4. Assessment of historic stock parameters

SGMED 09-02 did not undertake any analytical assessment of red mullet in GSA 01. Last year's assessment using VIT can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.16.5. Long term prediction

8.16.5.1. Justification

No forecast analyses were conducted.

8.16.5.2. Input parameters

No forecast analyses were conducted.

8.16.5.3. Results

No forecast analyses were conducted.

8.16.6. Scientific advice

8.16.6.1. Short term considerations

8.16.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.16.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.16.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.17. Stock assessment of red mullet in GSA 06

8.17.1. Stock identification and biological features

8.17.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.17.1.2. Growth

No information was documented during SGMED-09-02.

8.17.1.3. Maturity

No information was documented during SGMED-09-02.

8.17.2. Fisheries

8.17.2.1. General description of fisheries

STECF in 2007 (stock review part II) noted that Red mullet (*Mullus barbatus*) is one of the target species of the trawl fishery in the GFCM geographical sub-area 06 (Northern Spain). The trawl fleet operating in this area is composed by 647 boats averaging 47 TRB, 58 GT and 297 HP. Some of these units (smaller vessels) operate almost exclusively on the continental shelf, targeting red mullet, octopus, hake and different species of sea breams. According to official data, landings increased considerably between 1973 and 1982 and from this year until now a decreasing trend has been observed. In the period 1998-2004 landings of this species averaged 1315 t per year.

8.17.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.17.2.3. Catches

8.17.2.3.1. Landings

Tab. 8.17.2.3.1.1 lists the trend in reported landings taken by trawlers (Spain only). The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.2 of Appendix 3. Since 2002 the annual landings varied between 960 and 1,230 t.

Tab. 8.17.2.3.1.1 Annual landings (t) by fishing technique (otter trawlers only) in GSA 06.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
MUT	6	ESP	OTB	1159	1004	958	1027	1437	1232	1056

8.17.2.3.2. Discards

No information was documented during SGMED-09-02.

8.17.2.3.3. Fishing effort

Fishing effort data are listed in Appendix 3, Tables 3.10-3.12.

8.17.3.Scientific surveys

8.17.3.1.Medits

8.17.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 06 the following number of hauls was reported per depth stratum (s. Tab. 8.17.3.1.1.1).

Tab. 8.17.3.1.1.1. Number of hauls per year and depth stratum in GSA 06, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA06_010-050	7	8	7	8	7	8	9	8	11	9	9	11	12	6	8
GSA06_050-100	21	28	27	26	28	30	30	31	36	39	31	32	34	40	43
GSA06_100-200	11	19	17	15	13	17	19	20	20	21	17	18	19	24	30
GSA06_200-500	10	13	10	12	7	13	12	16	17	18	16	15	18	18	19
GSA06_500-800	7	8	9	7	4	9	6	8	7	11	11	8	10	15	14

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

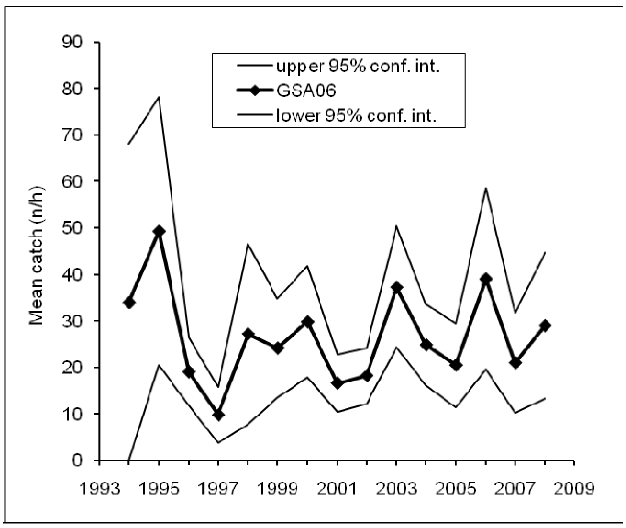
8.17.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.17.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 06 was derived from the international survey Medits. Figure 8.17.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 06.

The estimated abundance and biomass indices do not reveal any significant trends since 1994. However, the recent abundance and biomass indices in 2007 appear high but are subject to high variation (uncertainty). The analyses of Medits indices are considered preliminary.



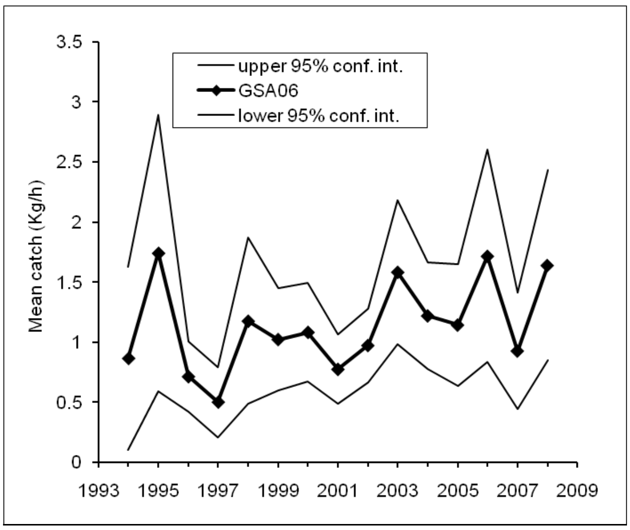


Fig. 8.17.3.1.3.1 Abundance and biomass indices of red mullet in GSA 06.

8.17.3.1.4. Trends in abundance by length or age

The following Fig. 8.17.3.1.4.1 and 2 display the stratified abundance indices of GSA 06 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

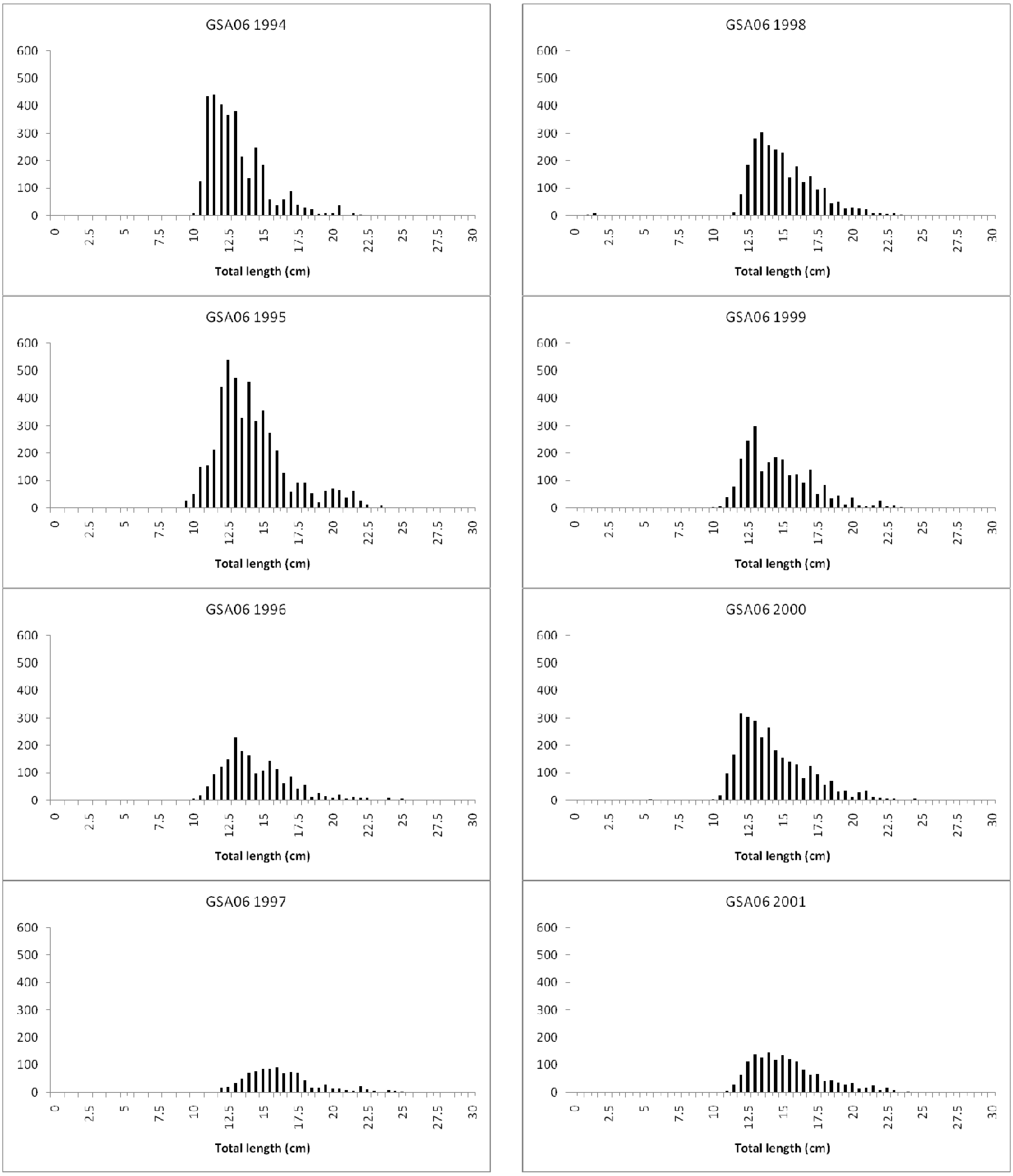


Fig. 8.17.3.1.4.1 Stratified abundance indices by size, 1994-2001.

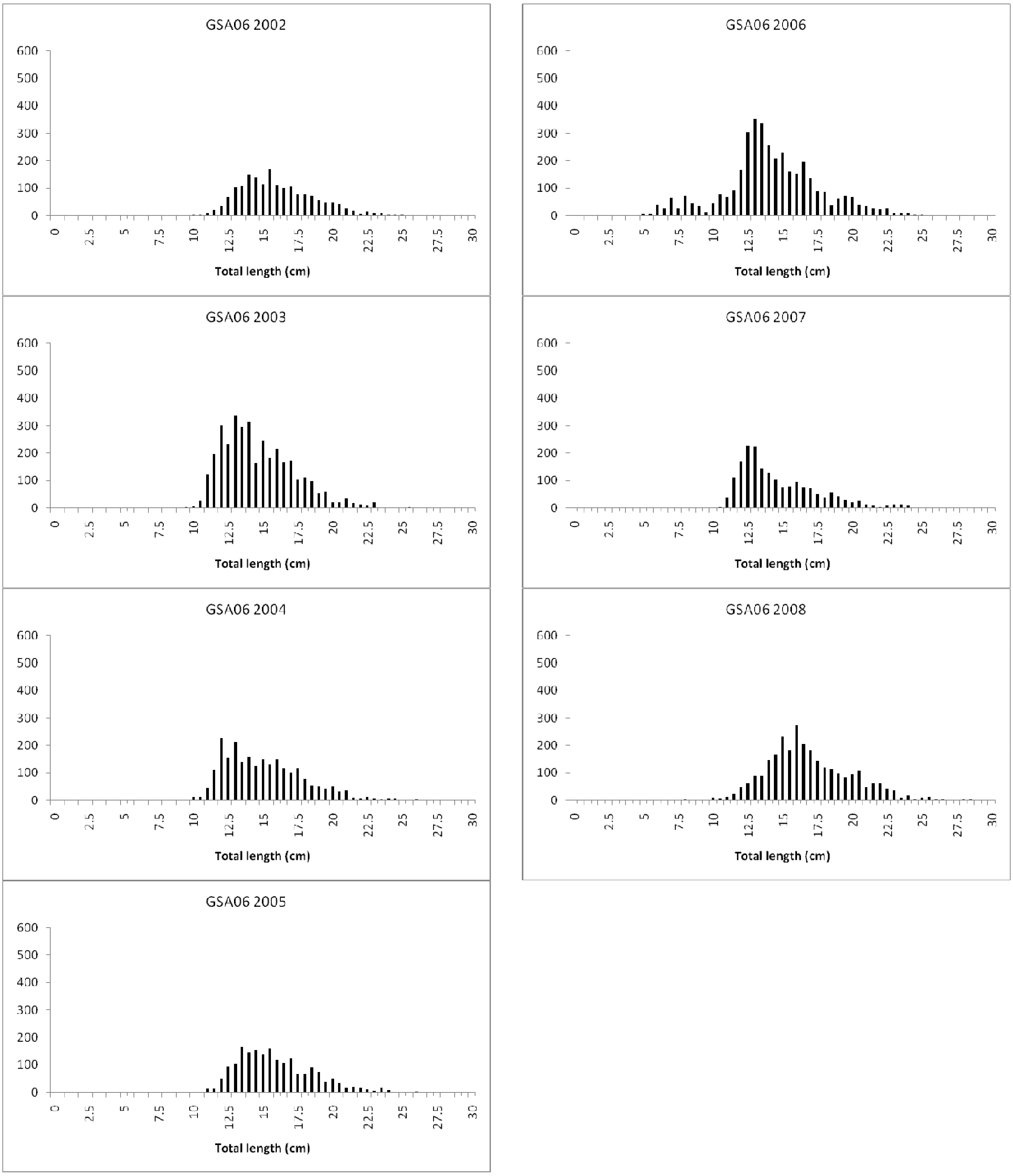


Fig. 8.17.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.17.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.17.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.17.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment. SGMED noted that red mullet in GSA 06 was assessed in 2008 and presented to SCSA/SAC/GFCM. This assessment can be viewed at:

http://www.gfcm.org/ for GSA06 open Doc04-MUT0608Gui.xls

8.17.5. Long term prediction

8.17.5.1. Justification

No forecast analyses were conducted.

8.17.5.2. Input parameters

No forecast analyses were conducted.

8.17.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 06.

8.17.6. Scientific advice

8.17.6.1. Short term considerations

8.17.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock given the preliminary state of the data and analyses.

8.17.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.17.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.18. Stock assessment of red mullet in GSA 07

8.18.1. Stock identification and biological features

8.18.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.18.1.2. Growth

No information was documented during SGMED-09-02.

8.18.1.3. Maturity

No information was documented during SGMED-09-02.

8.18.2. Fisheries

8.18.2.1. General description of fisheries

No information was documented during SGMED-09-02.

8.18.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.18.2.3. Catches

8.18.2.3.1. Landings

Tab. 8.18.2.3.1.1 lists the trend in reported landings taken by trawlers (France only). The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.2 of Appendix 3.

Tab. 8.18.2.3.1.1 Annual landings (t) by fishing technique (otter trawlers only) in GSA 07.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
MUT	7	FRA	OTB					183	172	111

8.18.2.3.2. Discards

Reported discards through the DCF data call to SGMED-09-02 are listed in Table A3.9 of Appendix 3.However, some values regarding French discards data appear unreasonable.

8.18.2.3.3. Fishing effort

Tab. 8.18.2.3.2.1 lists the trends in fishing effort by fishing technique deployed in GSA 07, 2003 to 2008 (Tab. A3.10-3.12 in Appendix 3). The data were reported to SGMED-09-02 trough the DCR data call.

Tab. 8.18.2.3.2.1 Trends in fishing effort by fishing technique deployed in GSA 07, 2003 to 2008. No values were reported for 2002.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	7	FRA	DRB		14016	11879	20632	15862	11466	8913
DAYS	7	FRA	FPO		4832	3704	3752	9712	7104	3659
DAYS	7	FRA	FYK		18087	24240	15856	16393	13986	11688
DAYS	7	FRA	GNF		40179	44379	58398	55776	54866	49161
DAYS	7	FRA	GNS		5278	5868	4973	2153	3238	1501
DAYS	7	FRA	GTR		36410	42371	49978	71342	56444	46983
DAYS	7	FRA	LA.		3308		1124	749	602	574
DAYS	7	FRA	LLS		15301	10685	11442	12808	8291	9775
DAYS	7	FRA	MIS		15926	14201	14804	35570	21477	19865
DAYS	7	FRA	OTB		42473	28242	21039	21297	20778	18430
DAYS	7	FRA	OTM		11919	4212	5901	6940	3622	2948
DAYS	7	FRA	SB-		2119	1778	1495	2831	1659	1667
GT*days	7	FRA	DRB		16086	13931	86216	46530	36716	18754
GT*days	7	FRA	FPO		15277	12063	13412	44521	31018	13791
GT*days	7	FRA	FYK		13367	24410	17241	15110	14353	12151
GT*days	7	FRA	GNF		115866	154780	178958	157379	225428	212101
GT*days	7	FRA	GNS		87300	82051	74160	18252	27824	8399
GT*days	7	FRA	GTR		146240	150874	176039	251669	251974	192206
GT*days	7	FRA	LA.		66549		15500	27016	21527	16910
GT*days	7	FRA	LLS		41399	30095	32006	38437	32262	29565
GT*days	7	FRA	MIS		28691	28733	30249	47655	30124	29249
GT*days	7	FRA	OTB		3055410	2009196	1461372	1782382	1604529	1412831
GT*days	7	FRA	OTM		1338274	500034	736179	937389	444863	352366
GT*days	7	FRA	SB-		9489	6507	4889	21627	32568	47803
kW*days	7	FRA	DRB		701658	498937	1446390	1474302	838511	503036
kW*days	7	FRA	FPO		543235	362280	332514	1039964	803688	384117
kW*days	7	FRA	FYK		439690	918434	633578	383108	438750	358399
kW*days	7	FRA	GNF		2846442	3221150	4273917	4580080	4743557	4085999
kW*days	7	FRA	GNS		896281	869433	749969	307954	458826	116992
kW*days	7	FRA	GTR		2381824	2734374	3335217	5657420	4661238	3519840
kW*days	7	FRA	LA.		671916		131612	170907	144068	128347
kW*days	7	FRA	LLS		919296	662464	634850	1014367	795610	806093
kW*days	7	FRA	MIS		881266	754958	569204	1927473	1093578	1102514
kW*days	7	FRA	OTB		12970505	8450443	5870844	6219184	5938674	5277458
kW*days	7	FRA	OTM		3766550	1330992	1864890	2193060	1144433	931468
kW*days	7	FRA	SB-		272065	145083	60475	364747	291432	304153

8.18.3. Scientific surveys

8.18.3.1. Medits

8.18.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 07 the following number of hauls was reported per depth stratum (s. Tab. 8.18.3.1.1.1).

Tab. 8.18.3.1.1.1. Number of hauls per year and depth stratum in GSA 07, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA07_010-050	12	12	12	15	12	12	12	12	12	13	12	12	12	15	12
GSA07_050-100	32	32	32	38	39	33	33	33	32	38	31	31	33	31	25
GSA07_100-200	10	9	9	9	9	9	10	9	9	10	13	11	10	10	7
GSA07_200-500	6	6	5	6	5	5	6	6	5	5	5	5	5	5	4
GSA07_500-800	8	7	5	5	4	5	6	5	4	5	6	5	6	5	5

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.18.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.18.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 07 was derived from the international survey Medits. Figure 8.18.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 07.

The estimated abundance and biomass indices do not reveal any significant trends since 1994. However, the recent abundance and biomass indices in 2007 appear high but are subject to high variation (uncertainty). The analyses of Medits indices are considered preliminary.

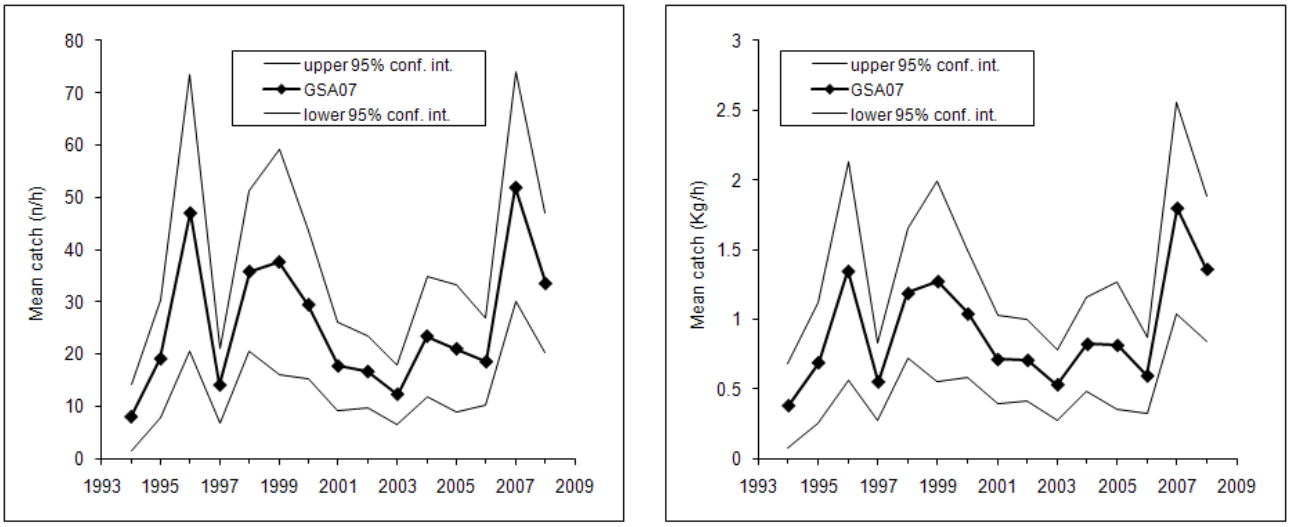


Fig. 8.18.3.1.3.1 Abundance and biomass indices of red mullet in GSA 07.

8.18.3.1.4. Trends in abundance by length or age

The following Fig. 8.18.3.1.4.1 and 2 display the stratified abundance indices of GSA 07 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

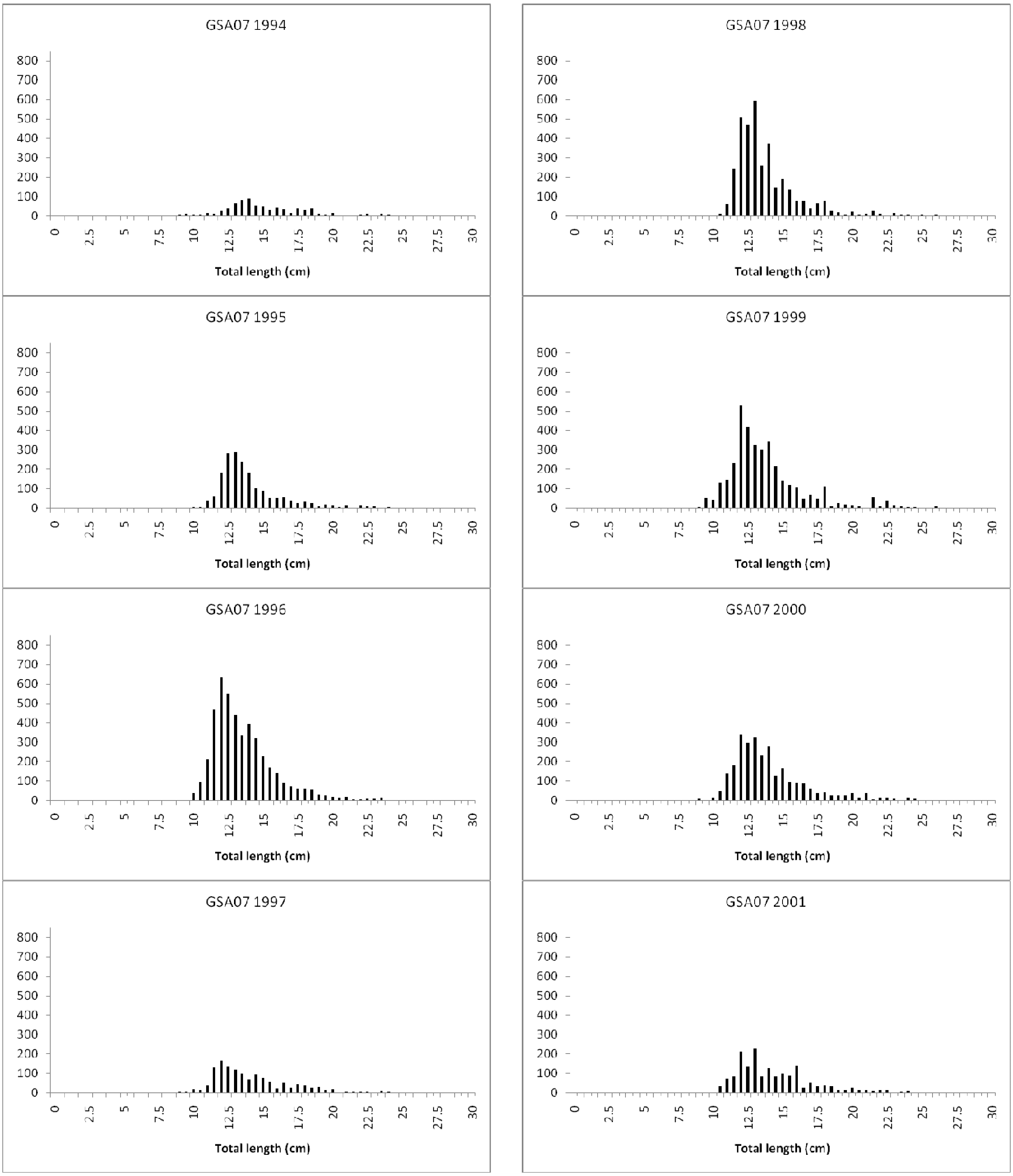


Fig. 8.18.3.1.4.1 Stratified abundance indices by size, 1994-2001.

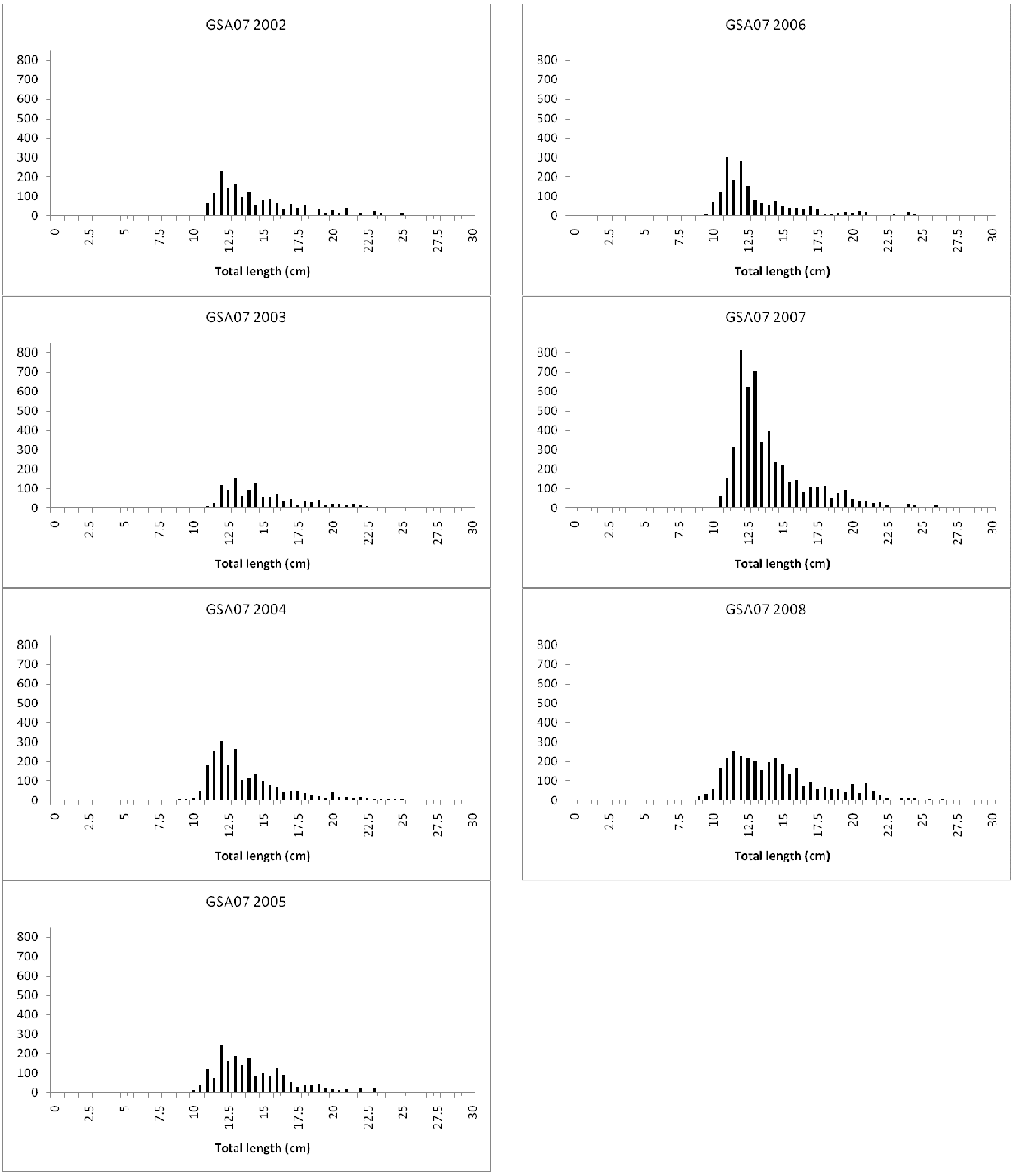


Fig. 8.18.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.18.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.18.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.18.4.Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.18.5.Long term prediction

8.18.5.1.Justification

No forecast analyses were conducted.

8.18.5.2.Input parameters

No forecast analyses were conducted.

8.18.5.3.Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 07.

8.18.6.Scientific advice

8.18.6.1.Short term considerations

8.18.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.18.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.18.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.19. Stock assessment of red mullet in GSA 08

8.19.1. Stock identification and biological features

8.19.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.19.1.2. Growth

No information was documented during SGMED-09-02.

8.19.1.3. Maturity

No information was documented during SGMED-09-02.

8.19.2. Fisheries

8.19.2.1. General description of fisheries

No information was documented during SGMED-09-02.

8.19.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.19.2.3. Catches

8.19.2.3.1. Landings

No information was documented during SGMED-09-02.

8.19.2.3.2. Discards

No information was documented during SGMED-09-02.

8.19.2.3.3. Fishing effort

No information was documented during SGMED-09-02.

8.19.3. Scientific surveys

8.19.3.1. Medits

8.19.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. SGMED-09-02 notes that the reported Medits data in GSA 08 only cover the eastern coast of Corsica. In GSA 08 the following number of hauls was reported per depth stratum (s. Tab. 8.19.3.1.1.1).

Tab. 8.19.3.1.1.1. Number of hauls per year and depth stratum in GSA 08, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA08_010-050	4														
GSA08_050-100	6	5	8	4	8	7	5	5		6	6	8	8	5	7
GSA08_100-200	3	5	6	2	5	5	5	5	1	5	5	5	5	4	5
GSA08_200-500	10	11	12	8	12	10	11	10		10	11	11	11	10	12
GSA08_500-800	6	5	4	4	5	6	5	5		4	5	5	5	5	5

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

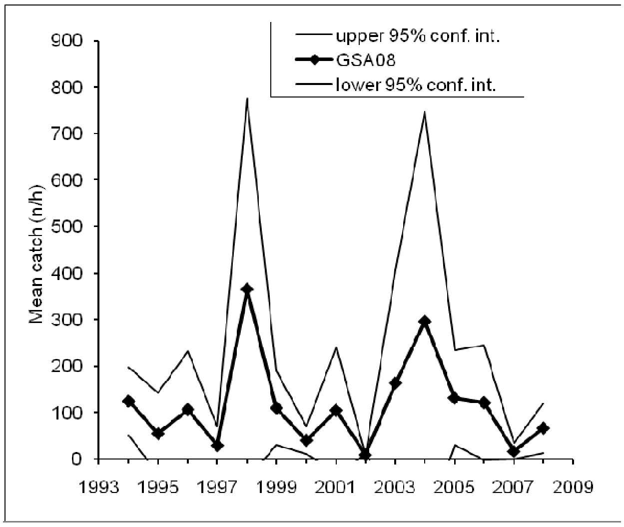
8.19.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.19.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 08 was derived from the international survey Medits. SGMED-09-02 notes that the reported Medits data in GSA 08 only cover the eastern coast of Corsica. Figure 8.19.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 08.

The estimated abundance and biomass indices do not reveal any significant trends since 1994. However, the recent abundance and biomass indices in 2007 appear very low. The analyses of Medits indices are considered preliminary.



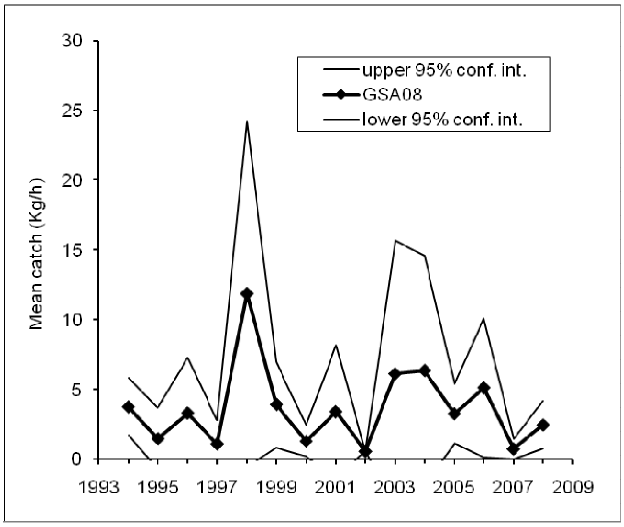


Fig. 8.19.3.1.3.1 Abundance and biomass indices of red mullet in GSA 08.

8.19.3.1.4. Trends in abundance by length or age

The following Fig. 8.19.3.1.4.1 and 2 display the stratified abundance indices of GSA 08 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

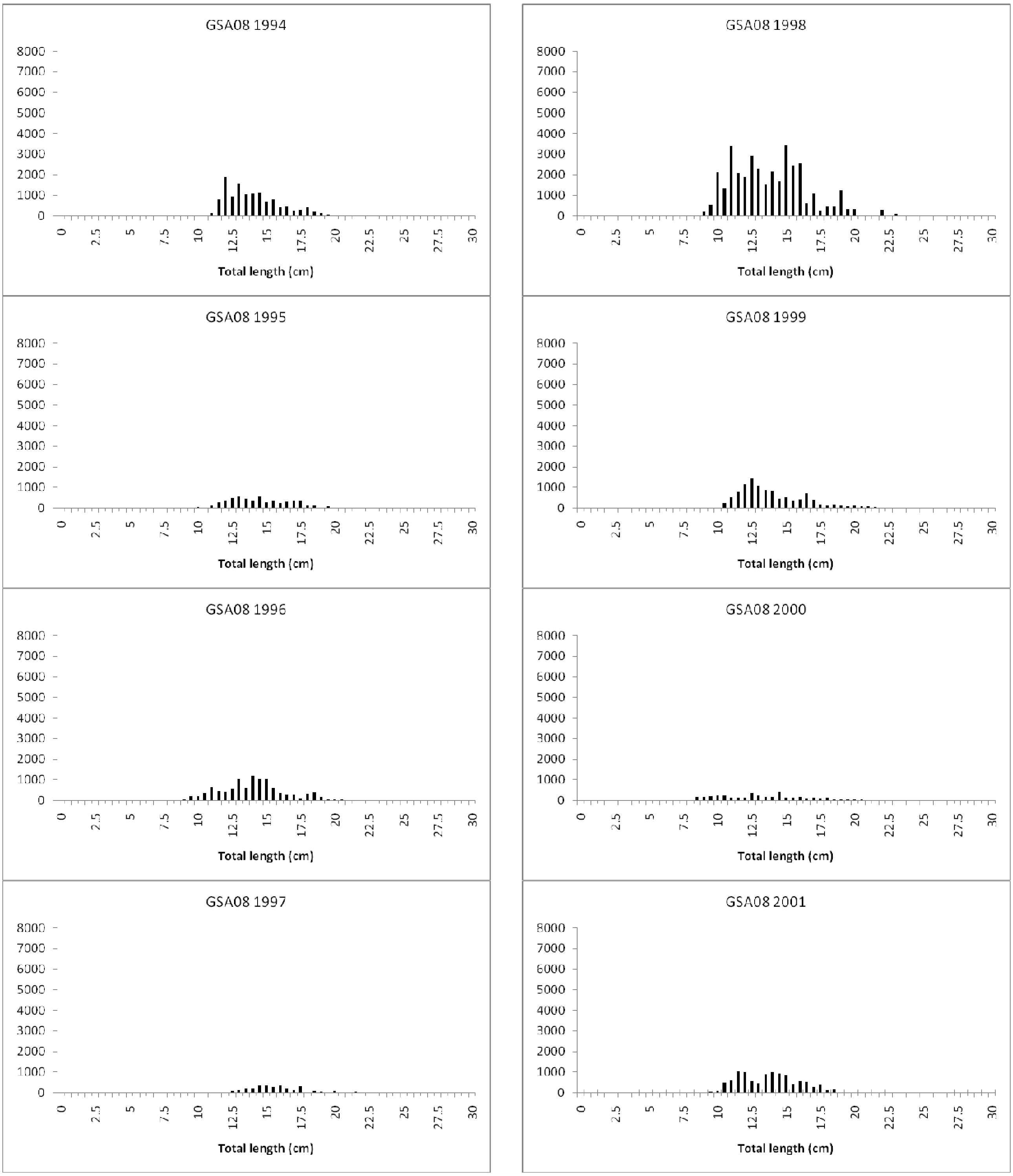


Fig. 8.19.3.1.4.1 Stratified abundance indices by size, 1994-2001.

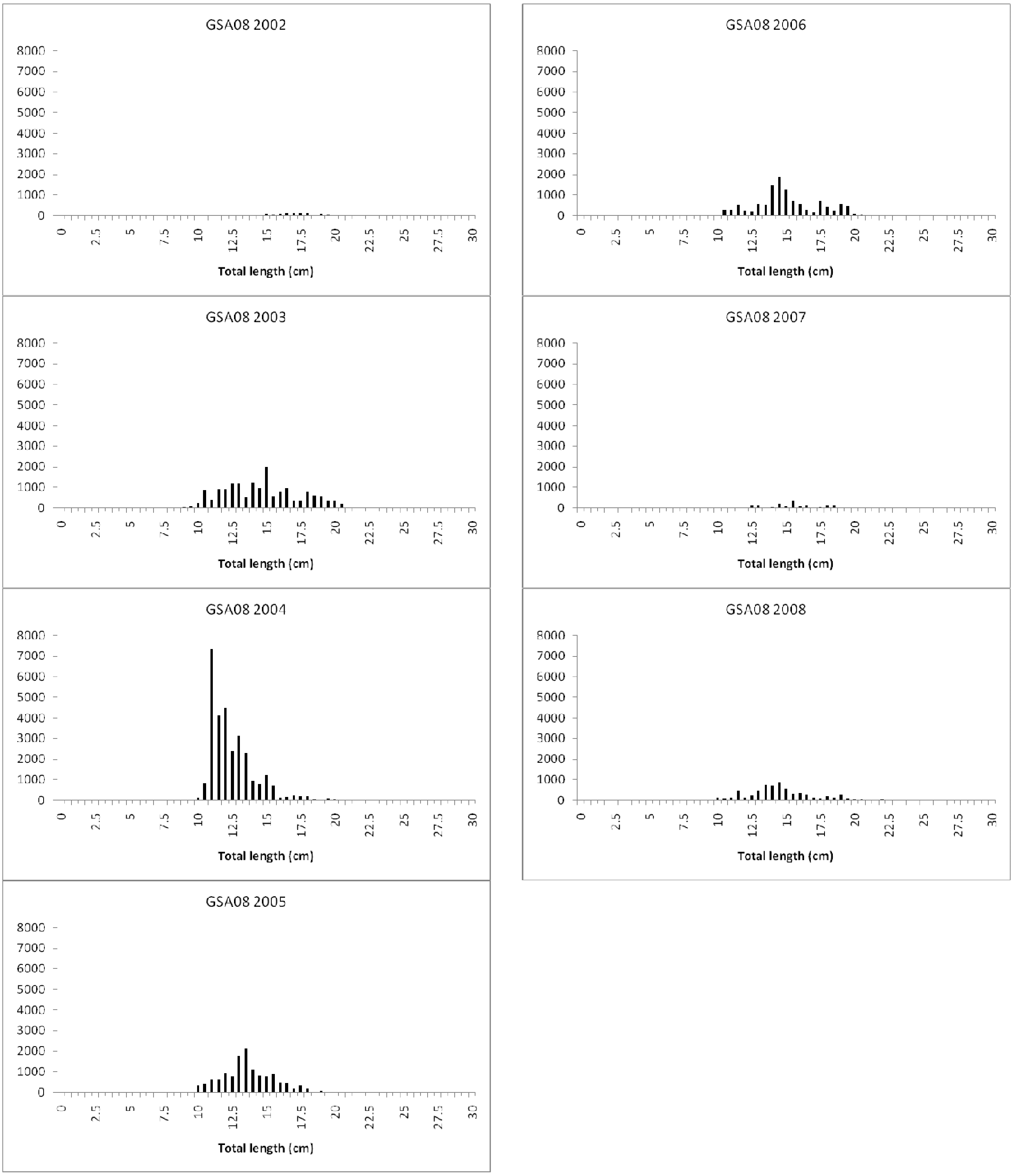


Fig. 8.19.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.19.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.19.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.19.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.19.5. Long term prediction

8.19.5.1. Justification

No forecast analyses were conducted.

8.19.5.2. Input parameters

No forecast analyses were conducted.

8.19.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 08.

8.19.6. Scientific advice

8.19.6.1. Short term considerations

8.19.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.19.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.19.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.20. Stock assessment of red mullet in GSA 09

8.20.1.Stock identification and biological features

8.20.1.1.Stock Identification

Red mullet is distributed along the shelf of all the Mediterranean countries. Even though the species can be found at depths over 200 m, it is mainly concentrated in the depth range 0-100 m. All the year classes and nursery and spawning areas are well distributed along the narrow Mediterranean shelves. There is not any available definition of unit stocks neither based on genetics, bio-chemistry, fishery-based nor on any alternative method based on somatic features. Under a management point of view, in the frame of GFCM, it has been decided, when the lack of any evidence does not allow suggesting an alternative hypothesis, that inside each one of the GSAs boundaries inhabits a single, homogeneous red mullet stock that behaves as a single well-mixed and self-perpetuating population. The GSA boundaries are however arbitrary and certaintly do not take under consideration neither the existence of any local biological feature nor of any difference in the spatial allocation in fishing pressure within it. The hypothesis of a single stock of red mullet in GSA 09, which includes waters belonging to 2 seas (Ligurian and Tyrrhenian) separated by the Elba Island and fleets that does not show any spatial overlapping is almost unlikely. The inability to account for spatial structure reduces flexibility and can lead to uncertainty in the definition of the status of the stocks, due to the possibility of local depletions and to a worse utilization of the potential productivity of the resources.

8.20.1.2.Growth

The species is fast growing, and reaches half of its total size when is one year old. Some light differences in growth speed has been observed within different zones within the GSA 09. In zones where the species is less exploited, individuals more densely concentrated or available food is lower, the mean size of 6 months old individuals is from 1 to 1.5 cm lower than in other areas of the same GSA were the species is more highly exploited and hence less abundant. In any case, the parameters reported as follows may be considered suitable for the description of an average growth performance valid for the whole GSA 09.

Table 8.20.1.2.1. Common growth parameters and natural mortality rates considered representative for *M. barbatus* in the GSA 09 utilized in the successive analyses.

L_∞	29
K	0.6
to	-0.1
L/W a	0.00053
L/W b	3.12
An M vector was used for LCA with age 0=1.30, age 1= 0.79, age 2= 0.62, age 3 or older = 0.54 and a weighted mean value of M of 0.8 for Y/R computations	

8.20.1.3.Maturity

The species reaches massively the sexual maturity at one year old. Observations of proportion of mature individuals by size and analysis with the standard procedure have produced the following sizes at age maturity by sex.

L_m	12.5 cm TL (females) 10 cm TL (males	Sanchez *et al*. 1995

The classical approach for the definition of Lm, as expected, produces a light underestimation of this size. In fact, the bulk of the females spawn at a size of about 14 cm.

In GSA 09 there have been performed studies on fecundity. The following relationship of fecundity at size (in cm) was defined in the area: Fec= 0.7599*TL^3.336

8.20.2.Fisheries

8.20.2.1.General description of fisheries

STECF in 2007 (stock review part II) notes that *Mullus barbatus* is among the most commercially valuable species in the area and is an important component of a species assemblage that is the target of the bottom trawling fleets operating near shore. It becomes a first order target of part of the fleet in some particular periods when the juveniles of the species are densely concentrated near the coast. The species in GSA 09 is mainly caught with three different variants of the Italian bottom trawl net ("tartana", "volantina" and wide vertical opening or "francese"). The small mesh size of the cod end in all cases defines a very precocious size/age of first capture.

L_c	7.4 cm TL (males + females)	De Ranieri *et al.* , 2000

Set nets catch modest quantitatives of relatively large individuals, in general over 12 cm TL. The exerted fishing pressure on this species on different zones of GSA 09 is quite variable because conditioned by the structural composition of the fractions of the fleets that operate close to their respective ports, by the bottom characteristics potentially exploitable close to the ports and also by differences in the fisheries' target among fleets and zones. *Mullus barbatus* catch rates are higher during the post-recruitment period (from September to November). About 200 of the 350 trawlers and a small number of artisanal vessels exploit the species in the GSA 09. Annual landings, mostly proceeding from trawling, ranged from 500 to 1100 tons in the last years. Discards of undersized individuals is in general limited (about 10% in weight in 2006), mainly due to the fact that immediately after recruitment, small sized individuals, even though potentially vulnerable to the gear, are mostly concentrated inside the 3 miles where trawling practices are forbidden.

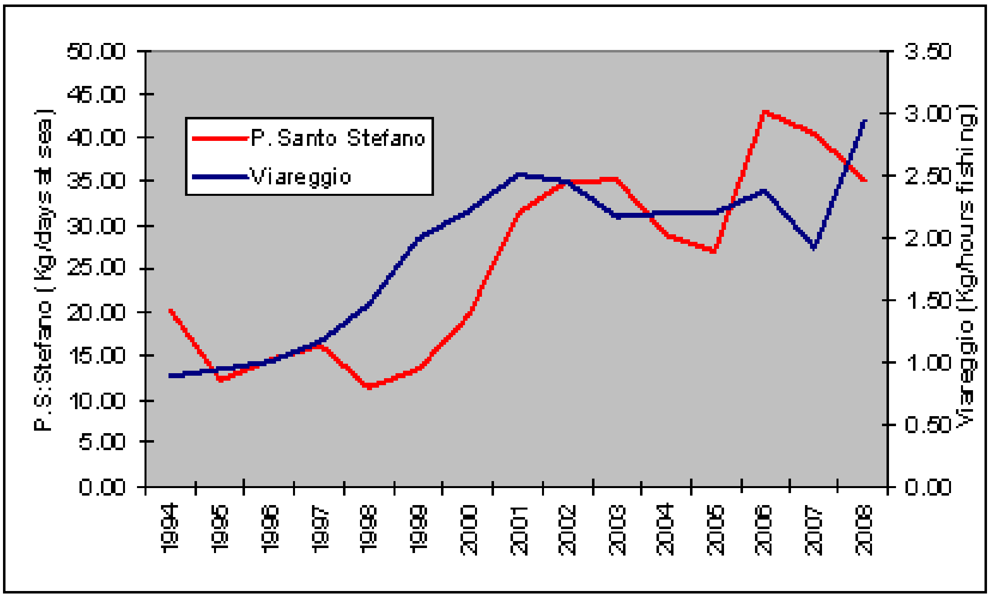


Fig. 8.20.2.1 Landings per unit of effort by year in two of the more important ports of GSA 09.

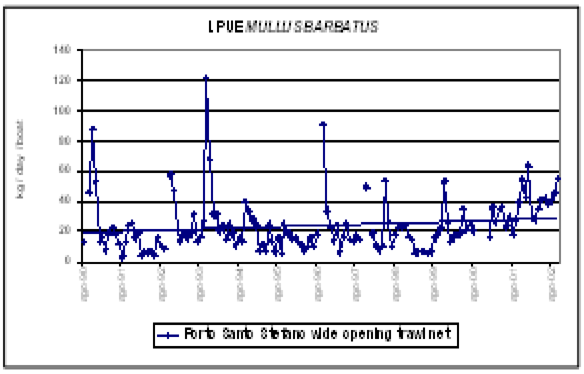
8.20.2.2.Management regulations applicable in 2008 and 2009

Fishing closure for trawling: 45 days in late summer have been enforced certain years for some fleets in GSA 09. In 2008 it was compulsory for all the trawlers in the area and is expected this measure will be repeated in 2009.
Minimum landing sizes: EC regulation 1967/2006 defined 12 cm TL as minimum legal landed size for red mullet.
Cod end mesh size of trawl nets: the 40 mm (stretched, diamond meshes) will continue to be utilized up to 30/05/2010. Since 1/6/2010, such cod end will be replaced by a 40 mm square meshes or alternatively by a net with a cod end of 50 mm (stretched) diamond meshes. It is not expected a noticeable increase in the size of entering to the fishery with the introduced changes because this size is only patially defined by the gear but also by the spatial distribution of juveniles.
Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

8.20.2.3.Catches

8.20.2.3.1. Landings

Landings data were reported through the Data collection regulation and are listed in Table A3.2 of Appendix 3. Since 2002 annual landings varied between 620 and 1,100 (Tab. 8.20.2.3.1.1). Demersal bottom trawlers dominate the landings by far. Landings size show a very high seasonal variability, with peaks at the end of summer (September) determined by the increase in availability/vulnerability after the massive recruitment on the coastal area.



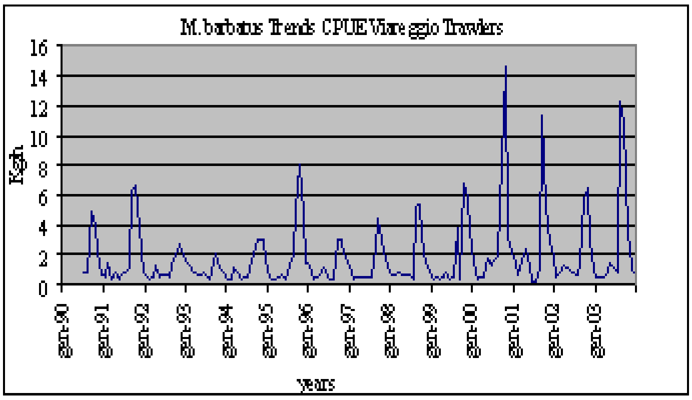


Fig. 8.20.2.3.1.1 Monthly catches with regular seasonal fluctuations in red mullet landings in two of the main ports of GSA 09.

Tab. 8.20.2.3.1.1 Annual landings (t) by fishing technique as reported to SGMED-09-02 through the DCR data call.

YEAR	Bottom trawls	Nets	Total catch (Tons)
2004	521.1	59.9	583.2
2005	684.0	30.8	714.9
2006	1033.2	16.4	1050.1
2007	1087.4	8.6	1096.0
2008	716.3	11.2	727.4

Tab. 8.20.2.3.1.2 Size structure of catches for trawlers and artisanal fleet for years 2006-2008.

	2006		2007		2008	
size (cm)	trawlers	nets	trawlers	nets	trawlers	nets
6	0.00	0.00	5.27	0.00	0.00	0.00
7	19.34	0.00	49.31	0.00	115.70	0.00
8	85.03	0.00	90.98	0.00	1023.94	0.00
9	456.91	0.00	391.35	0.00	2068.53	0.00
10	1283.77	5.44	738.57	0.00	4119.06	0.45
11	1715.53	28.54	1382.01	0.00	3933.30	4.09
12	2135.28	32.51	2606.97	0.00	3725.83	6.00
13	2795.66	32.16	3164.87	10.32	4887.99	7.55
14	2984.35	8.31	2558.87	34.58	2174.50	6.92
15	2714.90	11.72	3202.84	44.83	1777.36	19.92
16	1928.88	13.82	2374.11	30.74	1486.53	30.66
17	1603.74	15.04	2058.54	37.40	763.75	43.17
18	1206.94	11.51	1634.75	57.66	317.98	30.52
19	1445.07	7.52	1081.34	8.15	88.10	6.60
20	1230.68	3.62	595.52	5.94	54.49	3.30
21	544.97	4.05	317.92	3.80	65.28	1.37
22	140.28	3.78	187.45	23.42	47.20	1.10
23	51.03	3.57	129.83	0.11	30.01	0.55
24	36.54	0.73	49.88	0.57	28.93	0.00
25	39.75	0.00	26.47	0.00	28.93	0.00

8.20.2.3.2. Discards

158 t of discards in 2006 were reported to SGMED-09-02 and are listed in Tab. A3.9 of Appendix 3.

8.20.2.3.3. Fishing effort

Tab. 8.20.2.3.3.1 lists the effort by fishing technique deployed in GSA 09 as reported to SGMED-09-02 through the DCR data call and listed in Tab. A3.10-3.12 of Appendix 3. A minor decrease is observed for the main gear demersal otter trawl. It is however difficult to extract from these figures the real number of vessels that target red mullet.

In the last 15 years, a general decrease in the size of the fishing fleets operating in the GSA 09 targeting demersal species was observed. The number of vessels targeting the species in question and the changes (reduction) in number along the time interval 1990-2007 is only known for some ports of the GSA. The reduction of number of vessels has been particularly important in Porto Santo Stefano fleet (about 50% of reduction) in the South and in Viareggio (about 30%) in the North. It is likely that this general reduction in numbers of vessels also apply for the fraction of the fleet that exert its fishing effort on *M. barbatus* over all the GSA 09 fleets.

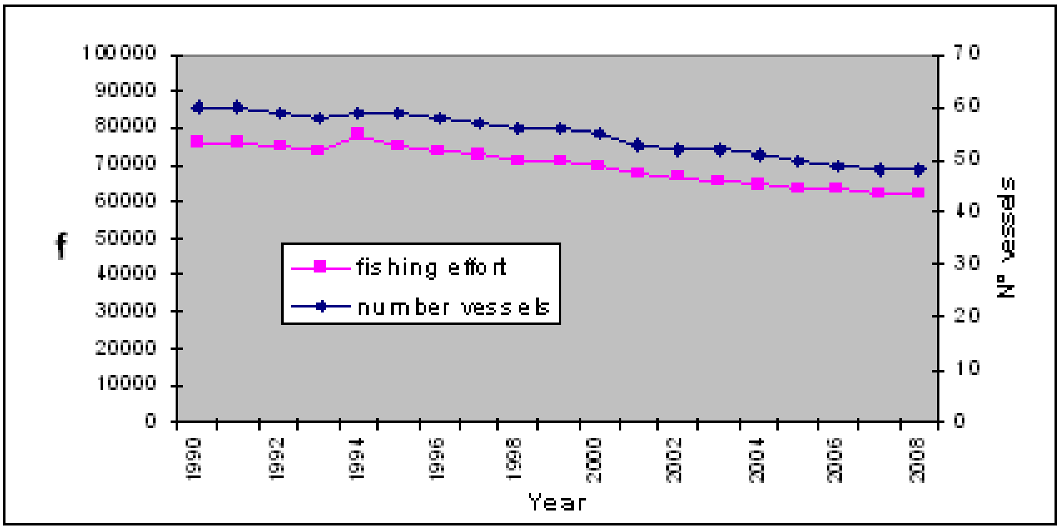


Fig. 8.20.2.3.3.1 Number of vessels and fishing activity in the port of Viareggio (1990-2008)

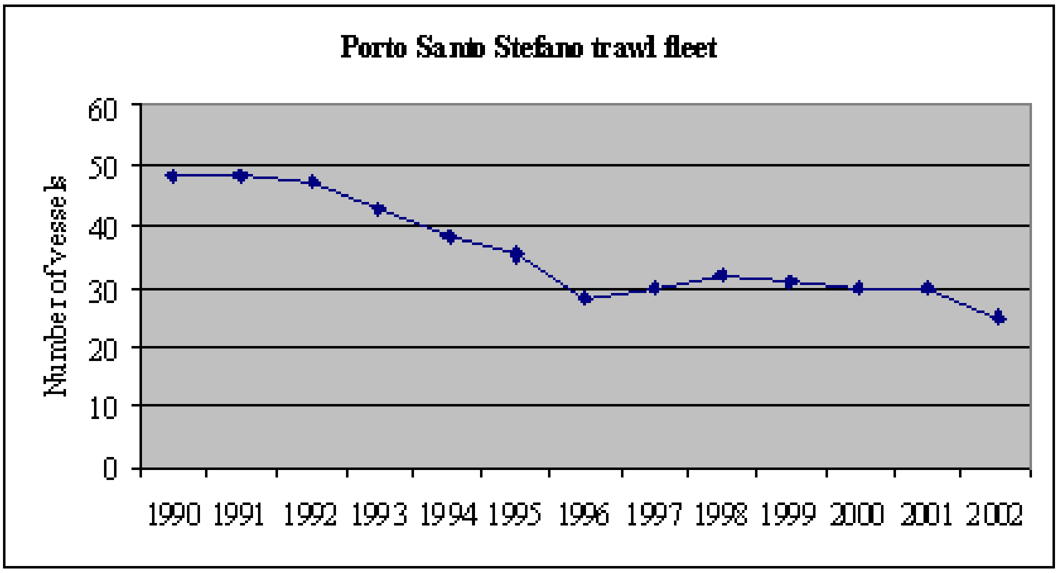


Fig. 8.20.2.3.3.2 Number of vessels in the port of Santo Stefano (1990-2002).

Tab. 8.20.2.3.3.1 Effort trends by fishing technique in GSA 09. Data regards the whole fleets by fishing typology without any distinction regarding targets, season nor operations depth interval).

Unit	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	9	ITA	DRB	1856	3332	2660	6303	8502	8405	
DAYS	9	ITA	DTS	62616	63331	64870				
DAYS	9	ITA	FPO					86	577	
DAYS	9	ITA	GND				3014	1970	1362	
DAYS	9	ITA	GNS				87509	81222	101245	
DAYS	9	ITA	GTR				61098	64285	42880	
DAYS	9	ITA	HOK			2568				
DAYS	9	ITA	LLD				8353	9168	5918	
DAYS	9	ITA	LLS				7213	4718	4011	
DAYS	9	ITA	LTL					359	139	
DAYS	9	ITA	MIS				5027	1043		
DAYS	9	ITA	OTB				65427	58739	61370	
DAYS	9	ITA	PGP	212455	182159	196758				
DAYS	9	ITA	PMP	52193	75479	16960				
DAYS	9	ITA	PS				4796	4554	3967	
DAYS	9	ITA	PTM					223		
DAYS	9	ITA	PTS	5453	6242	4728				
DAYS	9	ITA	SB-SV				17421	16166	13432	
GT*days	9	ITA	DRB	15733	28362	24050	28397	24666	25679	
GT*days	9	ITA	DTS	2154256	2147750	2410544				
GT*DAYS	9	ITA	FPO					86	1748	
GT*DAYS	9	ITA	GND				17625	8566	8782	
GT*DAYS	9	ITA	GNS				241838	216207	239030	
GT*DAYS	9	ITA	GTR				176723	189219	136816	
GT*days	9	ITA	HOK			22784				
GT*DAYS	9	ITA	LLD				29031	51046	31466	
GT*DAYS	9	ITA	LLS				24902	14632	6447	
GT*DAYS	9	ITA	LTL					359	139	
GT*DAYS	9	ITA	MIS				16776	2969		
GT*DAYS	9	ITA	OTB				2355691	2157251	2154665	
GT*days	9	ITA	PGP	624182	650560	521225				
GT*days	9	ITA	PMP	382454	382992	62599				
GT*DAYS	9	ITA	PS				181752	154273	132567	
GT*DAYS	9	ITA	PTM					223		
GT*days	9	ITA	PTS	193726	181590	143490				
GT*DAYS	9	ITA	SB-SV				40642	37698	28857	
kW*days	9	ITA	DRB	187147	335520	268423	317456	301864	306714	
kW*days	9	ITA	DTS	14583556	14671042	14130070				
KW*DAYS	9	ITA	FPO					1448	15787	
KW*DAYS	9	ITA	GND				273248	223990	146786	
KW*DAYS	9	ITA	GNS				3668438	2989348	3630165	
KW*DAYS	9	ITA	GTR				3392406	3459956	2528382	
kW*days	9	ITA	HOK			376470				
KW*DAYS	9	ITA	LLD				653659	816400	453585	
KW*DAYS	9	ITA	LLS				426713	357010	99478	
KW*DAYS	9	ITA	LTL					6081	2128	
KW*DAYS	9	ITA	MIS				352334	80944		
KW*DAYS	9	ITA	OTB				14351906	12112028	12809257	
kW*days	9	ITA	PGP	6504001	6925653	7060573				
kW*days	9	ITA	PMP	4715565	4051809	984241				
KW*DAYS	9	ITA	PS				1097509	934012	922193	
KW*DAYS	9	ITA	PTM					4671		
kW*days	9	ITA	PTS	1312412	1333245	947166				
KW*DAYS	9	ITA	SB-SV				950710	751142	550250	

8.20.3.Scientific surveys

8.20.3.1.Medits

8.20.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 09 the following number of hauls was reported per depth stratum (s. Tab. 8.20.3.1.1.1).

Tab. 8.20.3.1.1.1. Number of hauls per year and depth stratum in GSA 09, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA09_010-050	19	18	18	18	19	18	18	18	13	13	13	14	13	13	13
GSA09_050-100	19	20	18	19	18	19	20	20	15	15	15	14	16	16	13
GSA09_100-200	35	35	36	35	35	35	34	34	26	27	26	27	25	26	28
GSA09_200-500	32	33	33	36	32	36	37	35	27	27	27	28	29	33	30
GSA09_500-800	31	30	32	28	30	28	27	29	24	22	21	20	20	17	18

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.20.3.1.2. Geographical distribution patterns

The species is distributed all along the continental shelf of the GSA 09, with major abundance in the depth range 0-100 m. The species is highly concentarted along the coastal stripe 0-30 m when in late summer-beginnings of autumn juveniles massively settle to the bottom. The major nursery areas are allocated in the northern portion of the GSA, Northwards the Elba Island (yellow areas in Fig. 8.20.3.1.2.1).

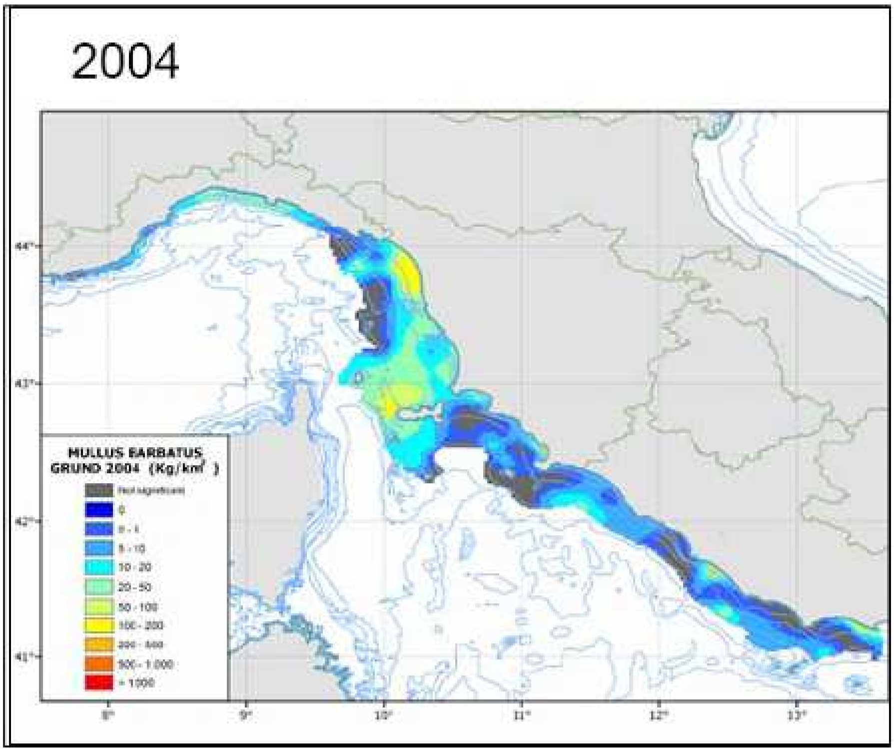


Fig. 8.20.3.1.2.1 Distribution of juveniles of red mullet in autumn 2004 (GRUND survey) in kg/km^2.

Also mature individuals are more abundant in the Northern part of the GSA 09.

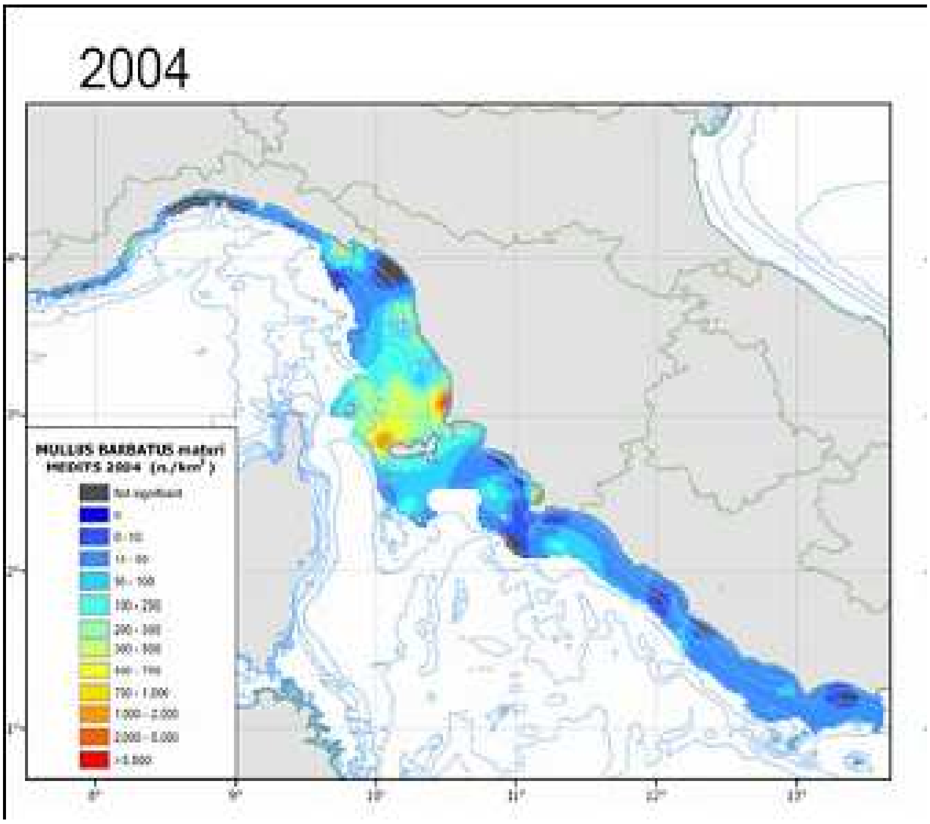


Fig. 8.20.3.1.2.2 Distribution of mature adults of red mullet in spring 2004 (MEDITS survey) in numbers/km^2.

The nursery concentrations show a marked spatial stability. Fig. 8.20.3.1.2.3 shows the areas where a major stability along time has been observed (in dark brown)

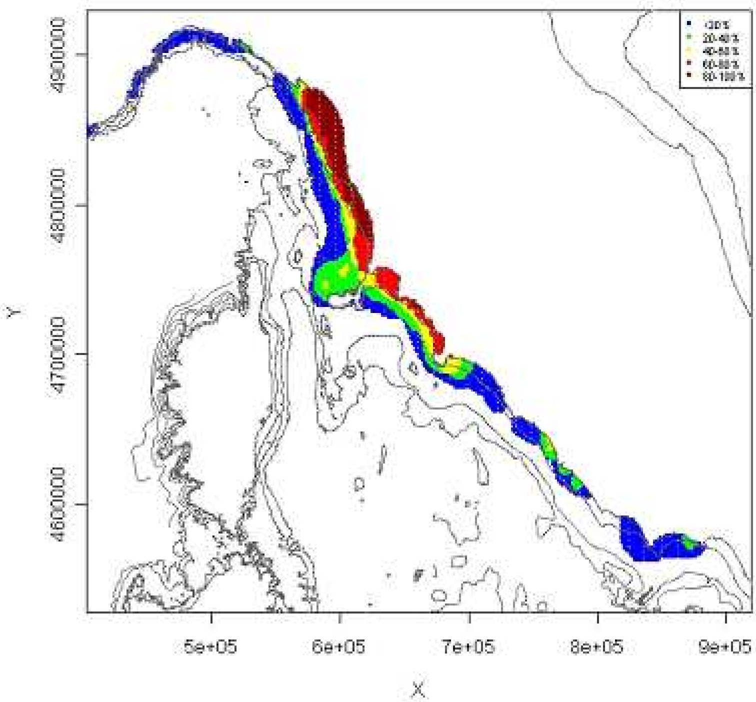


Fig. 8.20.3.1.2.3 Analysis of stability along time of red mullet nursery areas in GSA 09.

8.20.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 09 was derived from the international surveys Medits and Grund. Fig. 8.20.3.1.3.1 and 2 display the estimated trends in abundance and biomass.

The estimated abundance and biomass indices do not reveal any significant trend since 1994. However, since 2002 estimated abundance indices displayed a pronounced interannual variability and were subject to high uncertainty (high confidence intervals).

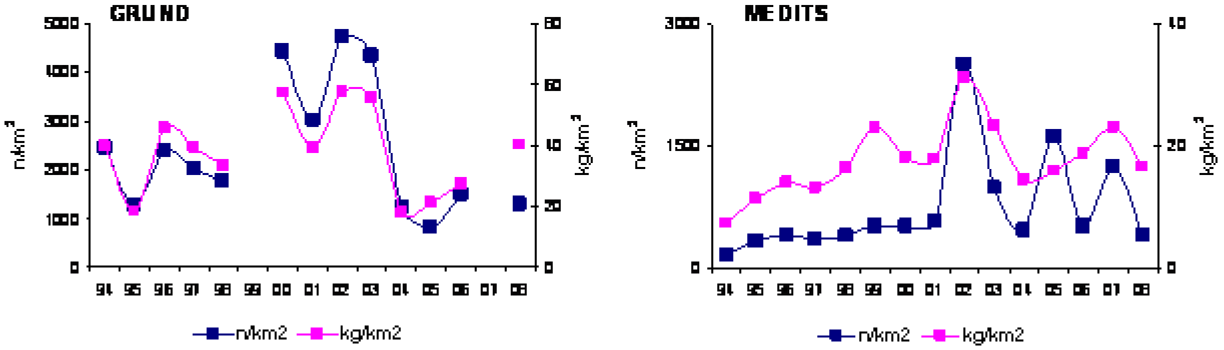


Fig. 8.20.3.1.3.1 GRUND and MEDITS survey abundance and biomass estimates.

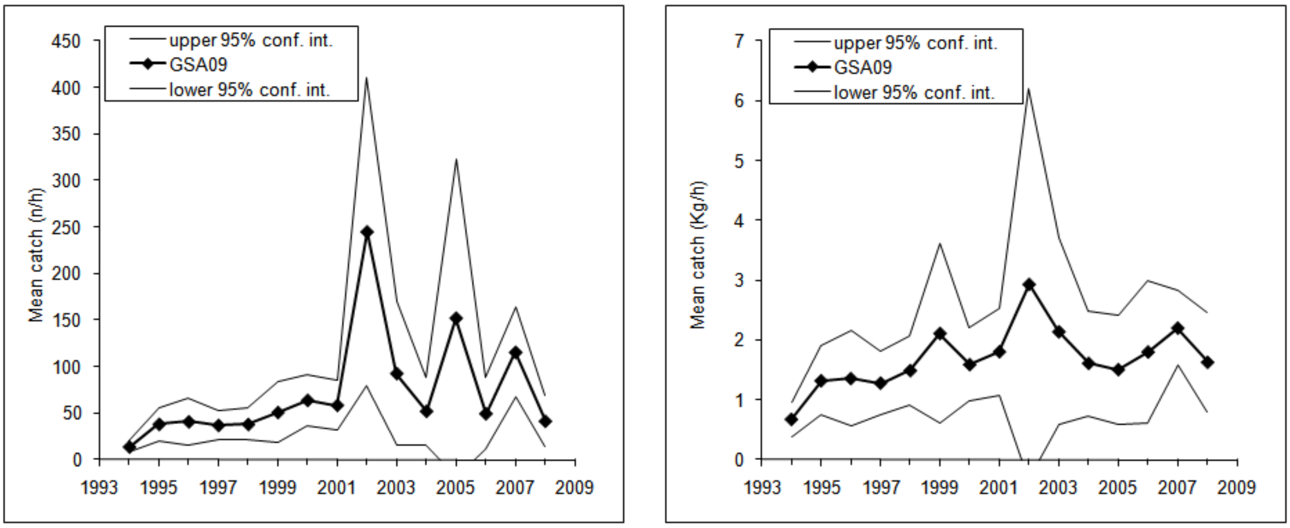


Fig. 8.20.3.1.3.2 Abundance and biomass indices of red mullet in GSA 09 derived from MEDITS.

8.20.3.1.4. Trends in abundance by length or age

The following Fig. 8.20.3.1.4.1 and 2 display the stratified abundance indices of GSA 09 in 1994-2001 and 2002-2008.

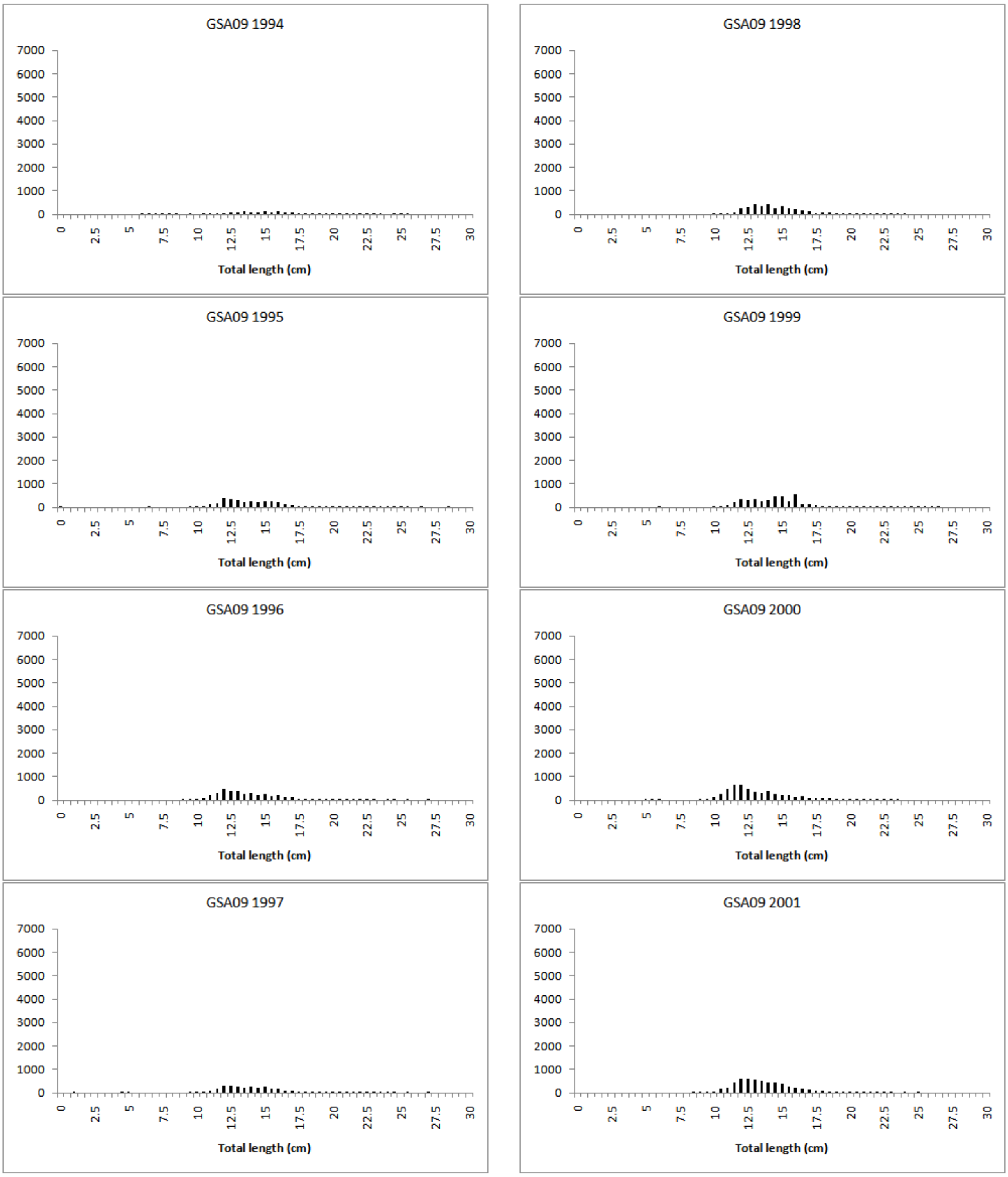


Fig. 8.20.3.1.4.1 Stratified abundance indices by size, 1994-2001.

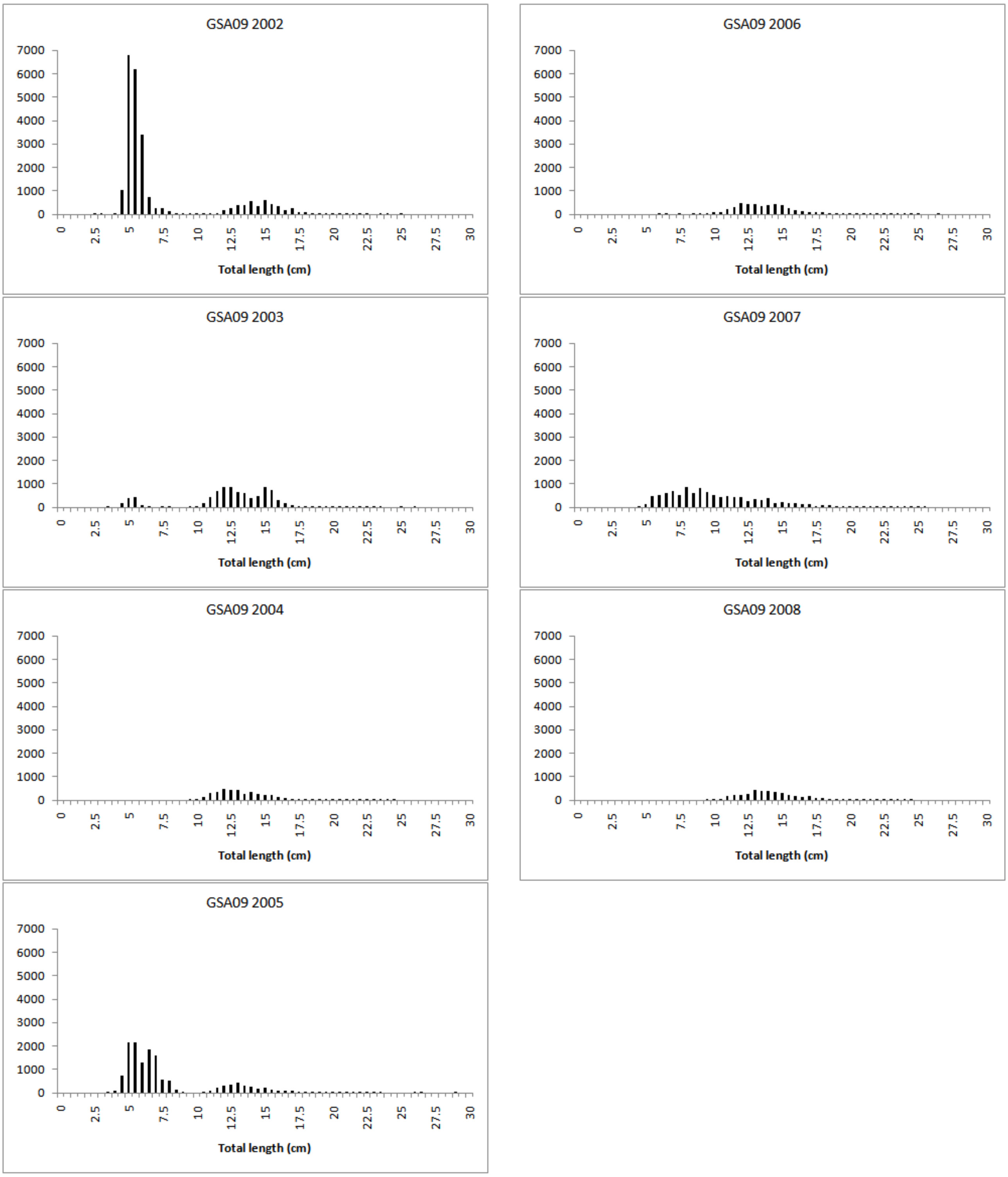


Fig. 8.20.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.20.3.1.5. Trends in growth

No analyses were conducted.

8.20.3.1.6. Trends in maturity

No analyses were conducted.

8.20.4. Assessment of historic stock parameters

8.20.4.1. Method 1: Length cohort analysis LCA

8.20.4.1.1. Justification

A LCA was performed aimed at the estimation of a vector of *F* at size, using data on total annual catches by size, including discard. Considering the short time series available, it was not possible to perform VPA. An average size distribution of the catch for the years 2006-2008 was used in order to approch an equilibrium status.

8.20.4.1.2. Input parameters

Catch of red mullet proceeds from two fisheries (bottom trawlers targeting a coastal demersal assemblage and artisanal fisheries using trammel nets. The catch of trammel nets is quite modest (<2% in numbers). A reasonable hypothesis of a declining rate of M with age derived from ProdBiom was used in the computations (mean values for age 0 =1.30, age 1 = 0.79, age 2 = 0.62, age 3=> 0.54).

8.20.4.1.3. Results

The analysis suggests a weighted mean *F* of about 0.97 between 8 cm and 20 cm which are the sizes with major contribution to the catch. The values of *F* for the bigger sizes may be handled with care due to the limited number of individuals included in the analysis. Very big sized individuals live at deeper waters and are seldom caught.
The simulations suggest that the current spawning stock biomass in the area is reduced to about 18% of the pristine SSB.

8.20.4.2. Method 2: Stock Production Model

8.20.4.2.1. Justification

The analysis was performed using the ASPIC.5 software (A Stock-Production model Incorporating Covariates) (Prager, 1994, 2005) assuming a Schaefer (1954) model. This program implements a non-equilibrium, continuous-time, observation-error estimator for the dynamic production model (Schnute, 1977; Prager, 1994). The model was used to estimate *r* (the intrinsic rate of population growth), *MSY*, the ratios of both current biomass or *F* to the biomass or F at which *MSY* can be attained, and *q* (the catchability coefficient, the proportion of total stock removed by one unit of fishing effort).

8.20.4.2.2. Input parameters

Input data consist of 2 sets of time series of total landings (in kg) and fishing effort expressed as kg/hour and kg/day for two of the main ports of the GSA 09 (Viareggio and Porto Santo Stefano) which are considered representative for the area and a time series of an index of abundance (kg/km^2) for the whole GSA 09 derived from MEDITS surveys. This is a new extension incorporated in ASPIC new versions.

Tab. 8.20.4.2.2.1 Aspic input parameters.

```
BOT                ## Run type (FIT, BOT, or IRF)
"None Selected"
LOGISTIC YLD SSE   ## Model type, conditioning type, objective function
100                ## Verbosity
500                ## Number of bootstrap trials, <= 1000
0 50000            ## 0=no MC search, 1=search, 2=repeated srch; N trials
1.00000d-08        ## Convergence crit. for simplex
3.00000d-08  6     ## Convergence crit. for restarts, N restarts
1.00000d-04  0     ## Convergence crit. for estimating effort; N steps/yr
8.00000d00         ## Maximum F allowed in estimating effort
0d0                ## Weighting for B1 > K as residual (usually 0 or 1)
3                  ## Number of fisheries (data series)
1.00000d00  1.00000d00  1.00000d00       ## Statistical weights for data series
4.00000d-01        ## B1/K (starting guess, usually 0 to 1)
3.50000d05         ## MSY (starting guess)
2.50000d06         ## K (carrying capacity) (starting guess)
5.00000d-04  5.00000d-04  5.00000d-04    ## q (starting guesses -- 1 per data series)
1 1 1 1 1 1        ## Estimate flags (0 or 1) (B1/K,MSY,K,q1...qn)
1.50000d05  1.00000d06      ## Min and max constraints -- MSY
4.00000d05  1.00000d07      ## Min and max constraints -- K
657438223          ## Random number seed
15                 ## Number of years of data in each series
"Porto Santo Stefano"
CE
  1994   1.92800d03   3.90290d04
  1995   2.25000d03   2.73570d04
  1996   2.32000d03   3.36430d04
  1997   2.13700d03   3.47150d04
  1998   2.62600d03   3.00910d04
  1999   2.45400d03   3.31610d04
  2000   2.35400d03   4.60630d04
  2001   1.53200d03   4.80690d04
  2002   1.17400d03   4.09930d04
  2003   1.44800d03   5.10270d04
  2004   1.59100d03   4.60480d04
  2005   1.47500d03   3.98440d04
  2006   1.62900d03   6.99550d04
  2007   1.55000d03   6.27350d04
  2008   1.42300d03   5.01170d04
"Viareggio"
CE
  1994   7.83750d04   6.96500d04
  1995   7.52400d04   7.13260d04
  1996   7.41950d04   7.46630d04
  1997   7.31500d04   8.51100d04
  1998   7.10600d04   1.04051d05
  1999   7.10600d04   1.41873d05
  2000   7.00150d04   1.54654d05
  2001   6.79250d04   1.70953d05
  2002   6.68800d04   1.63647d05
  2003   6.58350d04   1.43018d05
  2004   6.47900d04   1.42679d05
  2005   6.37450d04   1.40381d05
  2006   6.35560d04   1.50826d05
  2007   6.26320d04   1.19807d05
  2008   6.17260d04   1.81412d05
"Trawl surveys"
I1
  1994   7.35060d00
  1995   1.10108d01
  1996   1.29917d01
  1997   1.45988d01
  1998   1.76335d01
  1999   1.92935d01
  2000   1.98471d01
  2001   2.25128d01
  2002   2.42151d01
  2003   2.30405d01
  2004   1.79391d01
  2005   1.64171d01
  2006   1.88141d01
  2007   1.77500d01
   2008   1.66300d01
```

8.20.4.2.3. Results

Tab. 8.20.4.2.3.1 Aspic output main results.

Main output ASPIC

None Selected Page 1
Thursday, 11 Jun 2009 at 09:09:45
ASPIC -- A Surplus-Production Model Including Covariates (Ver. 5.16)
BOT program mode
Author: Michael H. Prager; NOAA Center for Coastal Fisheries and Habitat Research LOGISTIC model mode
101 Pivers Island Road; Beaufort, North Carolina 28516 USA YLD conditioning
Mike.Prager@noaa.gov SSE optimization

Reference: Prager, M. H. 1994. A suite of extensions to a nonequilibrium surplus-production model. Fishery Bulletin 92: 374-389.
CONTROL PARAMETERS (FROM INPUT FILE)

Operation of ASPIC: Fit logistic (Schaefer) model by direct optimization with bootstrap.
Number of years analyzed: 15 Number of bootstrap trials: 500
Number of data series: 3 Bounds on MSY (min, max): 1.500E+05 1.000E+06
Objective function: Least squares Bounds on K (min, max): 4.000E+05 1.000E+07
Relative conv. criterion (simplex): 1.000E-08 Monte Carlo search mode, trials: 0 50000
Relative conv. criterion (restart): 3.000E-08 Random number seed: 657438223
Relative conv. criterion (effort): 1.000E-04 Identical convergences required in fitting: 6
Maximum F allowed in fitting: 8.000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) Normal convergence

CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)
----

1 Series 1	1.000		
2 Series 2	0.709	1.000	
3 Series 3	0.501	0.765	1.000
	1	2	3

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

Loss component number and title	Weighted SSE	N	Weighted MSE	Current weight	Inv. var. weight	R-squared in CPUE
Loss(-1) SSE in yield	0.000E+00					
Loss(0) Penalty for B1 > K	0.000E+00	1	N/A	0.000E+00	N/A	
Loss(1) Series 1	1.765E+00	15	1.358E-01	1.000E+00	2.553E-01	0.438
Loss(2) Series 2	2.607E-01	15	2.006E-02	1.000E+00	1.729E+00	0.822
Loss(3) Series 3	4.436E-01	15	3.413E-02	1.000E+00	1.016E+00	0.480

....
TOTAL OBJECTIVE FUNCTION, MSE, RMSE: 2.46964227E+00 6.332E-02 2.516E-01
Estimated contrast index (ideal = 1.0): 0.4744 C* = (Bmax-Bmin)/K
Estimated nearness index (ideal = 1.0): 0.7805 N* = 1 - |min(B-Bmsy)|/K

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	User/pgm guess	2nd guess	Estimated	User guess
B1/K	Starting relative biomass (in 1994)	1.076E-01	4.000E-01	5.300E-01	1	1
MSY	Maximum sustainable yield	2.811E+05	3.500E+05	3.200E+05	1	1
K	Maximum population size	9.630E+05	2.500E+06	8.727E+05	1	1
phi	Shape of production curve (Bmsy/K)	0.5000	0.5000	----	0	1

--------- Catchability Coefficients by Data Series ---------------

q(1)	Series 1	1.213E-04	5.000E-04	4.750E-02	1	1	(effort in days fishing)
q(2)	Series 2	9.255E-06	5.000E-04	4.750E-02	1	1	(effort in hours fishing)
q(3)	Series 3	8.674E-05	5.000E-04	4.750E-02	1	1	(trawl survey abundance index)

MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Logistic formula	General formula
MSY	Maximum sustainable yield	2.811E+05	----	----
Bmsy	Stock biomass giving MSY	4.815E+05	K/2	K*n**(1/(1-n))
Fmsy	Fishing mortality rate at MSY	5.838E-01	MSY/Bmsy	MSY/Bmsy
n	Exponent in production function	2.0000	----	----
g	Fletcher's gamma	4.000E+00	----	[n**(n/(n-1))]/[n-1]
B./Bmsy	Ratio: B(2009)/Bmsy	5.479E-01	----	----
F./Fmsy	Ratio: F(2008)/Fmsy	1.487E+00	----	----
Fmsy/F.	Ratio: Fmsy/F(2008)	6.727E-01	----	----
Y.(Fmsy)	Approx. yield available at Fmsy in 2009	1.540E+05	MSY*B./Bmsy	MSY*B./Bmsy
	...as proportion of MSY	5.479E-01	----	----
Ye.	Equilibrium yield available in 2009	2.236E+05	4*MSY*(B/K-(B/K)**2)	g*MSY*(B/K-(B/K)**n)
	...as proportion of MSY	7.956E-01	----	----

--------- Fishing effort rate at MSY in units of each CE or CC series ---------

fmsy(1)	Series 1	4.811E+03	Fmsy/q(1)	Fmsy/q(1) (effort in days fishing)
fmsy(2)	Series 2	6.308E+04	Fmsy/q(2)	Fmsy/q(2) (effort in hours fishing)

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1994	1.057	1.036E+05	1.029E+05	1.087E+05	1.087E+05	1.073E+05	1.810E+00	2.151E-01
2	1995	0.902	1.022E+05	1.095E+05	9.868E+04	9.868E+04	1.133E+05	1.544E+00	2.122E-01
3	1996	0.854	1.167E+05	1.269E+05	1.083E+05	1.083E+05	1.286E+05	1.462E+00	2.425E-01
4	1997	0.790	1.370E+05	1.516E+05	1.198E+05	1.198E+05	1.490E+05	1.354E+00	2.846E-01
5	1998	0.717	1.662E+05	1.871E+05	1.341E+05	1.341E+05	1.758E+05	1.228E+00	3.453E-01
6	1999	0.797	2.079E+05	2.196E+05	1.750E+05	1.750E+05	1.979E+05	1.365E+00	4.318E-01
7	2000	0.858	2.308E+05	2.339E+05	2.007E+05	2.007E+05	2.068E+05	1.470E+00	4.793E-01
8	2001	0.958	2.368E+05	2.287E+05	2.190E+05	2.190E+05	2.036E+05	1.641E+00	4.919E-01
9	2002	0.943	2.214E+05	2.170E+05	2.046E+05	2.046E+05	1.963E+05	1.615E+00	4.598E-01
10	2003	0.912	2.130E+05	2.128E+05	1.940E+05	1.940E+05	1.936E+05	1.562E+00	4.425E-01
11	2004	0.873	2.125E+05	2.162E+05	1.887E+05	1.887E+05	1.958E+05	1.495E+00	4.414E-01
12	2005	0.774	2.196E+05	2.329E+05	1.802E+05	1.802E+05	2.061E+05	1.326E+00	4.560E-01
13	2006	0.920	2.454E+05	2.399E+05	2.208E+05	2.208E+05	2.103E+05	1.576E+00	5.098E-01
14	2007	0.721	2.350E+05	2.530E+05	1.825E+05	1.825E+05	2.177E+05	1.236E+00	4.881E-01
15	2008	0.868	2.701E+05	2.668E+05	2.315E+05	2.315E+05	2.252E+05	1.487E+00	5.610E-01
16	2009		2.638E+05				5.479E-01		

ESTIMATES FROM BOOTSTRAPPED ANALYSIS

Param name	Estimated Point estimate	Estimated bias in pt estimate	relative bias	Bias-corrected approximate confidence limits 80% lower	80% upper	50% lower	50% upper	Inter-quartile range	Relative IQ range
B1/K	1.076E-01	2.916E-03	2.71%	1.047E-01	1.115E-01	1.068E-01	1.080E-01	1.189E-03	0.011
K	9.630E+05	-1.965E+03	-0.20%	9.044E+05	1.101E+06	9.499E+05	1.003E+06	5.345E+04	0.056
q(1)	1.213E-04	-1.839E-06	-1.52%	1.059E-04	1.357E-04	1.142E-04	1.294E-04	1.515E-05	0.125
q(2)	9.255E-06	-8.677E-08	-0.94%	7.899E-06	1.029E-05	8.603E-06	9.746E-06	1.143E-06	0.123
q(3)	8.674E-05	-1.301E-06	-1.50%	7.647E-05	9.793E-05	8.243E-05	9.221E-05	9.781E-06	0.113
MSY	2.811E+05	-3.992E+03	-1.42%	2.673E+05	2.874E+05	2.798E+05	2.826E+05	2.772E+03	0.010
Ye(2009)	2.236E+05	-1.232E+03	-0.55%	1.823E+05	2.477E+05	2.020E+05	2.375E+05	3.545E+04	0.159
Y.@Fmsy	1.540E+05	3.748E+03	2.43%	1.104E+05	1.805E+05	1.261E+05	1.653E+05	3.923E+04	0.255
Bmsy	4.815E+05	-9.827E+02	-0.20%	4.522E+05	5.505E+05	4.749E+05	5.017E+05	2.673E+04	0.056
Fmsy	5.838E-01	-5.150E-04	-0.09%	5.098E-01	6.060E-01	5.588E-01	5.888E-01	3.001E-02	0.051
fmsy(1)	4.811E+03	1.041E+02	2.16%	4.375E+03	5.295E+03	4.552E+03	5.035E+03	4.832E+02	0.100
fmsy(2)	6.308E+04	1.006E+03	1.59%	5.779E+04	7.206E+04	6.026E+04	6.704E+04	6.783E+03	0.108
fmsy(3)	6.731E+03	1.441E+02	2.14%	6.093E+03	7.336E+03	6.350E+03	6.963E+03	6.133E+02	0.091
B./Bmsy	5.479E-01	2.521E-02	4.60%	3.930E-01	6.598E-01	4.426E-01	5.963E-01	1.536E-01	0.280

F./Fmsy	1.487E+00	-7.719E-03	-0.52%	1.305E+00	1.904E+00	1.400E+00	1.733E+00	3.324E-01	0.224
Ye./MSY	7.956E-01	9.627E-03	1.21%	6.316E-01	8.842E-01	6.894E-01	8.370E-01	1.477E-01	0.186
q2/q1	7.627E-02	7.860E-04	1.03%	6.640E-02	8.497E-02	6.999E-02	8.022E-02	1.022E-02	0.134
q3/q1	7.148E-01	2.940E-03	0.41%	6.302E-01	8.034E-01	6.715E-01	7.544E-01	8.292E-02	0.116

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

Unitless limit reference point in F (Fmsy/F.): 0.6727
CV of above (from bootstrap distribution): 0.1406

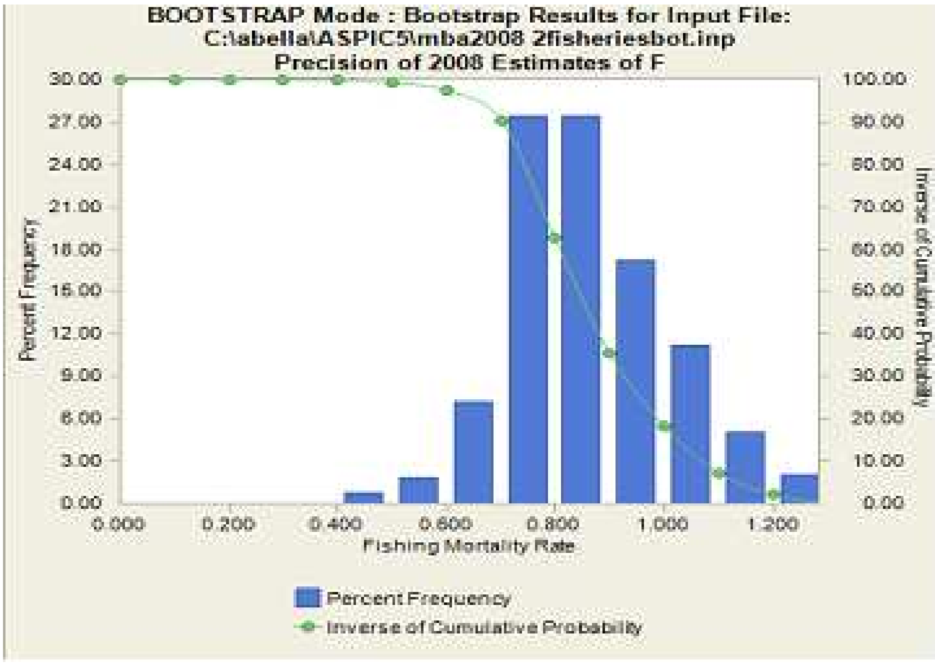


Fig. 8.20.4.2.3.1 Precision of estimated value of F for 2008 with bootstrapping with ASPIC. Bars display the range of the bootstrapped estimates; the percent confidence intervals can be derived from the inverse cumulative frequency.

The results of the Biomass Dynamic Model suggest that the species in the GSA 09 is overexploited (current F_{curr}/F_{MSY}=1.4 on average). Data of abundance index of Porto Santo Stefano have shown a lower correlation with surveys data, probably due to the fact that in this port, the fleet has a lightly different and variable spatial/temporal behaviour (they operate at a higher mean depth) because the species is not a priority commercial species. A value of F_{MSY} of 0.58 was estimated while for the more recent year the model estimated a value of F of about 0.86. It is important to highlight, as shown in Fig. 8.20.4.2.3.1, that the level of biomass shows a general increasing trend while F decreases along the analysed period.

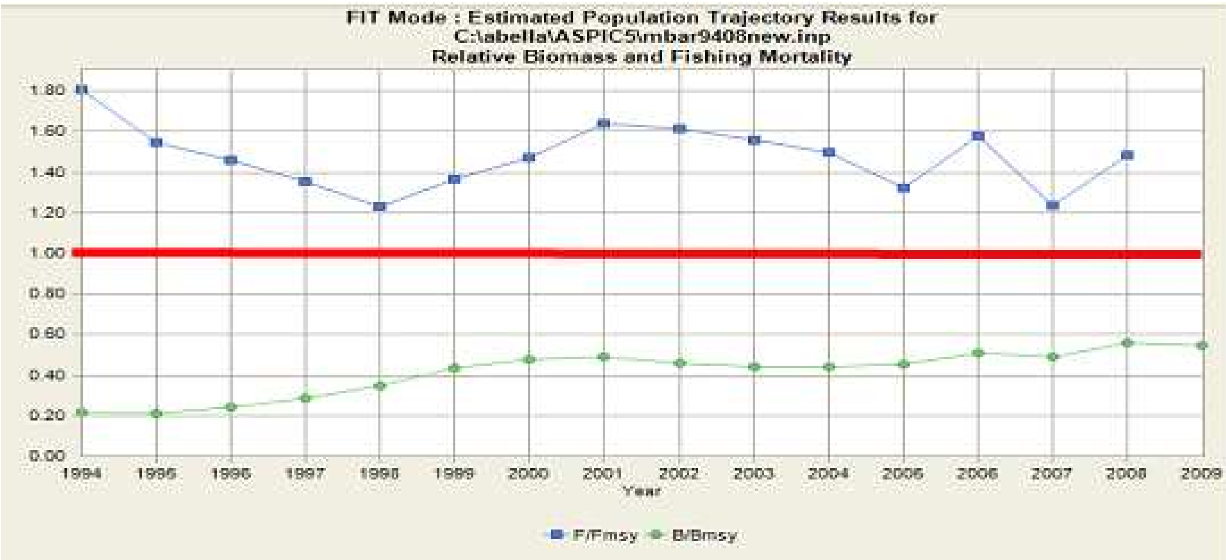


Fig. 8.20.4.2.3.2 Historic trend in estimated fishing mortality as F/FMSY ratio (upper panel) and biomass as B/BMSY ratio (lower panel).

8.20.5. Long term prediction

8.20.5.1. Justification

A traditional Beverton & Holt Y/R analysis was performed with the "Yield" software. The software does not allow using a vector of *M* and hence, in alternative, a weighted average value was used in input. The aproach also assumes an asymptotic behavior of catchability over the size of first capture. All the analysis were performed as a per-recruit basis, assuming recruitment constant with only a random fluctuation.

8.20.5.2. Input parameters

The used growth and L/W parameters are those included in Table 8.20.1.2.1. The characteristics of the software constrained the use of a weighted mean value of M =0.8 instead of a M-at-size vector.

8.20.5.3. Results

A value of *F*max =0.63 was estimated and of $F_{0.1}$ = 0.42 while the *F* rate at which the Spawning Biomass is expected to be reduced to 30% of the pristine Biomass ($F30\%SSB_0$) was estimated as 0.24. Relative per recruit estimated values of *Y*, *SSB*, Fished *B* and Total *B* are shown in Fig 8.20.5.3.1.

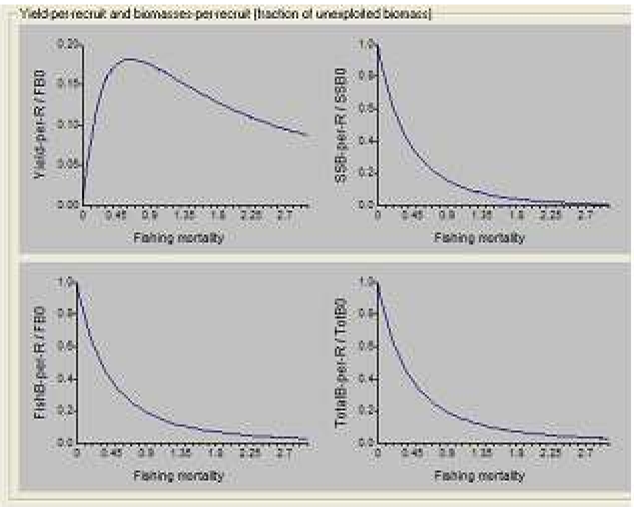


Fig. 8.20.5.3.1. Results of the Y/R analysis.

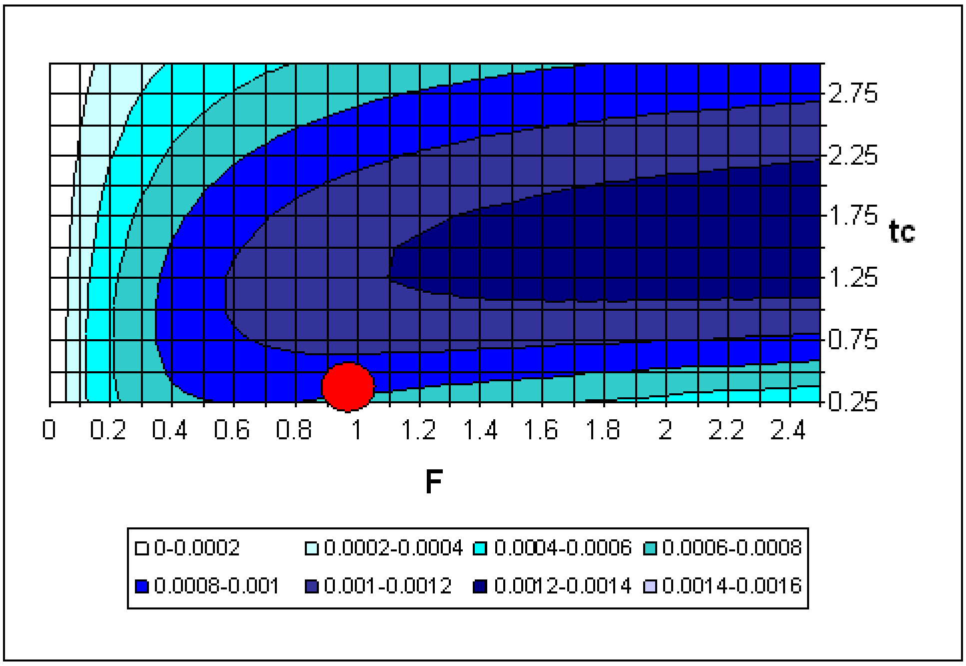


Fig. 8.20.5.3.2. Yield-per-Recruit isoplets. The red circle represents the current combination of F and tc.

8.20.6.Scientific advice

8.20.6.1.Short term considerations

8.20.6.1.1. State of the spawning stock size

The index of stock abundance from GRUND survey shows high variability throughout the time series, but no trend is observed.

The index of abundance from MEDITS survey, that approximates a spawning stock biomass index (mostly represented by mature fish), suggests an increasing trend from 1994 to 2008. High interannual variation is observed from 2002 to 2008.

The current spawning stock biomass roughly estimated through simulations with LCA outputs and yield-per-recruit analysis is assumed to be lower than 20% of the pristine one. Such surviving rate of spawners, is considered very low for ensuring the stock self-renewal (Clark, 1991; Mace & Sissenwine, 1993).

8.20.6.1.2. State of recruitment

Recruitment shows a slight increasing trend, especially in the most recent years.

8.20.6.1.3. State of exploitation

The stock can be considered overexploited. Quite consistent estimates of the current fishing mortality were obtained with 3 alternative approaches (F2008 = 0.85 with ASPIC, F2006-2008=0.97 with LCA) all of them decisely higher than the values recently estimated for the limit reference points F_{MSY}=0.58 and its proxy $F_{0.1}$ =0.49 as well as with a previous biomass dynamics model based on trawl surveys time series of Z and biomass index, that provided a F_{MSY} rate of 0.59 (SGMED-08-03). The size of first capture is too low (growth overfishing) and an increase in yield can be expected in the case a reduction of fishing effort do occur and/or more selective gears are used. It is advisable to avoid the illegal fishing within the 3 miles zone from the base line as well as the landing of undersized individuals in order to decrease fishing pressure on juveniles.

8.21. Stock assessment of red mullet in GSA 10

8.21.1. Stock identification and biological features

8.21.1.1. Stock Identification

Red mullet stock was assumed in the boundaries of the whole GSA 10, lacking specific information on stock identification. *M. barbatus* is with European hake and deep-water rose shrimp a key species of fishing assemblages in the central-southern Tyrrhenian Sea (GSA 10). The species is almost exclusively distributed on the continental shelf and is a rather small-sized, fast-growing and characterized by a relatively short lifespan. It spawns in late spring-early summer with a peak in June-July. In late summer, recently settled juveniles are highly concentrated near shore and this concentration is still present up to October. Aggregation of juveniles and subsequent movements towards more offshore grounds have been reported and indicated as a source of increased vulnerability of this population component to the harvest strategy (Voliani et al., 1998). During late summer-early autumn (September-October), the species is intensely caught and often represent an important fraction of the landings of the coastal bottom trawlers. About three-four months after settlement, red mullet has spread up to depths of about 100 m.

8.21.1.2. Growth

The growth of red mullet has been studied in the GSA using two different approaches that also allowed validation of the aging: 1) whole otolith readings and 2) the analysis of length-frequency distributions using techniques as Batthacharya for separation of modal components. The estimates of von Bertalanffy growth parameters for sex combined obtained using DCR data sets were the following: L_∞=26 cm k=0.412 t_0= -0.4. Parameters of the length-weight relationship estimated from the DCR data sets and related to the sex combined were a=0.0087; b=3.08 for length expressed in cm.

8.21.1.3. Maturity

Estimates of size at first maturity of females were conducted using Medits trawl survey data and the method developed within the Fisboat project (Rochet and Trenkel, 2005; Fisboat web-site: http://www.ifremer.fr/drvecohal/fisboat/). In the following table the size at first maturity (in cm) of females and the associated errors are reported.

Year	L_{50}.maturity	SdL_{50}.maturity
1994	13.7	0.0544
1995	13.2	0.09
1996	13.3	0.0964
1997	13.4	0.0808
1998	12.9	0.0258
1999	13.7	0.0309
2000	13.2	0.0386
2001	13.1	0.041

Size at first maturity of females was ranging from about 13 to 14 cm, which is when fish are aged 1 year. This range of length at first maturity was used in the assessment.

8.21.2.Fisheries

8.21.2.1.General description of fisheries

Red mullet is mostly targeted by trawlers, but also by small scale fisheries using trammel nets. Fishing grounds are located along the coasts of the whole GSA offshore 50 m depth or 3 miles from the coast.

8.21.2.2.Management regulations applicable in 2008 and 2009

Management regulations are based on technical measures and do not differ from those applied in the previous years: closed number of fishing licenses for the fleet and area limitation (fishing forbidden within 50 m depth or 3 miles from the shore, depending on the zone). Along northern Sicily coasts two main Gulfs (Patti and Castellammare) have been closed to the trawl fishery up 200 m depth, since 1990. Effects of protection have been also evaluated (Fiorentino et al., in press). Two closed areas were also established since 2004 along the mainland, in front of Sorrento peninsula (Napoli Gulf) and Amantea (Calabrian coasts), the latter including one of the areas where red mullet is more concentrated. In the GSA 10 the fishing ban has not been mandatory along the time, and from one year to the other it was adopted on a voluntary basis by fishers.

8.21.2.3.Catches

8.21.2.3.1. Landings

Available landing data are from DCR regulations and range from 839 tons of 2002 to 501 tons in 2007, being the lowest value of 393 tons registered in 2006. Most part of the landings of red mullet come from trawlers and shows a pattern similar to the total landing of red mullet, except for the last two years. In 2006 the landings of trawlers were increasing compared to 2005, while in 2007 they were decreasing. Opposite directions were observed from all the fishing segments (Fig. 8.21.2.3.1.1). This is more evident if the respective contributions of DTS and PGP segments along the years are considered.

Tab. 8.21.2.3.1.1 lists the annual landings by major fishing techniques. Data are listed in Tab. A3.2 of Appendix 3.

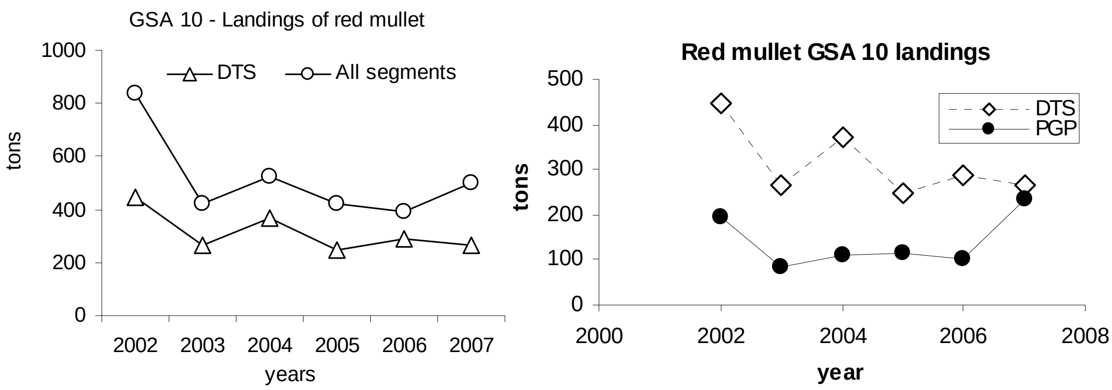


Fig. 8.21.2.3.1.1 Annual landings of red mullet in tons (DTS and total)

Tab. 8.21.2.3.1.1 Annual landings (t) by fishing technique, 2002-2008. . Landings data provided for the years 2002 and 2003, probably have a mistake in the units used.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
MUT	10	ITA	DTS	446174	264511					
MUT	10	ITA	GND							0
MUT	10	ITA	GNS			16	25	35	24	7
MUT	10	ITA	GTR			96	141	68	212	125
MUT	10	ITA	MIS			9		1		
MUT	10	ITA	OTB			401	255	290	265	182
MUT	10	ITA	PGP	194727	83302					
MUT	10	ITA	PMP	188787	71194					
MUT	10	ITA	PTS	9716						
MUT	10	ITA	SB-SV			2				

The length distribution of landings is reported in Fig. 8.21.2.3.1.2 for 2006 and 2007 and for the DTS and Nets segments. Both number of individuals and weight are reported. The number of individuals was raised to the total landings of the fleet segment using the proportion of the number of individuals by size class observed in the sample. The total weight corresponding to each length class was calculated using the obtained number of individuals and the average weight, from the length-weight relationship, at each central value of the length class.

The LFDs of the two years present a different pattern between the two fishing segments as showed in the Fig. 8.21.2.3.1.2. The contribution in term of number of individuals is more relevant for the nets segments in 2007, although the contribution in weight of trawlers (DTS) is more conspicuous. Analogously also the distribution by age and fleet segment shows a different pattern in the two years (Fig. 8.21.2.3.1.3).

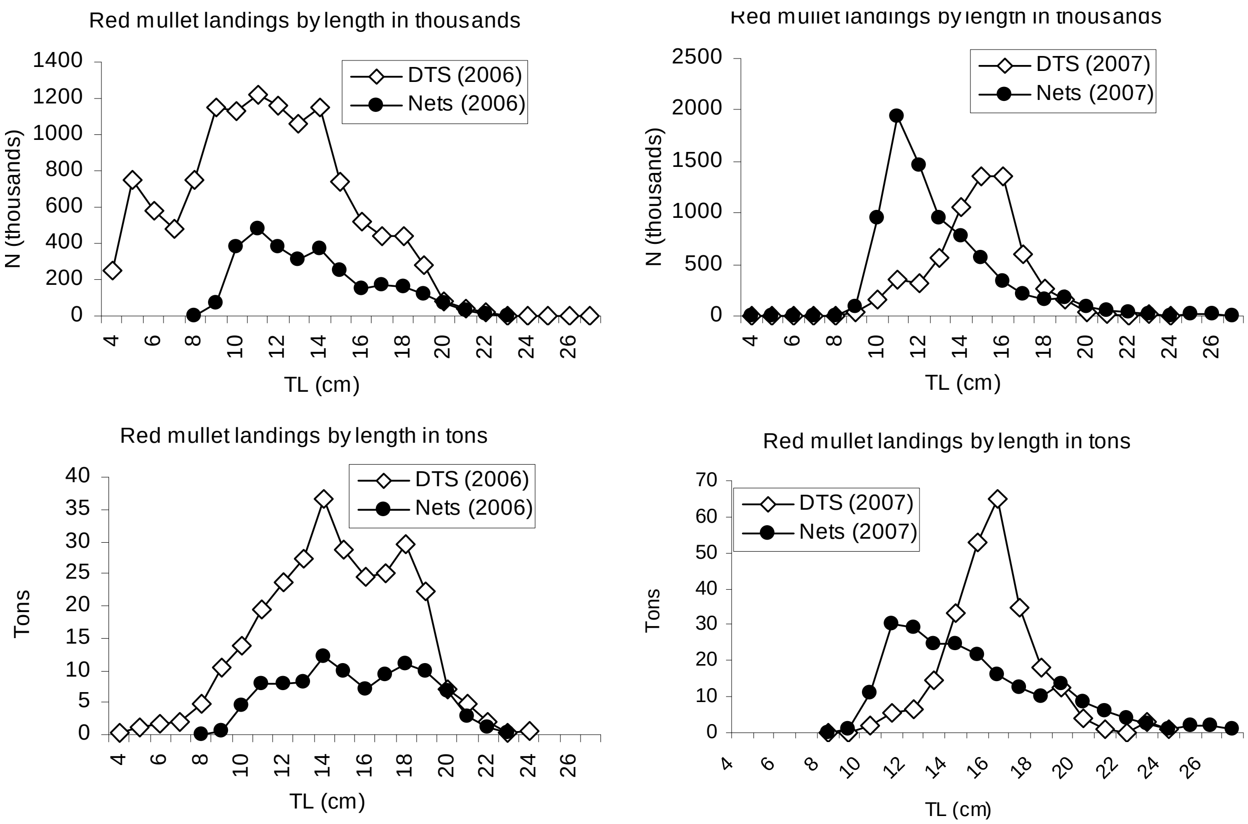


Fig. 8.21.2.3.1.2 Landings by length in thousands and tons in 2006 and 2007 for DTS and nets segments.

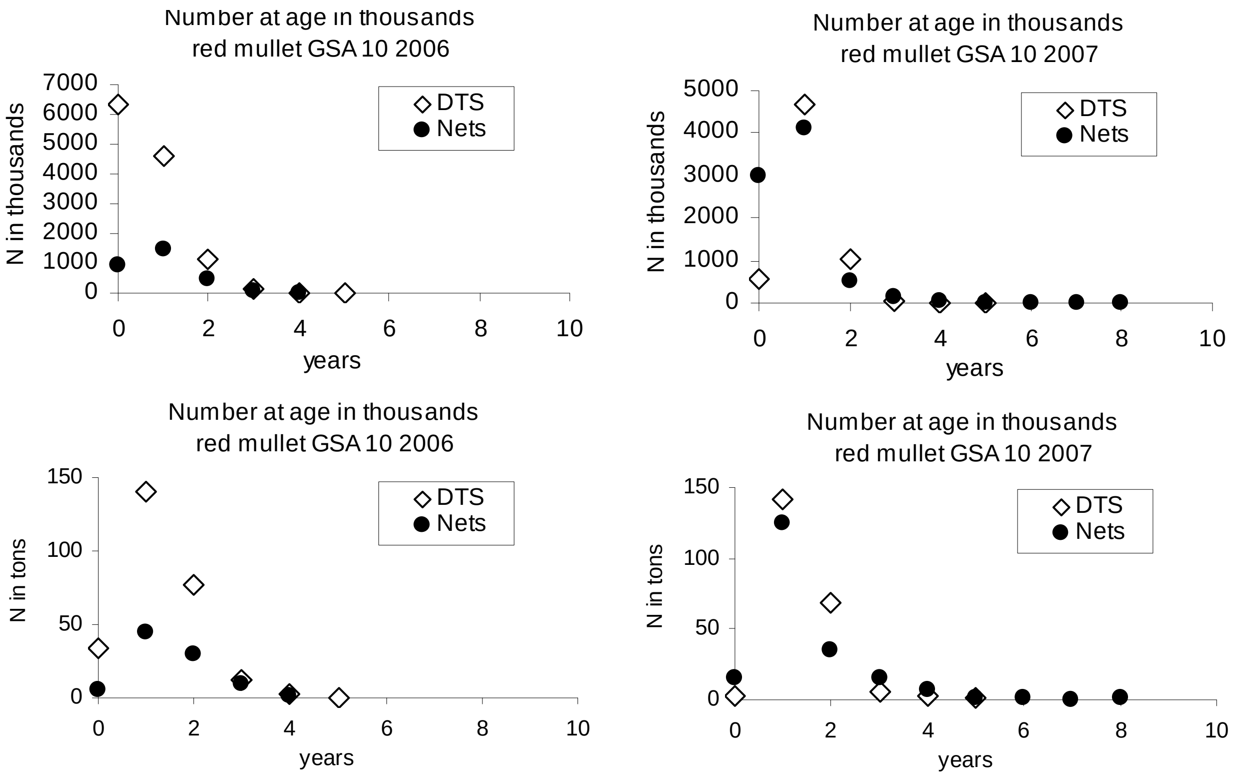


Fig. 8.21.2.3.1.3 Landings by age in thousands and tons in 2006 and 2007 for DTS and Nets segments.

8.21.2.3.2. Discards

The proportion of the discards of red mullet in the GSA 10 was generally low and concentrated in the third and fourth quarter, when recruitment is occurring. In 2006 the estimation of discard proportion compared to the total landings in the GSA was 3%. Despite this value was lower than the prescription of reg UE 1639/2001 (10% in weight or 20% in number) the composition in length and age was estimated, that highlighted the prevailing of the age 0 group; the average length was 8.7 cm (Fig. 8.21.2.3.2.1).

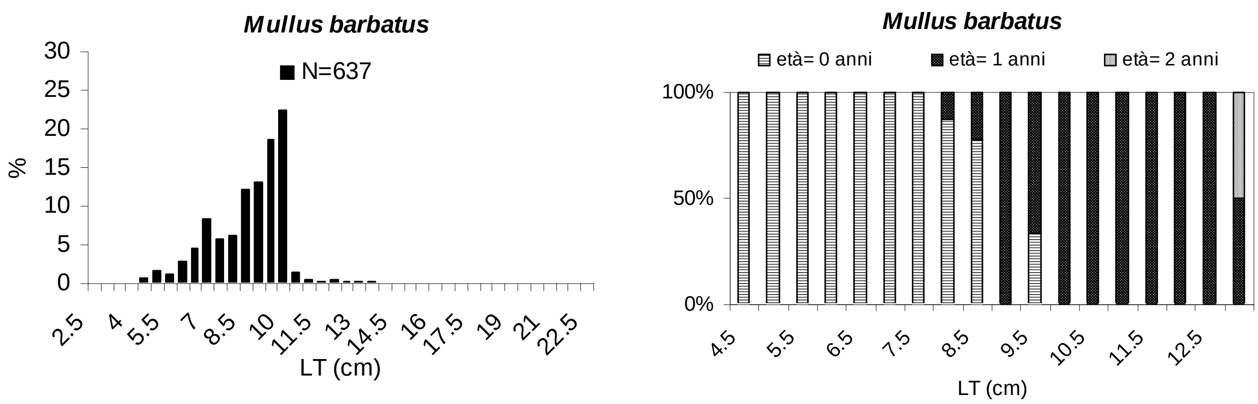


Fig. 8.21.2.3.2.1 Size and age composition of discards.

Only 3 t of discards in 2006 were reported to SGMED-09-02 (Tab. A3.9 of Appendix 3).

8.21.2.3.3. Fishing effort

In the area, the total fishing effort of the trawlers (OTB or DTS) and small scale fishery (PGP or Nets), the two main fishing segments targeting red mullet, is shown in Fig.8.21.2.3.3.1. The whole fishing effort (kw*days) of trawlers in the GSA shows an increasing trend from 2002 to 2005, and a decrease in 2006, while the effort of the small scale fishery (PGP) shows a slight decrease until 2005 and an increase in 2006.

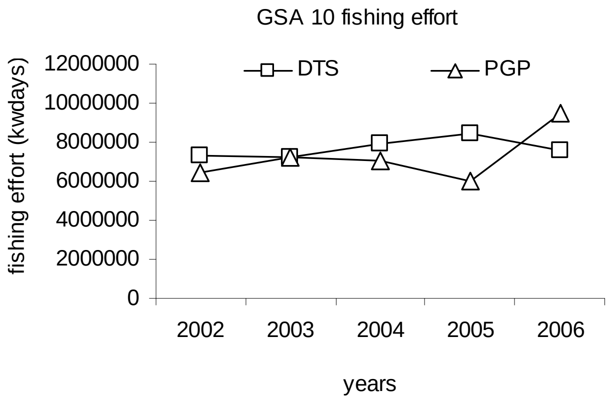


Fig.8.21.2.3.3.1 Trend in trawl and small scale fishery fishing effort (in kwdays) along 2002-2006.

Tab. 8.21.2.3.3.1 lists the effort by fishing technique deployed in GSA 10 as reported to SGMED-09-02 through the DCR data call and listed in Tab. A3.10-3.12 of Appendix 3.

Tab. 8.21.2.3.3.1 Effort trends by fishing technique in GSA 10.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	10	ITA	DRB	658	205	830	5233	5014	2092
DAYS	10	ITA	DTS	37949	38134	44087			
DAYS	10	ITA	FPO				6161	7506	290
DAYS	10	ITA	GND				45278	39973	35189
DAYS	10	ITA	GNS				110985	73863	52787
DAYS	10	ITA	GTR				67363	133193	139378
DAYS	10	ITA	HOK			20929			
DAYS	10	ITA	LHP-LHM				28927	27279	27229
DAYS	10	ITA	LLD				7052	5611	3557
DAYS	10	ITA	LLS				46739	32809	32067
DAYS	10	ITA	MIS				24393	7924	1396
DAYS	10	ITA	OTB				47569	38829	38766
DAYS	10	ITA	PGP	357895	311474	325523			
DAYS	10	ITA	PMP	105705	143062	62225			
DAYS	10	ITA	PS				11273	11527	7880
DAYS	10	ITA	PTS	8258	9780	11792			
DAYS	10	ITA	SB-SV				21649	24147	26703
GT*days	10	ITA	DRB	5899	1839	7968	23870	24328	11078
GT*days	10	ITA	DTS	1116708	1078525	1337882			
GT*DAYS	10	ITA	FPO				18019	12142	456
GT*DAYS	10	ITA	GND				329910	256598	282226
GT*DAYS	10	ITA	GNS				309872	180700	129411
GT*DAYS	10	ITA	GTR				133960	313252	311964
GT*days	10	ITA	HOK			157882			
GT*DAYS	10	ITA	LHP-LHM				37578	30468	33683
GT*DAYS	10	ITA	LLD				62043	82984	49609
GT*DAYS	10	ITA	LLS				127491	113306	93867
GT*DAYS	10	ITA	MIS				93707	36055	8364
GT*DAYS	10	ITA	OTB				1437500	1231702	1245641
GT*days	10	ITA	PGP	873286	873527	661958			
GT*days	10	ITA	PMP	1169004	922706	336053			
GT*DAYS	10	ITA	PS				258389	230656	189673
GT*days	10	ITA	PTS	482834	536460	390096			
GT*DAYS	10	ITA	SB-SV				67762	90326	87420
kW*days	10	ITA	DRB	94663	29540	110899	404243	392760	170557
kW*days	10	ITA	DTS	7344089	7231486	7883881			
KW*DAYS	10	ITA	FPO				226805	147562	5309
KW*DAYS	10	ITA	GND				2878658	2394591	2232763
KW*DAYS	10	ITA	GNS				4378416	2465382	1848657
KW*DAYS	10	ITA	GTR				1519874	3789078	3793640
kW*days	10	ITA	HOK			1654352			
KW*DAYS	10	ITA	LHP-LHM				441690	395408	417886
KW*DAYS	10	ITA	LLD				819922	654956	412060
KW*DAYS	10	ITA	LLS				1852150	1289606	1194311
KW*DAYS	10	ITA	MIS				936565	273517	73082
KW*DAYS	10	ITA	OTB				8102762	6944418	6882389
kW*days	10	ITA	PGP	6440217	7222145	7056306			
kW*days	10	ITA	PMP	12686947	8003452	3588004			
KW*DAYS	10	ITA	PS				1538303	1506523	1222112
kW*days	10	ITA	PTS	2631242	2930380	2308589			
KW*DAYS	10	ITA	SB-SV				701108	859501	959937

8.21.3. Scientific surveys

8.21.3.1. Medits

8.21.3.1.1. Methods

According to the MEDITS protocol (Bertrand et al., 2002), trawl surveys were yearly (May-July) carried out, applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish per surface unit) were standardised to square kilometre, using the swept area method.

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 10 the following number of hauls was reported per depth stratum (s. Tab. 8.21.3.1.1.1).

Tab. 8.21.3.1.1.1. Number of hauls per year and depth stratum in GSA 10, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA10_010-050	9	10	10	10	10	10	10	10	9	9	9	9	9	9	9
GSA10_050-100	12	12	12	12	12	12	12	12	10	10	10	10	10	10	10
GSA10_100-200	20	20	20	20	20	20	20	20	17	17	17	17	17	17	17
GSA10_200-500	26	27	26	26	27	26	26	28	22	22	22	22	22	22	22
GSA10_500-800	31	30	31	31	31	30	31	29	26	27	26	26	26	26	26

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

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

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

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

Where:

- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

GRUND survey was conducted in the area using a commercial gear and different vessels until 2003, when a unique sampler (combination of vessel and gear) was adopted in the whole GSA. Sampling scheme, stratification and protocols were as in Medits.

8.21.3.1.2. Geographical distribution patterns

Map of the bubble plot of the survey indices indicates a higher abundance of the population in the southernmost part of the area, along the mainland and the north Sicily coasts. The approach based on spatial indicators (Woillez et al., 2007) to characterise the spatial dynamics of red mullet life stages has been applied to the GSA 10 (Spedicato et al., 2007), with the objectives of identifying areas where red mullet recruits are more concentrated, establishing relationships with the adult distribution and detecting the ability of spatial indicators to capture the stability of the spatial occupation of preferential sites across the years. The spatial indices mainly studied were the centre of gravity (CG), the inertia (I) and the global index of collocation (GIC). Gravity centres (xcg-longitude; ycg-latitude; graph below) by age groups across years and life-stages highlighted a less changing spatial location of the younger age (A1) compared to the older ones (A2 and A3) that were more dispersed. The approach of the spatial indicators enabled the location of the geographical zone (along the Calabrian coast, southwards in the study area) where recruits (age 0 fish) of red mullet are mainly distributed and to verify that these locations are rather stable across years. Furthermore a first absolute estimate of juvenile abundance was performed.

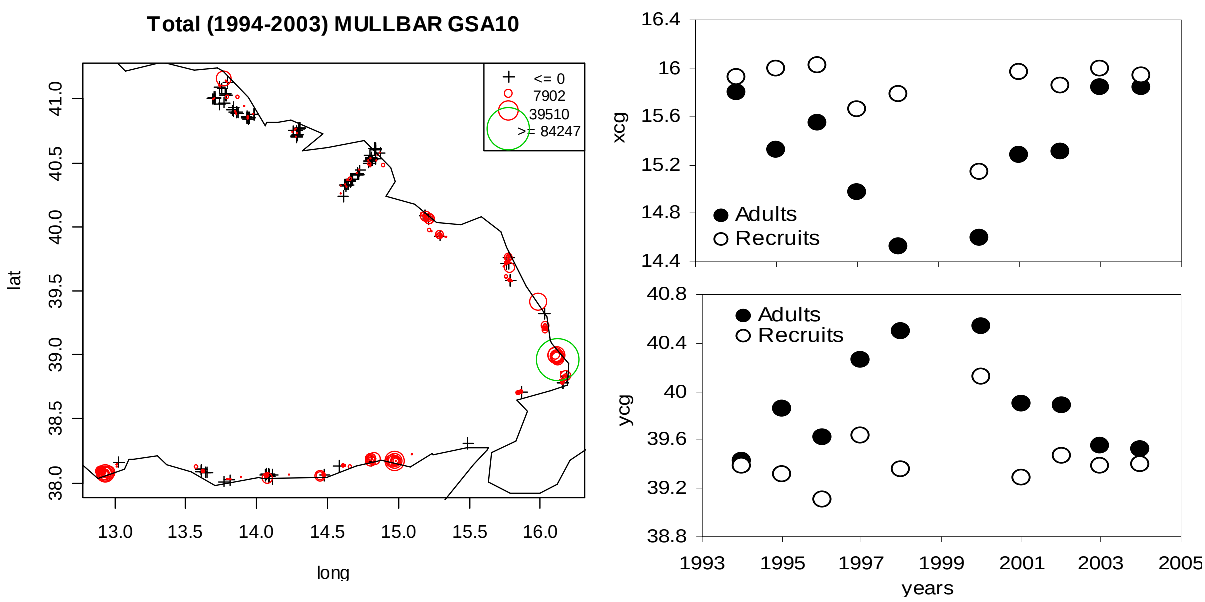


Fig. 8.21.3.1.2.1 Scaled survey catches of red mullet in GSA 10 and centre of gravity (CG) of recruits and adults.

8.21.3.1.3. Trends in abundance and biomass

Indices from Medits trawl-survey show a decreasing pattern from 1999 onwards (significant for the biomass index). In the year 2007, an increase of both indices was observed (Fig. 8.21.3.1.3.1).

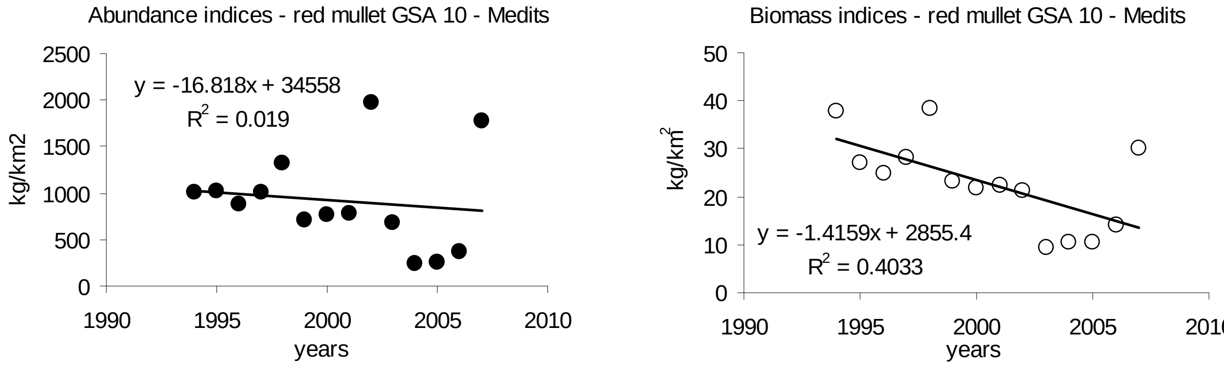


Fig. 8.21.3.1.3.1 Trends in survey abundance and biomass derived from Medits.

Fishery independent information regarding the state of the red mullet in GSA 10 was derived from the international survey Medits. Figure 8.21.3.1.3.2 displays the estimated trend in red mullet abundance and biomass in GSA 10.

The re-estimated abundance and biomass indices do reveal identical trends to those shown above. However, the recent abundance and biomass indices in 2007 appear high but are subject to high variation (uncertainty). The analyses of Medits indices are considered preliminary.

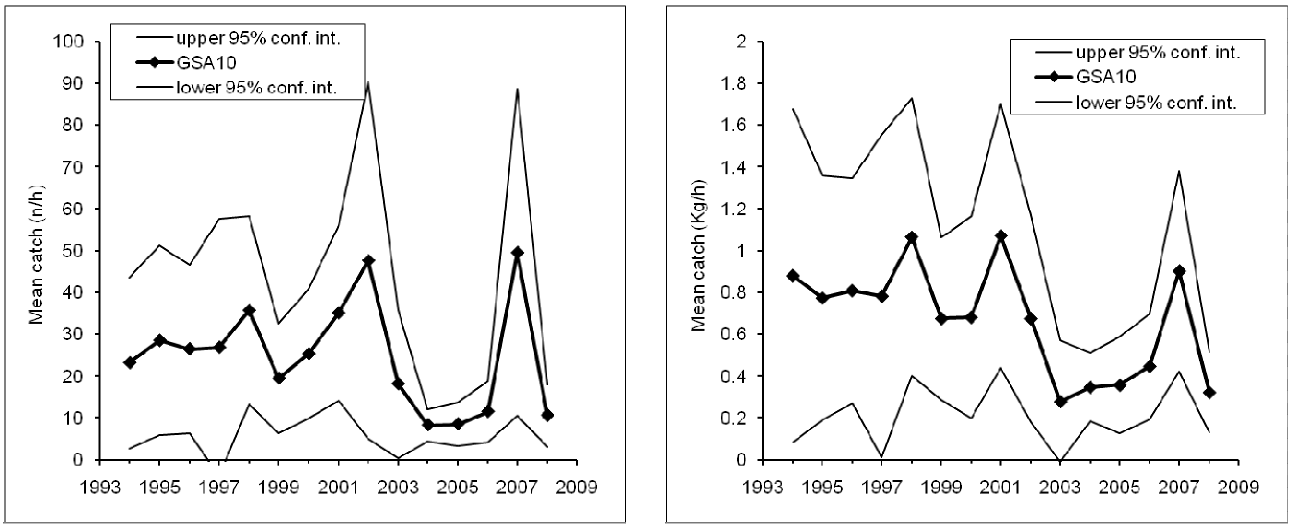


Fig. 8.21.3.1.3.2 Abundance and biomass indices of red mullet in GSA 10 derived from Medits.

8.21.3.1.4. Trends in abundance by length or age

No trend in the mean length was observed in Medits survey.

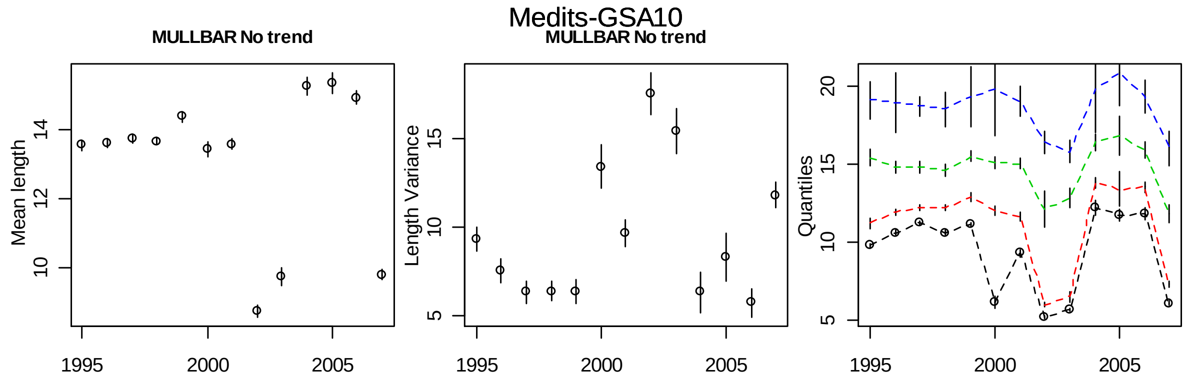


Fig. 8.21.3.1.4.1 Mean length, variance and quantiles derived from the Medits length compositions in 1995-2007.

The following Fig. 8.21.3.1.4.2 and 3 display the stratified abundance indices of GSA 10 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

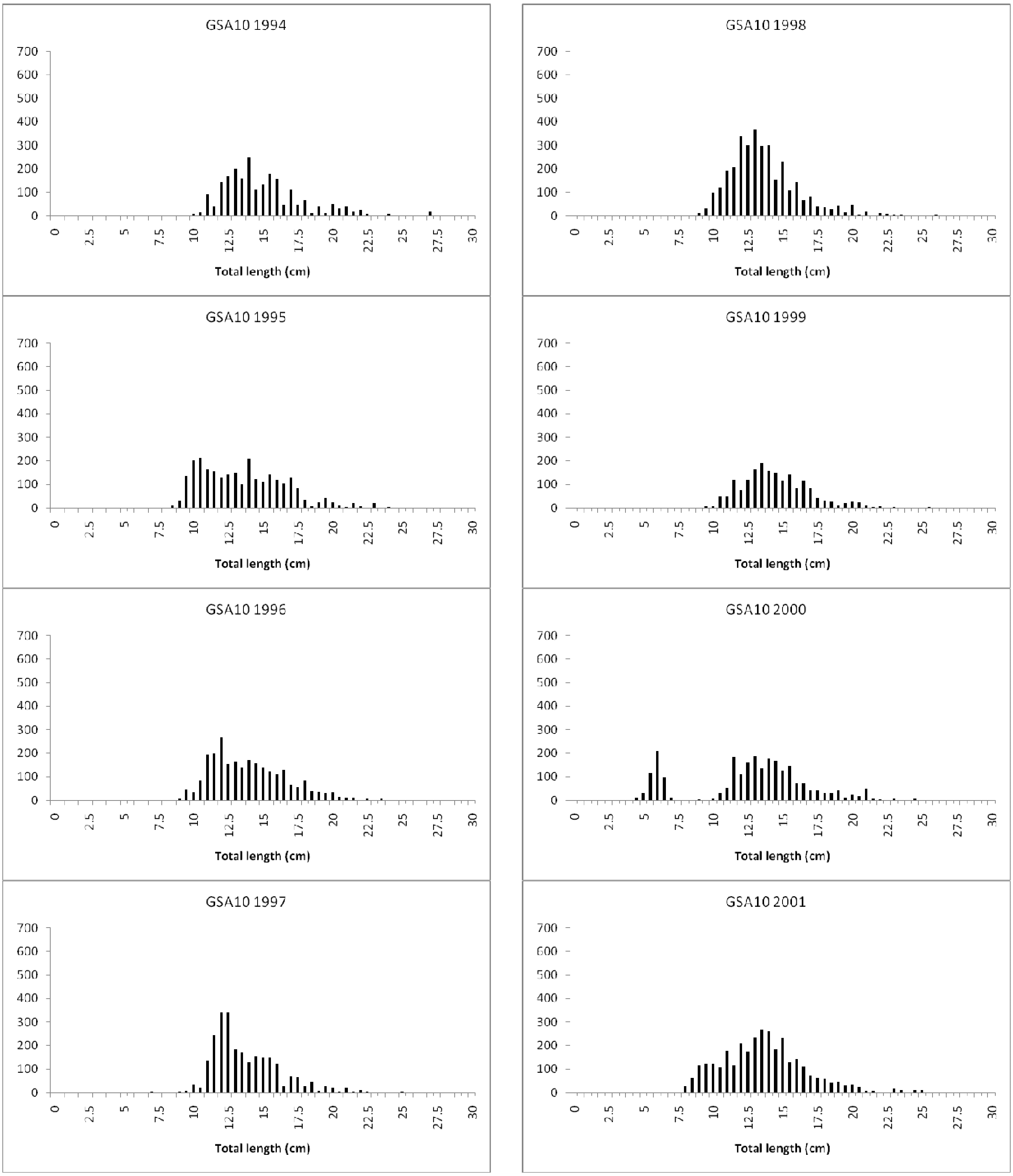


Fig. 8.21.3.1.4.2 Stratified abundance indices by size, 1994-2001.

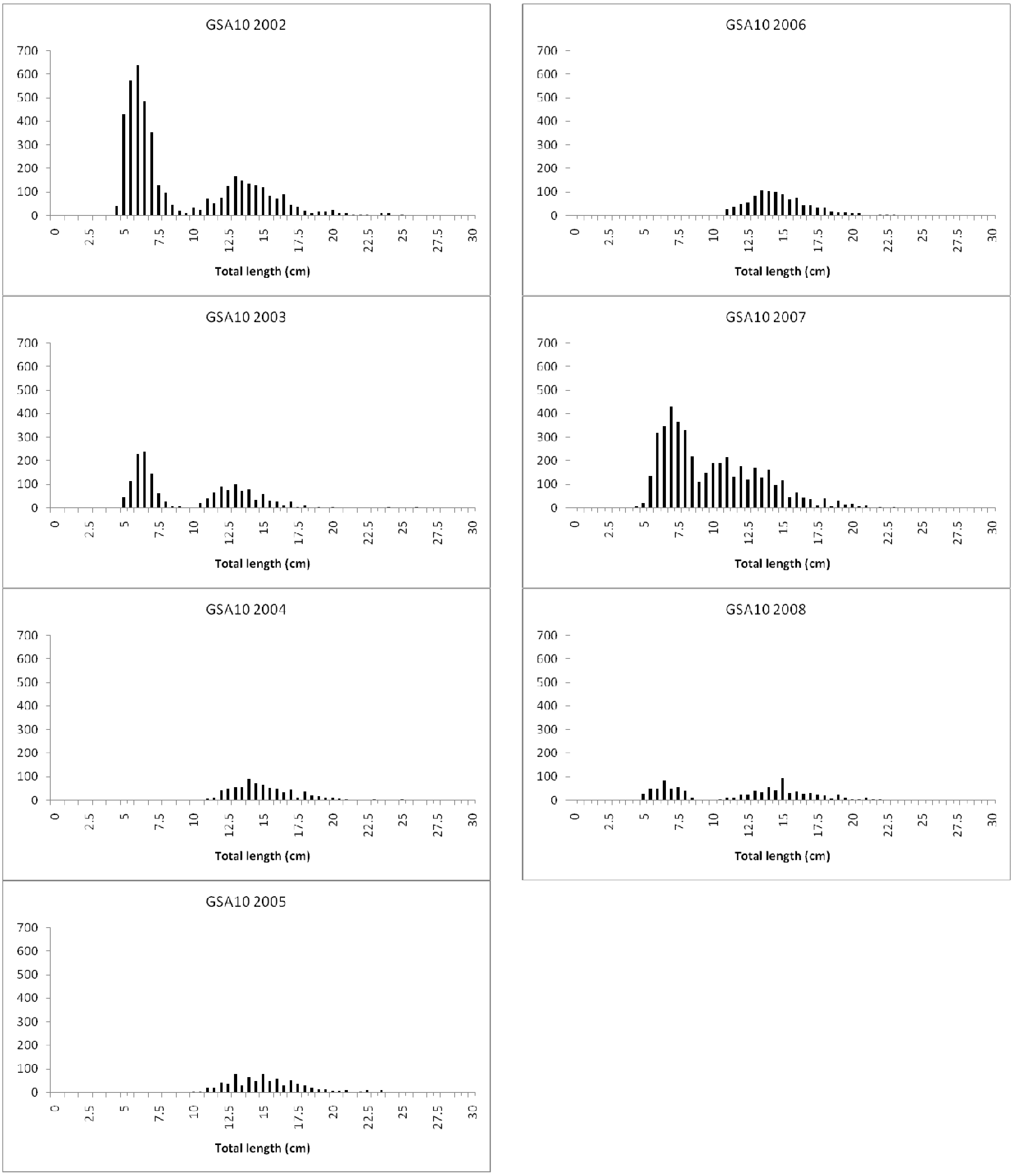


Fig. 8.21.3.1.4.3 Stratified abundance indices by size, 2002-2008.

8.21.3.2. GRUND

8.21.3.2.1. Methods

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

8.21.3.2.2. Geographical distribution patterns

Map of abundance of recruits (N/km^2) as estimated using Grund data and the ordinary kriging shows that the sub-zones where the recruits are mainly concentrated along the nearshore grounds of the southernmost part of the GSA, except a nucleus located in the northernmost side (Fig. 7.21.3.1.2.2). The higher values were around 25000 recruits/km^2.

Figure 8.21.3.1.2.2 shows a map of abundance of recruits (N/km^2) as estimated using Grund data and the ordinary kriging. The recruits were estimated each year using the length frequency distribution and separating the first mode applying the Bhattacharya method. On average, considering the analyzed distributions (years 1994-2005), the recruits are individual smaller than 11.5 cm (±1.08). These individual are mostly belonging to the age 0 group.

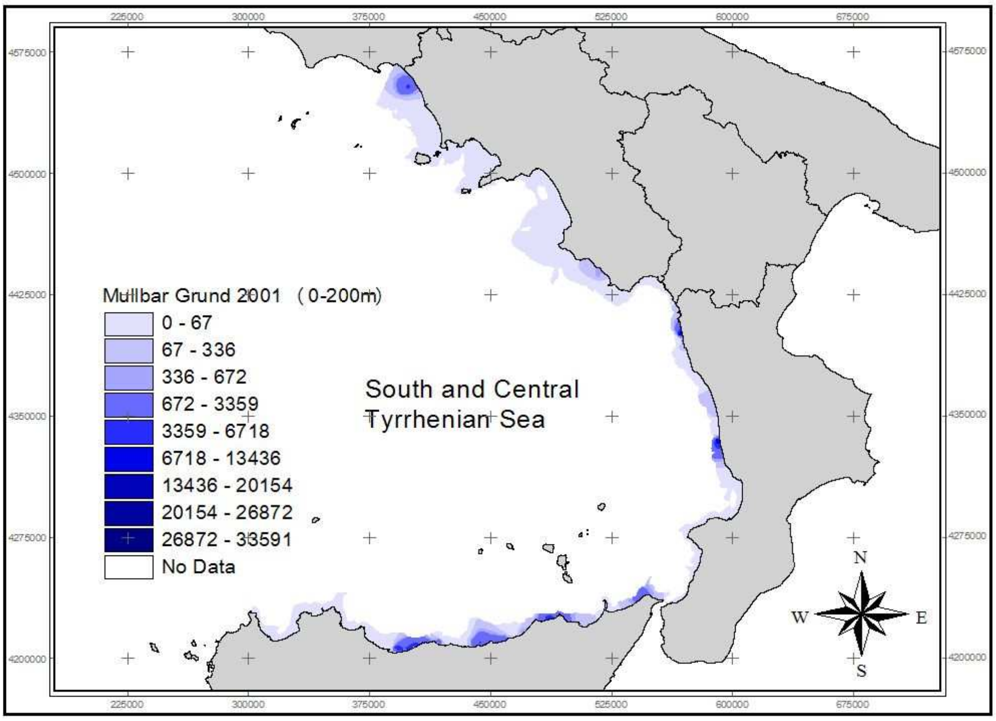


Fig. 8.21.3.1.2.2 Map of abundance of recruits (N/km^2) as estimated using Grund data and the ordinary kriging.

8.21.3.2.3. Trends in abundance and biomass

Similar trends are derived from the GRUND survey and shown in Fig. 8.21.3.2.3.1. Biomass and abundance indices were both significantly decreasing ($p<0.05$ on ln-transformed data), while the recruitment indices were highly variable but without any significant trend. Low levels were however observed in the periods 1994-1996 and 2003-2006. The analyses of Grund indices are considered preliminary.

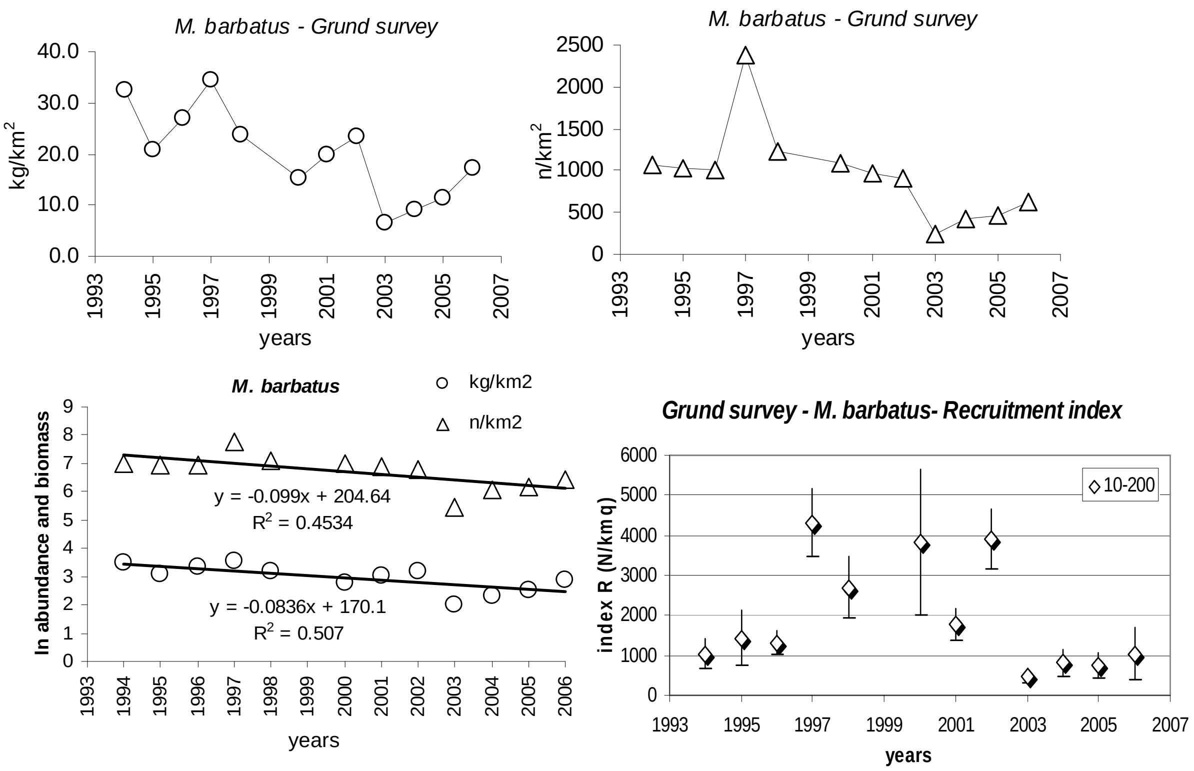


Fig. 8.21.3.1.3.3. Abundance and biomass indices of red mullet in GSA 10 derived from Grund survey. Ln transformed values and linear regression results are also presented and the recruitment indices (N/km^2) with standard deviation are reported.

8.21.3.2.4. Trends in abundance by length or age

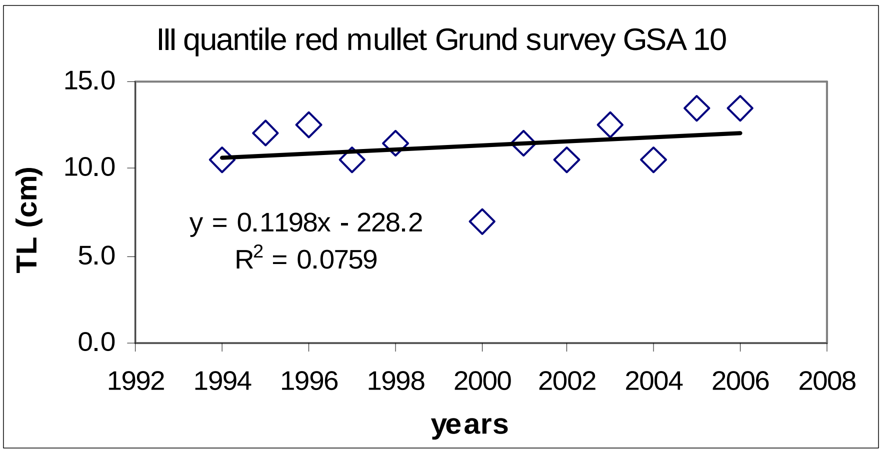


Fig. 8.21.3.1.4.4 III Quantile derived from the GRUND length compositions in 1994-2006.

8.21.3.2.5. Trends in growth

The occurrence of growth change along time was not fully explored during SGMED-09-02.

8.21.3.2.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.21.4.Assessment of historic stock parameters

SGMED 09-02 did not undertake any analytical assessment of red mullet in GSA 10. Last year's assessment using Aladym model and VIT can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.21.5.Long term prediction

8.21.5.1.Justification

Yield per recruit analysis has been conducted.

8.21.5.2.Input parameters

8.21.5.3.Results

Figures 8.21.5.3.1 and 8.21.5.3.2 show the per recruit predictions. Changes of the stock indicators: Biomass, Spawning Stock Biomass and Yield per recruit at increasing levels of fishing mortality, as derived by multiplying the current value (F status quo) by the F factor, are presented.

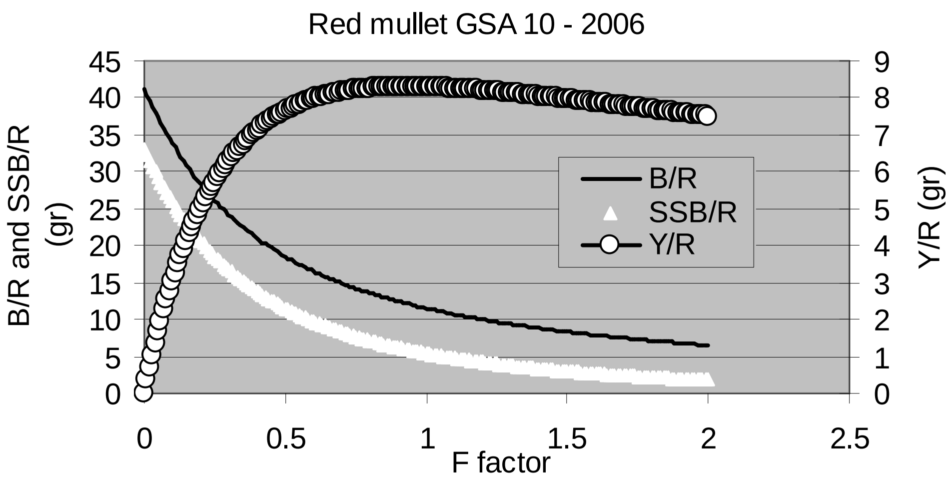


Fig. 8.21.5.3.2.1 Biomass, Spawning Stock Biomass and Yield per recruit at increasing levels of fishing mortality, as derived multiplying the current value (F status quo) by the F factor according to the VIT package (2006 analysis).

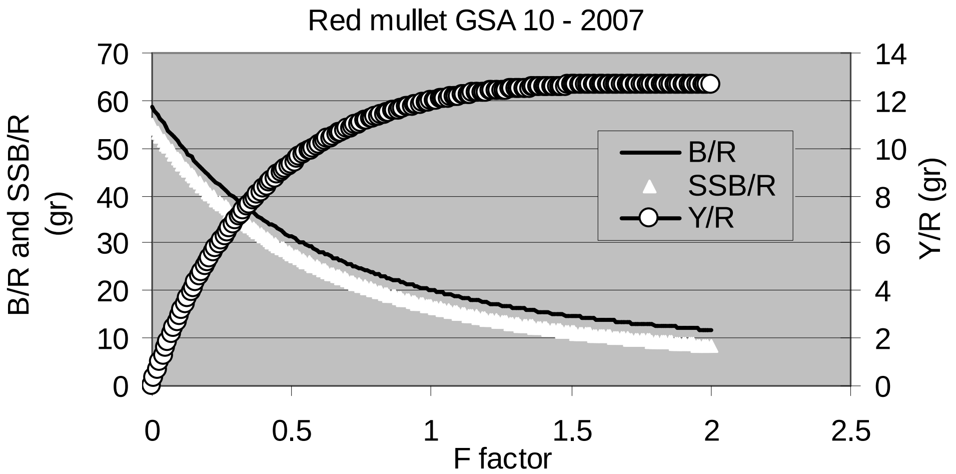


Fig. 8.21.5.3.2 Biomass, Spawning Stock Biomass and Yield per recruit at increasing levels of fishing mortality, as derived multiplying the current value (F status quo) by the F factor according to the VIT package (2007 analysis).

Assuming no variation of the exploitation pattern, the main results of Y/R analysis are reported in the Table 8.21.5.3.1 for 2006 and 2007.

Tab. 8.21.5.3.1 Estimation of yield (Y), biomass (B) and spawning stock biomass (SSB) per recruit (R) varying current fishing mortality (F) by a multiplier F factor.

2006	Factor	F	Y/R	B/R	SSB
F(0.1)	0.53	0.37	7.761	17.873	10.911
F(Max)	0.94		8.304	12.162	5.944
F(Current)	1.01		8.295	11.514	5.414
F(Double)	2		7.503	6.524	1.779
2007	Factor		Y/R	B/R	SSB
F(0.1)	0.91	0.59	11.709	21.51	18.001
F(Max)	1.75		12.671	13.082	9.666
F(Current)	1.01		11.971	20.078	16.58
F(Double)	2		12.635	11.752	8.364

Considering the level of F in 2006, (i.e. 0.7), a reduction of 47% would be necessary to reach F0.1 (0.37) (Table 8.21.7.3.1). In 2007 the situation seems different. Despite the fact that the value of status quo F (0.65) is close to that of 2006, the exploitation pattern was different and thus a reduction of about 10% would be needed to reach F0.1 (0.59).

8.21.6.Scientific advice

8.21.6.1.Short term considerations

8.21.6.1.1. State of the spawning stock size

SGMED-09-02 cannot provide any scientific advice of the state of the spawning stock in relation to proposed target level, given the preliminary state of the data and analyses, and the non availability of agreed reference points. However, the results of Aladym model suggested that the continuation of the level of pressure exerted in the recent past will contribute to the reduction of the spawning stock, bringing it around the lower level of the past.

8.21.6.1.2. State of recruitment

The recruitment observed from Grund survey data is in the recent years show low levels of abundance.

8.21.6.1.3. State of exploitation

Given the results of the present analysis, the stock appears to be subject to overfishing. The overfishing might be lower if the estimates related to the fishing mortality in 2007 will be confirmed in the successive years. Other signals, from survey indices and Aladym model predictions, showed that the condition of the stock could be at risk of being harvested unsustainably if the mortality levels observed in the past years (except 2007) will occur in the future.

8.22. Stock assessment of red mullet in GSA 11

8.22.1.Stock identification and biological features

8.22.1.1.Stock Identification

This stock was assumed to be confined within the GSA 11 boundaries, but no scientific evidence is available to confirm this hypothesis. Under a management point of view, in the frame of GFCM, it has been decided, when the lack of any evidence does not allow suggesting an alternative hypothesis that inside each one of the GSAs boundaries inhabits a single, homogeneous red mullet stock that behaves as a single well-mixed and self-perpetuating population.

In the GSA 11 red mullet is distributed between 0 and 300 m of depth, even though is generally found on shelf bottoms (within 200 m of depths) where the bulk of abundance and biomass is up to 100 m. Even though the species can be found at depths over 200 m, it is mainly concentrated in the depth range 0-100 m. The stock is mainly exploited by the local fishing fleet only, both with trawl and net gears.

Juveniles showed a patchy distribution with some main density hot spots (nurseries) showing a high spatio-temporal persistence in western and southern areas.

8.22.1.2.Growth

Tab. 8.22.1.2.1. Growth parameters and natural mortality rates for *M. barbatus* in the GSA 11 used in the analyses.

L_∞	29.1
K	0.41
to	-0.39
L/W a	0.001
L/W b	3.02

8.22.1.3.Maturity

The species reaches massively the sexual maturity at one year old. Observations of proportion of mature individuals by size and analysis with the standard procedure show the bulk of the females spawn at a size of about 10 cm.

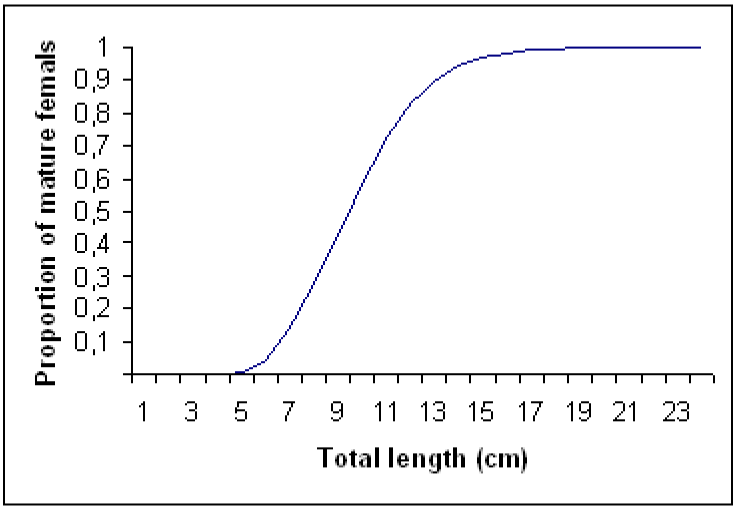


Fig. 8.22.1.3.1 Maturity ogive for females *M. barbatus* in the GSA 11.

Data on spawning (DCR 2006 and 2007) confirm that is taking place on spring (April-June), with a peak during late spring (May).

8.22.2.Fisheries

8.22.2.1.General description of fisheries

STECF in 2007 (stock review part II) noted that red mullet *Mullus barbatus is* among the most commercially important species in the area and forms part of an assemblage that is the target of the bottom trawling and small scale fleets, which operate near the shore. During the peak of post-recruitment (September-October), small trawlers target this species on shallower waters near the cost.

From 1994 to 2004, in GSA 11, the trawling-fleet has remarkably changed. The change has mostly consisted of a general increase of the number of vessels and by the replacement of the old, low tonnage wooden boats by larger steel boats. For the entire GSA a decrease of 20% for the smaller boats (<30 GRT), which principally exploit this species, was also observed.

8.22.2.2.Management regulations applicable in 2008 and 2009

As in other areas of the Mediterranean, the stock management is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area closures), and minimum landing sizes (EC 1967/06).
Two small closed areas were also established along the mainland (west and east coast respectively), although these are finalised to protected lobsters mainly.
Since 1991, a fishing ban for trawling for 45 days have been enforced almost every year in different periods for the small scale fishery (March, TSL<=15) and for the big vessels, hence trawlers (September, TSL<15). In Fig. 8.22.2.2.1, differences in the closure regime are showed; red points means that no fishing ban measure has been adopted for the year.

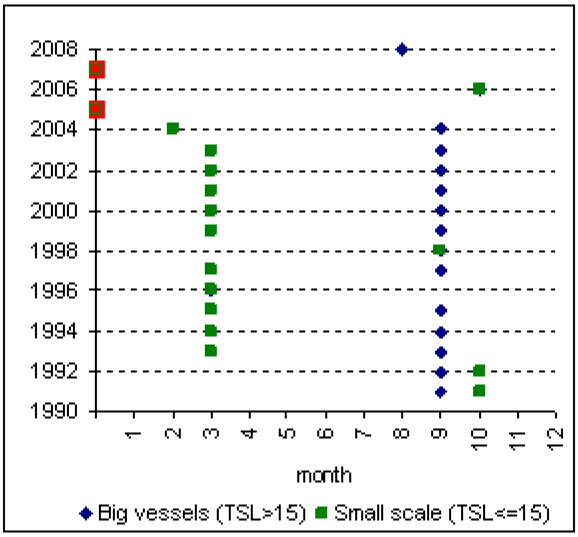


Fig. 8.22.2.2.1 Closed seasons since 1990.

Furthermore, in 2006 the closure was differentiated in time also considering the different coasts (west and east). Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

8.22.2.3. Catches

8.22.2.3.1. Landings

Tab. 8.22.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.2 of Appendix 3. Since 2002 the annual landings varied between 115 and 354 t. The landings were mainly from demersal otter trawls (on overage catches from nets are no more than 5% of the total).

Tab. 8.22.2.3.1.1 Annual landings (t) by fishing technique in GSA 11, 2002-2008 as reported through DCR.

FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DTS	38	253					
FPO						3	1
FYK						5	1
GNS			3				
GTR			11	13	13	0	1
OTB			333	253	249	346	263
PGP	0						
PMP	77	68					
total landings (all gears)	115	321	347	266	262	354	266

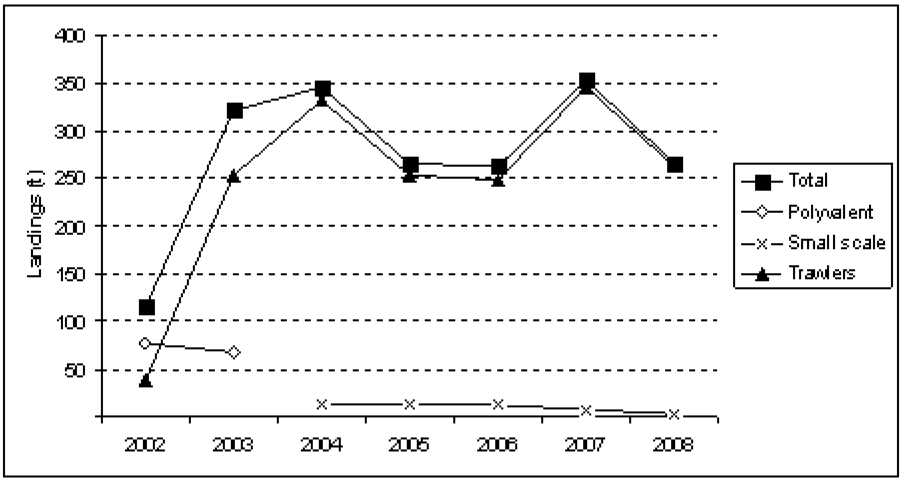


Fig. 8.22.2.3.1.1 Landings (t) by year and major gear types, in GSA 11, 2002-2008 as reported through DC.

8.22.2.3.2. Discards

7 t of discards in 2006 were reported to SGMED-09-02 through the DCR data call and are listed in Tab. A3.9 of Appendix 3.

8.22.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-09-02 are listed in Tab. 8.22.2.3.3.1 and in Tab. A3.10-3.12 of Appendix 3. The effort of the major trawler fleet has doubled during 2003-2004 and stayed at the high level thereafter.

Tab. 8.22.2.3.3.1 Trends in annual fishing effort (kW*days) by fishing technique deployed in GSA 11, 2002-2007. No effort data were reported for 2008.

FT_LVL4	2002	2003	2004	2005	2006	2007
FPO				79031	824017	1387022
FYK						13055
GND						11713
GNS				1007963	236313	781402
GTR				6358014	6476994	4393484
LHP-LHM				769	70523	122621
LLD				284297	480411	952876
LLS				832709	1159412	1054615
LTL					12388	1622
OTB				7679721	5879355	5957347
DTS	3679604	4652647	6711626			
PGP	2865738	5099814	7105771			
PMP	7159338	3245118				
total	13704680	12997579	13817397	16242504	15139413	14675757

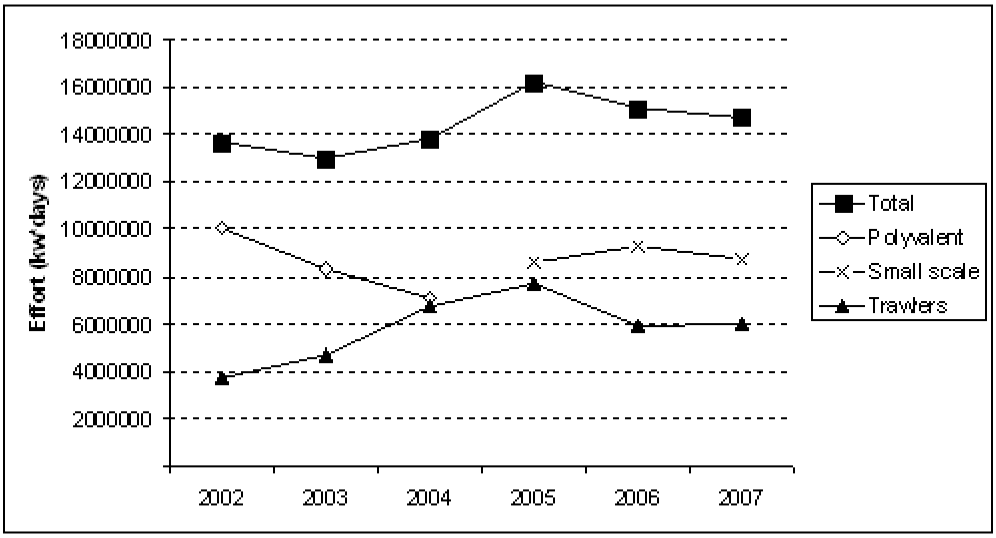


Fig. 8. 22.2.3.3.1 Trend in fishing effort (kW*days) for the Italian fleet in GSA 11, by major gear types, 2002-2007.

8.22.3.Scientific surveys

8.22.3.1.MEDITS

8.22.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 08 the following number of hauls was reported per depth stratum (s. Tab. 8.22.3.1.1.1).

Tab. 8.22.3.1.1.1. Number of hauls per year and depth stratum in GSA 11, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA11_010-050	17	19	21	21	21	21	19	18	20	18	17	17	19	19	17
GSA11_050-100	27	21	22	22	20	22	22	24	19	19	18	21	18	20	19
GSA11_100-200	22	23	30	31	31	30	31	30	24	24	24	24	24	24	22
GSA11_200-500	35	29	29	26	25	27	24	25	20	24	21	20	20	20	21
GSA11_500-800	23	16	21	25	25	24	27	26	16	14	15	14	16	17	16

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

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

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

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

Where:

- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.22.3.1.2. Geographical distribution patterns

The spatial structure of red mullet have been achieved by modelling the spatial correlation structure of the abundance indices through geostatistical techniques (i.e. krigging), showing clear areas of persistence in the south (Gulf of Cagliari) and western coasts (Carloforte and coast between Bosa Marina and Capo Mannu). Detailed results and maps are reported in the "nursery section" of this report.

8.22.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 11 was derived from the international survey Medits. Fig. 8.22.3.1.3.1 and 2 displays the estimated trend in red mullet abundance and biomass in GSA 11.

The estimated abundance and biomass indices do not reveal any significant trends since 1994. However, the recent abundance and biomass indices since 2005 appear high but are subject to high variation.

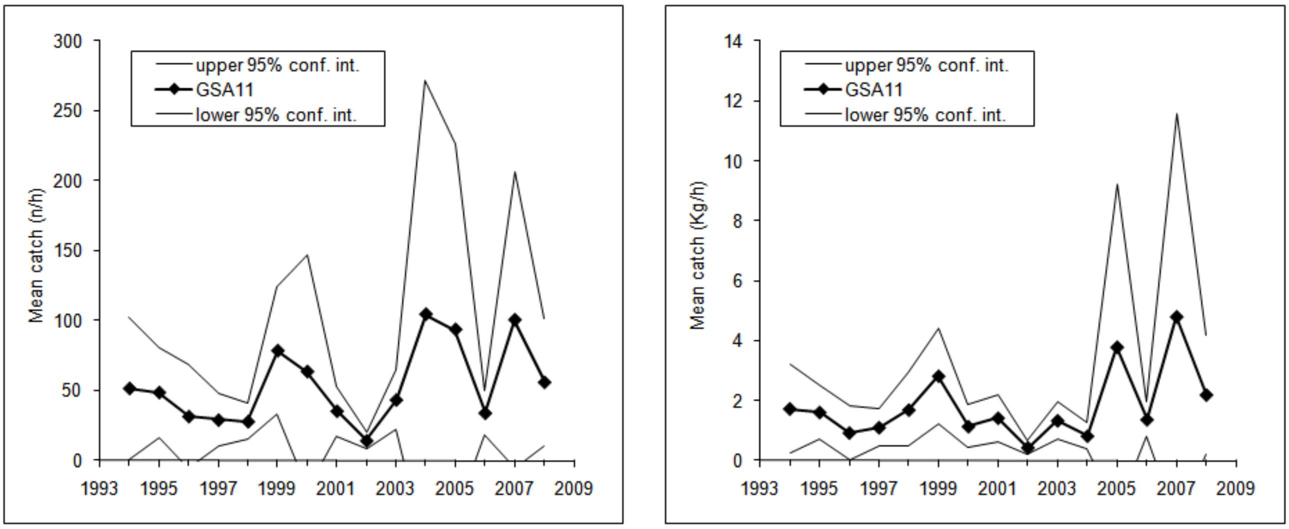


Fig. 8.22.3.1.3.1 Abundance and biomass indices of red mullet in GSA 11.

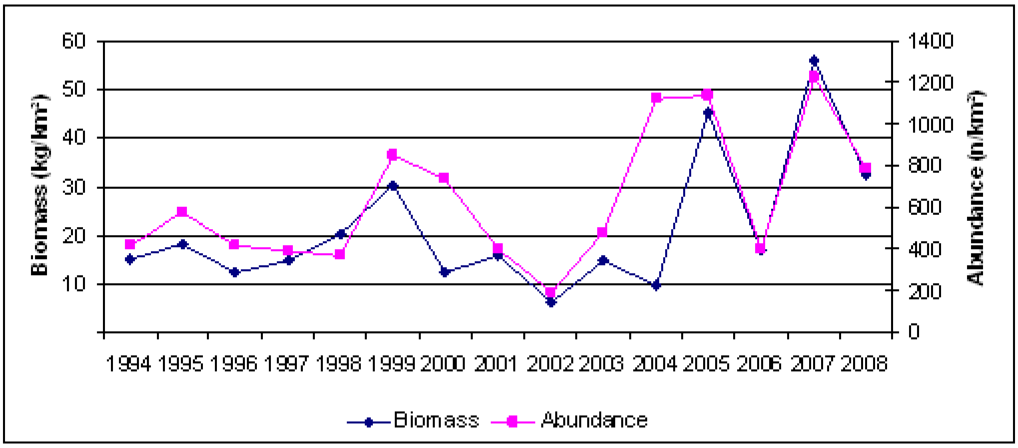


Fig. 8.22.3.1.3.2 Abundance and biomass indices of red mullet in GSA 11.

8.22.3.1.4. Trends in abundance by length or age

The following Fig. 8.22.3.1.4.1 and 2 display the stratified abundance indices of GSA 11 in 1994-2001 and 2002-2008.

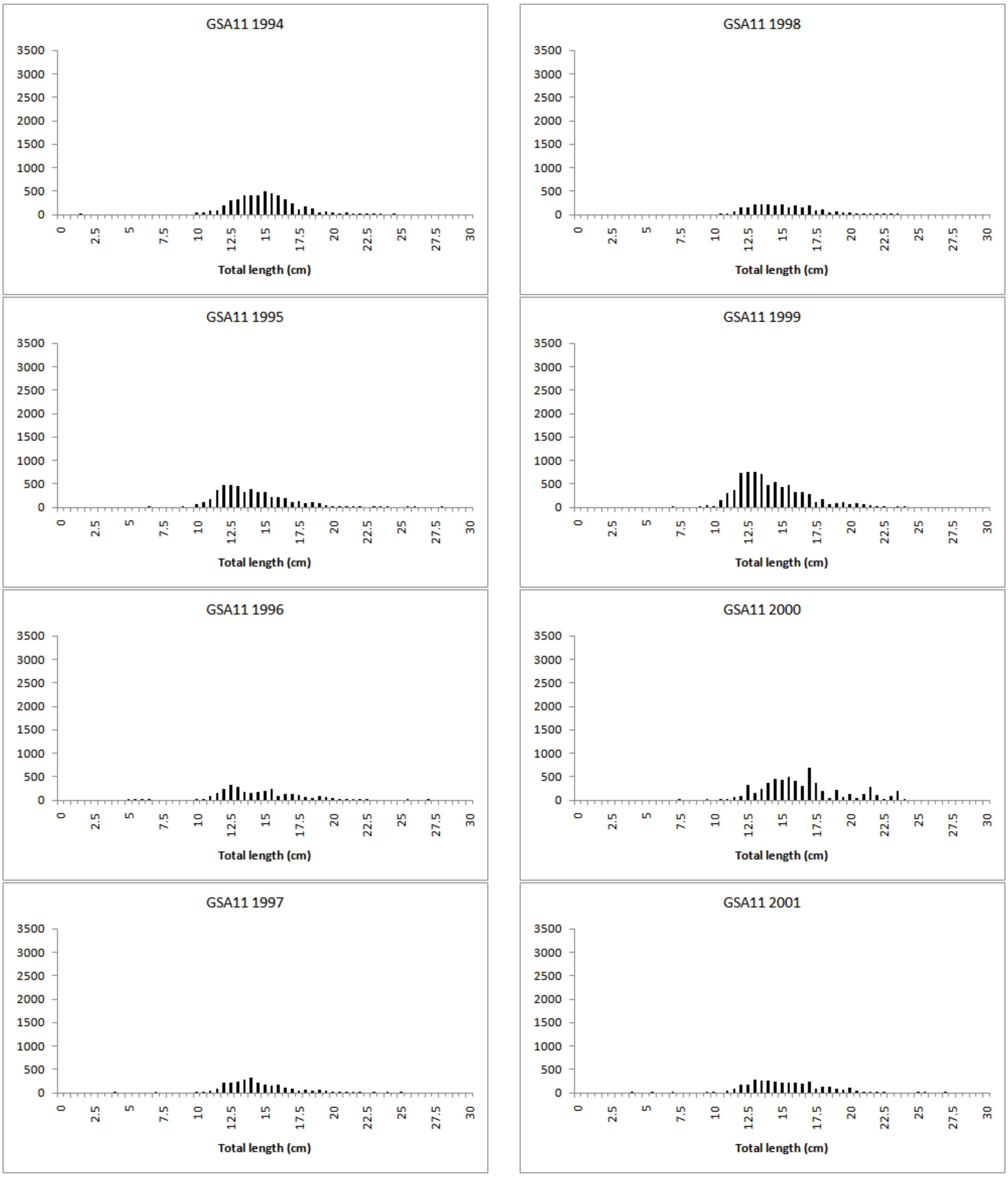


Fig. 8.22.3.1.4.1 Stratified abundance indices by size, 1994-2001.

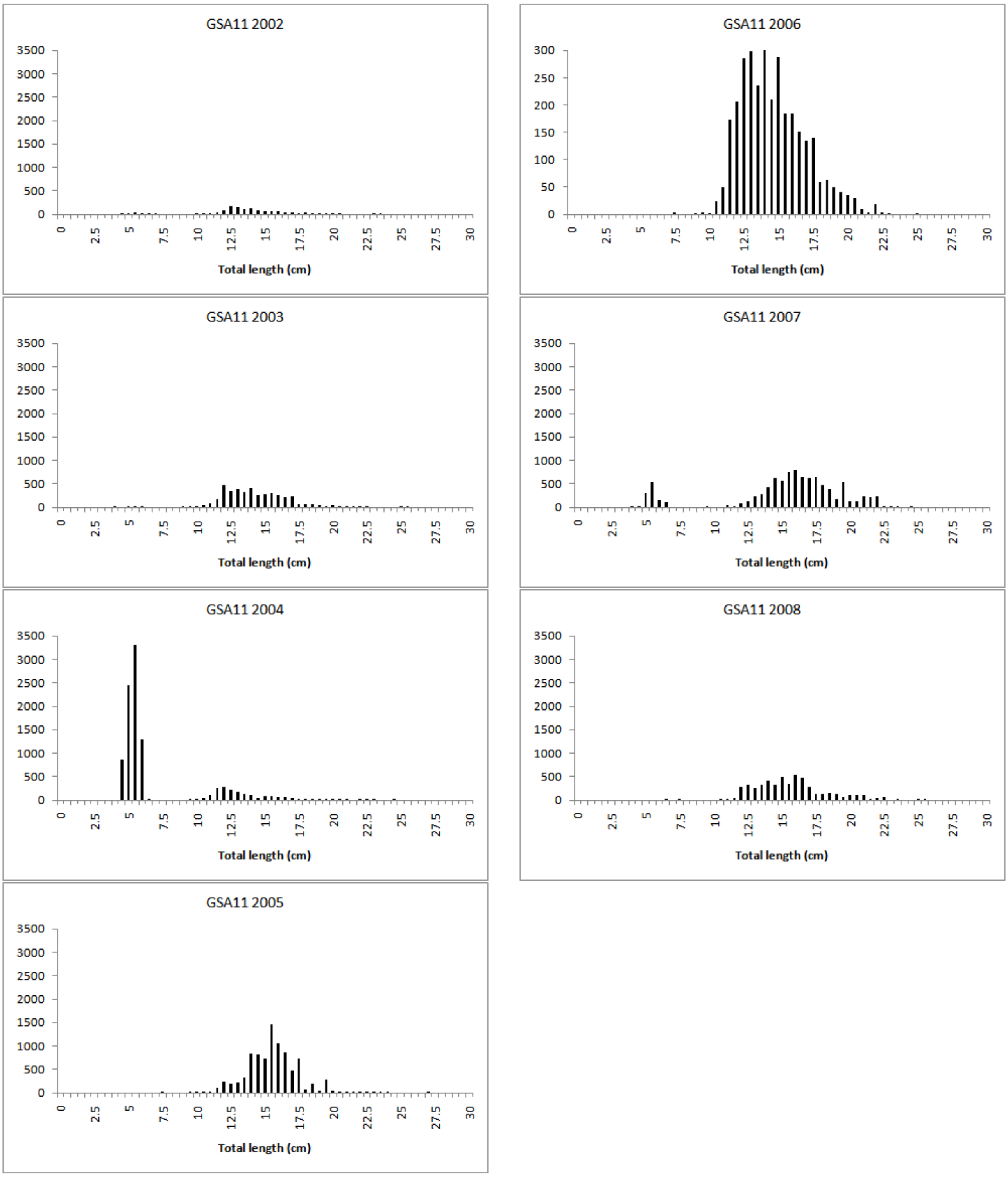


Fig. 8.22.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.22.3.1.5. Trends in growth

No analyses were conducted.

8.22.3.1.6. Trends in maturity

No analyses were conducted.

8.22.4.Assessment of historic stock parameters

8.22.4.1.Method 1: VIT

8.22.4.1.1. Justification

An approach under steady state (pseudocohort) assumption was applied due to the availability of length frequency distributions of landing (2006-2007 only, DCR). Cohort (VPA equation) and Y/R analyses as been carried out with VIT software on trawl fishery only.

8.22.4.1.2. Input parameters

No discard data were included and a plus group has been used.

According to the Prodbiom approach by Caddy and Abella (1999), a vectorial natural mortality at age was computed for the stock analysis (Tab. 8.22.4.1.2.1). Terminal F was fixed to 0.6.

Tab. 8.22.4.1.2.1 Input parameters used of the analysis (sex combined) in the GSA11.

VBGF	L_∞=29.1 cm, K=0.41, t_0= -0.39
M vector	Age_0=1.3 , Age_1=0.45, Age_2=0.27, Age_3=0.24, Age_4=0.21
Length at maturity (L50)	13 cm (sex combined)

8.22.4.1.3. Results

Fishing mortality rates (F), total fishing mortality and total mortality rate Z by length estimated by LCA using VIT (age groups 0-3).

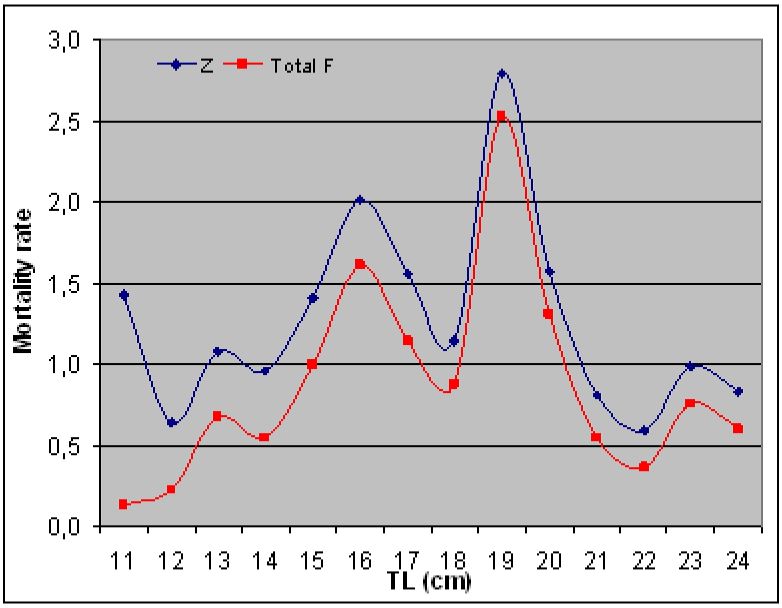


Fig. 8.22.4.1.3.1 Fishing (F) and total mortality (Z) rates by size in GSA 11.

8.22.5.Long term prediction

8.22.5.1.Justification

A YpR analysis was conducted applying the VIT software.

8.22.5.2.Input parameters

VIT inputs and resulting exploitation pattern was used.

8.22.5.3.Results

Assuming no variation of the exploitation pattern, the main result of Y/R analysis is reported in the table below.

Tab. 8.22.5.3.1 Estimation of yield (Y), biomass (B) and spawning stock biomass (SSB) per recruit (R) varying current fishing mortality (F) by a multiplier F factor.

	Factor φ	Y/R	B/R	SSB/R
F(Current)	1	2.954	3.227	2.236
F(0.1)	0.6	2.8	5.3	4.0
F(Max)	0.91	2.961	3.568	2.521
F(Double)	2	2.645	1.7	1.015

8.22.6.Scientific advice

8.22.6.1.Short term considerations

8.22.6.1.1. State of the spawning stock size

Survey indices did not reveal any significant trend. SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to precautionary or target levels given the preliminary state of the data and analyses.

8.22.6.1.2. State of recruitment

According to the data provided, the first length caught (11 cm,) corresponds to 0.87 years (i.e. 0+). However it is likely that smaller individuals are abundant in catches as in other Mediterranean regions, although not reported in the official data.
Index of abundance of juveniles obtained from MEDITS surveys shows a high variability.

8.22.6.1.3. State of exploitation

SGMED-09-02cannot fully evaluate the state of the stock. 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, the length range of red mullet size in the landings is expected to be wider than those reported in the official data (i.e. 11-24 cm). Because of obvious data deficiencies with unknown effects on the estimates of exploitation rates and the reference points derived from the YpR analysis, SGMED-09-02 is unable to provide any scientific advice.

8.23. Stock assessment of red mullet in GSA 16

8.23.1. Stock identification and biological features

8.23.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.23.1.2. Growth

No information was documented during SGMED-09-02.

8.23.1.3. Maturity

No information was documented during SGMED-09-02.

8.23.2. Fisheries

8.23.2.1. General description of fisheries

No information was documented during SGMED-09-02.

8.23.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.23.2.3. Catches

8.23.2.3.1. Landings

Landings data were reported to SGMED-09-02 through the Data collection regulation and are listed in Table A3.2 of Appendix 3. Annual landings decreased from 1,627 t in 2004 to 1,177 t in 2008 (Tab. 8.23.2.3.1.1). Demersal otter trawlers dominate the landings by far.

Table 8.23.2.3.1.1 Annual landings (t) by fishing technique as reported to SGMED-09-02 through the DCR data call. Landings data provided for the years 2002 and 2003, probably have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
MUT	16	ITA	DTS	1923944	3306397					
MUT	16	ITA	GTR			58	29	39	37	20
MUT	16	ITA	OTB			1568	1377	1084	1343	1158
MUT	16	ITA	PGP	168927	27089					
MUT	16	ITA	PMP	52368	46696					
MUT	16	ITA	PTS	3811	3679					

8.23.2.3.2. Discards

Discards data were reported for 2006 to 2008 to SGMED-09-02 and are listed in Tab. A3.9 of Appendix 3.

Tab. 8.23.2.3.3.1 Discards data by fishing technique in GSA 16.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
MUT	16	ITA	OTB					94	117	101

8.23.2.3.3. Fishing effort

Tab. 8.23.2.3.3.1 lists the effort by fishing technique deployed in GSA 16 as reported to SGMED-09-02 throught the DCR data call and listed in Tab. A3.10-3.12 of Appendix 3. The main gear demersal otter trawl does not reveal any significant trend in effort deployed.

Tab. 8.23.2.3.3.1 Effort trends by fishing technique in GSA 16.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	16	ITA	DTS	87300	76233	81853				
DAYS	16	ITA	FPO				18	20	28	
DAYS	16	ITA	GND				6717	6218	7547	
DAYS	16	ITA	GTR				78429	52961	50840	
DAYS	16	ITA	HOK			14856				
DAYS	16	ITA	LHP-LHM				1363	3695	4674	
DAYS	16	ITA	LLD				5759	6397	8493	
DAYS	16	ITA	LLS				16424	22888	19638	
DAYS	16	ITA	LTL				300	408		
DAYS	16	ITA	MIS				262			
DAYS	16	ITA	OTB				83124	84674	82261	
DAYS	16	ITA	OTM				756	1540	1471	
DAYS	16	ITA	PGP	146019	118660	118425				
DAYS	16	ITA	PMP	26655	34956	6939				
DAYS	16	ITA	PS				1612	2066	1971	
DAYS	16	ITA	PTM				1204	3746	4193	
DAYS	16	ITA	PTS	8778	8568	4899				
GT*days	16	ITA	DTS	6739948	6175213	6673029				
GT*DAYS	16	ITA	FPO				531	939	2962	
GT*DAYS	16	ITA	GND				51767	68581	70266	
GT*DAYS	16	ITA	GTR				183252	139048	146474	
GT*days	16	ITA	HOK			764595				
GT*DAYS	16	ITA	LHP-LHM				2757	7752	9603	
GT*DAYS	16	ITA	LLD				377485	290622	351965	
GT*DAYS	16	ITA	LLS				40376	41294	51455	
GT*DAYS	16	ITA	LTL				600	815		
GT*DAYS	16	ITA	MIS				1630			
GT*DAYS	16	ITA	OTB				7064255	7088706	6994494	
GT*DAYS	16	ITA	OTM				65935	141508	135199	
GT*days	16	ITA	PGP	410857	732725	249032				
GT*days	16	ITA	PMP	375921	418892	20134				
GT*DAYS	16	ITA	PS				101266	114791	95754	
GT*DAYS	16	ITA	PTM				57807	197450	225837	
GT*days	16	ITA	PTS	585964	327460	224188				
kW*days	16	ITA	DTS	23952310	20951845	21381964				
KW*DAYS	16	ITA	FPO				2602	4116	16280	
KW*DAYS	16	ITA	GND				484488	565283	560624	
KW*DAYS	16	ITA	GTR				2436223	1675235	1779917	
kW*days	16	ITA	HOK			3153486				
KW*DAYS	16	ITA	LHP-LHM				147929	332833	329113	
KW*DAYS	16	ITA	LLD				1102509	1319225	1938868	
KW*DAYS	16	ITA	LLS				812348	751898	805197	
KW*DAYS	16	ITA	LTL				2401	3260		
KW*DAYS	16	ITA	MIS				18900			
KW*DAYS	16	ITA	OTB				22936088	23764571	22757302	
KW*DAYS	16	ITA	OTM				159014	315468	300311	
kW*days	16	ITA	PGP	3133993	4603457	2691324				
kW*days	16	ITA	PMP	2792612	2761842	223470				
KW*DAYS	16	ITA	PS				444087	520717	459314	
KW*DAYS	16	ITA	PTM				280234	712936	862918	
kW*days	16	ITA	PTS	2510582	1750128	962786				

8.23.3.Scientific surveys

8.23.3.1.Medits

8.23.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 16 the following number of hauls was reported per depth stratum (s. Tab. 8.23.3.1.1.1).

Tab. 8.23.3.1.1.1. Number of hauls per year and depth stratum in GSA 16, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA16_010-050	4	4	4	4	4	4	4	4	7	7	7	10	10	11	11
GSA16_050-100	9	8	8	8	8	8	7	8	11	12	12	20	22	23	23
GSA16_100-200	4	4	4	4	5	5	6	5	11	10	11	20	19	21	21
GSA16_200-500	10	11	11	12	11	11	11	11	19	18	27	37	31	27	27
GSA16_500-800	10	14	14	13	14	14	14	14	20	20	21	33	33	38	38

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

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

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

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

Where:

- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.23.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.23.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 16 was derived from the international survey Medits. Figure 8.23.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 16.

The estimated abundance and biomass indices reveal a significant increasing trend since 1999. However, the highest abundance in 2003 coincides with the high landings recorded. The analyses of Medits indices are considered preliminary.

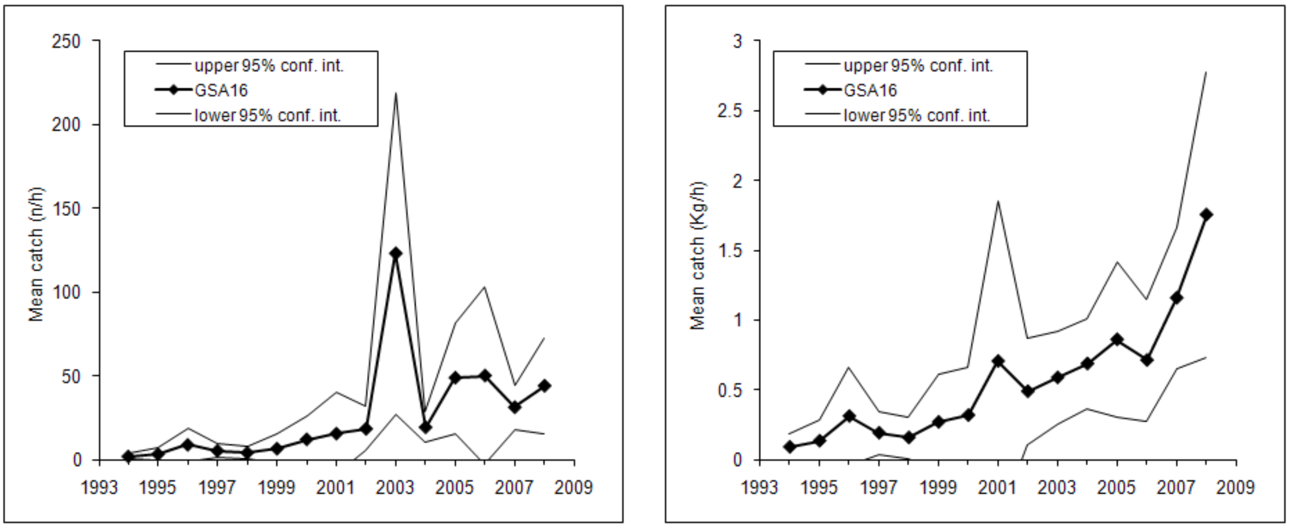


Fig. 8.23.3.1.3.1 Abundance and biomass indices of red mullet in GSA 16.

8.23.3.1.4. Trends in abundance by length or age

The following Fig. 8.23.3.1.4.1 and 2 display the stratified abundance indices by size of GSA 16 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

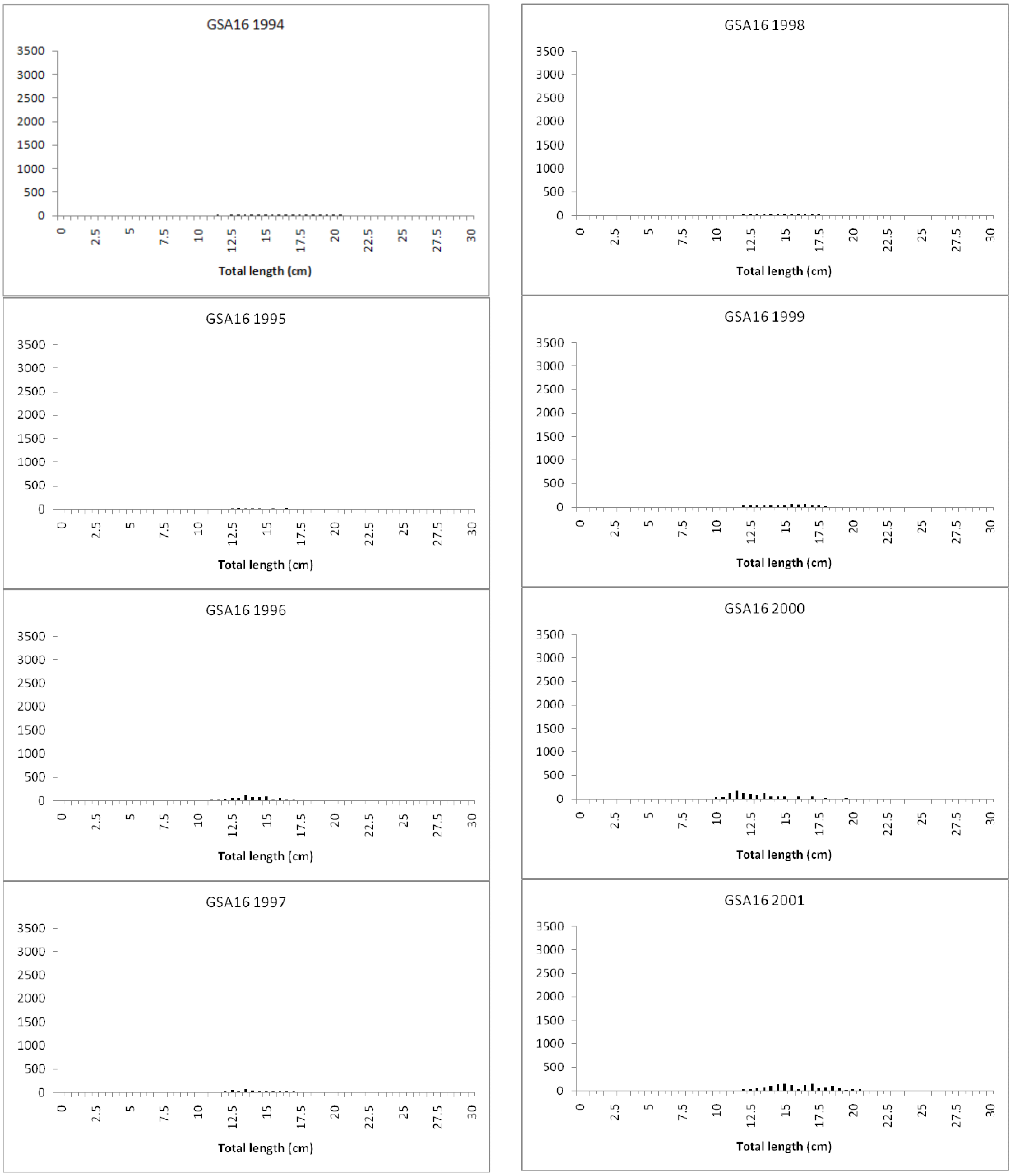


Fig. 8.23.3.1.4.1 Stratified abundance indices by size, 1994-2001.

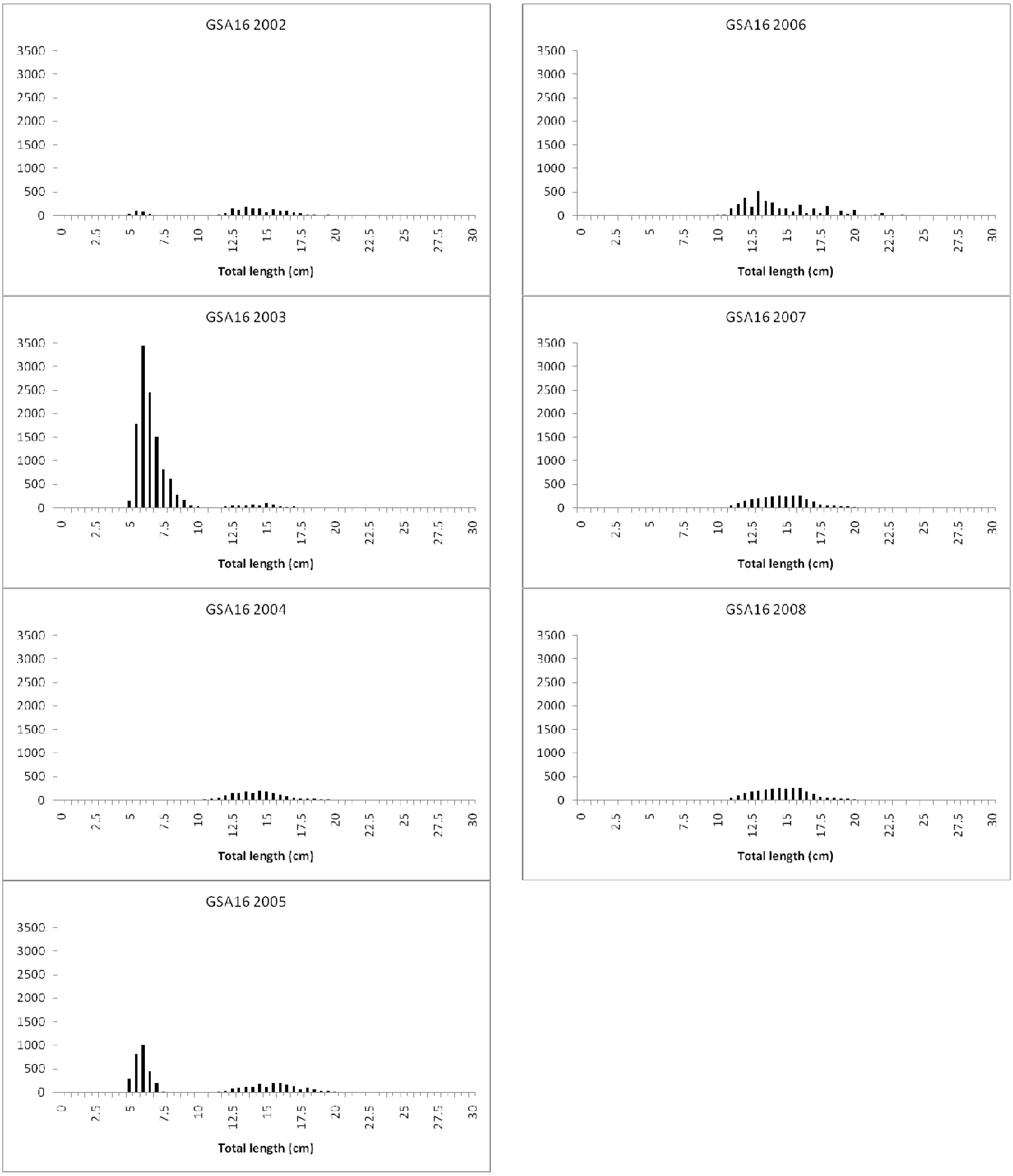


Fig. 8.23.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.23.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.23.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.23.4.Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.23.5.Long term prediction

8.23.5.1.Justification

No forecast analyses were conducted.

8.23.5.2.Input parameters

No forecast analyses were conducted.

8.23.5.3.Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 16.

8.23.6.Scientific advice

8.23.6.1.Short term considerations

8.23.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.23.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.23.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.24. Stock assessment of red mullet in GSA 17

8.24.1.Stock identification and biological features

8.24.1.1.Stock Identification

Red mullet is found across the whole GSA 17. However, patterns of abundance are observed over seasons and space. Along the eastern side of Adriatic, abundance seems to be relatively constant over the year. Along the western side, in late summer and autumn, large concentrations of individuals are observed in the shallow waters along the coast, whereas, in the subsequent months, a migration towards deeper waters occurs (Arneri and Jukic, 1986; SEC (2002) 1374; see also below).

The distribution of red mullet (*Mullus barbatus*) in the GSA 17, in spring-summer, is shown in the maps below (Fig. 8.24.1.1.1), imported from Sabatella and Piccinetti (2004). The picture on the left shows the depth contours, increasing with darker colour (0-50, 50-100, 100-200, > 200 m). The picture on the right displays mullet densities at sea from the MEDITS trawl survey in the second half of the 1990s, expressed as number of individuals per square kilometer.

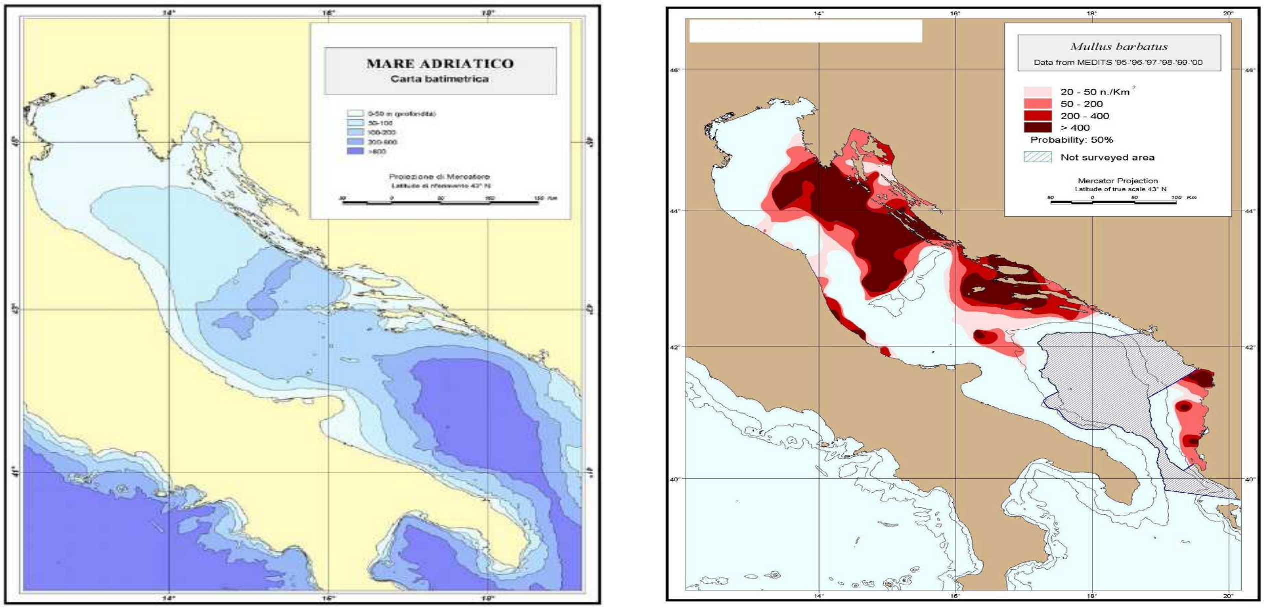


Fig. 8.24.1.1.1 Topography and geographical distribution patterns of red mullet in GSA 17.

Spawning of red mullet occurs in late spring and summer (Vrgoc *et al.*, 2004). In particular, the life cycle is characterized by the occurrence of juveniles in shallow coastal waters in late summer and autumn, and subsequent occurrence of adult individuals offshore in deeper waters during winter and spring months ((SEC (2002) 1374).

8.24.1.2.Growth

No information was documented during SGMED-09-02.

8.24.1.3.Maturity

The summary of the values of length at the first sexual maturity estimated for the Adriatic Sea was imported from Vrgoc *et al.* (2004) and listed in Table 8.24.1.3.1.

Tab. 8.24.1.3.1 Length and age at maturity and literature references.

Author	Sex	L_m (cm)	Age (yr)
Zei and Sabioncello, 1940	M+F	11-14	1
Scaccini, 1947a	M+F		2
Županović, 1963	M	11-12	
	F	12-13	
Haidar, 1970	M	10.5	1
	F	12	1
Jukić and Piccinetti, 1981	M	10.5	1
Marano *et al.*, 1998b, c	M+F	11-14	
Relini *et al.*, 1999	M	11-13	1
	F	12-14	1
Vrgoč, 2000	M	10.5-11.5	
	F	10 – 11	

8.24.2. Fisheries

8.24.2.1. General description of fisheries

The fishery for red mullet is one of the most important in the GSA 17. Fishing grounds correspond to the distribution of the stock particularly within 100 m depth. The allocation of fishing effort depends on the features of the life cycle as described above (SEC (2002) 1374).

8.24.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.24.2.3. Catches

8.24.2.3.1. Landings

Landings data were reported to SGMED-09-02 through the Data collection regulation and are listed in Table A3.2 of Appendix 3. Annual landings decreased from 3,884 t in 2004 to 3.236 t in 2008 (Tab. 8.24.2.3.1.1). Demersal otter trawlers dominate the landings by far.

Tab. 8.24.2.3.1.1 Annual landings (t) by fishing technique as reported to SGMED-09-02 through the DCR data call. Data provided for the years 2002 and 2003, probably have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
MUT	17	ITA	DRB	29378						
MUT	17	ITA	DTS	2474846	2393623					
MUT	17	ITA	FPO			1			1	
MUT	17	ITA	FYK				1		1	0
MUT	17	ITA	GNS			35	41	12	5	7
MUT	17	ITA	GTR			0	0		1	0
MUT	17	ITA	MIS					0	0	
MUT	17	ITA	OTB			3784	3575	3160	3323	3159
MUT	17	ITA	OTM					0		
MUT	17	ITA	PGP	208560	214493					
MUT	17	ITA	PMP	374344	486638					
MUT	17	ITA	PTM			0	4	1	0	
MUT	17	ITA	PTS	11149	16193					
MUT	17	ITA	TBB			63	77	53	94	70

According to FAO statistics (ftp://ftp.fao.org/fi/stat/windows/fishplus/gfcm.zip), in the northern and central Adriatic Sea, the annual landings of *Mullus* spp. (Fig. 8.24.2.3.1.1) were estimated to be over 2,000 tonnes in many years of the 1980s and 1990s. An increasing trend occurred over the 1990s.

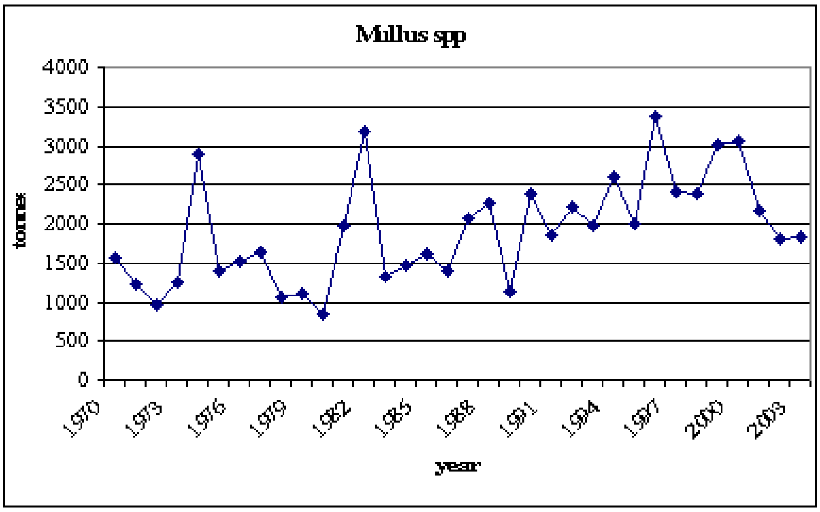


Fig. 8.24.2.3.1.1 Annual landings of red mullet in the northern and central Adriatic Sea according to FAO.

8.24.2.3.2. *Discards*

No discards data were reported to SGMED-09-02 for red mullet in GSA 17.

8.24.2.3.3. *Fishing effort*

Tab. 8.24.2.3.3.1 lists the effort by fishing technique deployed in GSA 17 as reported to SGMED-09-02 through the DCR data call and listed in Tab. A3.10-3.12 of Appendix 3. The main gear demersal otter trawl reveals a significant decreasing trend in effort deployed.

Tab. 8.24.2.3.3.1 Effort trends by fishing technique in GSA 17.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	17	ITA	DRB	58297	69126	64120	53905	55592	61072	
DAYS	17	ITA	DTS	124529	125106	134776				
DAYS	17	ITA	FPO				57270	75621	72165	
DAYS	17	ITA	FYK				16763	26395	33769	
DAYS	17	ITA	GND				1933	391	184	
DAYS	17	ITA	GNS				124822	104855	90594	
DAYS	17	ITA	GTR				17367	15132	17108	
DAYS	17	ITA	HOK			641				
DAYS	17	ITA	LLD				961	391	637	
DAYS	17	ITA	LLS					20	18	
DAYS	17	ITA	MIS				37020	17371	9020	
DAYS	17	ITA	OTB				129874	105577	94257	
DAYS	17	ITA	OTM				702	1044		
DAYS	17	ITA	PGP	335599	272040	287886				
DAYS	17	ITA	PMP	96386	98110	15512				
DAYS	17	ITA	PS				2702	2596	4037	
DAYS	17	ITA	PTM				16714	18236	17053	
DAYS	17	ITA	PTS	23522	25649	23387				
DAYS	17	ITA	TBB			12395	11382	15729	16246	
DAYS	17	SVN	PS					840	766	925
DAYS	17	SVN	PTM					556	669	489
GT*days	17	ITA	DRB	610984	724702	858864	701785	751815	886404	
GT*days	17	ITA	DTS	4521393	4459910	5624744				
GT*DAYS	17	ITA	FPO				129755	173844	155713	
GT*DAYS	17	ITA	FYK				21213	48049	62095	
GT*DAYS	17	ITA	GND				20395	4854	3540	
GT*DAYS	17	ITA	GNS				232491	192464	141092	
GT*DAYS	17	ITA	GTR				59566	55663	67511	
GT*days	17	ITA	HOK			9492				
GT*DAYS	17	ITA	LLD				15878	9200	12818	
GT*DAYS	17	ITA	LLS					39	35	
GT*DAYS	17	ITA	MIS				100776	38408	12101	
GT*DAYS	17	ITA	OTB				5488069	4273375	3993908	
GT*DAYS	17	ITA	OTM				1696	2995		
GT*days	17	ITA	PGP	631665	551556	518165				
GT*days	17	ITA	PMP	660337	545482	73495				
GT*DAYS	17	ITA	PS				87381	125919	228375	
GT*DAYS	17	ITA	PTM				1388235	1638485	1609761	
GT*days	17	ITA	PTS	1349466	1277088	1516671				
GT*days	17	ITA	TBB			673656	730413	1081644	1021605	
kW*days	17	ITA	DRB	6381241	7517860	6982982	5954396	6173978	6713642	
kW*days	17	ITA	DTS	27568094	27486393	26771813				
KW*DAYS	17	ITA	FPO				3599417	4907498	4431128	
KW*DAYS	17	ITA	FYK				850518	1383490	1518073	
KW*DAYS	17	ITA	GND				219617	53220	36434	
KW*DAYS	17	ITA	GNS				4556942	3978580	2419608	
KW*DAYS	17	ITA	GTR				977664	861488	1018946	
kW*days	17	ITA	HOK			153794				
KW*DAYS	17	ITA	LLD				188429	92528	134508	
KW*DAYS	17	ITA	LLS					1051	904	
KW*DAYS	17	ITA	MIS				2729814	1063909	288624	
KW*DAYS	17	ITA	OTB				25773719	20565276	19174064	
KW*DAYS	17	ITA	OTM				13347	20352		
kW*days	17	ITA	PGP	9297244	7646003	9120053				
kW*days	17	ITA	PMP	7989134	7039902	1072033				
KW*DAYS	17	ITA	PS				638587	718994	1270590	
KW*DAYS	17	ITA	PTM				6268640	6392893	6298871	
kW*days	17	ITA	PTS	7841347	7636049	6955633				
kW*days	17	ITA	TBB			3419642	3642104	5144016	5038186	

8.24.3.Scientific surveys

8.24.3.1.Medits

8.24.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 17 the following number of hauls was reported per depth stratum (s. Tab. 8.24.3.1.1.1).

Tab. 8.24.3.1.1.1. Number of hauls per year and depth stratum in GSA 17, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA17_010-050			2	2	2	2	2	2	62	47	51	63	49	60	53
GSA17_050-100									54	36	37	62	38	38	37
GSA17_100-200									50	27	23	43	22	24	23
GSA17_200-500									9	7	5	7	5	5	5
GSA17_500-800									1	1					

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

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

aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.24.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.24.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 17 was derived from the international survey Medits. Figure 8.24.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 17.

The analyses of Medits indices are considered preliminary.

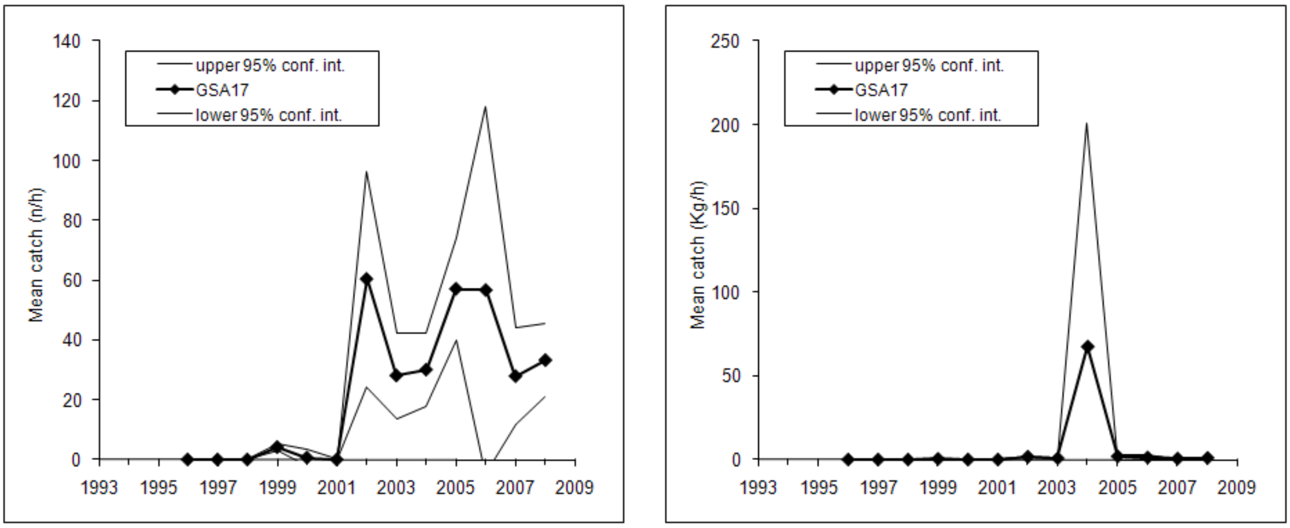


Fig. 8.24.3.1.3.1 Abundance and biomass indices of red mullet in GSA 17.

8.24.3.1.4. Trends in abundance by length or age

The following Fig. 8.24.3.1.4.1 displays the stratified abundance indices of GSA 17 in 1999-2008. These size compositions are considered preliminary.

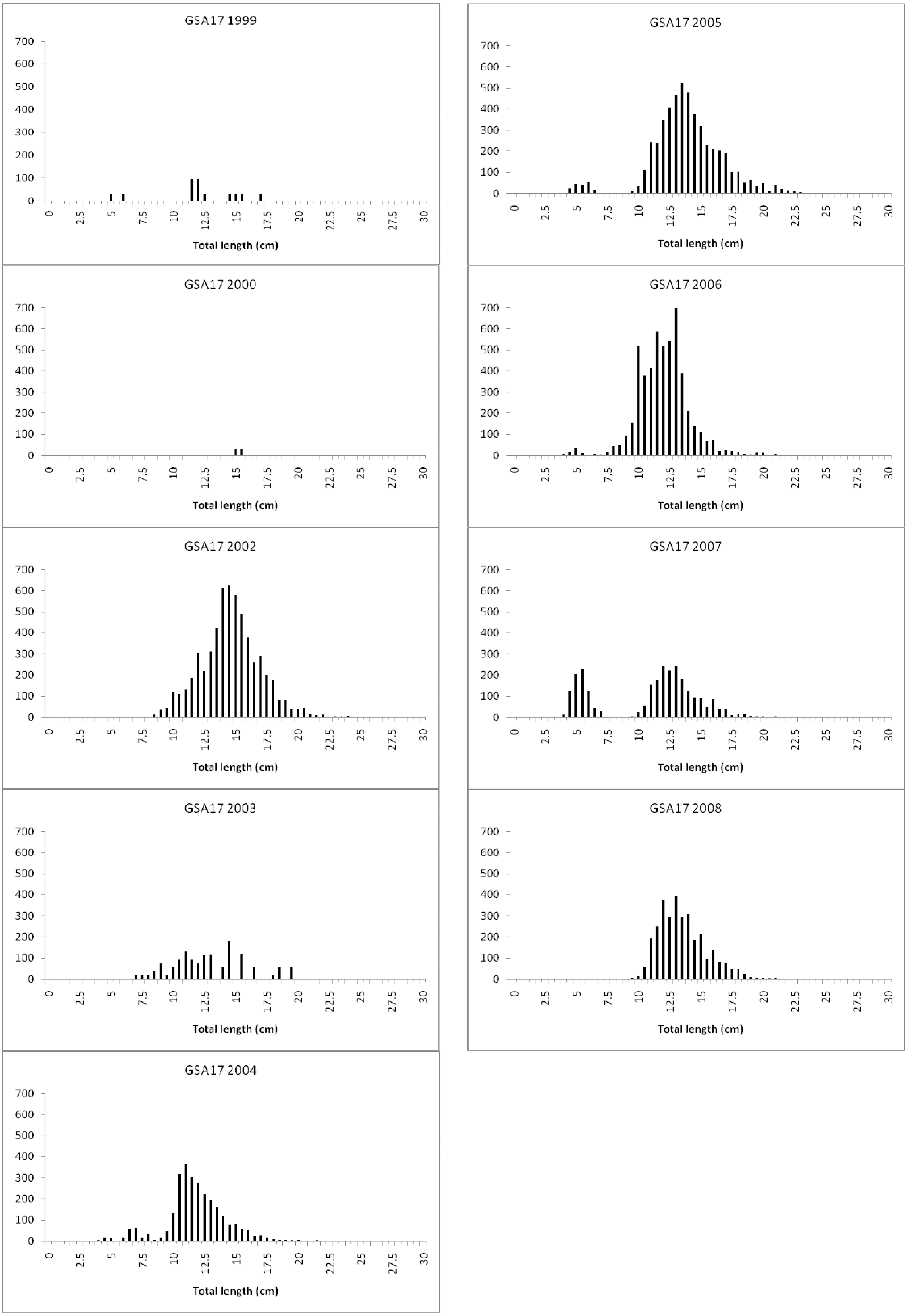


Fig. 8.24.3.1.4.1 Stratified abundance indices by size, 1999-2008.

8.24.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.24.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.24.4. Assessment of historic stock parameters

SGMED 09-02 did not undertake any analytical assessment of red mullet in GSA 17. Last year's assessment using LCA can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.24.5. Long term prediction

8.24.5.1. Justification

No forecast analyses were conducted.

8.24.5.2. Input parameters

No forecast analyses were conducted.

8.24.5.3. Results

SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 17.

8.24.6. Scientific advice

8.24.6.1. Short term considerations

8.24.6.1.1. State of the spawning stock size

The average stock biomass estimated by LCA in 2006-2007 was around 4,000 tonnes. In the absence of any proposed or agreed target referendes, SGMED-09-02 cannot fully evaluate the state of the stock.

8.24.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.24.6.1.3. State of exploitation

The average F not weighted on abundance was estimated to amount to 1.08, while the weighted average F amounted to 0.62. According to Rochet and Trenkel (2003), it would be safe to avoid F/Z higher than 0.50. Also, the seasonality of the fishing mortality of red mullet (from September to November) has to be taken into account. Thus, there is some risk of overexploitation for red mullet in GSA 17. However, in the absence of any proposed or agreed target referenses, SGMED-09-02 cannot fully evaluate the state of the exploitation.

8.25. Stock assessment of red mullet in GSA 18

8.25.1.Stock identification and biological features

8.25.1.1.Stock Identification

The stock of red mullet is defined within the boundaries of the whole GSA 18. Genetic studies conducted in the Adriatic (Garoia *et al*., 2004) evidenced that samples were characterised by high genetic diversity, but the spatial genetic heterogeneity was not related to a geographic cline. However, the randomness of genetic differences among samples indicated that the Adriatic red mullet stock probably belongs to a single population unit. Nevertheless, individuals may group into local, genetically differentiated sub-populations. The observed genetic fragmentation in the Adriatic stock might be due to reproductive success, survival rates or fishing pressure.

In addition to the genetic considerations, indications agreed upon by SGMED/ECA/RST-09-01 and based on correlation matrices of trawl-survey data in adjacent areas suggested a more geographically localised pattern for the distribution of red mullet.

In the Adriatic Sea Red mullet spawns in late spring and summer and according to Haidar (1970) the most intensive spawning occurs at depths of 60 to 70 m. After spawning, post larvae move towards shallower water (30-40 m) and then towards sandy coastal areas to become demersal at 4cm TL. Later, they start their dispersion in deeper waters towards sandy, muddy and gravel grounds (Relini *et al.*, 1999). Regarding the sex ratio males are generally prevailing up to 14-15 cm, while females are more frequent over 15-16 cm TL. The relative index of the population abundance is observed to decrease with depth. According to Haidar (1970) the main fish predators of juvenile and adult red mullet are *Lophius piscatorius*, *Raja clavata*, *Zeus faber* and *Merluccius merluccius*.

8.25.1.2.Growth

Literature data on the growth of red mullet in the Adriatic Sea are very variable (AdriaMed website). Asymptotic length for sex combined varies from 19.7 to 31.5 cm (range for females and males respectively: 26.2-34.5 cm; 17.8-27 cm), while the curvature parameter ranges for females and males respectively 0.122-0.23 and 0.184-0.282. According to Jardas (1996), red mullet grows up to about 30 cm (about 0.5 kg), although the usual total length in catches is from 10 to 20 cm. On average, females have greater body length than males and grow faster, which can be already noticed in the first year of their life (Haidar, 1970). Therefore, almost all largest specimens are females.

According to Scaccini (1947) the life cycle is 8 years with a faster growth rate in the firsts three years for both sexes, after a slower pattern is evidenced (y1=12.6-12.7 cm for males and females respectively, y2=17.5-20.3; y3=20.4-23.9; y8=25.5-29.3 cm). The estimated VBGF for sex combined from Scaccini (1947) were: L_∞=27.5 cm; K=0.5; t_0= -0.25. The growth parameters estimated by sex in the central-northern Adriatic area during the SAMED project (AAVV, 2002), using the analysis of length frequency distributions of MEDITS data, were: females: L_∞=27 cm; K=0.396; t_0= -0.78; males: L_∞=23 cm; K=0.43; t_0= -0.80.

Estimates of growth parameters were achieved using otolith data collected within the DCR framework. The following von Bertalanffy parameters were estimated for sex combined: L_∞=26.3 cm; K=0.45; t_0= -0.3.
Parameters of the length-weight relationship reported in literature for sex combined are a=0.008-0.0125, b=3.09-2.97 (Marano et al., 1994; 1998; Marano, 1996).

The parameters estimated within the DCR for sex combined were: a=0.0122, b=2.94; for females: a=0.017, b=2.85; and for males a=0.0169, b=2.85.

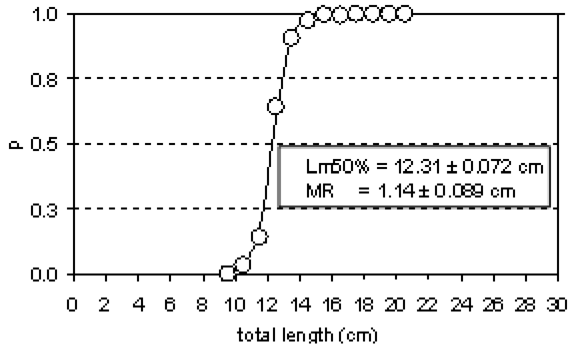
8.25.1.3.Maturity

According to Haidar (1970) females always have an annual reproduction cycle and reach sexual maturity in the first year of life at lengths around 12 cm. According to other literature data the size at first maturity for females is in the range 10-14 cm (AdriaMed website).

According to the data obtained in the DCR, the proportion of mature females (specimens belonging to the maturity stage 2 onwards) by length class is reported in the table below together with the maturity ogive estimated by a maximum likelihood procedure which indicates a $L_{m50\%}$ of about 12.3 cm (±0.072 cm) and a maturity range ($MR=L_{m75\%}-L_{m25\%}$) of 1.14±0.089 cm.

Tab. 8.25.1.3.1 and Fig. 8.25.1.3.1 Female maturity ogive (MR indicates the difference Lm75%-Lm25%).

CL (cm)	Proportion of mature females
9	0
10	0.032
11	0.141
12	0.642
13	0.906
14	0.976
15	0.996
16	0.995
17	1
18	1
19	1
20	1



The sex ratio from DCR evidenced the prevalence of males in the size class from 9 to 15 cm and from 16 cm onwards the proportion of females was dominant.

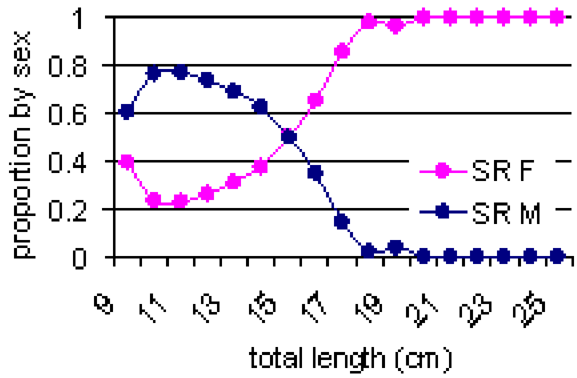


Fig. 8.25.1.3.2 Sex ratio at length for red mullet in GSA 18.

8.25.2.Fisheries

8.25.2.1.General description of fisheries

Red mullet is targeted by of trawlers but also small scale fisheries using gillnets and trammel nets. Fishing grounds are located along the coasts of the whole GSA. In the period from 1989 to 1994, the CPUE in the southern Adriatic was from 0.33 to 2.45 kg/h (EC XIV/298/96-EN, 1996). Red mullet co-occurs with other important commercial species as *Pagellus* sp., *Eledone* sp., *Octopus* sp., *M. merluccius*.

8.25.2.2.Management regulations applicable in 2008 and 2009

Management regulations are based on technical measures, like the number of fishing licenses and area limitation (distance from the coast and depth). In order to limit the over-capacity of the fleet, the Italian fishing licenses have been fixed since the late 1980s. After 2000, in agreement with the European Common Fisheries Policy, a gradual decreasing of the fleet capacity is implemented. Two closed areas were also established in 2004 along the mainland, in front of Bari and in the vicinity of Tremiti MPA on the northernmost part of the GSA. Other measures are mesh size, minimum landing sizes and the minimum distance (or depth) from the coastline (EC Reg. 1967/06). In the GSA 18 the fishing ban has been almost always mandatory since 1988 for a period of 30-45 days, generally during late July-early September.

8.25.2.3.Catches

8.25.2.3.1. Landings

Available landing data are from DCR regulations. SGMED-09-02 received Italian landings data for GSA 18 by major fishing gears which are listed in Tab. 8.25.2.3.1.1. The fishing segments (FT_LVL4) DTS and OTB identify the trawlers (OTB from 2004 onwards), while PGP and PMP indicate respectively small scale fishery (nets) and polyvalents. Also miscellanea (MIS) and pelagic trawlers (PTM) are reported although their contribution to the landings is negligible. Trawlers account for the major of the landing. Since 2002 to 2005 landings of red mullet were continuously decreasing. In 2006 and 2007 the quantities were slightly rising. In 2008 a reduction is observed (Fig. 8.25.2.3.1.1).

Tab. 8.25.2.3.1.1. Annual landings (t) of red mullet in GSA 18, by major gear type, 2002-2008.

Sum of weight (tons)	FT_LVL4								
YEAR	DTS	GNS	GTR	MIS	OTB	PGP	PMP	PTM	Total
2002	3114.2					89.6	1707.3		4911.1
2003	1749.8					312.0	307.8		2369.5
2004		82.5			1981.1			0.01	2063.6
2005		99.3	0.2		1350.0				1449.5
2006		123.5	6.3	1.2	1803.5				1934.4
2007		119.8	2.7	0.1	1679.6				1802.2
2008		41.9	4.7		914.4				961.0

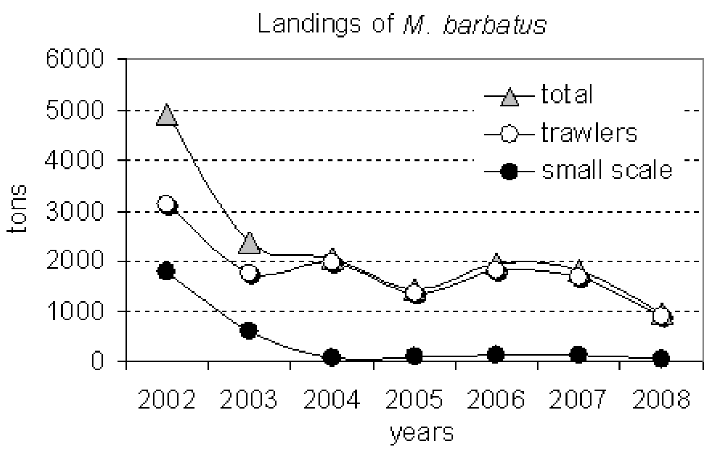


Fig. 8.25.2.3.1.1. Landings (t) of red mullet by year and major gear types, 2002-2008 as reported through DCR in the GSA 18.

8.25.2.3.2. Discards

No information was documented.

8.25.2.3.3. Fishing effort

Available fishing effort data are from DCR regulations. The trends in fishing effort by year and major gear type is listed in Tab. 8.25.2.3.3.1 and shown in Fig. 8.25.2.3.3.1 in terms of kW*days. The fishing segment (FT_LVL4) DTS and OTB, that identify trawlers, and PGP, PMP, GNS, GTR that mainly identify small scale fishery using fixed gears (gillnet and trammel net mainly) were considered for the fishing effort trend because the red mullet is exploited by these fleet segments. The fishing effort in kW*days was declining from 2002 to 2004, whilst since 2004 to 2006 it is slightly rising, decreasing again in 2007. In Fig. 8.25.2.3.3.1 also the ratio between trawlers fishing effort and total fishing effort as in Tab. 8.25.2.3.3.1 is reported. This indicator is increasing from 2002 to 2004, while after it remained almost stable.

Tab. 8.25.2.3.3.1. Trend in fishing effort (kW*days) in the GSA 18, 2002-2007.

	FT_LVL4	Kw*days							
YEAR	DTS	GNS	GTR	MIS	OTB	PGP	PMP	PTM	TOTAL
2002	17112022					1722336	7277279		26111637
2003	14530793					1002933	4416994		19950721
2004	14369490					1180371	351689		15901550
2005		1448541	402155	17234	14372055			1069744	17309730
2006		1515067	144123	32782	14808415			1436018	17936405
2007		1067720	312140	1933	12562033			1773275	15717101

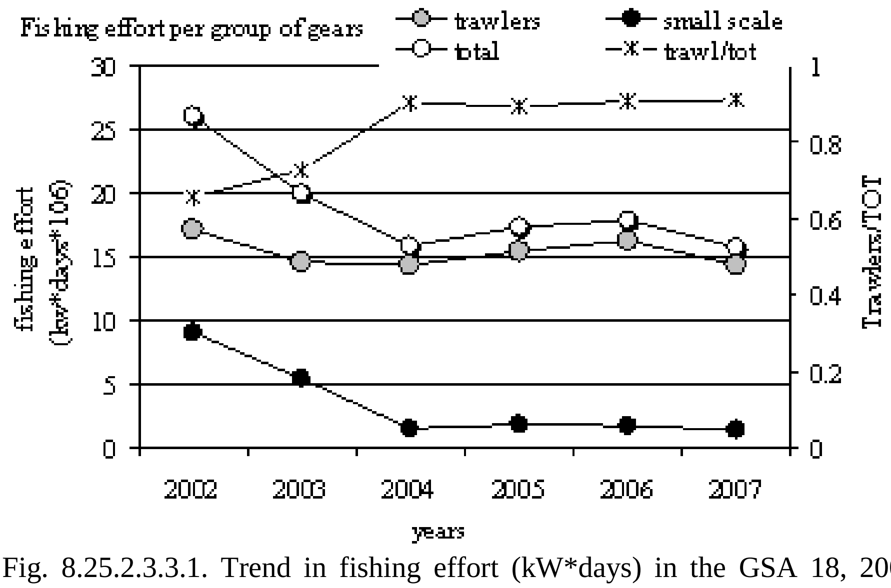


Fig. 8.25.2.3.3.1. Trend in fishing effort (kW*days) in the GSA 18, 2002-2007. Also the ratio between trawlers fishing effort and total fishing effort is shown.

8.25.3. Scientific surveys

8.25.3.1. Medits

8.25.3.1.1. Methods

Trawl surveys were carried out applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area (Bertrand et al., 2002). The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed.

Based on the DCR data call, abundance and biomass indices were calculated. In GSA 18 the following numbers of hauls were reported per depth stratum (Tab. 8.25.3.1.1.1).

Tab. 8.25.3.1.1.1. Number of hauls per year and depth stratum in GSA 18, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA18_010-050	14	15	15	14	14	14	14	15	13	13	12	9	10	11	10
GSA18_050-100	14	14	14	15	15	15	15	14	21	21	23	16	15	15	14
GSA18_100-200	24	23	23	23	23	23	23	23	34	31	32	25	25	23	22
GSA18_200-500	10	10	10	10	10	10	10	10	15	15	16	10	10	9	8
GSA18_500-800	10	10	10	10	10	10	10	10	14	14	14	7	7	7	5

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O’Brien et al. (2004)).

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

8.25.3.1.2. Geographical distribution patterns

The geographical distribution pattern of red mullet in the GSA 18 has been studied using trawl-survey data and geostatistical methods. In these studies the abundance indices of recruits were analysed. Results highlighted a patchy distribution of red mullet juveniles mostly concentrated along the coast of the South Adriatic Sea within 50 m of depth. The areas showing the highest probability and persistency were detected from 1997 to 2002 using cut-offs of 5000 and 10000 N/km2. In particular, the nursery areas distributed along the Gargano peninsula and along the coasts off the area between Molfetta and Brindisi were observed with a probability up to 0.8, within 50 m of depth. Mapping of the red mullet nursery obtained applying the median indicator kriging technique are reported below.

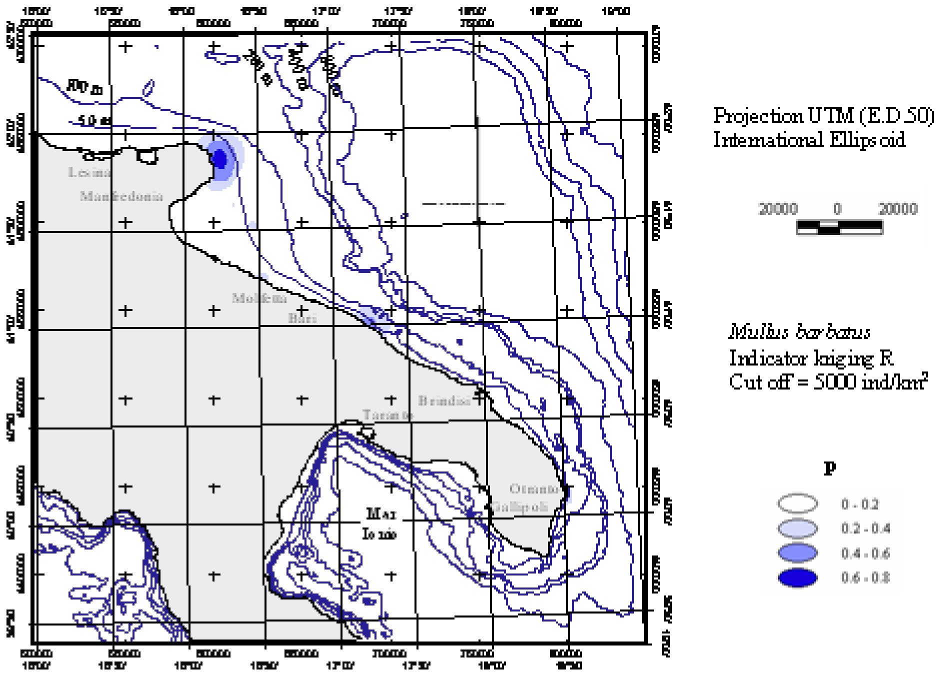
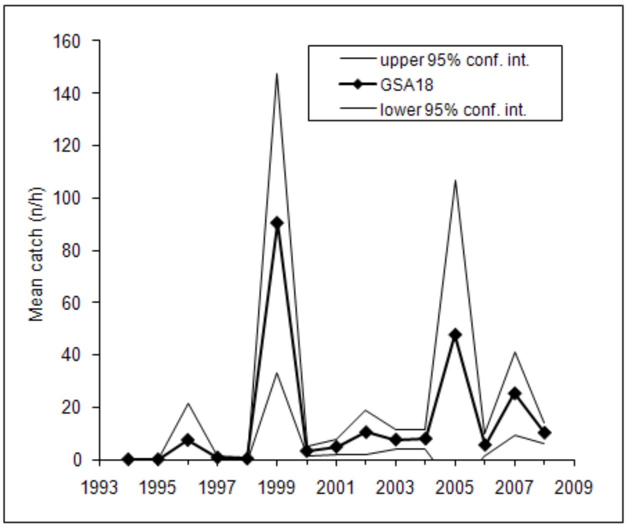


Fig. 8.25.3.1.3 Geographical distribution patterns.

8.25.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in the GSA 18 was derived from the international survey Medits. Figure 8.25.3.1.3.1 displays the estimated trend of red mullet abundance and biomass in GSA 18. Abundance and biomass indices show high interannual variations without a clear trend. However, estimated biomass indices appear at an increased level since 1999.



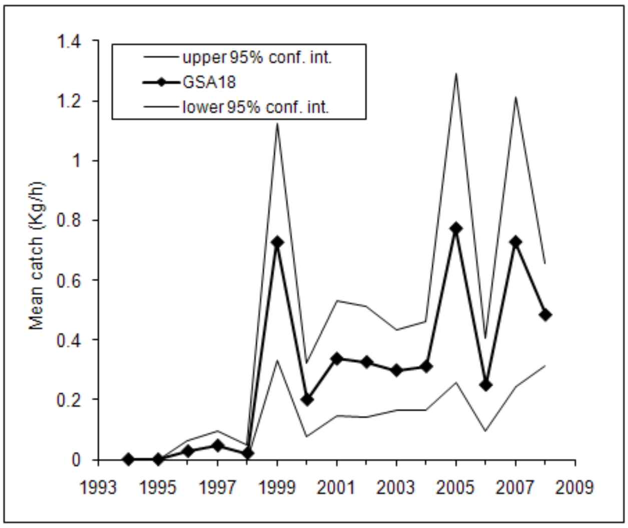


Fig. 8.25.3.1.3.1 Abundance and biomass indices of red mullet in GSA 18.

8.25.3.1.4. Trends in abundance by length or age

The following Fig. 8.25.3.1.4.1 and 2 display the stratified abundance indices of GSA 18 in 1994-2001 and 2002-2008.

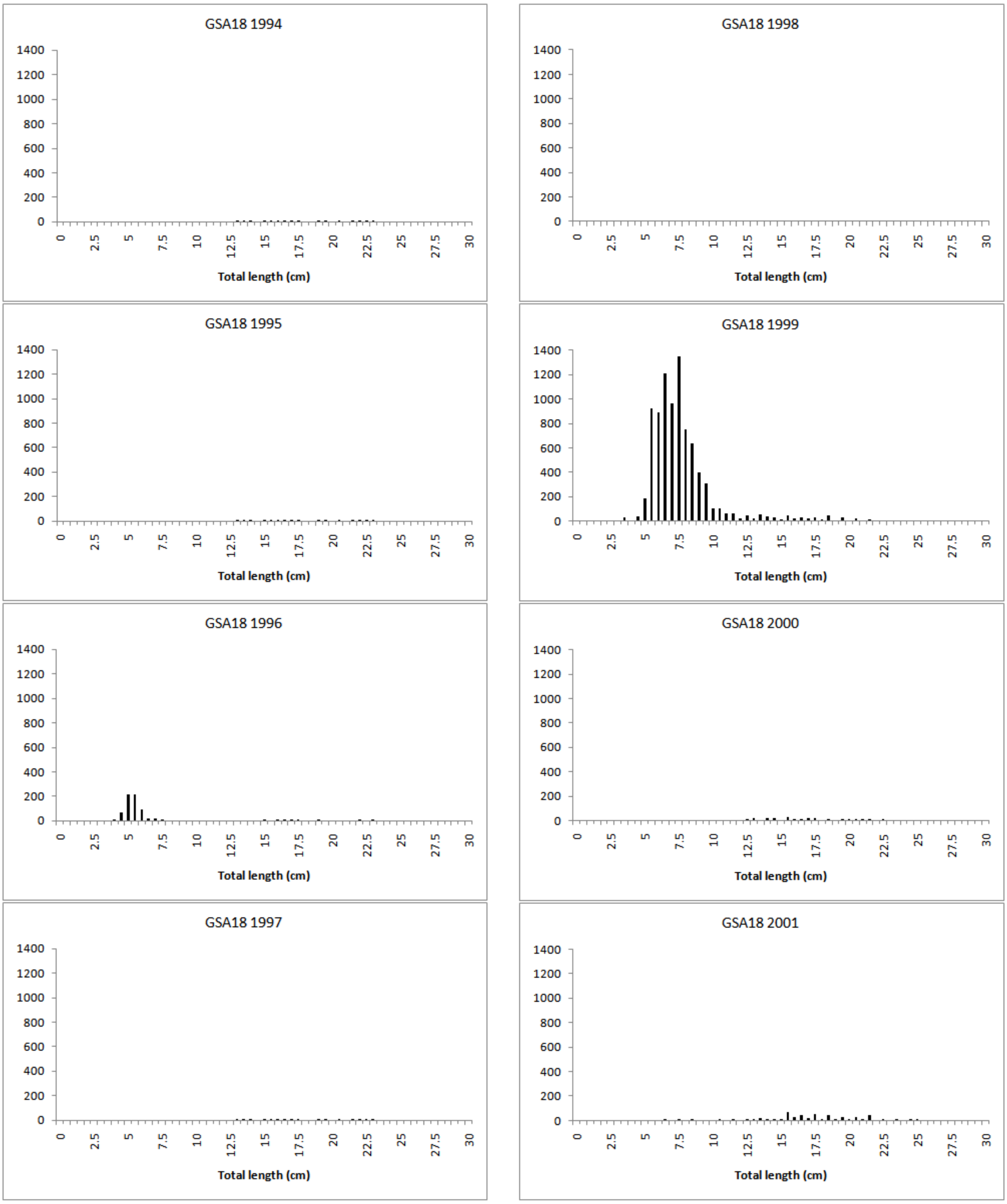


Fig. 8.25.3.1.4.1 Stratified abundance indices by size, 1994-2001.

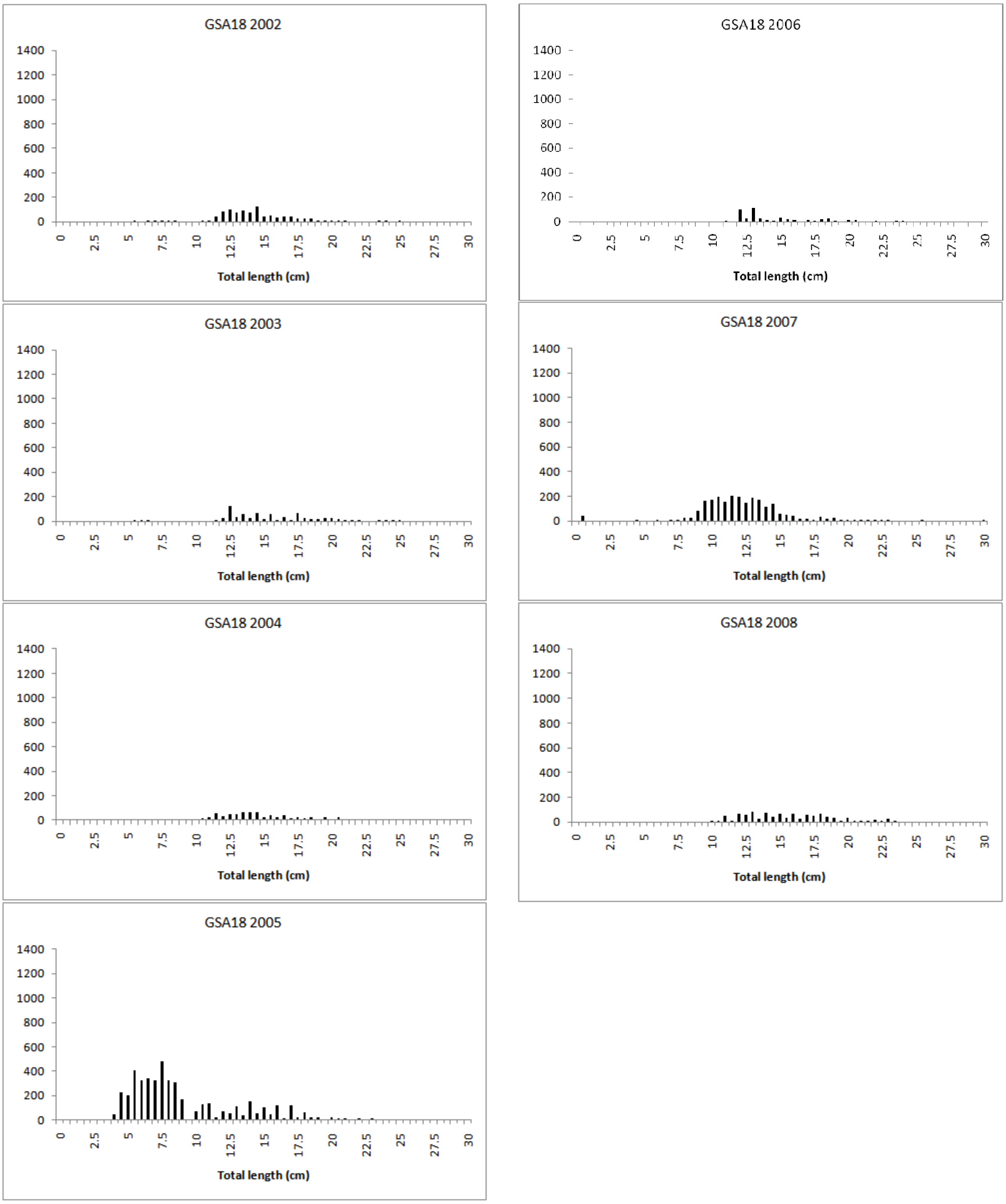


Fig. 8.25.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.25.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.25.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.25.4.Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.25.5.Long term prediction

8.25.5.1.Justification

No forecast analyses were conducted.

8.25.5.2.Input parameters

No forecast analyses were conducted.

8.25.5.3.Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 18.

8.25.6.Scientific advice

8.25.6.1.Short term considerations

8.25.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.25.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.25.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.26. Stock assessment of red mullet in GSA 19

8.26.1. Stock identification and biological features

8.26.1.1. Stock Identification

No information was documented.

8.26.1.2. Growth

The data provided during the meeting refer to von Bertalanffy parameters estimates, and are presented in the following table. The growth parameters agreed for red mullet in other areas are comprised between 25 and 27 cm for L(inf) and 0.3 and 0.5 for K (with negative correlation between both). Considering also other growth parameter estimates and that the maximum length is 24 cm, the following growth parameters have been adopted for assessment: 26, 0.3 and -1.0. With similar criteria the length-weight relationship are 0.007 and 3.17.

Table 8.26.1.2.1 Growth parameters and methods applied.

COUNTRY	GSA	YEAR_PERIOD	SPECIES	SEX	L_INF	K	TO	A	B	METHOD_USED
ITA	19	2003-2005	MUT	F	27.5	0.35	-0.9	0.0068	3.1	otoliths reading
ITA	19	2008	MUT	F				0.005	3.2	
ITA	19	2002-2005	MUT	F	24.5	0.27	-1.9	0.0072	3.2	otoliths reading
ITA	19	2003-2005	MUT	M	20.3	0.6	-0.6	0.0102	3.1	otoliths reading
ITA	19	2008	MUT	M				0.006	3.2	
ITA	19	2002-2005	MUT	M	22.4	0.28	-2	0.009	3.1	otoliths reading
ITA	19	2003-2005	MUT	C				0.0063	3.21	
ITA	19	2008	MUT	C				0.0055	3.2	

8.26.1.3. Maturity

Data available during SGMED-09-02 allow to estimate the maturity ogives, for males and females separately for 2008 and compare them with females in the period 2002-2005. It appears that the length at first maturity (L50%) for females has increased from 10.5 to 11.75 cm.

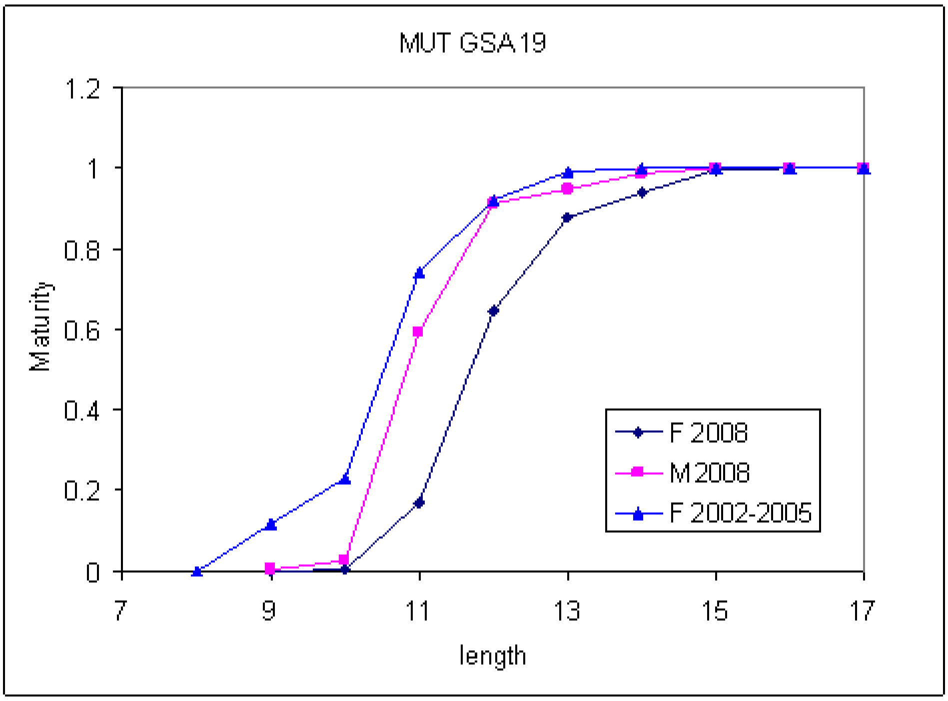


Fig. 8.26.1.3.1 Maturity ogives by sex and years.

Individuals larger than 19 cm are all females, implying sexual dimorphism regarding growth, with the asymptotic length of females larger than males (probably associated with differential natural mortality).

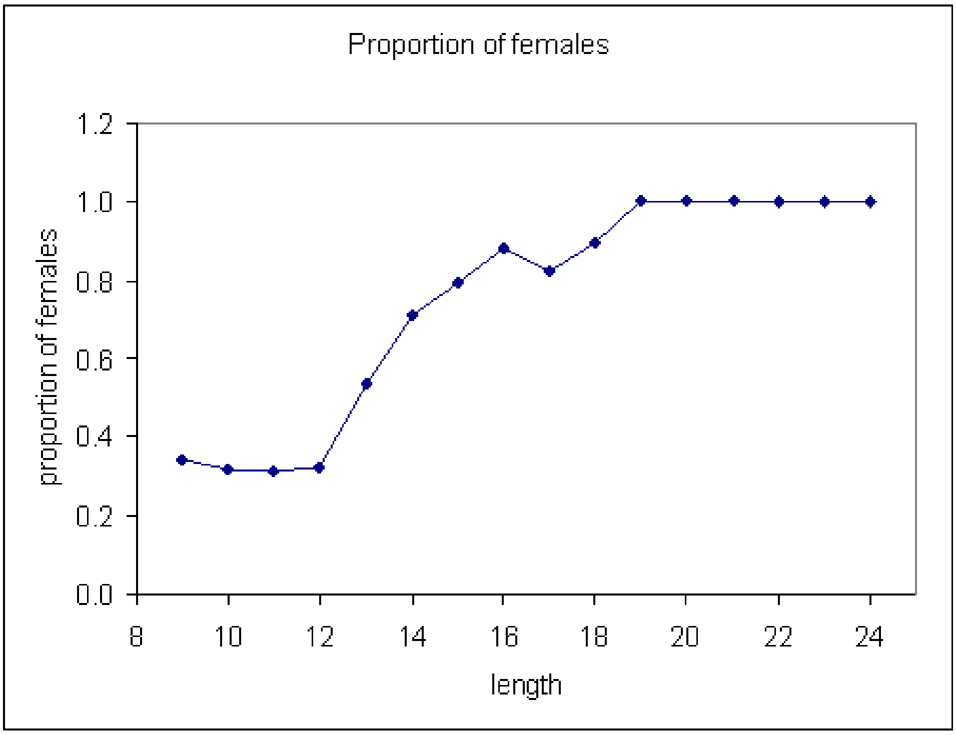


Fig. 8.26.1.3.2 Female maturity ogive.

8.26.2.Fisheries

8.26.2.1.General description of fisheries

STECF in 2007 (stock review part II) noted that red mullet *Mullus barbatus* is among the species with high commercial value. The highest trawl fishing pressure occurs along the Calabrian coast while the presence of rocky bottoms on the shelf along the Apulian coast prevents the fishing by trawling in this sector. The landings in the 2004 in the whole GSA 19 were detected around 321 t coming mainly from bottom trawling and small-scale boats.

8.26.2.2.Management regulations applicable in 2008 and 2009

No information was documented.

8.26.2.3.Catches

8.26.2.3.1. Landings

Tab. 8.26.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.2 of Appendix 3. Since 2003 the annual landings decreased from 2,450 t to only 540 t in 2008. Many geras contributed to the reported landings.

Data on landings are available for 2002 and 2003 according to the file provided by the secretariat during the meeting. However in the report SGME-08-04 part IV there are data from 2002 to 2007. FAO FishStat data on mullets are available from 1970 to 2005.

There are some inconsistencies between the data reported to FAO (Italy, Ionian Sea, MUX –both species mixed) and data reported to STECF for red mullet in GSA 16 and 19. In 2002 and 2003 STECF data are estimated to be twice what reported by FAO while this pattern is reversed in 2004 and 2005.

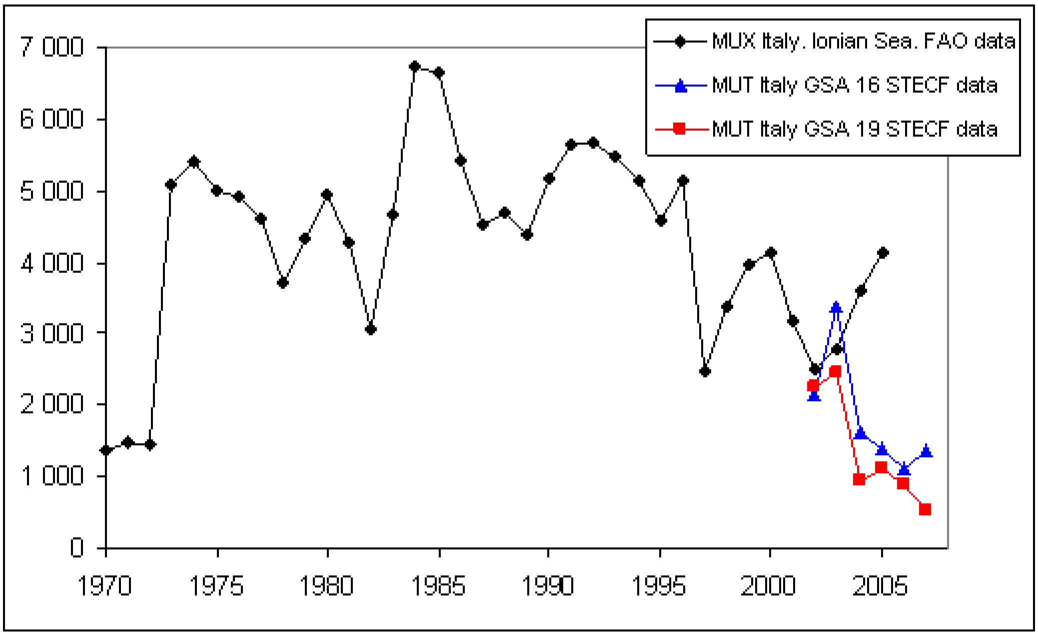


Fig. 8.26.2.3.1.1 Landings in GSAs 16 and 19 combined.

Tab. 8.26.2.3.1.1. Annual landings (t) by fishing technique in GSA 19.

Species	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
MUT	19	ITA	DTS	782	427					
MUT	19	ITA	GNS			52	43	65	55	69
MUT	19	ITA	GTR			535	761	241	190	29
MUT	19	ITA	LLS							1
MUT	19	ITA	OTB			364	298	566	288	348
MUT	19	ITA	PGP	243	1152					
MUT	19	ITA	PMP	1242	870					
Sum				2267	2449	951	1102	872	533	447

To proceed to the analysis we consider PTS and DTS as trawl and PGP and PMP as nets.

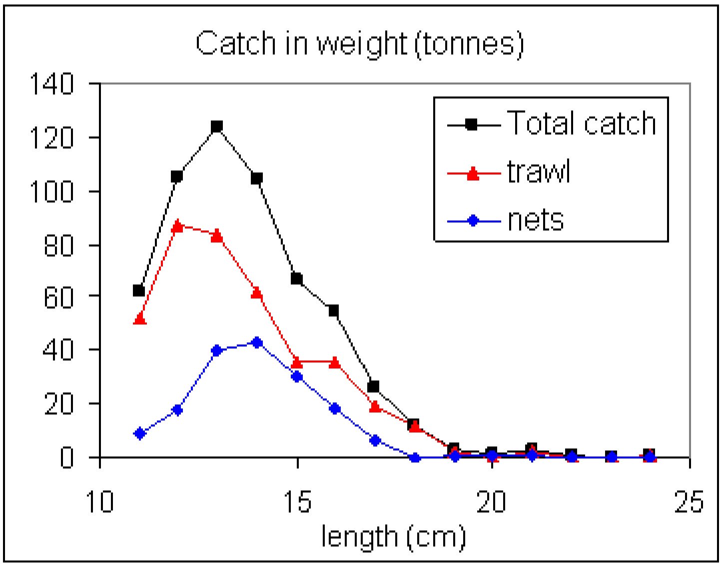


Fig. 8.26.2.3.1.2 Length composition of the landings by gear.

8.26.2.3.2. Discards

7 t of discards in 2005 were reported to SGMED-09-02 through the DCR data call and are listed in Tab. A3.9 of Appendix 3.

8.26.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-09-02 are listed in Table 8.26.2.3.3.1.

Tab. 8.26.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSA 19, 2002-2007. No data provided for 2008.

Unit	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	19	ITA	DRB				1318	3384	3998	
DAYS	19	ITA	DTS	31381	31586	37234				
DAYS	19	ITA	FPO				3189	2925	2473	
DAYS	19	ITA	GND				29731	20736	13328	
DAYS	19	ITA	GNS				49840	83590	73806	
DAYS	19	ITA	GTR				70390	53842	29510	
DAYS	19	ITA	HOK			39190				
DAYS	19	ITA	LHP-LHM				6539	5653	4829	
DAYS	19	ITA	LLD				21034	27841	20451	
DAYS	19	ITA	LLS				19503	12450	14608	
DAYS	19	ITA	LTL				2853	2862	371	
DAYS	19	ITA	MIS				1162	19	168	
DAYS	19	ITA	OTB				41760	45465	39604	
DAYS	19	ITA	PGP	233718	254881	225109				
DAYS	19	ITA	PMP	100208	122225	20325				
DAYS	19	ITA	PS				11984	9365	6768	
DAYS	19	ITA	PTM					150		
DAYS	19	ITA	PTS	3458	7302	6605				
DAYS	19	ITA	SB-SV				19427	24848	20184	
DAYS	19	ITA	DRB				1318	3384	3998	
DAYS	19	ITA	DTS	31381	31586	37234				
DAYS	19	ITA	FPO				3189	2925	2473	
DAYS	19	ITA	GND				29731	20736	13328	
DAYS	19	ITA	GNS				49840	83590	73806	
DAYS	19	ITA	GTR				70390	53842	29510	
DAYS	19	ITA	HOK			39190				
DAYS	19	ITA	LHP-LHM				6539	5653	4829	
DAYS	19	ITA	LLD				21034	27841	20451	
DAYS	19	ITA	LLS				19503	12450	14608	
DAYS	19	ITA	LTL				2853	2862	371	
DAYS	19	ITA	MIS				1162	19	168	
DAYS	19	ITA	OTB				41760	45465	39604	
DAYS	19	ITA	PGP	233718	254881	225109				
DAYS	19	ITA	PMP	100208	122225	20325				
DAYS	19	ITA	PS				11984	9365	6768	
DAYS	19	ITA	PTM					150		
DAYS	19	ITA	PTS	3458	7302	6605				
DAYS	19	ITA	SB-SV				19427	24848	20184	
KW*DAYS	19	ITA	DRB				7389	15175	36099	
kW*days	19	ITA	DTS	5125805	5002396	5802023				
KW*DAYS	19	ITA	FPO				57394	57121	56482	
KW*DAYS	19	ITA	GND				1185580	1388194	1130531	
KW*DAYS	19	ITA	GNS				1046673	1475918	1510335	
KW*DAYS	19	ITA	GTR				1818750	1347016	928503	
kW*days	19	ITA	HOK			6809150				
KW*DAYS	19	ITA	LHP-LHM				29910	160904	36015	
KW*DAYS	19	ITA	LLD				6607539	4495795	4304257	
KW*DAYS	19	ITA	LLS				724710	541247	670291	
KW*DAYS	19	ITA	LTL				159527	177770	20433	
KW*DAYS	19	ITA	MIS				26652	1760	16129	
KW*DAYS	19	ITA	OTB				6256653	6868746	5888163	
kW*days	19	ITA	PGP	4669873	9192254	4881153				
kW*days	19	ITA	PMP	13116917	9143878	1188078				
KW*DAYS	19	ITA	PS				1376127	942578	783035	
KW*DAYS	19	ITA	PTM					12646		
kW*days	19	ITA	PTS	978457	1629677	1105203				
KW*DAYS	19	ITA	SB-SV				510273	699325	584069	

8.26.3.Scientific surveys

8.26.3.1.MEDITS

8.26.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 19 the following number of hauls were reported per depth stratum (s. Tab. 8.26.3.1.1.1).

Tab. 8.26.3.1.1.1. Number of hauls per year and depth stratum in GSA 19, 2002-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA19_010-050	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9
GSA19_050-100	7	8	8	8	8	8	8	8	8	8	8	8	8	9	8
GSA19_100-200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11
GSA19_200-500	16	15	15	15	15	15	15	15	21	21	14	15	14	14	14
GSA19_500-800	31	32	32	32	32	32	32	32	29	29	29	28	29	29	29

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

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

aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.26.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.26.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 19 was derived from the international survey Medits. Figure 8.26.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 19.

The estimated abundance and biomass indices do not reveal any significant trends during 1994-2006. However, the recent abundance and biomass indices in 2007 and 2008 represent the highest values observed in the time series but are subject to high variation.

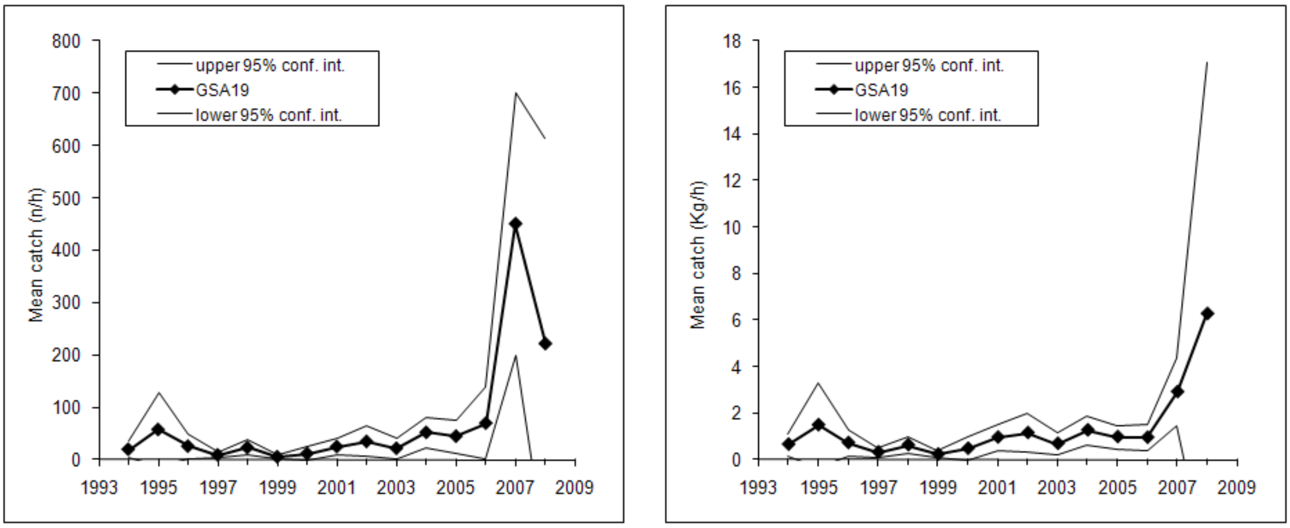


Fig. 8.26.3.1.3.1 Abundance and biomass indices of red mullet in GSA 19.

8.26.3.1.4. Trends in abundance by length or age

The following Fig. 8.26.3.1.4.1 and 2 display the stratified abundance indices of GSA 19 in 1994-2001 and 2002-2008, respectively.

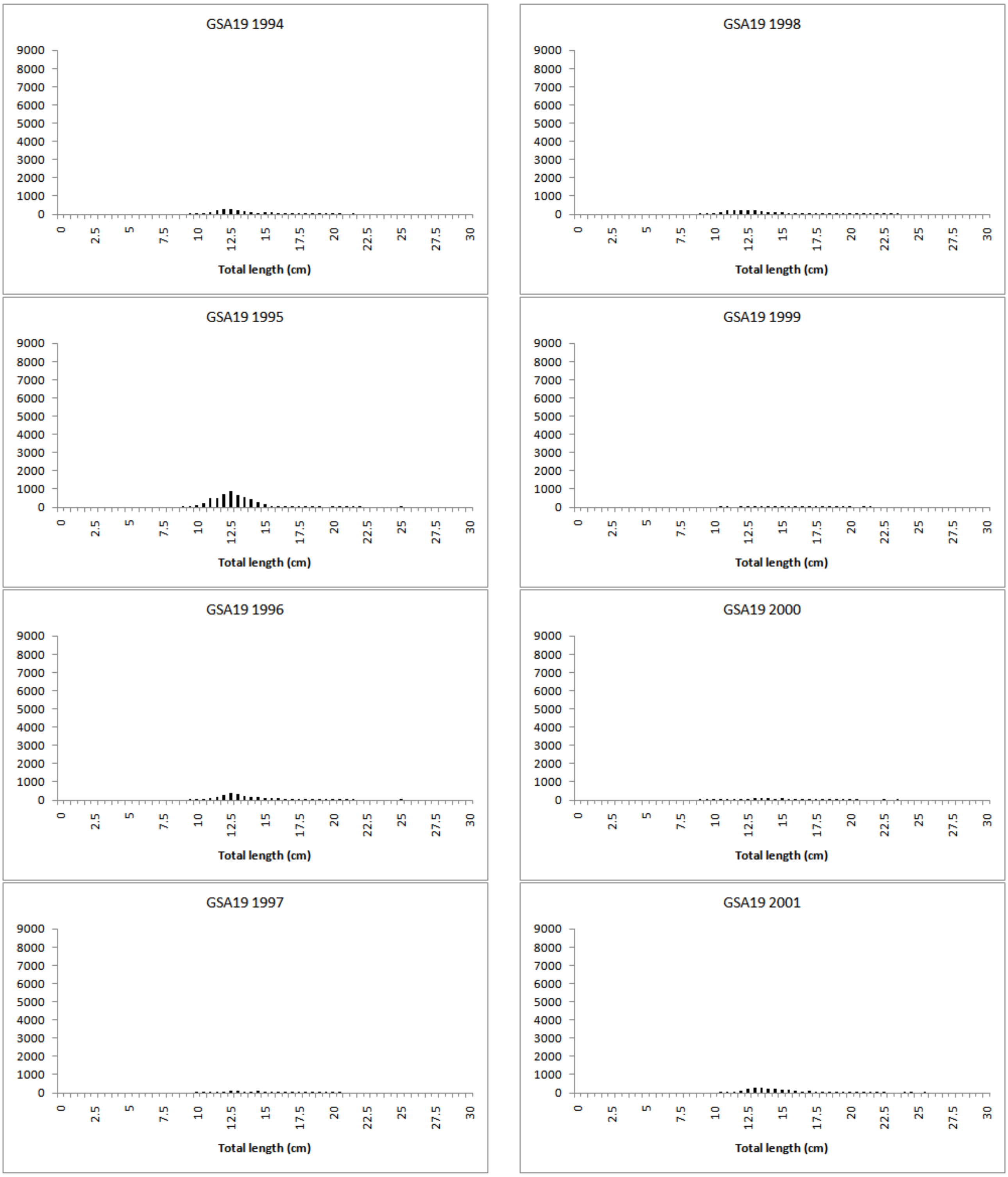


Fig. 8.26.3.1.4.1 Stratified abundance indices by size, 1994-2001.

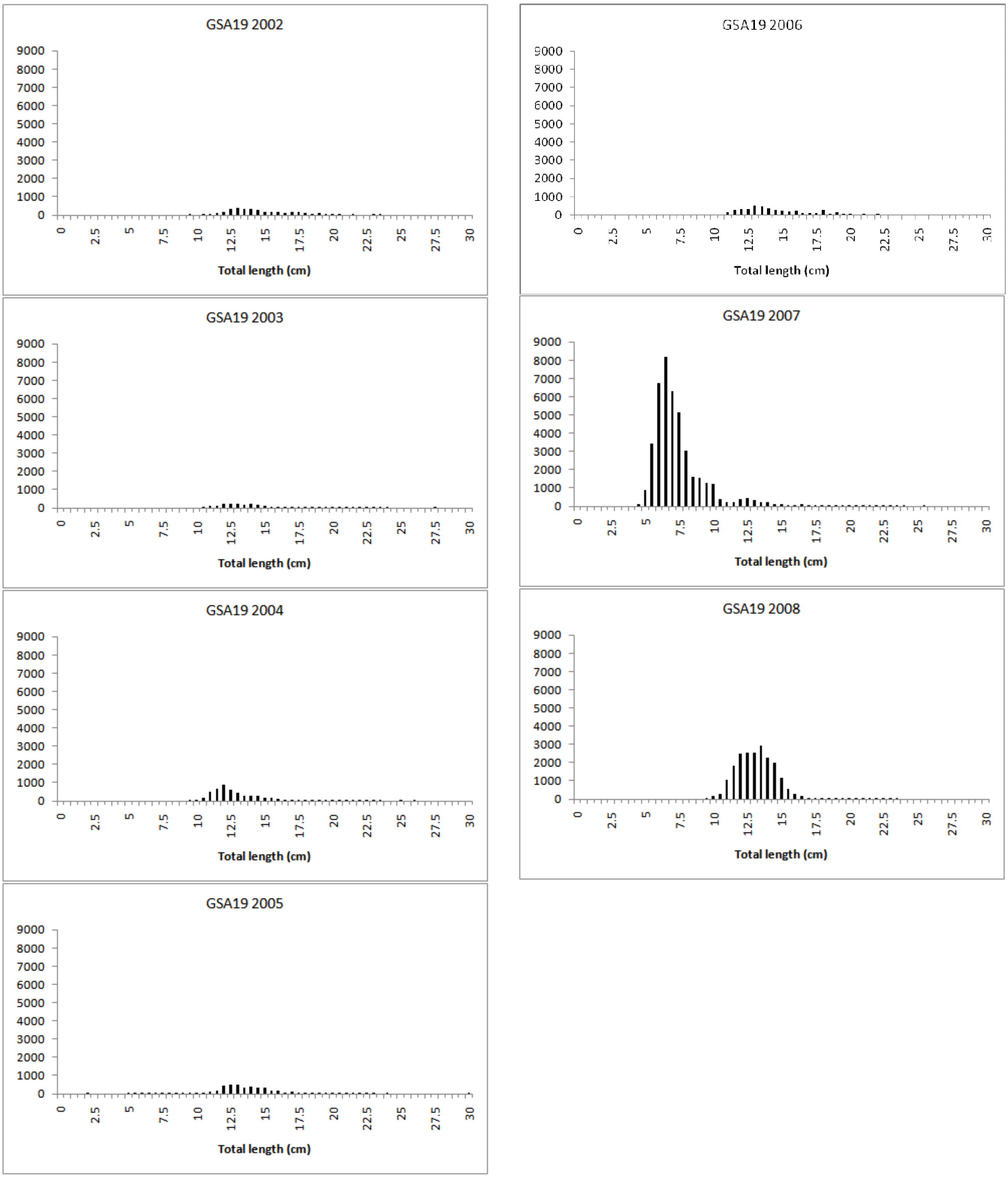


Fig. 8.26.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.26.3.1.5. Trends in growth

No analyses were conducted.

8.26.3.1.6. Trends in maturity

No analyses were conducted.

8.26.4.Assessment of historic stock parameters

8.26.4.1.Method 1: LCA VIT

8.26.4.1.1. Justification

SGMED-09-02 undertook an analytical assessment of this stock by means of Length Cohort Analysis (LCA), using Italian mean length frequency data from 2006 to 2008. Software VIT was used.

8.26.4.1.2. Input Data

Eight VIT runs were performed, using 4 terminal F (i.e. 0.05, 0.01, 0.005 and 0.001) and two different M vectors of decreasing values following a negative exponential function. The mean M were 0.31 and 0.68.

8.26.4.1.3. Results

In Table 8.26.4.1.3.1 a summary of the main indicators from different analyses are presented.

Tab. 8.26.4.1.3.1 VIT resulting parameters.

		M low (mean=0.31)				M high (mean=0.68)			
		F_t				F_t			
indicator	**Unit**	**0.05**	**0.01**	**0.005**	**0.001**	**0.05**	**0.01**	**0.005**	**0.001**
Virgin biomass (VB)*	tonnes	6653	6825	7041	8781	2819	3203	3681	7495
Biomass (B)	tonnes	430	607	827	2579	626	1011	1489	5304
SSB	tonnes	196	354	550	2112	283	580	949	3899
B/VB	%	6%	9%	12%	29%	22%	32%	40%	71%
SSB/B	%	46%	58%	67%	82%	45%	57%	64%	74%
Catch/B	%	130%	93%	68%	22%	90%	56%	38%	11%
Fmean	$Year^{-1}$	0.563	0.382	0.308	0.154	0.382	0.212	0.15	0.05
Fmean (trawl)	$Year^{-1}$	0.405	0.267	0.213	0.106	0.273	0.147	0.104	0.035
Fmean (nets)	$Year^{-1}$	0.158	0.115	0.095	0.048	0.109	0.065	0.046	0.015

* the estimator of Virgin Biomass by VIT is not very reliable

The estimated mortality rates by length are presented in Fig. 8.26.4.1.3.1 (being gear 1 trawl and gear 2 nets).

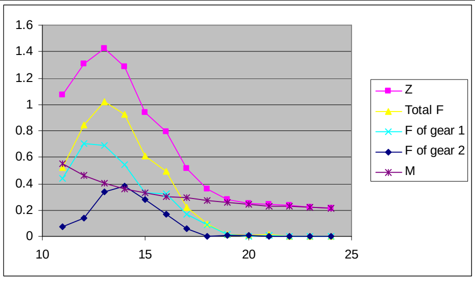
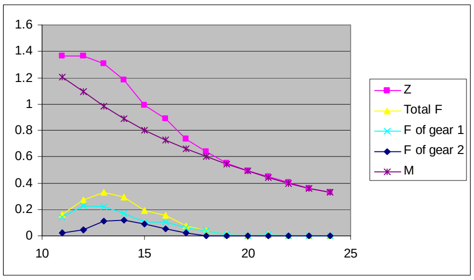
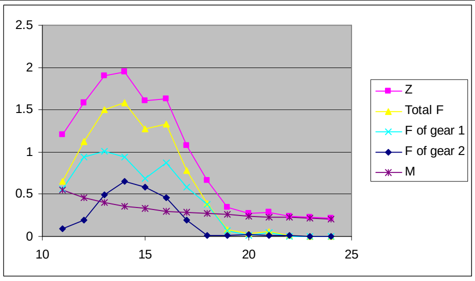
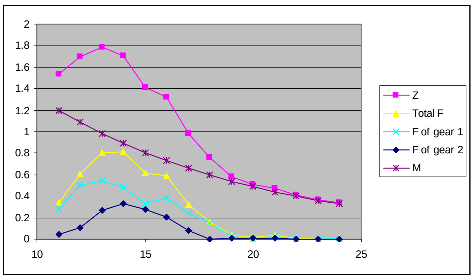
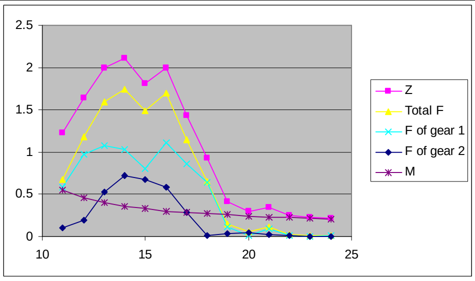
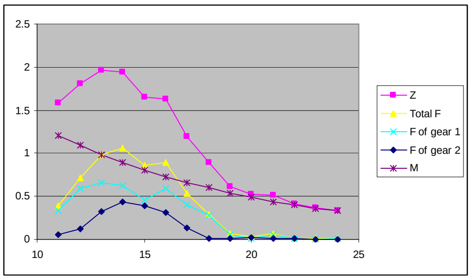
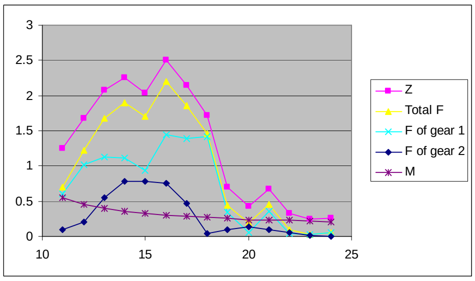
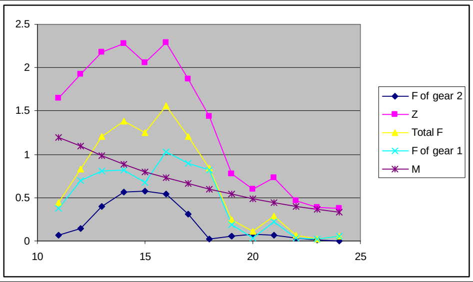
Ft	M low	M high
0.001		
0.005		
0.01		
0.05		

Fig. 8.26.4.1.3.1 Estimated mortalities at length with increasing length.

8.26.5.Long term prediction

8.26.5.1.Justification

A YpR analysis was conducted using the VIT software.

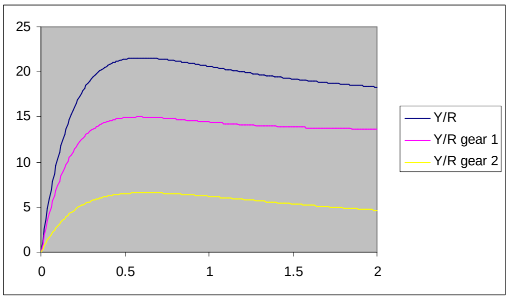
8.26.5.2.Input parameters

VIT data inputs are described above and VIT estimates of exploitation patterns were used.

8.26.5.3.Results

Considering the two extreme cases 1) M low and Ft 0.05, and 2) M high and Ft 0.001 the Y/R analysis shows even in the most pessimistic case (1) a low growth overexploitation. This is due to the “good” selectivity of the gears, especially trawl (no catch of individuals smaller than 11 cm) which is not reliable.

• M low Ft 0.05	• M high Ft =0.001



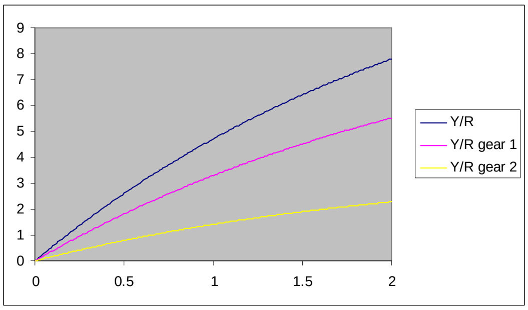


Fig. 8.26.5.3.1 Resulting YpR curves for 2 extreme input scenarios.

Given the catch data deficiencies SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 19.

8.26.6.Scientific advice

8.26.6.1.Short term considerations

8.26.6.1.1. State of the spawning stock size

Survey indices show significant abundance increases in 2007 and 2008. SGMED-09-02 is unable to fully evalute the stock status due to a lack of estimated target and precautionary levels of SSB.

8.26.6.1.2. State of recruitment

SGMED 09-02 notes that the recruitment in 2007 was exceptionally high resulting in stock size increases in 2007 and 2008.

8.26.6.1.3. State of exploitation

SGMED-09-02 is unable to fully evalute the stock status due to a lack of estimated target and precautionary levels of SSB. Significant landings data deficiency makes the results of analytical assessment approaches unreliable.

8.27. Stock assessment of red mullet in GSA 20

8.27.1.Stock identification and biological features

8.27.1.1.Stock Identification

Red mullet is one of the most common and most valuable fish species in Greek Seas. The species is fished by bottom trawl and nets (mainly gill nets) in shallow-mid waters along the Greek coast. The stock is distributed mainly on muddy bottoms along the coast. Its depth distribution is limited in depths less than 200 m. However, is not abundant in water deeper than 150 m. Spawning takes place during spring-early summer. The juveniles of the species are concentrated in shallow waters (10-50 m). Nursery grounds in GSA 20 have been defined along the Western Coast of Peloponnese and Epirus. The stock in GSA 20 is exploited exclusively by the Greek fleet.

8.27.1.2.Growth

No information was documented during SGMED-09-02.

8.27.1.3.Maturity

No information was documented during SGMED-09-02.

8.27.2.Fisheries

8.27.2.1.General description of fisheries

The main fishing gears targeting red mullet in GSA 20 are bottom trawls and gill nets. In some cases, trammel nets are used as well. According to the European and Greek Legislation, bottom trawls operate in waters deeper than 50 m or in a distance 3 miles from the coasts. Thus the gear is targeting the species in waters from the limit (as defined by the legislation) down to 150 m (or deeper but the abundance is not high so red mullet is not the target or one of the target species). Illegal fishing by bottom trawls was very common in the past (in waters less than 50 m or in a distance less than 3 miles) and could be considered as harmful for the species. Large quantities of 0 age specimens, with length 5-9 cm, were caught during autumn. Nowadays, with the use of VMS the situation has been improved significantly but the problem still exists.

There is no depth limit or restriction related to distance from shore for the nets in Greece. However, nets from October to May usually fish at depths <50 m or in a distance <3 miles from the coasts. During summer, when bottom trawl fishery is closed, nets may be used in deeper waters. The mesh size is usually 36-44 mm but there are cases where smaller mesh size (32 or 34 mm) is used. Mesh sizes >36 mm have no important impact on the juveniles. The optimum selection lengths were at 13.5 cm, 15 cm, 16.5 cm and 17 cm for the 34 mm, 38 mm, 42 mm and 44 mm nets respectively (Petrakis, 1998, SELMED Selectivity of fixed nets in Mediterranean EEC contract: 95/C/76/15). There is a clear seasonal pattern of the red mullet net metier, which varies between different areas depending on the abundance of the species and on the availability of other more profitable resources.

8.27.2.2.Management regulations applicable in 2008 and 2009

No specific regulation to manage the species is enforced.

The MLS is 11 cm (according to EE 1967/2006 regulation). The most important measures for managing bottom trawl or net fisheries in Greece have been described in the section 8.14.2.2.

8.27.2.3. Catches

8.27.2.3.1. Landings

Landings of red mullet in GSA 20 for the years 2003-2008 are presented in Tab. 8.27.2.3.1.1.

Tab. 8.27.2.3.1.1 Annual landings (t) by fishing technique as reported to SGMED-09-02 through the DCR data call, 2003-2008.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
MUT	20	GRC	GTR		2104	728	514	432		654
MUT	20	GRC	OTB		164	180	226	154		406
MUT	20	GRC	SB		87	28	37	24		39

8.27.2.3.2. Discards

No discards data were reported to SGMED-09-02 through the DCF data call for Greece.

8.27.2.3.3. Fishing effort

Tab. 8.27.2.3.3.2 lists the effort by fishing technique deployed in GSA 20 as reported to SGMED-09-02 through the DCR data call and listed in Tab. A3.10-3.12 of Appendix 3. A decrease is observed for the main fleet using gill nets.

Tab. 8.27.2.3.3.1 Effort trends by fishing technique deployed in GSA 20, 2003-2008.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	20	GRC	GTR		838891	749522	777934	688042		574268
DAYS	20	GRC	LLS		1212	6333	3843	11810		99755
DAYS	20	GRC	OTB		7810	7296	6279	6682		6753
DAYS	20	GRC	PS		5386	4646	6132	5559		5197
DAYS	20	GRC	SB		13429	11118	10883	11363		12774
GT*DAYS	20	GRC	GTR		3338474	2974825	2949967	2509455		2264227
GT*DAYS	20	GRC	LLS		9110	43698	26517	81492		396520
GT*DAYS	20	GRC	OTB		574443	580133	435054	565011		534692
GT*DAYS	20	GRC	PS		105429	123580	230265	189582		155249
GT*DAYS	20	GRC	SB		83099	65507	58441	57058		75249
KW*DAYS	20	GRC	GTR		33001422	25547517	24809229	19460968		18504513
KW*DAYS	20	GRC	LLS		125676	698284	423729	1302215		3486777
KW*DAYS	20	GRC	OTB		2374841	2359179	1729664	2024955		1800736
KW*DAYS	20	GRC	PS		725384	874064	747375	626335		615159
KW*DAYS	20	GRC	SB		863066	697644	604098	623628		807597

8.27.3. Scientific surveys

8.27.3.1. Medits

8.27.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were calculated. In GSA 20 the following number of hauls was reported per depth stratum (s. Tab. 8.27.3.1.1.1).

Tab. 8.27.3.1.1.1. Number of hauls per year and depth stratum in GSA 20, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA20_010-050	2	2	2	2	4	4	3	3		3	3	3	3		3
GSA20_050-100	3	4	8	7	11	10	11	10		10	10	10	9		10
GSA20_100-200	2	3	4	2	5	6	5	6		6	6	5	6		6
GSA20_200-500	2	3	4	4	7	7	7	8		8	9	8	8		7
GSA20_500-800	3	3	4	3	5	5	5	5		5	4	5	4		6

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.27.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.27.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 20 was derived from the international survey Medits. Figure 8.27.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 20.

The estimated abundance and biomass indices do not reveal any significant trends since 1997 when the indices increased from a lower level. The analyses of Medits indices are considered preliminary.

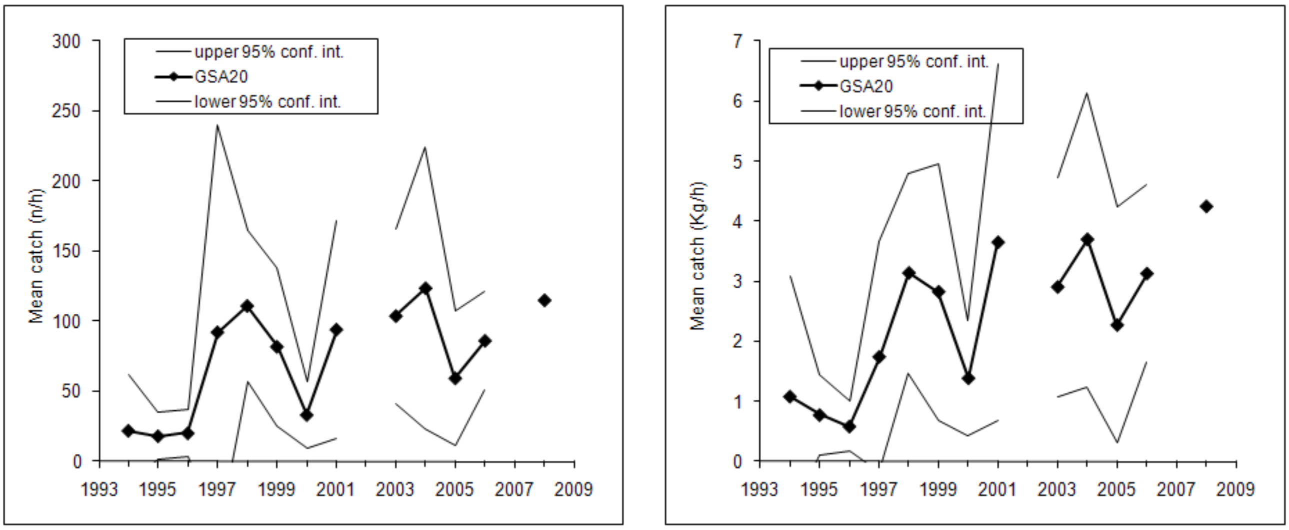


Fig. 8.27.3.1.3.1 Abundance and biomass indices of red mullet in GSA 20.

8.27.3.1.4. Trends in abundance by length or age

The following Fig. 8.27.3.1.4.1 and 2 display the stratified abundance indices of GSA 20 in 1994-2001 and 2003-2008. These size compositions are considered preliminary.

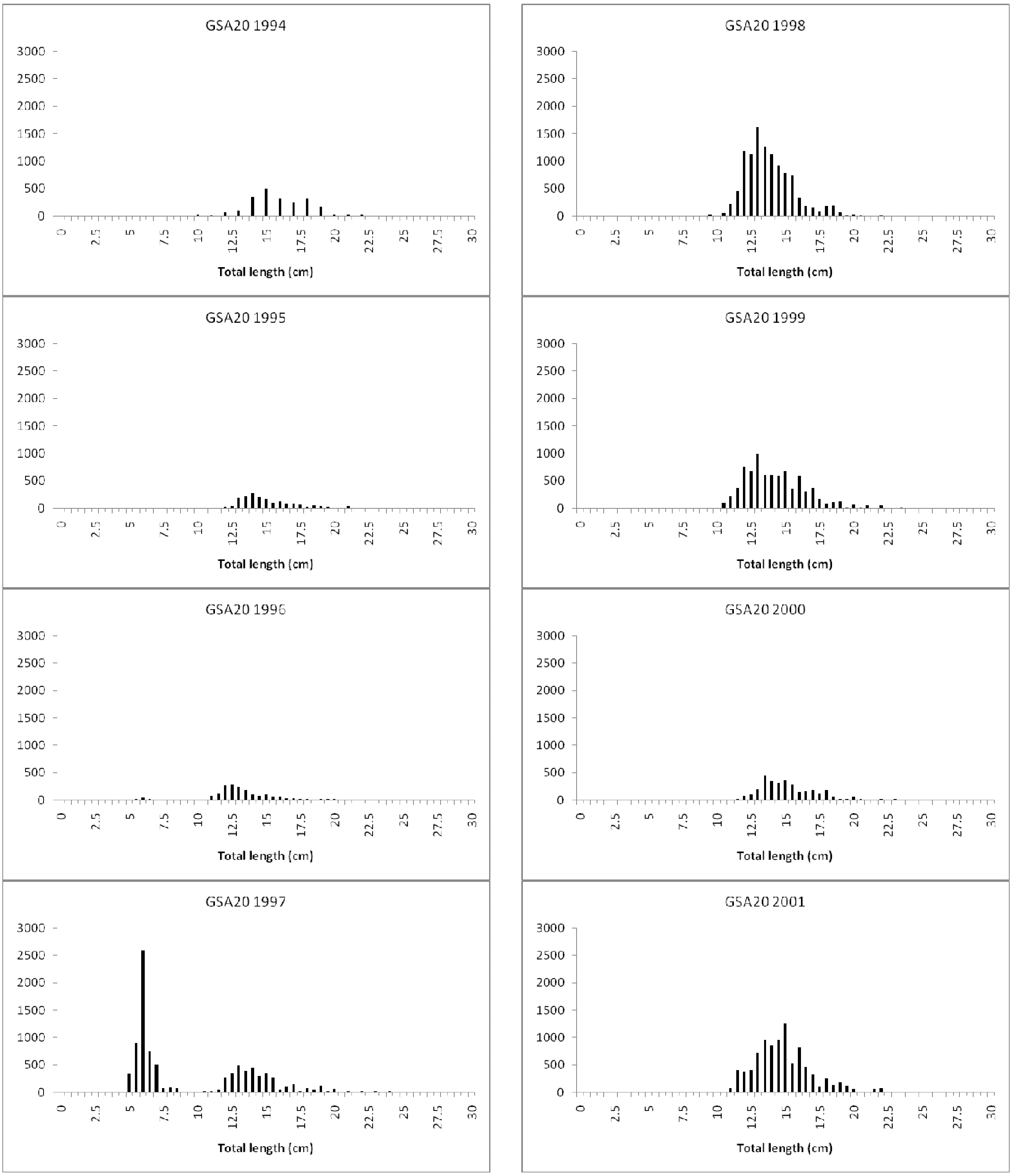


Fig. 8.27.3.1.4.1 Stratified abundance indices by size, 1994-2001.

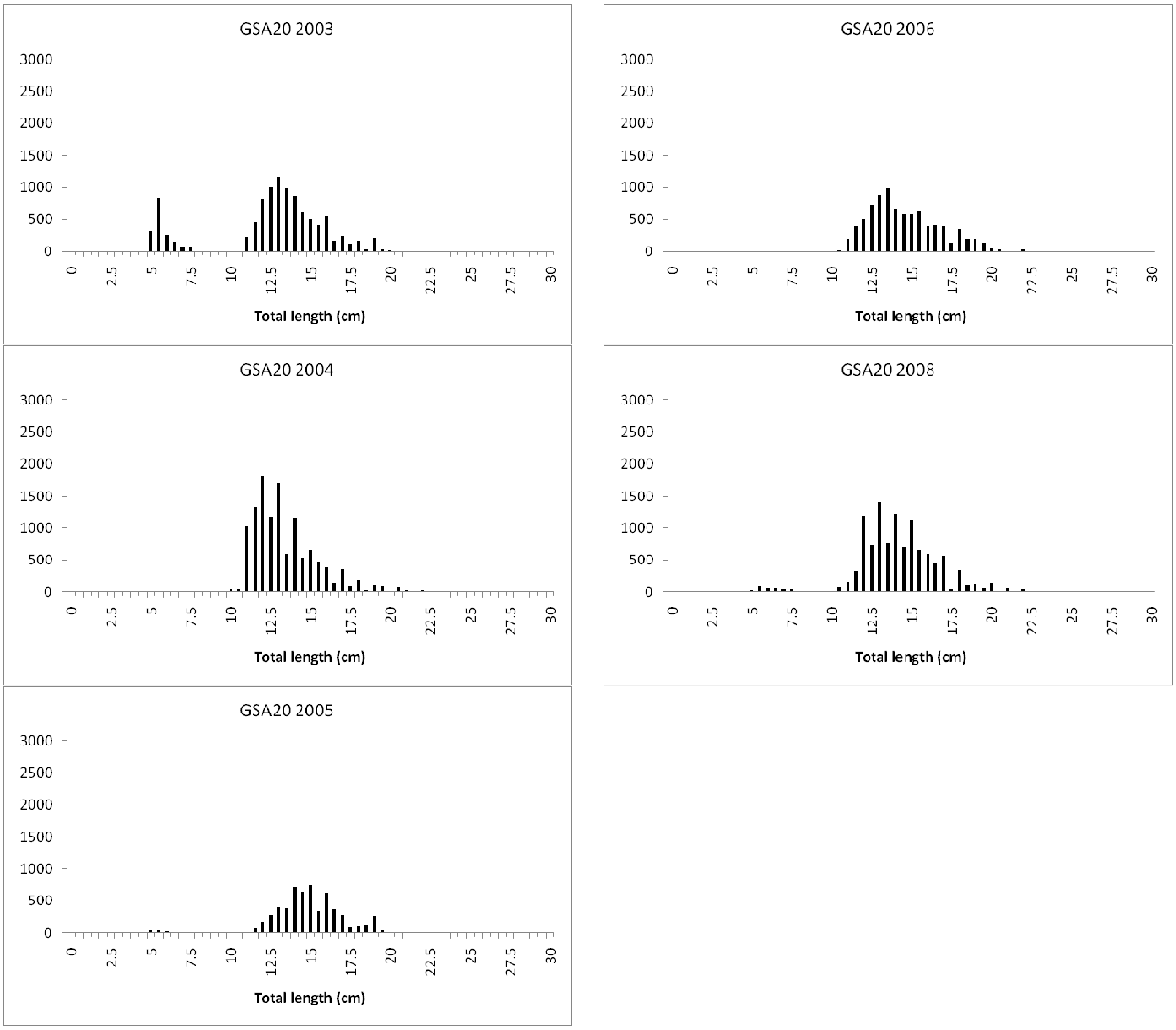


Fig. 8.27.3.1.4.2 Stratified abundance indices by size, 2003-2008.

8.27.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.27.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.27.4. Assessment of historic stock parameters

SGMED 09-02 did not undertake any analytical assessment of red mullet in GSA 20. Last year's preliminary assessment using SURBA can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.27.5. Long term prediction

8.27.5.1. Justification

No forecast analyses were conducted.

8.27.5.2. Input parameters

No forecast analyses were conducted.

8.27.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 20.

8.27.6. Scientific advice

8.27.6.1. Short term considerations

8.27.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.27.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.27.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.28. Stock assessment of red mullet in GSAs 22 and 23 combined

8.28.1.Stock identification and biological features

8.28.1.1.Stock Identification

Red mullet is one of the most common and most valuable fish species in Greek Seas. The species is fished by bottom trawl and nets (mainly gill nets) in shallow-mid waters along the Greek coast. The stock is distributed mainly on muddy bottoms along the coast. Its depth distribution is limited in depths less than 200 m. However, is not abundant in water deeper than 150 m. Spawning occurs during spring-early summer. The juveniles of the species are concentrated in shallow waters (10-50 m). Part of the stock in GSA 22 (in the coasts of eastern Aegean) is exploited by the Turkish fleet.

8.28.1.2.Growth

No information was documented during SGMED-09-02.

8.28.1.3.Maturity

No information was documented during SGMED-09-02.

8.28.2.Fisheries

8.28.2.1.General description of fisheries

The main fishing gears targeting red mullet in GSA 22-23 are bottom trawls and gill nets. In some cases, trammel nets are used as well. According to the European and Greek Legislation, bottom trawls operate in waters deeper than 50 m or in a distance >3 miles from the coasts. Thus the gear is targeting the species in waters from the limit (as defined by the legislation) down to 150 m (or deeper but the abundance is not high so red mullet is not the target or one of the target species). Illegal fishing by bottom trawls was very common in the past (in waters < 50 m or in a distance less than 3 miles) and could be considered as harmful for the species. Nowadays, with the use of VMS the situation has been improved significantly but the problem still exists.

There is not depth limit or distance from the coasts restriction for the nets in Greece. However, the nets from October to May are mainly used in waters <50 m or in a distance <3 miles from the coasts. During summer, when bottom trawl fishery is closed, nets could be used in deeper waters. The mesh size is usually 36-44 mm but there are cases where smaller mesh size (32 or 34 mm) is used. Mesh sizes larger than 36 mm have no important impact on the juveniles. The optimum selection lengths were at 13.5 cm, 15 cm, 16.5 cm and 17 cm for the 34 mm, 38 mm, 42 mm and 44 mm nets respectively (Petrakis, 1998, SELMED Selectivity of fixed nets in Mediterranean EEC contract: 95/C/76/15). There is a seasonal pattern of the red mullet net metier, which varies between different areas depending on the behaviour of the species and on the availability of other more profitable resources.

8.28.2.2.Management regulations applicable in 2008 and 2009

The MLS is 11 cm (according to EE 1967/2006 regulation). The most important measures for managing bottom trawl or net fisheries in Greece have been described in the section 8.14.2.2.

8.28.2.3.Catches

8.28.2.3.1. Landings

Landings of red mullet in GSA 22-23 for the years 2003-2008 are presented in Tab. 8.28.2.3.1.1.

Tab. 8.28.2.3.1.1 Annual landings (t) by fishing technique as reported to SGMED-09-02 through the DCR data call, 2003-2008.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
MUT	22	GRC	FPO							4
MUT	22	GRC	GTR		2366	1127	1589	1687		1028
MUT	22	GRC	OTB		1770	2145	1681	1191		1376
MUT	22	GRC	SB		186	167	286	219		190

8.28.2.3.2. Discards

No discards data were reported to SGMED-09-02 through the DCF data call for Greece.

8.28.2.3.3. Fishing effort

Table 8.28.2.3.3.1 lists the fishing effort reported to SGMED-09-02 through the DCR data call. The overview is given in Tab. A3.10-3.12 of Appendix 3 to this report.

Tab. 8.28.2.3.3.1 Fishing effort in different units by fishing technique deployed in GSAs 22 and 23, 2003-2008.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	22+23	GRC	GTR		2078058	1908626	1993815	1914951		1374948
DAYS	22+23	GRC	LLS		20905	41155	41568	51501		302098
DAYS	22+23	GRC	OTB		52536	53381	56580	53367		51855
DAYS	22+23	GRC	PS		44481	43772	48211	42874		40029
DAYS	22+23	GRC	SB		36266	31987	33200	30098		25138
GT*DAYS	22+23	GRC	GTR		8567144	8034837	7939836	7571041		5309125
GT*DAYS	22+23	GRC	LLS		332005	577572	603419	780138		1244484
GT*DAYS	22+23	GRC	OTB		4927349	4972085	5553804	5556446		5355704
GT*DAYS	22+23	GRC	PS		1998124	1987556	2295466	2108039		1930332
GT*DAYS	22+23	GRC	SB		294896	269645	276265	257271		214985
KW*DAYS	22+23	GRC	GTR		68845607	70633794	70746878	66780942		50244080
KW*DAYS	22+23	GRC	LLS		1888201	4977272	2715667	3848302		7914684
KW*DAYS	22+23	GRC	OTB		15792715	15874762	17730748	16424382		16013057
KW*DAYS	22+23	GRC	PS		9389351	9140980	9656463	8992650		8233643
KW*DAYS	22+23	GRC	SB		2775797	2206815	2193550	2022231		1774864

8.28.3.Scientific surveys

8.28.3.1.Medits

8.28.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were calculated. In GSAs 22 and 23 the following number of hauls were reported per depth stratum (s. Tab. 8.28.3.1.1.1).

Tab. 8.28.3.1.1.1. Number of hauls per year and depth stratum in GSAs 22 and 23, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA22+23_010-050	10	10	11	10	13	12	13	13		13	13	14	14		13
GSA22+23_050-100	19	21	22	28	24	26	21	25		25	23	24	24		27
GSA22+23_100-200	19	26	38	36	36	33	38	35		36	43	41	41		40
GSA22+23_200-500	32	35	45	50	51	54	50	48		51	53	52	52		52
GSA22+23_500-800	18	13	19	22	22	21	20	17		17	17	17	17		17

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

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

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

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

Where:

- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.28.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.28.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSAs 22 and 23 was derived from the international survey Medits. Figure 8.28.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSAs 22 and 23.

After a significant increase in abundance until 1999 and in biomass until 2001, the estimated indices decreased again to a low level in 2005-2006. The analyses of Medits indices are considered preliminary.

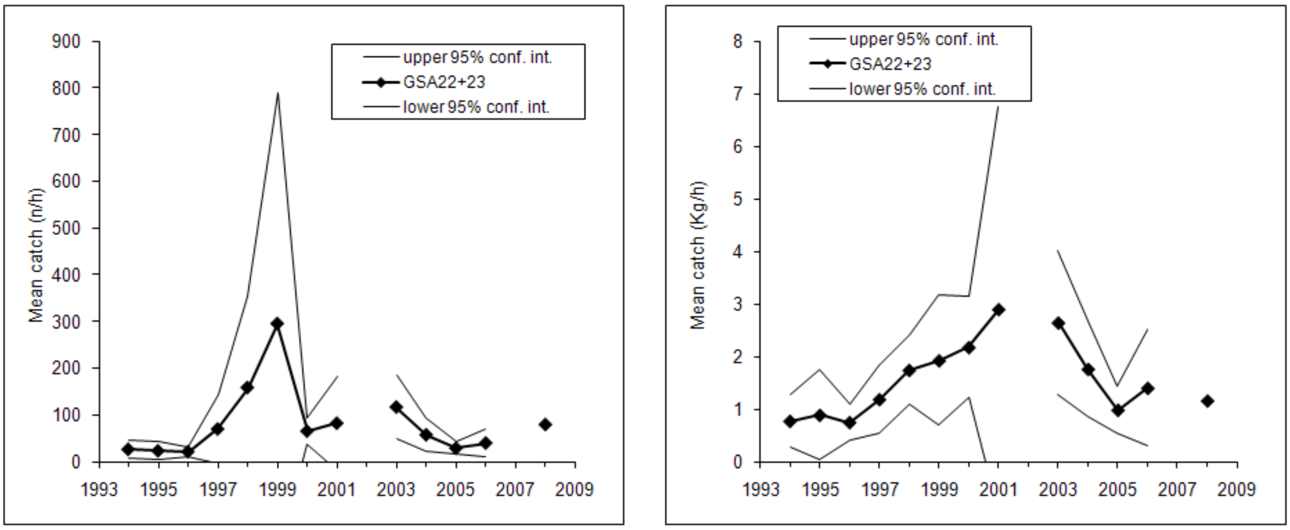


Fig. 8.28.3.1.3.1 Abundance and biomass indices of red mullet in GSAs 22 and 23.

8.28.3.1.4. Trends in abundance by length or age

The following Fig. 8.28.3.1.4.1 and 2 display the stratified abundance indices of GSAs 22 and 23 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

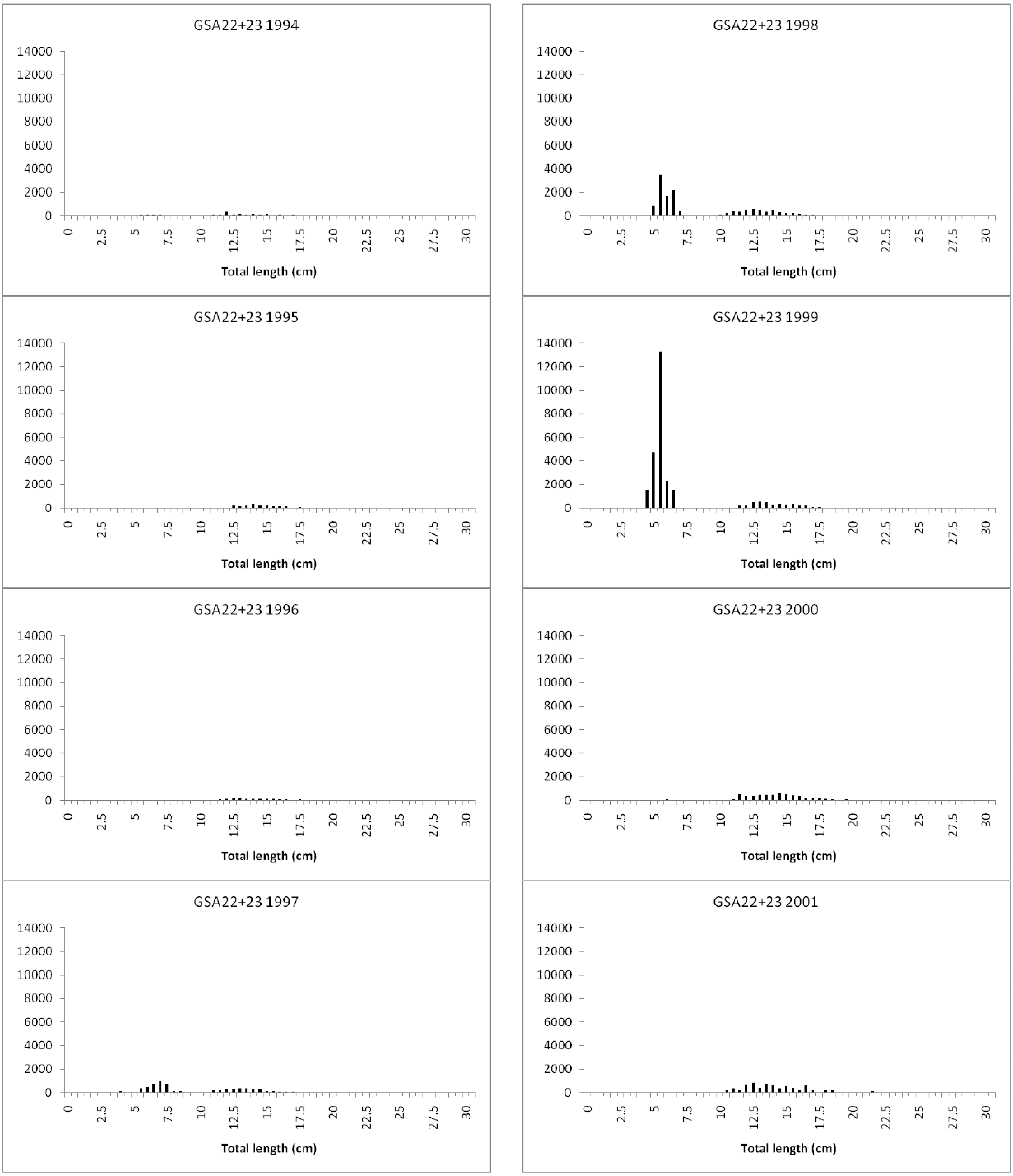


Fig. 8.28.3.1.4.1 Stratified abundance indices by size, 1994-2001.

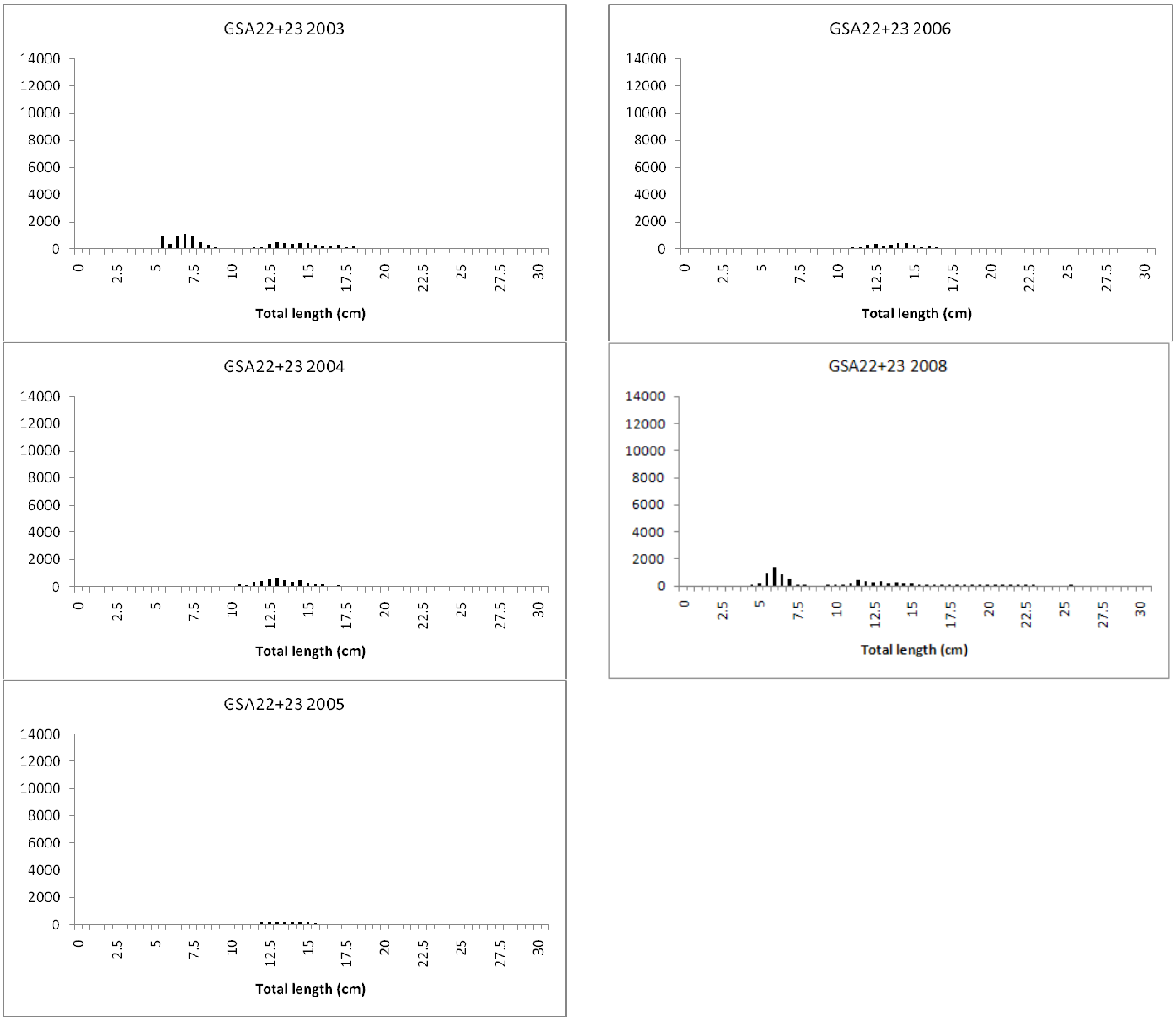


Fig. 8.28.3.1.4.2 Stratified abundance indices by size, 2003-2008.

8.28.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.28.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.28.4.Assessment of historic stock parameters

SGMED 09-02 did not undertake any analytical assessment of red mullet in GSAs 22 and 23. Last year's preliminary assessment using SURBA can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.28.5. Long term prediction

8.28.5.1. Justification

No forecast analyses were conducted.

8.28.5.2. Input parameters

No forecast analyses were conducted.

8.28.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSAs 22 and 23.

8.28.6. Scientific advice

8.28.6.1. Short term considerations

8.28.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.28.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.28.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.29. Stock assessment of red mullet in GSA 25

8.29.1. Stock identification and biological features

8.29.1.1. Stock Identification

Red mullet is a common demersal fish in the Mediterranean Sea, found in depths ranging from 10-200 meters, and mostly distributed in depths less than 100 m. It inhabits sandy and muddy bottoms. The species in GSA 25 is considered as a single stock, though this has not been evidenced by studies on population structure.

8.29.1.2. Growth

The von Bertalanffy growth parameters of red mullet in GSA 25 were estimated using otolith readings; the estimates for sex combined data, for the years 2006-2008, are the following: L_{inf} = 26.61, K=0.183 and t_0=-2.488.

Parameters of the length-weight relationship, related to sex combined data for the years 2006-2008, are: a=0.00797, b = 3.12 (for length expressed in cm).

The data used for the growth parameters were collected under the Cyprus National Data Collection Programme, within the Data Collection Regulation framework, and were provided through the 2009 Spring Official EC Data Call.

8.29.1.3. Maturity

The maturity ogive of the stock (sex combined), as provided through the 2009 Spring Official EC Data Call, is presented in Table 8.29.1.3.1. Data used were collected under the Cyprus National Programme during 2006-2008.

Tab. 8.29.1.3.1: Maturity ogive of *M. barbatus*

TL (cm)	Proportion of mature
7	0.00
8	0.33
9	0.60
10	0.87
11	0.88
12	0.88
13	0.94
14	0.95
15	0.98
16	0.99
17	1.00

8.29.2. Fisheries

8.29.2.1. General description of fisheries

Red mullet in GSA 25 is exploited with other demersal species by the bottom otter trawlers and the artisanal fleet using set nets (basically trammel nets). The main species caught with *M. barbatus* are: *Spicara* spp.

(mostly *S. smaris*), *Boops boops*, *M. surmuletus*, *Pagellus erythrinus* and cephalopods (*Octopus vulgaris, Loligo vulgaris* and *Sepia officinalis*). The artisanal (inshore) fishery catches also relatively large quantities of *Diplodus* spp, *Sparisoma cretense* and *Siganus* spp. The average percentage of *M. barbatus* in the overall landings of the bottom trawl and artisanal fishery, for the period 2005-2008, was 7% and 2% respectively.

The average composition of the landings of the artisanal and the bottom trawl fishery during the period 2002-2006 is provided in Figure 8.29.2.1.1.

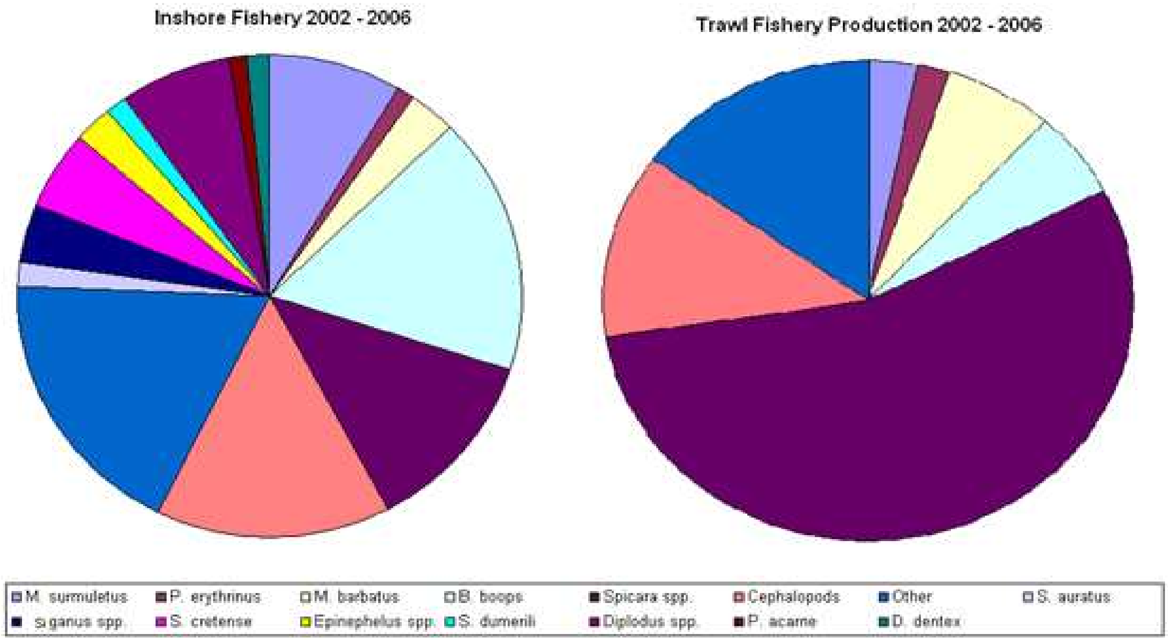


Fig. 8.29.2.1.1. Composition of landings of the artisanal and trawl fishery in Cyprus for the period 2002-2006.

Discards from the bottom otter trawl were evaluated for the first time in 2006, through a pilot study carried out as part of the 2006 Cyprus National Fisheries Data Collection Programme. The study suggested that discard quantities of *M. barbatus* are less than 1% in terms of biomass and 2% in terms of numbers.

Discards from the artisanal fishery are considered negligible.

8.29.2.2.Management regulations applicable in 2008 and 2009

The National and Community legislation provide for a number of management measures for the regulation of the Cyprus fisheries, including:

- Restrictive access to the fisheries (limited number of licenses for each fleet segment).
- Effort control: Restrictions on the use of fishing gears (quantities, soaking time, depth and distance off shore) and regulation of fishing capacity (scrapping, assignment for other uses than fishing, engine restrictions, ceiling of the fleet vessel register).
- Market restriction measures: minimum landing sizes for several species. For red mullet the minimum landing size applied is 11 cm (as set in Regulation (EC) 1967/2006).
- Technical conservation measures: minimum mesh sizes.
- Seasonal and area closures.

For the bottom otter trawl fishery in terrirorial waters (GSA 25) the following management measures were applicable in the last two years (2007-2008):

- Maximum number of licenses restricted to 4.
- Closed trawling period from the beginning of June until the 7th of November (in force since the mid ’80s).

– Minimum mesh size of the trawl net at 40mm (diamond shape). It is noted that from November 2009 the trawl net will be replaced by a square meshed net of 40 mm at the cod-end or by a diamond meshed net of 50 mm, in accordance with the provisions of the new Mediterranean Regulation (EC) No 1967/2006.
– Prohibition of bottom trawling at depths less than 50 meters and at distances less than 0.7 nautical miles off the coast. From November 2008 there is a prohibition of bottom trawling at distances between 0.7 and 1.5 nautical miles in certain areas within the terrirtorial waters, with the intention to fully implement this measure in all territorial waters.

For the artisanal fishery the following management measures were applicable in the last two years:

– Assignment of licensed fishermen in 3 categories, based on their fishing activity and certain criteria.
– Restriction of the maximum number of licenses
– Implementation of the provisions of the Mediterranean Regulation on restrictions on the use of fishing gears. Implementation of additional restrictions on fishing effort (use of fishing gears and number of fishing days) depending on the fishing license category.

8.29.2.3.Catches

8.29.2.3.1. Landings

Figure 8.29.2.3.1.1. provides the official landings of *M. barbatus* in GSA 25 by fishing gear, for the years 1985-2008. The figure presents a declining trend in the landings from both gears, mostly from the trammel nets. For the same period, the overall LPUE by fishing fleet (all gears combined for the artisanal fishery) is provided in same Figure. LPUE of both fleets show a declining trend until 2006; since then, LPUE for the artisanal fleet seems to be stable, while for the bottom trawl fishery LPUE in 2007 reached the highest value of the time period. It is noted that since 2006 the number of licensed bottom trawlers operating in GSA 25 has been reduced by 50% (from 8 to 4).

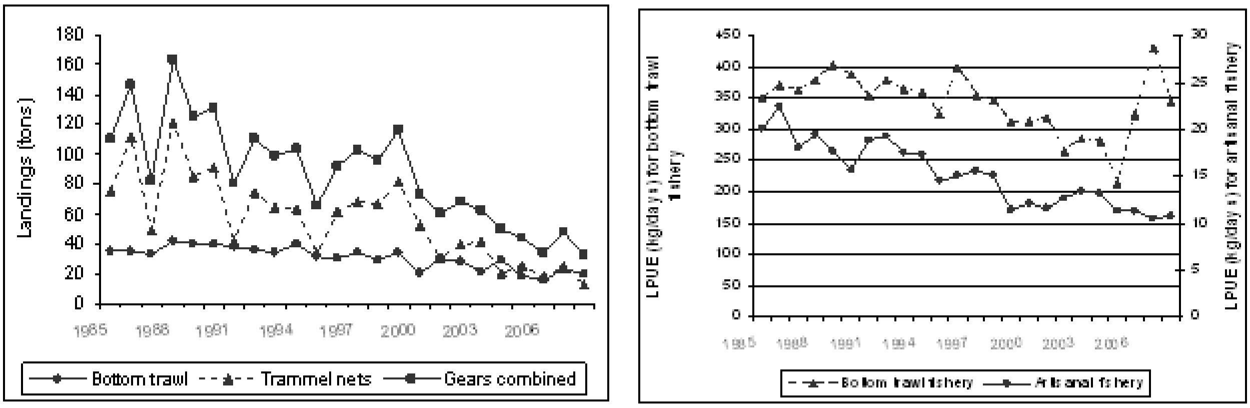


Fig. 8.29.2.3.1.1: Landings and LPUE of *M. barbatus* in GSA 25 by fishing gear for the period 1985-2008.

Data on landings and fishing effort are collected by the Department of Fisheries and Marine Research by the following sources:

- Logbooks (for vessels larger than 12 m)
- Landing declarations/inshore reports (from a 15% sample of licensed vessels less than 12m)
- Sampling of vessels at landing sites (for vessels less than 12m)

Landings data provided through the 2009 Spring Official EC Data Call refer to the years 2005-2008. The length distribution of the landings for this period for each fishing gear, as officially submitted, is provided in Figure 8.29.2.3.1.2.

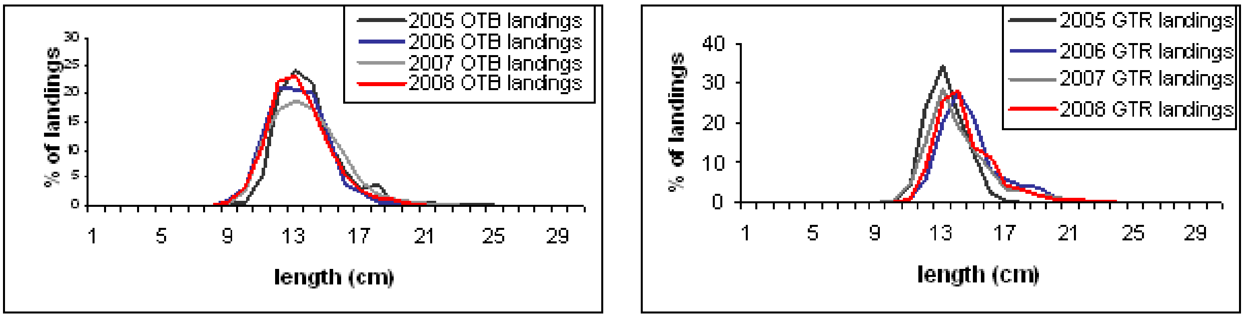


Fig. 8.29.2.3.1.2: Landings length distribution of *M. barbatus* in GSA 25 per fishing gear for the years 2005-2008.

8.29.2.3.2. Discards

The estimation of discards of the species involves on-board sampling of bottom otter trawlers; data are collected under the Cyprus National Data Collection Programme since 2006. Discards from the artisanal fishery is considered negligible.

The discard estimates of *M. barbatus* in terms of weight for 2006 and 2008 were less than 200kg (as provided through the 2009 Spring Official EC Data Call), accounting for about 1% of the total catch of the species. Under the official call, data were also sent on discards length distribution for the year 2008 (provided in figure 8.29.2.3.2.1).

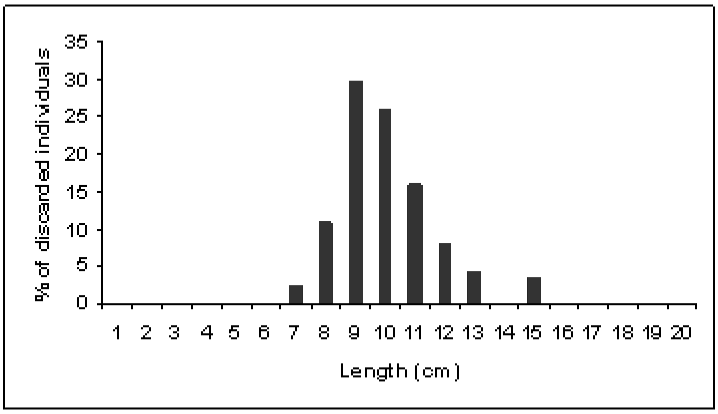


Fig. 8.29.2.3.2.1: Discards length distribution of *M. barbatus* in GSA 25 for the year 2008.

8.29.2.3.3. Fishing effort

Fishing effort data in GSA 25 were provided according to the 2009 Spring Official EC Data Call. Table 8.29.2.3.3.1 lists the reported effort by fishing technique deployed in GSA 25.

Tab. 8.29.2.3.3.1 Effort by métier in GSA 25, 2005-2008.

TYPE	AREA	COUNTRY	FT LVL4	VESSEL LENGTH	2005	2006	2007	2008
DAYS	25	CYP	GTR	VL1224	306	223	178	173
DAYS	25	CYP	GTR	VL0012 (*)	84400	89152	99925	96725
DAYS	25	CYP	OTB	VL1224	1018	726	752	773
GT*DAYS	25	CYP	GTR	VL1224	3236	2354.4	2089	2030
GT*DAYS	25	CYP	GTR	VL0012 (*)	253200	273113	299775	290175
GT*DAYS	25	CYP	OTB	VL1224	94561	72422	75036	77131
KW*DAYS	25	CYP	GTR	VL1224	33559	30453	36746	35714
KW*DAYS	25	CYP	GTR	VL0012 (*)	3271955	3496397	3860088	3736472
KW*DAYS	25	CYP	OTB	VL1224	327617	231816	240182	246889
* : For this vessel length category effort units refer to all passive gears employed by the artisanal fleet								

8.29.3.Scientific surveys

8.29.3.1.Medits

8.29.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 25 the following numbers of hauls were reported per depth stratum (s. Tab. 8.29.3.1.1.1).

Tab. 8.29.3.1.1.1. Number of hauls per year and depth stratum in GSA 25, 2005-2008.

STRATUM	2005	2006	2007	2008
GSA25_010-050	5	5	5	6
GSA25_050-100	8	8	8	9
GSA25_100-200	5	5	5	5
GSA25_200-500	3	3	3	3
GSA25_500-800	4	4	4	4

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

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

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

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

Where:
- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.29.3.1.2. Geographical distribution patterns

Figure 8.29.3.1.2.1. provides the distribution of sampling hauls of the Medits survey in GSA 25. No analyses on geographical distribution patterns were conducted during SGMED-09-02.

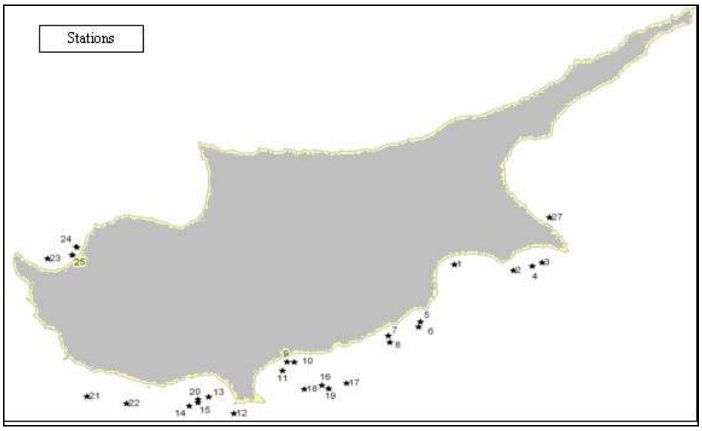


Fig. 8.29.3.1.2.1. Distribution of sampling hauls of the Medits survey in GSA 25.

8.29.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 25 was derived from the international survey Medits. SGMED-09-02 notes that the MEDITS survey covers only the southern and north-western slopes off Cyprus.

Figure 8.29.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 25. The estimated abundance and biomass indices do not reveal any significant trends since 2005 and are subject to high variability (uncertainty). This trend seems to be in agreement with the trend in the landings during the same period (see Figures 8.29.2.3.1.1 and 8.29.4.1.2.2).

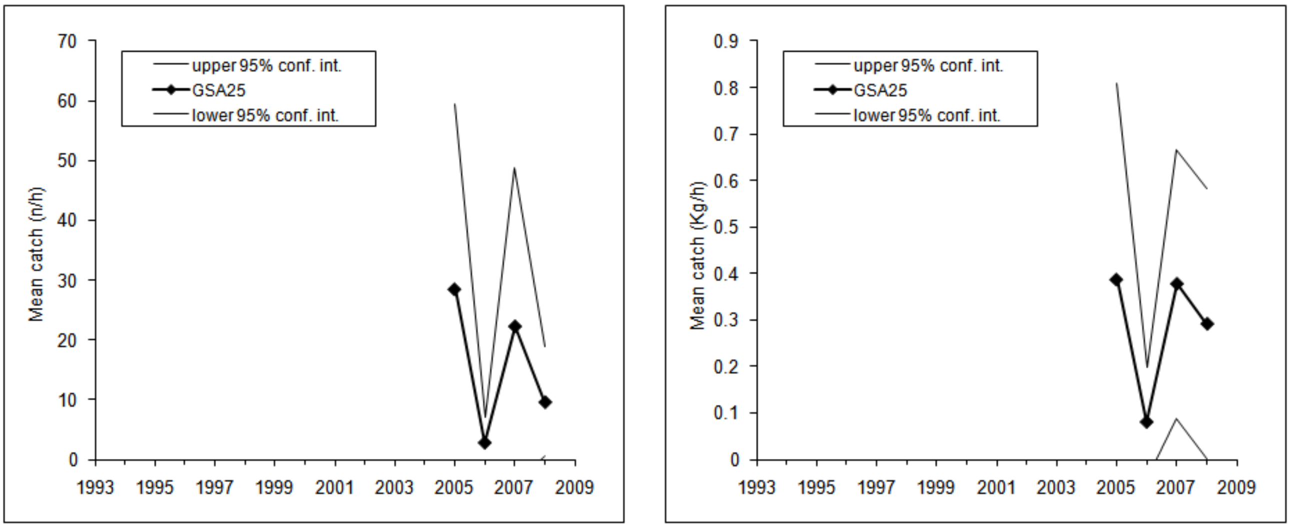


Fig. 8.29.3.1.3.1 Abundance and biomass indices of red mullet in GSA 25.

8.29.3.1.4. Trends in abundance by length or age

The following Fig. 8.29.3.1.4.1 displays the stratified abundance indices of GSA 25 in 2005-2008. These size compositions are considered preliminary.

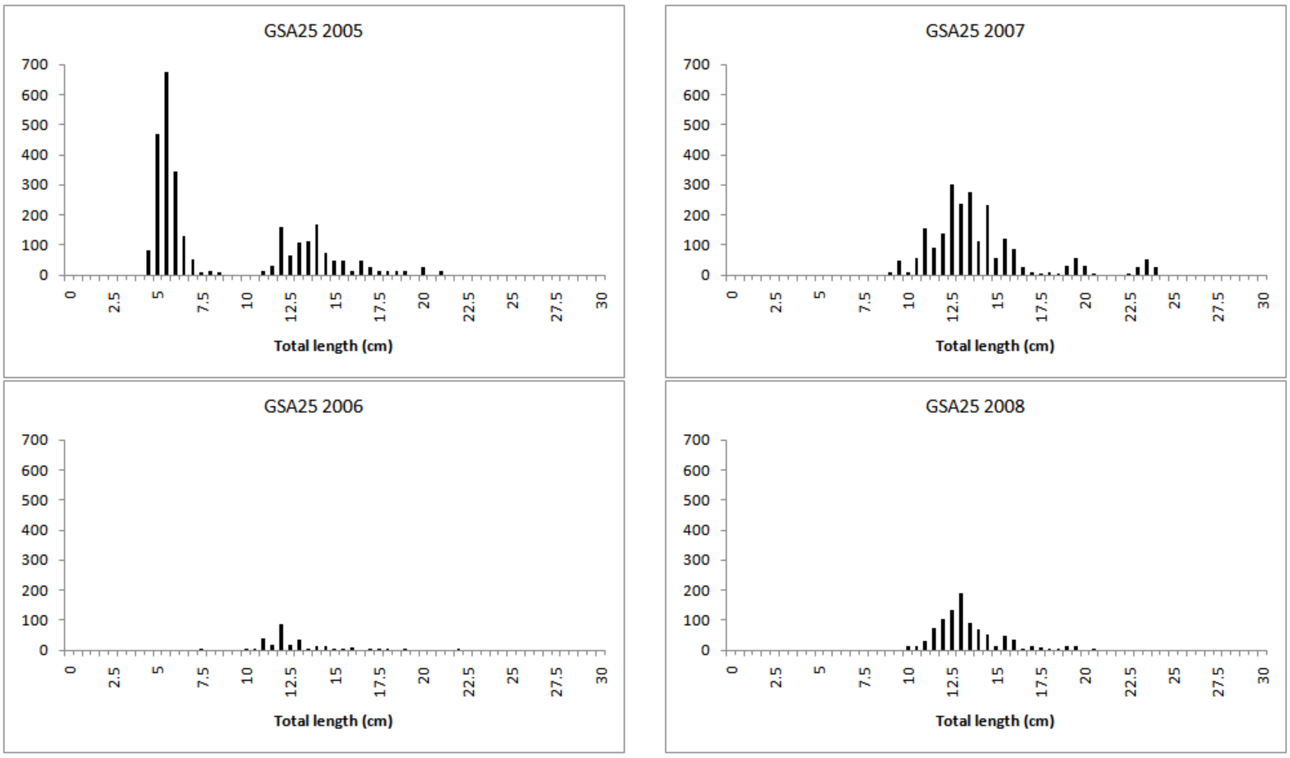


Fig. 8.29.3.1.4.1 Stratified abundance indices by size, 2005-2008.

8.29.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.29.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.29.4. Assessment of historic stock parameters

8.29.4.1. Method 1: VIT

8.29.4.1.1. Justification

Due to the short time data series provided under the DCR Data Call (2005-2008), and the almost equal exploitation of the stock by two fishing gears, the VIT software (Lleonart and Salat, 1992) was considered as the most appropriate software for assessing the stock in GSA 25.

The assessment was performed by means of VPA analysis (running the classic catch equation - Gulland 1965), using a mean pseudo-cohort from catch-at-age data for the period 2005-2008.

8.29.4.1.2. Input parameters

The biological parameters used were the ones collected within the framework of the Cyprus National Data Collection Programme and submitted under the 2009 Spring Official EC Data Call:

- VBGF growth parameters: L_{inf} = 26.61, K=0.183 and t_0= -2.488.
- Length-weight relationship: a = 0.00797, b = 3.12 (for length expressed in cm)
- Maturity ogive by age class (transformed from submitted maturity at length class, as shown in table 8.29.4.1.2.1)

Tab. 8.29.4.1.2.1 Maturity at Age for *M. barbatus* in GSA 25 for the period 2006-2008.

Age	0	1	2	3	4	5	6	7
Prop. Matures	0.465	0.9	0.94	1	1	1	1	1

An M vector was used, as estimated by PRODBIOM spreadsheet (Abella *et al*., 1997) (see Table 8.29.4.1.2.2.).

Tab. 8.29.4.1.2.2 M vector used for the assessment of *M. barbatus* in GSA 25 (estimated by PRODBIOM).

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

During SGMED 09-01 a range of L_{inf} between 27 to 31 cm TL was recommended to be adopted for the estimation of M of the species; since the value of L_{inf} is very close to this range, it was considered realistic. Because of the highly negative value of the parameter t_0, the following two sets of VBGF parameters were also used for estimating the M vector, for comparing the resulting values:

- L_{inf} = 34.5, K=0.34 and t_0= -0.143, proposed by SGMED 08-04 as “Fast” growth parameters
- L_{inf} = 26.01, K=0.41 and t_0= -0.4, proposed by SGMED 08-04 as “Slow” growth parameters.

Figure 8.29.4.1.2.1. provides the estimated M vectors that resulted from the Cyprus and the other two VBGF parameters. As indicated by the figure, the estimated M from the Cyprus parameters is lower than the ones

estimated using the other two sets. The M values used in the final assessment are shown in Table 8.29.4.1.2.2.

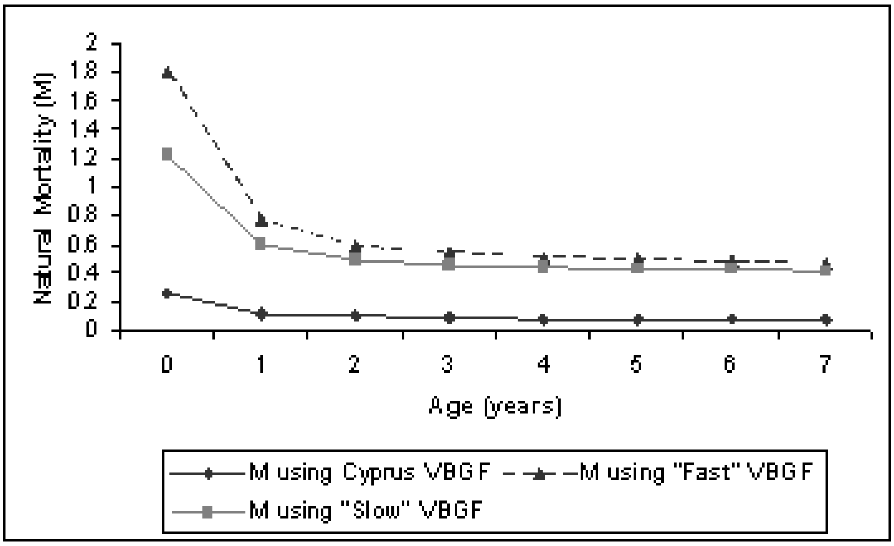


Fig. 8.29.4.1.2.1: M vectors of *M. barbatus* in GSA 25 as estimated by PRODBIOM, using different growth parameters.

Terminal fishing mortality (F_{term}) was set to 0.3. For the estimation of this parameter the length frequency data from the Medits survey (2005-2008) were used for plotting length-converted catch curves of the oldest ages, using the LFDA software (Kirkwood *et al*., 2001).

Catch-at-age data derived from landings for each fishing gear exploiting the stock (bottom otter trawl-OTB and trammel net-GTR), and discards data from bottom otter trawl. The input catch-at-age data are shown in Table 8.29.4.1.2.3.

The mean catch and the relevant percentage by fishing gear was used in terms of weight (g) (see table 8.29.4.1.2.4). The mean catch per gear was calculated using the landings and discards data, submitted under the 2009 Spring Official EC Data Call. Discards data were available only for bottom otter trawl for the years 2006 and 2008; as the discard values for these two years were similar, their average value was used for the years 2005 and 2007. Figure 8.29.4.1.2.2 provides the annual catches (in tons) by fishing gear for the period 2005-2008.

Tab. 8.29.4.1.2.3 Average age structure of *M. barbatus* catches for the period 2005-2008.

Age class	OTB Catch (%)	GTR Catch (%)
0	3.06	0.17
1	44.91	39.33
2	39.84	45.79
3	7.49	8.49
4	3.09	3.97
5	0.86	1.72
6	0.45	0.35
7	0.30	0.18

Tab. 8.29.4.1.2.4 Mean catch of *M. barbatus* for the years 2005-2008.

	Catch (tons)
Bottom Otter Trawl (OTB)	19.41 (49 %)
Trammel net (GTR)	20.21 (51 %)
Total	39.63

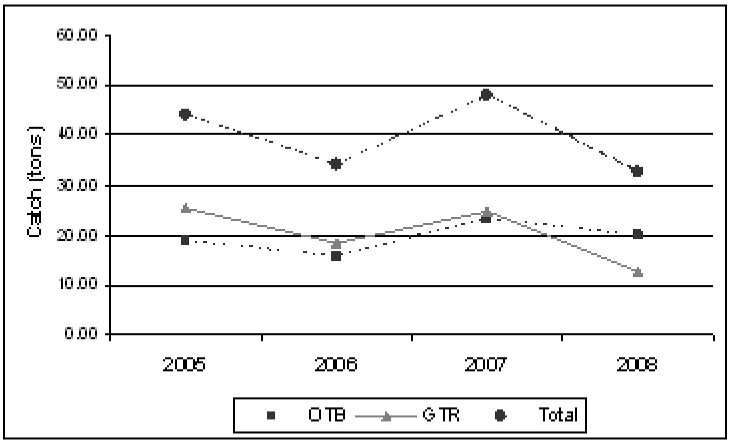


Fig. 8.29.4.1.2.2. Annual catches (t) by fishing gear for the period 2005-2008.

8.29.4.1.3. Results

Table 8.29.4.1.3.1 shows the summary results from the pseudocohort analysis on catch-at-age data, using the VBGF parameters provided by Cyprus under the Official Call. As indicated by the table the two gears show a similar exploitation patter and contribute almost equally to the landings (for the period 2005-2008). Mean age and mean length in the catch are higher (2.2 yr and 15.1 cm) than in the current stock (1.3 yr and 13 cm); figure 8.29.4.1.3.1 also shows that age class 2 is the most exploited age in the population. The estimated value of F_{mean} was 0.566, while $F_{bar\ (1\text{-}3)}$ was estimated at the value of 0.84. The mean biomass at sea was estimated at 71.72 tonnes, which is about double the mean catch for the relevant period.

Tab. 8.29.4.1.3.1 Summary results from pseudocohort analysis for *M. barbatus* in GSA 25, using the official Cyprus VBGF parameters.

	Total	Bottom trawl (OTB)	Trammel net (GTR)
Catch mean age (year)	2.185	2.109	2.262
Catch mean length (TL cm)	15.128	14.969	15.291
Mean F	0.566	0.268	0.297
Global F	0.37	0.187	0.183
F_{bar} (1-3)	0.84	0.41	0.43
Mean Catch (tons)	39.63	19.42	20.21
Catch/D%	79.04	38.73	40.31
Catch/B%	55.26	27.08	28.18
Current Stock Mean Age	1.295		
Current Stock Critical Age	1		
Virgin Stock Critical Age	0		
Current Stock Mean Length	13.037		
Current Stock Critical Length	12.555		
Virgin Stock Critical Length	9.732		
Number of recruits, R (x10^3)	1482.146		
Mean Biomass, B_{mean} (tons)	71.72		
Spawning Stock Biomass, SSB (tons)	58.16		
Biomass Balance, D (tons)	50.14		
Natural death/D (%)	20.96		
B_{max}/B_{mean}	33.63		
Turnover, D/B_{mean}	69.92		

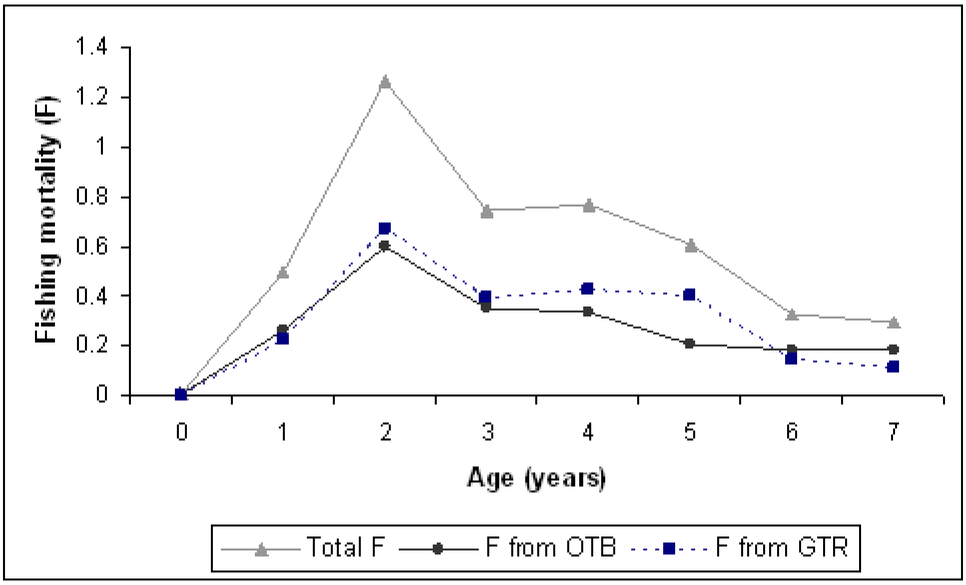


Fig. 8.29.4.1.3.1 Fishing mortality over age for *M. barbatus* in GSA 25 from pseudocohort analysis.

8.29.5.Long term prediction

8.29.5.1.Justification

Y/R analysis was conducted assuming equilibrium conditions, using VIT software.

8.29.5.2.Input parameters

For the analysis the results of VIT (pseudocohort) were used as inputs.

8.29.5.3.Results

Table 8.29.5.3.1 and Figure 8.29.5.3.1 present the results from Y/R analysis.

Tab. 8.29.5.3.1 Y/R results on *M. barbatus* in GSA 25 from VIT software.

Factor φ	B/R	SSB/R	Y/R	Y/R Bottom trawl	Y/R Trammel net
F current (1)	48.388	39.237	26.74	13.102	13.637
$F_{0.1}$ (0.38)	115.7	105.687	27.017	12.811	14.205
F_{max} (0.6)	78.922	69.255	28.4	13.596	14.803
Virgin Biomass (tons)	445.1930957				

Accepting that $F_{current}$ is equal to F_{mean} (=0.566, as estimated by the pseudocohort analysis) then the values of $F_{0.1}$ and F_{max} equal with 0.22 and 0.34 respectively. Furthermore, the results suggest that the current stock biomass (= 71.72 tons, as estimated by the pseudocohort analysis) is 16 % of the virgin stock biomass.

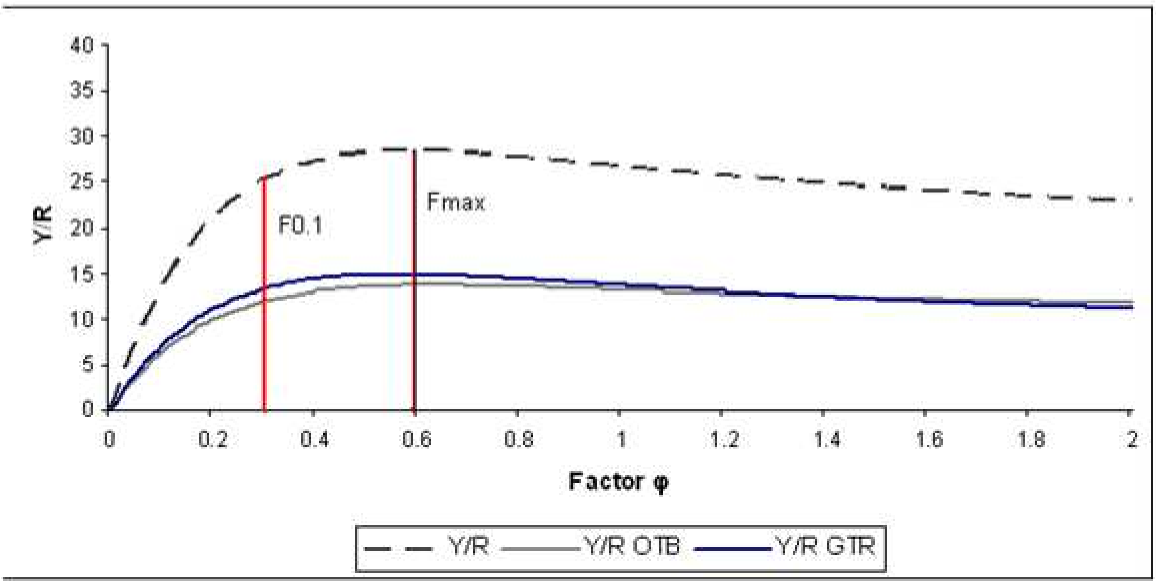


Fig. 8.29.5.1.1 Y/R analysis results.

A sensitivity analysis was carried out for investigating the sensitivity of Y/R results to changes in the input parameters (using the VIT software). Initially an automatic analysis was performed for each parameter with a factor increasing from 0.1 to 0.3. A sensitivity analysis followed on a combination of the VBGF parameters, as the results seem to be sensitive on these parameters. The results from the sensitivity analysis are provided in Table 8.29.5.1.2.

Tab. 8.29.5.1.2 Results from sensitivity analysis by VIT software on *M. barbatus* in GSA 25.

Combined parameters included in sensititivity analysis:				Linf	
				k	
Factor=0.1				t0	
Parameters	**Y/R**	**Biomass**	**SSB**	**Y/R Bottom trawl**	**Y/R Trammel net**
'ooooooooo'	26.74	48.39	39.24	13.1	13.64
'--oooooo'	14.06	24.46	20.2	6.87	7.2
'--+oooooo'	17.33	31.81	25.66	8.5	8.83
'-+-oooooo'	20.8	37.01	30.21	10.18	10.62
'-++oooooo'	25.2	47.41	37.8	12.39	12.81
'+--oooooo'	26.3	45.75	37.77	12.84	13.46
'+-+oooooo'	32.42	59.49	47.99	15.9	16.52
'++-oooooo'	38.91	69.21	56.49	19.05	19.86
'+++oooooo'	47.13	88.66	70.7	23.17	23.96

8.29.6.Scientific advice

8.29.6.1.Short term considerations

8.29.6.1.1. State of the spawning stock size

In the absence of proposed or agreed precautionary refernce points SGMED 09-02 is unable to fully evaluate the status of the spawning stock size. In the current stock assessment no trend in the spawning stock biomass is evident.

8.29.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment as no trend in recruitment is evident.

8.29.6.1.3. State of exploitation

The estimated reference points of $F_{0.1}$ (0.22) and F_{max} (0.34), in relation with the estimated value of $F_{bar\ (1-3)}$ (=0.84), sugggest an overexploitation state of the stock. SGMED 09-02 recommends a reduction in fishing effort of the relevant fleets until sustainable levels of fishing effort are achieved. This shoud be done by means of a multi-annual management plan taking into account mixed fisheries implications.

Given the assessment results, SGMED recommends $F_{0.1}$ of ages 1-3=0.22 be accepted as an approximation of F_{msy} and thus as the target management reference of sustainable exploitation.

8.30. Stock assessment of pink shrimp in GSA 01

8.30.1. Stock identification and biological features

8.30.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.30.1.2. Growth

Two sets of parameters were submitted to the meeting, obtained within the frame of the DCR call. These were for males and females combined, and GSA 01, GSA 05 and GSA 06 also combined. Growth parameters were estimated through length frequency analysis: "Slow" for the period 2005-2008 and "Fast" for the period 2002-2004.

Tab. 8.30.1.2.1 v. Bertalanffy growth parameters for the two options considered, fast and slow growth (data source: DCR).

	Linf (cm)	K	T0	Source
Fast	4.2	0.62	-0.08	Length freq. analysis
Slow	4.5	0.34	-0.06	Length freq. analysis

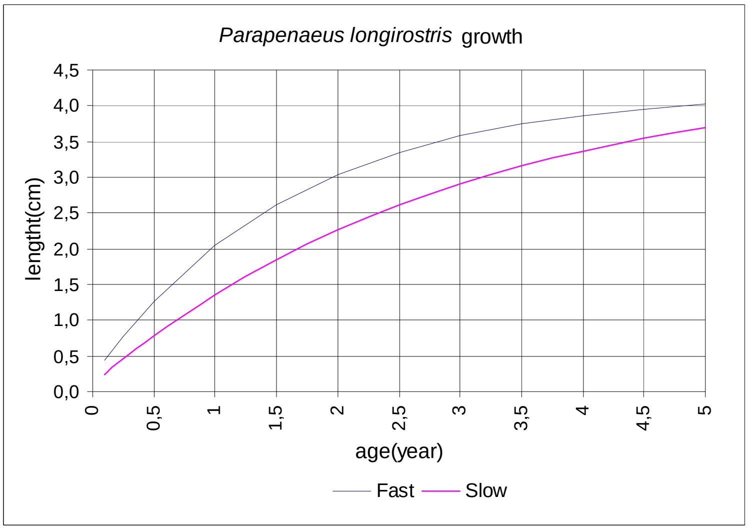


Fig. 8.30.1.2.2 Growth functions for the two fast and slow growth options.

Tab. 8.30.1.2.2 Length- weight relationship parameters, males and females combined.

a	b	
0.8142	2.6013	fast growth set
0.8148	2.61	slow growth set

8.30.1.3. Maturity

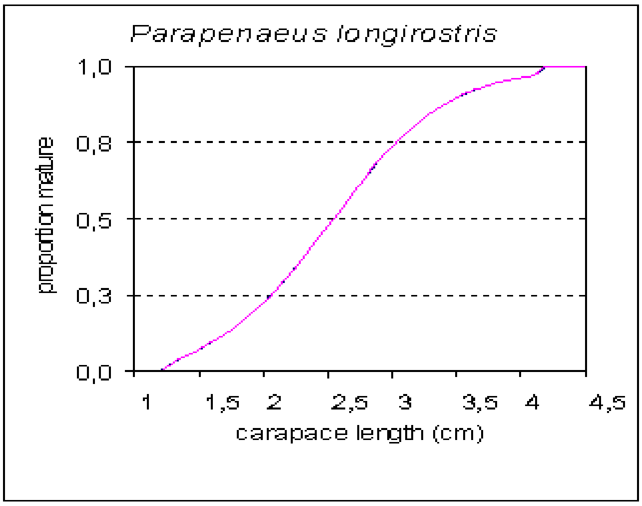


Fig. 8.30.1.3.1 Maturity ogive for males and females combined in GSA 01. Maturity stage determined macroscopically during the reproduction period (data source: DCR).

8.30.2.Fisheries

8.30.2.1.General description of fisheries

The bottom trawl fishery in GSA 01 is multispecies, targeting fish, cephalopods and crustaceans. Main target species are *Merluccius merluccius, Pagellus acarne, Octopus vulgaris* and *Parapenaeus longirostris.* Crustaceans get the highest values in the market representing 24% in the total catch, although *Nephrops norvegicus* and *Parapenaeus longirostris* contribute 6% to the total catch in weight. Fishing grounds are characterized by a narrow continental shelf, between 3 and 11 nautical miles wide (SEC(2004)772).

The species is found mainly at depths of between 140 and 400 m, i.e. on the continental shelf and in the upper slope on muddy or sandy muddy bottoms (Sbrana *et al.* 2006).

8.30.2.2.Management regulations applicable in 2008 and 2009

Unknown, assumed to be the same regulations in force within the Spanish Mediterranean (5 fishing days a week; to be practiced at >50 depth; 12 hours at sea per day). In the last years a two-month closure has been implemented in the first half of the year.

8.30.2.3.Catches

8.30.2.3.1. Landings

Tab. 8.30.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.3 of Appendix 3. Since 2002 the annual landings decreased from 173 t to only 37 t in 2006 and remained low in 2007. In 2008 112 t of landings were reported. The landings were only taken by demersal otter trawls.

Tab. 8.30.2.3.1.1 Annual landings (t) by fishing technique in GSA 01.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DPS	1	ESP	OTB	173	123	117	81	37	58	112

8.30.2.3.2. Discards

Reported discards through the DCF data call to SGMED-09-02 are listed in Table A3.9 of Appendix 3.

8.30.2.3.3. Fishing effort

No effort data were reported to SGMED-09-02 through the DCF data call for Spain.

8.30.3.Scientific surveys

8.30.3.1.Medits

8.30.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were calculated. In GSA 01 the following number of hauls was reported per depth stratum (s. Tab. 8.30.3.1.1.1).

Tab. 8.30.3.1.1.1. Number of hauls per year and depth stratum in GSA 01, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA01_010-050	3	1	2	2	2	2	2	3	3	3	3	2	3	3	4
GSA01_050-100	6	4	5	6	5	7	6	5	6	10	7	7	6	6	6
GSA01_100-200	3	3	3	5	5	5	5	5	8	6	5	6	5	6	6
GSA01_200-500	7	9	11	10	8	11	12	10	11	11	13	11	12	11	11
GSA01_500-800	6	10	13	10	13	12	10	13	15	14	13	11	15	10	9

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

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

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

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

Where:
- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

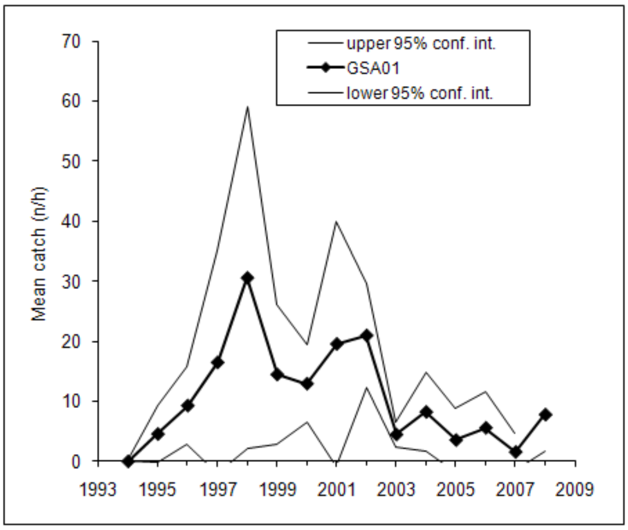
8.30.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.30.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the pink shrimp in GSA 01 was derived from the international survey Medits. Figure 8.30.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSA 01.

The estimated abundance and biomass indices peaked in 1998 and decreased significantly until 2003. Since then, the indices varied at a low level. The analyses of Medits indices are considered preliminary.



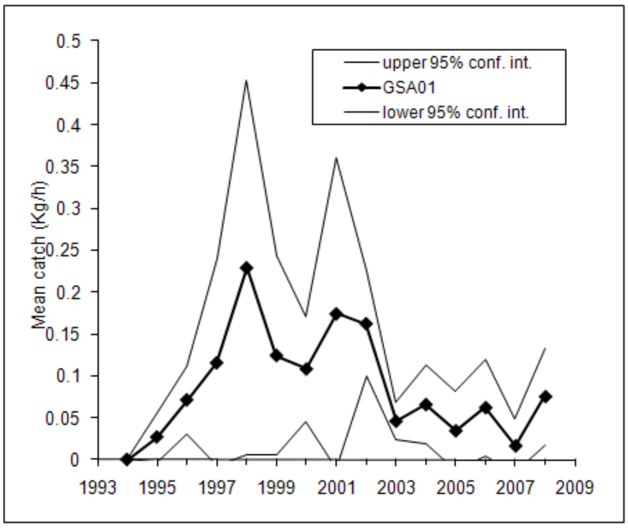


Fig. 8.30.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 01.

8.30.3.1.4. Trends in abundance by length or age

The following Fig. 8.30.3.1.4.1 and 2 display the stratified abundance indices of GSA 01 in 1995-2002 and 2003-2008. These size compositions are considered preliminary.

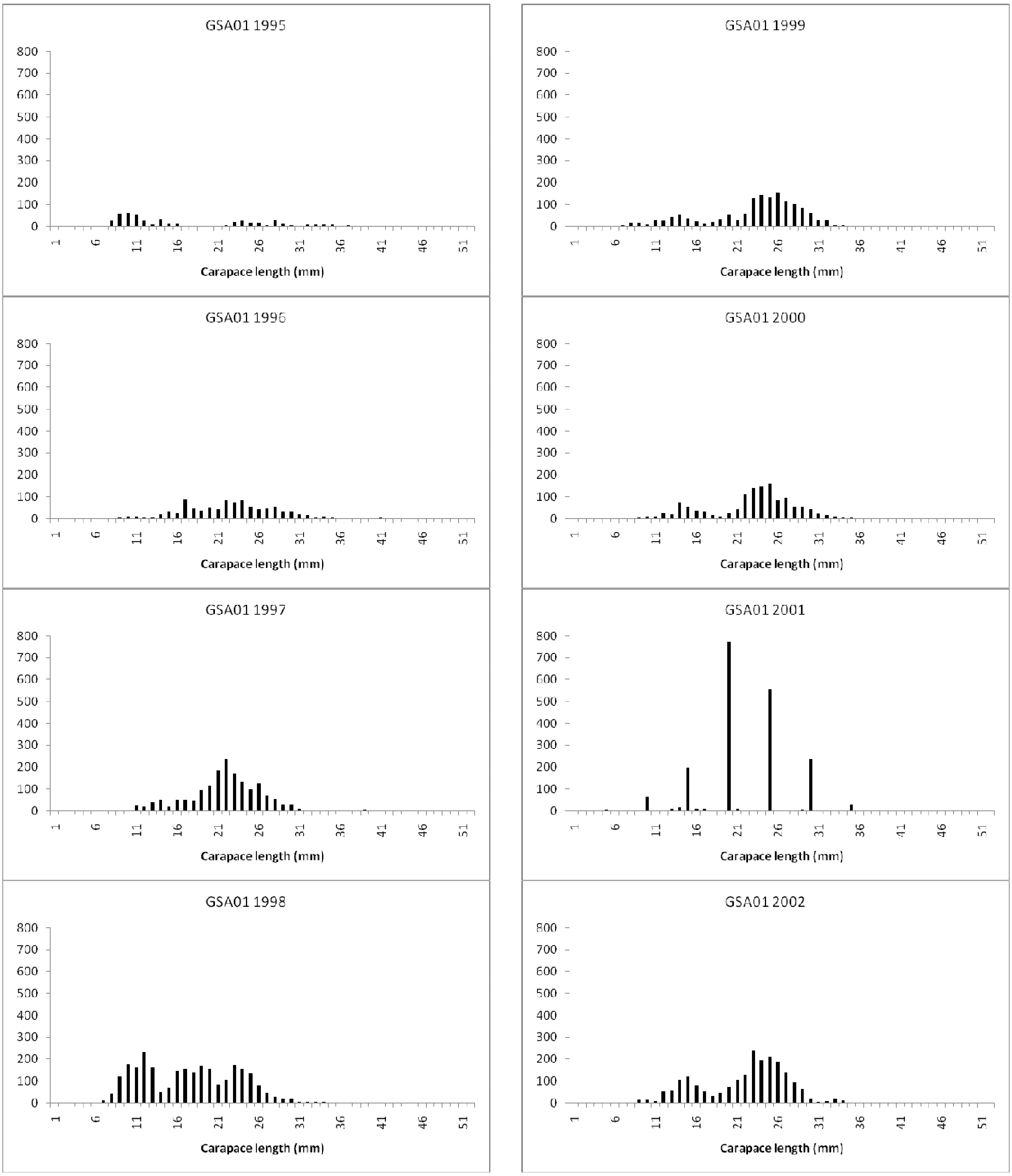


Fig. 8.30.3.1.4.1 Stratified abundance indices by size, 1995-2002.

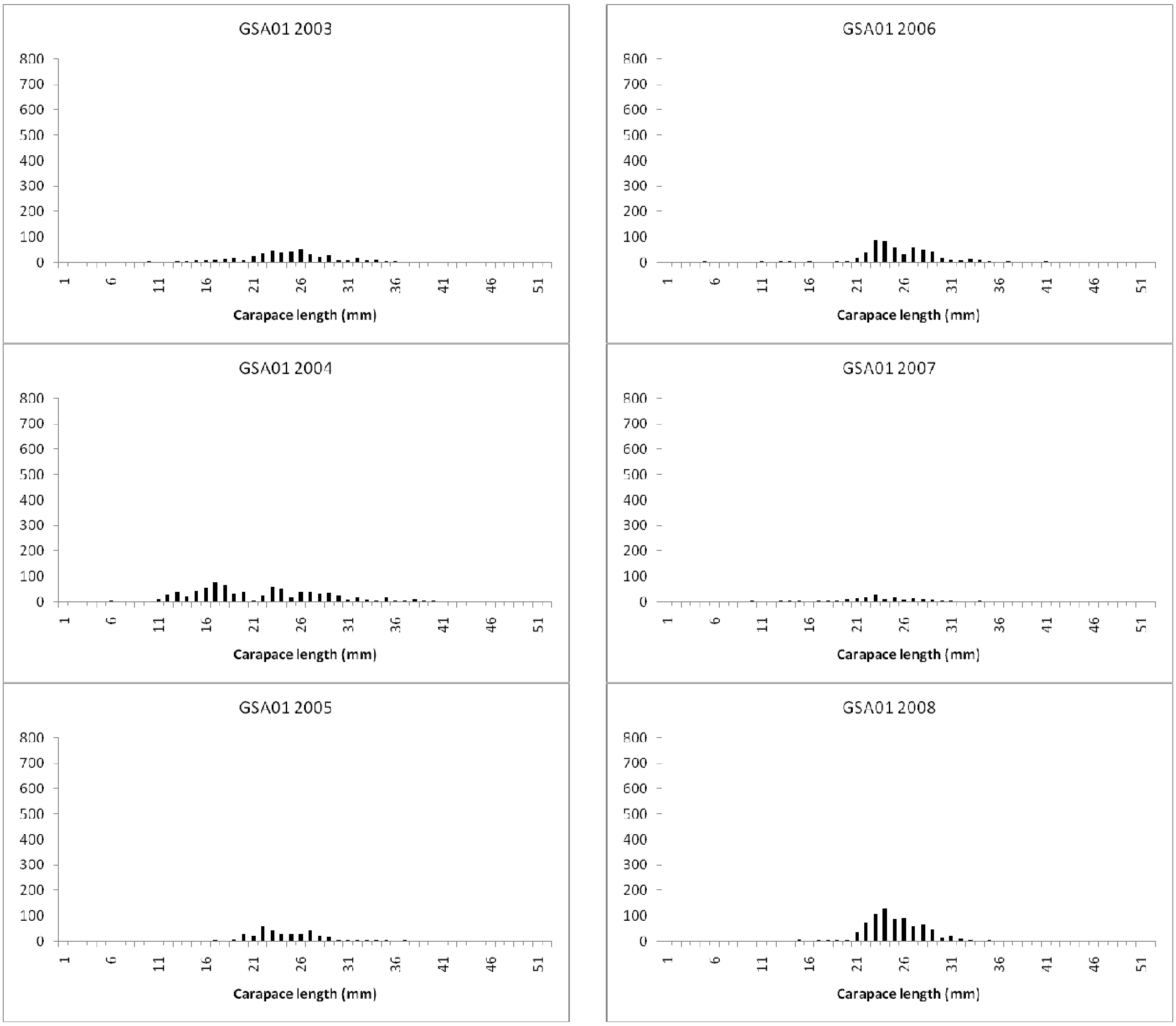


Fig. 8.30.3.1.4.2 Stratified abundance indices by size, 2003-2008.

8.30.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.30.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.30.4. Assessment of historic stock parameters

SGMED 09-02 did not undertake any analytical assessment of d in GSA 01. Last year's assessment using SURBA and VIT can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.30.5. Long term prediction

No analyses were conducted during SGMED-09-02.

8.30.5.1. Justification

Yield per recruit analyses were conducted assuming equilibrium conditions.

8.30.5.2. Input parameters

Based on the exploitation pattern resulting from the VPA (VIT) and its population parameters, yield per recruit analyses were formulated.

8.30.5.3. Results

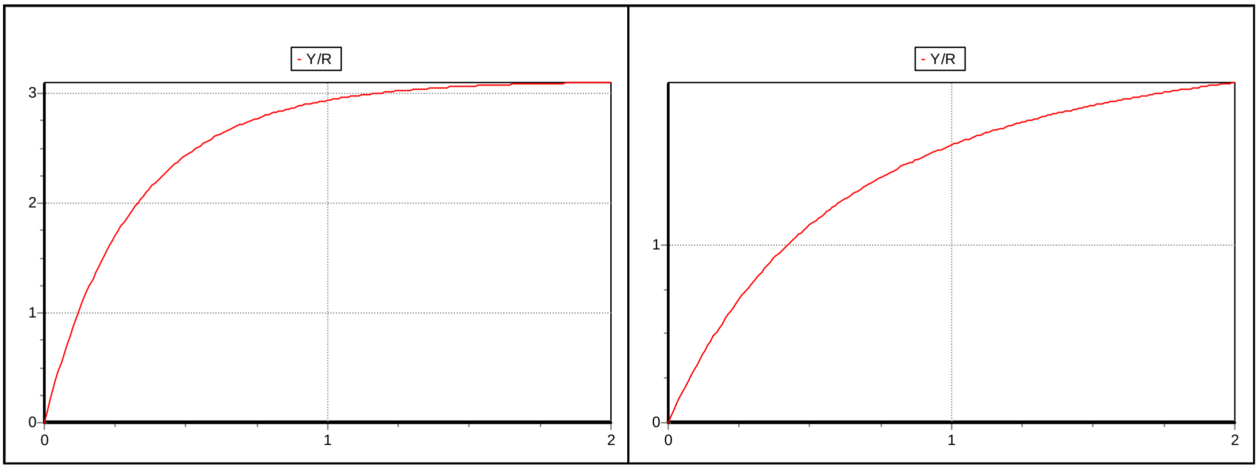


Fig. 8.30.5.3.1 Yield per recruit for fast (left) and slow growing scenarios (right) for the pink shrimp stock in GSA 01 (current effort).

Assuming equilibrium conditions, Fmax (F corresponding to the highest Y/R) seems to be in the region near the current F (F=1) in the fast growth scenario, or below it, in the slow growth scenario. Results suggest the stock would be in a situation near full exploitation in the fast growth scenario, where an increase in F would not result in an increase in Y/R, or underexploited in the case of slow growth scenario, where increasing F would lead to higher Y/R.

Because of the differences in growth, and under constant M, higher mean biomass and spawning stock biomass are needed in the case of slow growth scenario than in the fast growth, to sustain a given amount of landings. Also, current Fmean would be higher in the fast growth scenario.

SURBA results show decreasing F in the last years, when landings are at their lowest, and abundance and biomass indices from MEDITS are also low.

8.30.6. Scientific advice

8.30.6.1. Short term considerations

8.30.6.1.1. State of the spawning stock size

In the absence of proposed or agreed references SGMED-09-02 is unable to fully evaluate the state of the stock and provide any scientific advice in relation to them.

8.30.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.30.6.1.3. State of exploitation

In the absence of proposed or agreed references SGMED-09-02 is unable to fully evaluate the state of the stock and provide any scientific advice in relation to them.

8.31. Stock assessment of pink shrimp in GSA 06

8.31.1. Stock identification and biological features

8.31.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.31.1.2. Growth

SGMED-09-02 notes that the set of growth parameters used in the assessment were different to those used the year before, and a set more agreed with the "slow growth hypothesis" has been followed. Growth parameters used were those from Garcia-Rodriguez et al. (2009) over length distributions analysis (Linf= 45.0; K = 0.39; t0= 0.1019), and length-weight relationship (a= 0.0019; b= 2.611).

8.31.1.3. Maturity

Maturity ogive was taken from García Rodriguez et al. (2009), with size at first maturity (50 %) at 25.65 mm Cl.

Tab. 8.31.1.3.1 Maturity ogive for deep-water pink shrimp in GSA 06.

Age class	0	1	2	3	4	5	6	7
Maturity ratio	0	0.1343973	0.5044019	0.7877772	0.9015605	0.9738161	1	1

8.31.2. Fisheries

8.31.2.1. General description of fisheries

Deep-water pink shrimp (*Parapenaeus longirostris*) is one of the most important crustacean species for the trawl fisheries developed along the GFCM geographical sub-area Northern Spain (GSA 06). This resource is an important component of commercial landings in some ports of the Mediterranean Northern Spain and occasionally target species of the trawl fleet, composed by around 600 vessels, and especially by 260 vessels which operate on the upper slope.

8.31.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.31.2.3. Catches

8.31.2.3.1. Landings

During the last years, a sharp increase in landings was observed, starting in 1998 and reaching the maximum value in 2000, followed by a decreasing trend during the period 2001-2008. In 2008 the annual landings of this species amounts 33 tons in the whole area, which represents the lowest value of the historical series.

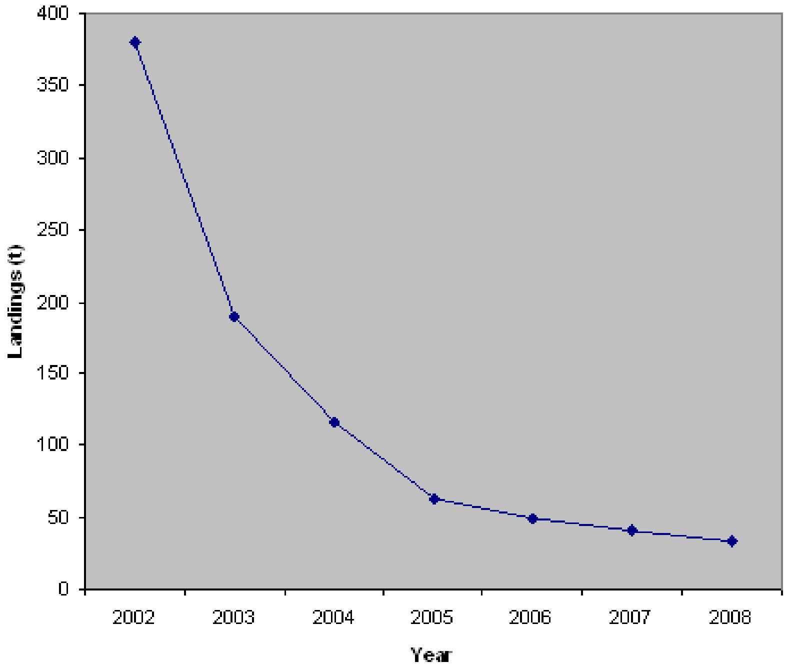


Fig. 8.31.2.3.1.1 Landings as used by GFCM SAC in 2007.

Tab. 8.31.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.3 of Appendix 3. Since 2002 the annual landings decreased from 380 t to only 33 t in 2008. The landings were only taken by demersal otter trawls.

Tab. 8.31.2.3.1.1 Annual landings (t) of deep-water pink shrimp by fishing technique in GSA 06.

ESP	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DPS	6	ESP	OTB	380	190	117	63	49	41	33

8.31.2.3.2. Discards

No information was documented during SGMED-09-02.

8.31.2.3.3. Fishing effort

Fishing effort has reduced from 50,000 days in 2000 to 13,000 in 2006, with a slight increase in 2007 and 2008 to 18,000. SGMED-09-02 notes that the fishing effort below only includes vessels that have landed pink shrimp in the given years. No official data have been reported to SGMED 09-02.

8.31.3.Scientific surveys

8.31.3.1.MEDITS

8.31.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 06 the following number of hauls were reported per depth stratum (s. Tab. 7.31.3.1.1.1).

Tab. 8.31.3.1.1.1. Number of hauls per year and depth stratum in GSA 06, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA06_010-050	7	8	7	8	7	8	9	8	11	9	9	11	12	6	8
GSA06_050-100	21	28	27	26	28	30	30	31	36	39	31	32	34	40	43
GSA06_100-200	11	19	17	15	13	17	19	20	20	21	17	18	19	24	30
GSA06_200-500	10	13	10	12	7	13	12	16	17	18	16	15	18	18	19
GSA06_500-800	7	8	9	7	4	9	6	8	7	11	11	8	10	15	14

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.31.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.31.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the pink shrimp in GSA 06 was derived from the international survey Medits. Figure 8.31.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSA 06.

The estimated abundance and biomass indices were high in 2000 and 2001 but varied at a low level since then. The analyses of Medits indices are considered preliminary.

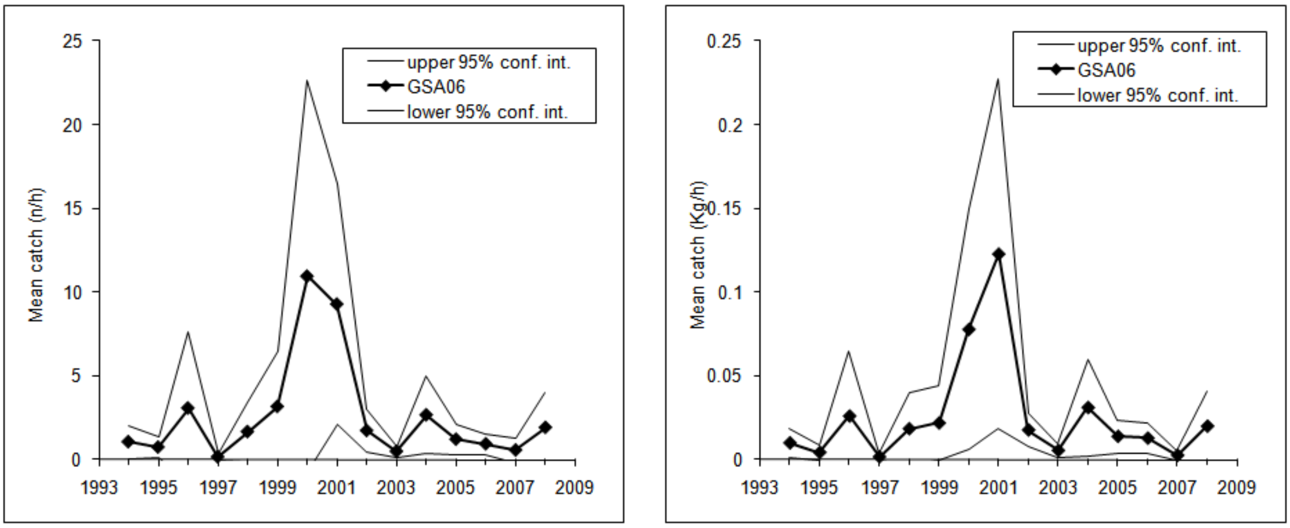


Fig. 8.31.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 06.

8.31.3.1.4. Trends in abundance by length or age

The following Fig. 8.31.3.1.4.1 and 2 display the stratified abundance indices of GSA 06 in 1994-2001 and 2002-2008.

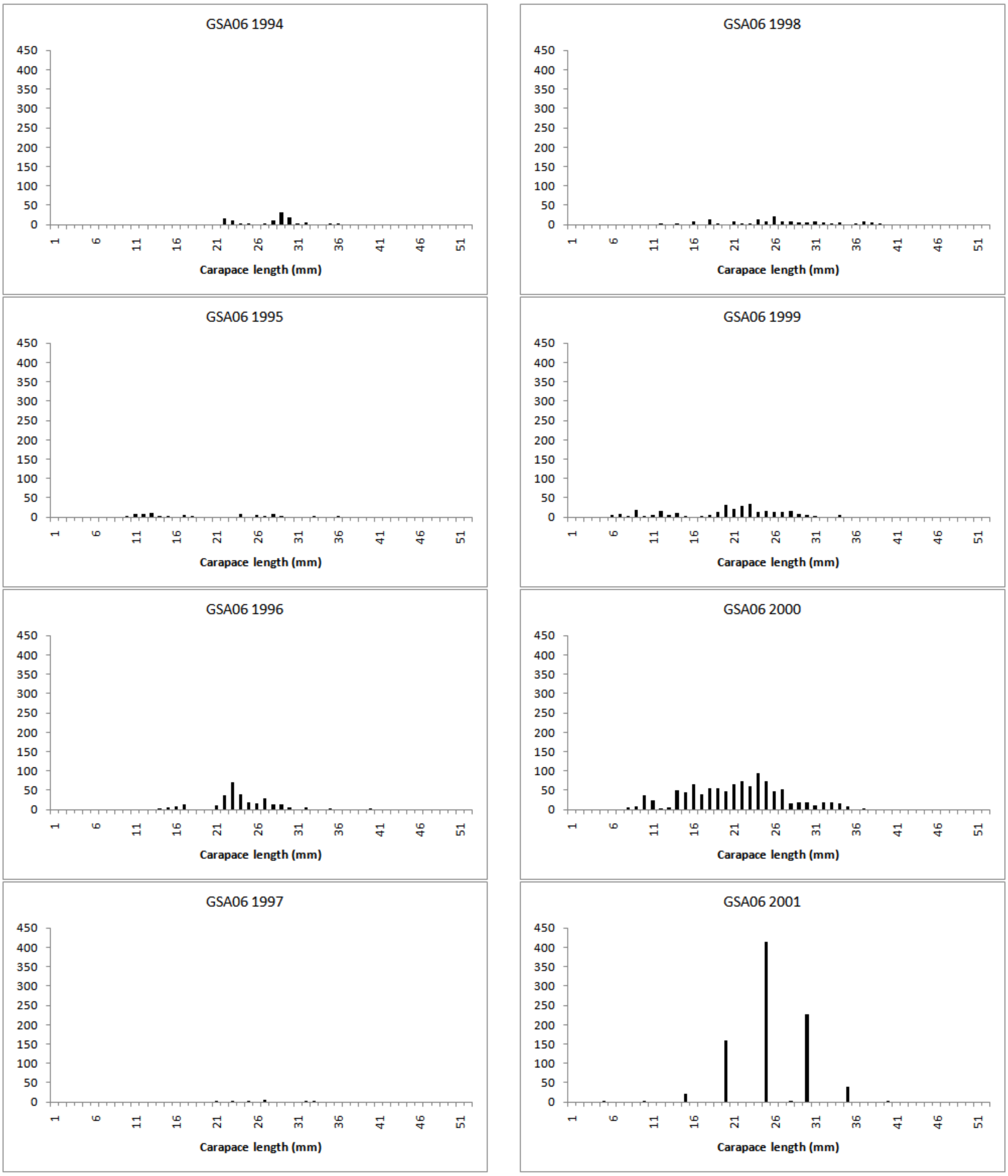


Fig. 8.31.3.1.4.1 Stratified abundance indices by size, 1994-2001.

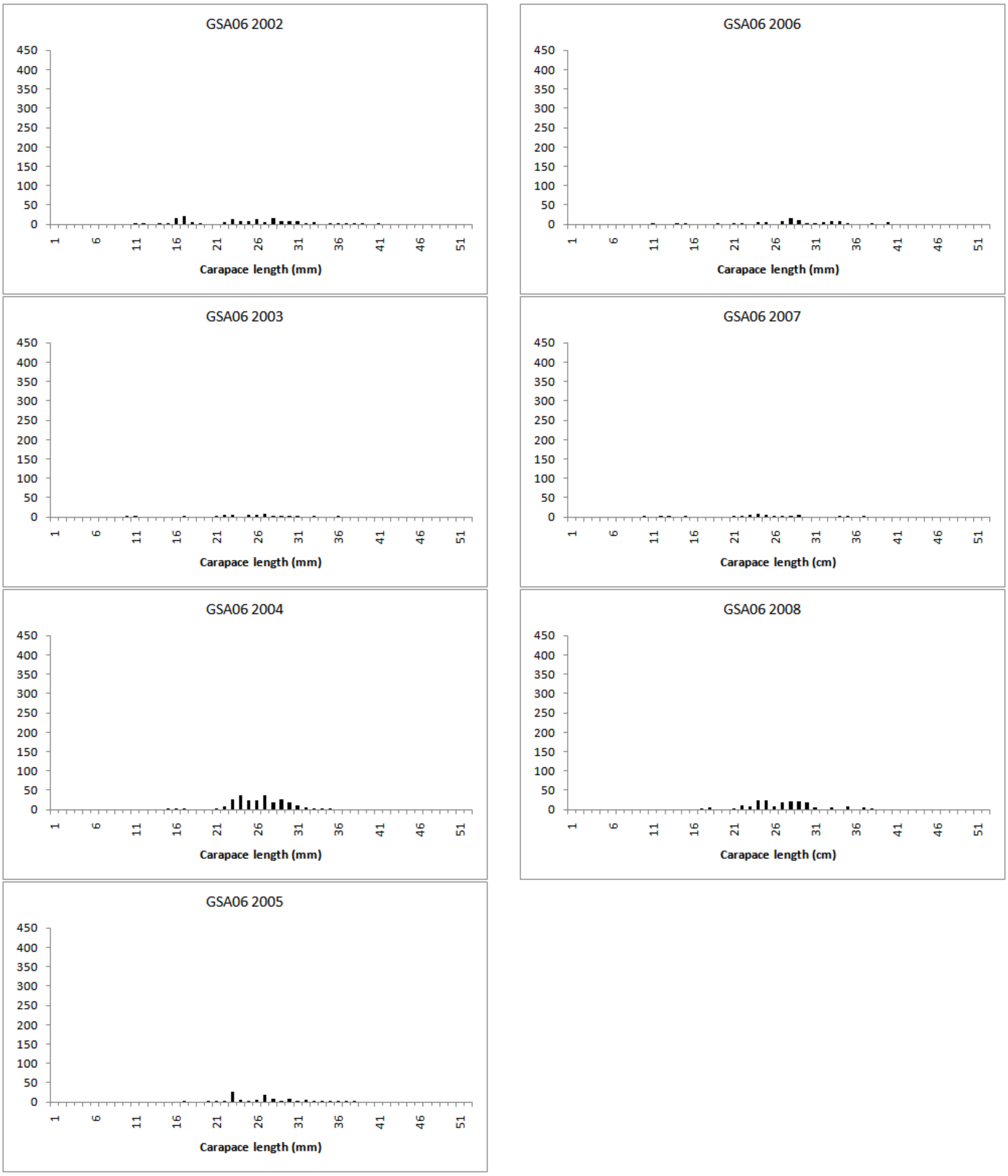


Fig. 8.31.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.31.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.31.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.31.4.Assessment of historic stock parameters

8.31.4.1.Method 1: XSA

8.31.4.1.1. Justification

During the SGMED-09-02, an assessment on pink shrimp from GSA 06 was performed applying XSA. Files dealing with official landings and effort were not available.

8.31.4.1.2. Input parameters

The following Table 8.31.4.1.2.1 lists the various input parameters at age.

Tab. 8.31.4.1.2.1 XSA input parameters.

Pink shrimp GSA 06			Catch at age				
Age class	2002	2003	2004	2005	2006	2007	2008
0	13	0.8	3.2	0	0	0	0
1	19506.9	4371.1	3970.5	1256.5	673.5	687.8	912.8
2	18438.2	8368.2	5369	2835.4	1888.4	2109	1854.5
3	4429	3589.3	2103.8	1131.2	588.7	598.6	295.6
4	596.3	601	200.9	212	180	168.1	70.1
5	54.6	81.7	26.5	51.8	44.5	73.8	12.8
6	8.1	13.3	2.5	15.9	9.6	21.4	4.6
7	0.2	0.4	0.1	4.4	4.9	4.7	0.7
8+	0	0	0	0.3	0.4	0.4	3.5
			Weight at age (kg)				
Age class	2002	2003	2004	2005	2006	2007	2008
0	0.002	0.002	0.001	0	0	0	0
1	0.006	0.005	0.006	0.006	0.006	0.006	0.006
2	0.01	0.011	0.01	0.01	0.01	0.01	0.01
3	0.017	0.017	0.017	0.017	0.017	0.017	0.017
4	0.022	0.022	0.023	0.023	0.023	0.023	0.022
5	0.027	0.027	0.027	0.027	0.027	0.028	0.028
6	0.031	0.031	0.031	0.031	0.031	0.031	0.031
7	0.032	0.032	0.032	0.034	0.034	0.034	0.033
8+	0	0	0	0.034	0.034	0.034	0.036
Age class	Maturity at age		Age class	Natural mortality			
0	0		0	1.25			
1	0.1343973		1	1.25			
2	0.5044019		2	1.25			
3	0.7877772		3	1.25			
4	0.9015605		4	1.25			
5	0.9738161		5	1.25			
6	1		6	1.25			
7	1		7	1.25			
8+	1		8+	1.25			
			Tunning parameters (MEDITS)				
Age class	2002	2003	2004	2005	2006	2007	2008
0	0.000597	0.000414	0	0	0.000068	0.000424	0
1	0.034812	0.004609	0.018124	0.010526	0.038326	0.009121	0.005283
2	0.214594	0.015352	0.189164	0.042187	0.12773	0.059118	0.04069
3	0.048323	0.004198	0.044402	0.033843	0.02891	0.024405	0.007893
4	0.006992	0.003313	0.001132	0.010925	0.004459	0.016246	0.006915
5	0.004155	0	0	0.002983	0.006564	0	0.001019
6	0.003048	0	0	0	0.004226	0.003888	0
7	0.000173	0	0	0	0	0.000221	0

8.31.4.1.3. Results

Tab. 8.31.4.1.3.1 Estimated fishing mortality at ages 0-8, 2002-2008.

Table 8	Fishing mortality (F) at age							
YEAR	2002	2003	2004	2005	2006	2007	2008	FBAR **
AGE								
0	0.0001	0	0	0	0	0	0	0
1	0.2072	0.0765	0.1235	0.0518	0.0388	0.0406	0.0483	0.0426
2	0.601	0.4226	0.4168	0.3969	0.3267	0.5661	0.4947	0.4625
3	0.6318	0.8206	0.6189	0.4785	0.4355	0.5576	0.466	0.4864
4	0.5496	0.54	0.2856	0.3586	0.4168	0.785	0.364	0.5219
5	0.7332	0.4313	0.1168	0.3532	0.3799	1.3468	0.3811	0.7026
6	1.5196	2.5229	0.0593	0.3002	0.3202	1.4944	0.9648	0.9265
7	0.8666	0.9555	0.3579	0.4707	0.4727	1.0353	0.5019	0.67
+gp	0.8666	0.9555	0.3579	0.4707	0.4727	1.0353	0.5019	
0 FBAR 2- 5	0.6289	0.5536	0.3595	0.3968	0.3897	0.8139	0.4265	

Tab. 8.31.4.1.3.2 Summary of estimated stock parameters, 2002-2008.

Table 17 Summary (with SOP correction)							
	Terminal Fs derived using XSA (With F shrinkage)						
	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 2- 5
	Age 0						
2002	387022	2979	812	380	0.4682	0.9704	0.6289
2003	222891	1767	550	190	0.3454	0.9959	0.5536
2004	162431	1019	355	117	0.33	0.9857	0.3595
2005	115435	588	237	63	0.2656	1.0153	0.3968
2006	112647	520	206	49	0.2384	1.267	0.3897
2007	126322	340	123	41	0.3341	0.9724	0.8139
2008	202213	361	111	33	0.2962	1.05	0.4265
Arith.							
Mean	189852	1082	342	125	0.3254		0.5098
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

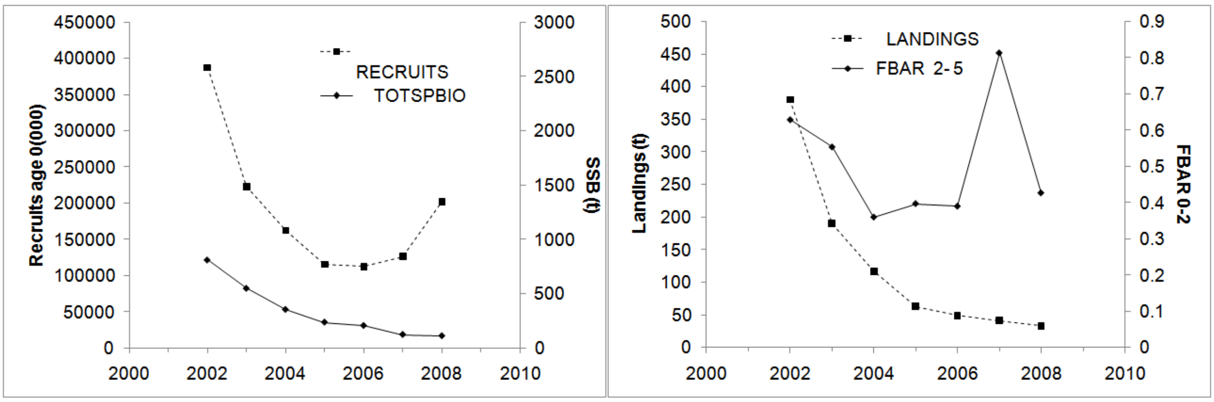


Fig. 8.31.4.1.3.1 Estimated trends in spawning stock biomass SSB, recruits and mean fishing mortality at ages 2-5.

8.31.5.Long term prediction

8.31.5.1.Justification

No forecast analyses were conducted.

8.31.5.2. Input parameters

No forecast analyses were conducted.

8.31.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for pink shrimp in GSA 06.

8.31.6. Scientific advice

8.31.6.1. Short term considerations

8.31.6.1.1. State of the spawning stock size

Since 2002, SSB, with an average for the whole period of 342 tons, declined rapidly and continuously to the lowest value observed in 2008 (111 mt) which represents only 8% of that observed in 2002. SGMED notes that the MEDITS survey abundance index shows a very high peak in abundance in the 1999-2001 period, which represents the start of the assessment period. Prior to 1999, abundance levels were comparable to those seen in the 2002-2008 period. SGMED cannot evaluate the state of the spawning stock relative to reference points, as these have not been proposed or defined. Given the rapid decline by 90% from 2001 values, SGMED considers the stock status to be far below any sustainable levels.

8.31.6.1.2. State of recruitment

Recruits (aged 0 individuals) were estimated to have declined from 2002 to 2005 in the same pattern as 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.

8.31.6.1.3. State of exploitation

Fishing mortality over ages 2-5 displays a high variation with an average value of 0.5. SGMED 09-02 is unable to fully evaluate the exploitation status as no limit or target reference points have been estimated.

F and effort should be kept at a low level to allow any strong future recruitments to rebuild the stock. SGMED recommends a recovery plan to be established for this stock that takes into account the mixed species nature of the fishery.

8.32. Stock assessment of pink shrimp in GSA 09

8.32.1.Stock identification and biological features

8.32.1.1.Stock Identification

Stock delimitations are considered unknown.

The species shows a wide bathymetric distribution in the GSA 09, being present from 50 to 650 m depth with greatest abundance between 150 and 400 m depth over muddy or sandy-muddy bottoms (Ardizzone and Corsi, 1997; Biagi *et al.*, 2002).

The highest abundances have been found in the Tyrrhenian part of the GSA (south Tuscany and Latium).

Recruits (CL ≤ 15 mm) occur all year round with a main peak from July to October (De Ranieri *et al*., 1997). The main nurseries revealed a high spatio-temporal persistency (Fig. 8.32.1.1.1) between 60 and 220 m depth. The core of nursery areas overlap with crinoid beds (*Leptometra phalangium*) areas over the shelf-break (Colloca *et al*., 2004, 2006; Reale *et al*., 2005). This is a peculiar habitat in the GSA 09 which is also an essential fish habitat for other commercially important species as the European hake, *Merluccius merluccius*. A positive size-depth distribution was found with an increased abundance of larger females with depth (Ardizzone *et al*., 1990).

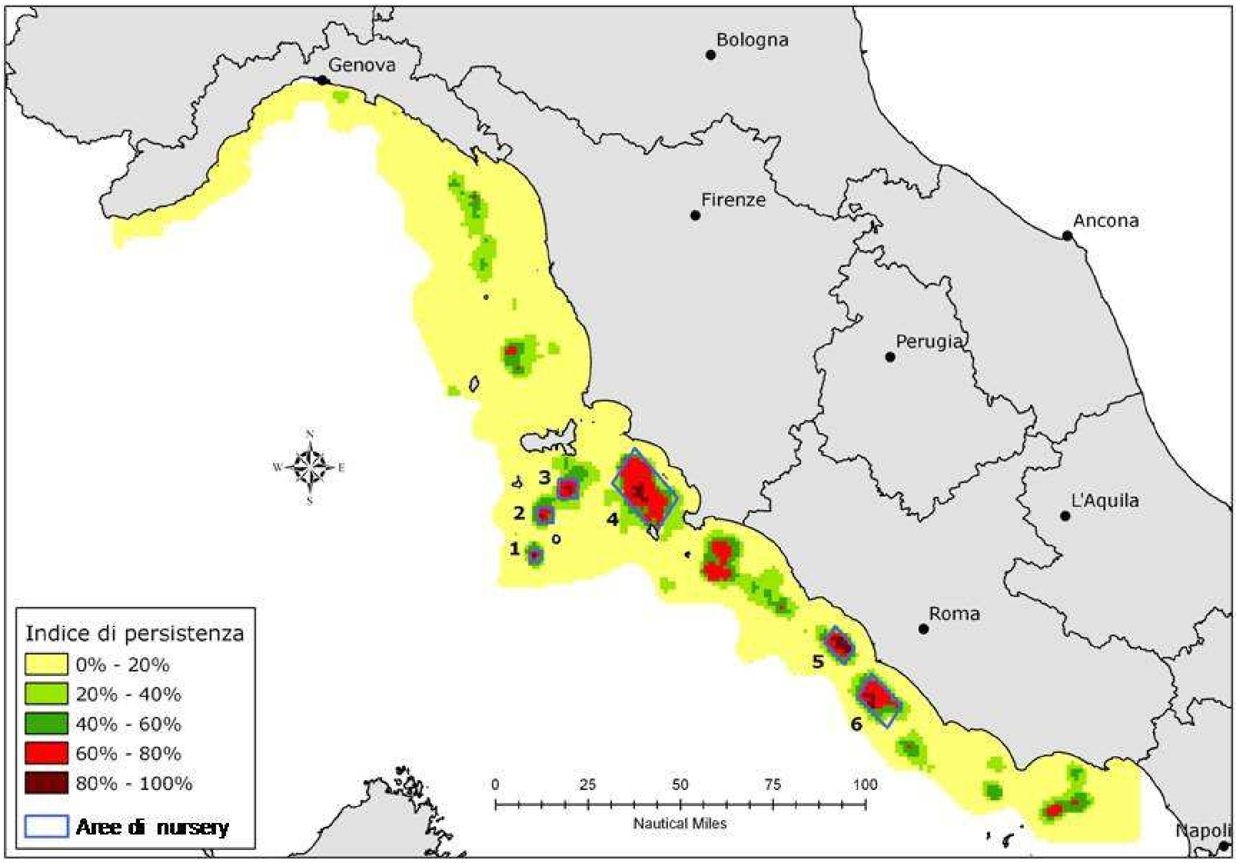


Fig. 8.32.1.1.1 Temporal persistence of *P. longirostris* nurseries in the GSA 09.

8.32.1.2.Growth

The growth of *P. longirostris* has been studied in the southern part of the GSA 09 (central Tyrrhenian Sea) using modal progression analysis (Ardizzone *et al*., 1990). The following sets of Von Bertalanffy growth parameters were estimated: Females: $L\infty$ = 43.5, K=0.74, t_0=-0.13; Males: $L\infty$ = 33.1, K=0.93, t_0=-0.05. The life cycle is of 3-4 years. Females grow faster than males attaining larger size-at-age.

P. longirostris diet is composed of a great variety of organisms; the prey items consisted mostly of external skeletons of bottom organisms, always crushed and often in an advanced state of deterioration. Crustaceans dominated the diet both qualitatively and quantitatively; they were characterized by a high abundance of peracarids, mainly represented by mysids (*Lophogaster typicus*) and amphipods (Lysianassidae). Molluscs (juvenile bivalves and gastropods); cephalopods (Sepiolids), small echinoderms, annelids, small fishes, foraminiferans, (Globigerinidae) and organic detritus are other important food item in the diet of the species (Mori *et al.*, 2000b).

8.32.1.3.Maturity

In the northern Tyrrhenian Sea, the reproduction area of *P. longirostris* is located from 150 to 350 m; mature females are present all year round, even though the species shows two peaks in reproductive activity, one in spring and another at the beginning of autumn (Mori *et al*., 2000a). In the central Tyrrhenian Sea, the southern part of GSA 09, a main winter spawning was hypothesized (Ardizzone *et al*., 1990). The size at onset of sexual maturity estimated for different years in northern Tyrrhenian Sea is about 24 mm CL (Mori *et al*., 2000a).

The number of oocytes in the ovary was related to the size of the females and ranged from 23,000 oocytes at 26 mm CL to 204,000 at 43 mm CL. An exponential relationship was observed between fecundity and carapace length: Fecundity = 0.0569 CL4.0177 (r = 0.829) (Mori *et al*. (2000a).

8.32.2.Fisheries

8.32.2.1.General description of fisheries

In the GSA 09 the deep water pink shrimp is one of the most important target species of the fishery carried out on the shelf break and upper part of continental slope. The species is exclusively exploited with otter bottom trawling.

The fishing grounds are located in the southern part of the GSA 09, to the south of Elba Island (northern and central Tyrrhenian Seas); they are mainly exploited by several trawlers of Porto Santo Stefano, Porto Ercole, Fiumicino, Terracina and Gaeta. *P. longirostris* belongs to a fishing assemblage distributed from 150 to 350 m depth, where the main target species are hake, *Merluccius merluccius*, horned octopus, *Eledone cirrhosa* and Norway lobster, *Nephrops norvegicus*, at greater depths (Biagi *et al.*, 2002; Colloca *et al*., 2003; Sartor *et al*., 2003; Sbrana *et al*., 2006).

The majority of bottom trawlers of GSA 09 operate daily fishing trips with some vessels (especially those of Porto Santo Stefano) staying out for two-three days and mainly in the summer. The mean number of fishing days/year per vessel carried out by the GSA 09 trawlers varied from 187 in 2004 to 177 in 2006. Due to the distance of the fishing grounds to the main harbours, fishing activity targeting *P. longirostris* shows some seasonal variations, with maxima from mid spring to mid autumn.

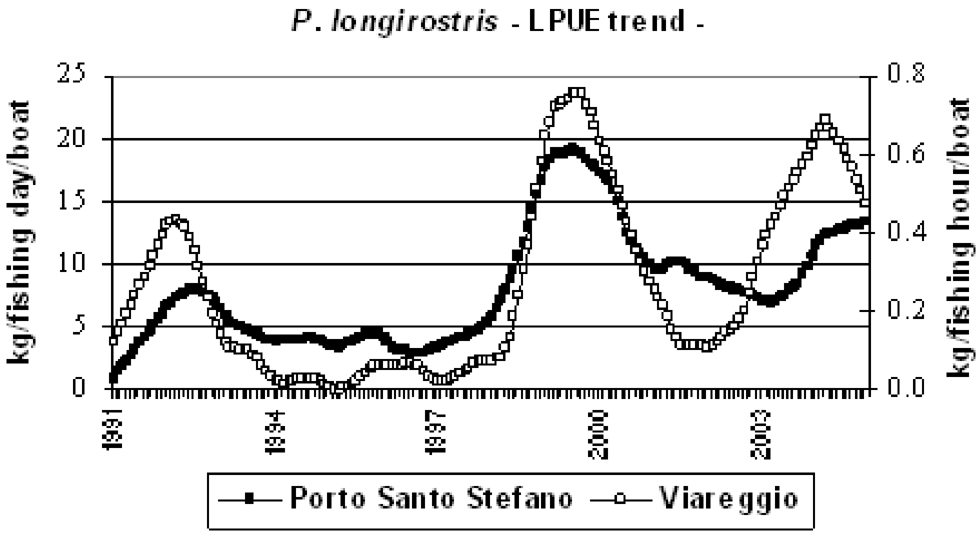


Fig. 8.32.2.1.1 *P. longirostris* LPUE of P. S. Stefano and Viareggio trawlers since 1991 (bottom).

The size structure of the landings, according to the DCR data, shows that the most exploited sizes ranged from 24 to35 mm CL (Fig. 8.32.2.1.2); the presence of specimens under the MLS (20 mm CL) is negligible. According to the growth pattern of the species, fishing exploits mainly 1^+ - 3^+ age classes.

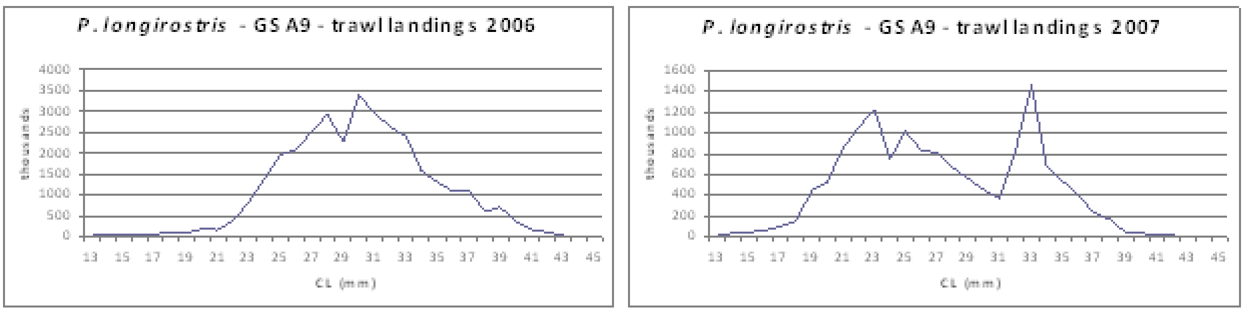


Fig. 8.32.2.1.2 Length frequency distribution of *P. longirostris* landed in the GSA 09 in 2006 and 2007.

8.32.2.2.Management regulations applicable in 2008 and 2009

The minimum legal landing size is 20 mm Carapace Length (EC regulation 1967/2006). The other management regulations are the same described for hake in the GSA 09.

8.32.2.3.Catches

8.32.2.3.1. Landings

Total landings of deep water rose shrimps fluctuated from 161 tons in 2002 to 254 tons in 2008, showing a peak in 2006 corresponding to 462 tons (Fig. 8.32.2.3.1.1; Tab. 8.32.2.3.1.1). The landings were mainly taken by demersal otter trawlers. The fluctuating trend is a proper characteristic of the landings of this species, as shown by the LPUE produced by the fleets of Porto Santo Stefano and Viareggio in the period 2001-2005 (Sartor *et al.*, 2005) (Fig. 8.32.2.1.1). The values of the two fleets showed the same temporal pattern with maxima in 1992, 1999 and 2004.

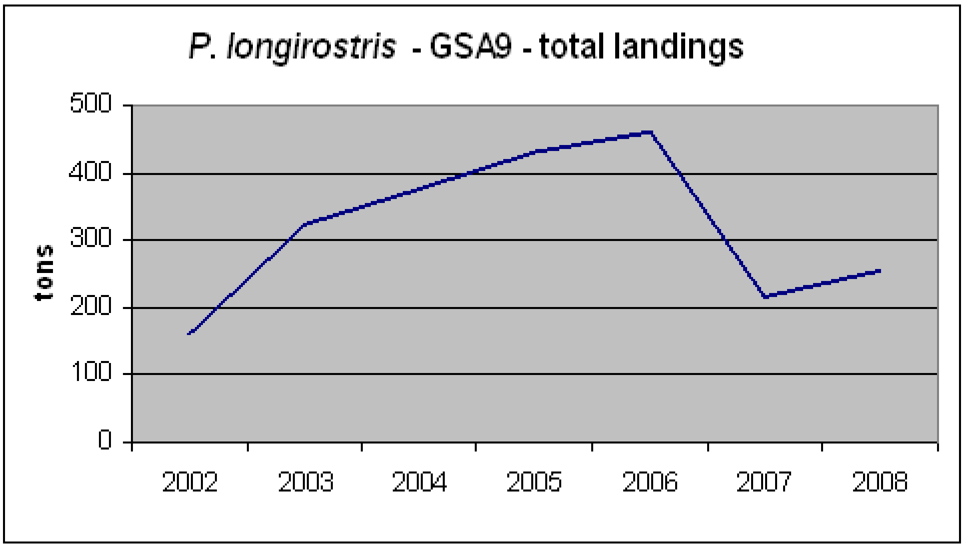


Fig. 8.32.2.3.1.1 Total landings in GSA 09.

Tab. 8.32.2.3.1.1 Annual landings (t) by fishing technique in GSA 09.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DPS	9	ITA	DTS	133	308	367	430	462	215	253
DPS	9	ITA	PGP		3	8	1		2	1
DPS	9	ITA	PMP	19	12					
DPS	9	ITA	PTS	9		1				
SUM	9	ITA		161	323	376	431	462	217	254

8.32.2.3.2. Discards

Discards of *P. longirostris* are scarce; according to Sbrana *et al*. (2006) they ranged from 0.35 to 1.24% of the total catch of the species. Discards occurred mainly on the fishing grounds located at depths of less than 200 m, where juvenile specimens are more abundant.

About 9 t of discards were reported to SGMED-09-02 for 2006 (Tab. A3.9 of Appendix 3).

8.32.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-09-02 are listed in Tab. 8.32.2.3.3.1 and in Tab. A3.10-12 of Appendix 3. After 2006, the effort of the major demersal trawler fleet decreased slightly.

Tab. 8.32.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSA 09, 2002-2008.

Unit	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	9	ITA	DRB	1856	3332	2660	6303	8502	8405	
DAYS	9	ITA	DTS	62616	63331	64870				
DAYS	9	ITA	FPO					86	577	
DAYS	9	ITA	GND				3014	1970	1362	
DAYS	9	ITA	GNS				87509	81222	101245	
DAYS	9	ITA	GTR				61098	64285	42880	
DAYS	9	ITA	HOK			2568				
DAYS	9	ITA	LLD				8353	9168	5918	
DAYS	9	ITA	LLS				7213	4718	4011	
DAYS	9	ITA	LTL					359	139	
DAYS	9	ITA	MIS				5027	1043		
DAYS	9	ITA	OTB				65427	58739	61370	
DAYS	9	ITA	PGP	212455	182159	196758				
DAYS	9	ITA	PMP	52193	75479	16960				
DAYS	9	ITA	PS				4796	4554	3967	
DAYS	9	ITA	PTM					223		
DAYS	9	ITA	PTS	5453	6242	4728				
DAYS	9	ITA	SB-SV				17421	16166	13432	
GT*days	9	ITA	DRB	15733	28362	24050	28397	24666	25679	
GT*days	9	ITA	DTS	2154256	2147750	2410544				
GT*DAYS	9	ITA	FPO					86	1748	
GT*DAYS	9	ITA	GND				17625	8566	8782	
GT*DAYS	9	ITA	GNS				241838	216207	239030	
GT*DAYS	9	ITA	GTR				176723	189219	136816	
GT*days	9	ITA	HOK			22784				
GT*DAYS	9	ITA	LLD				29031	51046	31466	
GT*DAYS	9	ITA	LLS				24902	14632	6447	
GT*DAYS	9	ITA	LTL					359	139	
GT*DAYS	9	ITA	MIS				16776	2969		
GT*DAYS	9	ITA	OTB				2355691	2157251	2154665	
GT*days	9	ITA	PGP	624182	650560	521225				
GT*days	9	ITA	PMP	382454	382992	62599				
GT*DAYS	9	ITA	PS				181752	154273	132567	
GT*DAYS	9	ITA	PTM					223		
GT*days	9	ITA	PTS	193726	181590	143490				
GT*DAYS	9	ITA	SB-SV				40642	37698	28857	
kW*days	9	ITA	DRB	187147	335520	268423	317456	301864	306714	
kW*days	9	ITA	DTS	14583556	14671042	14130070				
KW*DAYS	9	ITA	FPO					1448	15787	
KW*DAYS	9	ITA	GND				273248	223990	146786	
KW*DAYS	9	ITA	GNS				3668438	2989348	3630165	
KW*DAYS	9	ITA	GTR				3392406	3459956	2528382	
kW*days	9	ITA	HOK			376470				
KW*DAYS	9	ITA	LLD				653659	816400	453585	
KW*DAYS	9	ITA	LLS				426713	357010	99478	
KW*DAYS	9	ITA	LTL					6081	2128	
KW*DAYS	9	ITA	MIS				352334	80944		
KW*DAYS	9	ITA	OTB				14351906	12112028	12809257	
kW*days	9	ITA	PGP	6504001	6925653	7060573				
kW*days	9	ITA	PMP	4715565	4051809	984241				
KW*DAYS	9	ITA	PS				1097509	934012	922193	
KW*DAYS	9	ITA	PTM					4671		
kW*days	9	ITA	PTS	1312412	1333245	947166				
KW*DAYS	9	ITA	SB-SV				950710	751142	550250	

8.32.3. Scientific surveys

8.32.3.1. MEDITS

8.32.3.1.1. Methods

From 1994 two trawl surveys are regularly carried out each year: MEDITS, in spring, and GRUND, in autumn. The two surveys gave a similar temporal increasing trend in density and biomass of deep water pink shrimp, even though large fluctuations are present from year to year (Fig. 8.32.3.1.1.1). A similar increasing trend in abundance has been observed also in other Italian geographic subareas and could be related to the warming trend in water temperature. *P. longirostris* is a thermophile species that could benefit by the ongoing climatic change in the Mediterranean region. The relationship between environmental variability and deep-sea pink shrimp population dynamic has not been investigated yet.

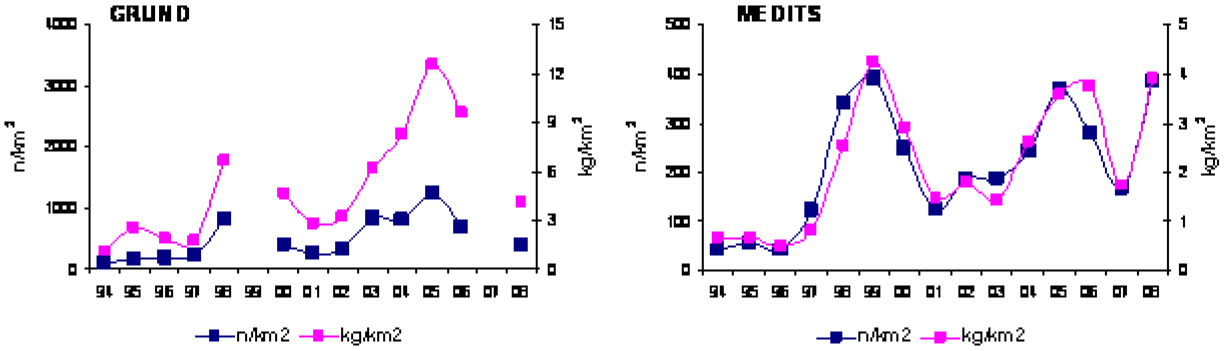


Fig. 8.32.3.1.1.1 *P. longirostris*: GRUND and MEDITS trends in density and biomass from 1994 to 2008 in GSA 09.

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 09 the following number of hauls was reported per depth stratum (s. Tab. 8.32.3.1.1.1).

Tab. 8.32.3.1.1.1. Number of hauls per year and depth stratum in GSA 09, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA09_010-050	19	18	18	18	19	18	18	18	13	13	13	14	13	13	13
GSA09_050-100	19	20	18	19	18	19	20	20	15	15	15	14	16	16	13
GSA09_100-200	35	35	36	35	35	35	34	34	26	27	26	27	25	26	28
GSA09_200-500	32	33	33	36	32	36	37	35	27	27	27	28	29	33	30
GSA09_500-800	31	30	32	28	30	28	27	29	24	22	21	20	20	17	18

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.32.3.1.2. Geographical distribution patterns

No analyses were conducted.

8.32.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the pink shrimp in GSA 09 was derived from the international survey MEDITS. Figure 8.32.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSA 09.

The estimated abundance and biomass indices do not reveal a clear trend.

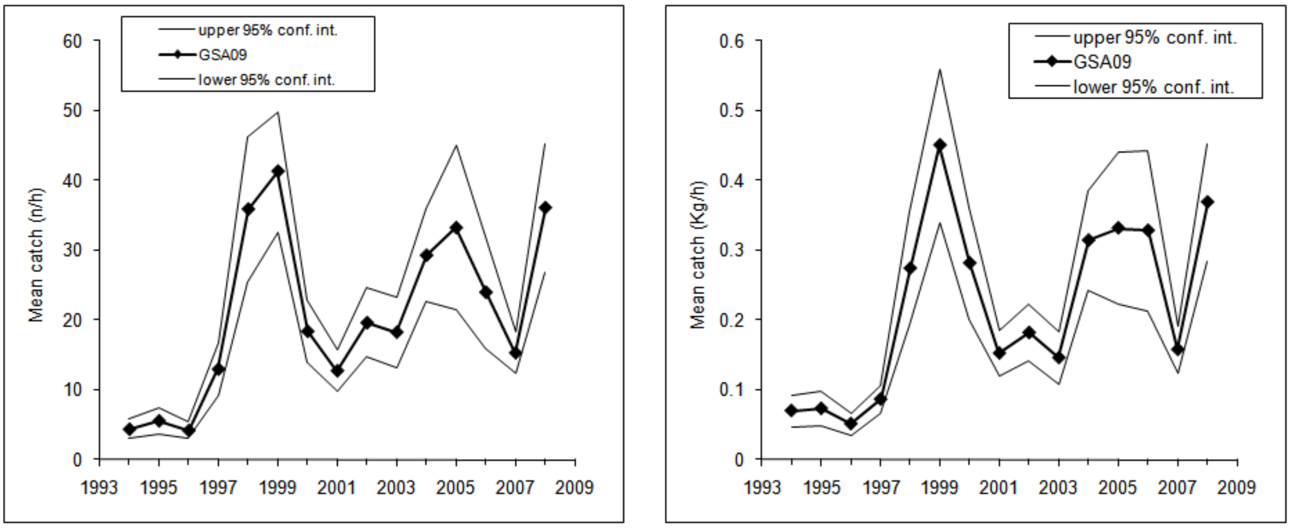


Fig. 8.32.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 09.

8.32.3.1.4. Trends in abundance by length or age

The following Fig. 8.32.3.1.4.1 and 2 display the stratified abundance indices of GSA 09 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

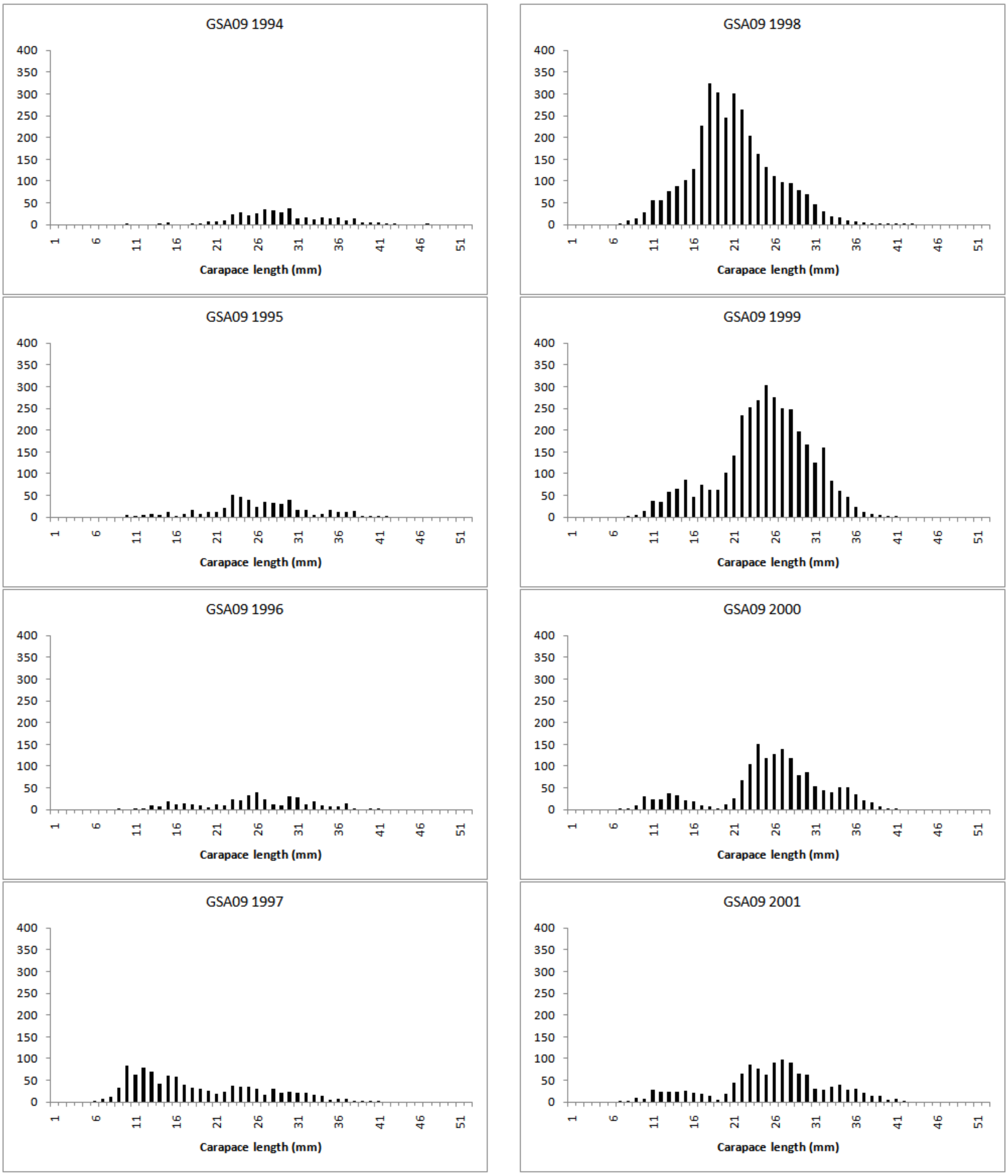


Fig. 8.32.3.1.4.1 Stratified abundance indices by size, 1994-2001.

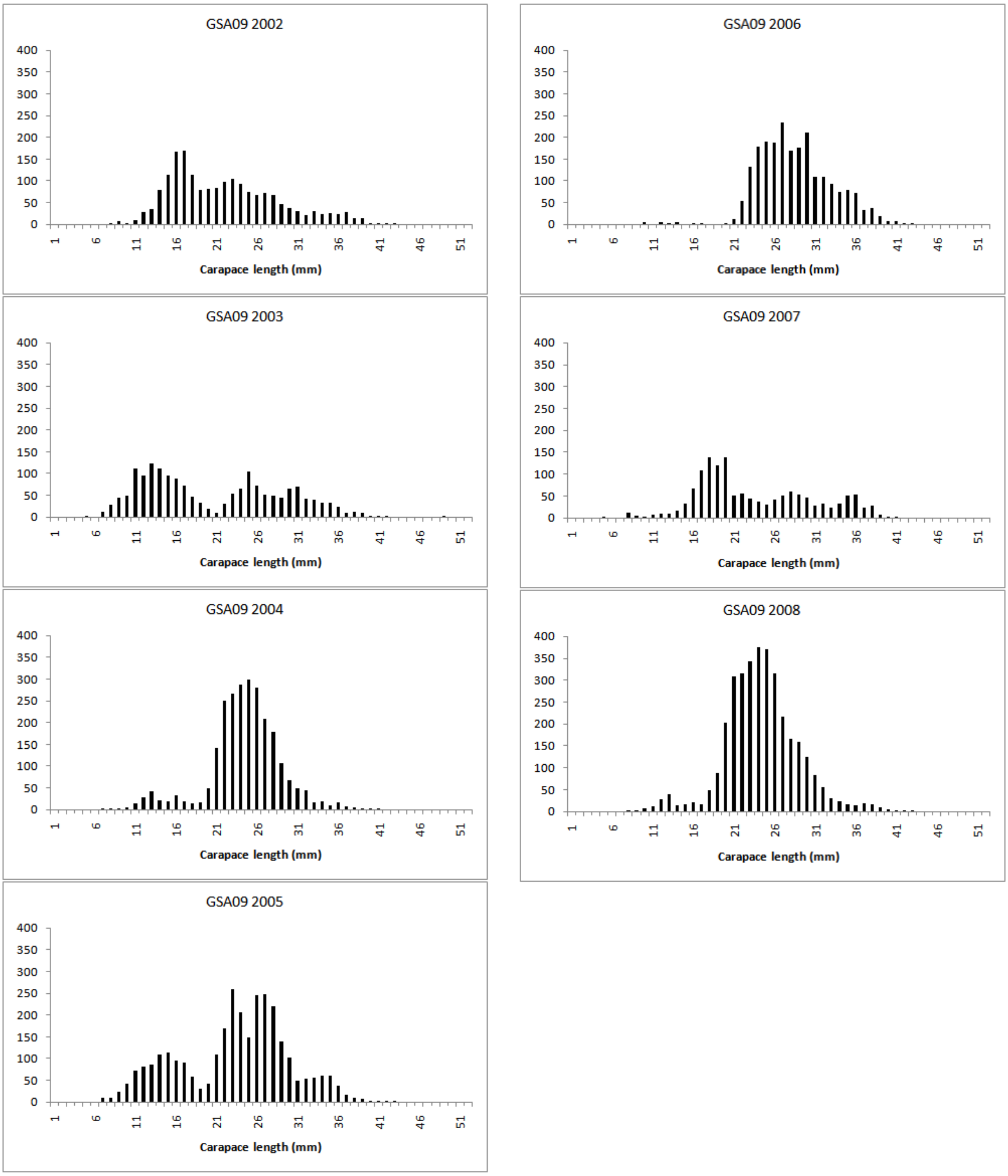


Fig. 8.32.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.32.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.32.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.32.4.Assessment of historic stock parameters

8.32.4.1.Method 1: SURBA

8.32.4.1.1. Justification

The MEDITS survey provided the longer standardized time-series data on abundance and population structure of *P. longirostris* in the GSA 09.

8.32.4.1.2. Input parameters

The survey-based stock assessment model SURBA (Needle, 2003) was used to reconstruct trend in population structure and fishing mortality.

The following set of input data and parameters were used (Tab. 8.32.4.1.2.1 and 2).

Tab. 8.32.4.1.2.1 Input data used in the SURBA model.

MEDITS					GRUND				
Abundance indices					Abundance indices				
	Age					Age			
Year	0	1	2	3 plus	Year	0	1	2	3 plus
1994		25.9541	9.72426	3.0482	1994	35.3032	14.5772	4.66516	0.81345
1995		33.8225	7.05174	2.47529	1995	80.6188	23.5831	4.3679	0.40755
1996		22.5966	7.07091	1.60413	1996	93.7731	16.1773	2.97484	0.3662
1997		33.2423	7.77798	0.98398	1997	74.2001	18.2187	1.98605	0.12986
1998		132.765	9.41024	0.92144	1998	444.352	33.195	2.62517	0.19366
1999		253.652	45.6518	1.85476	1999	339.528	53.0895	5.63031	0.18264
2000		155.606	39.5678	3.70167	2000	234.703	72.9841	8.63545	0.17163
2001		73.213	18.8227	3.92505	2001	141.925	40.6719	6.72077	0.34235
2002		70.1125	17.4029	3.98793	2002	176.265	28.1209	3.93123	0.58552
2003		58.1322	17.2738	2.46701	2003	235.825	63.7607	6.26353	0.68811
2004		186.91	16.5368	1.38521	2004	509.826	93.3674	23.4218	26.8489
2005		216.286	29.6521	2.41339	2005	566.975	177.413	16.8693	1.02686
2006		209.473	53.6493	7.74463	2006	470.9	187.045	14.5614	1.20193
2007		57.9188	26.0426	4.01691	2007	363.242	101.594	8.15385	0.60096
2008		260.719	16.4135	3.72848					
Proportion of mature					Proportion of mature				
	0	1	2	3		0	1	2	3 plus
1994		0.8	1	1	1994	0.4	0.8	1	1
1995		0.8	1	1	1995	0.4	0.8	1	1
1996		0.8	1	1	1996	0.4	0.8	1	1
1997		0.8	1	1	1997	0.4	0.8	1	1
1998		0.8	1	1	1998	0.4	0.8	1	1
1999		0.8	1	1	1999	0.4	0.8	1	1
2000		0.8	1	1	2000	0.4	0.8	1	1
2001		0.8	1	1	2001	0.4	0.8	1	1
2002		0.8	1	1	2002	0.4	0.8	1	1
2003		0.8	1	1	2003	0.4	0.8	1	1
2004		0.8	1	1	2004	0.4	0.8	1	1
2005		0.8	1	1	2005	0.4	0.8	1	1
2006		0.8	1	1	2006	0.4	0.8	1	1
2007		0.8	1	1	2007	0.4	0.8	1	1
2008		0.8	1	1					
Mean weight					Mean weight				
	0	1	2	3		0	1	2	3 plus
1994		15.517	18.133	25.144	1994	4.5	16.469	18.118	24.955
1995		15.078	18.001	24.722	1995	5	13.809	17.368	24.615
1996		16.469	18.118	24.955	1996	3.9	15.788	17.08	24.914
1997		13.809	17.368	24.615	1997	5.2	15.944	17.232	23.968
1998		15.788	17.08	24.914	1998	4.9	14.706	18.032	23.816
1999		15.944	17.232	23.968	1999	5	14.717	18.234	24.564
2000		14.706	18.032	23.816	2000	4.5	16.044	18.011	24.218
2001		14.717	18.234	24.564	2001	5.2	14.865	17.578	24.262
2002		16.044	18.011	24.218	2002	5.1	14.741	17.123	23.824
2003		14.865	17.578	24.262	2003	5	14.86	18.032	24.686
2004		14.741	17.123	23.824	2004	4.3	16.498	17.814	24.371
2005		14.86	18.032	24.686	2005	4.7	5	17.232	18.529
2006		16.498	17.814	24.371	2006	5.1	17.232	18.529	23.753
2007		17.232	18.529	23.753	2007	4.9	17.232	18.529	23.753
2008		17.232	18.529	23.753					

Tab. 8.32.4.1.2.2 Input parameters used in the SURBA model.

• **Growth**
L∞ = 43.5 mm carapace length
K = 0.6
to = 0
• **Length-Weight relationhips**
a = 0.00686
b = 2.24
• **Natural mortality**
M = 1.0 (age 0), 0.78 (age 1), 0.69 (age 2), 0.65 (age 3) (ProdBiom)
• **Length-at-maturity (L50)**
L50 = 24 mm
Lc100 = 20 mm

Standardized time series of MEDITS length-frequency-distributions were sliced into different age-groups using the same growth parameters for the whole time series (Fig. 8.32.4.1.2.1). The resulting age structures showed a very high internal consistency, thus showing the reliability of the growth parameters used (Fig. 8.32.4.1.2.1).

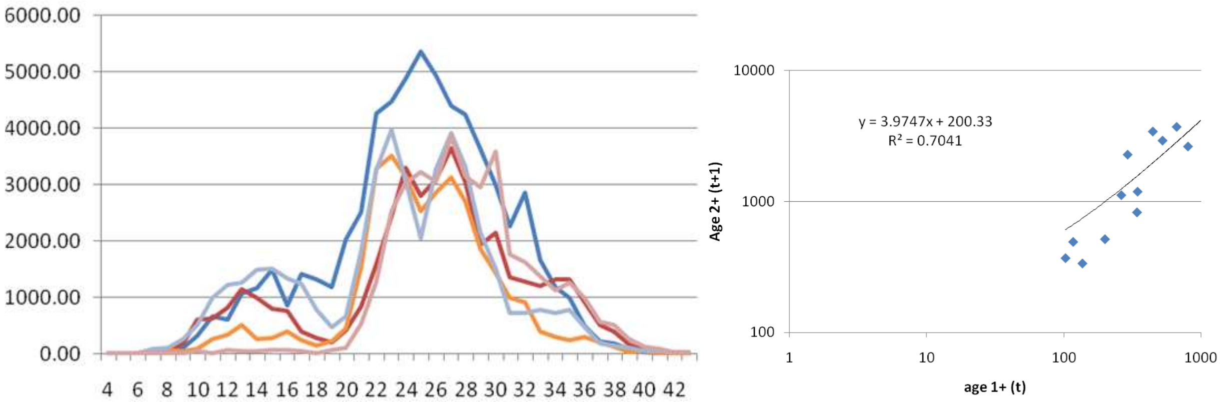


Fig. 8.32.4.1.2.1 Length frequency distributions of *P. longirostris* for 2000 to 2005 (left). Relationship between the estimated shrimp abundance at age 1 (time t) and age 2 (time t+1) (right).

A preliminary attempt to use Surba was made excluding 0+ (CL < 20mm) specimens from the dataset due to their low catchability with the MEDITS trawl net. A fixed M mortality value (M=1.0) obtained from literature was used.

8.32.4.1.3. Results

Average mortality ($F_{1\text{-}3}$) estimated from MEDITS ranged between 0.78 and 1.8 (1.16 in 2007). GRUND returned higher $F_{1\text{-}3}$ values with some outliers in 2002-03. Relative indices derived from MEDITS survey for the period 1994-2008 indicated an increasing trend of the spawning stock biomass with three peaks in 1999, 2006 and 2008. In 2008 the SSB was the highest observed since 1994. GRUND data showed a very similar temporal trend in SSB (Fig. 8.32.4.1.3.1). Young of the year (0+) are poorly sampled by the MEDITS survey. GRUND survey showed a clear increase of 0+ specimens since 1994 (Fig. 8.32.4.1.3.1).

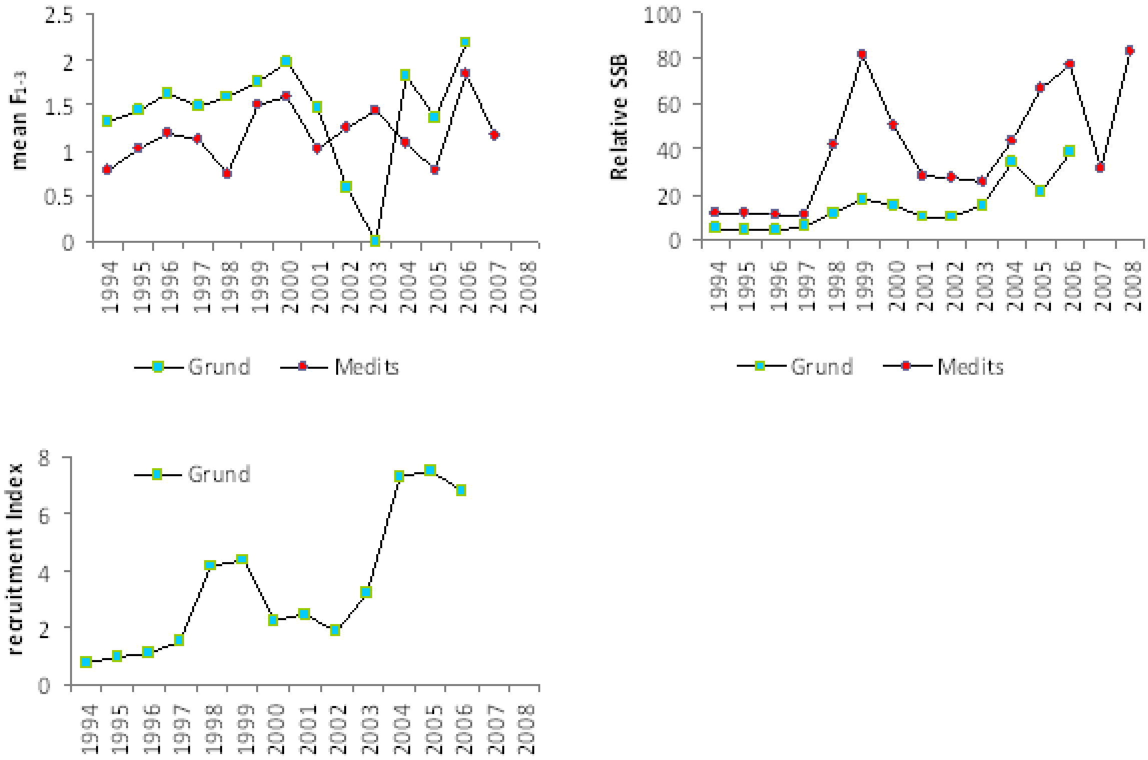


Fig. 8.32.4.1.3.1 Estimated trend in F_{1-3}, relative SSB and recruitment index at age 1+ of *P. longirostris* in the GSA 09, dotted lines are 2.5% and 97.5% confidence intervals.

<u>Model diagnostics</u>

The Surba model for *P. longirostris* fits very well on survey data as showed in Fig. 8.32.4.1.3.2.

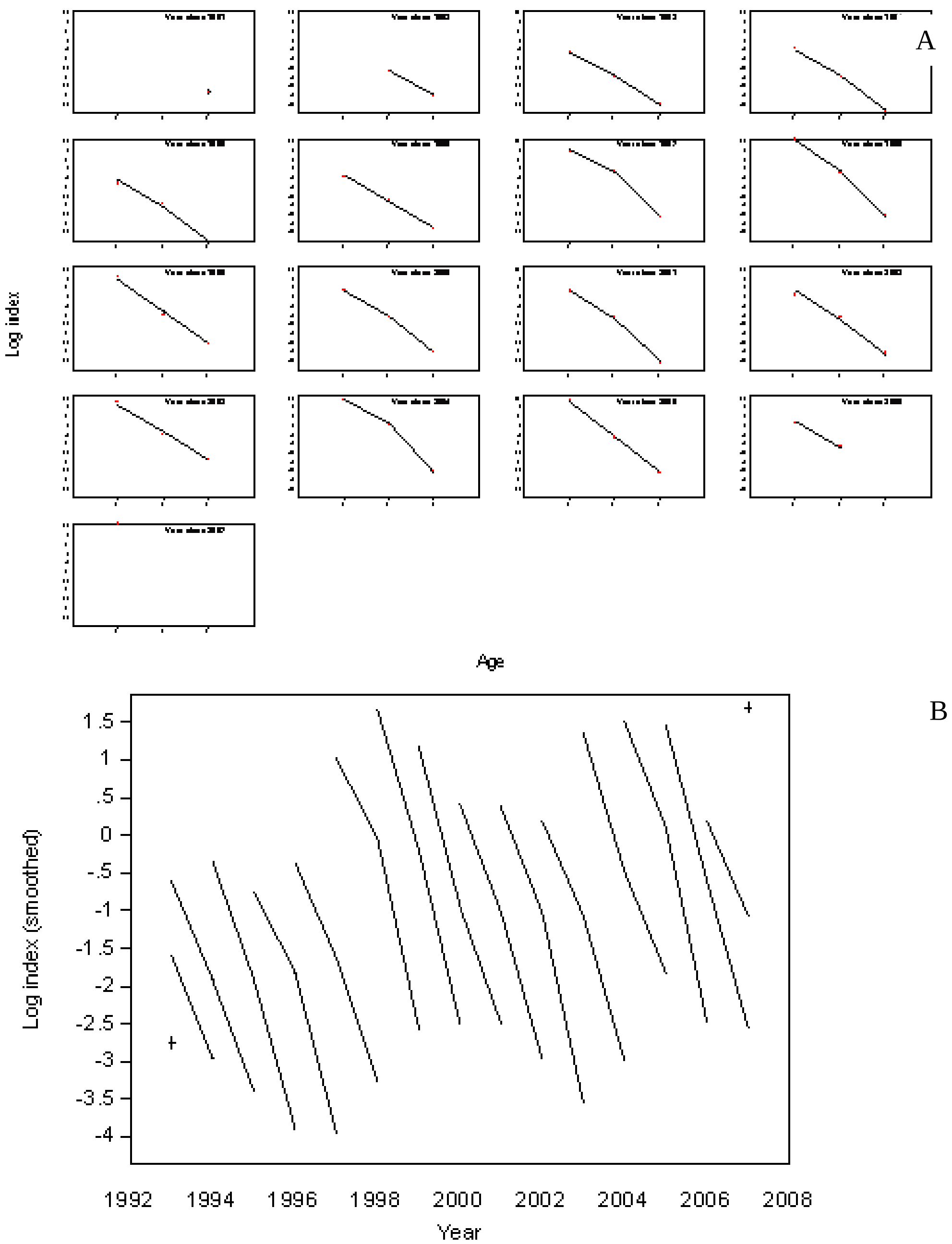


Fig. 8.32.4.1.3.2. Model diagnostic for Surba model of in the GSA 9. A) Comparison between observed (points) and fitted (lines) MEDITS survey abundance indices, for each year. B) Log survey abundance indices by cohort. Each line represents the log index abundance of a particular cohort throughout its life.

8.32.4.2.Method 2: LCA

8.32.4.2.1. Justification

The pseudo-cohort analysis VIT was applied.

8.32.4.2.2. Input parameters

Data coming from DCR provided at SGMED-09-02 contained information on deep water pink shrimp landings and the respective size structure for 2006-2007 (Fig. 8.32.4.3.2.1). VIT software was used to run an LCA analysis for each year separately, using data in Tab. 8.32.4.2.2.1 and biological parameters listed in Tab. 8.32.4.1.2.2. The same M-vector used for SURBA (ProdBiom estimation) was used (age 1: 1; age 2: 0.78; age 3: 0.69; age 4: 0.65; age 5. 0.5).

Tab. 8.32.4.3.2.1. Input data for LCA of deep water pink shrimp in GSA 09.

	Landings (thousands)		
CL (mm)	2006	2007	2008
13	18.2	11.1	
14	27.2	32.1	
15	65.9	40.2	
16	55.8	52.0	
17	67.4	102.0	419.9
18	120.8	147.0	584.2
19	91.6	447.4	626.3
20	181.9	520.8	585.6
21	164.5	843.7	650.6
22	396.3	1059.5	771.0
23	850.9	1223.9	703.7
24	1409.8	746.0	742.4
25	1938.5	1017.4	687.0
26	2088.3	827.1	532.3
27	2509.0	804.4	628.9
28	2907.6	667.7	718.3
29	2257.0	557.5	633.8
30	3385.7	446.6	593.5
31	2949.6	374.8	638.4
32	2627.6	832.4	696.6
33	2373.1	1460.4	550.4
34	1579.8	678.1	446.6
35	1298.3	531.9	361.0
36	1074.2	397.6	333.4
37	1072.9	232.8	214.0
38	596.3	165.8	212.4
39	690.0	46.7	139.7
40	363.0	29.1	95.6
41	170.7	12.6	36.8
42	109.9	6.6	24.5
43	16.1	3.7	61.0

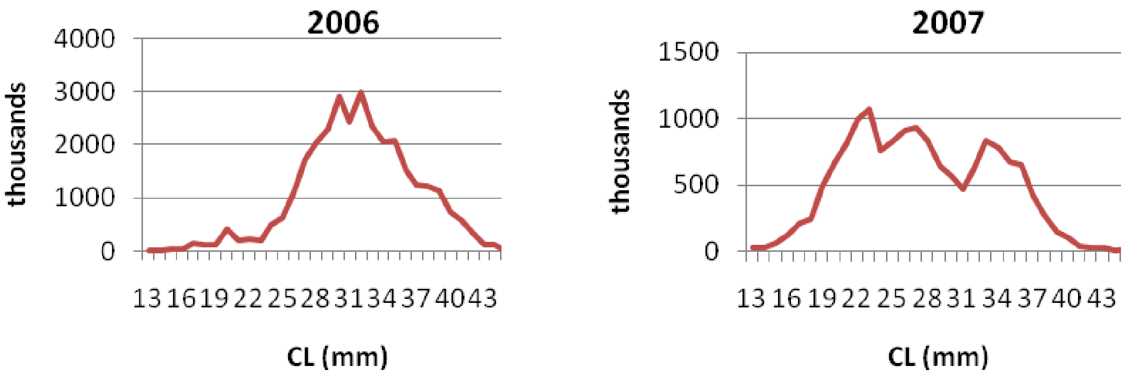


Fig. 8.32.4.3.2.1. Length frequency distributions of the *P. longirostris* catch in 2006 and 2007 in the GSA 09.

8.32.4.2.3. Results

Deep water pink shrimp landings in 2006 and 2008 were concentrated on adults of age classes 2-4. High landings were observed in 2006. Fishing mortality peaked for specimens of age classes 2 and 3 (Fig. 8.32.4.3.3.1). $F_{1\text{-}3}$ (obtained averaging the estimated F values of age classes 2, 3 and 4) was 0.53, 0.61 and 0.58 in 2006, 2007 and 2008, respectively.

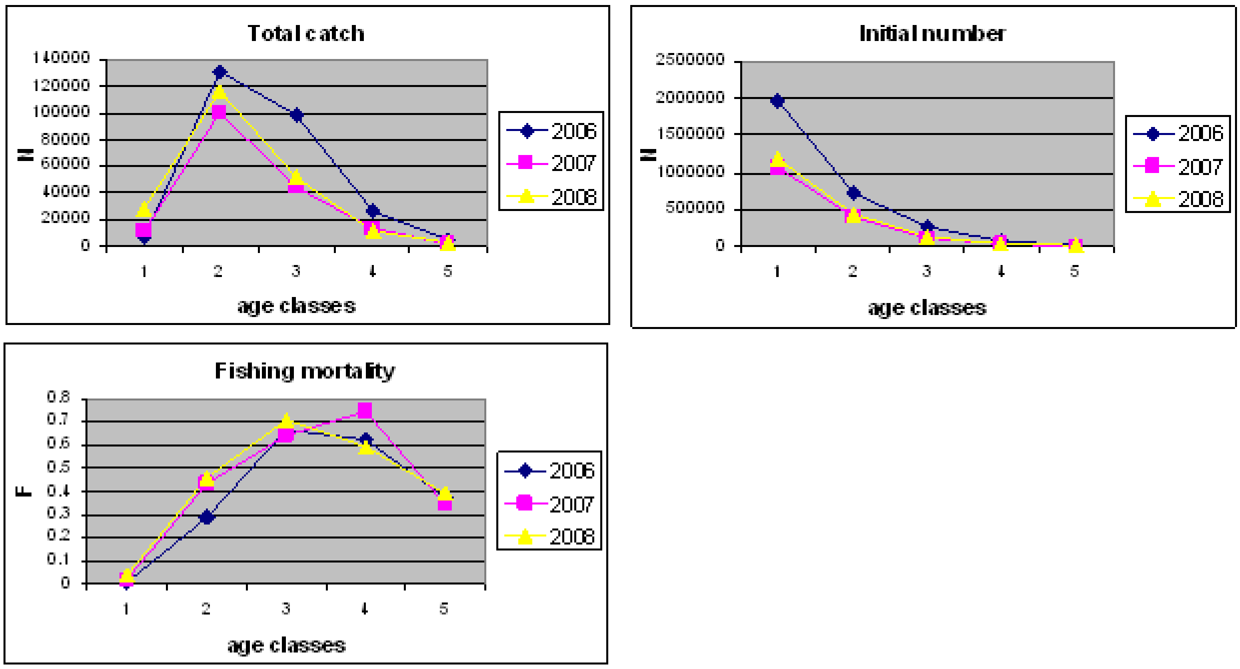


Fig. 8.32.4.3.3.1 Lca outputs: catch numbers, numbers-at-age and fishing mortality at age of *P. longirostris* in the GSA 09.

8.32.5. Long term prediction

8.32.5.1. Justification

The Yield software (Hoggarth et al., 2006) was used to estimate F_{01} as target equilibrium YPR reference point for the stock assuming a 20% uncertainty in parameters estimations.

8.32.5.2.Input parameters

The following parameters were used to estimate F0.1 through Yield software.

Tab. 8.32.5.2.1 Input to long term forecast.

L_∞ = 43.5 mm carapace length
K = 0.6
t_0 = 0
a = 0.00686
b = 2.24
M = 1.2 CV=0.1
L_{50} = 24 mm, CV=0.05
Lc100 = 20 mm, CV=0.05
Spawning season: March-August
Fishing season: January-December

8.32.5.3.Results

Fig. 8.32.5.3.1 shows the probability distribution of $F_{0.1}$ (1,000 simulations). Uncertainty in model parameters produced considerable variations in $F_{0.1}$ which ranged between 0.5 and 1.1 (mean = 0.7) with an increased probability for values between 0.7 and 0.8.

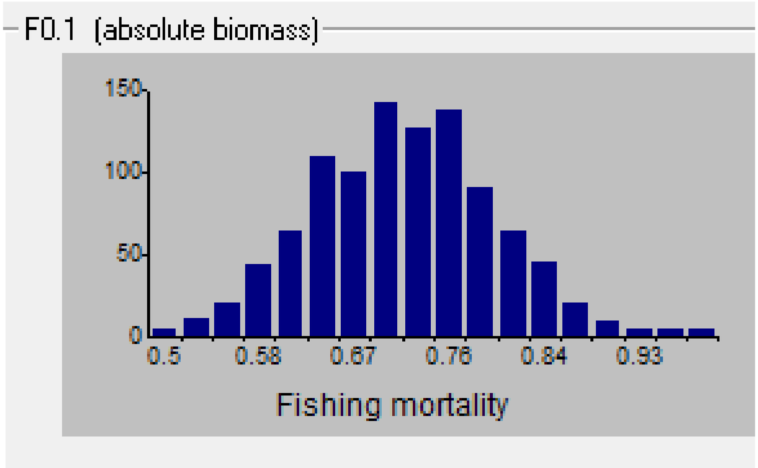


Fig. 8.32.5.3.1 Probability distribution of F0.1 obtained using the Yield software.

According to these $F_{0.1}$ estimates, Fcurr was in most of the year above the average and maximum estimated $F_{0.1}$ values.

8.32.6.Scientific advice

8.32.6.1.Short term considerations

8.32.6.1.1. State of the spawning stock size

SSB showed an increasing trend during the last 13 years.

8.32.6.1.2. State of recruitment

Relative indices for age 1+ indicated a general increasing trend since 1994 with two main recruitment peaks in 1999 and 2005. In 2007 recruitment estimated by GRUND survey (age 0) was 61% of the short term average (2004-06). In 2008 recruitment at age 1 (MEDITS) was 170% of the short term average (2005-07).

8.32.6.1.3. State of exploitation

According to the F estimates obtained using trawl surveys indices (GRUND and MEDITS) with SURBA, Fcurr was in most of the years (especially in the last five years) above the average and maximum estimated $F_{0.1}$ values. In this case, the stock would not appear to be able to sustain the current level of fishing effort in the GSA 09. In the period considered (1994-2007) it seemed to be in an overexploited status.

A different picture comes from the F estimates through LCA on the last three years of landing data. F_{1-3} was between 0.5 and 0.6 for the period 2006-2008, little below the estimated reference value of $F_{0.1}$=0.7. SGMED's advice relies on the LCA and considers the stock being harvested sustainably. It is important to consider that this stock could be strongly driven by environmental and ecological factors (e.g. water temperature, predatory release effect) that can make difficult to evaluate the effect of fishing on the stock.

8.33. Stock assessment of pink shrimp in GSA 10

8.33.1. Stock identification and biological features

8.33.1.1. Stock Identification

The stock of pink shrimp was assumed in the boundaries of the whole GSA10, lacking specific information on stock identification. The pink shrimp is epibenthic and inhabits the muddy or sandy- muddy bottoms of the continental shelf. A gradient of increasing size with depth has been observed in GSA 10 as in other areas, being the smallest specimens found more frequently in the upper part of the continental shelf (100-200 m), while the largest ones are mainly distributed along the slope at depths greater than 200 m (Spedicato et al., 1996). Aggregations with higher abundance were localised between 100 and 200 m depth, with some intrusions in the deeper levels. Two most important patches were located in the Gulf of Naples and along the Calabrian coasts in correspondence with Cape Bonifati, while a third one in the Gulf of Salerno (Lembo et al., 1999). These are also the areas where the main nurseries are localised (Lembo *et al*., 2000).

In the Central-Southern Tyrrhenian Sea the occurrence of mature females was observed in spring (May), summer (July-August) and autumn (October), with a higher relative frequency in spring-summer seasons (Spedicato et al., 1996). Thus, a continuous recruitment pattern is shown which, however, exhibits a main pulse in the autumn season. At 16 mm carapace length the pink shrimp is considered recruited to the grounds (AA.VV., 2002)

The overall sex ratio is about 0.5. The structure of the sizes of *P. longirostris* is characterised by differences in growth between the sexes, the larger individuals being females. The pink shrimp is a short-living crustacean with a life span of about 4 years (Carbonara et al., 1998).

The deep-water rose shrimp with hake and red mullet is a key species for fisheries in the central-southern Tyrrhenian Sea. In the last decade it is also generally ranked among the species with higher abundance indices (number of individuals) in the trawl surveys (e.g. Spedicato et al. 2003) as observed in other Mediterranean areas (Abellò et al., 2002).

The pink shrimp is caught on the same fishing grounds as European hake and the production of this shrimp is steadily growing in the last decade in the southern basin and it has reached about 10% of the demersal landings in 2006.

8.33.1.2. Growth

No information was documented during SGMED-09-02.

Past estimates of the growth pattern of the pink shrimp females were obtained using different methods based on the LFD analysis (modal progression analysis-MPA, Elefan, Multifan) applied to Grund data from 1990 to 1995. Parameters of VBGF were: L_∞=45.9; K=0.673 t_0= -0.251 (Carbonara *et al.*, 1998). VBGF parameters were also re-estimated during the Samed project (AA.VV., 2002) using the Medits time series from 1994 to 1999, that gave the following values: females: CL_∞=45.0 mm, K=0.7, t_0= -0.15; males: CL_∞=40.0 mm; K=0.78; t_0= -0.2. Maximum carapace lengths (CL) observed for females and males were respectively 42.3 mm and 39 mm. The growth parameters from DCR are as follows: females CL_∞=46 mm, K=0.575, t_0= -0.2; males CL_∞=40 mm, K=0.68, t_0= -0.25. They also describe a fast growing pattern albeit slightly lower than that previously observed. The length weight relationships by sex and for sex combined are as follows: females: a=0.8777-1.0103, b=2.496-2.422; males a=0.9189-1.0242; b=2.42-2.204 sex combined a=0.88125-0.9756; b= 2.483-2.447.

8.33.1.3. Maturity

The maturity ogive Fig. 8.33.1.3.1 was obtained from a maximum likelihood procedure applied grouping as "mature" individuals belonging to the maturity stage 2b-2e (according to the Medits maturity scale). The fitting of the curve was fairly good, although the estimates of the size at first maturity $L_{m50\%}$ (1.92 cm ±0.006 cm) and of the maturity range (0.31 cm ±0.009 cm) seem to be underestimated when compared with literature values (average of the smallest females = 24 mm CL; in Syndem, 1999).

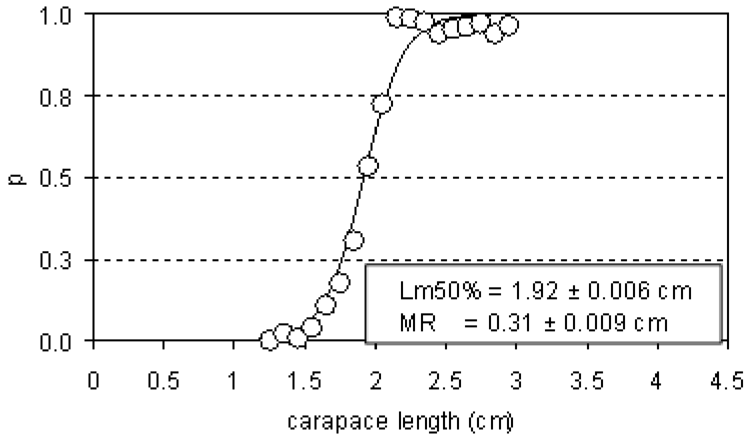


Fig. 8.33.1.3.1 Maturity ogive of pink shrimp in the GSA10 (MR indicates the difference $Lm_{75\%}$-$Lm_{25\%}$).

The sex ratio from DCR evidenced the prevalence of males between 1.2 and 2.0 cm, while from 2.4 cm onwards the proportion of females was dominant.

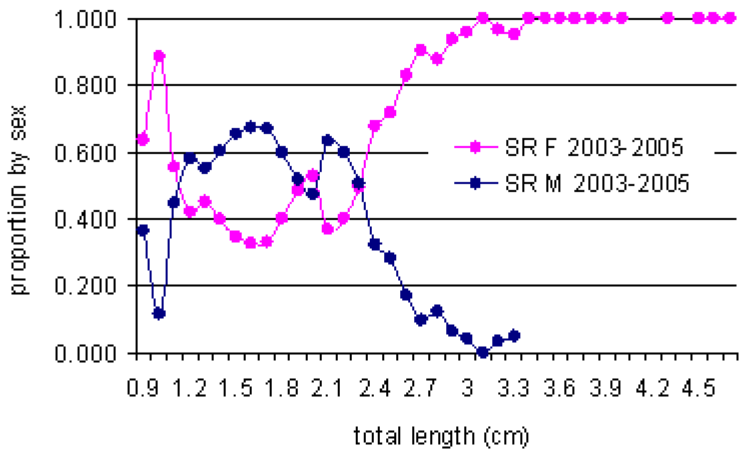


Fig. 8.33.1.3.2 Maturity ogive of pink shrimp in the GSA10 (MR indicates the difference $Lm_{75\%}$-$Lm_{25\%}$).

8.33.2.Fisheries

8.33.2.1.General description of fisheries

The pink shrimp is only targeted by trawlers and fishing grounds are located offshore 50 m depth, on the continental shelf and slope of the whole GSA. The pink shrimp occurs mainly with *M. merluccius*, *M. barbatus*, *Eledone cirrhosa*, *Illex coindetii* and *Todaropsis eblanae*, *N. norvegicus*, *P. blennoides*, depending on depth and area.

8.33.2.2.Management regulations applicable in 2008 and 2009

Management regulations are based on technical measures, like the number of fishing licenses and area limitation (distance from the coast and depth). In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late 1980s. After 2000, in agreement with the European Common

Policy of Fisheries, a gradual decreasing of the fleet capacity is implemented. Along the northern Sicily coasts two main Gulfs (Patti and Castellammare) have been closed to the trawl fishery up 200 m depth, since 1990. Two closed areas were also established in 2004 along the mainland, in front of Sorrento peninsula (Napoli Gulf) and Amantea (Calabrian coasts), although these protected area mainly cover the distribution of coastal species. Other measures on which the management regulations are based regard technical measures (mesh size) and minimum landing sizes (EC reg. 1967/06). In the GSA 10, the fishing ban has not been mandatory and it has been adopted on a voluntary basis by the fleet.

8.33.2.3.Catches

8.33.2.3.1. Landings

Available landing data are from DCR regulations. SGMED-09-02 received Italian landings data for GSA 10 by fishing gears which are listed in Tab. 8.33.2.3.2.1. The fishing segments DTS, PGP, PMP and PTS indicate respectively trawlers, small scale fishery (nets) polyvalent and pair trawl. After 2004, landings of the blue and red shrimp decreased in 2008 to the level of 2003 (about 20 t) (Fig. 8.33.2.3.1.1). Most part of the landings is from trawlers.

Tab. 8.33.2.3.1.1. Annual landings (t) by gear type in GSA 10, 2002-2008.

LW tons	FT_LVL4							
YEAR	DTS	GNS	GTR	OTB	PGP	PMP	PTS	Total
2002	1452				223	373	34	1861
2003	416					71		487
2004				552				552
2005		6	1.06	769				776
2006				1089				1089
2007				534				534
2008		0.13		400				400

If the value of 2002 is excluded, that seems anomalous, the catches of the species are rising from 2003 to 2006 when the 1089 tons were recorded and then are decreasing to 400 tons in 2008 that is a value very close to that of 2003 (487 tons).

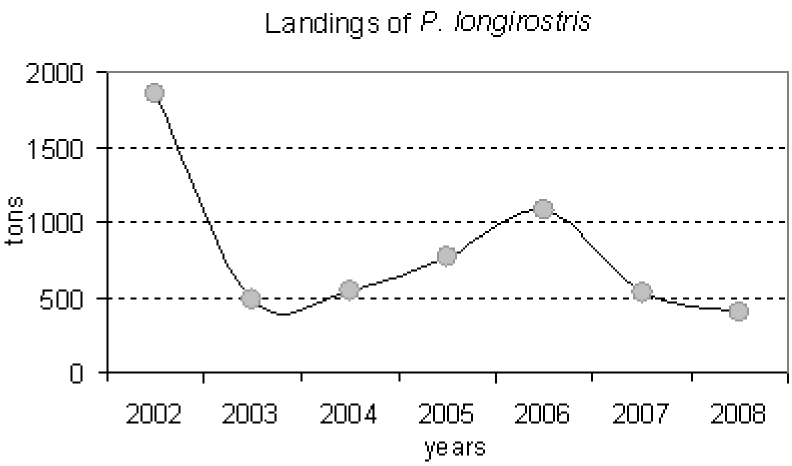


Fig. 8.33.2.3.1.1 Total landings (t) 2003-2008, as reported by DCR in the GSA 10.

8.33.2.3.2. Discards

1 t of discards in 2006 was reported to SGMED-09-02 through the DCR data call and is listed in Tab. A.3.9 of Appendix 3.

8.33.2.3.3. Fishing effort

The trends in fishing effort by year and gear type is listed in Tab. 8.33.2.3.3.1 and shown in Fig. 8.33.2.3.2.1 in terms of kW*days. The fishing segments DTS, HOK, PGP, PMP and PTS indicate respectively trawlers, long-lines, small scale fishery (nets), polyvalent, and pair trawls. The fishing effort in kW*days of the trawlers, that is the fishing segment targeting the giant red shrimp, was rising in 2004 and 2005 and then decreasing in 2006 and 2007.

Tab. 8.33.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSA 10, 2002-2007.

YEAR	FT_LVL4_TYPE		KW*DAYS						
	DRB	DTS	FPO	GND	GNS	GTR	HOK	LHP-LHM	LLD
2002	94663	7344089							
2003	29540	7231486							
2004	110899	7883881					1654352		
2005	404243		226805	2878658	4378416	1519874		441690	819922
2006	392760		147562	2394591	2465382	3789078		395408	654956
2007	170557		5309	2232763	1848657	3793640		417886	412060
YEAR	LLS	MIS	OTB	PGP	PMP	PS	PTS	SB-SV	Total
2002				6440217	12686947		2631242		29197158
2003				7222145	8003452		2930380		25417003
2004				7056306	3588004		2308589		22602033
2005	1852150	936565	8102762			1538303		701108	23800496
2006	1289606	273517	6944418			1506523		859501	21113301
2007	1194311	73082	6882389			1222112		959937	19212704

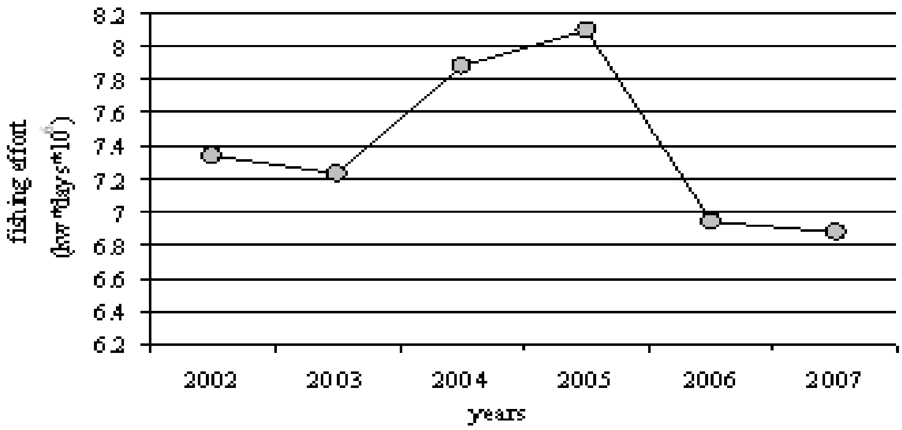


Fig. 8.33.2.3.3.1 Trend in fishing effort (kW*days*10^6) of trawlers in the GSA 10, 2002-2007.

8.33.3. Scientific surveys

8.33.3.1. Medits

8.33.3.1.1. Methods

According to the MEDITS protocol (Bertrand *et al*., 2002), trawl surveys were carried out yearly (May-July), applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish and weight per surface unit) were standardised to square kilometre, using the swept area method.

Based on the DCR data call, abundance and biomass indices were recalculated.

In GSA 10 the following number of hauls was reported per depth stratum (Tab. 8.33.3.1.1.1).

Tab. 8.33.3.1.1.1. Number of hauls per year and depth stratum in GSA 10, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA10_010-050	9	10	10	10	10	10	10	10	9	9	9	9	9	9	9
GSA10_050-100	12	12	12	12	12	12	12	12	10	10	10	10	10	10	10
GSA10_100-200	20	20	20	20	20	20	20	20	17	17	17	17	17	17	17
GSA10_200-500	26	27	26	26	27	26	26	28	22	22	22	22	22	22	22
GSA10_500-800	31	30	31	31	31	30	31	29	26	26	26	26	26	26	26

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O’Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.33.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.33.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the pink shrimp in GSA 10 was derived from the international survey Medits. Figure 8.33.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSA 10.

The estimated abundance and biomass indices peaked in 1999 and 2005-2006. However, the recent abundance and biomass indices in 2007 and 2008 appear low, which appears consistent with the low landings in these years.

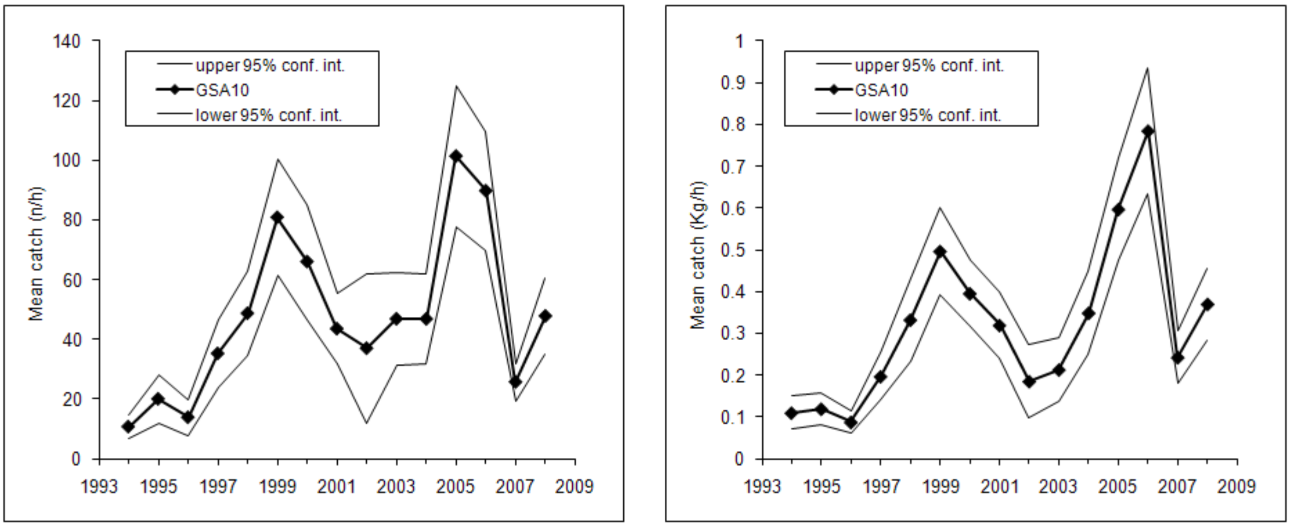


Fig. 8.33.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 10.

8.33.3.1.4. Trends in abundance by length or age

The following Fig. 8.33.3.1.4.1 and 2 display the stratified abundance indices of GSA 10 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

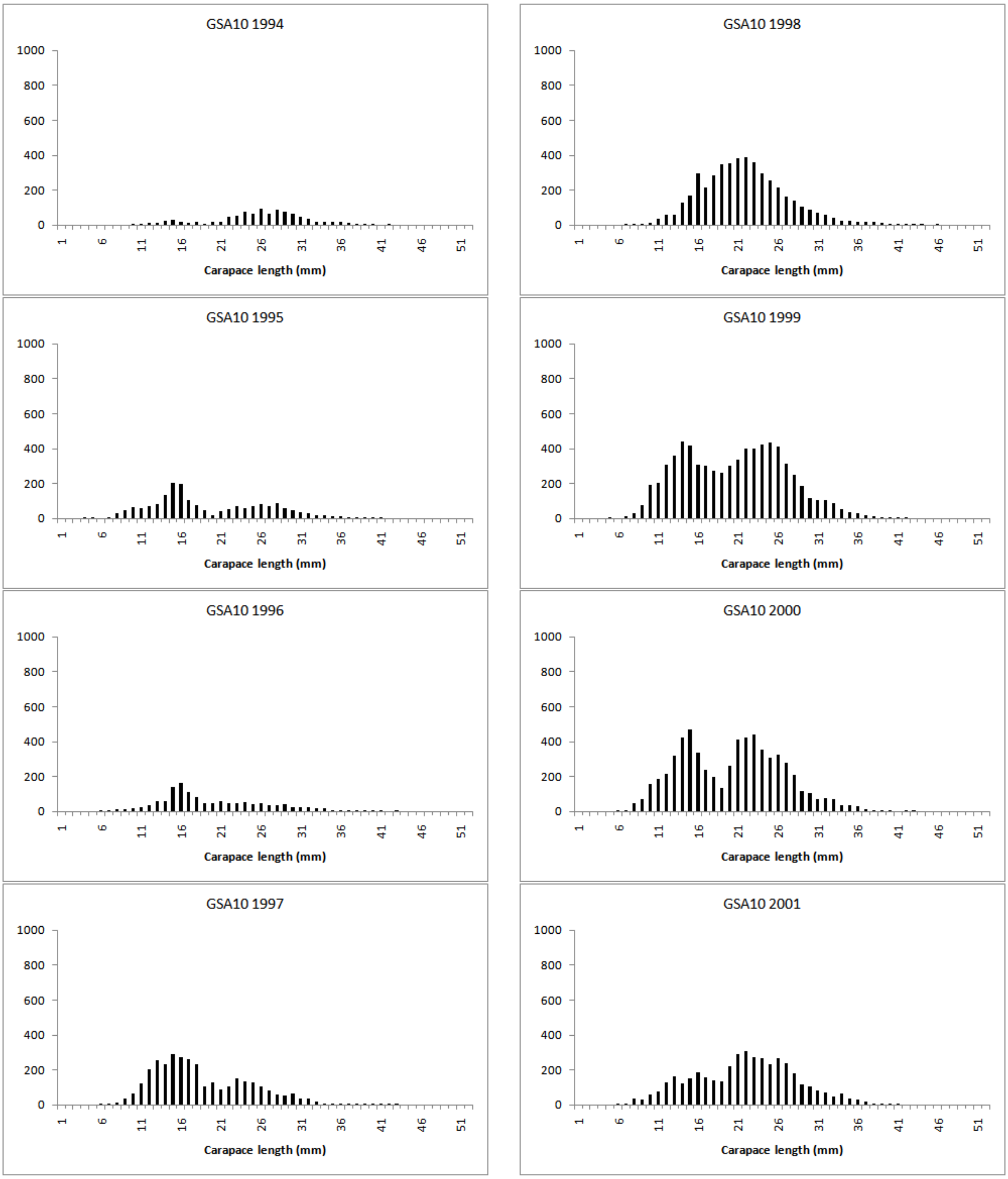


Fig. 8.33.3.1.4.1 Stratified abundance indices by size, 1994-2001.

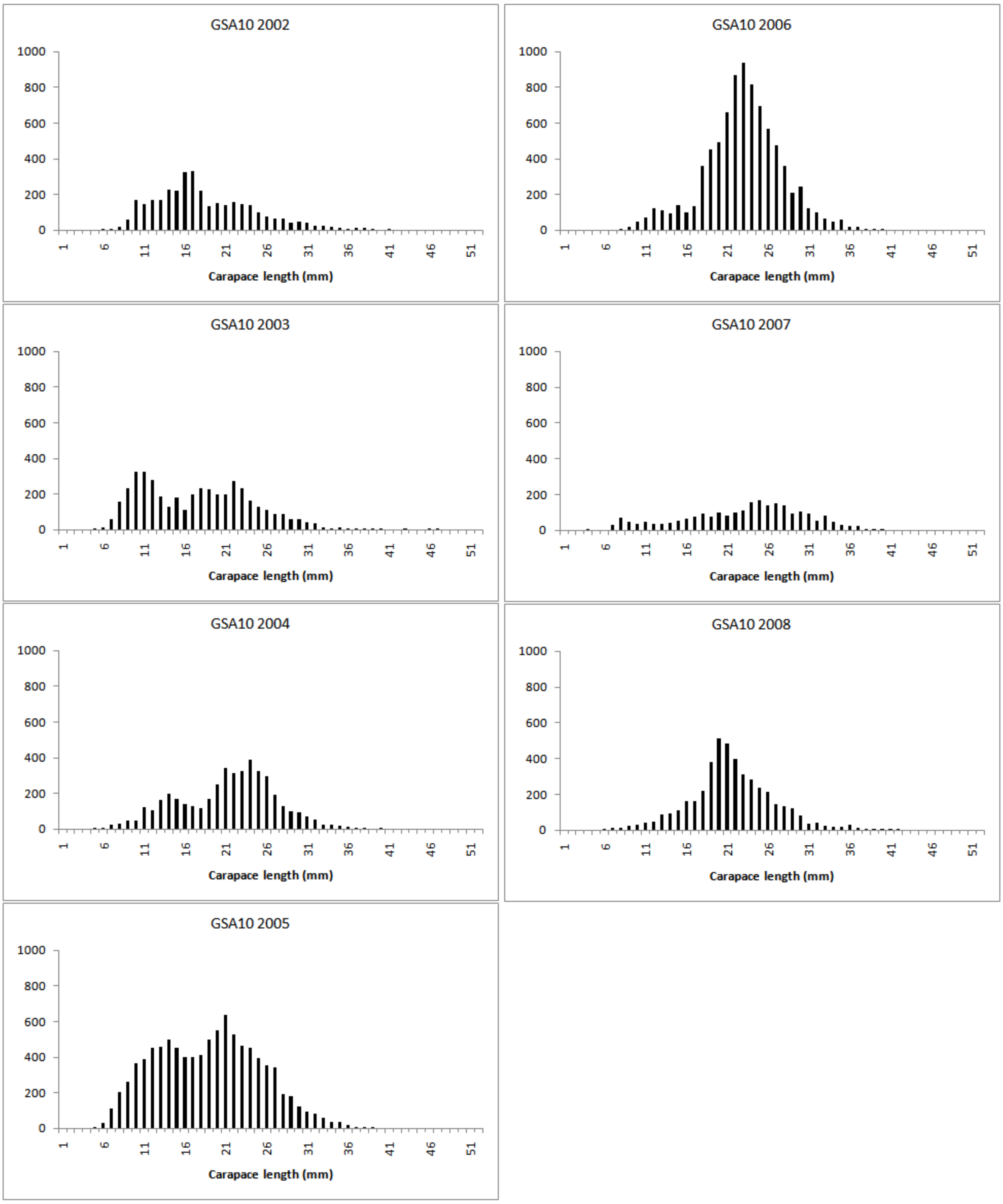


Fig. 8.33.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.33.3.2.GRUND

8.33.3.2.1. Methods

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

8.33.3.2.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.33.3.2.3. Trends in abundance and biomass

Trends derived from the GRUND surveys are shown in Fig. 8.33.3.2.1.1 Abundance and biomass indices show an increasing trend up to 2005 and a decreasing in 2006, as well as recruitment indices. In 1999 the survey was not performed.

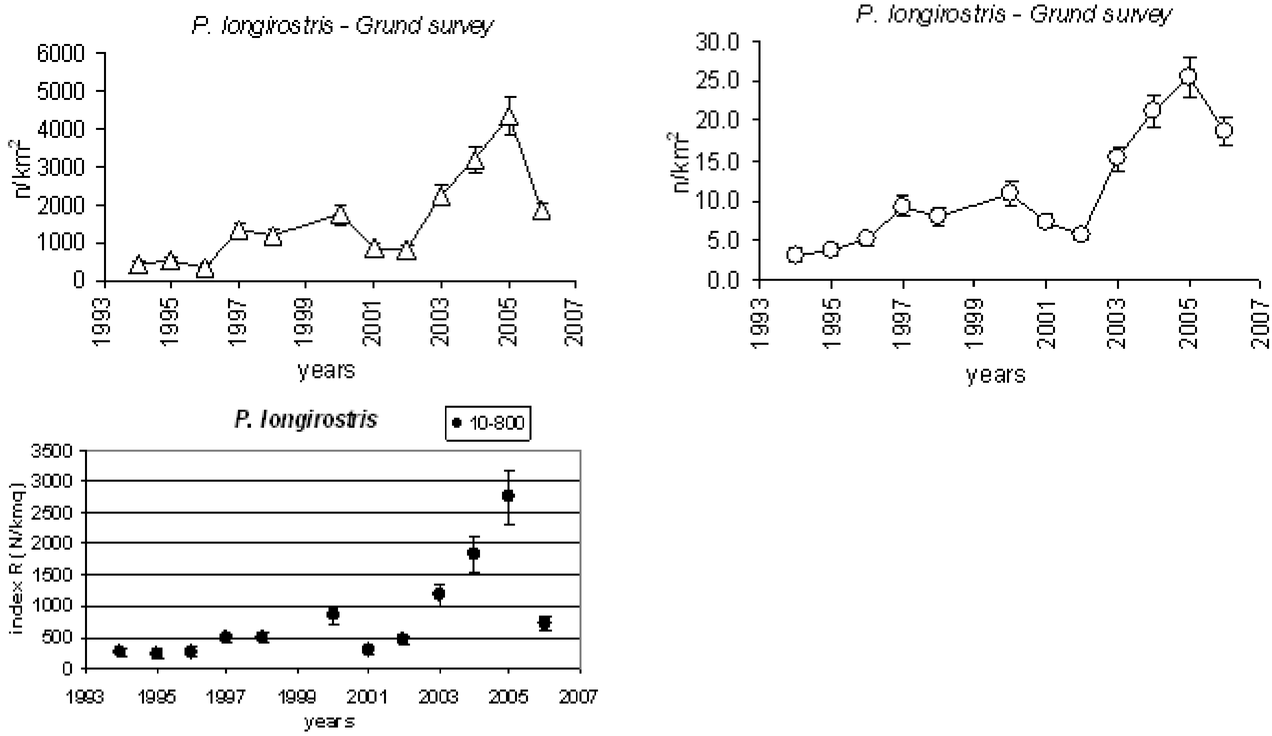


Fig. 8.33.3.2.1.1 Abundance and biomass indices of the pink shrimp in GSA 10 (bars indicate standard deviations). Recruitment indices (N/km^2) computed in the total depth range with standard deviation is also reported.

8.33.3.2.4. Trends in abundance by length or age

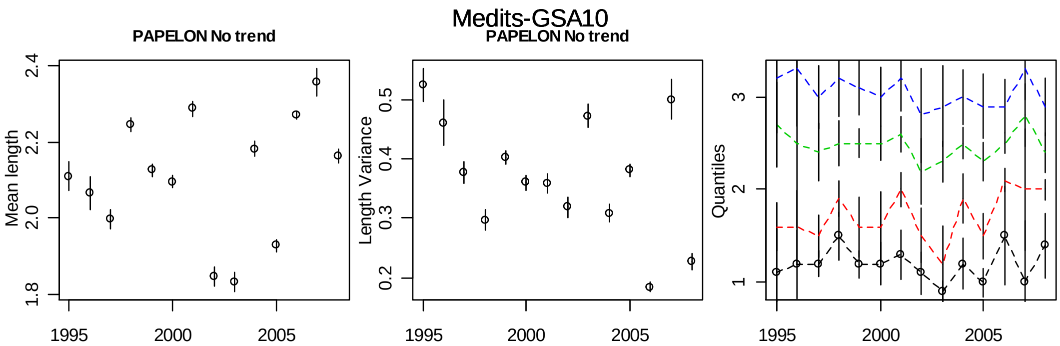


Fig. 8.33.3.2.1.1 Mean length, variance and quantiles derived from the Medits length compositions in 1995-2008.

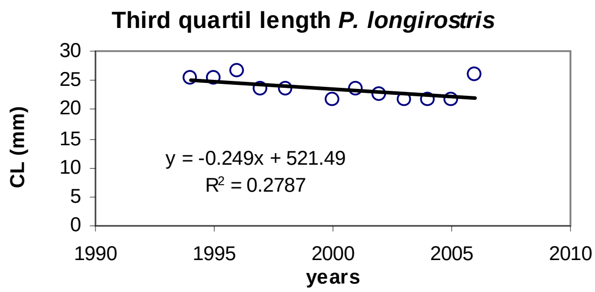


Fig. 8.33.3.2.1.2 III Quantile derived from the GRUND length structures in 1994-2006.

For most years the LFDs are rather similar throughout the Medits surveys, with a prevalence of individuals between 10 and 20 mm CL. The distribution of 1994 and 2006 are different due to a lower occurrence of juveniles, while the distribution of 2003 is different because of the higher number of recruits (Fig. 8.33.3.2.1.3).

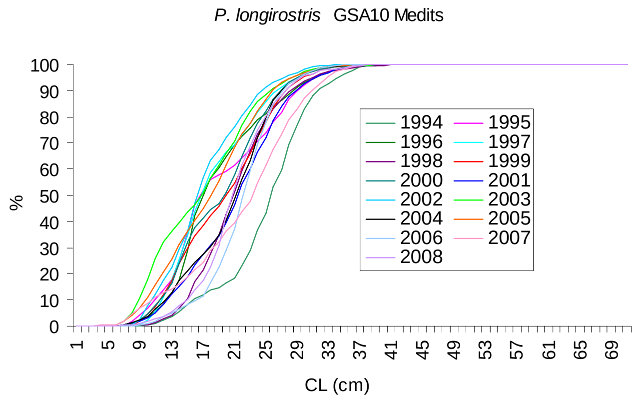


Fig. 8.33.3.2.1.3 Cumulative frequencies of the Medits LFDs (in percentage).

8.33.3.2.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.33.3.2.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.33.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.33.5. Scientific advice

8.33.5.1. Short term considerations

8.33.5.1.1. State of the spawning stock size

In the absence of proposed precautionary reference levels SGMED-09-02 is unable to fully evaluate the state of the spawning stock and provide scientific advice. Survey indices of total stock size appear highly variable and most recent indices are at an average level as observed during 1994-2007.

8.33.5.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.33.5.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.34. Stock assessment of pink shrimp in GSA 11

8.34.1. Stock identification and biological features

8.34.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.34.1.2. Growth

No information was documented during SGMED-09-02.

8.34.1.3. Maturity

No information was documented during SGMED-09-02.

8.34.2. Fisheries

8.34.2.1. General description of fisheries

No information was documented during SGMED-09-02.

8.34.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.34.2.3. Catches

8.34.2.3.1. Landings

Tab. 8.34.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.3 of Appendix 3. Since 2002 the annual landings varied, reaching 552 t in 2005 and decreasing to 46 t in 2008. The landings were mainly taken by demersal otter trawls.

Tab. 8.33.2.3.1.1 Annual landings (t) by fishing technique in GSA 11. Landings data provided for the years 2002 and 2003, probably have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DPS	11	ITA	DTS	38266	13305					
DPS	11	ITA	GTR				4	3		
DPS	11	ITA	OTB			232	548	127	79	46
DPS	11	ITA	PGP	935						
DPS	11	ITA	PMP	47302						

8.34.2.3.2. Discards

No information was documented during SGMED-09-02.

8.34.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-09-02 are listed in Tab. 8.34.2.3.3.1 and in Tab. A3.10-3.12 of Appendix 3.

Tab. 8.34.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSA 11, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	11	ITA	DTS	14539	18957	28840				
DAYS	11	ITA	FPO				1211	9616	31238	
DAYS	11	ITA	FYK						608	
DAYS	11	ITA	GND						51	
DAYS	11	ITA	GNS				21601	7574	29014	
DAYS	11	ITA	GTR				124877	139221	83350	
DAYS	11	ITA	LHP-LHM				50	1028	3379	
DAYS	11	ITA	LLD				2263	5117	4441	
DAYS	11	ITA	LLS				9758	16168	20224	
DAYS	11	ITA	LTL					128	31	
DAYS	11	ITA	OTB				29211	25368	25596	
DAYS	11	ITA	PGP	102826	126272	165945				
DAYS	11	ITA	PMP	57543	30879					
GT*days	11	ITA	DTS	772163	986387	1598912				
GT*DAYS	11	ITA	FPO				6215	49606	84529	
GT*DAYS	11	ITA	FYK						622	
GT*DAYS	11	ITA	GND						2544	
GT*DAYS	11	ITA	GNS				71331	18124	61528	
GT*DAYS	11	ITA	GTR				428009	430370	295688	
GT*DAYS	11	ITA	LHP-LHM				100	6394	10466	
GT*DAYS	11	ITA	LLD				26766	86801	158560	
GT*DAYS	11	ITA	LLS				42073	99731	84653	
GT*DAYS	11	ITA	LTL					270	63	
GT*DAYS	11	ITA	OTB				1934836	1399052	1423265	
GT*days	11	ITA	PGP	306226	468352	501550				
GT*days	11	ITA	PMP	611726	308212					
kW*days	11	ITA	DTS	3679604	4652647	6711626				
KW*DAYS	11	ITA	FPO				79031	824017	1387022	
KW*DAYS	11	ITA	FYK						13055	
KW*DAYS	11	ITA	GND						11713	
KW*DAYS	11	ITA	GNS				1007963	236313	781402	
KW*DAYS	11	ITA	GTR				6358014	6476994	4393484	
KW*DAYS	11	ITA	LHP-LHM				769	70523	122621	
KW*DAYS	11	ITA	LLD				284297	480411	952876	
KW*DAYS	11	ITA	LLS				832709	1159412	1054615	
KW*DAYS	11	ITA	LTL					12388	1622	
KW*DAYS	11	ITA	OTB				7679721	5879355	5957347	
kW*days	11	ITA	PGP	2865738	5099814	7105771				
kW*days	11	ITA	PMP	7159338	3245118					

8.34.3.Scientific surveys

8.34.3.1.Medits

8.34.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 11 the following number of hauls was reported per depth stratum (s. Tab. 8.34.3.1.1.1).

Tab. 8.34.3.1.1.1. Number of hauls per year and depth stratum in GSA 11, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA11_010-050	17	19	21	21	21	21	19	18	20	18	17	17	19	19	17
GSA11_050-100	27	21	22	22	20	22	22	24	19	19	18	21	18	20	19
GSA11_100-200	22	23	30	31	31	30	31	30	24	24	24	24	24	24	22
GSA11_200-500	35	29	29	26	25	27	24	25	20	24	21	20	20	20	21
GSA11_500-800	23	16	21	25	25	24	27	26	16	14	15	14	16	17	16

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

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

aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.34.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.34.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the pink shrimp in GSA 11 was derived from the international survey Medits. Figure 8.34.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSA 11.

The estimated abundance and biomass indices peaked in 1998-1999 and 2003. However, the recent abundance and biomass indices since 2005 appear low. The analyses of Medits indices are considered preliminary.

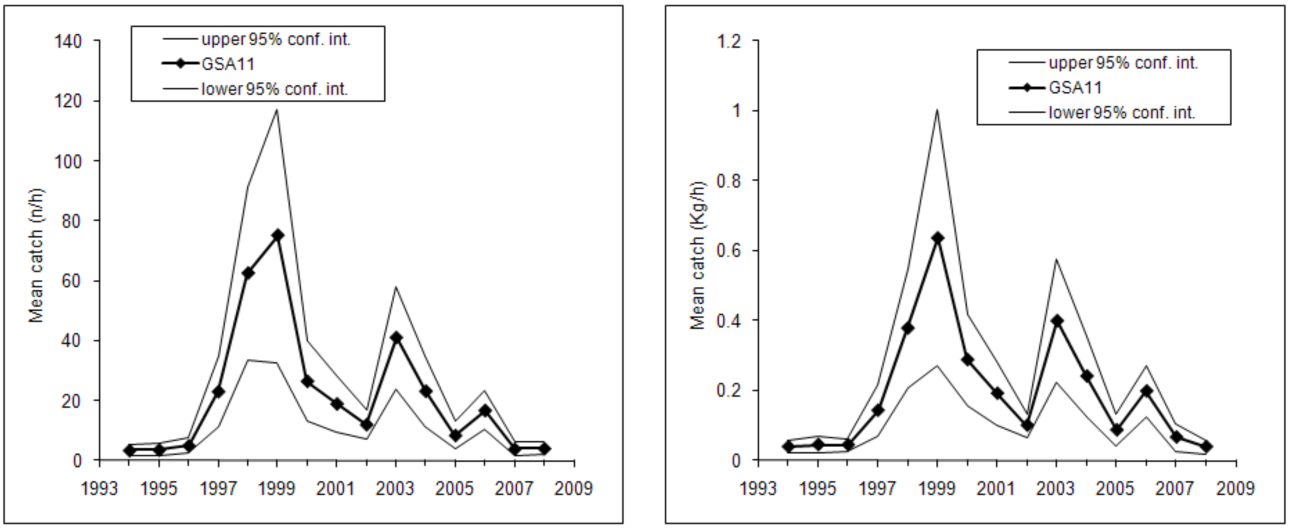


Fig. 8.34.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 11.

8.34.3.1.4. Trends in abundance by length or age

The following Fig. 8.34.3.1.4.1 and 2 display the stratified abundance indices of GSA 11 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

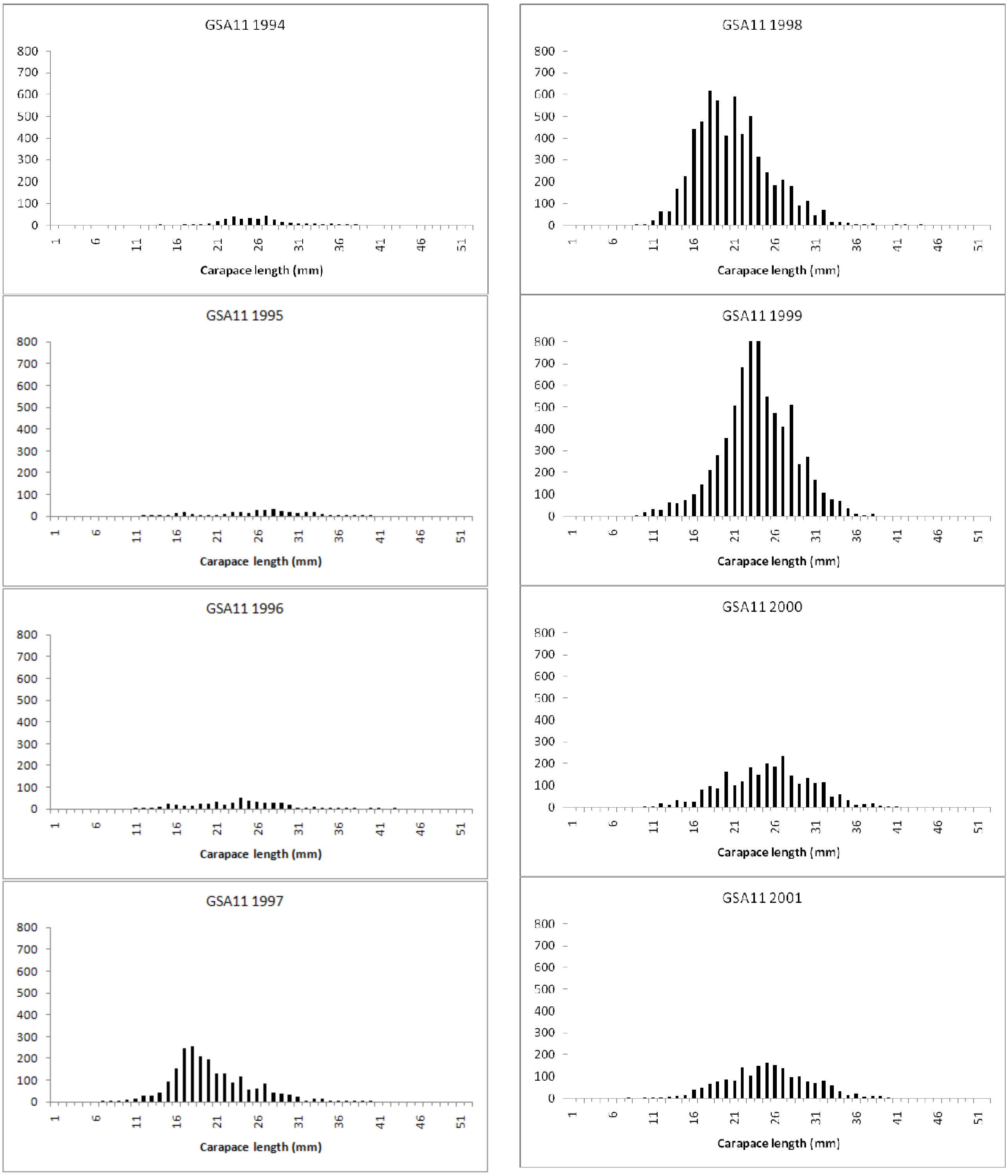


Fig. 8.34.3.1.4.1 Stratified abundance indices by size, 1994-2001.

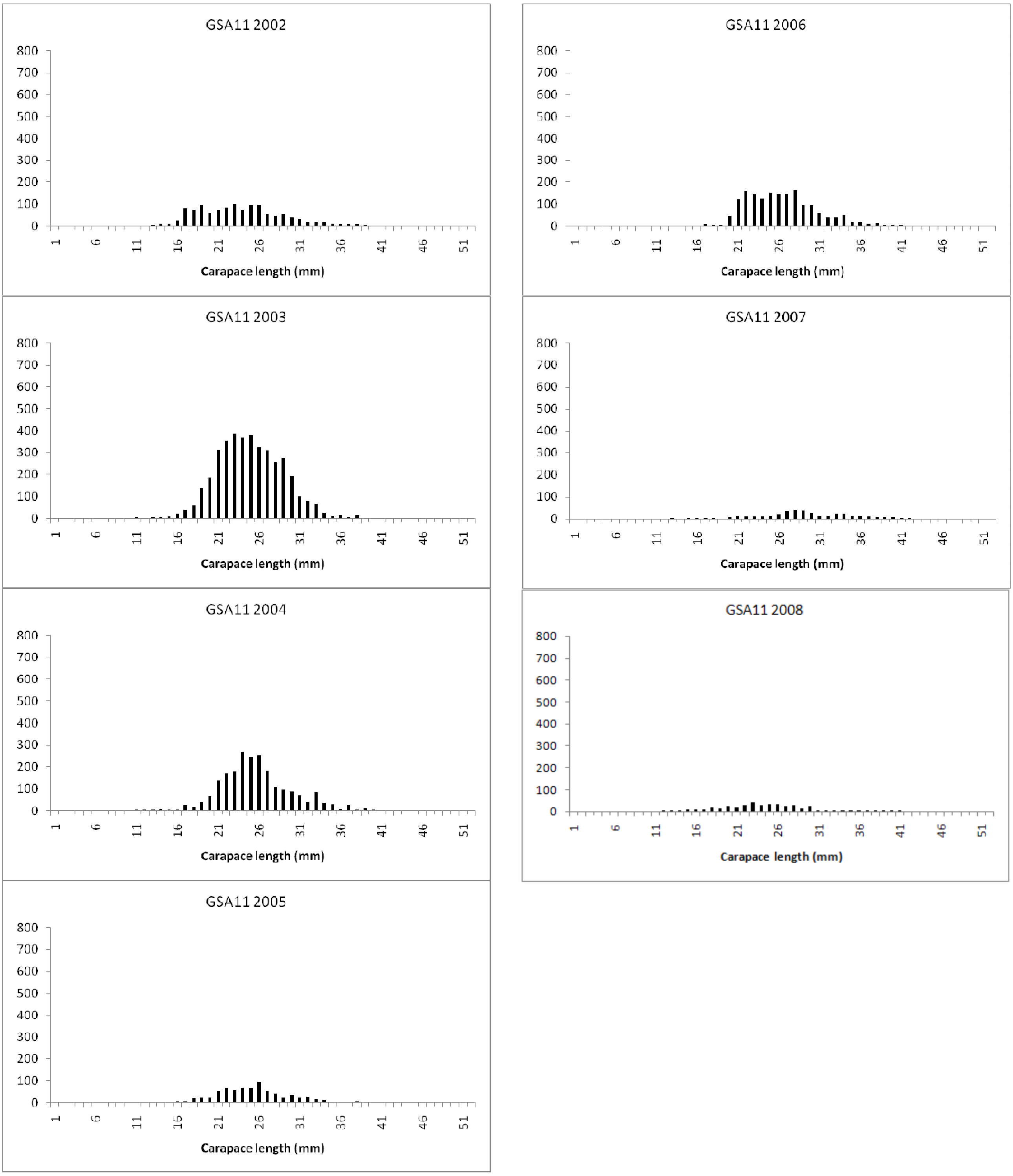


Fig. 8.34.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.34.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.34.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.34.4.Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.34.5.Long term prediction

8.34.5.1.Justification

No forecast analyses were conducted.

8.34.5.2.Input parameters

No forecast analyses were conducted.

8.34.5.3.Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for pink shrimp in GSA 11.

8.34.6.Scientific advice

8.34.6.1.Short term considerations

8.34.6.1.1. State of the spawning stock size

In the absence of proposed or agreed reference SGMED-09-02 is unable to fully evaluate the stock and provide any scientific advice of the state of the spawning stock in relation to them.

8.34.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.34.6.1.3. State of exploitation

In the absence of proposed or agreed reference SGMED-09-02 is unable to fully evaluate the stock and provide any scientific advice of the state of the spawning stock in relation to them.

8.35. Stock assessment of pink shrimp in GSAs 15 and 16

8.35.1.Stock identification and biological features

8.35.1.1.Stock Identification

Stock structure of the species in the Strait of Sicily is not well known. Levi et al. (1995) have hypothesed a flux from east to west of eggs, larvae and juveniles of *P. longirostris* due to the intermediate water current. More recently the existence of at least two sub-populations in the northern side of the area (GSA 15 and 16) were advanced by Camilleri et al. (in press). This idea is based on the occurrence of local spawning and nursery areas that are connected by the Atlantic Ionian Stream flow (0-150 m depth), which are considered the current in which the development of larval and juveniles phases occurs. These local sub-populations, one on the Adventure Bank and one on the Malta Bank, are separated by a wide area where the species abundance is scanty.

The maximum observed lengths in GSAs 15 and 16 recorded during trawl surveys over 14 years were 46 and 41 mm CL for females and males respectively (Sinacori G., pers. com.). Although very small specimens were caught in trawl surveys samples from a minimum size of 5 mm CL (Sinacori G., pers. com.), the size class at fully recruitment to the bottom in the GSAs 15 and 16 were 17 and 18 mm for females and males, respectively (SAMED, 2002).

A rough geographical mapping of nurseries in GSA 15 and 16 was reported in Fiorentino et al. (2004). The annual variability in nurseries' position was low. One important nursery was located off Capo Rossetto, in the western-central part of the area, another in the Eastern side of the Malta Bank, close to 200 m depth.

On the basis of trawl surveys carried out in the northern side of the Strait in GSA 16 sex ratio remained stable and close to 0.5 (Fiorentino et al., 2005). Sex ratio in weight from commercial landings (2006-2007) as F/(M+F) was 0.66.

Tursi et al. (1999) reported that *P. longirostris* feed on a wide variety of preys. During the hunting phase it eats small fish, cephalopods and crustaceans while during the digging phase it searches for preys in mud, such as polichets, bivalves, echinoderms and mostly foraminifers.

8.35.1.2.Growth

According to Ardizzone et al. (1990), the life cycle of *P. longirostris* lasts two years with the possibility of some larger animals entering a third year, and it is characterized by high rates of growth and mortality.

On the basis of comparison of results produced by different methods to estimate natural mortality (Chen & Watanabe; Beverton & Holt Invariants, Alagaraya), values of 1.04 and 1.15 for females and males, respectively, were proposed as reference values for stock assessment purposes in GSA 15 and 16 (SAMED, 2002). These last estimates of natural mortalities are compatible with longevities ranging between 4 and 4.5 years. The growth parameters were reported in Table 8.35.1.2.1.

Tab. 8.35.1.2.1 Von Bertalanffy growth function (cm; y) and length-weight relationship (cm; g) parameters in GSA 16.

Source	Sex	Linf	K	t_0	a	b
Samed, 2002	Females	43.0	0.68	-0.2	0.0035	2.4457
	Males	38.0	0.75	-0.2	0.0038	2.4090

8.35.1.3.Maturity

According to Levi et al. (1995) mature females are found in the GSAs 15 and 16 all round the year, although a wide maturity peak extended from November to February and another in April. The lowest percentage of mature females appeared in June-July, but continuous spawning seems to occur. Ben Mariem et al. (2001) reported that *P. longirostris* off the Tunisian coasts (GSA 12) reproduces all year along, with a peak in June-July and a minimum in winter.

The most recent parameters of maturity ogive were: L50% of 22.1 mm CL and the corresponding slope 0.45 in females, L50% of 14.3 mm CL and the corresponding slope 1.5 in males (CNR_IAMC, 2007).

8.35.2.Fisheries

8.35.2.1.General description of fisheries

The deep water pink shrimp is main target species of the Sicilian trawlers and is caught both on shelf and upper slope during all year round, but landing peaks are observed from March to July.

The Sicilian trawlers between 12 and 24 m LOA, are based in seven harbours along the southern coasts of Sicily. They operate mainly on a short-distance trawl fishery with trips from 1 to 2 days at sea, fishing on outer shelf and upper slope.

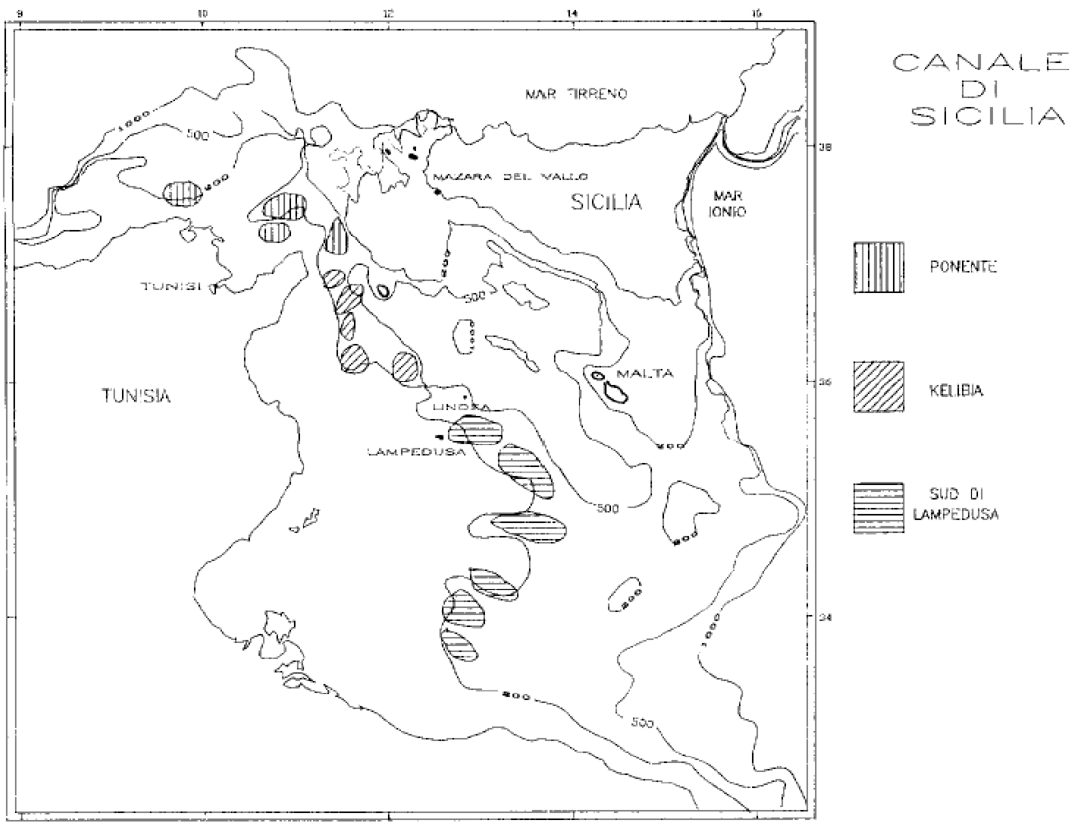


Fig. 8.35.2.1.1 The three main fishing areas for *P. longirostris* in the Strait of Sicily. Each fishing areas is divided into several fishing grounds (from Levi et al., 1995).

The distant trawlers of Mazara del Vallo represents the main commercial fleet of trawlers of the area and one of the most important of the Mediterranean. Differently from the other Sicilian fleets, the large trawlers of Mazara fleet (LOA>24m) are employed on long fishing trips (3 – 4 weeks) in offshore waters, both national and international, of the Strait of Sicily. The main fishing grounds of Mazara distant trawlers in the Strait of Sicily are shown in Fig. 8.35.2.1.1. After the recent increase of the fuel costs a critical phase for the deep water pink shrimp fishery started, affecting mainly the distant fleet, which needs about 1 ton of fuel per day during the fishing trip.\

P. longirostris is fished exclusively by otter trawl, together with other species (*Nephrops norvegicus, Merluccius merluccius, Eledone sp., Illex coindetii, Todaropsis eblanae, Lophius sp., Mullus sp., Pagellus sp., Zeus faber* and *Raja sp*.) (Anon., 2000).

8.35.2.2.Management regulations applicable in 2008 and 2009

At present there are no formal management objectives for deep water pink shrimp fisheries in the Strait of Sicily. As in other areas of the Mediterranean, the stock management is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area closures), and minimum landing sizes of 20 mm CL (EC 1967/06).

In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late eighties. After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity is occurring. Furthermore from 1987 to 2005 a 30-45 days stopping of fishing activities was enforced each year, although in different ways, in order to reduce fishing effort. However this measure is considered less effective in order to protect hake juveniles. In Malta the trawling fleet has been stable since the early 2000 with 16 trawlers having a license to fish. Unfortunately in 2008 due to a reduction in capacity of other fleets 8 new trawl licenses will be issued that will increase the trawl capacity for Malta by 50%.

The new regulation EC 1967 of 21 December 2006 fixed a minimum mesh size of 40 mm for bottom trawling of EU fishing vessels (Italian and Maltese trawlers). The mesh has to be modified in square 40 mm or diamond 50 mm after July 2008, however derogations are possible up to 2010.

A further and more effective improvement in the exploitation pattern of deep water pink shrimp might be obtained through an integrative technical measure having a similar effect to the increasing of mesh size, i.e. the protection of hake nurseries. Differently from red mullet, whose nurseries are in the already protected bottoms within three nautical miles from the coast, the location of deep water pink shrimp nurseries are on discrete off-shore areas on the outer shelf (100-200 m) and in international waters making the possibility of protecting the nursery areas a difficult task especially with respect to enforcement.

It must be outlined the existence in the Strait of Sicily of the Maltese FMZ (GSA 15) which extends up to 25 nautical miles from baselines around the Maltese islands, where fisheries are specifically managed on the basis of capacity control (EC 813/04; EC 1967/06).

The access of Community vessels to the waters and resources in the FMZ is regulated as follows:
(a) fishing within the management zone is limited to fishing vessels smaller than 12 metres overall length using other than towed gears and;
(b) the total fishing effort of those vessels, expressed in terms of the overall fishing capacity, does not exceed the average level observed in 2000-2001 that corresponds to 1 950 vessels with an overall engine power and tonnage of 83 000 kW and 4 035 GT respectively.

Trawlers not exceeding an overall length of 24 metres are authorised to fish in certain areas within the management zone. The overall fishing capacity of the trawlers allowed to operate in the management zone must not exceed the ceiling of 4 800 kW and the fishing capacity of any trawler authorised to operate at a depth of less than 200 metres must not exceed 185 kW. Trawlers fishing in the management zone hold a special fishing permit in accordance with Article 7 of Regulation (EC) No 1627/94 and are included in a list containing their external marking and vessel's Community fleet register number (CFR) to be provided to the Commission annually by the Member States concerned.

8.35.2.3.Catches

8.35.2.3.1. Landings

The estimation of yearly overall yield of Sicilian trawlers with 1-2 day trips in middle eighties ranged between 1290 and 1640 tons (Andreoli et al., 1995). The estimation of yearly overall yield of the Mazara distant fleet in late eighties-early nineties ranged between 2360 and 5180 tons (Levi et al., 1995).

Tab. 8.35.2.3.1.1 Annual landings (t) by fishing technique in GSAs 15 and 16. Landings data provided for the years 2002 and 2003, probably have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DPS	15	MLT	OTB				1	15	8	22
DPS	16	ITA	DTS	7462540	7387992					
DPS	16	ITA	GTR					15		
DPS	16	ITA	OTB			6665	8584	8441	5966	5941
DPS	16	ITA	PGP	682	22714					
DPS	16	ITA	PMP	100569						
DPS	16	ITA	PTS	19571	54912					

Considering that overall yield of trawling was about 9,666 tons in 2006 and 8,052 tons in 2007, deep water pink shrimp landings representing about 74-87% of total yield in the area. It should be noted that landings of deep water pink shrimp in the Sicilian ports do not derive solely from GSA 16 but from GSA 15 and 16 with some catches also from other GSAs in the Strait of Sicily.

The Maltese shrimp yield ranged from 1 t in 2005 to 22 t in 2008.

Since 2002 onwards the yield of all the Sicilian boats fishing in the Strait of Sicily (inshore and distant fisheries) ranged from 8600 tons in 2006 and 5990 tons in 2007 (from IREPA data).

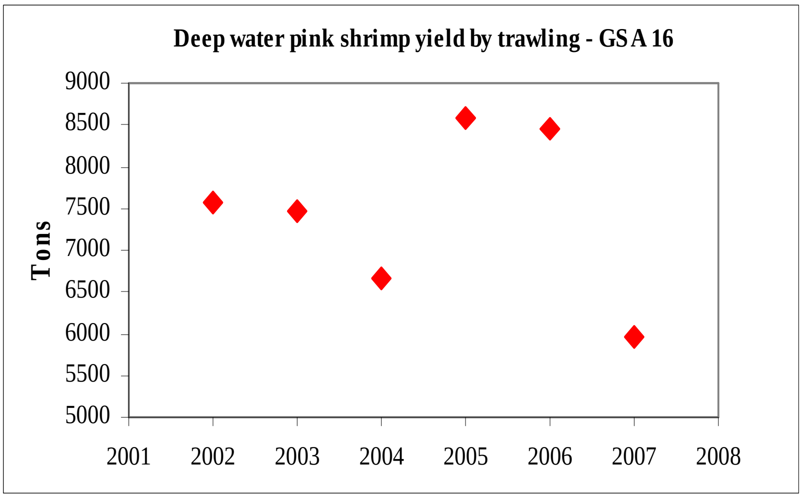


Fig. 8.35.2.3.1.1 Yield of Italian trawlers based in GSA 16 in the Strait of Sicily.

Detailed information on yield in 2006 and 2007 by trawler size is given in Table 8.35.2.3.1.2. The smaller trawlers (LOA 12-24 m) operating in more inshore water are more numerous (about 67% in number) and produce between 53% (2006) and 65% (2007) of the deep water pink shrimp yield of Sicilian trawlers in the Strait of Sicily.

Tab. 8.35.2.3.1.2 Yield by sex of Italian trawlers in the Strait of Sicily (number of boats: LOA 12-24 m = 350 in 2006 and 315 in 2007; LOA >24 m = 172 in 2006 and 151 in 2007) (IREPA source).

	LOA 12_24 m		LOA >24 m		total
2006	Yield	4535	Yield	3920	8455
	Females	3018	Females	2755	5773
	Males	1517	Males	1165	2682
2007	Yield	3880	Yield	2108	5989
	Females	2140	Females	1255	3395
	Males	1741	Males	853	2594

As the length compositions of landing concerns, information is available only for the Sicilian trawlers. Data were considered representative since the 3rd quarter of 2005, when a sampling scheme allowing a realistic raising of the sampled catches to the total ones was adopted (SIBM, 2005). Since there are differences in biological parameters by sex stock assessment based on length structure of landing was done only by females, since they represent about the 66% of landing and reach the largest size.

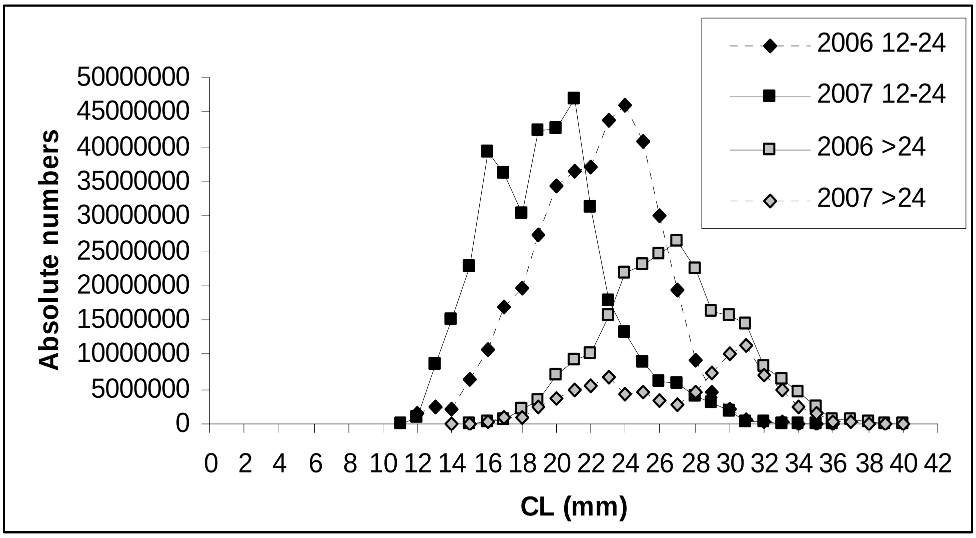


Fig. 8.35.2.3.1.2 Absolute catches in number of Italian trawlers in the Strait of Sicily, 2006-2007. Catches of the two operational units (LOA12-24 and LOA>24) are distinguished.

8.35.2.3.2. Discards

According to Levi et al. (1995) the length at 50% capture of 32 mm mesh size trawling estimated by catch curve on commercial landing was 16.1 mm CL (Selection Factor=0.5). More recently experiments of selectivity for the same mesh size gave a L50%=13.0±0.1 (mm) (Selection Range=5.2 and SF=0.42) (Ragonese & Bianchini, 2006). The modal size of the catch and discarded fraction of *P. longirostris* of Sicilian trawlers is very variable according to the season and the deep range of fisheries. The amount of discards are also variable, being higher in autumn-winter and between 150 and 300 m (Anon., 2000).

Tab. 8.35.2.3.2.1 Yearly modal length (LC in mm) of discarded fraction and landings of *P. longirostris* in typical inshore (Porto Palo- South eastern Sicily) and distant (Mazara del Vallo - South western Sicily) Sicilian trawling fisheries (from Anon., 2000).

	Modal length (mm)	
	discards	landings
Inshore fisheries	12	16 and 19
Distant fisheries	19	25-26

Recent studies on the discarded fraction of trawlers in GSA 16 during 2006 gave a length at 50% discard ranging between 14.6 and 17.0 mm CL (Gancitano V., pers. comm.)

8.35.2.3.3. Fishing effort

No information on specific effort of trawling on deep water pink shrimp is available. The trends in overall fishing effort by year and major gear type is listed in Tab. 8.35.2.3.3.1 and shown in Fig. 8.35.2.3.3.1 in terms of kW*days for the otter trawls.

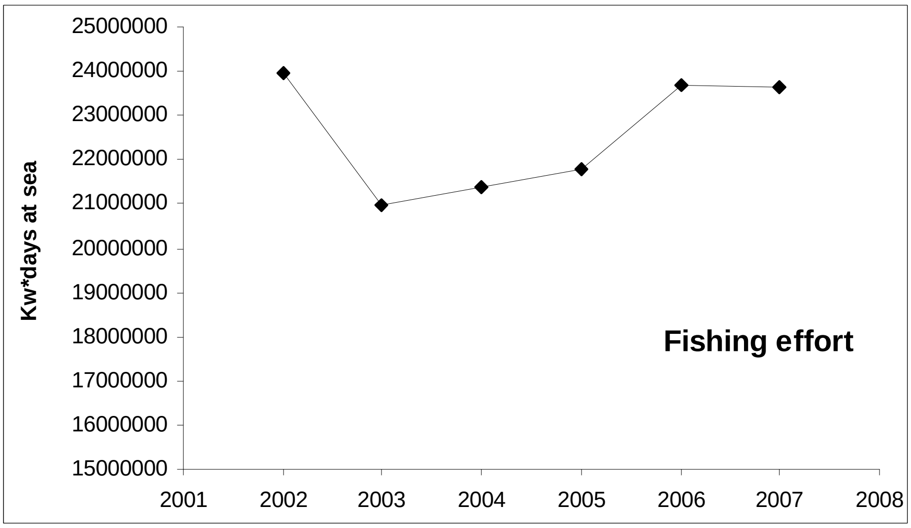


Fig. 8.35.2.3.3.1 Trend in annual effort (kW*days) of the Italian otter trawlers operating in the Strait of Sicily, 2002-2007.

Tab. 8.35.2.3.3.1 Trend in annual effort (days at sea, GT*days, kW*days) by country and gears in GSA 15 and 16, 2002-2008.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	15	MLT	[FPO]							596
DAYS	15	MLT	[GNS]				51			78
DAYS	15	MLT	[GTR]				200	152	320	244
DAYS	15	MLT	[LA]					1116	1096	978
DAYS	15	MLT	[LHP] [LHM]				157			337
DAYS	15	MLT	[LLD]				3164		2827	3264
DAYS	15	MLT	[LLS]				1197	1466	1624	2104
DAYS	15	MLT	[LTL]				263	142		
DAYS	15	MLT	[OTB]				421	404	688	1149
DAYS	15	MLT	[PS]							216
DAYS	15	MLT	[SB] [SV]						59	36
DAYS	15	MLT	[TBB]							10
DAYS	15	MLT	Other gear				64			163
DAYS	16	ITA	DTS	87300	76233	81853				
DAYS	16	ITA	FPO				18	20	28	
DAYS	16	ITA	GND				6717	6218	7547	
DAYS	16	ITA	GTR				78429	52961	50840	
DAYS	16	ITA	HOK			14856				
DAYS	16	ITA	LHP-LHM				1363	3695	4674	
DAYS	16	ITA	LLD				5759	6397	8493	
DAYS	16	ITA	LLS				16424	22888	19638	
DAYS	16	ITA	LTL				300	408		
DAYS	16	ITA	MIS				262			
DAYS	16	ITA	OTB				83124	84674	82261	
DAYS	16	ITA	OTM				756	1540	1471	
DAYS	16	ITA	PGP	146019	118660	118425				
DAYS	16	ITA	PMP	26655	34956	6939				
DAYS	16	ITA	PS				1612	2066	1971	
DAYS	16	ITA	PTM				1204	3746	4193	
DAYS	16	ITA	PTS	8778	8568	4899				
GT*DAYS	15	MLT	[FPO]							2061
GT*DAYS	15	MLT	[GNS]				135			175
GT*DAYS	15	MLT	[GTR]				1174	477	1023	570
GT*DAYS	15	MLT	[LA]					23999	29596	20678
GT*DAYS	15	MLT	[LHP] [LHM]				486			968
GT*DAYS	15	MLT	[LLD]				82011		60606	58322
GT*DAYS	15	MLT	[LLS]				16866	18866	18072	16220
GT*DAYS	15	MLT	[LTL]				2539	639		
GT*DAYS	15	MLT	[OTB]				24878	34527	69268	109332
GT*DAYS	15	MLT	[PS]							9036
GT*DAYS	15	MLT	[SB] [SV]						139	71
GT*DAYS	15	MLT	[TBB]							214
GT*DAYS	15	MLT	Other gear				226			400
GT*days	16	ITA	DTS	6739948	6175213	6673029				
GT*DAYS	16	ITA	FPO				531	939	2962	
GT*DAYS	16	ITA	GND				51767	68581	70266	
GT*DAYS	16	ITA	GTR				183252	139048	146474	
GT*days	16	ITA	HOK			764595				
GT*DAYS	16	ITA	LHP-LHM				2757	7752	9603	
GT*DAYS	16	ITA	LLD				377485	290622	351965	
GT*DAYS	16	ITA	LLS				40376	41294	51455	
GT*DAYS	16	ITA	LTL				600	815		
GT*DAYS	16	ITA	MIS				1630			
GT*DAYS	16	ITA	OTB				7064255	7088706	6994494	
GT*DAYS	16	ITA	OTM				65935	141508	135199	
GT*days	16	ITA	PGP	410857	732725	249032				
GT*days	16	ITA	PMP	375921	418892	20134				
GT*DAYS	16	ITA	PS				101266	114791	95754	
GT*DAYS	16	ITA	PTM				57807	197450	225837	
GT*days	16	ITA	PTS	585964	327460	224188				

Tab. 8.35.2.3.3.1 Continue.

GT*days	16	ITA	PGP	410857	732725	249032				
GT*days	16	ITA	PMP	375921	418892	20134				
GT*DAYS	16	ITA	PS				101266	114791	95754	
GT*DAYS	16	ITA	PTM				57807	197450	225837	
GT*days	16	ITA	PTS	585964	327460	224188				
KW*DAYS	15	MLT	[FPO]							50771
KW*DAYS	15	MLT	[GNS]				2121			4379
KW*DAYS	15	MLT	[GTR]				13889	8391	20724	14361
KW*DAYS	15	MLT	[LA]					203361	208456	175644
KW*DAYS	15	MLT	[LHP] [LHM]				6757			19368
KW*DAYS	15	MLT	[LLD]				554562		449900	502339
KW*DAYS	15	MLT	[LLS]				140846	159692	160914	210146
KW*DAYS	15	MLT	[LTL]				26318	10210		
KW*DAYS	15	MLT	[OTB]				129838	143909	240858	382542
KW*DAYS	15	MLT	[PS]							55823
KW*DAYS	15	MLT	[SB] [SV]						2507	1334
KW*DAYS	15	MLT	[TBB]							1785
KW*DAYS	15	MLT	Other gear				3394			6355
kW*days	16	ITA	DTS	23952310	20951845	21381964				
KW*DAYS	16	ITA	FPO				2602	4116	16280	
KW*DAYS	16	ITA	GND				484488	565283	560624	
KW*DAYS	16	ITA	GTR				2436223	1675235	1779917	
kW*days	16	ITA	HOK			3153486				
KW*DAYS	16	ITA	LHP-LHM				147929	332833	329113	
KW*DAYS	16	ITA	LLD				1102509	1319225	1938868	
KW*DAYS	16	ITA	LLS				812348	751898	805197	
KW*DAYS	16	ITA	LTL				2401	3260		
KW*DAYS	16	ITA	MIS				18900			
KW*DAYS	16	ITA	OTB				22936088	23764571	22757302	
KW*DAYS	16	ITA	OTM				159014	315468	300311	
kW*days	16	ITA	PGP	3133993	4603457	2691324				
kW*days	16	ITA	PMP	2792612	2761842	223470				
KW*DAYS	16	ITA	PS				444087	520717	459314	
KW*DAYS	16	ITA	PTM				280234	712936	862918	
kW*days	16	ITA	PTS	2510582	1750128	962786				

8.35.3.Scientific surveys

8.35.3.1.Medits

8.35.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSAs 15 and 16 the following number of hauls was reported per depth stratum (s. Tab. 8.35.3.1.1.1).

Tab. 8.35.3.1.1.1. Number of hauls per year and depth stratum in GSAs 15 and 16, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA15_010-050									1	3	6	1	1		
GSA15_050-100									6	13	10	5	5	12	6
GSA15_100-200									12	33	33	13	13	12	12
GSA15_200-500									9	26	23	9	9	4	9
GSA15_500-800									18	40	39	17	16	18	17
GSA16_010-050	4	4	4	4	4	4	4	4	7	7	7	10	10	11	11
GSA16_050-100	9	8	8	8	8	8	7	8	11	12	12	20	22	23	23
GSA16_100-200	4	4	4	4	5	5	6	5	11	10	11	20	19	21	21
GSA16_200-500	10	11	11	12	11	11	11	11	19	18	27	37	31	27	27
GSA16_500-800	10	14	14	13	14	14	14	14	20	20	21	33	33	38	38

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

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

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

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

Where:
A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.35.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.35.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSAs 15 and 16 was derived from the international surveys Medits. Figures 8.35.3.1.3.1 and 2 display the estimated trend in deep water pink shrimps density and biomass in GSAs 15 and 16.

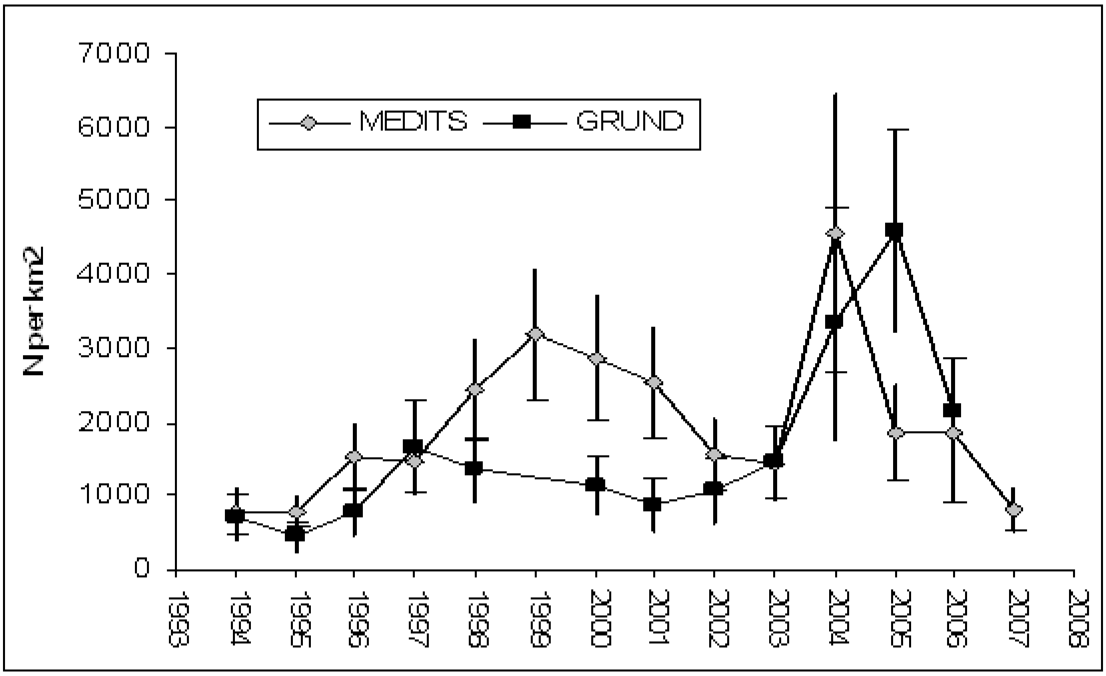


Fig. 8.35.1.3.1 Density indices (DI as N per km^2) obtained during the MEDITS and GRUND survey in GSAs 15 and 16.

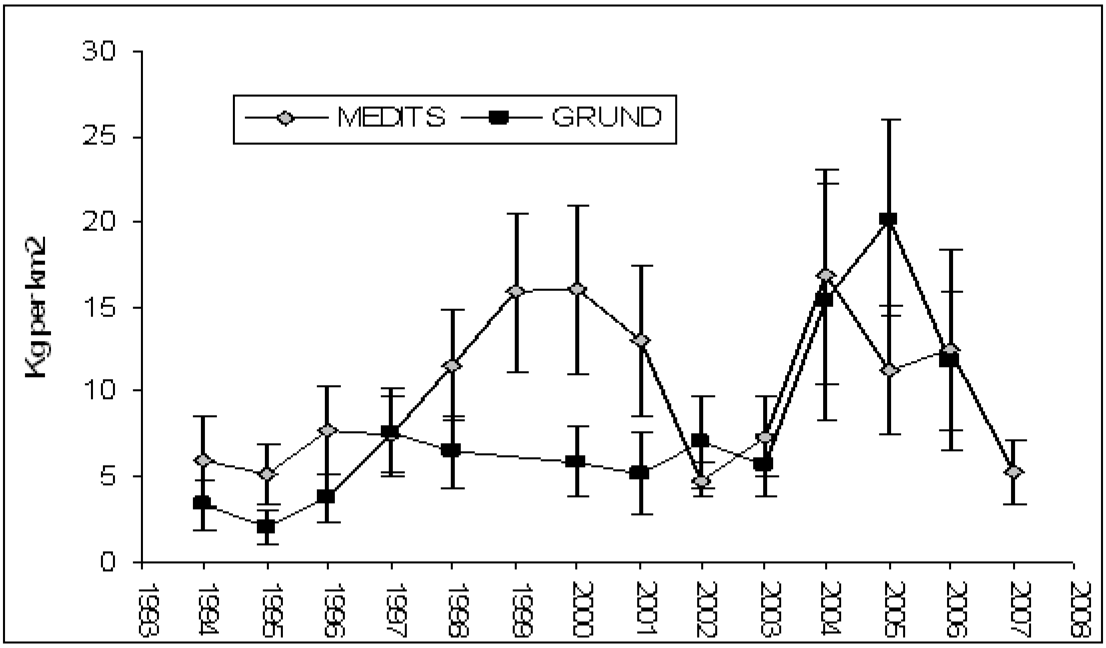


Fig. 8.35.1.3.2 Biomass indices (BI as kg per km^2) obtained during the MEDITS and GRUND survey in GSAs 15 and 16.

In the last years the biomass indices for both GSAs 15 and 16 show a similar pattern with an increasing trend since 2002 till 2005-2006 and decrease in 2006-2007.

Density indices (DI) of recruits (individuals less than 18 mm CL) derived from MEDITS trawl surveys were used to estimate recruitment strength in GSAs 15 and 16 assuming that recruitment occurs within 50 and 200 m depth (16500 km^2). The mean value (±sd) of DI and absolute number of recruits from 1994 to 2004 was 1601 ± 969 individuals per km^2 and 26.376 ± 15.959 millions of individuals (Fiorentino et al., in press).

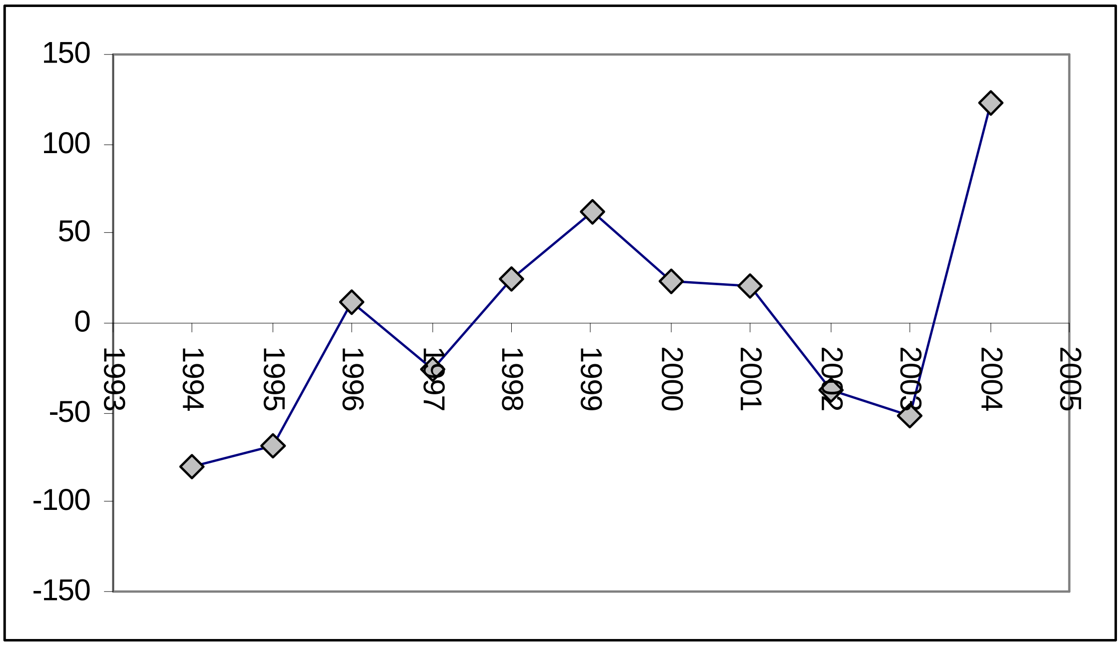
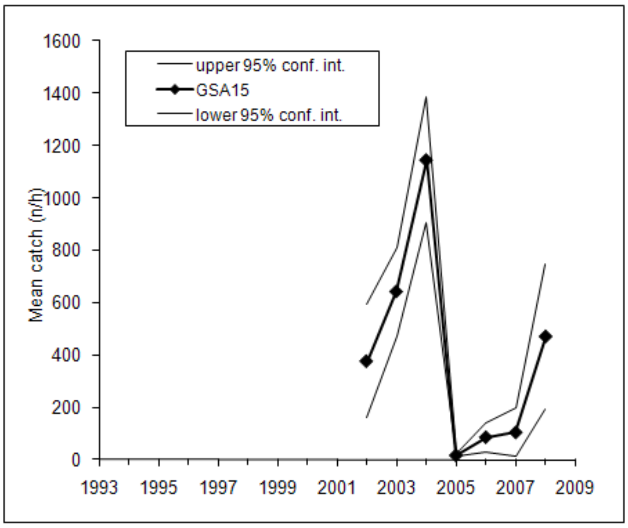


Fig 8.35.1.3.3 Percentage variation of annual values from mean recruitment of *P. longirostris* in the GSAs 15 and 16.

The trend in abundance and biomass as re-estimated by SGMED-09-02 are shown in Figures 8.35.3.1.3.4 and 8.35.3.1.3.5 for GSAs 15 and 16. Such analyses of Medits indices are considered preliminary.



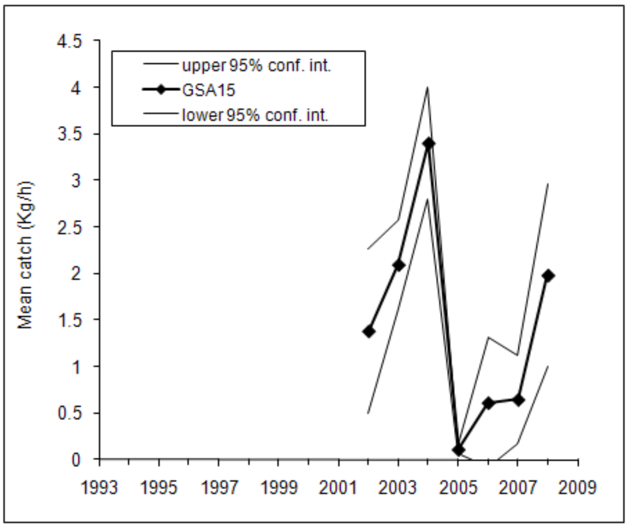


Fig. 8.35.3.1.3.4 Abundance and biomass indices of deep water pink shrimp in GSA 15.

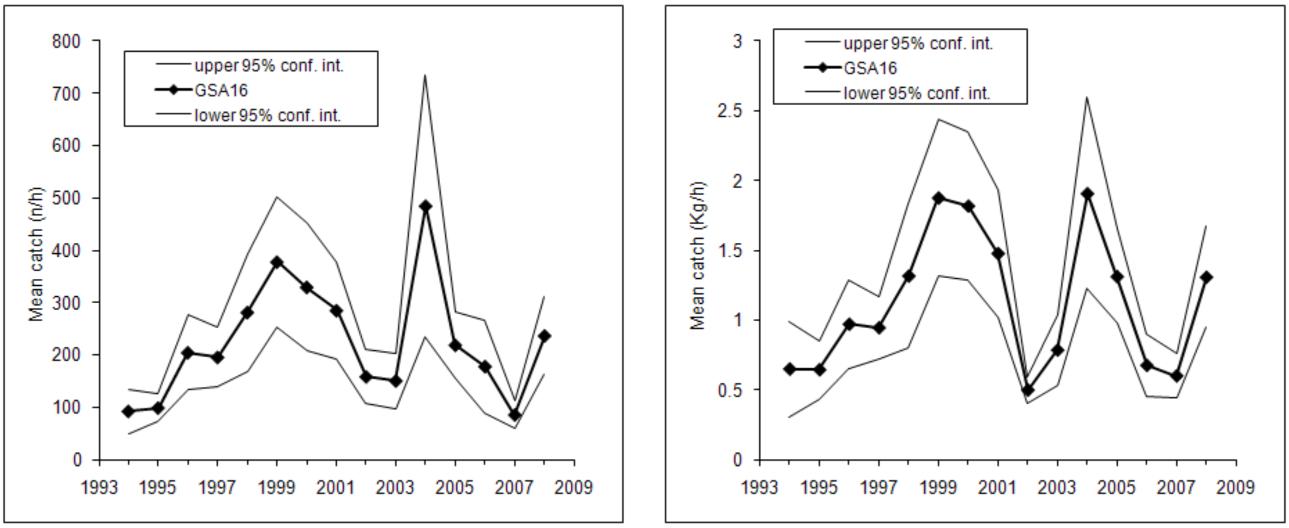


Fig. 8.35.3.1.3.5 Abundance and biomass indices of deep water pink shrimp in GSA 16.

8.35.3.1.4. Trends in abundance by length or age

The following Fig. 8.35.3.1.4.1 displays the stratified abundance indices of GSA 15 in 2002-2008. These size compositions are considered preliminary.

The Figures 8.35.3.1.4.2 and 8.35.3.1.4.3 display the stratified abundance indices of GSA 16 in 1994-2001 and 2002-2008. These size compositions are considered preliminary.

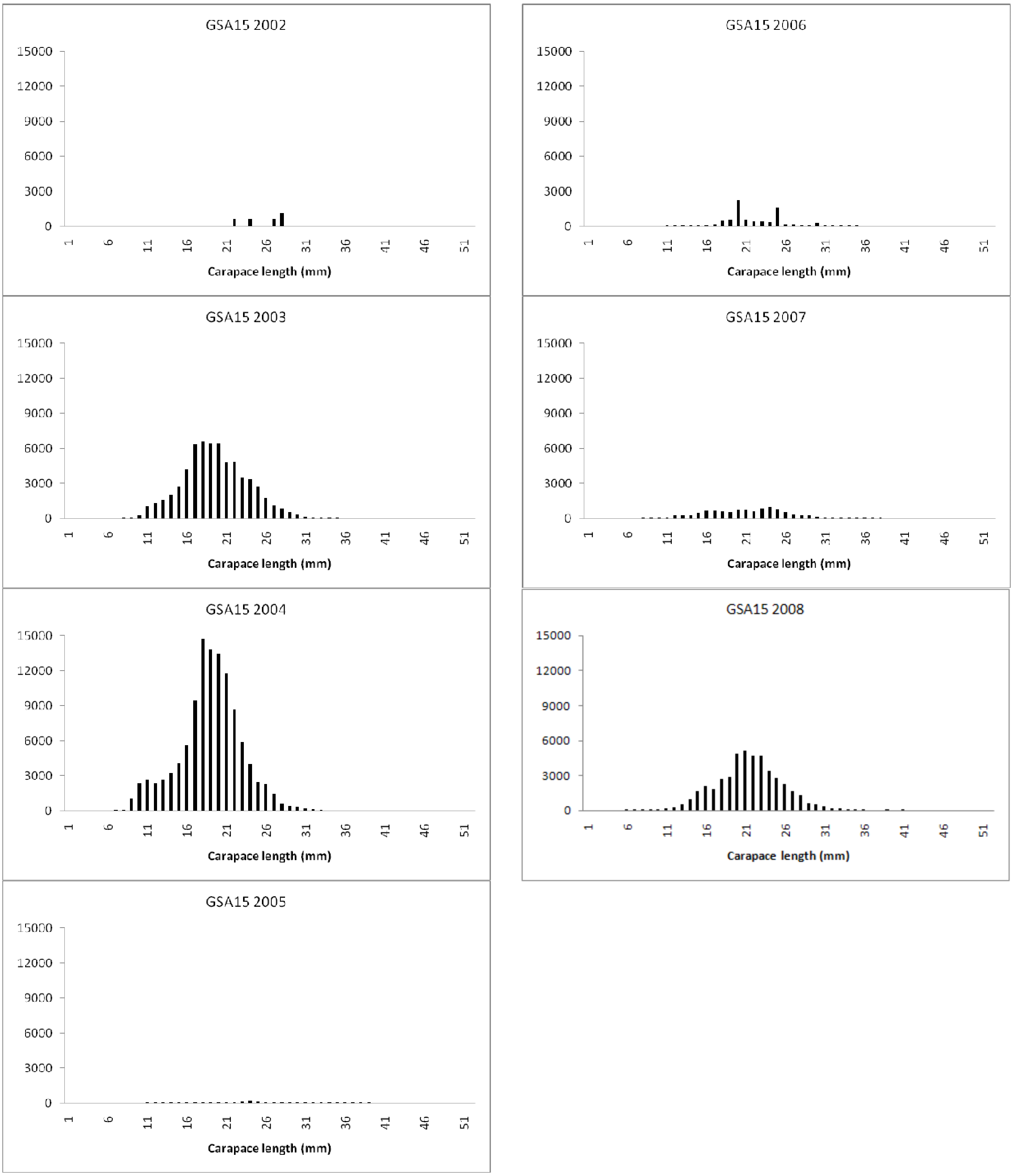


Fig. 8.35.3.1.4.1 Stratified abundance indices by size in GSA 15, 2002-2008.

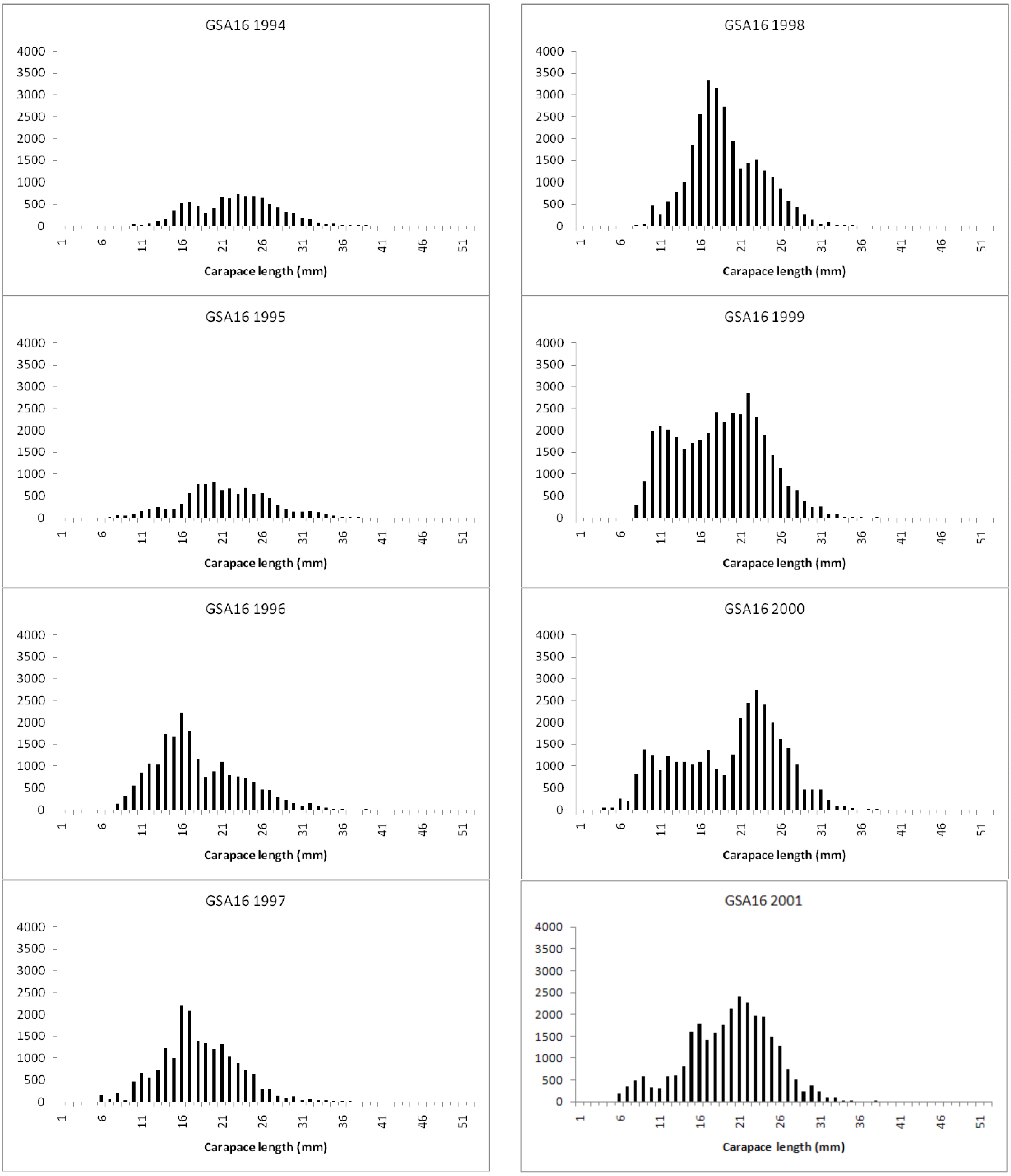


Fig. 8.35.3.1.4.1 Stratified abundance indices by size, 1994-2001.

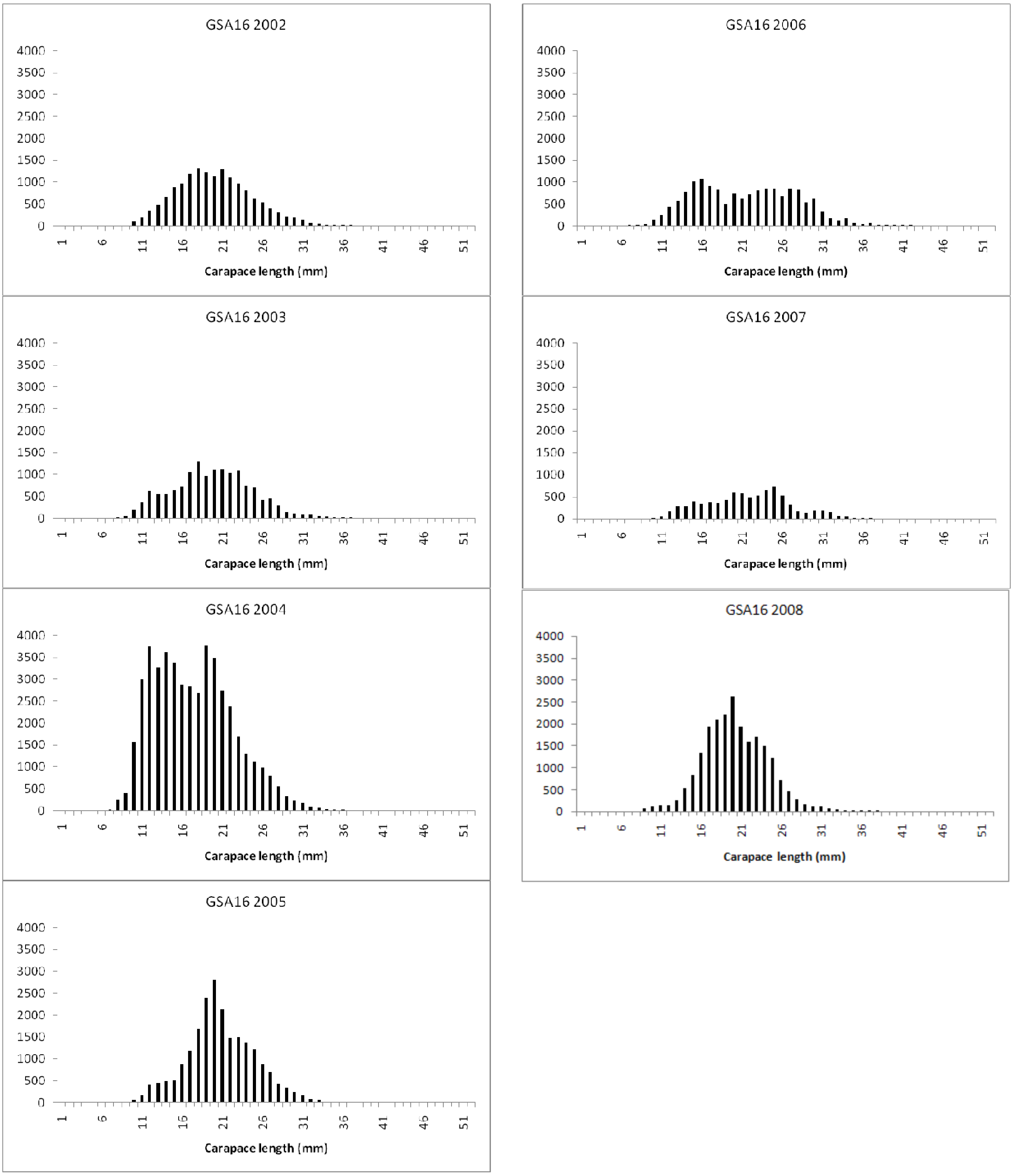


Fig. 8.35.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.35.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.35.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.35.4. Assessment of historic stock parameters

SGMED 09-02 did not undertake any analytical assessment of deep water pink shrimp in GSAs 15 and 16. Last year's assessments using Trends in LPUE and VIT can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.35.5. Long term prediction

8.35.5.1.1. Justification

No forecast analyses were conducted.

8.35.5.1.2. Input parameters

No forecast analyses were conducted.

8.35.5.1.3. Results

Given the state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for pink shrimp in GSAs 15 and 16.

8.35.6. Scientific advice

8.35.6.1. Short term considerations

8.35.6.1.1. State of the spawning stock size

In the absence of proposed or agreed references SGMED-09-02 is unable to fully evaluate the state of the stock. The last updated information regarding the state of spawning stock for pink shrimp in GSAs 15 and 16 can be found in the last year's report of SGMED-08-04 working group (Cardinale et al., 2008).

8.35.6.1.2. State of recruitment

No information available to SGMED-09-02.

8.35.6.1.3. State of exploitation

The last updated information regarding the state of exploitation for pink shrimp in GSAs 15 and 16 can be found in the last year's report of SGMED-08-04 working group (Cardinale et al., 2008).

8.36. Stock assessment of pink shrimp in GSA 18

8.36.1. Stock identification and biological features

8.36.1.1. Stock Identification

The stock of pink shrimp was assumed in the boundaries of the whole GSA18, lacking specific information on stock identification and given the preliminary indications agreed upon by SGMED 01.09. The deep-water rose shrimp inhabits only muddy sediments, at depths over 130 m (Karlovac, 1949) and in the southern Adriatic it is distributed mostly between 30 and 600 m depth although it is more abundant between 200 and 400 m depth (Pastorelli *et al*., 1996). Within the southern Adriatic, the eastern part is characterised by the higher occurrence and abundance of the species, given the charateristics of the water masses (warmer and saltier) and the lower fishing pressure (Abellò *et al*., 2002; Mannini et al., 2004) and particularly of the juvenile component of the population (Ungaro *et al*., 2006). Spawning time is considered extended almost all the year round, as for other Mediterranean areas (Relini, 1999) and sex ratio as estimated from trawl-survey data is approximately 0.45. The abundance of this shrimp is steadily growing in the last decade (Ungaro *et al*., 2006) that is one of the target species of the central and southern Adriatic multispecies trawl catches. In some fisheries the pink shrimp can represent a percentage between 5 and 10% of the total catches (Medits 2007).

8.36.1.2. Growth

P. longirostris can grow up to 16 cm (males) and 19 cm (females) in total length. However, males are usually 8 to 14 cm long and females from 12 to 16 cm long. Larger specimens are caught mainly in deeper waters. During the expedition “Hvar”, the largest specimen caught was a 17 cm long female (Karlovac, 1949). The growth rate differs between the sexes. Size distribution and growth parameters indicate a life cycle of 3-4 years (Froglia, 1982).

Estimates of growth parameters were achieved made in thewith data collected within the DCR framework using the analysis of length frequency distributions. The following von Bertalanffy parameters were estimated by sex: females CL_{∞}=44.0 mm; K=0.628; t0= -0.20; males: CL_{∞}=39 mm; K=0.69; t0= -0.20.
Parameters of the length-weight relationship reported in literature for carapace length expressed in mm and sex combined (Marano *et al*., 1998) are a=0.0034, b=2.4364. The parameters estimated within the DCRhere for sex combined and carapace length expressed in cm were: a=1.0692, b=2.23.

8.36.1.3. Maturity

In the Mediterranean Sea, both sexes of *P. longirostris* reach maturity in the first year of life (Froglia, 1982). After being spawned, the planctonic larval phases (nauplius, zoea and mysis) develop; the postlarva, similar to adults, reaches the sandy-muddy bottoms on the continental shelf and begins the bentho-pelagic cycle (Heldt, 1938). According to the data obtained in the DCR, the proportion of mature females (specimens belonging to the maturity stage 2 onwards) by length class is reported in the table below together with the maturity ogive estimated by a maximum likelihood procedure which indicates a $L_{m50\%}$ of about 1.83 cm (±0.01 cm) and a maturity range (MR) equal to 0.24 cm, ($L_{m75\%}$-$L_{m25\%}$ ±0.013 cm).

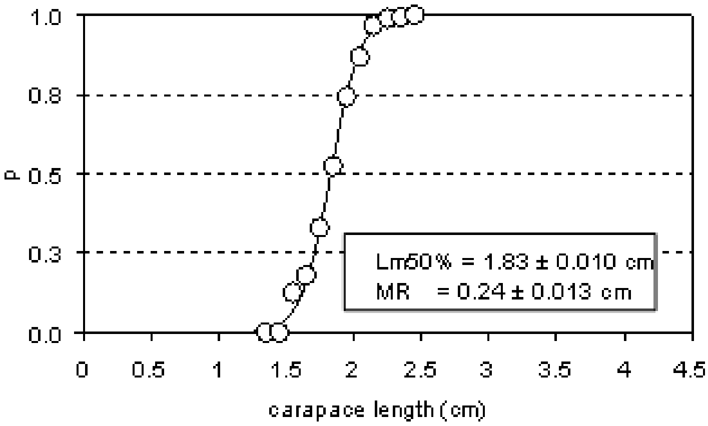


Fig. 8.36.1.3.1 Maturity ogive and proportions of mature female of pink shrimp in the GSA 18 (MR indicates the difference $L_{m75\%}$-$L_{m25\%}$).

The sex ratio evidenced the prevalence of males in the size class from 1.6 to 1.8 cm and from 2.3 to 2.5 cm, while from 2.7 cm onwards the proportion of females was dominant.

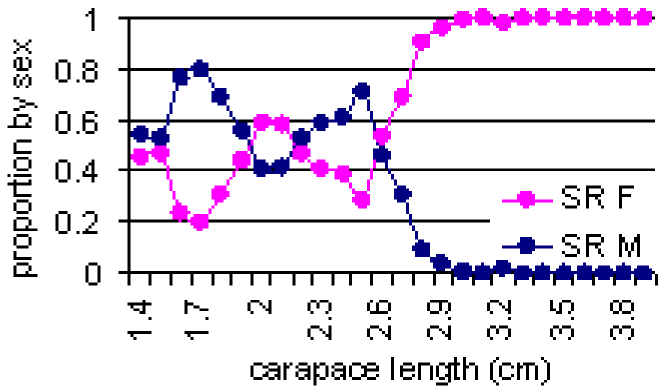


Fig. 8.36.1.3.2 Sex ratio at length of pink shrimp in the GSA 18.

8.36.2.Fisheries

8.36.2.1.General description of fisheries

Pink shrimp is only targeted by trawlers and fishing grounds are located along the coasts of the whole GSA. Catches from trawlers are from a depth range between 50-60 and 500 m and pink shrimp may co-occurs with other important commercial species as *M. merluccius*, *Illex coindetii*, *Eledone cirrhosa*, *Lophius* spp., *Lepidorhombus boscii*, *N. norvegicus*.

8.36.2.2.Management regulations applicable in 2008 and 2009

Management regulations are based on technical measures, like the number of fishing licenses and area limitation (distance from the coast and depth). In order to limit the over-capacity of the fleet, the Italian fishing licenses have been fixed since the late 1980s. After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity is implemented. Two closed areas were also established in 2004 along the mainland, in front of Bari and in the vicinity of Tremiti MPA on the northernmost part of the GSA. Other management regulations are mesh size, minimum landing sizes and the minimum distance (or depth) from the coastline (EC reg. 1967/06). In the GSA 18 the fishing ban has been almost always mandatory since 1988 for a period of 30-45 days, generally during late July-early September.

8.36.2.3.Catches

8.36.2.3.1. Landings

Available landing data are from DCR regulations. SGMED-09-02 received Italian landings data for GSA 18 by major fishing gears which are listed in Tab. 8.36.2.3.1.1. The fishing segments DTS and OTB identify the trawlers, while PGP and PMP indicate respectively small scale fishery (nets) and polyvalents, however trawlers account for the major landing quantity. Since 2002 to 2004 landings of pink shrimp were rising from 1,147 t to 1,857 t whereas in 2007 and 2008, a strong reduction is observed (Fig. 8.36.2.3.1.1).

Tab. 8.36.2.3.1.1. Annual landings (t) by major gear type, 2002-2008.

Sum of landings (tons)	FT_LVL4				
YEAR	DTS	OTB	PGP	PMP	Total
2002	903			244	1147
2003	1253		67	496	1816
2004		1857			1857
2005		1181			1181
2006		1473			1473
2007		863			863
2008		766			766

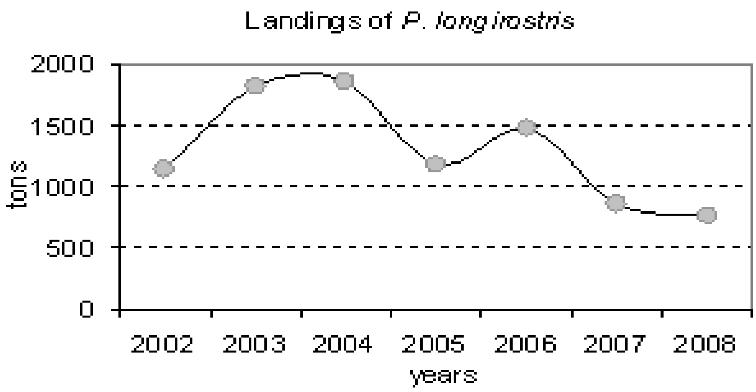


Fig. 8.36.2.3.1.1 Landings (t) by year (2002-2008) as reported through DCR in the GSA 18.

8.36.2.3.2. Discards

No information was documented during SGMED 09-02.

8.36.2.3.3. Fishing effort

The trends in fishing effort by year and major gear type is listed in Tab. 8.36.2.3.3.1 and shown in Fig. 8.36.2.3.3.1 in terms of kW*days. The fishing segment DTS and OTB, that identify trawlers, were considered for the fishing effort trend because the pink shrimp is exploited only by this fleet segment. The fishing effort in kW*days was declining from 2002 to 2004, whilst since 2004 to 2006 it is rising but a reduction to the levels of 2004 is observed in 2007.

Tab. 8.36.2.3.3.1 Trend in fishing effort (kW*days) of trawlers (DTS-OTB) in the GSA 18, 2002-2007.

	FT_LVL4	Kw*days		
YEAR	DTS	OTB	PTM	TOTAL
2002	17112022			17112022
2003	14530793			14530793
2004	14369490			14369490
2005		14372055	1069744	15441799
2006		14808415	1436018	16244432
2007		12562033	1773275	14335307

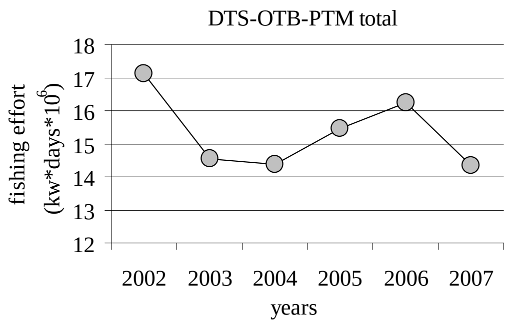


Fig. 8.36.2.3.3.1 Trend in fishing effort (kW*days*10^6) of trawlers (DTS-OTB) in the GSA 18, 2002-2007.

8.36.3.Scientific surveys

8.36.3.1.Medits

8.36.3.1.1. Methods

Trawl surveys were carried out applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area (Bertrand et al., 2002). The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed.

Based on the DCR data call, abundance and biomass indices were calculated. In GSA 18 the following number of hauls was reported per depth stratum (Tab. 8.36.3.1.1.1).

Tab. 8.36.3.1.1.1. Number of hauls per year and depth stratum in GSA 18, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA18_010-050	14	15	15	14	14	14	14	15	13	13	12	9	10	11	10
GSA18_050-100	14	14	14	15	15	15	15	14	21	21	23	16	15	15	14
GSA18_100-200	24	23	23	23	23	23	23	23	34	31	32	25	25	23	22
GSA18_200-500	10	10	10	10	10	10	10	10	15	15	16	10	10	9	8
GSA18_500-800	10	10	10	10	10	10	10	10	14	14	14	7	7	7	5
Total	72	72	72	72	72	72	72	72	97	94	97	67	67	65	59

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

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

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

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

Where:

- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.36.3.1.2. Geographical distribution patterns

The geographical distribution pattern of pink shrimp in the GSA 18 has been studied using trawl-survey data and geostatistical methods. In these studies the abundance indices of recruits were analysed. Results highlighted that areas localised in the Gulf of Manfredonia and between Monopoli and Brindisi coasts within 200 m depth are mainly characterised by higher concentration of pink shrimp recruits reaching 2000 individuals/km^2 in 2000-2001. A peak of 5000 individuals/km^2 was observed in the southernmost location (border between GSA 18 and 19) off Capo S. Maria di Leuca.

Maps of the pink shrimp nursery obtained applying the indicator kriging techniques are reported below.

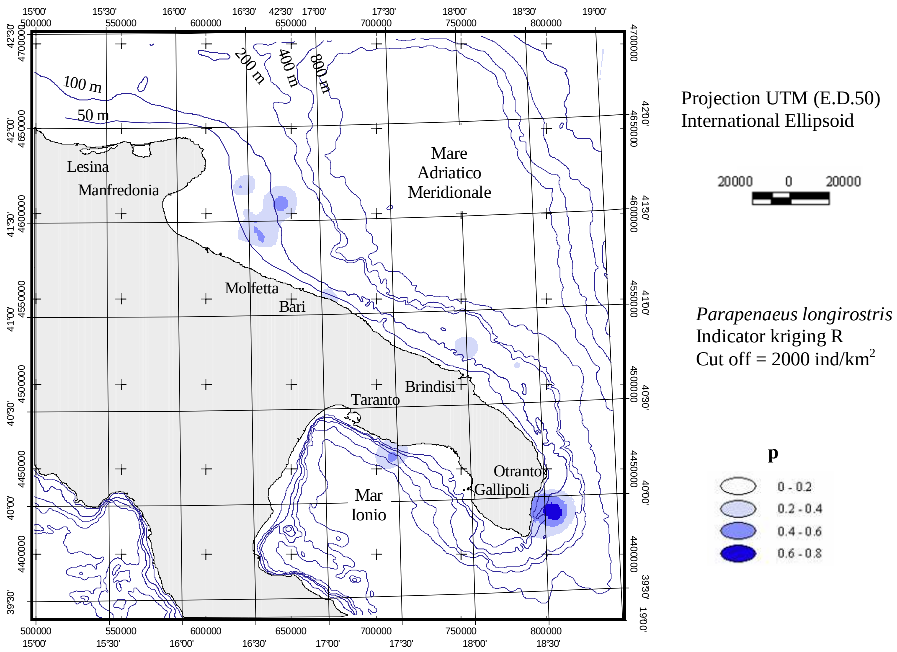


Fig. 8.36.3.1.2.1 Geographical distribution patters as derived from MEDITS.

8.36.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the pink shrimp in GSA 18 was derived from the international survey Medits. Figure 8.39.3.1.3.1 displays the estimated trend of pink shrimp abundance and biomass in GSA 18. Considering only the period from 2001 to 2008, indices show an increasing pattern up to 2005 and a sharp decline afterwards.

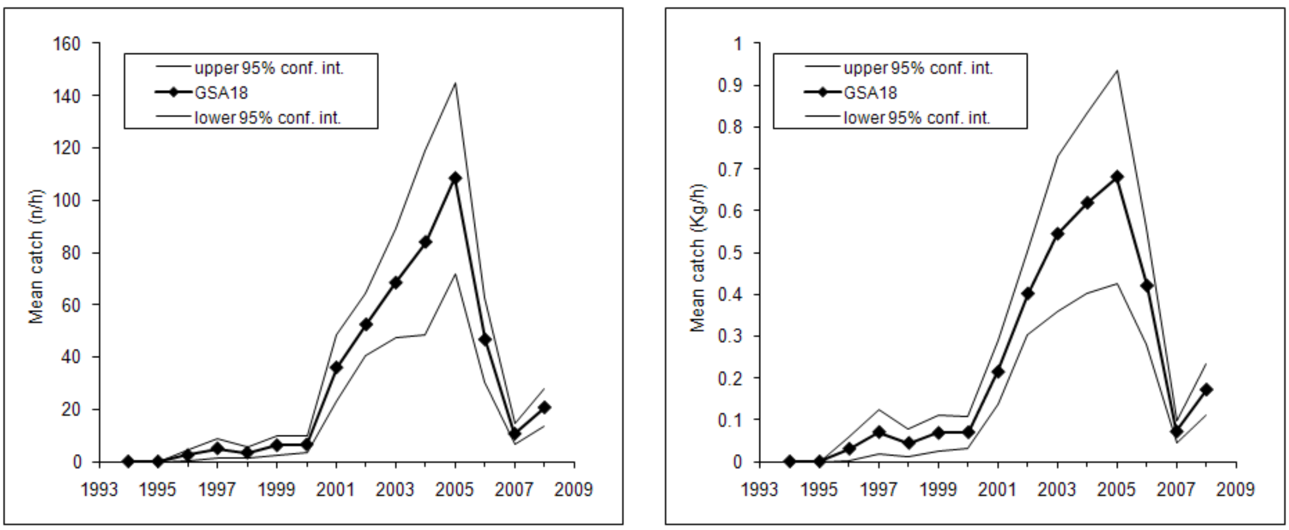


Fig. 8.36.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 18.

The Medits 2007 report highlighted some changes in the abundance of demersal resources from 1996 to 2006. They mostly refer to the general increase of the species characterised by short life span such as cephalopods and crustaceans (i.e. *Parapenaeus longirostris*) and the decrease of some gadiforms fish such as *Micromesistius poutassou* and *Trisopterus minutus*. The report stated that changes could be influenced by both the fishery pressure on large- sized and long-lived species (Jukic-Peladic *et al.* 2001) and the effects of the environmental conditions (i.e. increase of bottom temperature).

8.36.3.1.4. Trends in abundance by length or age

The following Fig. 8.36.3.1.4.1 and 2 display the stratified abundance indices of GSA 18 in 1996-2003 and 2004-2008.

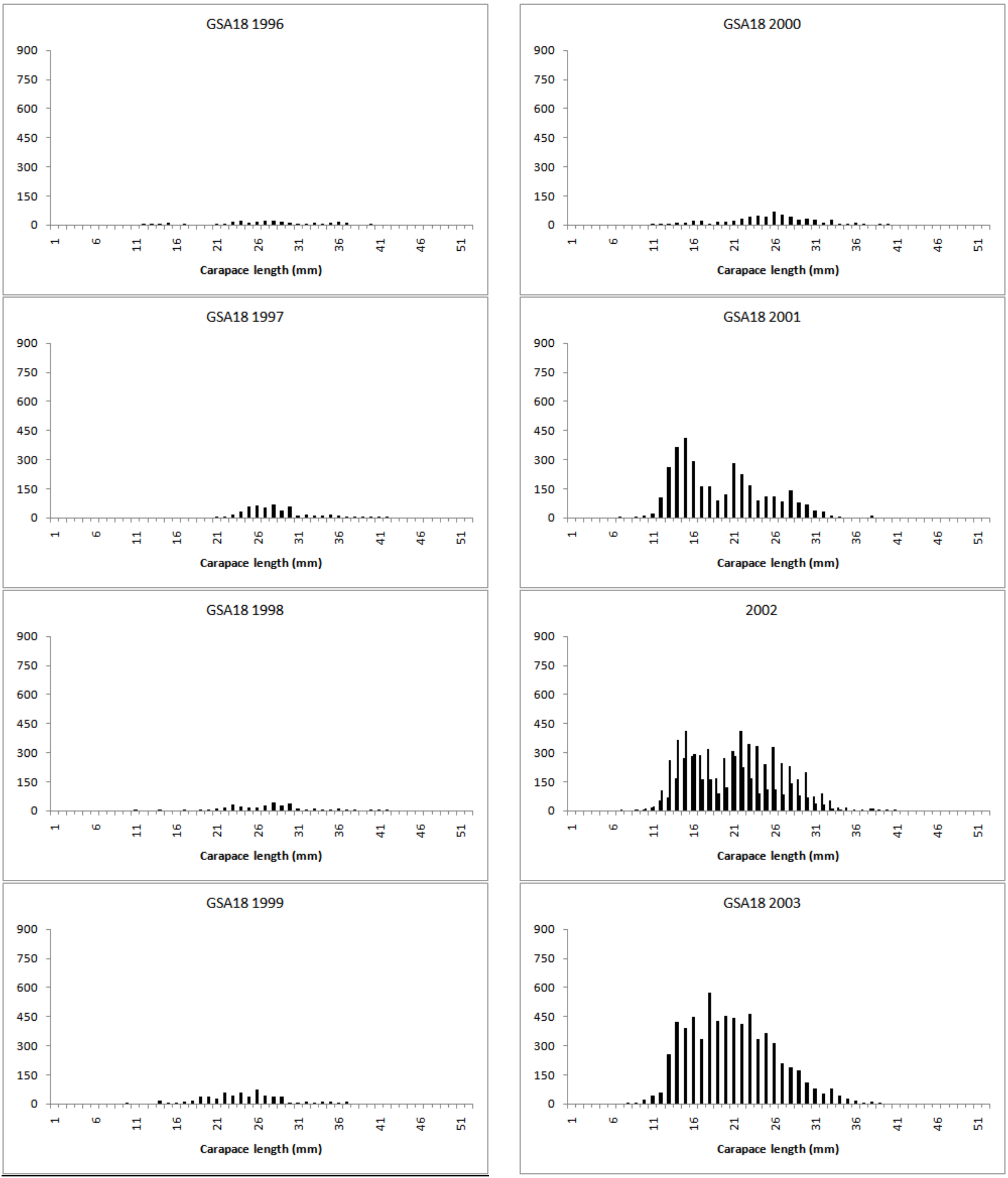


Fig. 8.36.3.1.4.1 Stratified abundance indices by size, 1996-2003.

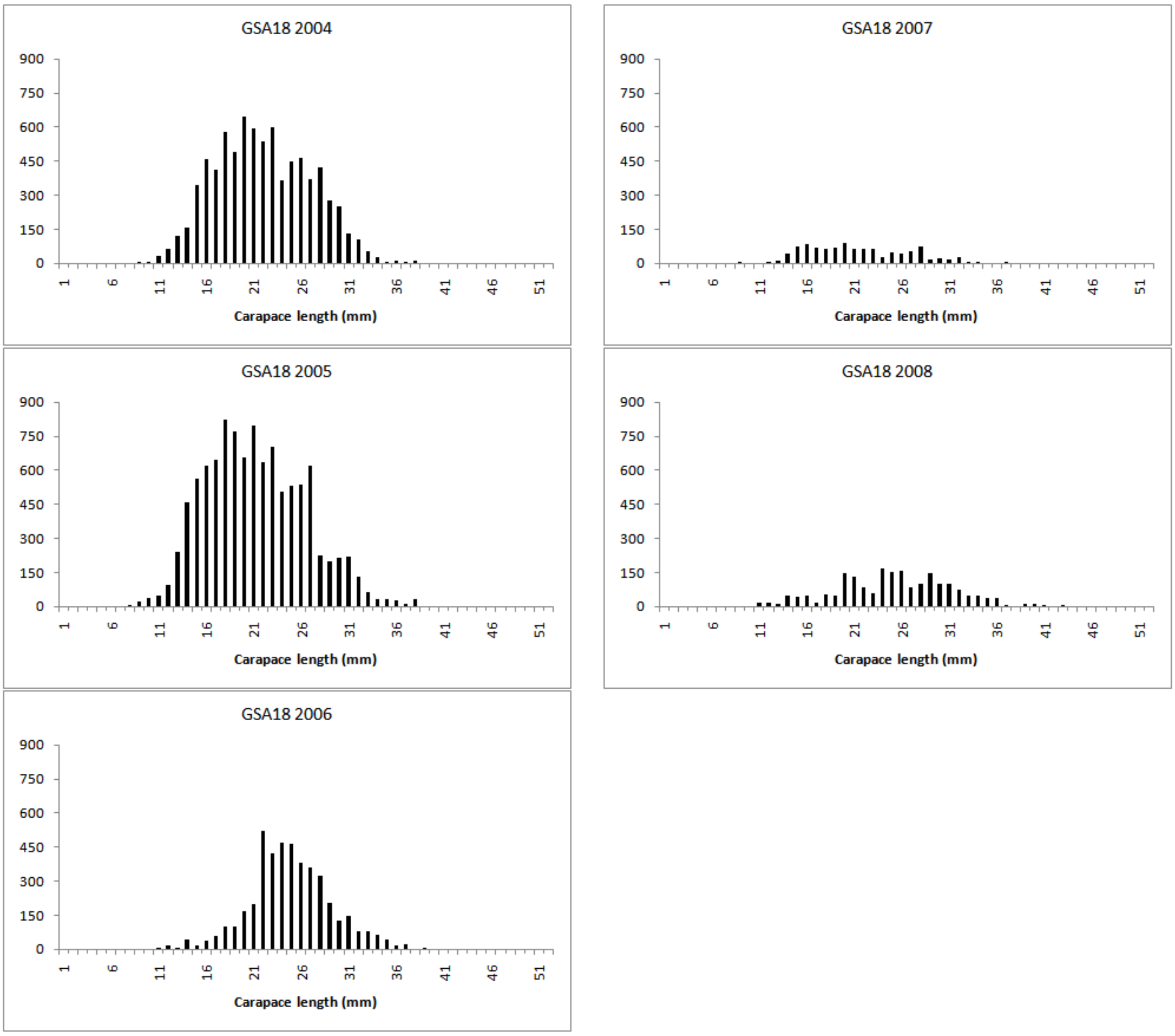


Fig. 8.36.3.1.4.2 Stratified abundance indices by size, 2004-2008.

8.36.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.36.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.36.4.Assessment of historic stock parameters

SGMED 09-02 did not undertake any analytical assessment.

8.36.5.Long term prediction

8.36.5.1. Justification

No forecast analyses were conducted.

8.36.6. Scientific advice

8.36.6.1. Short term considerations

8.36.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses. Survey results indicate the recent stock size being low.

8.36.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of recruitment in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.36.6.1.3. State of exploitation

In the absence of proposed or agreed references, SGMED 09-02 is unable to fully evaluate the state of the stock and provide scientific advice.

8.37. Stock assessment of pink shrimp in GSA 19

8.37.1.Stock identification and biological features

8.37.1.1.Stock Identification

No information was documented during SGMED-09-02.

8.37.1.2.Growth

No information was documented during SGMED-09-02.

8.37.1.3.Maturity

No information was documented during SGMED-09-02.

8.37.2.Fisheries

8.37.2.1.General description of fisheries

No information was documented during SGMED-09-02.

8.37.2.2.Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.37.2.3.Catches

8.37.2.3.1. Landings

Tab. 8.37.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.3 of Appendix 3. The landings in 2007 represent the record low. The landings were mainly taken by demersal otter trawls.

Tab. 8.37.2.3.1.1 Annual landings (t) by fishing technique in GSA 19. Landings data provided for the years 2002 and 2003, probably have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DPS	19	ITA	DTS	738490	646425					
DPS	19	ITA	GTR				1			
DPS	19	ITA	OTB			1201	1243	1245	608	785
DPS	19	ITA	PGP	2987						
DPS	19	ITA	PMP	364828	744623					
DPS	19	ITA	PTS	20248						

8.37.2.3.2. Discards

4 t of discards in 2006 was reported to SGMED-09-02 through the DCR data call and is listed in Tab. A.3.9 of Appendix 3.

8.37.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-09-02 are listed in Tab. 8.37.2.3.3.1 and in Tab. A3.10-3.12 of Appendix 3.

Tab. 8.37.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSA 19, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	19	ITA	DRB				1318	3384	3998	
DAYS	19	ITA	DTS	31381	31586	37234				
DAYS	19	ITA	FPO				3189	2925	2473	
DAYS	19	ITA	GND				29731	20736	13328	
DAYS	19	ITA	GNS				49840	83590	73806	
DAYS	19	ITA	GTR				70390	53842	29510	
DAYS	19	ITA	HOK			39190				
DAYS	19	ITA	LHP-LHM				6539	5653	4829	
DAYS	19	ITA	LLD				21034	27841	20451	
DAYS	19	ITA	LLS				19503	12450	14608	
DAYS	19	ITA	LTL				2853	2862	371	
DAYS	19	ITA	MIS				1162	19	168	
DAYS	19	ITA	OTB				41760	45465	39604	
DAYS	19	ITA	PGP	233718	254881	225109				
DAYS	19	ITA	PMP	100208	122225	20325				
DAYS	19	ITA	PS				11984	9365	6768	
DAYS	19	ITA	PTM					150		
DAYS	19	ITA	PTS	3458	7302	6605				
DAYS	19	ITA	SB-SV				19427	24848	20184	
GT*DAYS	19	ITA	DRB				1318	3384	5019	
GT*days	19	ITA	DTS	580641	581841	782163				
GT*DAYS	19	ITA	FPO				3189	3500	2633	
GT*DAYS	19	ITA	GND				143652	144284	119326	
GT*DAYS	19	ITA	GNS				90354	121741	116633	
GT*DAYS	19	ITA	GTR				168879	123220	85068	
GT*days	19	ITA	HOK			1015534				
GT*DAYS	19	ITA	LHP-LHM				6746	9985	5233	
GT*DAYS	19	ITA	LLD				1107106	810180	779709	
GT*DAYS	19	ITA	LLS				60709	48454	58917	
GT*DAYS	19	ITA	LTL				14316	17178	1683	
GT*DAYS	19	ITA	MIS				2246	207	2688	
GT*DAYS	19	ITA	OTB				745886	677976	571825	
GT*days	19	ITA	PGP	602573	1113240	473727				
GT*days	19	ITA	PMP	1379166	1015437	111129				
GT*DAYS	19	ITA	PS				159697	125312	103153	
GT*DAYS	19	ITA	PTM					1646		
GT*days	19	ITA	PTS	188356	320037	195882				
GT*DAYS	19	ITA	SB-SV				42997	64370	50261	
KW*DAYS	19	ITA	DRB				7389	15175	36099	
kW*days	19	ITA	DTS	5125805	5002396	5802023				
KW*DAYS	19	ITA	FPO				57394	57121	56482	
KW*DAYS	19	ITA	GND				1185580	1388194	1130531	
KW*DAYS	19	ITA	GNS				1046673	1475918	1510335	
KW*DAYS	19	ITA	GTR				1818750	1347016	928503	
kW*days	19	ITA	HOK			6809150				
KW*DAYS	19	ITA	LHP-LHM				29910	160904	36015	
KW*DAYS	19	ITA	LLD				6607539	4495795	4304257	
KW*DAYS	19	ITA	LLS				724710	541247	670291	
KW*DAYS	19	ITA	LTL				159527	177770	20433	
KW*DAYS	19	ITA	MIS				26652	1760	16129	
KW*DAYS	19	ITA	OTB				6256653	6868746	5888163	
kW*days	19	ITA	PGP	4669873	9192254	4881153				
kW*days	19	ITA	PMP	13116917	9143878	1188078				
KW*DAYS	19	ITA	PS				1376127	942578	783035	
KW*DAYS	19	ITA	PTM					12646		
kW*days	19	ITA	PTS	978457	1629677	1105203				
KW*DAYS	19	ITA	SB-SV				510273	699325	584069	

8.37.3.Scientific surveys

8.37.3.1.Medits

8.37.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 19 the following number of hauls was reported per depth stratum (s. Tab. 8.37.3.1.1.1).

Tab. 8.37.3.1.1.1. Number of hauls per year and depth stratum in GSA 19, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA19_010-050	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9
GSA19_050-100	7	8	8	8	8	8	8	8	8	8	8	8	8	9	8
GSA19_100-200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11
GSA19_200-500	16	15	15	15	15	15	15	15	21	21	14	15	14	14	14
GSA19_500-800	31	32	32	32	32	32	32	32	29	29	29	28	29	29	29

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.37.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.37.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the pink shrimp in GSA 19 was derived from the international survey Medits. Figure 8.37.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSA 19.

The estimated abundance and biomass varied without a clear trend. The recent abundance and biomass indices in 2007 appear very low, which appears consistent with the low landings in 2007. The analyses of Medits indices are considered preliminary.

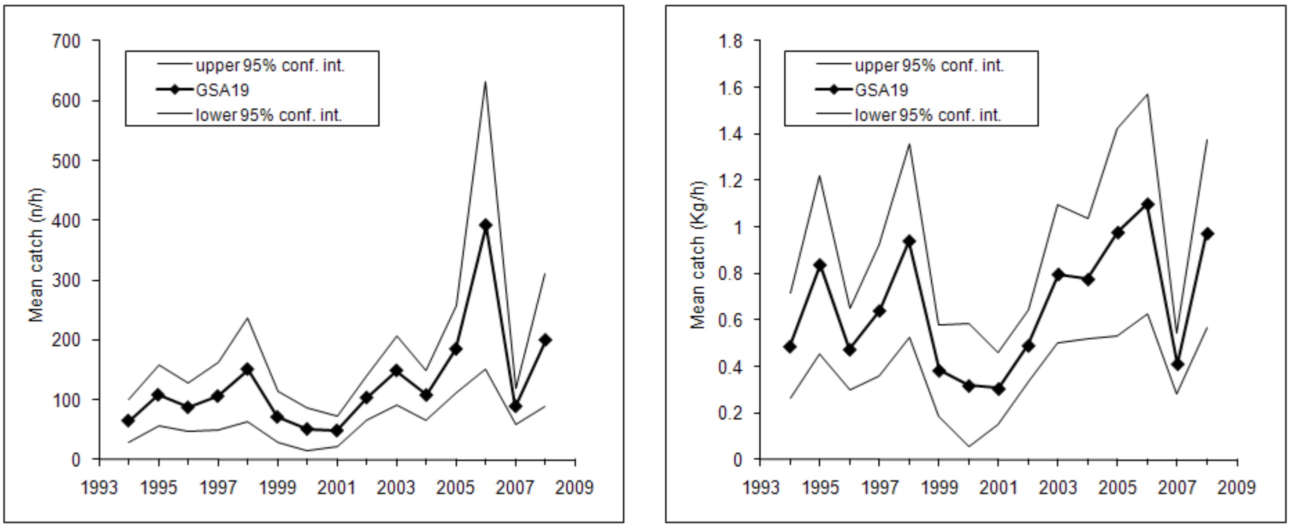


Fig. 8.37.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 19.

8.37.3.1.4. Trends in abundance by length or age

The following Fig. 8.37.3.1.4.1 and 2 display the stratified abundance indices of GSA 19 in 1994-2008. These size compositions are considered preliminary.

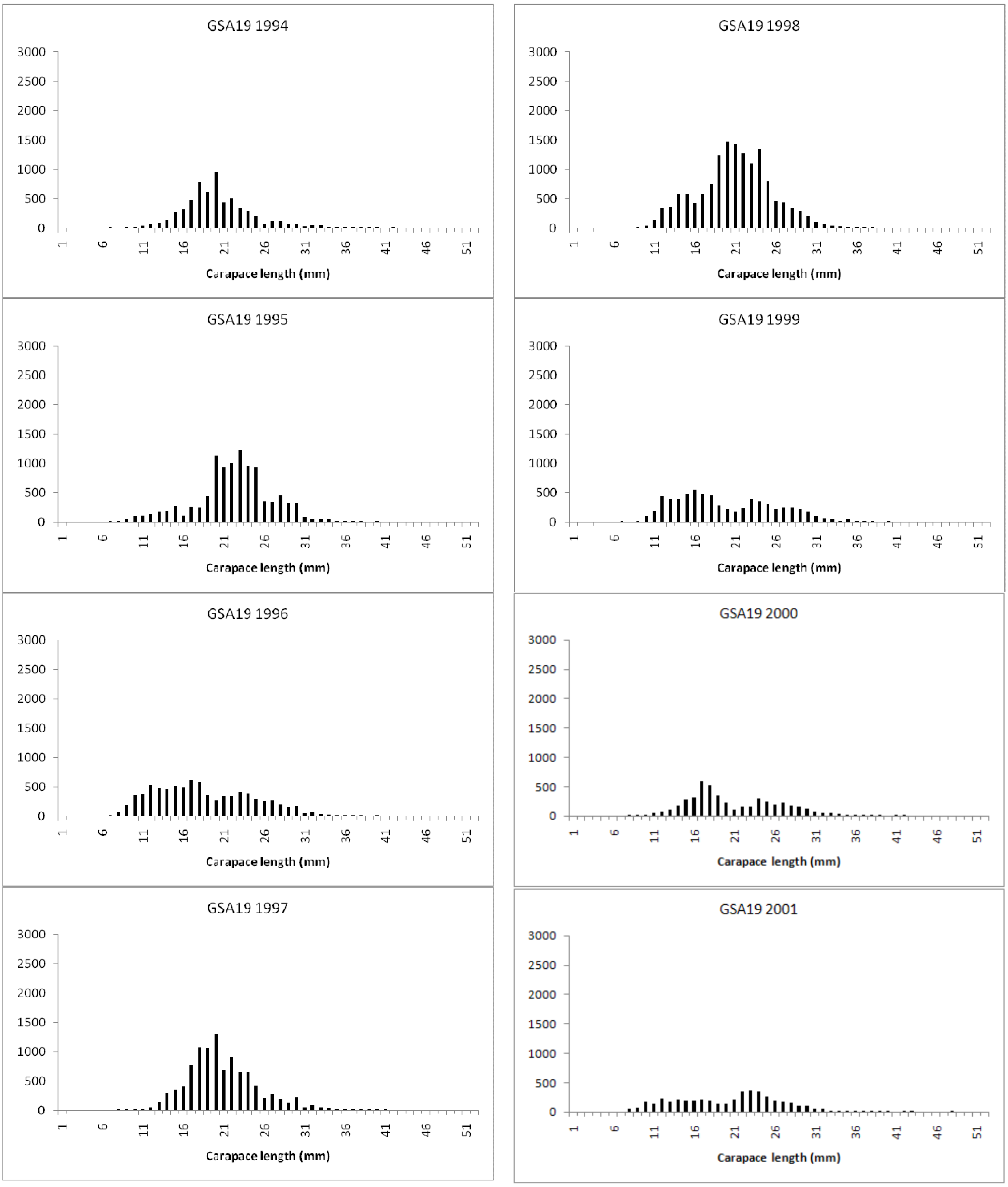


Fig. 8.37.3.1.4.1 Stratified abundance indices by size, 1994-2001.

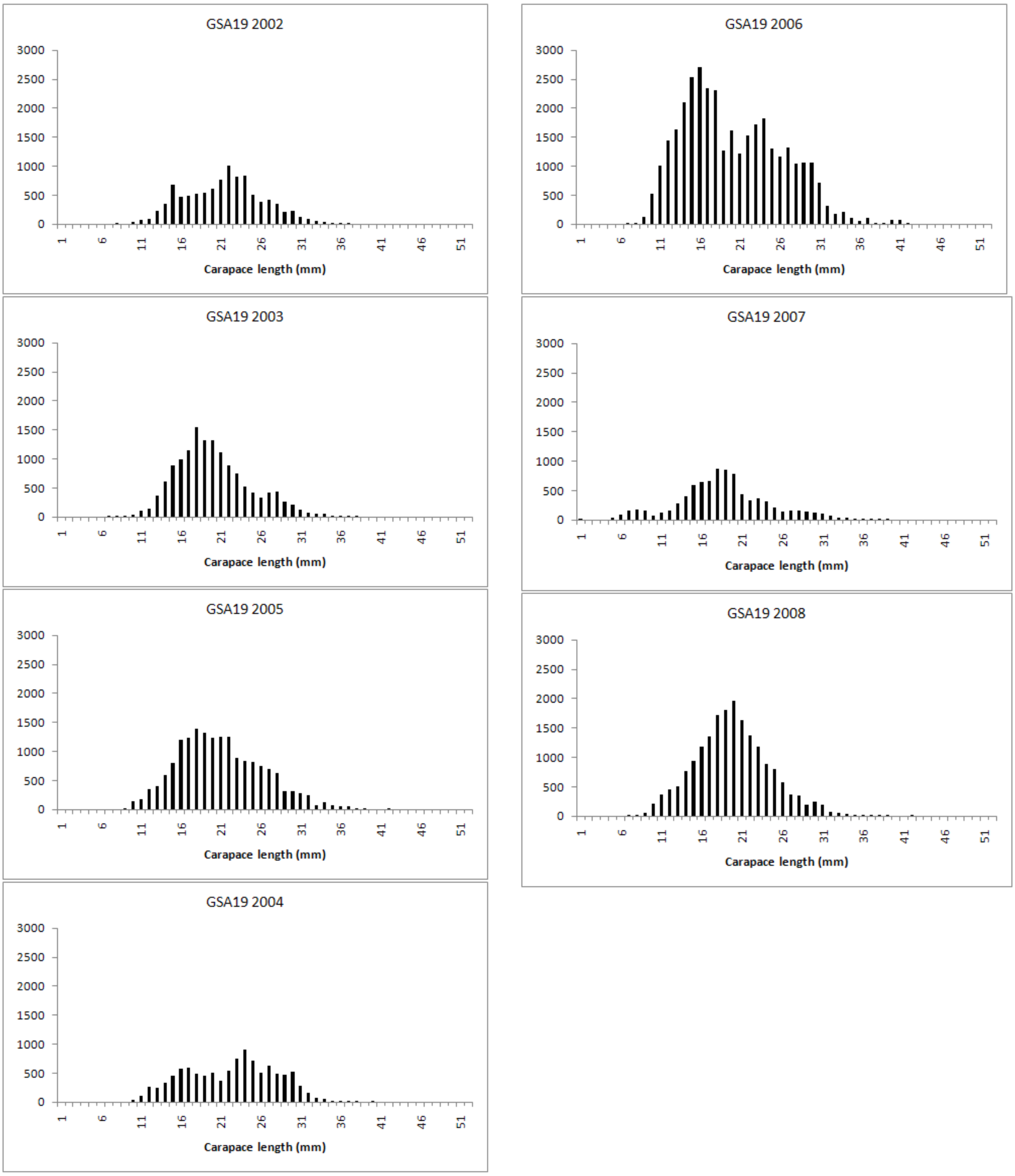


Fig. 8.37.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.37.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.37.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.37.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.37.5. Long term prediction

8.37.5.1. Justification

No forecast analyses were conducted.

8.37.5.2. Input parameters

No forecast analyses were conducted.

8.37.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for pink shrimp in GSA 19.

8.37.6. Scientific advice

8.37.6.1. Short term considerations

8.37.6.1.1. State of the spawning stock size

In the absence of proposed or agreed references, SGMED-09-02 is unable to fully evaluate the state of the stock and provide scientific advice.

8.37.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.37.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.38. Stock assessment of pink shrimp in GSAs 22 and 23 combined

8.38.1. Stock identification and biological features

8.38.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.38.1.2. Growth

No information was documented during SGMED-09-02.

8.38.1.3. Maturity

No information was documented during SGMED-09-02.

8.38.2. Fisheries

8.38.2.1. General description of fisheries

No information was documented during SGMED-09-02.

8.38.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.38.2.3. Catches

8.38.2.3.1. Landings

Tab. 8.38.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.3 of Appendix 3. Since 2003 the annual landings increased significantly from 1,074 t in 2003 and 3,899 t in 2008. The landings were mainly taken by demersal otter trawls.

Tab. 8.38.2.3.1.1 Annual landings (t) by fishing technique in GSAs 22 and 23.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DPS	22+23	GRC	GTR		207	98	72	124		97
DPS	22+23	GRC	OTB		867	3258	3926	4053		3745
DPS	22+23	GRC	SB							57

8.38.2.3.2. Discards

No discards data were reported to SGMED-09-02 through the DCF data call for Greece.

8.38.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-09-02 are listed in Tab. 8.38.2.3.3.1 and in Tab. A3.10-3.12 of Appendix 3.

Tab. 8.38.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSAs 22 and 23, 2003-2008.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	22+23	GRC	GTR		2078058	1908626	1993815	1914951		1374948
DAYS	22+23	GRC	LLS		20905	41155	41568	51501		302098
DAYS	22+23	GRC	OTB		52536	53381	56580	53367		51855
DAYS	22+23	GRC	PS		44481	43772	48211	42874		40029
DAYS	22+23	GRC	SB		36266	31987	33200	30098		25138
GT*DAYS	22+23	GRC	GTR		8567144	8034837	7939836	7571041		5309125
GT*DAYS	22+23	GRC	LLS		332005	577572	603419	780138		1244484
GT*DAYS	22+23	GRC	OTB		4927349	4972085	5553804	5556446		5355704
GT*DAYS	22+23	GRC	PS		1998124	1987556	2295466	2108039		1930332
GT*DAYS	22+23	GRC	SB		294896	269645	276265	257271		214985
KW*DAYS	22+23	GRC	GTR		68845607	70633794	70746878	66780942		50244080
KW*DAYS	22+23	GRC	LLS		1888201	4977272	2715667	3848302		7914684
KW*DAYS	22+23	GRC	OTB		15792715	15874762	17730748	16424382		16013057
KW*DAYS	22+23	GRC	PS		9389351	9140980	9656463	8992650		8233643
KW*DAYS	22+23	GRC	SB		2775797	2206815	2193550	2022231		1774864

8.38.3. Scientific surveys

8.38.3.1. Medits

8.38.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were calculated. In GSAs 22 and 23 the following number of hauls was reported per depth stratum (s. Tab. 8.38.3.1.1.1).

Tab. 8.38.3.1.1.1. Number of hauls per year and depth stratum in GSAs 22 and 23, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA22+23_010-050	10	10	11	10	13	12	13	13		13	13	14	14		13
GSA22+23_050-100	19	21	22	28	24	26	21	25		25	23	24	24		27
GSA22+23_100-200	19	26	38	36	36	33	38	35		36	43	41	41		40
GSA22+23_200-500	32	35	45	50	51	54	50	48		51	53	52	52		52
GSA22+23_500-800	18	13	19	22	22	21	20	17		17	17	17	17		17

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.38.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.38.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the pink shrimp in GSAs 22 and 23 was derived from the international survey Medits. Fig. 8.38.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSAs 22 and 23.

The estimated abundance and biomass indices increased from a very low level in 1994 to the highest value of the time series in 2006. The analyses of Medits indices are considered preliminary.

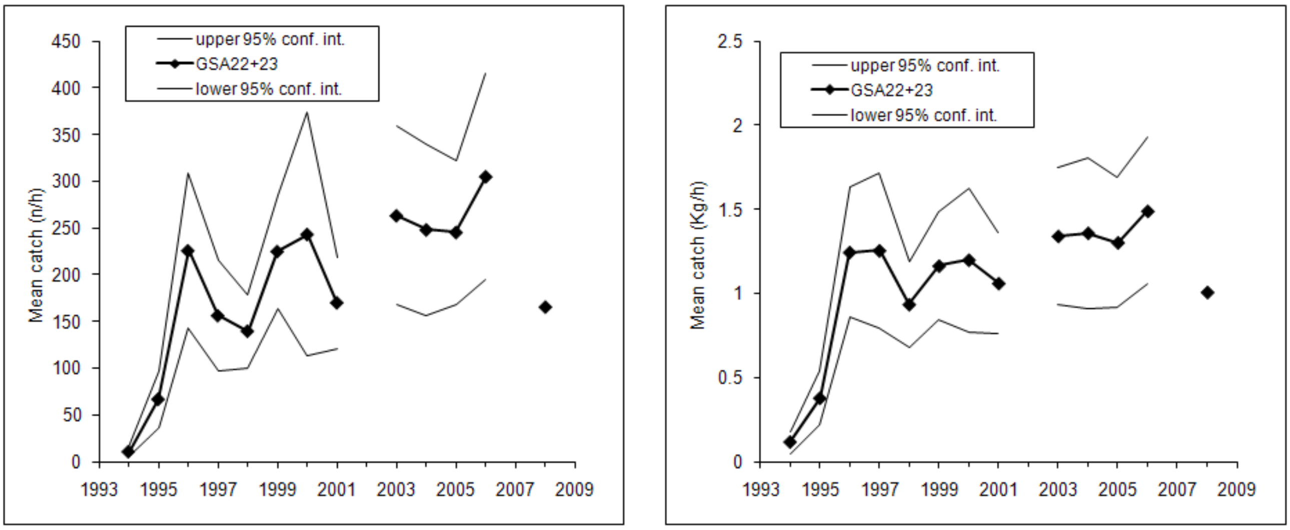


Fig. 8.38.3.1.3.1 Abundance and biomass indices of pink shrimp in GSAs 22 and 23.

8.38.3.1.4. Trends in abundance by length or age

The following Fig. 8.38.3.1.4.1 and 2 display the stratified abundance indices of GSAs 22 and 23 in 1994-2001 and 2003-2008. These size compositions are considered preliminary.

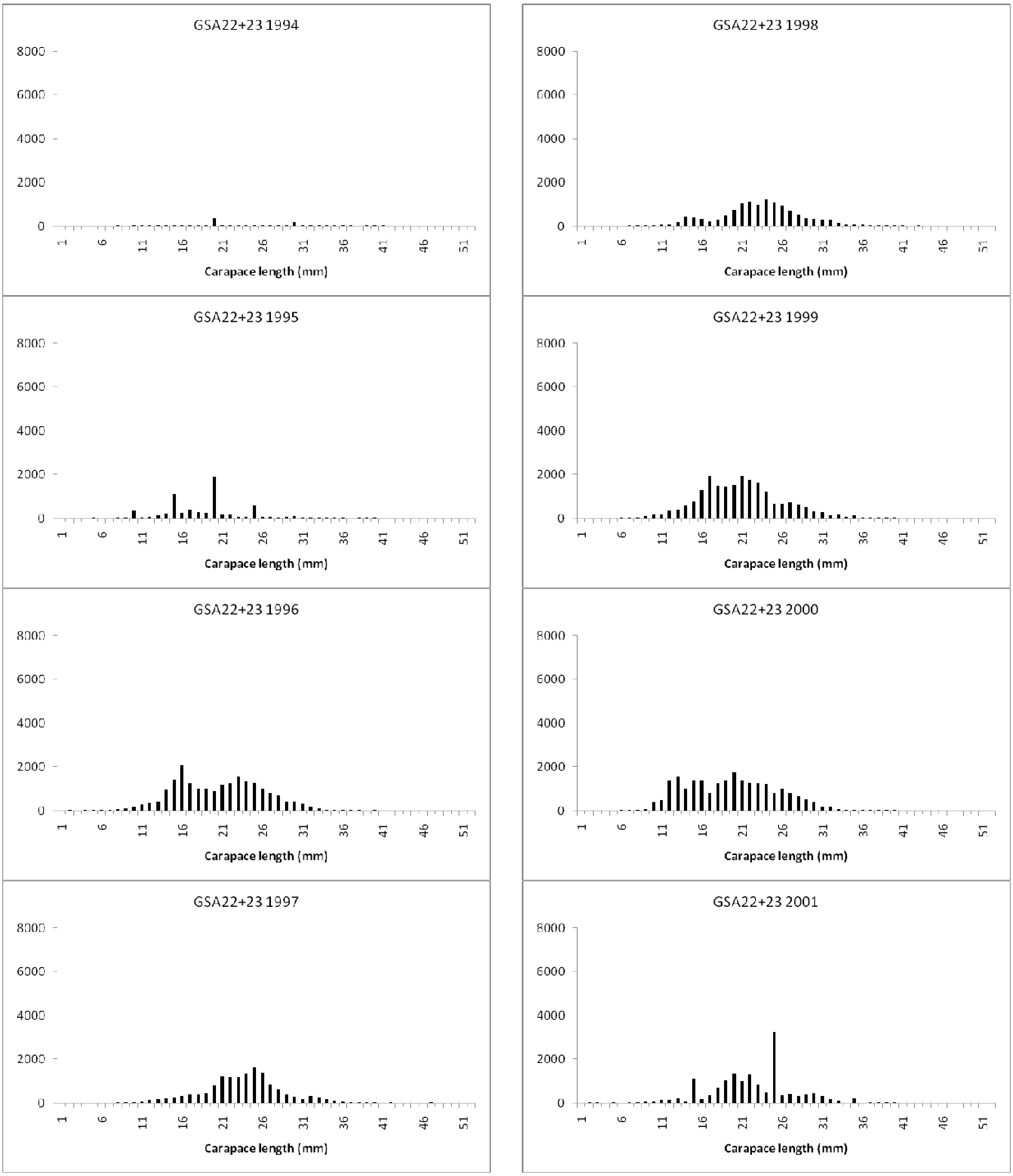


Fig. 8.38.3.1.4.1 Stratified abundance indices by size, 1994-2001.

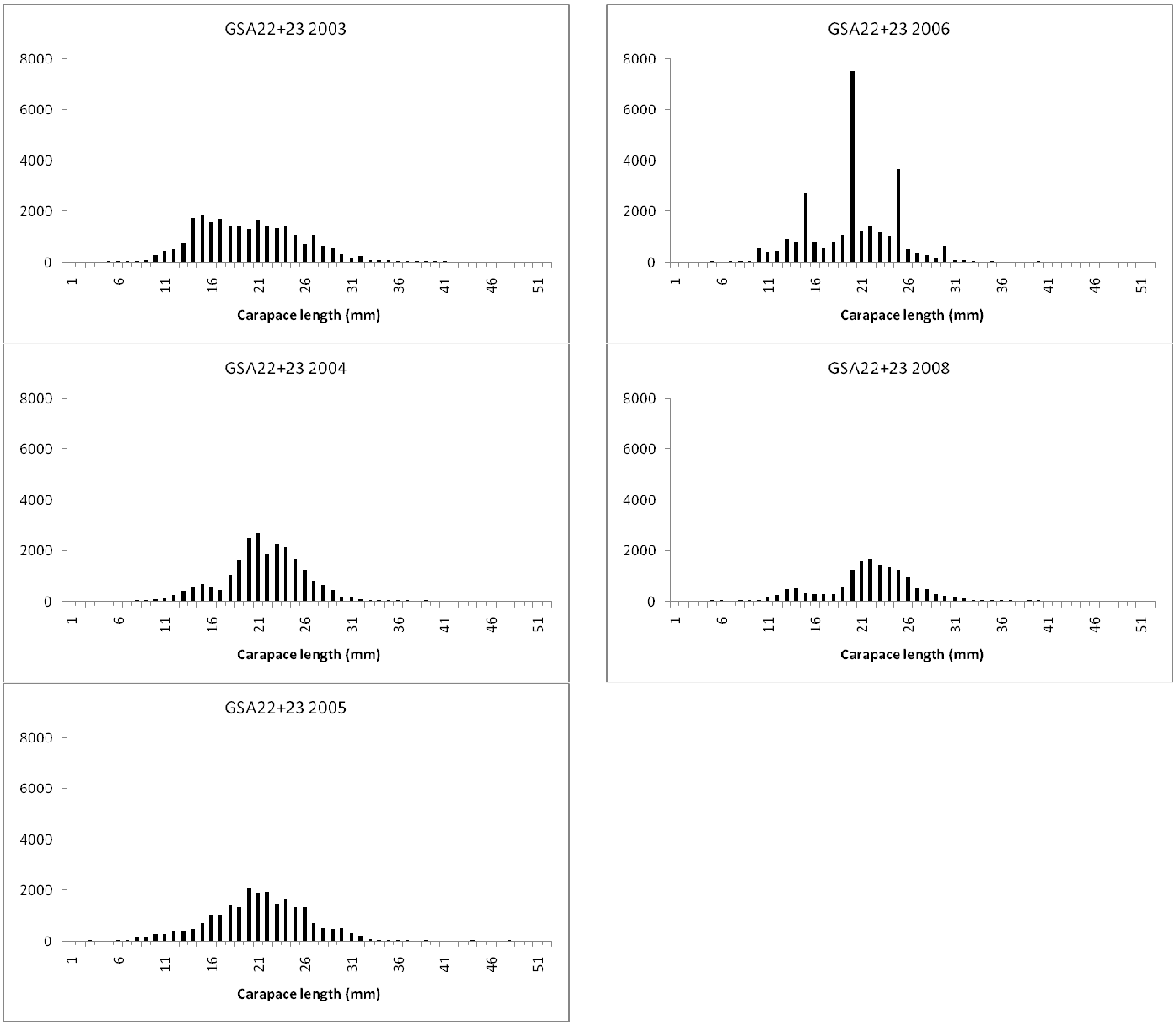


Fig. 8.38.3.1.4.2 Stratified abundance indices by size, 2003-2008.

8.38.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.38.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.38.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.38.5. Long term prediction

8.38.5.1. Justification

No forecast analyses were conducted.

8.38.5.2. Input parameters

No forecast analyses were conducted.

8.38.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for pink shrimp in GSAs 22 and 23.

8.38.6. Scientific advice

8.38.6.1. Short term considerations

8.38.6.1.1. State of the spawning stock size

In the absence of proposed or agreed references, SGMED-09-02 is unable to fully evaluate the state of the stock and provide scientific advice.

8.38.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.38.6.1.3. State of exploitation

In the absence of proposed or agreed references, SGMED-09-02 is unable to fully evaluate the state of the stock and provide scientific advice.

8.39. Stock assessment of anchovy in GSA 01

8.39.1. Stock identification and biological features

8.39.1.1. Stock Identification

Little or no specific work has been focus on the biological stock delimitation of anchovy in the Western Mediterranean, but exchanges between the Northern Alboran Sea (GSA 01) with both the Northern Spain (GSA 06) and South Alboran Sea (GSA 03) are believed non-existent. During the STECF-SGMED-08-02 the experts recommend continuing with the assessments on GFCM-GSA basis. The attached figure shows the GFCM Geographical Sub-Area GSA 01 (Northern Alboran Sea).

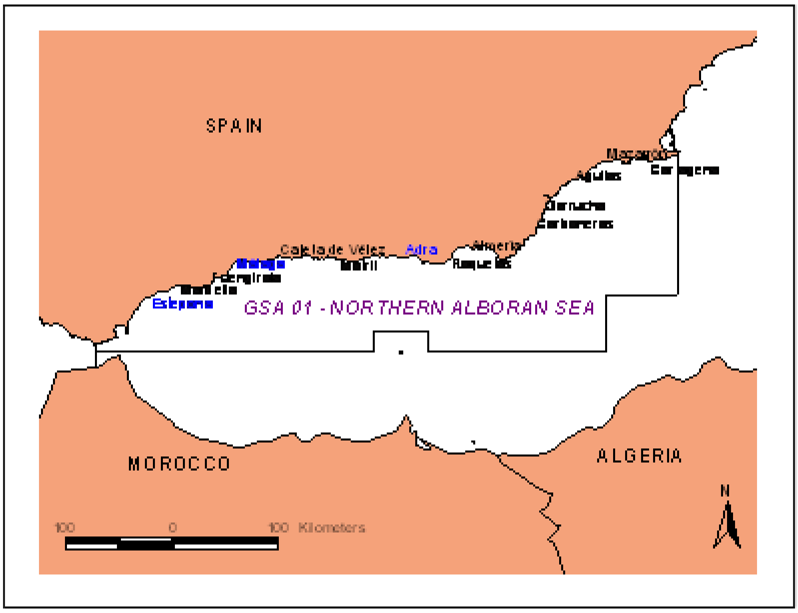


Fig. 8.39.1.1.1 Stock distribution area.

8.39.1.2. Growth

Growth parameters were estimated throughout the DCR biological sampling on a triennial basis. The method used was the Von Bertalanffy equation fit to the age (otoliths reading) and growth data using non-linear estimation with minimum least squares (Gauss-Newton algorithm) and bootstrapped precision estimates.

Tab. 8.39.1.2.1 Growth parameters.

PERIOD	$L\infty$	K	t0	A	B
2002-2004	19.0	0.3395	-1.8815	0.0029	3.3171
2005-2008	19.0	0.3419	-2.3210	0.0040	3.1945

8.39.1.3. Maturity

Maturity at age was estimated throughout the DCR biological sampling from years 2003-2007. These values were considered constant through the years of the assessed time series (2002-2007).

Tab. 8.39.1.3.1 Maturity ogive.

Age	0	1	2	3
Prop Matures	0.50	0.89	1.0	1.0

8.39.2. Fisheries

8.39.2.1. General description of fisheries

The current fleet in GSA 01 the Northern Alborán Sea is composed by 136 units, characterised by small vessels. 22% of them are smaller than 12 m and 78% between 12 and 24 m. The purse seine fleet has been continuously decreasing in the last two decades, from more than 230 vessels in 1980 to 136 in 2007.
Sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*) are the main target species of the purse seine fleet in Northern Alboran GSA 01, but other species with lower economical mackerel (*Trachurus spp.*), mackerel (*Scomber spp*.) and gilt sardine (*Sardinella aurita*).

8.39.2.2. Management regulations applicable in 2008 and 2009

- Fishing license
- Minimum landing size 11cm.
- Time at sea 12 hours per day and 5 days a week (no fishing allowed on weekend)
- Several technical measures regulations (gear and mesh size, engine, GRT, etc.)
- Temporary fishing closures (March and April).

8.39.2.3. Catches

8.39.2.3.1. Landings

The annual landings of anchovy in the Northern Alborán Sea show a strong annual fluctuation for the last six years ranged between 3268 and 112 tons. Landings decreased in 2008, reaching up 112 t that are the lowest of the time series. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.4 of Appendix 3.

Tab. 8.39.2.3.1.1 Annual landings (t) by fishing technique (Spanish purse seiners) in GSA 01.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
ANE	1	ESP	PS	3268	245	746	518	637	245	112

8.39.2.3.2. Discards

Anchovy discards in GSA 01 are negligible.

8.39.2.3.3. Fishing effort

No effort data were reported to SGMED-09-02 through the DCF data call for Spain.

8.39.3. Scientific surveys

8.39.3.1. ECOMED Acoustic Survey

8.39.3.1.1. Methods

Estimation of abundance index with Acoustic Survey (Biomass in metric tons and abundance in number of individuals by species and sector).

The ECOMED survey provided data from 1990 onwards, although the abundance time series used for XSA tuning goes from 2003 to 2006 because of acoustic data are being re-evaluated. As a result of a gradual increase in the abundance of other species (usually considered as accessory species in the pelagic system) it has been necessary to revaluate the previous data in ECOMED surveys using different values of the parameter target strength (TS).

The sampling coverage was completed only for two analysed years in GSA 01 (2004 and 2005), the survey did not cover the whole area only sampling the two most representative bays in 2003 and 2006, no data for 2007 was available as weather conditions and lack of available time did not allow to sample the area.

Surveys are carried out on board the R/V Cornide de Saavedra during late autumn (November-December). A multifrequency echosounder is utilised (SIMRAD-ER60) sampling at frequencies of 38 kHz, 70 kHz, 120 kHz and 200 kHz. The ESDU is 1 nm. The pulse duration is 1 msg. The software used echogram identification is *SonarData Ecoview*.

The sampling grid is comprised by parallel tracks, perpendicular to the coast. Acoustic sampling is performed during daytime. Experimental fishing with pelagic trawl for schools identification was done at night in the previously tracked positions.

8.39.3.1.2. Geographical distribution patterns

Anchovy in North Alborán Sea (GSA 01) is concentrated in Málaga Bay. This Bay is the most important recruitment and fishery area and this represent 85% of total landings.

8.39.3.1.3. Trends in abundance and biomass

Both XSA and acoustics methods have the same perception of the state of the stock. During the period from 1996-2006, the catches of anchovy stock in the Alborán Sea showed marked fluctuations. A successful recruitment, estimated by echo-acoustic tracking, was observed during 2001 (13,000 tons) producing a strong increment of landings in 2002. The catch dropped in 2003, continuing at low level to 2006 (600 tons). This decline is consistent with both XSA and acoustics methods.

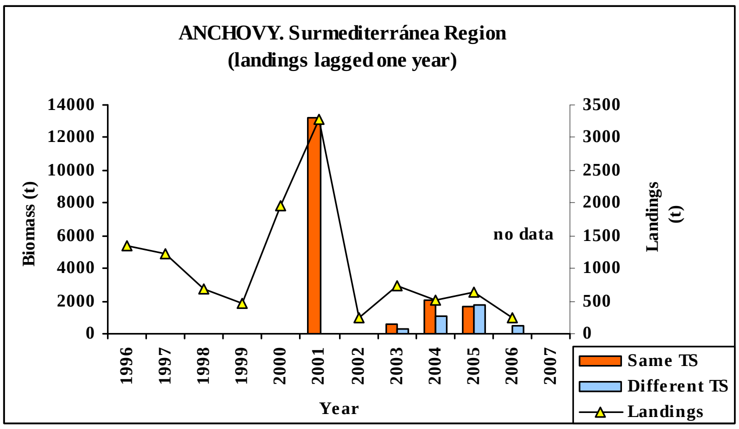


Fig. 8.39.3.1.3.1 Trends in biomass estimates and landings.

8.39.3.1.4. Trends in abundance by length or age

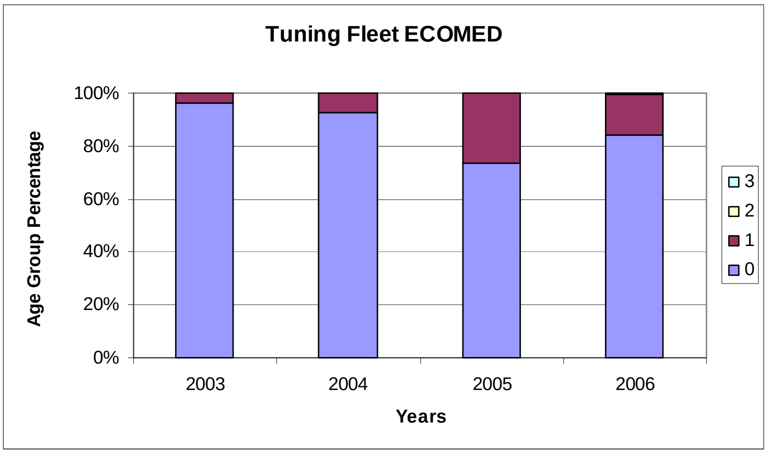


Fig. 8.39.3.1.4.1 Age compositon of the stock.

8.39.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.39.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.39.4.Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment of anhovy in GSA 01. Last year's assessment using VPA Extended Survivors Analysis (XSA) can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.39.5. Long term prediction

8.39.5.1.Justification

No forecast analyses were conducted.

8.39.5.2.Input parameters

No forecast analyses were conducted.

8.39.5.3.Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for anchovy in GSA 01.

8.39.6. Scientific advice

It should be noted that small pelagic fishery in GSA 01 is multispecies and effort on anchovy and sardine should be considered together.

Some work was done in SGMED-08-04 and some preliminary reference points were estimated based on yield-per-recruit analysis ($F_{0.1}$ & F_{max}). However the use of yield-per-recruit targets for long-term management of pelagic fisheries has been specifically discouraged (Patterson, 1992) and no reference points can be proposed at this time. Further research is aimed to produce effective Reference Points in this small pelagic fishery as well as Harvest Control Rules.

8.39.6.1. Short term considerations

8.39.6.1.1. State of the spawning stock size

No reference points were proposed for biomass levels, and hence SGMED-09-02 cannot comment on the state of the stock with this respect.

8.39.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.39.6.1.3. State of exploitation

No reference points were proposed for fishing mortality levels, and hence SGMED-09-02 cannot comment on the state of the stock with this respect.

8.40. Stock assessment of anchovy in GSA 06

8.40.1. Stock identification and biological features

8.40.1.1. Stock Identification

The small pelagic stock assessments in the Mediterranean are accomplished by Geografical Sub-Areas (GSAs) as defined in the GFCM. Little or no specific work has been focus on the biological stock identification of small pelagic species in the Mediterranean and more study is needed.

The attached figure shows the GFCM Geographical Sub- Area GSA 06, comprising all landings ports. Sampled ports are highlighted in blue.

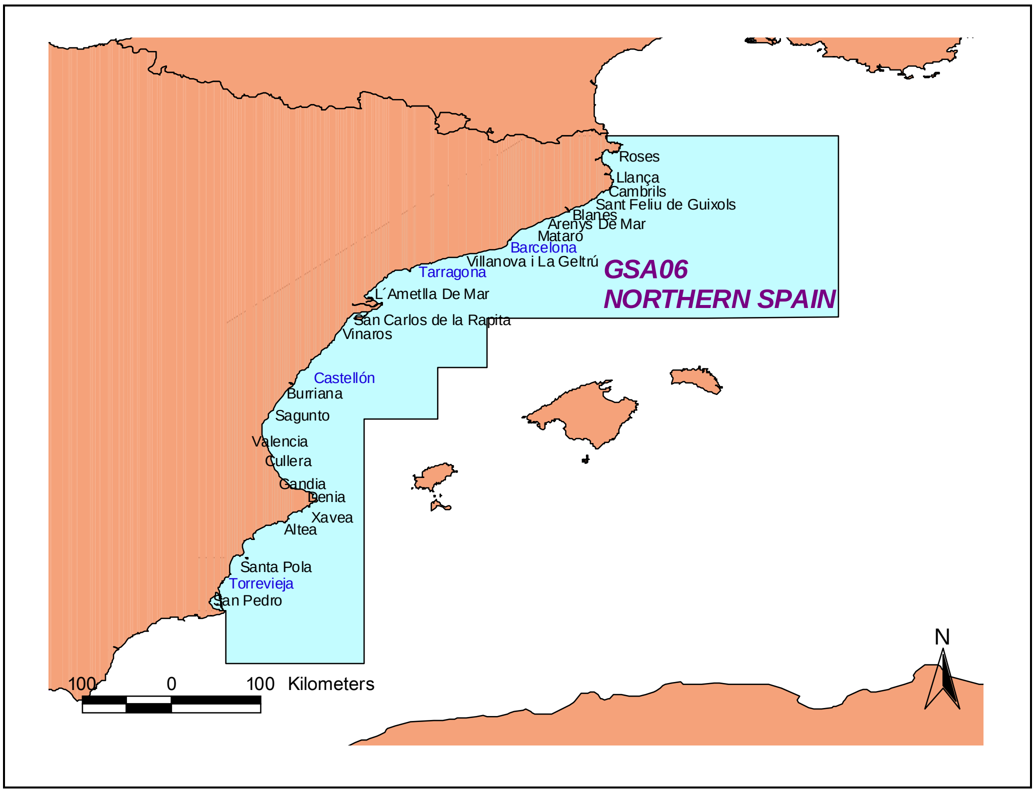


Fig. 8.40.1.1.1 Stock distribuition area.

8.40.1.2. Growth

Growth parameters were estimated throughout the DCR biological sampling on a triennial basis. The growth parameters come from the anchovy off GSA 01 and were applied to anchovy off GSA 06. The used method was the Von Bertalanffy equation fit to the age (otolith readings) and growth data using non-linear estimation with minimum least squares (Gauss-Newton algorithm) and Bootstrapped precision estimates.

Table 8.40.1.2.1 Growth paramters.

PERIOD	L_∞	K	t0	A	B
2002-2004	19.0	0.3395	-1.8815	0.0029	3.3171
2005-2008	19.0	0.3419	-2.3210	0.0040	3.1945

8.40.1.3.Maturity

Maturity at age was estimated throughout the DCR biological sampling from years 2004-2007. These values were considered constant through the years of the assessed time series (1994-2007).

Tab. 8.40.1.3.1 Maturity ogive.

Age	0	1	2	3
Prop. Matures	0.50	0.89	1.00	1.00

8.40.2.Fisheries

8.40.2.1.General description of fisheries

The purse seine fleet operate in GSA 06 Northern Spain is composed by 132 units: 4% are smaller than12 m in length, 87% between 12 and 24 m and 9% bigger than 24 m. The fleet continuously decreased in the last decade, from more than 222 vessels in 1995 to 132 in 2007. This strong reduction (59%) is possibly linked to a decreasing in anchovy catches.

Anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*) are the main target species of the purse seine fleet in Northern Spain GSA 06, but other species with lower economical importance are also captured, sometimes representing a high percentage of the capture: horse mackerel (*Trachurus* spp.), mackerel (*Scomber* spp.) and gilt sardine (*Sardinella aurita*).

This report is exclusively focused on fishery of anchovy.

8.40.2.2.Management regulations applicable in 2008 and 2009

- Fishing license.
- Minimum landing size 11cm.
- No fishing allowed on weekend. Time at sea 12 hours per day and 5 days a week: fully observed
- Several technical measures regulations (gear and mesh size, engine, GRT, etc.)
- Temporary fishing closures (From 1st December to 31st January).

8.40.2.3.Catches

8.40.2.3.1. Landings

The annual landings of anchovy (*Engraulis encrasicolus*) in the Northern Spain for the last seven years ranged between 14,338 and 2,570 t. This species is the most valuable one in pelagic fisheries off GSA 06.

Landings in 2008 were 2,888 t. The time series shows a very sharp decrease from the beginning of the times series in 2002. The lowest values of the assessed time series were reported in 2007.

Tab. 8.40.2.3.1.1 Annual landings (t) by fishing technique (purse seiners) in GSA 06.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
ANE	6	ESP	PS	14338	8538	8097	6216	3096	2570	2888

8.40.2.3.2. Discards

Discards are negliglible. Only 17 t in 2004 were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.9 of Appendix 3.

8.40.2.3.3. Fishing effort

No effort data were reported to SGMED-09-02 through the DCF data call for Spain.

8.40.3.Scientific surveys

8.40.3.1.ECOMED acoustic survey

8.40.3.1.1. Methods

The ECOMED survey provided data from 1990 onwards, although the abundance time series used for XSA tuning goes from 2003 onwards. The sampling coverage is completed for all analysed years in GSA 06.

Surveys are carried out on board the R/V Cornide de Saavedra during late autumn (November-December). A multifrequency echosounder is utilised (SIMRAD-ER60) sampling at frequencies of 38 kHz, 70 kHz, 120 kHz and 200 kHz. The ESDU is 1 nm. The pulse duration is 1 msg. The software used echogram identification is *SonarData Ecoview*.

The sampling grid is comprised by parallel tracks, perpendicular to the coast. Acoustic sampling is performed during daytime. Experimental fishing with pelagic trawl for schools identification was done at night in the previously tracked positions.

8.40.3.1.2. Geographical distribution patterns

The studied area is usually split in two regions, the Tramontana Region (from Cape Creus to Cape La Nao) and Levantine Region (from Cape La Nao to Cape Palos). This allows the use of the complete historic time series of ECOMED, which is carried out along the Tramontana Region from 1990. The time period (November – December) where the survey is conducted corresponds to the recruitment season of the anchovy and spawning season of sardine. Hence the acoustic provides an estimation of the recruitment of the anchovy. They are two recruitment areas: one located between Barcelona and the south of the Ebro River Delta (the most important) and other in Rosas Bay.

8.40.3.1.3. Trends in abundance and biomass

Anchovy biomass in year 2007 was the lowest for the past 8 years, 4,906 tons, 40% lower than in year 2006. There is not defined trend in calculated biomass since 1996, but it appears that the stock shows a dramatic decline trend since 2001. The recruitment has been low, the population consists almost exclusively of the recruits and has practically disappeared between southern Rosas Bay and Tarragona (North Ebro River Delta).

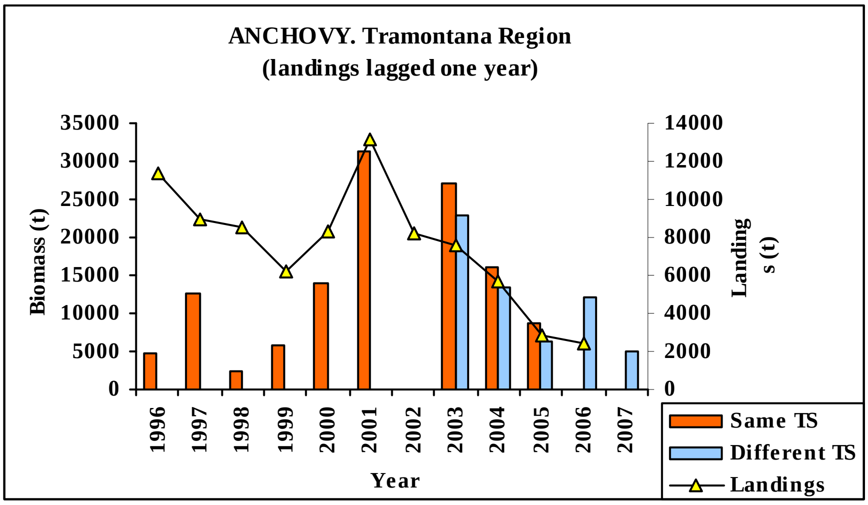


Fig. 8.40.3.1.3.1 Trends in estimated biomass and landings.

Up to date, the areas of greatest density for this species have been the two areas of recruitment: Rosas Bay and the mouth of the Ebro river. In 2007 the highest density was located in the Gulf of Valencia, where 67% of the total biomass was concentrated. This represents a change from the usual strategy of this species (see figure below).

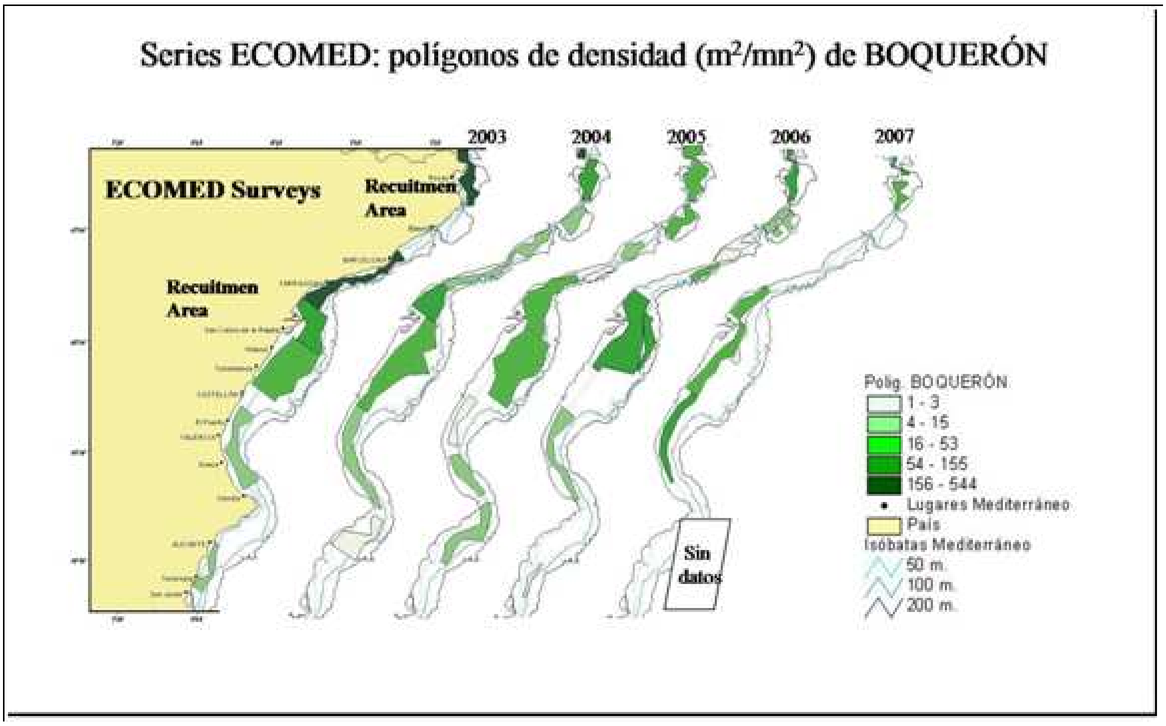


Fig. 8.40.3.1.3.2 Abundance in the survey area, 2003-2007.

- Trends in the pelagic community

Total small pelagics biomass, for all the 9 considered species, was 57,542 t in 2007. This accounted for a half from that estimated in 2006 (116,896 t). The distribution area of small pelagics has been reduced by 50%, especially in the key areas of recruitment of anchovy where the platform is wider: Rosas and Ebro River Delta. In these areas, acoustic integration was minimal out of the 80 m deep range.

It is important to note that for the last six years there was a gradual increase in the estimated biomass of other small pelagic species (mainly the three species of horse mackerel and bogue and in 2006 the *Scomber scombrus*) which are predators either eggs or anchovy larves as well as resources competitors. As regards 2007, the biomass of sardine and anchovy represented 44% of the total estimated biomass, in contrast to 63% and 83% in 2004 and 2003, respectively. The biomass of horse mackerel and bogue is still rising. In year 2007 accounted for 49% of the total biomass.

Other surveys: Some other surveys exist covering this area. The French survey PELMED2008 made an acoustic tracking of the area as far as the Gulf of Valencia. Some DEPM survey targeted to anchovy were also carried in 1993, 1994 and 2007. The document of the DEPM 2007 survey can be found in www.gfcm.org. The coverage of this survey was quite extensive, covering GSA 07 and GSA 06, although it was noted that Gulf of Alicante was not sampled. WG highlighted that DEPM results are not fitted to the management units GSA 06 and encourages re-estimating the SSB by considering those management units. This will allow making use of this survey for tuning the assessment model.

8.40.3.1.4. Trends in abundance by length or age

No analyses were conducted during SGMED-09-02.

8.40.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.40.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.40.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment of anhovy in GSA 06. Last year’s assessment using Extended Survivors Analysis (XSA) can be found in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.40.5. Long term prediction

8.40.5.1. Justification

No forecast analyses were conducted.

8.40.5.2. Input parameters

No forecast analyses were conducted.

8.40.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for anchovy in GSA 06.

8.40.6. Scientific advice

It should be noted that small pelagic fishery in GSA 06 is multispecies and effort on anchovy and sardine should be considered together.

8.40.6.1. Short term considerations

8.40.6.1.1. State of the spawning stock size

No reference points were proposed for biomass levels, and hence SGMED cannot comment on the state of the stock with this respect.

8.40.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.40.6.1.3. State of exploitation

In the absence of proposed or agreed references, SGMED-09-02 is unable to fully evaluate the state of the stock and provide scientific advice.

8.41. Stock assessment of anchovy in GSA 16

8.41.1. Stock identification and biological features

8.41.1.1. Stock Identification

This assessment of the anchovy stock in GSA 16 is mainly based on information collected over the last decade relating fishery grounds off the southern Sicilian coast (GSA 16, South of Sicily), and specifically using biomass estimates obtained by hydro-acoustic surveys and catch/effort data from local small pelagic fisheries. The main distribution area of the anchovy stock in GSA 16 is the narrow continental shelf area between Mazara del Vallo and the southernmost tip of Sicily, Cape Passero (Patti *et al*., 2004). Daily Egg Production Method (DEPM) surveys were also carried out starting from 1998, giving also information on spawning areas distribution.

8.41.1.2. Growth

Growth parameters were not used for this assessment.

8.41.1.3. Maturity

Maturity data were not used for this assessment.

8.41.2. Fisheries

8.41.2.1. General description of fisheries

In Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16, two operational units (OU) are presently active, purse seiners and pelagic pair trawlers. The fleet in GSA 16 is composed by about 50 units (17 purse seiners and 30 pelagic pair trawlers were counted up in a census carried out in December 2006). In both OUs, anchovy represents the main target species due to the higher market price.

8.41.2.2. Management regulations applicable in 2008 and 2009

Fisheries policy is strongly conditioned by EU regulations through the Common Fisheries Policy (CFP), based on the following principles: protection of resources; adjustment of (structure) facilities to the available resources; market organization; and definition of relationships with other countries.

The main technical measures regulating fishing concern minimum landing size (9 cm for anchovy, 11 cm for sardine), mesh regulations (20 mm for pelagic pair trawlers, 14 mm for purse seiners) and restrictions on the use of fishing gear. Towed fishing gears are not allowed in the coastal area in less than 50 m depth, or within a distance of 3 nautical miles from the coastline. A seasonal closure for trawling, generally during summer-autumn, has been established since 1993. In GSA 16, two operational units fishing for small pelagic are based in Sciacca port: purse seiners (lampara vessels, locally known as “Ciancioli”) and midwaters pair trawlers (“Volanti a coppia”). Midwaters trawlers are based in Sciacca port only, and receive a special permission from Sicilian Authorities on an annual basis. Another fleet fishing on small pelagic fish species is based in some northern Sicilian ports and targets on juvenile stages (mainly sardines). Also this fishery is allowed for a limited period (usually one or two months during the winter season) by a special Regional law renewed year by year.

8.41.2.3.Catches

8.41.2.3.1. Landings

Landings were obtained within the framework of the census data collection carried out by IAMC-CNR (Mazara del Vallo) in Sciacca port since 1998. Information collected in the framework of CA.SFO. study project (Patti et al., 2007) showed that landings in Sciacca port account for about 2/3 of the total landings in GSA 16. Average anchovy landings in Sciacca port over the last decade (1997-2008) were about 1,600 metric tons, with large inter-annual fluctuations.

It is worth noting that, though trend in biomass is clearly decreasing over the last years (Fig. 8.41.2.3.1.1), landings levels over the same period were relatively high, indicating an increased vulnerability of the resource.

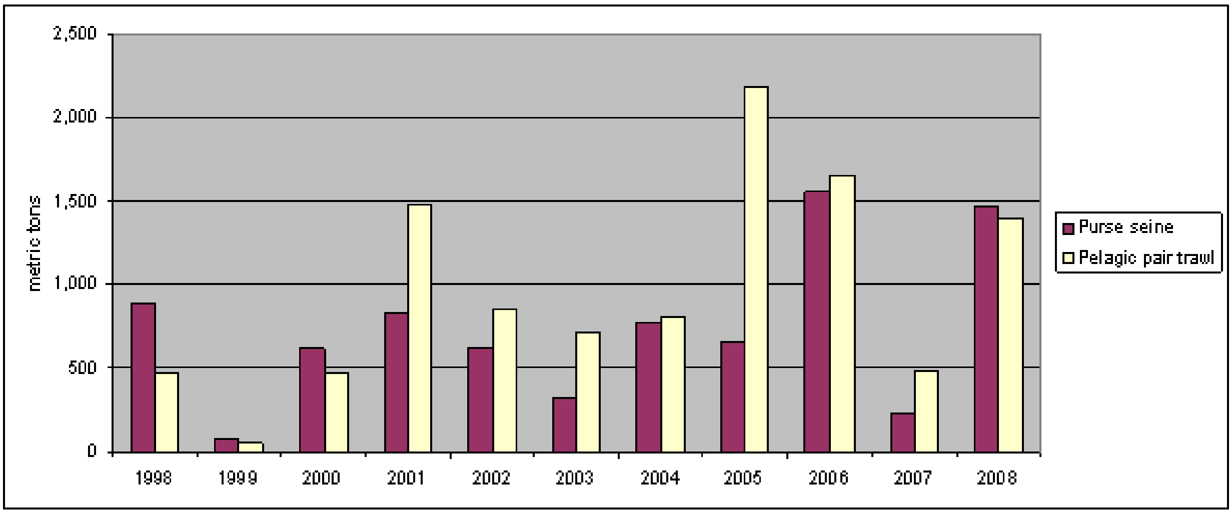


Fig. 8.41.2.3.1.1. Landings data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2008.

8.41.2.3.2. Discards

No discards data for anchovy were used for this assessment. However, discards are estimated to be less than 5% of total catch for both the pelagic pair trawl and the purse seine fisheries (Kallianiotis and Mazzola, 2002)

8.41.2.3.3. Fishing effort

Fishing effort data refer to census data collected in Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16.

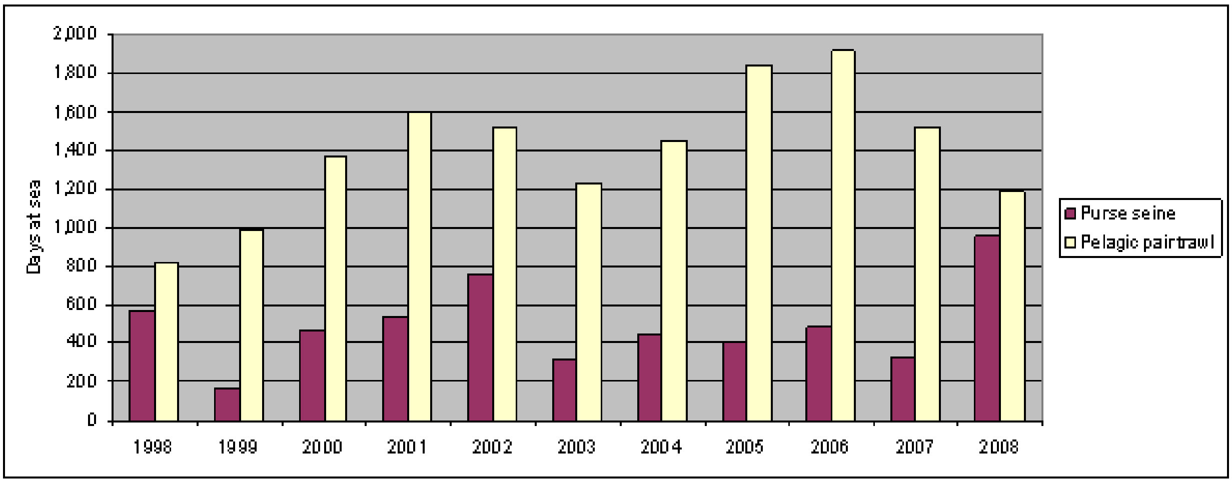


Fig. 8.41.2.3.3.1. Effort data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2008.

8.41.3. Scientific surveys

8.41.3.1. Acoustics

8.41.3.1.1. Methods

Acoustic surveys methodology

Steps for biomass estimation

- Collection of acoustic and biological data during surveys at sea;
- Extraction of $NASC_{Fish}$ (Fishes Nautical Area Scattering Coeffcient [$m^2/n.mi^2$]) by means of Echoview (Sonar Data) post-processing software;
- Link of NASC values to control catches;
- Calculation of Fish density (ρ) from $NASC_{Fish}$ values and biological data;
- Production of ρ distribution maps for different fish species and size classes;
- Integration of density areas for biomass estimation.

Collection of acoustic and biological data

Since 1998 the IAMC-CNR has been collecting acoustic data for evaluating abundance and distribution pattern of small pelagic fish species (mainly anchovy and sardine) in the Strait of Sicily (GSA 16). The scientific echosounder Kongsberg Simrad EK500 was used for acquiring acoustic data until summer 2005; for the echosurvey in the period 2006-2009 the EK60 echosounder was used. In both cases the echosounder was equipped with three split beam transducers pulsing at 38, 120 and 200 kHz. During the period 1998-2008 acoustic data were collected continuously during day and night time; since the 2009 echosurvey acoustic data are collected during day time, according to the MEDIAS protocol.

Before or after acoustic data collection a standard procedure for calibrating the three transducers was carried out by adopting the standard sphere method (Johannesson and Mitson, 1983).

Biological data were collected by a pelagic trawl net with the following characteristics: total length 78 m, horizontal mouth opening 13-15 m, vertical mouth opening 6-8 m, mesh size in the cod-end 10 mm. The net was equipped with two doors with weight 340 kg. During each trawl the monitoring system SIMRAD ITI equipped with trawl-eye and temp-depth sensors was adopted.

Extraction of $NASC_{Fish}$ by means of Echoview (Sonar Data) post-processing software

The evaluation of the $NASC_{Fish}$ (Fishes Nautical Area Scattering Coeffcient [$m^2/n.mi^2$]) and the total NASC for each nautical mile of the survey track was performed by means of the SonarData Echoview software v3.50, taking into account the day and night collection periods.

Link of NASC values to control catches

For the echo trace classification the nearest haul method was applied, taking into account only representative fishing stations along transects.

Calculation of Fish density (ρ) from $NASC_{Fish}$ values and biological data

For each trawl haul the frequency distribution of the *j*-th species (ν_j) and for the *k*-th lenght class (f_{jk}) are estimated as

$$\nu_j = \frac{n_j}{N} \qquad \text{and} \qquad f_{jk} = \frac{n_{jk}}{n_j}$$

where n_j is the total number of specimens of the *j*-th species, n_{jk} is the total number of specimens of the *k*-th lenght class in the *j*-th species, and *N* is the total number of specimens in the sample.

For each nautical mile the densities for each size class and for each fish species are estimated as

$$\rho_{jk} = \frac{NASC_{FISH} * n_{jk}}{\sum_{j=1}^{n}\sum_{k=1}^{m} n_{jk} * \sigma_{jk}} \qquad \text{(number of fishes / n.mi}^2\text{)}$$

$$\rho_{jk} = \frac{NASC_{FISH} * W_{jk} * 10^{-6}}{\sum_{j=1}^{n}\sum_{k=1}^{m} n_{jk} * \sigma_{jk}} \qquad \text{(t / n.mi}^2\text{)}$$

where W_{jk} is the total weight of the *k*-th lenght class in the *j*-th species, and σ_{jk} is the scattering cross section of the *k*-th lenght class in the *j*-th species. σ_{jk} *is given by*

$$\sigma_{spjk} = 4\pi * 10^{\frac{TS_{jk}}{10}}$$

where the target strenght (TS) is

$$TS_{jk} = a_j Log_{10}(L_k) + b_j$$

L_k is the length of the *k*-th lenght class while the a_j and b_j coefficient are linked to the fish species.

For anchovy, sardine and trachurus we adopted respectively the following relationships:

$TS = 20 \log L_k\ 76.1$ [*dB*]

$TS = 20 \log L_k\ 70.51$ [*dB*]

$TS = 20 \log L_k\ 72$ [*dB*]

Integration of density areas for biomass estimation

The abundance of each species was estimated by integrating the density surfaces for each species.

8.41.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.41.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the anchovy stock in GSA 16 was derived from the acoustics. Figure 8.41.3.1.3.1 displays the estimated trend in anchovy Total Biomass (estimated by acoustics) for GSA 16.

A decreasing trend was observed in biomass during the last years (Fig. 8.41.3.1.3.1).

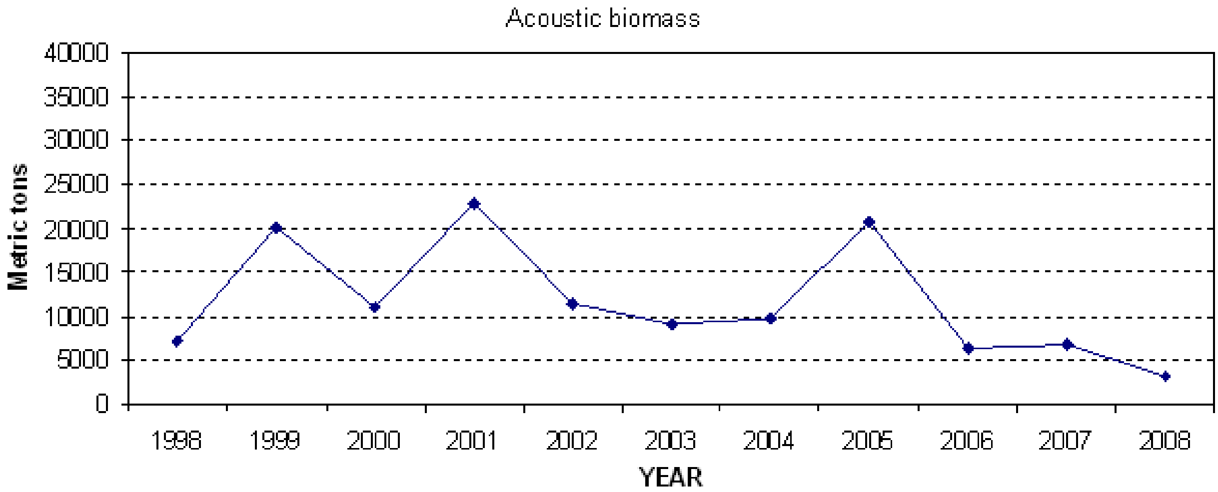


Fig. 8.41.3.1.3.1. Estimated anchovy biomass indices for GSA 16, years 1998-2008.

8.41.3.1.4. Trends in abundance by length or age

Length or age class data were not used for this assessment.

8.41.3.1.5. Trends in growth

Growth data were not used for this assessment.

8.41.3.1.6. Trends in maturity

Maturity data were not used for this assessement.

8.41.4. Assessment of historic stock parameters

Not applicable. No stock assessment model was run for this assessment.

8.41.5. Long term prediction

Not applicable. No forecast analyses were conducted.

8.41.6. Scientific advice

8.41.6.1. Short term considerations

8.41.6.1.1. State of the spawning stock size

Biomass estimates of total population obtained by hydro-acoustic surveys for anchovy in GSA 16 show a decreasing trend over the last years. The 2008 estimate is the lowest value of the series and represents approximately just one-tenth of the maximum recorded value. However, in the absence of proposed or agreed references, SGMED-09-02 is unable to fully evaluate the state of the stock and provide any scientific advice in relation to them.

8.41.6.1.2. State of recruitment

No recruitment data were provided by this assessment.

8.41.6.1.3. State of exploitation

The high and increasing yearly exploitation rates, as estimated by the ratio between total landings and biomass, indicates high fishing mortality levels. If this estimate of exploitation rate can be considered as equivalent to F/Z estimate obtained from the fitting of standard stock assessment models, the current exploitation (0.64) is higher than the reference point suggested by Patterson (1992). The fishing mortality level corresponding to F/Z=0.64 is F=1.17, if M=0.66, estimated with Pauly’s (1980) empirical equation, is assumed.

Using the exploitation rate as a reference point, this stock should be considered as being overexploited.

Given that biomass was very low for three consecutive years (2006, 2007 and 2008), fishing effort should be reduced by means of a multi-annual management plan until there is evidence for stock recovery. Consistent catch reductions along with effort reductions should be determined. The mixed fisheries effects, mainly the interaction with sardine, need to be taken into account when managing the Anchovy fishery.

General considerations for the management of the Anchovy fishery:

Taking into account that fishing effort was relatively stable in last decade, whereas CPUE trend was even increasing, results would suggest the importance of environmental factors variability on yearly recruitment success and/or a possible increase in the vulnerability of the resource.

However, the stock biomass did not recover from the 2006 "collapse" in biomass (-69% from July 2005 to June 2006), and also further decreased (-53%) in 2008. This fact, along with the quite high and increasing level of exploitation rates experienced over the last years, also suggests questioning about the sustainability of current levels of fishing effort.

A warning on the fishing of larval stages (locally named *bianchetto*) is also relevant for anchovy population if derogation of the fishing ban, normally operated for GSA 16 in wintertime, is postponed after the start of the anchovy spawning season, even though more data and investigation are needed in order to estimate the possible impact of this fishing activity on the exploited populations.

8.42. Stock assessment of anchovy in GSA 17

8.42.1. Stock identification and biological features

8.42.1.1. Stock Identification

The southern boundary of the GSA 17 is represented from the Gargano Promontory, as shown in the map below. However, the stock distribution area of anchovy in the Adriatic Sea extends into GSA 18. The spawning season of the Adriatic anchovy is in spring-summer. The spawning areas are mainly located in the western part of the GSA 17. On the basis of the database of CNR-ISMAR-SPM Fish Population Dynamics Unit, the maximum age recorded was 6 years while the maximum length was 19 cm.

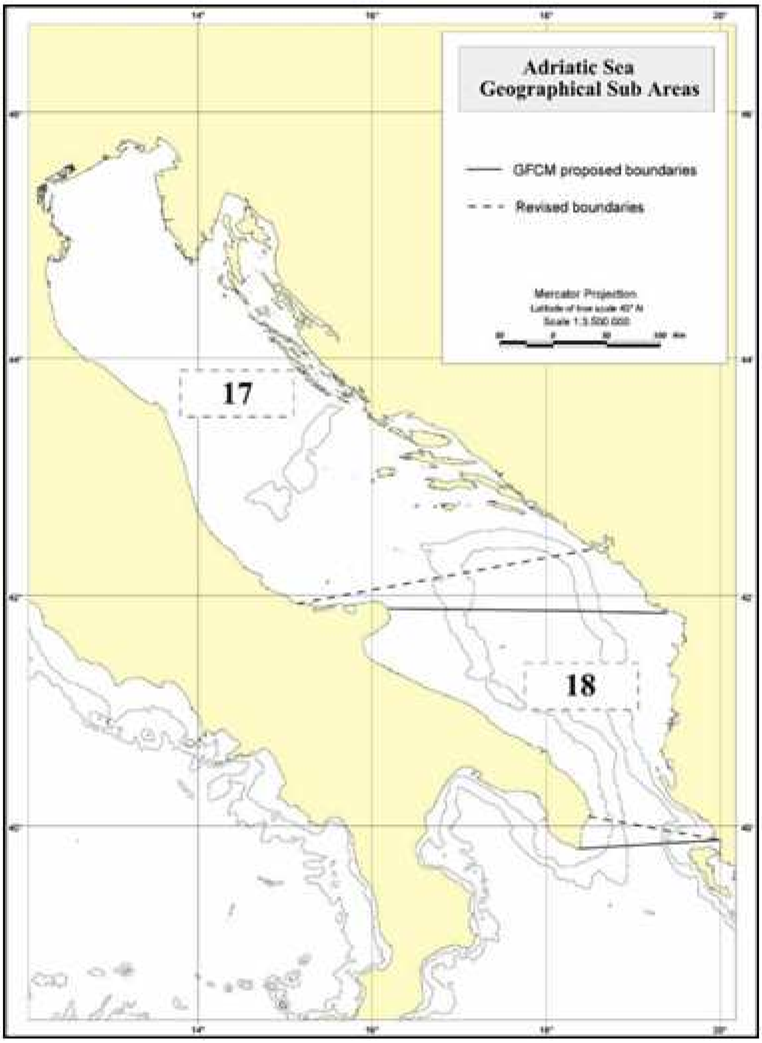


Fig. 8.42.1.1.1 Stock distribution map.

8.42.1.2. Growth

An example of age-length key expressed in number of individuals, obtained through DCR by CNR-ISMAR-SPM Fish Population Dynamics Unit, for the commercial catches of (Italian) mid-water trawlers in 2007, was reported in the table below.

Tab 8.42.1.2.1 GSA 17 anchovy: age-length key (year 2007, mid-water trawlers).

L (cm)	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Total
7.5	5						5
8.0	11						11
8.5	15	1					16
9.0	21	2					23
9.5	22	11					33
10.0	27	22	10				59
10.5	32	41	10				83
11.0	29	72	14				115
11.5	31	93	31	1			156
12.0	18	74	74	8			174
12.5	4	33	104	14			155
13.0		29	129	18			176
13.5		8	105	34	3		150
14.0			47	42	6		95
14.5			31	36	4	1	72
15.0			11	23	2		36
15.5			2	16	3		21
16.0				5			5
16.5				3	1		4
Total	215	386	568	200	19	1	1389

The corresponding age-length key obtained for the commercial catches of purse-seiners was reported in the table below. Different length ranges as a function of the gear were observed: the smallest size individuals can be better represented in the catch of mid-water trawlers.

Tab 8.42.1.2.2 GSA 17 anchovy: age-length key (year 2007, purse seiners).

L (cm)	Age 0	Age 1	Age 2	Age 3	Age 4	Total
9.5	1					1
10.0		1				1
10.5	2	1	1			4
11.0	1	2				3
11.5		1	2			3
12.0		1	1			2
12.5			2			2
13.0			3	3		6
13.5			1	4	1	6
14.0				2	2	4
14.5			2	2	3	7
15.0			2	2	4	8
15.5				5		5
16.0				2		2
16.5			1	2		3
17.0				2		2
Total	4	6	15	24	10	59

8.42.1.3.Maturity

According to Rampa *et al*. (2005), the first sexual maturity of Adriatic anchovy is around 8 cm.

8.42.2.Fisheries

8.42.2.1.General description of fisheries

In the GSA 17, anchovy is fished by mid-water trawlers and purse seiners attracting fish with light. Additional information was reported below in the paragraph “Catches”.

8.42.2.2.Management regulations applicable in 2008 and 2009

In Italy, the legal minimum length for anchovy is 9 cm (R.(CE) 1967/2006). The same value has been adopted in Croatia (G. Sinovčić, Institute of Oceanography and Fisheries of Split, personal communication).

8.42.2.3.Catches

8.42.2.3.1. Landings

On the basis of the database of CNR-ISMAR-SPM Fish Population Dynamics Unit, the amount of the total catch of anchovy relative to Italy, Slovenia and Croatia was plotted over years in the figure below. The average total catch was 28000 t in 1976-2007 and 43000 t in 2005-2007. The lowest values of the series - corresponding to the calendar year 1987 - were associated to a crisis of the Italian fishery of Adriatic anchovy. The main fraction of the total catch is usually taken by the Italian fleet but, in recent years, the fraction relative to the fleets of the eastern part of the GSA 17 has increased.

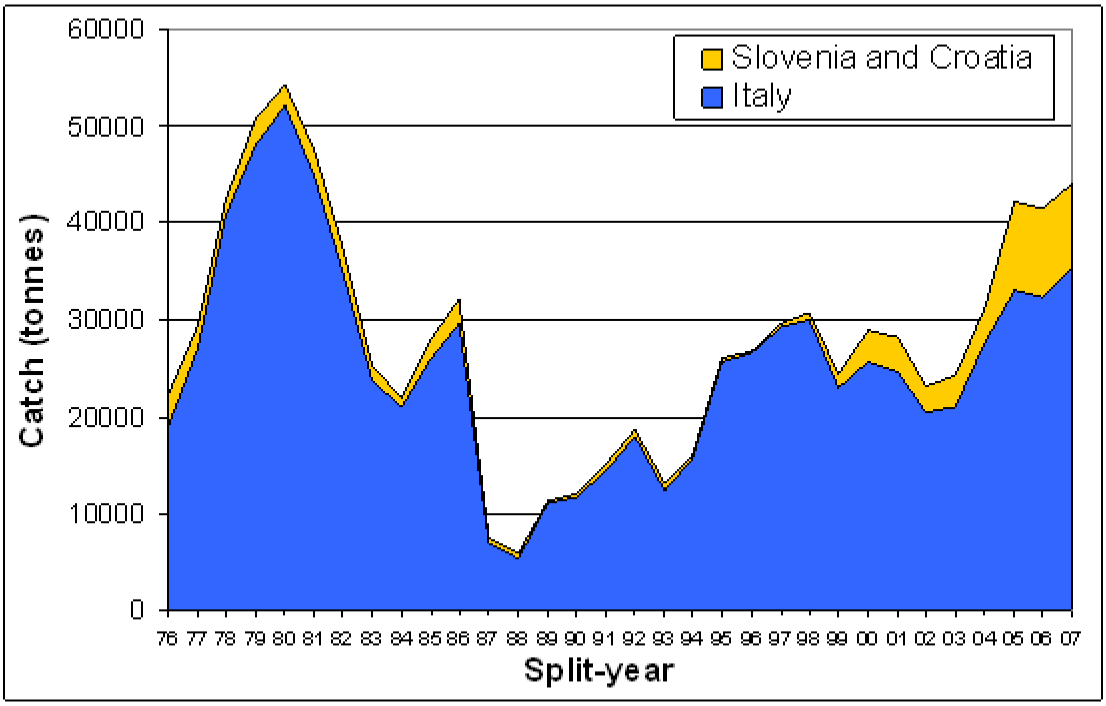


Fig. 8.42.2.3.1.1 GSA 17 anchovy: total catch over years.

The average length frequency distribution and the average age frequency distribution of the total catch were shown in the two figures below. The average for length was calculated including only the years from 1988 onwards as, after this date, length was measured using 0.5 cm classes, whereas 1 cm classes were used from 1975 to 1987. A comment relative to the different length range fished by mid-water trawlers and purse seiners was reported above, in the paragraph “Growth”.

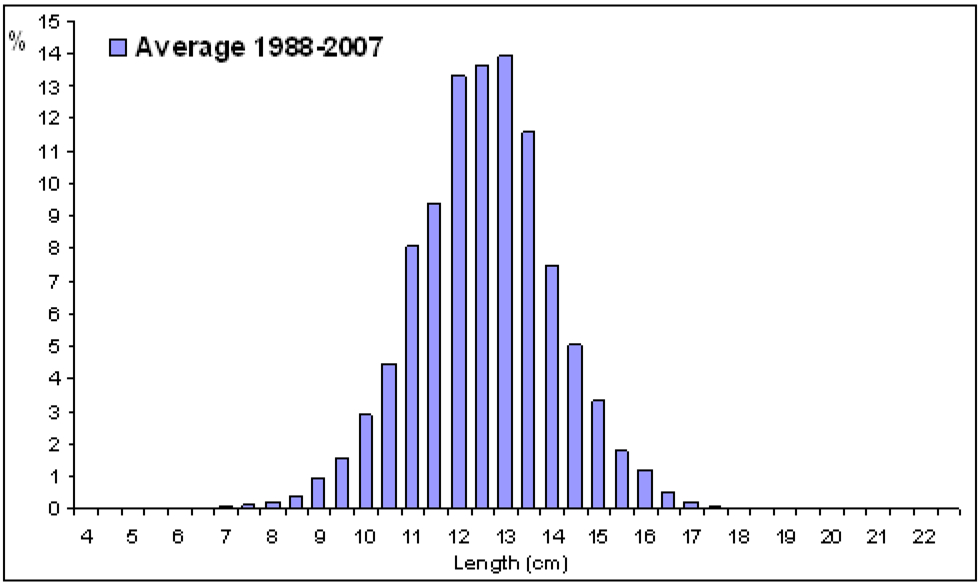


Fig. 8.42.2.3.1.2 GSA 17 anchovy: average length frequency distribution of the total catch.

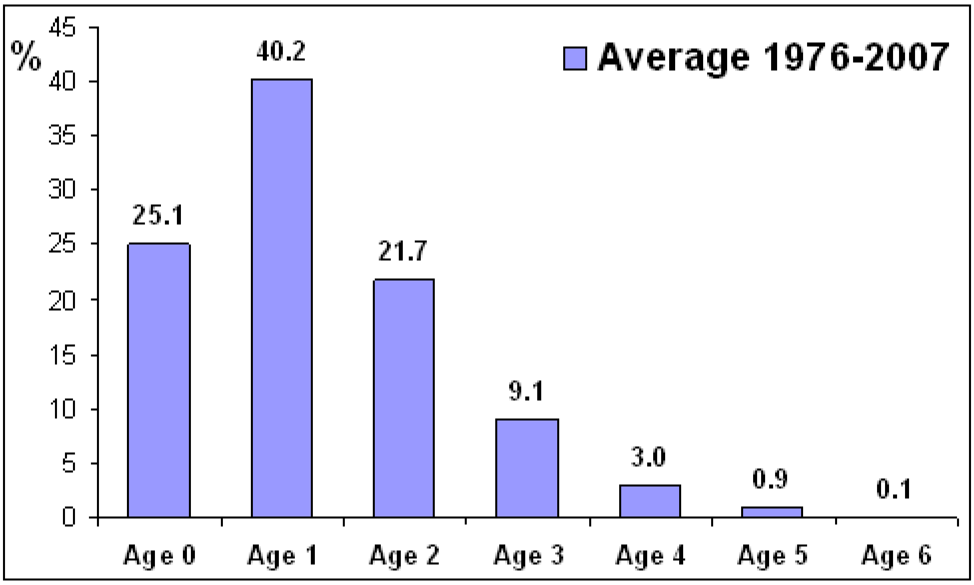


Fig. 8.42.2.3.1.3 GSA 17 anchovy: average age frequency distribution of the total catch.

8.42.2.3.2. Discards

This feature was investigated by CNR-ISMAR-SPM Fish Population Dynamics Unit, through an EU funded project at the end of 1990s (Santojanni *et al*., 2005) and DCR in 2005.

Discards of anchovy in the GSA 17, at least for the Italian fleet, can be considered as negligible because anchovy, usually, is strongly required by the market (more than sardine). For example, on the basis of the DCR investigation, the amount of anchovy discarded at sea by the Italian fleet was 65 t and 206 t in the third and fourth quarter of 2005, respectively. These quantities were very low in comparison with the corresponding landings: from 2000 to 2007, the annual amount of anchovy landed by the Italian fleet was always higher than 20000 t and, in 2005-2007, it was over 30000 t. In conclusion, the estimates of discards obtained for only one half of 2005 was considered negligible and fluctuating during the year and thus those were not included in the estimation of total catches.

8.42.2.3.3. Fishing effort

No information was presented on fishing effort

8.42.3.Scientific surveys

As mentioned below in the paragraph "Method", the results of the acoustic surveys carried out by CNR-ISMAR-SPM Marine Acoustics Unit from the mid-line to the western coast of the GSA 17, from 1976 to 2007, were used for VPA tuning.

8.42.4.Assessment of historic stock parameters

8.42.4.1.Method: VPA

8.42.4.1.1. Justification

The assessment of this stock was carried out by means of Virtual Population Analysis (VPA), using catch data collected for Italy, Slovenia and Croatia, from 1975 to 2007 (Cingolani *et al*., 1996; Santojanni *et al*., 2003, 2005, 2006a,b,c; 2008; Barange *et al*., in press; Santojanni, in press).

The Laurec-Shepherd tuning of VPA was performed using an abundance index series derived from echo-surveys carried out in the western part of the GSA 17. The software developed by Darby and Flatman (1994) was used for the VPA runs. The results of the assessment were also discussed during the last SCSA-SAC-GFCM meeting (Santojanni *et al*., 2008). Split-year data were used assuming the first of June as the birth date of Adriatic anchovy: e.g. split-year 1976 was composed of the months from June to December of calendar 1975 and months from January to May of calendar 1976.

Given the long time series available, VPA was thought to be a suitable method. Additional trials with Integrated Catch Analysis (ICA) were also done during the last SCSA-SAC-GFCM meeting (Izmir, 22-26 September 2008), but the results were not mentioned in this document; anyway, they were quite consistent with those derived from Laurec-Shepherd tuned VPA, as shown also in the report of SGMED-08-04 working group (Cardinale et al., 2008).

8.42.4.1.2. Input parameters

A time series of annual total catch at age in numbers of individuals is the main data input of VPA. It was shown (expressed using proportions) in the figure below. The age class 4+ is a plus group: it includes the class 4 (years) along with those classes higher than 6, i.e. 5 and 6 in the present case.

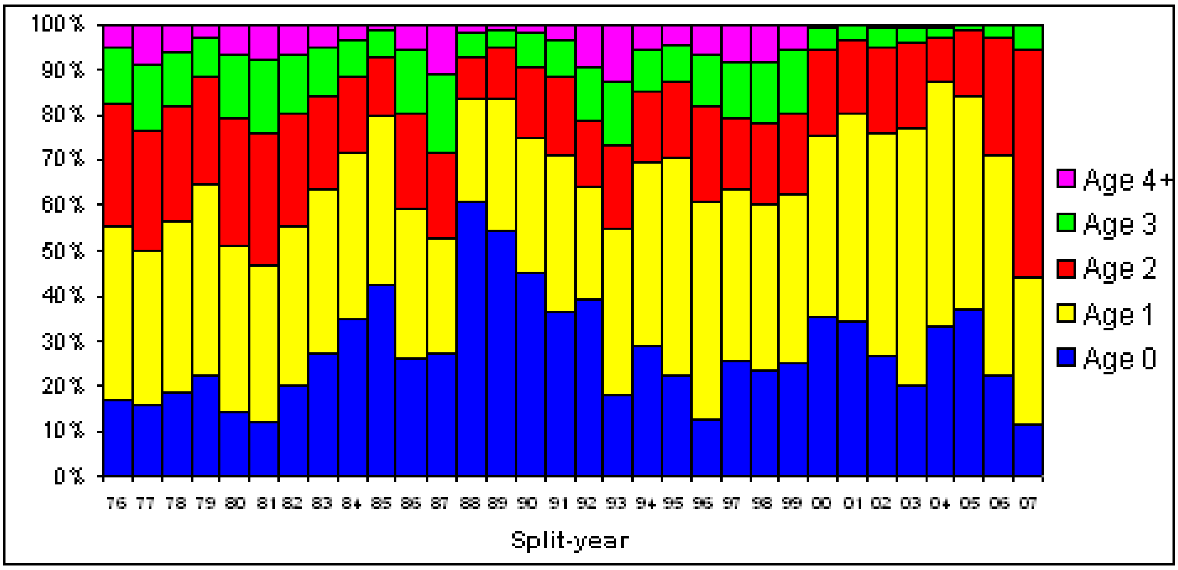


Fig. 8.42.4.1.2.1 GSA 17 anchovy: relative catch at age over years.

The annual natural mortality rates M = 0.6 and M = 0.8 (year^{-1}) were employed for VPA calculations. However, more emphasis was given to the results obtained with M = 0.6.

The two values were selected taking into account the literature and the maximum life-span observed in the commercial catches from 1976 onwards, i.e. 4 and even 5 and 6 years.

About the inverse relationship between longevity and mortality, as reported by Barange (2001), Pacific sardine (*Sardinops sagax*) is usually assumed to have a relatively low annual natural mortality rate, M = 0.4, and a lifespan of about 10 years, whereas for northern anchovy (*Engraulis mordax*) M = 0.8 is associated to a lifespan of about 4 years.

Moreover, useful information was gained from the relationship between total mortality Z (= F + M) and maximum life span tmax (year), Ln Z = 1.44 - 0.982 Ln tmax **,** found by Hoenig (1983; see also Hewitt and Hoenig, 2005). It was “based largely on data from unexploited stocks”, thus with Z being very close to M. On the basis of this equation, for example (table below), tmax = 6 is associated to Z = 0.73.

Tab. 8.42.4.1.2.1 Relationship between total mortality rate Z and maximum life-span tmax (see text).

tmax (year)	Z ($year^{-1}$)
1	4.22
2	2.14
3	1.43
4	1.08
5	0.87
6	0.73
7	0.62
8	0.55
9	0.49
10	0.44
11	0.40
12	0.37
13	0.34
14	0.32
15	0.30
16	0.28
17	0.26
18	0.25
19	0.23
20	0.22

8.42.4.1.3. Results

The stock biomass estimated by means of VPA using both M = 0.6 and M = 0.8 was plotted over years in the figure below, along with the total catch. The average stock biomass estimated by the VPA with M = 0.6 was 120,000 t in 1976-2007 and 210,000 t in 2005-2007; higher values were obtained with M = 0.8. The corresponding average ratio between total catch and stock biomass (with M = 0.6) was 0.23 in 1976-2007 and 0.20 in 2005-2007. The collapse in the second half of 1980s after a peak in the second half of 1970s was evident as well as recent fluctuations.

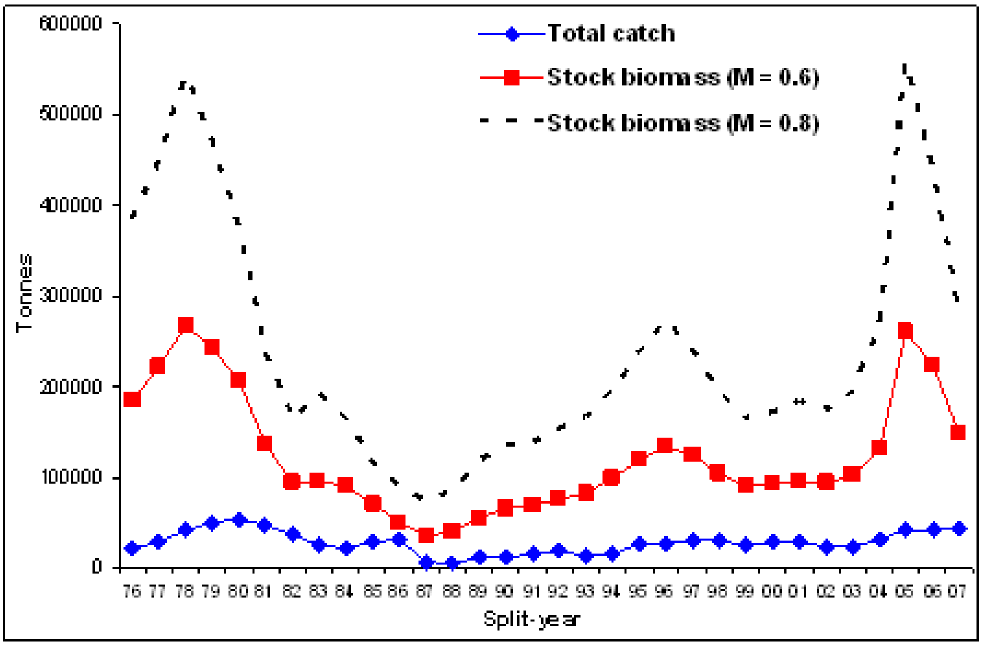


Fig. 8.42.4.1.3.1 GSA 17 anchovy: total catch and stock biomass estimated by VPA over years.

The stock biomass estimated by means of VPA using both M = 0.6 and M = 0.8 was compared over years with the stock biomass estimated by means of the echo-surveys carried out in the western part of the GSA 17. On the whole, there was agreement between the trends obtained with the two different methods: initial peak, decline, collapse and recovery. However, the recovery was more pronounced in the echo-survey data and, in the most recent years, the two series were clearly out of phase.

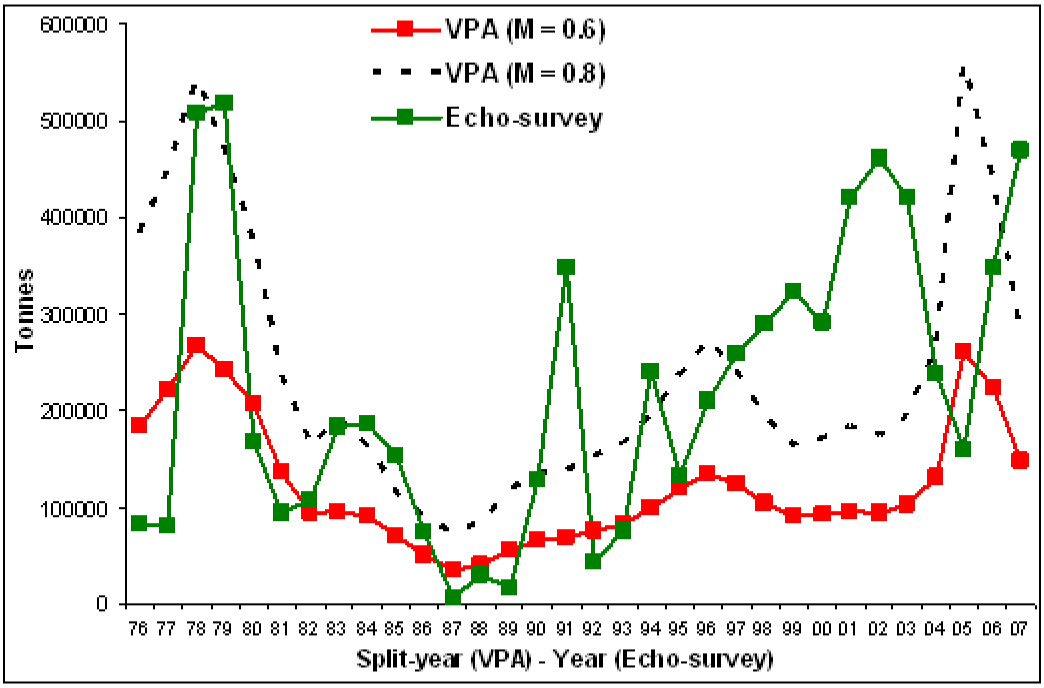


Fig. 8.42.4.1.3.2 GSA 17 anchovy: stock biomass estimated by VPA and echo-surveys over years.

The relationship between spawning stock biomass and number of recruits (age class 0) obtained from the VPA with M = 0.6 was plotted in the figure below. The current spawning stock biomass was over the values recorded immediately before the collapse in 1987.

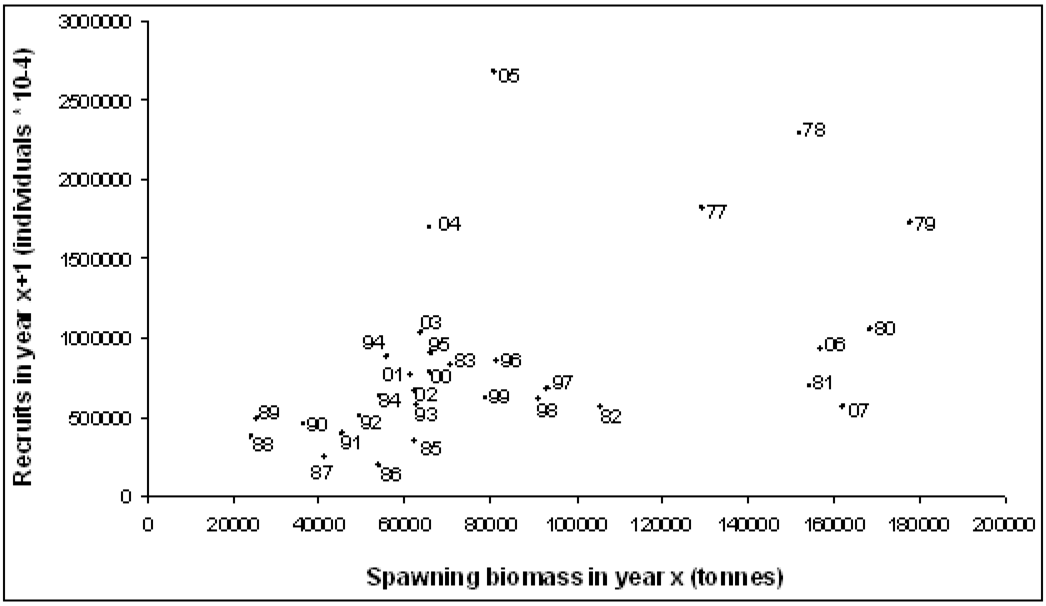


Fig. 8.42.4.1.3.3 GSA 17 anchovy: stock-recruitment relationship (VPA with M = 0.6).

The fishing mortality rate F derived from the VPA with M = 0.6 was plotted over ages and years in the figure below (left and right picture, respectively). In the former case, the average for the complete time series was calculated. In the latter case, two averages were calculated both weighting and without weighting the F at age values on the corresponding numbers of fish at sea.
Some average values over years were the following:
- unweighted F0-3 in 1976-2007 : 0.32;
- unweighted F0-3 in 2005-2007 : 0.24;
- weighted F0-4 in 1976-2007: 0.22;
- weighted F0-4 in 2005-2007: 0.19.

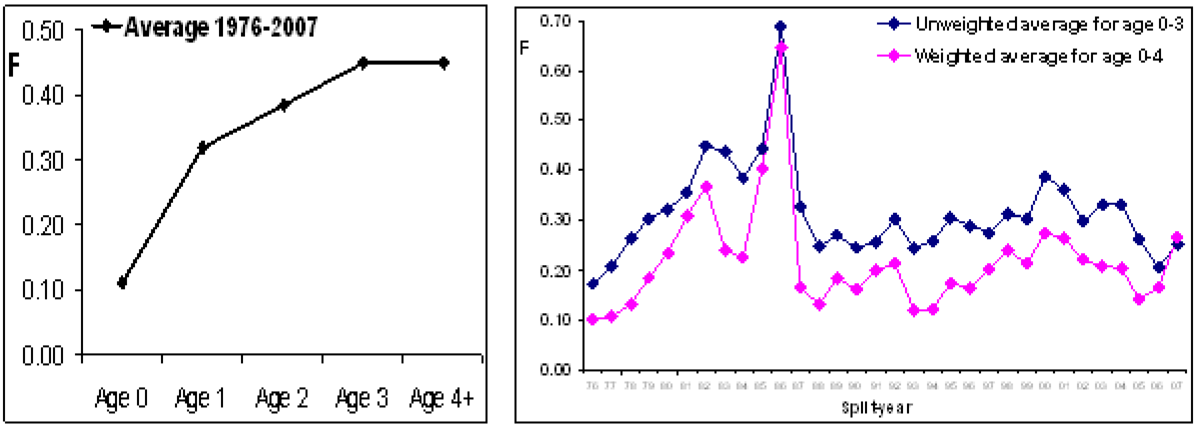


Fig. 8.42.4.1.3.4 GSA 17 anchovy: fishing mortality rate F over ages and years.

The annual exploitation rate E = F/(F+M) or F/Z was also calculated, both using the weighted and unweighted Fs mentioned above.

The values obtained were compared with the threshold F/Z = 0.4 (biological reference point), above which the stock collapse should be relatively likely, as pointed out by Patterson (1992) for small pelagics. Here, more emphasis was given to the F/Z calculated using unweighted Fs, as the author performed his statistical analysis on a data set mainly formed by unweighted Fs.

The values of F/Z were plotted over years in the figure below. Some average values over time were the following:
- F/Z in 1976-2007 with unweighted F0-3 : 0.34;
- F/Z in 2005-2007 with unweighted F0-3 : 0.28;
- F/Z in 1976-2007 with weighted F0-4 : 0.26;
- F/Z in 2005-2007 with weighted F0-4 : 0.24.

All these values are lower than 0.4. Values higher than 0.4 and even than 0.5 - which is the highest and more dangerous limit pointed by Patterson (1992) - were observed before the collapse. Likely, both fishery and some environmental factors contributed to this event (Santojanni *et al*., 2006a; Santojanni, in press).

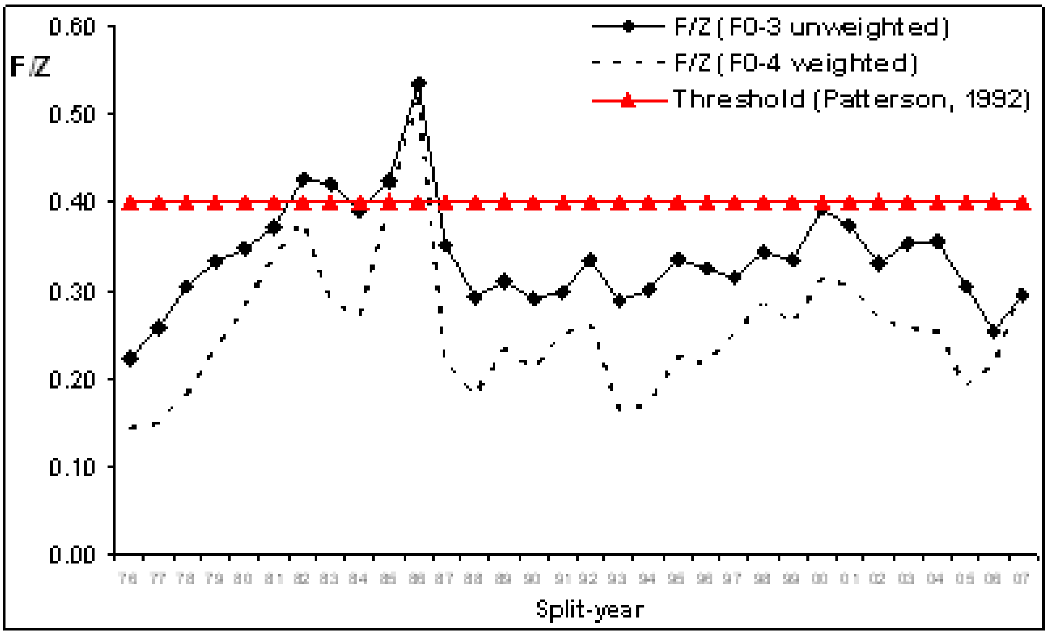


Fig. 8.42.4.1.3.5 GSA 17 anchovy: exploitation rate F/Z over years.

In 2009, VPA was also carried out using vectors of natural mortality rate at age, i.e. not constant over age as in the stock assessment of 2008. They were derived from Probiom software and Gislason's method, according to the first SGMED meeting of 2009 (Tab. 8.42.4.1.3.1). The values of von Bertalanffy parameters Linf = 16.15, k = 0.40, t0 = -2.04 and length-weight parameters a = 0.0025, b = 3.37 were used for the calculations of the M at age vectors and were derived from DCR (biological sampling of landing data, GSA 17, year 2007).

Some limits of the use of these M at age vectors are worth noting: with Probiom, values for oldest age classes seem to be quite low and thus not very realistic (e.g. 0.34 for age class 2); Gislason's should be preferably used for demersals rather than small pelagics. The new results obtained were compared with those based on the use of constant M = 0.6.

Substantial differences were not observed between constant M = 0.6 and Gislason's while Probiom provided lower estimates of stock biomass and higher values of the exploitation rate (Fig. 8.42.4.1.3.6 and Fig. 8.42.4.1.3.7). Stock recruitment relationships were also compared (Fig. 8.42.4.1.3.8 and Fig. 8.42.4.1.3.9).

Tab. 8.42.4.1.3.1 Values of natural mortality at age used.

Age	Constant	Probiom	Gislason
0	0.60	0.74	0.90
1	0.60	0.50	0.67
2	0.60	0.34	0.56
3	0.60	0.29	0.52
4+	0.60	0.29	0.50

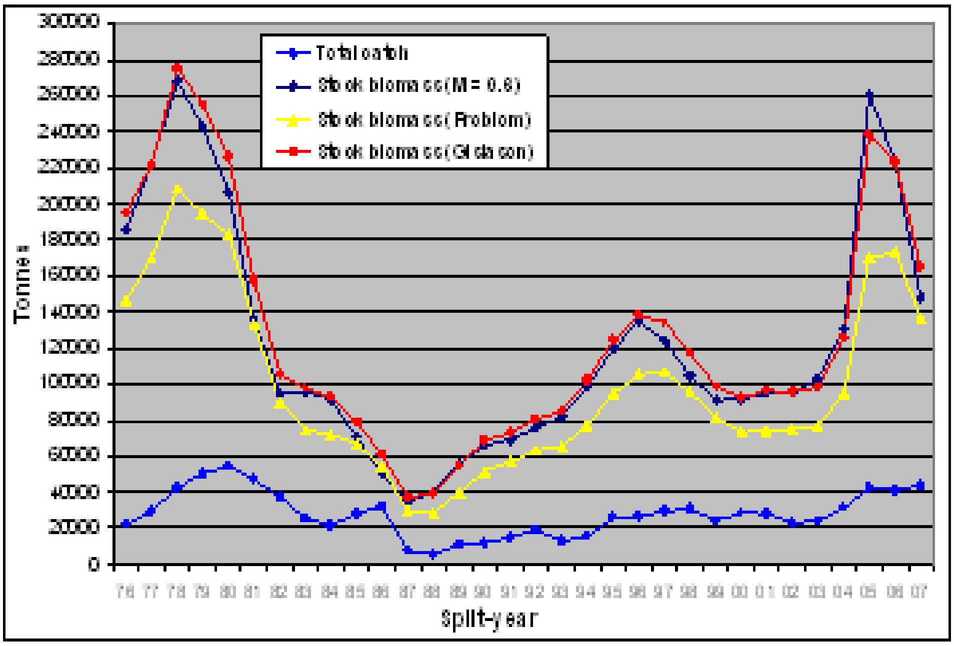


Fig. 8.42.4.1.3.6 Stock biomass estimated by VPA with constant M at age (0.6 as in the stock assessment performed in 2008) and M at age vectors obtained by means of Probiom software and Gislason's method.

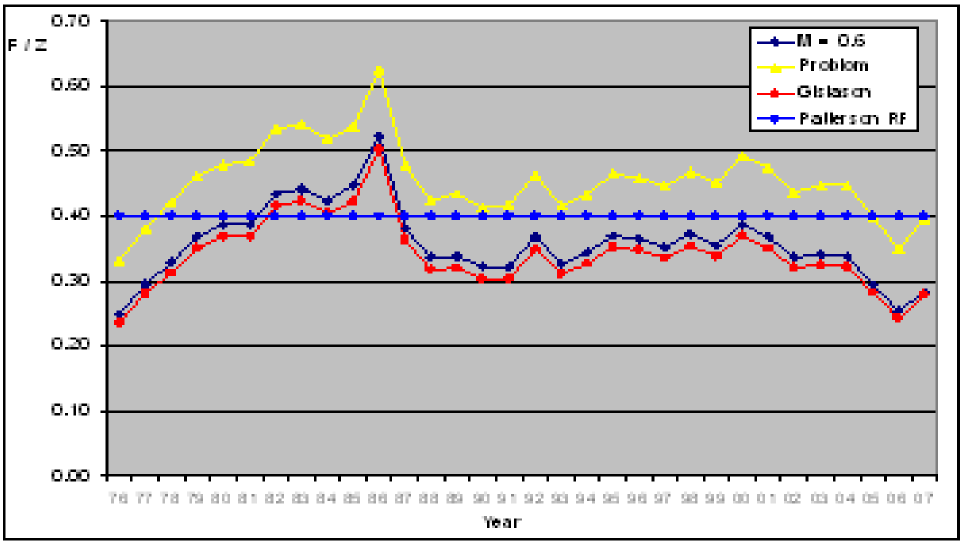


Fig. 8.42.4.1.3.7 Exploitation rate estimated by VPA with constant M at age (0.6 as in the stock assessment performed in 2008) and M at age vectors obtained by means of Probiom software and Gislason's method.

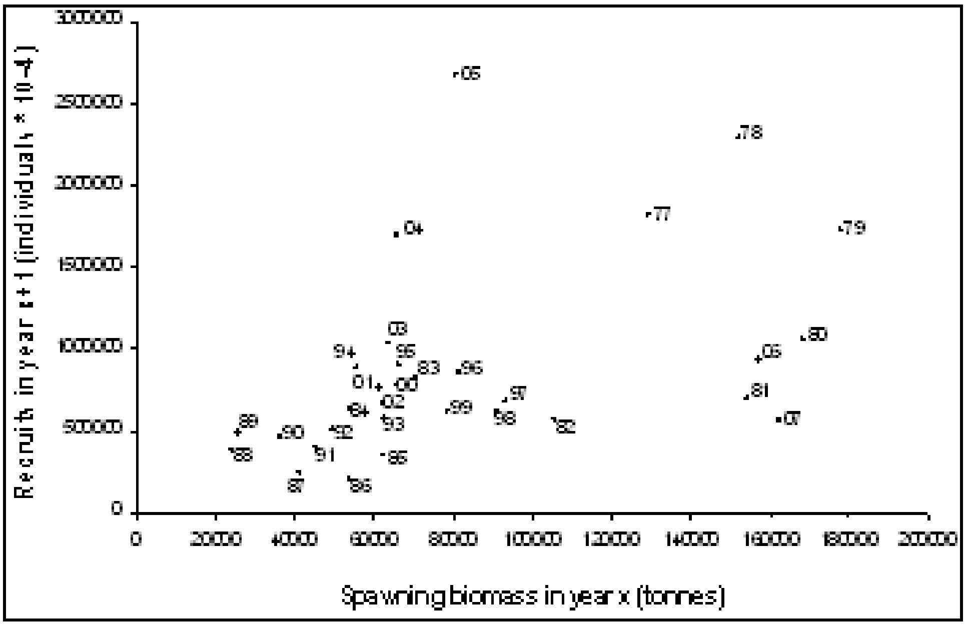


Fig. 8.42.4.1.3.8 Stock-recruitment relationship with constant M at age (0.6 as in the stock assessment performed in 2008). The split-years from 1977 to 2007 displayed are relative to the recruitment.

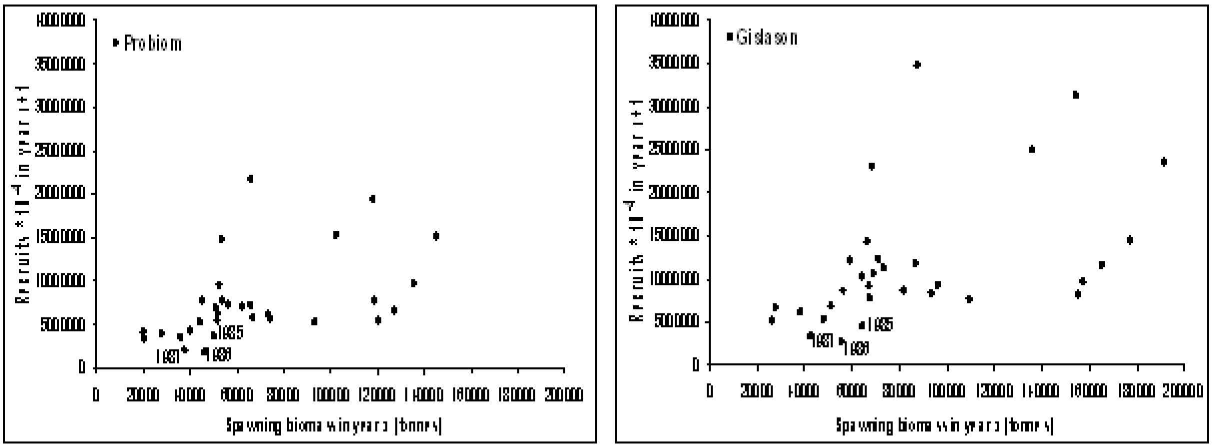


Fig. 8.42.4.1.3.9 Stock-recruitment relationship with M at age vectors, obtained by Probiom and Gislason's methods. The split-years 1985, 1986 and 1987 displayed are relative to the recruitment.

8.42.5. Long term prediction

8.42.5.1.Justification

No forecast analyses were conducted.

8.42.5.2.Input parameters

No forecast analyses were conducted.

8.42.5.3.Results

Given the preliminary state of the data and analyses SGMED 09-02 is not in the position to provide a long term prediction of catch and stock biomass for anchovy in GSA 17.

8.42.6. Scientific advice

8.42.6.1. Short term considerations

Consistent with it's own recommendations developed during the workshop 2-6 March 2009 held in Murcia(Spain), SGMED 09-02 considers the re-assessment based on the M-vector derived by the Probiom method as the most realistic one. SGMED 09-02 notes that this assessment consistently results in the lowest stock size and highest fishing mortality over the historic period 1976-2007.

8.42.6.1.1. State of the spawning stock size

The visual inspection of the scatter plot of recruitment versus spawning stock biomass clearly indicates that recruitment is impaired at stock sizes below 50,000 t. Thus, SGMED recommends establishing B_{lim}=50,000 t for the stock of anchovy in GSA 17. According to FAO recommendations (Cadima, 2003), B_{pa} should be in the range of 1.39*B_{lim} - 1.64*B_{lim}, accounting for uncertainty in the estimations of fishing mortality. Such factors would determine B_{pa} being in the range of 70,000 - 82,000 t. Thus, SGMED recommends establishing B_{pa}=80,000 t for the stock of anchovy in GSA 17.

Based on these reference points, SGMED-09-02 considers the stock of anchovy in GSA 17 by 2007 (about 120,000 t) as fully recovered from its low abundance estimated in the late 1980s.

8.42.6.1.2. State of recruitment

SGMED-09-02 estimates recent recruitment to be at an average level.

8.42.6.1.3. State of exploitation

SGMED concludes that the short term responses of the assessed anchovy stock to recent exploitation rates indicate that an exploitation rate in the order of $E \leq 0.4$ might be consistent with the management goal of high long term yields, taking into account the dynamic of the stocks. SGMED underlines that limited area and temporal coverage of the available stock assessments impede any quantification of risk related to this statement. As such, the expressed indication regarding Mediterranean small pelagic stocks is in agreement with empirical findings of Patterson (1992), who has proposed this exploitation level. SGMED recommends the application of the proposed exploitation rate $E \leq 0.4$ as management target for stocks of anchovy and sardine in the Mediterranean Sea. This value might be revised in the future when more information becomes available.

SGMED-09-02 estimated the most recent exploitation rates in 2005-2007 as at or slightly below the proposed sustainable level. As such, the stock is considered sustainably harvested. SGMED-09-02 recommends to maintain the effort constant and to determine consistent catches.

8.43. Stock assessment of anchovy in GSA 22

8.43.1. Stock identification and biological features

8.43.1.1. Stock Identification

This assessment of the anchovy stock in GSA 22 has been based on information derived from the Greek part of the Aegean Sea (GSA 22). The main distribution area of the anchovy stock in Aegean Sea is located in the continental shelf of the northern Aegean Sea (Giannoulaki *et al*., 2004; 2008a; Somarakis *et al*., 2007). Anchovy juveniles spatial distribution is strongly related to semi closed gulfs, shallow waters (less than 50 m depth) with high productivity, often related to areas of rivers outflows (Tsagarakis *et al*., 2007; 2008; SARDONE project interim report).

8.43.1.2. Growth

Fast growth parameter was considered and parameters are shown in Table 8.43.1.2.1. No sex discrimination was applied. Natural mortality M was estimated based on ProBiom (Abella *et al.*, 1997) as recommended in the report of the SG-ECA/RST/MED 09-01.

Tab. 8.43.1.2.1. Growth parameters (v. Bertalanffy) for anchovy in GSA 22.

	Fast growth Unsexed	Units
Linf	191	cm
K	0.385	$year^{-1}$
t0	-1.559	year
a	0.00004	gr
b	3.1157	
M age 0	1.5	$year^{-}$
M age 1	1	$year^{-}$
M age 2	0.72	$year^{-}$
M age 3	0.66	$year^{-}$
M age 4	0.62	$year^{-}$

8.43.1.3. Maturity

The following maturity at age ogive was used for assessments in GSA 22 estimated from biological sampling and the DEPM surveys (Somarakis *et al.*, 2004; 2007). Length at first maturity is estimated approximately at 105 mm (Somarakis, 1993; Somarakis *et al.*, 2004; 2007) in Aegean Sea. The anchovy spawning period in GSA 22 extends from May to August with a peak in June-July. The major spawning grounds of anchovy in the Aegean Sea are located in areas characterized by wide continental shelf and enrichment processes associated with the outflow from large rivers or the Black Sea Water (BSW) in the northern Aegean Sea. Consequently, the highest egg densities have been typically observed over the northern Aegean Sea continental shelf.

Tab. 8.43.1.3.1 Maturity ogives at age for female anchovy in GSA 22.

Year	Age 0	Age 1	Age 2	Age 3	Age 4
2003	0	0.62	0.99	1	1
2004	0	0.67	0.99	1	1
2005	0	0.46	0.98	1	1
2006	0	0.40	0.98	1	1
2007	0	0.40	0.98	1	1
2008	0	0.40	0.98	1	1

8.43.2. Fisheries

8.43.2.1.General description of fisheries

Anchovy (*Engraulis encrasicolus*) is one of the most important target species for the purse seine fishery in GSA 22. Anchovy is being exploited only by the purse seine fishery. Pelagic trawls are banned and benthic trawls are allowed to fish small pelagics in percentages less than 5% of their total catch. Commonly anchovy is caught from shallow waters about 30 m to 100 m depth.

8.43.2.2.Management regulations applicable in 2008 and 2009

Regarding the management regulations enforced they concern a closed period from the mid December till the end of February and technical measures such as minimum distance from shore (300 m), minimum bottom depth (30 m), gear and mesh size, engine, GRT restrictions etc. There is also a minimum landing size at 9 cm.

8.43.2.3.Catches

8.43.2.3.1. Landings

The trend in reported landings (from Greek purse seiners fleet) is shown in Figs. 8.43.2.3.1.1 and 8.43.2.3.1.2. Landings were obtained within the framework of the Hellenic Centre for Marine Research data collection system that covers the entire GSA 22. The data from 2003 to 2008 were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.4 of Appendix 3. An increasing trend in anchovy landings has been observed (Fig. 8.43.2.3.1.1). Data of the landings per vessel class indicate that small vessels (12-24 m) (Fig. 8.43.2.3.1.2) are mainly responsible for anchovy catches (>70% of anchovy catches).

Annual lengths of landings were reported to SGMED-09-02 for 2003-2008 and are shown in Fig. 8.43.2.3.1.3. No data on the age distribution of landings was reported to the SGMED-09-02, through the DCR. Fig. 8.43.2.3.1.4 shows the landings at age in GSA 22 as reported to SGMED-08-04 for 2003-2006. Data for 2007 and 2008 are based on data obtained within the framework of the Hellenic Centre for Marine Research data collection system that covers the entire GSA 22.

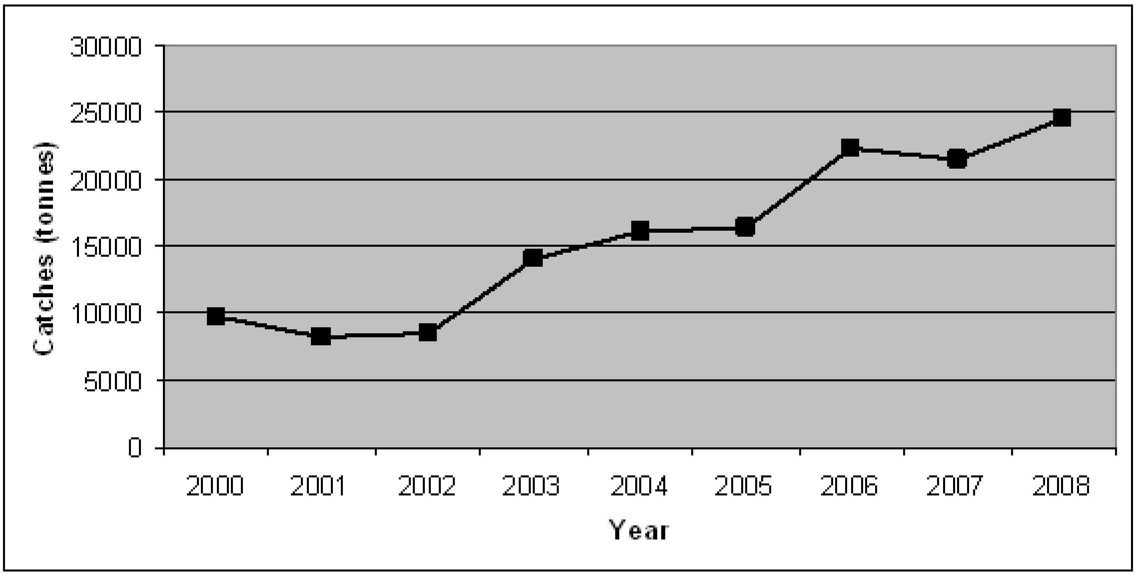


Fig. 8.43.2.3.1.1 Anchovy landings (t) in GSA 22 for 2000-2008.

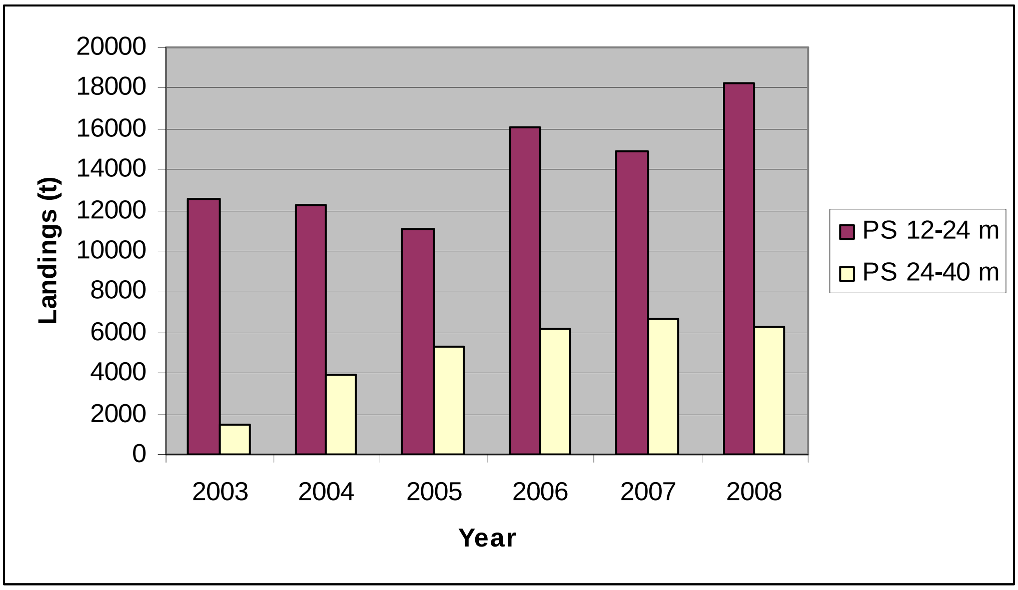


Fig. 8.43.2.3.1.2 Anchovy landings (t) in GSA 22 per fleet size (Greek waters).

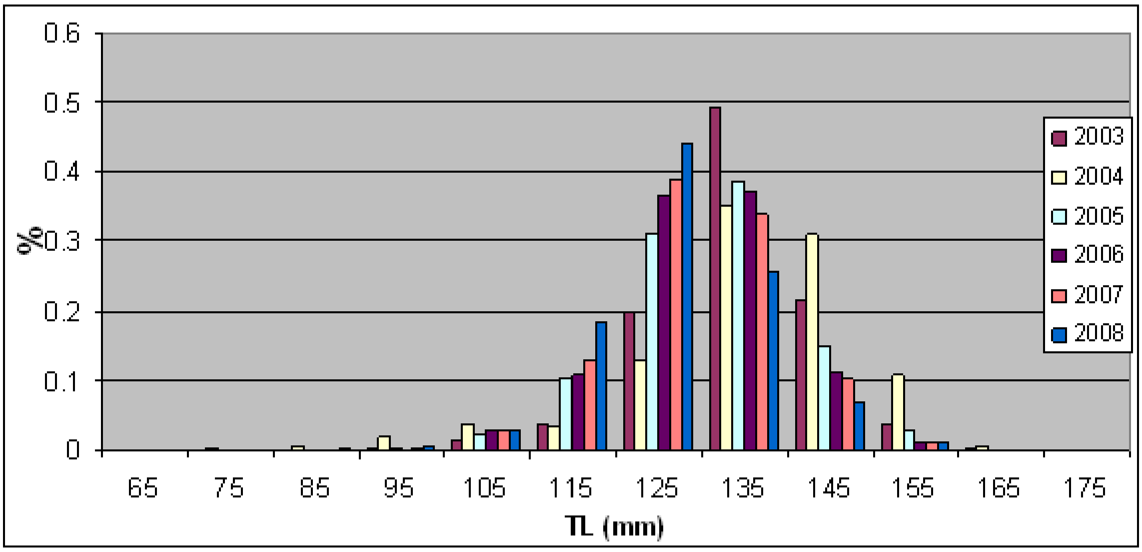


Fig. 8.43.2.3.1.3 Length frequency distribution of anchovy landings (t) in GSA 22 for 2003-2008.

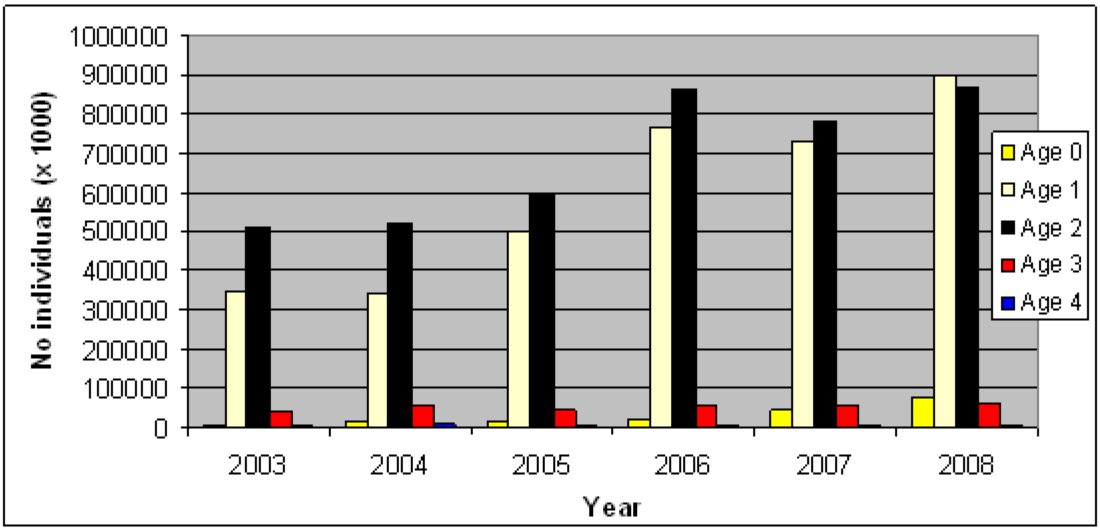


Fig. 8.43.2.3.1.4 Anchovy landings per age group (number of individuals in thousands) in GSA 22 for 2003-2008.

8.43.2.3.2. Discards

No discards data for anchovy were reported to the SGMED-09-02 and no data were reported through the Data collection regulation for 2003-2008. According to data obtained within the framework of the Hellenic Centre for Marine Research data collection system that covers the entire GSA 22, discards are estimated to less than 1%, consisting 0.06% of the purse seine fishery total catch. Although considered negligible they were taken into account for the assessment as a percentage to reported landings. The fishery is multispecies and fishermen tend to avoid schools of undersized anchovies due to sorting difficulties (blocking of the mesh) and low price, practically by using nets of bigger mesh size, targeting mostly mackerels or horse mackerels.

8.43.2.3.3. Fishing effort

Based on the fishing effort data reported through the Data collection regulation and data obtained within the framework of the Hellenic Centre for Marine Research data collection system covering the entire GSA 22, the following table was made:

Tab. 8.43.2.3.3.1 Effort data for the purse seine fleet in GSA 22 (GT=Gross tonnage, KW=engine power).

Year	PS 12-24 m	PS 24-40 m	PS 12-24 m	PS 24-40 m	PS 12-24 m	PS 24-40 m
	Days at Sea	**Days at Sea**	**Days at Sea x GT**	**Days at Sea x GT**	**Days at Sea x KW**	**Days at Sea x KW**
2003	41539	2942	1767398	230726	8709727	679624
2004	39783	3989	1620847	366709	8111571	1029410
2005	42520	5690	1753346	542120	8123673	1532790
2006	37255	5619	1568893	539146	7386042	1606608
2007	31492	5338	1305252	524544	6511187	1528440
2008	35090	4938	1457212	473121	6898061	1335582

8.43.3. Scientific surveys

8.43.3.1. Acoustics and DEPM

8.43.3.1.1. Methods

Acoustics

Based on data reported to SGMED-09-02 total biomass, abundance, length and age composition for GSA 22 were estimated by acoustics from 2003 to 2008. No age distribution data were reported through the DCR for 2008. No acoustic survey took place in 2007.

Acoustic surveys methodology

Acoustic echoes were registered continuously along 70 pre-defined transects in the study area in June 2003, 2004, 2005, 2006 and 2008 with a Biosonics Split Beam 38 kHz DT-X echosounder. The acoustic methodology followed is described in Somarakis *et al.* (2007) (GFCM 2007 related WD). Hydroacoustic data analysis was performed using the Sonardata Echoview software v3.30. Echo trace classification was applied based on a) echogram visual scrutinisation and direct allocation of school marks that characterise anchovy as well as b) allocation on account of representative fishing stations that were held along transects (MacLennan and Simmonds, 1992).

In order to estimate anchovy biomass, the length-weight relationship is required as well as species length frequency distribution per area. Therefore, 22, 23, 27, 37 and 30 pelagic trawls were made along transects in 2003, 2004, 2005, 2006 and 2008 respectively, in the positions of high fish concentrations. A random sample of 200 specimens was obtained from each haul for further laboratory analysis. Subsequently, the length-weight relationship was estimated from the total number of hauls according to the equation:

$$W = a\,L^b$$

where W is the total weight; L is the total length and a and b are constants that are estimated by regression analysis.

The mean length frequency was estimated in two sub-areas: (a) Eastern area (Thracian Sea and Strymonikos Gulf) and (b) Western area (Thermaikos and Evoikos Gulfs). In the two sub-areas, the mean frequency of each length class was estimated as follows:

$$f_j=\frac{\sum_{k=1}^{M}\left(\frac{n_{jk}}{t_k}\right)}{\sum_{k=1}^{M}\left(\frac{N_k}{t_k}\right)}$$

where f_j is the mean frequency of anchovy of length class j; n_{jk} is the number of specimens of length class j in haul k; N_k is the total number of anchovies in haul k; t_k is the duration of haul k and M is the number of hauls in the area. The above equation is appropriate even if the catches are small and the length distributions are poorly defined. It takes accounts of the haul duration, since it is supposed that on average, longer hauls will produce more fish (MacLennan and Simmonds, 1992).

The density of targets (F) from the observed echo integrals were estimated according to the equation $F=(K/\langle\sigma\rangle)E$, were K is the calibration factor, $\langle\sigma\rangle$ is the mean cross-section and E is the echo integral after partitioning (MacLennan and Simmonds, 1992). The target strength (TS) – total length relationship used for anchovy was: TS=20 logL-71.2, where L is fish total length (ICES, 2006). The $\langle\sigma\rangle$ was calculated for the mean total fish length of each area according to the equations $\langle\sigma\rangle=4\pi\sum_{\iota} f_i 10^{TS/10}$, where f_I is the corresponding length frequency as deduced from the fishing samples (MacLennan and Simmonds, 1992).

The abundance Q was estimated separately for the eastern and the western part of the study area. The abundance Q in each elementary statistical sampling area was calculated from the average density within each sub-area according to the equation:

$$Q = A_k \sum_i F_i / N_k \,,$$

where F_i is the i sample; A_k is the area of each elementary statistical sampling area and N_k is the number of transects in A_k. The variance V was estimated as

$$V=\sum_i \; (AF_I-Q)^2/[N_r(N_{r-1}-1)]$$

The data were log transformed and the means and variances of F estimated according to the following equations:

$F=\exp(m)\mathbf{G_N}[0.5\ S/(n-1)$; $V=F^2-\exp(2m)\ \mathbf{G_N}[S(n-2)/(n-1)^2]$;

where m = average (lnF); S= variance (lnF) and n = independent observations of F.

The total abundance Q_t and its variance were obtained by summing the results for each region $Q_t=Q_1+Q_2+\ldots$, and $V_t=V_1+V_2+\ldots$. Standard error of Q_t is the square root of V (MacLennan and Simmonds, 1992).

Daily Egg Production surveys (DEPM) methodology

The methodology of the DEPM is described in detail in Somarakis *et al*. (2007) GFCM WD. The spawning stock biomass was estimated according to the model described by Parker (1980) and subsequently modified by Stauffer & Picquelle (1980):

$$B = (k \cdot P \cdot A \cdot W)/(R \cdot F \cdot S)$$

where, B = spawning stock biomass in metric tons, k = conversion factor from grams to metric tons, P = daily egg production (number of eggs per sampling unit, m^2), A = total survey area (in sampling units, m^2), W = average weight of mature females (grams), R = sex ratio (fraction of mature females by weight), F = batch fecundity (mean number of eggs per mature females per spawning), S = fraction of mature females spawning per day (spawning frequency).

8.43.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.43.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the anchovy stock in GSA 22 was derived from the acoustics and the DEPM surveys. Figure 8.43.3.1.3.1 displays the estimated trend in anchovy Total Biomass (estimated by acoustics) and Spawning Stock Biomass (estimated by DEPM) for GSA 22. Figure 8.43.3.1.3.2 shows the estimated trend in anchovy abundance (estimated by acoustics).

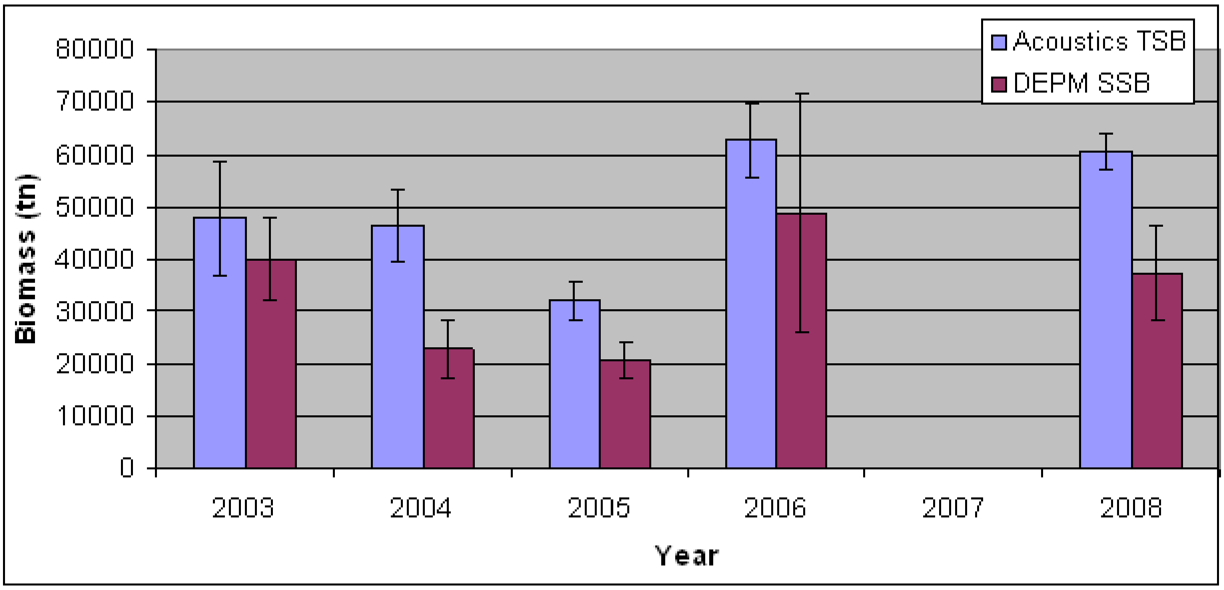


Fig. 8.43.3.1.3.1 Estimated anchovy biomass indices for GSA 22, 2003-2006 and 2008.

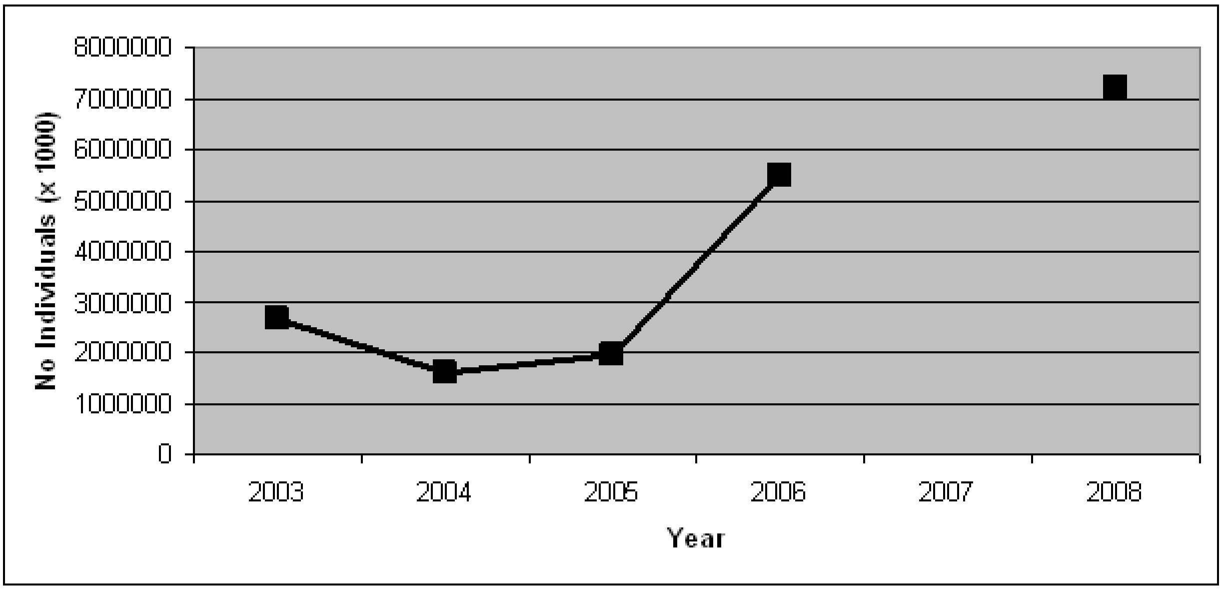


Fig. 8.43.3.1.3.2 Estimated abundance indices for GSA 22, 2003-2006 and 2008.

An increasing trend was observed in both biomass and abundance indices (Fig. 8.43.3.1.3.1, Fig. 8.43.3.1.3.2).

8.43.3.1.4. Trends in abundance by length or age

Figure 8.43.3.1.4.1 shows the length frequency composition of the anchovy stock as derived from the acoustic surveys in GSA 22.

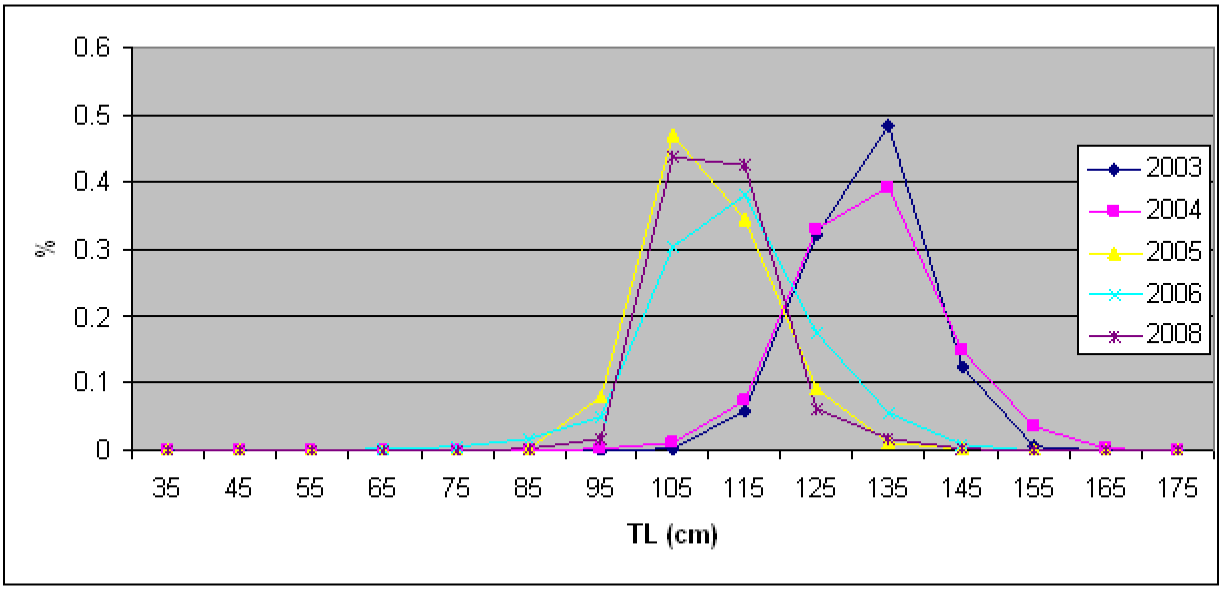


Fig. 8.43.3.1.4.1 Estimated changes in size compositions for GSA 22 for 2003-2006 and 2008.

The following Fig. 8.43.3.1.4.2 and Fig. 8.43.3.1.4.3 show the abundance indices by size and age of GSA 22 for 2003-2006 and 2008 based on acoustic surveys.

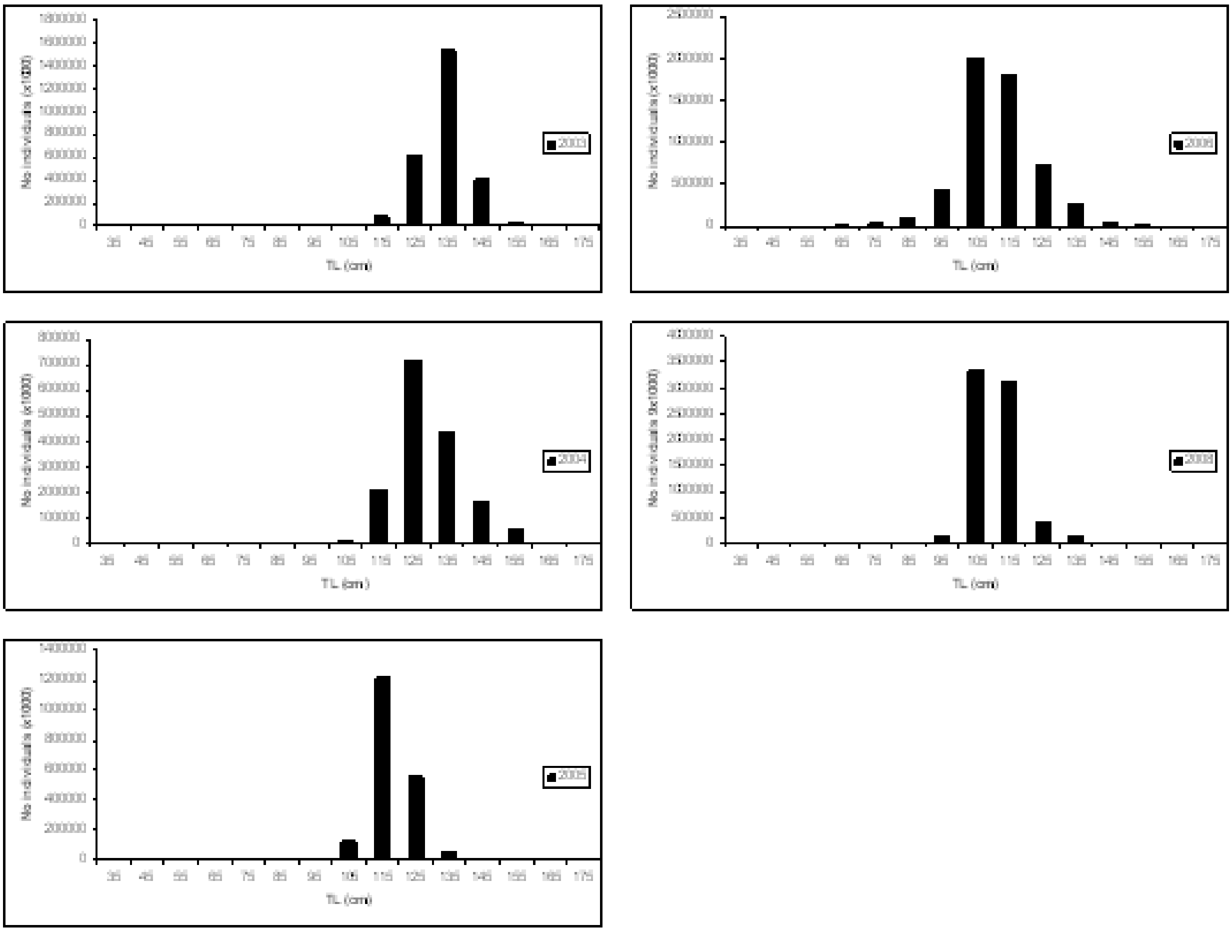


Fig. 8.43.3.1.4.2. Abundance indices by size for 2003-2006 and 2008.

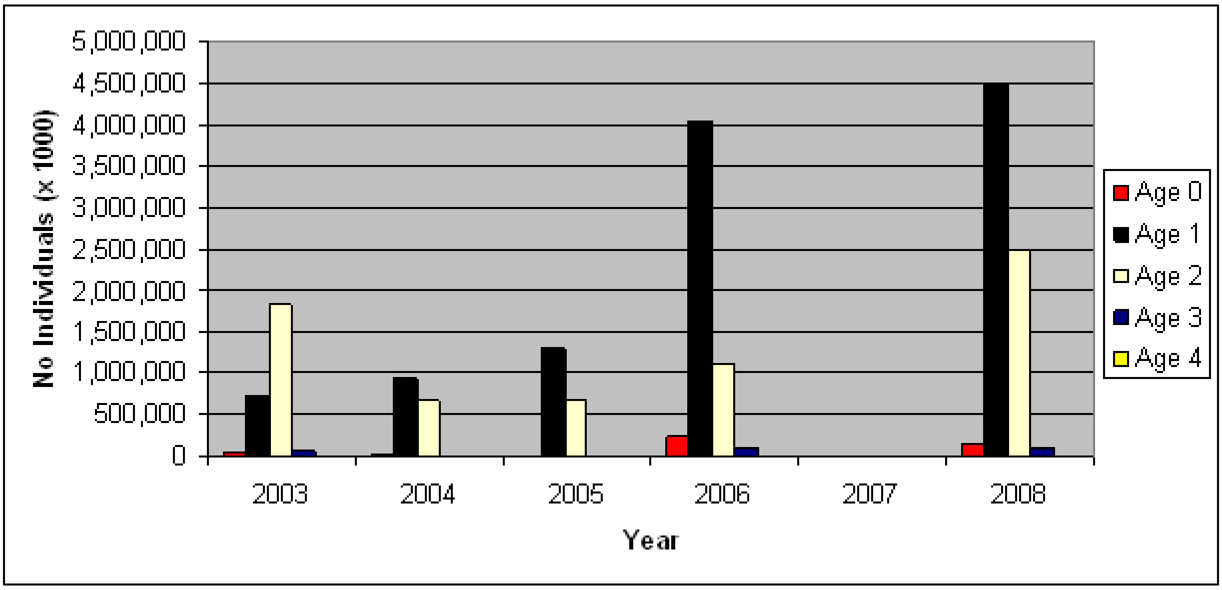


Fig. 8.43.3.1.4.3. Abundance indices by age for 2003-2006 and 2008.

8.43.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02. Growth equation was supplied through DCR and it was estimated based on aggregated data collected in GSA 22 for the period 2003 to 2008.

8.43.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02. Maturity ogive based on the results of the DEPM surveys was used (Table 8.43.3.1.6.1).

Tab. 8.43.3.1.6.1. Maturity ogive for anchovy in GSA 22 based on the results of DEPM surveys.

Age	2003	2004	2005	2006	2008
0	0	0	0	0	0
1	0.62	0.67	0.46	0.4	0.4
2	0.99	0.99	0.98	0.98	0.98
3	1	1	1	1	1
4	1	1	1	1	1

8.43.4. Assessment of historic stock parameters

8.43.4.1. Method: ICA

8.43.4.1.1. Justification

Integrated Catch at Age (ICA) analysis for stock assessment (Patterson and Melvin, 1998) was applied. Integrated Catch at age analysis uses separable virtual population analysis (VPA) (Pope & Shepherd, 1985) with weighted tuning indices. It was applied regarding the Aegean anchovy stock during the SGMED-09-02 as an update of the one adapted in the SGMED-08-04 report (Cardinale *et al*., 2008). This assessment of the anchovy stock in GSA22 is based on a short time series of available, so results should be considered with caution. In addition Y/R analysis was applied during the SGMED-09-02.

8.43.4.1.2. Input parameters

ICA was based on commercial catch data (2000-2008). Biomass estimates from acoustic surveys over the period 2003-2006 and 2008 and Daily Egg Production Method (DEPM) estimates were used as tuning indices. Anchovy data concerned annual anchovy landings, annual anchovy catch at age data (2000-2008), mean weights at age, maturity at age and the results of acoustic and DEPM surveys (2003-2006 and 2008) presented in Tables 8.43.4.1.2.1 to 8.43.4.1.2.7. Age-Length-Key was applied on a six month basis to convert length distribution into age distribution. In addition discards were taken into account. Specifically, according to data obtained within the framework of the Hellenic Centre for Marine Research data collection system that covers the entire GSA 22, discards are estimated to less than 1%, consisting 0.06% of the purse seine fishery total catch. Although considered negligible they were taken into account for the assessment as a percentage to reported landings.

Since, acoustics and DEPM are being applied at the same time and with the same research vessel in Aegean Sea, acoustic estimates were used as an index for the numbers at age of the population and DEPM estimates as stock spawning biomass estimates. Reference age for the fishery was age group 2, as fully exploited and fully recruited. Eight years separability was selected.The age groups 0, 4 and 5 were underweighted in the analysis based on their percentage in the catch. Age 1 was also underweighted in the acoustic surveys (0.5). Catchability for the DEPM index is assumed as absolute indicator of Biomass, linear catchability relationship is assumed for the acoustic surveys. Different natural mortality values were applied per age group but constant for all years based on ProBiom (Abella *et al.*, 1997) as recommended in the report of the SG-ECA/RST/MED 09-01. This method for estimating natural mortality is consistent with the methodology used in GSAs 05, 06 and 17 for small pelagics. Average values of maturity ogive and weight at age in the stock were used for 2007.

Tab. 8.43.4.1.2.1. Catch at age (numbers in thousands) of anchovy stock in GSA 22 for 2000-2008.

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

Tab. 8.43.4.1.2.2. Catch estimates (in t) of anchovy stock in GSA 22 for 2000-2008.

Year	Anchovy
2000	10348
2001	8726
2002	9063
2003	14843
2004	17064
2005	17327
2006	24461
2007	22791
2008	25950

Tab. 8.43.4.1.2.3. Weight at age in the catch of anchovy stock (in kg) in GSA 22 for 2000-2008.

	Year								
Age	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	0.0085	0.0093	0.0098	0.0057	0.0029	0.0036	0.0099	0.0102	0.0105
1	0.0125	0.0134	0.0133	0.0164	0.0146	0.0096	0.0151	0.0139	0.0127
2	0.0138	0.0151	0.015	0.0184	0.0184	0.0137	0.0161	0.0153	0.0146
3	0.0145	0.0161	0.0161	0.0188	0.0204	0.016	0.0174	0.0176	0.0179
4	0.0245	0.0297	0.0257	0.0398	0.0338	0.0334	0.0187	0.0223	0.0258

Tab. 8.43.4.1.2.4. Weight at age in the stock (in kg) of anchovy stock in GSA 22 for 2000-2008.

	Year								
Age	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	0.005	0.005	0.005	0.0057	0.0033	0.0014	0.0017	0.0016	0.0015
1	0.0011	0.0011	0.0011	0.0058	0.0086	0.0056	0.0067	0.0083	0.0098
2	0.0136	0.0136	0.0136	0.0201	0.0201	0.0147	0.0191	0.0167	0.0143
3	0.0153	0.0153	0.0153	0.0293	0.0224	0.0246	0.0231	0.0219	0.0207
4	0.0179	0.0179	0.0179	0.0398	0.0338	0.0334	0.0209	0.0227	0.0245

Tab. 8.43.4.1.2.5. Maturity ogive of anchovy stock in GSA 22 for 2003-2008.

Year	0	1	2	3	4
2003	0	.62	.99	1	1
2004	0	.67	.99	1	1
2005	0	.46	.98	1	1
2006	0	.40	.98	1	1
2007	0	.40	.98	1	1
2008	0	.40	.98	1	1

Tab. 8.43.4.1.2.6. Spawning biomass indices (SSB in t) of anchovy stock in GSA 22 for 2003-2008.

Year	SSB
2003	40042
2004	22799
2005	20533
2006	48700
2007	-
2008	37404

Tab. 8.43.4.1.2.7. Age-structure indices of anchovy (numbers in thousands) stock in GSA 22 for 2003-2008. Age 3 was considered a plus age group.

Age	2003	2004	2005	2006	2007	2008
1	711816	925773	1291270	4044093	-1	4469332
2	1822817	667953	663465	1109500	-1	2495923
3+	69679	5177	7524	99442	-1	95920

8.43.4.1.3. Results including sensitivity analyses

The graphical diagnostics of the model shown in Figs. 8.43.4.1.3.1 to 8.43.4.1.3.5, generally showed good model fit besides year 2002 and age 4, probably because they are poorly sampled. This further justifies the down weighting of age 4 in the model. Residual plots for recent years showed no strong deviations from separability. SSQ plot (Fig. 8.43.4.1.3.6) indicated moderate consistency between the model and the indices (minima fairly close to each other on x-axis, Needle (2000)).

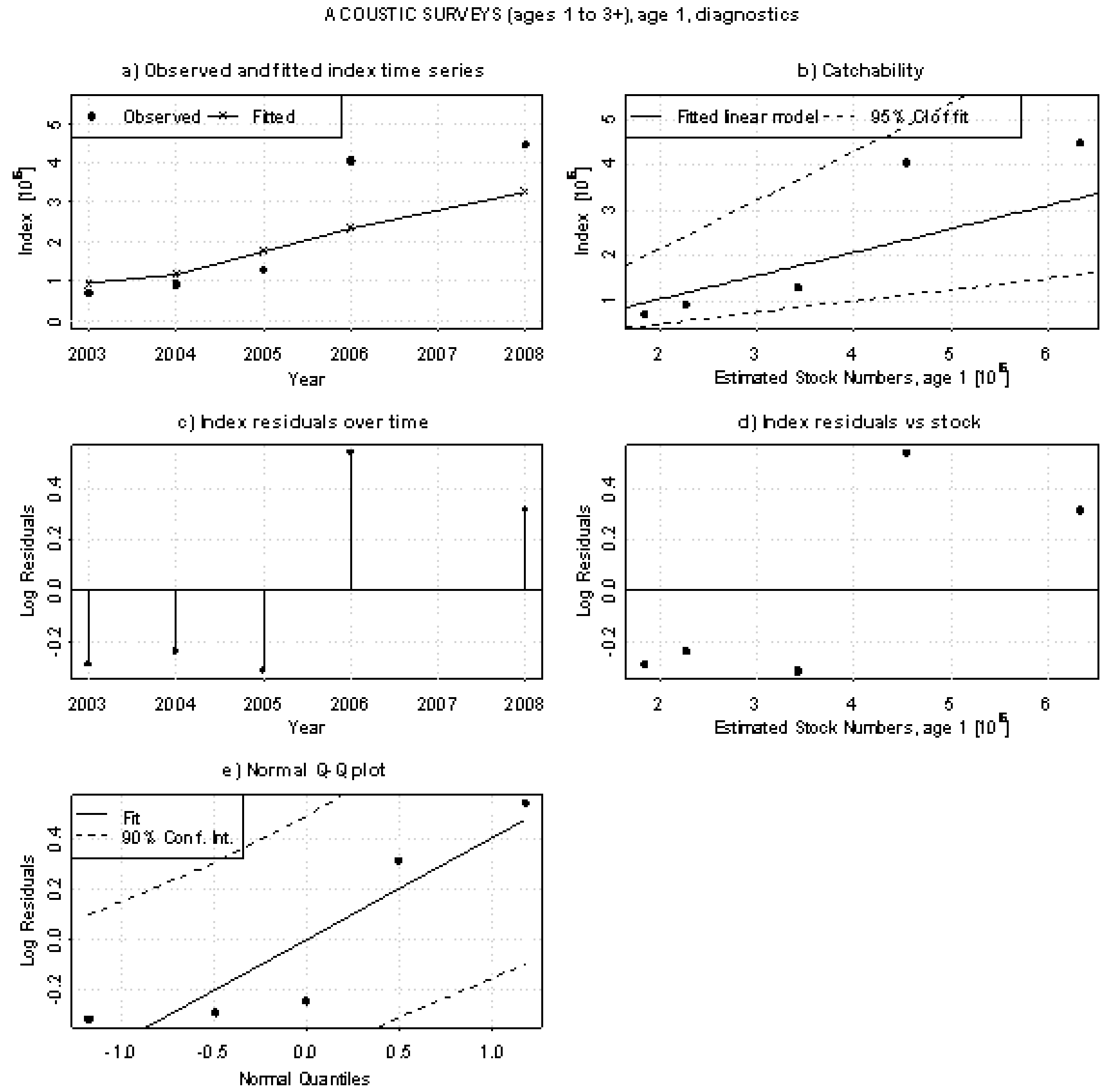


Fig. 8.43.4.1.3.1 Residual plots for age 1 indices of anchovy ICA model for GSA 22 (2003-2008).

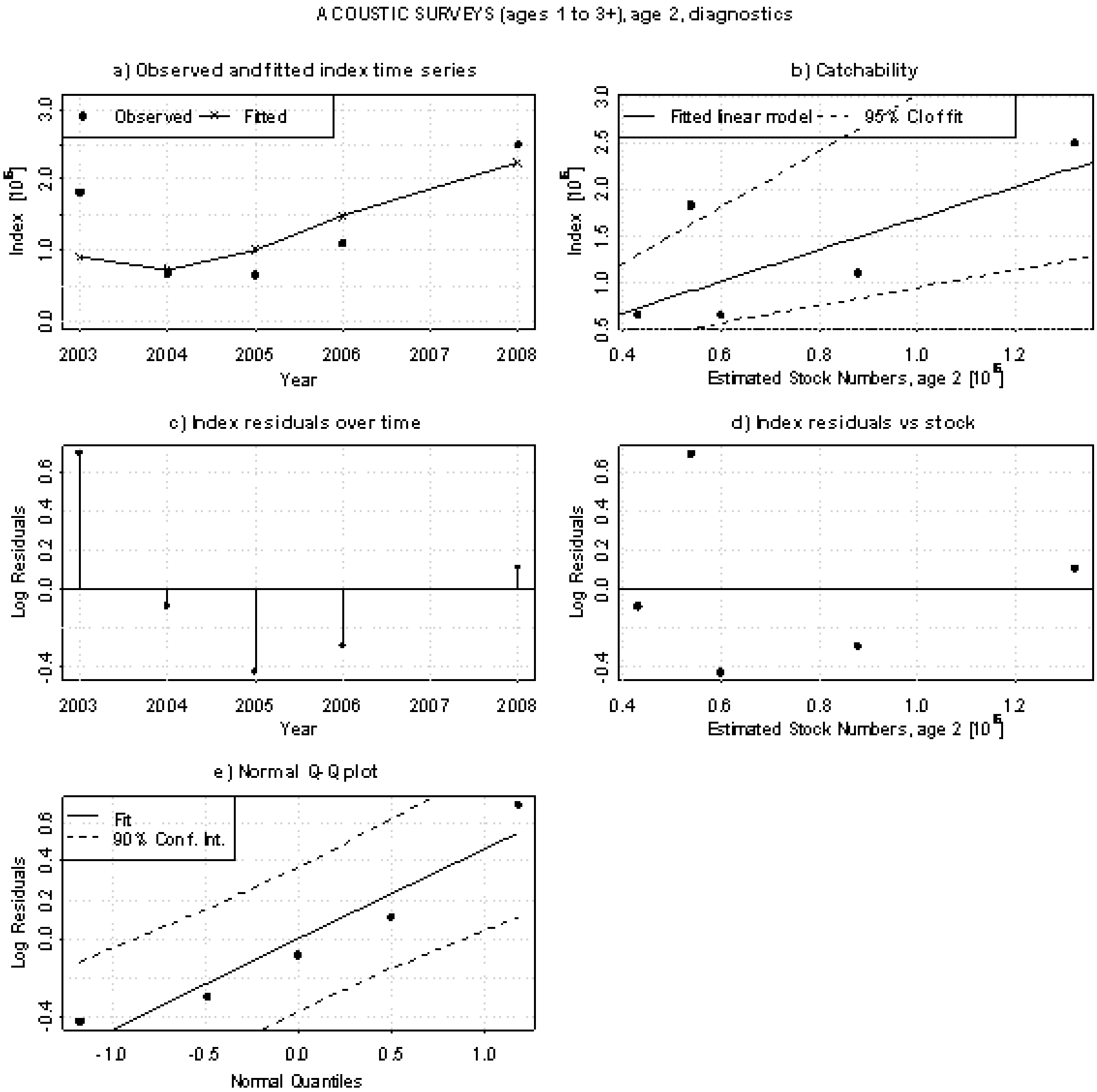


Fig. 8.43.4.1.3.2 Residual plots for age 2 indices of anchovy ICA model for GSA 22 (2003-2008).

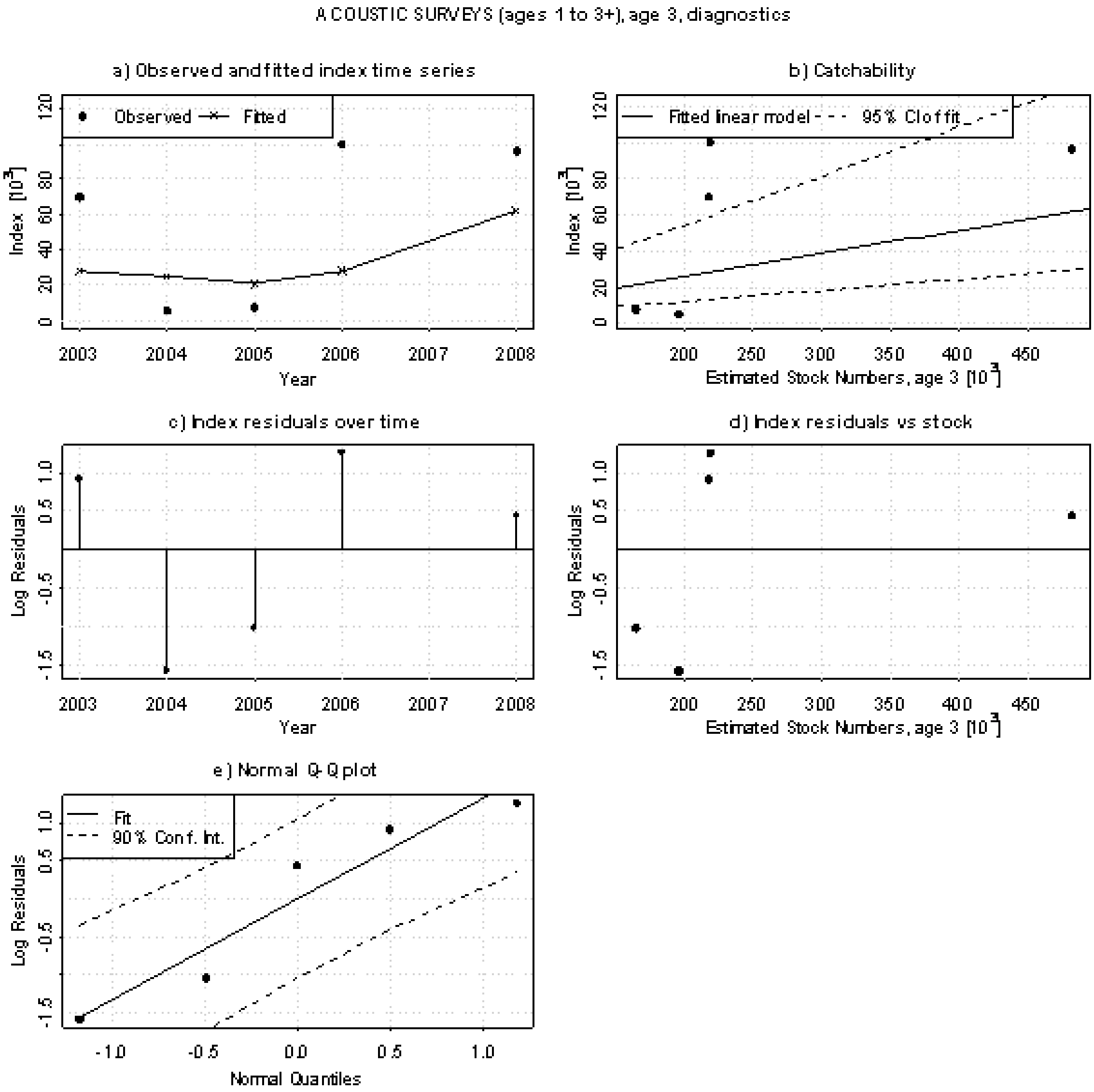


Fig. 8.43.4.1.3.3 Residual plots for age 3 indices of anchovy ICA model for GSA 22 (2003-2008).

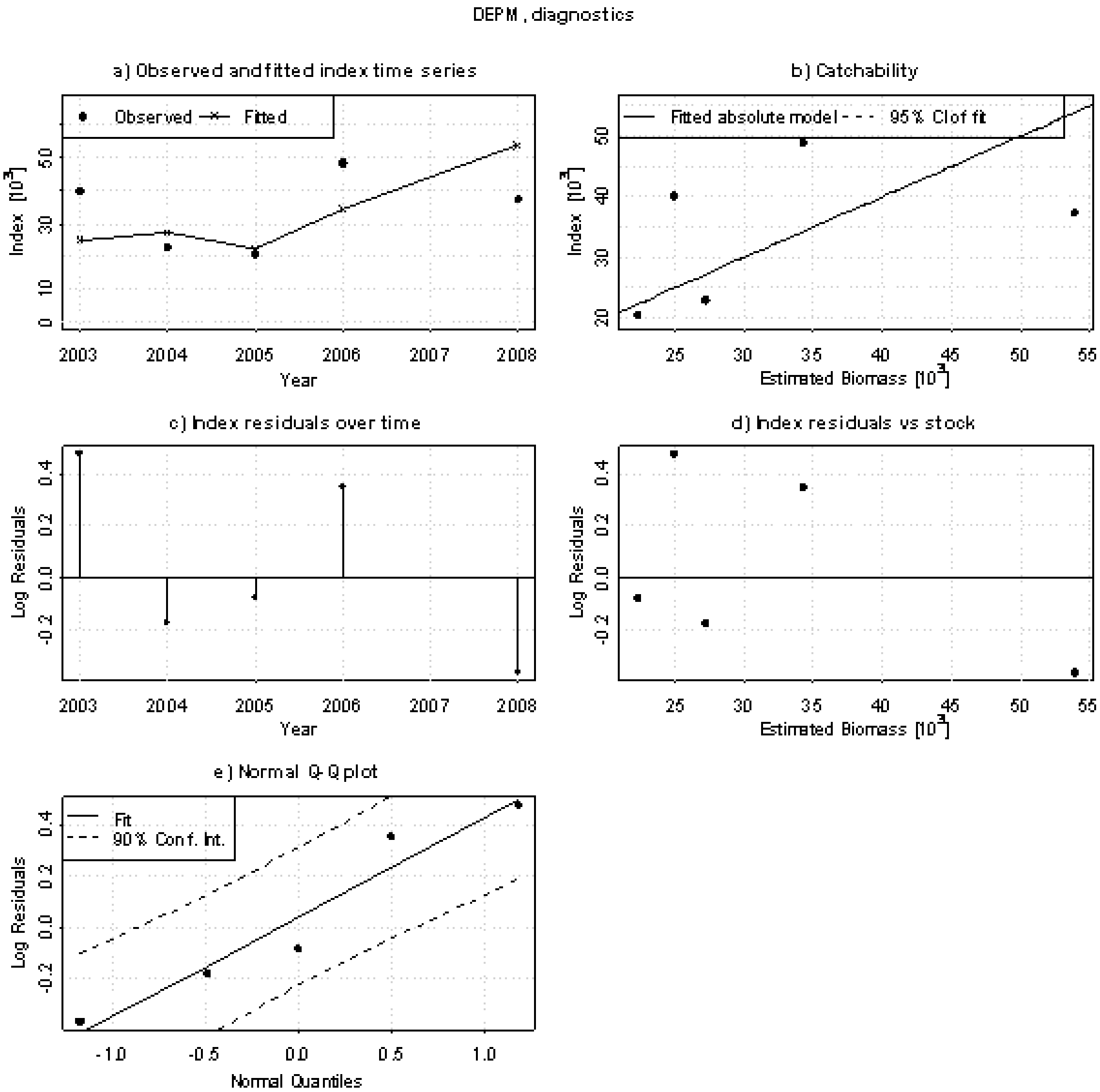


Fig. 8.43.4.1.3.4 Residual plots for SSB indices of anchovy ICA model for GSA 22 (2003-2008).

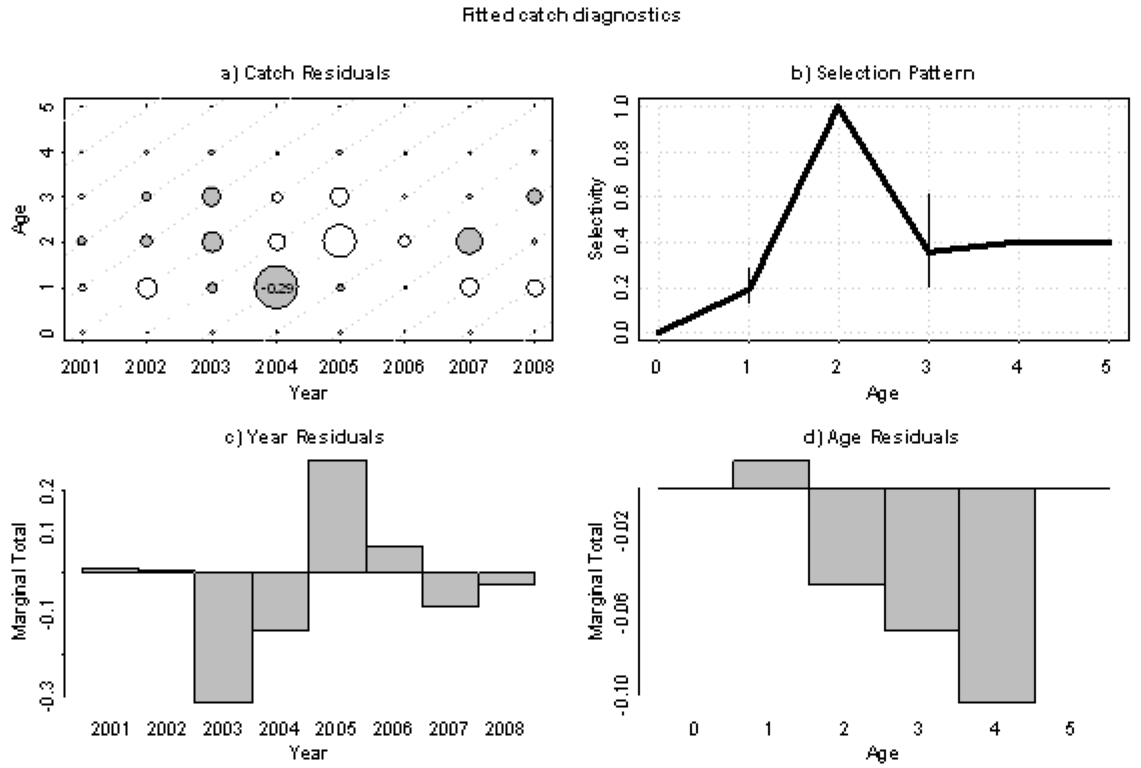


Fig. 8.43.4.1.3.5 The catch at age residuals plots for catch of anchovy ICA model for GSA 22 (2001-2008).

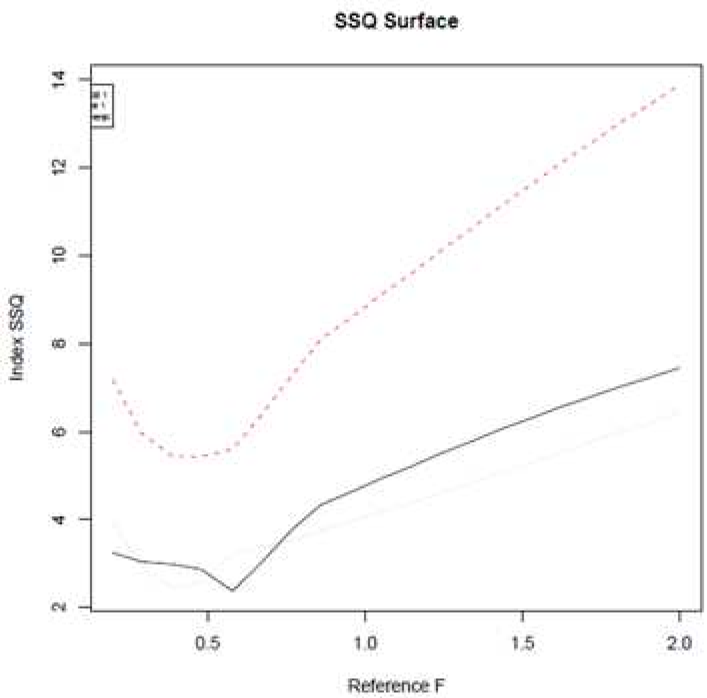


Fig. 8.43.4.1.3.6 Sum of Squares (SSQ) surface plot of the Anchovy ICA Model.

ICA model results for anchovy stock in GSA 22 are shown in Fig. 8.43.4.1.3.7, indicating an increasing trend for recruitment since 2004 with a pronounced increase for 2008. However this is probably an overestimation of the last year as the model predicts a decrease at the level of 2006 for 2009. An increase in biomass has also been observed since 2005. Average fishing mortality for ages 1 to 3 (which are target ages for the fishery) shows a decrease since 2004. The landings to total biomass ratio also decreases, approximating on average less than 10% based on model results in 2008. Similarly, the landings to SSB ratio also decreases, approximating on average 40% based on model results in 2008.

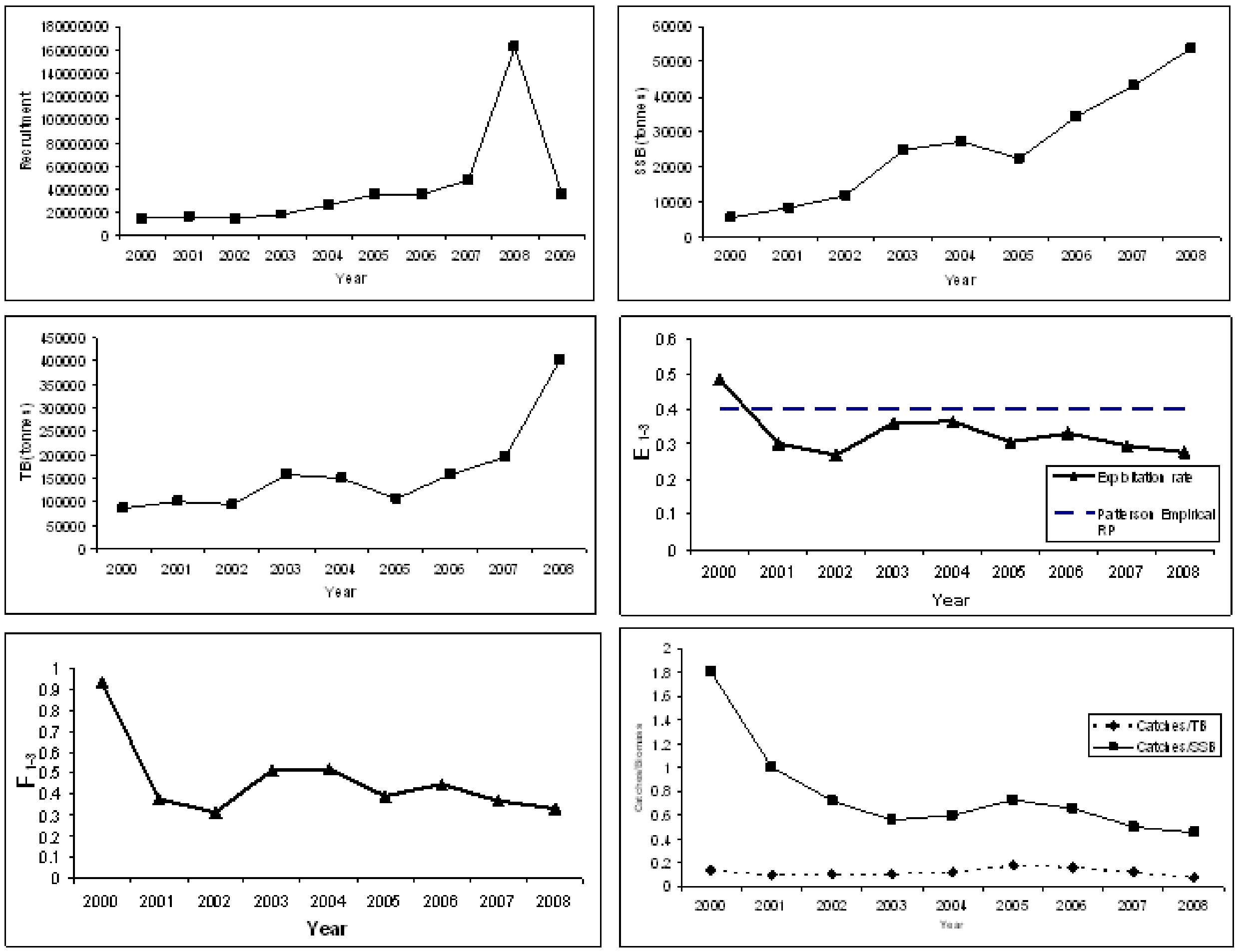


Fig. 8.43.4.1.3.7 Anchovy ICA Model results: Recruitment, SSB, Total biomass, exploitation rate (F/Z), F mean for ages 1-3, landings to biomass ratio.

Retrospective analysis was applied in the ICA model for the Aegean anchovy 2000-2008 with one year backward analysis. Applying the analysis with more than one year backward was not possible due to the short time series available. Results are presented in Fig. 8.43.4.1.3.8, showing no particular retrospective bias and consistency in the beginning of the time series.

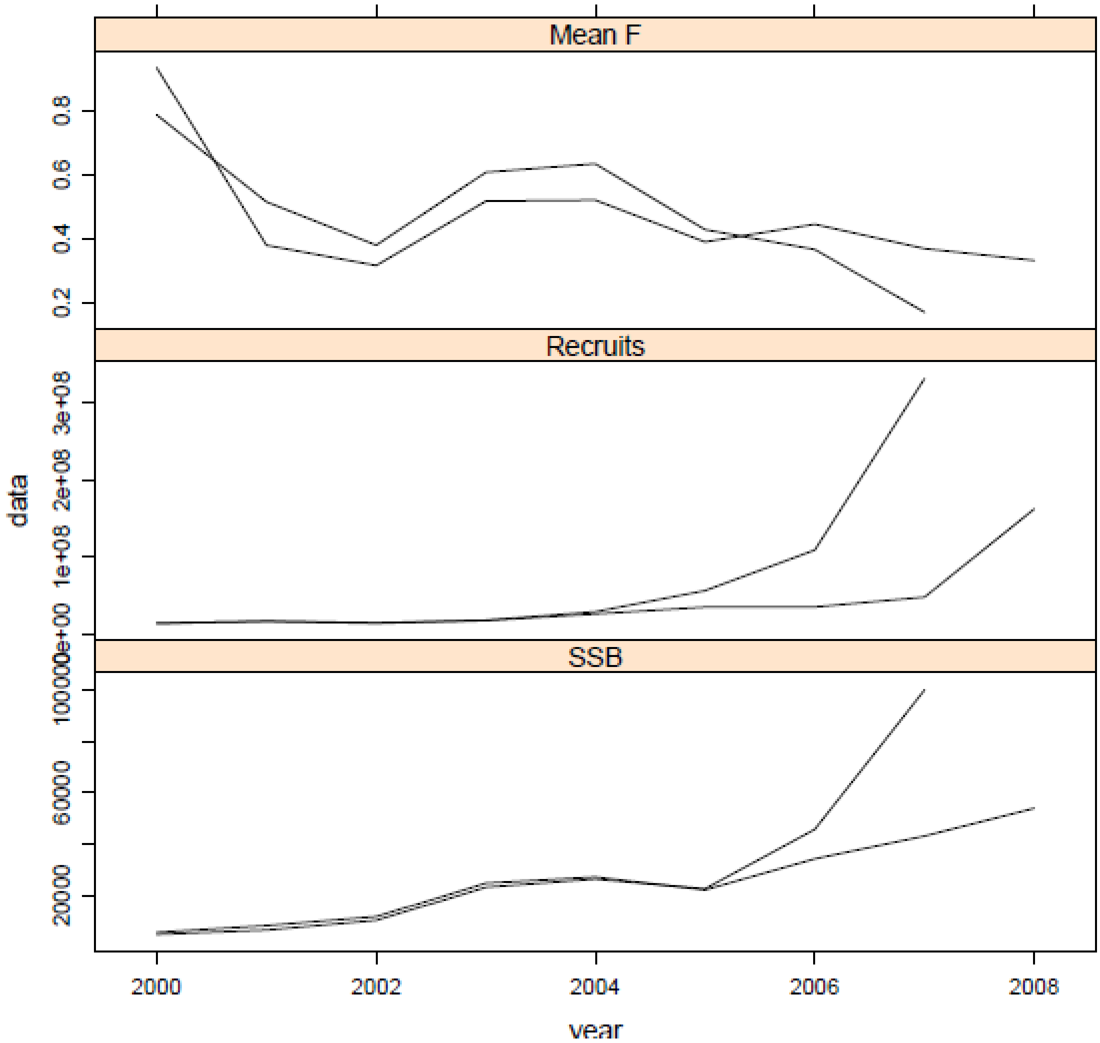


Fig. 8.43.4.1.3.8 The results of retrospective analysis in the Aegean Sea anchovy ICA model 2000-2008, concerning F mean 1-3, SSB and recruitment.

8.43.5. Long term prediction

8.43.5.1.Justification

Yield per recruit analysis was conducted in the SGMED-09-02 assuming equilibrium conditions.

8.43.5.2.Input parameters

Yield per recruit analyses was conducted based on the exploitation pattern resulting from the ICA model and population parameters, Minimum and maximum age for the analysis were considered to be age group 0 and 4, respectively. Stock weight at age, catch weight at age and maturity ogive were estimated as mean values on a long term basis (2000-2008). Different natural mortality values were applied per age group but constant for all years based on ProBiom (Abella *et al.*, 1997) as recommended in the report of the SG-

ECA/RST/MED 09-01. Fishing mortalities were estimated in a short term basis (2004-2008). Reference F was considered to be mean F for ages 1 to 3. Input parameters are shown in Table 8.43.5.2.1.

Tab. 8.43.5.2.1. Input parameters for Y/R analysis.

age group	stock weight	catch weight	maturity	F	M
0	0,003	0,008	0	0,0011	1,50
1	0,005	0,014	0.51	0,1561	1,00
2	0,016	0,016	0.98	0,8291	0,74
3	0,021	0,017	1	0,4169	0,66
4	0,025	0,028	1	0,3744	0,62

8.43.5.3.Results

Y/R analyses were performed (Fig. 8.43.5.3.1) but were not considered reliable due to its flat-topped shape. Therefore,$F_{0.1}$ (1.44) cannot be used as a reference point for this stock.

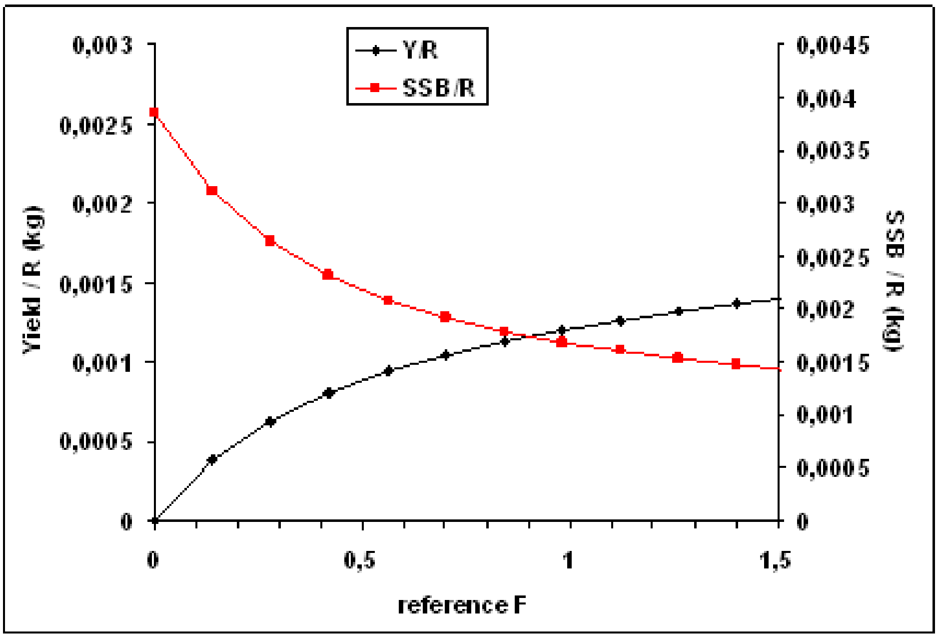


Fig. 8.43.5.3.1. Yield per recruit for the anchovy stock in GSA 22.

8.43.6. Scientific advice

8.43.6.1.Short term considerations

8.43.6.1.1. State of the spawning stock size

Estimates of fishery independent surveys for anchovy in GSA 22 indicated a slight increase from lower levels in 2005 to the most recent estimates in 2006 and 2008 concerning both Total Biomass (62,604 t in 2006 and 60,600 t estimated by acoustics) and SSB (48,700 t in 2006 and 37,400 in 2008 t estimated by DEPM). Similarly, results of the Integrated Catch at Age analysis indicated an increasing trend in total biomass and in SSB showing an increase in 2008 from the lower level observed in 2005. The state of the spawning biomass in relation to precautionary limits cannot be evaluated since there are no reference points derived form the short series of data available. However the level of anchovy SSB in 2008 is well above the lowest SSB level (in 2005) observed.

It should be considered that this assessment is based on a short time series of data and not suitable to suggest reference points of B_{lim}. Moreover, anchovy is a short lived species characterized by high fluctuations in abundance and recruitment strongly depends on environmental conditions.

8.43.6.1.2. State of recruitment

ICA model estimates had shown an increase in the number of recruits towards 2008. However the model predicts a decrease in 2009, similar to the 2006 level.

8.43.6.1.3. State of exploitation

Based on ICA results, the mean F (for ages 1 to 3) showed a decrease since 2003 with mean for 2000-2008 equal to 0.33 and, since 2004, is being well below the exploitation reference points (E<0.4, Patterson (1992)) suggested by SGMED as an appropriate target reference for small pelagics.

Furthermore, due to the high values of natural mortality used, Y/R analysis indicated no significant reduction in SSB at high values of F. Therefore the use of F_{max} and $F_{0.1}$ as a reference point was not considered appropriate. Precautionary the use of $F_{(E0.4)}$ that assures exploitation rate below the empirical level for stock decline (E<0.4, Patterson (1992)) for small pelagics was suggested by the SGMED-09-02 as exploitation reference point for this stock.

Based on this assessment results the stock is considered to be harvested sustainably, operating below but close to an optimal yield level, with no expected room for further increase in catch and effort. SGMED recommends that fishing effort should not increase beyond the current levels and consistent catches should be determined. This should allow maintaining the current levels of fishing mortality. However this has to be confirmed in following years and the anchovy stock should be monitored on an annual basis. Mixed fisheries implications, i.e. the interaction with sardine, need to be considered when managing this fishery.

For precautionary reasons the possibility of changing the closed period should be examined. Since the fishery is considered a multispecies targeting both anchovy and sardine, a shift of the closed period (present: mid December to end of February) towards the recruitment period of anchovy (e.g. October to December) / or the recruitment period of sardine (e.g. February to April) could be suggested allowing more individuals of anchovy and/or sardine to enter the fishery at an older age.

8.44. Stock assessment of sardine in GSA 16

8.44.1. Stock identification and biological features

8.44.1.1. Stock Identification

This assessment of the sardine stock in GSA 16 is mainly based on information collected over the last decade relating fishery grounds off the southern Sicilian coast (GSA 16, South of Sicily), and specifically on biomass estimates obtained by hydroacoustic surveys and catch-effort data from local small pelagic fisheries. The main distribution area of the sardine stock in GSA 16 is the narrow continental shelf area between Mazara del Vallo and the southernmost tip of Sicily, Cape Passero (Patti *et al*., 2004).

8.44.1.2. Growth

Growth parameters were not used for this assessement.

8.44.1.3. Maturity

Maturity data were not used for this assessement.

8.44.2. Fisheries

8.44.2.1. General description of fisheries

In Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA16), accounting for about 2/3 of total landings in GSA 16, two operational units (OU) are presently active, purse seiners and pelagic pair trawlers. The fleet in GSA 16 is composed by about 50 units (17 purse seiners and 30 pelagic pair trawlers were counted up in a census carried out in December 2006). In both OUs, anchovy represents the main target species due to the higher market price.

8.44.2.2. Management regulations applicable in 2008 and 2009

Fisheries policy is strongly conditioned by EU regulations through the Common Fisheries Policy (CFP), based on the following principles: protection of resources; adjustment of (structure) facilities to the available resources; market organization and definition of relationships with other countries.

The main technical measures regulating fishing concern minimum landing size (9 cm for anchovy, 11 cm for sardine), mesh regulations (20 mm for pelagic pair trawlers, 14 mm for purse seiners) and restrictions on the use of fishing gear. Towed fishing gears are not allowed in the coastal area in less than 50 m depth, or within a distance of 3 nautical miles from the coastline. A seasonal closure for trawling, generally during summer-autumn, has been established since 1993. In GSA 16, the two operational units fishing for small pelagic are present, mainly based in Sciacca port: purse seiners (lampara vessels, locally known as “Ciancioli”) and midwaters pair trawlers (“Volanti a coppia”). Midwaters trawlers are based in Sciacca port only, and receive a special permission from Sicilian Authorities on an annual basis. Another fleet fishing on small pelagic fish species is based in some northern Sicilian ports and targets on juvenile stages (mainly sardines). Also this fishery is allowed for a limited period (usually one or two months during the winter season) by a special Regional law renewed year by year.

8.44.2.3.Catches

8.44.2.3.1. Landings

Landings were obtained within the framework of the census data collection carried out by IAMC-CNR (Mazara del Vallo) in Sciacca port since 1998. Information collected in the framework of CA.SFO. study project (Patti *et al*., 2007) showed that landings in Sciacca port account for about 2/3 of the total landings in GSA 16. Average sardine landings over the last decade (1997-2008) were about 1,500 metric tons, with a general decreasing trend.

It is worth noting that, though trend in biomass is clearly decreasing over the last years (Fig. 8.44.3.1.3.1.), landings levels over the same period were relatively high, indicating an increased vulnerability of the resource (Fig. 8.44.2.3.1.1).

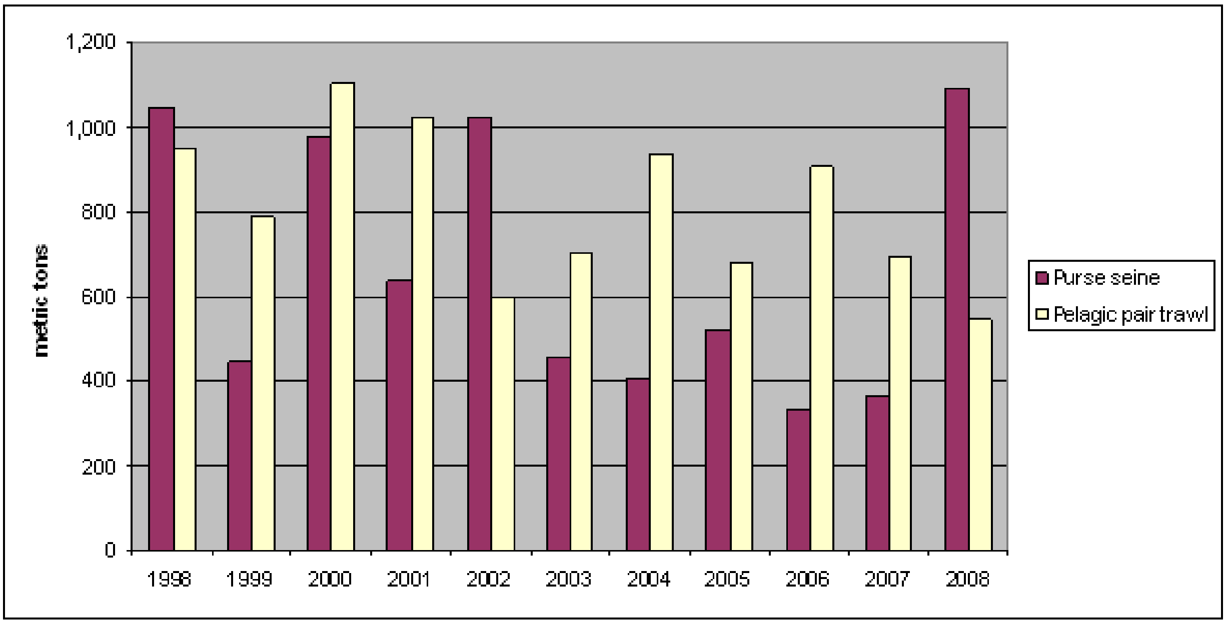


Fig. 8.44.2.3.1.1. Landings data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2008.

8.44.2.3.2. Discards

No discards data for sardine were used for this assessment. However, discards are estimated to be less than 5% of total catch for both the pelagic pair trawl and the purse seine fisheries (Kallianiotis and Mazzola, 2002)

8.44.2.3.3. Fishing effort

Fishing effort data refer to census data collected in Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16.

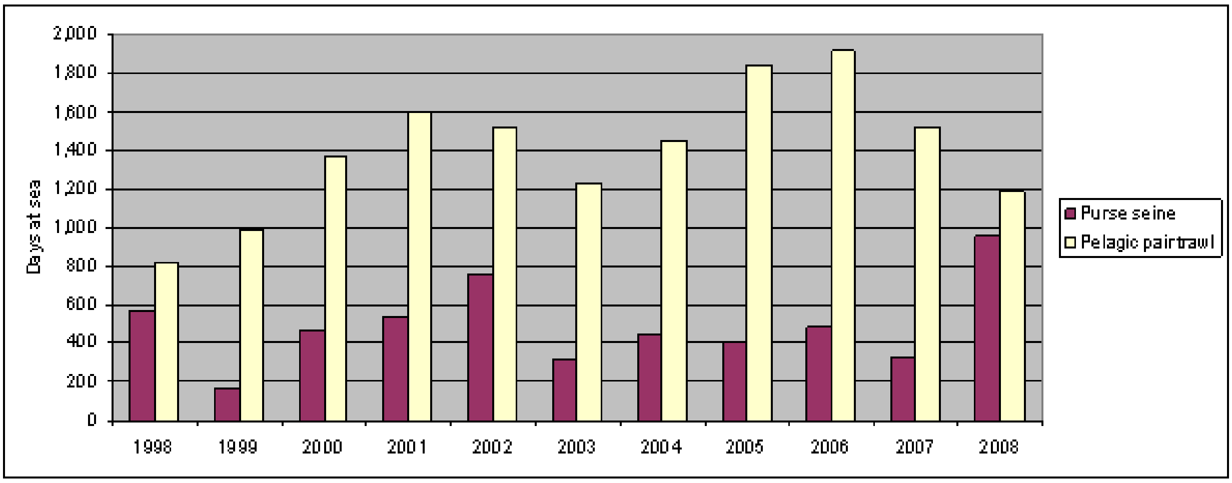


Fig. 8.44.2.3.3.1. Effort data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2008.

8.44.3. Scientific surveys

8.44.3.1. Acoustics

8.44.3.1.1. Methods

Acoustic surveys methodology

Steps for biomass estimation

- Collection of acoustic and biological data during surveys at sea;
- Extraction of $NASC_{Fish}$ (Fishes Nautical Area Scattering Coeffcient [$m^2/n.mi^2$]) by means of Echoview (Sonar Data) post-processing software;
- Link of NASC values to control catches;
- Calculation of Fish density (ρ) from $NASC_{Fish}$ values and biological data;
- Production of ρ distribution maps for different fish species and size classes;
- Integration of density areas for biomass estimation.

Collection of acoustic and biological data

Since 1998 the IAMC-CNR has been collecting acoustic data for evaluating abundance and distribution pattern of small pelagic fish species (mainly anchovy and sardine) in the Strait of Sicily (GSA 16). The scientific echosounder Kongsberg Simrad EK500 was used for acquiring acoustic data until summer 2005; for the echosurvey in the period 2006-2009 the EK60 echosounder was used. In both cases the echosounder was equipped with three split beam transducers pulsing at 38, 120 and 200 kHz. During the period 1998-2008 acoustic data were collected continuously during day and night time; since the 2009 echosurvey acoustic data are collected during day time, according to the MEDIAS protocol.

Before or after acoustic data collection a standard procedure for calibrating the three transducers was carried out by adopting the standard sphere method (Johannesson and Mitson, 1983).

Biological data were collected by a pelagic trawl net with the following characteristics: total length 78 m, horizontal mouth opening 13-15 m, vertical mouth opening 6-8 m, mesh size in the cod-end 10 mm. The net was equipped with two doors with weight 340 kg. During each trawl the monitoring system SIMRAD ITI equipped with trawl-eye and temp-depth sensors was adopted.

Extraction of $NASC_{Fish}$ by means of Echoview (Sonar Data) post-processing software

The evaluation of the $NASC_{Fish}$ (Fishes Nautical Area Scattering Coeffcient [$m^2/n.mi^2$]) and the total NASC for each nautical mile of the survey track was performed by means of the SonarData Echoview software v3.50, taking into account the day and night collection periods.

Link of NASC values to control catches

For the echo trace classification the nearest haul method was applied, taking into account only representative fishing stations along transects.

Calculation of Fish density (ρ) from $NASC_{Fish}$ values and biological data

For each trawl haul the frequency distribution of the j-th species (ν_j) and for the k-th lenght class (f_{jk}) are estimated as

$$\nu_j = \frac{n_j}{N} \qquad \text{and} \qquad f_{jk} = \frac{n_{jk}}{n_j}$$

where n_j is the total number of specimens of the j-th species, n_{jk} is the total number of specimens of the k-th lenght class in the j-th species, and N is the total number of specimens in the sample.

For each nautical mile the densities for each size class and for each fish species are estimated as

$$\rho_{jk} = \frac{NASC_{FISH} * n_{jk}}{\sum_{j=1}^{n}\sum_{k=1}^{m} n_{jk} * \sigma_{jk}} \qquad \text{(number of fishes / n.mi}^2\text{)}$$

$$\rho_{jk} = \frac{NASC_{FISH} * W_{jk} * 10^{-6}}{\sum_{j=1}^{n}\sum_{k=1}^{m} n_{jk} * \sigma_{jk}} \qquad \text{(t / n.mi}^2\text{)}$$

where W_{jk} is the total weight of the k-th lenght class in the j-th species, and σ_{jk} is the scattering cross section of the k-th lenght class in the j-th species. σ_{jk} *is given by*

$$\sigma_{spjk} = 4\pi * 10^{\frac{TS_{jk}}{10}}$$

where the target strenght (TS) is

$$TS_{jk} = a_j Log_{10}(L_k) + b_j$$

L_k is the length of the k-th lenght class while the a_j and b_j coefficient are linked to the fish species.

For anchovy, sardine and trachurus we adopted respectively the following relationships:

$TS = 20 \log L_k\ 76.1$ [dB]

$TS = 20 \log L_k\ 70.51$ [dB]

$TS = 20 \log L_k\ 72$ [dB]

Integration of density areas for biomass estimation

The abundance of each species was estimated by integrating the density surfaces for each species.

8.44.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.44.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the sardine stock in GSA 16 was derived from the acoustics. Figure 8.44.3.1.3.1 displays the estimated trend in sardine Total Biomass (estimated by acoustics) for GSA 16.

Values of the last three years are relatively low, well below the general average value over the last decade (about 17,000 t) (Fig. 8.44.3.1.3.1).

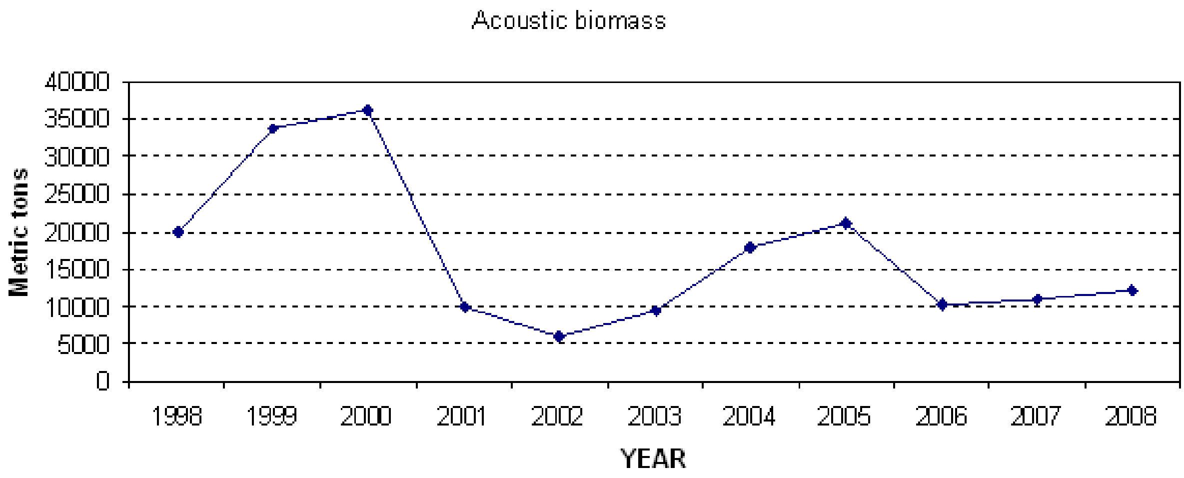


Fig. 8.44.3.1.3.1. Estimated sardine biomass indices for GSA 16, years 1998-2008.

8.44.3.1.4. Trends in abundance by length or age

Length or age class data were not used for this assessment.

8.44.3.1.5. Trends in growth

Growth data were not used for this assessment.

8.44.3.1.6. Trends in maturity

Maturity data were not used for this assessement.

8.44.4. *Assessment of historic stock parameters*

Not applicable. No stock assessment model was run for this assessment.

8.44.5. *Long term prediction*

Not applicable. No forecast analyses were conducted.

8.44.6. *Scientific advice*

8.44.6.1. Short term considerations

8.44.6.1.1. State of the spawning stock size

Biomass estimates of the total population obtained by hydro-acoustic surveys for sardine in GSA 16 show that the recent stock level is well below the average value over the last decade. However, in the absence of proposed or agreed references, SGMED-09-02 is unable to fully evaluate the state of the stock and provide any scientific advice in relation to them.

8.44.6.1.2. State of recruitment

No recruitment data were used for this assessment.

8.44.6.1.3. State of exploitation

Annual exploitation rates, as estimated by the ratio between total landings and biomass, indicates relatively low fishing mortality during the last decade. If this estimate of exploitation rate can be considered as equivalent to F/Z estimate obtained from the fitting of standard stock assessment models, the current exploitation rate (0.22) and even all the previous available estimates are lower than the reference point suggested by Patterson (1992) and confirmed by SGMED 09-02 in this report (section 6.1.3). The fishing mortality level corresponding to F/Z=0.22 is F=0.14, if M=0.51, estimated with Pauly (1980) empirical equation, is assumed.

Using the exploitation rate as a target reference point, the stock of sardine in GSA 16 is considered as being sustainably exploited.

Given that biomass was quite low for three consecutive years (2006, 2007 and 2008) and that the exploitation rate of sardine is moderate, fishing effort should not be increased beyond the current levels and consistent catches should be determined. However, as the small pelagic fishery is generally multispecies, any management of fishing effort targeting the anchovy stock (see above recommendations) would also have effects on sardine. In addition, due to the low level of the anchovy stock measures should be taken to prevent a shift of effort from anchovy to sardine.

General considerations

Taking into account that fishing effort was relatively stable in last decade, results would suggest the importance of environmental factors variability on yearly recruitment success. However, the stock did not recover from the 2006 "collapse" in biomass (-52% from July 2005 to June 2006), and this fact, along with a moderate exploitation rate and the decreasing trend in landings, also suggests questioning about the sustainability of current levels of fishing effort. In addition, possible negative effects on these populations could results from pressure of other fishing gears on larval stages.

A warning on the fishing of larval stages (locally named *bianchetto*) is relevant, taking into account that in the past years derogation of the fishing ban was normally operated in wintertime, i.e. during the sardine spawning season, even though more data and investigation are needed in order to estimate the possible impact of this fishing activity on the exploited populations.

8.45. Stock assessment of sardine in GSA 17

8.45.1. Stock identification and biological features

8.45.1.1. Stock Identification

The southern boundary of the GSA 17 is represented from the Gargano Promontory, as shown in the map below. However, the stock distribution area of sardine in the Adriatic Sea extends into GSA 18. The spawning season of the Adriatic sardine is in autumn-winter. The spawning areas are mainly located in the eastern part of the GSA 17. On the basis of the database of CNR-ISMAR-SPM Fish Population Dynamics Unit, the maximum age recorded was 12 years while the maximum length was 22.0 cm.

Fig. 8.45.1.1.1 Boundaries of the GSA 17.

8.45.1.2. Growth

An example of age-length key expressed in number of individuals, obtained through DCR by CNR-ISMAR-SPM Fish Population Dynamics Unit, for the commercial catches of (Italian) mid-water trawlers in 2007, was reported in the table below.

Tab. 8.45.1.2.1 GSA 17 sardine: age-length key (year 2007, mid-water trawlers).

L (cm)	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Total
11.5	8										8
12.0	19										19
12.5	22	9	1								32
13.0	25	12									37
13.5	40	19	3								62
14.0	33	28	5								66
14.5	13	53	7	1							74
15.0	3	10	52	8							73
15.5	1	3	57	14	1						76
16.0			34	28	8						70
16.5			14	40	10	2					66
17.0			2	6	14	7					29
17.5				2	12	9	1				24
18.0						1	3	2			6
18.5					1	1	1	3	1	1	8
19.0								1		1	2
19.5					1						1
Total	**164**	**134**	**175**	**99**	**47**	**20**	**5**	**6**	**1**	**2**	**653**

The corresponding age-length key obtained for the commercial catches of purse-seiners was reported below. Different length ranges as a function of the gear were observed: the smallest size individuals can be better represented in the catch of mid-water trawlers. However, such a difference is more typical for anchovy than sardine.

Tab. 8.45.1.2.2 GSA 17 sardine: age-length key (year 2007, mid-water trawlers).

L (cm)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Total
14.0	3								3
14.5	3								3
15.0	1	5							6
15.5		4	1						5
16.0		1	5						6
16.5			1	2	1				4
17.0			2		1				3
17.5				2	2				4
18.0				1		1	1	1	4
18.5					1	1	1		3
19.0					1	1	1		3
19.5						1	1	1	3
Total	**7**	**10**	**9**	**5**	**6**	**4**	**4**	**2**	**47**

8.45.1.3.Maturity

According to Sinovčić *et al*. (2003), the first sexual maturity of sardine in Krka River estuary, in the eastern Adriatic Sea, is around 8 cm. Also, Sinovčić (1984) mentioned a study from literature reporting 14 cm.

8.45.2. Fisheries

8.45.2.1.General description of fisheries

In the GSA 17, sardine is fished by mid-water trawlers and purse seiners attracting fish with light. Additional information was reported below in the paragraph “Catches”.

8.45.2.2.Management regulations applicable in 2008 and 2009

In Italy, the legal minimum length for sardine is 11 cm (R.(CE) 1967/2006). The value 10 cm has been adopted in Croatia (G. Sinovčić, Institute of Oceanography and Fisheries of Split, personal communication).

8.45.2.3.Catches

8.45.2.3.1. Landings

On the basis of the database of CNR-ISMAR-SPM Fish Population Dynamics Unit, the amount of the total catch of sardine relative to Italy, Slovenia and Croatia was plotted over years in Fig. 8.45.2.3.1.1. The average total catch was 44,000 tonnes in 1975-2007 and 17,000 tonnes in 2005-2007. A decrease was observed after the peak in the middle of 1980s, particularly in the Italian catches. The fractions of the total catch due to the fleets of the Italy and Slovenia-Croatia were quite similar, but the latter one accounted for higher fractions in recent years.

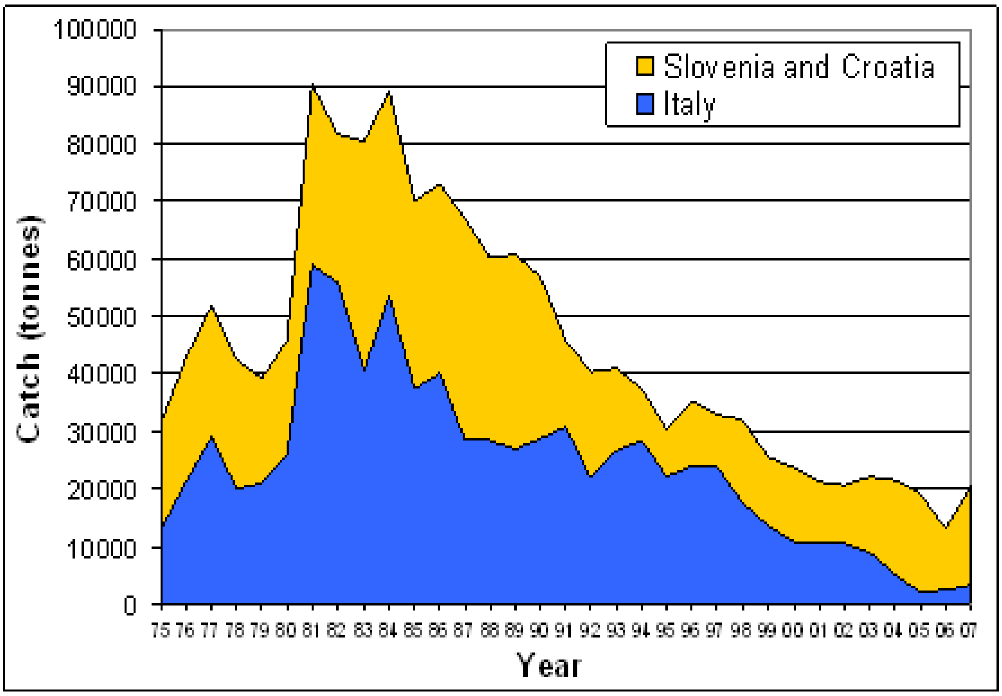


Fig. 8.45.2.3.1.1 GSA 17 sardine: total catch over years.

The average length frequency distribution and the average age frequency distribution of the total catch were shown in Fig. 8.45.2.3.1.2 and Fig. 8.45.2.3.1.3. The average for length was calculated including only the years from 1988 onwards as, since 1988 length was measured using 0.5 cm classes, whereas 1 cm classes were used before. A comment relative to the different length range fished by mid-water trawlers and purse seiners was reported above, in the paragraph “Growth”.

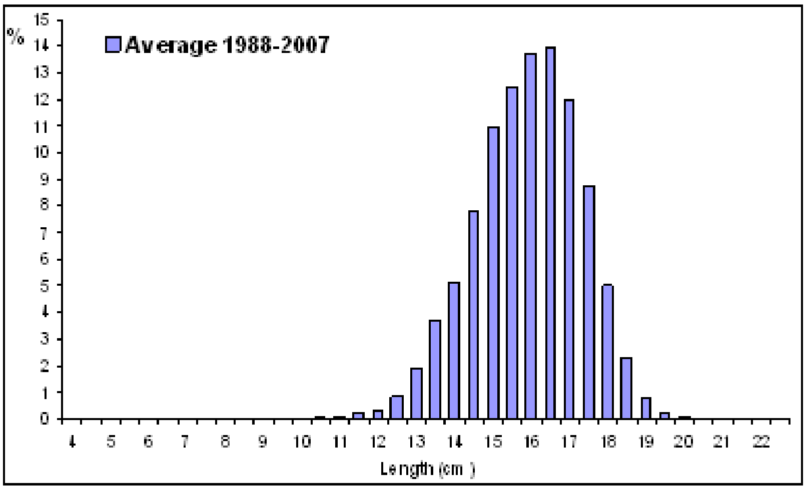


Fig. 8.45.2.3.1.2 GSA 17 sardine: average length frequency distribution of the total catch.

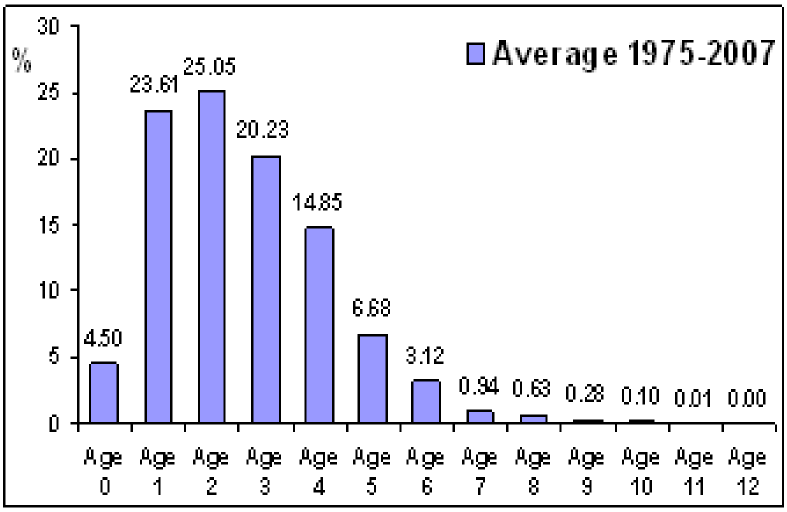


Fig. 8.45.2.3.1.3 GSA 17 sardine: average age frequency distribution of the total catch.

8.45.2.3.2. Discards

This feature was investigated by CNR-ISMAR-SPM Fish Population Dynamics Unit, through an EU funded project at the end of 1990s (Santojanni *et al*., 2005) and DCR in 2005.

Discards of sardine in the GSA 17, at least for the Italian fleet, were not considered as negligible in 1987-1999 and landings were corrected by adding amounts of smallest size sardine ranging from 1,000 to 4,000 tonnes; in fact, for the Italian fleet, this species is required at a lower degree than anchovy.

On the basis of the DCR investigation, the amount of sardine discarded at sea by the Italian fleet was 126 tonnes and 11 tonnes in the third and fourth quarter of 2005, respectively. These quantities were low in comparison with the corresponding landings: from 2000 to 2007, the annual amount of sardine landed by the Italian fleet ranged from 2,000 to 11,000 tonnes. Moreover, it is possible that, due the lower availability of sardine at sea, the proportion of the discarded catch in recent years was lower than in 1987-1999. In conclusion, the estimates of discards obtained for only one half of 2005 was considered negligible and fluctuating during the year and thus those were not included in the estimation of total catches.

8.45.2.3.3. Fishing effort

On the basis of the database of CNR-ISMAR-SPM Fish Population Dynamics Unit, in the calendar year 2007, the Italian fleet was composed of about 130 (65 pairs) pelagic trawlers (*volante*), mainly operating from Trieste (extreme north harbour) to Ancona (average GRT 43, average engine power 290 kW) and about 45 purse seiners attracting fish with light (*lampara*), operating in the Gulf of Trieste (24 small *lampara*, average GRT 9, average engine power 110 kW) and south of Ancona (21 big *lampara*, average GRT 97, average engine power 390 kW). In 2007, the Slovenian fleet was composed of 1 pelagic trawler pair and 7 purse seiners; no updated data are available for the Croatian fleet.

8.45.3. Scientific surveys

As mentioned below in the paragraph “Method”, the results of the acoustic surveys carried out by CNR-ISMAR-SPM Marine Acoustics Unit from the mid-line to the western coast of the GSA 17, from 1976 to 2007, were used for VPA tuning.

8.45.3.1.1. Trends in growth

No analyses were conducted during SGMED-09-02.

8.45.3.1.2. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.45.4. Assessment of historic stock parameters

8.45.4.1.Method 1: VPA

8.45.4.1.1. Justification

Given the long time series available, VPA was thought to be a suitable method.

8.45.4.1.2. Input parameters

A time series of annual total catch at age in numbers of individuals is the main data input of VPA. It is shown (expressed using proportions) in Fig. 8.45.4.1.2.1. The age class 6+ is a plusgroup: it includes the class 6 (years) along with those classes higher than 6, thus up to 12 in the present case.

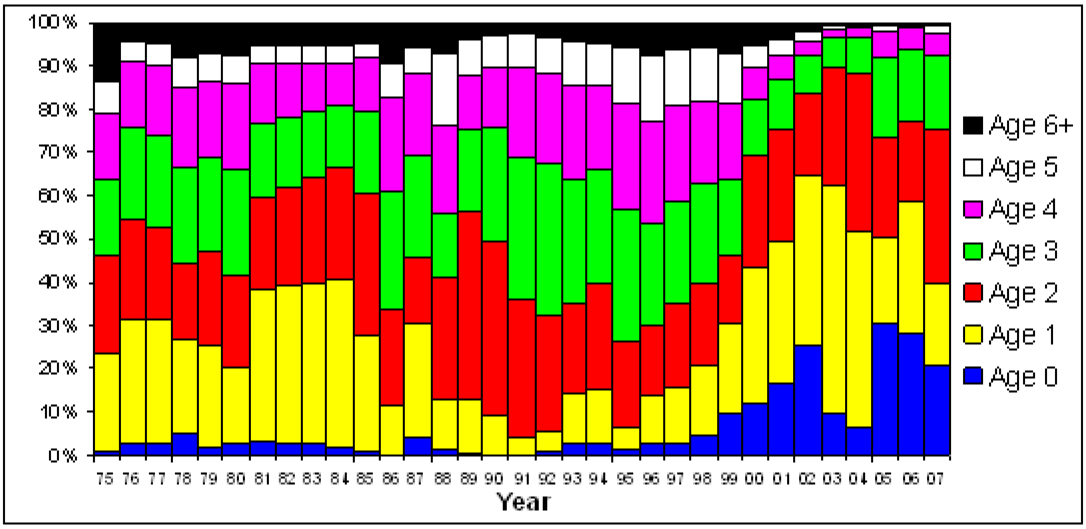


Fig. 8.45.4.1.2.1 GSA 17 sardine: total catch at age over years.

The annual natural mortality rates M = 0.5 ($year^{-1}$) was employed for VPA calculations.

This value was selected taking into account the literature and the maximum life-span observed in the commercial catches from 1975 onwards, i.e. higher even than 8 years.

About the inverse relationship between longevity and mortality, as reported by Barange (2001), Pacific sardine (*Sardinops sagax*) is usually assumed to have a relatively low annual natural mortality rate, M = 0.4, and a lifespan of about 10 years, whereas for northern anchovy (*Engraulis mordax*) M = 0.8 is associated to a lifespan of about 4 years.

Moreover, useful information was gained from the relationship between total mortality Z (= F + M) and maximum life span tmax (year), Ln Z = 1.44 - 0.982 Ln tmax **,** found by Hoenig (1983; see also Hewitt and Hoenig, 2005). It was “based largely on data from unexploited stocks”, thus with Z being very close to M. On the basis of this equation, for example (Tab. 8.45.4.1.2.1), tmax = 8 is associated to Z = 0.55.

Tab. 8.45.4.1.2.1 Relationship between total mortality rate Z and maximum life-span tmax (see text).

tmax (year)	Z ($year^{-1}$)
1	4.22
2	2.14
3	1.43
4	1.08
5	0.87
6	0.73
7	0.62
8	0.55
9	0.49
10	0.44
11	0.40
12	0.37
13	0.34
14	0.32
15	0.30
16	0.28
17	0.26
18	0.25
19	0.23
20	0.22

8.45.4.1.3. Results

The stock biomass estimated by means of VPA was plotted over years in Fig. 8.45.4.1.3.1, along with the total catch.

The average stock biomass estimated by VPA was 440,000 tonnes in 1975-2007 and 90,000 tonnes in 2005-2007. The corresponding average ratio between total catch and stock biomass was 0.10 in 1975-2007 and 0.19 in 2005-2007.

A strong decline of stock biomass occurred after the peak in the first half of 1980s; this decline was continuous till the end of 1990s: then, biomass was quite stable around values slightly lower than 100,000 tonnes, which corresponded to the lowest abundance of the series.

In the same picture, the stock biomass estimated by means of the echo-surveys carried out in the western part of the GSA 17 was reported: also this series showed (most of) the lowest values after the end of 1990s.

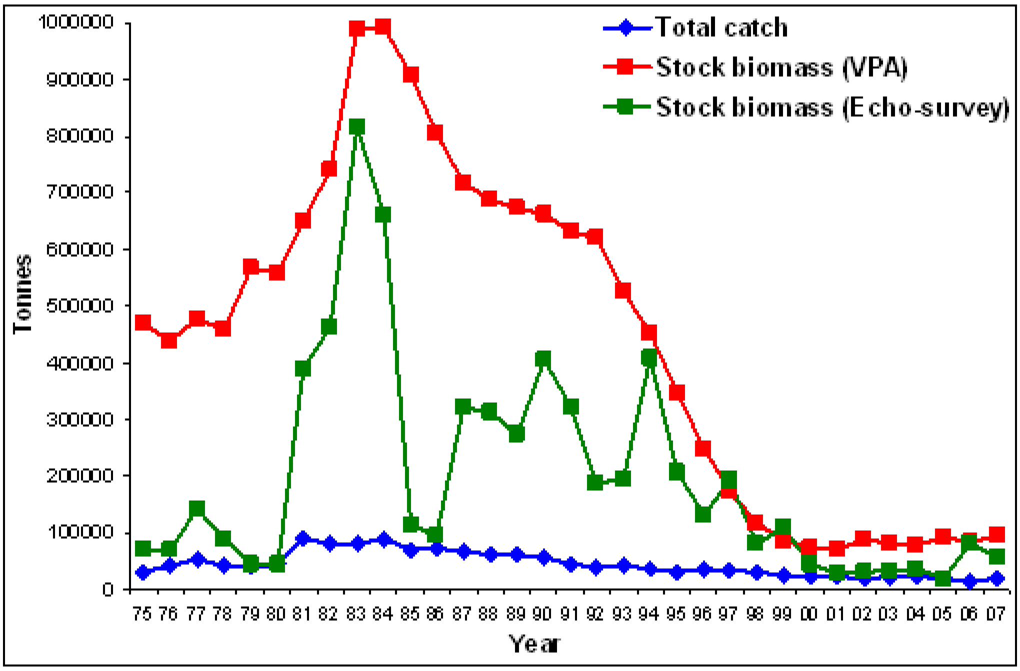


Fig. 8.45.4.1.3.1 GSA 17 sardine: total catch and stock biomass estimated by VPA (entire GSA 17) and echo-surveys (western part of GSA 17) over years.

The relationship between spawning stock biomass and number of recruits (age class 0) obtained from VPA was plotted in Fig. 8.45.4.1.3.2. The values of current spawning stock biomass were the lowest of the series as well as the recruitment level.

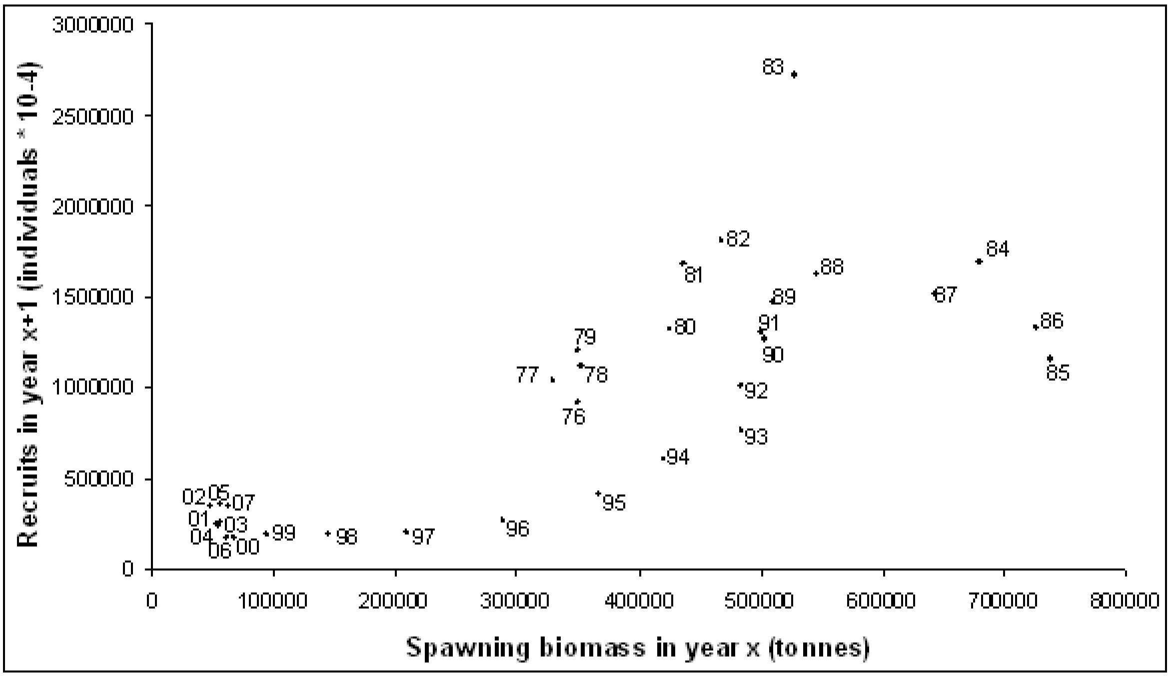
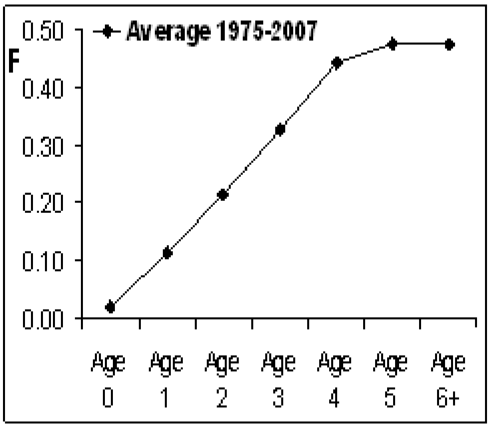


Fig. 8.45.4.1.3.2 GSA 17 sardine: stock-recruitment relationship.

The fishing mortality rate F derived from VPA was plotted over ages and years in Fig. 8.45.4.1.3.3 (left and right picture, respectively). In the former case, the average for the complete time series was calculated. In the latter case, two averages were calculated both weighting and without weighting the F at age values on the corresponding numbers of fish at sea.

Some average values over years were the following:
- unweighted F0-5 in 1975-2007 : 0.27;
- unweighted F0-5 in 2005-2007 : 0.48;
- weighted F0-6 in 1975-2007: 0.12;
- weighted F0-6 in 2005-2007: 0.17.



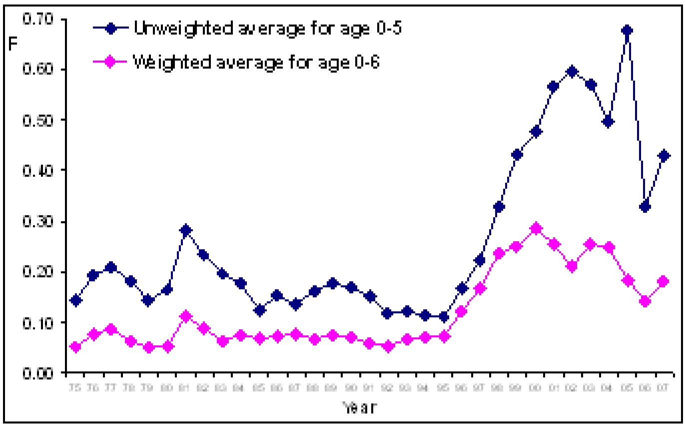


Fig. 8.45.4.1.3.3 GSA 17 sardine: fishing mortality rate F over ages and years.

The annual exploitation rate E = F/(F+M) or F/Z was also calculated, both using the weighted and unweighted Fs mentioned above.

The values obtained were compared with the threshold F/Z = 0.4 (biological reference point), above which the stock collapse should be relatively likely, as pointed out by Patterson (1992) for small pelagics. Here, more emphasis was given to the F/Z calculated using unweighted Fs, as the same author performed his statistical analysis on a data set mainly formed by unweighted Fs.

The values of F/Z were plotted over years in the figure below. Some average values over time were the following:
- F/Z in 1975-2007 with unweighted F0-5: 0.32;
- F/Z in 2005-2007 with unweighted F0-5: 0.48;
- F/Z in 1975-2007 with weighted F0-6: 0.19;
- F/Z in 2005-2007 with weighted F0-6: 0.25.

Hence, in 2005-2007, the value of F/Z based on F0-5 unweighted was estimated to be higher than 0.4 and close to 0.5 (0.48), which is the highest and more dangerous limit pointed by Patterson (1992). When the unweighted F1-3 was used instead of F0-5, F/Z in 2005-2007 was still higher than 0.4 (0.42).

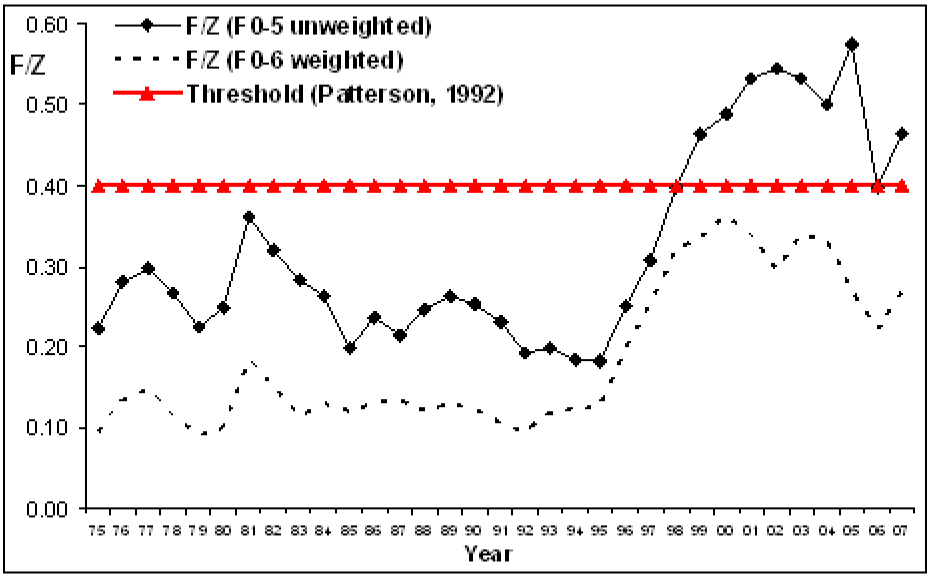


Fig. 8.45.4.1.3.4 GSA 17 sardine: exploitation rate F/Z over years.

In 2009, VPA was also carried out using vectors of natural mortality rate at age, i.e. not constant over age as in the stock assessment of 2008. They were derived from Probiom software and Gislason's method, according to the first SGMED meeting of 2009 (Tab. 8.45.4.1.3.1). The values of von Bertalanffy parameters Linf = 18.783, k = 0.379, t0 = -2.302 and length-weight parameters a = 0.0095, b = 2.94 were used for the calculations of the M at age vectors and were derived from DCR (biological sampling of landing data, GSA 17, year 2007).

Some limits of the use of these M at age vectors are worth noting: with Probiom, values for oldest age classes seem to be quite low and thus not very realistic (e.g. 0.25 for age classes 4-6+); Gislason's should be preferably used for demersal species rather small pelagics.

The new results obtained were compared with those based on the use of constant M = 0.5.

Substantial differences in stock biomass estimated by VPA between the three series were observed at the higher levels of biomass observed in the past (Fig. 8.45.4.1.3.5). These differences were less relevant for recent years (Fig. 8.45.4.1.3.5 and Tab. 8.45.4.1.3.2). On the whole, the results obtained with constant M and Gislason's vector were more similar. This was also true for the exploitation rate, particularly in recent years (Fig. 8.45.4.1.3.6). Stock recruitment relationships were also compared (Fig. 8.45.4.1.3.7 and Fig. 8.45.4.1.3.8). Finally, ratios between recruits and spawners were also shown over years (Fig. 8.45.4.1.3.9).

Tab. 8.45.4.1.3.1 - Values of natural mortality at age used.

Age	Constant	Probiom	Gislason
0	0.50	0.71	0.75
1	0.50	0.47	0.68
2	0.50	0.32	0.58
3	0.50	0.28	0.53
4	0.50	0.25	0.49
5	0.50	0.25	0.47
6+	0.50	0.25	0.43

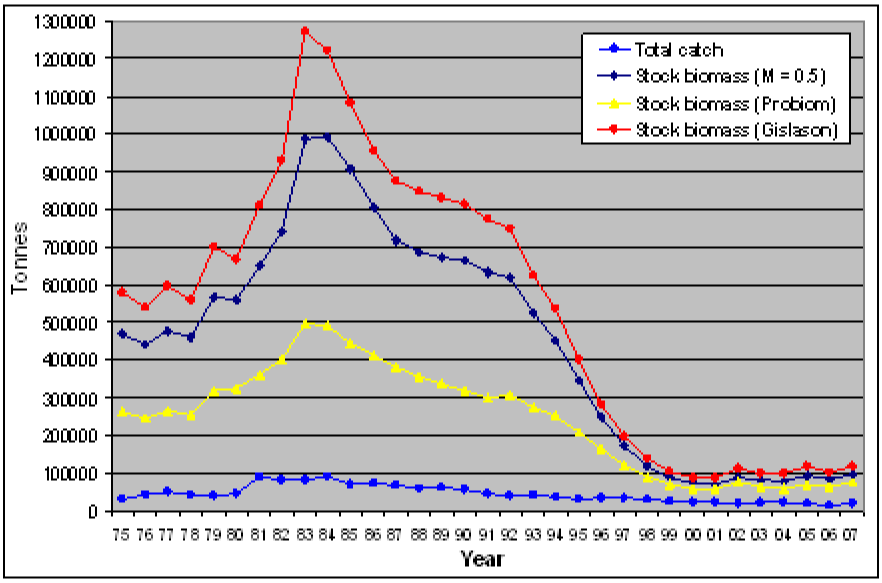


Fig. 8.45.4.1.3.5 Stock biomass estimated by VPA with constant M at age (0.5 as in the stock assessment performed in 2008) and M at age vectors obtained by means of Probiom software and Gislason's method.

Tab. 8.45.4.1.3.2 Average values of estimated stock biomass (tonnes) using different values of M at age.

Period	Constant	Probiom	Gislason
1999-2007	84000	67000	103000
2005-2007	91000	71000	113000

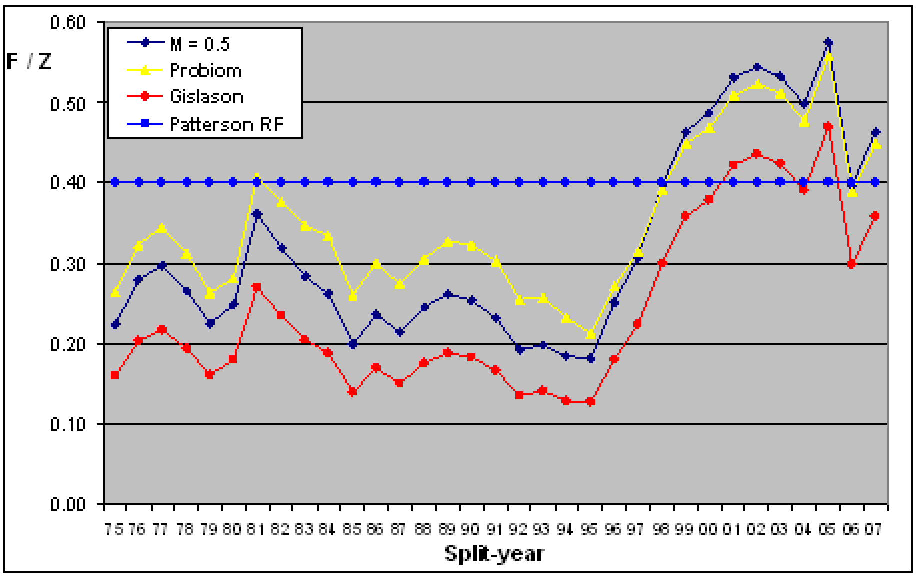


Fig. 8.45.4.1.3.6 Exploitation rate estimated by VPA with constant M at age (0.5 as in the stock assessment performed in 2008) and M at age vectors obtained by means of Probiom software and Gislason's method.

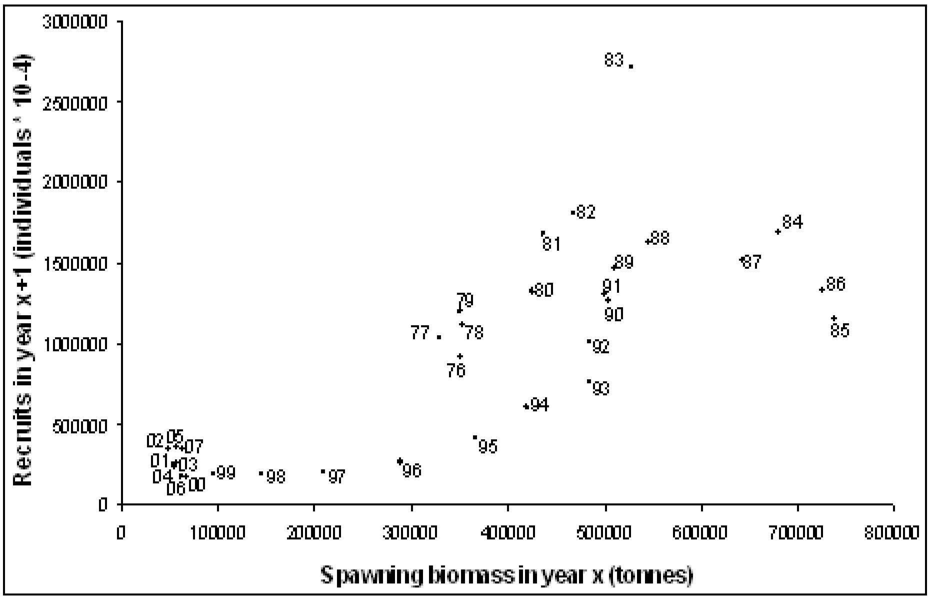


Fig. 8.45.4.1.3.7 Stock-recruitment relationship from VPA with constant M at age (0.5 as in the stock assessment performed in 2008). The years from 1976 to 2007 displayed are relative to the recruitment.

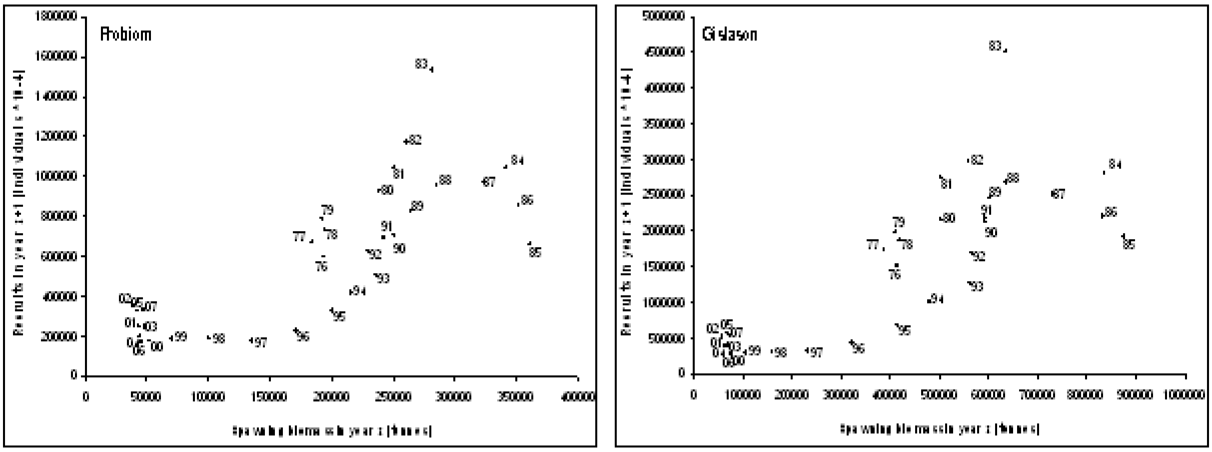


Fig. 8.45.4.1.3.8 Stock-recruitment relationships from VPA with M at age vectors, obtained by Probiom and Gislason's methods. The years from 1976 to 2007 displayed are relative to the recruitment.

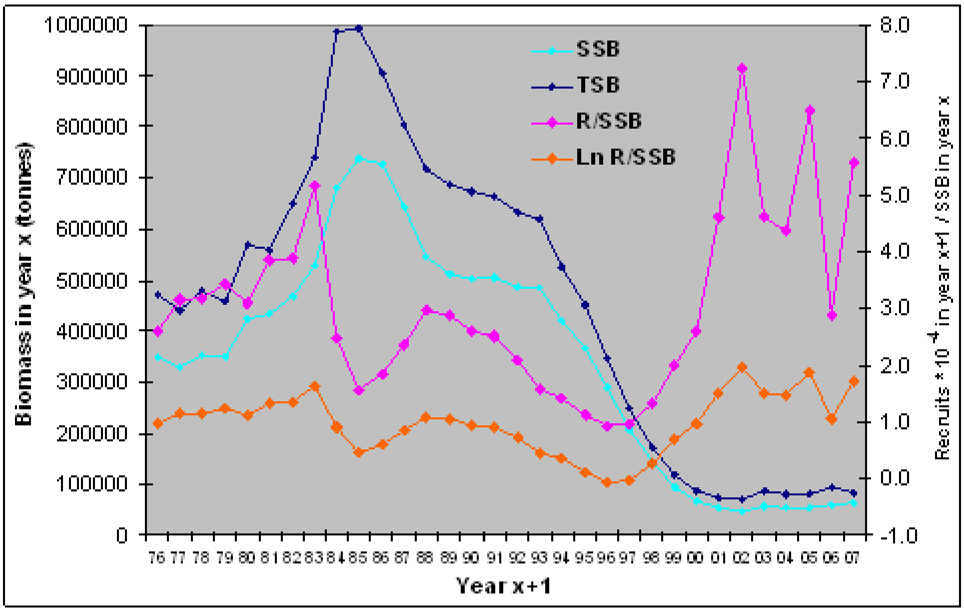


Fig. 8.45.4.1.3.9 Stock biomass (TSB) and spawning biomass (SSB) are compared with ratios between recruits and spawning biomass over years, on the basis of VPA with constant M at age (0.5 as in the stock assessment performed in 2008).

8.45.5. Long term prediction

8.45.5.1. Justification

No forecast analyses were conducted.

8.45.5.2. Input parameters

No forecast analyses were conducted.

8.45.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for sardine in GSA 17.

8.45.6. Scientific advice

8.45.6.1. Short term considerations

8.45.6.1.1. State of the spawning stock size

SGMED 09-02 bases its recommendations regarding the proposed biomass reference points of B_{lim}=50,000 t and B_{pa}=300,000 t on a revised stock assessment taking into consideration natural mortality rates as recommended by the Murcia SGMED workshop 2-6 March 2009 (Probiom model results). The visual inspection of the scatter plot of recruitment versus spawning stock biomass clearly indicates that recruitment is impaired at stock sizes below 180,000 t. Thus, SGMED recommends establishing B_{lim}=180,000 t for the stock of sardine in GSA 17.

According to FAO recommendations (Cadima, 2003), B_{pa} should be in the range of 1.39*B_{lim} - 1.64*B_{lim}, accounting for uncertainty in the estimations of fishing mortality. Such factors would determine B_{pa} being in the range of 250,000 t-295,000 t. Thus, SGMED-09-02 recommends establishing B_{pa}=270,000 t for the stock of sardine in GSA 17.

Since 2000, SGMED 09-02 estimates of SSB remained significant below B_{lim}. In 2007, SSB was estimated to amount to less than 100,000 t. SGMED 09-02 therefore recommends recovering the stock biomass in order to increase stock productivity.

8.45.6.1.2. State of recruitment

Since the mid 1995, recruitment remained significantly below the average recruitment.

8.45.6.1.3. State of exploitation

SGMED-09-02 concludes that the short term responses of the assessed sardine stock to recent exploitation rates indicate that an exploitation rate in the order of $E \leq 0.4$ might be consistent with the management goal of high long term yields, taking into account the dynamic of the stocks of small pelagics. SGMED-09-02 underlines that limited area and temporal coverage of the available stock assessments impede any quantification of risk related to this statement. As such, the expressed indication regarding Mediterranean small pelagic stocks is in agreement with empirical findings of Patterson (1992), who has proposed this exploitation level. SGMED-09-02 recommends the application of the proposed exploitation rate $E \leq 0.4$ as management target for stocks of anchovy and sardine in the Mediterranean Sea.

SGMED 09-02 considers the stock of sardine to be over-exploited, as the estimated $E>0.4$. Fishing mortality should be reduced in order to allow future recruitment contributing to stock recovery. In order to decrease the fishing mortality, SGMED 09-02 advises to reduce fishing effort by means of a multiannual management plan and consistent catches should be determined. The management of the sardine fisheries in GSA 17 needs to account for multi-species effects, mainly the interaction with anchovy.

8.46. Stock assessment of sardine in GSA 22

8.46.1. Stock identification and biological features

8.46.1.1. Stock Identification

This assessment of the sardine stock in GSA 22 has been based on information derived from the Greek part of the Aegean Sea (GSA 22). In Aegean Sea, the main distribution area of the sardine stock of GSA 22 is located in the continental shelf of the northern Aegean Sea (Giannoulaki *et al.*, 2004; 2007; Machias *et al.*, 2007; Tsagarakis *et al.*, 2008). Sardine juveniles spatial distribution is strongly related to semi closed gulfs, shallow waters (less than 30 m depth) with high productivity, influenced by the presence of rivers outflows (Tsagarakis *et al.*, 2007; SARDONE project interim report).

8.46.1.2. Growth

Fast growth parameter was considered and parameters are shown in Table 8.46.1.2.1. No sex discrimination was applied.

Tab. 8.46.1.2.1. Growth parameters (v. Bertalanffy) for sardine in GSA 22.

	Fast growth Unsexed	Units
Linf	195	cm
K	0.39	year^{-1}
t0	-0.48	year
a	0.00003	gr
b	3.2144	
Mage0	1.5	year^{-1}
Mage1	0.96	year^{-1}
Mage2	0.69	year^{-1}
Mage3	0.61	year^{-1}
Mage4	0.57	year^{-1}

8.46.1.3. Maturity

The following maturity at age ogive was used for sardine assessments in GSA 22 as estimated from biological sampling based on length at first maturity estimated approximately at 115 mm (Machias *et al.*, 2001; 2007) in Aegean Sea. The sardine spawning period in GSA 22 extends from November to April with a peak in December-January.

Tab. 8.46.1.3.1 Maturity ogives at age for female sardine in GSA 22.

Year	Age 0	Age 1	Age 2	Age 3	Age 4
2003	0	0.5	1	1	1
2004	0	0.5	1	1	1
2005	0	0.5	1	1	1
2006	0	0.5	1	1	1
2007	0	0.5	1	1	1
2008	0	0.5	1	1	1

8.46.2. Fisheries

8.46.2.1.General description of fisheries

Sardine (*Sardina pilchardus*) is one of the most important target species for the purse seine fishery in GSA 22. Sardine is being exploited only by the purse seine fishery. Pelagic trawls are banned and benthic trawls are allowed to fish small pelagics in percentages less than 5% of their total catch. Commonly sardine is caught from shallow waters about 30 m to 100 m depth.

8.46.2.2.Management regulations applicable in 2008 and 2009

Regarding the management regulations enforced they concern a closed period from the mid December till the end of February and technical measures such as minimum distance from shore (300 m), minimum bottom depth (30 m), gear and mesh size, engine, GRT restrictions etc. There is also a minimum landing size at 11 cm.

8.46.2.3.Catches

Landings were obtained within the framework of the Hellenic Centre for Marine Research data collection system that covers the entire GSA 22. The data from 2003 to 2008 were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.4 of Appendix 3.

8.46.2.3.1. Landings

The trend in reported landings (from Greek purse seiners fleet) is shown in Figs. 8.46.2.3.1.1 and 8.46.2.3.1.2. The data from 2003 to 2006 and 2008 were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.5 of Appendix 3. The rest of the data are obtained within the framework of the Hellenic Centre for Marine Research data collection system that covers the entire GSA 22. A decreasing trend in sardine landings has been observed in the long term (2000-2008). Landings per vessel class indicate that small vessels (12-24 m) (Fig. 8.46.2.3.1.2) are mainly responsible for sardine catches (> 88% of the total catches).

Annual lengths of landings were reported to SGMED-09-02 for 2003-2006 and 2008 and are shown in Fig. 8.46.2.3.1.3. Fig. 8.46.2.3.1.4 shows the landings at age in GSA 22 as reported to SGMED-08-04 for 2003-2006. Data for 2007 and 2008 are based on unreported data obtained within the framework of the Hellenic Centre for Marine Research data collection system that covers the entire GSA 22.

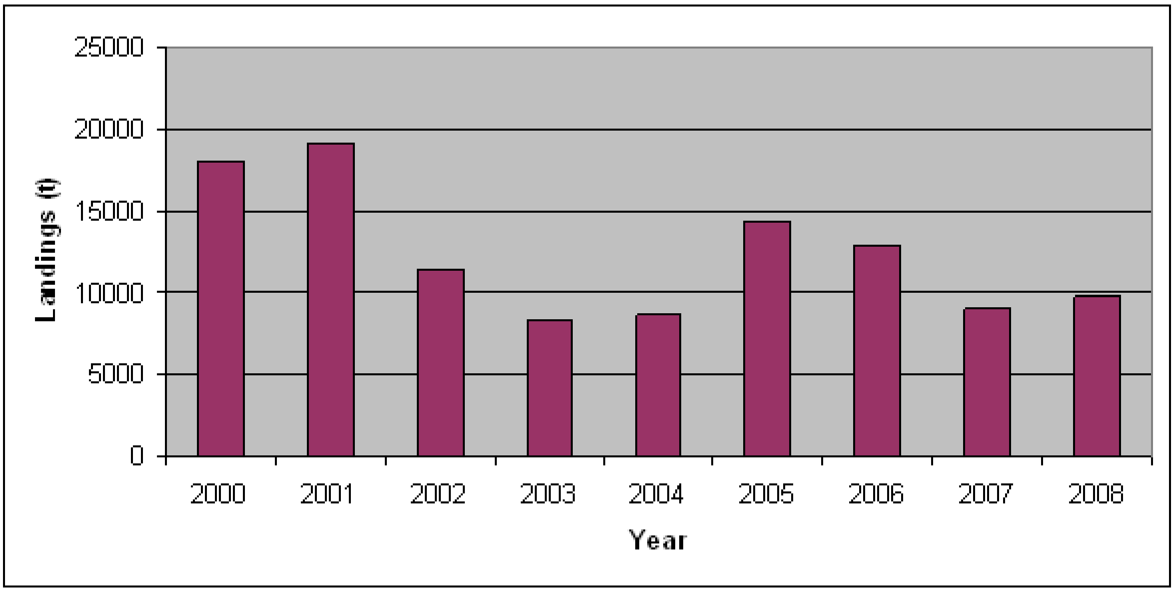


Fig. 8.46.2.3.1.1 Sardine landings (t) in GSA 22 for 2000-2008.

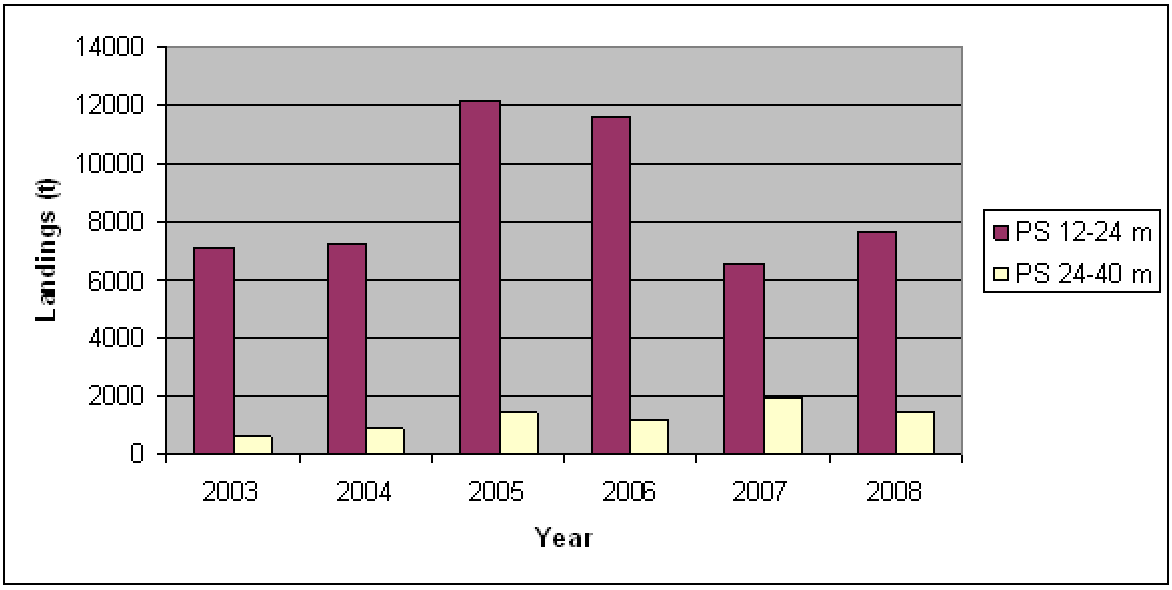


Fig. 8.46.2.3.1.2 Sardine landings (t) in GSA 22 per fleet size (purse seine fleet in Greek waters) for 2003-2008.

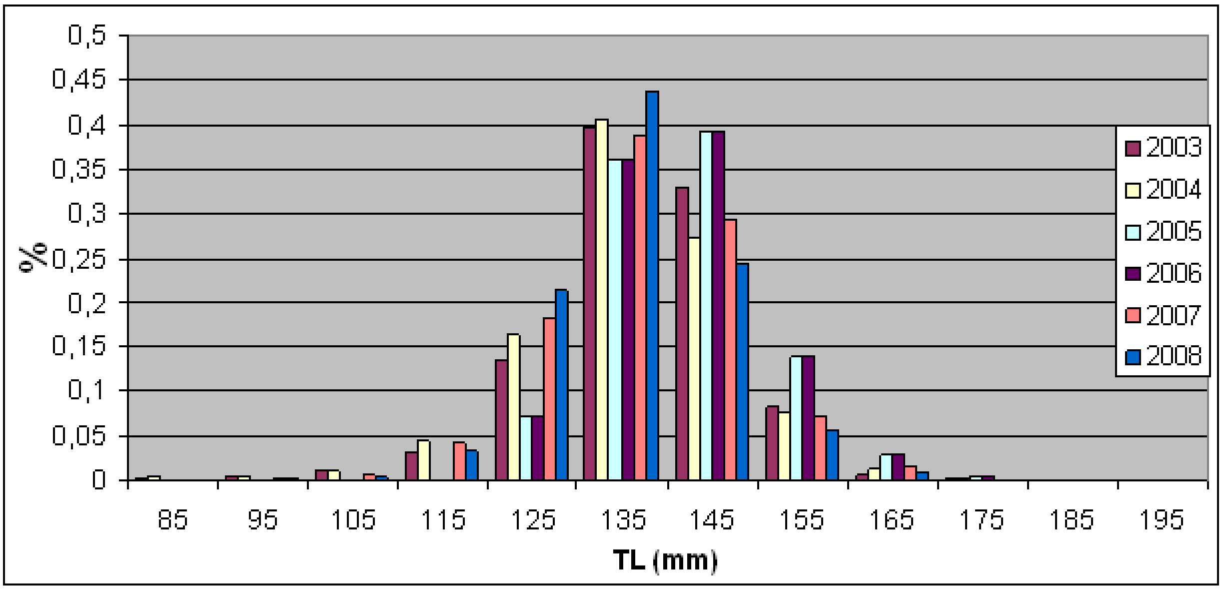


Fig. 8.46.2.3.1.3 Length frequency composition of sardine landings for 2003-2008.

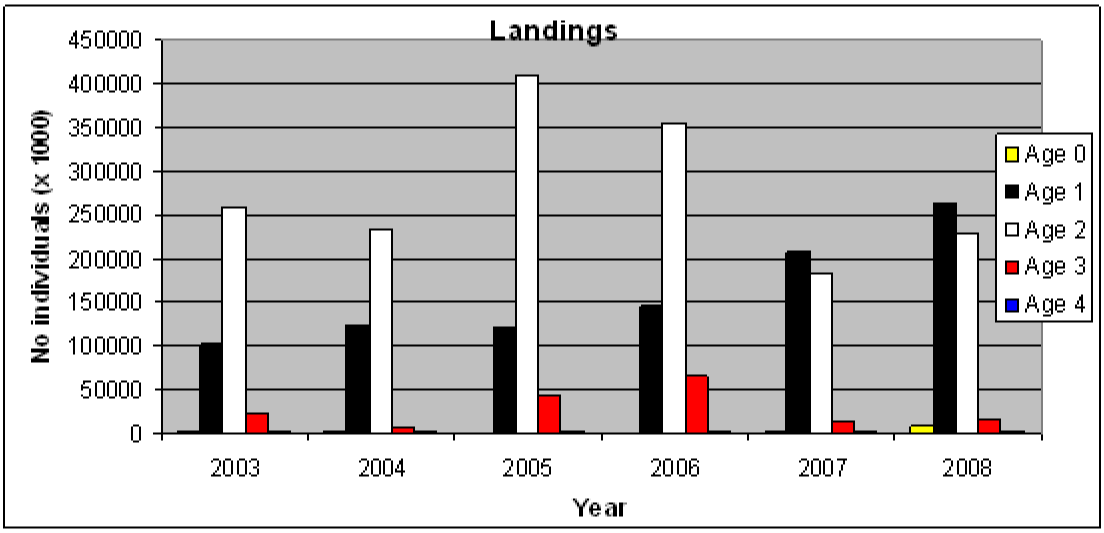


Fig. 8.46.2.3.1.4 Sardine landings per age group (number of individuals in thousands) for GSA 22 for 2003-2008.

8.46.2.3.2. Discards

No discards data for sardine were reported to the SGMED-09-02 and no data were reported through the Data collection regulation for 2003-2008. According to data obtained within the framework of the Hellenic Centre for Marine Research data collection system that covers the entire GSA 22, discards are estimated to less than 1%, consisting 0.3% of the purse seine fishery total catch. Although considered negligible they were taken into account for the assessment as a percentage to reported landings. The fishery is multispecies and fishermen tend to avoid schools of undersized sardines due to sorting difficulties (blocking of the mesh) and low price, practically by using nets of bigger mesh size, targeting mostly mackerels or horse mackerels.

8.46.2.3.3. Fishing effort

Based on the fishing effort data reported through the Data collection regulation and data obtained within the framework of the Hellenic Centre for Marine Research data collection system covering the entire GSA 22, the following table was made:

Tab. 8.46.2.3.3.1 Effort data for the purse seine fleet in GSA 22 (GT=Gross tonnage, KW=engine power).

Year	PS 12-24 m	PS 24-40 m	PS 12-24 m	PS 24-40 m	PS 12-24 m	PS 24-40 m
	Days at Sea	**Days at Sea**	**Days at Sea x GT**	**Days at Sea x GT**	**Days at Sea x KW**	**Days at Sea x KW**
2003	41539	2942	1767398	230726	8709727	679624
2004	39783	3989	1620847	366709	8111571	1029410
2005	42520	5690	1753346	542120	8123673	1532790
2006	37255	5619	1568893	539146	7386042	1606608
2007	31492	5338	1305252	524544	6511187	1528440
2008	35090	4938	1457212	473121	6898061	1335582

8.46.3. Scientific surveys

8.46.3.1. Acoustics

8.46.3.1.1. Methods

Acoustics

Based on data reported to SGMED-09-02 total biomass, abundance, length and age composition for GSA 22 were estimated by acoustics from 2003 to 2008. No age distribution data were reported through the DCR for 2008. No acoustic survey took place in 2007.

Acoustic surveys methodology

Acoustic echoes were registered continuously along 70 pre-defined transects in northern Aegean Sea in June 2003, 2004, 2005, 2006 and 2008 with a Biosonics Split Beam 38 kHz DT-X echosounder. The acoustic methodology followed is described in Machias et al., 2007 (see GFCM 2007 related WD). Hydroacoustic data analysis was performed using the Sonardata Echoview software v3.30. Echo trace classification was applied based on a) echogram visual scrutinisation and direct allocation of school marks that characterise sardine as well as b) allocation on account of representative fishing stations that were held along transects (MacLennan and Simmonds, 1992).

In order to estimate sardine biomass, the length-weight- relationship is required as well as species length frequency distribution per area. Therefore, 22, 23, 27, 37 and 30 pelagic trawls were made along transects in 2003, 2004, 2005, 2006 an 2008 respectively, in the positions of high fish concentrations. A random sample of 200 specimens was obtained from each haul for further laboratory analysis. Subsequently, the length-weight- relationship was estimated from the total number of hauls according to the equation:

$$W = a\ L^{b}$$

where W is the total weight; L is the total length and a and b are constants that are estimated by regression analysis.

The mean length frequency was estimated in two sub-areas: (a) Eastern area (Thracian Sea and Strymonikos Gulf) and (b) Western area (Thermaikos and Evoikos Gulfs). In the two sub-areas, the mean frequency of each length class was estimated as follows:

$$f_j = \frac{\sum_{k=1}^{M} \left(\frac{n_{jk}}{t_k} \right)}{\sum_{k=1}^{M} \left(\frac{N_k}{t_k} \right)}$$

where f_j is the mean frequency of sardine of length class j; n_{jk} is the number of specimens of length class j in haul k; N_k is the total number of sardines in haul k; t_k is the duration of haul k and M is the number of hauls in the area. The above equation is appropriate even if the catches are small and the length distributions are poorly defined. It takes accounts of the haul duration, since it is supposed that on average, longer hauls will produce more fish (MacLennan and Simmonds 1992).

The density of targets (F) from the observed echo integrals were estimated according to the equation $F = (K/\langle\sigma\rangle)E$, were K is the calibration factor, $\langle\sigma\rangle$ is the mean cross-section and E is the echo integral after partitioning (MacLennan and Simmonds ,1992). The target strength (TS) – total length relationship used for sardine was: TS=20 logL-72.6, where L is fish total length (ICES 2006). The $\langle\sigma\rangle$ was calculated for the mean total fish length of each area according to the equations $\langle\sigma\rangle = 4\pi \sum_{\iota} f_i 10^{TS/10}$, where f_I is the corresponding length frequency as deduced from the fishing samples (MacLennan and Simmonds, 1992).

The abundance Q was estimated separately for the eastern and the western part of the study area. The abundance Q in each elementary statistical sampling area was calculated from the average density within each sub-area according to the equation:

$$Q = A_k \sum_{i} F_i / N_k ,$$

where F_i is the i sample; A_k is the area of each elementary statistical sampling area and N_k is the number of transects in A_k. The variance V was estimated as

$$V = \sum_{i} (AF_I - Q)^2 / [N_r(N_{r-1} - 1)]$$

The data were log transformed and the means and variances of F estimated according to the following equations:

$$F = \exp(m)\mathbf{G_N}[0.5\ S/(n-1);\ V = F^2 - \exp(2m)\ \mathbf{G_N}[S(n-2)/(n-1)^2];$$

where m = average (lnF); S= variance (lnF) and n = independent observations of F.
The total abundance Q_t and its variance were obtained by summing the results for each region $Q_t = Q_1 + Q_2 + \ldots$, and $V_t = V_1 + V_2 + \ldots$. Standard error of Q_t is the square root of V (MacLennan and Simmonds 1992).

8.46.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.46.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the sardine stock in GSA 22 was derived from the acoustics surveys. Figure 8.46.3.1.3.1 shows the estimated trend in sardine Total Biomass (estimated by acoustics) for GSA 22. Figure 8.46.3.1.3.2 shows the estimated trend in sardine abundance (estimated by acoustics).

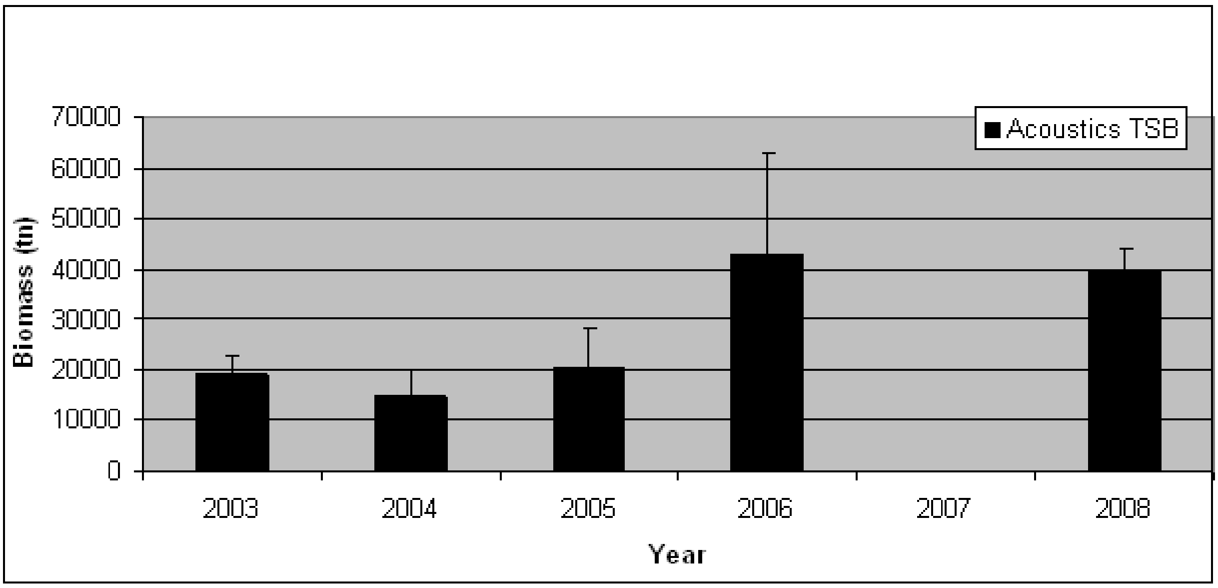


Fig. 8.46.3.1.3.1 Estimated sardine biomass indices for GSA 22, 2003-2006 and 2008.

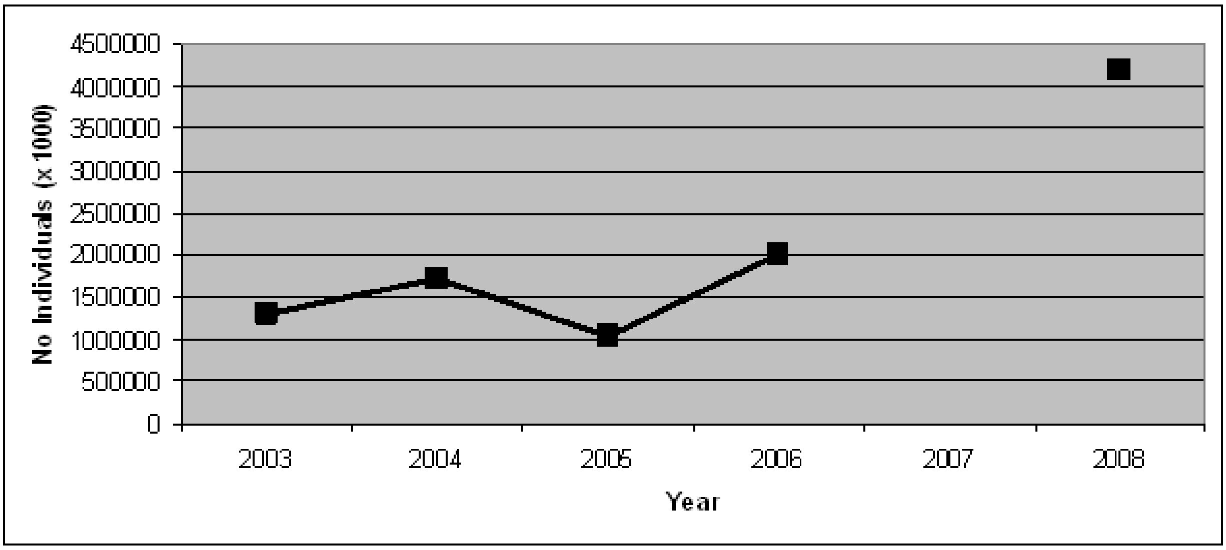


Fig. 8.46.3.1.3.2 Estimated sardine abundance indices from acoustic surveys for GSA 22, 2003-2006 and 2008.

An increasing trend was observed in both biomass and abundance indices since 2005 based on acoustic surveys estimates (Fig. 8.46.3.1.3.1, Fig. 8.46.3.1.3.2).

8.46.3.1.4. Trends in abundance by length or age

Figure 8.46.3.1.4.1 displays the length frequency composition of the sardine stock as derived from the acoustic survey for GSA 22.

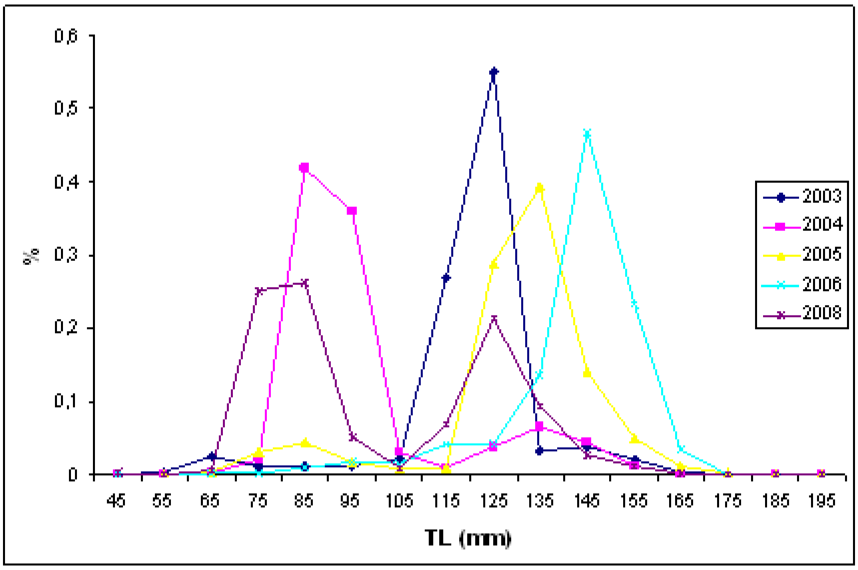


Fig. 8.46.3.1.4.1 Estimated changes in size compositions for GSA 22 for 2003-2006 and 2008.

Fig. 8.46.3.1.4.2 and Fig. 8.46.3.1.4.3 show the abundance indices by size and age of GSA 22 in 2003-2006 and 2008 as derived from acoustic surveys.

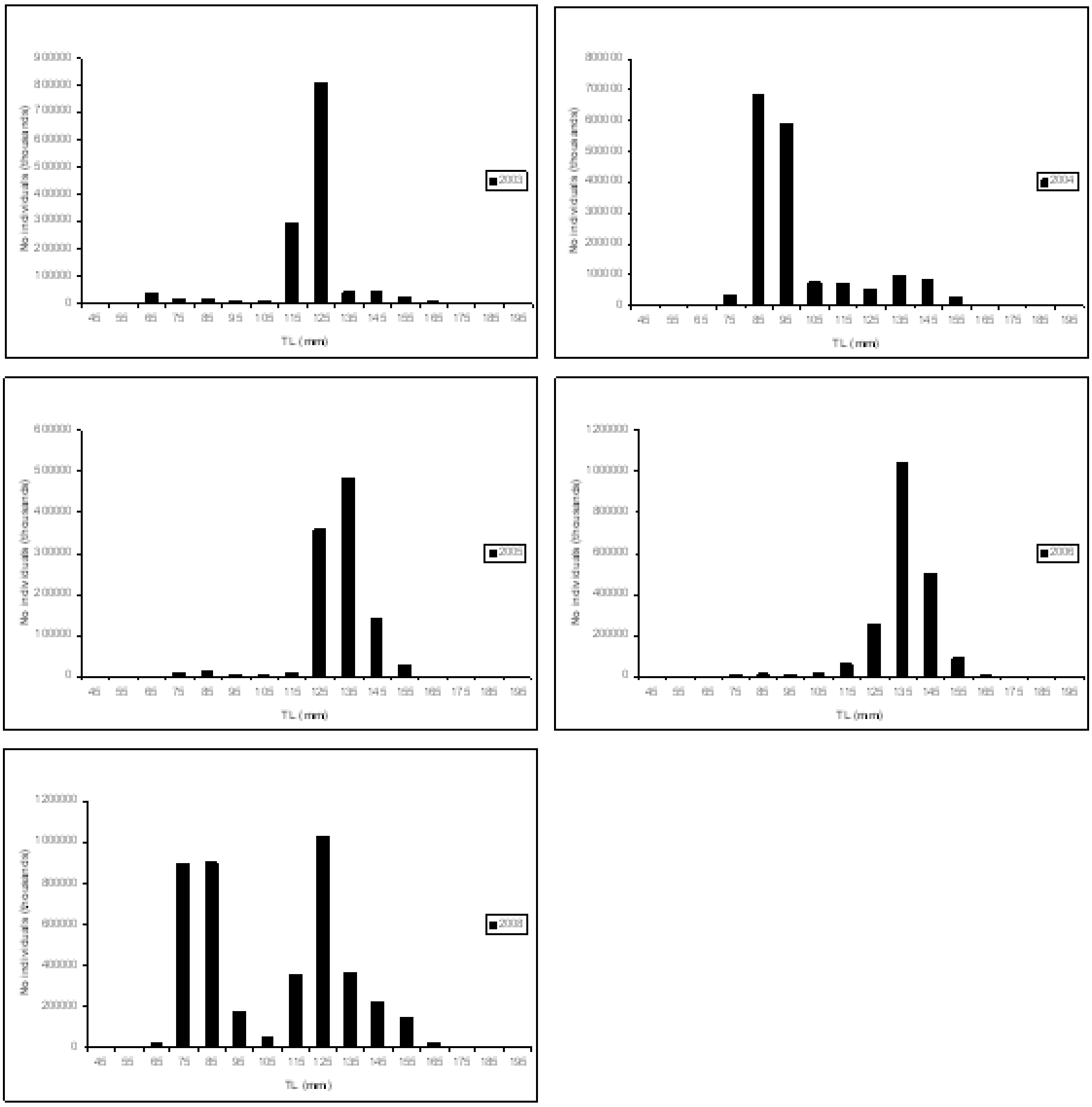


Fig. 8.46.3.1.4.2. Abundance indices by size for sardine in GSA 22 based on acoustic surveys for 2003-2006 and 2008.

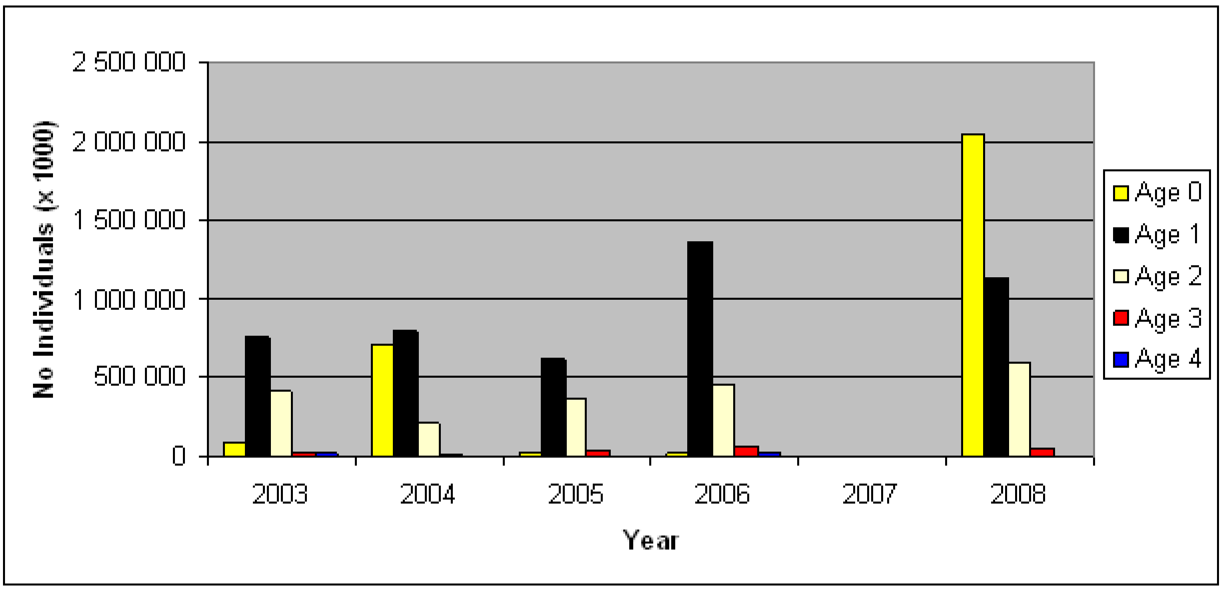


Fig. 8.46.3.1.4.3. Abundance indices by age for sardine in GSA 22 based on acoustic surveys for 2003-2006 and 2008.

8.46.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02. Growth equation was supplied through DCR and it was estimated based on aggregated data collected in GSA22 for the period 2003 to 2008.

8.46.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02. Maturity ogive based on biological sampling and length at first maturity estimates were used (Tab. 8.46.3.1.6.1).

Tab. 8.46.3.1.6.1. Maturity ogive for sardine in GSA 22.

Age	2003	2004	2005	2006	2007	2008
0	0	0	0	0	0	0
1	0.5	0.5	0.5	0.5	0.5	0.5
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1

8.46.4. Assessment of historic stock parameters

8.46.4.1. Method: ICA

8.46.4.1.1. Justification

Integrated Catch at Age (ICA) analysis for stock assessment (Patterson and Melvin 1996; Patterson, 1998) was applied. Integrated Catch at age analysis uses separable virtual population analysis (VPA) (Pope & Shepherd, 1985) with weighted tuning indices. It was applied regarding the Aegean sardine stock during the SGMED-09-02 as an update of the one adapted in the SGMED-08-04 report (Cardinale *et al*., 2008). In addition Y/R analysis was applied during the SGMED-09-02.

8.46.4.1.2. Input parameters

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 presented in Table 8.46.4.1.2.1 to 8.46.4.1.2.6. Reference age for the fishery was age group 2, as fully exploited and fully recruited. Six years separability was selected. The age groups 0, 4 and 5 were underweighted in the analysis based on their percentage in the catch. Age 1 was also underweighted in the acoustic surveys (0.5). Linear catchability relationship was assumed for the acoustic surveys. Different natural mortality values were applied per age group but constant for all years based on ProBiom (Abella *et al.*, 1997) as recommended in the report of the SG-ECA/RST/MED 09-01. This method for estimating natural mortality is consistent with the methodology used in GSAs 05, 06 and 17 for small pelagics. Estimated M was considered realistic, representative of the actual situation in the area taking into account the abundance of predators in the area and the strong dependence of the juveniles of small pelagics from environmental conditions. Average values of maturity ogive and weight at age in the stock were use for 2007.

Tab. 8.46.4.1.2.1. Catch at age (numbers in thousands) of sardine stock in GSA 22 for 2000-2008.

Year	0	1	2	3	4
2000	542	167063	545713	53729	2803
2001	757	271776	593377	47206	2875
2002	2112	210186	340393	23117	1662
2003	1124	102214	257926	21728	1088
2004	1165	123086	234820	5952	1247
2005	629	122114	411857	42586	2264
2006	492	146366	356388	65384	2100
2007	2660	207030	183717	14145	1254
2008	7395	262961	228636	16988	1165

Tab. 8.46.4.1.2.2. Catches estimates (in t) of sardine stock in GSA 22 for 2000-2008.

Year	Sardine
2000	18075
2001	19115
2002	11483
2003	8260
2004	8660
2005	14444
2006	12984
2007	9064
2008	9700

Tab. 8.46.4.1.2.3. Weight at age in the catch of sardine stock (in kg) in GSA 22 for 2000-2008.

	Year								
Age	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
0	.0064	.0081	.0103	.0071	.0068	.0005	.0095	.0086	.0063
1	.0206	.0191	.0185	.0190	.0210	.0220	.0214	.0216	.0185
2	.0247	.0200	.0198	.0215	.0235	.0260	.0231	.0236	.0201
3	.0241	.0240	.0218	.0250	.0249	.0265	.0252	.0246	.0212
4	.0441	.0650	.0516	.0516	.0516	.0516	.0415	.0498	.0469

Tab. 8.46.4.1.2.4. Weight at age in the stock (in kg) of sardine stock in GSA 22 for 2000-2008.

	Year								
Age	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
0	.0036	.0036	.0036	.0029	.0044	.0037	.0037	.0036	.0035
1	.0152	.0152	.0152	.0152	.0073	.0183	.0203	.0171	.0141
2	.0201	.0201	.0201	.0162	.0225	.0225	.0239	.0198	.0163
3	.0237	.0237	.0237	.0169	.0317	.0223	.0296	.0235	.0180
4	.0383	.0383	.0383	.0206	.0516	.0516	.0298	.0339	.0378

Tab. 8.46.4.1.2.5. Maturity ogive of sardine stock in GSA 22 for 2003-2008.

Year	0	1	2	3	4
2003	0	.5	1	1	1
2004	0	.5	1	1	1
2005	0	.5	1	1	1
2006	0	.5	1	1	1
2007	0	.5	1	1	1
2008	0	.5	1	1	1

Tab. 8.46.4.1.2.6. Age-structure indices of sardine (numbers in thousands) stock in GSA 22 for 2003-2006 and 2008. Age 3 was considered a plus age group.

Age	2003	2004	2005	2006	2007	2008
1	752287	790094	622031	1398063	-1	1213128
2	422307	208857	363658	487685	-1	871381
3+	39859	7771	35816	87914	-1	54074

8.46.4.1.3. Results including sensitivity analyses

The graphical diagnostics of the model shown in Figs. 8.46.4.1.3.1 to 8.46.4.1.3.4 generally showed good model fit besides the acoustic surveys index at age 3 in years 2006 and 2008. Residual plots for recent years showed no strong deviations from separability. SSQ plot (Fig. 8.46.4.1.3.5) possibly indicated some degree of inconsistency between the model and the indices (minima not fairly close to each other on x-axis, Needle (2000)).

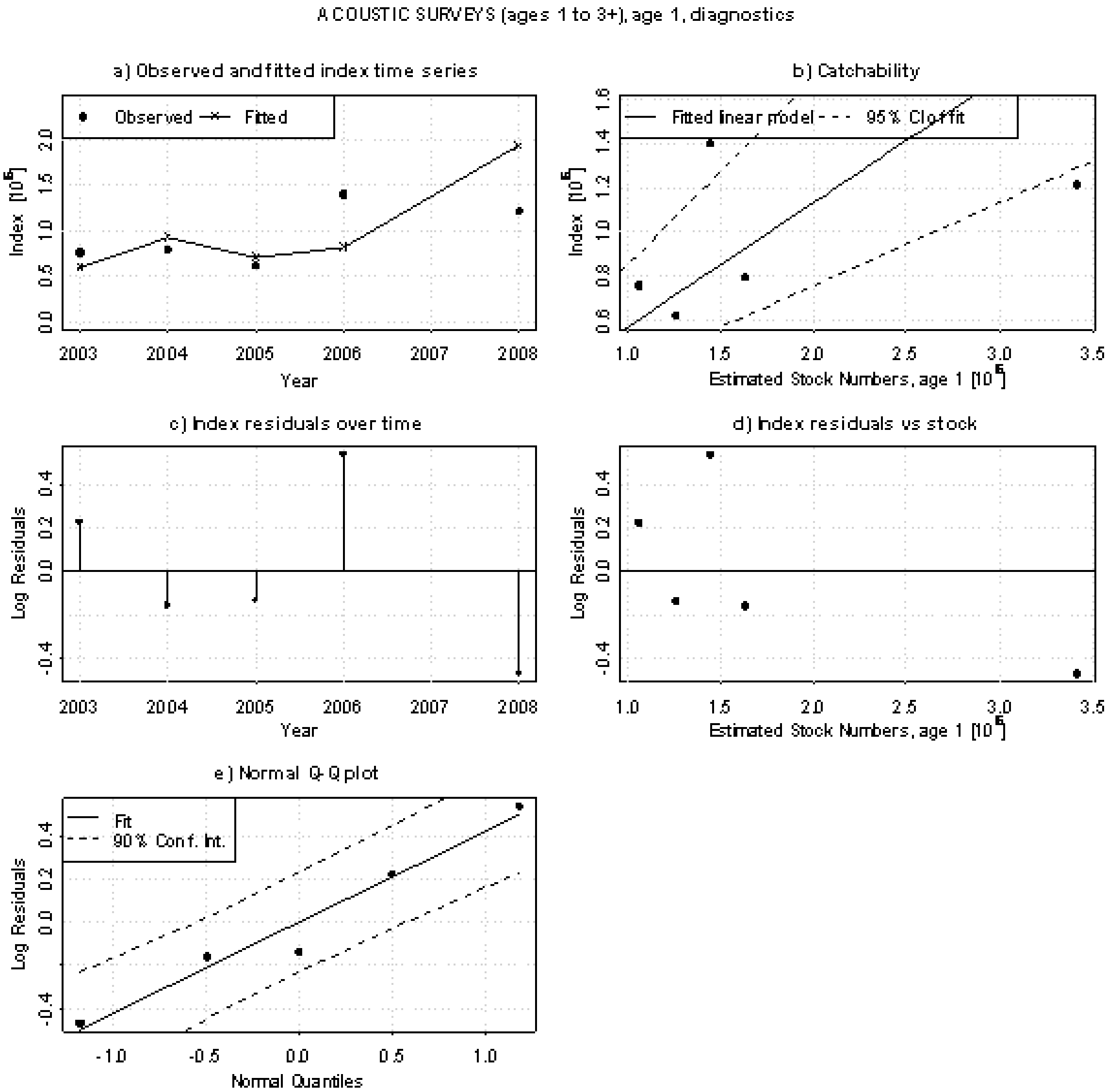


Fig. 8.46.4.1.3.1 Residual plots for age 1 indices of sardine ICA model for GSA 22 (2003-2008).

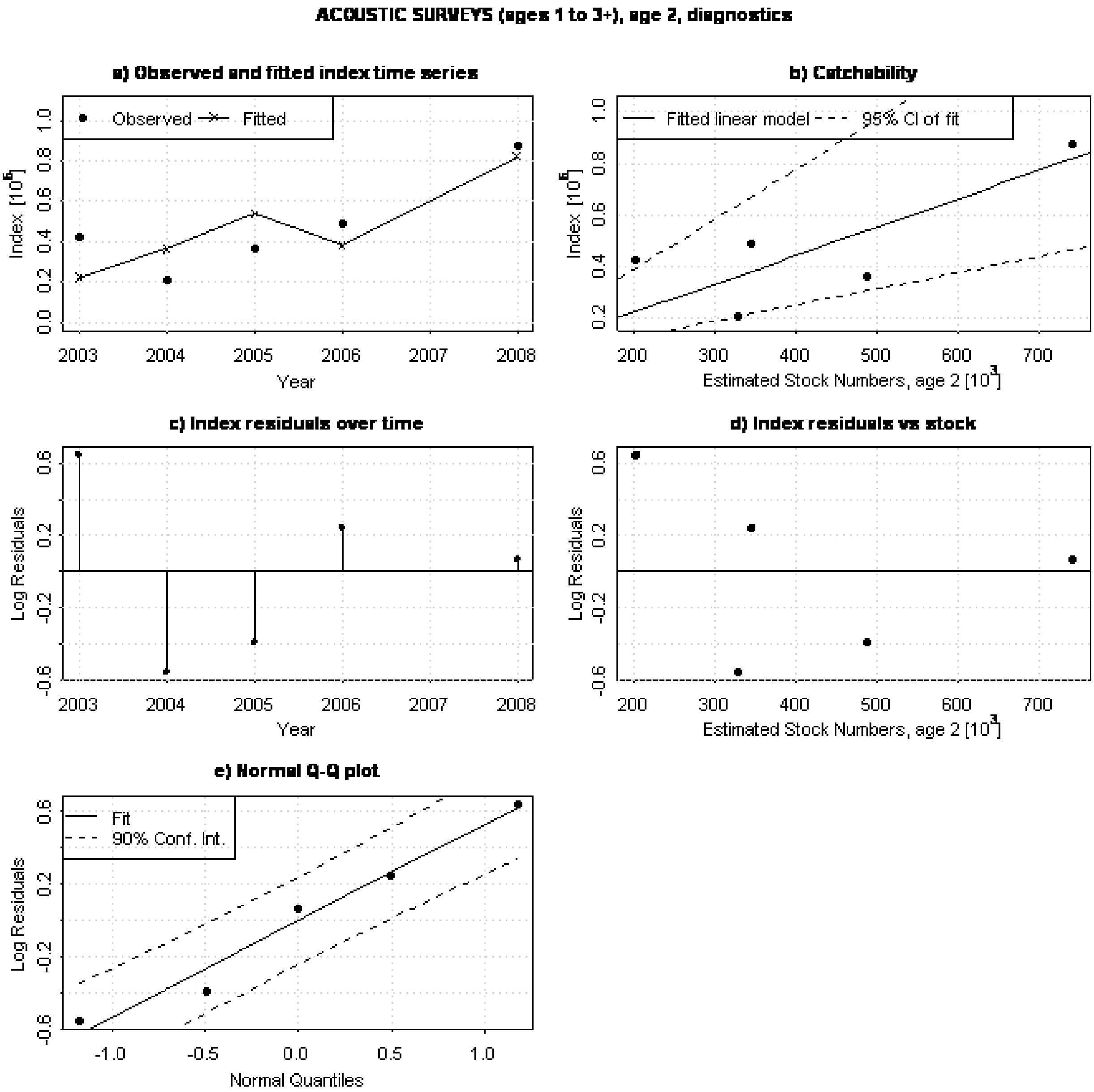


Fig. 8.46.4.1.3.2 Residual plots for age 2 indices of sardine ICA model for GSA 22 (2003-2008)

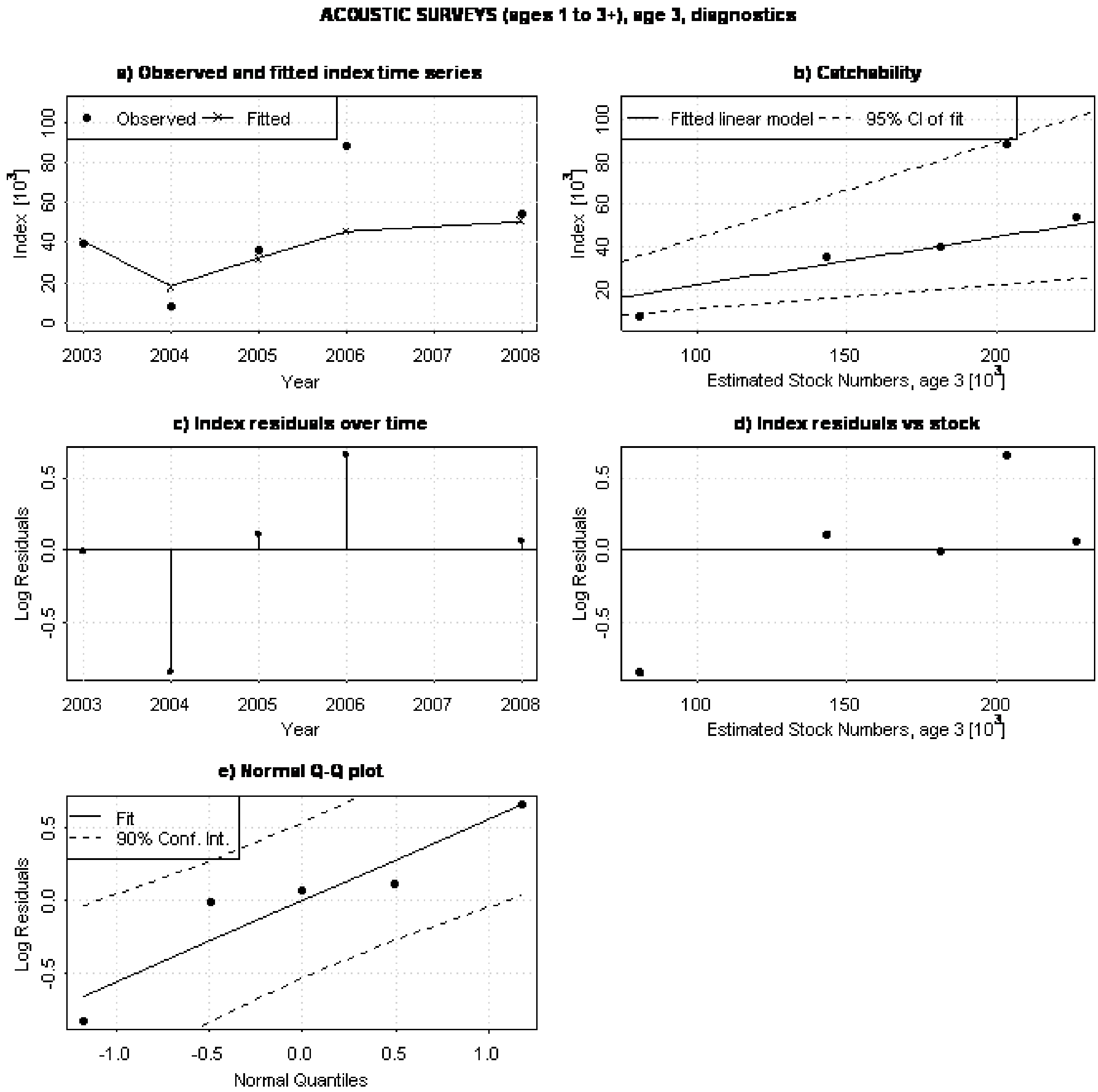


Fig. 8.46.4.1.3.3 Residual plots for age 3 indices of sardine ICA model for GSA 22 (2003-2008)

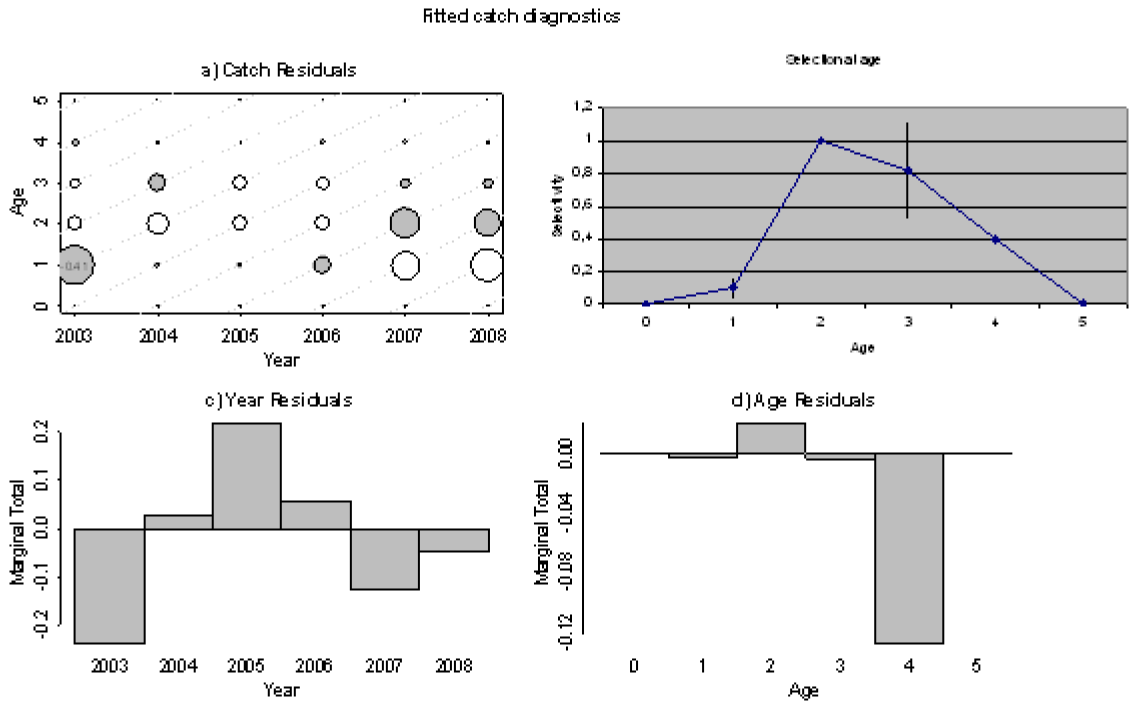


Fig. 8.46.4.1.3.4 The catch at age residuals Residual plots for catch of sardine ICA model for GSA 22 (2003-2008)

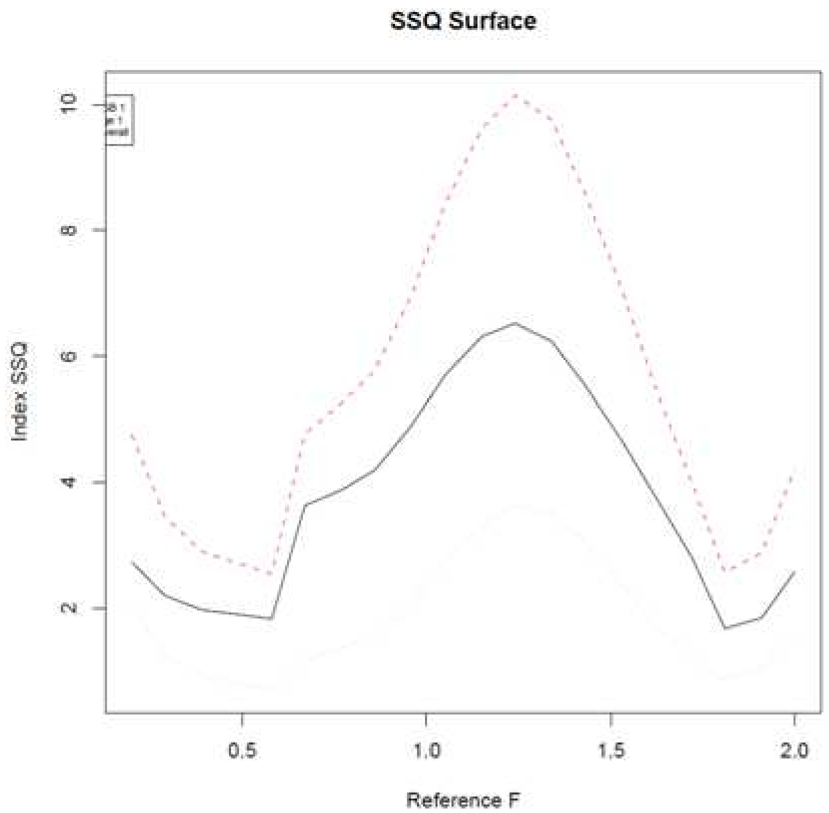


Fig. 8.46.4.1.3.5 Sum of Squares (SSQ) surface plot of the Anchovy ICA Model.

ICA model results for sardine stock in GSA 22 are shown in Fig. 8.46.4.1.3.6, indicating an increasing trend for recruitment in 2008. However this is probably an overestimation of the last year as the model predicts a decrease at the level of 2006 for 2009. An increase in biomass has also been observed since 2004. F mean (ages 1to 3) shows a decrease since 2006. The landings to Total Biomass ratio decreases, approximating on average 2% in 2008 based on model results. Similarly, the landings to SSB ratio decreases approximating on average 40% based on model results

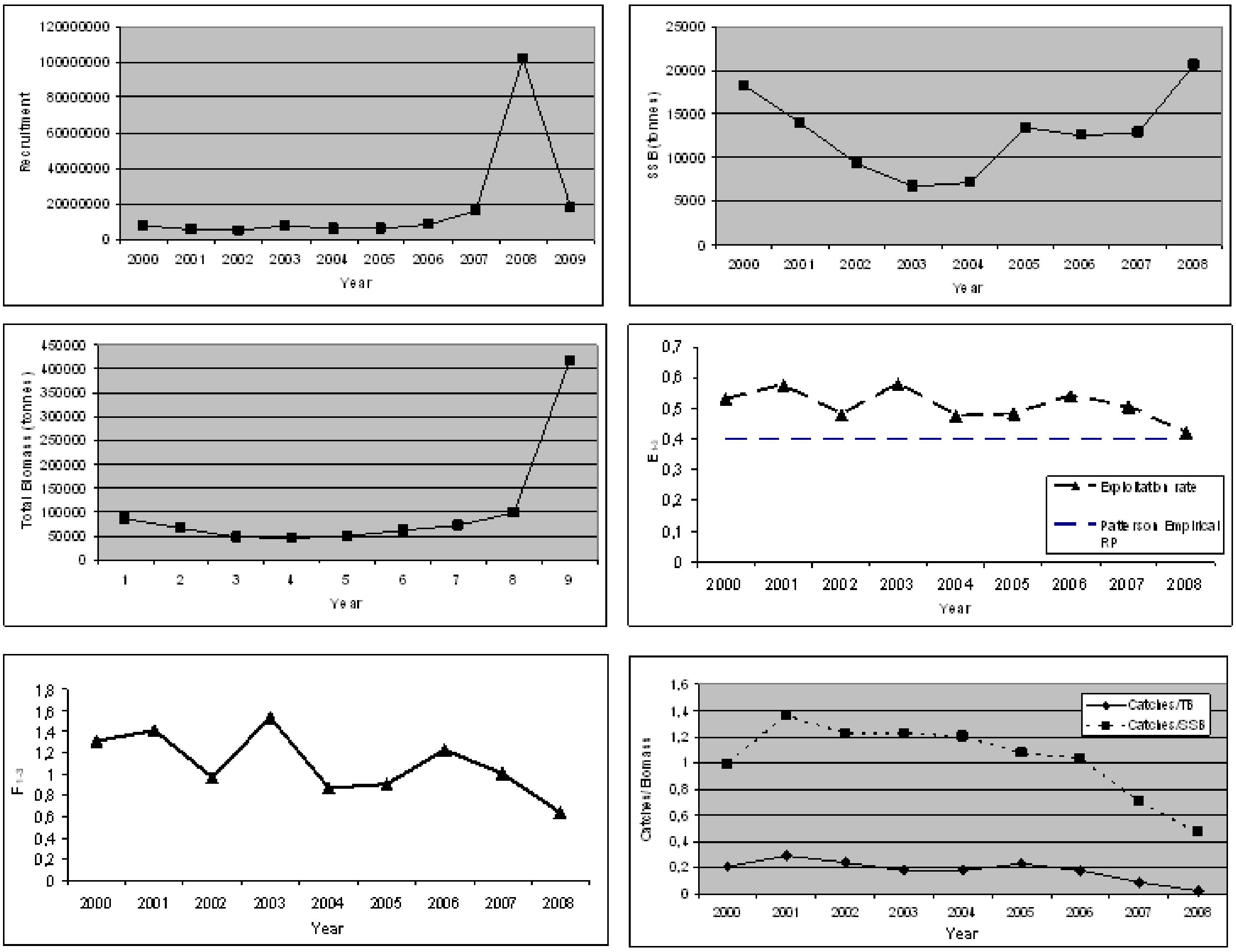


Fig. 8.46.4.1.3.6 Sardine ICA Model results: Recruitment, SSB, Total biomass, exploitation rate (F/Z), Fmean for ages 1-3, landings to biomass ratio.

Retrospective analysis was applied in the ICA model for the Aegean sardine 2000-2008 with one year backward analysis. Applying the analysis with more than one year backward was not possible due to the short time series available. Results are presented in Fig. 8.46.4.1.3.7., showing no particular retrospective bias.

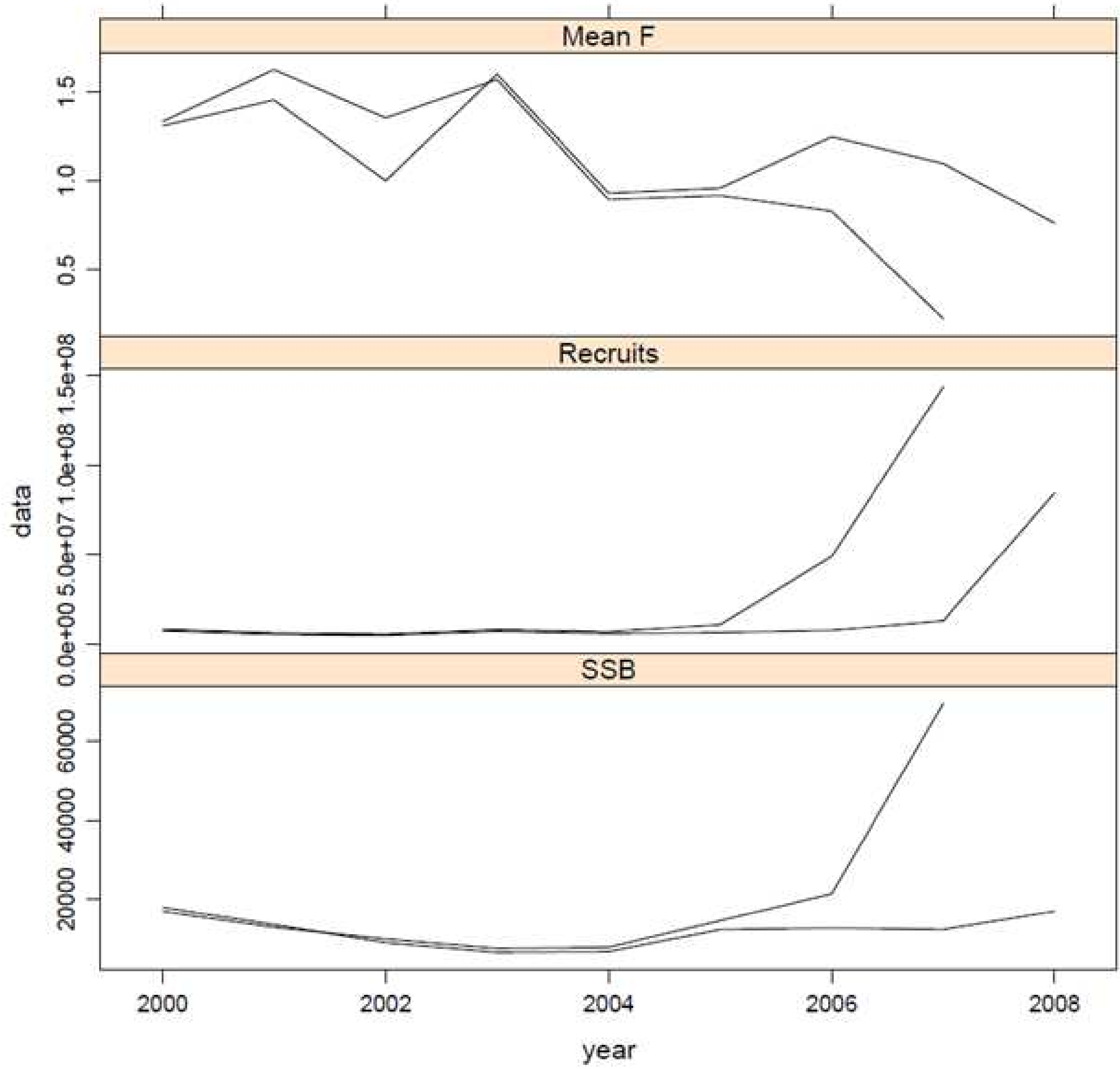


Fig. 8.46.4.1.3.7. The results of retrospective analysis in the Aegean Sea sardine ICA model 2000-2008, concerning F mean 1-3, SSB and recruitment.

8.46.5. Long term prediction

8.46.5.1.Justification

Yield per recruit analysis was conducted in the SGMED-09-02 assuming equilibrium conditions.

8.46.5.2.Input parameters

Yield per recruit analyses was conducted based based on the exploitation pattern resulting from the ICA model and population parameters, Minimum and maximum age for the analysis were considered to be age group 0 and 4, respectively. Stock weight at age, catch weight at age and maturity ogive were estimated as mean values on a long term basis (2000-2008). Natural mortality was considered different per age group based on ProBiom estimations. Fishing mortalities were estimated in a short term basis (2004-2008). Reference F was considered to be mean F for ages 1 to 3. Input parameters are shown in Table 8.46.5.2.1.

Tab. 8.46.5.2.1. Input parameters for Y/R analysis.

age group	stock weight	catch weight	maturity	F	M
0	0.004	0.007	0	0.0003	1.50
1	0.015	0.020	0.5	0.1804	0.96
2	0.020	0.022	1	1.7100	0.69
3	0.024	0.024	1	1.3951	0.61
4	0.038	0.050	1	0.7055	0.57

8.46.5.3.Results

Y/R analyses were performed (Fig. 8.46.5.3.1) but were not considered reliable due to its flat-topped shape. Therefore,$F_{0.1}$ (1.20) cannot be used as a reference point for this stock.

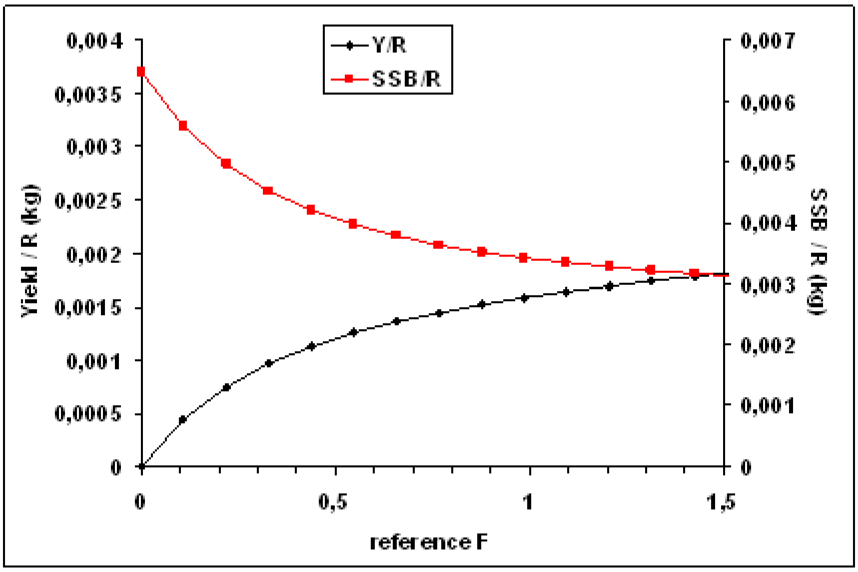


Fig. 8.46.5.3.1. Yield per recruit for the sardine stock in GSA 22.

8.46.6. Scientific advice

8.46.6.1.Short term considerations

8.46.6.1.1. State of the spawning stock size

The results of the short time series of data do not allow to conclude on reference points of B_{lim} or B_{pa}. In the absence of proposed or agreed references, SGMED-09-02 is unable to fully evaluate the state of the stock and provide scientific advice.

Recent estimates of fishery independent surveys for sardine in GSA 22 indicated an increase of total biomass estimates when compared to the earlier years 2003-2005 (42,850 t in 2006 and 39,000 t in 2008 estimated by acoustics). Similarly, results of the Integrated Catch at Age analysis indicated an increasing trend in total biomass and SSB showing a slight recovery of SSB to 20,000 t in 2008 from the low 2003-2004 estimates of 7,000 t.

8.46.6.1.2. State of recruitment

ICA model estimates showed above average recruitment since 2007, with a very high peak in 2008.

8.46.6.1.3. State of exploitation

Based on ICA results, the mean fishing mortality (averaged over ages 1 to 3) is highly variable but showed a clear decreasing trend since 2006, amounting approximating 0.64 in 2008.

The mean F/Z has declined from 2003 reaching the value of 0.41 which approximates the exploitation reference points (E<0.4, Patterson 1992) suggested by SGMED for small pelagics. Taking into account the uncertainty in the estimate, SGMED-09-02 considers the stock as being harvested sustainably. The exploitation rate should be kept at this level through constant effort and consistent catches should be determined. The management of the sardine fishery requires mixed fisheries implications to be considered, mainly with anchovy.

8.47. Stock assessment of sole in GSA 17

8.47.1. Stock identification and biological features

8.47.1.1. Stock Identification

Tagging experiments carried out on common sole in the northern Adriatic Sea, using the traditional mark-and-recapture procedure, showed that all individuals were re-captured within the sub-basin (Pagotto *et al.*, 1979). Local currents, eddies and marked differences of oceanographic features of this sub-basin with respect to those of southern Adriatic and Ionian Sea (Artegiani *et al.*, 1997) may prevent a high rate of exchange of adult spawners and the mixing of planktonic larval stages from nursery areas of adjacent basins (Magoulas *et al.*, 1996). Guarnieri *et al.* (2002), taking into account differences of sole specimens from five different central Mediterranean areas in the control region sequence marker, suggested that two near-panmictic populations of common sole could exist in the Adriatic Sea. The former population would inhabit the entire GSA 17 (northern Adriatic Sea). The second unit seems to be spread along the Albanian coasts (eastern part of the GSA 18). The hydrogeographical features of this semi-enclosed basin might support the overall pattern of differentiation of the Adriatic common soles.

The northern Adriatic Sea has a high geographical homogeneity, with a wide continental shelf and eutrophic shallow-waters. The southern Adriatic in contrast is characterized by narrow continental shelves and a marked, steep continental slope (1200 m deep; Adriamed, 2000). This deep canyon could represent a significant geographical barrier for *S. solea*.

On these bases, different actions for fishery management should be proposed for the Adriatic common sole stocks in GSA 17 and GSA 18. In the former area the stock is shared among Italy, Slovenia and Croatia, while in the latter one seems to be shared only between Montenegro and Albania.

S. solea is a demersal and sedentary species, living on sandy and muddy bottoms (Tortonese, 1975, Fisher *et al.*, 1987, Jardas, 1996). Although Jardas (1996) stated that the species is distributed from coastal waters to 250 m depth, it was exclusively caught up to 100 m during the expedition MEDITS (1996-1998) (Vrgoč, 2000).

Common sole usually feeds very often on small quantities of prey (Sà *et al.*, 2003). This suggests a high evacuation rate between the stomach and the intestine, and lack of digestion in the stomach (Lagardère, 1987). The fish feeds night and day and for the remaining time usually lives embedded in the seabed. In the Adriatic Sea food items mostly include invertebrates and small fish (Tortonese, 1975; Fisher *et al.*, 1987; Jardas, 1996). Within the framework of SoleMon project, a study of gut content using carbon- and nitrogen stable isotopes along the sole food web was carried out, indicating that *S. solea* diet depends on both the geographical position and the size of soles, which change their feeding habit with the increase of the age. This could be related to the fact that the sole selects its preys basing on both their energetic value and the energy spent to catch them. The choice of sole would be also related to prey abundance, as postulated by the "*optimal foraging theory*" (MacArthur and Pianka, 1966) and observed in other flatfish (Hinz *et al.*, 2005). Stergiou and Karpouzi (2002) found that in the Mediterranean Sea the sole increases its trophic level with the increasing of the size, reaching values around 3.4. The mean trophic level estimated from the SoleMon project data through the stable isotope analysis was slightly higher (3.9), but similar to the value obtained in a study carried out in the Rodano mouth (Darnaude, 2005).

8.47.1.2. Growth

In the Adriatic sea, growth analyses on this species have been made using otoliths, scales and tagging experiments. A great variability in the growth rate was noted: some specimens had grown 2 cm in one month, while others, of the same age group, needed a whole year (Piccinetti and Giovanardi, 1984; Tab. 8.47.1.2.1.). Von Bertalanffy growth equation parameters have been calculated using various methods. Within the framework of SoleMon project, growth parameters of sole were estimated through the length-frequency distributions obtained from surveys (Fig. 8.47.1.2.1; Tab. 8.47.1.2.2).

Tab. 8.47.1.2.1. Growth rates of *S. solea* from different studies (TL, cm; age, yr).

Author	**Sex**	**Age**					
		1	**2**	**3**	**4**	**5**	**6**
Ghirardelli (1959)	M+F	16.8	21.4	23.9	25.6	33.1	-
Piccinetti and Giovanardi (1984)	M+F	18-20	21-30	-	-	-	-
Vallisneri *et al*. (2000)	F	20	25	29	32	34	37

Tab. 8.47.1.2.2. Von Bertalanffy parameters of *S. solea* estimated in different studies.

Author	**Sex**	**W_∞(g)**	**L_∞(cm)**	**k (month^{-1})**	**t_0 (month)**
Piccinetti and Giovanardi (1984)	M+F	-	40.10	0.68*	-
Froglia and Giannetti (1985)	M+F	-	38.25	0.041	-3.57
Froglia and Giannetti (1986)	M	323	23.20	0.069	-1.66
	F	562	37.87	0.042	-5.36
	M+F	576	38.25	0.041	-3.57
Fabi *et al.* (2009)	M+F	-	39.60	0.44*	-0.46*

*(k, yr^{-1}; t_0, yr)

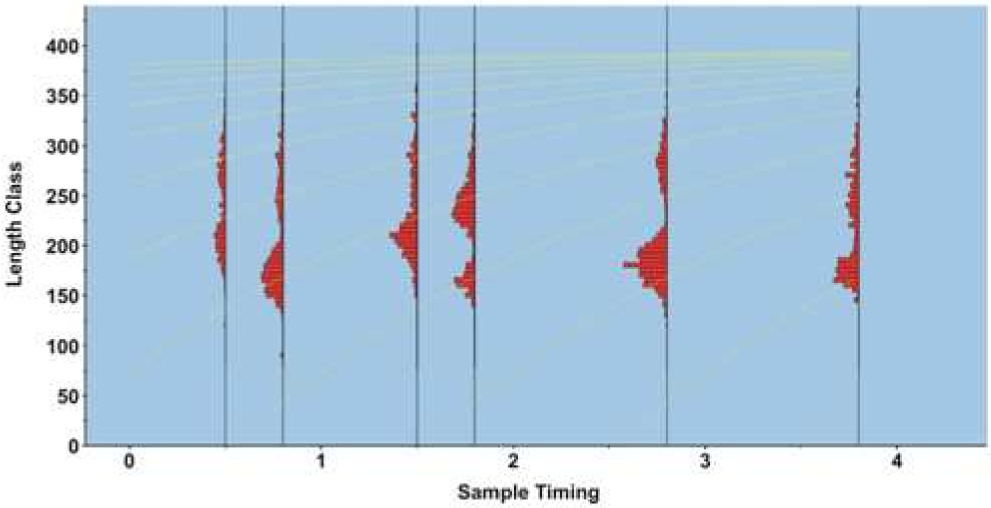


Fig. 8.47.1.2.1. Von Bertalanffy growth functions for sole in the GSA 17, based on SoleMon length frequency distributions.

8.47.1.3. Maturity

In the Mediterranean Sea, the reproduction of common sole occurs from December to May (Bini, 1968-70; Tortonese, 1975; Fisher *et al*., 1987). Within the framework of SoleMon project, it has been observed that in the central and northern Adriatic Sea the reproduction takes place from November to March. Data on the spatial distribution of spawners provided by the project show a higher concentration of reproducers outside the western coast of Istria (Fabi *et al.*, 2009).

Length at first maturity is 25 cm (Fisher *et al.*, 1987; Jardas, 1996; Vallisneri *et al.*, 2000); this value has been estimated at 25.8 using data from SoleMon project. Females having a weight of 300 g have about 150,000 eggs, while those weighting 400 g have about 250,000 eggs (Piccinetti and Giovanardi, 1984); eggs are pelagic. The male-female ratio is approximately 1:1 (Piccinetti and Giovanardi, 1984; Fabi *et al.*, 2009).

Hatching occurs after eight days and the larva measures 3 to 4 mm TL (Tortonese, 1975). Eye migration starts at 7 mm TL and ends at 10-11 mm TL. Benthic life begins after seven or eight weeks (15 mm) in coastal and brackish waters (Bini, 1968-70; Fabi *et al*., 2009).

8.47.2. Fisheries

8.47.2.1. General description of fisheries

The common sole is a very important commercial species in the central and northern Adriatic Sea (Ghirardelli, 1959; Piccinetti, 1967; Jardas, 1996; Vallisneri *et al.*, 2000; Fabi *et al.*, 2009). Italian *rapido* trawlers exploit this resource providing more than 80% of landings. Sole is also a target species of the Italian and Croatian set netters, while it represents an accessory species for otter trawlers.

From censuses carried out at the landing sites, the Italian rapido trawl fleet operating in GSA 17 was made of 155 vessels in 2005 and 124 vessels in 2006 ranging from 9 to 30 m in vessel length, GRT ranged from 4 to 100 and the engine power from 60 to 1000 HP. Each vessel can tow from 2 to 4 rapido trawls depending on its dimensions. The *rapido* trawl is a gear used specifically for catching flatfish and other benthic species (e.g. cuttlefish, mantis shrimp, etc.). It resembles a toothed beam-trawl and is made of an iron frame provided with 3-5 skids and a toothed bar on its lower side. These gears are usually towed at a greater speed (up to 10-13 km h^{-1}) in comparison to the otter trawl nets; this is the reason of the name "*rapido*", the Italian word for "fast". The mesh opening of the codend used by the Italian *rapido* trawlers is larger (48 mm stretched or more) than the legal one. The main Italian *rapido* trawl fleets of GSA 17 are sited in the following harbours: Ancona, Rimini and Chioggia.

The Italian artisanal fleet in GSA 17, according to SoleMon project data (end of 2006), accounted for 469 vessels widespread in many harbours along the coast. They use gill net or trammel net especially from spring to fall and target small and medium sized sole (usually smaller than 25 cm TL).

8.47.2.2. Management regulations applicable in 2008 and 2009

- Fishing closure for trawling: 30 days in summer.
- Minimum landing sizes: EC regulation 1967/2006: 20 cm TL for sole.
- Cod end mesh size of trawl nets: 40 mm (stretched, diamond meshes) till 30/05/2010. From 01/06/2010 the existing nets will be replaced with a cod end with 40 mm (stretched) square meshes or a cod end with 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

8.47.2.3. Catches

8.47.2.3.1. Landings

In the last four years the total landings of sole of GSA 17 fluctuated between 1,673 to about 2,184 tons and even though the time series is short, the general shape suggests a stable trend (Fig. 8.47.2.3.1.1).

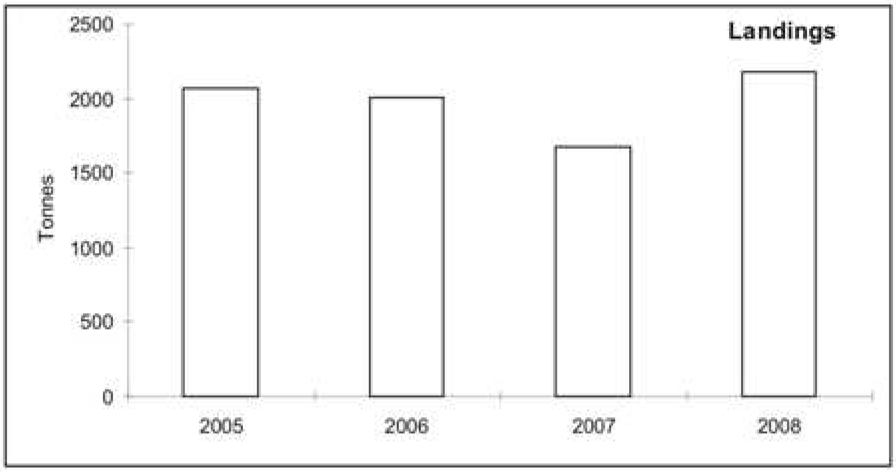


Fig. 8.47.2.3.1.1 Landings of sole (all gears) in the GSA 17, from 2005 to 2008.

Rapido trawl landings were traditionally dominated by small sized specimens; they are basically composed by 1 and 2 year old individuals. Set net fishery lands mostly the same portion of the population, while the otter trawl fishery, exploiting wider fishing grounds, shows a different size distribution of the landings (Fig. 8.47.2.3.1.2).

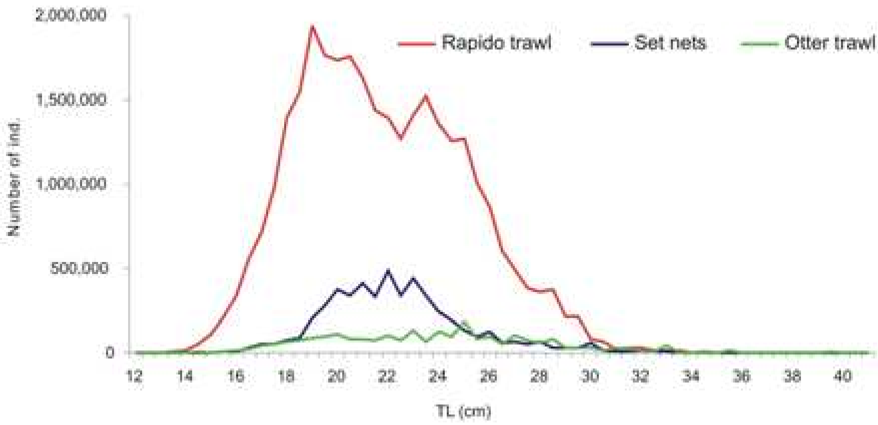


Fig. 8.47.2.3.1.2 Size structure of the landings of common sole provided in 2005-2006 by *rapido* trawl, otter trawl and set nets in the GSA 17 (SoleMon project data).

8.47.2.3.2. Discards

Several projects carried out in a portion of GSA 17 highlighted that the discard of sole both by *rapido* trawl and set net fisheries is negligible (Fabi *et al*., 2002a; 2002b) as the damaged specimens are also commercialized, even though at a lower price.

8.47.2.3.3. Fishing effort

Exploitation is based on young age classes, mainly 1 and 2 year old individuals, with immature fraction dominating the landings. From SoleMon project data, the overall Italian fleet exploiting sole in the GSA 17 is made up by around 1,300 vessels (rapido trawlers, set netters, otter trawlers; Tab. 8.47.2.3.3.1)

Tab. 8.47.2.3.3.1 Number of vessels x days exploiting sole in GSA 17 (SoleMon project data).

Year	**2005**	**2006**	**2007**	**2008**
Effort (vessels x days)	152,182	122,669	108,830	116,860

The trends of the fishing effort of Ancona and Rimini *rapido* trawl fleets have been analyzed over the years 1996-2009 and 2005-2008 respectively. The fishing effort of Ancona fleet increased from 1996 to 2003 and declined in the subsequent years. A similar decreasing pattern also occurred for the Rimini fleet in the last four years (Fig. 8.47.2.3.3.1).

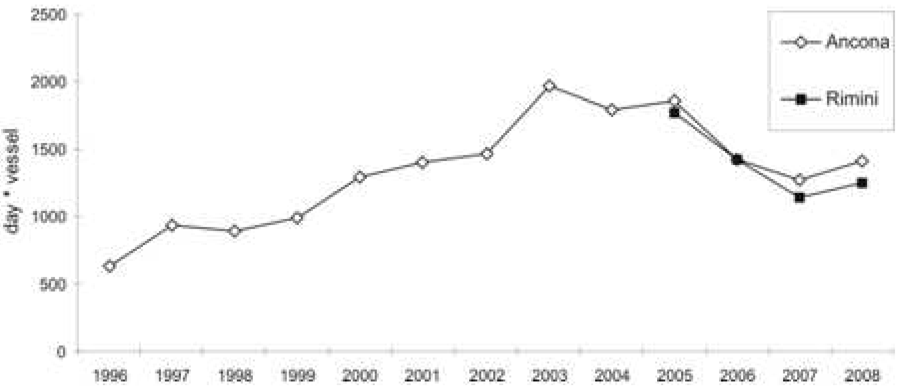


Fig. 8.47.2.3.3.1 Trends of effort (days* vessel) by Ancona and Rimini rapido trawl fleets

8.47.3. Scientific surveys

8.47.3.1. SoleMon

8.47.3.1.1. Methods

Six *rapido* trawl fishing surveys were carried out in GSA 17 from 2005 to 2008: two systematic "pre-surveys" (spring and fall 2005) and four random surveys (spring and fall 2006, fall 2007-2008) stratified on the basis of depth (0-30 m, 30-50 m, 50-100 m). Hauls were carried out by day using 2-4 *rapido* trawls simultaneously (stretched codend mesh size = 40.2 ± 0.83). The following number of hauls was reported per depth stratum (Tab. 8.47.3.1.1.1).

Tab. 8.47.3.1.1.1 Number of hauls per year and depth stratum in GSA 17, 2005-2008.

Depth strata	**Spring 2005**	**Fall 2005**	**Spring 2006**	**Fall 2006**	**Fall 2007**	**Fall 2008**
0-30	30	30	20	35	32	39
30-50	14	12	10	20	19	17
50-100	24	15	8	8	11	11
HR islands	0	5	4	4	0	0
TOTAL	68	62	42	67	62	67

Abundance and biomass indices from *rapido* trawl surveys were computed using ATrIS software (Gramolini *et al*., 2005) which also allowed drawing GIS maps of the spatial distribution of the stock, spawing females and juveniles. Underestimation of small specimens in catches due to gear selectivity was corrected using the selective parameters given by Ferretti and Froglia (1975).

The abundance and biomass indices by GSA 17 were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum area in the GSA 17:

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al.*, 2004).

Length distributions represented an aggregation (sum) of all standardized length frequencies over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.47.3.1.2. Geographical distribution patterns

According to data collected during SoleMon surveys (Fabi *et al.*, 2009), age class 0+ aggregates inshore along the Italian coast, mostly in the area close to the Po river mouth (Fig. 8.47.3.1.2.1). Age class 1+ gradually migrates off-shore and adults concentrate in the deepest waters located at South West from Istria peninsula (Fig. 8.47.3.1.2.1).

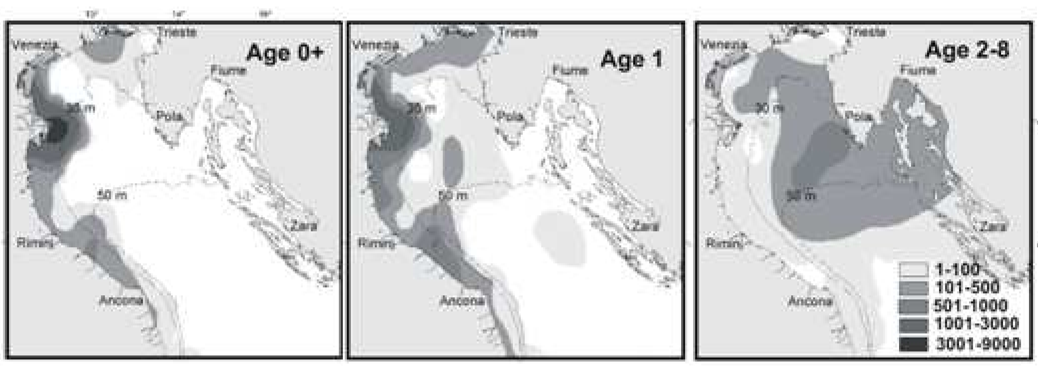


Fig. 8.47.3.1.2.1 Example of abundance indices (ind.·km^{-2}) for sole from SoleMon survey carried out in GSA 17 (fall 2007) interpolated using Kriging (Fabi *et al.*, 2009).

8.47.3.1.3. Trends in abundance and biomass

The SoleMon trawl surveys provided data either on sole total abundance and biomass as well as on important biological events (recruitment, spawning).

Fig. 8.47.3.1.3.1 shows the abundance and biomass indices of sole obtained from 2005 to 2008; slightly increasing trends occurred till fall 2007, followed by a decrease in fall 2008.

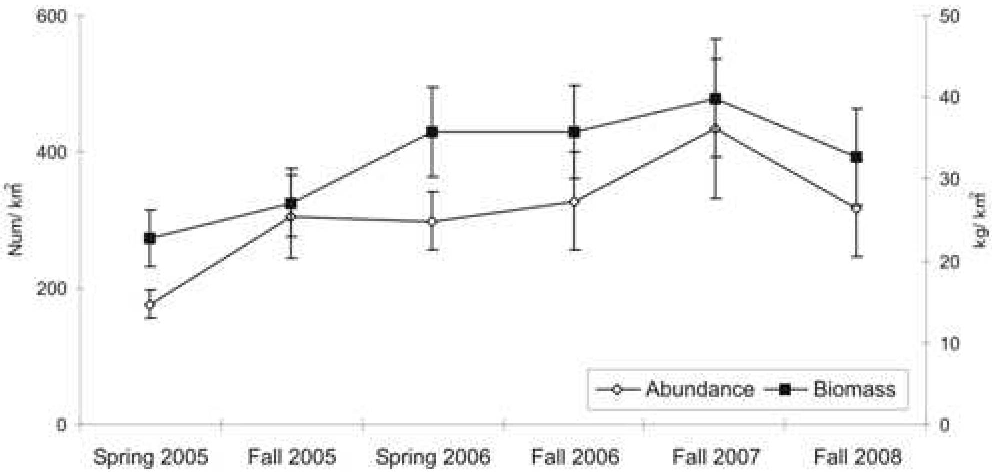


Fig. 8.47.3.1.3.1 Abundance and biomass indices of sole obtained from SoleMon surveys.

The recruitment showed a fluctuating trend with the lowest values in 2006 and 2008 (Fig. 8.47.3.1.3.2). The number and biomass of spawners remained practically constant from 2005 to 2008 (Fig. 8.47.3.1.3.3).

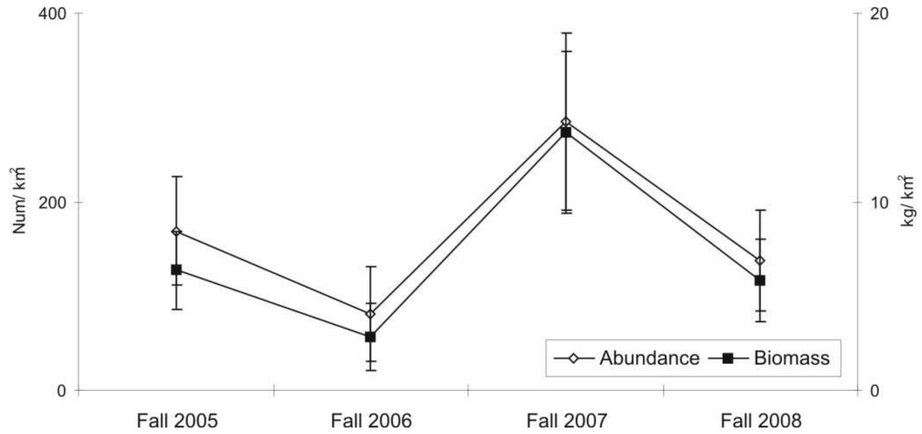


Fig. 8.47.3.1.3.2 Abundance and biomass indices of recruits of sole obtained from SoleMon surveys.

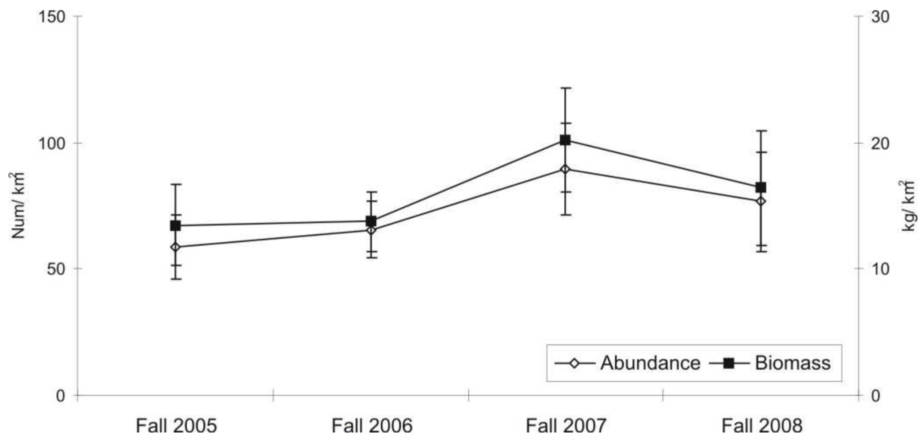


Fig. 8.47.3.1.3.3 Abundance and biomass indices of spawners of sole obtained from SoleMon surveys.

8.47.3.1.4. Trends in abundance by length or age

Fig. 8.47.3.1.4.1 displays the stratified abundance indices obtained in the GSA 17 in the years 2005-2008.

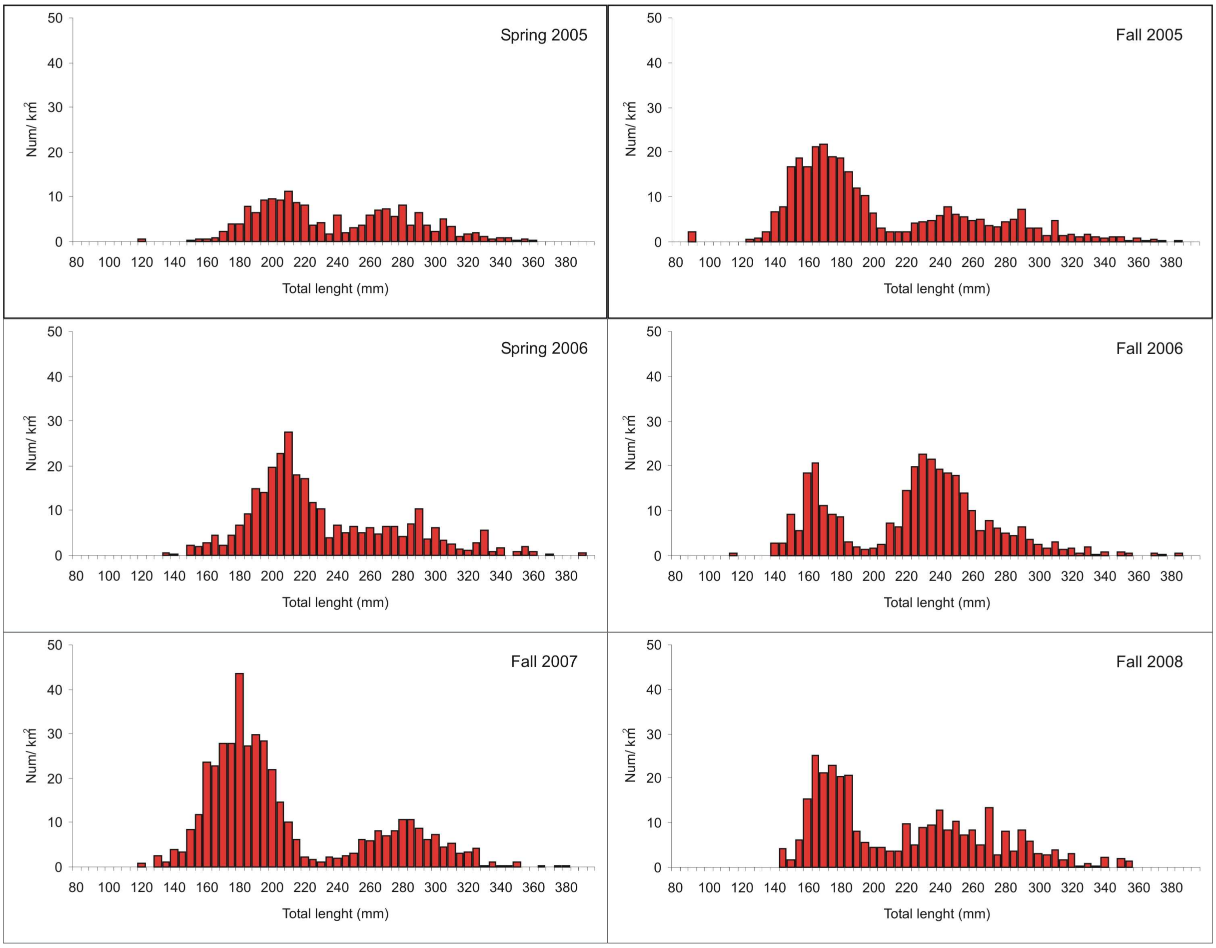


Fig. 8.47.3.1.4.1 Stratified abundance indices by size, 2005-2008.

8.47.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.47.3.1.6. *Trends in maturity*

No analyses were conducted during SGMED-09-02.

8.47.4. Assessment of historic stock parameters

Sole has been object of assessments in the GSA 17 and results are published and regularly updated in the GFCM SAC sheets. The assessments, often performed with different approaches, showed substantially convergent results.

From the last GFCM SAC meeting (Fabi *et al.*, 2008), the sole stock in the GSA 17 seems to be overexploited, as shown by the results of the analytical models (reference points as F_{max}, $F_{0.1}$). A growth overfishing situation was detected, with excessive fishing mortality on 1+ and 2+ age classes.

As concern the STECF-SGMED-09-02, two new assessments were produced. The main results are presented below.

8.47.4.1. Method 1: XSA

8.47.4.1.1. *Justification*

Despite of the short data series, the assessment is based on non-equilibrium method. VPA Lowestoft software suite (Darby and Flatman, 1994) was used and XSA was the assessment method. A separable VPA (Pope and Sheperd, 1982) was also run as exploratory analysis for this stock.

8.47.4.1.2. *Input parameters*

Landings time series 2005-2008 from all fishing ports from GSA17.
Length distributions 2005-2008 (SoleMon project).
Biological sampling 2005-2006 for Maturity at age and Weight-Length relationships (SoleMon project).
Tuning data from SoleMon surveys carried out in fall for the years 2005-2008.
These data come from independent monitoring activities performed by the research institutes working in the GSA 17 (Tab. 8.47.4.1.2.1).

Tab. 8.47.4.1.2.1 Input parameters.

Catch at age in numbers (x 1000)	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

Survey indexes (N. ind. · km^{-2})	0	1	2	3	4	5	6+
2005	169	82	36	12	3	1.5	0.4
2006	92	179	43	10	1	0.7	0.5
2007	205	138	72	18	1	0.4	0.2
2008	117	123	61	10	6	0.1	0.1

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

Tab. 8.47.4.1.2.2 Growth parameters.

PERIOD	L_∞	k	T_0
2005-2008	39.6 cm	0.44 y^{-1}	-0.46 y

Tab. 8.47.4.1.2.3 Length-weight relationships.

PERIOD	a	b
2005-2008	0.007	3.0638

Tab. 8.47.4.1.2.4 Maturity at Age.

PERIOD	Age	0	1	2	3	4	5+
2005-2008	Prop. Matures	0	0.25	0.75	1.0	1.0	1.0

A vector of natural mortality rate at age was estimated using the PROBIOM spreadsheet (Abella *et al.*, 1997).

Tab. 8.47.4.1.2.5 Natural mortality rate at age

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

8.47.4.1.3. Results

A separable VPA was run as exploratory analysis. Log catchability residual plots were produced (Fig. 8.47.4.1.3.1) and no major conflict between ages seems to appear.

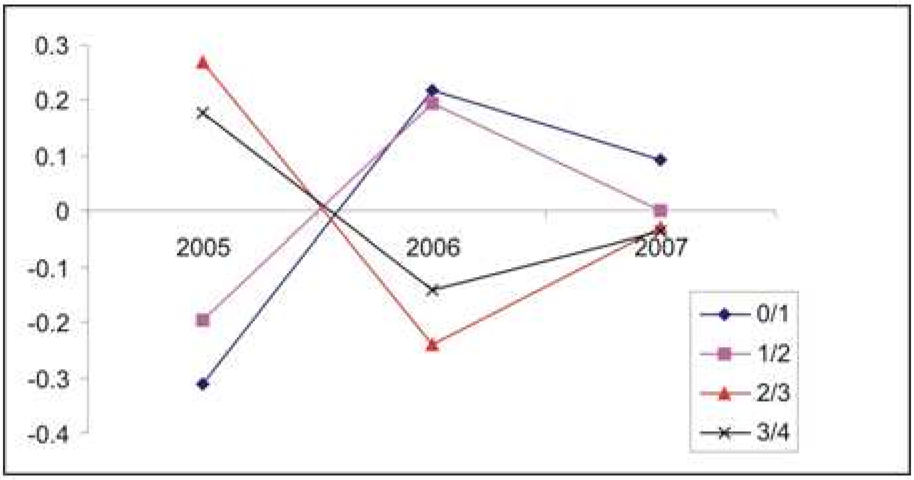


Fig. 8.47.4.1.3.1 Residuals of log catchabilities.

Then a XSA assessment was made. The main settings for the XSA are the following:

- F_{bar} 0-4.
- Age 1 for q stock-size independent and age 1 for q independent of age.
- F shrink age = 0.500 and S.E. for fleet terminal estimates ≥ 0.300

XSA Diagnostics in the form of residuals by survey data are shown in the Fig. 8.47.4.1.3.2.

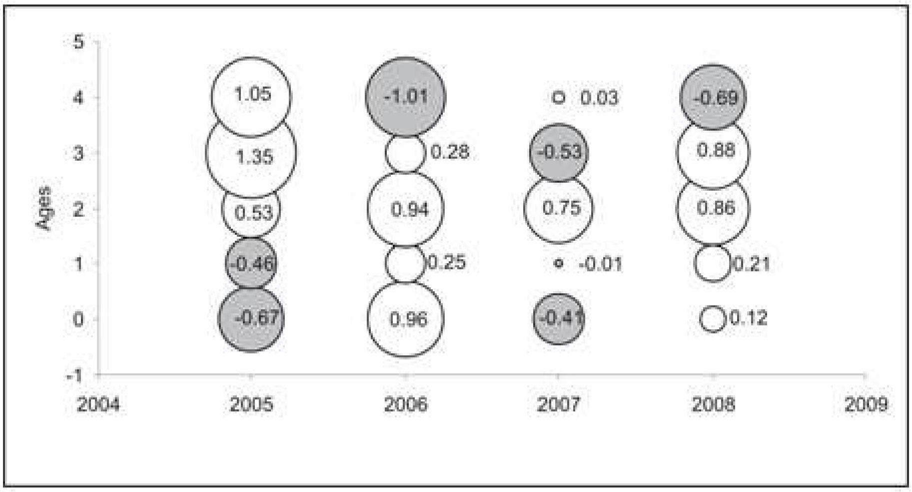


Fig. 8.47.4.1.3.2 Residuals by fleet.

The inclusion of tuning data from *rapido* trawl commercial fleet of Rimini did not provide additional information or different results. Therefore, the definitive assessment only included tuning data from SoleMon survey.

Fig. 8.47.4.1.3.3 presents the main results from the XSA: fishing mortality, relative F at age, total biomass, spawning stock biomass (SSB) and recruitment.

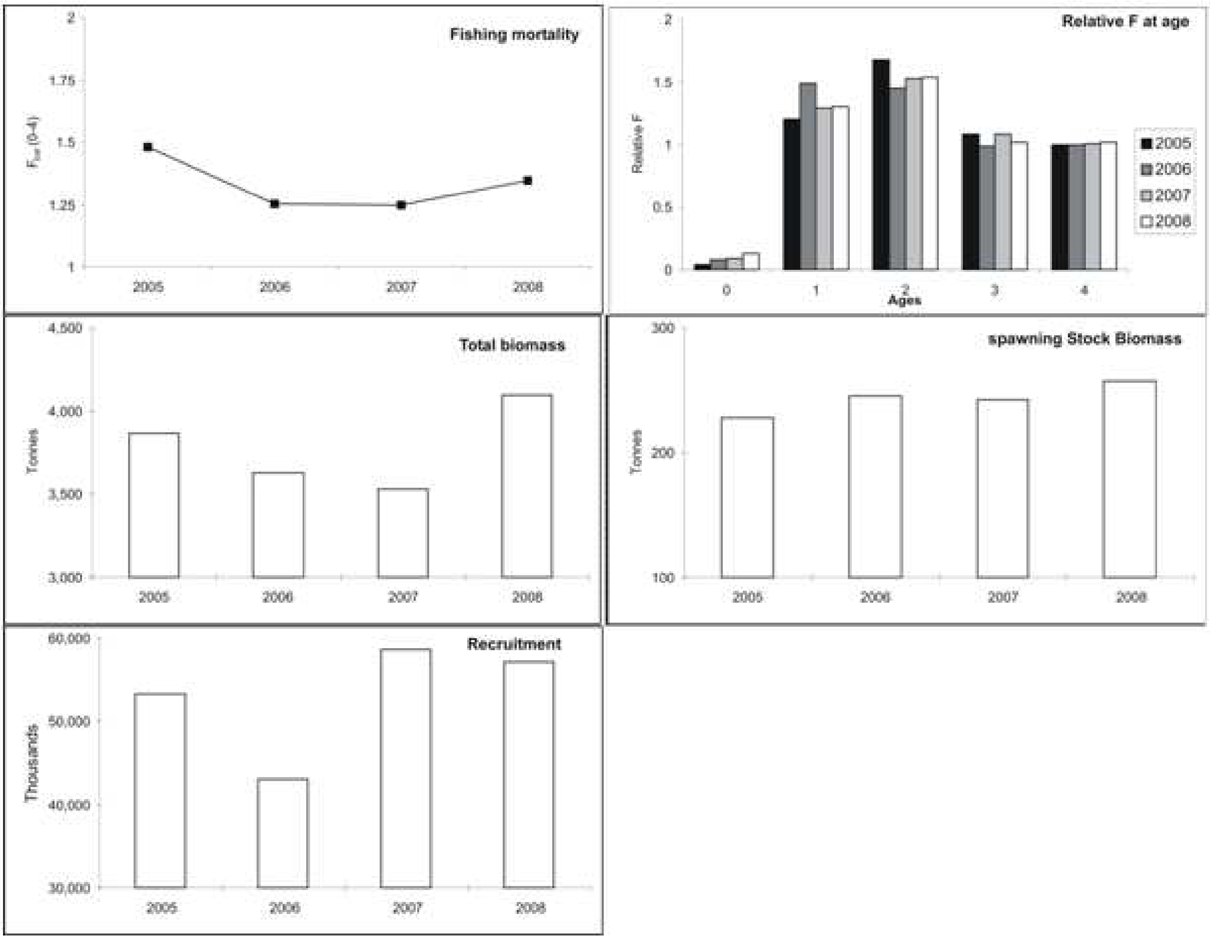


Fig. 8.47.4.1.3.3 Final assessment results.

<u>State of exploitation</u>: Exploitation decreased from 2005 to 2006, was constant in 2006-2007 and increased in 2008. The most recent estimate of fishing mortality (F_{0-4}) is 1.35, the highest values of relative F are for ages 1 and 2.
<u>State of the juveniles (recruits)</u>: Recruitment varied without any trend in the years 2005-2008, reaching a minimum in 2006.
<u>State of the total biomass and adult biomass</u>: The total biomass regularly decreased from 2005 to 2007 and increased in 2008 reaching the maximum value. The SSB reached the minimum value in 2005, was constant in 2006 and 2007 and increased in 2008.

8.47.4.2. Method 2: SURBA

8.47.4.2.1. Justification

The availability of a time series of data from SoleMon surveys allows the use of the SURBA assessment tool. Using the software, the evolution of fishing mortality rates of sole in the GSA 17 was reconstruct starting from the analysis of the length frequency distribution (LFD).

8.47.4.2.2. Input parameters

The main input parameters to run the SURBA-survey based stock analysis are abundances, natural mortality rates and catchability. The parameters used in this analysis were the same used in the XSA analysis.

8.47.4.2.3. Results

The results and the diagnostic of the analyses are summarized in Fig. 8.47.4.2.3.1 and 8.47.4.2.3.2 respectively. The results of the model are in general accordance with the previous method providing the same perception of the state of the stock. Comparison between observed *vs* fitted data obtained with SURBA (Fig. 8.47.4.2.3.2A) shows an adequate fitting of the model in sole data in GSA 17.

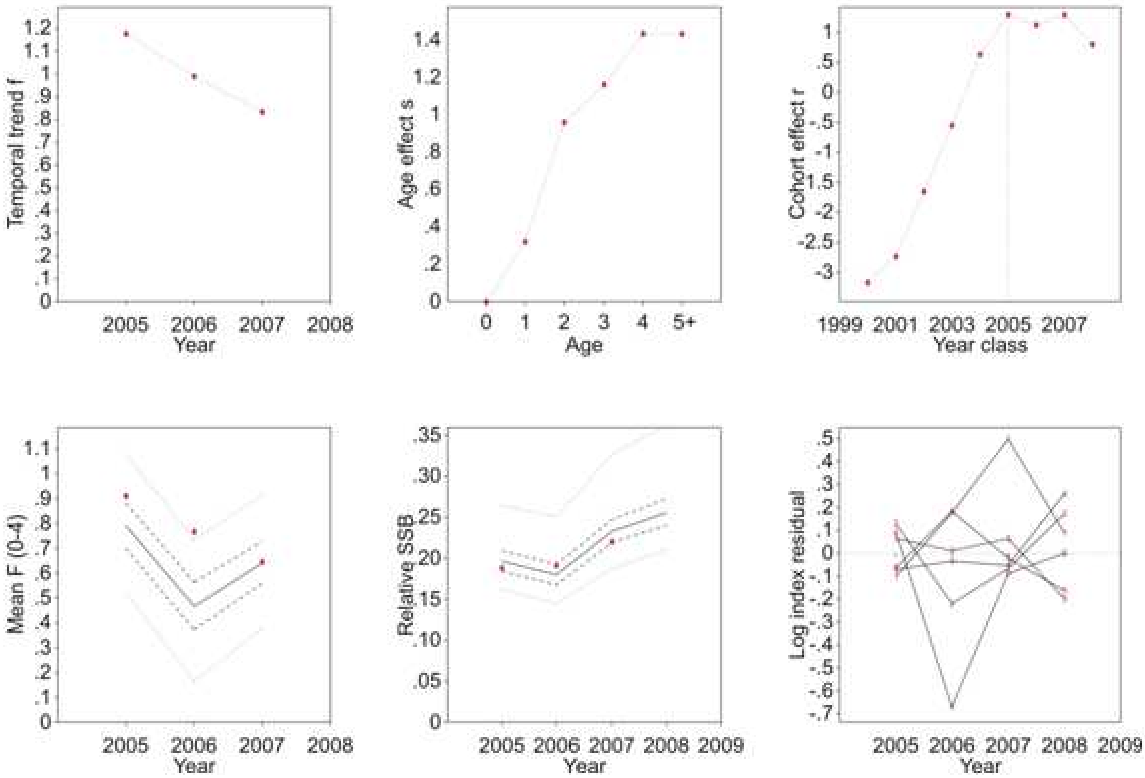
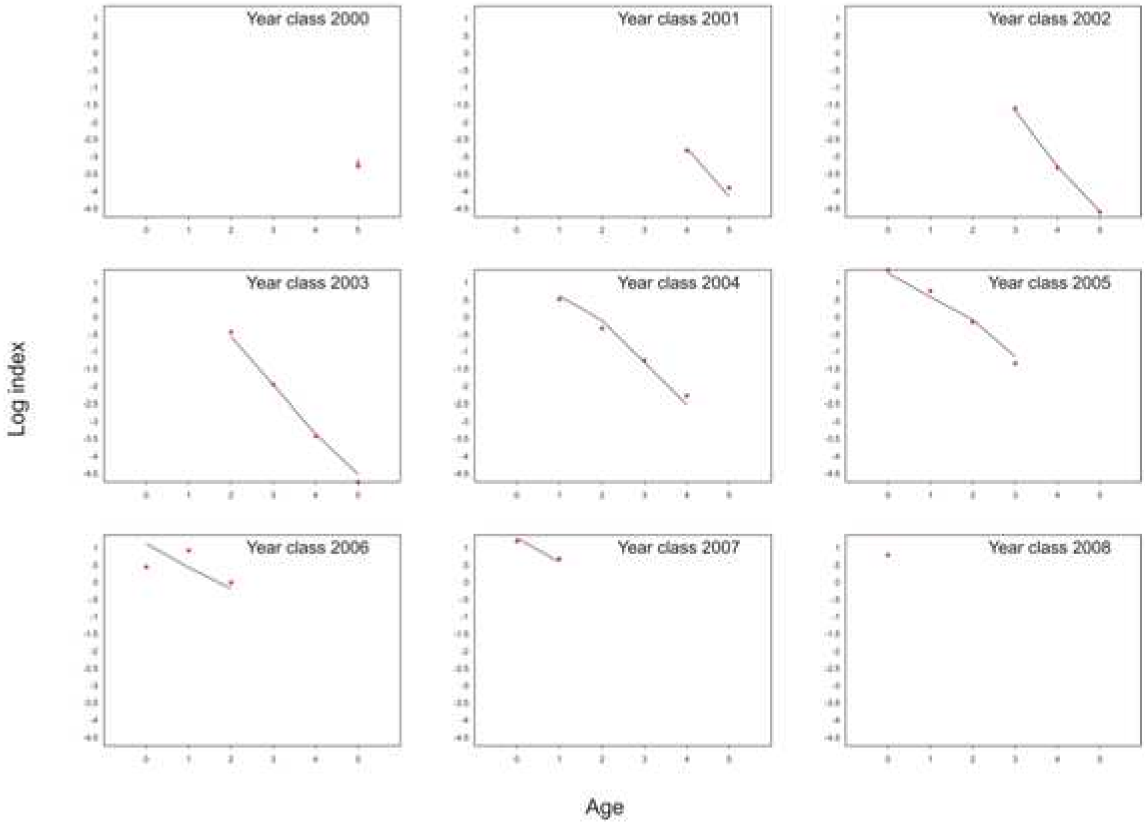


Fig. 8.47.4.2.3.1 Trends in stock parameters (SoleMon survey) in GSA 17 from SURBA.

B

(A)



(B)

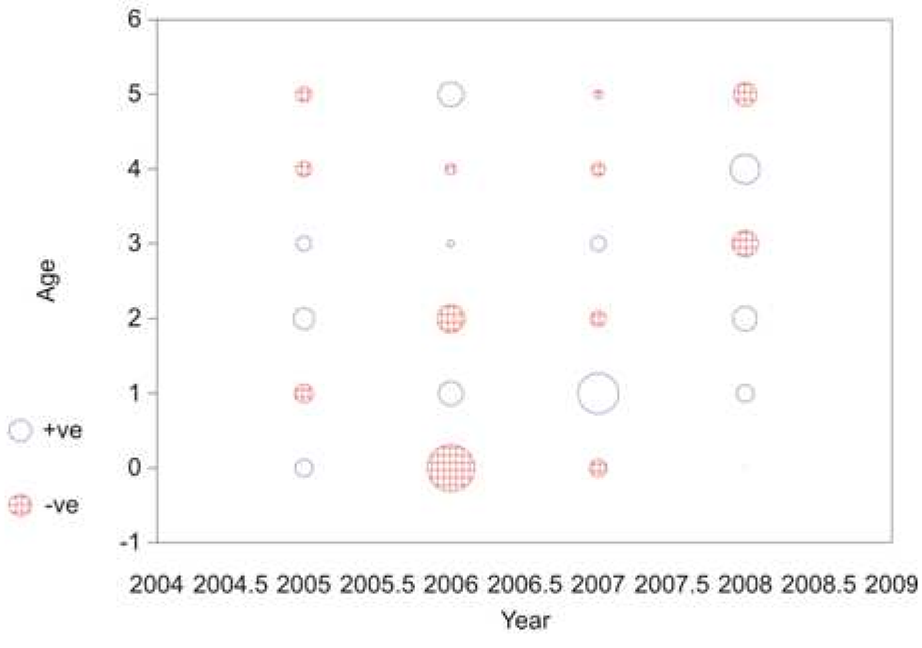


Fig. 8.47.4.2.3.2. Model diagnostic (SoleMon survey) in GSA 17 from SURBA. Comparison between observed (points) and fitted (lines) of SoleMon survey abundance indices, for each year (A); bubble plot of log-index residuals by age (B).

8.47.5. Long term prediction

8.47.5.1. Justification

Availability of biological parameter and length at first capture allows to quantify by simulation the likely changes in Y, B and SSB per recruit in function of fishing mortality (F) with the Yield package.

8.47.5.2. Input parameters

Growth, length-weight relationship, natural mortality and maturity ogive were the same used in the previous paragraphs. Length at first capture was 16 cm TL (about 0.7 year old).

A guess estimate of uncertainty in terms of coefficient of variation (CV=0.2) was added to each parameter.

Beverton and Holt stock-recruit relationship commonly employed for North Sea flatfish (Kell *et al.*, 2005; Pilling *et al.*, 2008) was used with steepness of 0.9 and virgin SSB of 13,000 t. The value of steepness represents a hypotheses on the high resilience of the stocks at low spawning-stock size. The value of virgin SSB was estimated from previous analyses carried out by VIT package. The recruitment variability among years was estimated as CV=0.3 from recruit indices obtained in trawl surveys.

8.47.5.3. Results

Estimation of Y and SSB per recruit are shown in Fig 8.47.5.3.1.

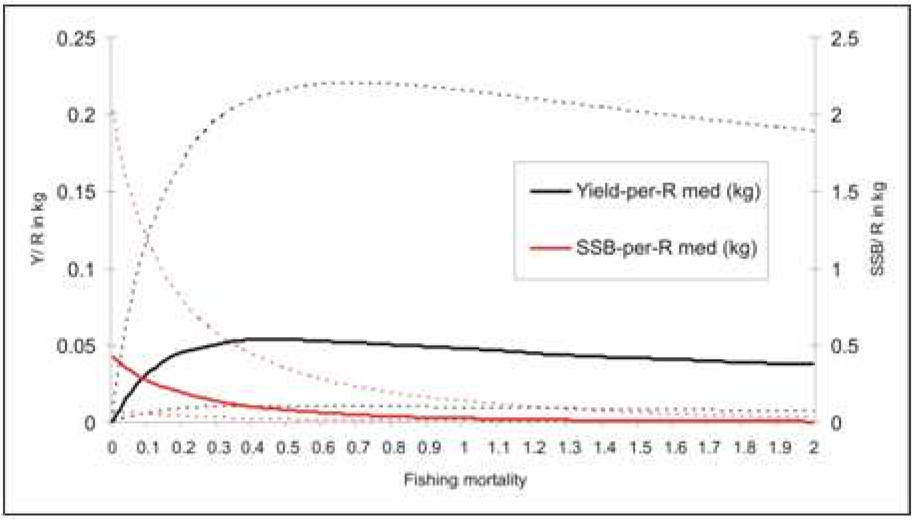


Fig. 8.47.5.3.1 Yield and spawning stock biomass per recruit and corresponding uncertainty of sole in the GSA 17 according to the Yield Package.

Searching for biological reference points (BRP) through 1000 simulation produced the median values reported in Tab. 8.47.5.3.1. Y/R_{max}, F_{max} and Y/R_{ref}, F_{ref}, the two latter corresponding to Y/R and F at SSB/initial SSB = 0.30, were assumed as limiting reference points. Whereas $Y/R_{0.1}$ and $F_{0.1}$, should be considered as target reference points.

RPs suggest an overfishing situation for the stock considering F current (1.35 from XSA) is much higher than the limit and target RPs F.

The effect of several bad recruitment years in a row has been evaluated using the transient analysis of SSB. A fishing mortality rate of 0.24 will result in a probability of 0.1 of the SSB falling below 0.2 of its unexploited level at least once in 20 years.

Tab. 8.47.5.3.1 Yield (kg) per recruit and fishing mortality based BRP of sole for GSA 17 according to the Yield package.

Yield based RP	value	F based RP	value
Y/R_{max}	0.054	F_{max}	0.46
Y/R_{ref}	0.051	F_{ref}	0.32
$Y/R_{0.1}$	0.048	$F_{0.1}$	0.26

8.47.6. Scientific advice

8.47.6.1. Short term considerations

8.47.6.1.1. State of the spawning stock size

According to the XSA and SURBA analyses the SSB was practically constant in the period considered but, taking into account the high values of relative F for the oldest ages, the stock is considered overexploited.

8.47.6.1.2. State of recruitment

According to the XSA and SURBA analyses the recruitment of sole in GSA 17 fluctuated since 2005, despite of the fact that the SSB remained practically constant during this period.

8.47.6.1.3. State of exploitation

Based on the XSA estimates, in 2008 the fishing mortality appears much higher than reference points calculated by the Yield package and, hence, it can be concluded that the resource is overexploited. Fishing effort should be reduced by means of a multi-annual management plan. Annual catches consistent with such effort reductions should be determined.

SGMED 09-02 recommends $F_{0.1}$=0.26 as a target management reference point for sustainable exploitation related to high long term yield.

Further fisheries management recommendations:

A reduction of fishing pressure, especially by *rapido* trawling, would be recommended, also taking into account that the exploitation is mainly orientated towards juveniles and the success of recruitment seems to be strictly related to environmental conditions (Domenichetti *et al.*, 2009). Hence, in the case of both increasing fishing effort and yearly bad recruitment, there could be a high risk of stock depletion.

A two-months closure for rapido trawling inside 11 km off-shore along the Italian coast, after the biological fishing ban (August), would be advisable to reduce the portion of juvenile specimens in the catches. For the same reason, specific studies on rapido trawl selectivity are necessary. In fact, it is not sure that the adoption of a larger mesh size would correspond to a decrease of juvenile catches, considering that the mesh opening currently used by the Italian rapido trawlers is larger (48 mm or more) than the legal one. The same uncertainty regards the adoption of a square mesh.

SSB was practically constant over the 4 years, maybe because, as observed during the SoleMon project, in late fall - winter the main spawning area is only partially exploited by the Croatian set netters and Italian fleets (Figure 8.47.6.1.3.1). The safeguard of such area (identified by the *rapido* trawl survey) to prevent a possible future exploitation might be crucial for the sustainability of the Adriatic sole stock.

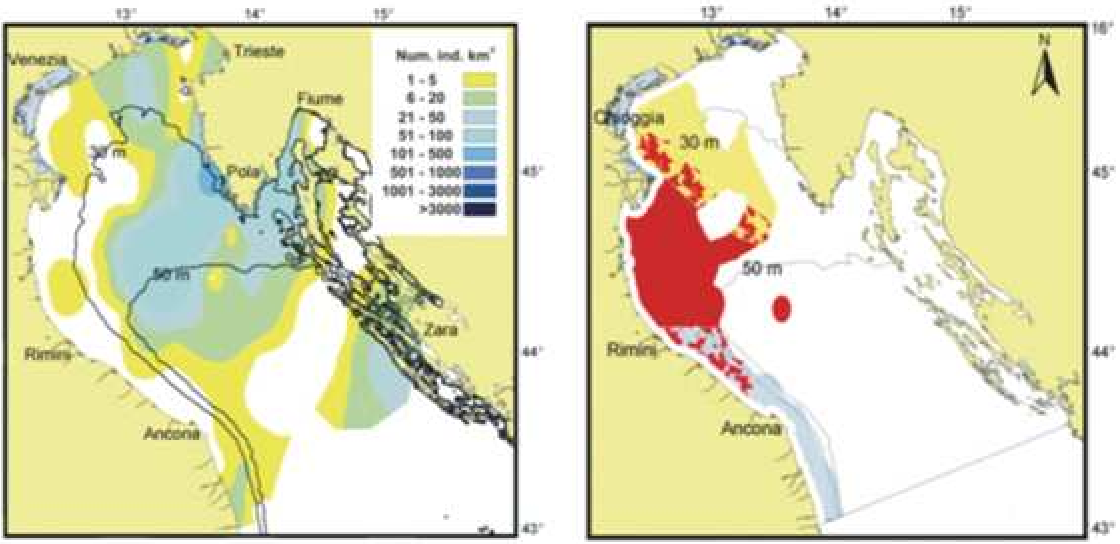


Fig. 8.47.6.1.3.1 Spatial distribution of spawning females in fall (left) and fishing grounds of the Italian rapido trawl fleets (right; in yellow Chioggia rapido trawl fleet; in red Rimini rapido trawl fleet; in light blue Ancona rapido trawl fleet).

8.48. Stock assessment of blue and red shrimp in GSA 06

8.48.1. Stock identification and biological features

8.48.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.48.1.2. Growth

Growth parameters used were those from Garcia-Rodriguez (2003) over length distributions analysis (Linf = 77.0; K = 0.38; t0= -0.065), and length-weight relationship (a= 0.0024; b= 2.467).

8.48.1.3. Maturity

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

Age class	0	1	2	3	4	5
Maturity ratio	0.07863309	0.7669088	0.9980806	1	1	1

8.48.2. Fisheries

8.48.2.1. General description of fisheries

Blue and red shrimp (*Aristeus antennatus*) is one of the most important crustacean species for the trawl fisheries developed along the GFCM geographical sub-area Northern Spain (GSA 06). This resource is an important component of commercial landings in some ports of the Mediterranean Northern Spain, and is a target species of a specific trawl fleet. The red shrimp has a wide bathymetric distribution, between 80 and 3300 m depth (Sardà *et al*., 2005), and some areas may constitute a reservoir for the resource since they are located a long way from ports and in deeper zones up to 1000 m. Females predominate in the landings nearly 80% of the total. Discards of the red shrimp are null. The number of harbours with red shrimp fleets is 14 for the whole area. Exploitation is based on very young age classes, mainly 1 and 0 year old individuals, indicating a dependence on recruitments.

8.48.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.48.2.3. Catches

8.48.2.3.1. Landings

Updated information on landings and effort has been collected on annual basis (2002-2008). Throughout the time series landings fluctuated between 300 and 650 tonnes, with an average of c.a. 500 tonnes, with a recovering trend in 2007 and 2008.

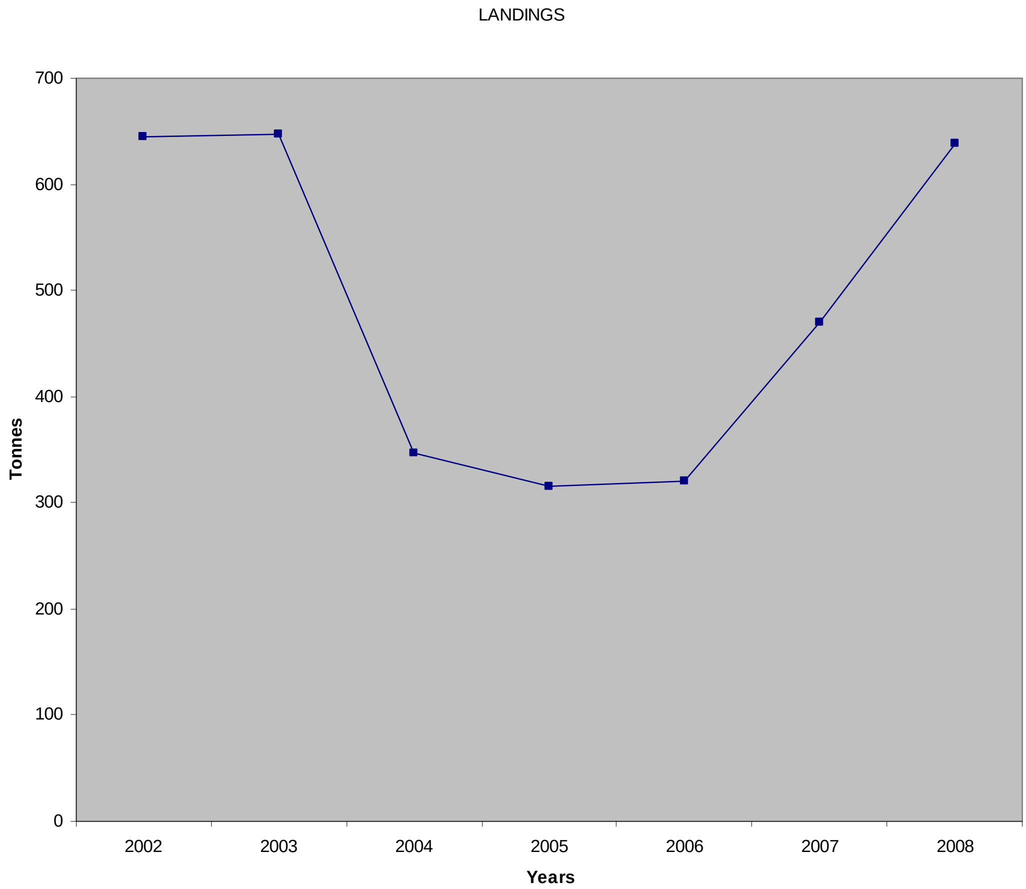


Fig. 8.48.2.3.1.1 Annual blue and red shrimp landings (t) by Spanish trawlers.

Tab. 8.48.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.6 of Appendix 3. Since 2002 the annual landings decreased from 645 t to 316 t in 2005, recovering the initial values in 2008. The landings were only taken by demersal otter trawls.

Tab. 8.48.2.3.1.1 Annual landings (t) by fishing technique in GSA 06.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
ARA	6	ESP	OTB	645	647	347	316	320	470	638

8.48.2.3.2. Discards

No information was documented during SGMED-09-02.

8.48.2.3.3. Fishing effort

Fishing effort has reduced from 20,000 days in 2002 to 9,000 in 2006, with an increase thereafter, reaching the 23,000 in 2008. SGMED notes that the fishing effort below only includes vessels that have landed blue and red shrimp in the given years.

No official data have been reported to SGMED 09-02.

8.48.3. Scientific surveys

8.48.3.1.Medits

8.48.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 06 the following number of hauls were reported per depth stratum (s. Tab. 8.48.3.1.1.1).

Tab. 8.48.3.1.1.1. Number of hauls per year and depth stratum in GSA 06, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA06_010-050	7	8	7	8	7	8	9	8	11	9	9	11	12	6	8
GSA06_050-100	21	28	27	26	28	30	30	31	36	39	31	32	34	40	43
GSA06_100-200	11	19	17	15	13	17	19	20	20	21	17	18	19	24	30
GSA06_200-500	10	13	10	12	7	13	12	16	17	18	16	15	18	18	19
GSA06_500-800	7	8	9	7	4	9	6	8	7	11	11	8	10	15	14

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

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

frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.48.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.48.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red shrimp in GSA 06 was derived from the international survey Medits. Figure 8.48.3.1.3.1 displays the estimated trend in blue and red shrimp abundance and biomass in GSA 06.

The estimated abundance and biomass indices were high in 2000, 2001 and 2002 but varied at a low level since then. The last year (2008) shows a big increase in values.

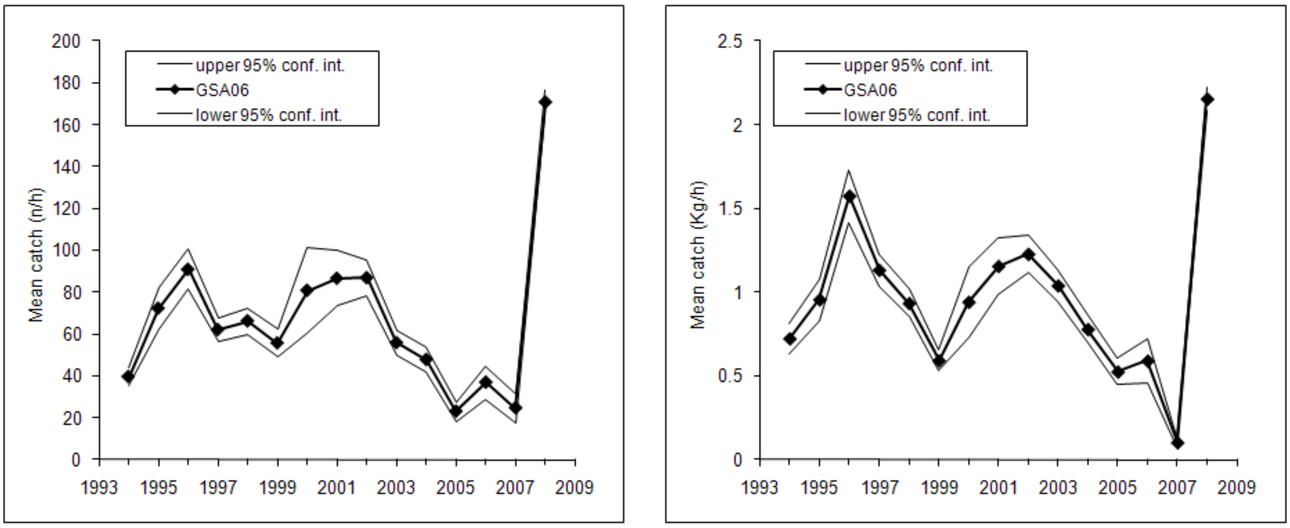


Fig. 8.48.3.1.3.1 Abundance and biomass indices of red shrimp in GSA 06.

8.48.3.1.4. Trends in abundance by length or age

The following Fig. 8.48.3.1.4.1 and 2 display the stratified abundance indices of GSA 06 in 1994-2008.

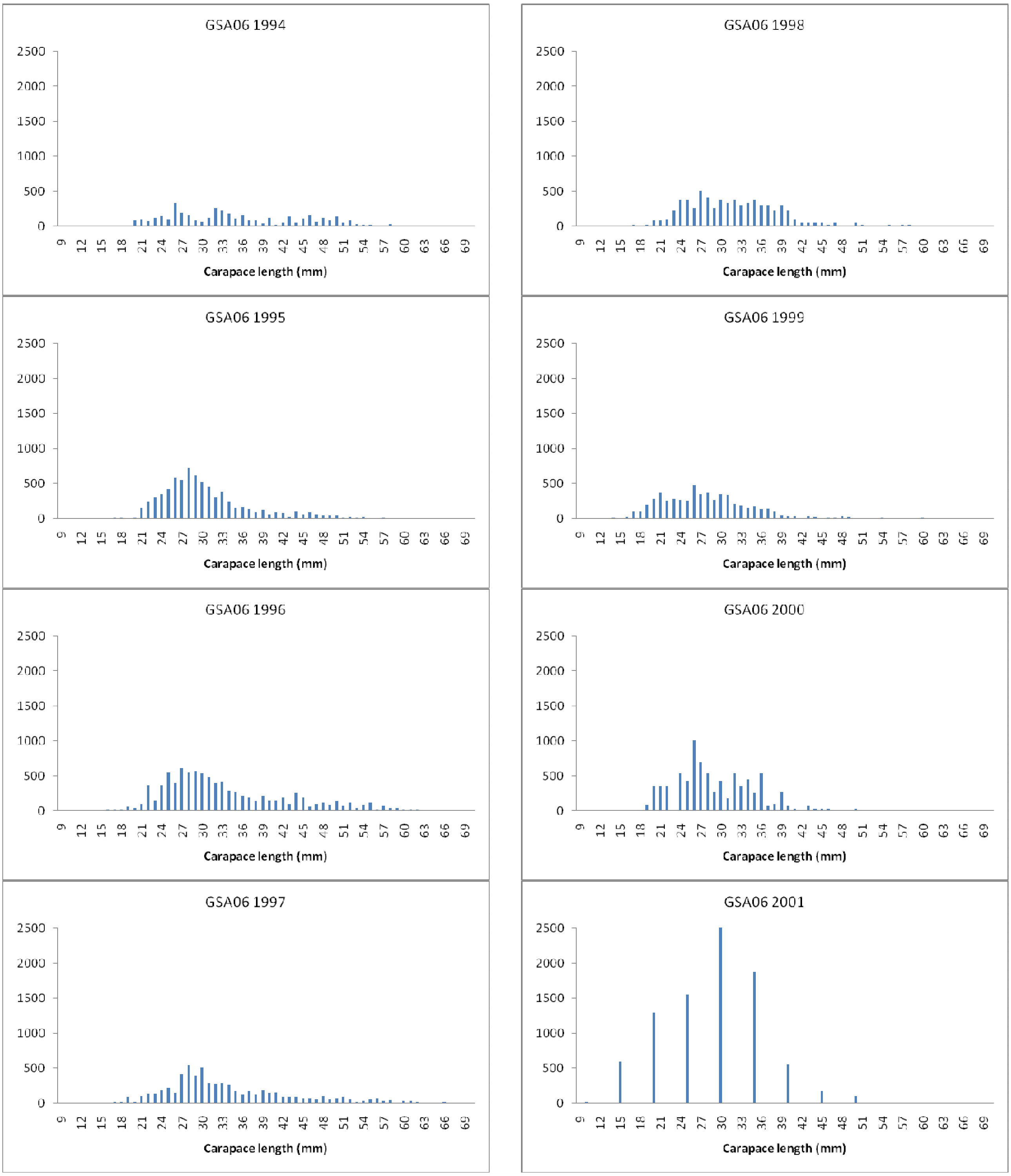


Fig. 8.48.3.1.4.1 Stratified abundance indices by size, 1994-2001.

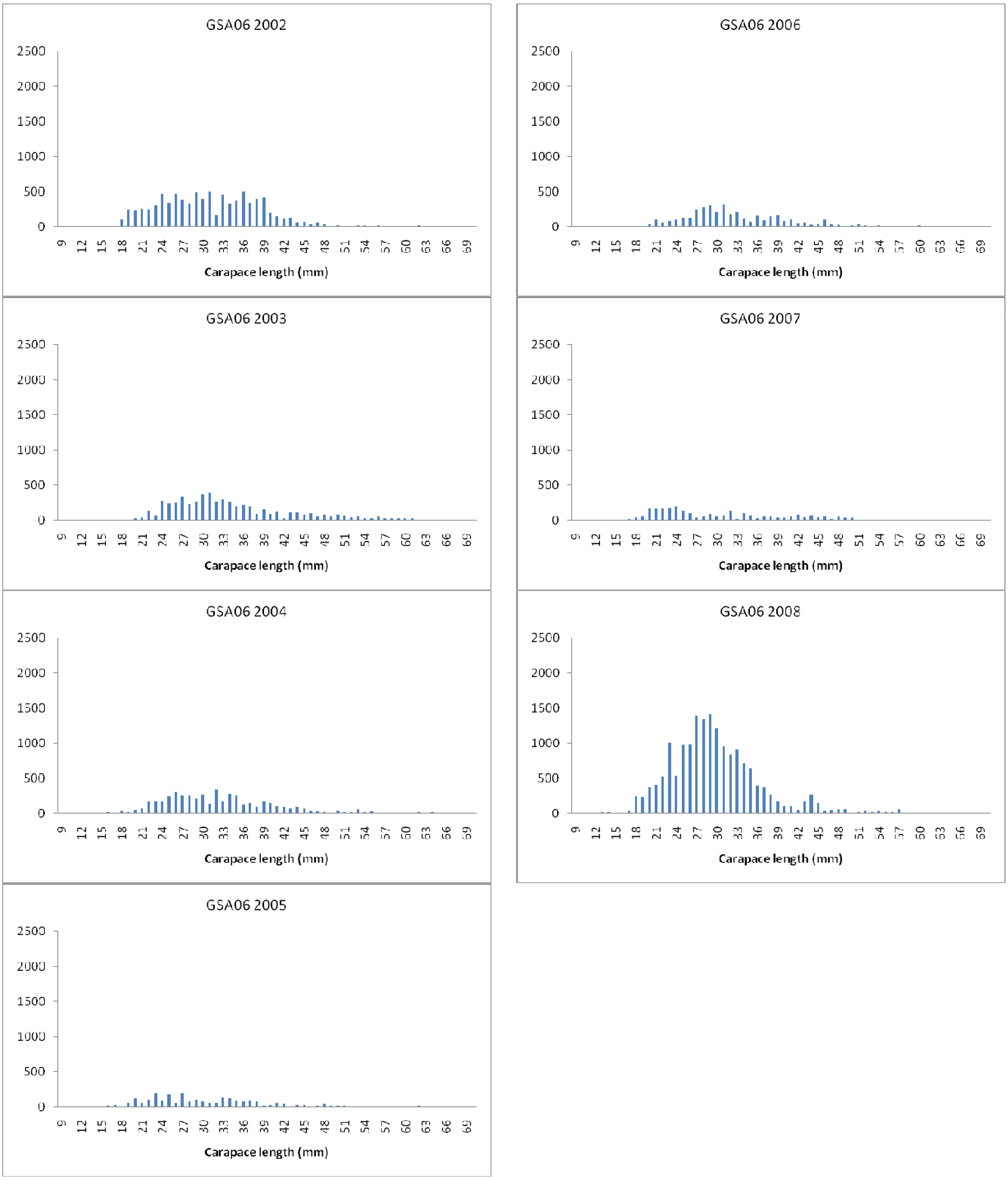


Fig. 8.48.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.48.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.48.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.48.4. Assessment of historic stock parameters

8.48.4.1.Method 1: XSA

8.48.4.1.1. Justification

During the SGMED-09-02, an assessment on red shrimp from GSA 06 was performed. Files dealing with official landings and effort were not available. Consequently data on landings and effort for 2008, were derived, by regression, from the series.

8.48.4.1.2. Input data

Tab. 8.48.4.1.2.1 Input data used in the XSA assessment.

Red shrimp				**Catch at age**			
Age class	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
0	1724.7	4580.2	3790.5	4160.8	3688.8	4475	9796.5
1	16115.7	14664.6	25356.9	23263.4	23119.8	30558.2	39672.2
2	2525.4	2528.4	1807.6	1695.7	1897.8	2185.1	3859.5
3	313.9	365.6	411	324.3	127.7	221.3	808.1
4+	14.3	47.3	42	55.9	10.2	2.7	40.9
				Weight at age (kg)			
Age class	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
0	0.005	0.004	0.005	0.005	0.005	0.005	0.005
1	0.012	0.011	0.011	0.01	0.011	0.01	0.009
2	0.027	0.027	0.028	0.028	0.027	0.028	0.028
3	0.046	0.047	0.048	0.047	0.046	0.046	0.046
4+	0.061	0.062	0.061	0.062	0.06	0.057	0.061
Age class	**Maturity at age**		Age class	**Natural mortality**			
0	0.07863309		0	0.45			
1	0.7669088		1	0.45			
2	0.9980806		2	0.45			
3	1		3	0.45			
4+	1		4+	0.45			
				Tunning parameters (MEDITS)			
Age class	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
0	0.98763066	0.32547841	0.71542121	0.34818368	0.58151751	2.49106938	0.09087769
1	8.35745246	4.17407313	4.5871268	1.60779257	14.0884189	6.58091453	0.6404755
2	2.19192715	2.14427471	1.52464883	0.66831594	6.84555265	5.59664485	0.12580226
3	0.14173455	0.97178209	0.24546964	0.09977672	0.52608953	7.5953E-05	0.03186625
4+	0.08140866	0.12189778	0.12348588	0.06894482	3.4299E-05	3.4299E-05	3.4299E-05

8.48.4.1.3. Results including sensitivity analyses

Tab. 8.48.4.1.3.1 Results of the XSA assessment. Estimated fishing mortality and summary table listing trends in recruitment at age 0, total and spawning stock biomass, landings, ratio between yield and SSB as well as mean fishing mortality over ages 0-3.

Table 8	Fishing mortality (F) at age							
YEAR	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**FBAR ****
AGE								
0	0.0574	0.0974	0.0854	0.087	0.0595	0.0615	0.1447	0.0886
1	1.3833	1.5526	2.1926	1.9511	1.5723	1.5899	2.1403	1.7675
2	1.4101	1.3287	1.2724	1.8	1.4799	0.8345	1.4833	1.2659
3	1.115	1.2141	1.2301	1.2836	0.9074	0.9687	1.4108	1.0956
+gp	1.115	1.2141	1.2301	1.2836	0.9074	0.9687	1.4108	
0 FBAR 0- 3	0.9915	1.0482	1.1951	1.2805	1.0048	0.8636	1.2948	
1								

Table 17	Summary (with SOP correction)						
	Terminal Fs derived using XSA (With F shrinkage)						
	RECI	**TOTALBIO**	**TOTSPBIO**	**LANDINGS**	**YIELD/SSB**	**SOPCOFA**	**FBAR 0- 3**
	Age 0						
2002	38696	1487	913	645	0.7062	2.2591	0.9915
2003	61795	1582	887	647	0.7291	2.4141	1.0482
2004	58006	759	422	347	0.8213	0.9359	1.1951
2005	62513	747	384	316	0.8234	0.9887	1.2805
2006	80014	870	422	320	0.7577	0.9683	1.0048
2007	93908	1302	661	470	0.7113	1.1765	0.8636
2008	91043	1385	766	638	0.8332	1.1521	1.2948
Arith.							
Mean	69425	1162	637	483	0.7689		1.0969
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

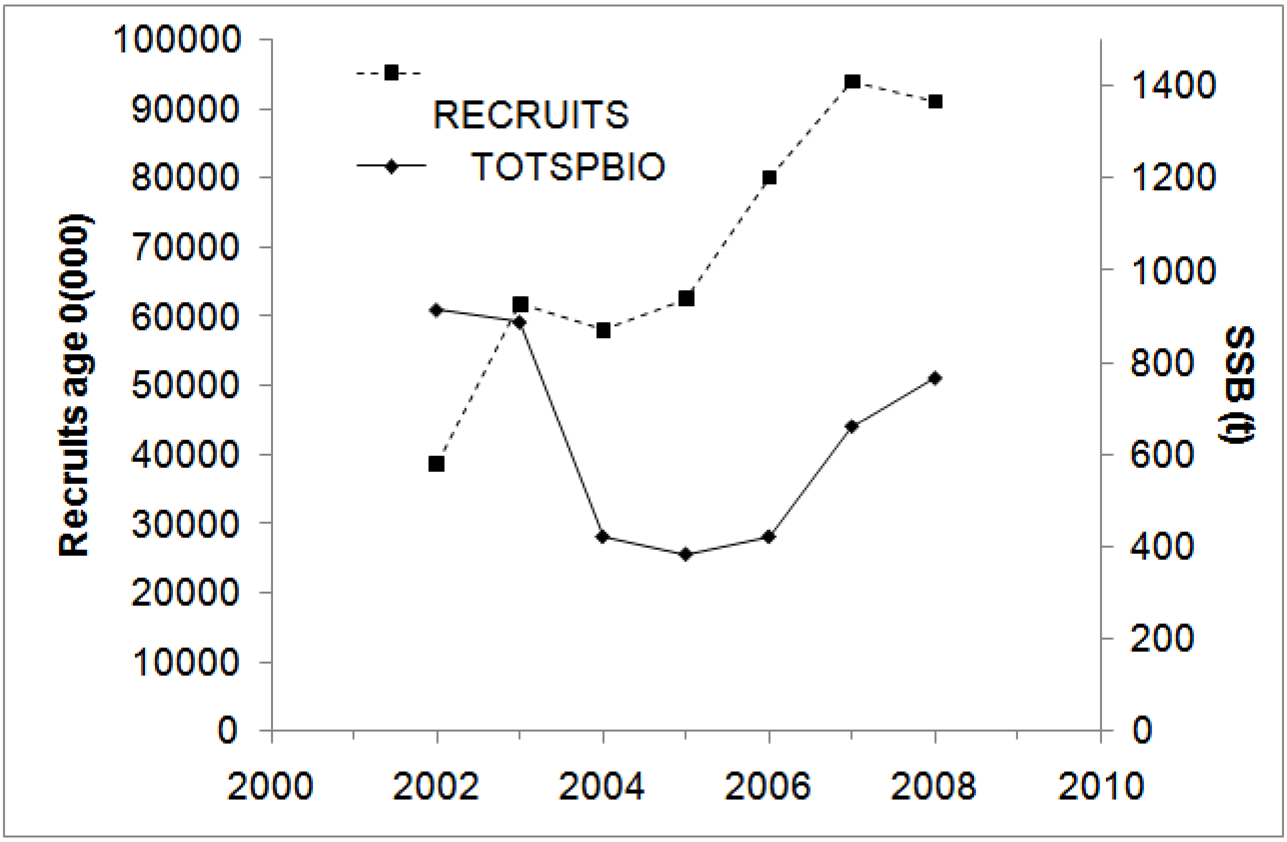


Fig. 8.48.4.1.3.1 Trends is spawning stock biomass (SSB) and recruitment as estimated by XSA.

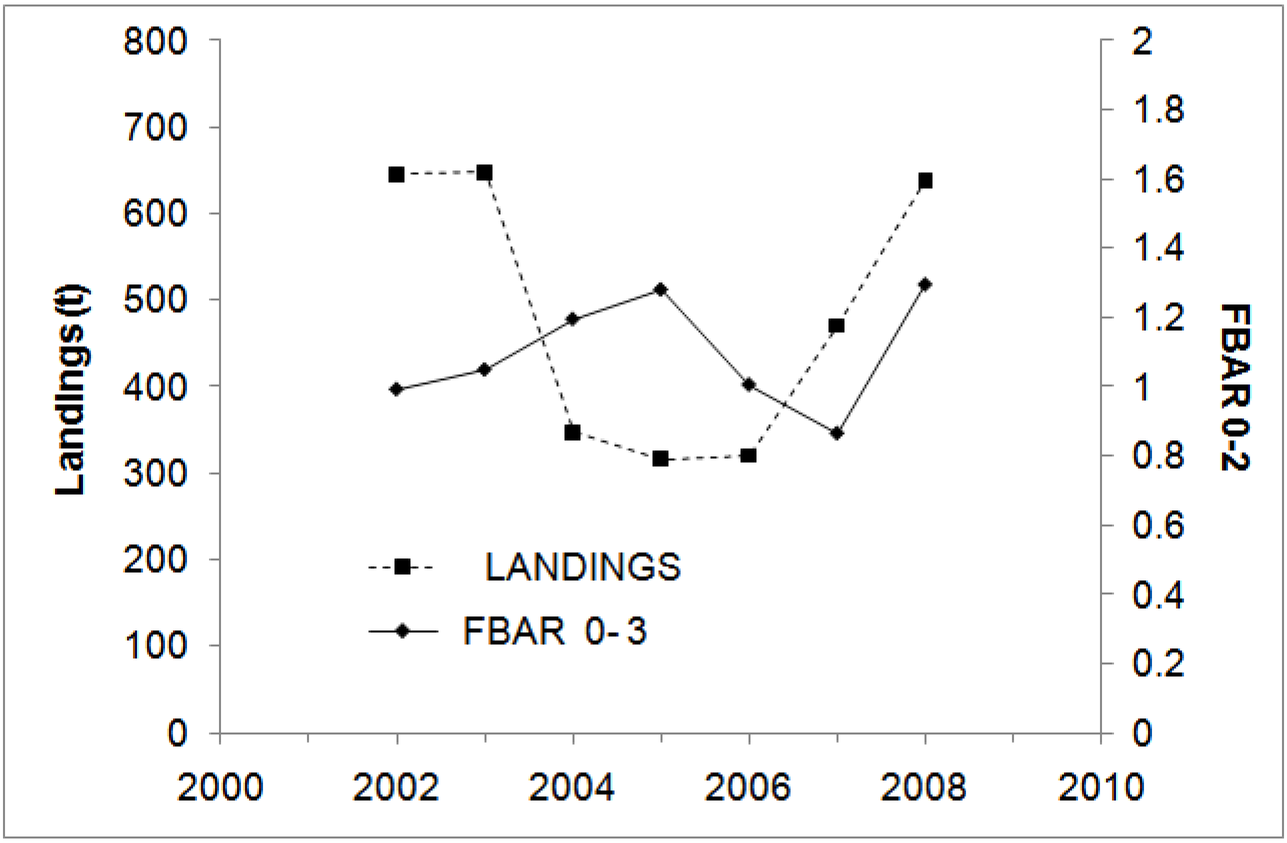


Fig. 8.48.4.1.3.2 Trends in landings and mean fishing mortality (FBAR) as estimated by XSA.

8.48.5. *Long term prediction*

8.48.5.1. Justification

No forecast analyses were conducted.

8.48.5.2. Input parameters

No forecast analyses were conducted.

8.48.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for red shrimp in GSA 06.

8.48.6. *Scientific advice*

8.48.6.1. Short term considerations

8.48.6.1.1. State of the spawning stock size

Since 2002, SSB, with an average for the whole period of 637 mt, declined rapidly from 2002 to 2004 reaching the lowest value (384 t) observed in 2002-2008 which represents a 25% of that observed in 2002. Thereafter, SSB is estimated to increase until 2008 almost to the level seen in the beginning of the assessed time period.

SGMED-09-02 notes that the MEDITS survey abundance index shows oscillations along the period, generally decreasing from 1996 to 2007 and largely increasing in 2008. The large variation in the CPUE might be related to the fact that MEDITS survey is principally able to track recruitment or that the SSB is such low that the stock (and relative stock indices) is highly dependent to the incoming year classes. However, this would require further data and analysis.

SGMED-09-02 cannot evaluate the state of the spawning stock relative to reference points, as these have not been proposed or defined.

8.48.6.1.2. State of recruitment

Recruits (aged 0 individuals) were estimated to increase significantly from 2003 to 2007 and remain high in 2008.

8.48.6.1.3. State of exploitation

Mean fishing mortality from 2002 to 2008 varied without a clear trend between 0.8 and 1.3. The highest value is observed in 2008.

The lack of a target management reference point for exploitation causes SGMED-09-02 being unable to fully evaluate the state of exploitation.

8.49. Stock assessment of blue and red shrimp in GSA 10

8.49.1. Stock identification and biological features

8.49.1.1. Stock Identification

Recent studies based on microsatellite DNA analysis have evidenced genetic differences between the central-southern Tyrrhenian Sea (Sardinia and north Sicily) populations and north Tyrrhenian-Ligurian Sea and Algeria populations (AAVV, 2008, EU Project, Ref. Fish/2004/03-32). Given the preliminary state of these outcomes and lacking other specific analyses the stock of blue and red shrimp *Aristeus antennatus* was assumed in the boundaries of the whole GSA 10. This species and the giant red shrimp *Aristaeomorpha foliacea* are deep-water decapods characterised by seasonal variability and annual fluctuations of abundance (Spedicato *et al*., 1995), as reported for other geographical areas (e.g. Relini and Orsi Relini, 1987). The blue and red shrimp is mainly distributed beyond 500 m depth.

The depth factor appears to influence the sex ratio, which is generally dominated by the females (sex ratio ~0.8-0.9) at 500-700 m depth, as sexes are partially segregated into different bathymetric ranges (e.g. Sardà *et al.*, 2004). The spawning period extends from April to October-November with a peak in July-August (Spedicato *et al.*, 1995). Males are mature all year round. The smallest mature female observed in the area was 18 mm carapace length.

Considering the length of the spawning season, the recruitment has an almost continuous pattern, although there are no clear and well separated peaks of recruit abundance in the LFDs, because this fraction of the population is not fully available. Indeed, from Medits and Grund surveys, individuals less than 20 mm are in general about 2% and, according to the current literature knowledge on the growth pattern, they should already been older than 1 year (16 mm average length at 1 year; e.g. Orsi Relini and Relini, 1998).

In general, the length frequency distributions of the blue and red shrimp have a pattern with overlapping modes and poorly separable components. For the females a life span of 6-10 years was estimated. The structure of the sizes of *A. antennatus* is characterised by marked differences in growth between the sexes. The larger individuals are females.

According to the benthic bionomic classification of Pérès and Picard (1964) *P. longirostris*, *N. norvegicus* and red-shrimps typify the populations of slope and bathyal bottoms in the GSA 10. Depending on the depth and zone, this fauna is accompanied by characteristic bentic species as *Funiculina quadrangularis*, *Geryon longipes*, *Polycheles typhlops*, *Isidella elongata*, *Griphus vitreus*.

In the central-southern Tyrrhenian Sea the blue and red shrimp represents a specific target of deep-waters trawling fishery given its high economic value (Spedicato *et al.*, 1995).

8.49.1.2. Growth

In the central-southern Tyrrhenian the maximum carapace length (CL) observed in females and males was 65 mm and 39.7 mm (Spedicato *et al*., 1995). After estimates of VBGF obtained in the past, growth has been also recently re-assessed in the DCR framework and in the Red Shrimps project (AAVV, 2008) through the analysis of the LFDs. Given the difficulty to separate LFDs into normal components, the LFDs have been analysed according to the procedure first adopted in the Samed project (Anonymous 2002). Thus, an L_{max} (predicted maximum length; procedure implemented in FiSAT) value to be used as guess estimate of L_∞ was computed. This value was then tuned with that obtained from the Powell and Wetherall approach, which gives also estimates of the Z/K ratio. According to the hypothesis of a slow growth pattern (Orsi Relini and Relini, 1998) age 1 at a mean size of 16 mm was assumed and a first estimate of K derived from the ratio: average length at age $1/L\infty$. Thus also a first value of Z was obtained. These parameters were finally calibrated trough the Length Converted Catch Curve (LCCC) and the set giving the better determination coefficient was adopted: females CL_{∞}=66 mm, K=0.243, t_0= -0.2. Parameters of the length-weight relationship were a=0.8512, b=2.4 for females and a=0.9747, b=2.187 for males, for length expressed in cm.

8.49.1.3. Maturity

The maturity ogive was estimated from a maximum likelihood procedure considering as mature the individuals with maturity stage 2 and onwards. The value of $CL_{m50\%}$ was 2.44 cm (±0.049 cm). However the fitting obtained was poor and seems to overestimates the length at first maturity.

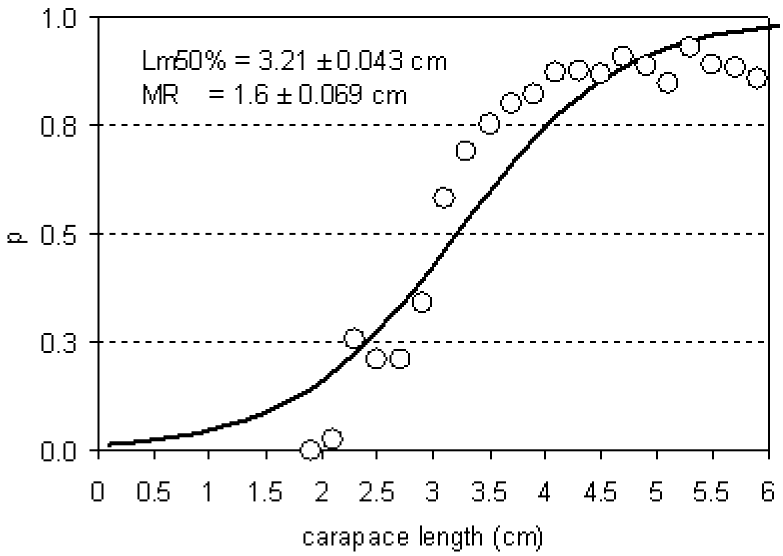


Fig. 8.49.1.3.1 Maturity ogive of blue and red shrimp in the GSA 10 (MR indicates the difference $Lm_{75\%}$-$Lm_{25\%}$).

The sex ratio from DCR evidenced the prevalence of males in the first two size classes (1.8-2.0 cm) while from 2.4 cm onwards the proportion of females was dominant (Fig. 8.49.1.3.2).

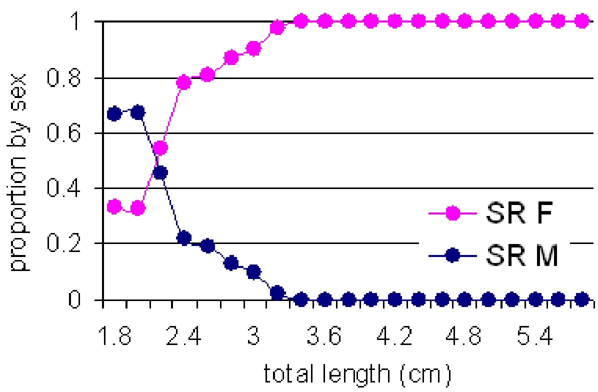


Fig. 8.49.1.3.2 Sex ratio over length.

8.49.2. Fisheries

8.49.2.1. General description of fisheries

The blue and red shrimp is only targeted by trawlers on fishing grounds located offshore 200 m depth, mainly southward Salerno Gulf. Catches from trawlers are from a depth range between 400 and 700 m depth and the blue and red shrimp occurs with *A. foliacea*, *P. longirostris* and *N. norvegicus*, *P. blennoides*, *M. merluccius*, depending on operative depth and area.

8.49.2.2. Management regulations applicable in 2008 and 2009

Management regulations are based on technical measures, like the number of fishing licenses and area limitation (distance from the coast and depth). In order to limit the over-capacity of the fishing fleet, the Italian fishing licenses have been fixed since the late 1980s. After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity is implemented. Along northern Sicily coasts two main Gulfs (Patti and Castellammare) have been closed to the trawl fishery up 200 m depth, since 1990. Two closed areas were also established in 2004 along the mainland, in front of Sorrento peninsula (Napoli Gulf) and Amantea (Calabrian coasts) although these protected area mainly cover the distribution of coastal species. Other measures on which the management regulations are based are technical measures (mesh size) and minimum landing sizes (EC reg. 1967/06). In the GSA 10 the fishing ban has not been mandatory and it has been adopted on a voluntary basis by the fleet.

8.49.2.3. Catches

8.49.2.3.1. Landings

Available landing data are from DCR regulations. SGMED-09-02 received Italian landings data for GSA 10 by major fishing gears which are listed in Tab. 8.49.2.3.1.1. The fishing segments DTS and OTB, GNS, and PMP indicate respectively trawlers and small scale fishery (gillnet and polyvalent). After 2004, landings of the blue and red shrimp decreased in 2008 to the level of 2003 (about 20 t) (Fig. 8.49.2.3.1.1). Most part of the landings is from trawlers.

Tab. 8.49.2.3.1.1. Annual landings (t) by gear type, 2003-2008.

Sum of LW	FT_LVL4				
YEAR	DTS	GNS	OTB	PMP	Total
2003	17.0			1.5	18.5
2004		0.1	120.1		120.2
2005		1.6	62.4		63.9
2006		0.0	51.6		51.7
2007			39.5		39.5
2008			23.0		23.0

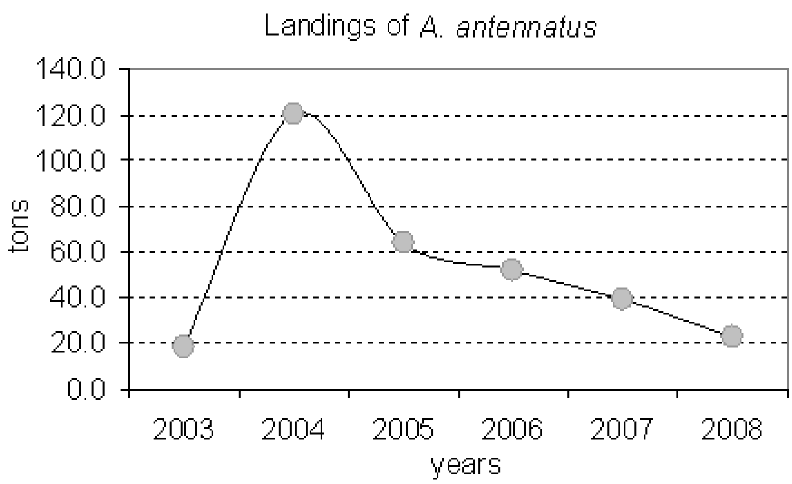


Fig. 8.49.2.3.1.1Total landings (t) 2003-2008 as reported by DCR in the GSA10.

8.49.2.3.2. Fishing effort

The trends in fishing effort by year and major gear type is listed in Tab. 8.49.2.3.2.1 and shown in Fig. 8.49.2.3.2.1 in terms of kW*days. The fishing segments DTS, HOK, PGP, PMP and PTS indicate respectively trawlers, long-lines, small scale fishery (nets), polyvalent and pair trawls. The fishing effort in kW*days of the trawlers, that is the fishing segment targeting the giant red shrimp, was rising in 2004 and 2005 and then decreasing in 2006 and 2007.

Tab. 8.49.2.3.2.1 Trend in fishing effort (kW*days) for GSA10 by major gear types, 2002-2007.

YEAR	FT_LVL4_TYPE		KW*DAYS						
	DRB	DTS	FPO	GND	GNS	GTR	HOK	LHP-LHM	LLD
2002	94663	7344089							
2003	29540	7231486							
2004	110899	7883881					1654352		
2005	404243		226805	2878658	4378416	1519874		441690	819922
2006	392760		147562	2394591	2465382	3789078		395408	654956
2007	170557		5309	2232763	1848657	3793640		417886	412060
YEAR	LLS	MIS	OTB	PGP	PMP	PS	PTS	SB-SV	Total
2002				6440217	12686947		2631242		29197158
2003				7222145	8003452		2930380		25417003
2004				7056306	3588004		2308589		22602033
2005	1852150	936565	8102762			1538303		701108	23800496
2006	1289606	273517	6944418			1506523		859501	21113301
2007	1194311	73082	6882389			1222112		959937	19212704

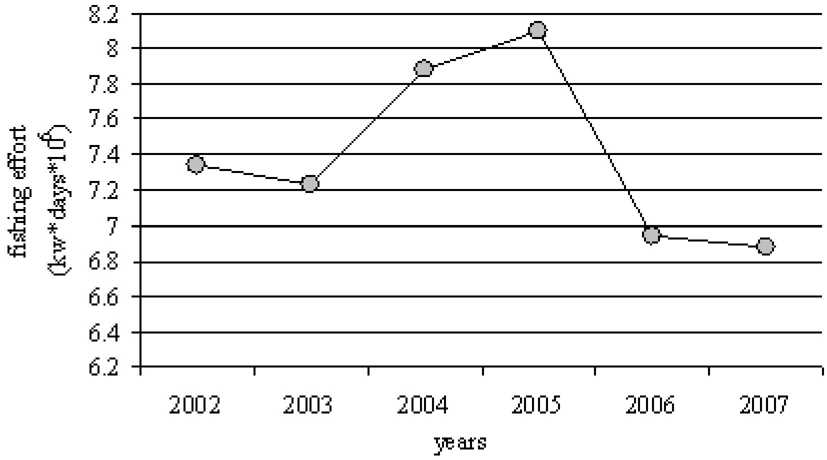


Fig. 8.49.2.3.2.1 Trend in fishing effort (kW*days*10) of trawlers in the GSA 10, 2002-2007.

8.49.3. Scientific surveys

8.49.3.1. Medits

8.49.3.1.1. Methods

According to the MEDITS protocol (Bertrand *et al*., 2002), trawl surveys were carried out yearly (May-July), applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed.

Based on the DCR data call, abundance and biomass indices were calculated. In GSA 10 the following number of hauls were reported per depth stratum (Tab. 8.49.3.1.1.1).

Tab. 8.49.3.1.1.1 Number of hauls per year and depth stratum in GSA 10, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA10_010-050	9	10	10	10	10	10	10	10	9	9	9	9	9	9	9
GSA10_050-100	12	12	12	12	12	12	12	12	10	10	10	10	10	10	10
GSA10_100-200	20	20	20	20	20	20	20	20	17	17	17	17	17	17	17
GSA10_200-500	26	27	26	26	27	26	26	28	22	22	22	22	22	22	22
GSA10_500-800	31	30	31	31	31	30	31	29	26	27	26	26	26	26	26

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Only hauls considered as valid were used in the analysis including stations with no catches (zero catches are included).

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

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

8.49.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.49.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red shrimp in GSA 10 was derived from the international survey Medits. Figure 8.49.3.1.3.1 displays the estimated trend in blue and red shrimp abundance and biomass in GSA 10.

The estimated abundance and biomass indices varied without a clear trend during 1994-2008.

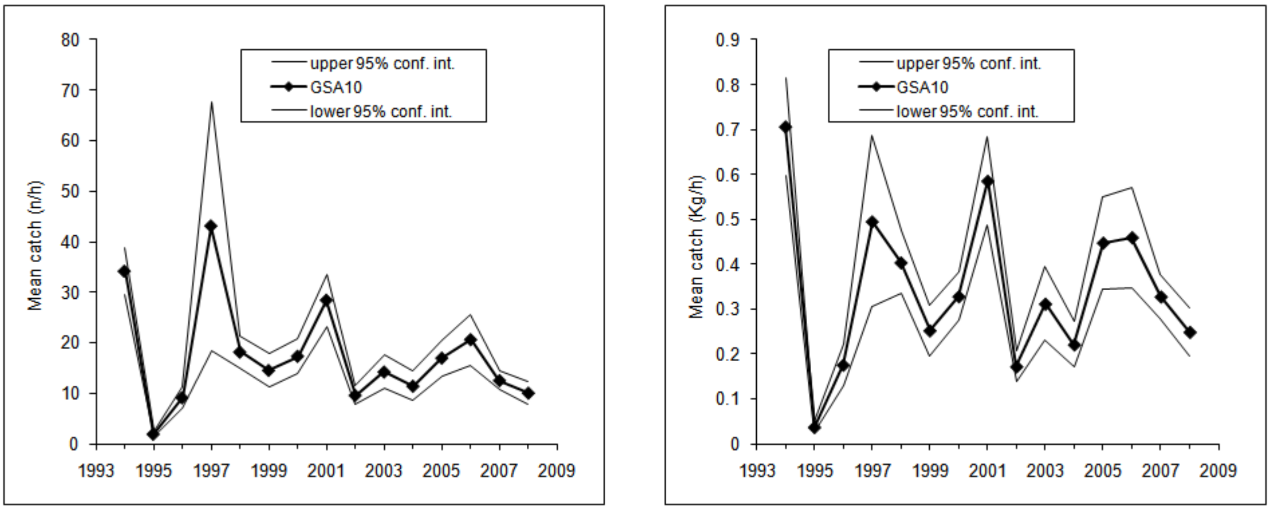


Fig. 8.49.3.1.3.1 Abundance and biomass indices of red shrimp in GSA 10.

8.49.3.1.4. Trends in abundance by length or age

The following Fig. 8.49.3.1.4.1 and 2 display the stratified abundance indices of GSA 10 in 1994-2008.

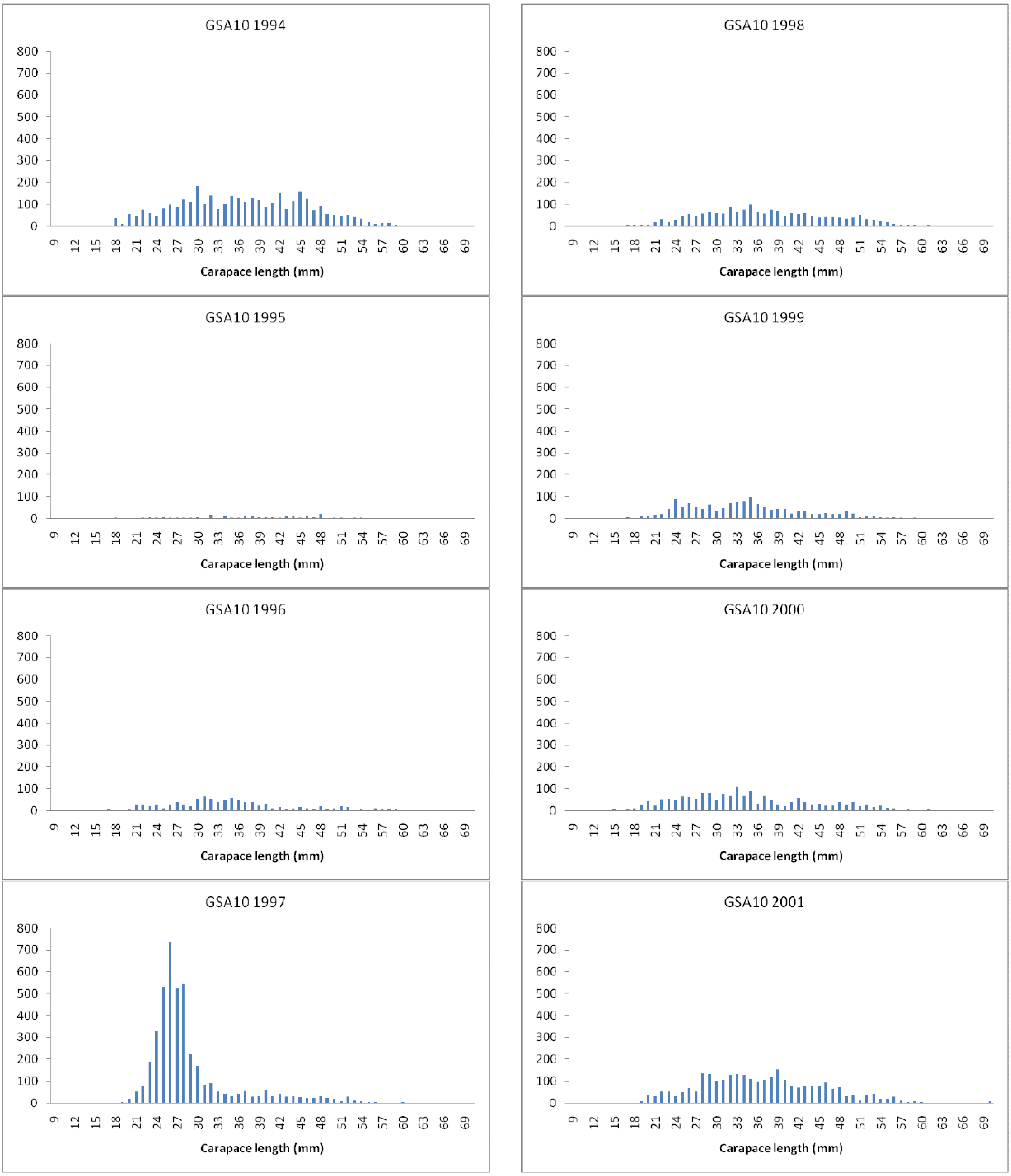


Fig. 8.48.3.1.4.1 Stratified abundance indices by size, 1994-2001.

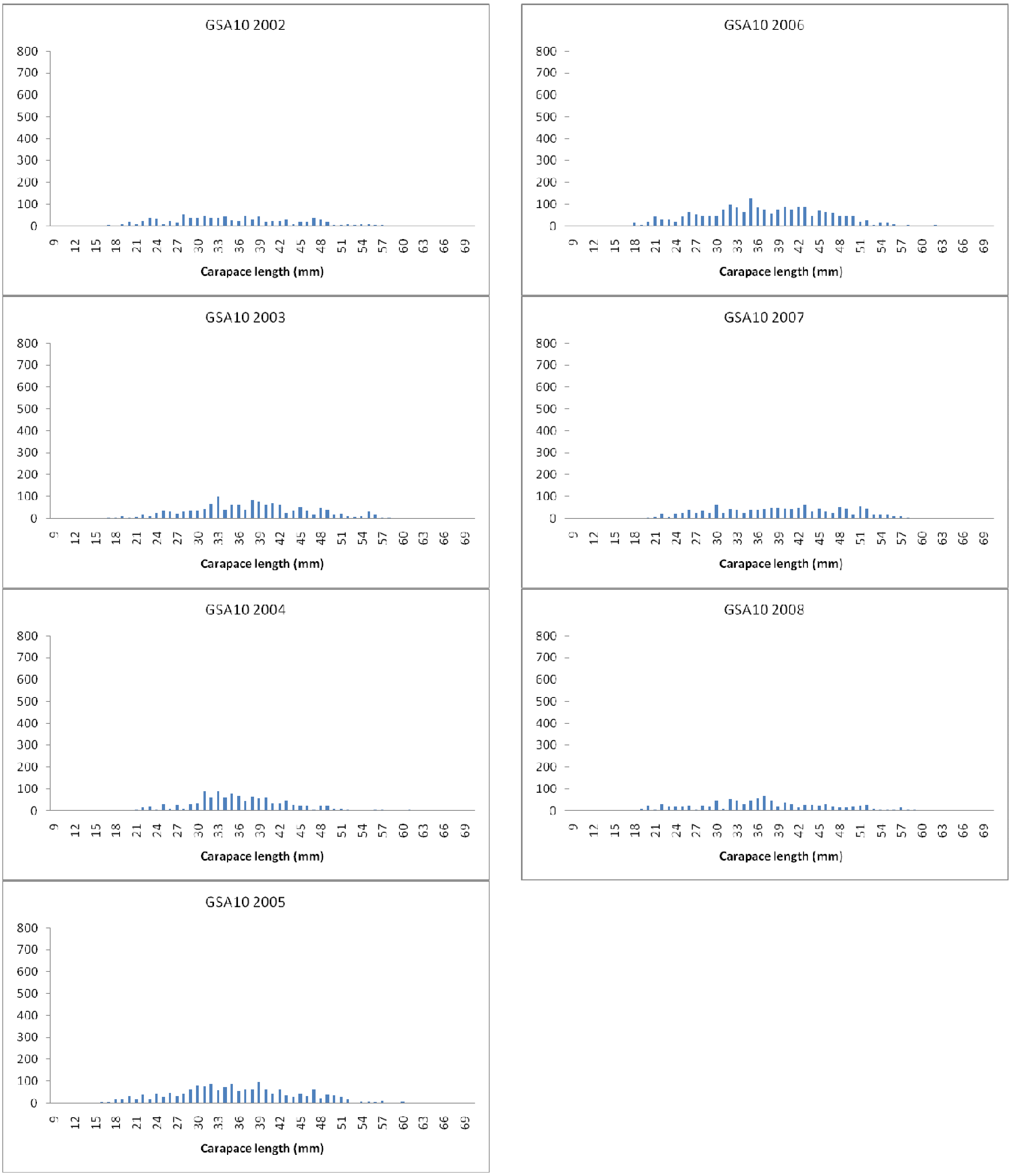


Fig. 8.49.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.49.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.49.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.49.3.2. GRUND

8.49.3.2.1. Methods

Since 2003 Grund surveys (Relini, 2000) was conducted using the same sampler (vessel and gear) in the whole GSA. Sampling scheme, stratification and protocols were similar as in Medits. All the abundance and biomass data were standardised to the square kilometre, using the swept area method.

8.49.3.2.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.49.3.2.3. Trends in abundance and biomass

Trends derived from the GRUND surveys are shown in Fig. 8.49.3.2.3.1. Abundance and biomass indices show some fluctuations with peaks in different years from Medits (Fig. 8.49.3.1.3.1). Higher values were recorded in 1996 and 2005.

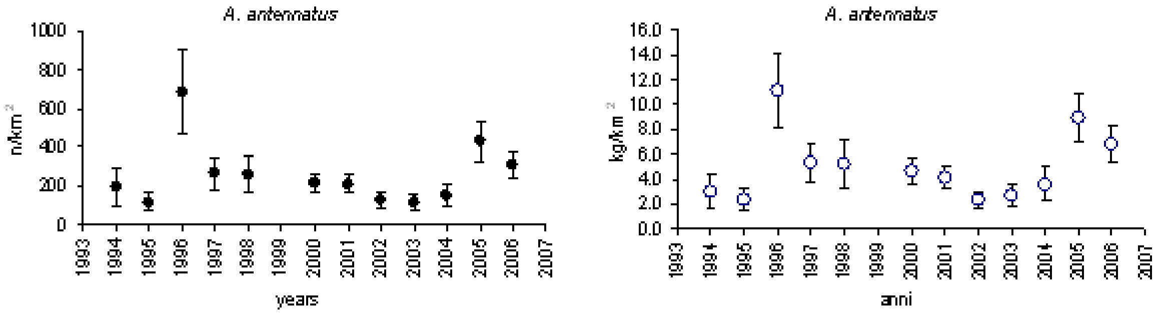


Fig. 8.49.3.2.3.1. Abundance and biomass indices of blue and red shrimp in GSA 10 (bars indicate standard deviations) derived from Grund surveys.

8.49.3.2.4. Trends in abundance by length or age

No annual figures of length compositions were constructed.

A positive trend in the mean length was observed in Medits survey (Fig. 8.49.3.2.4.1), while no trend at the third quantile lengths was observed in the length structures of Grund time series from 1994 to 2006 (Fig. 8.49.3.2.4.2).

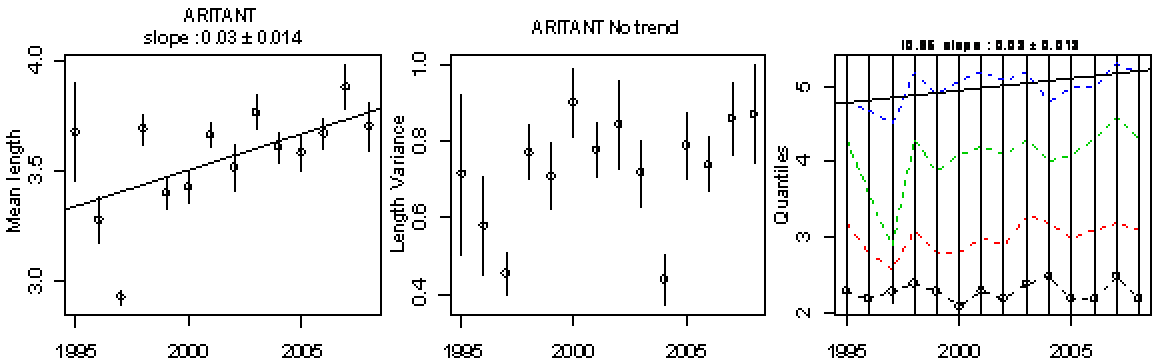


Fig. 8.49.3.2.4.1 Mean length, variance and quantiles derived from the Medits length compositions in 1995-2008.

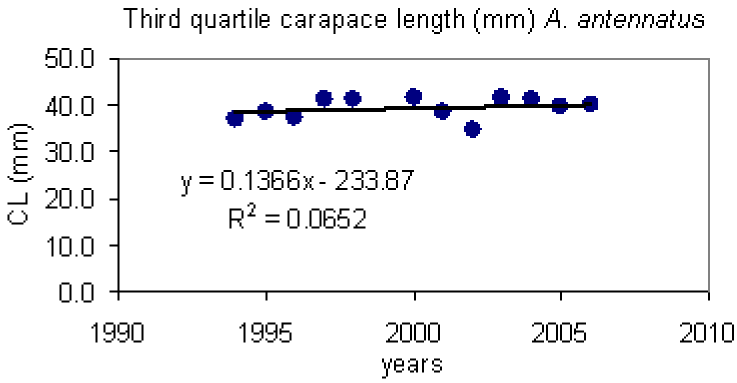


Fig. 8.49.3.2.4.2 III Quantile derived from the GRUND length structures in 1994-2006.

8.49.3.2.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.49.3.2.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.49.4. Assessment of historic stock parameters

No analytical assessment was performed.

8.49.5. Long term prediction

8.49.5.1. Justification

No forecast analyses were conducted.

8.49.5.2. Input parameters

No forecast analyses were conducted.

8.49.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a short term prediction of catch and stock biomass for blue and red shrimp in GSA 10.

8.49.6. Scientific advice

8.49.6.1. Short term considerations

8.49.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.49.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of recruitment in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.49.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of exploitation in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.50. Stock assessment of blue and red shrimp in GSA 11

8.50.1. Stock identification and biological features

8.50.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.50.1.2. Growth

No information was documented during SGMED-09-02.

8.50.1.3. Maturity

No information was documented during SGMED-09-02.

8.50.2. Fisheries

8.50.2.1. General description of fisheries

No information was documented during SGMED-09-02.

8.50.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.50.2.3. Catches

8.50.2.3.1. Landings

Tab. 8.50.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.8 of Appendix 3. The landings were mainly taken by demersal otter trawls.

Tab. 8.50.2.3.1.1 Annual landings (t) by fishing technique in GSA 11. Landings data provided for the year 2003 probably have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
ARA	11	ITA	DTS		101407					
ARA	11	ITA	OTB			174	299	225	125	112
ARA	11	ITA	PMP		18922					

8.50.2.3.2. Discards

According to information available to the SGMED-09-02 no catches of *Aristeus antennatus* were discarded by the Italian fleet.

8.50.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-09-02 are listed in Tab. 8.50.2.3.3.1 and in Tab. A3.10-3.12 of Appendix 3.

Tab. 8.50.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSA 11, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	11	ITA	DTS	14539	18957	28840				
DAYS	11	ITA	FPO				1211	9616	31238	
DAYS	11	ITA	FYK						608	
DAYS	11	ITA	GND						51	
DAYS	11	ITA	GNS				21601	7574	29014	
DAYS	11	ITA	GTR				124877	139221	83350	
DAYS	11	ITA	LHP-LHM				50	1028	3379	
DAYS	11	ITA	LLD				2263	5117	4441	
DAYS	11	ITA	LLS				9758	16168	20224	
DAYS	11	ITA	LTL					128	31	
DAYS	11	ITA	OTB				29211	25368	25596	
DAYS	11	ITA	PGP	102826	126272	165945				
DAYS	11	ITA	PMP	57543	30879					
GT*days	11	ITA	DTS	772163	986387	1598912				
GT*DAYS	11	ITA	FPO				6215	49606	84529	
GT*DAYS	11	ITA	FYK						622	
GT*DAYS	11	ITA	GND						2544	
GT*DAYS	11	ITA	GNS				71331	18124	61528	
GT*DAYS	11	ITA	GTR				428009	430370	295688	
GT*DAYS	11	ITA	LHP-LHM				100	6394	10466	
GT*DAYS	11	ITA	LLD				26766	86801	158560	
GT*DAYS	11	ITA	LLS				42073	99731	84653	
GT*DAYS	11	ITA	LTL					270	63	
GT*DAYS	11	ITA	OTB				1934836	1399052	1423265	
GT*days	11	ITA	PGP	306226	468352	501550				
GT*days	11	ITA	PMP	611726	308212					
kW*days	11	ITA	DTS	3679604	4652647	6711626				
KW*DAYS	11	ITA	FPO				79031	824017	1387022	
KW*DAYS	11	ITA	FYK						13055	
KW*DAYS	11	ITA	GND						11713	
KW*DAYS	11	ITA	GNS				1007963	236313	781402	
KW*DAYS	11	ITA	GTR				6358014	6476994	4393484	
KW*DAYS	11	ITA	LHP-LHM				769	70523	122621	
KW*DAYS	11	ITA	LLD				284297	480411	952876	
KW*DAYS	11	ITA	LLS				832709	1159412	1054615	
KW*DAYS	11	ITA	LTL					12388	1622	
KW*DAYS	11	ITA	OTB				7679721	5879355	5957347	
kW*days	11	ITA	PGP	2865738	5099814	7105771				
kW*days	11	ITA	PMP	7159338	3245118					

8.50.3.Scientific surveys

8.50.3.1.Medits

8.50.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 11 the following number of hauls was reported per depth stratum (s. Tab. 8.50.3.1.1.1).

Tab. 8.50.3.1.1.1. Number of hauls per year and depth stratum in GSA 11, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA11_010-050	17	19	21	21	21	21	19	18	20	18	17	17	19	19	17
GSA11_050-100	27	21	22	22	20	22	22	24	19	19	18	21	18	20	19
GSA11_100-200	22	23	30	31	31	30	31	30	24	24	24	24	24	24	22
GSA11_200-500	35	29	29	26	25	27	24	25	20	24	21	20	20	20	21
GSA11_500-800	23	16	21	25	25	24	27	26	16	14	15	14	16	17	16

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

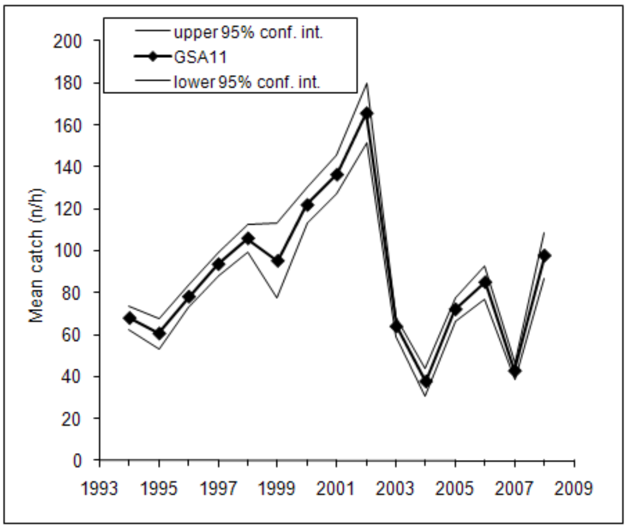
Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.50.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.50.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the blue and red shrimp in GSA 11 was derived from the international survey Medits. Figure 8.50.3.1.3.1 displays the estimated trend in blue and red shrimp abundance and biomass in GSA 11. The analyses of Medits indices are considered preliminary.



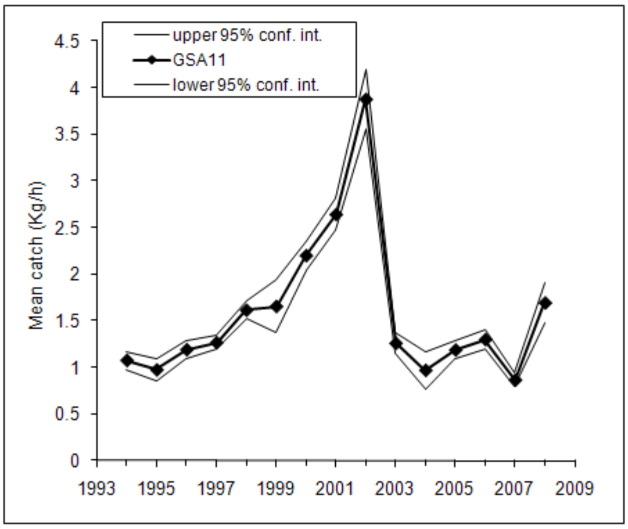


Fig. 8.50.3.1.3.1 Abundance and biomass indices of blue and red shrimp in GSA 11.

8.50.3.1.4. Trends in abundance by length or age

The following Fig. 8.50.3.1.4.1 and 2 display the stratified abundance indices of GSA 11 in 1994-2008. These size compositions are considered preliminary.

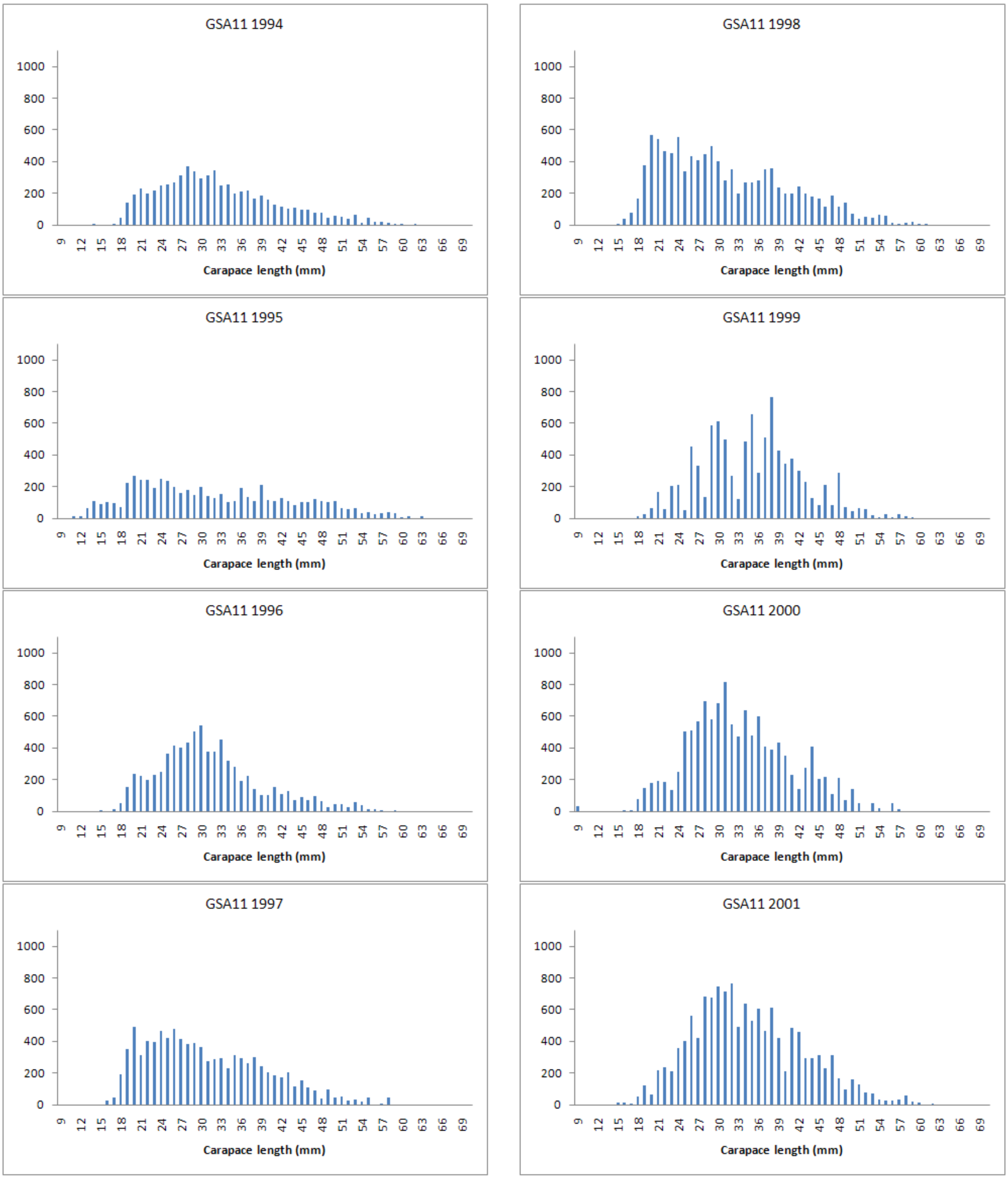


Fig. 8.50.3.1.4.1 Stratified abundance indices by size, 1994-2001.

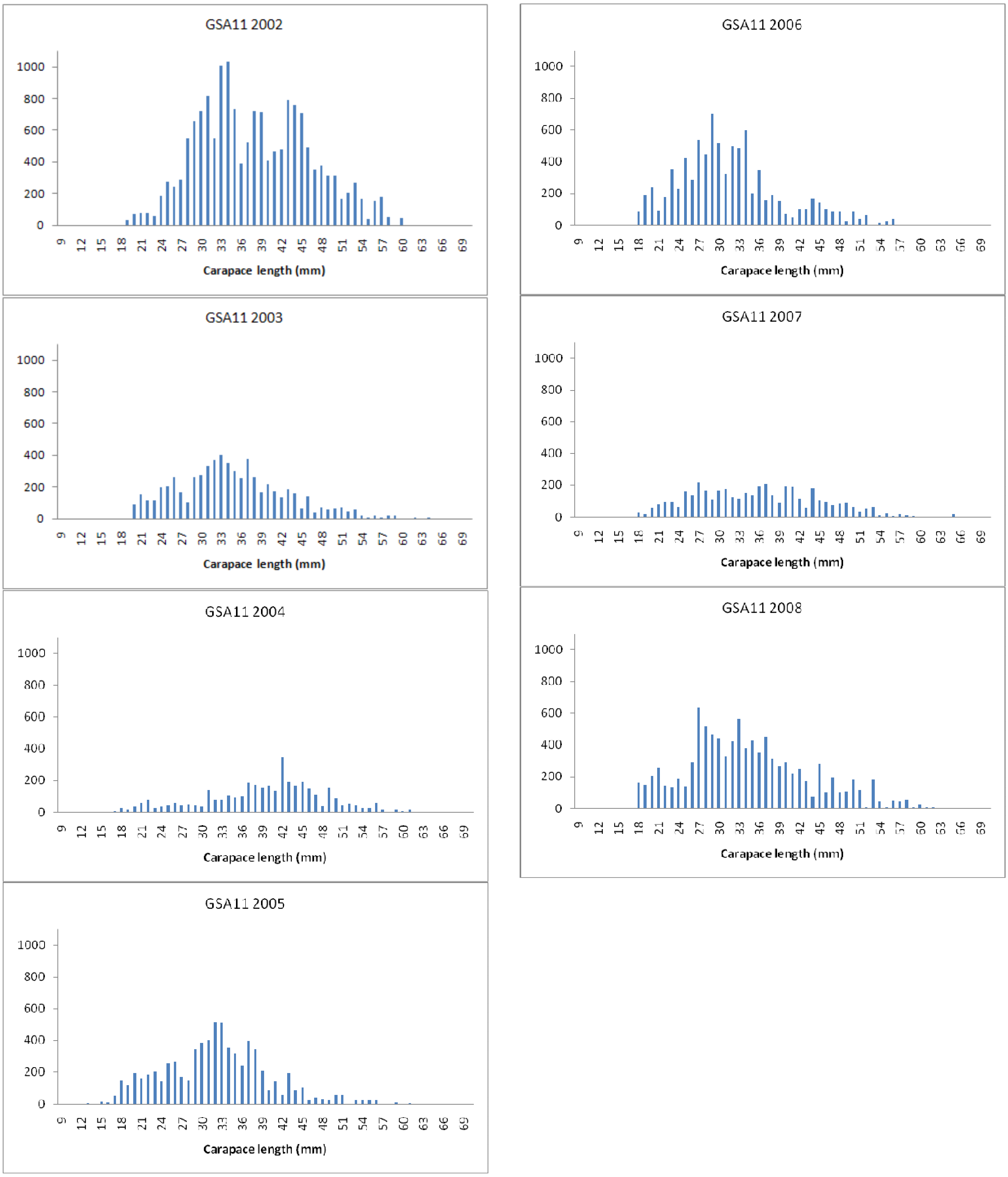


Fig. 8.50.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.50.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.50.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.50.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.50.5. Long term prediction

8.50.5.1. Justification

No forecast analyses were conducted.

8.50.5.2. Input parameters

No forecast analyses were conducted.

8.50.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for blue and red shrimp in GSA 11.

8.50.6. Scientific advice

8.50.6.1. Short term considerations

8.50.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock given the preliminary state of the data and analyses.

8.50.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.50.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.51. Stock assessment of blue and red shrimp in GSA 16

8.51.1. Stock identification and biological features

8.51.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.51.1.2. Growth

No information was documented during SGMED-09-02.

8.51.1.3. Maturity

No information was documented during SGMED-09-02.

8.51.2. Fisheries

8.51.2.1. General description of fisheries

No information was documented during SGMED-09-02.

8.51.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.51.2.3. Catches

8.51.2.3.1. Landings

Tab. 8.51.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.8 of Appendix 3. The landings were taken by demersal otter trawls.

Tab. 8.51.2.3.1.1 Annual landings (t) by fishing technique in GSA 16.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
ARA	16	ITA	OTB			182	140	163	164	135

8.51.2.3.2. Discards

According to information available to the SGMED-09-02 no catches of *Aristeus antennatus* were discarded by the Italian fleet.

8.51.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-09-02 are listed in Tab. 8.51.2.3.3.1 and in Tab. A3.10-3.12 of Appendix 3.

Tab. 8.51.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSA 16, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	16	ITA	DTS	87300	76233	81853				
DAYS	16	ITA	FPO				18	20	28	
DAYS	16	ITA	GND				6717	6218	7547	
DAYS	16	ITA	GTR				78429	52961	50840	
DAYS	16	ITA	HOK			14856				
DAYS	16	ITA	LHP-LHM				1363	3695	4674	
DAYS	16	ITA	LLD				5759	6397	8493	
DAYS	16	ITA	LLS				16424	22888	19638	
DAYS	16	ITA	LTL				300	408		
DAYS	16	ITA	MIS				262			
DAYS	16	ITA	OTB				83124	84674	82261	
DAYS	16	ITA	OTM				756	1540	1471	
DAYS	16	ITA	PGP	146019	118660	118425				
DAYS	16	ITA	PMP	26655	34956	6939				
DAYS	16	ITA	PS				1612	2066	1971	
DAYS	16	ITA	PTM				1204	3746	4193	
DAYS	16	ITA	PTS	8778	8568	4899				
GT*days	16	ITA	DTS	6739948	6175213	6673029				
GT*DAYS	16	ITA	FPO				531	939	2962	
GT*DAYS	16	ITA	GND				51767	68581	70266	
GT*DAYS	16	ITA	GTR				183252	139048	146474	
GT*days	16	ITA	HOK			764595				
GT*DAYS	16	ITA	LHP-LHM				2757	7752	9603	
GT*DAYS	16	ITA	LLD				377485	290622	351965	
GT*DAYS	16	ITA	LLS				40376	41294	51455	
GT*DAYS	16	ITA	LTL				600	815		
GT*DAYS	16	ITA	MIS				1630			
GT*DAYS	16	ITA	OTB				7064255	7088706	6994494	
GT*DAYS	16	ITA	OTM				65935	141508	135199	
GT*days	16	ITA	PGP	410857	732725	249032				
GT*days	16	ITA	PMP	375921	418892	20134				
GT*DAYS	16	ITA	PS				101266	114791	95754	
GT*DAYS	16	ITA	PTM				57807	197450	225837	
GT*days	16	ITA	PTS	585964	327460	224188				
kW*days	16	ITA	DTS	23952310	20951845	21381964				
KW*DAYS	16	ITA	FPO				2602	4116	16280	
KW*DAYS	16	ITA	GND				484488	565283	560624	
KW*DAYS	16	ITA	GTR				2436223	1675235	1779917	
kW*days	16	ITA	HOK			3153486				
KW*DAYS	16	ITA	LHP-LHM				147929	332833	329113	
KW*DAYS	16	ITA	LLD				1102509	1319225	1938868	
KW*DAYS	16	ITA	LLS				812348	751898	805197	
KW*DAYS	16	ITA	LTL				2401	3260		
KW*DAYS	16	ITA	MIS				18900			
KW*DAYS	16	ITA	OTB				22936088	23764571	22757302	
KW*DAYS	16	ITA	OTM				159014	315468	300311	
kW*days	16	ITA	PGP	3133993	4603457	2691324				
kW*days	16	ITA	PMP	2792612	2761842	223470				
KW*DAYS	16	ITA	PS				444087	520717	459314	
KW*DAYS	16	ITA	PTM				280234	712936	862918	
kW*days	16	ITA	PTS	2510582	1750128	962786				

8.51.3.Scientific surveys

8.51.3.1.Medits

8.51.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 16 the following number of hauls was reported per depth stratum (s. Tab. 8.51.3.1.1.1).

Tab. 8.51.3.1.1.1. Number of hauls per year and depth stratum in GSA 16, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA16_010-050	4	4	4	4	4	4	4	4	7	7	7	10	10	11	11
GSA16_050-100	9	8	8	8	8	8	7	8	11	12	12	20	22	23	23
GSA16_100-200	4	4	4	4	5	5	6	5	11	10	11	20	19	21	21
GSA16_200-500	10	11	11	12	11	11	11	11	19	18	27	37	31	27	27
GSA16_500-800	10	14	14	13	14	14	14	14	20	20	21	33	33	38	38

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.51.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.51.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the blue and red shrimp in GSA 16 was derived from the international survey Medits. Figure 8.51.3.1.3.1 displays the estimated trend in blue and red shrimp abundance and biomass in GSA 16. The analyses of Medits indices are considered preliminary.

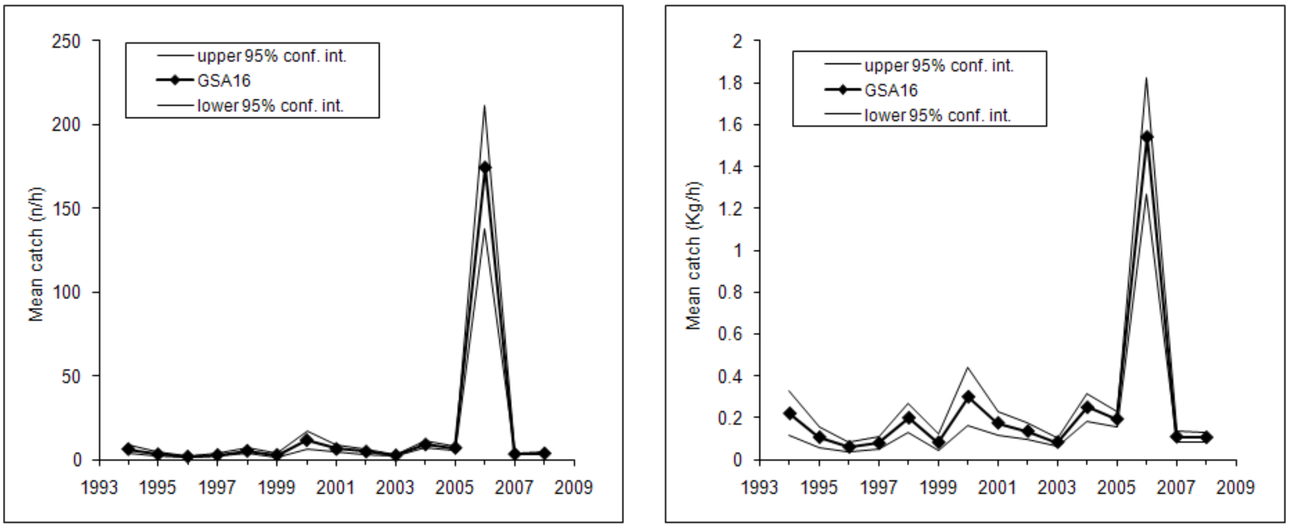


Fig. 8.51.3.1.3.1 Abundance and biomass indices of blue and red shrimp in GSA 16.

8.51.3.1.4. Trends in abundance by length or age

The following Fig. 8.51.3.1.4.1 and 2 display the stratified abundance indices of GSA 16 in 1994-2008. These size compositions are considered preliminary.

Fig. 8.51.3.1.4.1 Stratified abundance indices by size, 1994-2001.

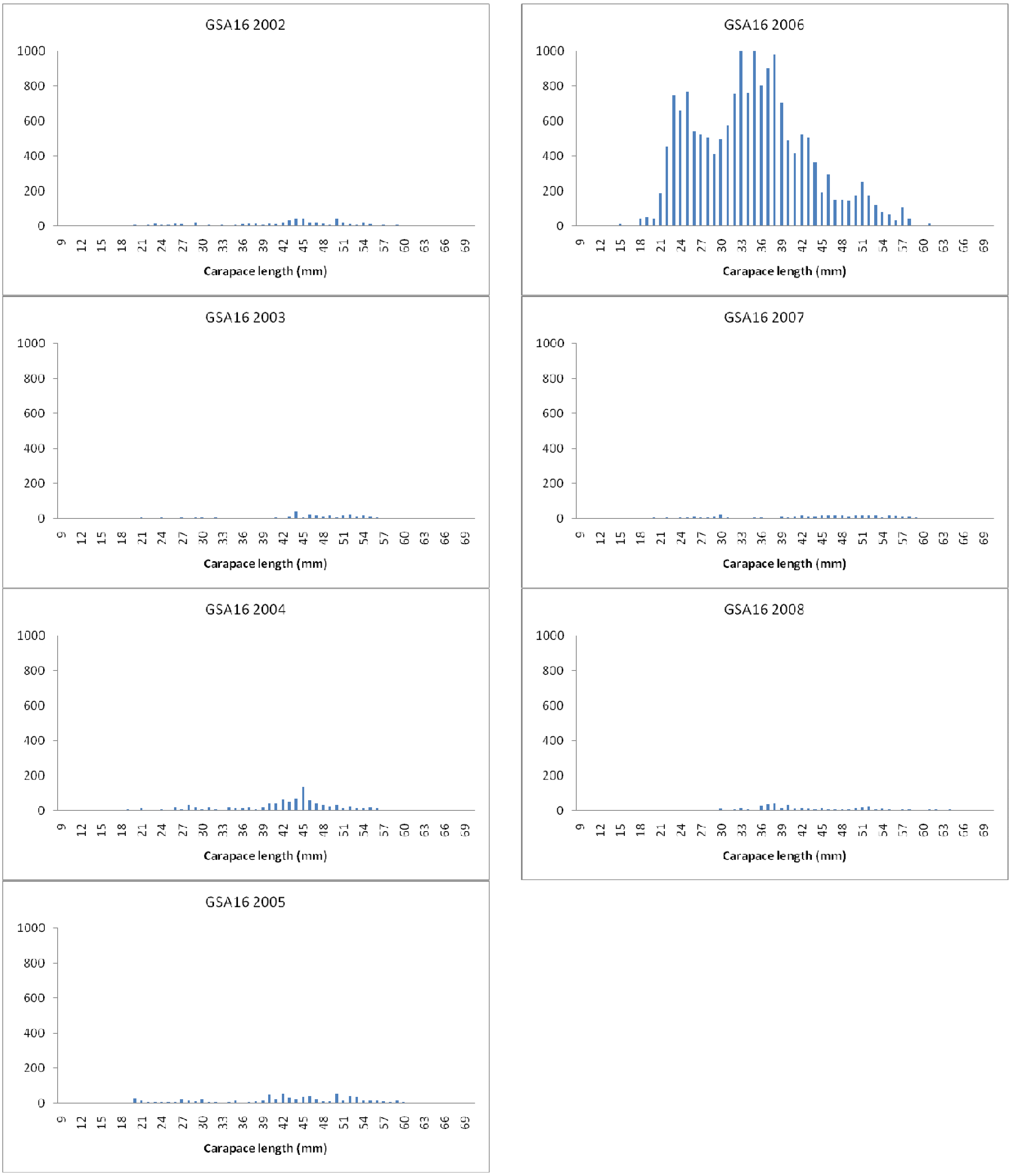


Fig. 8.51.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.51.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.51.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.51.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.51.5. Long term prediction

8.51.5.1. Justification

No forecast analyses were conducted.

8.51.5.2. Input parameters

No forecast analyses were conducted.

8.51.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for blue and red shrimp in GSA 16.

8.51.6. Scientific advice

8.51.6.1. Short term considerations

8.51.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock given the preliminary state of the data and analyses.

8.51.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.51.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.52. Stock assessment of giant red shrimp in GSA 10

8.52.1. Stock identification and biological features

8.52.1.1. Stock Identification

The stock of giant red shrimp, *Aristaeomorpha foliacea* was assumed in the boundaries of the whole GSA10, lacking specific information on stock identification. This species and the blue-red shrimp, *Aristeus antennatus*, are deep-water decapods characterised by seasonal variability and annual fluctuations of abundance (Spedicato *et al.*, 1994), as reported for different geographical areas (e.g. Relini and Orsi Relini, 1987). The giant red shrimp *A. foliacea* is distributed beyond 350 m depth, but mainly in water deeper than 500 m. Generally mean length estimated using trawl survey data varies remarkably with depth, for the whole population and the two sexes, increasing at deeper waters.

In the recent years *A. foliacea* is ranked among the more abundant species (in number and weight) in the trawl survey catches. Higher biomass indices occur particularly southwards the Gulf of Naples (Spedicato *et al.*, 1994).

This species has a discrete recruitment pattern and during spring trawl surveys (Medits) a recruitment pulse is observed. Since the reproduction takes place in the late spring-summer, recruits could be attributed to the spawning events of the previous year (Spedicato *et al.*, 1999). *A. foliacea* is considered fully recruited to grounds at about 24 mm CL (from Samed, AAVV, 2002). Recently a study at Mediterranean scale, using Medits data from 1994 to 2004, has evidenced that the higher abundance indices of recruits were observed in the central-southern Tyrrhenian Sea (AAVV, 2008).

In general the length frequency distributions of the giant red shrimp have a polymodal pattern, with 4-5 components for females (the modes of adults are less defined) and 2-3 components for the males. For the females a life span of 6-8 years was estimated. The structure of the sizes of *A. foliacea* is characterised by marked differences in growth between the sexes. The larger individuals are females and inhabit deeper waters.

Sex ratio values of about 0.5 shows that males and females are not segregated into different bathymetric ranges (Spedicato *et al*., 1994). The reproduction period extends from May to September, with a peak in the summer (July-August) (Spedicato *et al.*, 1999). Mature males have been observed all year round.

According to the benthic bionomic classification of Pérès and Picard (1964) *P. longirostris*, *N. norvegicus* and red-shrimps typify the populations of slope and bathyal bottoms in the GSA 10. Depending on the depth and zone, this fauna is accompanied by characteristic benthic species as *Funiculina quadrangularis*, *Geryon longipes*, *Polycheles typhlops*, *Isidella elongata*, *Griphus vitreus*.

In the central-southern Tyrrhenian Sea the giant red shrimp represents a specific target of the deep-waters trawling fishery given its high economic value (Spedicato *et al.*, 1994).

8.52.1.2. Growth

Estimates of the growth pattern of the giant red shrimp in the GSA 10 were previously obtained using Grund length frequency distributions from 1991 to 1995 and methods as Elefan and Batthacharya for the analysis of LFDs. Parameters of females were as follows: CL_∞=73.24 mm; K=0.483; t_0= -0.435 (Spedicato *et al.*, 1998). In the Samed project (AAVV, 2002) and using the Medits data from 1994 to 1999 a new set of parameters was estimated for the Tyrrhenian Sea down the Strait of Messina (females: L_∞=73 mm; K=0.44; t_0= -0.05; males: L_∞=48 mm; K=0.59; t_0= -0.2). The observed maximum carapace length of females and males were 72 and 46 mm respectively.

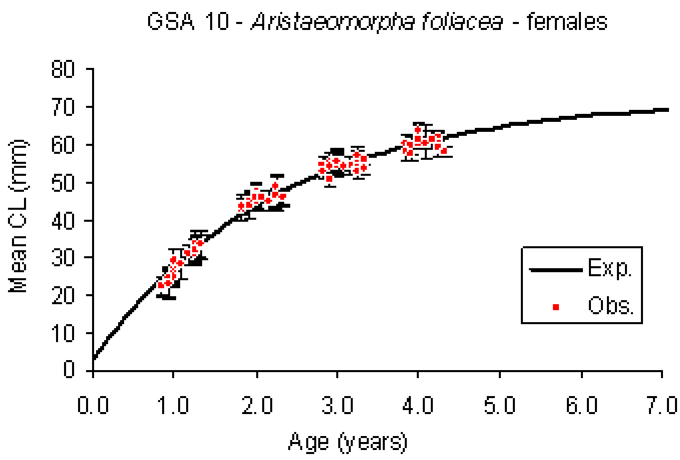
Growth has been also studied in the DCR framework and in the Red Shrimps project (AAVV, 2008) through the analysis of the LFDs and the separation of modal components. These estimates have been done using both Medits and Grund average length at estimated age, where age was set according to the date of each survey with a birthday on 1st July. Table 8.52.1.2.1 reports estimated ages, mean carapace lengths with relative standard deviations for females.

The following estimates of von Bertalanffy growth parameters for each sex were obtained from average length at age using an iterative non-liner procedure that minimises the sum of the square differences between observed and expected values and fixing the asymptotic length on the basis of the observed maximum values: females CL_{∞}=72.5 mm, K=0.438, t_0= -0.1; males: CL_{∞}=44 cm, K=0. 5, t_0= -0.1. These estimates are more accurate, although very close to those previously obtained.

Parameters of the length-weight relationship were a=0.54, b=2.71 for females and a=0.48, b=2.81 for males, for length expressed in cm.

Tab. 8.52.1.2.1 Estimated age, mean length of modal components of the LFD of Medits and Grund survey and relative standard deviations.

putative age	mean CL	st. dev.	putative age	mean CL	st. dev.	putative age	mean CL	st. dev.
0.8	21.9	2.29	2.0	45.5	2.58	3.1	54.3	1.01
0.8	22.5	2.36	2.0	47.5	2.05	3.2	54.5	2.11
0.9	23.0	3.38	2.0	44.9	1.8	3.2	53.5	1.33
0.9	24.6	2.78	2.0	46.7	3.06	3.2	55.3	1.52
0.9	23.0	3.75	2.0	45.9	3.76	3.2	57.0	1.53
1.0	26.6	2.96	2.1	46.2	1.85	3.2	57.2	2.1
1.0	25.0	3.16	2.2	45.1	2.59	3.2	54.3	2.23
1.0	26.0	1.95	2.2	46.6	1.55	3.2	53.5	1.71
1.0	24.8	2.26	2.2	49.2	2.23	3.2	52.9	1.97
1.0	29.1	2.79	2.2	45.6	2.98	3.3	56.0	1.47
1.1	28.2	3.82	2.2	49.1	3.31	3.3	53.6	1.25
1.2	31.0	2.58	2.2	45.8	2.3	3.8	60.3	2.46
1.2	33.3	2.68	2.2	45.9	2.62	3.8	57.9	2.14
1.2	32.8	2.37	2.2	46.6	1.98	3.9	60.0	2.38
1.2	33.4	2.65	2.3	46.1	1.8	3.9	57.6	2.15
1.2	33.7	3.05	2.3	46.2	2.39	4.0	63.1	2.54
1.2	31.1	2.66	2.8	54.7	2.38	4.0	60.3	1.55
1.2	32.1	3.55	2.8	52.6	1.84	4.0	63.8	1.3
1.2	32.0	2.81	2.9	55.0	3.16	4.0	61.1	2.35
1.3	32.9	3.07	2.9	54.0	2.05	4.1	60.5	4.56
1.3	33.5	3.16	2.9	50.9	1.81	4.2	61.3	2.35
1.8	42.6	2.77	3.0	54.8	3.05	4.2	62.0	1.14
1.8	43.8	2.42	3.0	54.9	2.74	4.2	60.4	3.37
1.9	44.4	2.38	3.0	55.7	2.9	4.2	58.8	2.05
1.9	45.2	2.53	3.0	54.8	3.53	4.2	59.6	1.03
1.9	43.8	3.6	3.0	55.6	3.18	4.3	57.8	1.37



	females	males
CL_{∞} (mm)=	72.5	44
k/year=	0.438	0.5
t_0(year)=	-0.10	-0.1

Fig. 8.52.1.2.1 V. Bertalanffy growth functions and parameters for female of giant red shrimp in the GSA 10. Used data are those reported in the Tab. 8.52.1.2.1.

8.52.1.3. Maturity

The maturity ogive Fig. 8.52.1.3.1 was obtained from a maximum likelihood procedure applied grouping as mature individuals belonging to the maturity stage 2b (according to the Medits maturity scale) and onwards. The fitting of the curve was fairly good, however the estimates of the size at first maturity $L_{m50\%}$ (3.5 cm ±0.023 cm) and the maturity range (0.36 cm ±0.020 cm) seem underestimated if compared with literature values (average of the smallest females in the GSA is 34 mm CL; 39.6 mm carapace length according to Ragonese & Bianchini, 1995).

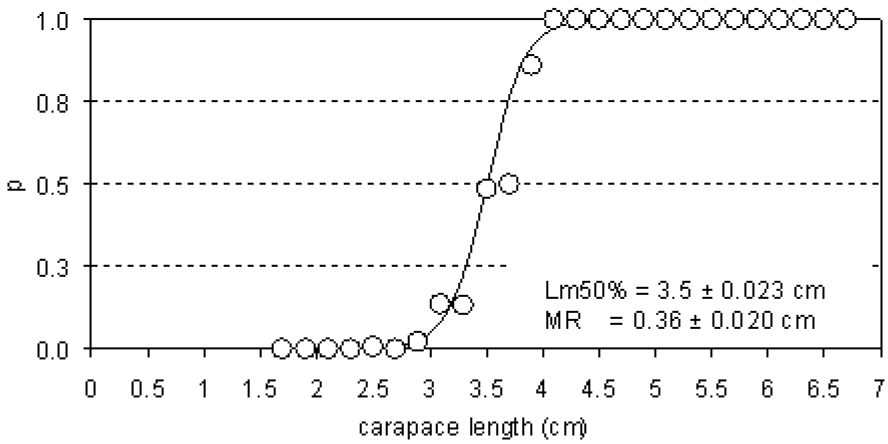


Fig. 8.52.1.3.1 Maturity ogive and proportions of mature female of giant red shrimp in the GSA 10 (MR indicates the difference $Lm_{75\%}$-$Lm_{25\%}$).

The sex ratio from DCR evidenced the prevalence of males in the size class from 3.4 to 3.8 cm while from 4 cm onwards the proportion of females was dominant.

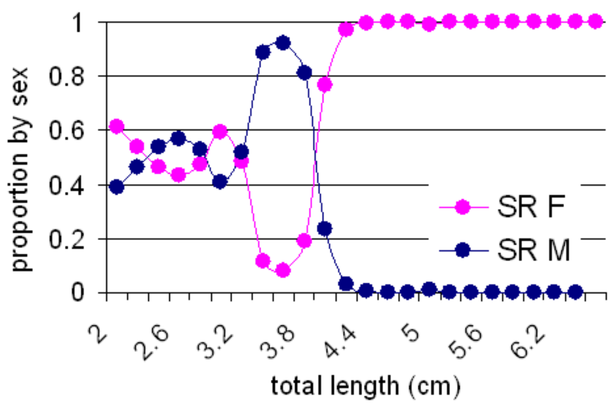


Fig. 8.52.1.3.2 Sex ratio over length.

8.52.2. Fisheries

8.52.2.1. General description of fisheries

The Giant red shrimp is only targeted by trawlers on fishing grounds located offshore deeper than 200 m, mainly southward Salerno Gulf. Catches from trawlers are from a depth range between 400 and 700 m depth and giant red shrimp occurs with *A. antennaus*, *P. longirostris* and *N. norvegicus*, *P. blennoides*, *M. merluccius*, depending on depth and area.

8.52.2.2. Management regulations applicable in 2008 and 2009

Management regulations are based on technical measures, like the number of fishing licenses and area limitation (distance from the coast and depth). In order to limit the over-capacity of the fleet, the Italian fishing licenses have been fixed since the late 1980s. After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity is implemented. Along northern Sicily coasts two main Gulfs (Patti and Castellammare) have been closed to the trawl fishery up 200 m depth, since 1990. Two closed areas were also established in 2004 along the mainland, in front of Sorrento peninsula (Napoli Gulf) and Amantea (Calabrian coasts) although these protected areas mainly cover the distribution of coastal species. Other measures on which the management regulations are based are technical measures (mesh size) and minimum landing sizes (EC reg. 1967/06). In the GSA 10 the fishing ban has not been mandatory and it was adopted on a voluntary basis by the fleet.

8.52.2.3. Catches

8.52.2.3.1. Landings

Available landing data are from DCR regulations. SGMED-09-02 received Italian landings data for GSA 10 by major fishing gears which are listed in Tab. 8.52.2.3.1.1. The fishing segments DTS and OTB, PGP PMP and GNS indicate respectively trawlers, small scale fishery (nets), polyvalent and pair trawl. Since 2003, landings of the giant red shrimp increased from 148 t to 505 t in 2005 and decreased to 120 t in 2008 (Fig. 8.52.2.3.1.1). Most part of the landings is from trawlers.

Tab. 8.52.2.3.1.1. Annual landings (t) by gear type, 2003-2008.

	Sum of LW	FT_LVL4				
YEAR	DTS	GNS	OTB	PGP	PMP	Total
2003	125.2			6.7	16.0	148.0
2004		4.0	202.6			206.6
2005		6.7	498.4			505.1
2006		7.9	411.8			419.6
2007		9.3	290.9			300.3
2008		7.3	112.8			120.1

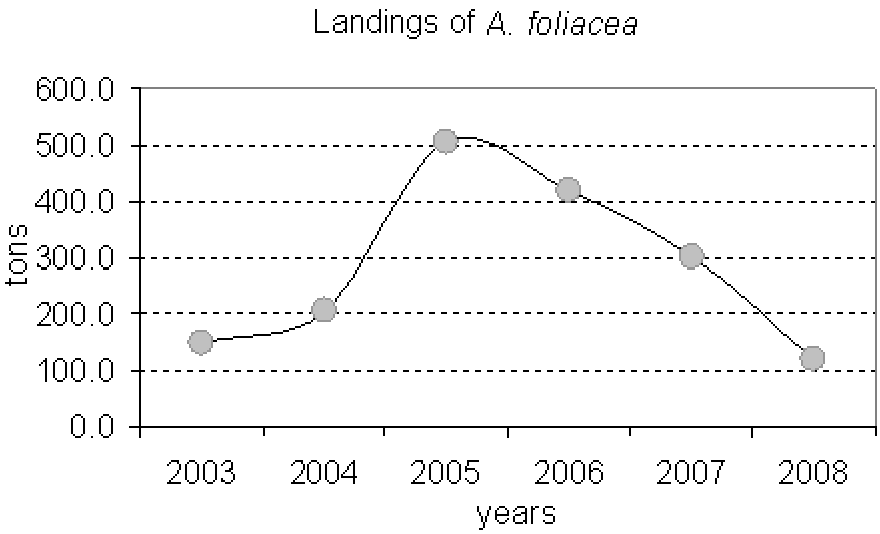


Fig. 8.52.2.3.1.1 Total landings (t) 2003-2008 as reported through DCR in the GSA10.

8.52.2.3.2. Fishing effort

The trends in fishing effort by year and major gear type is listed in Tab. 8.52.2.3.2.1 and shown in Fig. 8.52.2.3.2.1 in terms of kW*days. The fishing segments DTS, HOK, PGP, PMP and PTS indicate respectively trawlers, long-lines, small scale fishery (nets), polyvalent and pair trawls. The fishing effort in kW*days of the trawlers, that is the fishing segment targeting the giant red shrimp, was rising in 2004 and 2005 and decreasing in 2006 and 2007.

Tab. 8.52.2.3.2.1 Trend in fishing effort (kW*days) for GSA10 by major gear types, 2002-2007.

YEAR	FT_LVL4_TYPE		KW*DAYS						
	DRB	DTS	FPO	GND	GNS	GTR	HOK	LHP-LHM	LLD
2002	94663	7344089							
2003	29540	7231486							
2004	110899	7883881					1654352		
2005	404243		226805	2878658	4378416	1519874		441690	819922
2006	392760		147562	2394591	2465382	3789078		395408	654956
2007	170557		5309	2232763	1848657	3793640		417886	412060
YEAR	LLS	MIS	OTB	PGP	PMP	PS	PTS	SB-SV	Total
2002				6440217	12686947		2631242		29197158
2003				7222145	8003452		2930380		25417003
2004				7056306	3588004		2308589		22602033
2005	1852150	936565	8102762			1538303		701108	23800496
2006	1289606	273517	6944418			1506523		859501	21113301
2007	1194311	73082	6882389			1222112		959937	19212704

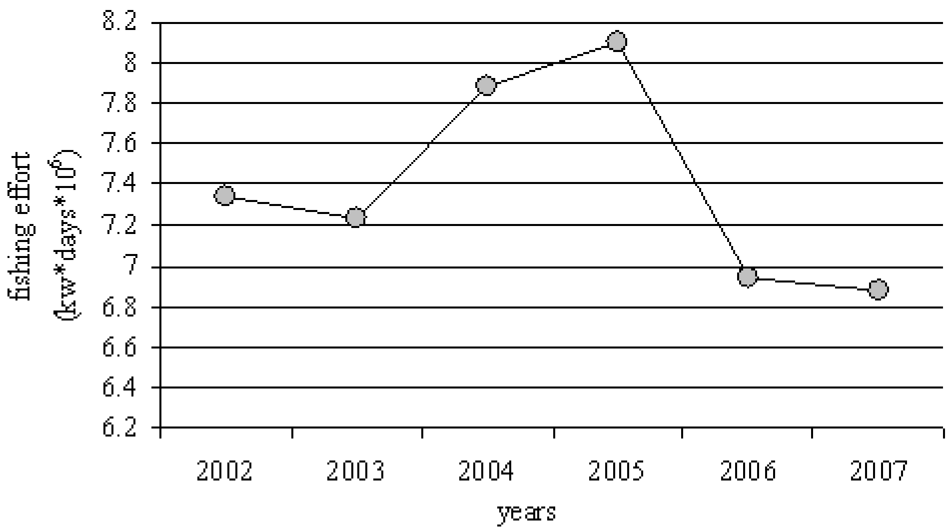


Fig. 8.52.2.3.2.1 Trend in fishing effort (kW*days*10) of trawlers in the GSA 10, 2002-2007.

8.52.3. Scientific surveys

8.52.3.1. Medits

8.52.3.1.1. Methods

According to the MEDITS protocol (Bertrand *et al*., 2002), trawl surveys were carried out yearly (May-July), applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish and weight per surface unit) were standardised to square kilometre, using the swept area method.

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 10 the following number of hauls was reported per depth stratum (s. Tab. 8.52.3.1.1.1).

Tab. 8.52.3.1.1.1. Number of hauls per year and depth stratum in GSA 10, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA10_010-050	9	10	10	10	10	10	10	10	9	9	9	9	9	9	9
GSA10_050-100	12	12	12	12	12	12	12	12	10	10	10	10	10	10	10
GSA10_100-200	20	20	20	20	20	20	20	20	17	17	17	17	17	17	17
GSA10_200-500	26	27	26	26	27	26	26	28	22	22	22	22	22	22	22
GSA10_500-800	31	30	31	31	31	30	31	29	26	27	26	26	26	26	26

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls considered as valid were used in the analysis, including stations with no catches (zero catches are included).

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

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

frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

8.52.3.1.2. Geographical distribution patterns

A comparative analysis of MEDITS and GRUND distribution patterns is presented in the following section 8.52.3.2.2 under the GRUND survey results.

8.52.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the giant red shrimp in GSA 10 was derived from the international survey Medits. Figure 8.52.3.1.3.1 displays the estimated trend of *A. foliacea* abundance and biomass standardized to the surface unit in GSA 10. Indices from Medits trawl-surveys show a fluctuating pattern with two peaks in 1997 and 2005, but without any trend (Fig. 8.52.3.1.3.1).

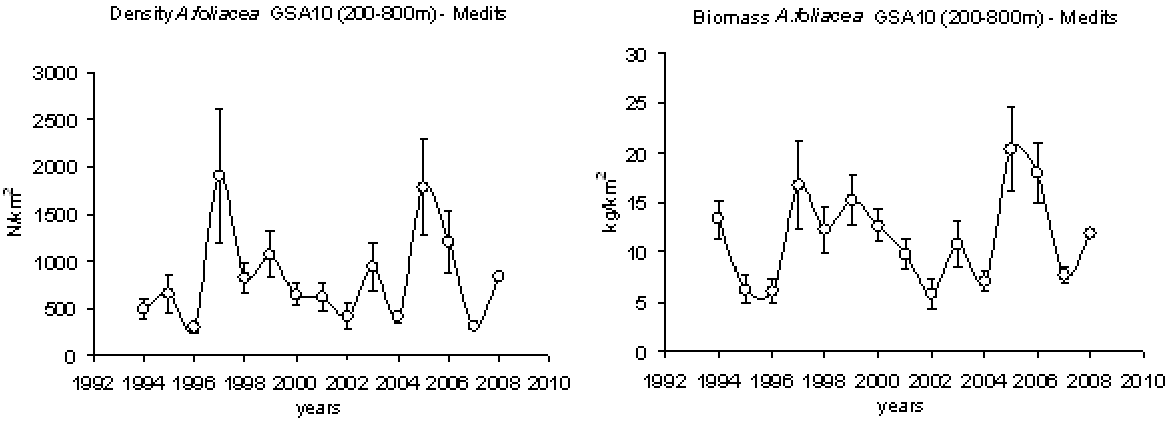


Fig. 8.52.3.1.3.1 Trends in survey abundance and biomass indices standardized to the surface unit and derived from Medits.

Medits indices were re-estimated based on the data obtained from the international data call. Such re-estimated indices from Medits trawl-surveys show a fluctuating pattern with two peaks in 1997 and 2005, but without any trend (Fig. 8.52.3.1.3.2). The indices vary without a clear trend.

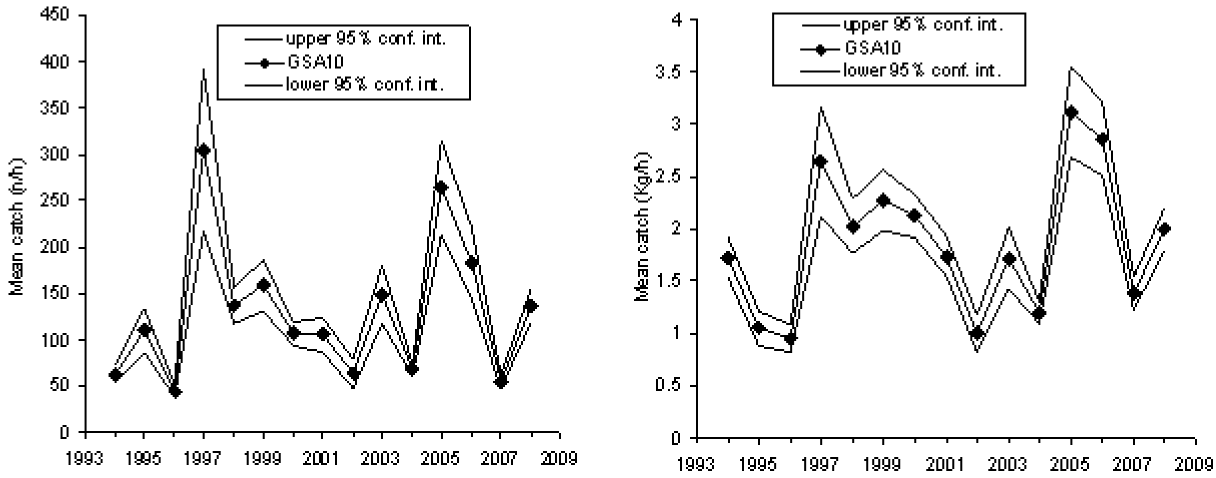


Fig. 8.52.3.1.3.2 Abundance and biomass indices of giant red shrimp in GSA 10.

8.52.3.1.4. Trends in abundance by length or age

The following Fig. 8.52.3.1.4.1 and 2 display the stratified abundance indices of GSA 10 in 1994-2008.

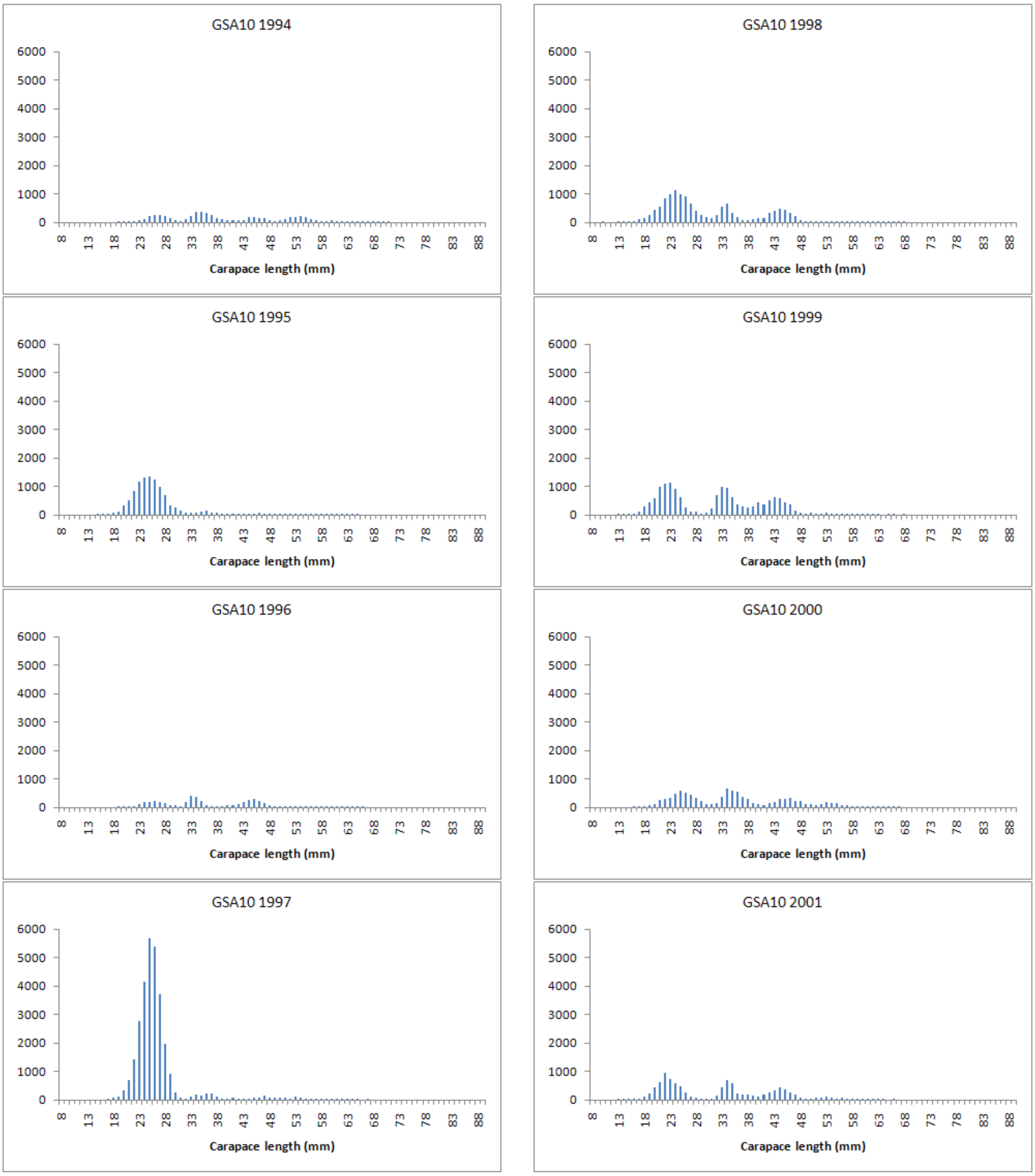


Fig. 8.52.3.1.4.1 Stratified abundance indices by size, 1994-2001.

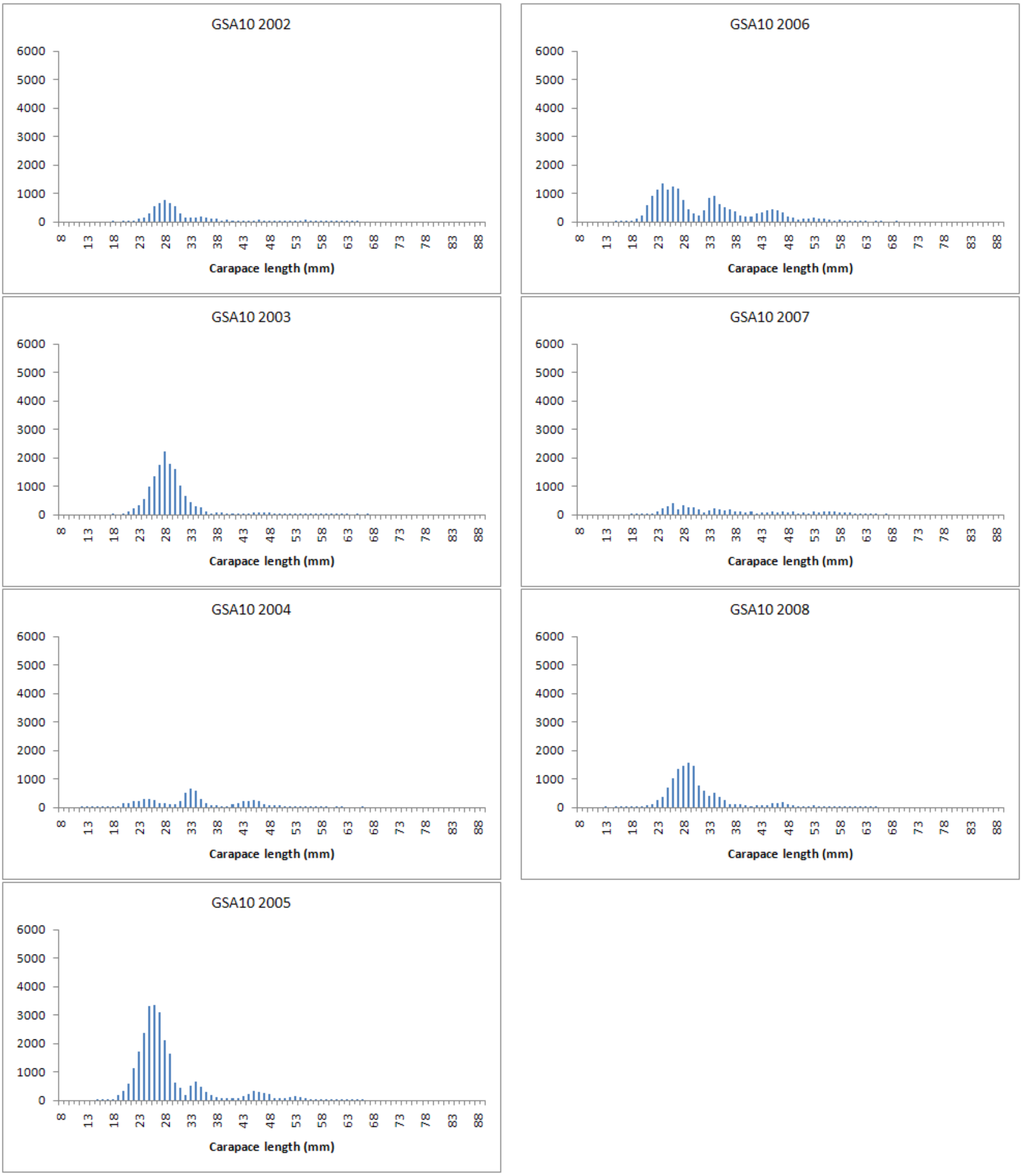


Fig. 8.52.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.52.3.2. GRUND

8.52.3.2.1. Methods

Since 2003 Grund surveys (Relini, 2000) was conducted using the same sampler (vessel and gear) in the whole GSA. Sampling scheme, stratification and protocols were similar as in Medits. All the abundance and biomass data were standardised to the square kilometre, using the swept area method.

8.52.3.2.2. Geographical distribution patterns

The geographical distribution pattern of the giant red shrimp has been studied in the area using trawl-survey data, length frequency distribution analyses via modal component separation techniques and geostatistical methods. The abundance of the whole population, as derived from both Medits and Grund surveys, was higher in the southern part of the GSA, along the Calabrian coast (Fig. 8.52.3.2.2.1) as well as the abundance of recruits (Fig. 8.52.3.2.2.2). The probability of find a nursery area was the highest in the same zone with a high temporal continuity.

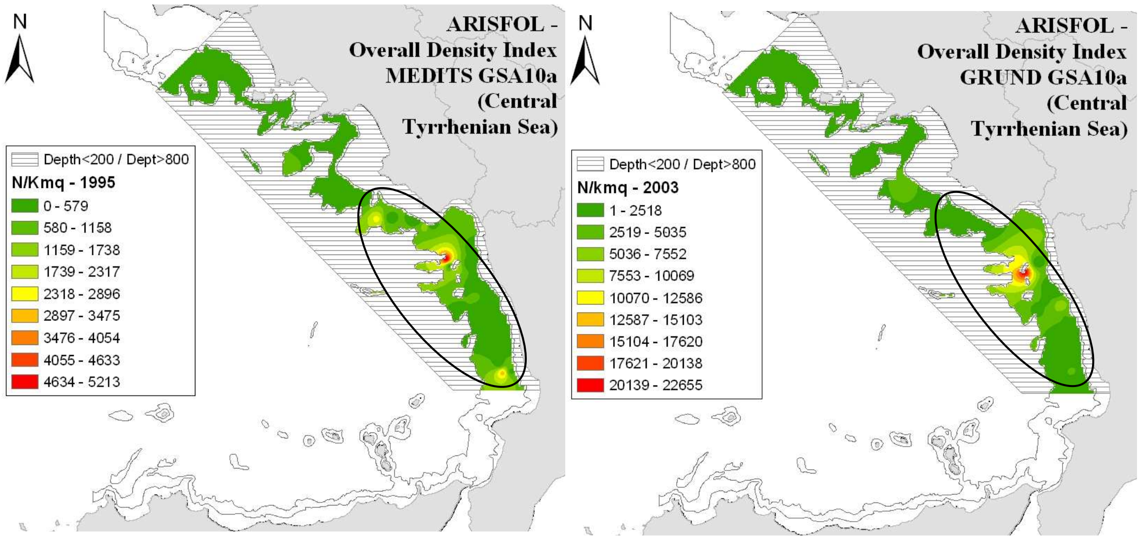


Fig. 8.52.3.2.2.1 Maps of the abundance of the giant red shrimp from Medits and Grund surveys.

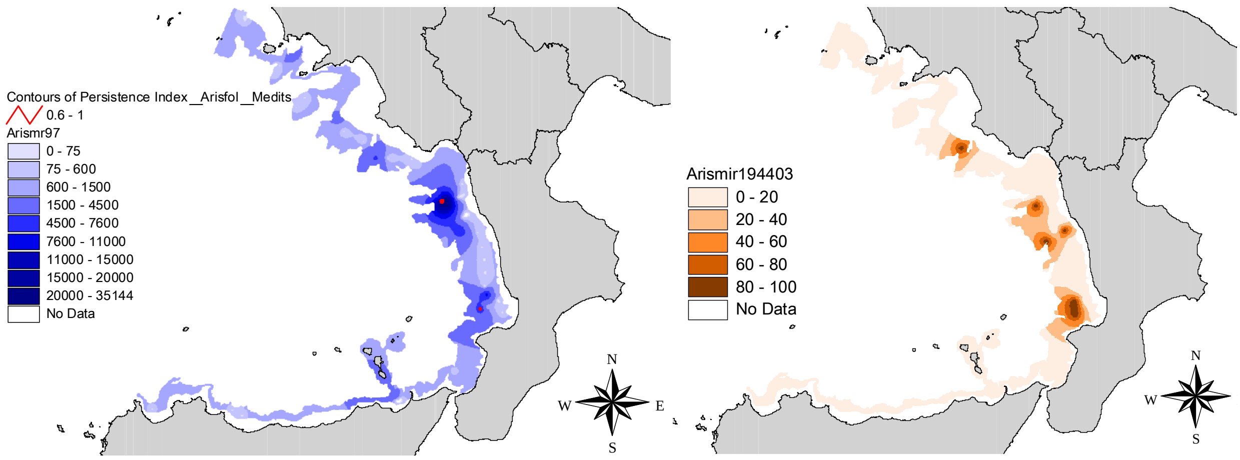


Fig. 8.52.3.2.2.2 Maps of the abundance of the giant red shrimp recruits (left) and of the probability of nursery localization (right) from Medits survey of 1997 and 2003 respectively. The contour of persistence areas is also evidenced in the map of abundance.

8.52.3.2.1. Trends in abundance and biomass

Trends derived from the GRUND surveys are shown in Fig. 8.52.3.2.1.1. Abundance and biomass indices show some peaks and fluctuations, but without any trend, as well as recruitment indices (Fig. 8.52.3.2.1.1). Higher values are recorded in 2003 and 2005. Although less varying, the pattern is similar to that observed in the Medits series.

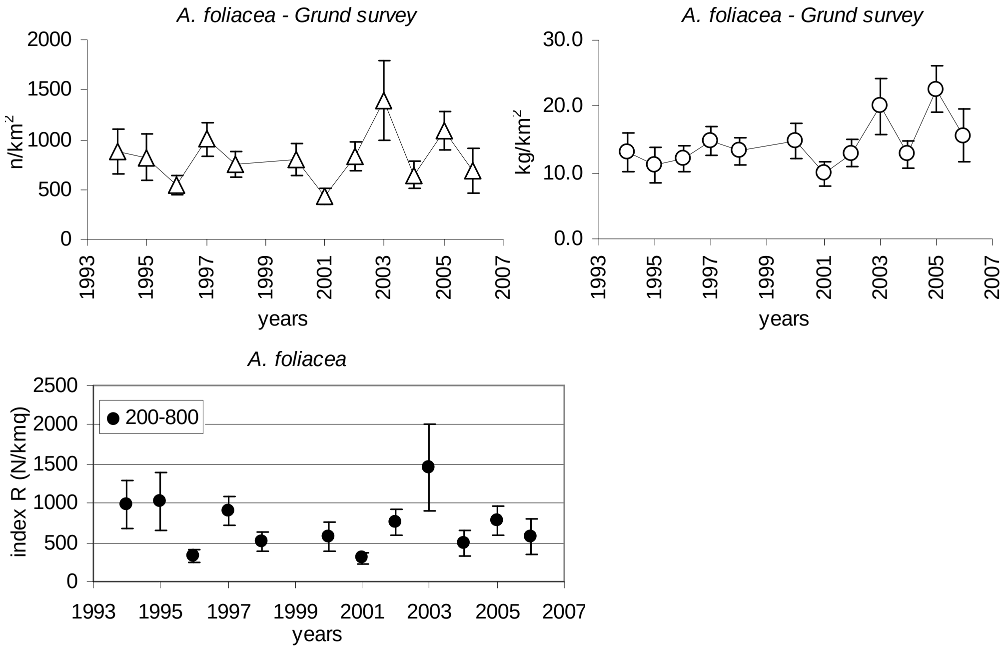


Fig. 8.52.3.2.1.1. Abundance and biomass indices of giant red shrimp in GSA 10 (bars indicate standard deviations) derived from Grund surveys. Recruitment indices (N/km^2) computed in the stratum 200-800 m depth with standard deviation is also reported.

8.52.3.2.2. Trends in abundance by length or age

No trend in the mean length was observed in Medits survey (Fig. 8.52.3.2.2.1), nor at the third quantile lengths, as obtained from the length structures of Grund time series from 1994 to 2006 (Fig. 8.52.3.2.2.2).

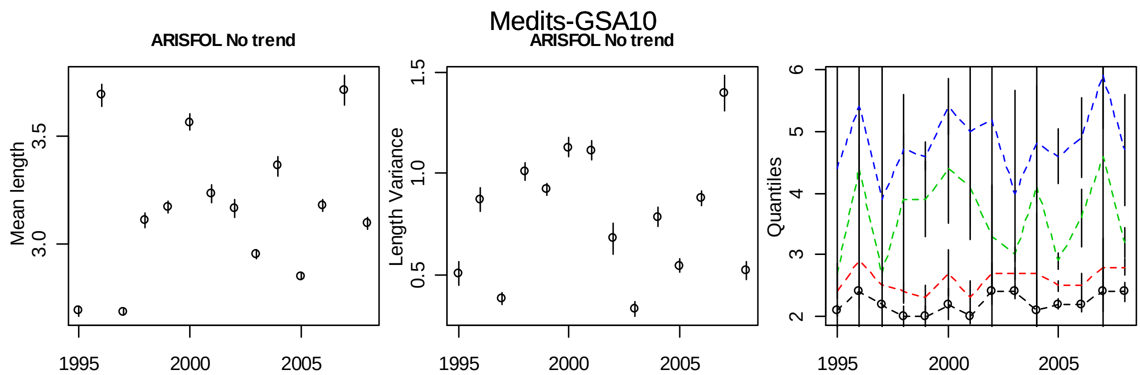


Fig. 8.52.3.2.2.1 Mean length, variance and quantiles derived from the Medits length compositions in 1995-2008.

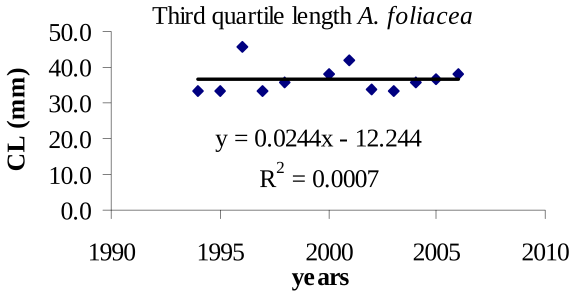


Fig. 8.52.3.2.2.2 III Quantile derived from the GRUND length structures in 1994-2006.

The LFDs are rather varying throughout the Medits surveys, mainly for the recruitment strength that determines a dominance of the juvenile component in the LFDs of 1995, 1997, 2003 and 2005, while in the other years recruits are on average 30-50% of the total distribution (Fig. 8.52.3.2.2.3).

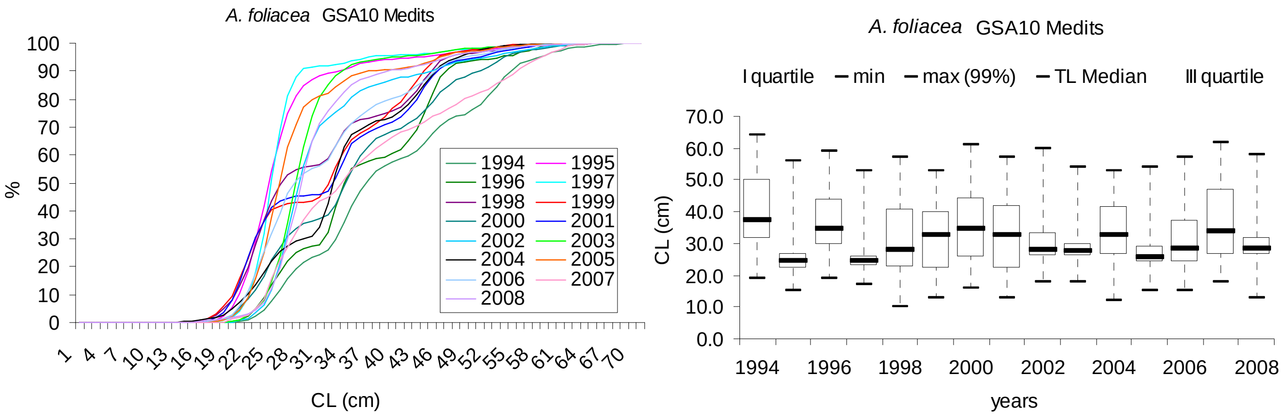


Fig. 8.52.3.2.2.3 Cumulative frequencies of the Medits LFDs (in percentage) and box plots.

8.52.3.2.3. Trends in growth

No analyses were conducted during SGMED-09-02.

8.52.3.2.4. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.52.4. Assessment of historic stock parameters

No analytical assessment of historic stock parameters was conducted.

8.52.5. Long term prediction

8.52.5.1. Justification

No forecast analyses were conducted.

8.52.5.2. Input parameters

No forecast analyses were conducted.

8.52.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a short term prediction of catch and stock biomass for giant red shrimp in GSA 10.

8.52.6. Scientific advice

8.52.6.1. Short term considerations

8.52.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.52.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of recruitment in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.52.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of exploitation in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.53. Stock assessment of giant red shrimp in GSA 11

8.53.1. Stock identification and biological features

8.53.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.53.1.2. Growth

No information was documented during SGMED-09-02.

8.53.1.3. Maturity

No information was documented during SGMED-09-02.

8.53.2. Fisheries

8.53.2.1. General description of fisheries

No information was documented during SGMED-09-02.

8.53.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.53.2.3. Catches

8.53.2.3.1. Landings

Tab. 8.53.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.8 of Appendix 3. The landings were mainly taken by demersal otter trawls.

Tab. 8.53.2.3.1.1 Annual landings (t) by fishing technique in GSA 11. Landings data provided for the year 2003 probably have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
ARS	11	ITA	DTS		56692					
ARS	11	ITA	OTB			314	171	129	82	67
ARS	11	ITA	PMP		15138					

8.53.2.3.2. Discards

According to information available to the SGMED-09-02 no catches of *Aristaeomorpha foliacea* were discarded by the Italian fleet.

8.53.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-09-02 are listed in Tab. 8.53.2.3.3.1 and in Tab. A3.10-3.12 of Appendix 3.

Tab. 8.53.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSA 11, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	11	ITA	DTS	14539	18957	28840				
DAYS	11	ITA	FPO				1211	9616	31238	
DAYS	11	ITA	FYK						608	
DAYS	11	ITA	GND						51	
DAYS	11	ITA	GNS				21601	7574	29014	
DAYS	11	ITA	GTR				124877	139221	83350	
DAYS	11	ITA	LHP-LHM				50	1028	3379	
DAYS	11	ITA	LLD				2263	5117	4441	
DAYS	11	ITA	LLS				9758	16168	20224	
DAYS	11	ITA	LTL					128	31	
DAYS	11	ITA	OTB				29211	25368	25596	
DAYS	11	ITA	PGP	102826	126272	165945				
DAYS	11	ITA	PMP	57543	30879					
GT*days	11	ITA	DTS	772163	986387	1598912				
GT*DAYS	11	ITA	FPO				6215	49606	84529	
GT*DAYS	11	ITA	FYK						622	
GT*DAYS	11	ITA	GND						2544	
GT*DAYS	11	ITA	GNS				71331	18124	61528	
GT*DAYS	11	ITA	GTR				428009	430370	295688	
GT*DAYS	11	ITA	LHP-LHM				100	6394	10466	
GT*DAYS	11	ITA	LLD				26766	86801	158560	
GT*DAYS	11	ITA	LLS				42073	99731	84653	
GT*DAYS	11	ITA	LTL					270	63	
GT*DAYS	11	ITA	OTB				1934836	1399052	1423265	
GT*days	11	ITA	PGP	306226	468352	501550				
GT*days	11	ITA	PMP	611726	308212					
kW*days	11	ITA	DTS	3679604	4652647	6711626				
KW*DAYS	11	ITA	FPO				79031	824017	1387022	
KW*DAYS	11	ITA	FYK						13055	
KW*DAYS	11	ITA	GND						11713	
KW*DAYS	11	ITA	GNS				1007963	236313	781402	
KW*DAYS	11	ITA	GTR				6358014	6476994	4393484	
KW*DAYS	11	ITA	LHP-LHM				769	70523	122621	
KW*DAYS	11	ITA	LLD				284297	480411	952876	
KW*DAYS	11	ITA	LLS				832709	1159412	1054615	
KW*DAYS	11	ITA	LTL					12388	1622	
KW*DAYS	11	ITA	OTB				7679721	5879355	5957347	
kW*days	11	ITA	PGP	2865738	5099814	7105771				
kW*days	11	ITA	PMP	7159338	3245118					

8.53.3.Scientific surveys

8.53.3.1.Medits

8.53.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 11 the following number of hauls was reported per depth stratum (s. Tab. 8.53.3.1.1.1).

Tab. 8.53.3.1.1.1. Number of hauls per year and depth stratum in GSA 11, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA11_010-050	17	19	21	21	21	21	19	18	20	18	17	17	19	19	17
GSA11_050-100	27	21	22	22	20	22	22	24	19	19	18	21	18	20	19
GSA11_100-200	22	23	30	31	31	30	31	30	24	24	24	24	24	24	22
GSA11_200-500	35	29	29	26	25	27	24	25	20	24	21	20	20	20	21
GSA11_500-800	23	16	21	25	25	24	27	26	16	14	15	14	16	17	16

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

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

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

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

Where:
- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

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

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

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

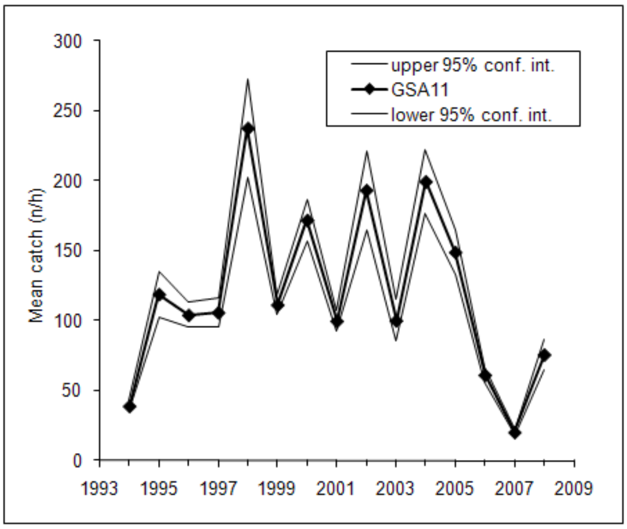
aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.53.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.53.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the giant red shrimp in GSA 11 was derived from the international survey Medits. Figure 8.53.3.1.3.1 displays the estimated trend in giant red shrimp abundance and biomass in GSA 11. The analyses of Medits indices are considered preliminary.



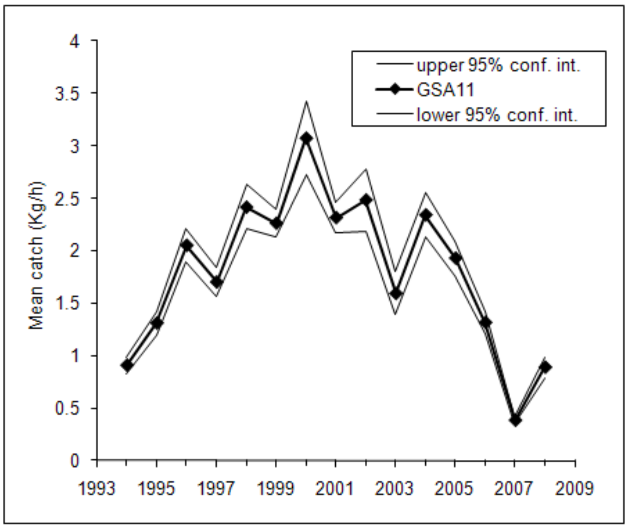


Fig. 8.53.3.1.3.1 Abundance and biomass indices of giant red shrimp in GSA 11.

8.53.3.1.4. Trends in abundance by length or age

The following Fig. 8.53.3.1.4.1 and 2 display the stratified abundance indices of GSA 11 in 1994-2008. These size compositions are considered preliminary.

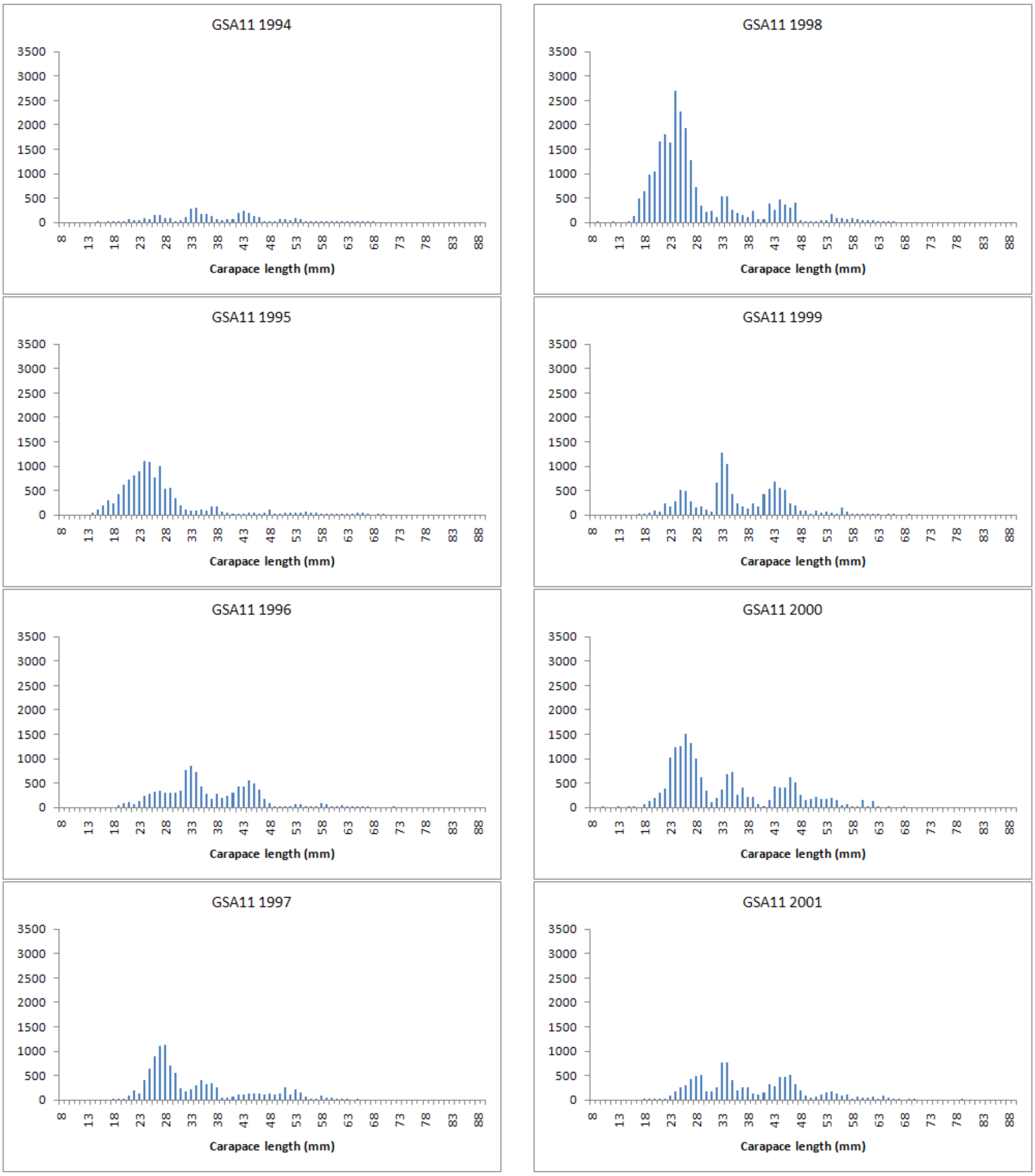


Fig. 8.53.3.1.4.1 Stratified abundance indices by size, 1994-2001.

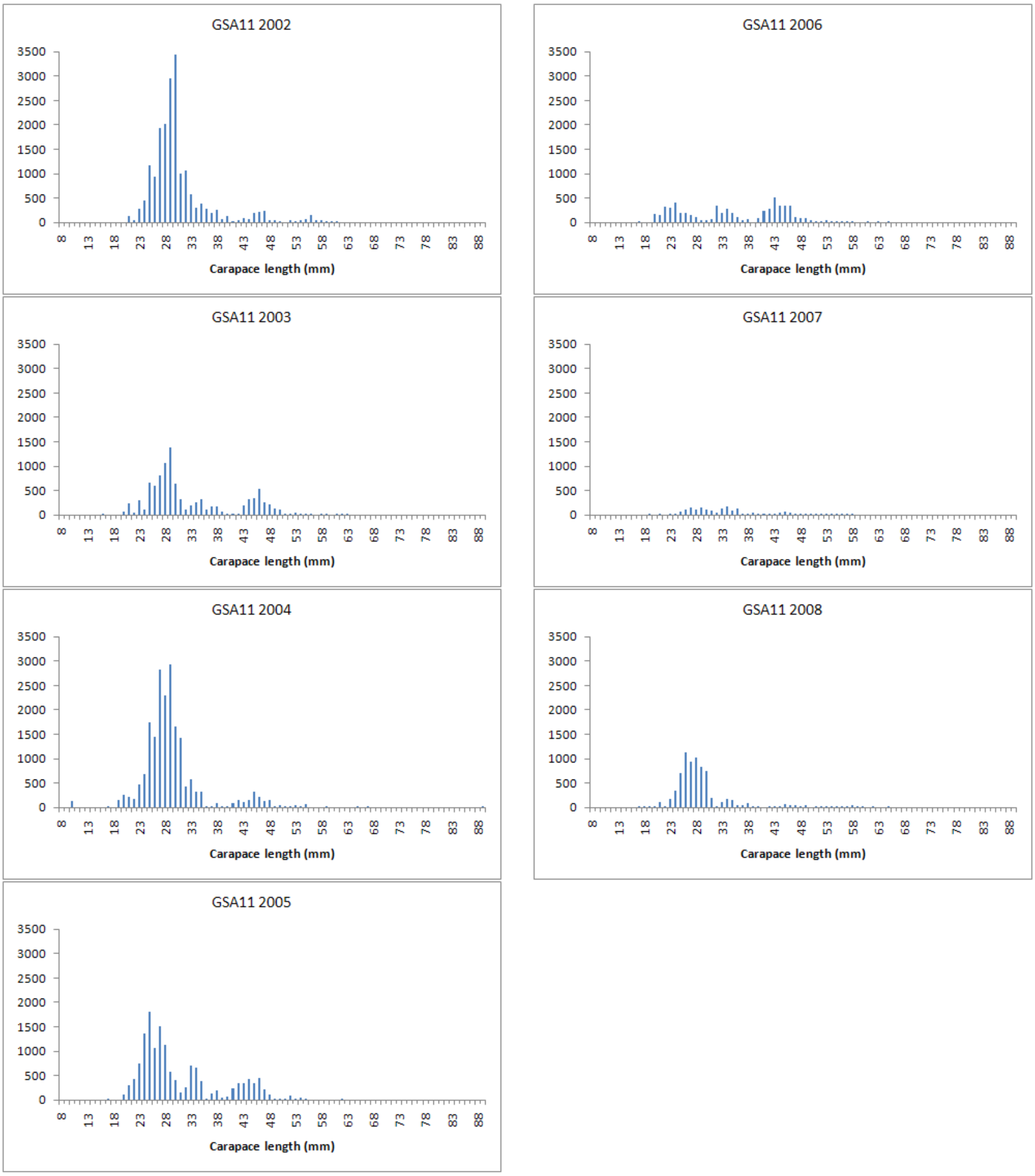


Fig. 8.53.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.53.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.53.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.53.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.53.5. Long term prediction

8.53.5.1. Justification

No forecast analyses were conducted.

8.53.5.2. Input parameters

No forecast analyses were conducted.

8.53.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for giant red shrimp in GSA 11.

8.53.6. Scientific advice

8.53.6.1. Short term considerations

8.53.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock given the preliminary state of the data and analyses.

8.53.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.53.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.54. Stock assessment of giant red shrimp in GSAs 15 and 16

8.54.1. Stock identification and biological features

8.54.1.1. Stock Identification

No information is available to the SGMED-09-02 on stock unity in the area and thus the stock was assumed to be confined within the boundaries of the GSA 15 and 16 also according recommendations made by SGMED-09-01.

8.54.1.2. Growth and natural mortality

Considering the northern sector of the Strait of Sicily (GSA 15 and 16) the observed maximum length was 70 mm. After age slicing with the parameters estimated by CNR-IAMC (2009; Tab. 8.54.1.2.1), the maximum estimated age in years in the exploited part of the stock resulted to be 6 years. The growth parameters estimated in the past for the Strait of Sicily are reported in Tab. 8.54.1.2.1 for comparative purposes.

During SGMED-09-02 new parameters were estimated in order to allow a better performance of the VIT approach. These new parameters, had a higher L_{inf} and lower k than the parameters given by the data call, but were nevertheless characterised by a very similar growth performance (see Φ' column in Tab. 8.54.1.2.1), as obtained by the Powel-Wetherall method (linf) and the ELEFAN "K scan" routine (K). The data used for this application were the length frequency distributions collected in trawl surveys from 1994 to 2008. Parameters were then estimated by the package FISAT II (Gayanilo *et al*., 2005).

Tab. 8.54.1.2.1 Von Bertalanffy growth function, growth performance index and length-weight relationship parameters in the Strait of Sicily (GSA 15 and 16) (L_{inf} as CL in mm).

Reference	Sex	Linf	K	t_0	Φ'	a	b
Ragonese *et al.* (1994)	Females	65.5	0.67	0.28	3.459	/	/
	Males	41.5	0.96	0.28	3.218	/	/
Cau et al. (2002)	Females	65.5	0.67	/	3.459	/	/
AAVV (2008); Red's Project	Females	62.24	0.65	0.05	3.401	0.002	2.507
	Males	40.31	0.79	-0.44	3.108	0.002	2.618
Ragonese *et al.* (2004)	Females	65.8	0.52	-0.23	3.352	0.00176-0.00210	2.51-2.56
	Males	/	/	/	/	0.00116-0.00135	2.65-2.69
CNR-IAMC (2009)	Females	61,66	0,78	-0,22	3.472	0.0016	2.5884
	Males	41.95	0,70	-0,18	3.091	0.0010	2.7456
SGMED 02 09	Females	68.9	0.61	-0.2	3.462	0.0013	2.636

8.54.1.3. Maturity

Although spawning in *A. foliacea* occurs from spring till autumn in the Strait of Sicily, maturity peaks in summer (Ragonese and Bianchini, 1995). According to Ragonese *et al*. (2004) the length at 50% of maturity is 42 mm CL in females and 30-33 mm CL in males. The most recent assessment of maturity ogive was given by CNR_IAMC (2009), with $L_{50\%}$ = 37.17 (es = 0.108) mm CL and slope g = 0.541 (es = 0.028) in females and $L_{50\%}$ = 27.41 (es = 0.0.037) mm CL and slope g = 0.988 (es = 0.031) in males.

8.54.2. Fisheries

8.54.2.1. General description of fisheries

The giant red shrimps is a relevant target species of the Sicilian and Maltese trawlers and is caught on the slope ground during all year round, although landing peaks are observed in summer. *A.foliacea* is fished mainly in the central - eastern side of the Strait of Sicily, whereas in the western side it is substituted by the blue and red shrimp, ***Aristeus antennatus.*** A rough delimitation of the most important fishing grounds of red shrimps in the Strait of Sicily is reported in Ragonese (1989) (Fig. 8.54.2.1.1). However, due to reduction of catch rates since 2004, some trawlers based in Mazara del Vallo, which is the main fleet in the area, recently moved to the eastern Mediterranean (Aegean and Levant Sea) to fish red shrimps (Garofalo *et al*., 2007).

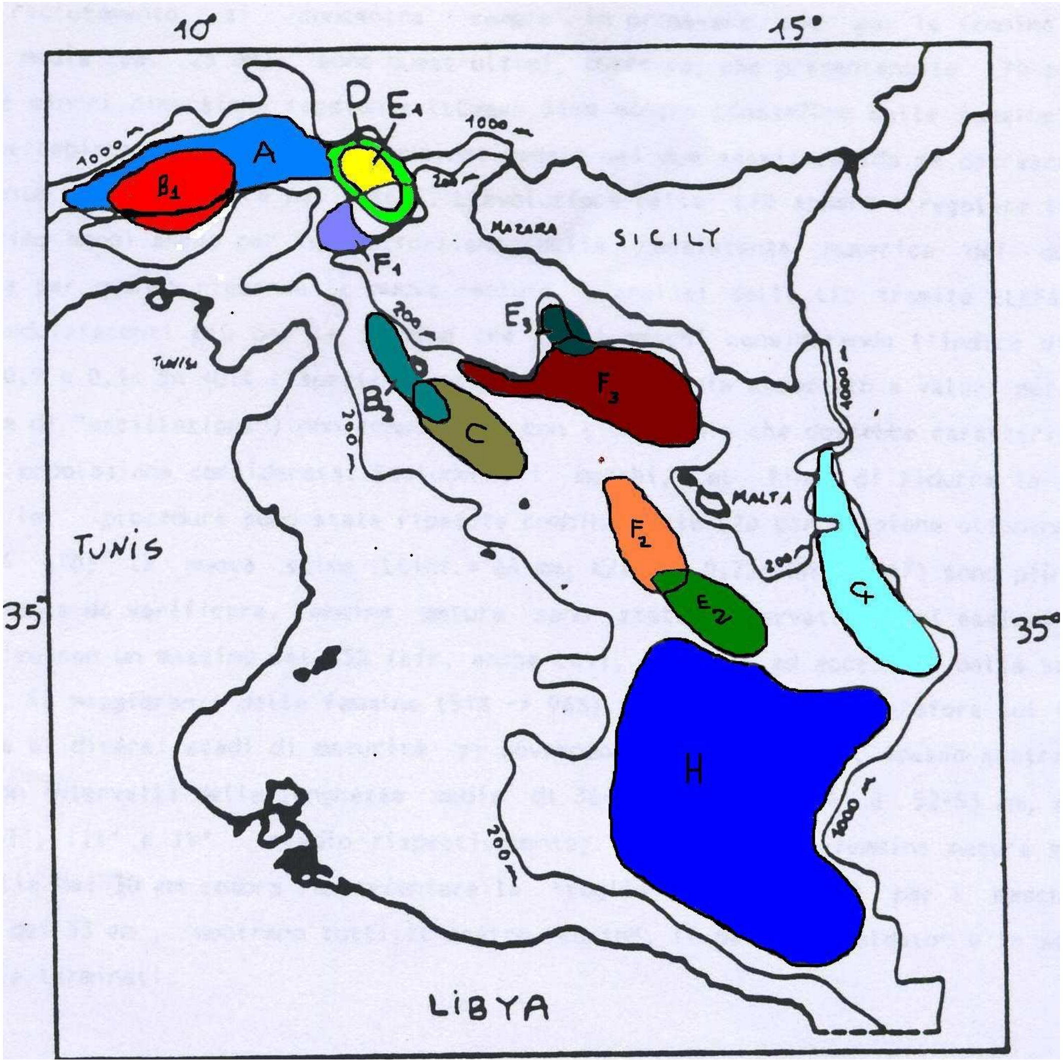


Fig 8.54.2.1.1 Main fishing grounds of red shrimps in the Strait of Sicily according to Ragonese (1989).

In Maltese waters, trawlers targeting the giant red shrimp *A. foliacea* within the 25nm fisheries management zone trawl either to the north / north-west of the Island of Gozo, or to the west / south-west of Malta, at depths of about 600 m. Detailed maps of the trawling grounds for Maltese Fisheries Management Zone (FMZ), including a wide part of GSA 15 will soon be available in Camilleri *et al*. (in press).

In terms of fishing gear, the Italian and Maltese trawlers operating in the Strait of Sicily use the same typology of trawl net called “Italian trawl net”, which is a type of otter trawl. Although some differences in material between the net used in shallow waters ("banco" net, mainly targeting shelf fish and cephalopods) and that employed in deeper ones ("fondale" net, mainly targeting deep water crustaceans) exist, the Italian trawl net is characterized by a low vertical opening (up to 1.5 m) with dimensions changing with engine power (Fiorentino *et al*., 2003). Using this gear, giant red shrimps are frequently caught together with Norway lobster (*Nephrops norvegicus*), large sized deep water pink shrimp (*Parapenaeus longirostris*), the more rare blue and red shrimp (*Aristeus antennatus*) as well as large hake (*Merluccius merluccius*).

8.54.2.2. Management regulations applicable in 2008 and 2009

At present there are no formal management objectives for giant red shrimp fisheries in the Strait of Sicily. As in other areas of the Mediterranean, the stock management is based on control of fishing capacity (licenses), fishing effort (fishing activity) and technical measures (mesh size and area/season closures). In addition, a compulsive fishing ban for 30 days was adopted by Sicilian Government (August - September). No minimum landing sizes have been established for this species (EC 1967/06).

In Maltese waters there are no closed seasons, however in order to limit the over-capacity of fishing fleet, Maltese fishing licenses have been fixed at a total of 16 trawlers since 2000. Eight new licences were however issued in 2008, a move made possible under EU law by the reduction of the capacities of other Maltese fishing fleets. Moreover, the Maltese Islands are surrounded by a 25 nautical miles (nm) fisheries management zone, where fishing effort and capacity are being managed by limiting vessel sizes, as well as total vessel engine powers (EC 813/04; EC 1967/06). Trawling is allowed within this designated conservation area, however only by vessels not exceeding an overall length of 24 m. Such vessels fishing in the management zone hold a special fishing permit in accordance with Article 7 of Regulation (EC) No 1627/94, and are included in a list containing their external marking and vessel's Community fleet register number (CFR) to be provided to the Commission annually by the Member State. Moreover, the overall capacity of the trawlers allowed to fish in the 25 nm zone can not exceed 4,800 kW, and the total fishing effort of all vessels is not allowed to exceed an overall engine power and tonnage of 83,000 kW and 4,035 GT respectively. The fishing capacity of any single vessel with a license to operate at less than 200 m depth can not exceed 185 kW. In addition, the use of all trawl nets within 1.5 nm of the coast is prohibited according to EC regulation 1967/2006, although a transitional derogation is at present in place until 2010.

In terms of technical measures, the EC regulation 1967/2006 fixed a minimum mesh size of 40 mm for bottom trawling of EU fishing vessels (Italian and Maltese trawlers). Mesh size had to be modified to square 40 mm or diamond 50 mm in July 2008, however derogations are possible up to 2010.

In addition to these management measures, the protection of spawning grounds has been suggested to be one of the most effective management approaches to enhance recruitment whilst maintaining the reproductive potential of the populations. Similarly, reducing fishing effort on juveniles is vital if stocks are to be harvested at maximum sustainable yield, in particular when juveniles are vulnerable to unselective fishing gears. The location of nursery and spawning areas of *A. foliacea* was recently identified using MEDITS trawl survey data from GSA 15 (2003-2007). The distribution of mature and immature individuals of *N. norvegicus* and *A. foliacea* was however found to be patchy, with sites distributed throughout the waters lying to the west / northwest of the Maltese Islands (Fig 8.54.2.2.1 and Fig 8.54.2.2.2). This makes difficult the designation of a single protected area for protecting the vulnerable life cycle stages of this species.

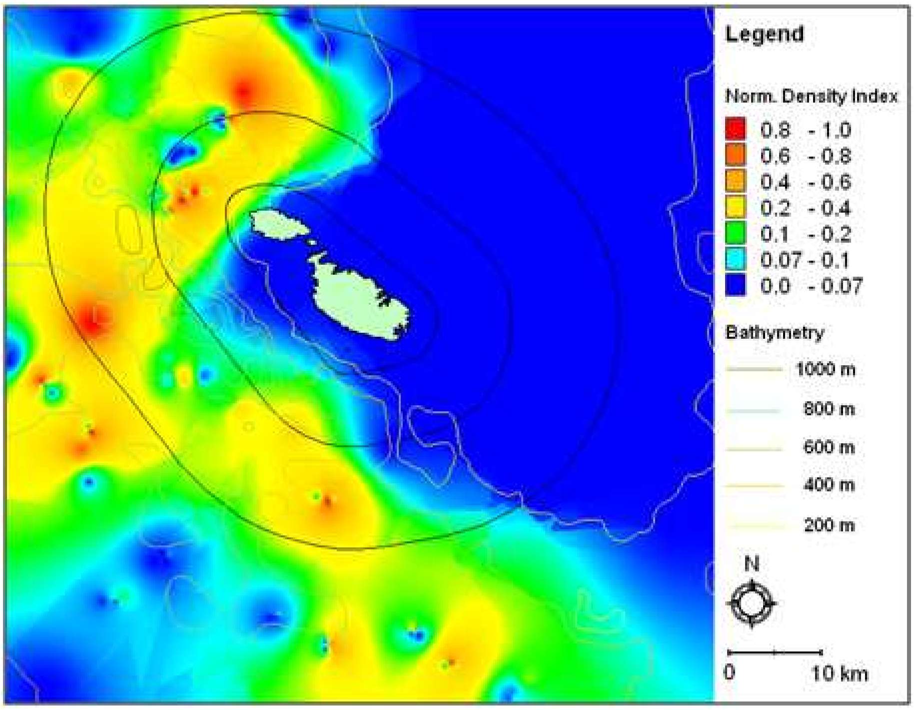


Fig. 8.54.2.2.1: Map of GSA 15, showing distribution of normalised density indices for immature *A. foliacea.*

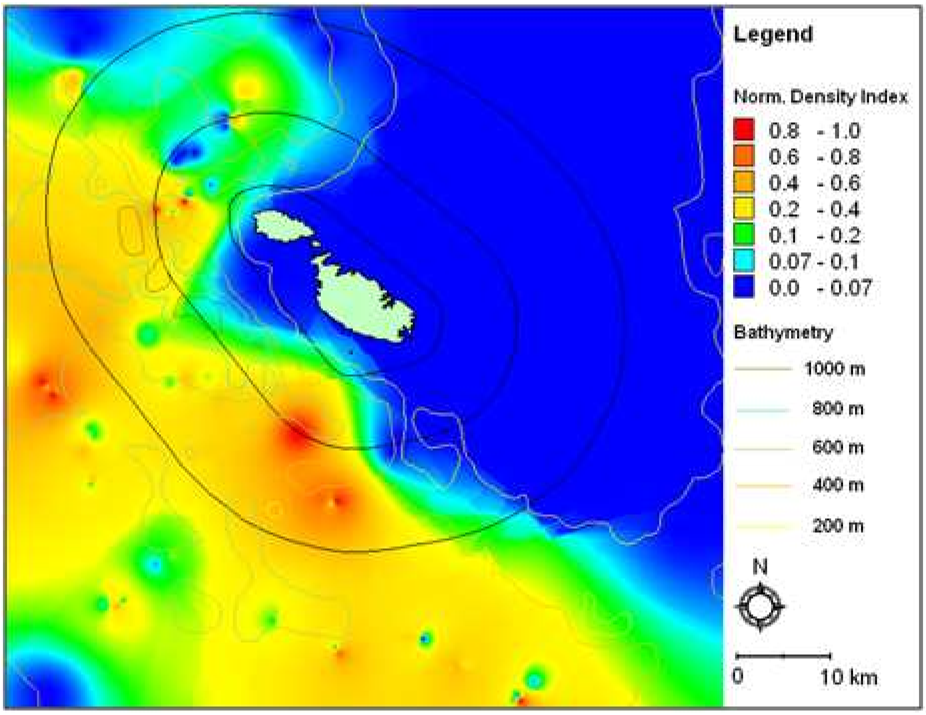


Fig. 8.54.2.2.1: Map of GSA 15, showing distribution of normalised density indices for mature *A. foliacea.*

8.54.2.3. Catches

8.54.2.3.1. Landings

Yield of the Italian trawlers in 2006 was about 1,883 t decreasing to 1,721 t in 2008. The Maltese trawlers landed 25 t in 2006 and 34 t in 2007.

Tab. 8.54.2.3.1.1 Landings (t) by year and major gear types, 2005-2008 as reported through DCR, OTB = bottom otter trawls.

Species	Area	Country	Fleet	2005	2006	2007	2008
ARS	15	Malta	OTB	17	26	34	27
ARS	16	Italy	OTB	1270	1424	1540	1260
ARS	15&b 16	Italy	OTB	1287	1450	1574	1287

The most recent Italian and Maltese data were collected within the framework of the DCR. Available information is considered feasible by the experts attending the working group.

In GSA 15 about 704 tonnes of fish were landed in 2007. The most landed species in terms of weight were *Thunnus thynnus* (34%), *Coryphaena hippurus* (25%), *Xiphias gladius* (19%). These species together constitute about 78 % of the total landed catch in 2007. *A. foliacea* was the most landed crustacean by total weight, making up 1.3% of catches. The following table summarises the percentage distribution of landings estimtated through sales vouchers.

Tab. 8.54.2.3.1.2 Landed catch for GSA 15 in 2007 estimated through sales vouchers (from Malta Technical Report 2007).

Species	**% importance of total catch**
Thunnus thynnus	34.2
Coryphaena hippuris	25.2
Xiphias gladius	19.3
Squalus blainvillei	1.8
Boops boops	1.5
Scorpaena scrofa	1.4
Aristaeomorpha foliacea	1.3
Epinephelus spp.	1.3
Others	14.0
Grand Total	**100%**

Regarding length compositions of landings, information is only available for Sicilian vessels (Fig. 8.54.2.3.1.1). Data were considered representative since the 3rd quarter of 2005, when a sampling scheme allowing a realistic raising of the sampled catches to the total ones was adopted (SIBM, 2005).

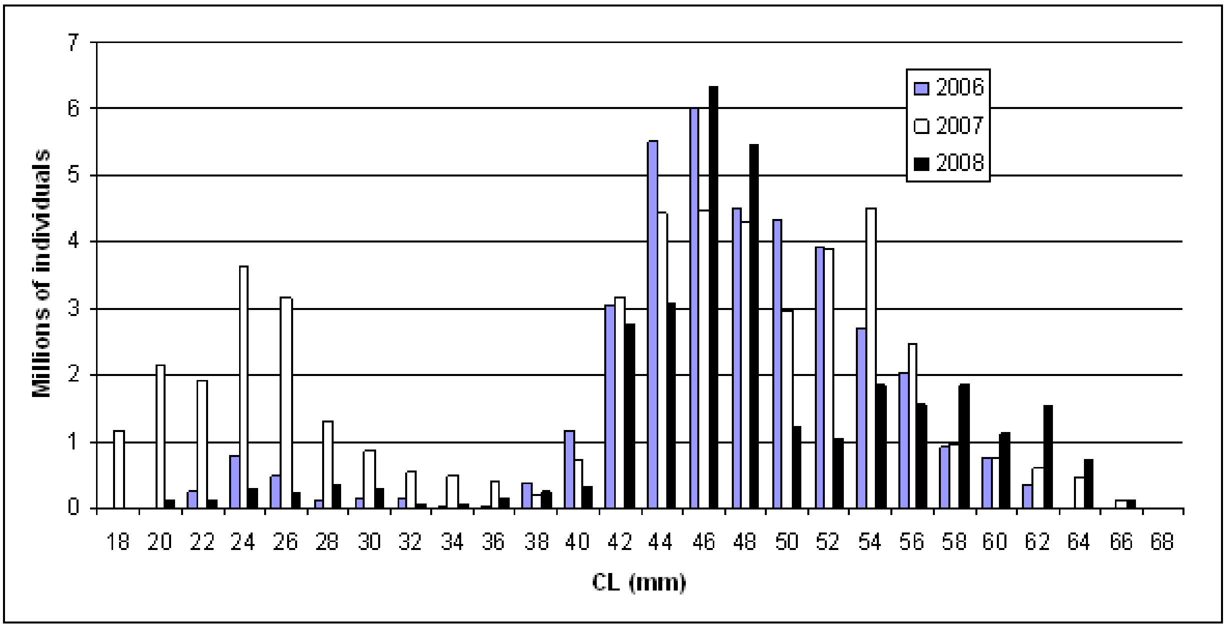


Fig. 8.54.2.3.1.1 Yearly length structure of giant red shrimp landings (females) in absolute numbers of Sicilian trawlers (GSA 16).

8.54.2.3.2. Discards

According to information available to the SGMED-09-02 no catches of red shrimp were discarded by Italian trawlers. An assessment of the discards made by the Maltese fishing industry was carried out in 2005. Results showed that there is no discard practice amongst boats smaller than 10 m and that for larger boats the discard rate is negligible (average 4.7%). More detailed information on volume and species composition of the discards of vessels larger than 10 m by gear type and fleet segment is at present being compiled under the new Data Collection Framework. The bottom otter trawl fleet is being monitored monthly since January 2009, however preliminary analyses are still not available.

8.54.2.3.3. Fishing effort

The trends in fishing effort by year and major gear type is listed in Tab. 8.54.2.3.3.1 and shown in Fig. 8.54.2.3.3.1 in terms of GT*days for the otter trawls.

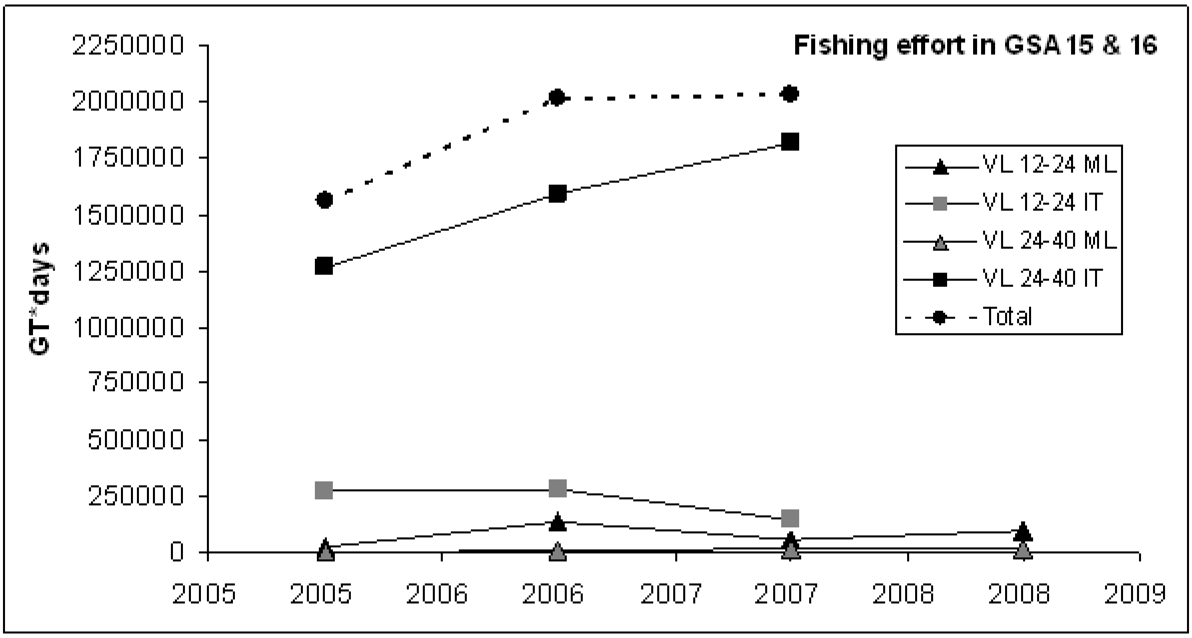


Fig. 8.54.2.3.3.1 Fishing effort in terms of GT*days of trawlers targeted to demersal species in GSAs 15 and 16.

Tab. 8.54.2.3.3.1 Annual effort of trawlers as GT*days by country and vessel length in GSAs 15 and 16, 2005-2008.

COUNTRY	AREA	YEAR	FT_LVL3	FT_LVL4	TYPE	EF	FT_LVL	VESSEL_LENGTH
MLT	15	2005	Bottom trawls	[OTB]	GT*DAYS	24240	5	VL1224
MLT	15	2005	Bottom trawls	[OTB]	GT*DAYS	638	5	VL2440
ITA	16 + OTHERS	2005	Bottom trawls	[OTB]	GT*DAYS	275756	5	VL1224
ITA	16 + OTHERS	2005	Bottom trawls	[OTB]	GT*DAYS	1263550	5	VL2440
MLT	15	2006	Bottom trawls	[OTB]	GT*DAYS	133167	5	VL1224
MLT	15	2006	Bottom trawls	[OTB]	GT*DAYS	10742	5	VL2440
ITA	16 + OTHERS	2006	Bottom trawls	[OTB]	GT*DAYS	280813	5	VL1224
ITA	16 + OTHERS	2006	Bottom trawls	[OTB]	GT*DAYS	1591338	5	VL2440
MLT	15	2007	Bottom trawls	[OTB]	GT*DAYS	55542	5	VL1224
MLT	15	2007	Bottom trawls	[OTB]	GT*DAYS	13727	5	VL2440
ITA	16 + OTHERS	2007	Bottom trawls	[OTB]	GT*DAYS	145441	5	VL1224
ITA	16 + OTHERS	2007	Bottom trawls	[OTB]	GT*DAYS	1817553	5	VL2440
MLT	15	2008	Bottom trawls	[OTB]	GT*DAYS	96907	5	VL1224
MLT	15	2008	Bottom trawls	[OTB]	GT*DAYS	12425	5	VL2440
ITA	16 + OTHERS	2008	Bottom trawls	[OTB]	GT*DAYS	NA	5	VL1224
ITA	16 + OTHERS	2008	Bottom trawls	[OTB]	GT*DAYS	NA	5	VL2440

8.54.3. Scientific surveys

8.54.3.1. Medits

8.54.3.1.1. Methods

In GSA 15 and 16 the following number of hauls was reported per depth stratum (s. Tab. 8.54.3.1.1.1).

Tab. 8.54.3.1.1.1 Number of hauls per year and depth stratum in GSAs 15 and 16, 1994-2008.

GSA	Stratum	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08
15	a									1	1	2	1	1	0	0
15	b									5	5	4	5	2	12	6
15	c									13	13	13	13	13	12	13
15	d									10	10	10	9	10	4	9
15	e									16	16	15	17	16	17	17
16	a	4	4	4	4	4	4	4	4	7	7	7	10	10	11	11
16	b	8	8	8	8	8	8	7	8	11	12	12	20	22	23	23
16	c	4	4	4	4	5	5	6	5	10	8	9	18	19	21	21
16	d	10	11	11	12	11	11	11	11	19	18	19	28	31	27	27
16	e	10	14	14	13	14	14	14	14	19	20	19	32	33	38	38

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.54.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02. However some information on aggregates of female spawners have been reported by Ragonese and Bianchini (1995).These are shown in Fig. 8.54.3.1.2.1 below.

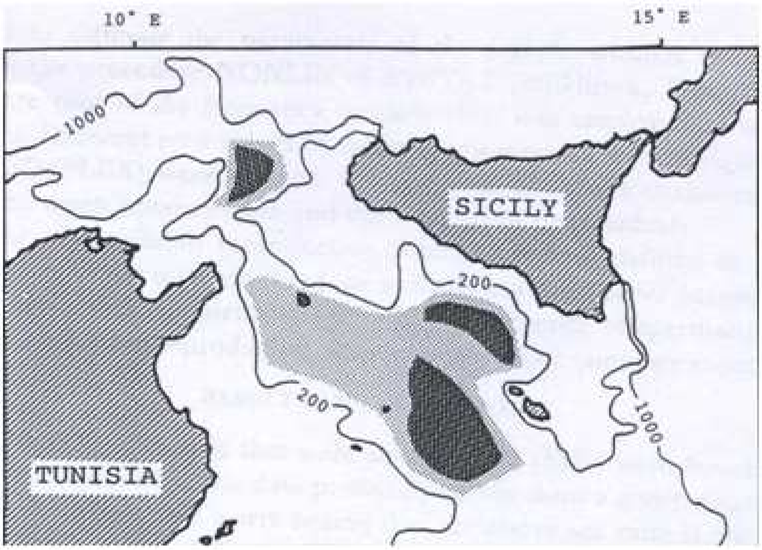


Fig. 8.54.3.1.2.1 Spawning areas of female according to Ragonese and Bianchini (1995).

8.54.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the giant red shrimp in GSAs 15 and 16 was derived from the international surveys MEDITS. Fig. 8.54.3.1.3.1 and Fig. 8.54.3.1.3.2 indicate the stock to vary without an evident trend in the last year (2002-2008), although the abundance of giant red females in both GSAs reached its highest level in 2008 compared with the last 3 years.

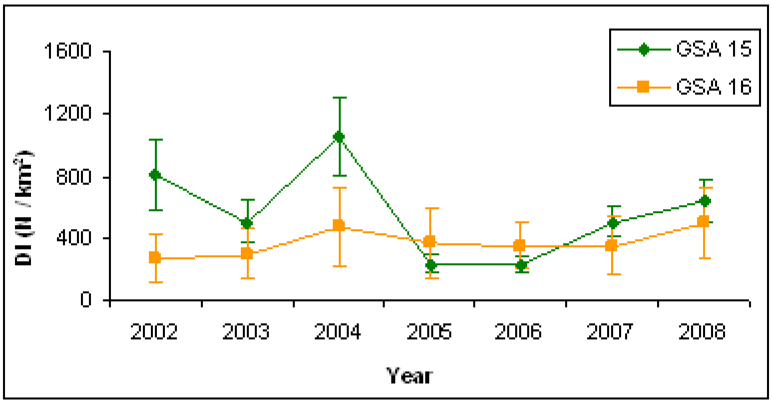


Fig. 8.54.3.1.3.1 DI in N/km^2 (MEDITS survey data) in GSAs 15 and 16 for female *A. foliacea*. Only slope grounds were considered (201-800 m).

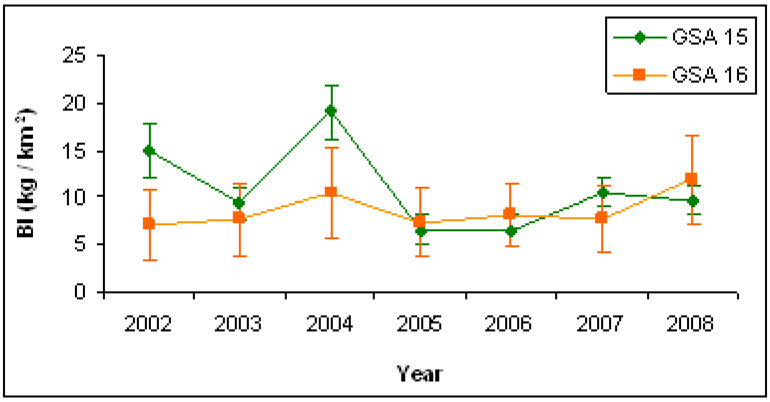


Fig 8.54.3.1.3.2. BI in kg/km^2 (MEDITS survey data) in GSAs 15 and 16 for female *A. foliacea*. Only slope ground was considered (201-800 m).

The trend in abundance and biomass as re-estimated by SGMED-09-02 are shown in Figures 8.54.3.1.3.3 and 8.54.3.1.3.4 for GSAs 15 and 16. Such analyses of Medits indices are considered preliminary.

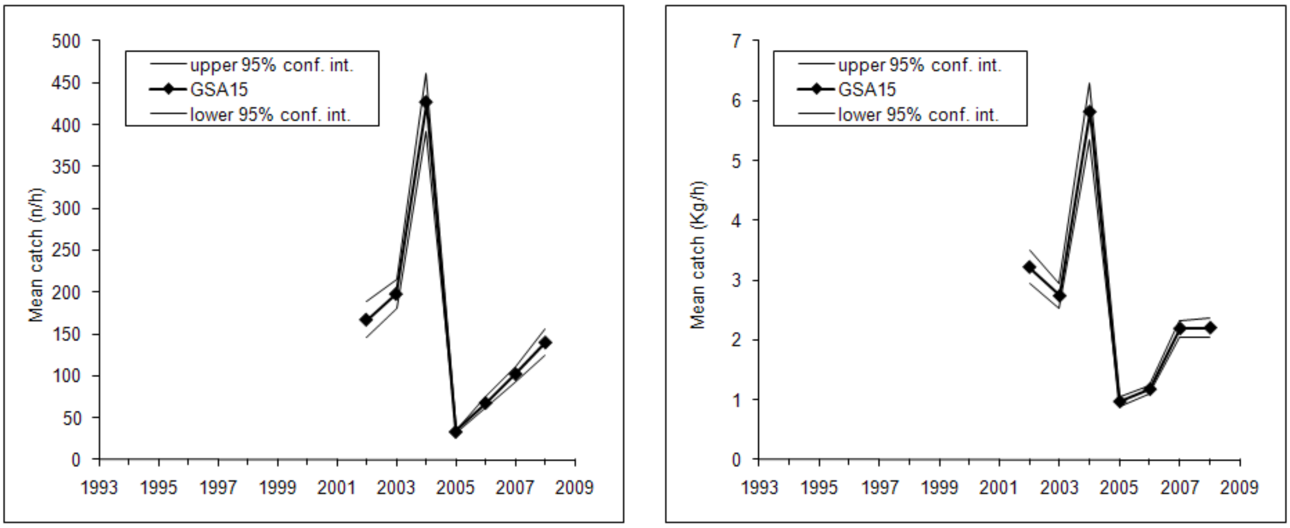


Fig. 8.35.3.1.3.4 Abundance and biomass indices of giant red shrimp in GSA 15.

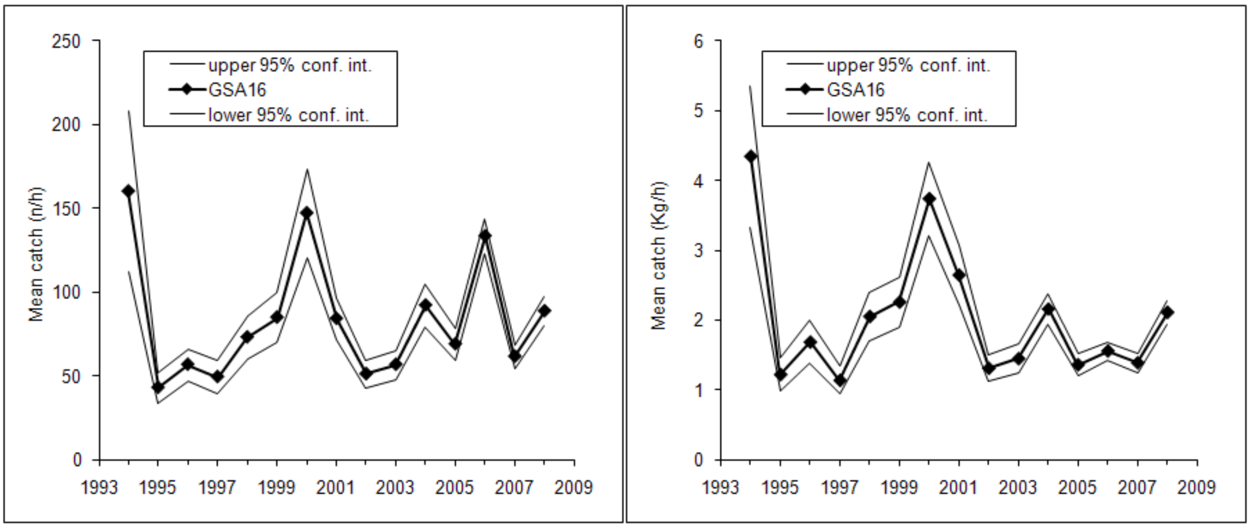


Fig. 8.35.3.1.3.5 Abundance and biomass indices of giant red shrimp in GSA 16.

8.54.3.1.4. Trends in abundance by length or age

Fig. 8.54.3.1.4.1 displays the stratified abundance indices (strata d and e) of giant red shrimp in GSAs 15 and 16 in 2002-2008.

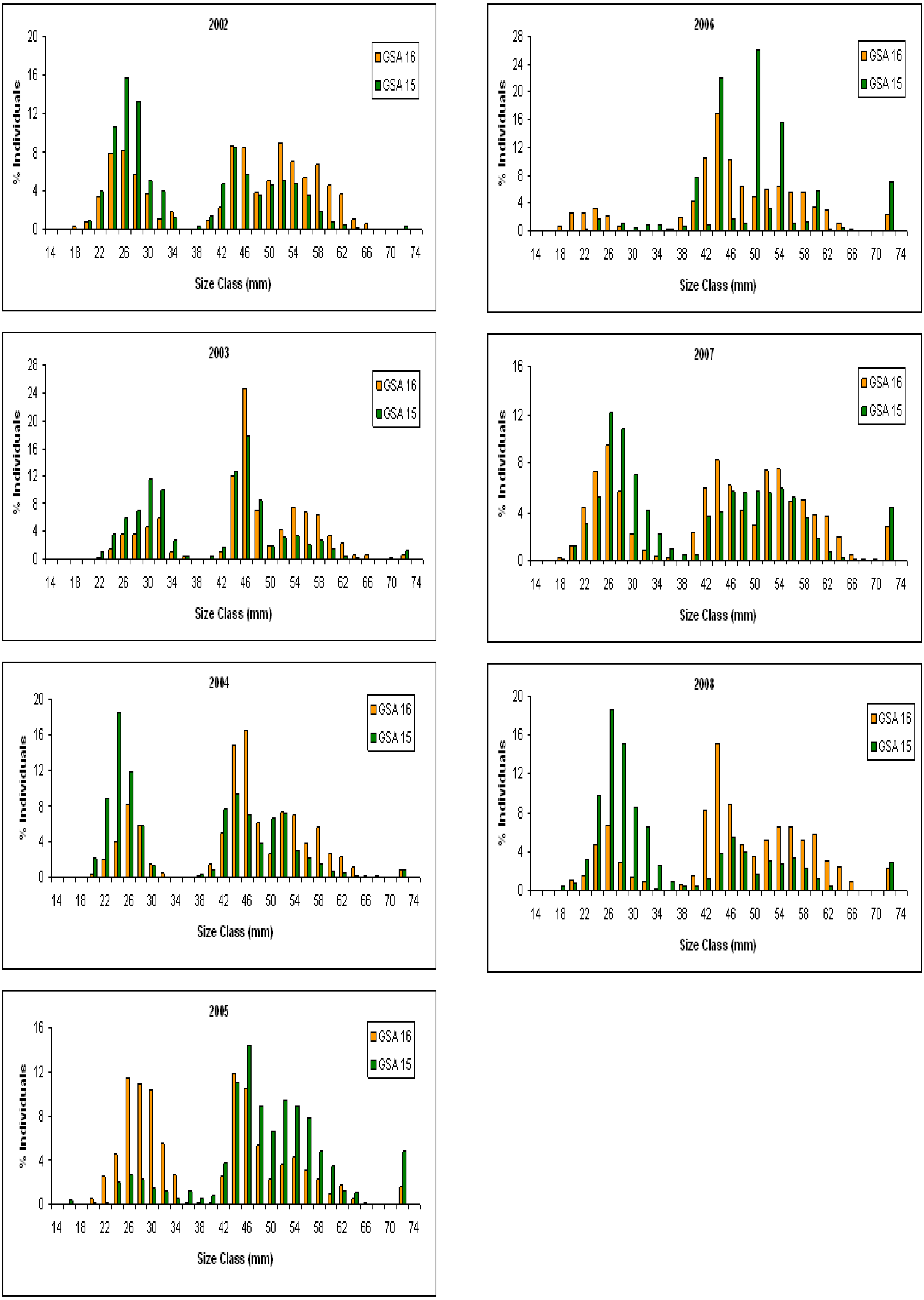


Fig. 8.54.3.1.4.1 Stratified abundance indices by size class in GSAs 15 and 16, 2002-2008.

Figure 8.54.3.1.4.2 displays the stratified abundance indices of giant red shrimp in GSA 16 in 1994-2001.

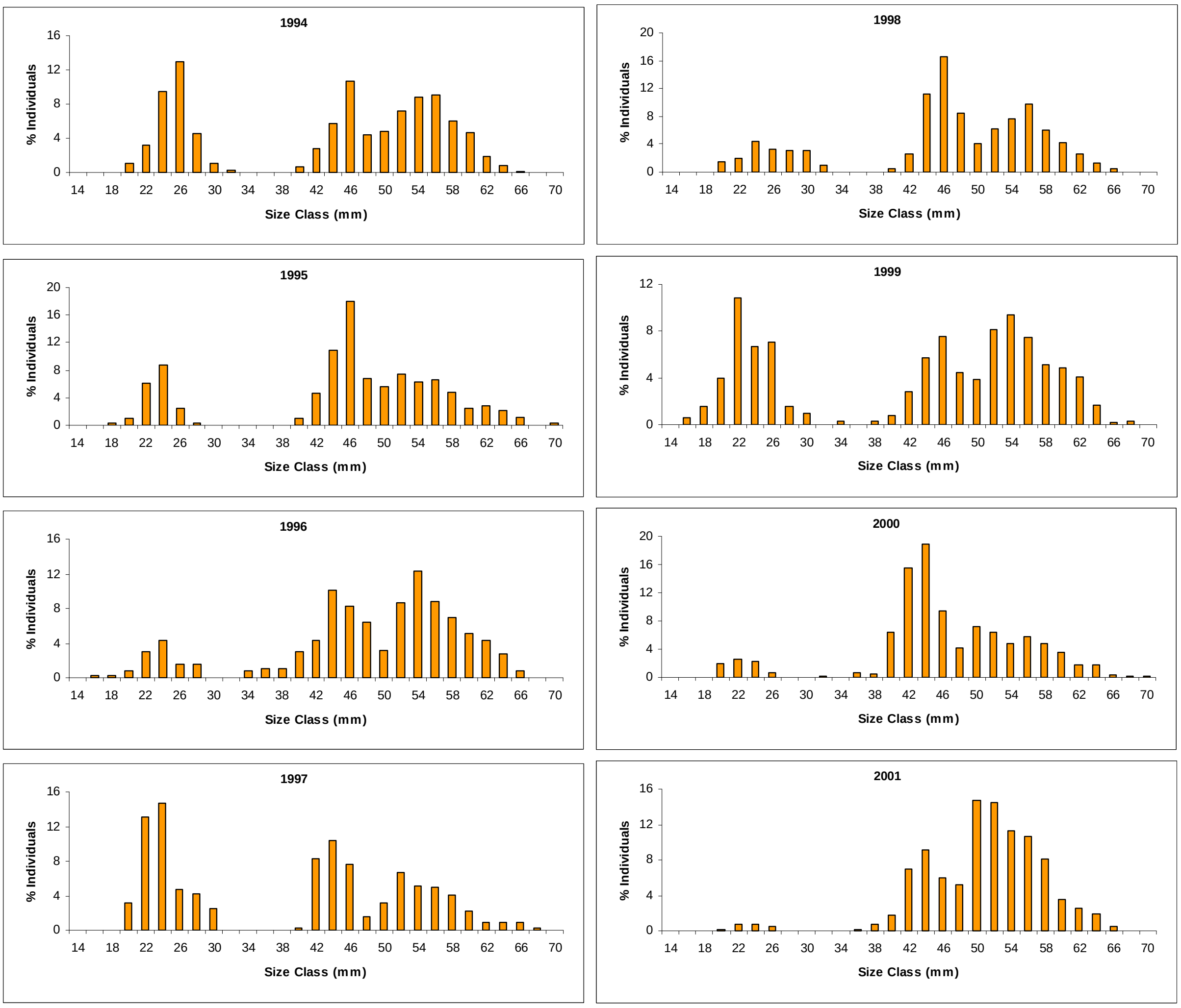


Fig. 8.54.3.1.4.2 Stratified abundance indices by size class in GSA 16, 1994-2001.

8.54.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.54.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.54.4. Assessment of historic stock parameters

8.54.4.1. Method 1: SURBA

8.54.4.1.1. Justification

The availability of length frequency distribution (LFD) time series (2002-2008 for GSA 15 and 1994-2008 for GSA 16) from trawl survey data allowed the reconstruction of the evolution of main stock parameters (recruitment and spawning stock biomass indices, as well as fishing mortality rates) of giant red shrimps in the GSA 15 and 16 by using the SURBA software package. Since females reach the largest size and they are more sensitive to fishery pressure, analyses were carried out only on the female fraction, which represented about 70% of the commercial catches (Gancitano *et al*., 2008).

Firstly the LFD by sex from the MEDITS trawl surveys was corrected by including the data for the individuals with unidentified sex. This was based on the sex ratio per size class. The corrected LFDs by sex for each GSA were then converted in numbers by age group using the subroutine “age slicing” as implemented in the software package LFDA (Kirkwood *et al*., 2001). Secondly we estimated the mean weight and maturity at age using VBGF and natural mortality at age (PROBIOM excel sheet as implemented by Abella in SGMED-09-01) for the SURBA software to run the analysis. Then the numbers at age were used to estimate time series of fishing mortality rates, as well as recruitment and SSB indices. This was done due to the difficulties in obtaining feasible information from commercial fisheries data, especially from GSA 15 where length frequencies distributions from landings do not exist. For GSA 16 data from commercial fisheries were only available since 2002, when the DCR regulation (EC 1639/01; EC 1581/04) was implemented, although data were considered reliable since 2005.

8.54.4.1.2. Input parameters

The input parameters are reported in Tab. 8.54.4.1.2.1.

Tab. 8.54.4.1.2.1 Biological parameters used for SURBA analyses for giant red shrimp (females) in the Strait of Sicily (GSAs 15 and 16).

Growth			maturity		weight	
Linf	K	t0	Lm	g	a	b
68.9	0.61	-0.2	37.17	0.541	0.0016	2.5884

A declining value of M with age instead of a constant value was used based on the outcome of discussions held at SGMED-09-01, where the experts concluded such an approach is necessary considering the early age of first capture and the massive catch of juveniles characterised by higher M rates in most of the Mediterranean fisheries: Natural mortality rates by age were thus calculated according to the ProBiom model developed by Abella, Caddy and Serena (1997), based on Caddy (1991).

The value by age used in the analysis are given in Tab. 8.54.4.1.2.2. The age slicing in GSA 15 produced only 4 age groups (up age 3+).

Tab. 8.54.4.1.2.2. Values by age used for SURBA analyses for giant red shrimp (females) in GSAs 15 and 16.

Age	0	1	2	3	4	5+
Natural mortality at age	0.62	0.30	0.23	0.19	0.17	0.16
Maturità at age	0.00	1.0	1.0	1.0	1.0	1.0
Weight at age	10.44	34.95	56.48	70.97	79.72	85.5
Catchability coefficient	0.4	1.0	1.0	1.0	1.0	1.0

8.54.4.1.3. Results

State of adult / juvenile abundance:

Figures 8.54.4.1.3.1 and 8.54.4.1.3.2 combining GSAs indicate the stock to vary without an evident trend in the last year (2002-2008), although SSB reached its highest level in 2008 compared with the last 6 years.

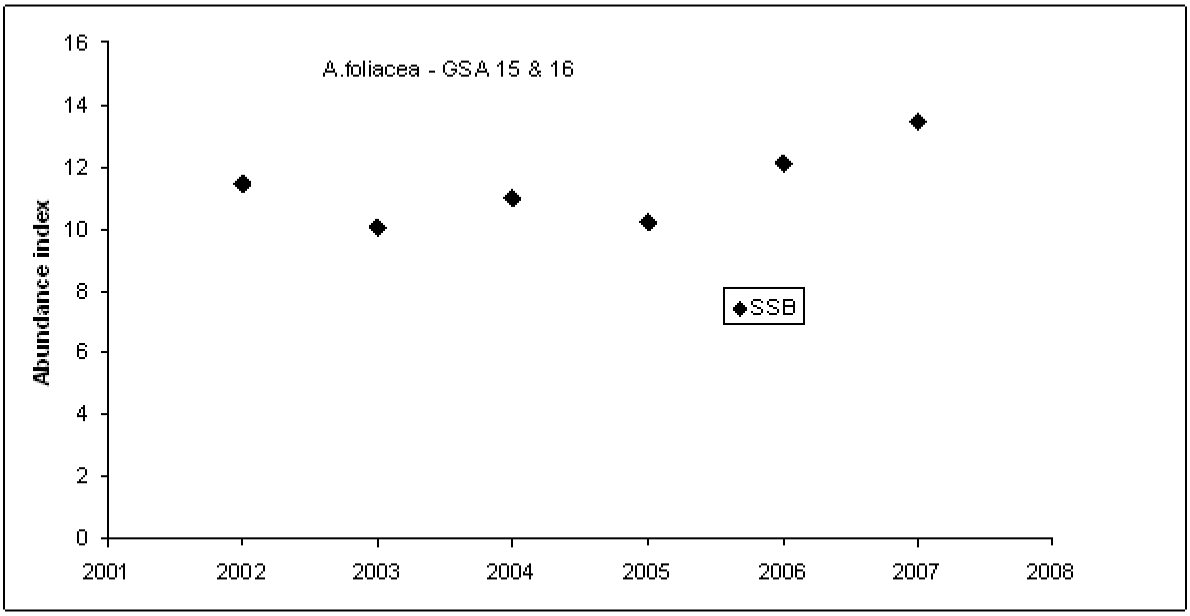


Fig. 8.54.4.1.3.1 SSB in kg/km^2 (MEDITS survey) in GSAs 15 and 16 from SURBA. Only slope grounds were considered (201-800 m).

Considering only the GSA 16 where the time series is longer (1994-2008), SSB shows stably low level since 2001.

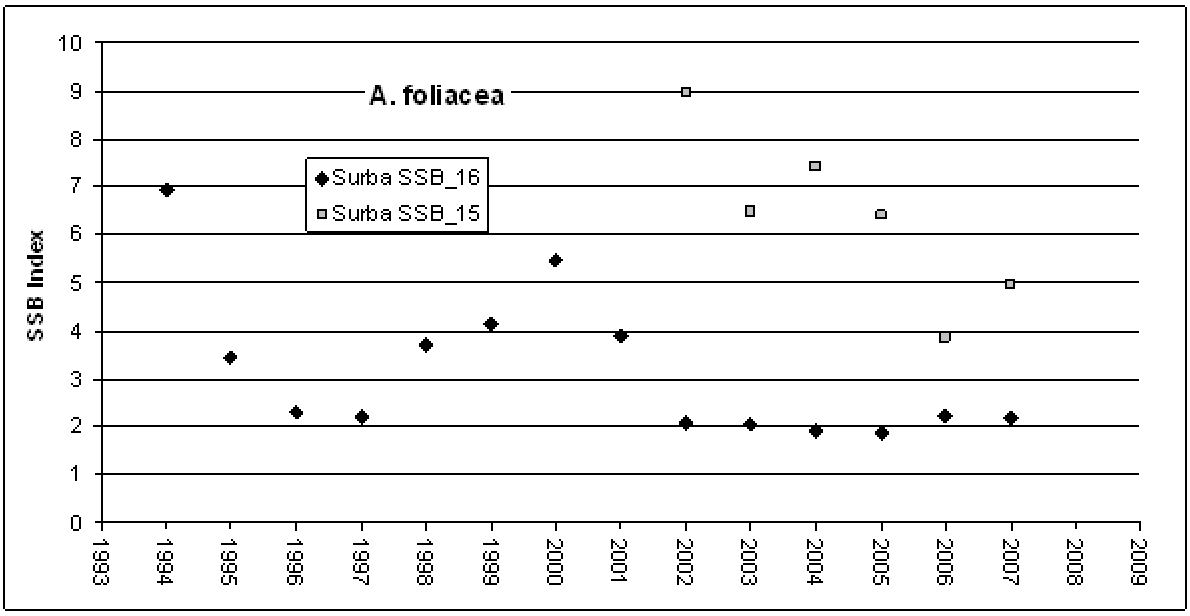


Fig. 8.54.4.1.3.2 SSB in kg/km^2 (MEDITS survey), as median of SURBA bootstrapped values, in GSAs 15 and 16. Only slope grounds were considered (201-800 m).

Survey indices in 2008 indicate the recruitment level to have recovered to average levels following a sharp drop in 2006.

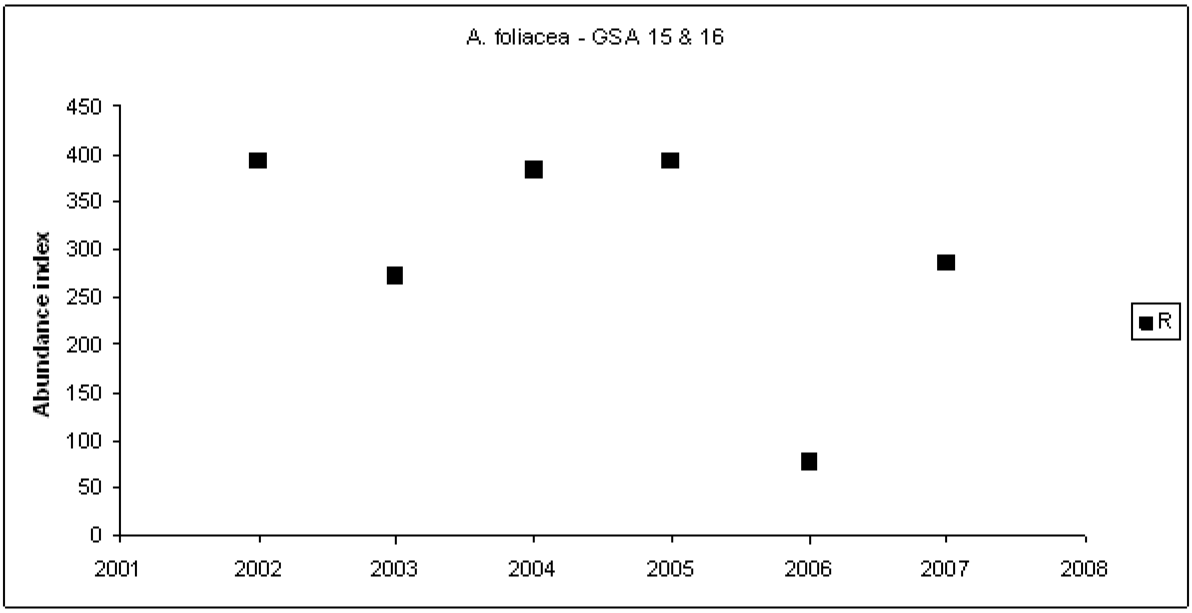


Fig. 8.54.4.1.3.3 Recruits n/km^2 (MEDITS survey) in GSAs 15 and 16 from SURBA analysis.

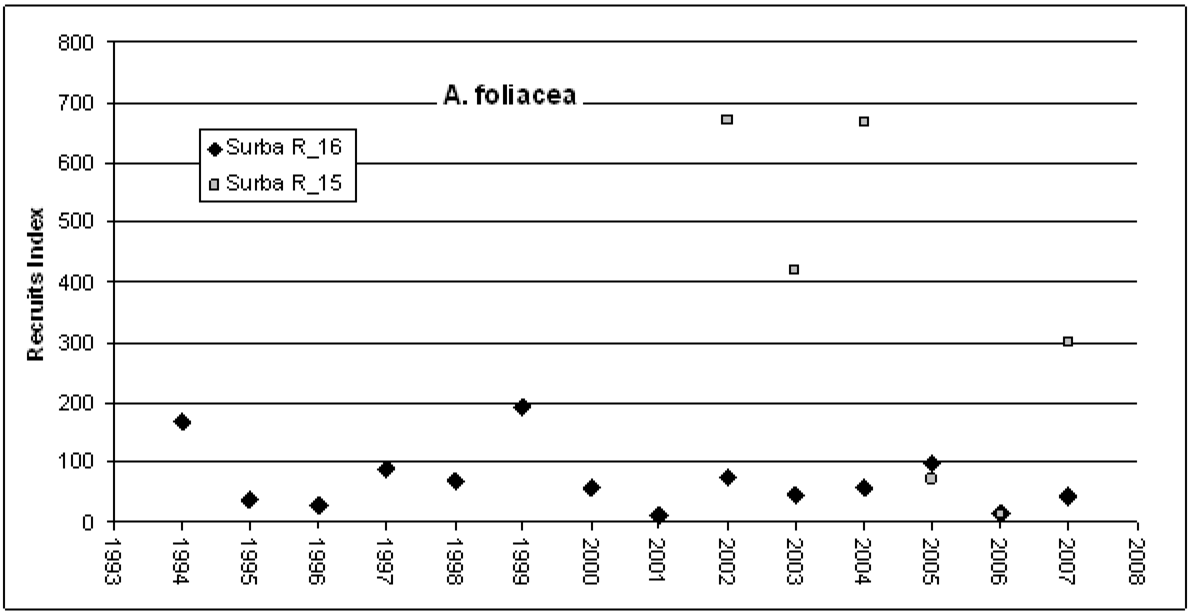


Fig. 8.54.4.1.3.4. Recruits n/km^2 (MEDITS survey), as median of SURBA bootstrapped values, in GSAs 15 and 16. Only slope ground was considered (201-800 m).

The stability of recruitment indices in the last years is also confirmed by the analysis of the longer series from GSA 16.

The values of F (age 1-3) in GSA 16 from 2000 to 2004 remains very stable around 0.83 (SD=0.06). Time series from GSA 15 is still no long enough to evaluate any trend.

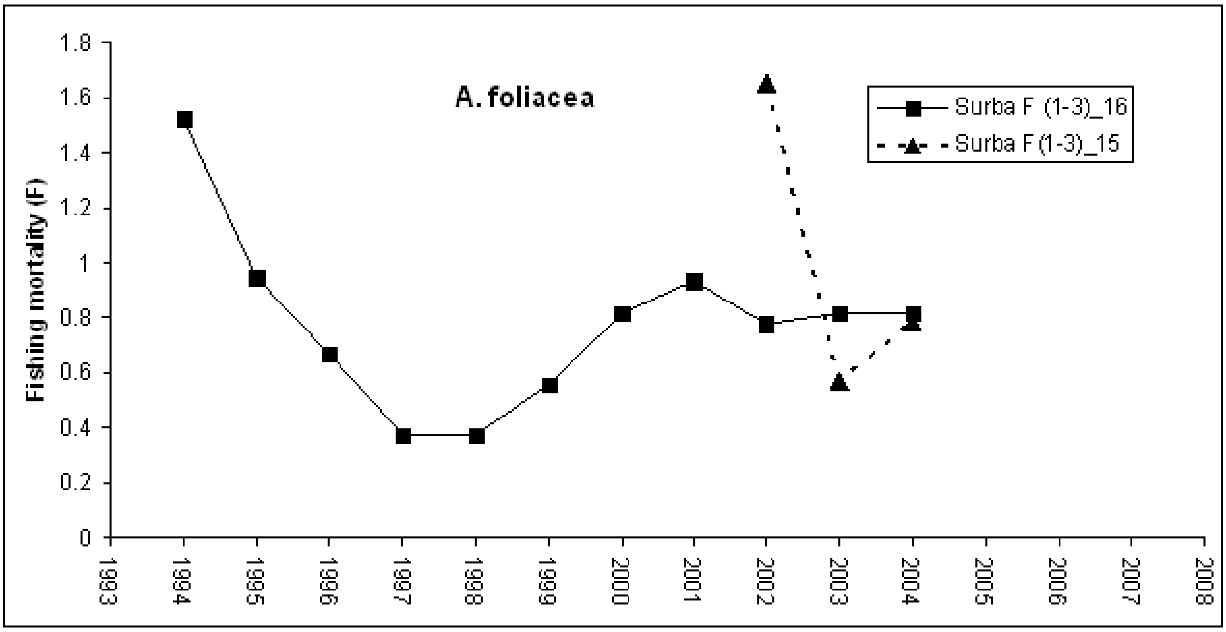


Fig. 8.54.4.1.3.5. Development of fishing mortality in GSAs 15 and 16.

8.54.4.2. Method 3: VIT

8.54.4.2.1. Justification

According to the SGMED-08-03, an approach assuming a steady state (pseudocohort) was used, keeping separate the available years (2006, 2007 and 2008). Cohort (VPA equation) and Y/R analysis as implemented in the package VIT4win were used (Lleonart and Salat, 2000). Data were derived from the DCR data call.

8.54.4.2.2. Input parameters

The parameters used in the analysis are reported in Tab. 8.54.4.2.2.1. No discard data were included as those were considered negligible. Analysis were carried out on the landings of the Italian trawlers which contribute to more than 97% of the total yield in the GSAs 15 and 16 (Tab. 8.54.2.3.1.1). Since females reach larger size than males and amount to more than 75% of landing in weight (Gancitano *et al*., 2008), females parameters were used to asses stock exploitation.

Natural mortality and maturity by size are shown in Fig. 8.54.4.2.2.1.

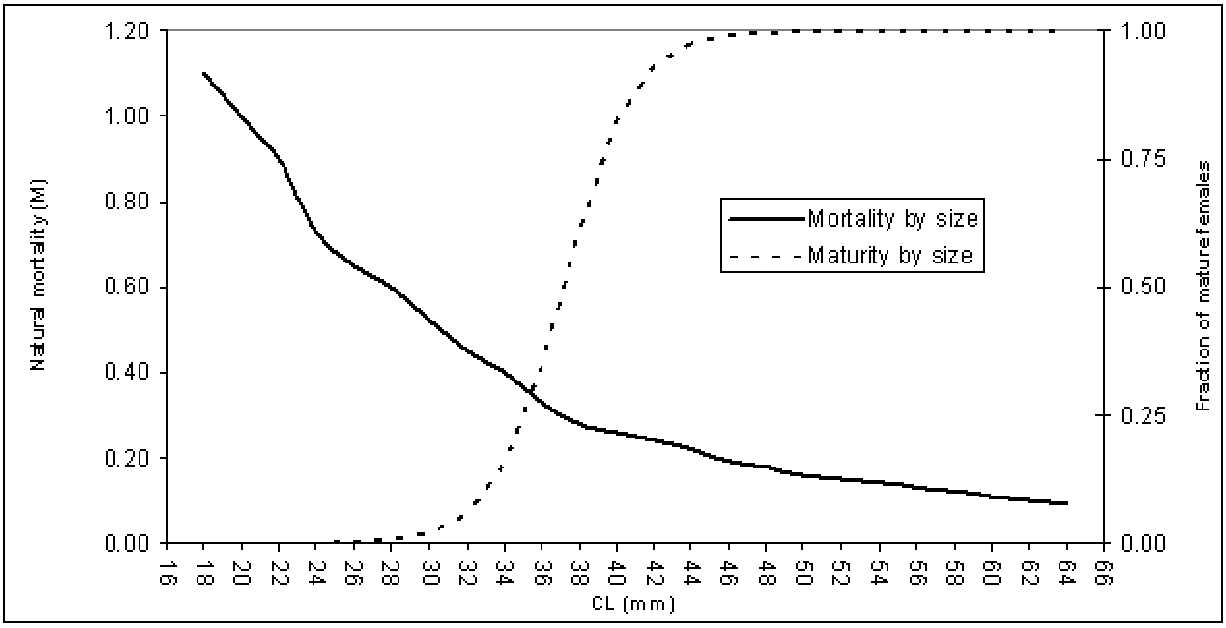


Fig. 8.54.4.2.2.1 Natural mortality (M) and maturity by length (CL) in females of giant red shrimp in the Strait of Sicily.

Tab. 8.54.4.2.2.1 Absolute number by length class (CL in mm) of females landed by year in the Strait of Sicily.

CL (mm)	2006	2007	2008
18	0	1147734	0
20	0	2127086	100309
22	237775	1890516	100309
24	772770	3623983	305050
26	475551	3149768	215550
28	118888	1318593	341753
30	127266	842297	256323
32	127266	532429	58259
34	31831	470665	41614
36	31831	408899	145916
38	379236	181206	243625
40	1142386	711999	327251
42	3044008	3151318	2740892
44	5496558	4435325	3064386
46	6012676	4454360	6327938
48	4499250	4313970	5444486
50	4328759	2964055	1190896
52	3934095	3878377	1051100
54	2702964	4481251	1845141
56	2027310	2456775	1555210
58	904016	962723	1846338
60	760428	761051	1128533
62	359591	574772	1515948
64	0	446168	712475
66	0	110053	101305
Total	37516461	49397379	30662613

8.54.4.2.3. Results

Fishing mortality rates (F) by size of female giant red shrimps caught by trawlers in GSAs 15 and 16 are shown in Fig. 8.54.4.2.3.1.

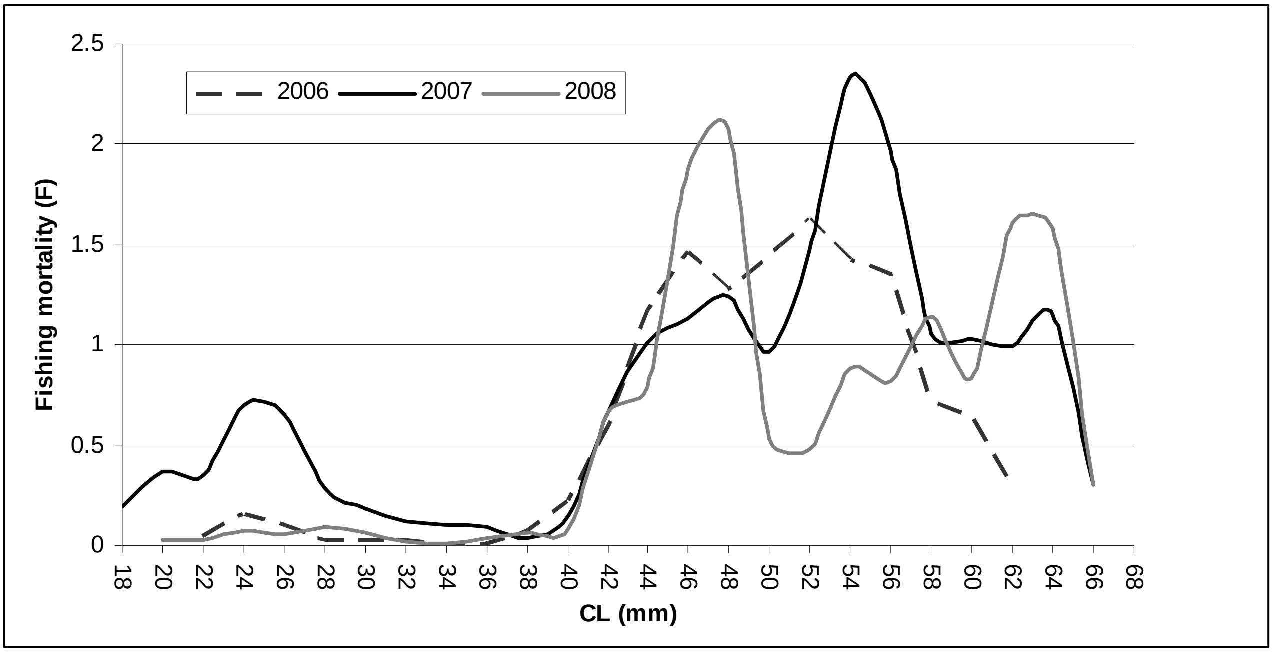


Fig. 8.54.4.2.3.1 Fishing mortality by size size of female giant red shrimps caught by trawlers in GSA 15 and 16.

The reconstructed yields obtained by the VIT package are virtually equal to the observed ones. Absolute recruitment estimation and other major results of the VIT analysis, including current mortality rates, are listed in Tab. 8.54.4.2.3.1.

Tab. 8.54.4.2.3.1. The main results of VIT analysis.

Year	2006	2007	2008	Median
Recostructed yield (t)	1424	1540	1260	1424
Biomass at sea (t)	1883	1825	1721	1825
SSB at sea (t)	1418	1307	1304	1307
Recruitment (ml)	73.8	95.3	62.8	73.8
Mean Z over all sizes	0.989	0.985	0.943	0.985
Mean F over all sizes	0.733	0.806	0.774	0.774
Mean F (1-3 age groups)	0.879	1.010	0.849	0.879

8.54.5. Long term prediction

8.54.5.1. Method 1: Y, B and SSB per recruit according to the VIT package

8.54.5.1.1. Justification

The VIT approach to Biomass and Yield per recruit analysis has been applied in order to analyse the stock production with increasing exploitation under equilibrium conditions.

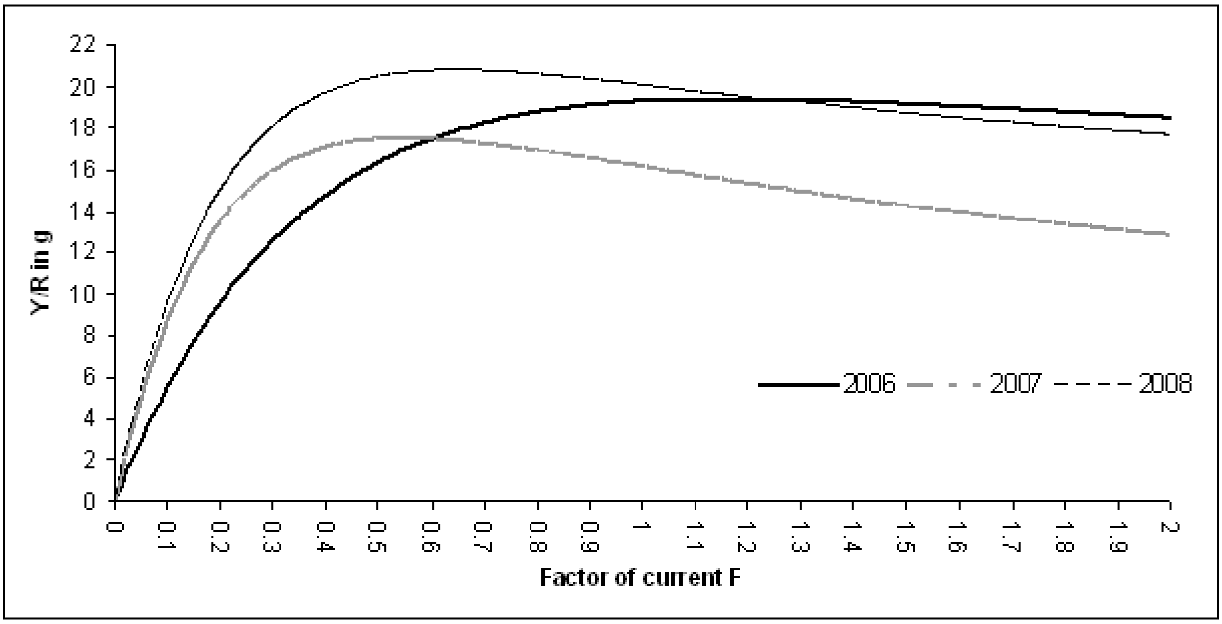


Fig. 8.54.5.1.1.1. Yield per recruit varying current fishing mortality (Fc) by a multiplicative factor according to the VIT package. Analyses deal with pseudo-cohorts 2006, 2007 and 2008.

Assuming no variation in the exploitation pattern, the main result of Y/R analysis in terms of current F and optimal ones are reported in Tab. 8.54.5.1.1.1.

Tab. 8.54.5.1.1.1 Estimation of current F, as F_{mean}, and optimal ones, as F_{max} and $F_{0.1}$, by pseudo cohorts according to VIT package. Median values are reported in bold.

Fishing mortalities	2006	2007	2008
Fcurrent	**0.774**	0.806	0.733
Fmax	0.913	0.451	**0.476**
F0.1	0.542	0.282	**0.293**

Comparing current F with BRP according to the obtained by VIT steady state VPA, a overfishing was clearly detected.

8.54.5.2. Method 2: Y, B and SSB per recruit according to the Yield package

8.54.5.2.1. Justification

Availability of biological parameter and length at first capture information allows the simulated quantification of likely changes in Y, B and SSB per recruit as a function of fishing mortality (F) with the

Yield package (Branch *et al.*, 2001). The package was also used to calculate a probability estimation of BRP (F_{max} and $F_{0.1}$).

8.54.5.2.2. Input parameters

All parameters were converted from Carapace Length (CL) in mm to Total Length (TL) by using the relation given by Gancitano (Pers. Com.): TL (mm) = 2.678 CL (mm) + 28.564

The new parameters were subsequently converted in terms of cm and g. A guess estimate of uncertainty in terms of coefficient of variation was added to each parameter (Tab. 8.54.5.2.2.1). The natural mortality rate was assumed constant at M=0.40 (Ragonese *et al.*, 2004). Stock-recruitment relationship was not used, and instead recruitment was assumed to be constant with a random variability among years of CV=0.4.

Tab. 8.54.5.2.2.1. Parameters used for stock assessment through Yield approach. Lengths are in cm and weights in gr. Only the female fraction of the fished stock was assessed.

L∞	21.6 (0.1)	**Tm**	1 (0.1)
K	0.61 (0.1)	**Tc**	1 (0.1)
t0	-0.2 (0.1)	**M**	0.40 (0.1)
A	0.0034	**Recruitment**	Constant with CV=0.4
B	3.3562		

8.54.5.2.3. Results

Estimation of Y and SSB per recruit according to the Yield package are shown in Fig 8.54.5.2.3.1.

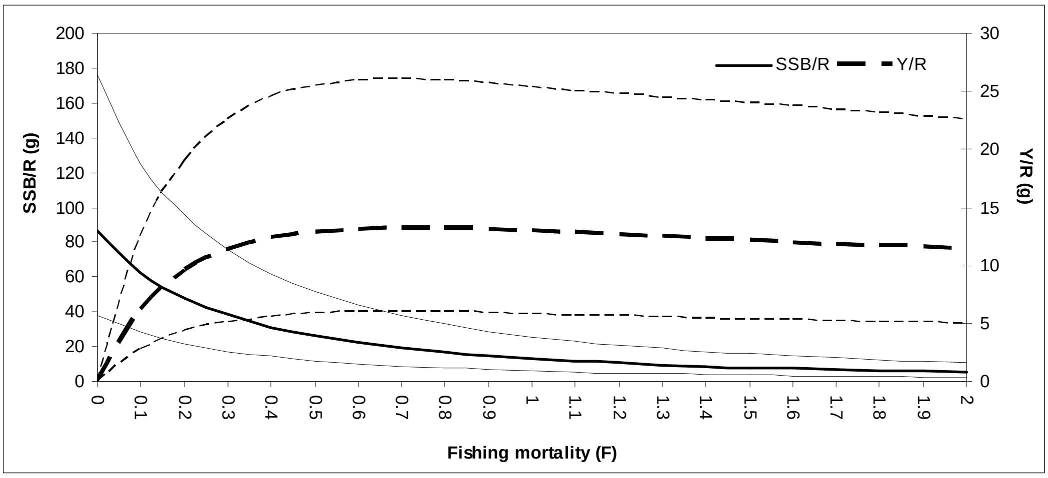


Fig. 8.54.5.2.3.1 Median of yield and spawning stock biomass per recruit and corresponding uncertainty of female giant red shrimp in the GSAs 15 and 16 according to the Yield Package.

Searching for biological reference points (BRP) through 2000 simulation produced the probability distribution of F_{max} and $F_{0.1}$ shown in Fig. 8.54.5.2.3.2.

The median value of F_{max} = 0.75 should be considered as Limit Reference Points (LRP) whereas the median value of $F_{0.1}$=0.4 should be considered as Target reference points (TRP).

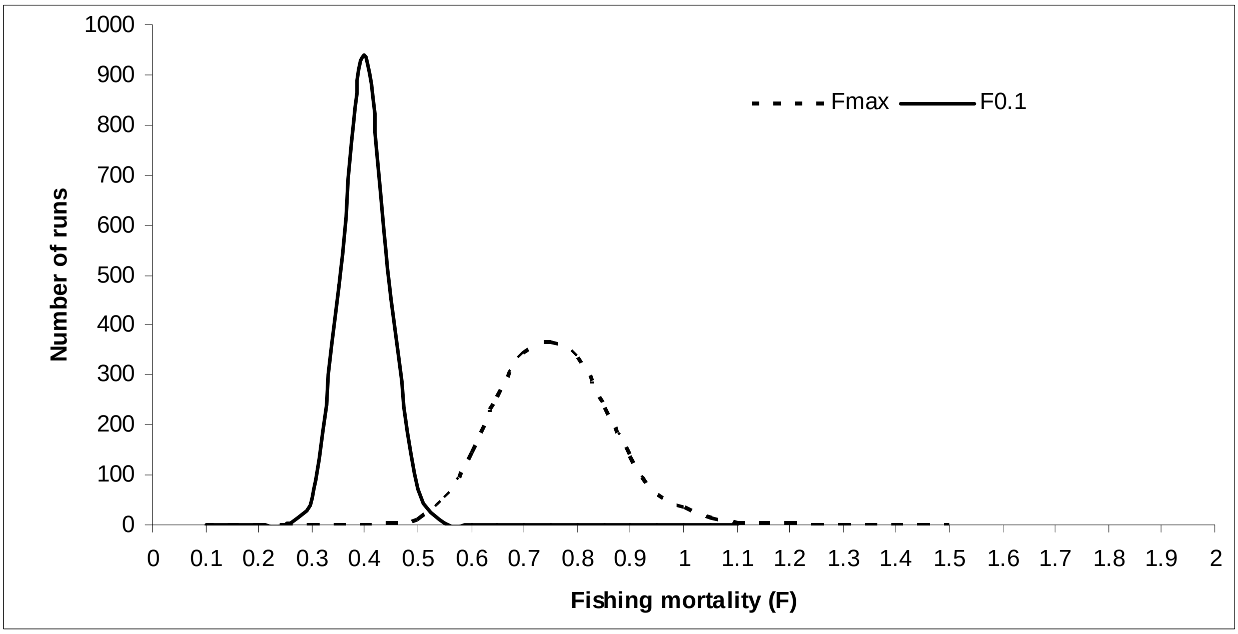


Fig. 8.54.5.2.3.2 Probability distribution of F_{max} and $F_{0.1}$ according to Yield package.

8.54.6. Scientific advice

8.54.6.1. Short term considerations

8.54.6.1.1. State of the spawning stock size

SGMED-09-02 estimated the absolute levels of stock abundance in 2006, 2007 and 2008 using the VIT approach on length structure of Sicilian trawlers which catch about 98% of the total yield in the area. Mean total biomass ranges between 1,721 t (2008) and 1,883 t (2006), being SSB about 75% of the total stock biomass.

Survey indices (MEDITS) combining GSAs indicate the stock to vary without an evident trend in the last year (2002-2008), although SSB reached its highest level in 2008 compared with the last 6 years. Considering only the GSA 16, where the time series is longer (1994-2008), SSB shows stably low level since 2001.

SGMED-09-02 cannot fully evaluate the state of the SSB due to the lack of precautionary management references.

8.54.6.1.2. State of recruitment

Absolute estimate of recruitment (18-22 mm CL) from VIT ranged between 63 (2008) and 95 (2007) millions of recruits. A low variability in recruitment indices derived from SURBA was observed when combining GSA data from 2002 to 2007, with the exception of sudden fall in recruit density observed in 2006 both in GSAs 15 and 16. The stability of recruitment indices in the last years is also confirmed by the analysis of the longer series from GSA 16.

8.54.6.1.3. State of exploitation

8.54.6.2. Medium term considerations

SGMED-09-02 proposes $F_{0.1}$=0.35 (average if both applied methods) as target management reference point of exploitation consistent with high long term yield.

The giant red shrimp in the Northern sector of the Strait of Sicily is considered overfished since the current fishing mortality is significantly higher than both F_{max} and $F_{0.1}$.

SGMED-09-02 recommends fishing mortality to be reduced by about 50% in order to avoid significant long term loss in potential yield. This should be realized by a multi-annual management plan reducing the fishing effort accordingly. It is advised to estimate the landings in accordance with the effort reductions.

SGMED-09-02 noted that the Italian government is adopting a management plan, in which a reduction of fishing mortality of 25% is planned within 2013. SGMED-09-02 supports the adoption of a management plan to continuously reduce current F through consistent effort reductions and catch estimations.

8.55. Stock assessment of giant red shrimp in GSA 19

8.55.1. Stock identification and biological features

8.55.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.55.1.2. Growth

No information was documented during SGMED-09-02.

8.55.1.3. Maturity

No information was documented during SGMED-09-02.

8.55.2. Fisheries

8.55.2.1. General description of fisheries

No information was documented during SGMED-09-02.

8.55.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.55.2.3. Catches

8.55.2.3.1. Landings

Tab. 8.55.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.8 of Appendix 3. The landings were mainly taken by demersal otter trawls.

Tab. 8.55.2.3.1.1 Annual landings (t) by fishing technique in GSA 19. Landings data provided for the year 2003 probably have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
ARS	19	ITA	DTS		3580					
ARS	19	ITA	GNS			1				
ARS	19	ITA	OTB			62	55	236	199	133

8.55.2.3.2. Discards

According to information available to the SGMED-09-02 no catches of *Aristaeomorpha foliacea* were discarded by the Italian fleet.

8.55.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-09-02 are listed in Tab. 8.55.2.3.3.1 and in Tab. A3.10-3.12 of Appendix 3.

Tab. 8.55.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSA 19, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	19	ITA	DRB				1318	3384	3998	
DAYS	19	ITA	DTS	31381	31586	37234				
DAYS	19	ITA	FPO				3189	2925	2473	
DAYS	19	ITA	GND				29731	20736	13328	
DAYS	19	ITA	GNS				49840	83590	73806	
DAYS	19	ITA	GTR				70390	53842	29510	
DAYS	19	ITA	HOK			39190				
DAYS	19	ITA	LHP-LHM				6539	5653	4829	
DAYS	19	ITA	LLD				21034	27841	20451	
DAYS	19	ITA	LLS				19503	12450	14608	
DAYS	19	ITA	LTL				2853	2862	371	
DAYS	19	ITA	MIS				1162	19	168	
DAYS	19	ITA	OTB				41760	45465	39604	
DAYS	19	ITA	PGP	233718	254881	225109				
DAYS	19	ITA	PMP	100208	122225	20325				
DAYS	19	ITA	PS				11984	9365	6768	
DAYS	19	ITA	PTM					150		
DAYS	19	ITA	PTS	3458	7302	6605				
DAYS	19	ITA	SB-SV				19427	24848	20184	
GT*DAYS	19	ITA	DRB				1318	3384	5019	
GT*days	19	ITA	DTS	580641	581841	782163				
GT*DAYS	19	ITA	FPO				3189	3500	2633	
GT*DAYS	19	ITA	GND				143652	144284	119326	
GT*DAYS	19	ITA	GNS				90354	121741	116633	
GT*DAYS	19	ITA	GTR				168879	123220	85068	
GT*days	19	ITA	HOK			1015534				
GT*DAYS	19	ITA	LHP-LHM				6746	9985	5233	
GT*DAYS	19	ITA	LLD				1107106	810180	779709	
GT*DAYS	19	ITA	LLS				60709	48454	58917	
GT*DAYS	19	ITA	LTL				14316	17178	1683	
GT*DAYS	19	ITA	MIS				2246	207	2688	
GT*DAYS	19	ITA	OTB				745886	677976	571825	
GT*days	19	ITA	PGP	602573	1113240	473727				
GT*days	19	ITA	PMP	1379166	1015437	111129				
GT*DAYS	19	ITA	PS				159697	125312	103153	
GT*DAYS	19	ITA	PTM					1646		
GT*days	19	ITA	PTS	188356	320037	195882				
GT*DAYS	19	ITA	SB-SV				42997	64370	50261	
KW*DAYS	19	ITA	DRB				7389	15175	36099	
kW*days	19	ITA	DTS	5125805	5002396	5802023				
KW*DAYS	19	ITA	FPO				57394	57121	56482	
KW*DAYS	19	ITA	GND				1185580	1388194	1130531	
KW*DAYS	19	ITA	GNS				1046673	1475918	1510335	
KW*DAYS	19	ITA	GTR				1818750	1347016	928503	
kW*days	19	ITA	HOK			6809150				
KW*DAYS	19	ITA	LHP-LHM				29910	160904	36015	
KW*DAYS	19	ITA	LLD				6607539	4495795	4304257	
KW*DAYS	19	ITA	LLS				724710	541247	670291	
KW*DAYS	19	ITA	LTL				159527	177770	20433	
KW*DAYS	19	ITA	MIS				26652	1760	16129	
KW*DAYS	19	ITA	OTB				6256653	6868746	5888163	
kW*days	19	ITA	PGP	4669873	9192254	4881153				
kW*days	19	ITA	PMP	13116917	9143878	1188078				
KW*DAYS	19	ITA	PS				1376127	942578	783035	
KW*DAYS	19	ITA	PTM					12646		
kW*days	19	ITA	PTS	978457	1629677	1105203				
KW*DAYS	19	ITA	SB-SV				510273	699325	584069	

8.55.3.Scientific surveys

8.55.3.1.Medits

8.55.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 19 the following number of hauls was reported per depth stratum (s. Tab. 8.55.3.1.1.1).

Tab. 8.55.3.1.1.1. Number of hauls per year and depth stratum in GSA 19, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA19_010-050	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9
GSA19_050-100	7	8	8	8	8	8	8	8	8	8	8	8	8	9	8
GSA19_100-200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11
GSA19_200-500	16	15	15	15	15	15	15	15	21	21	14	15	14	14	14
GSA19_500-800	31	32	32	32	32	32	32	32	29	29	29	28	29	29	29

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

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

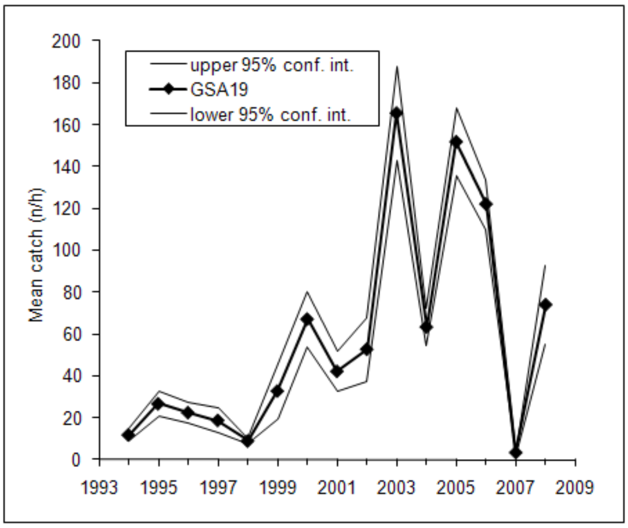
frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.55.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.55.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the giant red shrimp in GSA 19 was derived from the international survey Medits. Figure 8.55.3.1.3.1 displays the estimated trend in giant red shrimp abundance and biomass in GSA 19. The analyses of Medits indices are considered preliminary.



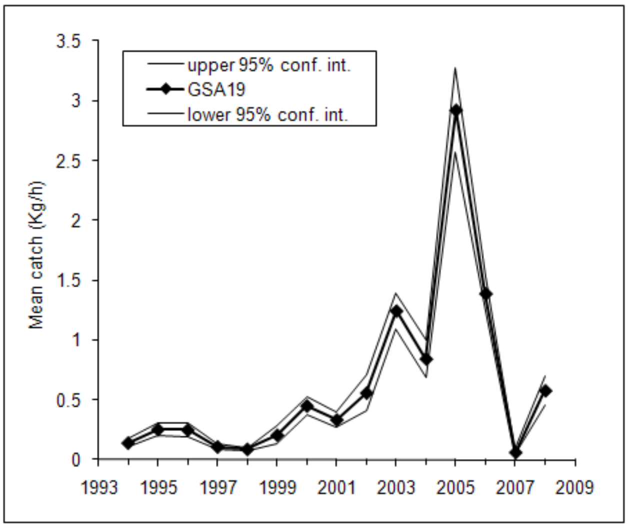


Fig. 8.55.3.1.3.1 Abundance and biomass indices of giant red shrimp in GSA 19.

8.55.3.1.4. Trends in abundance by length or age

The following Fig. 8.55.3.1.4.1 and 2 display the stratified abundance indices of GSA 19 in 1994-2008. These size compositions are considered preliminary.

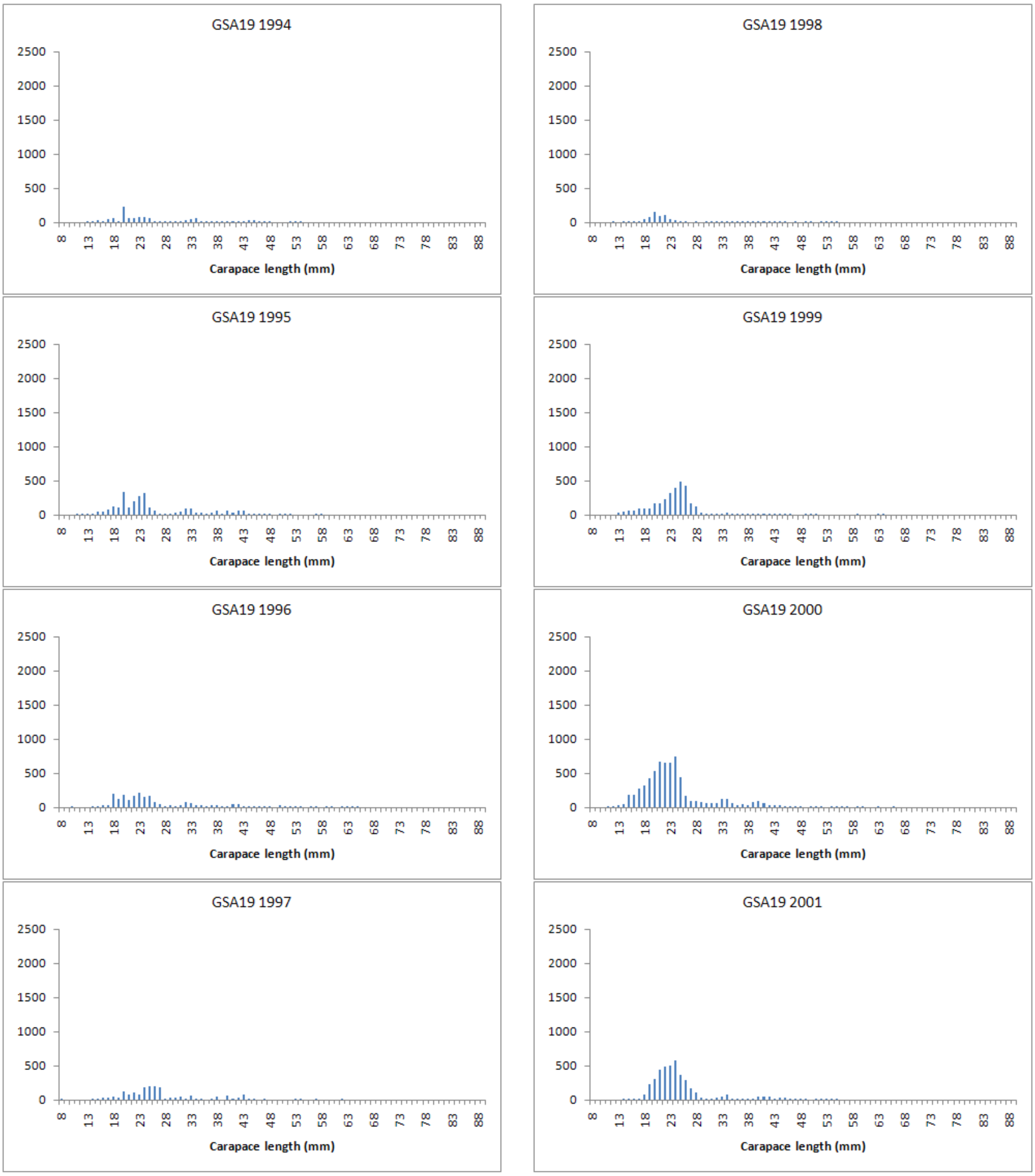


Fig. 8.55.3.1.4.1 Stratified abundance indices by size, 1994-2001.

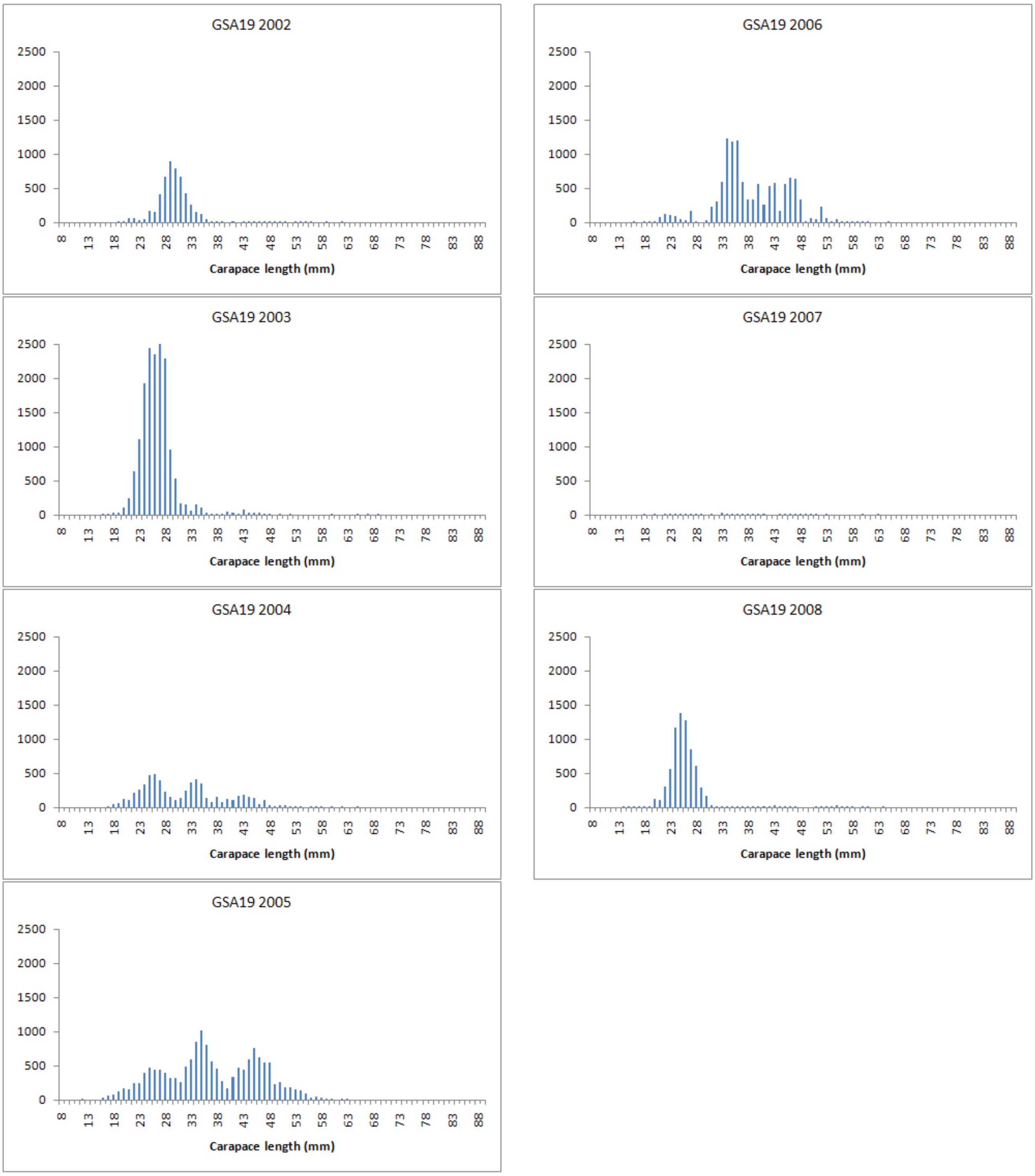


Fig. 8.55.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.55.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.55.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.55.4.Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.55.5.Long term prediction

8.55.5.1.Justification

No forecast analyses were conducted.

8.55.5.2.Input parameters

No forecast analyses were conducted.

8.55.5.3.Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for giant red shrimp in GSA 19.

8.55.6.Scientific advice

8.55.6.1.Short term considerations

8.55.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock given the preliminary state of the data and analyses.

8.55.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.55.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.56. Stock assessment of Norway lobster in GSA 09

8.56.1. Stock identification and biological features

8.56.1.1. Stock identification

Due to a lack of information about the structure of Norway lobster (*Nephrops norvegicus*) population in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries. Adults tend to be territorial, with limited migration. However, transferal of larvae between areas may occur.

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

The species lives on muddy substrates at depths between 150 and 800 m, but in the area is more commonly found between 250 and 800 m depth (Biagi *et al*., 2002; Colloca *et al*., 2003).

Recruits peak in abundance between 400 and 500 m depth over the upper slope and appear to move slightly deeper when they reach 30 mm carapace length (Fig. 8.56.1.1.1).

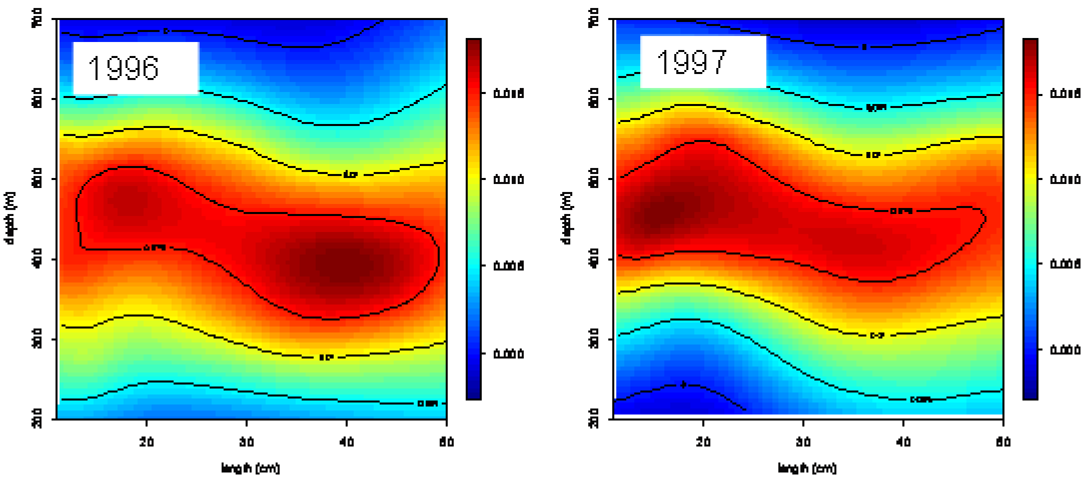


Fig. 8.56.1.1.1 Size-depth distribution of Norway lobster in the GSA 09 in 1996 and 1997 (GRUND survey).

8.56.1.2. Growth

The species shows a noticeable sexual dimorphism, with males that reach bigger sizes than females. Maximum observed size in the GSA 09 was 72 mm CL for males and 57 mm CL for females.
Growth parameters defined in the area were:
L_∞ =72.1 (males) 56 (females)
K = 0.169 (males) 0.214 (females)
Length-weight relationship for both sexes: a = 0.00040, b = 3.126

8.56.1.3. Maturity

Males reach maturity at 40 mm CL and females at 30.3 mm CL. Sex ratio is about 1:1 until 26 mm CL; in favour of females from 26 to 35 mm CL; in favour of males from 38 mm CL (De Ranieri *et al*., 1996). Reproduction peak is between spring and summer, and females with external eggs are observed in autumn-winter.

8.56.2. Fisheries

8.56.2.1. General description of fisheries

Norway lobster is one of the most important components of bottom trawlers catch in the GSA 09, as total annual value of the landings.

The trawlers fleet of GSA 09 at the end of 2006 accounted for 361 vessels (Tab. 8.56.2.1.1). From those vessels, only a fraction targets *Nephrops norvegicus.*

The main trawl fleets of GSA 09 are present in the following continental harbours: Viareggio, Livorno, Porto Santo Stefano (Tuscany), Fiumicino, Terracina, Gaeta (Latium).

Tab. 8.56.2.1.1 Technical characteristics of the trawl fleet of GSA 09 (year 2007, DCR official data).

N. of boats	361
GT	13.191
kW	75.514
Mean GT	36.5
Mean kW	209.2

As concerns fishing activity, the majority of bottom trawlers of GSA 09 operates daily fishing trips with only some vessels able to stay out of the port for two-three days and especially in summer.

Norway lobster fishing grounds include soft bottoms of upper slope, generally between 350 and 600 m depth. Fishing pressure shows some geographical differences inside the GSA 09 according to the consistency of the fleets, the availability of the resources and the morphology of the continental shelf and upper slope. The species by-catch is mainly represented by *Micromesistius poutassou, Phycis blennoides, Lepidorhombus bosci, Galeus melastomus, Parapenaeus longirostris, Eledone cirrhosa, Todaropsis eblanei, Trachurus spp.*

8.56.2.2. Management regulations applicable in 2009

- Fishing closure for trawling: 45 days in late summer (not every year have been enforced).
- Minimum landing sizes: EC regulation 1967/2006: 20 mm CL for Norway lobster.
- Cod end mesh size of trawl nets: 40 mm (stretched, diamond meshes) till 30/05/2010. From 01/06/2010 the existing nets will be replaced with a cod end with 40 mm (stretched) square meshes or a cod end with 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

8.56.2.3. Catches

8.56.2.3.1. Landings

Landings of Norway lobster in GSA 09 are almost exclusively provided by trawling. In the last three years the total landings of *N. norvegicus* of GSA 09 varied between 228 and 260 tons (Fig. 8.56.2.3.1.1).

Tab. 8.56.2.3.1.1 Landings (t) of Norway lobster in GSA 09 by gear type.

Species	Year	DTS	PGP	PTS	Total
NEP	2006.0	247.4	0.7		248.1
NEP	2007.0	260.3	0.2		260.5
NEP	2008.0	227.7	0.1		227.8

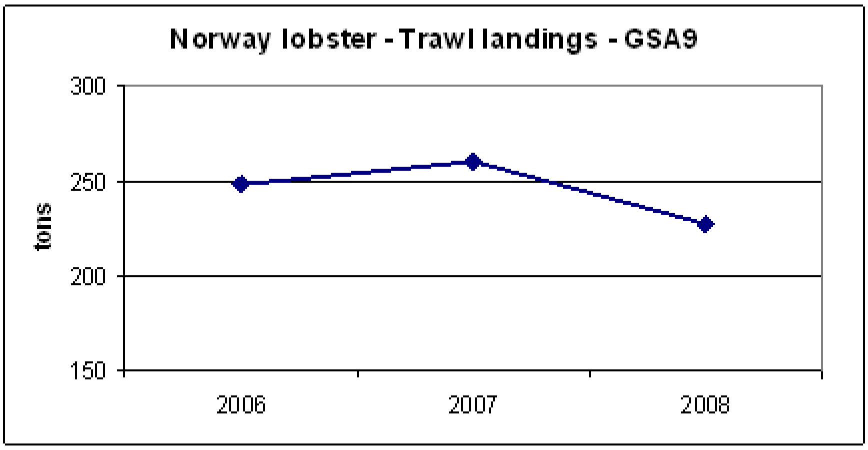


Fig. 8.56.2.3.1.1 Landings of Norway lobster (trawl nets) in the GSA 09, from 2006 to 2008 (DCR official data).

Landings are mostly composed by specimens from 25 to 50 mm CL (Fig. 8.56.2.3.1.2). Due to the sexual dimorphism of the species, the majority of the specimens greater than 40 mm CL are males.

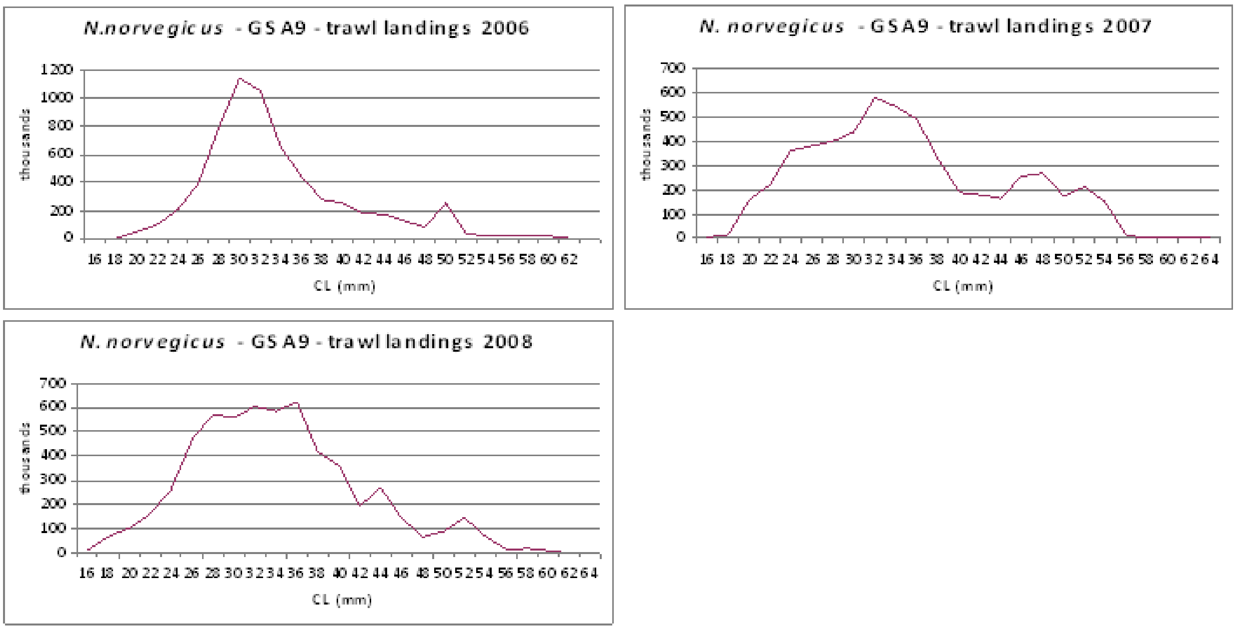


Fig. 8.56.2.3.1.2 Size structure of the landings of *N. norvegicus* in 2006-2008 caught by otter trawling in the GSA 09 (DCR official data).

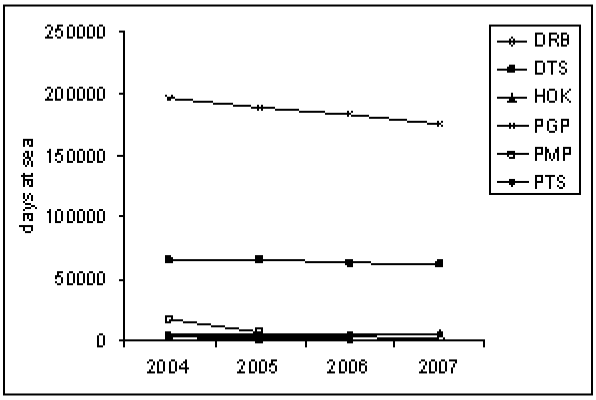
8.56.2.3.2. Discards

Several EU and national projects carried out in GSA 09 highlighted that discard of Norway lobster in GSA 09 is negligible. At the same time, the presence of specimens under the MLS (20 mm CL) in the landings is very scarce. The same picture was obtained during the monitoring of discard performed in the 2006 DCR.

8.56.2.3.3. Fishing effort

The fishing capacity of the GSA 09 has shown in these last 10 years a progressive decrease; from 1996 to 2006 the number of bottom trawlers of GSA 09 decreased of about 30%.

The total fishing days carried out by all the GSA 09 trawlers varied from about 65,000 in 2004 to about 63,000 in 2006 (Fig. 8.56.2.3.3.1), a little decrease of the mean number of fishing days/year per vessel was observed in this period, from 187 to 177. Anyway, there is no information on the specific effort directed to *N. norvegicus* in GSA 09.



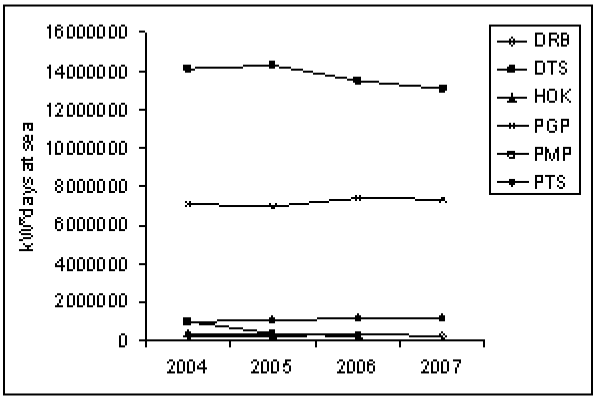


Fig. 8.56.2.3.3.1 Effort trends (days and kW*days) in 2004-2007 by major fleets for GSA 09. The data are listed in Tables A3.10 and A3.12 of Appendix 3.

8.56.3. Scientific surveys

8.56.3.1. MEDITS

8.56.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 09 the following number of hauls was reported per depth stratum (s. Tab. 8.56.3.1.1.1).

Tab. 8.56.3.1.1.1. MEDITS survey. Number of hauls per year and depth stratum in GSA 09, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA_09_010-50 M	21	20	20	20	21	20	20	19	15	14	15	16	15	16	16
GSA_09_050-100 M	21	21	20	20	20	21	22	23	17	18	17	16	18	18	18
GSA_09_100-200 M	38	40	40	40	39	39	38	38	30	30	30	31	30	29	29
GSA_09_200-500 M	40	40	42	42	41	41	42	41	32	33	36	35	35	36	35
GSA_09_500-800 M	33	32	31	31	32	32	31	32	26	25	22	22	22	21	22
TOTAL	153	153	153	153	153	153	153	153	120	120	120	120	120	120	120

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

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

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

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

Where:

- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.56.3.1.2. Geographical distribution patterns

Norway lobster is distributed in the whole GSA with the highest abundance in the south Ligurian Sea and northern Tyrrhenian Sea.

8.56.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the *N. norvegicus* in GSA 09 was derived from the international survey MEDITS. Figure 8.56.3.1.3.1 displays the re-estimated trend in *N. norvegicus* abundance and biomass in GSA 09 based on the DCR data call. No particular long term trend is present.

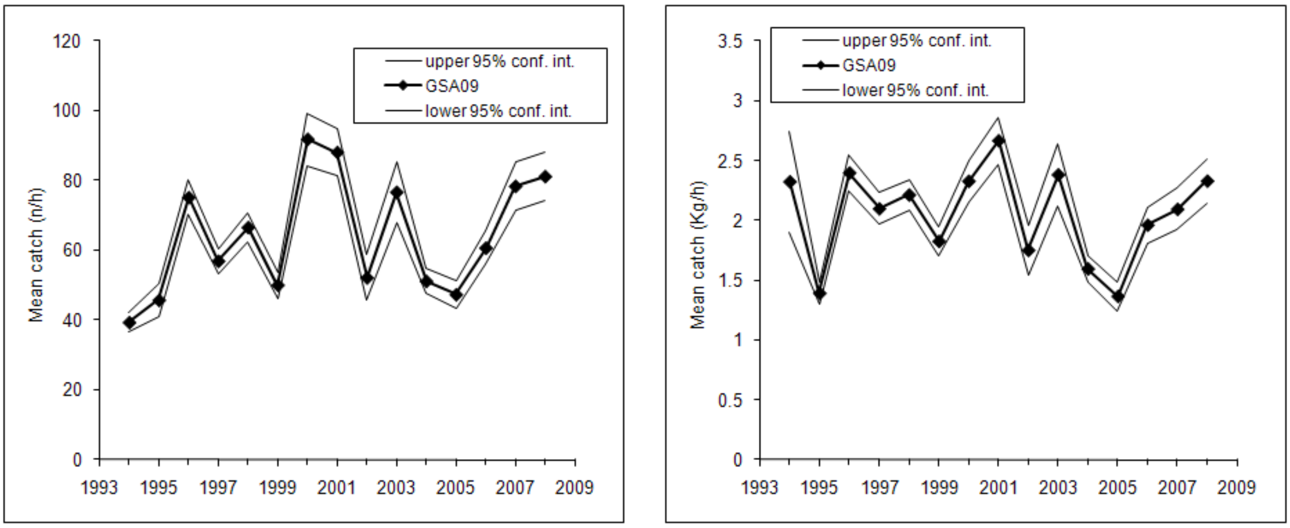


Fig. 8.56.3.1.3.1 Abundance and biomass indices of *Nephrops norvegicus* in GSA 09.

8.56.3.1.4. Trends in abundance by length or age

The following Fig. 8.56.3.1.4.1 and 2 display the stratified abundance indices of GSA 09 in 1994-2001 and 2002-2008.

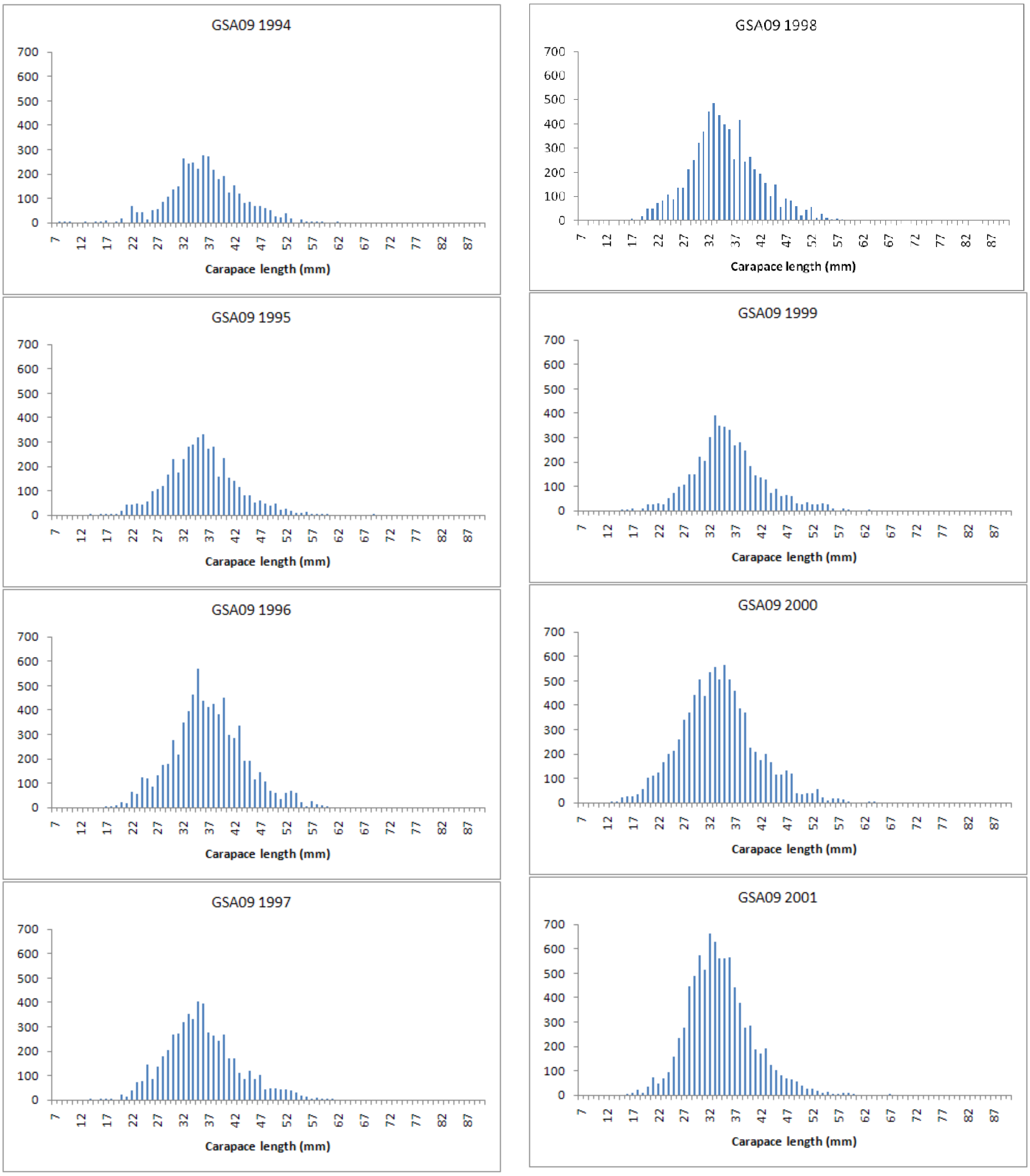


Fig. 8.56.3.1.4.1 Stratified abundance indices by size, 1994-2001.

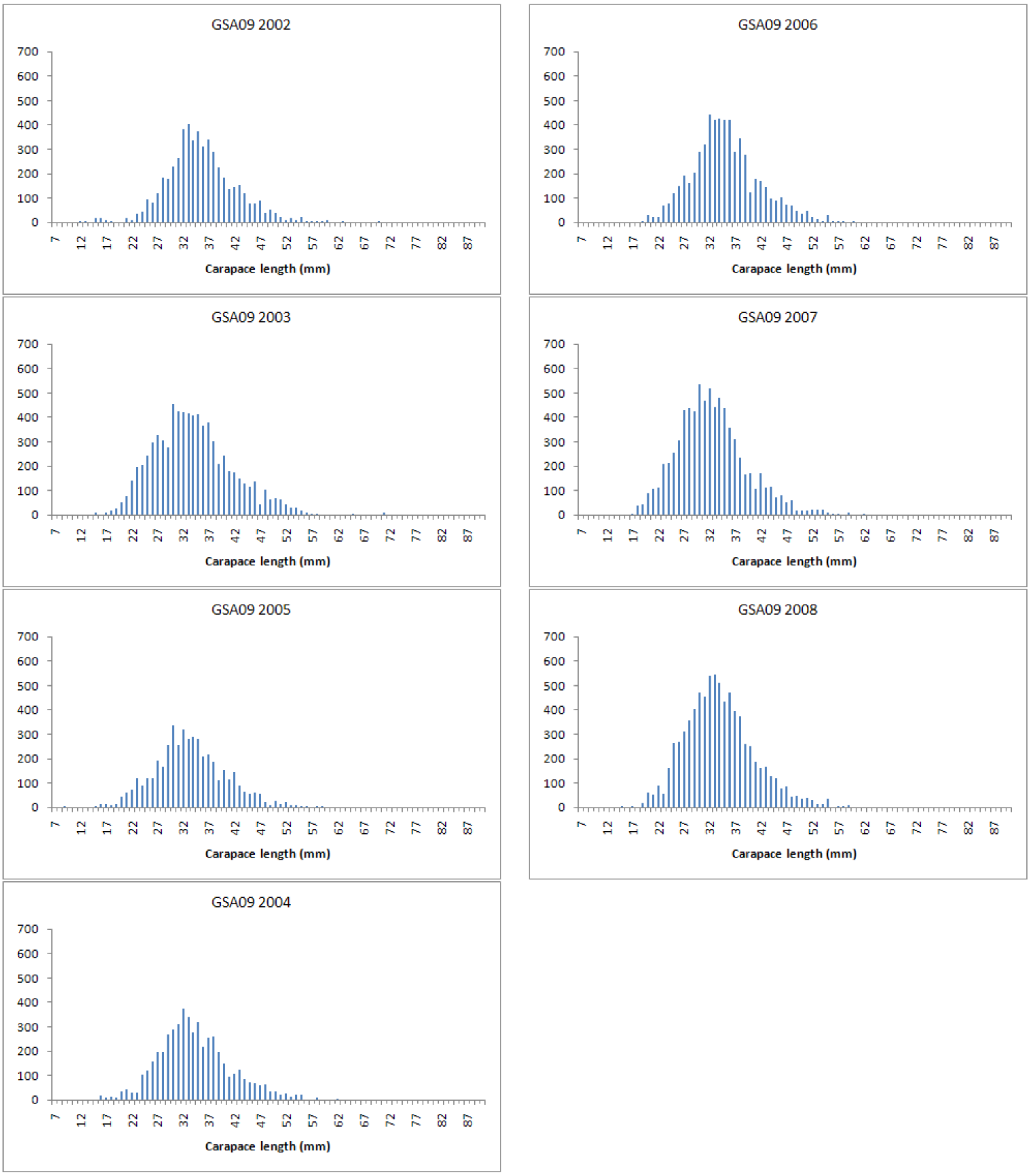


Fig. 8.56.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.56.3.2. GRUND

8.56.3.2.1. Methods

The national GRUND trawl survey (Relini, 1998) is regularly carried out along the Italian coasts in addition to MEDITS. It has been carried out since 1985, with some years lacking (1988, 1989 and 1999). Sampling is random stratified, except in the period 1990-93 where a different sampling design, based on transects, was applied. Locations of stations were selected randomly within each stratum in the period 1985-87, while since

1996, the same stations were sampled every year. Therefore from 1994 two trawl surveys are regularly carried out in Italy each year: MEDITS, in spring, and GRUND, in autumn. The two surveys provide integrate pictures on different seasons, allowing to monitor the most important biological events (recruitment, spawning) for the majority of the demersal species.

8.56.3.2.2. *Geographical distribution patterns*

Norway lobster is distributed in the whole GSA with the highest abundance in the south Ligurian Sea and northern Tyrrhenian Sea.

8.56.3.2.3. *Trends in abundance and biomass*

Fig. 8.56.3.2.3.1 shows the density and biomass indices of Norway lobster obtained from 1994 to 2008. The GRUND data series show a fluctuating trend and quite stable trend till 2006, while in 2008 values considerably lover than those of the previous years were recorded.

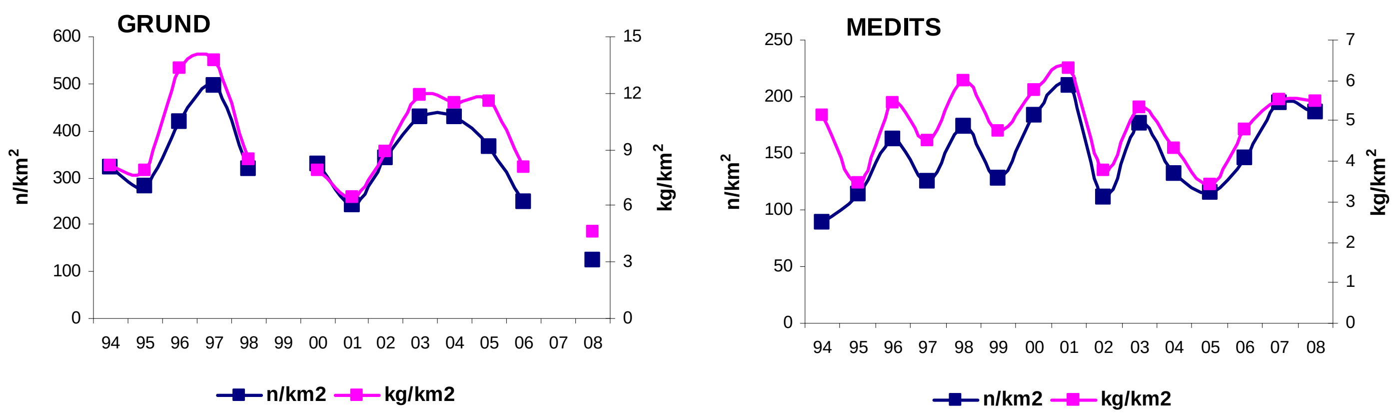


Fig. 8.56.3.2.3.1 Density and abundance indices of *N. norvegicus* according to the GRUND (left) and MEDITS (right) surveys.

8.56.3.2.4. *Trends in abundance by length or age*

Not presented to SGMED-09-02.

8.56.3.2.5. *Trends in growth*

No analyses were conducted during SGMED-09-02.

8.56.3.2.6. *Trends in maturity*

No analyses were conducted during SGMED-09-02.

8.56.4. Assessment of historic stock parameters

Due to its importance as demersal resource, *N. norvegicus* has been object of several assessments in the GSA 09 (Ardizzone *et al*., 1998; Abella *et al*., 1995; 1998; 1999; 2002; 2007; Biagi *et al*., 1990a; 1990b; 1990c; De Ranieri 1999; Mori *et al*., 1993; 1998; Sartor *et al*., 2003, Sbrana *et al*., 2003). These results are published and have been regularly updated in the GFCM SAC sheets. The assessments performed with different approaches in different periods or in different subareas of the GSA 09 showed divergent results as *Nephrops* grounds within GSA 09 are not exploited with the same rate. It is likely that the current status (abundance and demographic structure) may depend mainly on the fishing pressure exerted in the different sub areas of the GSA. This fact does not exclude the possibility of drifting of eggs and larvae from one ground to others contributing to recruitments in grounds different from the parental ones.

The Norway lobster in the GSA 09 seems to be fully or in some cases underexploited, as shown by the results of the analytical models (reference points as F_{max}, $F_{0.1}$ and SSB_{curr}/SSB_0). The production models based on Z provided total mortality estimates for the whole GSA 09 greater than the mortality corresponding to the maximum biological production (Z_{MBP}).

A clear growth overfishing is not observed, considering that the smaller individuals, even though present in the fishing grounds, show a limited vulnerability to the fishing gear, due to the lower frequency of emergence fishing mortality on 0+ and 1+ age classes. The values of the SSB/SSB_0 ratio are between 0.33 and 0.45.

As concern the SGMED-09-02, two new assessments were produced. The main results are presented below.

8.56.4.1. Method 1: SURBA

8.56.4.1.1. Justification

The relatively long time series of data available from the GRUND and MEDITS surveys provided the most promising data sets for analysis. The survey-based stock assessment approach SURBA (Needle, 2003) was used both on MEDITS (1994-2007) and GRUND (1994-2004) data of the Norway lobster of GSA 09.

8.56.4.1.2. Input parameters

The following set of parameters was adopted:

Tab. 8.56.4.1.2.1 Input parameters.

Growth parameters (Von Bertalanffy)
L∞ = 74 mm, carapace length
K = 0.17
to = 0
L*W
a = 0.0005
b = 3.04
Natural mortality
M = 0.4
Catchability (q)
q = 1 for all the age classes
Length at maturity (L50)
L50 = 29 mm

Tab. 8.56.4.1.2.2 Input parameters used for the SURBA model.

MEDITS						GRUND					
Abundance indices						Abundance indices					
	Age						Age				
Year	3	4	5	6	7 plus	Year	3	4	5	6	7 plus
1994	60.946	63.556	30.673	12.25	6.964	1994	242.777	127.183	53.419	21.705	19.896
1995	80.366	72.157	30.413	10.785	8.456	1995	221.069	166.76	58.819	27.018	20.02
1996	144.074	117.405	27.992	4.658	2.276	1996	289.507	275.622	115.509	35.866	24.992
1997	97.535	78.183	32.36	13.149	11.054	1997	433.848	262.818	97.977	32	21.271
1998	138.817	107.463	49.734	18.362	10.939	1998	252.633	163.617	67.649	23.738	16.976
1999	97.647	84.989	32.917	12.558	10.991	1999	266.423	151.232	56.5505	21.0545	14.722
2000	143.239	103.062	37.82	17.306	11.701	2000	280.213	138.846	45.452	18.371	12.468
2001	193.001	118.264	42.596	14.213	9.258	2001	190.278	115.934	40.263	16.5	10.367
2002	89.481	75.401	29.724	11.083	5.916	2002	259.997	188.754	74.654	20.05	15.061
2003	133.345	87.239	36.739	17.392	12.053	2003	355.393	214.867	71.982	23.228	23.989
2004	111.043	76.458	29.057	12.392	9.341	2004	397.958	194.311	75.479	22.341	17.553
2005	96.326	59.498	27.529	8.589	5.157	2005	274.599	202.487	83.982	28.661	31.782
2006	118.943	94.291	33.57	14.526	8.125						
2007	177.222	84.955	31.544	12.319	7.343						
2008	151.37	107.783	41.734	13.949	9.235						
Proportion of mature						Proportion of mature					
1994	1	1	1	1	1	1994	1	1	1	1	1
1995	1	1	1	1	1	1995	1	1	1	1	1
1996	1	1	1	1	1	1996	1	1	1	1	1
1997	1	1	1	1	1	1997	1	1	1	1	1
1998	1	1	1	1	1	1998	1	1	1	1	1
1999	1	1	1	1	1	1999	1	1	1	1	1
2000	1	1	1	1	1	2000	1	1	1	1	1
2001	1	1	1	1	1	2001	1	1	1	1	1
2002	1	1	1	1	1	2002	1	1	1	1	1
2003	1	1	1	1	1	2003	1	1	1	1	1
2004	1	1	1	1	1	2004	1	1	1	1	1
2005	1	1	1	1	1	2005	1	1	1	1	1
2006	1	1	1	1	1						
2007	1	1	1	1	1						
2008	1	1	1	1	1						
Mean weight						Mean weight					
1994	50.8	72.5	95.2	117.8	139.5	1994	50.8	72.5	95.2	117.8	139.5
1995	50.8	72.5	95.2	117.8	139.5	1995	50.8	72.5	95.2	117.8	139.5
1996	50.8	72.5	95.2	117.8	139.5	1996	50.8	72.5	95.2	117.8	139.5
1997	50.8	72.5	95.2	117.8	139.5	1997	50.8	72.5	95.2	117.8	139.5
1998	50.8	72.5	95.2	117.8	139.5	1998	50.8	72.5	95.2	117.8	139.5
1999	50.8	72.5	95.2	117.8	139.5	1999	50.8	72.5	95.2	117.8	139.5
2000	50.8	72.5	95.2	117.8	139.5	2000	50.8	72.5	95.2	117.8	139.5
2001	50.8	72.5	95.2	117.8	139.5	2001	50.8	72.5	95.2	117.8	139.5
2002	50.8	72.5	95.2	117.8	139.5	2002	50.8	72.5	95.2	117.8	139.5
2003	50.8	72.5	95.2	117.8	139.5	2003	50.8	72.5	95.2	117.8	139.5
2004	50.8	72.5	95.2	117.8	139.5	2004	50.8	72.5	95.2	117.8	139.5
2005	50.8	72.5	95.2	117.8	139.5	2005	50.8	72.5	95.2	117.8	139.5
2006	50.8	72.5	95.2	117.8	139.5						
2007	50.8	72.5	95.2	117.8	139.5						
2008	50.8	72.5	95.2	117.8	139.5						

8.56.4.1.3. Results

Fishing mortality (F_{3-6}) estimated with MEDITS showed large fluctuations in the first three years (1994-1996) while successively the range was narrower (0.23-0.57) from 1997 to 2007, with values between 0.31 and 0.36 in the last three years (2005-07). F_{3-6} obtained from GRUND data ranged between 0.16 in 1995 and 0.67 in 2005

Relative spawning stock biomass (SSB) indices derived from MEDITS (1994-2008) and GRUND (1994-2006) showed a fluctuating trend in the spawning stock biomass (SSB). An increase in SSB occurred in recent years (2005-08, MEDITS survey, Fig. 8.56.4.1.3.1).

Young of the year are poorly captured by the commercial fleet and during surveys. Relative indices for ages 1+ and 2+, obtained from MEDITS survey indicated a clear increasing trend (Fig. 8.56.4.1.3.2).

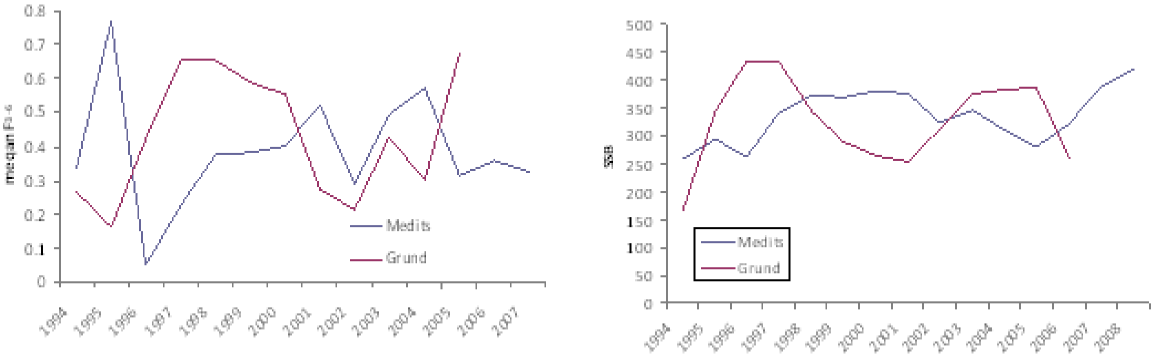


Fig. 8.56.4.1.3.1 MEDITS and GRUND surveys. SURBA estimates of mean F_{1-3} and relative SSB.

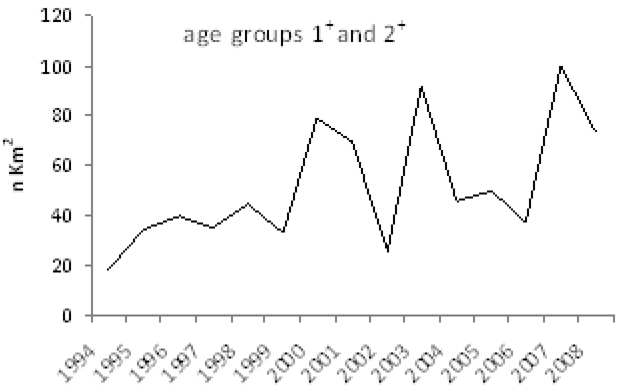


Fig. 8.56.4.1.3.2 MEDITS abundance trend of age groups 1+ and 2+ (data pooled).

Model diagnostics are shown in the Fig. 8.56.4.1.3.3.

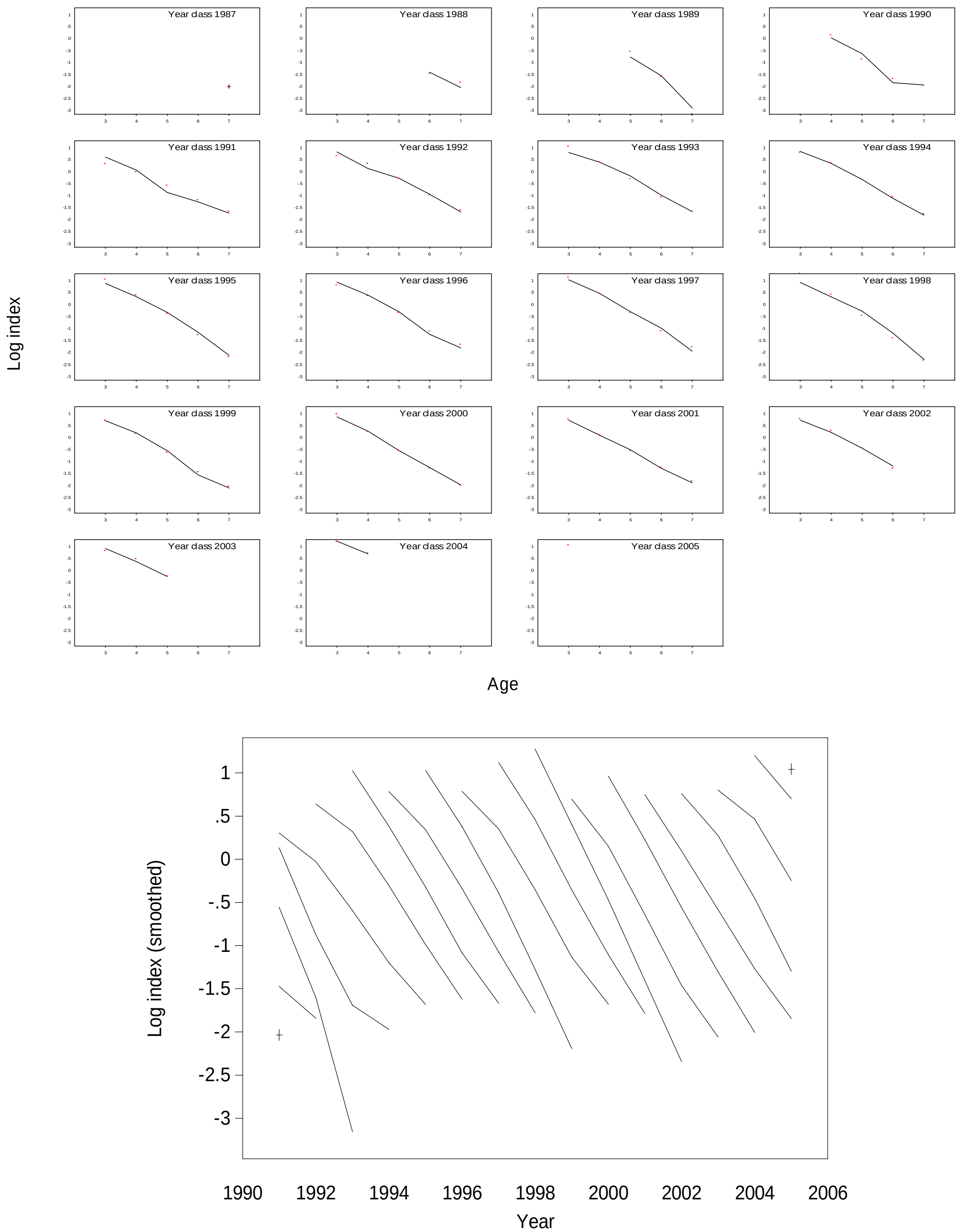


Fig. 8.56.4.1.3.3. Model diagnostic for Surba model in the GSA 09. a) Comparison between observed (points) and fitted (lines) of MEDITS survey abundance indices, for each year. b) Log survey abundance indices by cohort. Each line represents the log index abundance of a particular cohort throughout its life.

8.56.4.2. Method 2: LCA on DCR data

8.56.4.2.1. Justification

Assessment was performed using an LCA (VIT software, Lleonart and Salat 1997) on an annual pseudocohort (year 2006).

8.56.4.2.2. Input parameters

Data coming from DCR provided at SGMED-09-02 contained, for GSA 09, information on hake landings and the respective size/age structure for 2006-2008. The short data time series did not allow the application of VPA.

LCA was performed using VIT software on data of the years 2006, 2007, 2008. Tab. 8.56.4.2.2.1 shows the input data. The used parameters were the same of the SURBA analysis, including the M-vector and the maturity ogive.

Tab. 8.56.4.2.2.1. Input data for LCA of the Norway lobster in GSA 09.

Carapace Length (mm)	2006	2007	2008
18	0.0	16.0	63.9
20	45.3	160.7	103.2
22	99.3	221.2	159.9
24	203.2	363.4	260.8
26	388.2	384.0	473.2
28	790.4	401.4	572.2
30	1139.5	439.4	558.0
32	1055.9	581.5	603.3
34	650.3	543.6	587.2
36	444.0	490.6	622.7
38	279.5	331.6	423.3
40	252.8	187.5	357.8
42	177.3	178.5	192.3
44	173.5	167.7	271.7
46	120.5	253.8	147.1
48	82.3	269.7	66.2
50	249.3	175.9	89.5
52	34.4	213.8	148.8
54	14.8	151.6	70.5
56	18.5	10.1	14.3
58	16.4	4.2	19.7
60	12.2	5.0	8.8
62	0.0	2.9	1.9
64	0.0	0.4	0.5

8.56.4.2.3. Results

The general results of LCA (Fig. 8.56.4.2.3.1) show mean values of F (3-6) ranging from 0.30 to 0.36, very similar to those estimated with SURBA.

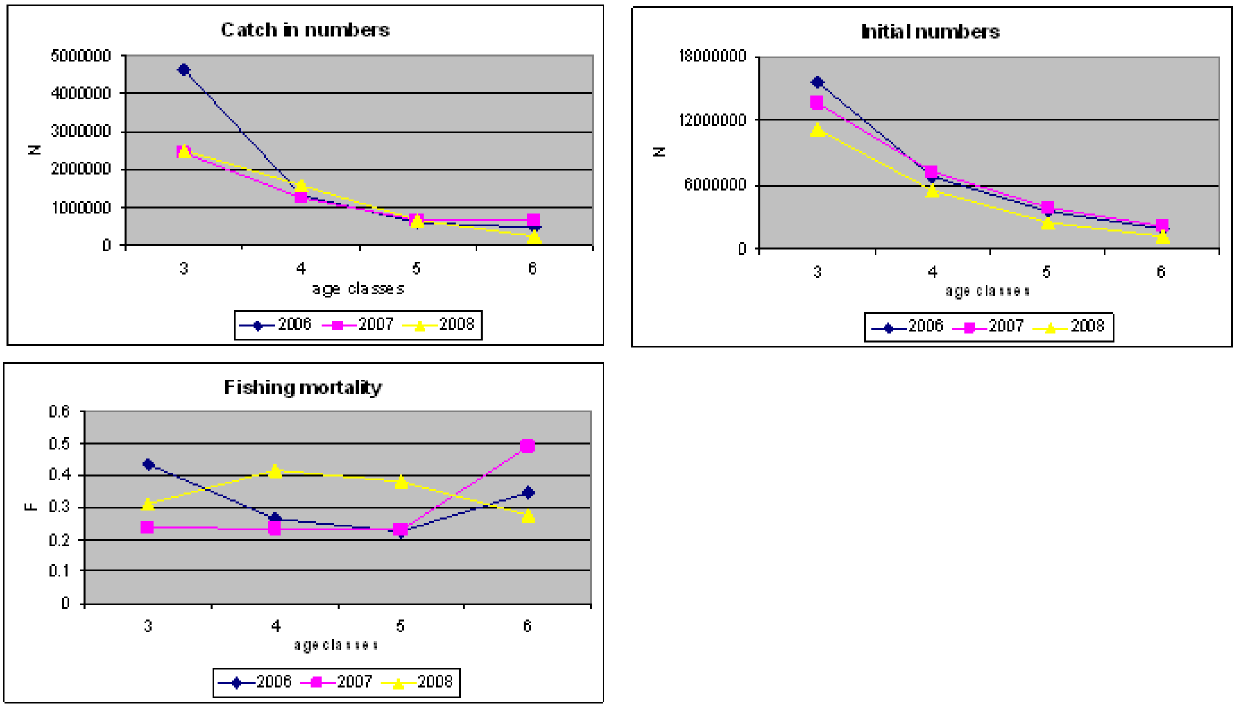


Fig. 8.56.4.2.3.1. LCA outputs: catch numbers, numbers-at-age and fishing mortality at age of *N. norvegicus* in GSA 09.

8.56.5. Long term prediction

8.56.5.1. Justification

Equilibrium YPR reference points for the stock estimated through the Yield software (Hoggarth *et al.*, 2006) were assessed. Further YPR analyses were conducted based on the VIT (pseudocohort) results.

8.56.5.2. Input parameters

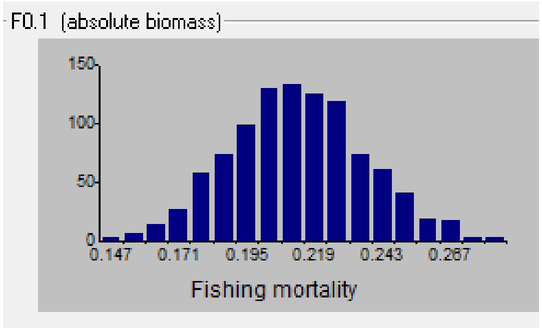
Equilibrium YPR reference points for the stock were estimated through the Yield software (Hoggarth et al., 2006) assuming recruitment fluctuating randomly around a constant value and 20% uncertainty in input parameters.

The second YPR analyses used the results of VIT (pseudocohort) as inputs. The used parameters were the same of the SURBA and LCA analyses previously shown.

8.56.5.3. Results

Yield software quantified uncertainty by repeatedly selecting a set of biological and fishery parameters by sampling from the probability distributions for uncertain parameters set by the user, and then calculating the quantities of interest. In this sampling, it is assumed that each of the uncertain parameters are independently distributed, even though for some biological parameters, this assumption is almost certainly incorrect (Hoggarth *et al.*, 2006). F_{max} and $F_{0.1}$ were assumed respectively as limiting and target reference points. Their probability distributions showed a considerable variation (Fig. 8.56.5.3.1). The following median values were obtained: F_{max} = 0.36; $F_{0.1}$= 0.21. The maximum predicted values were respectively 0.59 (F_{max}) and 0.30 (F_{01}).

Considering that the estimated current F was arround 0.3, RPs suggest that the *N. norvegicus* stock is currently overexploited.



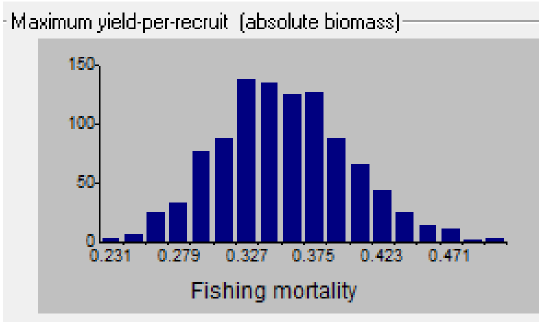


Fig. 8.56.5.3.1 Probability distribution of Norway lobster RPs in the GSA 09 obtained using the Yield software.

8.56.6. Scientific advice

8.56.6.1. Short term considerations

8.56.6.1.1. State of the spawning stock size

Relative spawning stock biomass (SSB) indices derived from MEDITS (1994-2008) and GRUND (1994-2006) showed a fluctuating trend in the spawning stock biomass (SSB). An increase in SSB occurred in recent years (2005-08, MEDITS survey).

SGMED-09-02 cannot fully evaluate the state of the SSB due to a lack of precautionary management reference points.

8.56.6.1.2. State of recruitment

Recruitment (age groups 1+ and 2+) showed a significant increasing trend since 1994.

8.56.6.1.3. State of exploitation

SGMED-09-02 proposed the estimated $F_{0.1}$ =0.21 as target management reference point for sustainable exploitation consistent with high long term yield.

Recent values of F_{3-7} obtained on commercial data with LCA (VIT) and using SURBA indicate that the stock is currently overexploited. SGMED-09-02 recommends a reduction of fishing effort to be achieved by means of a multiannual management plan towards the target exploitation in order to avoid long term losses in yield. Such management plan should consider the mixed fisheries implications for the Nephrops fisheries. SGMED-09-02 recommends the resulting catches consistent with the effort reductions be determined.

8.57. Stock assessment of Norway lobster in GSA 10

8.57.1. Stock identification and biological features

8.57.1.1. Stock Identification

The stock of Norway lobster was assumed in the boundaries of the whole GSA 10, lacking specific information on stock identification. *N. norvegicus* is a sedentary long-living, slow growing lobster which inhabits burrows constructed in muddy substrates of the upper slope and its presence appears to be related with heterogeneity in the characteristics of the sediment as well as with variations in fishing effort (e.g. Maynou and Sardà, 1997). Abundance of Norway lobster is generally rather scant in the southern Tyrrhenian Sea and the areas with the highest concentration of biomass are found between 200 and 500 m depth. Patchiness in population structure characteristics has been also identified in the GSA 10.

It has been reported that in GSA 10 the mean length of this crustacean is slightly lower than in the Northern Tyrrhenian but higher (38 against 39) than in Sicily Strait (38 against 34). Total mortality has been found negatively correlated with the mean size obtained in different Mediterranean GSAs, although also environmental influences at geographical scale could play an important role (Abellò *et al.*, 2002). Indeed, differences in growth have been highlighted for *N. norvegicus* from different habitats in the same geographical area (Central Adriatic) (Froglia and Gramitto, 1987).

The overall sex ratio is about 0.5. The Norway lobster is a long-living crustacean with a life span of 16-18 years (AA.VV., 2002) and larger individuals are males.

In the Central-Southern Tyrrhenian Sea the occurrence of mature females was observed in late spring-early summer with a spawning beginning mainly at the end of the summer (September, Carbonara *et al*., 2006) as reported by other authors for the western Mediterranean basin (Orsi Relini *et al*., 1998). Thus, a continuous recruitment pattern is shown and at 34-36 mm carapace length the Norway lobster is considered recruited to the grounds (AA.VV., 2002).

In the central-southern Tyrrhenian Sea commercial catches of Norway lobster are taken on the same fishing grounds as pink shrimp and European hake but are less abundant than other crustaceans (AA.VV. 2000; EU project 97/0066 –Medland).

8.57.1.2. Growth

Estimates of the growth pattern of Norway lobster in the Tyrrhenian Sea were obtained in the Samed project (Anonymous 2002) according to the following procedure. L_{max} (predicted maximum length; procedure implemented in FiSAT) value to be used as guess estimate of L_∞ was computed for each sex. This value was then tuned with that obtained from the Powell and Wetherall approach, which gives also estimates of the Z/K ratio. According to literature (Mytilineou *et al*., 1998) estimate of the phi' indicator was obtained and thus preliminary guess values of K computed. Thus also a first value of Z was obtained. These parameters were finally calibrated through the Length Converted Catch Curve (LCCC) and the set giving the better determination coefficient was adopted: females CL_∞=60 mm; K=0.18; t_0= -0.5; males CL_∞=72 mm; K=0.17; t_0= -0.5.

In the DCR framework parameters were re-estimated following the same procedure and the following values were obtained: females CL_∞=58 mm; K=0.19; t_0= -0.2; males CL_∞=75 mm; K=0.15; t_0= -0.5.

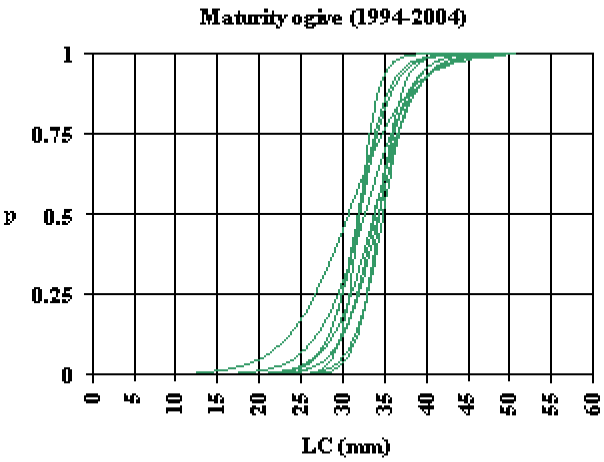
Parameters of the length-weight relationship were a=0.668, b=3.027 for females and a=0.7329, b=2.991 for males (length in cm).

8.57.1.3. Maturity

Maturity and fecundity of Norway lobster have been studied in the GSA 10 using trawl-survey data (1994-2004) collected in a ten years period (20 surveys carried out in late spring and early summer) (Carbonara *et al*., 2006). Results evidenced that maturity process is completed from late-spring summer through autumn and the smallest ovigerous female was 23.5 mm carapace length. Length at first maturity (Lm_{50}) was within 30.6-34.8 mm, depending on the year. These differences were probably due to the seasonal variations and diverse availability of the species to the gear. The lower value was similar to findings in other Mediterranean areas (29.9 mm-32.1 mm: e.g. Bianchini *et al*., 1998; AA.VV., 2002), while the upper size was higher and more close to the Alboran figure (36 mm; Orsi Relini *et al*., 1998).

The proportion of mature females per length class (Tab. 8.57.1.3.1) from DCR data is similar to the estimates previously calculated for the area.

The relationship between carapace length and number of early eggs on the pleopods is fitted by the following non-linear equation: $F=0.0029*LC^{3,7221}$ (R^2=0.79) comparable with the findings of Froglia and Gramitto (1980).



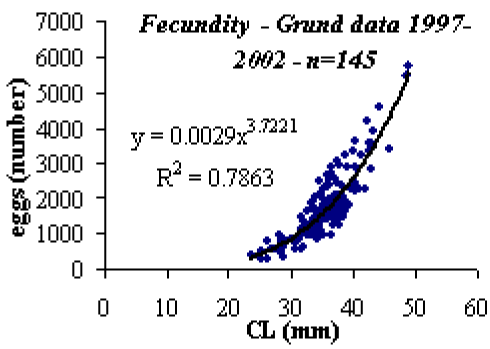


Fig. 8.57.1.3.1 The maturity ogives and relationship between fecundity and carapace length of females.

Tab. 8.57.1.3.1 Proportion of mature females for length class from DCR.

CL	Proportion of mature females
2.6	0.017
2.8	0.05
3	0.119
3.2	0.362
3.4	0.557
3.6	0.779
3.8	0.938
4	1

The sex ratio from DCR evidenced the prevalence of males in the different size classes.

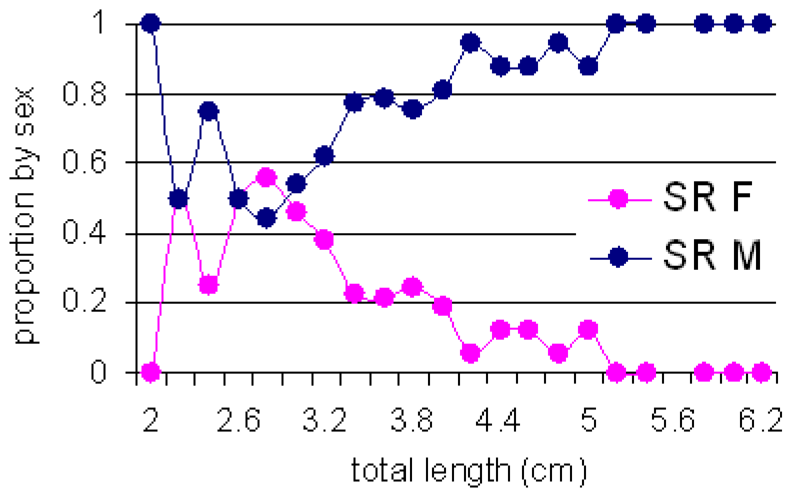


Fig. 8.57.1.3.2 Sex ratio over length (carapace length).

8.57.2. Fisheries

8.57.2.1. General description of fisheries

The Norway lobster is only targeted by trawlers on fishing grounds located offshore at 200 m depth, on the slope of the whole GSA. The Norway lobster occurs mainly with *M. merluccius*, *P. longirostris*, *P. blennoides*, depending on depth and area.

8.57.2.2. Management regulations applicable in 2008 and 2009

Management regulations are based on technical measures, like the number of fishing licenses and area limitation (distance from the coast and depth). In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late 1980s. After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity is implemented. Along the northern Sicily coasts two main Gulfs (Patti and Castellammare) have been closed to the trawl fishery up 200 m depth, since 1990. Two closed areas were also established in 2004 along the mainland, in front of Sorrento peninsula (Napoli Gulf) and Amantea (Calabrian coasts), although these protected area mainly cover the distribution of coastal species. Other measures on which the management regulations are based regard technical measures (mesh size) and minimum landing sizes (EC reg. 1967/06). In the GSA 10, the fishing ban has not been mandatory and it has been adopted on a voluntary basis by the fleet.

8.57.2.3. Catches

8.57.2.3.1. Landings

Available landing data are from DCR regulations. SGMED-09-02 received Italian landings data for GSA 10 by fishing gears which are listed in Tab. 8.57.2.3.1.1. The fishing segments DTS, PGP, PMP and PTS indicate respectively trawlers, small scale fishery (nets) polyvalent and pair trawls. Landings of the Norway lobster decreased from 2002 to 2004 from about 140 to 60 tons. Then landings were fairly stable until 2007 (60 tons) with a peak in 2005 (80 tons), while in 2008 a further decrease to 40 tons was observed (Fig. 8.57.2.3.1.1). Most part of the landings is from trawlers.

Tab. 8.57.2.3.1.1. Annual landings (t) by gear type, 2002-2008.

LW tons	FT_LVL4							
YEAR	DTS	GNS	GTR	OTB	PGP	PMP	PTS	Total
2002	114.29				0.41	14.22	5.62	134.54
2003	77.31				7.18	3.90	0.04	88.44
2004		5.59	1.41	56.60				63.60
2005		14.28		73.31				87.59
2006		9.02	0.14	56.77				65.93
2007		9.90		54.07				63.97
2008		7.84		30.72				38.56

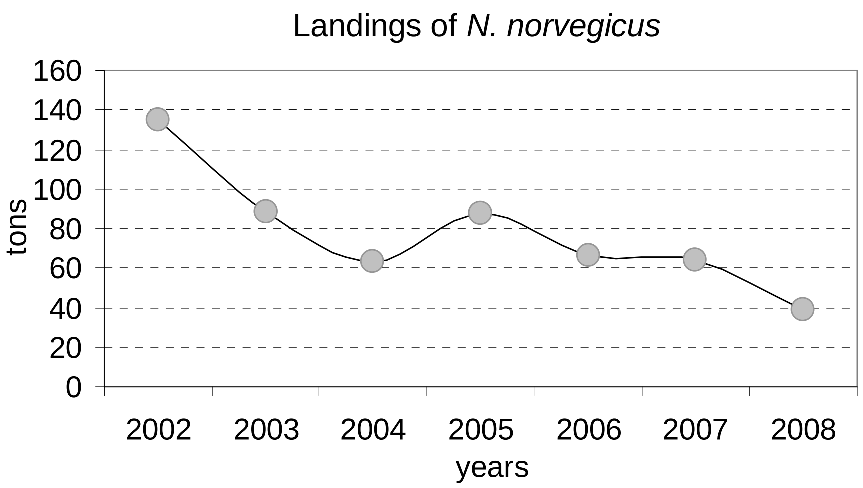


Fig. 8.57.2.3.1.1 Total landings (t) 2003-2008 as reported by DCR in the GSA 10.

8.57.2.3.2. Fishing effort

The trends in fishing effort by year and gear type is listed in Tab. 8.57.2.3.2.1 and shown in Fig. 8.57.2.3.2.1 in terms of kW*days. The fishing segments DTS, HOK, PGP, PMP and PTS indicate respectively trawlers, long-lines, small scale fishery (nets), polyvalent, and pair trawls. The fishing effort in kW*days of the trawlers, that is the fishing segment targeting the giant red shrimp, was rising in 2004 and 2005 and then decreasing in 2006 and 2007.

Tab. 8.57.2.3.2.1 Trend in fishing effort (kW*days) for GSA 10 by major gear types, 2002-2007.

YEAR	FT_LVL4_TYPE		KW*DAYS						
	DRB	DTS	FPO	GND	GNS	GTR	HOK	LHP-LHM	LLD
2002	94663	7344089							
2003	29540	7231486							
2004	110899	7883881					1654352		
2005	404243		226805	2878658	4378416	1519874		441690	819922
2006	392760		147562	2394591	2465382	3789078		395408	654956
2007	170557		5309	2232763	1848657	3793640		417886	412060
YEAR	LLS	MIS	OTB	PGP	PMP	PS	PTS	SB-SV	Total
2002				6440217	12686947		2631242		29197158
2003				7222145	8003452		2930380		25417003
2004				7056306	3588004		2308589		22602033
2005	1852150	936565	8102762			1538303		701108	23800496
2006	1289606	273517	6944418			1506523		859501	21113301
2007	1194311	73082	6882389			1222112		959937	19212704

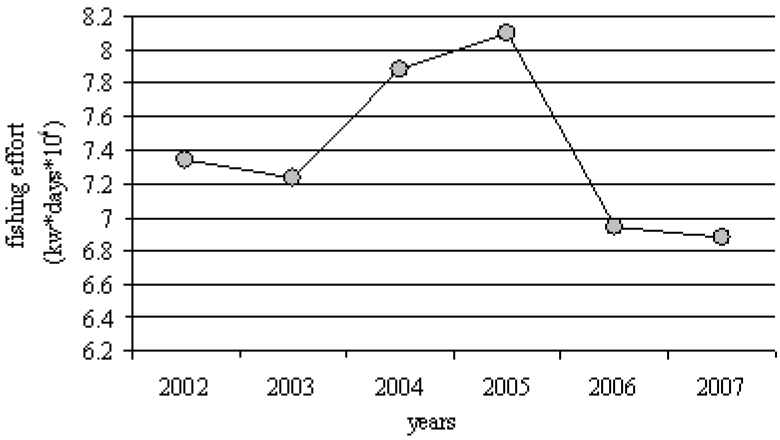


Fig. 8.57.2.3.2.1 Trend in fishing effort (kW*days*10) of trawlers in the GSA 10, 2002-2007.

8.57.3. Scientific surveys

8.57.3.1. Medits

8.57.3.1.1. Methods

According to the MEDITS protocol (Bertrand *et al*., 2002), trawl surveys were carried out yearly (May-July), applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish and weight per surface unit) were standardised to square kilometre, using the swept area method.

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 10 the following number of hauls was reported per depth stratum (Tab. 8.57.3.1.1.1).

Tab. 8.57.3.1.1.1. Number of hauls per year and depth stratum in GSA 10, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA10_010-050	9	10	10	10	10	10	10	10	9	9	9	9	9	9	9
GSA10_050-100	12	12	12	12	12	12	12	12	10	10	10	10	10	10	10
GSA10_100-200	20	20	20	20	20	20	20	20	17	17	17	17	17	17	17
GSA10_200-500	26	27	26	26	27	26	26	28	22	22	22	22	22	22	22
GSA10_500-800	31	30	31	31	31	30	31	29	26	27	26	26	26	26	26

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

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

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

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

Where:

- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

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

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

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

8.57.3.1.2. Geographical distribution patterns

No analyses based on Medits data were presented.

8.57.3.1.3. Trends in abundance and biomass

The re-estimated abundance indices are shown in Figure 8.57.3.1.3.1. No temporal patterns are evident..

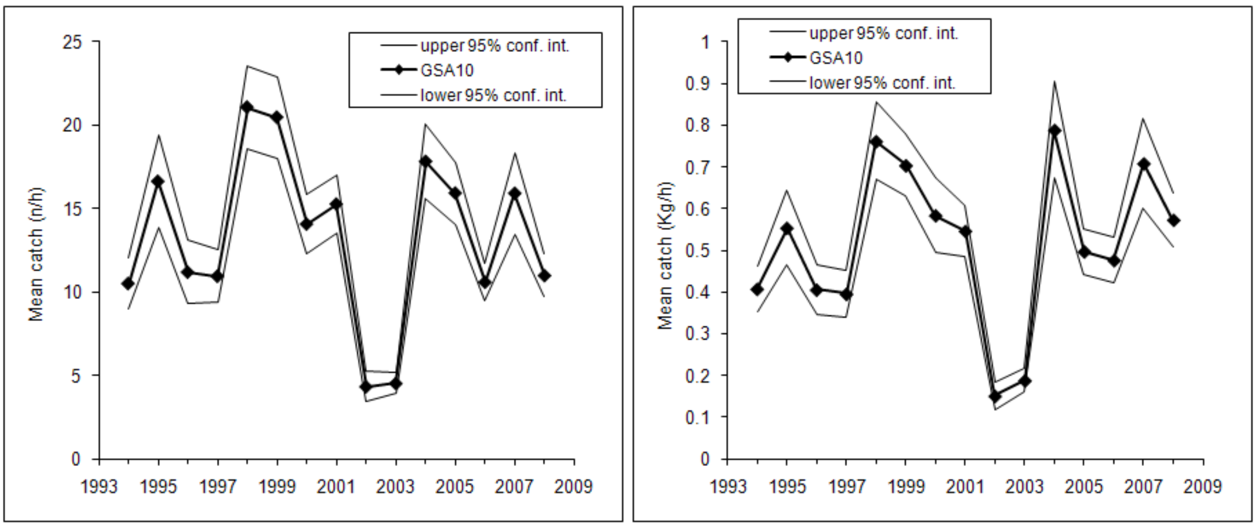


Fig. 8.57.3.1.3.1 Trends in survey abundance and biomass indices (Medits) of Norway lobster in GSA 10.

8.57.3.1.4. Trends in abundance by length or age

The following Fig. 8.57.3.1.4.1 and 2 display the stratified abundance indices of GSA 10 in 1994-2001 and 2002-2008.

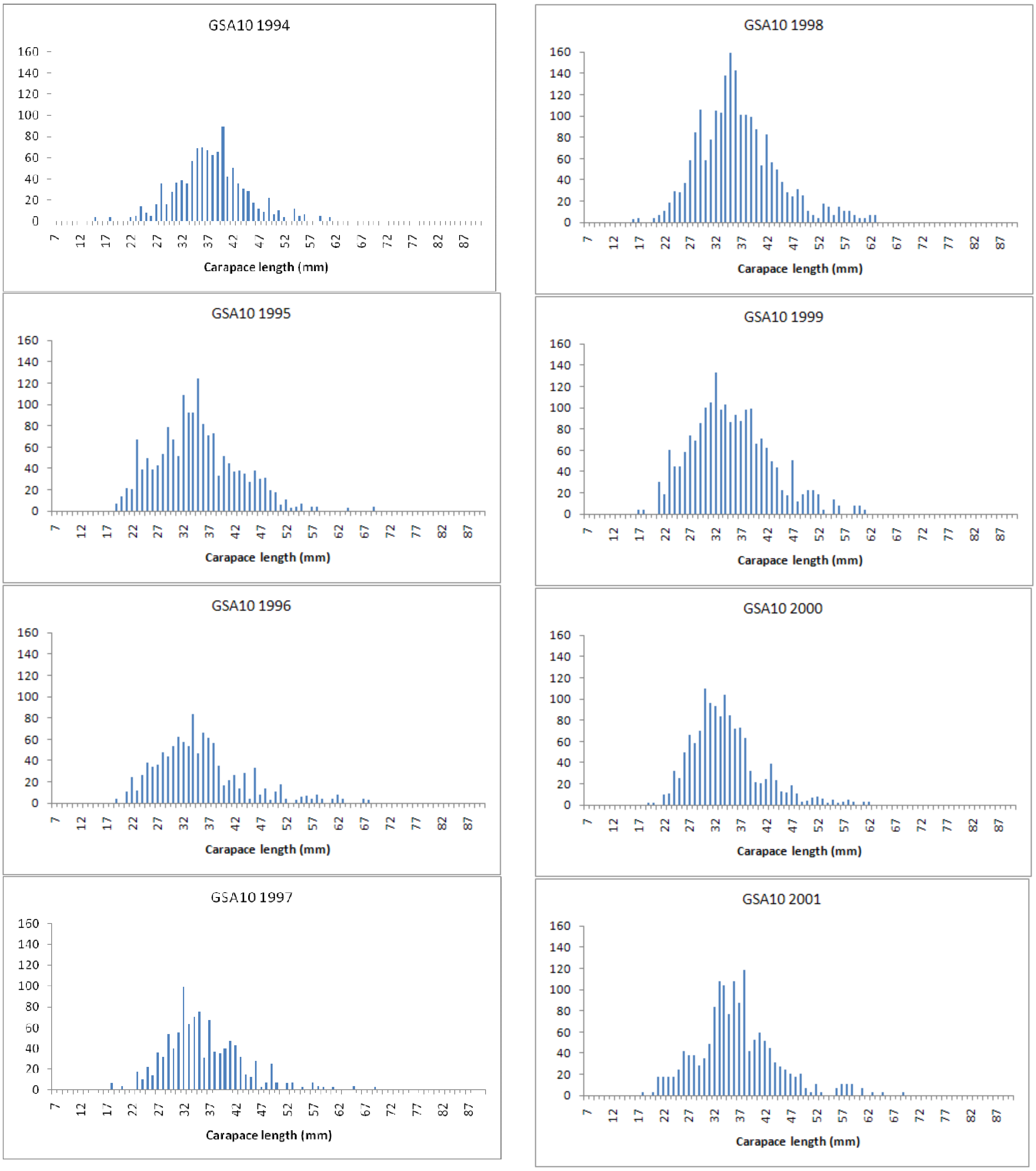


Fig. 8.57.3.1.4.1 Stratified abundance indices by size, 1994-2001.

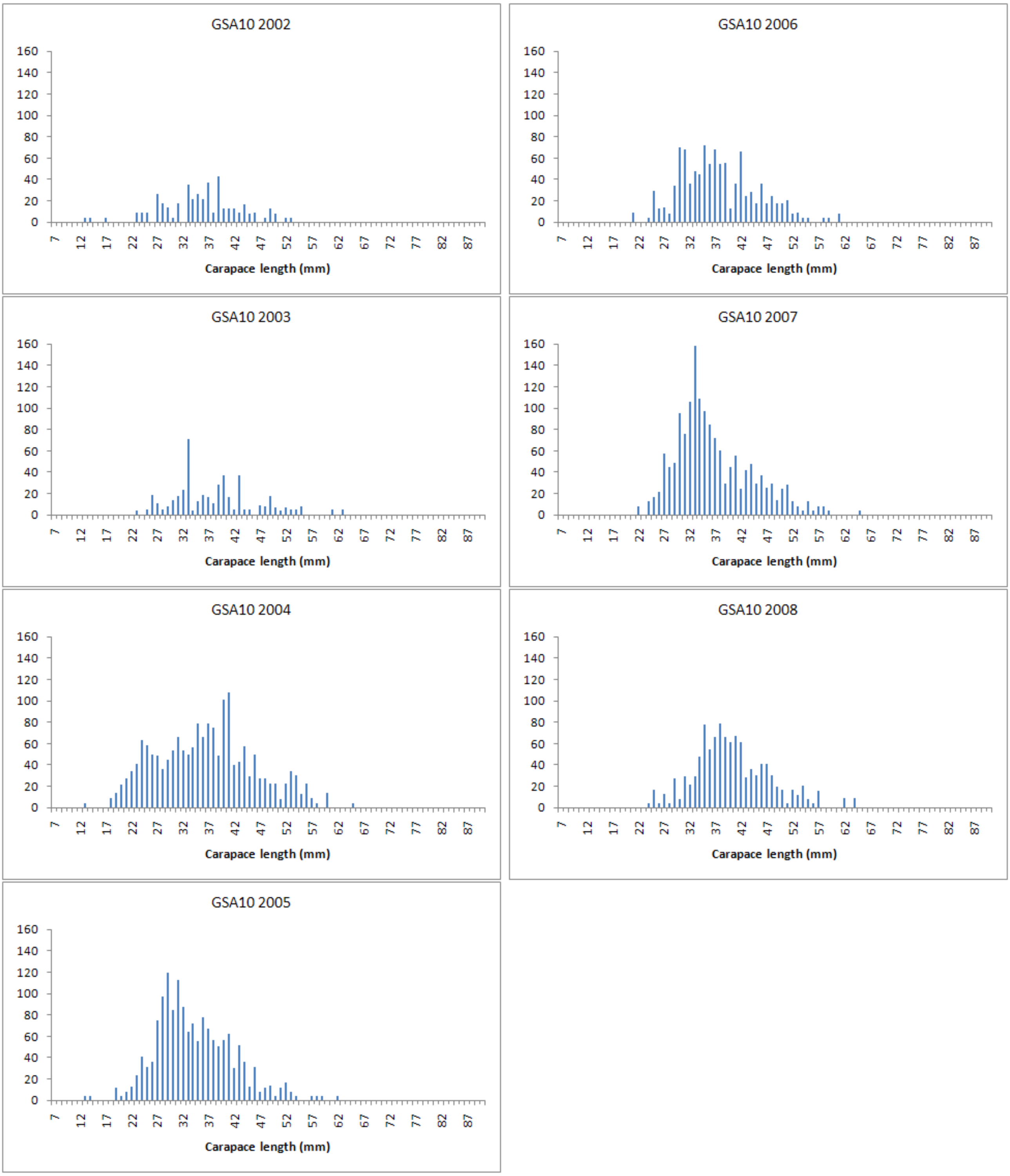


Fig. 8.57.3.1.4.2. Stratified abundance indices by size, 2002-2008.

8.57.3.2. GRUND

8.57.3.2.1. Methods

Since 2003 Grund surveys (Relini, 2000) was conducted using the same sampler (vessel and gear) in the whole GSA. Sampling scheme, stratification and protocols were similar as in Medits. All the abundance and biomass data were standardised to the square kilometre, using the swept area method.

8.57.3.2.2. Geographical distribution patterns

The geographical distribution pattern of the Norway lobster has been studied in the area using trawl-survey data (Grund and Medits), length frequency distribution analyses via modal component separation techniques and geostatistical methods. Nurseries were localized with a higher level of probability offshore the Garigliano river in the northernmost part of the GSA and offshore Capo Suvero, on the southern part of the area. These areas were also persistent along the time.

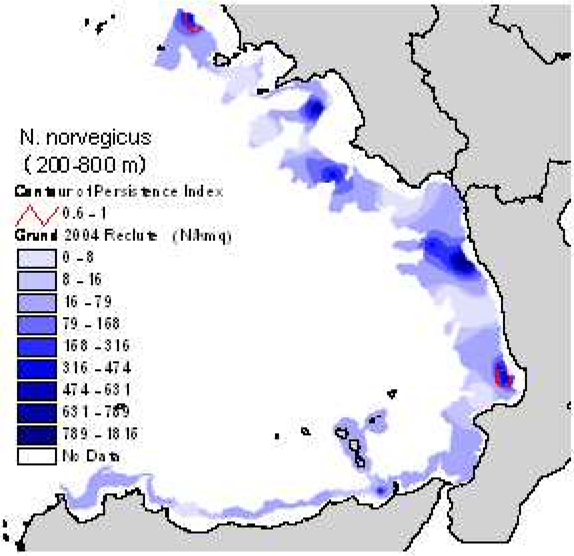


Fig. 8.57.3.2.2.1 Map of nursery area of Norway lobster.

8.57.3.2.3. Trends in abundance and biomass

Trends derived from the GRUND surveys are shown in Fig. 8.57.3.2.3.1. Abundance and biomass indices show an increasing trend up to 2005 and a decreasing in 2006, as well as recruitment indices (Fig. 8.57.3.2.3.1). In 1999 the survey was not performed.

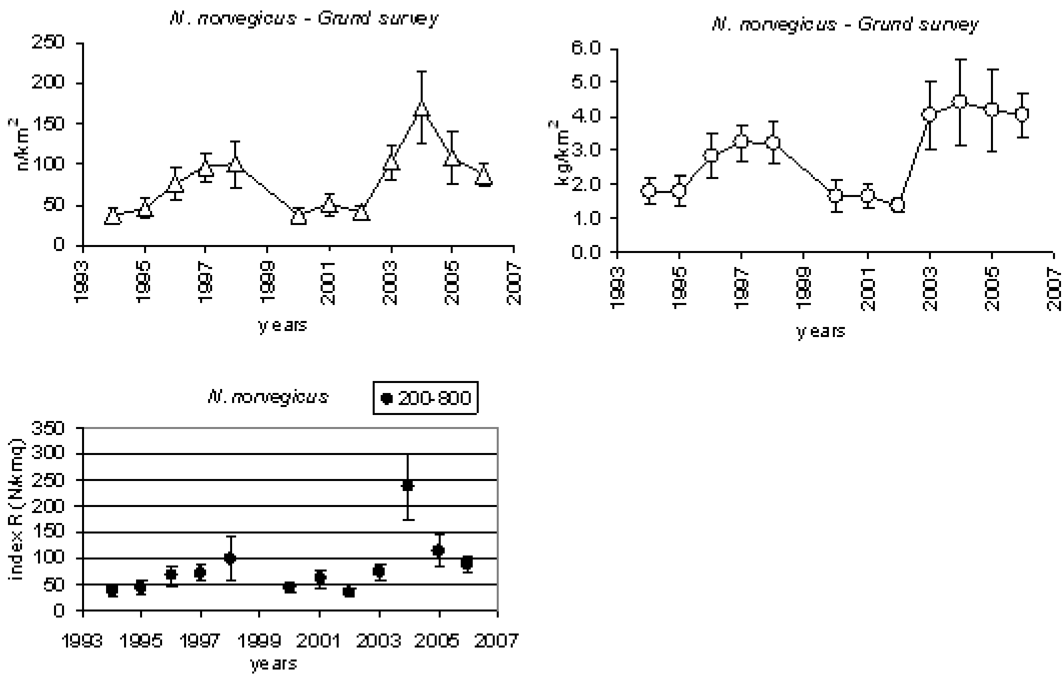


Fig. 8.57.3.2.3.1. Abundance and biomass indices of the Norway lobster in GSA 10 (bars indicate standard deviations) derived from Grund surveys. Recruitment indices (N/km^2) computed in the total depth range with standard deviation is also reported.

8.57.3.2.4. Trends in abundance by length or age

Grund time series of length structures from 1994 to 2006 (Fig. 8.57.3.2.4.1) did not show any trend.

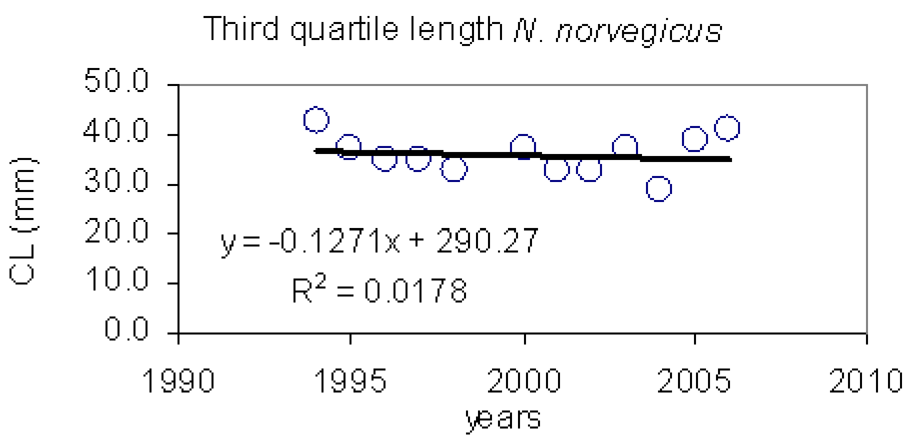


Fig. 8.57.3.2.4.1 III Quantile derived from the GRUND length structures in 1994-2006.

8.57.3.2.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.57.3.2.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.57.4. Assessment of historic stock parameters

No analytical assessment of historic stock parameters was conducted.

8.57.5. Long term prediction

8.57.5.1. Justification

No forecast analyses were conducted.

8.57.5.2. Input parameters

No forecast analyses were conducted.

8.57.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a short term prediction of catch and stock biomass for Norway lobster in GSA 10.

8.57.6. Scientific advice

8.57.6.1. Short term considerations

8.57.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.57.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of recruitment in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.57.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of exploitation in relation to proposed precautionary level given the preliminary state of the data and analyses.

8.58. Stock assessment of Norway lobster in GSA 11

8.58.1. Stock identification and biological features

8.58.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.58.1.2. Growth

No information was documented during SGMED-09-02.

8.58.1.3. Maturity

No information was documented during SGMED-09-02.

8.58.2. Fisheries

8.58.2.1. General description of fisheries

No information was documented during SGMED-09-02.

8.58.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.58.2.3. Catches

8.58.2.3.1. Landings

Tab. 8.58.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.8 of Appendix 3. The landings were mainly taken by demersal otter trawls.

Tab. 8.58.2.3.1.1 Annual landings (t) by fishing technique in GSA 11. Landings data provided for the years 2002 and 2003, probably have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
NEP	11	ITA	DTS	26108	53079					
NEP	11	ITA	OTB			60	29	48	61	55
NEP	11	ITA	PGP	171						
NEP	11	ITA	PMP	5477						

8.58.2.3.2. Discards

According to information available to the SGMED-09-02 no catches of Norway lobster were discarded by the Italian fleet.

8.58.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-09-02 are listed in Tab. 8.58.2.3.3.1 and in Tab. A3.10-3.12 of Appendix 3.

Tab. 8.58.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSA 11, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	11	ITA	DTS	14539	18957	28840				
DAYS	11	ITA	FPO				1211	9616	31238	
DAYS	11	ITA	FYK						608	
DAYS	11	ITA	GND						51	
DAYS	11	ITA	GNS				21601	7574	29014	
DAYS	11	ITA	GTR				124877	139221	83350	
DAYS	11	ITA	LHP-LHM				50	1028	3379	
DAYS	11	ITA	LLD				2263	5117	4441	
DAYS	11	ITA	LLS				9758	16168	20224	
DAYS	11	ITA	LTL					128	31	
DAYS	11	ITA	OTB				29211	25368	25596	
DAYS	11	ITA	PGP	102826	126272	165945				
DAYS	11	ITA	PMP	57543	30879					
GT*days	11	ITA	DTS	772163	986387	1598912				
GT*DAYS	11	ITA	FPO				6215	49606	84529	
GT*DAYS	11	ITA	FYK						622	
GT*DAYS	11	ITA	GND						2544	
GT*DAYS	11	ITA	GNS				71331	18124	61528	
GT*DAYS	11	ITA	GTR				428009	430370	295688	
GT*DAYS	11	ITA	LHP-LHM				100	6394	10466	
GT*DAYS	11	ITA	LLD				26766	86801	158560	
GT*DAYS	11	ITA	LLS				42073	99731	84653	
GT*DAYS	11	ITA	LTL					270	63	
GT*DAYS	11	ITA	OTB				1934836	1399052	1423265	
GT*days	11	ITA	PGP	306226	468352	501550				
GT*days	11	ITA	PMP	611726	308212					
kW*days	11	ITA	DTS	3679604	4652647	6711626				
KW*DAYS	11	ITA	FPO				79031	824017	1387022	
KW*DAYS	11	ITA	FYK						13055	
KW*DAYS	11	ITA	GND						11713	
KW*DAYS	11	ITA	GNS				1007963	236313	781402	
KW*DAYS	11	ITA	GTR				6358014	6476994	4393484	
KW*DAYS	11	ITA	LHP-LHM				769	70523	122621	
KW*DAYS	11	ITA	LLD				284297	480411	952876	
KW*DAYS	11	ITA	LLS				832709	1159412	1054615	
KW*DAYS	11	ITA	LTL					12388	1622	
KW*DAYS	11	ITA	OTB				7679721	5879355	5957347	
kW*days	11	ITA	PGP	2865738	5099814	7105771				
kW*days	11	ITA	PMP	7159338	3245118					

8.58.3.Scientific surveys

8.58.3.1.Medits

8.58.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 11 the following number of hauls was reported per depth stratum (s. Tab. 8.58.3.1.1.1).

Tab. 8.58.3.1.1.1. Number of hauls per year and depth stratum in GSA 11, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA11_010-050	17	19	21	21	21	21	19	18	20	18	17	17	19	19	17
GSA11_050-100	27	21	22	22	20	22	22	24	19	19	18	21	18	20	19
GSA11_100-200	22	23	30	31	31	30	31	30	24	24	24	24	24	24	22
GSA11_200-500	35	29	29	26	25	27	24	25	20	24	21	20	20	20	21
GSA11_500-800	23	16	21	25	25	24	27	26	16	14	15	14	16	17	16

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

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

frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.58.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.58.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the Norway lobster in GSA 11 was derived from the international survey Medits. Figure 8.58.3.1.3.1 displays the estimated trend in Norway lobster abundance and biomass in GSA 11. The analyses of Medits indices are considered preliminary.

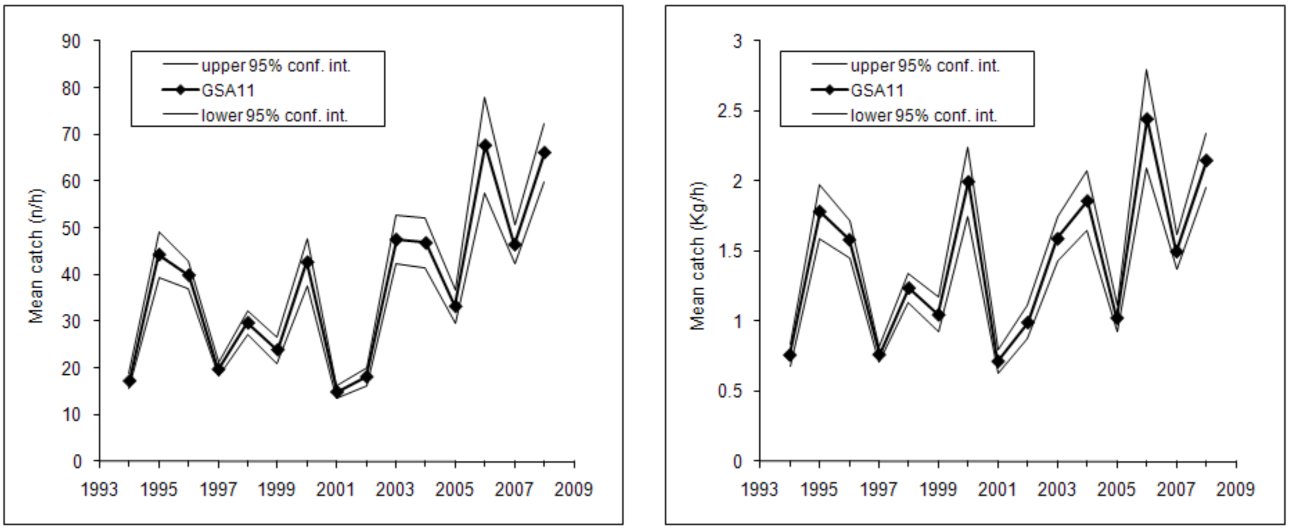


Fig. 8.58.3.1.3.1 Abundance and biomass indices of Norway lobster in GSA 11.

8.58.3.1.4. Trends in abundance by length or age

The following Fig. 8.58.3.1.4.1 and 2 display the stratified abundance indices of GSA 11 in 1994-2008. These size compositions are considered preliminary.

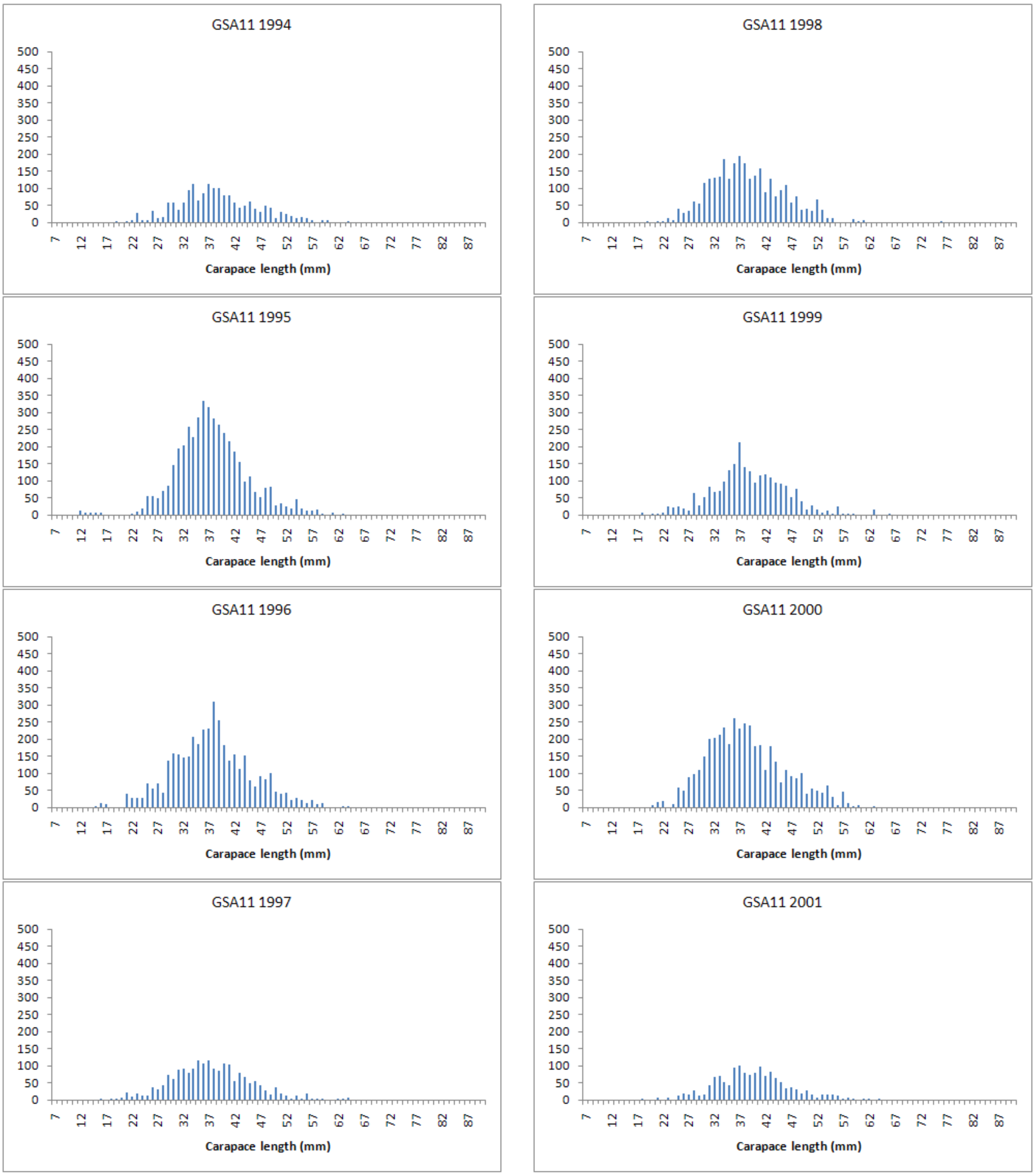


Fig. 8.58.3.1.4.1 Stratified abundance indices by size, 1994-2001.

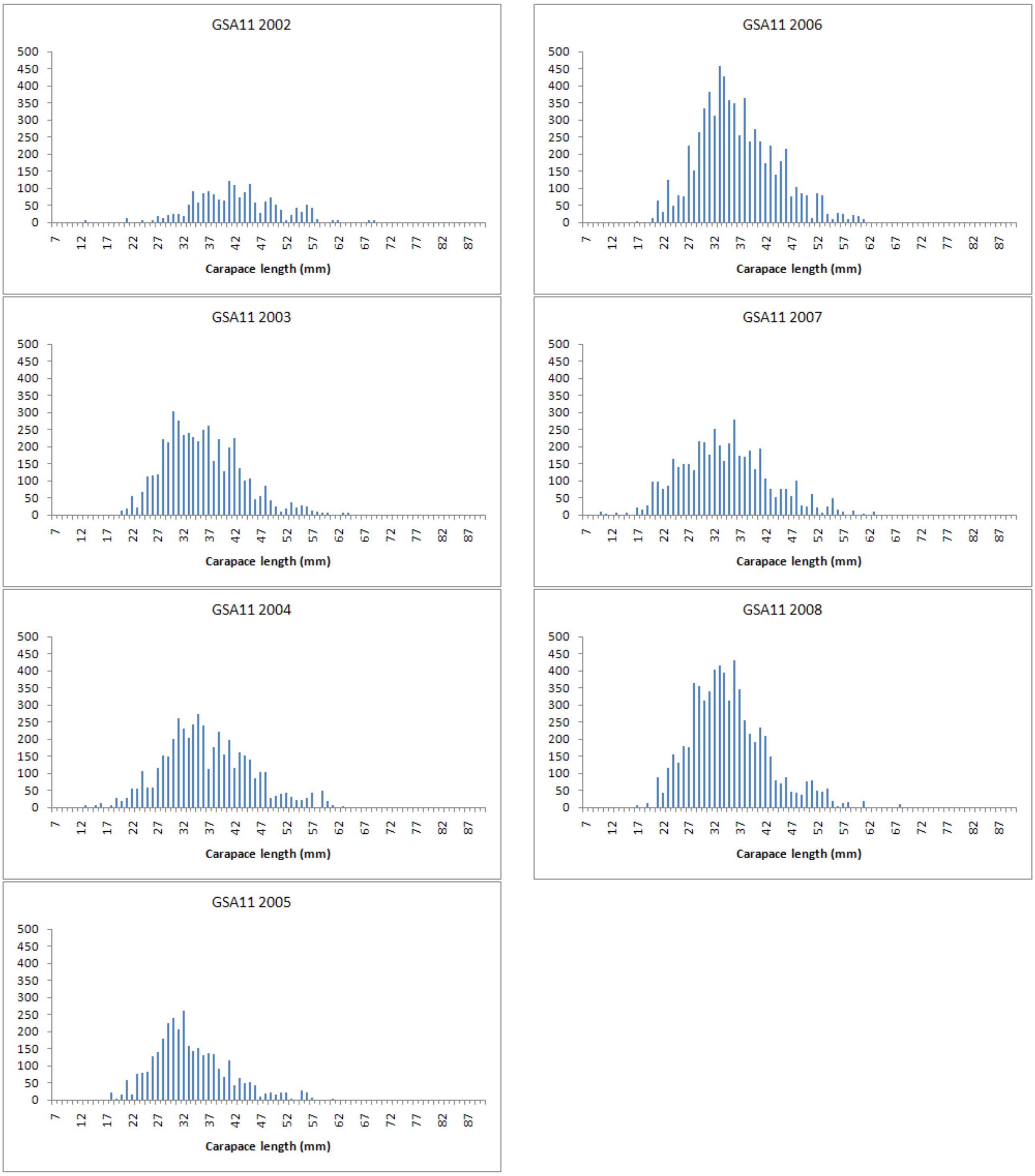


Fig. 8.58.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.58.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.58.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.58.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.58.5. Long term prediction

8.58.5.1. Justification

No forecast analyses were conducted.

8.58.5.2. Input parameters

No forecast analyses were conducted.

8.58.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for Norway lobster in GSA 11.

8.58.6. Scientific advice

8.58.6.1. Short term considerations

8.58.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock given the preliminary state of the data and analyses.

8.58.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.58.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.59. Stock assessment of Norway lobster in GSA 16

8.59.1. Stock identification and biological features

8.59.1.1. Stock Identification

No information was documented during SGMED-09-02.

8.59.1.2. Growth

No information was documented during SGMED-09-02.

8.59.1.3. Maturity

No information was documented during SGMED-09-02.

8.59.2. Fisheries

8.59.2.1. General description of fisheries

No information was documented during SGMED-09-02.

8.59.2.2. Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.59.2.3. Catches

8.59.2.3.1. Landings

Tab. 8.59.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.8 of Appendix 3. The landings were mainly taken by demersal otter trawls.

Tab. 8.59.2.3.1.1 Annual landings (t) by fishing technique in GSA 16. Landings data provided for the years 2002 and 2003, probably have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
NEP	16	ITA	DTS	515992	646942					
NEP	16	ITA	OTB			428	490	673	797	673
NEP	16	ITA	PGP	125	17001					
NEP	16	ITA	PMP	3605						
NEP	16	ITA	PTS	2467	14211					

8.59.2.3.2. Discards

According to information available to the SGMED-09-02 no catches of Norway lobster were discarded by the Italian fleet.

8.59.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-09-02 are listed in Tab. 8.59.2.3.3.1 and in Tab. A3.10-3.12 of Appendix 3.

Tab. 8.59.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSA 16, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	16	ITA	DTS	87300	76233	81853				
DAYS	16	ITA	FPO				18	20	28	
DAYS	16	ITA	GND				6717	6218	7547	
DAYS	16	ITA	GTR				78429	52961	50840	
DAYS	16	ITA	HOK			14856				
DAYS	16	ITA	LHP-LHM				1363	3695	4674	
DAYS	16	ITA	LLD				5759	6397	8493	
DAYS	16	ITA	LLS				16424	22888	19638	
DAYS	16	ITA	LTL				300	408		
DAYS	16	ITA	MIS				262			
DAYS	16	ITA	OTB				83124	84674	82261	
DAYS	16	ITA	OTM				756	1540	1471	
DAYS	16	ITA	PGP	146019	118660	118425				
DAYS	16	ITA	PMP	26655	34956	6939				
DAYS	16	ITA	PS				1612	2066	1971	
DAYS	16	ITA	PTM				1204	3746	4193	
DAYS	16	ITA	PTS	8778	8568	4899				
GT*days	16	ITA	DTS	6739948	6175213	6673029				
GT*DAYS	16	ITA	FPO				531	939	2962	
GT*DAYS	16	ITA	GND				51767	68581	70266	
GT*DAYS	16	ITA	GTR				183252	139048	146474	
GT*days	16	ITA	HOK			764595				
GT*DAYS	16	ITA	LHP-LHM				2757	7752	9603	
GT*DAYS	16	ITA	LLD				377485	290622	351965	
GT*DAYS	16	ITA	LLS				40376	41294	51455	
GT*DAYS	16	ITA	LTL				600	815		
GT*DAYS	16	ITA	MIS				1630			
GT*DAYS	16	ITA	OTB				7064255	7088706	6994494	
GT*DAYS	16	ITA	OTM				65935	141508	135199	
GT*days	16	ITA	PGP	410857	732725	249032				
GT*days	16	ITA	PMP	375921	418892	20134				
GT*DAYS	16	ITA	PS				101266	114791	95754	
GT*DAYS	16	ITA	PTM				57807	197450	225837	
GT*days	16	ITA	PTS	585964	327460	224188				
kW*days	16	ITA	DTS	23952310	20951845	21381964				
KW*DAYS	16	ITA	FPO				2602	4116	16280	
KW*DAYS	16	ITA	GND				484488	565283	560624	
KW*DAYS	16	ITA	GTR				2436223	1675235	1779917	
kW*days	16	ITA	HOK			3153486				
KW*DAYS	16	ITA	LHP-LHM				147929	332833	329113	
KW*DAYS	16	ITA	LLD				1102509	1319225	1938868	
KW*DAYS	16	ITA	LLS				812348	751898	805197	
KW*DAYS	16	ITA	LTL				2401	3260		
KW*DAYS	16	ITA	MIS				18900			
KW*DAYS	16	ITA	OTB				22936088	23764571	22757302	
KW*DAYS	16	ITA	OTM				159014	315468	300311	
kW*days	16	ITA	PGP	3133993	4603457	2691324				
kW*days	16	ITA	PMP	2792612	2761842	223470				
KW*DAYS	16	ITA	PS				444087	520717	459314	
KW*DAYS	16	ITA	PTM				280234	712936	862918	
kW*days	16	ITA	PTS	2510582	1750128	962786				

8.59.3.Scientific surveys

8.59.3.1.Medits

8.59.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 16 the following number of hauls was reported per depth stratum (s. Tab. 8.59.3.1.1.1).

Tab. 8.59.3.1.1.1. Number of hauls per year and depth stratum in GSA 16, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA16_010-050	4	4	4	4	4	4	4	4	7	7	7	10	10	11	11
GSA16_050-100	9	8	8	8	8	8	7	8	11	12	12	20	22	23	23
GSA16_100-200	4	4	4	4	5	5	6	5	11	10	11	20	19	21	21
GSA16_200-500	10	11	11	12	11	11	11	11	19	18	27	37	31	27	27
GSA16_500-800	10	14	14	13	14	14	14	14	20	20	21	33	33	38	38

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.59.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.59.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the Norway lobster in GSA 16 was derived from the international survey Medits. Figure 8.59.3.1.3.1 displays the estimated trend in Norway lobster abundance and biomass in GSA 16. The analyses of Medits indices are considered preliminary.

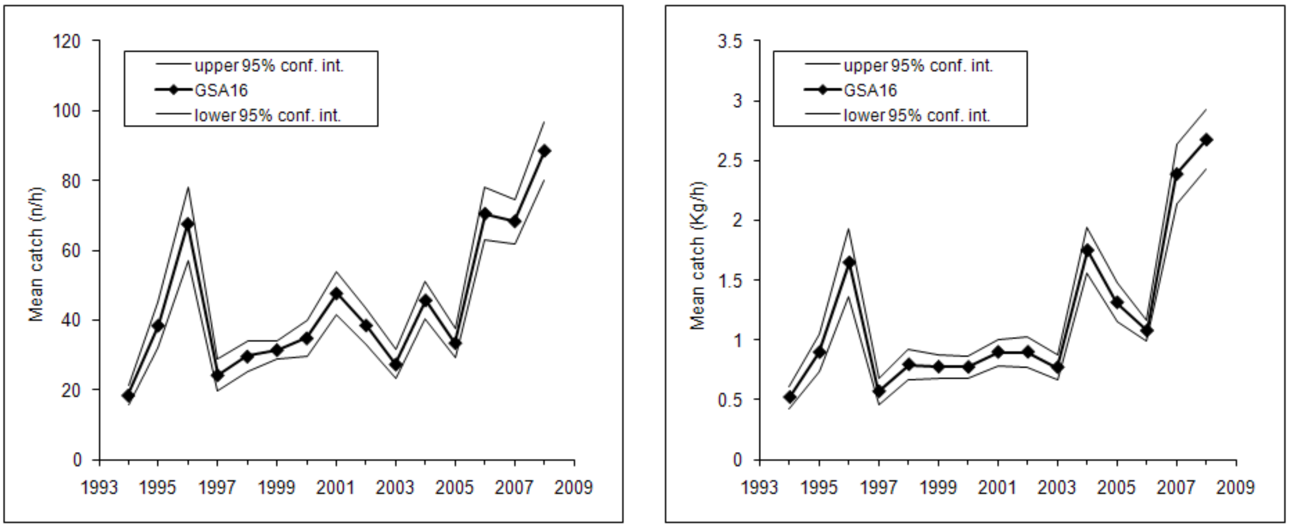


Fig. 8.59.3.1.3.1 Abundance and biomass indices of Norway lobster in GSA 16.

8.59.3.1.4. Trends in abundance by length or age

The following Fig. 8.59.3.1.4.1 and 2 display the stratified abundance indices of GSA 16 in 1994-2008. These size compositions are considered preliminary.

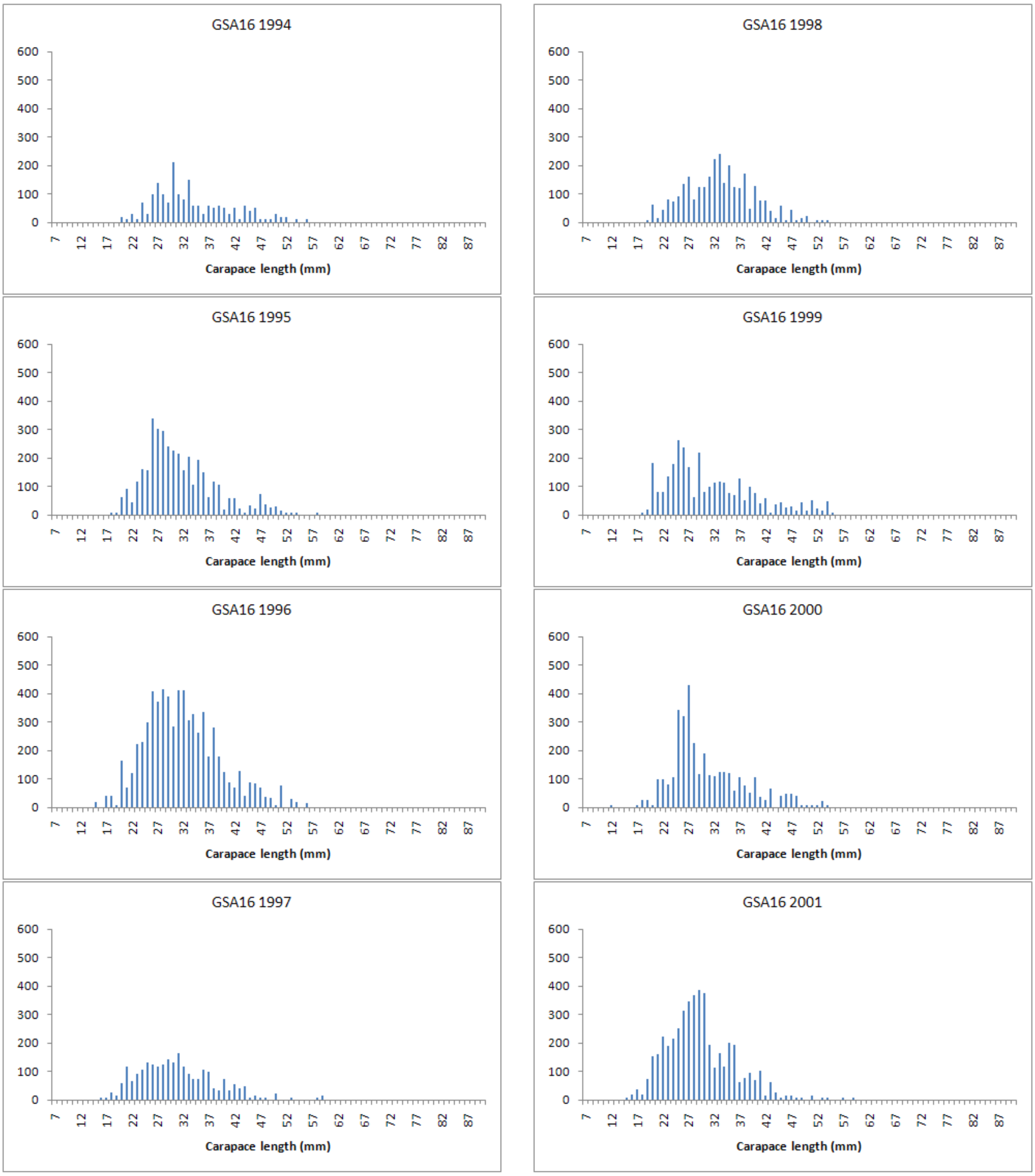


Fig. 8.59.3.1.4.1 Stratified abundance indices by size, 1994-2001.

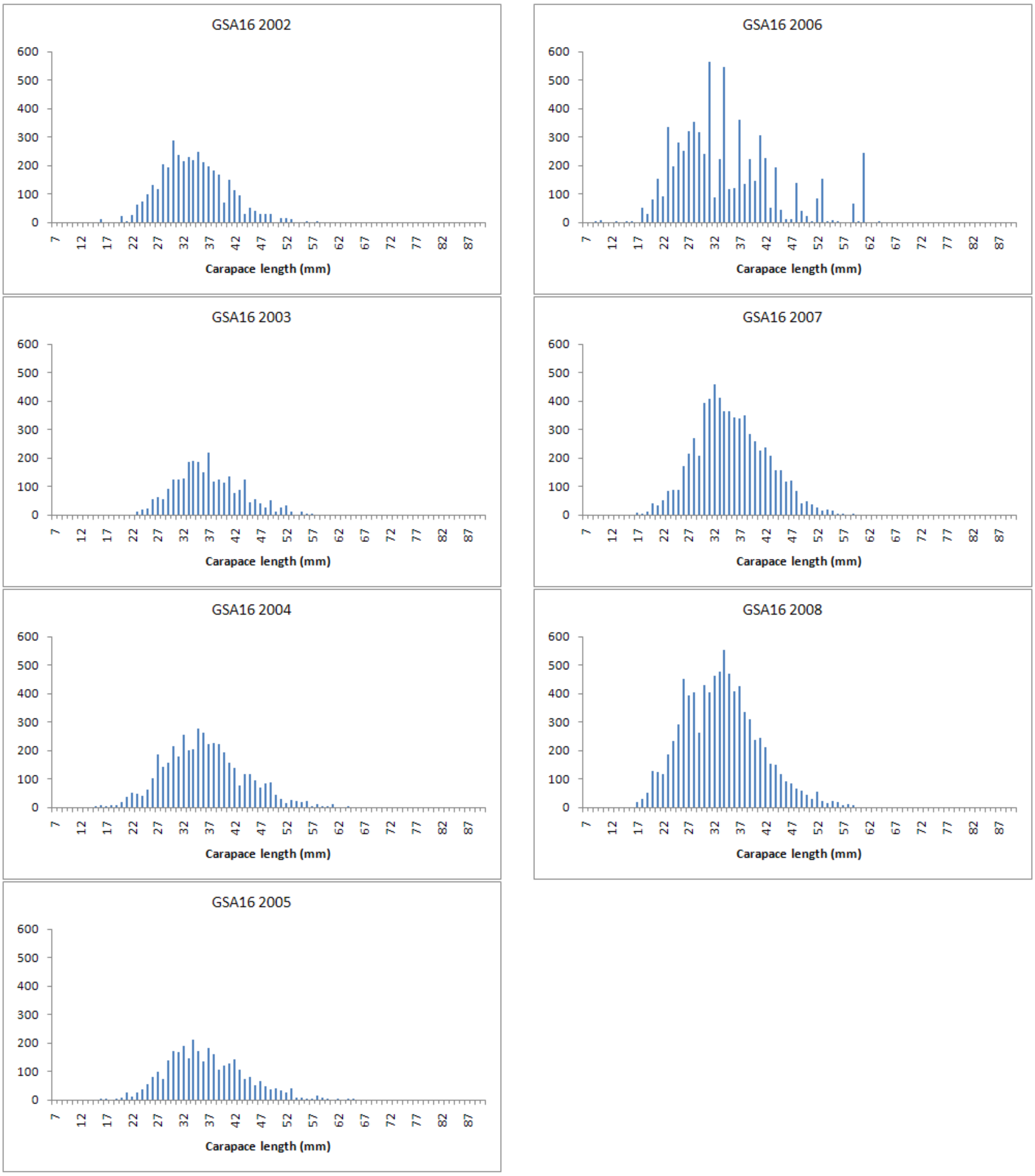


Fig. 8.59.3.1.4.2 Stratified abundance indices by size, 2002-2008.

8.59.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.59.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.59.4.Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.59.5.Long term prediction

8.59.5.1.Justification

No forecast analyses were conducted.

8.59.5.2.Input parameters

No forecast analyses were conducted.

8.59.5.3.Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for Norway lobster in GSA 16.

8.59.6.Scientific advice

8.59.6.1.Short term considerations

8.59.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock given the preliminary state of the data and analyses.

8.59.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.59.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

8.60. Stock assessment of Norway lobster in GSA 18

8.60.1.Stock identification and biological features

8.60.1.1.Stock Identification

No information was documented during SGMED-09-02.

8.60.1.2.Growth

No information was documented during SGMED-09-02.

8.60.1.3.Maturity

No information was documented during SGMED-09-02.

8.60.2.Fisheries

8.60.2.1.General description of fisheries

No information was documented during SGMED-09-02.

8.60.2.2.Management regulations applicable in 2008 and 2009

No information was documented during SGMED-09-02.

8.60.2.3.Catches

8.60.2.3.1. Landings

Tab. 8.60.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-09-02 through the Data Collection Regulation and are listed in Table A3.8 of Appendix 3. The landings were mainly taken by demersal otter trawls.

Tab. 8.60.2.3.1.1 Annual landings (t) by fishing technique in GSA 18. Landings data provided for the years 2002 and 2003, probably have a mistake in the units used.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
NEP	18	ITA	DTS	442156	1039255					
NEP	18	ITA	GNS				2	10	15	10
NEP	18	ITA	OTB			1218	1196	1437	1300	1005
NEP	18	ITA	PGP		5528					
NEP	18	ITA	PMP	36317	141766					

8.60.2.3.2. Discards

According to information available to the SGMED-09-02 no catches of Norway lobster were discarded by the Italian fleet.

8.60.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-09-02 are listed in Tab. 8.60.2.3.3.1 and in Tab. A3.10-3.12 of Appendix 3.

Tab. 8.60.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSA 18, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	18	ITA	DRB	11081	5890	3865	6083	7723	8158	
DAYS	18	ITA	DTS	85424	71203	80259				
DAYS	18	ITA	GNS				41046	44570	31727	
DAYS	18	ITA	GTR				26899	29749	22260	
DAYS	18	ITA	HOK			1799				
DAYS	18	ITA	LHP-LHM					30		
DAYS	18	ITA	LLD				1207	580	371	
DAYS	18	ITA	LLS				18676	20819	16620	
DAYS	18	ITA	MIS				2446	872	49	
DAYS	18	ITA	OTB				82436	85956	70678	
DAYS	18	ITA	PGP	110621	63332	67232				
DAYS	18	ITA	PMP	53475	35980	3667				
DAYS	18	ITA	PS				1382	915	1014	
DAYS	18	ITA	PTM				2447	4006	4558	
DAYS	18	ITA	PTS	4140	4526	4679				
GT*days	18	ITA	DRB	101523	53962	41347	58156	78840	83726	
GT*days	18	ITA	DTS	2648217	2309802	2568868				
GT*DAYS	18	ITA	GNS				81222	103569	61647	
GT*DAYS	18	ITA	GTR				52099	34536	40270	
GT*days	18	ITA	HOK			27800				
GT*DAYS	18	ITA	LHP-LHM					30		
GT*DAYS	18	ITA	LLD				14253	5477	4533	
GT*DAYS	18	ITA	LLS				68422	77823	66105	
GT*DAYS	18	ITA	MIS				5104	4206	103	
GT*DAYS	18	ITA	OTB				2522892	2649998	2225039	
GT*days	18	ITA	PGP	262823	150987	120701				
GT*days	18	ITA	PMP	655187	416888	40920				
GT*DAYS	18	ITA	PS				166872	111889	125116	
GT*DAYS	18	ITA	PTM				181912	391845	506393	
GT*days	18	ITA	PTS	278115	270956	369876				
kW*days	18	ITA	DRB	1100225	584801	381968	613628	792317	848774	
kW*days	18	ITA	DTS	17112022	14530793	14369490				
KW*DAYS	18	ITA	GNS				1448541	1515067	1067720	
KW*DAYS	18	ITA	GTR				402155	144123	312140	
kW*days	18	ITA	HOK			284535				
KW*DAYS	18	ITA	LHP-LHM					1364		
KW*DAYS	18	ITA	LLD				147964	53215	35447	
KW*DAYS	18	ITA	LLS				920272	819044	652678	
KW*DAYS	18	ITA	MIS				17234	32782	1933	
KW*DAYS	18	ITA	OTB				14372055	14808415	12562033	
kW*days	18	ITA	PGP	1722336	1002933	1180371				
kW*days	18	ITA	PMP	7277279	4416994	351689				
KW*DAYS	18	ITA	PS				619543	466158	597297	
KW*DAYS	18	ITA	PTM				1069744	1436018	1773275	
kW*days	18	ITA	PTS	1480945	1464793	1842716				

8.60.3.Scientific surveys

8.60.3.1.Medits

8.60.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 18 the following number of hauls was reported per depth stratum (s. Tab. 8.60.3.1.1.1).

Tab. 8.60.3.1.1.1. Number of hauls per year and depth stratum in GSA 18, 1994-2008.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSA18_010-050	14	15	15	14	14	14	14	15	13	13	12	9	10	11	10
GSA18_050-100	14	14	14	15	15	15	15	14	21	21	23	16	15	15	14
GSA18_100-200	24	23	23	23	23	23	23	23	34	31	32	25	25	23	22
GSA18_200-500	10	10	10	10	10	10	10	10	15	15	16	10	10	9	8
GSA18_500-800	10	10	10	10	10	10	10	10	14	14	14	7	7	7	5

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

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

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

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

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

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

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

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

aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

8.60.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-09-02.

8.60.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the Norway lobster in GSA 18 was derived from the international survey Medits. Figure 8.60.3.1.3.1 displays the estimated trend in Norway lobster abundance and biomass in GSA 18. The analyses of Medits indices are considered preliminary.

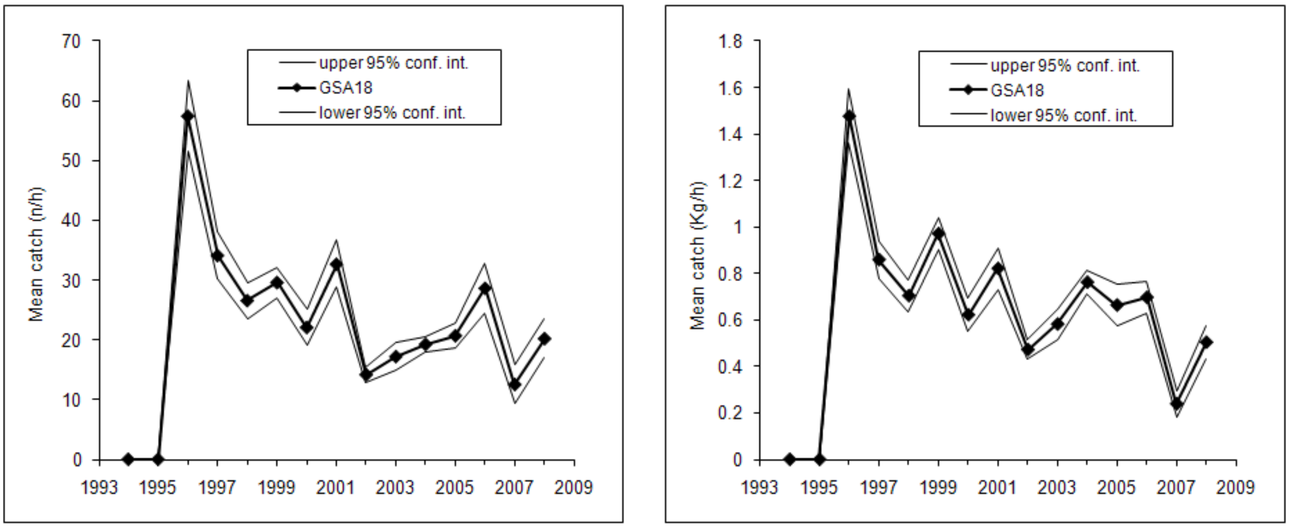


Fig. 8.60.3.1.3.1 Abundance and biomass indices of Norway lobster in GSA 18.

8.60.3.1.4. Trends in abundance by length or age

The following Fig. 8.60.3.1.4.1 and 2 display the stratified abundance indices of GSA 18 in 1996-2008. These size compositions are considered preliminary.

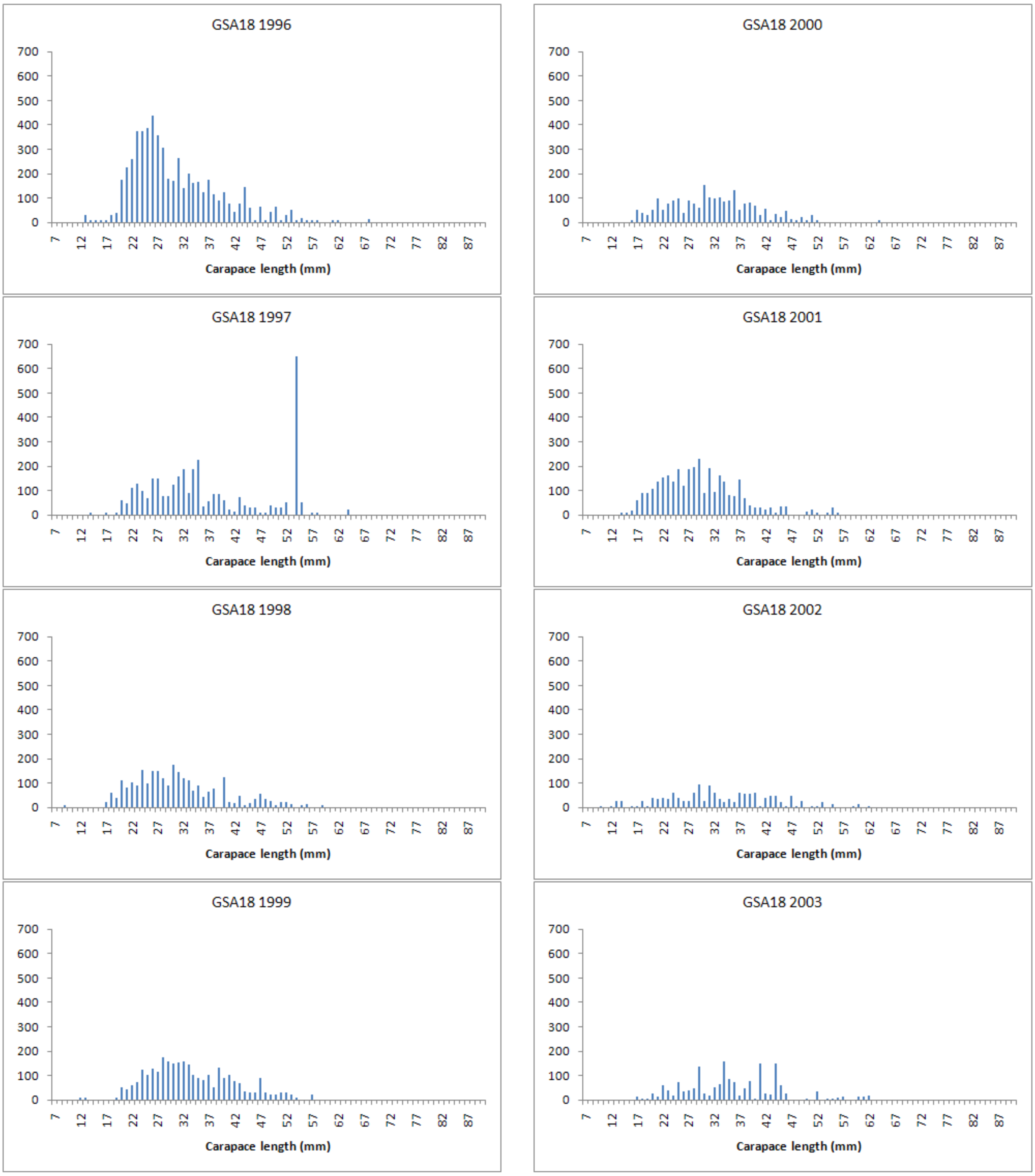


Fig. 8.60.3.1.4.1 Stratified abundance indices by size, 1996-2003.

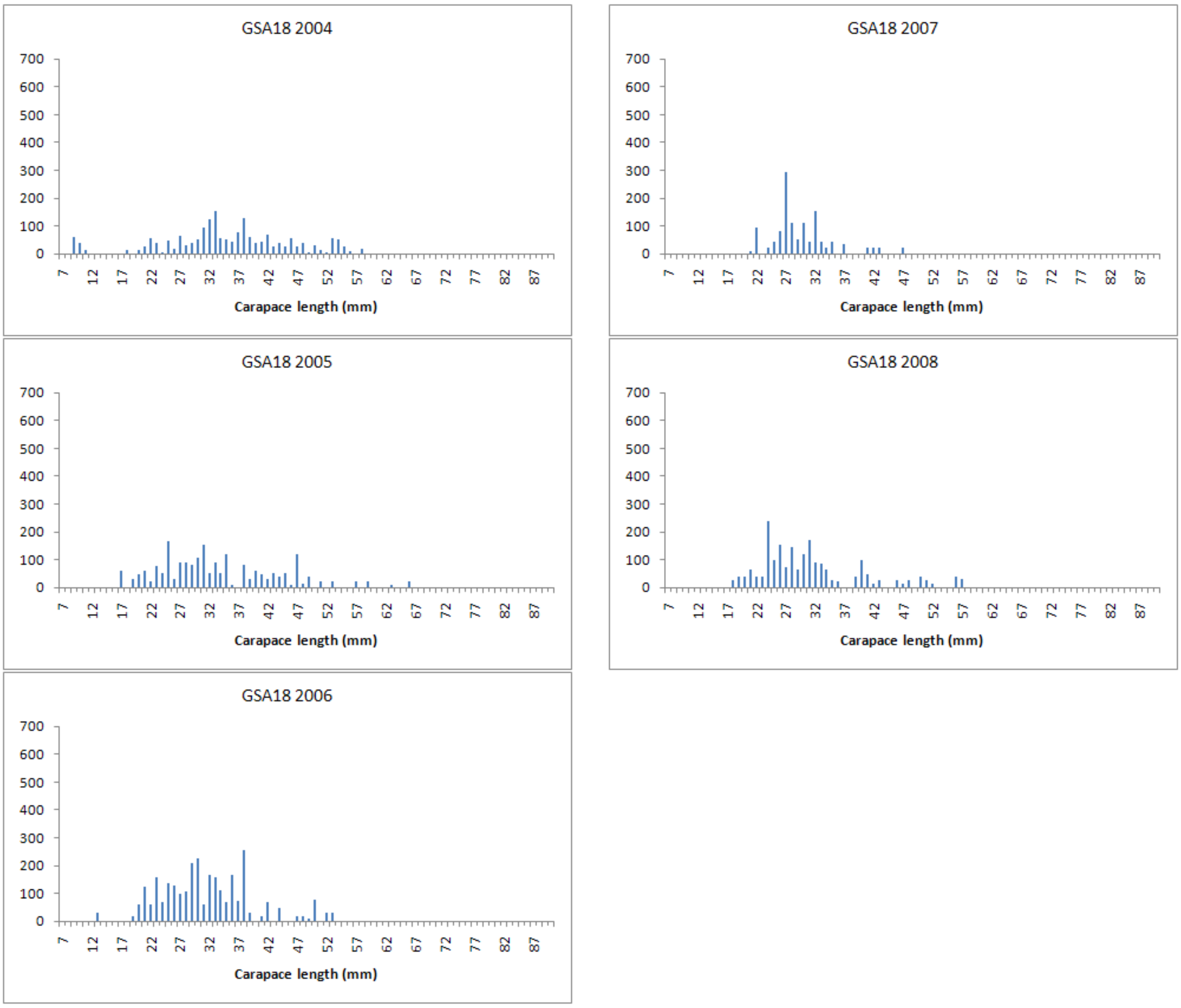


Fig. 8.60.3.1.4.2 Stratified abundance indices by size, 2004-2008.

8.60.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-02.

8.60.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-02.

8.60.4. Assessment of historic stock parameters

SGMED-09-02 did not undertake any analytical assessment.

8.60.5. Long term prediction

8.60.5.1. Justification

No forecast analyses were conducted.

8.60.5.2. Input parameters

No forecast analyses were conducted.

8.60.5.3. Results

Given the preliminary state of the data and analyses SGMED-09-02 is not in the position to provide a long term prediction of catch and stock biomass for Norway lobster in GSA 18.

8.60.6. Scientific advice

8.60.6.1. Short term considerations

8.60.6.1.1. State of the spawning stock size

SGMED-09-02 is unable to provide any scientific advice of the state of the spawning stock given the preliminary state of the data and analyses.

8.60.6.1.2. State of recruitment

SGMED-09-02 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

8.60.6.1.3. State of exploitation

SGMED-09-02 is unable to provide any scientific advice of the state of the exploitation in relation to proposed precautionary and target levels given the preliminary state of the data and analyses.

9. REFERENCES

AAVV. 2000 MEDiterranean LANDings pilot project-Medland. Final Report EU Project n° 97/0066.

AAVV (2008). Status of deep-sea red shrimps in the Central and Eastern Mediterranean Sea. Final Report, Red's Project. Proj. Ref. FISH/2004/03-32.

AAVV 2002. Stock Assessment in the Mediterranean-SAMED. Final Report EU Project n° 99/047.

Abella A., Bartolino V., Bertrand J., Colloca F., Follesa C., Mannini A., Reale B., Rinelli P., Sbrana M., Spedicato M.T., Voliani A., Zupa R., 2007. Use of composite models for the assessment of European hake, Red mullet and Norway lobster stocks in the North-Western Mediterranean (GSAs 7, 8, 9, 10 and 11). WG SAC Athens, September 2007.

Abella A., Belluscio A., Bertrand J., Carbonara P. L., Giordano D., Sbrana M., Zamboni A., 1999. Use of MEDITS trawl survey data and commercial fleet information for the assessment of some Mediterranean demersal resources. Aquatic Living Resources, 12(3): 155-166.

Abella A., Caddy J., 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.

Abella A., F. Fiorentino, A. Mannini and L. Orsi Relini.- 2008. Exploring relationships between recruitment of European hake (*Merluccius merluccius* L. 1758) and environmental factors in the Ligurian Sea and the Strait of Sicily (Central Mediterranean). Journal of Marine Systems 71: 279-293.

Abella A., Ria M., Serena F (2005). Usefulness of legal size for the recovery of a European hake stock in a Northwestern Mediterranean bottom trawl fishery. ICES CM 2005/W:19

Abella A., Righini P. (1995) - Valutazione di Nephrops norvegicus nel batiale dell'Alto Tirreno. *Biol. Mar. Medit*., 2 (2) 233-238.

Abella A., Righini P. (1998) - Biological reference points for the management of *Nephrops norvegicus* stocks in the Northern Tyrrhenian Sea. J. Nat. Hist., 32:1419-1430.

Abella A., Serena F. (1995) - Definition of the groundfish assemblages caught off the Tuscanian coasts for fisheries purposes. Rapp. Comm. Int. Mer.Medit., 34: 235.

Abella A., Serena F., Ria M., 2005. Distributional response to variations in abundance over spatial and temporal scales for juveniles of European hake (*Merluccius merluccius*) in the Western Mediterranean Sea. Fisheries Research, 71: 295–310.

Abella A.J., Serena F., 1998. Selettività e vulnerabilità del nasello nella pesca a strascico. Biol. Mar. Medit., 5 (2): 496-504.

Abelló P., Abella A., Adamidou A., Jukic-Peladic S., Spedicato M.T., Tursi A. (2002) - Global population characteristics of two decapod crustaceans of commercial interest (*Nephrops norvegicus* and *Parapenaeus longirostris*) along the European Mediterranean coasts. *Scientia Marina*, 66 (Suppl. 2): 125-141.

Accadia, P. and Spagnolo, M. 2006. A bio-economic simulation model for the Italian fisheries, Proceedings of the Thirteenth Biennial Conference of the International Institute of Fisheries Economics & Trade (IIFET), July 11-14, 2006, Portsmouth, UK. The International Institute of Fisheries Economics & Trade, Corvallis, Oregon, 2006. ISBN 0-9763432-3-1. CD-ROM Format.

AdriaMed 2000. Priority topics related to shared demersal fishery resources of the Adriatic Sea. Report of the first meeting of the AdriaMed Working Group on shared demersal resources. FAO-MiPAF Scientific Cooperation to Support Responsible Fisheries in the Adriatic Sea. GCP/RER/010/ITA/TD-02: 21 pp.

Aldebert, Y., L. Recasens & J. Lleonart, 1993. Analysis of gear interactions in a hake fishery: The case of the Gulf of Lions (NW Mediterranean). Sci. Mar., 57(2 3):207 217

Alheit J., Pitcher J., 1995. Hake. Fisheries, Ecology and Markets. Fish and Fisheries Series 15. Chapman and Hall, London.

Andaloro F., 1996. Recupero dello scarto nella pesca a strascico e dei residui di lavorazione dell' industria di trasformazione dei prodotti ittici. Regione siciliana (L. 28/96), 1-25 pp.

Andaloro F., Arena P., Prestipino Giarritta S., 1985. Contribution to the knowledge of the age, growth and feeding of hake *Merluccius merluccius* (L. 1758) in the Sicilian Channel. FAO Fish. Rep., 336: 93-97.

Andreoli M. G., Campanella N., Cannizzaro L., Garofalo G., Giusto G. B., Jereb P., Levi D., Norrito G., Ragonese S., Rizzo P., Sinacori G., 1995. Sampling statistics of Southern Sicily trawl fisheries (MINIPESTAT): data report. NTR-ITPP Special publication 4, (vol.II).

Anonymous, 2000. Analysis of trawls' discard operation in the central and eastern Mediterranean Sea. Commission of the European Communities. Directorate-General for Fisheries XIV. Contract No 97/0044. Final Report.

Ardizzone (resp) (1999) – Valutazione delle risorse demersali dall'isola di Giannutri alla foce del Garigliano. Ministero per le Politiche Agricole, Final Report.

Ardizzone G. D., 1998. Un tentativo di valutazione delle condizioni di *Merluccius merluccius* e Mullus barbatus nei mari italiani. Biol. Mar. Medit., 5(2): 151-168.

Ardizzone G. D., Corsi F., 1997. Atlas of Italian Demersal Fishery Resources. Biol. Mar. Medit., 4: 568 pp.

Ardizzone G.D., Gravina M.F., Belluscio A., Schintu P., 1990. Depth-size distribution pattern of *Parapenaeus longirostris* (Lucas, 1846) (Decapoda) in the central Mediterranean Sea. Journal of Crustacean Biology, 10(1): 139-147.

Ardizzone G.D., S. Agnesi; Biagi F., Baino O R., Corsi F.,2000 – Geographical Information Systems and Surplus Production Models: A new model for spatial assessment of demersal resources, In Actes de colloques Demersal resources in the Mediterranean, IFREMER (26): 97-111.

Arneri E., Jukic S., 1986. Some preliminary observations on the biology and dynamics of *Mullus barbatus* in the Adriatic Sea. FAO Fisheries Report, 345: 79-86.

Artegiani A., Bregant D., Paschini E., Pinardi N., Raicich F., Russo A. 1997. The Adriatic Sea general circulation. Part II. Baroclinic circulation structure. J. Phys. Oceanogr., 27: 1515–1532.

Barange M. (ed.), 2001. Report of the first meeting of the SPACC/IOC study group on the "Use of environmental indices in the management of pelagic fish populations", 3-5 September 2001, Cape Town, South Africa. GLOBEC Special Contribution, 5, 122 pp.

Barange M., Bernal M., Cercole M.C., Cubillos L.A., Cunningham C.L., Daskalov G.M., De Oliveira J.A.A., Dickey-Collas M., Gaughan D., Hill K., Jacobson L.D., Köster F.W., Massè J., Nishida H., Ñiquen M., Oozeki Y., Palomera I., Saccardo S.A., Santojanni A., Serra R., Somarakis S., Stratoudakis Y., van der Lingen C.D., Uriarte A., Yatsu A. Current trends in the assessment and management of small pelagic fish stocks. Chapter 10, in: Checkley D.M. Jr, Roy C., Oozeki Y., Alheit J. (editors), Climate change and small pelagic fish. Cambridge University Press, in press.

Bartolino V., Colloca F., Sartor P., Ardizzone G., 2008b. Modelling recruitment dynamics of hake, *Merluccius merluccius*, in the central Mediterranean in relation to key environmental variables. Fisheries Research, 92: 277-288.

Bartolino V., Ottavi A., Colloca F., Ardizzone G.D., Stefánsson G. 2008a. Bathymetric preferences of juvenile European hake (*Merluccius merluccius*). ICES J. Mar. Sci. 65: 963-969.

Belcari P., Ligas A., Viva C., 2006. Age determination and growth of juveniles of the European hake, *Merluccius merluccius* (L., 1758), in the northern Tyrrhenian Sea (NW Mediterranean). Fisheries Research., 78: 211-217

Bellido J.M., Brown A.M., Valavanis V.D., Giraldez A., Pierce G.J., Iglesias M., Palialexis A., 2008. Identifying essential fish habitat for small pelagic species in Spanish Mediterranean waters. Hydrobiologia, 612:171–184

Bertrand J.A., Gil de Sola L., Papaconstantinou C., Relini G., Souplet A., 2002. The general specifications of the MEDITS surveys. Sci. Mar., 66 (Suppl. 2): 9-17.

Beverton R.J., Holt S.J., 1957. On the dynamics of exploited fish populations. Fish. Invest. Ser. 2, Vol.19.

Biagi F., Cesarini A., Sbrana M., Viva C., 1995. Reproductive biology and fecundity of *Merluccius merluccius* (Linnaeus, 1758) in the Northern Tyrrhenian Sea. Rapp. Comm. int. Mer Médit., 34: 23.

Biagi F., De Ranieri S., Mori M. (1990) - Reproductive biology of the females of *Nephrops norvegicus* in the northern Tyrrhenian Sea. *Rapp. Comm. int. Mer Médit*., 32(1): 33.

Biagi F., De Ranieri S., Mori M. (1990) - Size at sexual maturity for males of *Nephrops norvegicus* (L.) in the northern Tyrrhenian Sea. *Rapp. Comm. int. Mer Médit*., 32(1): 32.

Biagi F., De Ranieri S., Mori M. (1990) - Relative growth of the crusher propodite of *Nephrops norvegicus* (L.) in the northern Tyrrhenian Sea. *Rapp. Comm. int. Mer Médit*., 32(1): 33.

Biagi F., Sartor P., Ardizzone G.D., Belcari P., Belluscio A., Serena F., 2002. Analysis of demersal fish assemblages of the Tuscany and Latium coasts (north-western Mediterranean). Scientia Marina, 66 (Supp. 2): 233-242.

Biagi F., Sbrana M., Mori M. (1999) - Valutazione dello stato di sfruttamento di *Nephrops norvegicus* (Crustacea; Decapoda) nel Mar Tirreno Settentrionale. *Biol. Mar. Medit*., 6(1): 529-533.

Bini G. 1968-70. Atlante dei pesci delle coste italiane. 1-10. Mondo Sommerso Roma.

Bouaziz A., Bennoui A., Djabali F., Maurin C., 1998. Reproduction du merlu *Merluccius merluccius* (Linnaeus, 1758) dans la région de Bou-Ismaïl. Cah. Options Medit., 35: 109-117.

Bouhlel M., 1973. Le merlu de côtes nord de la Tunisie: Etude économique et biologique (reproduction, sex ratio et répartition bathymétrique). Bull. Inst. Océanogr. Pêche Salammbô, 2: 579-603.

Branch T.A., Kirkwood G.P., Nicholson S.A., Lawlor B., Zara S.J., 2000. Yield version 1.0, MRAG Ltd, London, U.K.

Brian C. Battaile and Terrance J. Quinn II, 2004. Catch per unit effort standardization of the eastern Bering Sea walleye pollock (*Theragra chalcogramma*) fleet. Fish. Res., 70 (2-3): 161-177.

Caddy J. F., and Abella A. J., 1999. Reconstructing reciprocal M vectors from length cohort analysis (LCA) of commercial size frequencies of hake, and fine mesh trawl surveys over the same grounds. Fish. Res. 41: 169-175

Caddy J. F., Csirke J., 1983. Approximations to sustainable yield for exploited and unexploited stocks. Ocean. Trop. 18 (1): 3-15.

Caddy J.F., 1991. Death rates and time intervals: is there an alternative to the constant natural mortality axiom? Reviews in Fish Biology and Fisheries, 1: 109-138.

Cadima, E.L. 2003. Fish stock assessment manual. FAO Fisheries Technical Paper. No. 393. Rome, FAO. 2003. 161p.

Camilleri M., Drago A., Fiorentino F., Garofalo G., Gristina M., Bahri T., Massa F., (in press). Spatial pattern of fisheries demersal resources, environmental factors and fishery activities in GSA 15. Pilot study. MedSudMed GCP/RER/010/ITA.

Camilleri M., Drago A., Fiorentino F., Garofalo G., Gristina M., Fortibuoni T., Massa F., Coppola S., Bahri T., Giacalone V. (in press). Pilot Study: Spatial pattern of fisheries resources, environmental factors and fishery activities in GSA 15. GCP/RER/010/ITA/MSM-TD. MedSudMed Technical Documents.

Campbell, R.A., 2004. CPUE standardisation and the construction of indices of stock abundance in a spatially varying fishery using general linear models. Fish. Res. 70, 209–227.

Campillo A., Y. Aldebert, J.L. Bigot, B. Liorzou, C. Carries, P.Y. Dremiere, J.Duclerc, H.Farrugio, G. Le Corre, 1989 : Données sur la distribution des principales especes commerciales du golfe du lion (et plus particulièrement des groupes O et 1) Contrat CEE DG XIV n° 88/121 08501TF. Rapp.IFREMER DRV-89.041-RH/SETE : 137 p.

Cannizzaro L., Alagna A., Andreoli M.G., Gianformaggio N., 1991. Relazione taglia-peso per alcuni pesci del Canale di Sicilia. NTR-ITPP, 39: 33 pp.

Carbonara P., Silecchia T., Zupa R., Spedicato M.T. 2006. Maturità e fecondità dello scampo *Nephrops norvegicus* (Linnaeus, 1758) nel Tirreno centro-meridionale. Biol. Mar. Med. 13 (1): 827-830.

Carlucci R., Lembo G., P. Maiorano, F. Capezzuto, C.A. Marano, L. Sion, M.T. Spedicato, N. Ungaro, A., Tursi, G. D'Onghia, 2009. Nursery areas of red mullet (*Mullus barbatus*), hake (*Merluccius merluccius*) and deep-water rose shrimp (*Parapenaeus longirostris*) in the Eastern-Central Mediterranean Sea. Estuarine, Coastal and Shelf Science, 83: 529-538.

Carpentieri P., Colloca F., Ardizzone G.D., 2008. Daily ration and feeding activity of juvenile hake in the central Mediterranean Sea. J. Mar. Biol. Ass. U.K., 88 (7): 1493-1501.

Carpentieri P., Colloca F., Cardinale M., Belluscio A., Ardizzone G.D., 2005. Feeding habits of European hake (*Merluccius merluccius*) in the central Mediterranean Sea. Fisheries Bulletin US, 103 (2): 411-416.

Cau A., Carbonell A., Cristina Follesa M., Mannini A., Norrito G., Orsi-Relini L. Politou C.-Y., Ragonese S., Rinelli P. (2002). MEDITS-based information on the deep-water red shrimps *Aristaeomorpha foliacea* and *Aristeus antennatus* (Crustacea: Decapoda: Aristeidae). Sci. Mar. 66 (Suppl. 2): 103-124.

Chen S., Watanabe S., 1989. Age Dependence of Natural Mortality Coefficient in Fish Population Dynamics. Nippon Suisan Gakkaishi, 55(2): 205-208.

Cingolani N., Giannetti G., Arneri E., 1996. Anchovy fisheries in the Adriatic Sea. Scientia Marina, 60(Suppl.2): 269-277.

CNR-IAMC (2009). Programma Nazionale Italiano per la raccolta di dati alieutici 2008. Modulo I - “Altri campionamenti biologici risorse demersali e piccoli pelagici” - GSA 16 (Stretto di Sicilia): relazione finale, IAMC-CNR, Mazara del Vallo (TP), Italia, 79 pp.

CNR-IAMC, 2007. Programma nazionale Italiano per la raccolta di dati alieutici. Modulo “Altri campionamenti biologici”- Risorse demersali - Unità Gestionale 16 (Stretto di Sicilia): rapporto finale, CNR-IAMC, Mazara del Vallo (TP), Italia: 46 pp.

Cochran,W. G., 1953. Sampling techniques. John Wiley & Sons Inc. New York: 1-330.

COISPA Tecnologia e Ricerca, 2003

Coll M., Santojanni A., Palomera I., Tudela S., Arneri E., 2007. An ecological model of the Northern and Central Adriatic Sea: Analysis of ecosystem structure and fishing impacts. Journal of Marine Systems, 67: 119-154.

Colloca F., 1999. *Merluccius merluccius*. In Relini G., J. A. Bertrand & A. Zamboni (eds), Synthesis of Knowledge on Bottom Fishery Resources in Central Mediterranean (Italy and Corsica). Biol. Mar. Medit., 6 (1): 259-270.

Colloca F., Belluscio A., Ardizzone G.D., 2000. Sforzo di pesca, catture e gestione dello stock di nasello (*Merluccius merluccius*) in un’area del Tirreno centrale. Biol. Mar. Med 7(1): 117-129.

Colloca F., Cardinale M., Belluscio A., Ardizzone G., 2003. Pattern of distribution and diversity of demersal assemblages in the Central Mediterranean Sea. Estuarine, Coastal and Shelf Science, 56: 469-480.

Colloca F., Carpentieri P., Balestri E., Ardizzone G.D., 2004. A critical habitat for Mediterranean fish resources: shelf-break areas with *Leptometra phalangium* (Echinodermata: Crinoidea). Marine Biology, 145: 1129-1142.

Colloca F., Maiorano L., Carpentieri P., Baino R., Belluscio A., Mannini A., Sartor P., Serena F., Ardizzone G.D.. 2006a. Identification of Essential Fish Habitat in the GSA 9 for hake (*Merluccius merluccius*) and deep water pink shrimp (*Parapenaeus longirostris*) EU STECF-SGRMED Meeting on Sensitive and Essential Fish Habitat in the Mediterranean Sea (Rome, March 2006), internal document, 18 pp.

Colloca F., Maiorano L., Carpentieri P., Baino R., Mannini A., Sartor P., Belluscio A., Corsi F., Ardizzone G.D., 2006b. Hake abundance and nurseries in the Tyrrhenian Sea (GSA 9): from 1985 to 2003. Biol. Mar. Med., 13: 219-222.

Colloca, F., V. Bartolino, G. Jona Lasinio L. Maiorano, P. Sartor and G. Ardizzone.- 2009. Identifying fish nurseries using density and persistence measures. Mar Ecol Prog Ser. 381: 287–296

Council Conclusions 2007. Communication from the Commission (COM(2006)360 final) Implementing sustainability in EU fisheries through maximum sustainable yield, 2841st AGRICULTURE and FISHERIES Council meeting Brussels, 17 December 2007, http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/agricult/97717.pdf

Darby C.D., 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.

Darnaude A.M. 2005. Fish ecology and terrestrial carbon use in coastal areas: implications for marine fish production. J. Anim. Ecol., 74: 864–876.

Davison AC, Hinkley DV (1997) Bootstrap Methods and their Applications, Cambridge University Press, New York.

De Pontual, H., Bertignac, M., Battaglia, A., Bavouzet, G., Moguedet, P., Groison, A.L., 2003. A pilot tagging experiment on European hake (*Merluccius merluccius*): methodology and preliminary results. ICES J. Mar. Sci., 60: 1318-1327.

De Ranieri S. (ed) (1999) - Valutazione delle risorse demersali dall'Isola d'Elba all'Isola di Giannutri – Ministero per le Politiche Agricole, Final Report.

De Ranieri S., 2007. Programma Nazionale Raccolta Dati Alieutici. MODULO: SCARTI 2006 (solo strascico). Final report.

De Ranieri S., Belcari P., Bertolini D., Biagi F., Chiericoni V., Cognetti A.G., Mori M., Nannini N., Reale B., Rocca V., Sartor P., Sbrana M. (1996). - Valutazione delle risorse demersali dall'Isola d'Elba all'Isola di Giannutri nel periodo 1994-1996 – Ministero per le Politiche Agricole, Final Report.

De Ranieri S., Belcari P., Bertolini D., Biagi F., Chiericoni V., Cognetti A.G., Mori M., Nannini N., Reale B., Rocca V., Sartor P., Sbrana M., 1997. Reclutamento di alcune specie ittiche demersali nel Mar Tirreno Settentrionale. Biol. Mar. Medit., 4(1): 237-243.

Demestre M., Sbrana M., Alvarez F., Sánchez P., 1997. Analysis of the interaction of fishing gear in *Mullus barbatus* fisheries of the Western Mediterranean. J. Appl. Ichthyol., 13: 49-56.

Di Crescenzo D. (1990) – Biologia e dinamica di popolazione di *Nephrops norvegicus* (Crustacea; Decapoda) nel Tirreno Centrale. Tesi di Laurea, Università di Roma La Sapienza.

Domenichetti F., Bolognini L., Celic I., Fabi G., Giovanardi O., Grati F., Polidori P., Raicevich S., Scarcella G. Submitted. Relazione di alcuni parametri ambientali e abbondanza dei giovanili di *Solea solea* (Linneo, 1758) in un'area di nursery in Adriatico centro-settentrionale. Biol. Mar. Medit.

Elith, J., C. H. Graham, R. P. Anderson, M. Dudık, S. Ferrier, A. Guisan, R. J. Hijmans, F. Huettmann, J. R. Leathwick, A. Lehmann, J. Li, L. G. Lohmann, B. A. Loiselle, G. Manion, C. Moritz, M. Nakamura, Y. Nakazawa, J. Mc C.Overton, A. T. Peterson, S. J. Phillips, K. S. Richardson, R. Scachetti-Pereira, R. E. Schapire, J. Soberon, S. Williams,M. S. Wisz & N. E. Zimmermann, 2006. Novel methods improve prediction of species' distributions from occurrence data. Ecography 29: 129–151.

Fabi G., Giovanardi O., Grati F., Isajlovič I., Pehar D., Polidori P., Raicevich S., Scarcella G., Vrgoč N. 2008. Assessment of Common Sole (*Solea vulgaris*) from GSA 17 - Northern Adriatic. Report of the SAC 10th Meeting of the Sub-Committee on Stock Assessment (SCSA) Working Group on Demersals, Izmir (Turkey), 15-19 September 2008: 15-16.

Fabi G., Grati F., Raicevich S., Santojanni A., Scarcella G. 2009. Valutazione dello stock di *Solea solea* del medio e alto Adriatico e dell'incidenza di diverse attività di pesca. Relazione finale. Ministero per le Politiche Agricole e Forestali. Direzione generale della pesca e dell'acquacoltura. VI Piano Triennale della pesca marittima e acquacoltura in acque marine e salmastre (tematica c – c6). Programma di ricerca 6-a-74. 133 – XVII pp.

Fabi G., Grati F., Sbrana M. 2002a. Attrezzi della piccola pesca utilizzati in funzione della successione stagionale e dell'eco-etologia delle specie ittiche in due aree costiere Tirreno settentrionale e medio Adriatico). Rapporto finale per il Ministero delle Politiche Agricole e Forestali, Direzione Generale della Pesca e dell'Acquacoltura. 159 pp.

Fabi G., Sartor P. 2002b. Study on the mixed species of the rapido trawl fishery along the Italian Coasts. Study contract n. 99/051. Final Report for the Commission of the European Communities, DG XIV. 124 pp.

Ferretti M., Froglia C. 1975. Results of selectivity experiments, made with different trawls, on more important Adriatic demersal fish. Quad. Lab. Tec. Pes., 2 (1): 3-16.

Fiorentino F., Badalamenti F., D'Anna G., Garofano G., Gianguzza P., Gristina M., Pipitone C., Rizzo P., Fortibuoni T., 2008. Changes in spawning-stock structure and recruitment pattern of red mullet, *Mullus barbatus*, after a trawl ban in the Gulf of Castellammare (central Mediterranean Sea). ICES Journal of Marine Science, 65: 1175-1183.

Fiorentino F., Bono G., Garofalo G., Gristina M., Ragonese S., Gancitano S., Giusto G.B., Rizzo P., Sinacori G., 2003a. A further contribution on stock's status and fisheries of main demersal resources in the Strait of Sicily: ED/TN/FF-GB-GG-MG-SR-SG-GBG-PR-GS/4/0303/DRAFT.

Fiorentino F., Gancitano S., Giusto G. B., Rizzo P., 2003b. Assessing longevity of gadoids in the Strait of Sicily on the basis of otolith microstructure. Biol. Mar. Medit., 10 (2): 814-818.

Fiorentino F., Garofalo G., Fortibuoni T., Bahri T., Camilleri M., Drago A., Gristina M., Massa F., 2006. Delineating habitats used by different life phases of hake in the Strait of Sicily. Commission staff working paper presented at STECF-SGRMED meeting on sensitive and essential fish habitats in the Mediterranean sea (Rome, March 2006): 203-234.

Fiorentino F., Mazzola S., Garofalo G., Patti B., Gristina M., Bonanno A., Massi D., Basilone G., Cuttitta A., Giusto G.B., Gancitano S., Sinacori G., Rizzo P., Levi D., Ragonese S., 2005. Lo stato delle risorse demersali e dei piccoli pelagici e le prospettive di pesca "sostenibile" nello Stretto di Sicilia. Convenzione con Assessorato Regione Siciliana Cooperazione, Commercio, Artigianato e Pesca, Mazara del Vallo, Italia. ID/TN/FF-SM-GG-BP-MG-AB-DM-GB-AC-GBG-SG-GS-PR-DL-SR/8/0305/rel.1: 136 pp

Fiorentino, F., G. Garofalo, A. De Santi, G. Bono, G. B. Giusto & G. Norrito.- 2003. Spatio-temporal distribution of recruits (0 group) of *Merluccius merluccius* and *Phycis blennoides* (Pisces, Gadiformes) in the Strait of Sicily (Central Mediterranean). Hydrobiologia 503: 223–236.

Fiorentino, F., G. Garofalo, T. Fortibuoni, T. Bahri, M. Camilleri, A. Drago, M. Gristina and F. Massa.- 2006. Delineating habitats used by different life phases of hake in the Strait of Sicily. Abstract in SCSA.- 2006. Report of the Sub-Committee on Stock Assessment (SCSA) SAC GFCM. Rome, Italy, 11-14 September, 2006. 56 pp. Doc 38.

Fisher W., Schneider M., Bauchot M.L. 1987. Fishes FAO d'identification des espèces pour les besoins de la pêche. Mediterranée et mer Noire. Vol. I – II., Rome, FAO. 1-2: 760 p.

Froglia C., Giannetti G. 1985. Growth of common sole *Solea vulgaris* Quensel in the Adriatic Sea. Rapp. Comm. int. Mer Medit., 29 (8): 91-93.

Froglia C., Giannetti G. 1986. Remarks on rings formation in otoliths of *Solea vulgaris* and other flatfishes from the Adriatic Sea. FAO Fish. Rep., 345: 121-122.

Froglia, C. and M.E. Gramitto.- 1987. An estimate of growth and mortality parameters for Norway lobster (*Nephrops norvegicus*) in the central Adriatic Sea. *FAO Fish.Rep.*, 394: 189-204.

Gancitano V., Cusumano S., Giusto G.B, Garofalo G., Ingrande G., Sabatella E., Ragonese S., Fiorentino F. (2008). Valutazione dello stato di sfruttamento del gambero rosso *Aristaeomorpha foliacea* (Risso, 1827) (Crustacea; Decapode) nello Stretto di Sicilia. Biol. Mar. Medit., 15(1): 326-327.

García-Rodríguez M., Esteban A. 2002. How fast hake grows? A study on the Mediterranean hake (*Merluccius merluccius*, L.) comparing whole otoliths readings and length frequency distributions data. Scientia Marina, 66: 145–156.

Garofalo G., Giusto G. B., Cusumano S., Ingrande G., Sinacori G., Gristina M., Fiorentino F. (2007). Sulla cattura per unità di sforzo della pesca a gamberi rossi sui fondi batiali del mediterraneo orientale. Biol. Mar. Medit., 14(2): 250-251.

Garofalo, G., Fiorentino, F., Bono, G., Gancitano S., Norrito, G., 2004. Localisation of spawning and nursery areas of red mullet (*Mullus barbatus*, Linnaeus) in the Italian side of the Strait of Sicily (Central Mediterranean). p. 101-110. GIS/Spatial analyses in Fishery and Aquatic Sciences, edited by T.Nishida, P.J.Kailola and C.E. Hollingworth, Proceedings of the Second International Symposium on GIS/Spatial Analyses in Fishery and Aquatic Sciences, University of Sussex, Brighton, UK, 3-6 September 2002.

Gayanilo F.C. Jr., Sparre P., Pauly D. (2005). Food and Agriculture Organization of the United Nations. Fisat II (version 1.2.2) Roma, 2005.

GFCM 2008a. Report of the ninth session of the sub-committee on marine environment and ecosystems (SCMEE).Antalya, Turkey, 13–16 October 2008

GFCM 2008b. Report of the eleventh session of the Scientific Advisory Committee. Marrakech, Morocco, 1 - 5 December 2008/

GFCM 2009. Report of the thirty-third session. Tunis, 23-27 March, 2009.

Ghirardelli E. 1959. Contribution à l'étude de la biologie des soles (*Solea solea*) en moyenne Adriatique. Proc. gen. Fish. Coun. Medit., 5: 481-487.

Giannoulaki M., Machias A., Somarakis S., Tsagarakis K., Laurinjen J., Siapatis A., Petrakis G., Tserpes G., Papaconstantinou K., Schismenou E., Nikolioudakis N., Kallianiotis A., Argiri, A., Vidoris P., 2008b. Improvement of in year management of small pelagic fish in Aegean Sea. Contract No FISH/2004/03. Final report to EU 121p.

Giannoulaki M., Machias A., Somarakis S., Tsimenides, N., 2004. The spatial distribution of anchovy and sardine in the northern Aegean Sea in relation to hydrographic regimes. Belgian Journal of Zoology, 134 (Supplement 1): 43-48.

Giannoulaki M., Machias A., Valavanis V., Somarakis S., Palialexis A., Tsagarakis K., Papaconstantinou C., 2007. Spatial modeling of the European sardine habitat in the Eastern Mediterranean basin using GAMs and GIS tools. Proceedings of the 38th CIESM Congress, Istanbul (Turkey), April 2007, p. 486.

Giannoulaki M., Somarakis S., Machias A., Kalianiotis A., Tserpes G., Petrakis G., Papaconstantinou C. 2007. Preliminary results from stock assessment of the Aegean Sea anchovy stock by Integrated Catch at age analysis. GFCM, SAC, Sub-Committee for Stock Assessment, Working Group on Small Pelagic Species, Athens, 11-14 September 2007.

Giannoulaki M., Valavanis V., Palialexis A., Tsagarakis K., Machias A., Somarakis S., Papaconstantinou K., 2008a. Modelling the presence of anchovy *Engraulis encrasicolus* in the Aegean Sea during early summer, based on satellite environmental data. Hydrobiologia, 612: 225-240.

Gil de Sola, L.- 2006. Main demersal hake (M. merluccius) nursery areas along the Spanish Mediterranean Coast. Internal Rapport, MEDITS results. IEO Spain

Gramolini R., Mannini P., Milone N., Zeuli V. 2005. AdriaMed Trawl Survey Information System (ATrIS): User manual. FAO-MiPAF Scientific Cooperation to support Responsible Fisheries in the Adriatic Sea. GCP/RER/010/ITA/TD-17

Guarniero I., Franzellitti S., Ungaro N., Tommassini S., Piccinetti C., Tinti F. 2002. Control region haplotype variation in the central Mediterranean common sole indicates geographical isolation and population structuring in Italian stocks. J. Fish Biol.**,** 60(6): 1459-1474.

Guisan, A. & N. E. Zimmermann, 2000. Predictive habitat distribution models in ecology. Ecological Modelling 135: 147–186.

Hastie, T., Tibshirani, R., 1990. Generalized Additive Models. Chapman & Hall, London.

Hewitt D.A., Hoenig J.M., 2005. Comparison of two approaches for estimating natural mortality based on longevity. Fishery Bulletin, 103: 433-437.

Hinz H., Kröncke I., Ehrich S. 200). The feeding strategy of dab *Limanda limanda* in the southern North Sea: linking stomach contents to prey availability in the environment. J. Fish Biol.**,** 67(B): 125-145.

Hoenig J.M. 1983. Empirical use of longevity data to estimate mortality rates. Fishery Bulletin, 82: 898-903.

Hoggarth D. D., Abeyasekera S., Arthur R. I., Beddington J. R., Burn R. W., Halls A. S., Kirkwood G. P., McAllister M., Medley P., Mees C. C., Parkes G. B., Pilling G. M., Wakeford R. C., Welcomme R. L., 2006. Stock assessment for fishery management- A framework guide to the stock assessment tools of the fisheries management sciences Programme (FMSP). Fao Fish. Tech. Pap. No 487, 261p.

ICES 2006. Report of the working group on acoustic and egg surveys for sardine and anchovy in ICES areas VII and IX (WGACEGG), ICES CM 2006/LRC:18.

ICES 2008. Workshop on herring management plans (WKHMP). ICES CM 2008, ACOM:27.

Jacobson L.D., De Oliveira J.A.A., Barange M., Cisneros-Mata M.A., Félix-Uraga R., Hunter J.R., Kim J.Y., Matsuura Y., Ñiquen M., Porteiro C., Rothschild B., Sanchez R.P., Serra R., Uriarte A., Wada T., 2001. Surplus production, variability, and climate change in the great sardine and anchovy fisheries. Canadian Journal of Fisheries and Aquatic Science, 58(9): 1891-1903.

Jardas I. 1996. Jadranska ihtiofauna. Školska knjiga, Zagreb (Croatia). 536 pp.

Jensen A.L., 1996. Beverton and Holt life history invariants result from optimal trade-off of reproduction and survival. Canadian Journal of Fisheries and Aquatic Science, 53: 820-822.

Jensen A.L., 2001. Comparison of theoretical derivations, simple linear regressions, multiple linear regression and principal components for analysis of fish mortality, growth and environmental temperature data. Environmetrics, 12: 591-598.

Johannesson, K.A. and Mitson, R.B. (1983). Fisheries Acoustics - FAO Fisheries Technical Paper N.240:249pp.

Jona Lasinio G., Colloca F., Maiorano L., Bartolino V., Abella A., Mannini A., Sartor P., Belcari P., Relini G., Ardizzone G., 2007. A geostatistical approach for the identification of MPAs for fishery management in the central Mediterranean Sea. European Symposium on MPAs as a tool for fisheries management & ecosystem conservation. Murcia 25-28 September 2007.

Kallianotis, A. and Mazzola, S. (2002). Final report of EC-DG XIV study project “Study on purse seine activity in Eastern and Central Mediterranean” (MED 99-035).

Karlou-Riga, C. 2002. Juvenile concentrations in the Saronikos Gulf and the Cyclades islands (Central Aegean Sea). Scientific Advisory Committee GFCM. 21 pp. Sub-Committee of Stock Assessment. Working Group on Small Pelagics. Rome, Italy. 20-22 March 2002.

Karlou-Riga, C. and I. Varkitzi 2002. Spatial and seasonal juvenile concentrations in the Saronikos Gulf and the Cyclades islands (Central Aegean Sea). Scientific Advisory Committee GFCM. 21 pp. S Working Document N°4 to the G.F.C.M. SAC Working Group on the Assessment of Demersal stocks. Rome 20-22 March 2002.

Kell L. T., Pastoors M., Scott R., Smith M., Van Beek F., O’Brien C. M., Pilling G. M. 2005. Evaluation of multiple management objectives for Northeast Atlantic flatfish stocks: sustainability vs. stability of yield. ICES J. Mar. Sci., 62: 1104–1117.

Kell, L.T. and J.-M. Fromentin. – 2007. Evaluation of the robustness of maximum sustainable yield based management strategies to variations in carrying capacity or migration pattern of Atlantic bluefin tuna (*Thunnus thynnus*). Can. J. Fish. Aquat., 64: 837-847

Kirkwood G.P., Aukland R., Zara S.J., (2001). Length Frequency Distribution Analysis (LFDA), version 5.0. MRAG Ltd, London, U.K.

Knittweis L. and Dimech M,. 2009. Unpublished internal report, Malta Centre for Fisheries Science).

Lagardère J.P. 1987. Feeding ecology and daily food consumption of common sole, *Solea vulgaris* Quensel, juveniles on the French Atlantic coast. J. Fish Biol.**,** 30: 91-104.

Lembo G., Carbonara P., Silecchia T., Spedicato M.T., 2002. Prove di pesca a strascico con rete a doppio sacco per la valutazione della selettività dell'attrezzo e della qualità del prodotto. I quaderni scientifici della Lega Pesca, Roma: 1-47.

Lembo G., Silecchia T., Carbonara P., Contegiacomo M., Spedicato M.T. (2000a) – Localization of nursery areas of *Parapenaeus longirostris* (Lucas, 1846) in the Central-Southern Tyrrhenian Sea by Geostatistics. Crustaceana, 73 (1): 39-51.

Lembo G., Silecchia T., Carbonara P., Spedicato M.T., 2000b. Nursery areas of *Merluccius merluccius* in the Italian Seas and in the East Side of the Adriatic Sea. Biol. Mar. Medit., 7 (3): 98-116.

Lembo G., Spedicato M.T., D'Agostino V., 1998a. Distribuzione spazio-temporale dei rendimenti orari del nasello (*Merluccius merluccius*, L. 1758) mediante tecniche di co-regionalizzazione. Biol. Mar. Medit., 5 (2): 117-127.

Lembo G., Spedicato M.T., Silecchia T., D'Agostino V., 1998b. Distribution of nursery areas of *Merluccius merluccius* obtained by geostatistical techniques. Cah. Options Méditerr., 35: 147-154.

Lembo, G. Valutazione delle Risorse Demersali: Gruppo Metodologie Statistiche

Lembo, G., Abella, A., Fiorentino, F., Martino, S. and Spedicato, M. T. 2009. ALADYM: an age and length-based single species simulator for exploring alternative management strategies. Aquatic Living Resources, vol (22).

Levi D., 1991. Recruitment calendar and fishing ban: the case of the Sicilian Channel. Oebalia, 17 (ns): 237-257.

Levi D., Andreoli M.G., Arneri E., Giannetti G., Rizzo P., 1994. Otolith reading as a tool for stock identification. Fish. Res., 20: 97-107.

Levi D., Patti B., Rizzo P., Lo Brutto S., Parrinello N., Arculeo M., 2004. Genetic and morphometric variations of Mediterranean hake, *Merluccius merluccius*, in the Strait of Sicily (central Mediterranean): implications for stock assessment of shared resources. Italian Journal of Zoology, 71 (2):165-170.

Lleonart J., Salat J., 1997. VIT: Software for fishery analysis. User's manual. FAO Computerised Information Series. Fisheries, 11: 107 p.

Lleonart J., Salat J., 2000. Vit4winVersion 1.1.www.faocopemed.org/es/activ/infodif.htm

Lleonart, J. 2001. Impact of fishery and environment on hake recruitment in Northwestern Mediterranean. EU Contract FAIR CT-97-3522 (1998-2000). Final report. 680 pp. (mimeo)

Lleonart, J., Maynou, F., Recasens,L. 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.]

Lo Brutto S., Arculeo M., Mauro A., Scalisi M., Cammarata M., Parrinello N., 1998. Allozymic variation in Mediterranean hake *Merluccius merluccius* (Gadidae). Ital. J. Zool., 65: 49-52.

Lo, N.C., Jacobson, L.D., Squire, J.L., 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49, 2515-2526.

MacArthur R.H., Pianka E. R. 1966. On the optimal use of a patchy environment. Am. Nat., 100: 603-606.

Machias A., Giannoulaki M., Somarakis S., Schismenou E., Tsagarakis K., Siapatis A., Stamataki C., Vassilopoulou V., Kalianiotis A., Papaconstantinou C., 2007. Acoustic Biomass estimates of sardine in the Aegean Sea (June 2003, 2004, 2005 and 2006) GFCM SAC, Sub-Committee for Stock Assessment, Working Group on Small Pelagic Species, Athens, 11-14 September 2007

Machias A., Somarakis S., Magoulas A., Koutsikopoulos C., 2001. Evaluation of the southern Greek sardine stocks. Contract No 98/030. *Final Report* to EU 105 p.

MacLennan D., Simmonds E.J., 1992. Fisheries acoustics. Chapman & Hall, London, 325p.

MacLennan, D.N., Fernandes, P.G., and Dalen, J. (1996). A consistent approach to definitions and symbols in fisheries acoustics. ICES Journal of Marine Science, 59:365-369.

Malta Technical Report (2007). Report on national data collection programme under EC 1938 /2001, amended by EC 1581 / 2004. Malta Centre for Fisheries Science, 50pp.

Maltagliati F., Camilli L., Biagi F., Abbiati M. (1998) - Genetic structure of Norway lobster *Nephrops norvegicus* (L.) (Crustacea Nephropidae) from the Mediterranean Sea. Sci. Mar., 62(1): 91-99.

Maltagliati F., Camilli L., Biagi F., De Ranieri S., Abbiati M. 1996. Population genetics of *Nephrops norvegicus* (Crustacea: Nephropidae). Preliminary data regarding a population in the northern Tyrrhenian Sea. *Biol. Mar. Medit.*, 3(1): 479-480.

Massutí, E., F. Ordinas, N. González, A. Pérez, B. Guijarro, U. Fernández de Arcaya, V. Rubio y G. Pomar.- 2008. Informe del seguimiento científico de la acción Piloto RAI/AP-26/2007: pesca experimental con arte de arrastre de fondo en el Golfo de León (Mediterráneo noroccidental). 112 pp

Maynou, F. and F. Sardá.- 1997. *Nephrops norvegicus* population and morphometrical characteristics in relation to substrate heterogeneity. *Fish. Res*., 30: 139-149.

Maynou, F. M. Demestre, P. Sánchez, 2003. Analysis of catch per unit effort by multivariate analysis and generalised linear models for deep-water crustacean fisheries off Barcelona (NW Mediterranean). Fisheries Research 65: 257–269.

Maynou, F., J. Lleonart & J.E. Cartes, 2003. Seasonal and spatial variability of hake (*Merluccius merluccius* L.) recruitment in the NW Mediterranean. Fish.Res. 60:65-68.

Maynou, F., Sardà, F., Tudela, S. 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.

McCullagh, P., Nelder, J.A. FRS. 1991. Generalized Linear Models, 2nd ed. Monographs on Statistics and Applied Probability 37. Chapman and Hall, London.

MEDSUDMED, 2007. Spatial distribution of demersal fishery resources, environmental factors and fishing activities in GSA 15 (Malta Island). GCP/RER/010/ITA/MSM-TD-13. MedSudMed Technical Documents, 13: 103pp.

MEDSUDMED, 2008. Preliminary results on spatial distribution of abundance indices, nursery and spawning areas of Merluccius merluccius and Mullus barbatus in the central Mediterranean. GCP/RER/010/ITA/MSM-TD 19: 24pp.

Merino, G., Karlou-Riga, C., Anastopoulou, I., Maynou, F. and Lleonart, J. 2007. Bioeconomic simulation analysis of hake and red mullet fisheries in the Gulf of Saronikos (Greece). Scientia Marina, 71(3): 525-535

Mertz G., Myers R.A. ,1998. A simplified formulation for fish production. Canadian Journal of Fisheries and Aquatic Science, 55: 478–484.

Mori M., Biagi F., De Ranieri S. (1998) - Fecundity and egg loss during incubation in Norway lobster (*Nephrops norvegicus*) in the north Tyrrhenian sea. J. Nat. Hist., 32(10-11): 1641-1650.

Mori M., De Ranieri S., Biagi F. (1993) – Length-weight relationships for *Nephrops norvegicus* (L.) of the northern Tyrrhenian Sea in relation to sex, season, moult and maturity. *Atti Soc. Tosc. Sci. Nat. Mem.*, Ser. B, 100: 171-182.

Mori M., Lattes A., Biagi F. (1994) - Investigation on the relative growth of the cephalothorax, abdomen and telson of *Nephrops norvegicus* (L.). Boll. Mus. Ist. Biol. Univ. Genova, 58-59: 171-179.

Mori M., Modena M., Biagi F. (1998) – Egg number/egg dry weight: a relationship for annually monitoring the fecundity of Norway lobster. Boll. Mus. Ist. Biol. Univ. Genova 62-63: 39-45.

Mori M., Modena M., Biagi F. (2001) – Fecundity and egg volume in Norway lobster (*Nephrops norvegicus*) from different depths in the northern Tyrrhenian Sea. Sci. Mar., 65(2): 111-116.

Mori M., Sartor P., Biagi F., 2000b. Diet of adult females of *Parapenaeus longirostris* (Crustacea, Decapoda) in the northern Tyrrhenian Sea (Western Mediterranean). Atti Soc. Tosc. Sci. Nat. Mem. Serie B., 107: 7-10.

Mori M., Sbrana M., De Ranieri S., 2000a. Reproductive biology of female *Parapenaeus longirostris* (Crustacea, Decapoda, Penaeidae) in the Northern Tyrrhenian sea (Western Mediterranean). Atti Soc. tosc. Sci. nat., Mem., Serie B, 107: 1-6.

Mytilineou C., Castro M., Gancho P., Fourtouni A. 1998 Growth studies on Norway lobster, *Nephrops norvegicus* (L.), in different areas of the Mediterranean Sea and the adjacent Atlantic. *Scientia Marina, Vol 62, doi:10.3989/scimar.1998.62s143.*

Nannini N., Pinna D., Chiericoni V., Biagi F., Belcari P., 2001. Ciclo ovarico di *Merluccius merluccius* (Linnaeus, 1758) nel mar Tirreno settentrionale. Biol. Mar Medit., 8 (1): 745-748.

Needle C. L., 2003. Survey-based assessments with SURBA. Working Document to the ICES Working Group on Methods of Fish Stock Assessment, Copenhagen, 29 January to 5 February 2003.

Needle C.L., 2000. The ins and outs of ICA. Fisheries Research Services, Marine Laboratory, Aberdeen. 78p.

Nishida, T. & Chen, D. 2004. Incorporating spatial autocorrelation into the general linear model with an application to the yellowfin tuna (*Thunnus albacares*) longline CPUE data. Fish. Res., 70: 265-274.

O'Brien C.M., Pilling G.M., Brown C., 2004. Development of an estimation system for U.S. longline discard estimates. In Payne, A., O'Brien, C. and Rogers, S. (Eds). Management of shared fish stocks. Blackwell Publishing, Oxford. 384p.
Orsi Relini L., Capparena M., Fiorentini F., 1989. Spatial–temporal distribution and growth of *Merluccius merluccius* recruits in the Ligurian Sea. Observations on the 0-group. Cybium 13: 263–270.
Orsi Relini L., Papaconstantinou C., Jukic-Peladic S., Souplet A., Gil de Sola L., Piccinetti C., Kavadas S., Rossi M., 2002. Distribution of the Mediterranean hake populations (*Merluccius merluccius smiridus* Rafinesque, 1810) (Osteichthyes: Gadiforems) based on six years monitoring by trawl surveys: some implications for management. Sci. Mar. 66 (Suppl.2): 21-38.
Orsi Relini L., Relini G. (1998). Seventeen instars of adult life in female *Aristeus antennatus* (Crustacea: Decapoda: Aristeidae). A new interpretation of life span and growth. Journal of Natural History, 32: 1719-1734.
Orsi Relini L., Zamboni A., Fiorentino F., Massi D., (1998) – Reproductive patterns in Norway lobster *Nephrops norvegicus* (L.) (Crustacea Decapoda Nephropidae) of different Mediterranean areas. *Sci. Mar*., 62 (Supp. 1): 25-41.
Pagotto G., Piccinetti C., Specchi M. 1979. Premières résultats des campagnes de marquage des Soles en Adriatique: déplacements. Rapp. Comm. int. Mer Medit., 25/26: 111-112.
Patterson K., 1992. Fisheries for small pelagic species: an empirical approach to management targets. Review of Fish Biology and Fisheries, 2: 321-338.
Patterson K.R. and Melvin G.D. 1996. Integrated catch-at-age analysis version 1.2. Scottish Fisheries Research Report 56. Aberdeen: FRS.
Patterson K.R., 1998. Integrated catch-at-age analysis, v.1.4. Aberdeen, Marine Laboratory.
Patti, B., Bonanno, A., Basilone, G., Goncharov, S., Mazzola, S., Buscaino, G., Cuttitta, A., García Lafuente, J., García, A., Palombo, V. and Cosimi, G. (2004). Interannual fluctuations in acoustic biomass estimates and in landings of small pelagic fish populations in relation to hydrology in the Strait of Sicily. Chemistry and Ecology, 20(5), 365-375.
Patti, B., Venezia, S., Piazza, I., Basilone, G., Patti, C., Caruana, L. and Mazzola, S. (2007). Final Report of Project CAS.FO. "Cattura e sforzo di piccoli pelagici nel Canale di Sicilia per la gestione delle risorse pescabili". In Italian. Regolamento C.E.E. n. 1263/99 – SFOP – Misura n 4.17 – Sottomisura B.
Pauly D., 1980. On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. J. Cons. Int. Explor. Mer 39 (2): 175-192.
Pennington E., Grosslein MD., 1978.- Acuracy of abundance indices based on stratified random trawl surveys. - ICES, CH 1978 / D: 13.
Piccinetti C., Giovanardi O. 1984. Données biologiques sur *Solea vulgaris* Quensel en Adriatique. FAO, Fish. Rep., 290: 117-121.
Pilling G. M., Kell L. T., Hutton T., Bromley P. J., Tidd A. N., Bolle L. J. 2008. Can economic and biological management objectives be achieved by the use of MSY-based reference points? A North Sea plaice (*Pleuronectes platessa*) and sole (*Solea solea*) case study. – ICES J. Mar. Sci., 65: 1069–1080.
Planque, B., E. Bellier & P. Lazure, 2007. Modelling potential spawning habitat of sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*) in the Bay of Biscay. Fisheries Oceanography 16: 16–30.
Pope J. G., Shepherd J. G., 1982. A simple method for the consistent interpretation of catch-at-age data. J. Cons. Int. Explor. Mer, 40: 176–184.
Pope J., Shepherd J. G., 1985. A comparison of the performance of various methods for tuning VPAs using effort data. J. Cons. Int. Explor. Mer, 42: 129-151.
Powell D.G. 1979. Estimation of mortality and growth parameters from the length-frequency in the catch. Rapp. P.-V. Réun. CIEM, 175: 167-169.
Prager M. H., 1994. A suite of extensions to a nonequilibrium surplus-production model. Fishery Bulletin 92: 374-389.
Prager M. H., Porch C. E., Shertzer K. W., Caddy J. F., 2003. Targets and limits for management of fisheries: a simple probability-based approach. North American Journal of Fisheries Management 23: 349–361

Prellezo, R., Accadia, P., Andersen J. L, Little, A., Nielsen R., Andersen, B.S., Röckmann C., Powell J. and Buisman, E. 2009. Survey of existing bioeconomic models: Final report. Sukarrieta: AZTI-Tecnalia. 283 pages.
Ragonese S. (1989). Prima Valutazione dello stock di *Aristaeomorpha foliacea* (Crustacea, Aristeidae) del Canale di Sicilia. Nova Thalassia, 10 (suppl.1): 457-465.
Ragonese S., Andreoli M.G., Bono G., Giusto G.B., Rizzo P., Sinacori G. (2004). Overview of the available biological information on demersal resources of the Strait of Sicily. MedSudMed Technical Documents 2: 67-74.
Ragonese S., Bianchini L., Galluci V.F. (1994). Growth and mortality of the red shrimp *Aristaemorpha foliacea* in the Sicilian channel (Mediterranean Sea). Crustaceana 67, 348-361.
Ragonese S., Bianchini M. L. (1995). Size at sexual maturity in red shrimp females *Aristaeomorpha foliacea*, from the Sicilian Channel (Mediterranean Sea). *Crustaceana* , 68 (1): 73-82.
Rampa R., Arneri E., Belardinelli A., Caputo E., Cingolani N., Colella S., Donato F., Giannetti G., Santojanni A., 2005. Length at first maturity of the Adriatic anchovy (*Engraulis encrasicolus*, L.). GFCM-SAC SubCommittee on Stock Assessment (SCSA), Roma, 26-30 September 2005. 10 pp.
Reale B., Sbrana M., De Ranieri S., 1995. Population dynamics of *Merluccius merluccius* exploited by two different trawl-nets in the Northern Tyrrhenian Sea. Rapp. Comm. int. Mer Médit., 34: 254.
Reale C, Sartor P, Ligas A, Viva C, Bertolini D, De Ranieri S, Belcari P., 2005. Demersal resources assemblages on the *Leptometra phalangium* (J. Müller, 1841) (Echinodermata; Crinoidea) bottoms in the Northern Tyrrhenian Sea. Biol Mar Medit 12 (1): 571-574.
Recasens L., Chiericoni V., Belcari P., 2008. Spawning pattern and batch fecundity of the European hake (*Merluccius merluccius* (L.)) in the western Mediterranean. Scientia Marina, in press.
Relini G., 1998. Demersal trawl surveys in Italian seas: a short review. Ifremer, Actes de Colloques, 26: 46-75
Relini G., Orsi Relini L. (1987) - The decline of red shrimps stocks in the Gulf of Genoa. *Inv. Pesq.*, **51** (Supl.1): 245-260.
Relini G., Orsi Relini L., Fiorentino F., Zamboni A., Massi D., Rossi M., Mannini A., Gatto A. (1999) - Gruppo Nazionale Valutazione Risorse Demersali (Gru.N.D.) Ministero per le Politiche Agricole, Final Report.
Ricker W.E., 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Bd. Can., 191: 383 pp.
Rochet M.J., Trenkel V.M., 2003. Which community indicators can measure the impact of fishing? A review and proposals. Canadian Journal of Fisheries and Aquatic Science, 60: 86-99.
Sá R., Bexiga C., Vieira L., Veiga P., Erzini, K. 2003. Diets of the sole *Solea vulgaris* Quensel, 1806 and *Solea senegalensis* Kaup, 1858 in the lower estuary of the Guadiana River (Algarve, southern Portugal): Preliminary results. Bol. Inst. Esp. Ocean., 2003; 19 (1-4).
Sabatella E., Piccinetti C., 2004. Example of capacity assessment of a Mediterranean fishery and relevant bio-economic indicators. In AdriaMed Seminar of Fishing Capacity: definition, measurement and assessment, AdriaMed Technical Documents, 13: 27 pp.
Sala A., Lucchetti A., Piccinetti C., Ferretti M., 2008. Size selection by diamond- and square-mesh codends in multi-species Mediterranean demersal trawl fisheries. Fisheries Research, 93: 8–21.
SAMED, 2002. Stock Assessment in the MEDiterranean. European Commission – DG XIV, Project 99/047 – Draft final Report.
Santojanni A. Comments on “Is anchovy (*Engraulis encrasicolus*, L.) overfished in the Adriatic Sea?” by Klanjšček and Legović, 2007, Ecological Modelling, 201: 312-316. Ecological Modelling, in press.
Santojanni A., Arneri E., Barry C., Belardinelli A., Cingolani N., Giannetti G., Kirkwood G., 2003. Trends of anchovy (*Engraulis encrasicolus*, L.) biomass in the northern and central Adriatic Sea. Scientia Marina, 67(3): 327-340.
Santojanni A., Arneri E., Bernardini V., Cingolani N., Di Marco M., Russo A., 2006a. Effects of environmental variables on recruitment of anchovy in the Adriatic Sea. Climate Research, 31(2-3): 181-193.
Santojanni A., Cingolani N., Arneri E., Belardinelli A., Giannetti G., Colella S., Donato F., 2006b. Use of an exploitation rate threshold in the management of anchovy and sardine stocks in the Adriatic Sea. Biologia Marina Mediterranea, 13(3): 98-111.

Santojanni A., Cingolani N., Arneri E., Belardinelli A., Giannetti G., Colella S., Donato F., Russo A., 2006c. Recruitment of sardine (*Sardina pilchardus* Walbaum 1792) in the Adriatic Sea and environmental factors. Biologia Marina Mediterranea, 13(1): 158-166.
Santojanni A., Cingolani N., Arneri E., Kirkwood G., Belardinelli A., Giannetti G., Colella S., Donato F., Barry C., 2005. Stock assessment of sardine (*Sardina pilchardus*, WALB.) in the Adriatic Sea, with an estimate of discards. Scientia Marina, 69(4): 603-617.
Santojanni A., Cingolani N., Donato F., Colella S., Belardinelli A., Giannetti G., Leonori I. Sinovčić G., Marčeta B., 2008. Anchovy and sardine stock assessment in the GSA 17: 1975-2007. Meeting of the GFCM-SAC SubCommittee on Stock Assessment (SCSA), Izmir, 22-26 September 2008. 2 pp.
Sardà F., D'Onghia G., Politou C.-Y., Company J.B., Maiorano P., Kapiris K. (2004). Maximum deep-sea distribution and ecological aspects of *Aristeus antennatus* in the western and central Mediterranean Sea. Sci. Mar., 68 (3): 117-127.
Sartor P., Carlini F., De Ranieri S., 2003a. Diet of young european hake (*Merluccius merluccius*) in the northern Tyrrhenian Sea. Biol. Mar. Medit. 10 (2): 904-908.
Sartor P., Reale B., Sbrana M., Biagi F. (1998) - Analisi dello sbarcato commerciale con reti a strascico presso un porto del Mar Tirreno Settentrionale negli anni 1990-95. Biol. Mar. Medit., 5 (2): 81-91.
Sartor P., Sartini M., Reale B., Sbrana M., 2001b. Analysis of the discard practices in the *Merluccius merluccius* (l., 1758) bottom trawl fishery of the Northern Tyrrhenian Sea. Biol. Mar. Medit. 8(1): 771-774.
Sartor P., Sbrana M., Reale B., Belcari P., 2003b. Impact of the deep sea trawl fishery on demersal communities of the northern Tyrrhenian Sea- (Western Mediterranean). J. Northw. Atl. Fish. Sci., 31: 1-10.
Sartor, P., Recasens L., Viva C., Lleonart J., 2001a. Analysis of the impact of the fishery on the adult population of European hake in the Northwestern Mediterranean. Rapp. Comm. Int. Mer Médit., 36: 321-322.
Saville A., 1977. Survey methods of appraising fishery resources. FAO Fish. Tech. Pap., 171: 1-76.
Sbrana, M, Viva C., Belcari P., 2006. Fishery of the deep-water rose shrimp *Parapenaeus longirostris* (Lucas, 1846) (Crustacea: Decapoda) in the northern Tyrrhenian Sea (western Mediterranean. Hydrobiologia 557: 135-144.
Sbrana, M., P. Sartor, P. Belcari, (2003). Analysis of the factors affecting catch rates of crustaceans trawl fishery of the Northern Tyrrhenian Sea (western Mediterranean). Fisheries Research, 65: 271-284.
Schaefer M.B. 1954. Some aspects of the dynamics of populations important to the management of the commercial marine fisheries. Inter-Am. Trop. Tuna Comm. Bull. 1: 27-56.
Schismenou E., Giannoulaki M., Valavanis V.D., Somarakis S., 2008. Modeling and predicting potential spawning habitat of anchovy (*Engraulis encrasicolus*) and round sardinella (*Sardinella aurita*) based on satellite environmental information. Hydrobiologia, 612: 201-214.
SEC (2002) 1374. Mediterranean fisheries: shared stocks. Report of the first meeting of the Subgroup on the Mediterranean Sea (SGMED) of the Scientific, Technical and Economic Committee for Fisheries (STECF). Brussels, 4-7 September 2002. 308 pp. http://ec.europa.eu/fisheries/legislation/reports_en.htm
SEC (2004) 772. European Union Mediterranean Fisheries and exploited resources. Report of the Subgroup on the Mediterranean Sea (SGMED) of the Scientific, Technical and Economic Committee for Fisheries (STECF) ttp://ec.europa.eu/fisheries/legislation/reports/sec_2004_772_en.htm
Shepherd J. G., 1999. Extended survivors analysis: An improved method for the analysis of catch-at-age data and abundance indices. ICES J. Mar. Sci 56: 584–591.
Silvestri, S. and Maynou, F. 2009. Application of a bioeconomic model for supporting the management process of the small pelagic fishery in the Veneto Region, northern Adriatic Sea, Italy. Scientia Marina, 73(3): 563-572.
Sinovčić G., 1984. Summary of biological parameters of sardine (*Sardina pilchardus*, Walb.) from the Central Adriatic. FAO Fisheries Reports, 290: 147-148.
Sinovčić G., Zorica B., Franičević M., Keč V. C., 2003. First sexual maturity of sardine, *Sardina pilchardus* (Walb.), in the eastern Adriatic Sea. Periodicum biologorum, 105(4): 401-404.
Somarakis S., 1999. Ichthyoplankton of the Northeastern Aegean Sea with emphasis on anchovy *Engraulis encrasicolus* (Linnaeus, 1758) (June 1993, 1994, 1995, 1996). PhD Thesis, University of Crete (in Greek with English Abstract).

Somarakis S., Machias A., Giannoulaki M., Sxismenou E., Tsagarakis K., Siapatis A., Stamataki C., Torre M., Anastasopoulou K., Vassilopoulou V., Kalianiotis A., Papaconstantinou C., 2007. Ichthyoplankton and acoustic biomass estimates of anchovy in the Aegean Sea (June 2003, June 2004, 2005 and 2006). GFCM SAC, Sub-Committee for Stock Assessment, Working Group on Small Pelagic Species, Athens, 11-14 September 2007.

Somarakis S., Palomera I., Garcia A., Quintanilla L., Koutsikopoulos C., Uriarte A., Motos L., 2004. Daily egg production of anchovy in European waters. ICES Journal of Marine Science 61: 944-958.

Somarakis, S. and N. Nikolioudakis, 2007. Oceanographic habitat, growth and mortality of larval anchovy (Engraulis encrasicolus) in the northern Aegean Sea (eastern Mediterranean). Marine Biology 152: 1143–1158.

Somarakis, S., 2005. Marked interannual differences in reproductive parameters and daily egg production of anchovy in the northern Aegean Sea. Belgian Journal of Zoology 134: 123–132.

Somarakis, S., C. Koutsikopoulos, A. Machias & N. Tsimenides, 2002b. Applying the daily egg production method (DEPM) to small stocks in highly heterogenous seas. Fisheries Research 55: 193–204.

Somarakis, S., D. E. Tsianis, A. Machias & K. I. Stergiou, 2006. An overview of biological data related to anchovy and sardine stocks in Greek waters. In Palomares, M. L. D., K. I. Stergiou & D. Pauly (eds), Fishes in Databases and Ecosystems, Fisheries Centre Research Reports. Fisheries Centre, University of British Columbia: 56–64.

Somarakis, S., P. Drakopoulos & V. Filippou, 2002a. Distribution and abundance of larval fish in the northern Aegean Sea -eastern Mediterranean- in relation to early summer oceanographic conditions. Journal of Plankton Research 24: 339–357.

Spedicato M.T., Carbonara P., Lembo G., 2003. Valutazione delle risorse demersali dal Fiume Garigliano a Capo Suvero nel triennio 2000-2002. Relazione Finale GRU.N.D. (L.N. 41/82) U.O. 5, COISPA Tecnologia e Ricerca, Bari: 146 pp.

Spedicato M.T., Greco S., Lembo G., Perdichizzi F., Carbonara P. (1995) - Prime valutazioni sulla struttura dello stock di *Aristeus antennatus* (Risso, 1816) nel Tirreno Centro-Meridionale. *Biol. Mar. Medit.*, **2** (2): 239-244.

Spedicato M.T., Lembo G., Carbonara P., Silecchia T. (1994) - A first attempt to estimate biological parameters and dynamics of *Aristaeomorpha foliacea* in the Southern Tyrrhenian Sea. In *"Life cycles and fisheries of deep water red shrimps Aristaeomorpha foliacea and Aristeus antennatus*". Proceedings of the International Workshop held in the Istituto di Tecnologia della Pesca e del Pescato (ITPP - CNR), Mazara del Vallo (Italy), 28-30 Aprile 1994. *N.T.R. - I.T.P.P. Special Publication, n.* **3***:* 35-36.

Spedicato M.T., Lembo G., Silecchia T., Carbonara P. (1998) - Contributo alla valutazione dello stato di sfruttamento del gambero rosso (*Aristaeomorpha foliacea*, Risso, 1827) nel Tirreno Centro-Meridionale. *Biol. Mar. Medit*., **5** (2): 252-261.

Spedicato M.T., Silecchia T., Carbonara P. (1999) – *Aristaeomorpha foliacea.* In: *Sintesi delle conoscenze sue risorse da pesca dei fondi del Mediterraneo Centrale (Italia e Corsica).* Relini G., Bertrand J., Zamboni A (eds.). *Biol. Mar. Medit*., **6** (suppl. 1): 503-516.

Spedicato M.T., Silecchia T., Carbonara P. (1999) – *Aristeus antennatus.* In: *Sintesi delle conoscenze sue risorse da pesca dei fondi del Mediterraneo Centrale (Italia e Corsica).* Relini G., Bertrand J., Zamboni A (eds.). *Biol. Mar. Medit*., **6** (suppl. 1): 517-530.

Stauffer G.D., Picquelle S.J., 1980. Estimates of the 1980 spawning biomass of northern anchovy. Natl. Mar. Fish. Serv., Southwest Fish. Cent., La Jolla, CA, Admin. Rep. LJ-80-09. 41p.

Stergiou K.I., Karpouzi V.S. 2002. Feeding habits and tropic levels of Mediterranean fish. Rev. Fish Biol. Fish., 11: 217-254.

T. Helser, A. Punt, and R. Methot, “A generalized linear mixed model analysis of a multi-vessel fishery resource survey,” Fish. Res., vol. 70, pp. 251–264, 2004.

Tortonese E. 1975. Fauna d'Italia. Osteichthyes. Calderni Ed. Bologna. 11: 636 p.

Tsagarakis K, Machias A., Somarakis S., Giannoulaki M., Palialexis A., Valavanis V.D., 2008. Habitat discrimination of juvenile sardines in the Aegean Sea using remotely sensed environmental data. Hydrobiologia, 612: 215-223.

Tsagarakis K., Somarakis S., Machias A., Giannoulaki M., Valavanis V., Palialexis A., Papaconstantinou C., 2007. Preliminary analysis of the habitat characteristics of anchovy and sardine in the Aegean Sea in relation to fish size. Proceedings of the 38th CIESM Congress, Istanbul (Turkey), April 2007, p.621.

UN 2002. Report of the World Summit on Sustainable Development. Johannesburg, South Africa, 26 August-4 September 2002. A/CONF.199/20*, United Nations publication, Sales No. E.03.II.A.1, ISBN 92-1-104521-5, 173pp.
Valavanis V., Pierce G.J., Zuur A.F., Palialexis A., Saveliev A., Katara I., Wang J. 2008. Modelling of essential fish habitat based on remote sensing, spatial analysis and GIS. Hydrobiologia, 612:5–20.
Vallisneri M., Piccinetti C., Stagni A.M., Colombari A., Tinti F. 2000. Dinamica di popolazione, accrescimento, riproduzione di *Solea vulgaris* (Quensel 1806) nell'alto Adriatico. Biol. Mar. Med., 7 (1): 65-70.
Venables W. and C. Dichmont, 2004. GLMs, GAMs and GLMMs: an overview of theory for applications in fisheries research. Fish. Res., vol. 70, p. 319-337.
Voliani A., Abella A., Serena F., 1998. Considerations for the best choice of a stock assessment approach for *Mullus barbatus*. Biol. Mar. Medit. 5 (2): 169-183.
Vrgoc N., Arneri E., Jukic-Peladic S., Krstulovic Sifner S., Mannini P., Marceta B., Osmani K., Piccinetti C., Ungaro N., 2004. Review of current knowledge on shared demersal stocks of the Adriatic Sea. AdriaMed Technical Documents, 12: 91pp.
Vrgoč, N. 2000. Struktura i dinamika pridnenih zajednica riba Jadranskog mora. Disertacija. Sveučilište u Zagrebu. 198 pp.
Walters C.J., R. Hilborn, 1976. Adaptive control of fishing systems. Journal of the Fisheries Research Board of Canada 33: 145-159.
Wetherall J.A. 1986. A new method for estimating growth and mortality parameters from length-frequency data. ICLARM Fishbyte, 4(1): 12-14.
Wieczorek S.K., Campagnuolo S., Moore P.G., Froglia C., Atkinson R.J.A., Gramitto M.E., Bailey N., 1999. The composition and fate of discards from the *Nephrops norvegicus* trawling in Scottish and Italian waters. EC project 96/092, final report. 323 pp.
Wood, S. N., 2006. Generalized Additive Models. An Introduction with R. Chapman & Hall, London.

10. 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[4].

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.

[4] 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[5]. 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[6], as well as the report of the STECF working group on balance between fishing capacity and fishing opportunities[7].

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;

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[5] 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

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

[7] 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.

11. APPENDIX 2. SGMED-09-02 PARTICIPANTS LIST

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12. Appendix 3. Summary of the landing, discards and effort data obtained through the DCR call by GSA, country and species

Table A3.1 Landings data (tons) for hake by GSA. Note that Italian landing in 2002 and 2003 appear unreasonable.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
HKE	1	ESP	OTB	353	201	374	208	212	220	242
HKE	5	ESP	OTB	91	44	57	86	102	72	68
HKE	6	ESP	OTB	3195	3411	3441	3363	3864	3701	3494
HKE	7	FRA	GNS	177	248	99	255	299	168	111
HKE	7	FRA	LLS	5						
HKE	7	FRA	OTB	2163	2029	1018	995	1011	1277	1898
HKE	9	ITA	DTS	508156	1147563					
HKE	9	ITA	GNS			291	551	602	580	349
HKE	9	ITA	GTR			346	304	404	132	61
HKE	9	ITA	LLS			4	11	142	16	5
HKE	9	ITA	OTB			553	1054	1183	1025	915
HKE	9	ITA	PGP	154324	658514					
HKE	9	ITA	PMP	236146	258385					
HKE	9	ITA	PTS	7208	15395					
HKE	9	ITA	SB-SV					0		
HKE	10	ITA	DTS	515342	425119					
HKE	10	ITA	GNS			383	294	343	220	319
HKE	10	ITA	GTR			202	297	152	168	68
HKE	10	ITA	LLS			266	270	288	240	234
HKE	10	ITA	OTB			487	624	761	641	501
HKE	10	ITA	PGP	224825	328535					
HKE	10	ITA	PMP	245601	321715					
HKE	10	ITA	PTS	26539	21325					
HKE	10	ITA	SB-SV							1
HKE	11	ITA	DTS	167120	591875					
HKE	11	ITA	GNS			32	60	8	37	22
HKE	11	ITA	GTR			81	101	206	63	29
HKE	11	ITA	LLS			1	2	16	8	10
HKE	11	ITA	OTB			597	765	594	442	279
HKE	11	ITA	PGP	3890	26450					
HKE	11	ITA	PMP	190475	278896					
HKE	15	MLT	[LHP] [LHM]				0			
HKE	15	MLT	FPO				0			
HKE	15	MLT	GNS				0			
HKE	15	MLT	GTR				1	0	0	0
HKE	15	MLT	LLD				0			
HKE	15	MLT	LLS				2	1	2	1
HKE	15	MLT	LTL				0	0		0
HKE	15	MLT	OTB				4	5	6	1
HKE	15	MLT	Other				0			
HKE	15	MLT	TBB							0
HKE	16	ITA	DTS	1716292	1960135					
HKE	16	ITA	GTR				46	6	83	16
HKE	16	ITA	LLS			0	23	22	36	12
HKE	16	ITA	OTB			1949	1720	1598	1599	1367
HKE	16	ITA	OTM							0
HKE	16	ITA	PGP	91753	11820					
HKE	16	ITA	PMP	51884	23321					
HKE	16	ITA	PTS	13183	17709					

Table A3.1 continued.

HKE	17	ITA	DRB	55639						
HKE	17	ITA	DTS	2338500	2386560					
HKE	17	ITA	GNS			17	39	50	26	32
HKE	17	ITA	GTR			2	6	4	2	3
HKE	17	ITA	OTB			2938	3421	4102	3525	3037
HKE	17	ITA	OTM					1		
HKE	17	ITA	PGP	1092	7027					
HKE	17	ITA	PMP	216073	179211					
HKE	17	ITA	PTM			1	0	1	0	
HKE	17	ITA	PTS	26130	33126					
HKE	17	ITA	TBB			88	142	237	212	105
HKE	18	ITA	DTS	2005806	2899137					
HKE	18	ITA	GNS			19	38	31	19	15
HKE	18	ITA	GTR			21	18	26	18	42
HKE	18	ITA	LLS			233	454	837	620	551
HKE	18	ITA	MIS						0	
HKE	18	ITA	OTB			2932	3275	4613	3497	3643
HKE	18	ITA	PGP	26247	198611					
HKE	18	ITA	PMP	277090	1353022					
HKE	18	ITA	PTM			0				
HKE	19	ITA	DTS	687745	668449					
HKE	19	ITA	GNS			35	20	8		37
HKE	19	ITA	GTR			7	26	92	25	16
HKE	19	ITA	LLS			204	147	200	286	197
HKE	19	ITA	OTB			1053	1078	1330	572	682
HKE	19	ITA	PGP	262664	366669					
HKE	19	ITA	PMP	390439	477986					
HKE	19	ITA	PTM					0		
HKE	19	ITA	PTS	15971	711					
HKE	20	GRC	FPO							4
HKE	20	GRC	GTR		1445	3112	3404	2768		2545
HKE	20	GRC	LLS							286
HKE	20	GRC	OTB		308	404	516	754		459
HKE	20	GRC	PS			1				
HKE	20	GRC	SB		12	4	1			
HKE	22	GRC	FPO							0
HKE	22	GRC	GTR		2507	4039	4649	5229		2612
HKE	22	GRC	LLS		22	16	90			747
HKE	22	GRC	OTB		2444	3572	3857	3835		3793
HKE	22	GRC	PS		0	3				
HKE	22	GRC	SB		13	5	7	15		8
HKE	25	CYP	GTR				1	1	1	7
HKE	25	CYP	LLS				2	5	3	6
HKE	25	CYP	OTB				3	2	5	2

Table A3.2 Landings data (tons) for red mullet by GSA. Note that Italian landing in 2002 and 2003 appear unreasonable.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
MUT	1	ESP	OTB	68	81	109	94	109	138	113
MUT	5	ESP	OTB	14	11	20	13	11	14	18
MUT	6	ESP	OTB	1159	1004	958	1027	1437	1232	1056
MUT	7	FRA	OTB					183	172	111
MUT	9	ITA	DTS	453524	838573					
MUT	9	ITA	GNS			21	16	3	3	4
MUT	9	ITA	GTR			39	15	13	6	7
MUT	9	ITA	LLS							0
MUT	9	ITA	MIS			2		0		
MUT	9	ITA	OTB			521	684	1033	1087	716
MUT	9	ITA	PGP	14143	43924					
MUT	9	ITA	PMP	150305	174239					
MUT	9	ITA	PTS	2815	7386					
MUT	9	ITA	SB-SV			0	0			
MUT	10	ITA	DTS	446174	264511					
MUT	10	ITA	GND							0
MUT	10	ITA	GNS			16	25	35	24	7
MUT	10	ITA	GTR			96	141	68	212	125
MUT	10	ITA	MIS			9		1		
MUT	10	ITA	OTB			401	255	290	265	182
MUT	10	ITA	PGP	194727	83302					
MUT	10	ITA	PMP	188787	71194					
MUT	10	ITA	PTS	9716						
MUT	10	ITA	SB-SV			2				
MUT	11	ITA	DTS	37968	253405					
MUT	11	ITA	FPO						3	1
MUT	11	ITA	FYK						5	1
MUT	11	ITA	GNS			3				
MUT	11	ITA	GTR			11	13	13	0	1
MUT	11	ITA	OTB			333	253	249	346	263
MUT	11	ITA	PGP	304						
MUT	11	ITA	PMP	77037	67795					
MUT	15	MLT	GNS				0			
MUT	15	MLT	GTR				8	1	6	1
MUT	15	MLT	LLS					0		
MUT	15	MLT	OTB				2	11	26	13
MUT	15	MLT	Other				0	0	0	
MUT	16	ITA	DTS	1923944	3306397					
MUT	16	ITA	GTR			58	29	39	37	20
MUT	16	ITA	OTB			1568	1377	1084	1343	1158
MUT	16	ITA	PGP	168927	27089					
MUT	16	ITA	PMP	52368	46696					
MUT	16	ITA	PTS	3811	3679					
MUT	17	ITA	DRB	29378						
MUT	17	ITA	DTS	2474846	2393623					
MUT	17	ITA	FPO			1			1	
MUT	17	ITA	FYK				1		1	0
MUT	17	ITA	GNS			35	41	12	5	7
MUT	17	ITA	GTR			0	0		1	0

Tab. 3.2 continued.

MUT	17	ITA	MIS					0	0	
MUT	17	ITA	OTB			3784	3575	3160	3323	3159
MUT	17	ITA	OTM					0		
MUT	17	ITA	PGP	208560	214493					
MUT	17	ITA	PMP	374344	486638					
MUT	17	ITA	PTM			0	4	1	0	
MUT	17	ITA	PTS	11149	16193					
MUT	17	ITA	TBB			63	77	53	94	70
MUT	18	ITA	DTS	3114210	1749802					
MUT	18	ITA	GNS			82	99	123	120	42
MUT	18	ITA	GTR				0	6	3	5
MUT	18	ITA	MIS					1	0	
MUT	18	ITA	OTB			1981	1350	1803	1680	914
MUT	18	ITA	PGP	89601	311954					
MUT	18	ITA	PMP	1707263	307761					
MUT	18	ITA	PTM			0				
MUT	19	ITA	DTS	781751	427071					
MUT	19	ITA	GNS			52	43	65	55	69
MUT	19	ITA	GTR			535	761	241	190	29
MUT	19	ITA	LLS							1
MUT	19	ITA	OTB			364	298	566	288	348
MUT	19	ITA	PGP	242793	1152265					
MUT	19	ITA	PMP	1242262	870131					
MUT	19	ITA	PTM					0		
MUT	19	ITA	PTS	5869	2301					
MUT	19	ITA	SB-SV			0	12	15	9	1
MUT	20	GRC	GTR		2104	728	514	432		654
MUT	20	GRC	OTB		164	180	226	154		406
MUT	20	GRC	SB		87	28	37	24		39
MUT	22	GRC	FPO							4
MUT	22	GRC	GTR		2366	1127	1589	1687		1028
MUT	22	GRC	OTB		1770	2145	1681	1191		1376
MUT	22	GRC	PS			0	0			
MUT	22	GRC	SB		186	167	286	219		190
MUT	25	CYP	GTR				76	55	74	38
MUT	25	CYP	OTB				55	47	69	59

Table A3.3 Landings data (tons) for pink shrimp by GSA. Note that Italian landing in 2002 and 2003 appear unreasonable.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DPS	1	ESP	OTB	173	123	117	81	37	58	112
DPS	5	ESP	OTB	36	22	6	2	1	1	3
DPS	6	ESP	OTB	380	190	117	63	49	41	33
DPS	9	ITA	DTS	132963	307744					
DPS	9	ITA	GNS						2	1
DPS	9	ITA	GTR				1			
DPS	9	ITA	OTB			375	430	462	215	253
DPS	9	ITA	PGP		2573					
DPS	9	ITA	PMP	18539	12232					
DPS	9	ITA	PTS	8676	217					
DPS	10	ITA	DTS	1451560	415955					
DPS	10	ITA	GNS				6			0
DPS	10	ITA	GTR				1			
DPS	10	ITA	OTB			552	769	1089	534	400
DPS	10	ITA	PGP	2228						
DPS	10	ITA	PMP	373433	71204					
DPS	10	ITA	PTS	33743						
DPS	11	ITA	DTS	38266	13305					
DPS	11	ITA	GTR				4	3		
DPS	11	ITA	OTB			232	548	127	79	46
DPS	11	ITA	PGP	935						
DPS	11	ITA	PMP	47302						
DPS	15	MLT	OTB				1	15	8	22
DPS	16	ITA	DTS	7462540	7387992					
DPS	16	ITA	GTR					15		
DPS	16	ITA	OTB			6665	8584	8441	5966	5941
DPS	16	ITA	PGP	682	22714					
DPS	16	ITA	PMP	100569						
DPS	16	ITA	PTS	19571	54912					
DPS	17	ITA	DRB	6232						
DPS	17	ITA	DTS	49272	48699					
DPS	17	ITA	GTR					0		
DPS	17	ITA	OTB			58	79	64	60	45
DPS	17	ITA	PGP	1315						
DPS	17	ITA	PMP	2785						
DPS	17	ITA	PTS	24901	984					
DPS	17	ITA	TBB			5	2	5	7	6
DPS	18	ITA	DTS	902859	1253006					
DPS	18	ITA	OTB			1857	1181	1473	863	766
DPS	18	ITA	PGP		66681					
DPS	18	ITA	PMP	244378	496315					
DPS	19	ITA	DTS	738490	646425					
DPS	19	ITA	GTR				1			
DPS	19	ITA	OTB			1201	1243	1245	608	785
DPS	19	ITA	PGP	2987						
DPS	19	ITA	PMP	364828	744623					
DPS	19	ITA	PTS	20248						
DPS	20	GRC	GTR		4	3	8	15		2
DPS	20	GRC	OTB		273	419	94	307		105
DPS	20	GRC	SB		5					
DPS	22	GRC	GTR		207	98	72	124		97
DPS	22	GRC	OTB		867	3258	3926	4053		3745
DPS	22	GRC	SB							57

Table A3.4 Landings data (tons) for anchovy by GSA. Note that Italian landing in 2002 and 2003 appear unreasonable.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
ANE	1	ESP	PS	3268	245	746	518	637	245	112
ANE	5	ESP	PS	6	14	13	18	17	1	0
ANE	6	ESP	PS	14338	8538	8097	6216	3096	2570	2888
ANE	7	FRA	OTB		271	1063	204	83	285	
ANE	7	FRA	OTM		6803	3435	2045	2042	3823	4003
ANE	9	ITA	DTS	35950	42960					
ANE	9	ITA	GNS			2	27	13	16	22
ANE	9	ITA	LLD					3		
ANE	9	ITA	MIS			0				
ANE	9	ITA	OTB			59	119	81	84	92
ANE	9	ITA	PGP	13340	59241					
ANE	9	ITA	PMP	54703	464673					
ANE	9	ITA	PS			1432	1956	3630	2193	1242
ANE	9	ITA	PTS	7071250	4263175					
ANE	9	ITA	SB-SV				5			
ANE	10	ITA	DTS	48710	23751					
ANE	10	ITA	GND			128	197	111	87	85
ANE	10	ITA	GNS				2			0
ANE	10	ITA	GTR				8	1		1
ANE	10	ITA	MIS				4	43		
ANE	10	ITA	OTB			63	37	85	37	51
ANE	10	ITA	PGP	568801	18161					
ANE	10	ITA	PMP	483233	95553					
ANE	10	ITA	PS			3298	4437	8136	3875	3550
ANE	10	ITA	PTS	2153008	1269523					
ANE	10	ITA	SB-SV					2	2	
ANE	11	ITA	OTB				0		1	
ANE	11	ITA	PGP	17838						
ANE	11	ITA	PMP	38353						
ANE	11	ITA	PS			18				
ANE	15	MLT	OTB							0
ANE	15	MLT	PS							1
ANE	16	ITA	DTS	381041	463					
ANE	16	ITA	OTB				0	33	3	
ANE	16	ITA	PGP	582263						
ANE	16	ITA	PMP	472887	238962					
ANE	16	ITA	PS			2789	2606	3177	2022	2539
ANE	16	ITA	PTM				413	842	896	1134
ANE	16	ITA	PTS	2729051	2852448					
ANE	17	ITA	DRB	5126						
ANE	17	ITA	DTS	492096	169503					
ANE	17	ITA	FPO			0			1	
ANE	17	ITA	FYK			0	0			1
ANE	17	ITA	GNS			0				
ANE	17	ITA	MIS			11	8		15	3
ANE	17	ITA	OTB			3366	1563	386	105	138
ANE	17	ITA	PGP	26710	223893					
ANE	17	ITA	PMP	2024786	152606					
ANE	17	ITA	PS			4185	1215	8338	5626	3280

Table A3.4 continued.

ANE	17	ITA	PTM			28604	35008	34897	32604	22800
ANE	17	ITA	PTS	17487148	29497659					
ANE	17	ITA	TBB			45	39		0	0
ANE	17	SVN	PS					128405	109411	
ANE	17	SVN	PTM					281457	296134	
ANE	18	ITA	DTS	35662	37119					
ANE	18	ITA	OTB			28	23	72	38	47
ANE	18	ITA	PMP	693	71134					
ANE	18	ITA	PS			5066	6086	4680	3868	2623
ANE	18	ITA	PTM			7821	4927	11223	8912	6870
ANE	18	ITA	PTS	13976519	12084930					
ANE	19	ITA	DTS	45836	34142					
ANE	19	ITA	GND			270	363	554	186	160
ANE	19	ITA	MIS					1		
ANE	19	ITA	OTB				2			
ANE	19	ITA	PGP	454843	185425					
ANE	19	ITA	PMP	953156	1235853					
ANE	19	ITA	PS			1412	1873	1729	646	400
ANE	19	ITA	PTM					6		
ANE	19	ITA	PTS	1037418	351460					
ANE	19	ITA	SB-SV			0	2	6		
ANE	20	GRC	PS		1820	108	924	628		1239
ANE	22	GRC	PS		14002	16099	16347	22311		24480

Table A3.5 Landings data (tons) for sardine by GSA. Note that Italian landing in 2002 and 2003 appear unreasonable.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
PIL	1	ESP	PS	5348	8244	3964	7208	10002	6766	3777
PIL	5	ESP	PS	477	280	152	67	71	30	21
PIL	6	ESP	PS	18762	20817	24874	22081	29381	23984	14433
PIL	7	FRA	OTB		557	812	926	665	1261	
PIL	7	FRA	OTM		6555	6682	8546	10306	11996	6740
PIL	9	ITA	DTS	18494	37162					
PIL	9	ITA	GNS			0	1	1	0	1
PIL	9	ITA	GTR			0				
PIL	9	ITA	MIS			1				
PIL	9	ITA	OTB			71	98	43	41	35
PIL	9	ITA	PGP		12544					
PIL	9	ITA	PMP	15481	116840					
PIL	9	ITA	PS			4486	2967	4344	5112	2288
PIL	9	ITA	PTS	3109854	4015780					
PIL	9	ITA	SB-SV			26				2
PIL	10	ITA	DTS	43328						
PIL	10	ITA	GND					84	64	17
PIL	10	ITA	GTR				14	2		
PIL	10	ITA	MIS				9	59		
PIL	10	ITA	OTB			22	12	6	4	13
PIL	10	ITA	PGP	224829	61980					
PIL	10	ITA	PMP	363414	754259					
PIL	10	ITA	PS			3796	1615	1662	1439	1127
PIL	10	ITA	PTS	1245424	1260561					
PIL	11	ITA	OTB				1	0	1	0
PIL	11	ITA	PGP	5183						
PIL	11	ITA	PMP	11144						
PIL	11	ITA	PS			27				
PIL	15	MLT	GTR				0			
PIL	15	MLT	LA						0	
PIL	15	MLT	LLS				0			
PIL	15	MLT	OTB							1
PIL	15	MLT	PS					3	0	
PIL	16	ITA	DTS	239258	1319					
PIL	16	ITA	OTB			1	14	9	6	3
PIL	16	ITA	PGP	152558						
PIL	16	ITA	PMP	209126						
PIL	16	ITA	PS			889	904	1717	1559	1622
PIL	16	ITA	PTM				332	500	610	442
PIL	16	ITA	PTS	1663594	1184204					
PIL	17	ITA	DTS	435274	95134					
PIL	17	ITA	GNS			0	2	8	0	0
PIL	17	ITA	MIS					0	1	0
PIL	17	ITA	OTB			318	251	160	87	75
PIL	17	ITA	PGP	7285	128192					
PIL	17	ITA	PMP	1705579	132861					
PIL	17	ITA	PS			1214	304	261	412	279
PIL	17	ITA	PTM			6019	2807	2718	3454	4221
PIL	17	ITA	PTS	13708993	12559961					

Tab. A3.5 continued.

PIL	17	ITA	TBB			9	0	0		
PIL	17	SVN	PS					71338	48851	
PIL	17	SVN	PTM					223869	195046	
PIL	18	ITA	DTS	417	4651					
PIL	18	ITA	GNS					15		
PIL	18	ITA	GTR					1		
PIL	18	ITA	OTB			4	23	47	33	12
PIL	18	ITA	PGP		336					
PIL	18	ITA	PMP		8299					
PIL	18	ITA	PS			995	157	81	88	70
PIL	18	ITA	PTM			1962	751	568	715	1395
PIL	18	ITA	PTS	3328756	2403020					
PIL	19	ITA	DTS	37448	54074					
PIL	19	ITA	GND			35		148	31	39
PIL	19	ITA	GTR			6				
PIL	19	ITA	MIS					2		
PIL	19	ITA	OTB				24		0	
PIL	19	ITA	PGP	214636	33038					
PIL	19	ITA	PMP	397781	1358436					
PIL	19	ITA	PS			2541	1286	1184	472	376
PIL	19	ITA	PTM					9		
PIL	19	ITA	PTS	542126	403835					
PIL	19	ITA	SB-SV				5	39	6	6
PIL	20	GRC	PS		1862	734	1925	1377		2807
PIL	22	GRC	PS		7792	8169	13626	12784		9701

Table A3.6 Landings data (tons) for red shrimp by GSA. Note that Italian landing in 2002 and 2003 appear unreasonable.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
ARA	1	ESP	OTB	340	423	346	284	371	217	150
ARA	5	ESP	OTB	141	122	140	152	164	140	149
ARA	6	ESP	OTB	645	647	347	316	320	470	638
ARA	9	ITA	DTS		51353					
ARA	9	ITA	GNS				2			
ARA	9	ITA	OTB			82	154	93	47	63
ARA	9	ITA	PMP		25599					
ARA	9	ITA	PTS		4794					
ARA	10	ITA	DTS		16985					
ARA	10	ITA	GNS			0	2	0		
ARA	10	ITA	OTB			120	62	52	39	23
ARA	10	ITA	PMP		1535					
ARA	11	ITA	DTS		101407					
ARA	11	ITA	OTB			174	299	225	125	112
ARA	11	ITA	PMP		18922					
ARA	16	ITA	OTB			182	140	163	164	135
ARA	17	ITA	OTB				1		5	12
ARA	18	ITA	MIS					0		
ARA	18	ITA	OTB			5	8	21	14	5
ARA	19	ITA	DTS		82671					
ARA	19	ITA	GNS			1				
ARA	19	ITA	OTB			40	121	438	360	202
ARA	19	ITA	PMP		49996					

Table A3.7 Landings data (tons) for giant red shrimp by GSA. Note that Italian landing in 2002 and 2003 appear unreasonable.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
ARS	9	ITA	DTS		27991					
ARS	9	ITA	GNS			0	2			1
ARS	9	ITA	OTB			143	76	63	37	33
ARS	9	ITA	PMP		2052					
ARS	9	ITA	PTS		962					
ARS	10	ITA	DTS		125195					
ARS	10	ITA	GNS			4	7	8	9	7
ARS	10	ITA	OTB			203	498	412	291	113
ARS	10	ITA	PGP		6746					
ARS	10	ITA	PMP		16045					
ARS	11	ITA	DTS		56692					
ARS	11	ITA	OTB			314	171	129	82	67
ARS	11	ITA	PMP		15138					
ARS	15	MLT	OTB				18	26	34	27
ARS	16	ITA	DTS		971232					
ARS	16	ITA	OTB			786	1270	1424	1541	1260
ARS	16	ITA	PGP		7400					
ARS	16	ITA	PTS		6955					
ARS	17	ITA	OTB			145	113	52	56	67
ARS	17	ITA	TBB			1				
ARS	18	ITA	DTS		113007					
ARS	18	ITA	MIS					3		
ARS	18	ITA	OTB			89	72	166	115	97
ARS	18	ITA	PGP		12664					
ARS	18	ITA	PMP		72343					
ARS	19	ITA	DTS		3580					
ARS	19	ITA	GNS			1				
ARS	19	ITA	OTB			62	55	236	199	133

Table A3.8 Landings data (tons) for Norway lobster by GSA. Note that Italian landing in 2002 and 2003 appear unreasonable.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
NEP	1	ESP	OTB	168	156	121	65	64	62	80
NEP	5	ESP	OTB	17	18	19	16	17	20	32
NEP	6	ESP	OTB	333	311	250	188	271	307	344
NEP	9	ITA	DTS	181139	283798					
NEP	9	ITA	FPO							0
NEP	9	ITA	GNS			5	0	0		0
NEP	9	ITA	GTR				0			
NEP	9	ITA	OTB			269	289	248	261	228
NEP	9	ITA	PGP		2000					
NEP	9	ITA	PMP	13471	35058					
NEP	9	ITA	PTS	1583	9906					
NEP	10	ITA	DTS	114287	77314					
NEP	10	ITA	GNS			6	14	9	10	8
NEP	10	ITA	GTR			1		0		
NEP	10	ITA	OTB			57	73	57	54	31
NEP	10	ITA	PGP	407	7183					
NEP	10	ITA	PMP	14221	3904					
NEP	10	ITA	PTS	5621	42					
NEP	11	ITA	DTS	26108	53079					
NEP	11	ITA	GNS							0
NEP	11	ITA	GTR							0
NEP	11	ITA	OTB			60	29	48	61	55
NEP	11	ITA	PGP	171						
NEP	11	ITA	PMP	5477						
NEP	15	MLT	OTB				3	0	1	1
NEP	16	ITA	DTS	515992	646942					
NEP	16	ITA	OTB			428	490	673	797	673
NEP	16	ITA	PGP	125	17001					
NEP	16	ITA	PMP	3605						
NEP	16	ITA	PTS	2467	14211					
NEP	17	ITA	DRB	36175						
NEP	17	ITA	DTS	1796513	1465575					
NEP	17	ITA	GTR						0	
NEP	17	ITA	OTB			1890	1961	1659	1456	1272
NEP	17	ITA	PGP	240	22					
NEP	17	ITA	PMP	89576	10577					
NEP	17	ITA	PTS	8982	8268					
NEP	17	ITA	TBB			14	14	17	15	6
NEP	18	ITA	DTS	442156	1039255					
NEP	18	ITA	GNS				2	10	15	10
NEP	18	ITA	OTB			1218	1196	1437	1300	1005
NEP	18	ITA	PGP		5528					
NEP	18	ITA	PMP	36317	141766					
NEP	19	ITA	DTS	161478	174417					
NEP	19	ITA	GNS			0				
NEP	19	ITA	OTB			214	249	230	190	126
NEP	19	ITA	PGP	545						
NEP	19	ITA	PMP	40293	84769					
NEP	19	ITA	PTS	3390						
NEP	20	GRC	FPO							14
NEP	20	GRC	GTR		172	35	45	65		53
NEP	20	GRC	OTB		6	38	4			
NEP	20	GRC	SB			0				
NEP	22	GRC	FPO							0
NEP	22	GRC	GTR		161	70	215	401		120
NEP	22	GRC	OTB		482	529	650	599		588
NEP	22	GRC	PS			3				
NEP	22	GRC	SB				3			

Table A3.9 Discards data (tons) by species and GSA. Note that some French discards appear unreasonable.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
ANE	1	ESP	PS				0	0		
ANE	5	ESP	PS				0			0
ANE	6	ESP	PS			17				
ANE	7	FRA	OTB							1463
ANE	7	FRA	OTM						61	244
ANE	17	SVN	PTM						1	1
ARA	1	ESP	OTB				0			0
ARA	5	ESP	OTB				0			0
ARS	1	ESP	OTB							0
ARS	5	ESP	OTB				0			0
DPS	1	ESP	OTB				1			1
DPS	5	ESP	OTB	0	0		0			0
DPS	6	ESP	OTB				0			
DPS	9	ITA	OTB					9		
DPS	10	ITA	OTB					1		
DPS	16	ITA	OTB					25	18	18
DPS	19	ITA	OTB					4		
HKE	1	ESP	OTB				6			16
HKE	5	ESP	OTB	10	5		7			6
HKE	6	ESP	GNS						0	
HKE	6	ESP	OTB				80			
HKE	7	FRA	GNS			491				
HKE	7	FRA	OTB		17		63507	130600	41	10
HKE	7	FRA	OTM							30
HKE	9	ITA	OTB					467		
HKE	10	ITA					5			
HKE	10	ITA	OTB					6		
HKE	11	ITA	LLS				15			
HKE	11	ITA	OTB					63		
HKE	16	ITA	OTB					54	54	46
HKE	19	ITA	OTB					10		
HKE	25	CYP	OTB					0		0
MUT	1	ESP	OTB				0			0
MUT	5	ESP	OTB	0	0		0			0
MUT	6	ESP	GTR						0	
MUT	6	ESP	OTB				9			
MUT	7	FRA	OTB				18425	154501	3	0
MUT	7	FRA	OTM							0
MUT	9	ITA	OTB					158		
MUT	10	ITA	OTB					3		
MUT	11	ITA	OTB					7		
MUT	16	ITA	OTB					94	117	101
MUT	19	ITA	GTR				7			
MUT	19	ITA	OTB					0		
MUT	25	CYP	OTB					0		0
NEP	1	ESP	OTB				0			0
NEP	5	ESP	OTB				0			0
PIL	1	ESP	PS				115	71		
PIL	5	ESP	PS				0			0
PIL	6	ESP	PS			383				
PIL	7	FRA	OTB							1500
PIL	7	FRA	OTM						90	633
PIL	17	SVN	PTM						8	10

Table A3.10 Effort in days at sea by GSA and fleet.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
DAYS	7	FRA	DRB		14016	11879	20632	15862	11466	8913
DAYS	7	FRA	FPO		4832	3704	3752	9712	7104	3659
DAYS	7	FRA	FYK		18087	24240	15856	16393	13986	11688
DAYS	7	FRA	GNF		40179	44379	58398	55776	54866	49161
DAYS	7	FRA	GNS		5278	5868	4973	2153	3238	1501
DAYS	7	FRA	GTR		36410	42371	49978	71342	56444	46983
DAYS	7	FRA	LA.		3308		1124	749	602	574
DAYS	7	FRA	LLS		15301	10685	11442	12808	8291	9775
DAYS	7	FRA	MIS		15926	14201	14804	35570	21477	19865
DAYS	7	FRA	OTB		42473	28242	21039	21297	20778	18430
DAYS	7	FRA	OTM		11919	4212	5901	6940	3622	2948
DAYS	7	FRA	SB-		2119	1778	1495	2831	1659	1667
DAYS	9	ITA	DRB	1856	3332	2660	6303	8502	8405	
DAYS	9	ITA	DTS	62616	63331	64870				
DAYS	9	ITA	FPO					86	577	
DAYS	9	ITA	GND				3014	1970	1362	
DAYS	9	ITA	GNS				87509	81222	101245	
DAYS	9	ITA	GTR				61098	64285	42880	
DAYS	9	ITA	HOK			2568				
DAYS	9	ITA	LLD				8353	9168	5918	
DAYS	9	ITA	LLS				7213	4718	4011	
DAYS	9	ITA	LTL					359	139	
DAYS	9	ITA	MIS				5027	1043		
DAYS	9	ITA	OTB				65427	58739	61370	
DAYS	9	ITA	PGP	212455	182159	196758				
DAYS	9	ITA	PMP	52193	75479	16960				
DAYS	9	ITA	PS				4796	4554	3967	
DAYS	9	ITA	PTM					223		
DAYS	9	ITA	PTS	5453	6242	4728				
DAYS	9	ITA	SB-SV				17421	16166	13432	
DAYS	10	ITA	DRB	658	205	830	5233	5014	2092	
DAYS	10	ITA	DTS	37949	38134	44087				
DAYS	10	ITA	FPO				6161	7506	290	
DAYS	10	ITA	GND				45278	39973	35189	
DAYS	10	ITA	GNS				110985	73863	52787	
DAYS	10	ITA	GTR				67363	133193	139378	
DAYS	10	ITA	HOK			20929				
DAYS	10	ITA	LHP-LHM				28927	27279	27229	
DAYS	10	ITA	LLD				7052	5611	3557	
DAYS	10	ITA	LLS				46739	32809	32067	
DAYS	10	ITA	MIS				24393	7924	1396	
DAYS	10	ITA	OTB				47569	38829	38766	
DAYS	10	ITA	PGP	357895	311474	325523				
DAYS	10	ITA	PMP	105705	143062	62225				
DAYS	10	ITA	PS				11273	11527	7880	
DAYS	10	ITA	PTS	8258	9780	11792				
DAYS	10	ITA	SB-SV				21649	24147	26703	
DAYS	11	ITA	DTS	14539	18957	28840				
DAYS	11	ITA	FPO				1211	9616	31238	

Table A3.10 continued.

DAYS	11	ITA	FYK						608	
DAYS	11	ITA	GND						51	
DAYS	11	ITA	GNS				21601	7574	29014	
DAYS	11	ITA	GTR				124877	139221	83350	
DAYS	11	ITA	LHP-LHM				50	1028	3379	
DAYS	11	ITA	LLD				2263	5117	4441	
DAYS	11	ITA	LLS				9758	16168	20224	
DAYS	11	ITA	LTL					128	31	
DAYS	11	ITA	OTB				29211	25368	25596	
DAYS	11	ITA	PGP	102826	126272	165945				
DAYS	11	ITA	PMP	57543	30879					
DAYS	15	MLT	[FPO]							596
DAYS	15	MLT	[GNS]				51			78
DAYS	15	MLT	[GTR]				200	152	320	244
DAYS	15	MLT	[LA]					1116	1096	978
DAYS	15	MLT	[LHP] [LHM]				157			337
DAYS	15	MLT	[LLD]				3164		2827	3264
DAYS	15	MLT	[LLS]				1197	1466	1624	2104
DAYS	15	MLT	[LTL]				263	142		
DAYS	15	MLT	[OTB]				421	404	688	1149
DAYS	15	MLT	[PS]							216
DAYS	15	MLT	[SB] [SV]						59	36
DAYS	15	MLT	[TBB]							10
DAYS	15	MLT	Other gear				64			163
DAYS	16	ITA	DTS	87300	76233	81853				
DAYS	16	ITA	FPO				18	20	28	
DAYS	16	ITA	GND				6717	6218	7547	
DAYS	16	ITA	GTR				78429	52961	50840	
DAYS	16	ITA	HOK			14856				
DAYS	16	ITA	LHP-LHM				1363	3695	4674	
DAYS	16	ITA	LLD				5759	6397	8493	
DAYS	16	ITA	LLS				16424	22888	19638	
DAYS	16	ITA	LTL				300	408		
DAYS	16	ITA	MIS				262			
DAYS	16	ITA	OTB				83124	84674	82261	
DAYS	16	ITA	OTM				756	1540	1471	
DAYS	16	ITA	PGP	146019	118660	118425				
DAYS	16	ITA	PMP	26655	34956	6939				
DAYS	16	ITA	PS				1612	2066	1971	
DAYS	16	ITA	PTM				1204	3746	4193	
DAYS	16	ITA	PTS	8778	8568	4899				
DAYS	17	ITA	DRB	58297	69126	64120	53905	55592	61072	
DAYS	17	ITA	DTS	124529	125106	134776				
DAYS	17	ITA	FPO				57270	75621	72165	
DAYS	17	ITA	FYK				16763	26395	33769	
DAYS	17	ITA	GND				1933	391	184	
DAYS	17	ITA	GNS				124822	104855	90594	
DAYS	17	ITA	GTR				17367	15132	17108	
DAYS	17	ITA	HOK			641				
DAYS	17	ITA	LLD				961	391	637	

Table A3.10 continued.

DAYS	17	ITA	LLS					20	18	
DAYS	17	ITA	MIS				37020	17371	9020	
DAYS	17	ITA	OTB				129874	105577	94257	
DAYS	17	ITA	OTM				702	1044		
DAYS	17	ITA	PGP	335599	272040	287886				
DAYS	17	ITA	PMP	96386	98110	15512				
DAYS	17	ITA	PS				2702	2596	4037	
DAYS	17	ITA	PTM				16714	18236	17053	
DAYS	17	ITA	PTS	23522	25649	23387				
DAYS	17	ITA	TBB			12395	11382	15729	16246	
DAYS	17	SVN	PS					840	766	925
DAYS	17	SVN	PTM					556	669	489
DAYS	18	ITA	DRB	11081	5890	3865	6083	7723	8158	
DAYS	18	ITA	DTS	85424	71203	80259				
DAYS	18	ITA	GNS				41046	44570	31727	
DAYS	18	ITA	GTR				26899	29749	22260	
DAYS	18	ITA	HOK			1799				
DAYS	18	ITA	LHP-LHM					30		
DAYS	18	ITA	LLD				1207	580	371	
DAYS	18	ITA	LLS				18676	20819	16620	
DAYS	18	ITA	MIS				2446	872	49	
DAYS	18	ITA	OTB				82436	85956	70678	
DAYS	18	ITA	PGP	110621	63332	67232				
DAYS	18	ITA	PMP	53475	35980	3667				
DAYS	18	ITA	PS				1382	915	1014	
DAYS	18	ITA	PTM				2447	4006	4558	
DAYS	18	ITA	PTS	4140	4526	4679				
DAYS	19	ITA	DRB				1318	3384	3998	
DAYS	19	ITA	DTS	31381	31586	37234				
DAYS	19	ITA	FPO				3189	2925	2473	
DAYS	19	ITA	GND				29731	20736	13328	
DAYS	19	ITA	GNS				49840	83590	73806	
DAYS	19	ITA	GTR				70390	53842	29510	
DAYS	19	ITA	HOK			39190				
DAYS	19	ITA	LHP-LHM				6539	5653	4829	
DAYS	19	ITA	LLD				21034	27841	20451	
DAYS	19	ITA	LLS				19503	12450	14608	
DAYS	19	ITA	LTL				2853	2862	371	
DAYS	19	ITA	MIS				1162	19	168	
DAYS	19	ITA	OTB				41760	45465	39604	
DAYS	19	ITA	PGP	233718	254881	225109				
DAYS	19	ITA	PMP	100208	122225	20325				
DAYS	19	ITA	PS				11984	9365	6768	
DAYS	19	ITA	PTM					150		
DAYS	19	ITA	PTS	3458	7302	6605				
DAYS	19	ITA	SB-SV				19427	24848	20184	
DAYS	20	GRC	GTR		838891	749522	777934	688042		574268
DAYS	20	GRC	LLS		1212	6333	3843	11810		99755
DAYS	20	GRC	OTB		7810	7296	6279	6682		6753
DAYS	20	GRC	PS		5386	4646	6132	5559		5197
DAYS	20	GRC	SB		13429	11118	10883	11363		12774
DAYS	22	GRC	GTR		2078058	1908626	1993815	1914951		1374948
DAYS	22	GRC	LLS		20905	41155	41568	51501		302098
DAYS	22	GRC	OTB		52536	53381	56580	53367		51855
DAYS	22	GRC	PS		44481	43772	48211	42874		40029
DAYS	22	GRC	SB		36266	31987	33200	30098		25138
DAYS	25	CYP	GTR				85320	89828	100459	97244
DAYS	25	CYP	LLS				2126	2253	2459	2393
DAYS	25	CYP	OTB				3054	2178	2256	2319

Table A3.11 Effort in GT*days at sea by GSA and fleet.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
GT*days	7	FRA	DRB		16086	13931	86216	46530	36716	18754
GT*days	7	FRA	FPO		15277	12063	13412	44521	31018	13791
GT*days	7	FRA	FYK		13367	24410	17241	15110	14353	12151
GT*days	7	FRA	GNF		115866	154780	178958	157379	225428	212101
GT*days	7	FRA	GNS		87300	82051	74160	18252	27824	8399
GT*days	7	FRA	GTR		146240	150874	176039	251669	251974	192206
GT*days	7	FRA	LA.		66549		15500	27016	21527	16910
GT*days	7	FRA	LLS		41399	30095	32006	38437	32262	29565
GT*days	7	FRA	MIS		28691	28733	30249	47655	30124	29249
GT*days	7	FRA	OTB		3055410	2009196	1461372	1782382	1604529	1412831
GT*days	7	FRA	OTM		1338274	500034	736179	937389	444863	352366
GT*days	7	FRA	SB-		9489	6507	4889	21627	32568	47803
GT*days	9	ITA	DRB	15733	28362	24050	28397	24666	25679	
GT*days	9	ITA	DTS	2154256	2147750	2410544				
GT*DAYS	9	ITA	FPO					86	1748	
GT*DAYS	9	ITA	GND				17625	8566	8782	
GT*DAYS	9	ITA	GNS				241838	216207	239030	
GT*DAYS	9	ITA	GTR				176723	189219	136816	
GT*days	9	ITA	HOK			22784				
GT*DAYS	9	ITA	LLD				29031	51046	31466	
GT*DAYS	9	ITA	LLS				24902	14632	6447	
GT*DAYS	9	ITA	LTL					359	139	
GT*DAYS	9	ITA	MIS				16776	2969		
GT*DAYS	9	ITA	OTB				2355691	2157251	2154665	
GT*days	9	ITA	PGP	624182	650560	521225				
GT*days	9	ITA	PMP	382454	382992	62599				
GT*DAYS	9	ITA	PS				181752	154273	132567	
GT*DAYS	9	ITA	PTM					223		
GT*days	9	ITA	PTS	193726	181590	143490				
GT*DAYS	9	ITA	SB-SV				40642	37698	28857	
GT*days	10	ITA	DRB	5899	1839	7968	23870	24328	11078	
GT*days	10	ITA	DTS	1116708	1078525	1337882				
GT*DAYS	10	ITA	FPO				18019	12142	456	
GT*DAYS	10	ITA	GND				329910	256598	282226	
GT*DAYS	10	ITA	GNS				309872	180700	129411	
GT*DAYS	10	ITA	GTR				133960	313252	311964	
GT*days	10	ITA	HOK			157882				
GT*DAYS	10	ITA	LHP-LHM				37578	30468	33683	
GT*DAYS	10	ITA	LLD				62043	82984	49609	
GT*DAYS	10	ITA	LLS				127491	113306	93867	
GT*DAYS	10	ITA	MIS				93707	36055	8364	
GT*DAYS	10	ITA	OTB				1437500	1231702	1245641	
GT*days	10	ITA	PGP	873286	873527	661958				
GT*days	10	ITA	PMP	1169004	922706	336053				
GT*DAYS	10	ITA	PS				258389	230656	189673	
GT*days	10	ITA	PTS	482834	536460	390096				
GT*DAYS	10	ITA	SB-SV				67762	90326	87420	
GT*days	11	ITA	DTS	772163	986387	1598912				
GT*DAYS	11	ITA	FPO				6215	49606	84529	

Table A3.11 continued.

GT*DAYS	11	ITA	FYK						622	
GT*DAYS	11	ITA	GND						2544	
GT*DAYS	11	ITA	GNS				71331	18124	61528	
GT*DAYS	11	ITA	GTR				428009	430370	295688	
GT*DAYS	11	ITA	LHP-LHM				100	6394	10466	
GT*DAYS	11	ITA	LLD				26766	86801	158560	
GT*DAYS	11	ITA	LLS				42073	99731	84653	
GT*DAYS	11	ITA	LTL					270	63	
GT*DAYS	11	ITA	OTB				1934836	1399052	1423265	
GT*days	11	ITA	PGP	306226	468352	501550				
GT*days	11	ITA	PMP	611726	308212					
GT*DAYS	15	MLT	[FPO]							2061
GT*DAYS	15	MLT	[GNS]				135			175
GT*DAYS	15	MLT	[GTR]				1174	477	1023	570
GT*DAYS	15	MLT	[LA]					23999	29596	20678
GT*DAYS	15	MLT	[LHP] [LHM]				486			968
GT*DAYS	15	MLT	[LLD]				82011		60606	58322
GT*DAYS	15	MLT	[LLS]				16866	18866	18072	16220
GT*DAYS	15	MLT	[LTL]				2539	639		
GT*DAYS	15	MLT	[OTB]				24878	34527	69268	109332
GT*DAYS	15	MLT	[PS]							9036
GT*DAYS	15	MLT	[SB] [SV]						139	71
GT*DAYS	15	MLT	[TBB]							214
GT*DAYS	15	MLT	Other gear				226			400
GT*days	16	ITA	DTS	6739948	6175213	6673029				
GT*DAYS	16	ITA	FPO				531	939	2962	
GT*DAYS	16	ITA	GND				51767	68581	70266	
GT*DAYS	16	ITA	GTR				183252	139048	146474	
GT*days	16	ITA	HOK			764595				
GT*DAYS	16	ITA	LHP-LHM				2757	7752	9603	
GT*DAYS	16	ITA	LLD				377485	290622	351965	
GT*DAYS	16	ITA	LLS				40376	41294	51455	
GT*DAYS	16	ITA	LTL				600	815		
GT*DAYS	16	ITA	MIS				1630			
GT*DAYS	16	ITA	OTB				7064255	7088706	6994494	
GT*DAYS	16	ITA	OTM				65935	141508	135199	
GT*days	16	ITA	PGP	410857	732725	249032				
GT*days	16	ITA	PMP	375921	418892	20134				
GT*DAYS	16	ITA	PS				101266	114791	95754	
GT*DAYS	16	ITA	PTM				57807	197450	225837	
GT*days	16	ITA	PTS	585964	327460	224188				
GT*days	17	ITA	DRB	610984	724702	858864	701785	751815	886404	
GT*days	17	ITA	DTS	4521393	4459910	5624744				
GT*DAYS	17	ITA	FPO				129755	173844	155713	
GT*DAYS	17	ITA	FYK				21213	48049	62095	
GT*DAYS	17	ITA	GND				20395	4854	3540	
GT*DAYS	17	ITA	GNS				232491	192464	141092	
GT*DAYS	17	ITA	GTR				59566	55663	67511	
GT*days	17	ITA	HOK			9492				
GT*DAYS	17	ITA	LLD				15878	9200	12818	

Table A3.11 continued.

GT*DAYS	17	ITA	LLS					39	35	
GT*DAYS	17	ITA	MIS				100776	38408	12101	
GT*DAYS	17	ITA	OTB				5488069	4273375	3993908	
GT*DAYS	17	ITA	OTM				1696	2995		
GT*days	17	ITA	PGP	631665	551556	518165				
GT*days	17	ITA	PMP	660337	545482	73495				
GT*DAYS	17	ITA	PS				87381	125919	228375	
GT*DAYS	17	ITA	PTM				1388235	1638485	1609761	
GT*days	17	ITA	PTS	1349466	1277088	1516671				
GT*days	17	ITA	TBB			673656	730413	1081644	1021605	
GT*days	18	ITA	DRB	101523	53962	41347	58156	78840	83726	
GT*days	18	ITA	DTS	2648217	2309802	2568868				
GT*DAYS	18	ITA	GNS				81222	103569	61647	
GT*DAYS	18	ITA	GTR				52099	34536	40270	
GT*days	18	ITA	HOK			27800				
GT*DAYS	18	ITA	LHP-LHM					30		
GT*DAYS	18	ITA	LLD				14253	5477	4533	
GT*DAYS	18	ITA	LLS				68422	77823	66105	
GT*DAYS	18	ITA	MIS				5104	4206	103	
GT*DAYS	18	ITA	OTB				2522892	2649998	2225039	
GT*days	18	ITA	PGP	262823	150987	120701				
GT*days	18	ITA	PMP	655187	416888	40920				
GT*DAYS	18	ITA	PS				166872	111889	125116	
GT*DAYS	18	ITA	PTM				181912	391845	506393	
GT*days	18	ITA	PTS	278115	270956	369876				
GT*DAYS	19	ITA	DRB				1318	3384	5019	
GT*days	19	ITA	DTS	580641	581841	782163				
GT*DAYS	19	ITA	FPO				3189	3500	2633	
GT*DAYS	19	ITA	GND				143652	144284	119326	
GT*DAYS	19	ITA	GNS				90354	121741	116633	
GT*DAYS	19	ITA	GTR				168879	123220	85068	
GT*days	19	ITA	HOK			1015534				
GT*DAYS	19	ITA	LHP-LHM				6746	9985	5233	
GT*DAYS	19	ITA	LLD				1107106	810180	779709	
GT*DAYS	19	ITA	LLS				60709	48454	58917	
GT*DAYS	19	ITA	LTL				14316	17178	1683	
GT*DAYS	19	ITA	MIS				2246	207	2688	
GT*DAYS	19	ITA	OTB				745886	677976	571825	
GT*days	19	ITA	PGP	602573	1113240	473727				
GT*days	19	ITA	PMP	1379166	1015437	111129				
GT*DAYS	19	ITA	PS				159697	125312	103153	
GT*DAYS	19	ITA	PTM					1646		
GT*days	19	ITA	PTS	188356	320037	195882				
GT*DAYS	19	ITA	SB-SV				42997	64370	50261	
GT*DAYS	20	GRC	GTR		3338474	2974825	2949967	2509455		2264227
GT*DAYS	20	GRC	LLS		9110	43698	26517	81492		396520
GT*DAYS	20	GRC	OTB		574443	580133	435054	565011		534692
GT*DAYS	20	GRC	PS		105429	123580	230265	189582		155249
GT*DAYS	20	GRC	SB		83099	65507	58441	57058		75249
GT*DAYS	22	GRC	GTR		8567144	8034837	7939836	7571041		5309125
GT*DAYS	22	GRC	LLS		332005	577572	603419	780138		1244484
GT*DAYS	22	GRC	OTB		4927349	4972085	5553804	5556446		5355704
GT*DAYS	22	GRC	PS		1998124	1987556	2295466	2108039		1930332
GT*DAYS	22	GRC	SB		294896	269645	276265	257271		214985
GT*DAYS	25	CYP	GTR				262934	280251	306041	296265
GT*DAYS	25	CYP	LLS				45930	1494452	19264	18747
GT*DAYS	25	CYP	OTB				283683	217266	225108	231393

Table A3.12 Effort in kW*days at sea by GSA and fleet.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007	2008
kW*days	7	FRA	DRB		701658	498937	1446390	1474302	838511	503036
kW*days	7	FRA	FPO		543235	362280	332514	1039964	803688	384117
kW*days	7	FRA	FYK		439690	918434	633578	383108	438750	358399
kW*days	7	FRA	GNF		2846442	3221150	4273917	4580080	4743557	4085999
kW*days	7	FRA	GNS		896281	869433	749969	307954	458826	116992
kW*days	7	FRA	GTR		2381824	2734374	3335217	5657420	4661238	3519840
kW*days	7	FRA	LA.		671916		131612	170907	144068	128347
kW*days	7	FRA	LLS		919296	662464	634850	1014367	795610	806093
kW*days	7	FRA	MIS		881266	754958	569204	1927473	1093578	1102514
kW*days	7	FRA	OTB		12970505	8450443	5870844	6219184	5938674	5277458
kW*days	7	FRA	OTM		3766550	1330992	1864890	2193060	1144433	931468
kW*days	7	FRA	SB-		272065	145083	60475	364747	291432	304153
kW*days	9	ITA	DRB	187147	335520	268423	317456	301864	306714	
kW*days	9	ITA	DTS	14583556	14671042	14130070				
KW*DAYS	9	ITA	FPO					1448	15787	
KW*DAYS	9	ITA	GND				273248	223990	146786	
KW*DAYS	9	ITA	GNS				3668438	2989348	3630165	
KW*DAYS	9	ITA	GTR				3392406	3459956	2528382	
kW*days	9	ITA	HOK			376470				
KW*DAYS	9	ITA	LLD				653659	816400	453585	
KW*DAYS	9	ITA	LLS				426713	357010	99478	
KW*DAYS	9	ITA	LTL					6081	2128	
KW*DAYS	9	ITA	MIS				352334	80944		
KW*DAYS	9	ITA	OTB				14351906	12112028	12809257	
kW*days	9	ITA	PGP	6504001	6925653	7060573				
kW*days	9	ITA	PMP	4715565	4051809	984241				
KW*DAYS	9	ITA	PS				1097509	934012	922193	
KW*DAYS	9	ITA	PTM					4671		
kW*days	9	ITA	PTS	1312412	1333245	947166				
KW*DAYS	9	ITA	SB-SV				950710	751142	550250	
kW*days	10	ITA	DRB	94663	29540	110899	404243	392760	170557	
kW*days	10	ITA	DTS	7344089	7231486	7883881				
KW*DAYS	10	ITA	FPO				226805	147562	5309	
KW*DAYS	10	ITA	GND				2878658	2394591	2232763	
KW*DAYS	10	ITA	GNS				4378416	2465382	1848657	
KW*DAYS	10	ITA	GTR				1519874	3789078	3793640	
kW*days	10	ITA	HOK			1654352				
KW*DAYS	10	ITA	LHP-LHM				441690	395408	417886	
KW*DAYS	10	ITA	LLD				819922	654956	412060	
KW*DAYS	10	ITA	LLS				1852150	1289606	1194311	
KW*DAYS	10	ITA	MIS				936565	273517	73082	
KW*DAYS	10	ITA	OTB				8102762	6944418	6882389	
kW*days	10	ITA	PGP	6440217	7222145	7056306				
kW*days	10	ITA	PMP	12686947	8003452	3588004				
KW*DAYS	10	ITA	PS				1538303	1506523	1222112	
kW*days	10	ITA	PTS	2631242	2930380	2308589				
KW*DAYS	10	ITA	SB-SV				701108	859501	959937	
kW*days	11	ITA	DTS	3679604	4652647	6711626				
KW*DAYS	11	ITA	FPO				79031	824017	1387022	

Table A3.12 continued.

KW*DAYS	11	ITA	FYK						13055	
KW*DAYS	11	ITA	GND						11713	
KW*DAYS	11	ITA	GNS				1007963	236313	781402	
KW*DAYS	11	ITA	GTR				6358014	6476994	4393484	
KW*DAYS	11	ITA	LHP-LHM				769	70523	122621	
KW*DAYS	11	ITA	LLD				284297	480411	952876	
KW*DAYS	11	ITA	LLS				832709	1159412	1054615	
KW*DAYS	11	ITA	LTL					12388	1622	
KW*DAYS	11	ITA	OTB				7679721	5879355	5957347	
kW*days	11	ITA	PGP	2865738	5099814	7105771				
kW*days	11	ITA	PMP	7159338	3245118					
KW*DAYS	15	MLT	[FPO]							50771
KW*DAYS	15	MLT	[GNS]				2121			4379
KW*DAYS	15	MLT	[GTR]				13889	8391	20724	14361
KW*DAYS	15	MLT	[LA]					203361	208456	175644
KW*DAYS	15	MLT	[LHP] [LHM]				6757			19368
KW*DAYS	15	MLT	[LLD]				554562		449900	502339
KW*DAYS	15	MLT	[LLS]				140846	159692	160914	210146
KW*DAYS	15	MLT	[LTL]				26318	10210		
KW*DAYS	15	MLT	[OTB]				129838	143909	240858	382542
KW*DAYS	15	MLT	[PS]							55823
KW*DAYS	15	MLT	[SB] [SV]						2507	1334
KW*DAYS	15	MLT	[TBB]							1785
KW*DAYS	15	MLT	Other gear				3394			6355
kW*days	16	ITA	DTS	23952310	20951845	21381964				
KW*DAYS	16	ITA	FPO				2602	4116	16280	
KW*DAYS	16	ITA	GND				484488	565283	560624	
KW*DAYS	16	ITA	GTR				2436223	1675235	1779917	
kW*days	16	ITA	HOK			3153486				
KW*DAYS	16	ITA	LHP-LHM				147929	332833	329113	
KW*DAYS	16	ITA	LLD				1102509	1319225	1938868	
KW*DAYS	16	ITA	LLS				812348	751898	805197	
KW*DAYS	16	ITA	LTL				2401	3260		
KW*DAYS	16	ITA	MIS				18900			
KW*DAYS	16	ITA	OTB				22936088	23764571	22757302	
KW*DAYS	16	ITA	OTM				159014	315468	300311	
kW*days	16	ITA	PGP	3133993	4603457	2691324				
kW*days	16	ITA	PMP	2792612	2761842	223470				
KW*DAYS	16	ITA	PS				444087	520717	459314	
KW*DAYS	16	ITA	PTM				280234	712936	862918	
kW*days	16	ITA	PTS	2510582	1750128	962786				
kW*days	17	ITA	DRB	6381241	7517860	6982982	5954396	6173978	6713642	
kW*days	17	ITA	DTS	27568094	27486393	26771813				
KW*DAYS	17	ITA	FPO				3599417	4907498	4431128	
KW*DAYS	17	ITA	FYK				850518	1383490	1518073	
KW*DAYS	17	ITA	GND				219617	53220	36434	
KW*DAYS	17	ITA	GNS				4556942	3978580	2419608	
KW*DAYS	17	ITA	GTR				977664	861488	1018946	
kW*days	17	ITA	HOK			153794				
KW*DAYS	17	ITA	LLD				188429	92528	134508	

Table A3.12 continued.

KW*DAYS	17	ITA	LLS					1051	904	
KW*DAYS	17	ITA	MIS				2729814	1063909	288624	
KW*DAYS	17	ITA	OTB				25773719	20565276	19174064	
KW*DAYS	17	ITA	OTM				13347	20352		
kW*days	17	ITA	PGP	9297244	7646003	9120053				
kW*days	17	ITA	PMP	7989134	7039902	1072033				
KW*DAYS	17	ITA	PS				638587	718994	1270590	
KW*DAYS	17	ITA	PTM				6268640	6392893	6298871	
kW*days	17	ITA	PTS	7841347	7636049	6955633				
kW*days	17	ITA	TBB			3419642	3642104	5144016	5038186	
kW*days	18	ITA	DRB	1100225	584801	381968	613628	792317	848774	
kW*days	18	ITA	DTS	17112022	14530793	14369490				
KW*DAYS	18	ITA	GNS				1448541	1515067	1067720	
KW*DAYS	18	ITA	GTR				402155	144123	312140	
kW*days	18	ITA	HOK			284535				
KW*DAYS	18	ITA	LHP-LHM					1364		
KW*DAYS	18	ITA	LLD				147964	53215	35447	
KW*DAYS	18	ITA	LLS				920272	819044	652678	
KW*DAYS	18	ITA	MIS				17234	32782	1933	
KW*DAYS	18	ITA	OTB				14372055	14808415	12562033	
kW*days	18	ITA	PGP	1722336	1002933	1180371				
kW*days	18	ITA	PMP	7277279	4416994	351689				
KW*DAYS	18	ITA	PS				619543	466158	597297	
KW*DAYS	18	ITA	PTM				1069744	1436018	1773275	
kW*days	18	ITA	PTS	1480945	1464793	1842716				
KW*DAYS	19	ITA	DRB				7389	15175	36099	
kW*days	19	ITA	DTS	5125805	5002396	5802023				
KW*DAYS	19	ITA	FPO				57394	57121	56482	
KW*DAYS	19	ITA	GND				1185580	1388194	1130531	
KW*DAYS	19	ITA	GNS				1046673	1475918	1510335	
KW*DAYS	19	ITA	GTR				1818750	1347016	928503	
kW*days	19	ITA	HOK			6809150				
KW*DAYS	19	ITA	LHP-LHM				29910	160904	36015	
KW*DAYS	19	ITA	LLD				6607539	4495795	4304257	
KW*DAYS	19	ITA	LLS				724710	541247	670291	
KW*DAYS	19	ITA	LTL				159527	177770	20433	
KW*DAYS	19	ITA	MIS				26652	1760	16129	
KW*DAYS	19	ITA	OTB				6256653	6868746	5888163	
kW*days	19	ITA	PGP	4669873	9192254	4881153				
kW*days	19	ITA	PMP	13116917	9143878	1188078				
KW*DAYS	19	ITA	PS				1376127	942578	783035	
KW*DAYS	19	ITA	PTM					12646		
kW*days	19	ITA	PTS	978457	1629677	1105203				
KW*DAYS	19	ITA	SB-SV				510273	699325	584069	
KW*DAYS	20	GRC	GTR		33001422	25547517	24809229	19460968		18504513
KW*DAYS	20	GRC	LLS		125676	698284	423729	1302215		3486777
KW*DAYS	20	GRC	OTB		2374841	2359179	1729664	2024955		1800736
KW*DAYS	20	GRC	PS		725384	874064	747375	626335		615159
KW*DAYS	20	GRC	SB		863066	697644	604098	623628		807597
KW*DAYS	22	GRC	GTR		68845607	70633794	70746878	66780942		50244080
KW*DAYS	22	GRC	LLS		1888201	4977272	2715667	3848302		7914684
KW*DAYS	22	GRC	OTB		15792715	15874762	17730748	16424382		16013057
KW*DAYS	22	GRC	PS		9389351	9140980	9656463	8992650		8233643
KW*DAYS	22	GRC	SB		2775797	2206815	2193550	2022231		1774864
KW*DAYS	25	CYP	GTR				3372769	3589105	3970327	3843614
KW*DAYS	25	CYP	LLS				316634	410610	401713	390935
KW*DAYS	25	CYP	OTB				982850	695448	720545	740667

13. APPENDIX 4. FLEET SEGMENTATION IN THE MEDITERRANEAN SEA

(copied from SGMED-08-01 report).

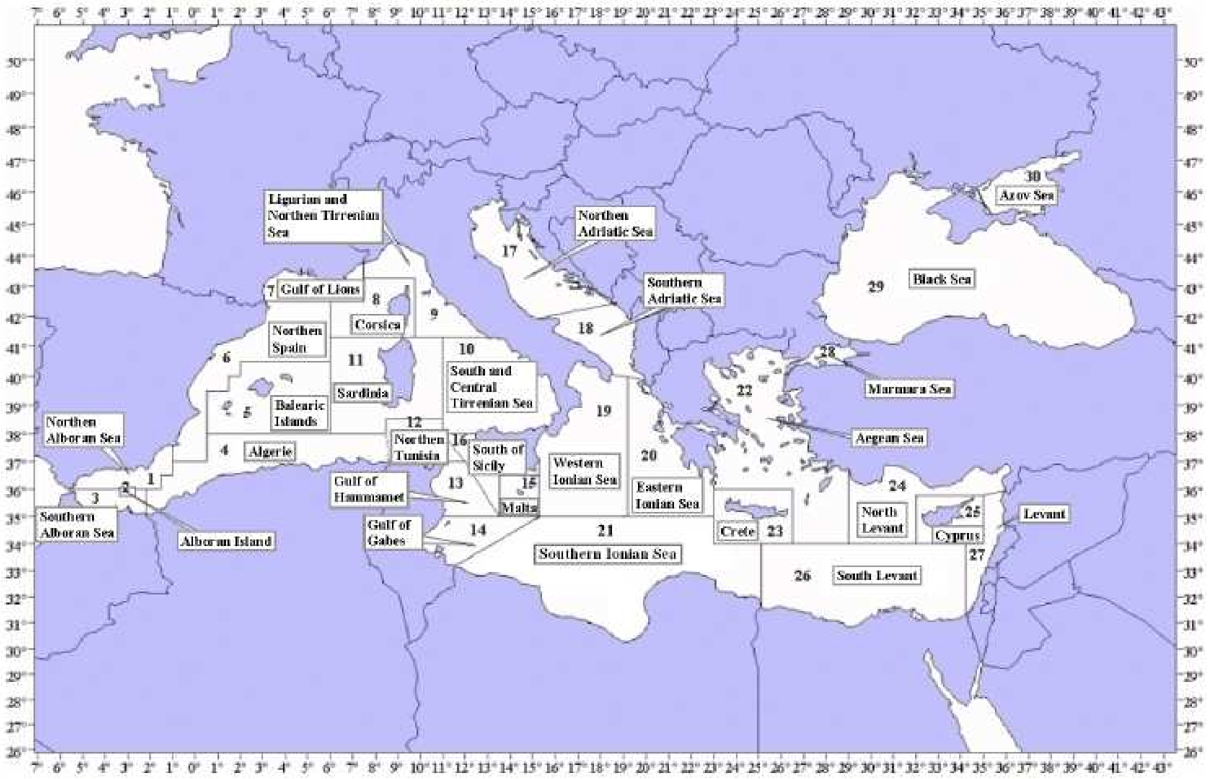
Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	LOA classes					
Activity	Gear classes	Gear groups	Gear type	Target assemblage	Mesh size and other selective devices	< 6	6-12	12-18	18-24	24-40	> 40
Fishing activity	Dredges	Dredges	Boat dredge [DRB]	Molluscs	(a)						
	Trawls	Bottom trawls	Bottom otter 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.

14. APPENDIX 5. GFCM GSAS



15. 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

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Abstract
SGMED-09-02 was held on 8-12 June 2009 in Sardinia (Italy). The report is a compilation of information on existing fisheries and stock data in order to update the status of the main demersal and small pelagic stocks. The report deals with assessment of historic and recent trends in stock parameters (stock size, recruitment and exploitation) and relevant scientific advice. STECF reviewed the report during its Plenary meeting on 9-13 November 2009.

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