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Scientific, Technical and Economic Committee for Fisheries (STECF)

Report of the SGMED-08-03 Working Group on the Mediterranean Part III Joint Black Sea Working Group

9-13 JUNE 2008, ISPRA, ITALY

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JOINT BLACK SEA WORKING GROUP
Ispra 9-13th June 2008

STECF UNDERTOOK THE REVIEW DURING THE PLENARY MEETING

HELD IN HELSINKI 7-11 JULY 2008

1. BACKGROUND

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 channelled into or completed by the GFCM working groups.

STECF was requested at its November plenary session to set up an operational workprogramme 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.

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. 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, as well as the report of the STECF working group on balance between fishing capacity and fishing opportunities.

STECF shall contribute to identify and setup a 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 derived at the April 2008 plenary the Commission launched an 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;
- ✓ 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.

STECF is requested to review the report of the Black Sea working group which worked in parallel to the STECF April plenary and SGMED-08-03 of June 9-13 (Barza, Ispra) meetings, evaluate the findings and make any appropriate comments and recommendations. STECF is requested in particular to advice on 2009 catch limitations for turbot and sprat as well as on any other technical measures that is considered adequate for sustainable exploitation of these stocks. For the year 2008, the European Community adopted catch limitations and associated technical measures for sprat and turbot fisheries in the Black Sea. With a view to update the assessments and catch forecast of the concerned stocks and fisheries in the area an ad-hoc STECF working group on Black Sea was convened.

2. STECF OBSERVATIONS

No specific observations were formulated.

3. STECF COMMENTS AND CONCLUSIONS

STECF comments on Mediterranean Sea part

1. STEFC recognises that the SGMED framework has represented an excellent forum to support stock assessment and advice within the region. While the work performed at SGMED-08-03 did not complete the extensive terms of reference set for the meeting, it has built the foundations upon which further work can be successfully undertaken. Further refining of the assessment models and their parameterisation should be continued in future SGMED meetings.
2. STEFC recognises that an extensive number of assessment areas were to be covered in less than five working days (38 stocks to be assessed according to the ToRs). In the light of time and manpower limitations, SGMED-08-03 has focused on 3 species (hake, red mullet and pink shrimp). Nevertheless, assessments were performed for 13 different stocks (including the Black Sea stocks).
3. STEFC recognises that assessments performed during the meeting were considered preliminary and that more time will be required during SGMED-08-04 in order to continue with these demersal assessments and give an evaluation of the stock status.
4. The use of survey data was suggested as a tuning index, as well as for direct use in assessment approaches such as SURBA. Changes in the design and execution of surveys were noted over time. STEFC suggested that the data be standardized over time using GLMs or GAMs to take account of these changes and agrees with the approach taken by SGMED-08- 03.
5. STECF stresses that there is a need to:

- compare stock assessment results to potential maximum production levels (e.g. MSY or appropriate proxy values both in terms of F and spawning biomass).
- make comparable analyses of the status of the stocks between the different GSA, within the Mediterranean and the Black Sea. In that context, VIT might constitute a common method to describe the current situation in terms of F and biomass using data collected within DCR.

6. STECF also recommends that estimates of F and biomass as obtained from VIT should be combined with estimates of Fmsy (or appropriate proxies) derived from YPR analysis and virgin biomass to produce simple indicators of the exploitation rate and stock status such as Fsq/Fmsy and Bsq/Bvirgin. This is particular important in the light of the shortness of most of the time series used by SGMED.
7. STECF also considers that trends in SSB or biomass obtained from time series shorter than 15-20 years should not be used to define absolute stock status. Stability in biomass in the short term does not automatically imply that the stock is not overexploited. With exploitation having started more than a century ago, such extrapolations are run the serious risk of "shifting the baseline syndrome" and should be avoided.
8. In light of the above observations and since most of the time series used in the SGMED are shorter than 10 years, STECF recommended that that effort is made for collating historical information on biological descriptors of the stock such as L_{max} or standardized CPUE from surveys or other sources that can be compared with current CPUE estimates.
9. STECF considers that exploration and comparisons of the results between different assessment methods is advisable and it should be continued. However, after benchmark analysis have been undertaken, effort should be made to establish the "stock specific ad hoc assessment methods" for future evaluations of stock status and allow for "update" assessments.
10. STECF notes that the Black Sea Working Group needs to build capacity in quantitative stock assessment and welcomes the Commissions initiative in planning for that a population dynamics and stock assessment training course.
11. STECF recommends that input data for assessments should be carefully checked for consistency before being used in XSA and ICA. Model settings should also be carefully scrutinised and justified (see also point 12).
12. STECF encourages the undertaking of acoustic and juvenile research surveys covering the areas of the main stock distribution in the Black Sea. STECF also consider that the use of commercial CPUE to tune catch-at-age data for pelagic stocks should be discouraged.
13. SGMED suggests that in future, environmental influences and ecosystem interactions need to be taken into consideration when suggesting reference levels for the fisheries and designing management procedures as well as other important species such as anchovy, horse mackerel, bonito, and Rapa whelk should be assessed. STECF agrees with the approach taken by SGMED-08-03.
14. STECF notes that economical aspects have not been dealt with during SGMED meetings. Specific data calls should be performed. However, this should follow the assessment of the biological stock status and be thus integrated afterwards.

STECF comments on the Black Sea part

15. STECF notes that the SG MED 08-03 Black Sea subgroup, has recommended candidate TACs for 2009 for Black Sea sprat and Turbot, as follows:
    - Sprat No greater than 15,000 t
    - Turbot 100 t
16. STECF concludes that there is insufficient scientific basis to support these recommendations. In the absence of appropriate scientific data and information STECF is therefore at this stage, unable to advise on an appropriate catch level for Black Sea sprat and turbot for 2009.

SGMED-08-03 WORKING GROUP REPORT

THE MEDITERRANEAN PART III
JOINT BLACK SEA WORKING GROUPGROUP

Ispra, 9-13 June 2008

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

1. EXECUTIVE SUMMARY

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. In order to meet these requests, a series of STECF Subgroups on the Mediterranean were initiated. The third of these (SGMED-08-03) met in Ispra from 9th to 13th June 2008. In summary, the specific terms of reference for SGMED-08-03 were:

STECF SGMED-08-03 Subgroup for Mediterranean is requested to:
a) assess the status of the stocks of hake by all relevant GSAs (15 and 16, 22 and 23 combined) in the Mediterranean Sea and provide short term, medium term and long term forecasts of stock biomass and yield under different management options, by fisheries if possible.
b) assess the status of the stocks of red mullet by all relevant GSAs (22 and 23 combined) in the Mediterranean Sea and provide short term, medium term and long term forecasts of stock biomass and yield under different management options by fisheries if possible.
c) assess the status of the stocks of *Parapenaeus longirostris* by all relevant GSAs (15 and 16, 22 and 23 combined) in the Mediterranean Sea and provide short term, medium term and long term forecasts of stock biomass and yield under different management options by fisheries if possible.
d) assess historic and recent trends (capacity, technological creep, nominal fishing effort) in the major fisheries by GSAs (22 and 23 combined) exploiting the stocks assessed. The trends should be interpreted in light of management regulations applicable to them.
e) review and propose biological reference points related to high yields and low risk in long term of each of the stocks assessed.
f) identify any needs for management measures required to safeguard the stocks assessed.
g) review the applicability and fully document all applied methodologies for the assessments, projections and determination of the proposed biological reference points.
h) fully document the data used and their origin for the assessments, projections and determination of the proposed biological reference points.
i) review social economic reference points.
j) provide and review population and community indicators.

STECF SGMED-08-03 Subgroup for Black Sea is requested to:
a) Evaluate the status and trends of the sprat and turbot stocks with respect to their production potential, reproductive capacity and sustainable levels of exploitation. Provide elements for establishing catch limitations in order to limit the exploitation rates in line with sustainable exploitation of the stocks;
b) Up-date the description of EU fisheries exploiting these stocks, in terms of fleets, fishing gears, deployed fishing effort (capacity in N°-GT-kW, activity in days at sea, gear characteristics), catches and catch composition, size composition, discards, fishing grounds and seasonality.
c) Determine whether fishing fleets of non-EU countries exploit the same stocks and provide relevant information if available;
d) Identify knowledge and monitoring gaps for fisheries, stocks, vital fish habitats and other environmental aspects relevant to fisheries in the area. Suggest monitoring and scientific actions that need to be developed in the short and mid-term to fill these gaps;
e) Evaluate the progress made in addressing such gaps since last year;
f) Address, in particular, the gaps in data identified in the report produced by the ad-hoc working group in Constantza in 2007;
g) Prepare a plan for a joint acoustic survey on the sprat stock in Bulgarian and Romanian waters.
h) Review all information on the selectivity of specific mesh sizes for turbot, in relation to MLS, and provide information for a possible harmonization of minimum mesh size and MLS for turbot;
i) Identify other important fisheries and stocks that may be in need of specific management measures and analyze whether the scientific basis needs to be further developed.

1.1. SGMED-08-03 – Mediterranean sub-group

The Terms of Reference for SGMED-08-03 were extensive, and required up to 38 stock assessments to be performed during the meeting. Given the number of stock assessment scientists at the meeting, the length of the meeting, the timing of the arrival of the DCR data, and the time needed during the meeting to check and collate these data, this was not feasible, despite the excellent efforts by the attendees at the Working Group.

During the meeting, assessments for 17 species/GSA combinations were initiated (ToR A-H; see Section 7). It must be noted that **ALL** assessments must be viewed as provisional at this stage. Further improvements to these assessments will be made during future SGMED meetings. The layout of the assessment report forms was designed to facilitate this process and allow scientists and managers to review the data underlying the assessments presented, the issues encountered during the assessment and the assumptions made, the assessment outputs and subsequent management advice, in a consistent way.

The preliminary results from the assessments performed are presented below.

Species	GSA	Assessment methods						Reference point	Comments
		Trawl survey (MEDITS/GRUND)			Commercial data				
		SURBA	ALADYM	Tuning data	LCA	XSA	YPR		
Hake	1				x		x	F_{MAXYPR}, SSB/SSB_0	$F>F_{MAXYPR}$, SSB $<7\%SSB_0$, scenarios for effort reduction show increase in catch and stock biomass possible.
	9	x						B_{lim}, F_{MSY}	Overexploited. SSB=5% of that at F_{MSY}, but still able to produce recruits. HCR analysis performed.
	11	x	x					FMAXYPR SSB/SSB_0	Overexploited, $F>F_{MAXYPR}$, SSB<12% SSB_0
	15 & 16	x	x		x		x	$F_{0.1}$, $F_{0.35}$, F_{MAXYPR}, SSB/SSB_0,, Y/Rmax, Y/RF0.1 Y/RSPR_0.35 Zmbp Fmbp	The stock is overfished and to reach a target such as $F_{0.1}$. The reduction of current F should be of about 60%
	17				x			F/Z ratio	Risk of overexploitation, juvenile fish caught.

	20	x		x					Model-based	Stable SSB with some increase, recruits increasing. Potential to improve stock status with management
	22/23	x		x					Model-based	SSB decreasing, recruits and yield stable. Potentially overexploited. Potential to improve stock status with management
Red mullet	1					x		x	F_{MAXYPR}, SSB/SSB_0	$F>F_{MAXYPR}$, SSB ~ 21%SSB_0, exploitation considered moderate. Effort reduction scenarios suggest a small increase in YPR possible
	5				x	x	x	x	F_{MAXYPR}, SSB/SSB_0	XSA: Fishing mortality constant, slight decline in SSB over time. $F>F_{MAXYPR}$, SSB ~ 25% SSB_0, moderate to fully exploited. Little increase in YPR with effort reduction
	6									For the next meeting
	10			x		x			F_{MAXYPR} SSB/SSB_0	Overexploited
	11	x		x					F_{MAXYPR} SSB/SSB_0	Slightly increasing yield and SSB over last years, $F>F_{MAXYPR}$, SSB~29%SSB_0, moderate to fully exploited.
	17					x			F/Z ratio	Fully exploited, degree of risk of overexploitation
	25					x		x	F_{MAXYPR}, SSB/SSB_0	$F> F_{MAXYPR}$, SSB ~ 12-15%SSB_0. Effort reduction could increase YPR
Pink shrimp	1					x		x	F_{MAXYPR}	$F<= F_{MAXYPR}$, F ~ optimum
	9	x							$F_{0.1}$	Near fully or underexploited,

					$F_{curr} < F_{0.1}$
Sprat	29		ICA		Low level of exploitation. Keep Bulgarian and Romanian catch <15,000t
Turbot	29		x		Stock improvement since 1990s. Keep Bulgarian and Romanian catch <100t

The economist members of the Working Group reviewed social and economic reference points appropriate for Mediterranean fisheries (section 10). It was noted that the range of socio-economic indicators described could be estimated using data collected both under the new DCR Regulation and under GFCM data collection. However, these data are collected at the country scale, and hence cannot be related to biological assessments that are performed at the GSA level (either individually or combined). As economic profitability can vary significantly between GSAs, indicators by country cannot be considered representative of fisheries by GSA. This is particularly true for countries whose territorial waters consist of a number of GSAs, like Italy, Spain and Greece.

The socio-economic indicators recommended by the SGRST-07-05 and SGECA/SGRST-08-01 and those calculated for the Annual Economic Report (AER), by the SGECA-08-02 working groups compared with appropriate reference points provide a useful overview of the status of fisheries. However, they cannot be used on their own to perform a socio-economic analysis and to identify potential causes of social and economic unsustainability. The larger number of indicators from the CopeMed and AdriaMed projects would be more useful for this. However, they should not be used to perform assessments on the impact that management measures and the evolution of resources may have on fleets. In this case bio-economic models are the desired tools.

Finally, preliminary analysis of the MEDITS data made available through the DCR call was initiated at the meeting (ToR J; see section 11). While issues remain with the information (e.g. particular values need to be checked and confirmed), an analysis of catch rates by species and GSA was performed to stimulate discussion.

During the Working Group, a number of specific recommendations were made for future meetings:

- It must be re-iterated that assessments performed during the meeting were considered preliminary. **The Working Group requests** that further time be provided at SGMED-08-04 in order to continue with these demersal assessments.

- Some inconsistencies in the estimation of biological parameters were noted during the Working Group (e.g. methods to define the point of maturity on maturity scales). **The Working Group suggests** that this requires further consideration, particularly where assessments move toward the estimation of stock-recruitment relationships.

- The use of survey data (e.g. MEDITS, GRUND) was suggested as a tuning index, as well as for direct use in assessment approaches such as SURBA (as used in many of the assessments described). Changes in the design and execution of surveys were noted over time **The Working Group suggests** that the data be standardised over time using GLMs to take account of these changes and allow improved assessments to be performed.

- Although intended for the meeting, the examination of alternative reference point levels was not fully undertaken during SGMED-08-03, due to time constraints. However, discussion did re-iterate the need to compare stock assessment results to potential maximum production

levels (e.g. MSY or appropriate proxy values). **The Working Group suggests** that this be continued in future SGMED meetings.

- All participants found the Working Group an excellent opportunity for exchange of ideas, approaches and skills. 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.

Overall the SGMED framework has so far represented an excellent forum to support stock assessment and advice within the region. While the work performed at SGMED-08-03 did not complete the extensive terms of reference set for the meeting, it has built the foundations upon which further work can be successfully undertaken.

1.2. SGMED-08-03 Black Sea Sub-group

The Terms of Reference for the Sub-Group on the Black Sea were also extensive. During the meeting in Ispra 2008 the WG made a very good progress in assembling and reviewing the available data, and compiling data in operational format for application of integrated stock assessment models (ICA and XSA).

The WG performed initial runs with the stock assessment models (ICA and XSA). Although initial results are very preliminary, and at this stage cannot be used for assessing the stocks' state and dynamics, they represent a necessary background for further assessment refinement, which will hopefully bring stable results and improved model diagnostics.

Having said that, the WG will further need more time and resources to complete the historical assessments of sprat and turbot, which especially for turbot could be quite complicated, because the large uncertainties in catches, age composition and abundance indices.

The WG found the state of catch and age data for sprat stock assessment acceptable.

The state of the abundance indices in sprat is not as good as it used be in previous years, when several CPUE indices from commercial fleets and research surveys were available. At present the WG has used only CPUE from Ukrainian and Bulgarian commercial fleets. These data seem to reflect the relative dynamics of the stock, but in future, more research survey indices are needed in order to produce reliable assessments.

A juvenile survey is already taking place in Romania for several years (and previously in Ukraine), but it needs to be extended, initially at least in Bulgarian waters in order to produce more reliable estimates. This index is very important for estimating the strength of recruitment in the current year and needs a special attention in planning of the future sampling programmes. Gathering experience with the acoustic survey, which is expected to start in Bulgarian waters will hopefully provide a reliable biomass index.

From the analyses of relative trends in data, indices and preliminary assessment results, it appears that during early 2000s the sprat stock has recovered from the low state which occurred in the early 1990s. The stock seems to have reached a maximum in 2000-2003. The present biomass is possibly lower, but the stock does not seem to be threatened by overfishing, because of the relatively low level of exploitation.

Catch data of turbot are very problematic. Official landings from different countries show divergent trends, that can be due to various causes including misreporting. In future the WG will need more

information on how catches are reported to allow plausible interpretation of the variable dynamics of catches.

Both CPUE from commercial catches and biomass estimates from research swept area surveys were available to the WG, but most of them, unfortunately, do not show consistent trends and are difficult to interpret and use for tuning of assessment models. Further attempt will be make to chose the best data and models to perform satisfying assessments.

Provided that turbot fisheries and survey information is quite contradictory, a cross-examination of different sources is needed to find out which part of the information is more reliable and can be used.

Future turbot assessments need to rely more on standardized biomass surveys and improved catch reporting.

Because of the controversial results produced with different settings of the assessment model, at this stage it is impossible to make a firm judgement about the absolute biomass or trend of the stock in the last years. However, given the indications from the research surveys, the WG can assume that the state of the stock has improved since the collapse in the 1990s (at least in Bulgarian and Romanian waters).

The WG discussed some ecosystem considerations that apply to the state and dynamics of the fish stocks in the Black Sea. It appears that the distribution and behaviour of sprat on the north-western shelf and specifically in Romanian waters vary to a great extend depending on the environmental conditions. Sprat schools tend to be negatively affected by jellyfish swarms. Previous studies have found that stock dynamics is related to climate fluctuations, trophic interactions and other environmental factors. Predators such as bonito in the pelagic system, and Rapa whelk (*Rapana thomasiana*) in the benthic system can have significant effects on abundance and behaviour of their prey populations, as well as through trophic cascades - at the ecosystem level.

The question of assessing other stocks in the Black Sea was discussed throughout the meeting. The WG recognised the need to undertake assessments of important species such as anchovy, horse mackerel, bonito, and Rapa whelk. However, the WG admitted the insufficient capacity to undertake all these assessments simultaneously, and **the need to first complete and refine the ongoing historical assessments of sprat and turbot**.

During the Black Sea sub-group meeting, a number of recommendations were made:

- The Working Group needs to build capacity in quantitative stock assessment. Therefore, **the Working Group suggests** that a population dynamics and stock assessment training course be arranged.

- **The Working Group suggests** that in future, a cross-examination of the sprat fisheries information (catches, effort and CPUE) would greatly improve the reliability of input data.

- **The Working Group suggests** and encourages the undertaking of acoustic and juvenile research surveys covering the areas of the main stock distribution.

- Given the available information, **the Working Group suggests** that the catch of sprat in Bulgarian and Romanian waters is kept below 15 000t.

- Given the available information, **the Working Group suggests** that the exploitation level of turbot in Bulgarian and Romanian waters be kept below the current TAC of 100t.

- Noting the influence of environment and species-interactions on stock biomass levels, **the Working Group suggests** that in future, environmental influences and ecosystem interactions need to be taken into consideration when suggesting reference levels for the fisheries and designing management procedures.

- The Working Group recognised the need to undertake assessments of other important species such as anchovy, horse mackerel, bonito, and Rapa whelk. However, **the Working Group suggests** that there is insufficient capacity currently to undertake all these assessments simultaneously, and the priority is to first complete and refine the ongoing historical assessments of sprat and turbot.

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.

For the year 2008, the European Community adopted catch limitations and associated technical measures for sprat and turbot in the Black Sea. With a view to update the assessments of the concerned stocks and fisheries in the area, an ad-hoc STECF working group on the Black Sea is convened; a data preparatory meeting was embedded into the STECF plenary session of April 2008.

With the aim of establishing the scientific evidence that will be required to support the development of such plans and to strengthen the Community's scientific input to the work of GFCM, the Commission requested STECF to:

- Evaluate whether available data allow for stock assessments to be conducted and scientific management advice to be formulated.
- Set up operational frameworks for stock assessment and edification of economic indicators.
- Evaluate if age-based assessment methods (VPA type models) are adequate assessment tools for Mediterranean stocks.
- Identify adequate empirical modelling approaches.
- Identify decision-making support modelling.
- Consider the precision and accuracy of estimated parameters.
- Provide information on data requirements.

To address the request, the STECF Subgroup on the Mediterranean (SGMED-08-03) for demersal stocks plus the Black Sea met in Ispra from 9-13th June 2008. The meeting was opened at 09:00 on the 9th, and closed at 17:00 on the 13th. The meeting built upon the work performed during SGMED-08-01 (10 – 14th March 2008) and SGMED-08-02 (21-25th April 2008) to pursue the Commission's requests.

3. TERMS OF REFERENCE FOR SGMED-08-03

The overall terms of reference for the SGMED meetings are listed in Appendix 1. The specific terms of reference for SGMED-08-03 were:

STECF SGMED-08-03 Subgroup for Mediterranean is requested to:

a) assess the status of the stocks of hake by all relevant GSAs (15 and 16, 22 and 23 combined) in the Mediterranean Sea and provide short term, medium term and long term forecasts of stock biomass and yield under different management options, by fisheries if possible.
b) assess the status of the stocks of red mullet by all relevant GSAs (22 and 23 combined) in the Mediterranean Sea and provide short term, medium term and long term forecasts of stock biomass and yield under different management options by fisheries if possible.
c) assess the status of the stocks of *Parapenaeus longirostris* by all relevant GSAs (15 and 16, 22 and 23 combined) in the Mediterranean Sea and provide short term, medium term and long term forecasts of stock biomass and yield under different management options by fisheries if possible.
d) assess historic and recent trends (capacity, technological creep, nominal fishing effort) in the major fisheries by GSAs (22 and 23 combined) exploiting the stocks assessed. The trends should be interpreted in light of management regulations applicable to them.
e) review and propose biological reference points related to high yields and low risk in long term of each of the stocks assessed.
f) identify any needs for management measures required to safeguard the stocks assessed.
g) review the applicability and fully document all applied methodologies for the assessments, projections and determination of the proposed biological reference points.
h) fully document the data used and their origin for the assessments, projections and determination of the proposed biological reference points.
i) review social economic reference points.
j) provide and review population and community indicators.

STECF SGMED-08-03 Subgroup for Black Sea is requested to:

a) Evaluate the status and trends of the sprat and turbot stocks with respect to their production potential, reproductive capacity and sustainable levels of exploitation. Provide elements for establishing catch limitations in order to limit the exploitation rates in line with sustainable exploitation of the stocks;
b) Up-date the description of EU fisheries exploiting these stocks, in terms of fleets, fishing gears, deployed fishing effort (capacity in N°-GT-kW, activity in days at sea, gear characteristics), catches and catch composition, size composition, discards, fishing grounds and seasonality;
c) Determine whether fishing fleets of non-EU countries exploit the same stocks and provide relevant information if available;
d) Identify knowledge and monitoring gaps for fisheries, stocks, vital fish habitats and other environmental aspects relevant to fisheries in the area. Suggest monitoring and scientific actions that need to be developed in the short and mid-term to fill these gaps;
e) Evaluate the progress made in addressing such gaps since last year;
f) Address, in particular, the gaps in data identified in the report produced by the ad-hoc working group in Constantza in 2007;
g) Prepare a plan for a joint acoustic survey on the sprat stock in Bulgarian and Romanian waters;
h) Review all information on the selectivity of specific mesh sizes for turbot, in relation to MLS, and provide information for a possible harmonization of minimum mesh size and MLS for turbot;
i) Identify other important fisheries and stocks that may be in need of specific management measures and analyze whether the scientific basis needs to be further developed.

4. PARTICIPANTS

The full list of participants at SGMED-08-03 is presented in Appendix 2.

5. SUMMARY OF DATA PROVIDED FOR THE MEDITERRANEAN THROUGH THE DCR CALL

Data underpins all assessments. Hence SGMED-08-02 developed an official data call designed to obtain consistent and necessary information to underpin the assessments proposed for SGMED-08-03. A summary of the data provided to the SGMED-08-03 meeting by country is presented in Table 1.

Details of the total landing, discards and effort data by species, GSA, fishing technique and years successfully obtained through the DCR call is presented in Appendix 3 (section 16).

Overall, the DCR call was extremely successful in obtaining required information prior to, or early on in, the SGMED-08-03 meeting. However, some delays were experienced, and this had knock-on effects for the ability of SGMED-08-03 assessment scientists completing the detailed Terms of Reference.

Table 1. Overview of data provided by country from the DCR call

REQUESTED FILES	FILENAME	DESCRIPTION	CYPRUS	FRANCE	GREECE	ITALY								MALTA	SLOVENIA	SPAIN
Fisheries Data							GSA9	GSA10	GSA11	GSA16	GSA17	GSA18	GSA19			
FILE_1	M01_MED_LAN	LANDINGS	2002-2007, 5, MUT HKE only	2002-2007 HKE 2006-2007 MUT, 5	2003-2006, 5	2007, 5 and 2002-2007, FT to be checked								2005-2007, 5		2002-2007, 5
FILE_2	M02_MED_EFF	EFFORT	2005-2007, 5	2004-2006, 5	2003-2006, 5	2002-2007, FT to be checked								2005-2007, 5		
FILE_3	M03_MED_LAN_LEN	LENGTH_DISTRIBUTION_LANDINGS	2005-2007, 5, MUT only	2002-2007 HKE 2006-2007 MUT, 5			2002-2007, 2002-2005 not expanded	2006-2007		2006-2007	MUT, HKE only, average 2006-2007	only 2007	2005-2007	2002-2007, 5		2002-2007, 5
FILE_4	M04_MED_LAN_AGE	AGE_DISTRIBUTION_LANDINGS	2005-2007, 5, MUT only	2006-2007 MUT, 5			2002-2007, 2002-2005 not expanded	2006-2007		2006-2007	MUT, HKE only, average 2006-2007	only 2007	2006-2007			2002-2007, 5
FILE_5	M05_MED_MAT	MATURITY_AT_LENGTH	2005-2007, MUT only	2006-2007 MUT, 5	2003-2005, MUT HKE only, F only		2002, 2005	2003-2005		2002-2005			2003-2005	2002-2007		2002-2007
FILE_6	M06_MED_GRO	GROWTH_PARAMETERS	2005-2007, MUT only	2005-2007 MUT, 5	2003-2005, MUT HKE only, F only		2002-2007	2002-2007		1994-1999, 2003-2007	MUT, HKE only, 2006 and 2007		2002-2006			2002-2007
FILE_7	M07_MED_SEX	SEX_RATIO	2005-2007, MUT only	2006-2007 MUT, 5			2002, 2005	2003-2005		2007	MUT, HKE only, 2007 only		2005-2006	2002-2007		2002-2007, no sex info
FILE_8	M08_MED_DIS	DISCARDS	2006, 5	2003-2007 HKE 2006-2007 MUT, 5	2003-2005, MUT HKE only, F only		only 2006	only 2006		2006	MUT, HKE only, 2006 only		only 2006, 2005-2006 for MUT			2002-2007, 5
FILE_9	M09_MED_DIS_LEN	LENGTH_DISTRIBUTION_DISCARDS		2003, 2007 HKE, 5			2006 only, HKE and MUT only				MUT, HKE only, 2006 only					2002-2005, 5, HKE only
Survey Data		**DEMERSAL**														
FILE_10	M10_MED_TA	MEDITS_TA	2005-2007		1994-2006		1994-2007	1994-2007	1994-2007	1994-2007	2002-2006	1994-2007	2002-2007	2002-2007		1994-2007
FILE_11	M11_MED_TB	MEDITS_TB	2005-2007		1994-2006		1994-2007	1994-2007	1994-2007	1994-2007	2002-2006	1994-2007	2002-2007, HKE, MUT, DPS only	2002-2007		1994-2007
FILE_12	M12_MED_TC	MEDITS_TC	2005-2007		1994-2006		1994-2007	1994-2007	1994-2007	1994-2007	2002-2006	1994-2007	2002-2007, HKE, MUT, DPS only	2002-2007		1994-2007

6. DATA POLICY

Working Group members were reminded that data collected under the DCR call and supplied to SGMED-08-03 for all GSAs could not be used outside the meeting. Requests will be made to relevant country contacts to allow the data to be stored by the EU to enable future assessments under the auspices of SGMED or related groups to be performed without the need to produce a further DCR call.

7. STOCK ASSESSMENTS PERFORMED DURING SGMED-08-03 (TOR A – H)

7.1. Summary

Stock assessments were performed using data obtained through the DCR call (Section 5) and from individual institutes. The range of assessment proposed by GSA is presented in Table 2. These represented a total of 38 assessments across 15 GSAs.

Table 2. Matrix of assessments targeted during SGMED-08-03.

GSA	Hake	Red mullet	Pink shrimp	Sprat	Turbot
1	x	x	x		
5	x	x	x		
6	x	x	x		
9	x	x	x		
10	x	x	x		
11	x	x			
15	x	x	x		
16		x	x		
17	x	x			
18	x	x			
19	x	x			
20	x	x			
22	x	x			
23		x			
25		x			
29				x	x

Clear boxes with 'x' represent those GSA/species assessments performed during SGMED-08-03. Lightly shaded boxes with 'x' represent GSA/species combinations for which GFCM assessments were acknowledged and reviewed at SGMED-08-03, dark shaded boxes with 'x' represent GSA/species combinations for which an assessment was not performed.

Given the large number of assessments and the limited time and resources available, Working Group members concentrated on key assessments for their respective GSAs, using the available information and a range of assessment methodologies. A total of 17 assessments were performed during the meeting.

As noted in the SGMED-08-02 meeting, the growth and natural mortality parameters used within assessments can have significant effects on the output of stock assessment. During SGMED-08-03, a preliminary examination of the range of growth parameters available for particular species of interest was made. It was noted that growth parameter estimates for species varied notably. These differences were driven not only by biological variations between areas (in particular from west to east in the Mediterranean), but also by the data available on which to derive the estimates. A lack of small or large individuals within the sample used to derive estimates meant that $L\infty$ and K values could be very uncertain. This was often signalled by a highly (and biologically unrealistic) negative t_0 estimate. A set of 'upper' and 'lower' growth parameter values were therefore developed for each species, to be used where experts felt that growth parameter estimates for their GSA were unrealistic. The use of

alternative growth parameter values allowed experts to examine the sensitivity of stock assessments to this uncertainty (Table 3).

Table 3. 'Upper' and 'lower' growth parameter estimates for each species

Species	Param. set	L_{inf} (cm)	K	T_0	Source
M. barbatus	Fast	34.5	0.34	-0.143	Length
	Slow	26.0	0.41	-0.4	Otoliths[1]
*M. merluccius**	Female	100.7	0.25	-0.35	Tagging
	Male	72.8	0.30	-0.38	Tagging
*P. longirostris***	High	4.2	0.62	-0.08	Length
	Low	4.5	0.34	-0.06	Length

* suggest generating size at length using sex ratio at length data
** Spanish figures – suggest using those figures most relevant to your GSA (e.g. Italian, Spanish)
NOTE: ensure related parameters (e.g. natural mortality) are consistent with growth parameters used

Reports for each of the stock assessments performed or reviewed at SGMED-08-03 are presented below. These sections cover ToRs a to h for each GSA and species examined during the meeting. In addition, specific stock assessments performed during the 2007 GFCM stock assessment meeting were presented and discussed. For these species, the link to the assessment report is provided, and the discussions made during the meeting noted.

A template was developed for the stock assessment summaries, to be followed by study group members. This was designed to allow assessment scientists to understand, and if necessary to repeat, the assessments performed. It must be noted that these templates were designed as a 'living document' to be developed over time as data, approaches, and results are expanded and refined. Therefore, many parts within individual assessments are not yet completed. It is intended that these sections be developed during future SGMED meetings.

Table 4 presents a summary of the assessment approaches used for each GSA and species, as well as the reference points used within the assessments and resulting perception of the stock. **NOTE: given the time available at the meeting, and the lack of time to analyse data prior to the meeting due to the timing of data provision, ALL assessments must be viewed as provisional. Further improvements will be made during future SGMED meetings.**

[1] GSA 9 and 10 combined, from otoliths

Table 4. Summary of assessment approaches used at SGMED-08-03

Species	GSA	Assessment methods						Reference point	Comments
		Trawl survey (MEDITS/GRUND)			Commercial data				
		SURBA	ALADYM	Tuning data	LCA	XSA	YPR		
Hake	1				x		x	F_{MAXYPR}, SSB/SSB_0	$F>F_{MAXYPR}$, SSB <7%SSB_0, scenarios for effort reduction show increase in catch and stock biomass possible.
	9	x						B_{lim}, F_{MSY}	Overexploited. SSB=5% of that at F_{MSY}, but still able to produce recruits. HCR analysis performed.
	11	x	x					FMAXYPR SSB/SSB_0	Overexploited, $F>F_{MAXYPR}$, SSB<12% SSB_0
	15 & 16	x	x		x		x	$F_{0.1}$, $F_{0.35}$, F_{MAXYPR}, SSB/SSB_0,, Y/Rmax, Y/RF0.1 Y/RSPR_0.35 Zmbp Fmbp	The stock is overfished and to reach a target such as $F_{0.1}$. The reduction of current F should be of about 60%
	17				x			F/Z ratio	Risk of overexploitation, juvenile fish caught.
	20	x	x					Model-based	Stable SSB with some increase, recruits increasing. Potential to improve stock status with management
	22/23	x	x					Model-based	SSB decreasing, recruits and yield stable. Potentially overexploited. Potential to improve stock status with management
Red mullet	1				x		x	F_{MAXYPR}, SSB/SSB_0	$F>F_{MAXYPR}$, SSB ~ 21%SSB_0, exploitation considered moderate. Effort reduction scenarios suggest a small increase in YPR possible
	5			x	x	x	x	F_{MAXYPR}, SSB/SSB_0	XSA: Fishing mortality constant, slight decline in SSB over time. $F>F_{MAXYPR}$, SSB ~ 25% SSB_0, moderate to fully exploited. Little increase in YPR with effort reduction
	6								For the next meeting
	10		x		x			F_{MAXYPR} SSB/SSB_0	Overexploited
	11	x	x					F_{MAXYPR} SSB/SSB_0	Slightly increasing yield and SSB over last years, $F>F_{MAXYPR}$, SSB~29%SSB_0, moderate to fully exploited.
	17				x			F/Z ratio	Fully exploited, degree of risk of overexploitation
	25				x		x	F_{MAXYPR}, SSB/SSB_0	$F> F_{MAXYPR}$, SSB ~ 12-15%SSB_0. Effort reduction could increase YPR
Pink shrimp	1				x		x	F_{MAXYPR}	$F<= F_{MAXYPR}$, F ~ optimum
	9	x						$F_{0.1}$	Near fully or underexploited, $F_{curr} <F_{0.1}$

Sprat	29		ICA		Low level of exploitation. Keep Bulgarian and Romanian catch <15,000t
Turbot	29		x		Stock improvement since 1990s. Keep Bulgarian and Romanian catch <100t

7.2. Stock assessment of hake in GSA01

7.2.1.Stock identification and biological features

7.2.1.1. Stock Identification

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

7.2.1.2. Growth

Two growth parameter sets were considered: fast and slow. Also different values were used for males and females.They are shown in Table 7.2.1.2.1.

Table 7.2.1.2.1. 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	$year^{-1}$

7.2.1.3. Maturity

The following maturity at length ogive was used for assessments in GSAs 01, 05 and 06. The more recent years indicate signifianct reduction in size at maturation.

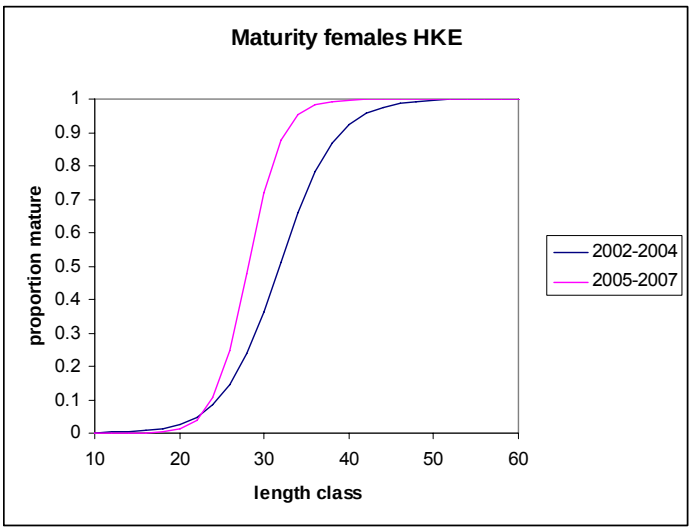
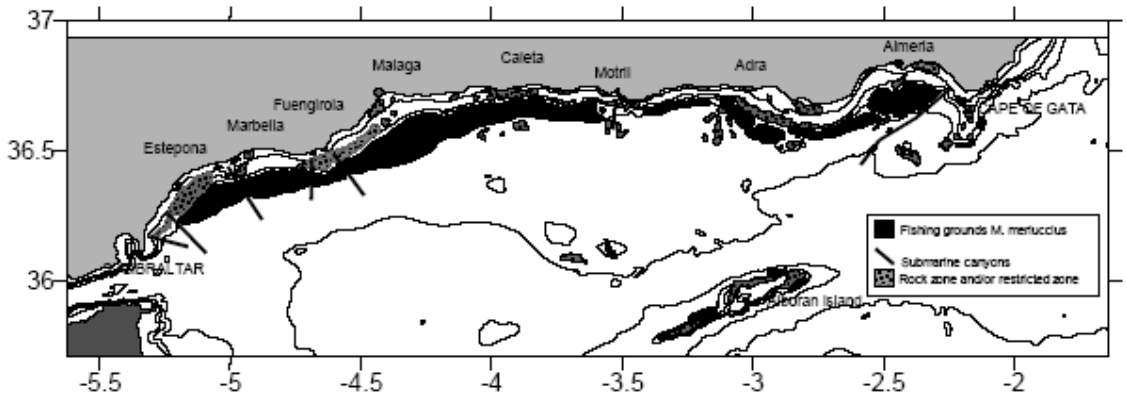


Fig. 7.2.1.3.1 Maturity ogives for female hake in GSAs 01, 05 and 06.

7.2.2.Fisheries

7.2.2.1. General description of fisheries

Hake is exploited in all trawlable areas from Gibraltar straight to Cape of Gata, including the deep-bottom fishing grounds about GSA 2. Commonly small hakes are caught from 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. Hake (*Merluccius merluccius*) is one of the most important target species for the trawl fisheries in GSA 01.



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

Fig. 7.2.2.1.1 Fishing grounds of hake in GSA 01. Countries: only Spain

7.2.2.2. Management regulations applicable in 2007 and 2008

No information was provided to SGMED-08-03.

7.2.2.3. Catches

7.2.2.3.1. Landings

Fig. 7.2.2.3.1.1 shows the trend in reported landings taken by trawlers (Spain only). The data were reported to SGMED-08-03 through the Data collection regulation and are listed in Table A3.1 of Appendix 3.

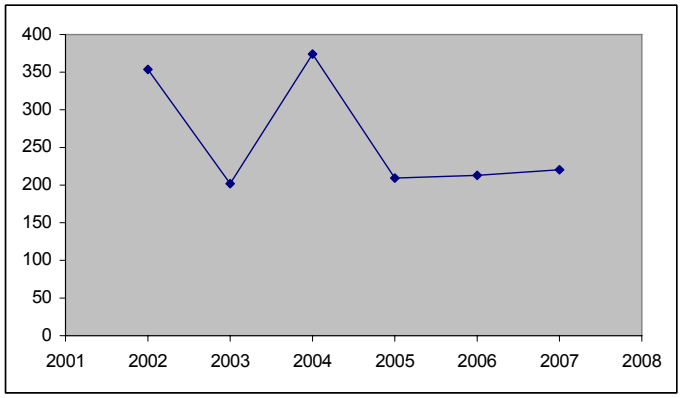


Fig. 7.2.2.3.1.1 Annual hake landings (t) by Spanish trawlers.

Annual lengths of landings were reported to SGMED-08-03 only for 2005-2007 and are shown in Fig. 7.2.2.3.1.2.

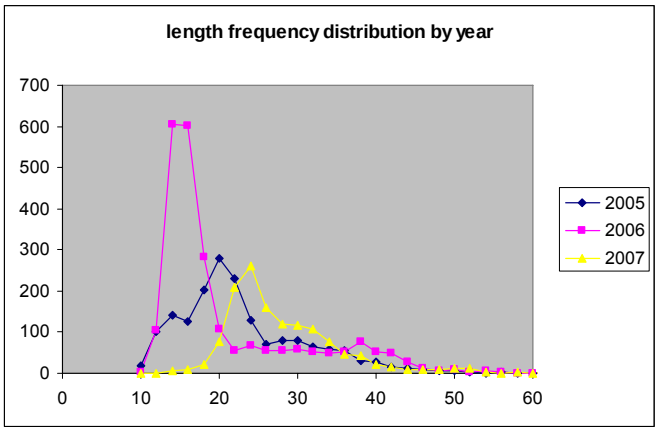


Fig. 7.2.2.3.1.2 Annual size composition of hake landings (t) by Spanish trawlers, 2005-2007.

7.2.2.3.2. Discards

SGMED-08-03 received discard data only for 2005. A total of 5.7 tons discarded in 2005 (2.7% of the landings). The data were compiled and reported through the Data collection regulation and are listed in Table A3.4 of Appendix 3.

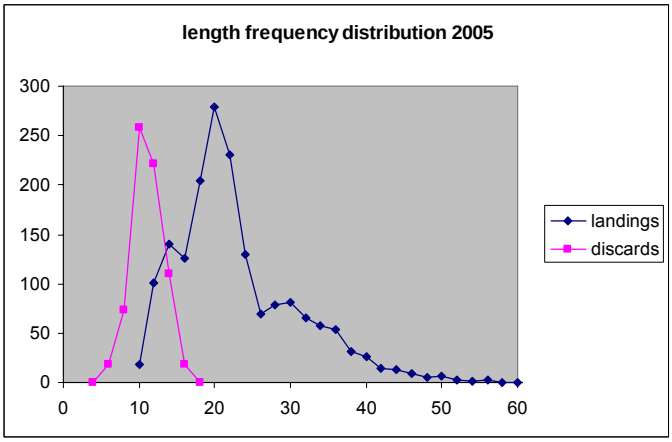


Fig. 7.2.2.3.2.1 Annual size composition of hake landings and discards (t) by Spanish trawlers, in 2005.

7.2.2.3.3. Fishing effort

No data on fishing effort were available at the meeting. STECF (stock review part II in 2007) noted that in the GSA 01 there are 140 trawlers landing around 400 tonnes by year.

7.2.3.Scientific surveys

7.2.3.1. Medits

7.2.3.1.1. Methods

SGMED was provided with evaluations of abundance and length composition for joint GSAs 1 and 6. Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 1 the following number of hauls were reported per depth stratum (s. Tab. 7.2.3.1.1.1)

Tab. 7.2.3.1.1.1. Number of hauls per year and depth stratum in GSA 01, 1994-2007

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

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

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

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

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

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

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± 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.

7.2.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.2.3.1.3. 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 for the joint GSAs 01 and 06. The re-estimated trends based on the DCR data call are illustrated in section 11 of this report.

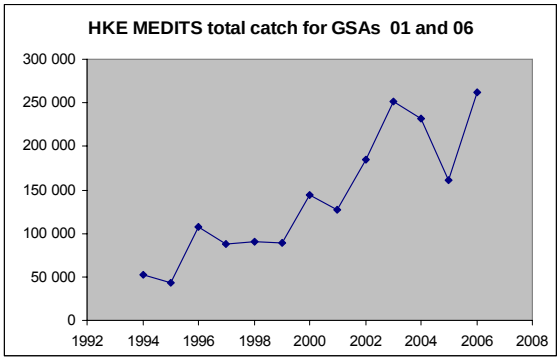


Fig. 7.2.3.1.3.1 Estimated trend in abundance indices for joint GSAs 01 and 06, 1994-2007.

However, 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. 7.2.3.1.3.2). The analyses of Medits indices are considered preliminary.

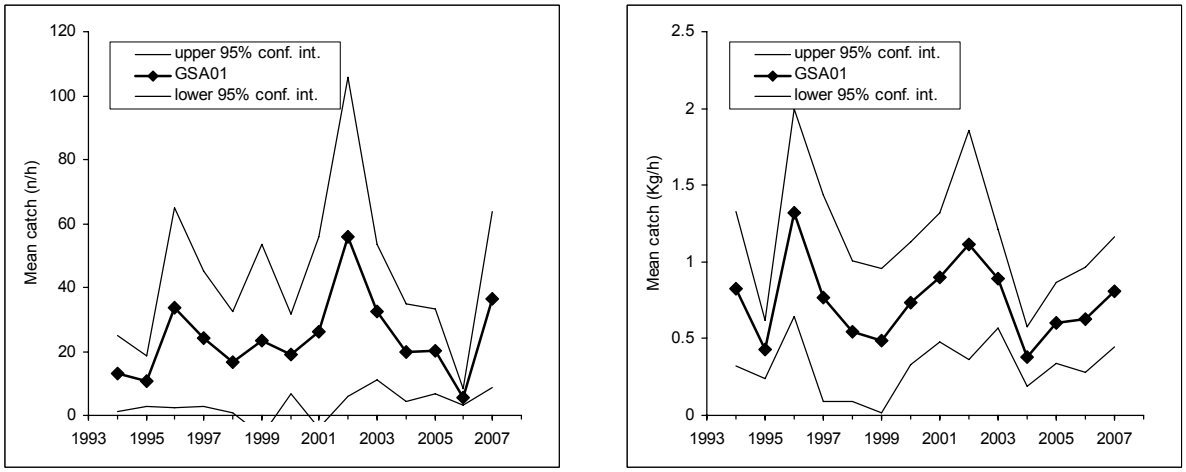


Fig. 7.2.3.1.3.2. Abundance and biomass indices of hake in GSA 01.

7.2.3.1.4. Trends in abundance by length or age

Fig. 7.2.3.1.4.1 displays the length composition of the hake stock as derived from the Medits survey for joint GSAs 01 and 06.

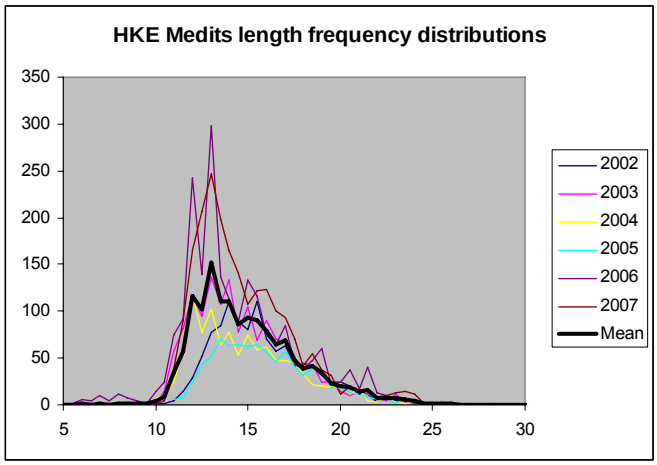


Fig. 7.2.3.1.4.1 Estimated changes in size compositions for GSAs 01 and 06, 2002-2007.

The following Fig. 7.2.3.1.4.2 and 3 display the stratified abundance indices of GSA 01 in 1994-1999 and 2000-2007. These size compositions are considered preliminary.

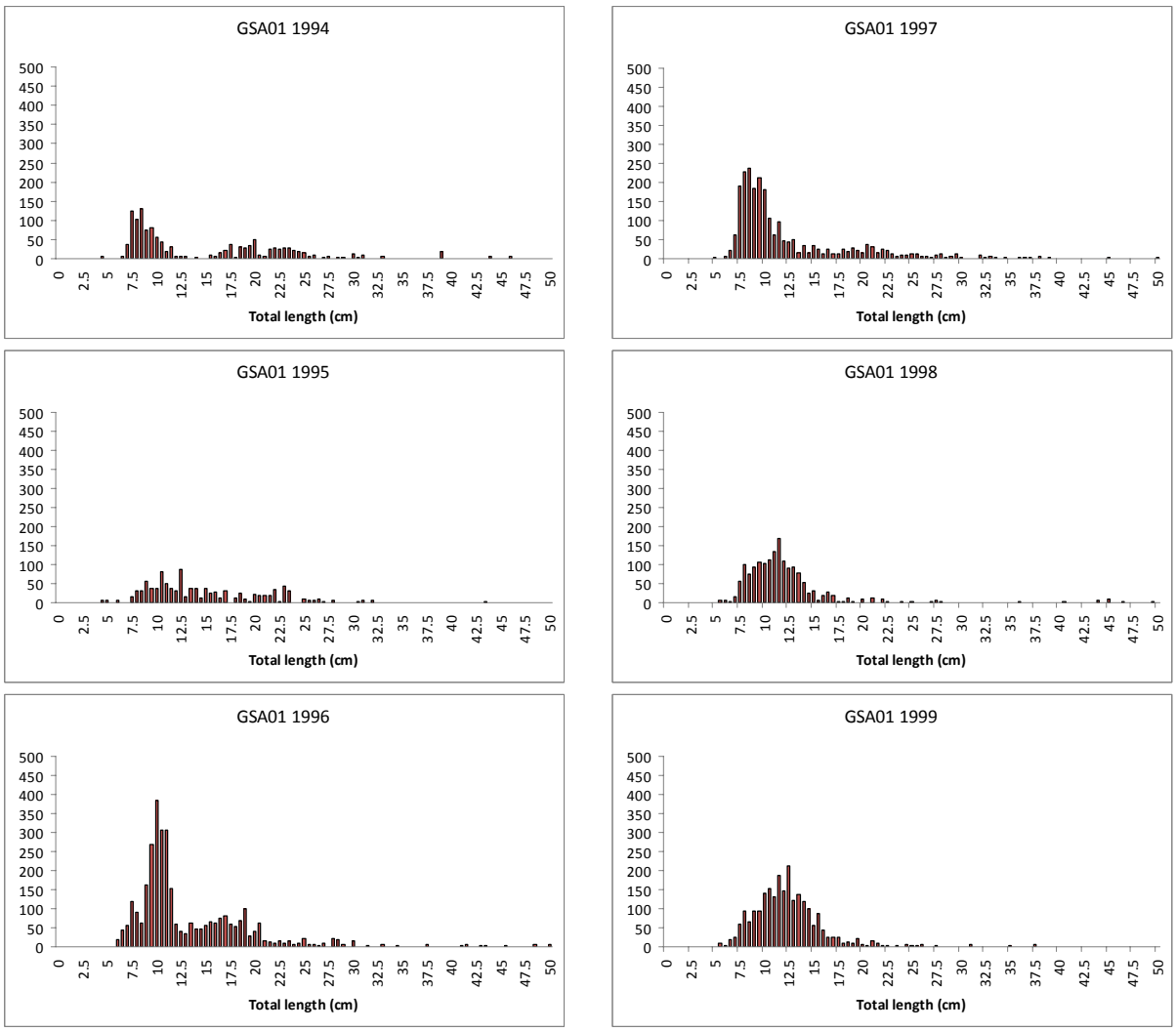


Fig. 7.2.3.1.4.2 Stratified abundance indices by size, 1994-1999.

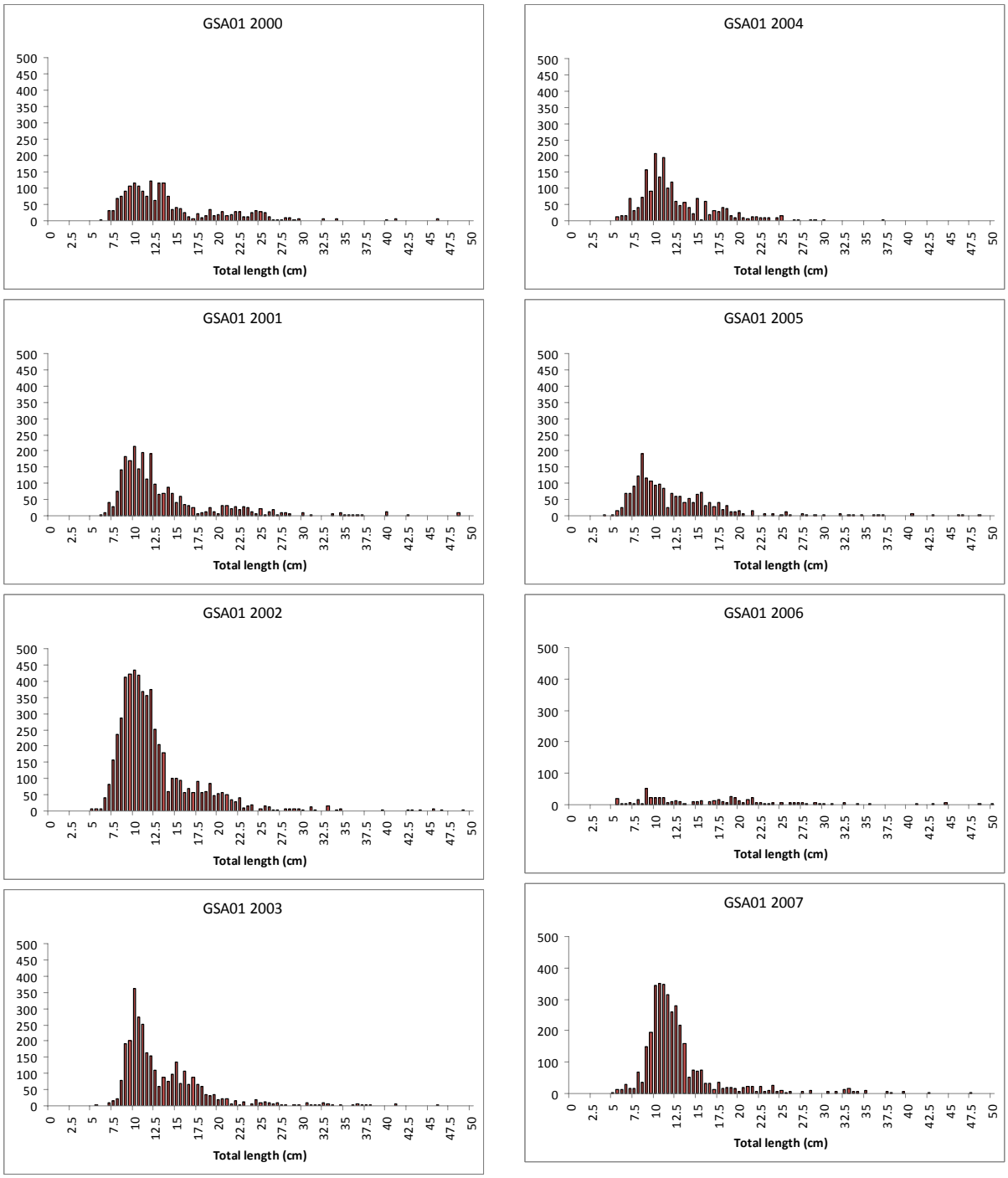


Fig. 7.2.3.1.4.3 Stratified abundance indices by size, 2000-2007.

7.2.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.2.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.2.4.Assessment of historic stock parameters

7.2.4.1. Method 1: VIT

7.2.4.1.1. Justification

This is the first assessment of the hake stock in GSA01. There are only three years with data on length compositions so an XSA does not seem applicable. Survey data could not be disaggregated between GSAs within the time available. For these reasons we applied VIT (pseudocohort analysis, Y/R and simulation under two different management scenarios) using the commercial data series from the DCR.

7.2.4.1.2. Input parameters

As presented above, two sets of growth parameters (slow and fast growth) were used, and a separate analysis performed by sex. No discards were included. There were no data on CPUE used.

7.2.4.1.3. Results including sensitivity analyses

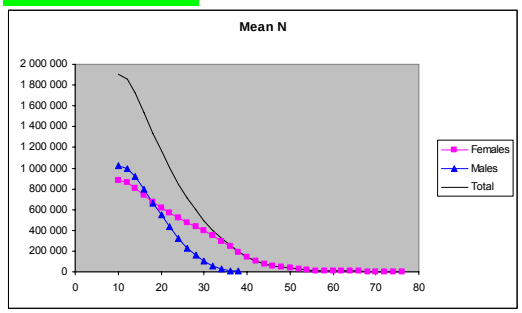
All the results refer to the observable range of length/ages. Since the analysis is based on pseudocohort analysis, it is not possible to present trends. The sensitivity analysis has been done only for comparison of fast and slow growth. The estimated stock parameters are listed in Table 7.2.4.1.3.1.

Table 7.2.4.1.3.1 Estimated stock parameters of hake in GSA 01 as derived from the VIT model.

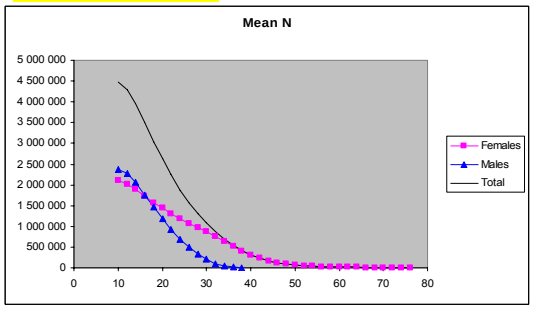
	FAST GROWTH	SLOW GROWTH
Biomass (B)	1730	3758
SSB	826	1762
Virgin Biomass (V)	44191	54303
B/V	3.91%	6.9%

Resulting stock size composition, mean weights and fishing mortalities over fish size for both fast and slow growth assumptions are shown in Fig. 7.2.4.1.3.1.

FAST GROWTH



SLOW GROWTH



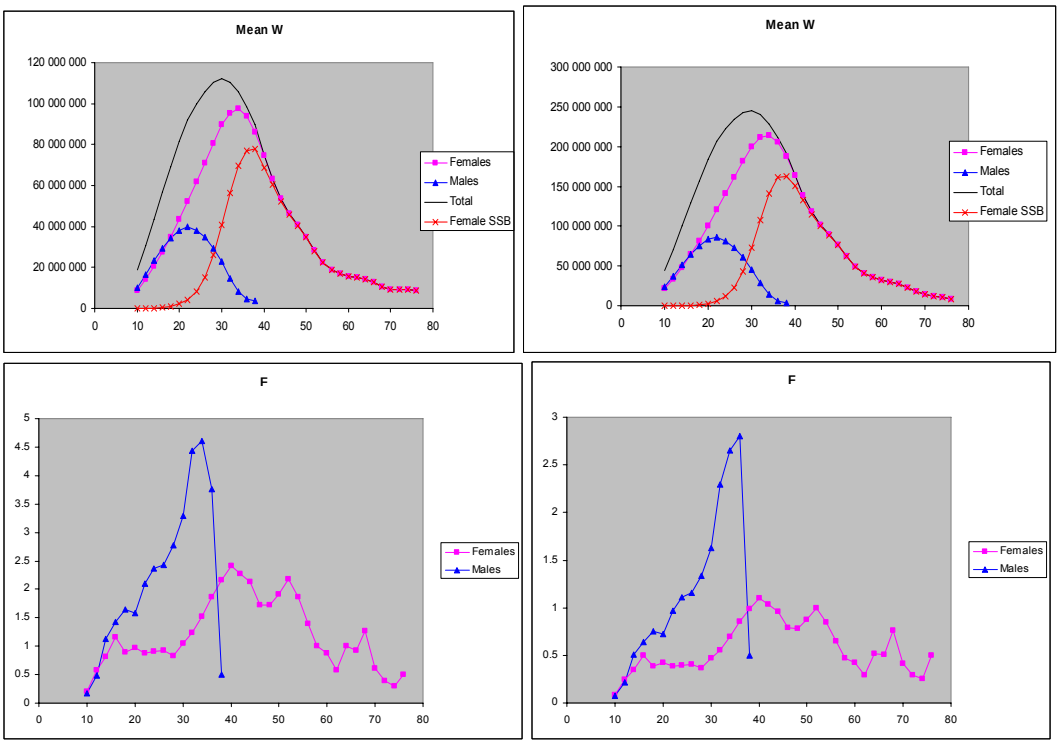


Fig. 7.2.4.1.3.1 Resulting stock size composition, mean weights and fishing mortalities over fish size for both fast and slow growth assumptions.

7.2.5.Short term prediction for 2008 and 2009

7.2.5.1. Justification

No forecast analyses were conducted.

7.2.5.2. Input parameters

No forecast analyses were conducted.

7.2.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSA 01.

7.2.6. Medium term prediction

7.2.6.1. Justification

No forecast analyses were conducted.

7.2.6.2. Input parameters

No forecast analyses were conducted.

7.2.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for hake in GSA 01.

7.2.7. Long term prediction

7.2.7.1. Justification

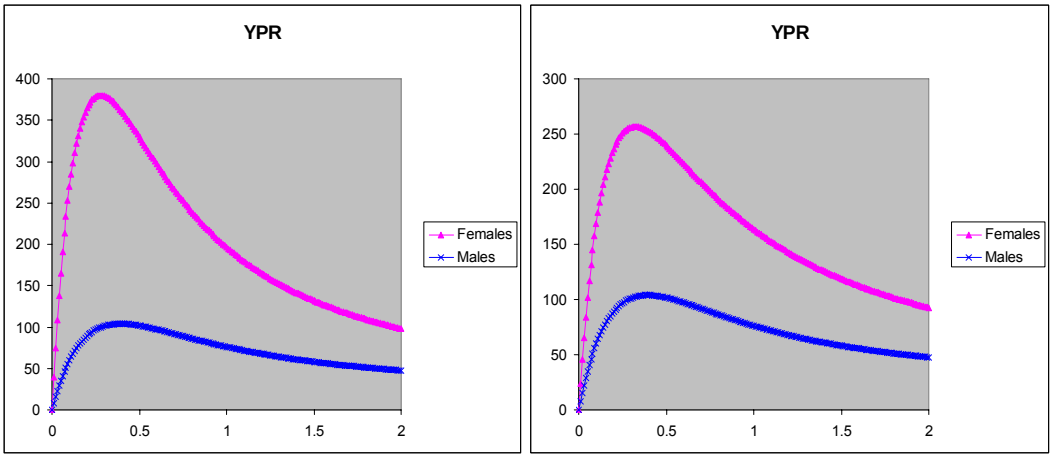
Yield per recruit analyses were conducted assuming equilibrium conditions.

7.2.7.2. Input parameters

Based on the exploitation pattern resulting from the VIT model and its population parameters, yield per recruit analyses were formulated.

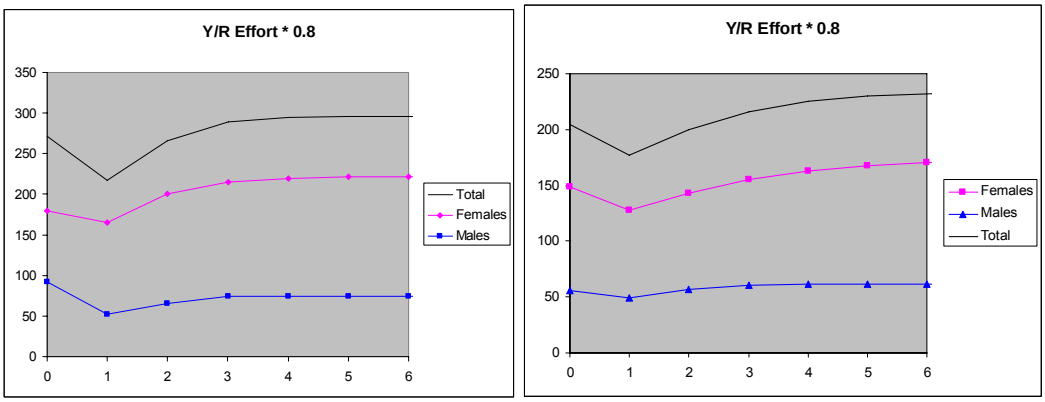
7.2.7.3. Results

Assuming equilibrium conditions, Fmax seems to be in the region of F=0.25 for both sexes (Fig. 7.2.7.3.1).



(Fig. 7.2.7.3.1). Yield per recruit for the hake stock in GSA 01.

Simulations of two management measures were performed: removal of 20% of effort (equivalent to remove one day of fishing, fro m 5 to 4 per week), and modification of selectivity: the F on class 0 reduced to 1/3 of its value, the F on class 1 reduced to 2/3 of its value, keeping the rest (Fig. 7.2.7.3.2).



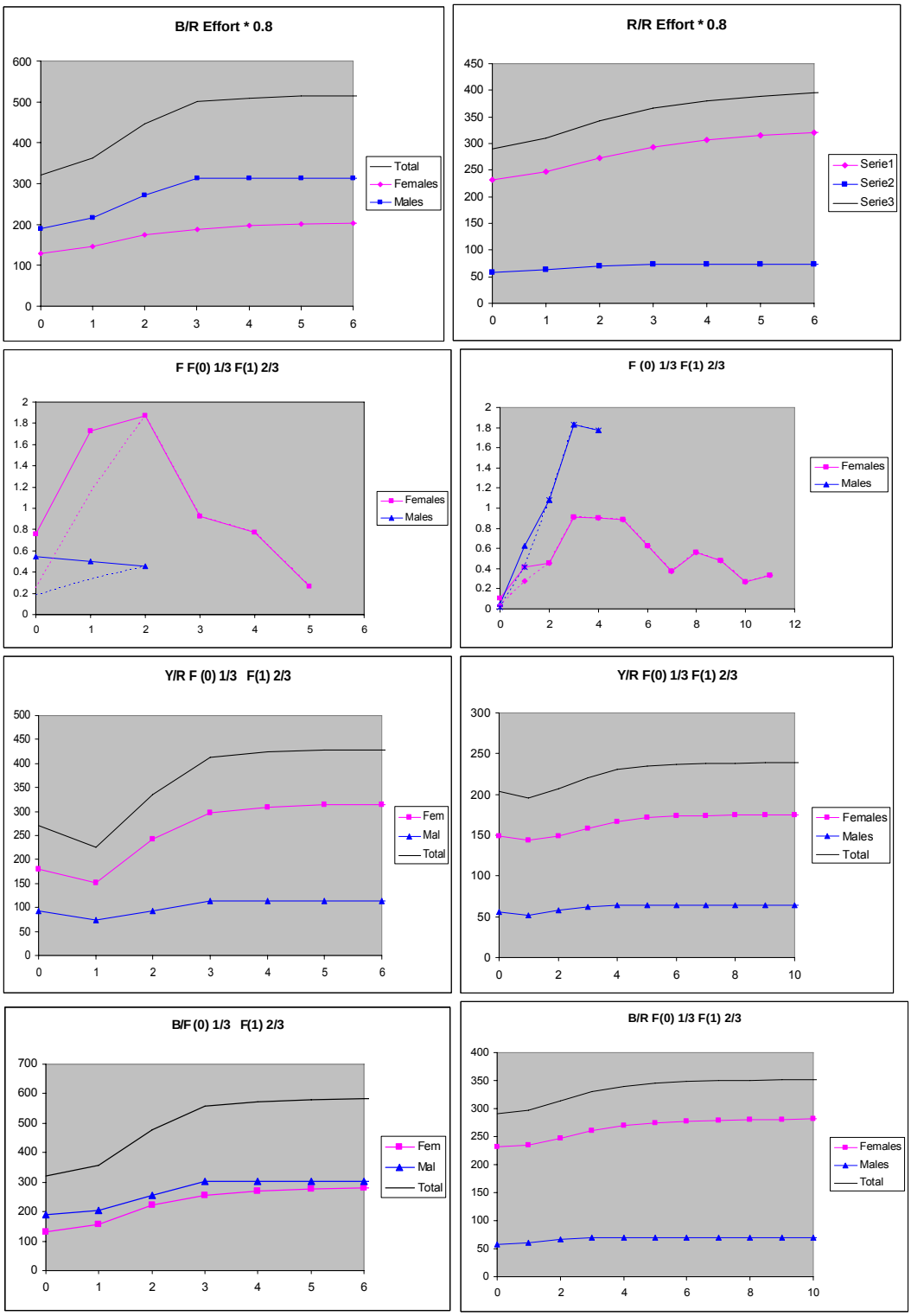


Fig. 7.2.7.3.2 Various stock parameters under the assumption of an effort reduction by 20% and modification of selectivity.

7.2.8. Scientific advice

7.2.8.1. Short term considerations

7.2.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.2.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.2.8.1.3. State of exploitation

SGMED-08-03 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.

7.2.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.3. Stock assessment of hake in GSA 05

7.3.1.Stock identification and biological features

7.3.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.3.1.2. Growth

No information was documented during SGMED-08-03.

7.3.1.3. Maturity

No information was documented during SGMED-08-03.

7.3.2.Fisheries

7.3.2.1. 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.

7.3.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.3.2.3. Catches

7.3.2.3.1. Landings

Fig. 7.3.2.3.1.1 shows the trend in reported landings taken by trawlers (Spain only). The data were reported to SGMED-08-03 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.

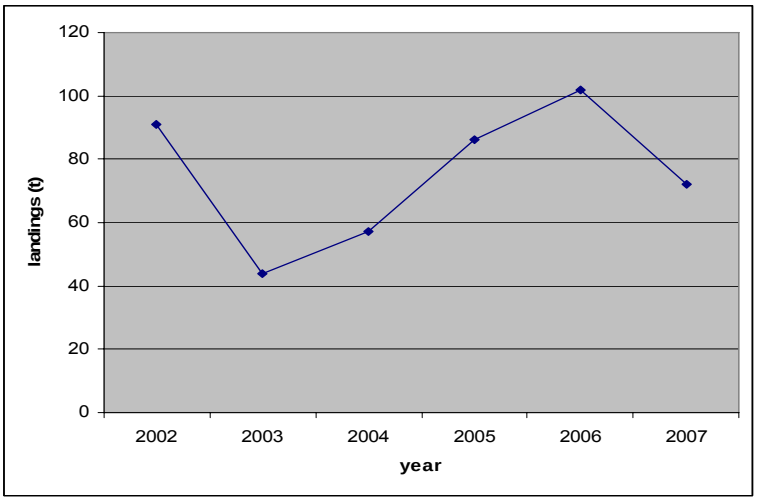


Fig. 7.3.2.3.1.1 Annual hake landings (t) by Spanish trawlers.

7.3.2.3.2. Discards

Reported discards through the DCR data call to SGMED-08-03 varied among 5 and 10 t annually during 2002 to 2007. The data are listed in Table A3.4 of Appendix 3.

7.3.2.3.3. Fishing effort

No data on fishing effort were available at the meeting. STECF (stock review part II in 2007) 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).

7.3.3.Scientific surveys

7.3.3.1. Medits

7.3.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 05 the following number of hauls were reported per depth stratum (s. Tab. 7.3.3.1.1.1)

Tab. 7.3.3.1.1.1. Number of hauls per year and depth stratum in GSA 05, 1994-2007

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

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.

7.3.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.3.3.1.3. 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 7.3.3.1.3.1 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.

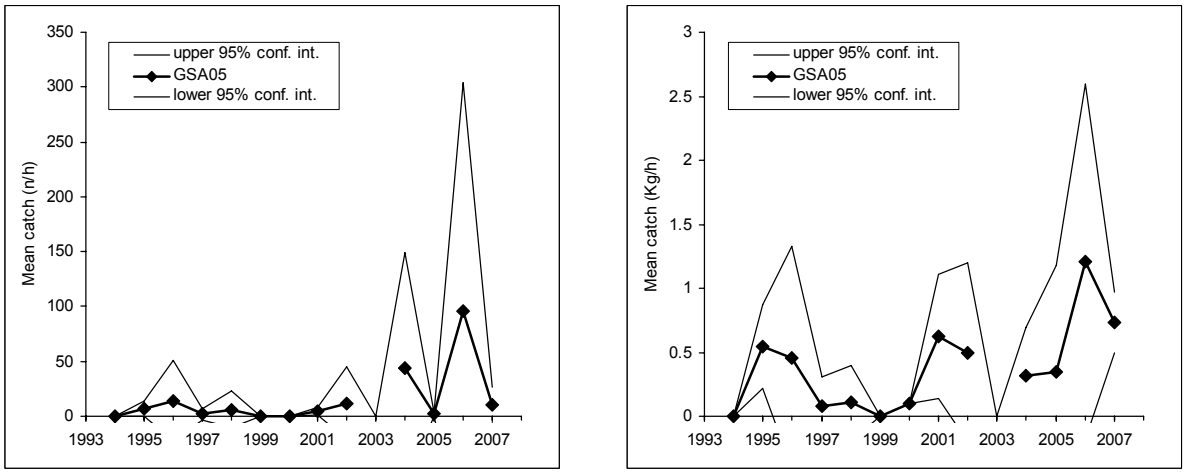
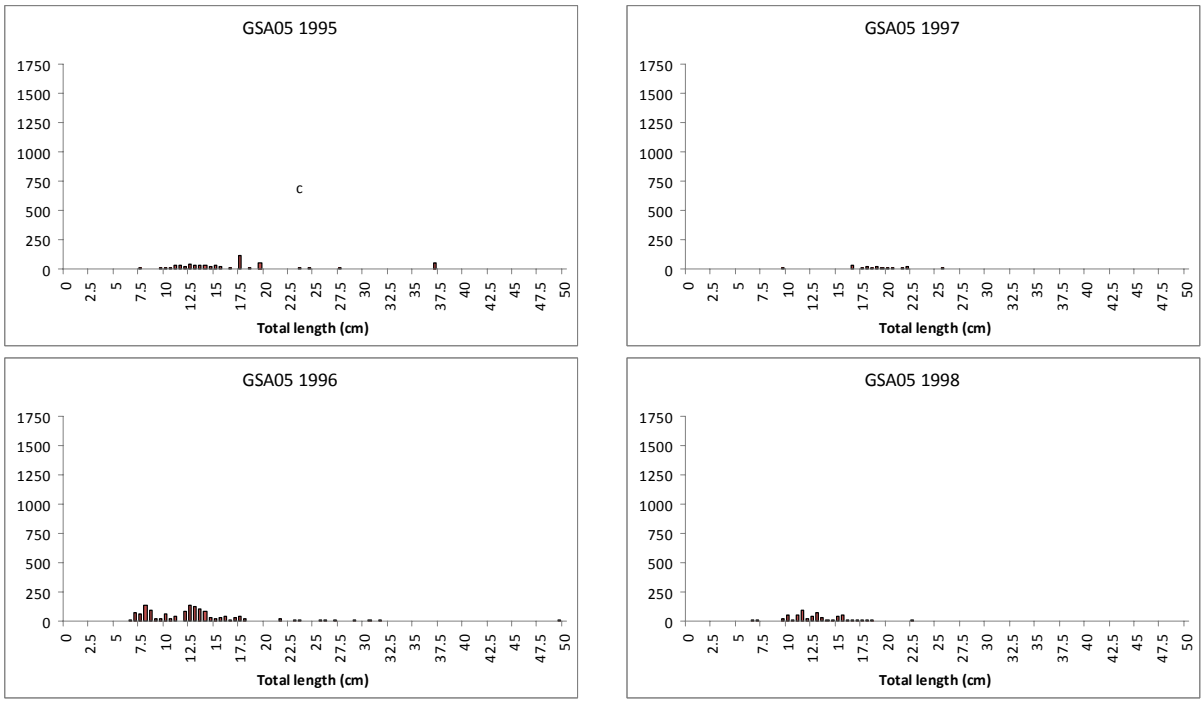


Fig. 7.3.3.1.3.1 Abundance and biomass indices of hake in GSA 05.

7.3.3.1.4. Trends in abundance by length or age

The following Fig. 7.3.3.1.4.1 and 2 display the stratified abundance indices of GSA 05 in 1995-2004 and 2005-2007. These size compositions are considered preliminary.



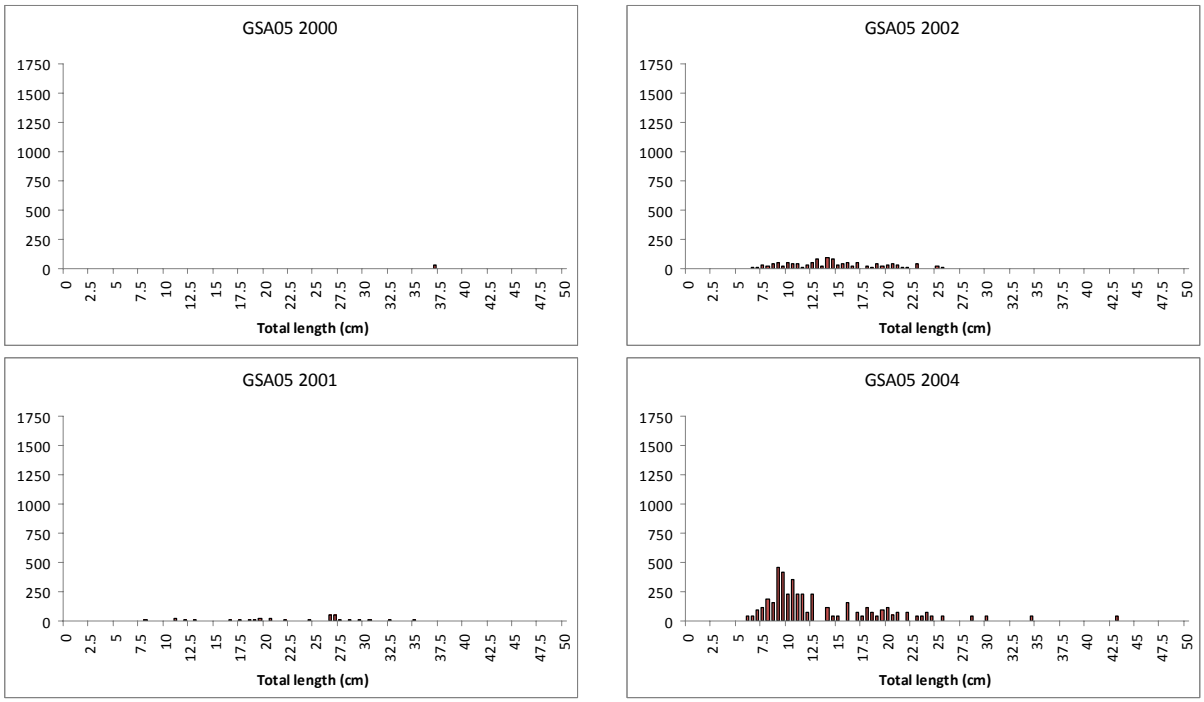


Fig. 7.3.3.1.4.1 Stratified abundance indices by size, 1995-2004.

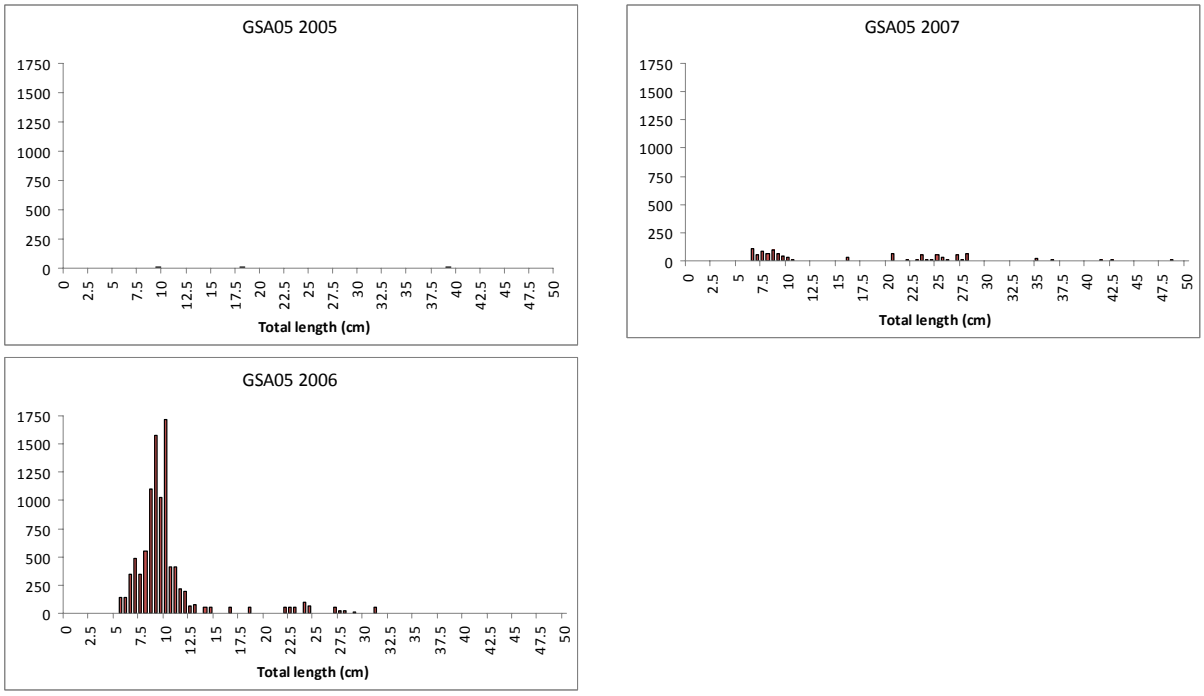


Fig. 7.3.3.1.4.2 Stratified abundance indices by size, 2005-2007.

7.3.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.3.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.3.4. Assessment of historic stock parameters

SGMED-08-03 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.icm.csic.es/rec/projectes/scsa/Demersals_2007/open documents.zip
for GSA05 open Doc05-HKE0507Gui.xls

7.3.5. Short term prediction for 2008 and 2009

7.3.5.1. Justification

No forecast analyses were conducted.

7.3.5.2. Input parameters

No forecast analyses were conducted.

7.3.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSA 05.

7.3.6. Medium term prediction

7.3.6.1. Justification

No forecast analyses were conducted.

7.3.6.2. Input parameters

No forecast analyses were conducted.

7.3.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for hake in GSA 05.

7.3.7. Long term prediction

7.3.7.1. Justification

No forecast analyses were conducted.

7.3.7.2. Input parameters

No forecast analyses were conducted.

7.3.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 05.

7.3.8. Scientific advice

7.3.8.1. Short term considerations

7.3.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.3.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.3.8.1.3. State of exploitation

SGMED-08-03 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.

7.3.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.4. Stock assessment of hake in GSA 06

7.4.1.Stock identification and biological features

7.4.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.4.1.2. Growth

No information was documented during SGMED-08-03.

7.4.1.3. Maturity

No information was documented during SGMED-08-03.

7.4.2.Fisheries

7.4.2.1. 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 6). In the last years, the annual landings of this species, which are mainly composed by juveniles living on the continental shelf, were situated around 3,800 tonnes in the whole area.

7.4.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.4.2.3. Catches

7.4.2.3.1. Landings

Fig. 7.4.2.3.1.1 shows the trend in reported landings taken by trawlers (Spain only). The data were reported to SGMED-08-03 through the Data Collection Regulation and are listed in Table A3.1 of Appendix 3. The annual landings increased from 3,400 t in 2005 to 3,700 t in 2007.

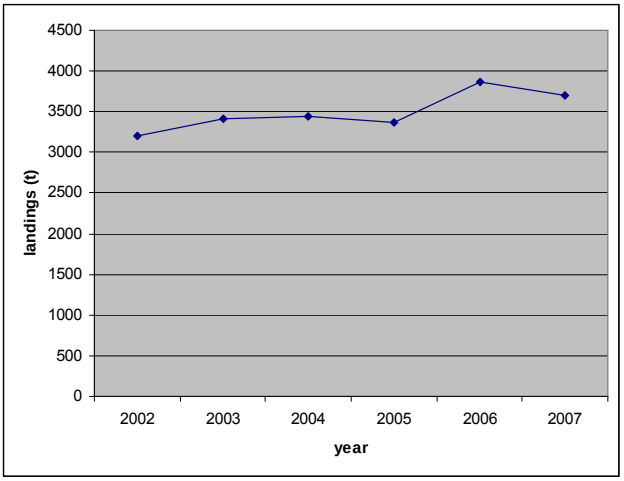


Fig. 7.4.2.3.1.1 Annual hake landings (t) by Spanish trawlers.

7.4.2.3.2. Discards

Reported discards through the DCR data call to SGMED-08-03 amount 80 t in 2005. The data are listed in Table A3.4 of Appendix 3.

7.4.2.3.3. Fishing effort

No data on fishing effort were available at the meeting. STECF (stock review part II in 2007) noted that the trawl fishery off northern Spain (GSA 06) is carried out by around 647 vessels.

7.4.3.Scientific surveys

7.4.3.1. Medits

7.4.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 06 the following number of hauls were reported per depth stratum (s. Tab. 7.4.3.1.1.1).

Tab. 7.4.3.1.1.1. Number of hauls per year and depth stratum in GSA 06, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA06_010-050	7	8	7	7	7	8	9	8	11	9	9	11	11	6
GSA06_050-100	19	26	26	26	28	29	29	31	36	38	31	32	34	27
GSA06_100-200	11	17	17	15	13	17	18	20	20	21	17	18	19	15
GSA06_200-500	10	12	10	12	7	13	12	16	17	18	16	15	18	11
GSA06_500-800	6	8	9	7	4	9	6	8	7	11	11	8	10	8

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.

7.4.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.4.3.1.3. 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 7.4.3.1.3.1 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 year 2007, when the indices suddenly decreased to the lowest level obsered. The analyses of Medits indices are considered preliminary.

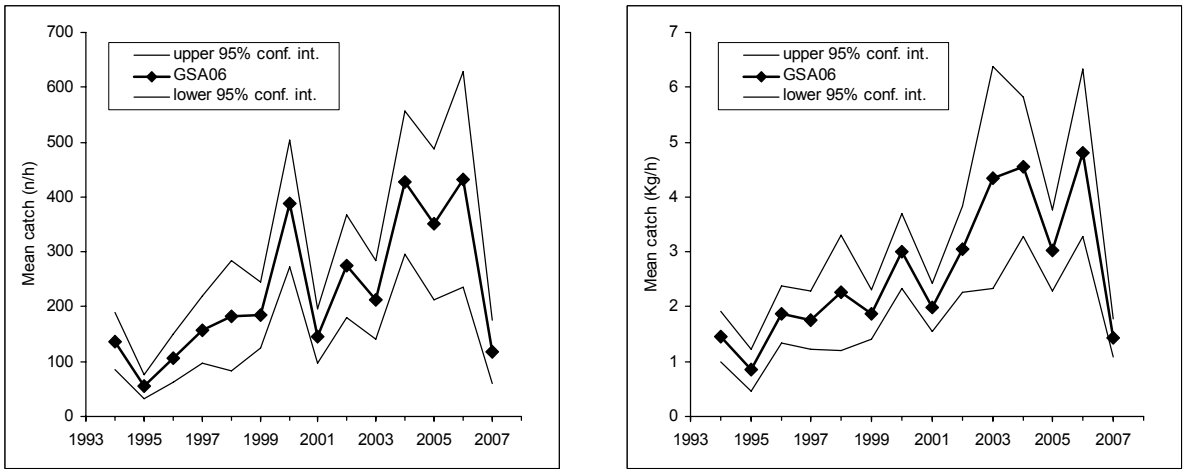


Fig. 7.4.3.1.3.1 Abundance and biomass indices of hake in GSA 06.

7.4.3.1.4. Trends in abundance by length or age

The following Fig. 7.4.3.1.4.1 and 2 display the stratified abundance indices of GSA 06 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

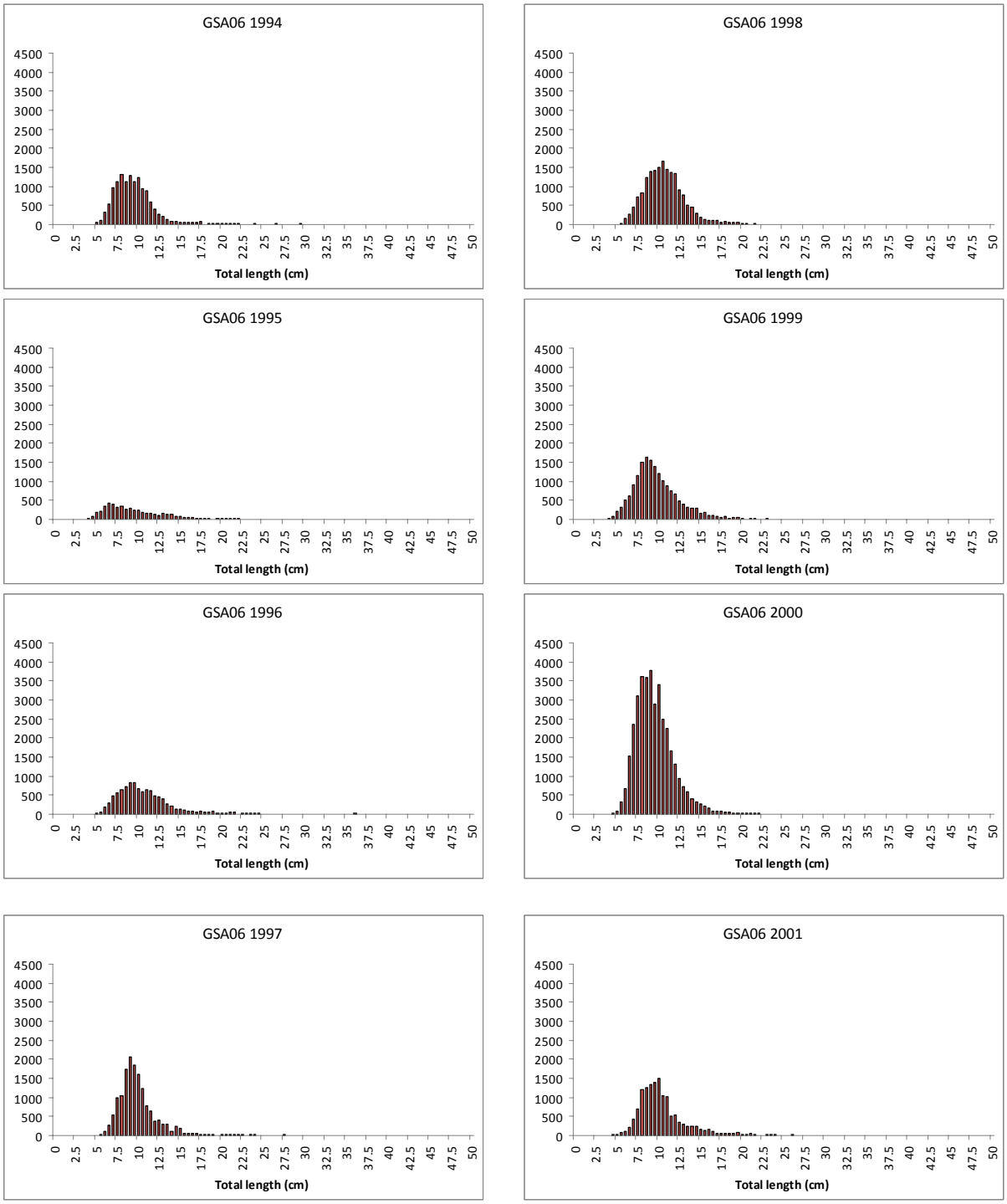


Fig. 7.4.3.1.4.1 Stratified abundance indices by size, 1994-2001.

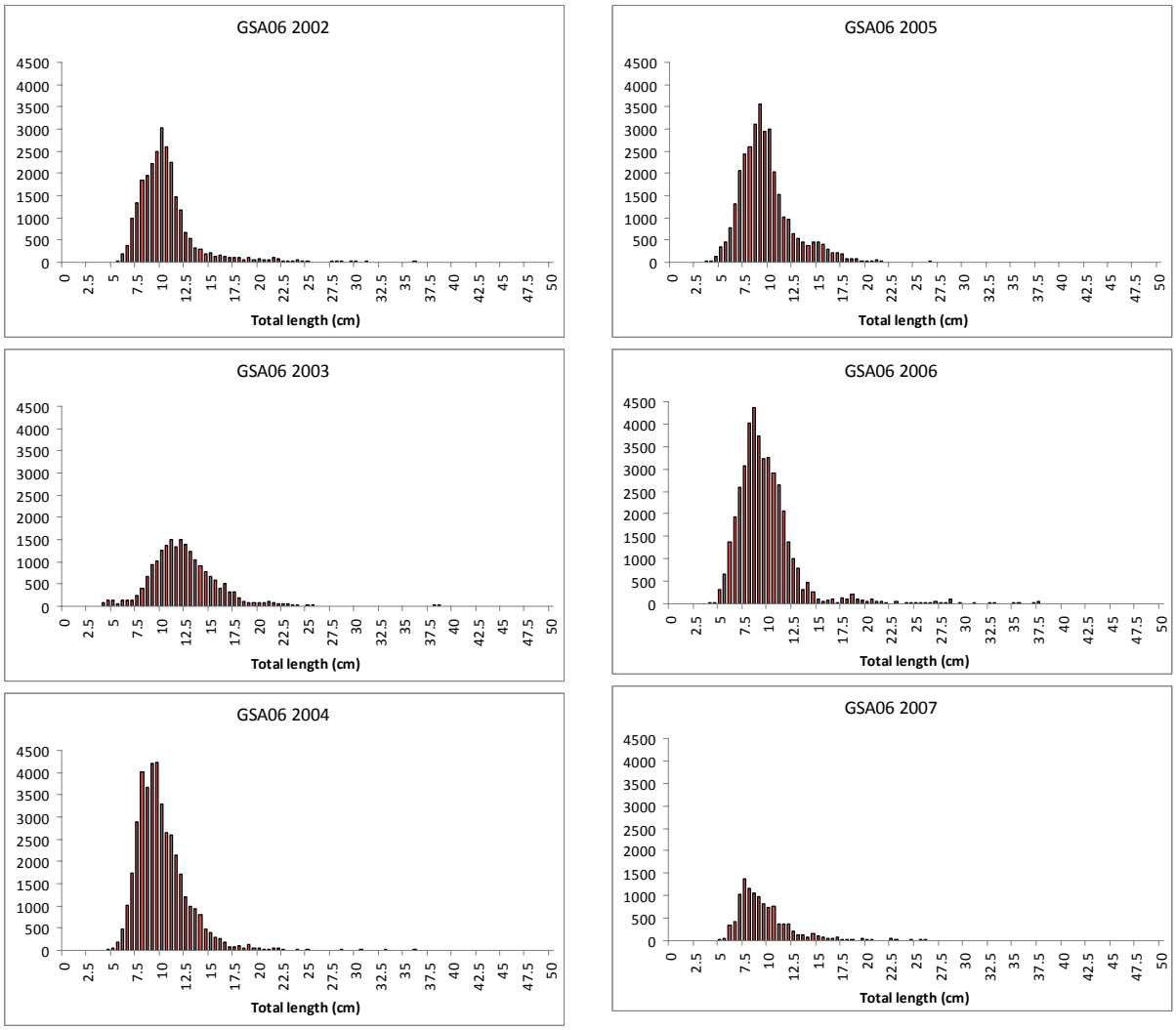


Fig. 7.4.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.4.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.4.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.4.4.Assessment of historic stock parameters

SGMED-08-03 did not undertake any analytical assessment. It was noted that hake in GSA 06 was assessed in 2007 and presented to SCSA/SAC/GFCM. This assessment can be viewed at:

http://www.icm.csic.es/rec/projectes/scsa/Demersals_2007/open documents.zip
for GSA06 open Doc06-HKE0607Gar.xls

7.4.5.Short term prediction for 2008 and 2009

7.4.5.1. Justification

No forecast analyses were conducted.

7.4.5.2. Input parameters

No forecast analyses were conducted.

7.4.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSA 06.

7.4.6. Medium term prediction

7.4.6.1. Justification

No forecast analyses were conducted.

7.4.6.2. Input parameters

No forecast analyses were conducted.

7.4.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for hake in GSA 06.

7.4.7. Long term prediction

7.4.7.1. Justification

No forecast analyses were conducted.

7.4.7.2. Input parameters

No forecast analyses were conducted.

7.4.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 06.

7.4.8. Scientific advice

7.4.8.1. Short term considerations

7.4.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.4.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.4.8.1.3. State of exploitation

SGMED-08-03 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.

7.4.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.5. Stock assessment of hake in GSA 07

7.5.1.Stock identification and biological features

7.5.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.5.1.2. Growth

No information was documented during SGMED-08-03.

7.5.1.3. Maturity

No information was documented during SGMED-08-03.

7.5.2.Fisheries

7.5.2.1. 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

tonnes 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).

7.5.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.5.2.3. Catches

7.5.2.3.1. Landings

SGMED-08-03 received French landings data for GSA 07 which are listed in Tab. 7.5.2.3.1.1. Otter trawls dominate the landings which have stabilized around 1,100 t and 1,400 t since 2004 after a major decrease by about one third. The trend in landings is shown in Fig. 7.5.2.3.1.1. The data are listed in Table A3.1 of Appendix 3.

No Spanish data for GSA 07 were provided.

Table 7.5.2.3.1.1 French landings (t) by year and major gear types, 2002-2004 as reported through DCR.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
HKE	7	FRA	GNS	177	248	99	255	299	168
HKE	7	FRA	LLS	5					
HKE	7	FRA	OTB	2163	2029	1018	995	1011	1277
Sum				2345	2277	1117	1250	1310	1445

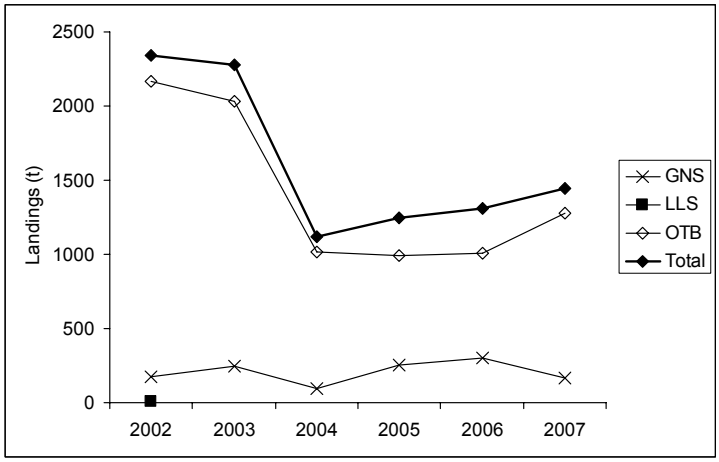


Fig. 7.5.2.3.1.1 Annual hake landings (t) by French fisheries.

7.5.2.3.2. Discards

Reported discards through the DCR data call to SGMED-08-03 vary among 16-56 t in 2003-2007. The data are listed in Table A3.4 of Appendix 3.

7.5.2.3.3. 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. 7.5.2.3.3.1 and shown in Fig. 7.5.2.3.3.1 for trawls only in terms of kW*days, as the gill net figures appear inconsistent. The fishing effort in kW*days appear quite stable during 2004-2006.

No Spanish effort data for GSA 07 were provided.

Tab. 7.5.2.3.3.1 Trend in fishing effort (days, GT*days, kW*days) for France by major gear types, 2004-2006.

TYPE	AREA	COUNTRY	FT_LVL4	2004	2005	2006
DAYS	7	FRA	GNS	81460	76785	93193
DAYS	7	FRA	LLS	6459	6593	5028
DAYS	7	FRA	OTB	20561	19327	17991
GT*DAYS	7	FRA	GNS	329230	305685	315704
GT*DAYS	7	FRA	LLS	23742	23436	17232
GT*DAYS	7	FRA	OTB	1610963	1480834	1322919
KW*DAYS	7	FRA	GNS	7007171	5908142	88698170
KW*DAYS	7	FRA	LLS	669338	716765	385004
KW*DAYS	7	FRA	OTB	6361248	5923541	6127438

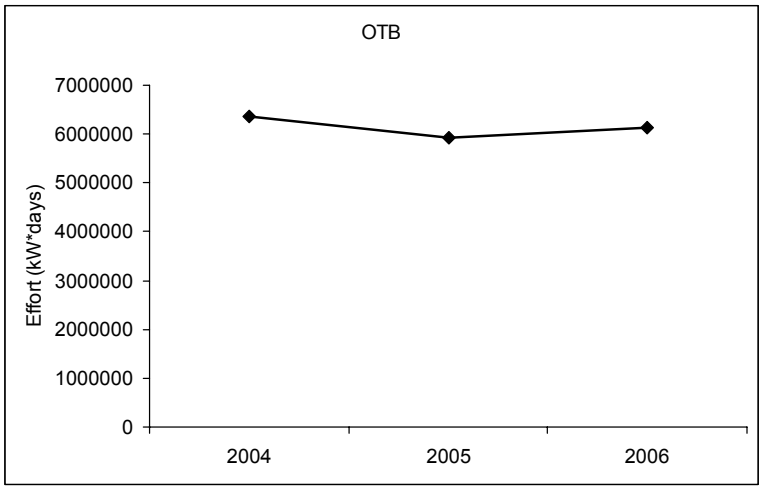


Fig. 7.5.2.3.3.1 Trend in fishing effort (kW*days) for France trawlers, 2004-2006.

7.5.3.Scientific surveys

7.5.3.1. Medits

7.5.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 07 the following number of hauls were reported per depth stratum (s. Tab. 7.5.3.1.1.1).

Tab. 7.5.3.1.1.1. Number of hauls per year and depth stratum in GSA 06, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA07_010-050	12	12	12	14	12	12	12	12	12	13	12	12	12	14
GSA07_050-100	32	32	32	35	39	32	32	32	31	38	31	30	33	31
GSA07_100-200	10	9	9	9	9	9	10	9	9	10	13	11	10	10
GSA07_200-500	6	6	5	5	5	5	5	6	4	5	5	5	5	5
GSA07_500-800	8	7	4	5	4	4	6	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.

7.5.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.5.3.1.3. 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 7.5.3.1.3.1 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. The analyses of Medits indices are considered preliminary.

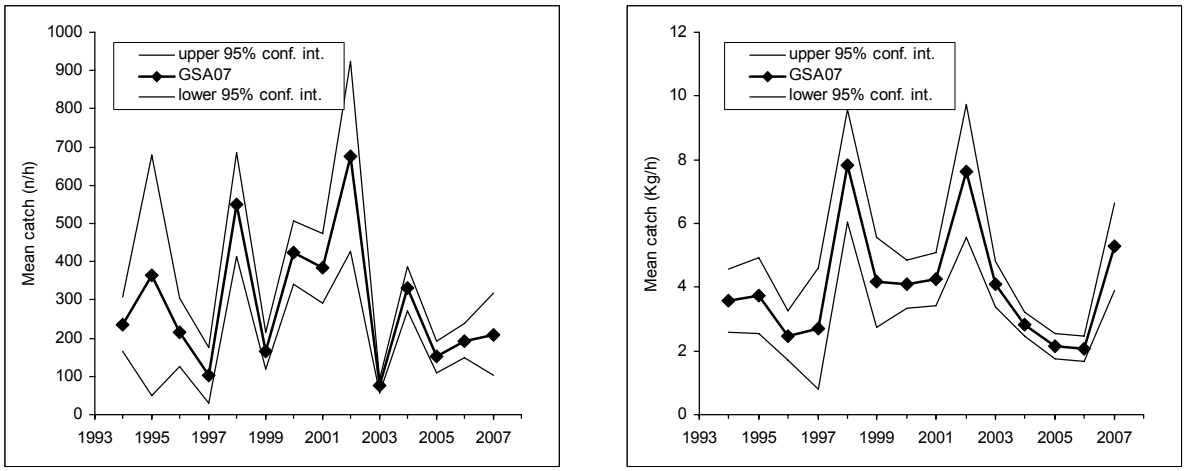


Fig. 7.5.3.1.3.1 Abundance and biomass indices of hake in GSA 07.

7.5.3.1.4. Trends in abundance by length or age

The following Fig. 7.5.3.1.4.1 and 2 display the stratified abundance indices of GSA 07 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

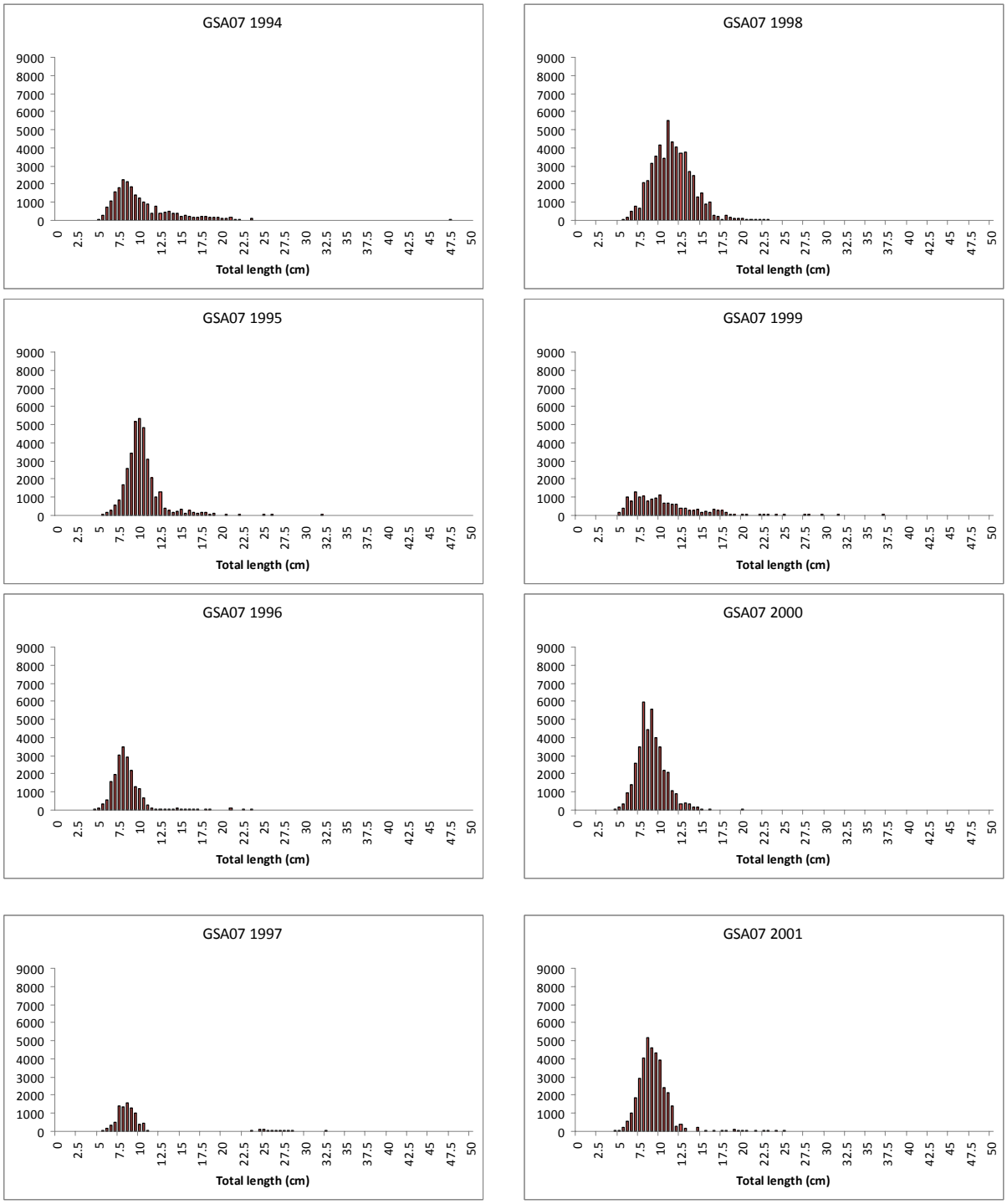


Fig. 7.5.3.1.4.1 Stratified abundance indices by size, 1994-2001.

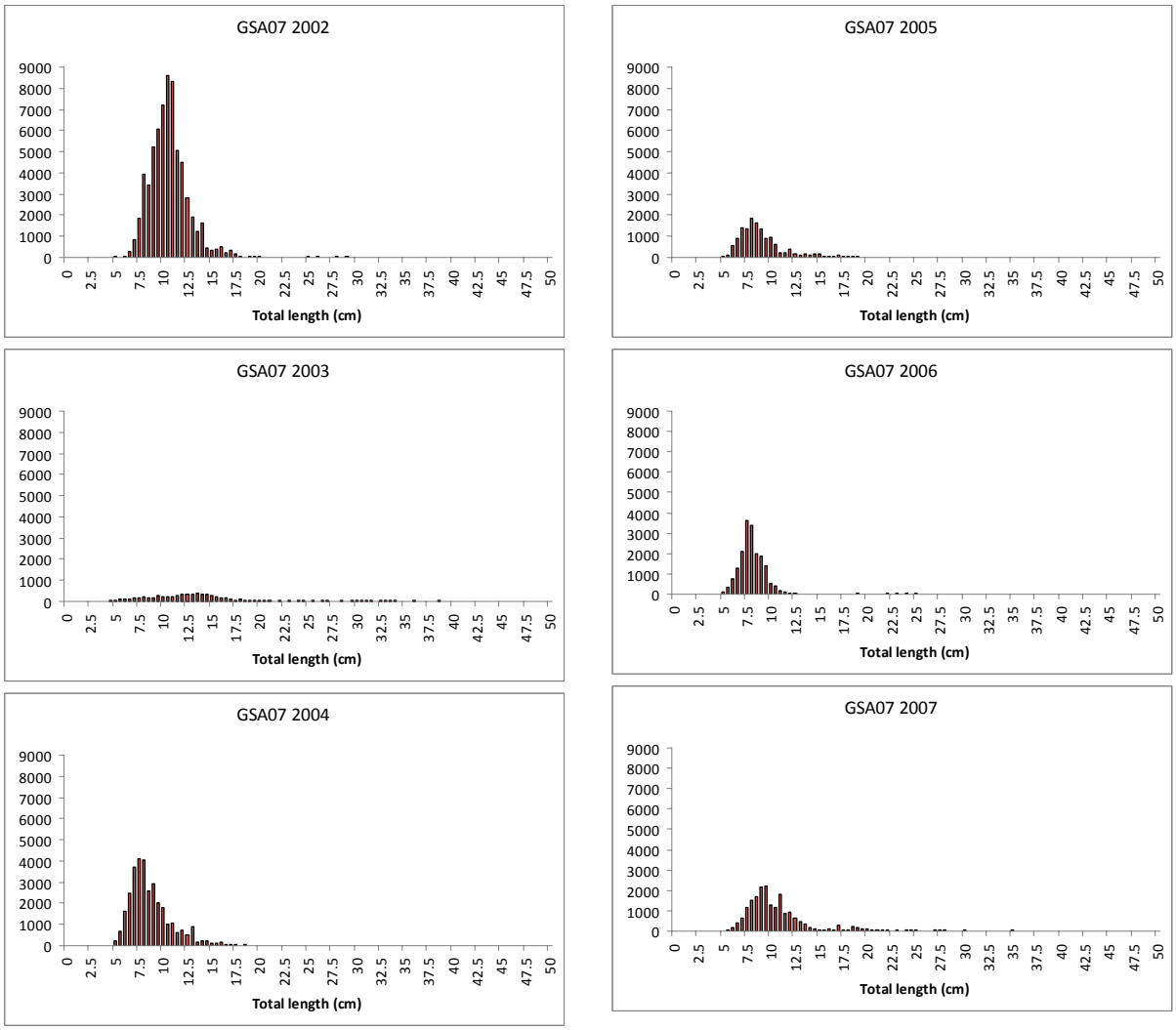


Fig. 7.5.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.5.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.5.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.5.4.Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.5.5.Short term prediction for 2008 and 2009

7.5.5.1. Justification

No forecast analyses were conducted.

7.5.5.2. Input parameters

No forecast analyses were conducted.

7.5.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSA 07.

7.5.6. Medium term prediction

7.5.6.1. Justification

No forecast analyses were conducted.

7.5.6.2. Input parameters

No forecast analyses were conducted.

7.5.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for hake in GSA 07.

7.5.7. Long term prediction

7.5.7.1. Justification

No forecast analyses were conducted.

7.5.7.2. Input parameters

No forecast analyses were conducted.

7.5.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 07.

7.5.8. Scientific advice

7.5.8.1. Short term considerations

7.5.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.5.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.5.8.1.3. State of exploitation

SGMED-08-03 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.

7.5.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.6. Stock assessment of hake in GSA 08

7.6.1.Stock identification and biological features

7.6.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.6.1.2. Growth

No information was documented during SGMED-08-03.

7.6.1.3. Maturity

No information was documented during SGMED-08-03.

7.6.2.Fisheries

7.6.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.6.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.6.2.3. Catches

7.6.2.3.1. Landings

No information was documented during SGMED-08-03.

7.6.2.3.2. Discards

No information was documented during SGMED-08-03.

7.6.2.3.3. Fishing effort

No information was documented during SGMED-08-03.

7.6.3.Scientific surveys

7.6.3.1. Medits

7.6.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

SGMED-08-03 notes that the reported Medits data in GSA 08 only cover the eastern coast of Corsica. In GSA 08 the following number of hauls were reported per depth stratum (s. Tab. 7.6.3.1.1.1).

Tab. 7.6.3.1.1.1. Number of hauls per year and depth stratum in GSA 08, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA08_010-050	3													
GSA08_050-100	5	5	7	3	7	6	5	5		6	6	7	7	5
GSA08_100-200	3	5	4	2	5	5	5	5	1	5	5	5	5	3
GSA08_200-500	9	11	12	8	12	10	11	10		10	10	10	11	8
GSA08_500-800	5	5	4	4	4	5	4	5		4	5	5	4	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.

7.6.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.6.3.1.3. 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-08-03 notes that the reported Medits data in GSA 08 only cover the eastern coast of Corsica. Figure 7.6.3.1.3.1 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.

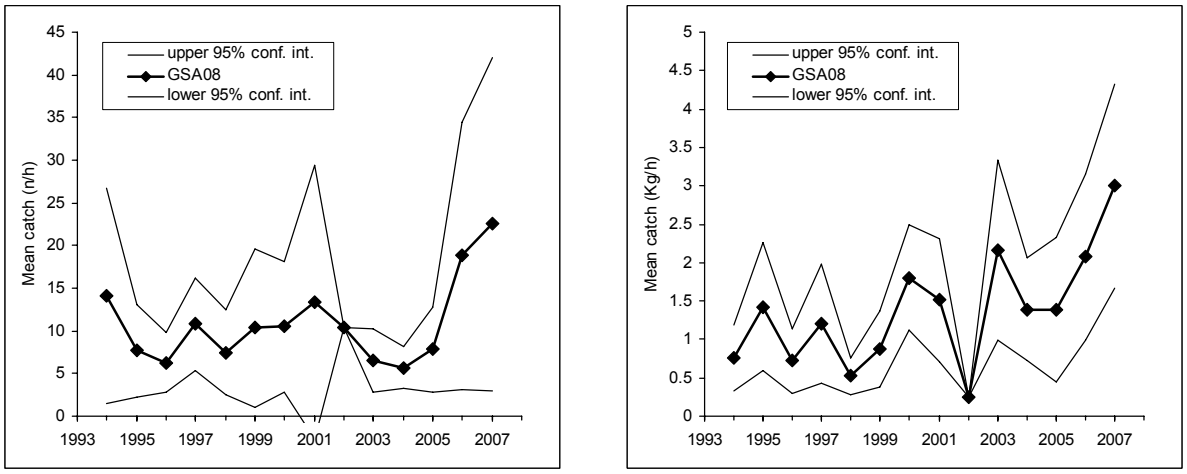


Fig. 7.6.3.1.3.1 Abundance and biomass indices of hake in GSA 08.

7.6.3.1.4. Trends in abundance by length or age

The following Fig. 7.6.3.1.4.1 and 2 display the stratified abundance indices of GSA 08 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

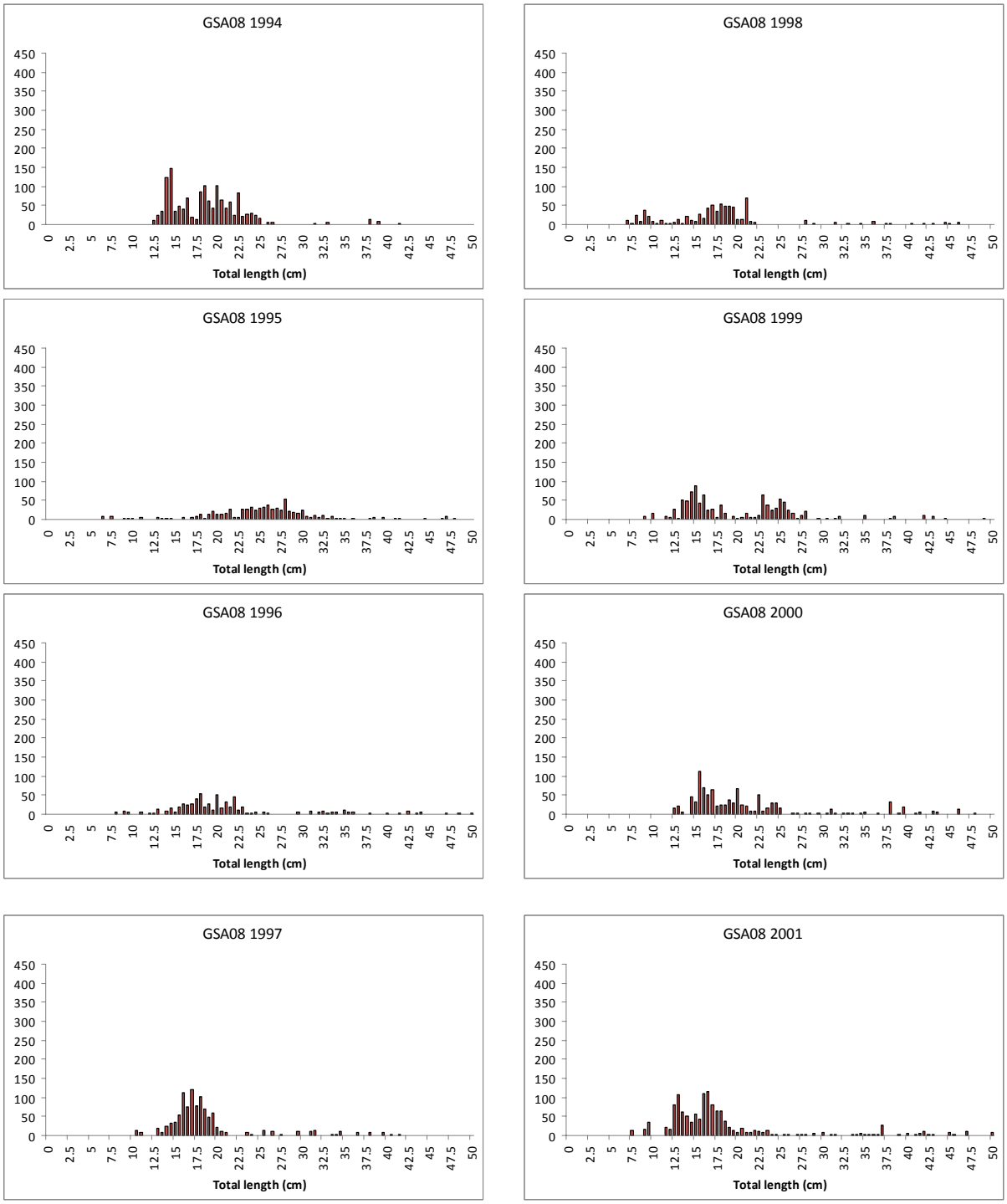


Fig. 7.6.3.1.4.1 Stratified abundance indices by size, 1994-2001.

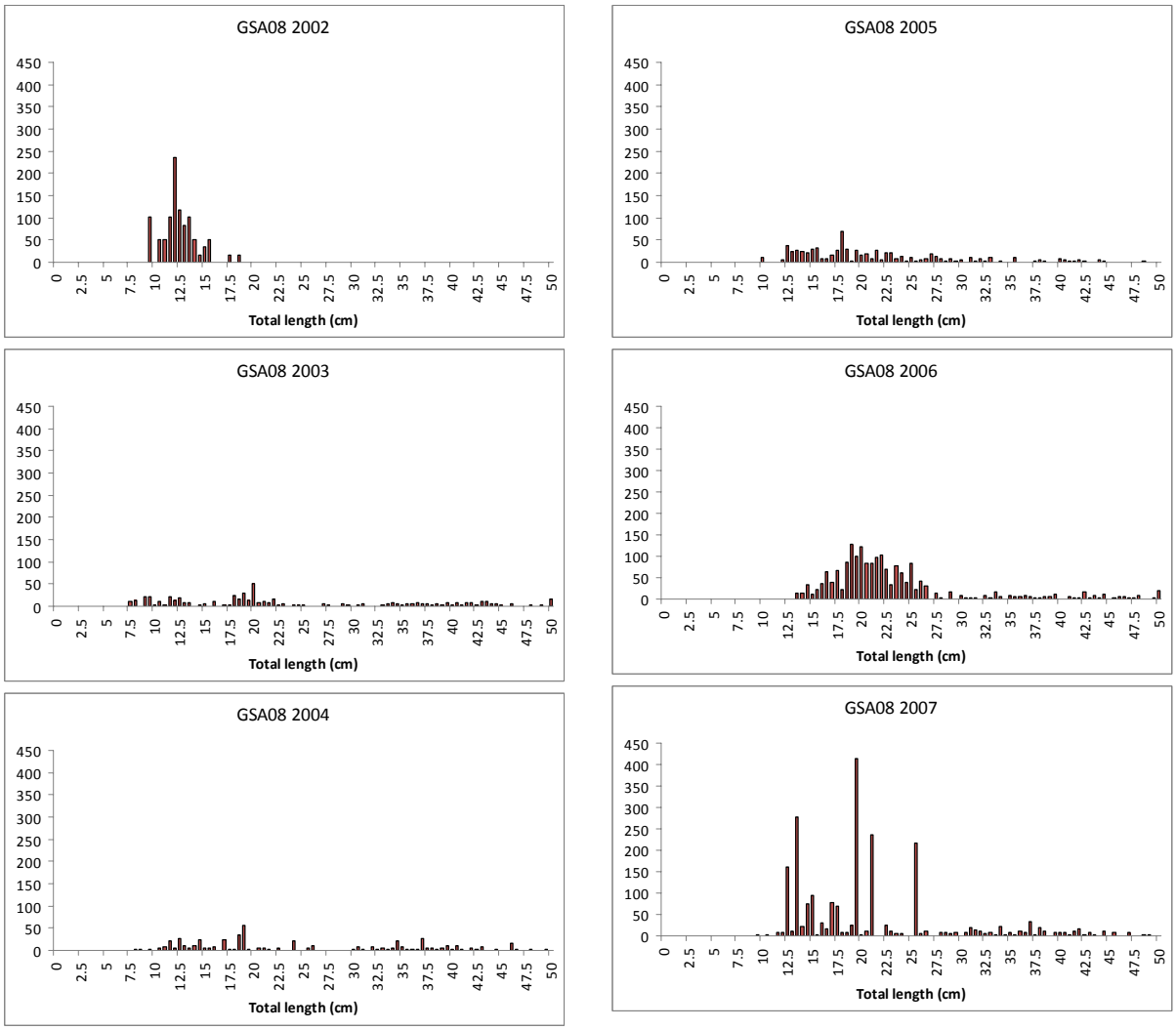


Fig. 7.6.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.6.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.6.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.6.4.Assessment of historic stock parameters

SGMED-08-03 did not undertake any analytical assessment.

7.6.5.Short term prediction for 2008 and 2009

7.6.5.1. Justification

No forecast analyses were conducted.

7.6.5.2. Input parameters

No forecast analyses were conducted.

7.6.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSA 08.

7.6.6. Medium term prediction

7.6.6.1. Justification

No forecast analyses were conducted.

7.6.6.2. Input parameters

No forecast analyses were conducted.

7.6.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for hake in GSA 08.

7.6.7. Long term prediction

7.6.7.1. Justification

No forecast analyses were conducted.

7.6.7.2. Input parameters

No forecast analyses were conducted.

7.6.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 08.

7.6.8. Scientific advice

7.6.8.1. Short term considerations

7.6.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.6.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.6.8.1.3. State of exploitation

SGMED-08-03 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.

7.6.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.7. Stock assessment of hake in GSA 09

7.7.1.Stock identification and biological features

7.7.1.1. 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 9 boundaries. Hake is distributed in the whole area between 10 and 800 m depth (Biagi et al., 2003; 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 palangium*) 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 (nurseries) showing a high spatio-temporal persistence (Abella et al., 2005; Colloca et al., 2006, Jona Lasinio et al., 2007) (Fig. 7.7.1.1.1) in areas with frontal terms and other oceanographic structures that can enhance larval retention (Abella et al., 2008).

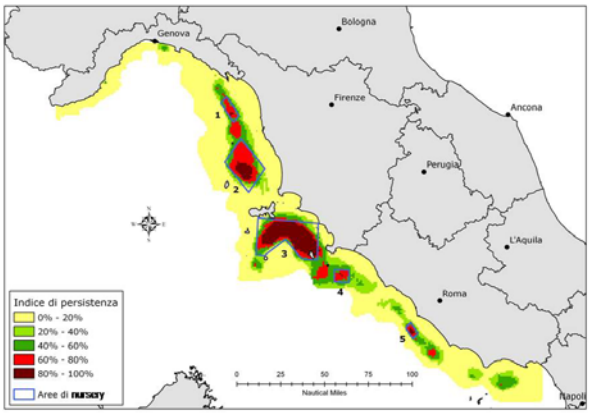
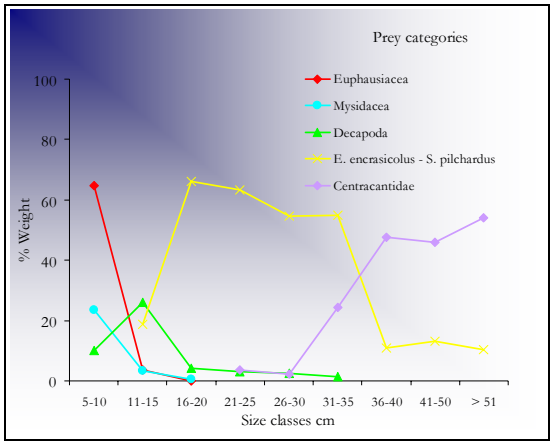


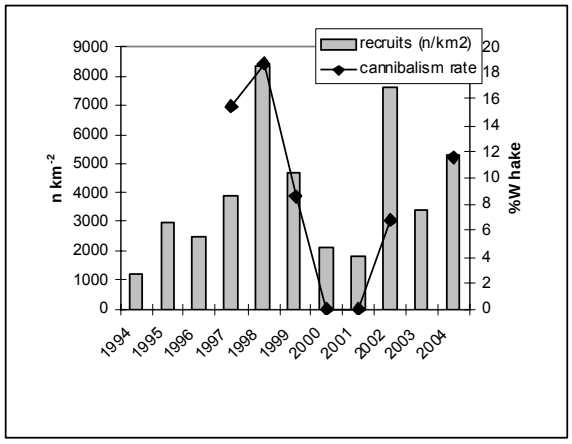
Fig 7.7.1.1.1 Temporal persistence of hake nurseries calculated from Medits and Grund time-series density maps (1994-2005) of juveniles.

Although hakes are demersal fish, they feed typically upon prey that are fast-moving pelagics, 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 9 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 icthyophagous 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. 7.7.1.1.2).



A)



B)

Fig. 7.7.1.1.2 A) Hake diet composition in GSA 9 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%.

7.7.1.2. 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 9 seems to follow the pattern estimated in the NW Mediterranean (Garcia-Rodriguez and Esteban, 2002) adopting the hypothesis that two rings are laid down within otoliths each year. This new interpretation of otolith ring patterns returns a growth rate ($L\infty$ = 103.9, K/year = 0.212, to =0.031) double than that assumed in the past.

As showed in the Fig. 7.7.1.2.1, cohorts obtained through age slicing of LFDS MEDITS data according to fast growth parameters, can be consistently followed during time, while an unreliable pattern was obtained according to the slow growth parameters.

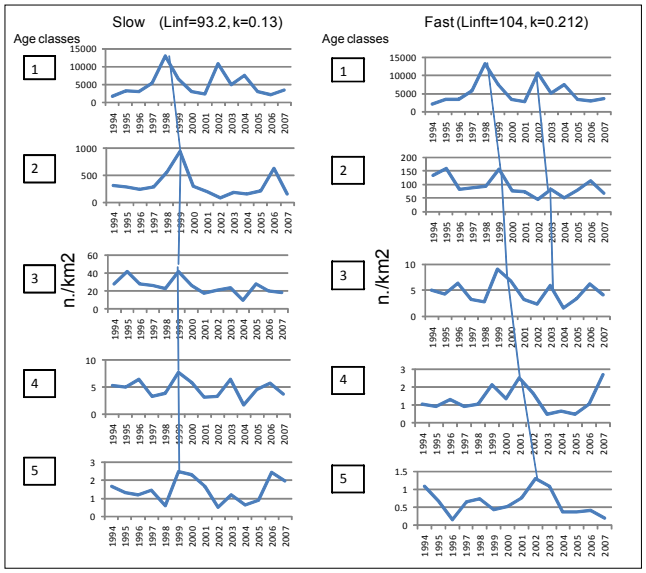


Fig. 7.7.1.2.1 Trends in abundance of age classes obtained using age slicing according to two different sets of growth parameters on Medits data.

7.7.1.3. Maturity

The catchability of hake spawners to the Mediterranean trawl nets is rather limited. Either the distribution of adults is in deeper and untrawable areas, or the ability of larger fish to avoid capture have been claimed as causes of the observed 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 pattern 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 GSA9 (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., in press) 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 GSA9, in particular in northern Tyrrhenian Sea.

Female length at first maturity was estimated at 35.1 cm TL in northern Tyrrhenian Sea (Recasens et al., in press.). This value is consistent with the observations obtained from trawl surveys over the Latium (Colloca, pers. comm.) reporting first maturity from 31 to 37 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., in press).

7.7.2.Fisheries

7.7.2.1. General description of fisheries

Hake is 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 is due to bottom trawl vessels; the remaining fraction is provided by artisanal vessels using set nets, in particular gillnets.

The trawl fleet of GSA9 at the end of 2006 accounted for 361 vessels (Tab. 7.7.2.1.1).

The main trawl fleets of GSA9 are present in the following continental harbours: Viareggio, Livorno, Porto Santo Stefano (Tuscany), Fiumicino, Terracina, Gaeta (Latium).

Tab. 7.7.2.1.1 Technical characteristics of the trawl fleet of GSA 09 (year 2006, 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 performs daily fishing trips; only some vessels can stay out of the port for two-three days, especially in summer.

Hake fishing grounds comprise all the soft bottoms of continental shelfs and the upper part of continental slope. Fishing pressure shows some geographical differences inside the GSA9 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; widespread in many harbours along the continental and insular coasts. Of these, about 50 vessels, located in some harbors of the GSA 09 (e.g. Marina di Campo, Ponza, Porto Santo Stefano), especially from winter to summer, utilize gillnets and target medium and large sized hakes (greather than 25 cm TL).

7.7.2.2. Management regulations applicable in 2007 and 2008

- 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). In both areas fishing gears operating on the bottom are not allowed.

7.7.2.3. Catches

7.7.2.3.1. Landings

In the last five years the total landings of hake of GSA 09 fluctuated between 1,000 to about 2,300 tons, and even though the time series is short the general shape suggests an increasing trend (Fig. 7.7.2.3.1.1).

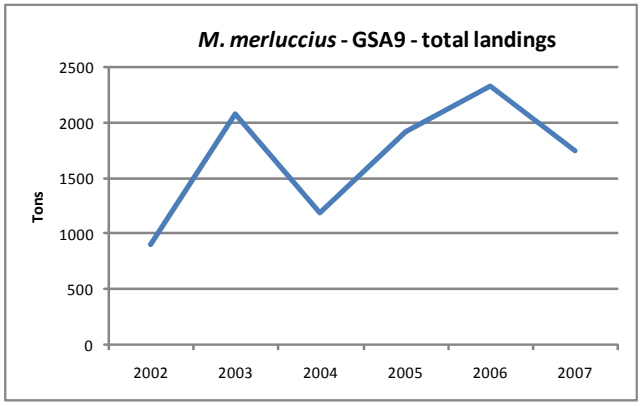


Fig. 7.7.2.3.1.1 Landings of hake (all gears) in the GSA 09, from 2002 to 2007 (DCR official data).

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 year old individuals. Gillnet fishery lands mostly 2 and 3 years old fish, as shown by the two following histograms (Fig. 7.7.2.3.1.2).

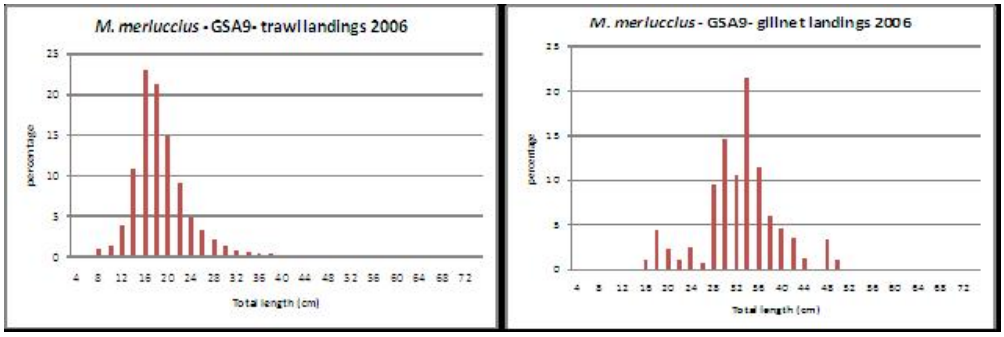


Fig. 7.7.2.3.1.2 Size structure of the landings of hake provided in 2006 by otter trawling and by set nets in the GSA 09 (DCR official data).

The landings data were reported to SGMED-08-03 through the Data Collection Regulation and are listed in Table A3.1 of Appendix 3 by major gear types.

7.7.2.3.2. 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. 7.7.2.3.2.1).

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).

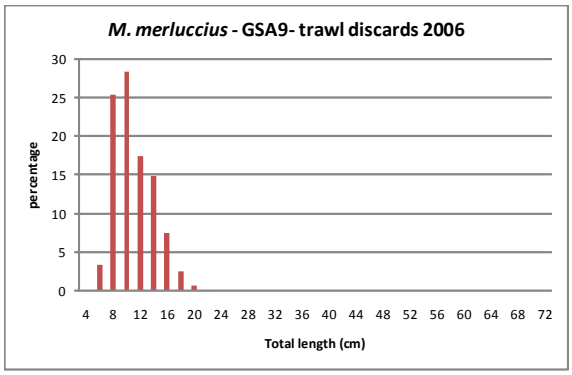


Fig. 7.7.2.3.2.1 Size structure of the hake discarded by the trawl fleets operating in the GSA9 in 2006 (DCR official data).

Reported discards through the DCR data call to SGMED-08-03 amount 467 t in 2006 for trawlers. The data are listed in Table A3.4 of Appendix 3.

7.7.2.3.3. 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 GSA9 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. 7.7.2.3.3.1), a little decrease of the mean number of fishing days/year per vessel was observed in this period, from 187 to 177.

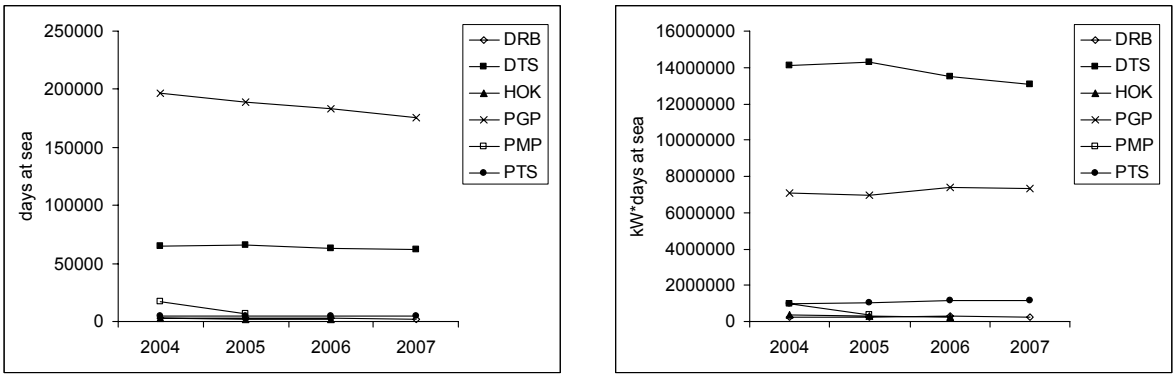


Fig. 7.7.2.3.3.1 Effort trends (days and kW*days) by major fleets, 2004-2007. The data are listed in Tables A3.5 and A3.7 of Appendix 3.

7.7.3.Scientific surveys

7.7.3.1. Medits

7.7.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 09 the following number of hauls were reported per depth stratum (s. Tab. 7.7.3.1.1.1).

Tab. 7.7.3.1.1.1. Number of hauls per year and depth stratum in GSA 09, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA09_010-050	19	18	18	18	19	18	18	18	13	13	13	14	13	13
GSA09_050-100	19	19	18	19	18	19	20	20	15	15	15	14	16	16
GSA09_100-200	35	35	36	35	35	35	34	34	26	27	26	27	25	26
GSA09_200-500	32	33	33	36	32	36	37	35	27	27	27	28	29	33
GSA09_500-800	31	30	31	28	30	28	27	29	24	22	21	20	20	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.

7.7.3.1.2. Geographical distribution patterns

According to recent studies (Orsi Relini et al., 2002), the density of hake recruits concentrations in nursery areas in GSA9 is by far higher than that of the other GSAs of the western Mediterranean and, probably, also of the other Mediterranean GSAs (Fig. 7.7.3.1.2.1).

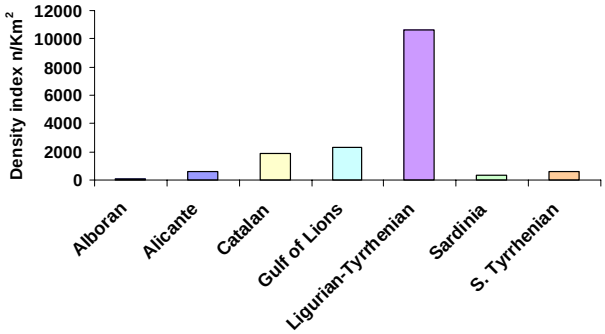


Fig. 7.7.3.1.2.1 MEDITS density indices of the hake recruits (<12 cm TL) obtained in different Mediterranean GSAs (from Orsi-Relini et al., 2002, modified).

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, characterised 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. 7.7.3.1.2.2).

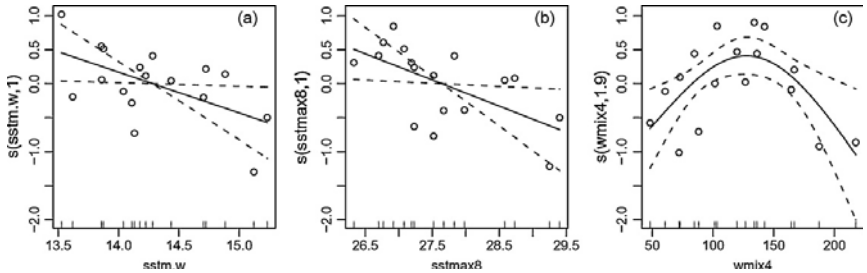


Fig. 7.7.3.1.2.2 Effects of: (a) sstm.w, (b) sstmax8 and (c) wmix4 on hake recruitment in the central Tyrrhenian (from Bartolino et al., 2007).

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. 7.7.3.1.2.3).

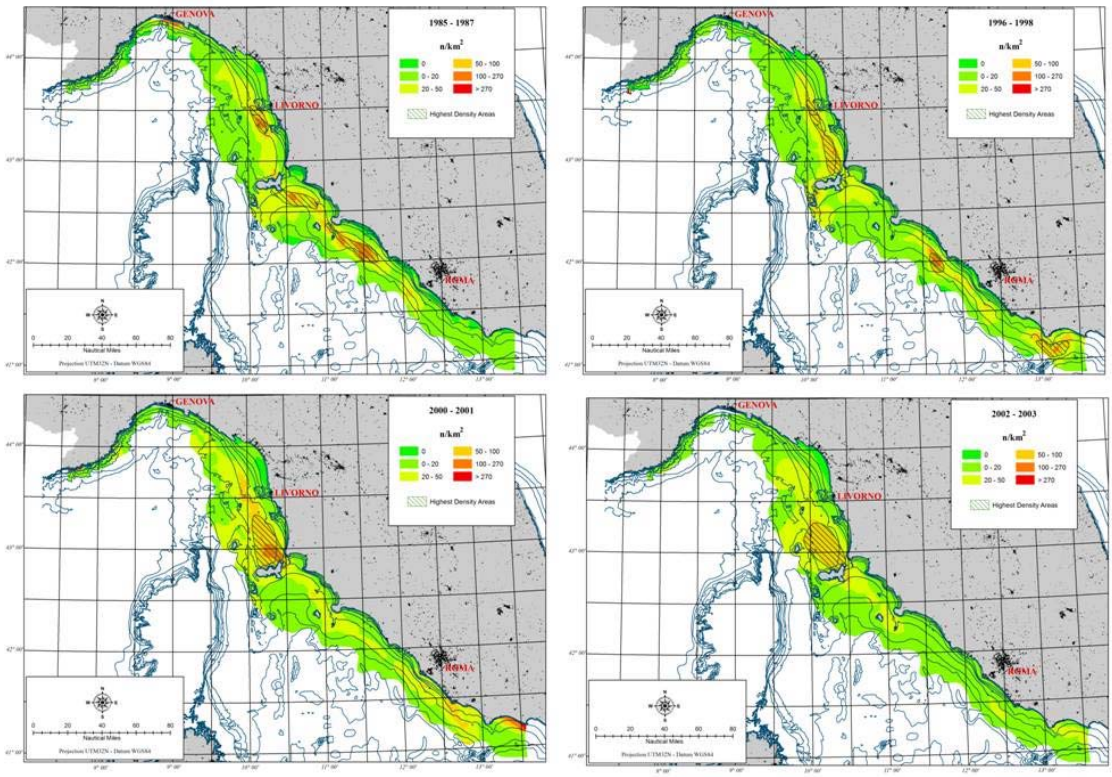


Fig. 7.7.3.1.2.3 Distribution of hakes larger than 26 cm TL in 1985-87, 1996-98, 2000-01, 2002-03.

7.7.3.1.3. Trends in abundance and biomass

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 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.

Fig. 7.7.3.1.3.1 shows the density and biomass indices of hake obtained from 1994 to 2006; no evident trends are present.

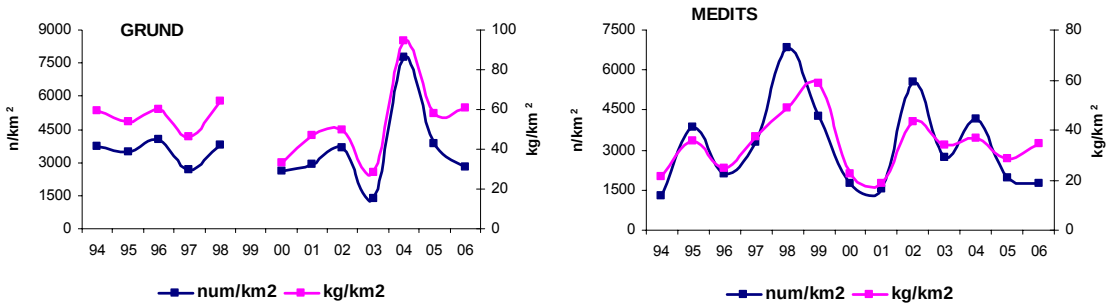


Fig. 7.7.3.1.3.1 Density and abundance indices of hake according to the GRUND (left) and MEDITS (RIGHT) surveys.

Fishery independent information regarding the state of the hake in GSA 09 was derived from the international survey Medits. Figure 7.7.3.1.3.2 displays the re-estimated trend in hake abundance and biomass in GSA 09 based on the DCR data call. Both Medits trends presented are similar without any long term trend. Hovever, abundance and biomass appear low since 2005.

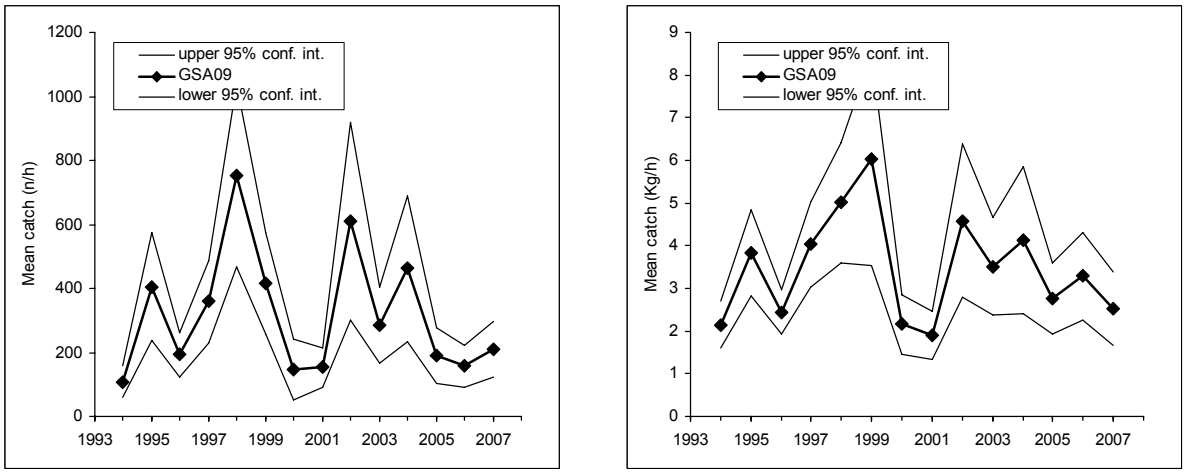


Fig. 7.7.3.1.3.2 Abundance and biomass indices of hake in GSA 09.

GRUND data showed a progressive reduction in the average density of recruits within nursery areas, from 9223 ind. km^{-2} in 1985-87 to 1250.7 ind. km^{-2} in 2002-03. In the time series we observed an increasing in the proportion of low density hauls in the surveys and a decreasing of hauls characterized by very high catches of juveniles (more than 20.000 ind. km^{-2}, Fig. 7.7.3.1.3.3).

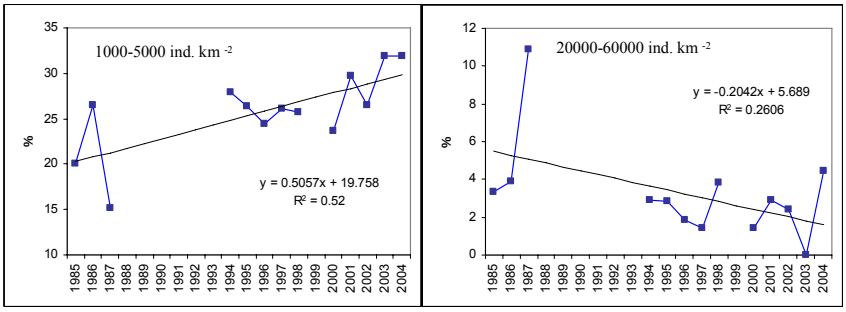


Fig. 7.7.3.1.3.3 Proportion of low density and high density hake recruits hauls during GRUND surveys

7.7.3.1.4. Trends in abundance by length or age

The following Fig. 7.7.3.1.4.1 and 2 display the stratified abundance indices of GSA 09 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

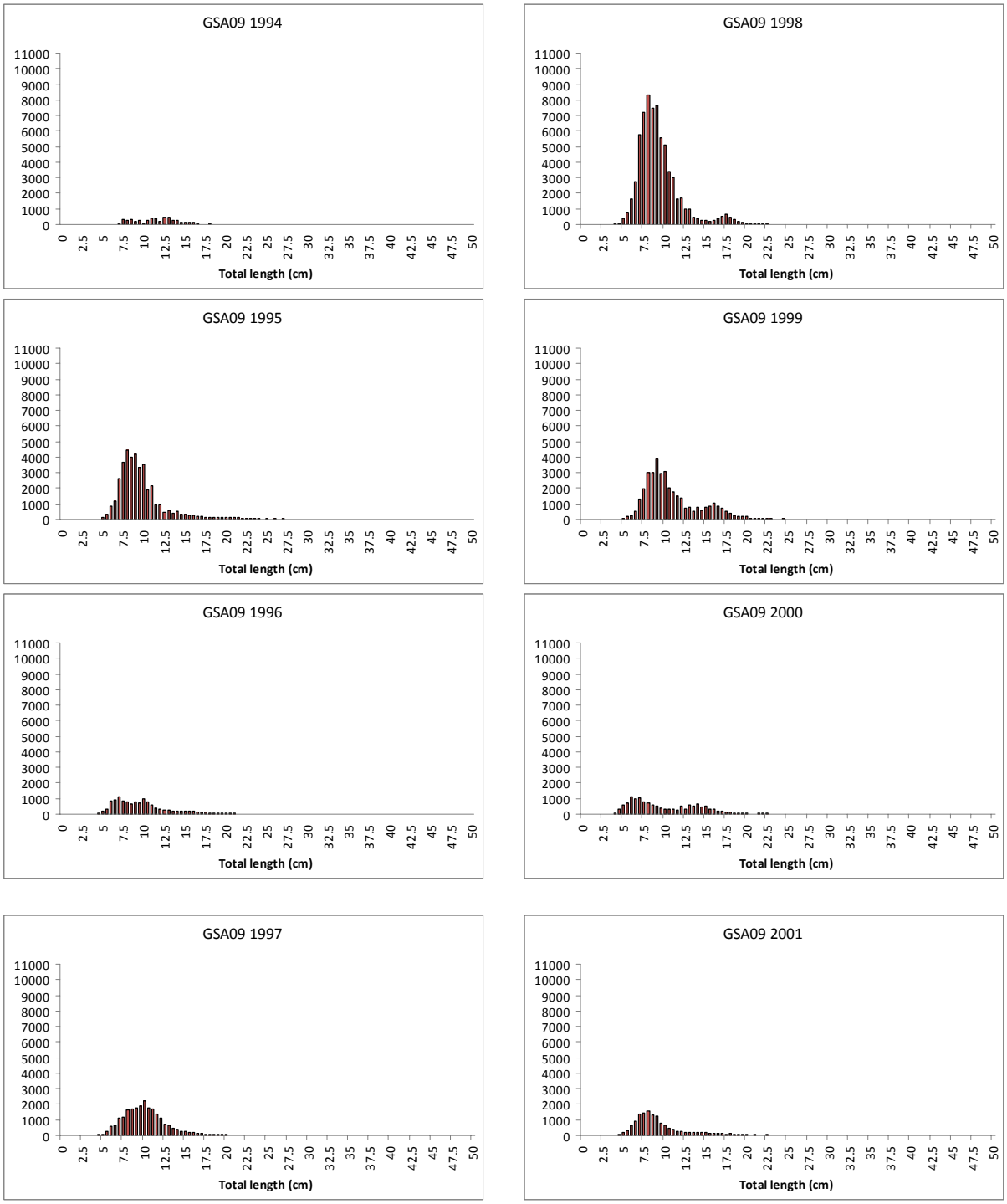


Fig. 7.7.3.1.4.1 Stratified abundance indices by size, 1994-2001.

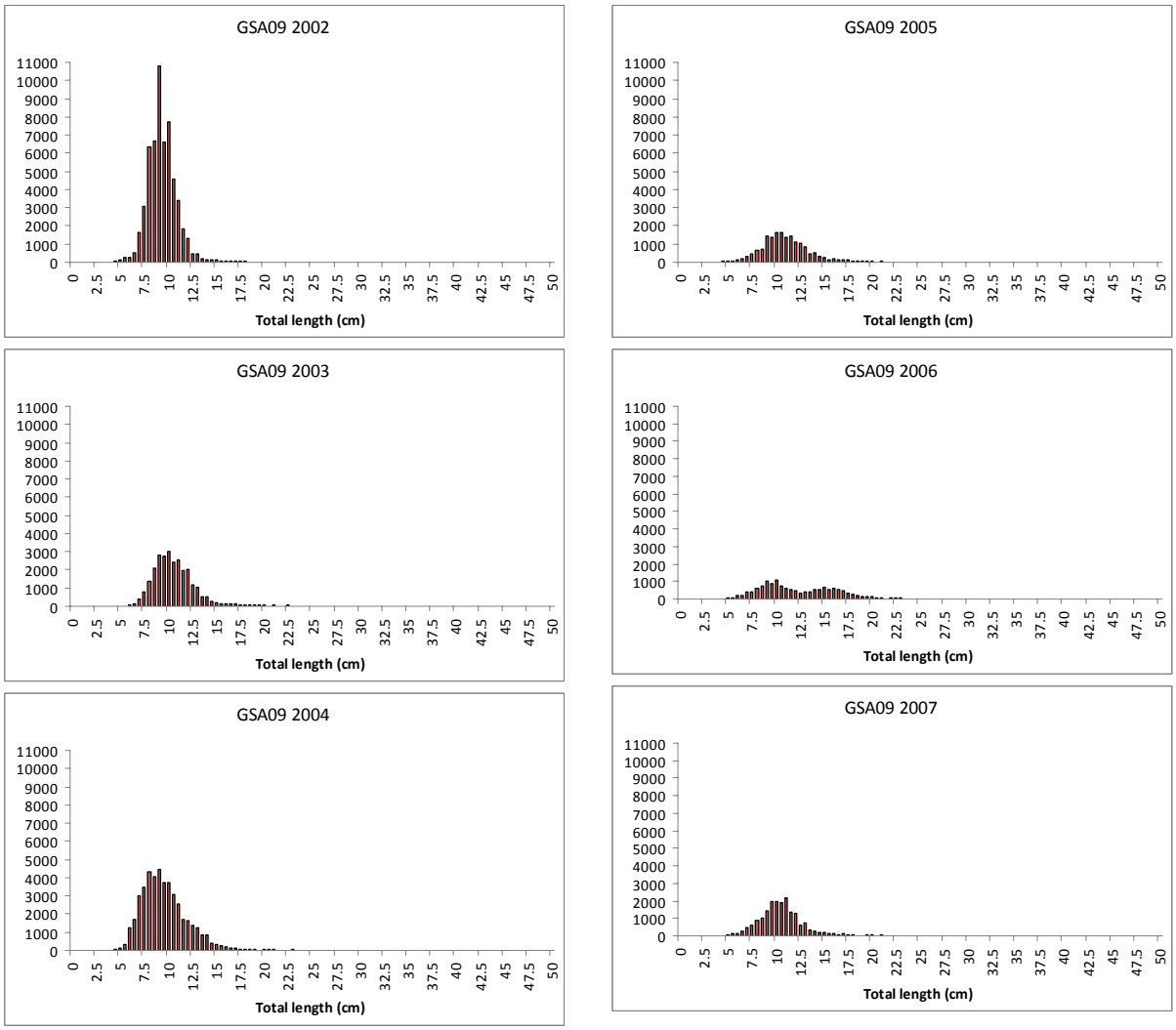


Fig. 7.7.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.7.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.7.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.7.4.Assessment of historic stock parameters

Due to its importance as demersal resource, hake has been object of several assessments in the GSA9 (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 GSA9, showed substantially convergent results.

The hake in the GSA9 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 ESSB/USSB). Also the production models 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 ESSB/USSB ratio are always lower than 0.1.

As concern the STECF-SGMED-08-03, two new assessments were produced. The main results are presented below.

7.7.4.1. 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.

7.7.4.1.1. Justification

Trends in LPUE may provide insight into trends in stock size. SGMED-08-03 recommends that technological creep should be considered when trends in LPUE are interpreted.

7.7.4.1.2. Input parameters

These data come from independent monitoring activities performed by the research institutes working in the GSA.

7.7.4.1.3. Results

As an example, the LPUE evolution in the period 1991-2006 is reported in Fig. 7.7.4.1.3.1. LPUE showed a continuous decreasing trend till 2004, then a little increase was observed in the last two 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).

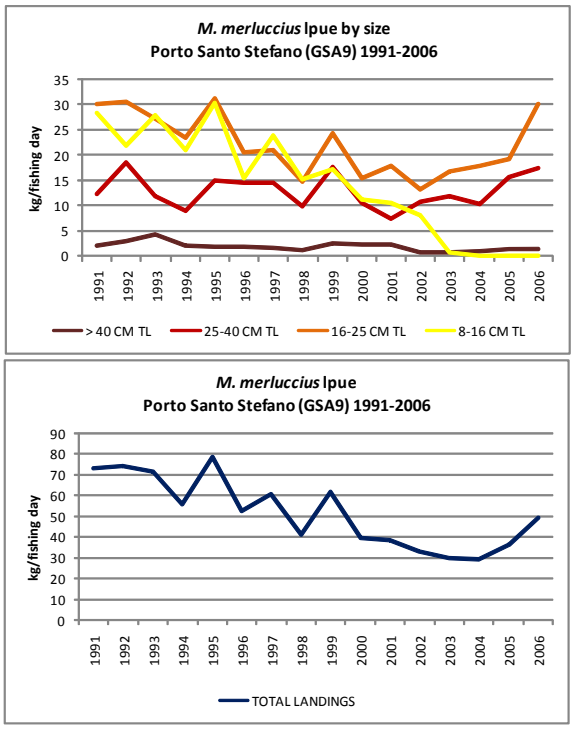


Fig. 7.7.4.1.3.1 Hake LPUE of the Porto Santo Stefano trawl fleet (1991-2006); above: LPUE by size class; below: total LPUE

7.7.4.2. Method 2: SURBA

7.7.4.2.1. 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 hake of GSA 09.

7.7.4.2.2. Input parameters

The following set of parameters was adopted:

Growth parameters (Von Bertalanffy)
L∞ = 104 (mm, length carapace)
K = 0.2
to = - 0.03
L*W
a = 0.006657
b = 3.028
Natural mortality
M vector Age_1=1.3 , Age_2=0.8, Age_3=0.4, Age_4=0.3, Age_5=0.2; Age_6=0.2
Catchability (q)
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 (L50)
L50 = 30 cm
Length of first capture (Lc)

Lc = 12 cm

7.7.4.2.3. Results

The two surveys gave a similar picture for F(1-5) and SSB. F shows a clear increasing trend (Medits, $p<0.01$) from 1.2 (1994) to 1.8 (2007). Relative SSB decreased significantly ($p<0.01$) in the same period. Recruitment fluctuated from year to year without a clear temporal pattern. (Fig. 7.7.4.2.3.1).

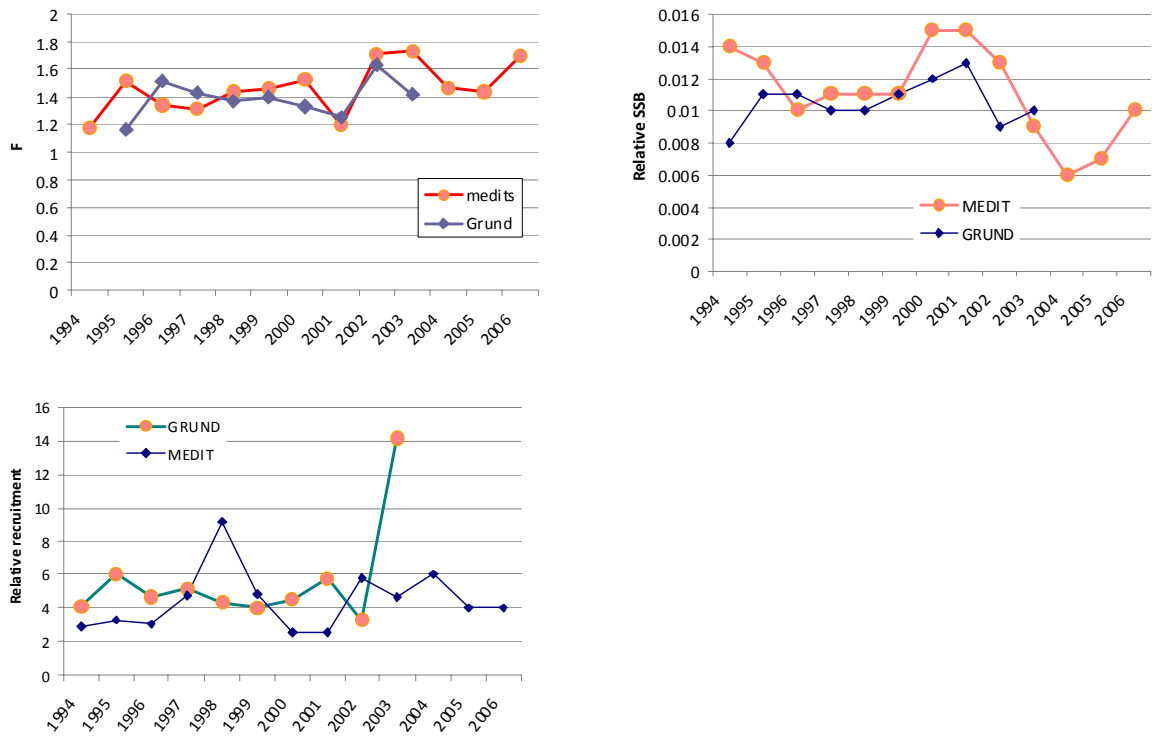


Fig. 7.7.4.2.3.1 Medits and Grund surveys. Estimated trend in F, relative SSB and recruitment using SURBA.

7.7.4.3. Method 3: LCA on DCR data

7.7.4.3.1. Justification

Assessment was performed using an LCA (VIT software, Lleonart and Salat 1997) on an annual pseudocohort (year 2006).

7.7.4.3.2. Input parameters

Data coming from DCR provided at SGMED 08-03 contained, for GSA9, information on hake landings and the respective size/age structure for 2005-2007; discard size structure was also available but only for 2006. Such data were available for the two main fishing gears exploiting hake in GSA9: trawling and set nets (gillnets). Anyway, the short data time series did not allow to apply a VPA.

Landing data were "corrected" including the information on discard; the growth parameters, natural mortality and maturity vectors used were the same of SURBA analysis.

Two scenarios were considered: the first reflects the official DCR data on landings (about 60% for trawling, about 40% for set nets). According to the common knowledge of the GSA 09 hake fisheries, probably the official data gives an overestimation of the set nets, so in the second scenario the percentage contribution of set nets was reduced to 10% a more reliable value taking account the expert's knowledge of the GSA 09 fisheries. These 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 of the official data.

7.7.4.3.3. Results

The general results of LCA highlight an exploitation focused on young age classes, mainly 0+ and 1+, reflecting a growth overfishing state. A global F of 1.3 was estimated using official landing data, while a higher F value (1.6) was obtained using the "adjusted" data even though the two scenarios gave a similar exploitation picture (Fig. 7.7.4.3.3.1).

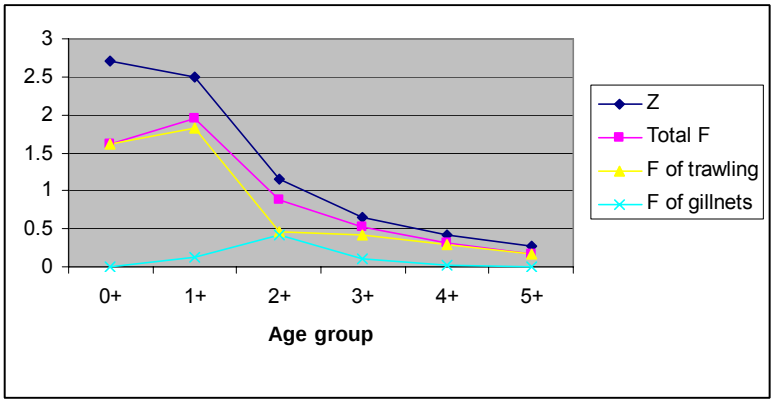


Fig. 7.7.4.3.3.1 Evolution of total and fishing mortalities for the first age groups ("adjusted data").

These results substantially agree with old assessments made in the GSA9 with LCA (Reale et al., 1995); only a small decrease in global F was detected, still insufficient to produce a significant recovery of the stock, also considering the reduction in fishing capacity and fishing effort showed by the trawl fleets of GSA 09.

7.7.5.Short term prediction for 2008 and 2009

7.7.5.1. Justification

No forecast analyses were conducted.

7.7.5.2. Input parameters

No forecast analyses were conducted.

7.7.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSA 09.

7.7.6. Medium term prediction

7.7.6.1. Justification

A simulation of an example of Harvest Control Rule (HCR) for the GSA9 hake stock was performed during SGMED-08-03. This exercise does not represent an official recommendation for this rule by SGMED, but was a theoretical exercise to demonstrate the potential impacts of such a rule (combined with example target and limit reference levels as per ICES) on future population status.

7.7.6.2. Input parameters

The HCR examined aimed to achieve a target fishing mortality F[A], from a point at which the stock was above a trigger SSB [C], using TAC limits (not usually applied in the Mediterranean). The HCR included a maximum inter annual variation in TAC[B], expressed as interannual variation (%IAV). When the SSB was lower than [C] a linear decrease in F was applied according to the following relationship:

$$F = (F_A - F_{low}) \times (SSB_{TAC} - SSB_L)/(SSB_C - SSB_L) + F_{low}$$

F is estimated by iteration of TAC levels and subsequent SSB to the TAC; SSBL is a limit spawning stock level below which a Flow= 0.1 is expected. The HCS simulation tool was used to explore the effect of harvest rule parameters and model conditions. In each of several scenario runs a range of levels of target F[A] and trigger SSB [C] and levels of maximum TAC variation %IAV [B] were explored. The different scenarios differed in catches used to estimate number at age from VIT (i.e. official and adjusted catches) and %IAV (i.e. 15% and 50%). Initial numbers at age, weight at age in the catch, weight at age in the stock, natural mortality, maturity at age, selection patterns and proportions of F and M taken before spawning were taken from VIT analysis (Table 7.7.6.2.1). Reference F was set at age 1 to 5. CV was set at 0.25 for all age classes. Catch in the starting year and first year of the analysis (2006 and 2007) was set equal to observed catches in 2006. For details see WKHMP report in 2008 (ICES 2008).

Stock and recruitment data were derived from rescaling SURBA relative estimates of SSB and R developed above, using 2006 estimates from VIT for this stock (Fig. 7.7.6.2.1). Stock recruitment was assumed to follow a lognormal distribution around a hockey stick model with a SSB break point (SSBL). Geometric mean recruitments (92 and 77 millions, respectively for official and adjusted catches VIT scenario) and CVs (0.36) were estimated from official and adjusted catches VIT scenario. SSBL was set at 830 t and 470 t for official and adjusted catches VIT scenario respectively, equal to the lowest observed SSB in the time series 1994-2007. Parameters of the hockey stick model are presented in Table 7.7.6.2.2.

Total catches in 2006 were estimated around 2000 and 1200 t for official and adjusted catches through VIT analysis. Current (2006) F (age 1-5) varies between 1 and 1.2.

The yield per recruit curve levels approached a plateau at fishing mortalities around 0.20 (Fig. 7.7.6.2.2), with $F_{0.1}$ around 0.14. As with yield per recruit from the other scenarios the recruitment level only affects the level of the plateau not the curvature with F (and the corresponding F levels). The current SSB is likely to be less than 5% of the SSB at F_{msy}.

Table 7.7.6.2.1. Parameters used in the HCR analysis. M is the natural mortality, SEL is the selectivity pattern, WECA and WEST are weight at age in the catch and in the stock and NAA is the number at age. GEO_{recr} is the geometrical mean recruitment and SSB_L is the limit biomass. Parameters are from VIT estimated for 2006.

Official

Age	M	SEL	WECA	WEST	MAT	NAA (millions)
0	1.09	0.70	0.01	0.01	0.00	83.96
1	0.54	0.90	0.15	0.15	0.40	7.81
2	0.26	1.00	0.59	0.59	0.95	1.11
3	0.14	0.80	1.35	1.35	1.00	0.20
4	0.10	0.50	2.29	2.29	1.00	0.08
5	0.10	0.20	3.31	3.31	1.00	0.04
GEO_{recr}	92 millions					
SSB_L	830 tonnes					

Adjusted

Age	M	SEL	WECA	WEST	MAT	NAA (millions)
0	1.09	0.78	0.01	0.01	0.00	71.24
1	0.54	1.00	0.14	0.14	0.40	4.73
2	0.26	0.73	0.61	0.61	0.95	0.39
3	0.14	0.53	1.37	1.37	1.00	0.12
4	0.10	0.37	2.30	2.30	1.00	0.07
5	0.10	0.21	3.31	3.31	1.00	0.04
GEO_{recr}	77 millions					
SSB_L	470 tonnes					

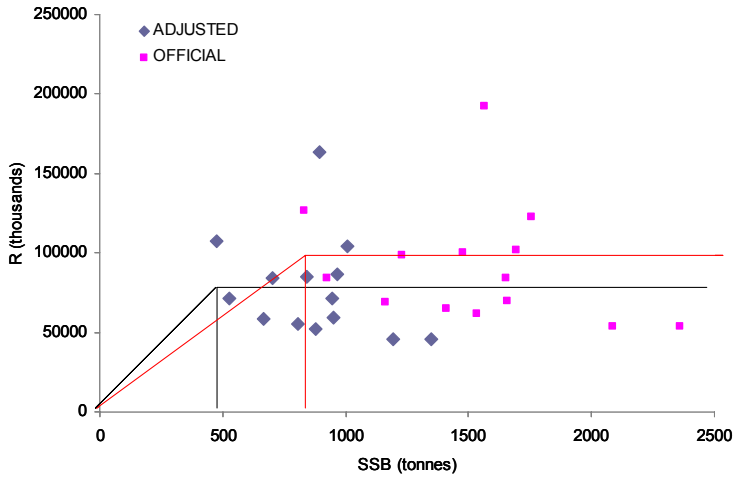


Fig. 7.7.6.2.1 Stock recruitment relationship derived from SURBA data using 2006 VIT estimates of SSB and R as rescaling factor.

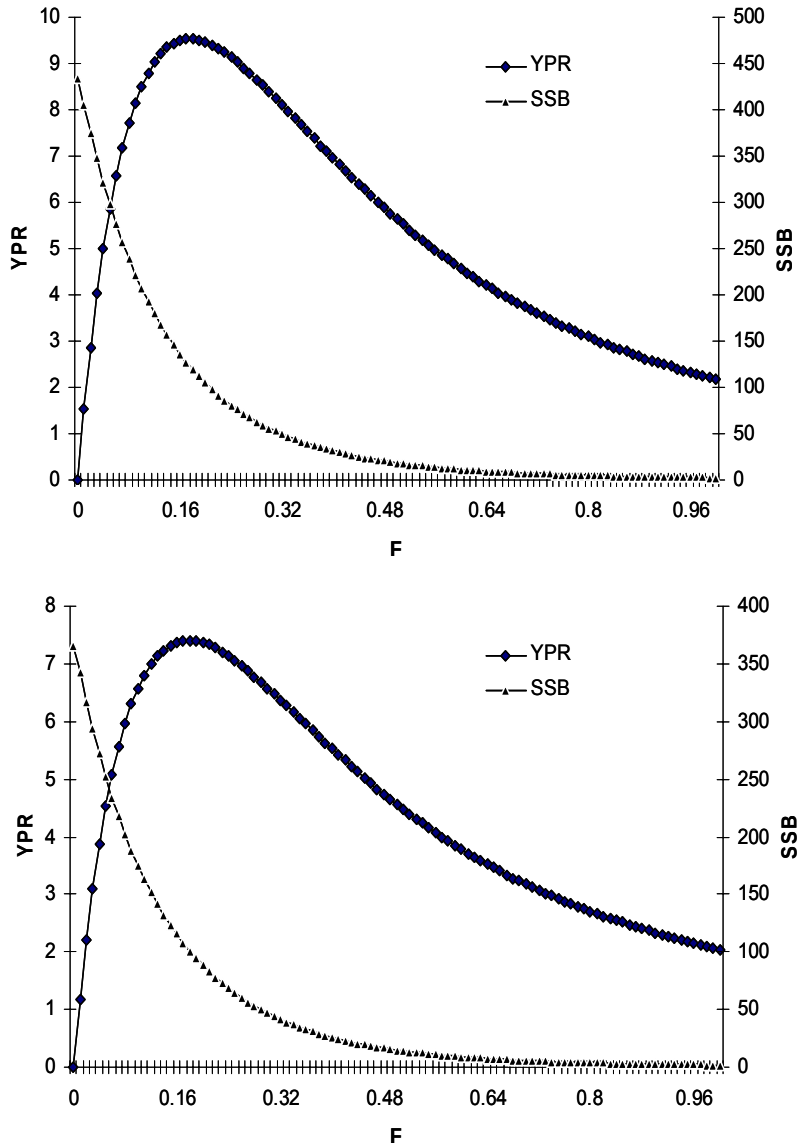


Fig. 7.7.6.2.2 Yield per recruit analysis estimated by HCR software using official and adjusted data.

7.7.6.3. Results

For official landings, F values above 0.8 increase risks to Blim (>2-5%) dependent of imposed maximum TAC variation (%IAV: 15-20%) (Fig. 7.7.6.3.1). For adjusted landings, F values above which the risk to Blim increases are quite different depending on the imposed maximum TAC variation (%IAV: 15-20%). When IAV% is 50%, F above 0.8 increase the risk to Blim (>5%) while with smaller IAV% risks are much smaller (around 2%) at the same F (Fig. 7.7.6.3.2). However, it is important to stress that B_{lim} is set as B_{loss} in that stock and thus, it might be largely underestimated.

Catches approach a maximum level at target fishing mortalities F[A] between 0.2 and 0.4 irrespective of the scenario used. Also, except for adjusted catches with %IAV of 15%, the catches decrease at higher target fishing mortality (Fig. 7.7.6.3.3 and 7.7.6.3.4). The level of catches varies between 6,500 and 10,000 tonnes per year, depending on scenarios used.

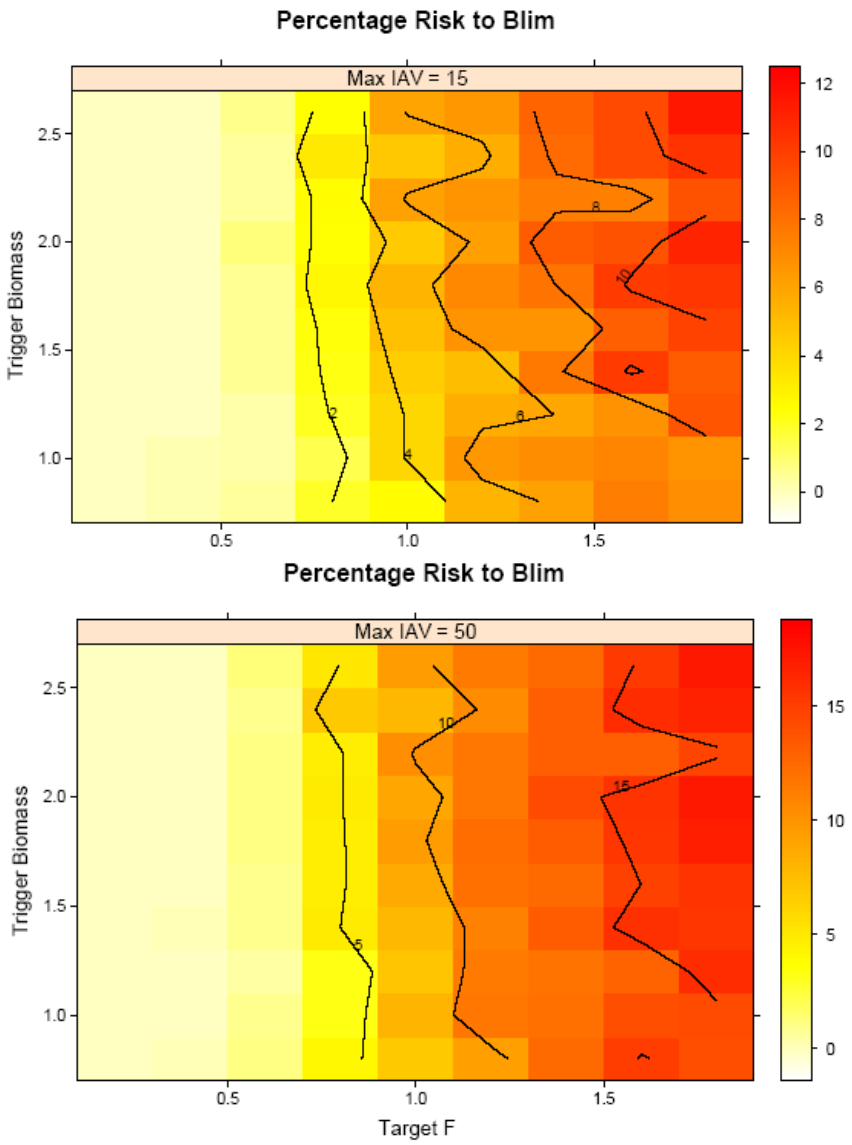


Fig. 7.7.6.3.1. Risk to B_{lim} with different values of trigger biomass, IAV% (15 and 50%) and different values of target F using official catches.

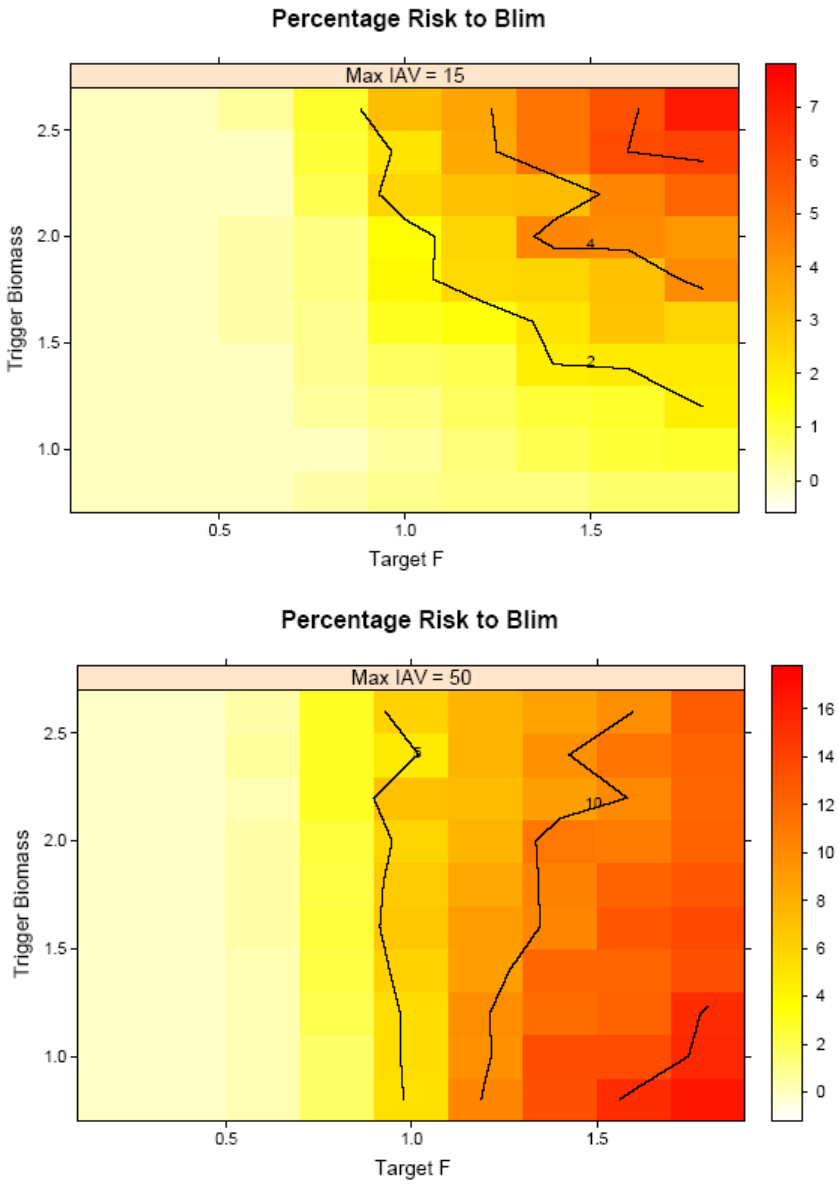


Fig. 7.7.6.3.2 Risk to B_{lim} with different values of trigger biomass, IAV% (15 and 50%) and different values of target F, using adjusted catches.

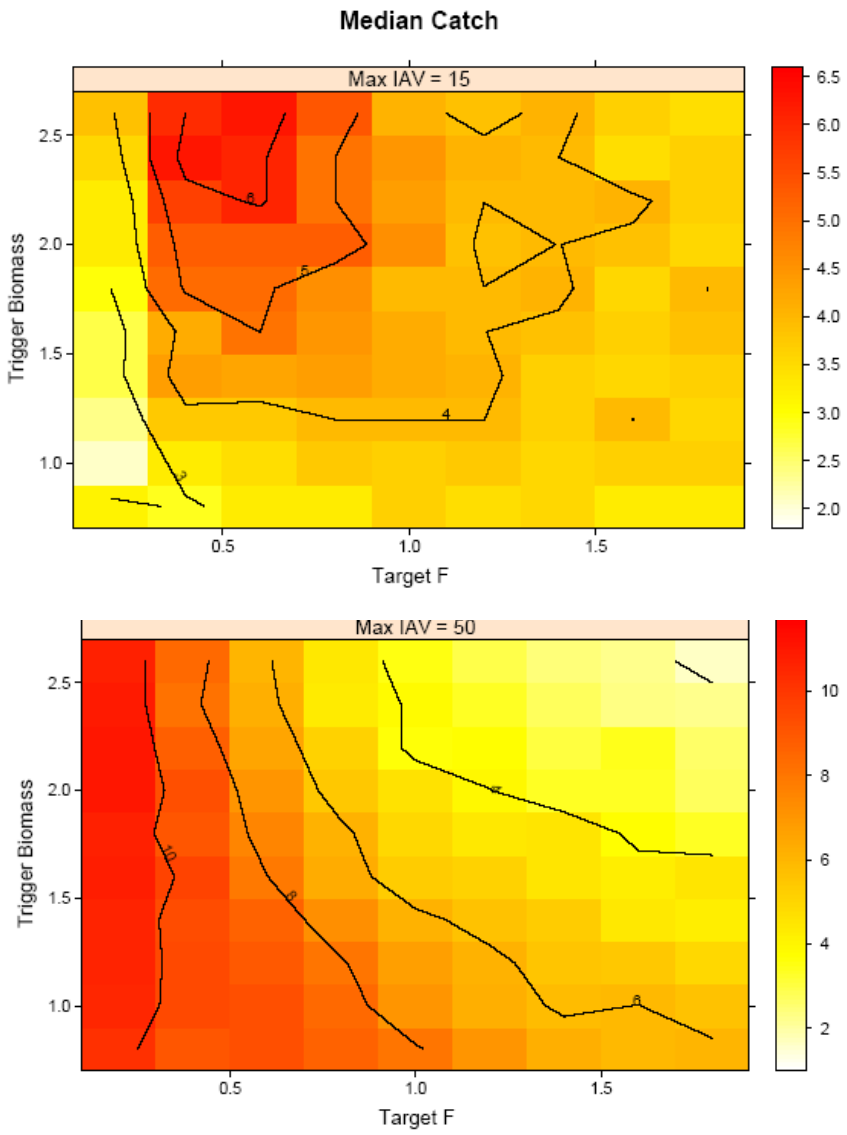


Fig. 7.7.6.3.3 Median yearly catches during 20 years with different values of trigger biomass, IAV% (15 and 50%) and different values of target F using official catches.

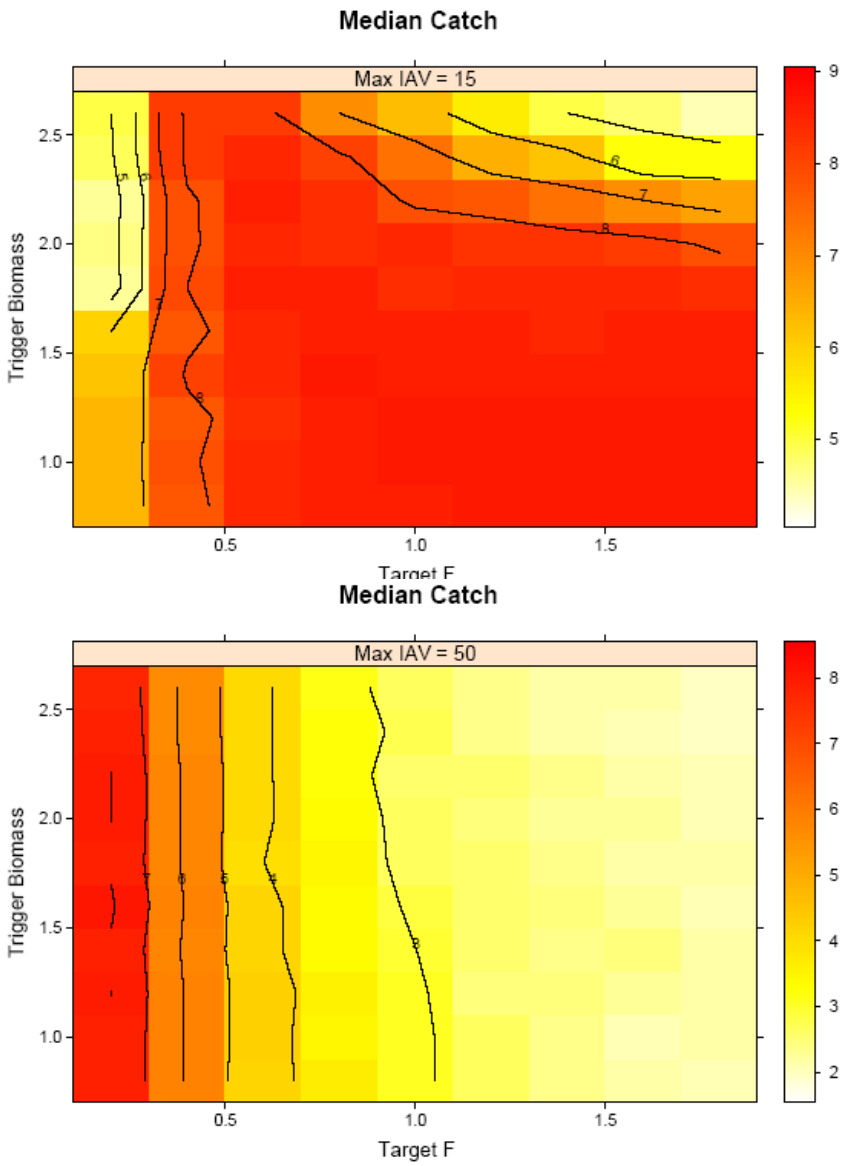


Fig. 7.7.6.3.4 Median yearly catches during 20 years with different values of trigger biomass, IAV% (15 and 50%) and different values of target F using adjusted catches.

7.7.7. Long term prediction

7.7.7.1. 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.

7.7.7.2. 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.

7.7.7.3. 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. 7.7.7.3.1). The following mean values were obtained: F_{max} = 0.34; $F_{0.1}$= 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}). Interesting to note that $F_{0.1}$ and F_{ref} showed a similar distribution in the estimated values.
RPs suggest an overfishing situation for the stock considering F curr six-eight times higher than the limit and target RPs F.

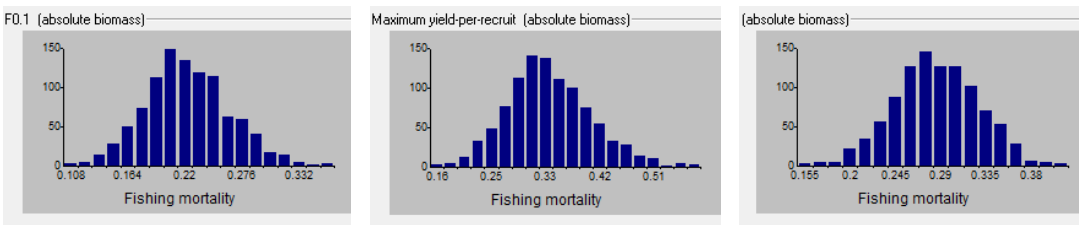


Fig. 7.7.7.3.1 Probability distribution of hake RP in the GSA 09 obtained using the Yield software.

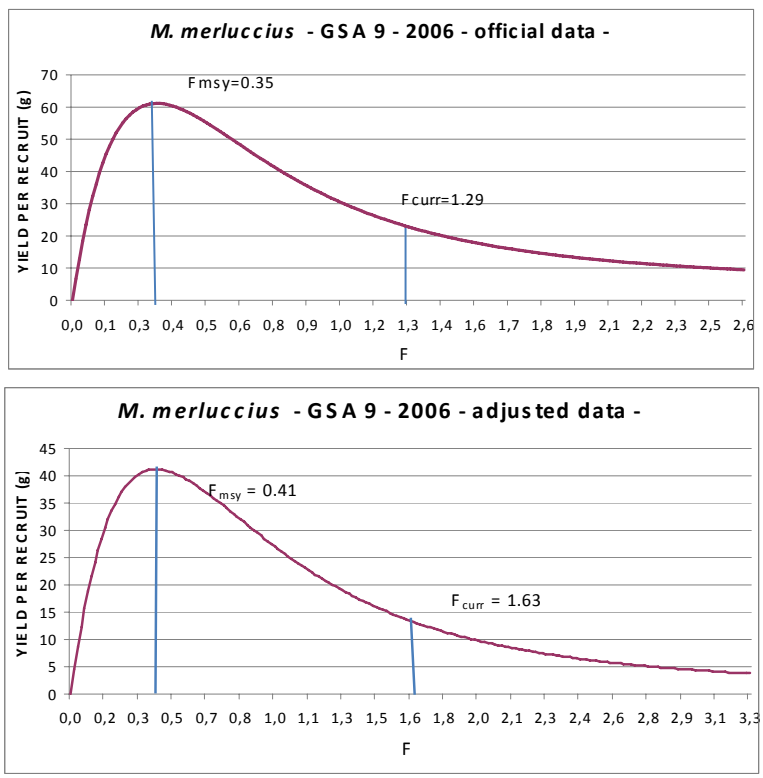


Fig. 7.7.7.3.2 Y/R curves from VIT analyses.

7.7.8. Scientific advice

7.7.8.1. Short term considerations

7.7.8.1.1. State of the spawning stock size

SGMED-08-03 concludes that the current SSB is likely to between 5 and 10% of the SSB at F_{msy}.

7.7.8.1.2. State of recruitment

Stock productivity does not appear to be impaired and able to still produce relatively large year classes.

7.7.8.1.3. State of exploitation

The stock appears to be highly overexploited and F needs to be reduced in the order of 75-85% considering candidate reference point for long term sustainability F between 0.2-0.4 and current F around 1.6 (SURBA estimates). 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}.

7.7.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.8. Stock assessment of hake in GSA 10

7.8.1.Stock identification and biological features

7.8.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.8.1.2. Growth

No information was documented during SGMED-08-03.

7.8.1.3. Maturity

No information was documented during SGMED-08-03.

7.8.2.Fisheries

7.8.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.8.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.8.2.3. Catches

7.8.2.3.1. Landings

SGMED-08-03 received Italian landings data for GSA 10 by major fishing gears which are listed in Tab. 7.8.2.3.1.1. Since 2002, landings increased from 1,000 t to 1,540 t in 2006 and decreased to 1,270 t in 2007 (Fig. 7.8.2.3.1.1). The data are listed in Table A3.1 of Appendix 3.

Table 7.8.2.3.1.1 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	10	ITA	DTS	515	425	446	595	758	638
HKE	10	ITA	HOK			58	96	111	41
HKE	10	ITA	PGP	225	329	694	484	663	578
HKE	10	ITA	PMP	246	322	123	303	12	12
HKE	10	ITA	PTS	27	21	17	7		
			Sum	1013	1097	1338	1485	1544	1269

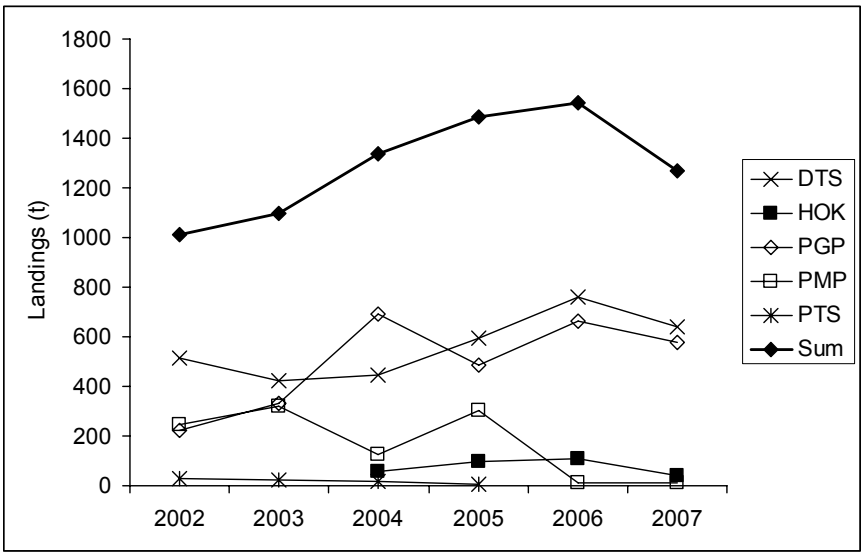


Fig. 7.8.2.3.1.1 Italian landings (t) by year and major gear types, 2002-2007 as reported through DCR.

7.8.2.3.2. Discards

SGMED-08-03 noted 6 t of discard reported for 2006 through the DCR data call. The data are listed in Table A3.4 of Appendix 3.

7.8.2.3.3. Fishing effort

The trends in fishing effort by year and major gear type is listed in Tab. 7.8.2.3.3.1 and shown in Fig. 7.8.2.3.3.1 in terms of kW*days. The fishing effort in kW*days appear quite stable during 2004-2007 for most gear types.

Tab. 7.8.2.3.3.1 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	10	ITA	DRB	830	1776	1984	1040
DAYS	10	ITA	DTS	44087	46547	43848	40724
DAYS	10	ITA	HOK	20929	20418	8064	7043
DAYS	10	ITA	PGP	325523	268441	346849	311693
DAYS	10	ITA	PMP	62225	64177	10532	7261
DAYS	10	ITA	PTS	11792	11206	9332	9367
GT*DAYS	10	ITA	DRB	7968	17128	19136	9939
GT*DAYS	10	ITA	DTS	1337882	1622062	1331071	1266460
GT*DAYS	10	ITA	HOK	157882	143835	103111	82342
GT*DAYS	10	ITA	PGP	661958	534880	800036	693057
GT*DAYS	10	ITA	PMP	336053	333845	152717	110850
GT*DAYS	10	ITA	PTS	390096	468145	367417	280190
KW*DAYS	10	ITA	DRB	110899	244013	272628	142455
KW*DAYS	10	ITA	DTS	7883881	8467144	7596783	7105075
KW*DAYS	10	ITA	HOK	1654352	1413547	925244	794816
KW*DAYS	10	ITA	PGP	7056306	6018600	9486681	8397010
KW*DAYS	10	ITA	PMP	3588004	3728376	1404642	1003285
KW*DAYS	10	ITA	PTS	2308589	2434470	2016508	1680295

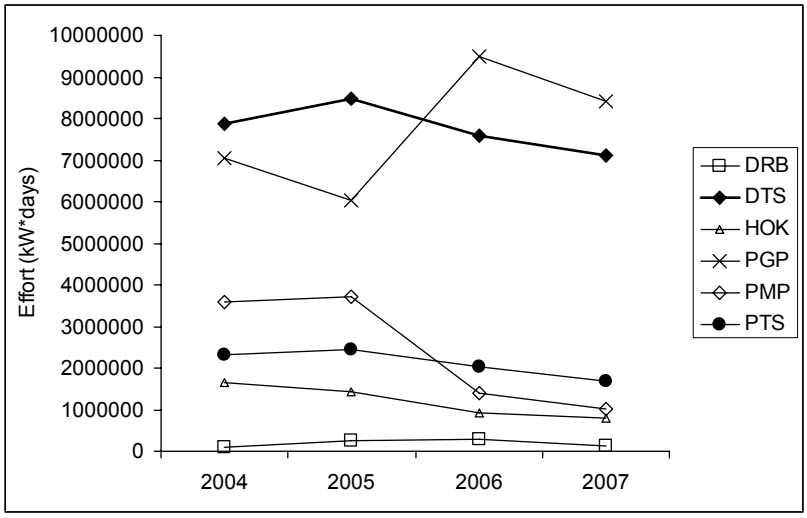


Fig. 7.8.2.3.3.1 Trend in fishing effort (kW*days) for Italy by major gear types, 2004-2007.

7.8.3.Scientific surveys

7.8.3.1. Medits

7.8.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 10 the following number of hauls were reported per depth stratum (s. Tab. 7.8.3.1.1.1).

Tab. 7.8.3.1.1.1. Number of hauls per year and depth stratum in GSA 10, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA10_010-050	9	10	10	10	10	10	10	10	9	9	9	9	9	9
GSA10_050-100	12	12	12	12	12	12	12	12	10	10	10	10	10	10
GSA10_100-200	20	20	20	20	20	20	20	20	17	17	17	17	17	17
GSA10_200-500	26	27	26	26	27	26	26	28	22	22	22	22	22	22
GSA10_500-800	31	30	31	31	31	30	31	29	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.

7.8.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.8.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 10 was derived from the international survey Medits. Figure 7.8.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 10.

The estimated abundance and biomass indices reveal increasing trends since 2002. However, the recent high abundance and biomass indices are subject to high variation (uncertainty). The analyses of Medits indices are considered preliminary.

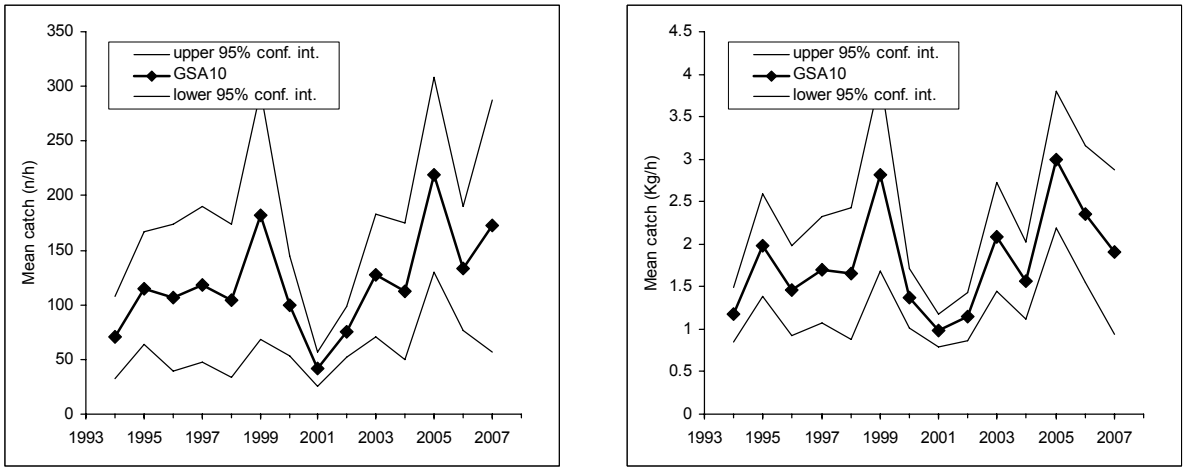


Fig. 7.8.3.1.3.1 Abundance and biomass indices of hake in GSA 10.

7.8.3.1.4. Trends in abundance by length or age

The following Fig. 7.8.3.1.4.1 and 2 display the stratified abundance indices of GSA 10 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

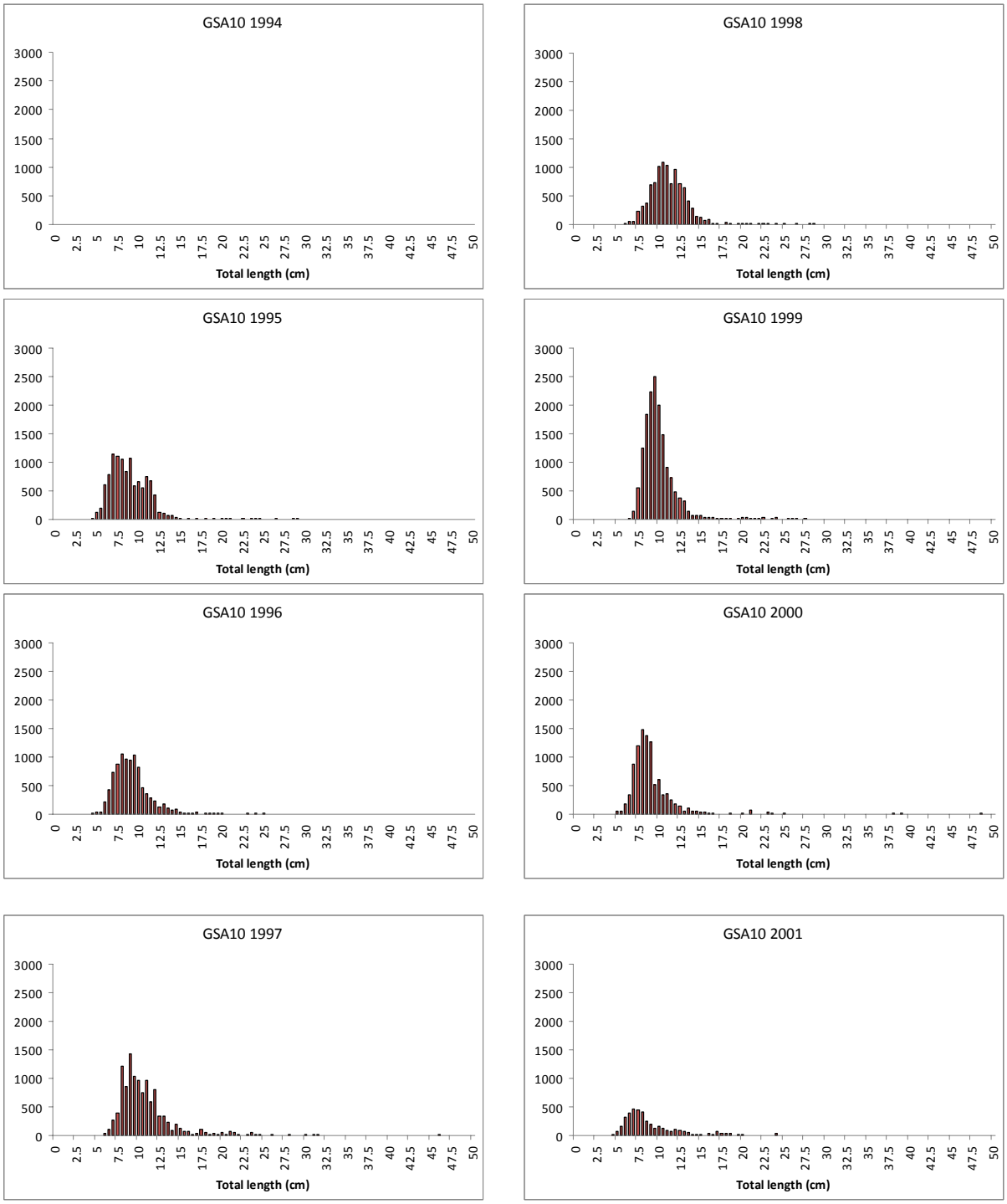


Fig. 7.8.3.1.4.1 Stratified abundance indices by size, 1994-2001.

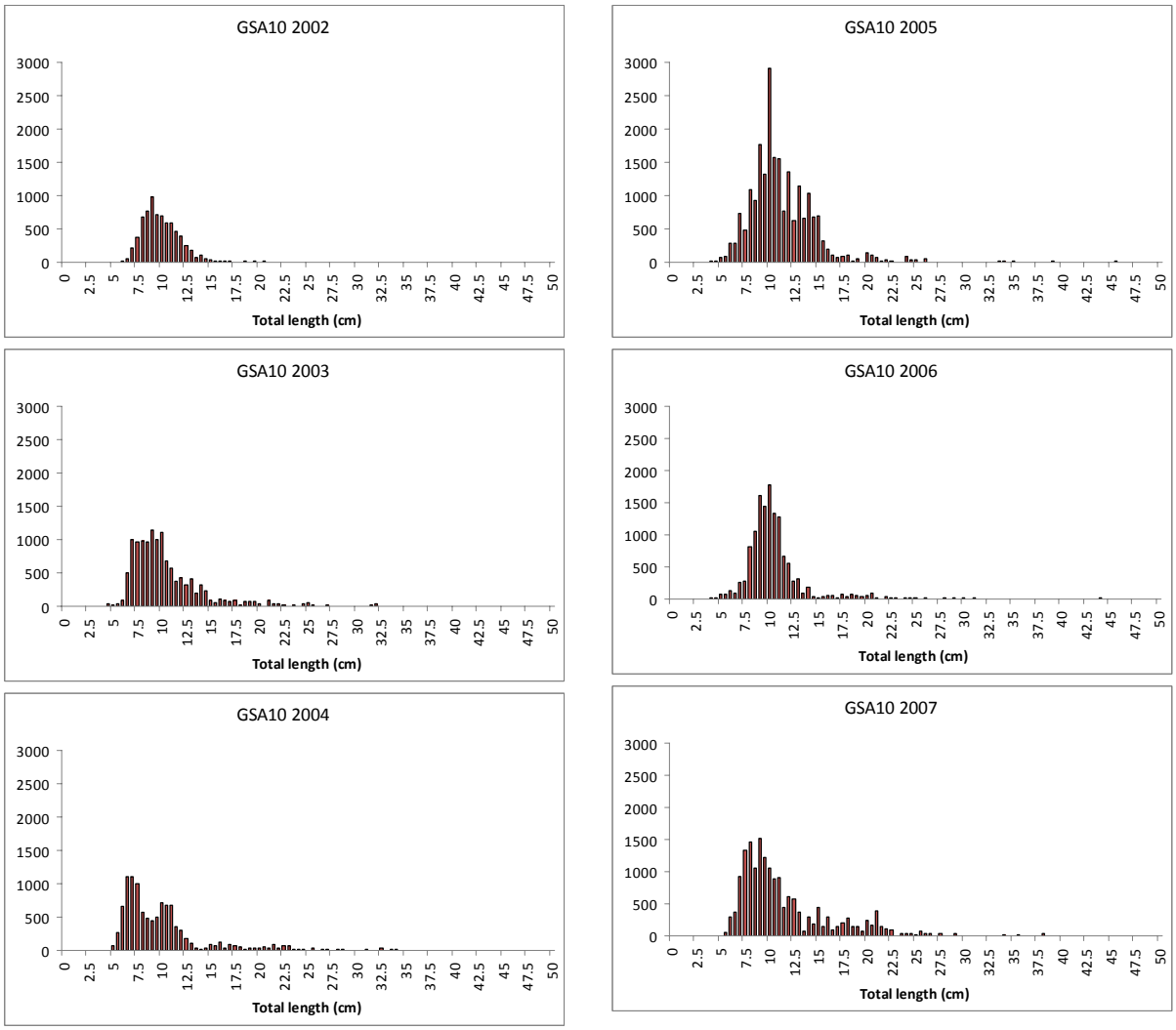


Fig. 7.8.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.8.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.8.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.8.4.Assessment of historic stock parameters

SGMED-08-03 did not undertake any analytical assessment.

7.8.5.Short term prediction for 2008 and 2009

7.8.5.1. Justification

No forecast analyses were conducted.

7.8.5.2. Input parameters

No forecast analyses were conducted.

7.8.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSA 10.

7.8.6. Medium term prediction

7.8.6.1. Justification

No forecast analyses were conducted.

7.8.6.2. Input parameters

No forecast analyses were conducted.

7.8.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for hake in GSA 10.

7.8.7. Long term prediction

7.8.7.1. Justification

No forecast analyses were conducted.

7.8.7.2. Input parameters

No forecast analyses were conducted.

7.8.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 10.

7.8.8. Scientific advice

7.8.8.1. Short term considerations

7.8.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.8.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.8.8.1.3. State of exploitation

SGMED-08-03 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.

7.8.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.9. Stock assessment of hake in GSA 11

7.9.1.Stock identification and biological features

7.9.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.9.1.2. Growth

No information was documented during SGMED-08-03.

7.9.1.3. Maturity

No information was documented during SGMED-08-03.

7.9.2.Fisheries

7.9.2.1. 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 where the biology and population dynamics have been studied intensively in the past fifteen years. 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.

7.9.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.9.2.3. Catches

7.9.2.3.1. Landings

SGMED-08-03 received Italian landings data for GSA 11 by major fishing gears which are listed in Tab. 7.9.2.3.1.1. Since 2002, landings increased form 360 t to 930 t in 2005 and decreased to 550 t in 2007 (Fig.. 7.9.2.3.1.1). Landings are dominated by demersal trawl fisheries. The data are listed in Table A3.1 of Appendix 3.

Table 7.9.2.3.1.1 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

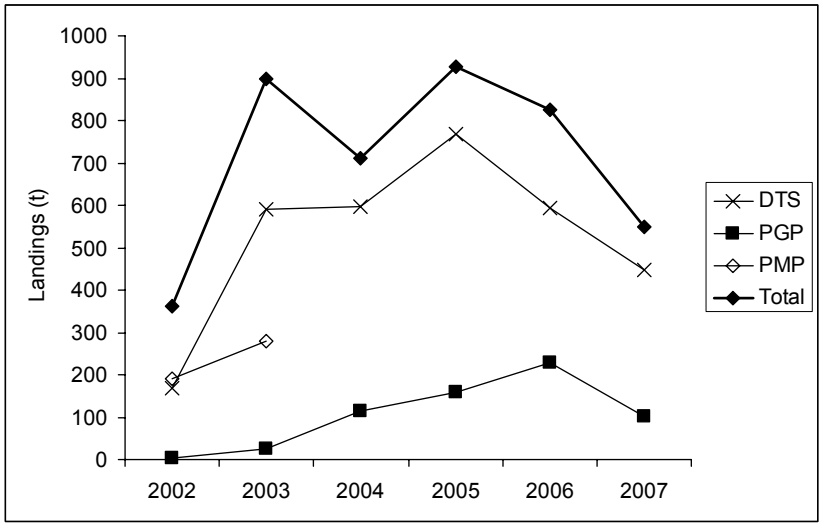


Fig. 7.9.2.3.1.1 Italian landings (t) by year and major gear types, 2002-2007 as reported through DCR.

7.9.2.3.2. Discards

SGMED-08-03 noted 15 and 63 t of discard reported for 2005 and 2006 through the DCR data call, respectively. The data are listed in Table A3.4 of Appendix 3.

7.9.2.3.3. Fishing effort

The trends in fishing effort by year and major gear type is listed in Tab. 7.9.2.3.3.1 and shown in Fig. 7.9.2.3.3.1 in terms of kW*days.

Tab. 7.9.2.3.3.1 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

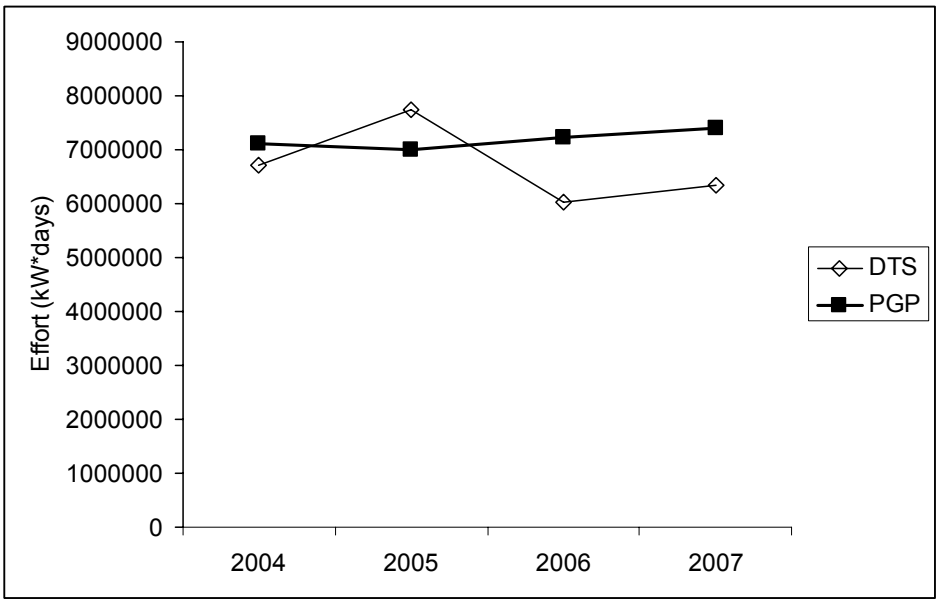


Fig. 7.9.2.3.3.1 Trend in fishing effort (kW*days) for Italy by major gear types, 2004-2007.

7.9.3.Scientific surveys

7.9.3.1. Medits

7.9.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 11 the following number of hauls were reported per depth stratum (s. Tab. 7.9.3.1.1.1).

Tab. 7.9.3.1.1.1. Number of hauls per year and depth stratum in GSA 11, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA11_010-050	16	18	21	21	21	20	19	17	28	18	17	17	19	19
GSA11_050-100	25	21	22	22	20	22	22	24	25	19	18	21	18	20
GSA11_100-200	20	23	30	31	31	30	29	30	32	24	24	24	24	24
GSA11_200-500	33	29	29	26	25	27	24	25	32	24	21	20	20	20
GSA11_500-800	23	16	21	25	25	24	27	26	27	14	15	14	16	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.

7.9.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.9.3.1.3. 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 7.9.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 11.

The estimated abundance and biomass indices reveal increasing trends since 1999 but appear highly variable. However, the recent abundance and biomass indices in 2007 dropped significantly to the lowest level observed since 1994. The analyses of Medits indices are considered preliminary.

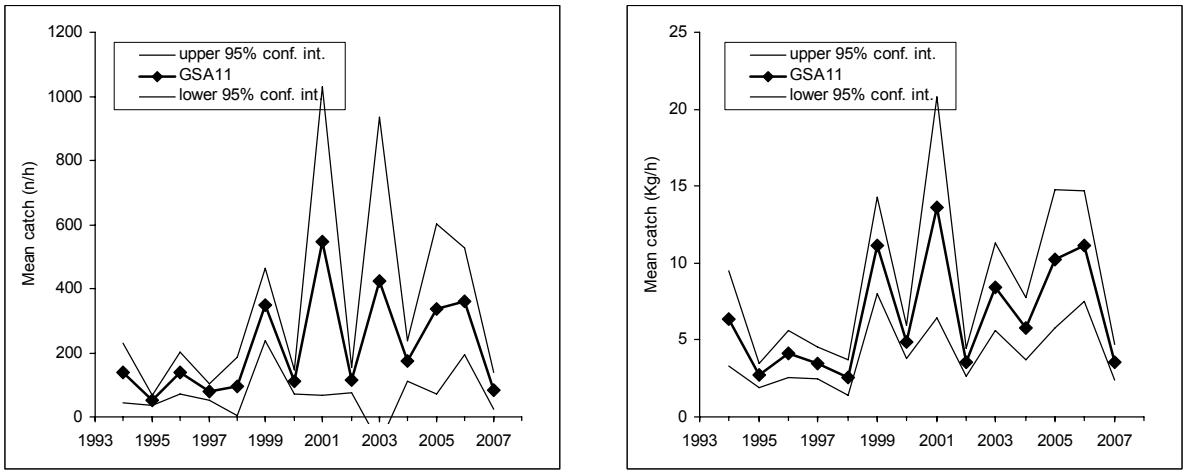


Fig. 7.9.3.1.3.1 Abundance and biomass indices of hake in GSA 11.

7.9.3.1.4. Trends in abundance by length or age

The following Fig. 7.9.3.1.4.1 and 2 display the stratified abundance indices of GSA 11 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

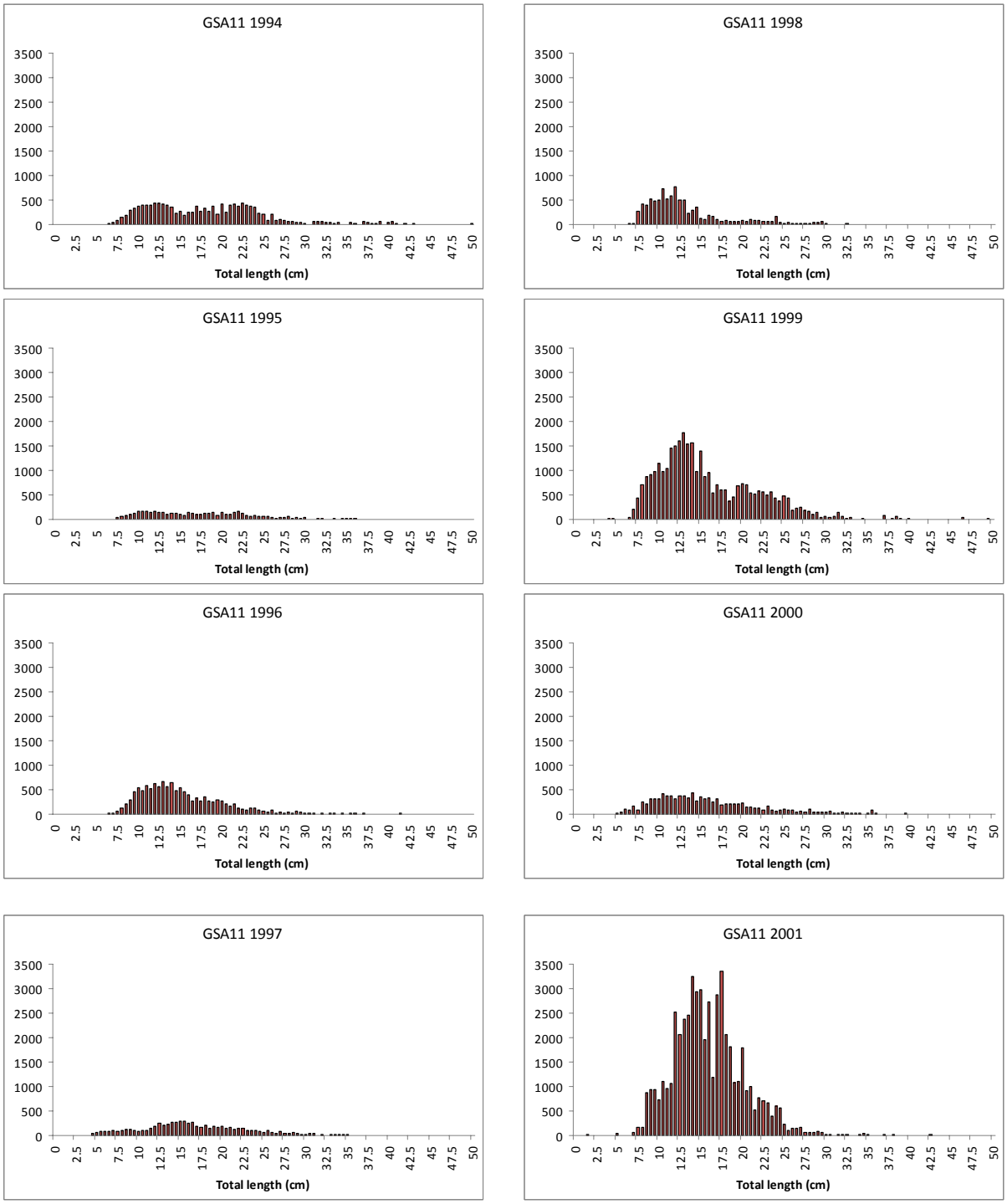


Fig. 7.9.3.1.4.1 Stratified abundance indices by size, 1994-2001.

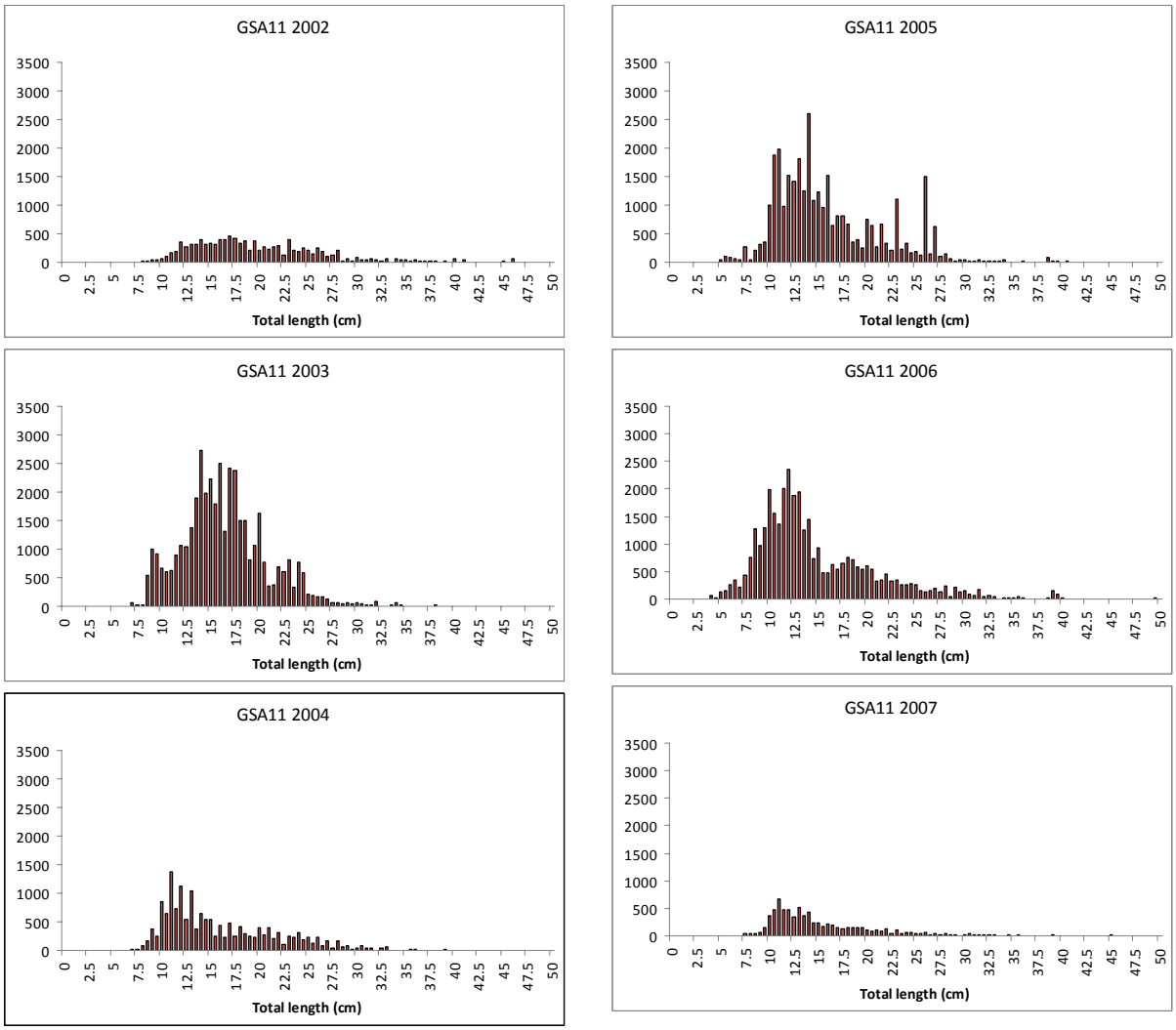


Fig. 7.9.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.9.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.9.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.9.4.Assessment of historic stock parameters

SGMED-08-03 did not undertake any analytical assessment.

7.9.5.Short term prediction for 2008 and 2009

7.9.5.1. Justification

No forecast analyses were conducted.

7.9.5.2. Input parameters

No forecast analyses were conducted.

7.9.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSA 11.

7.9.6. Medium term prediction

7.9.6.1. Justification

No forecast analyses were conducted.

7.9.6.2. Input parameters

No forecast analyses were conducted.

7.9.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for hake in GSA 11.

7.9.7. Long term prediction

7.9.7.1. Justification

No forecast analyses were conducted.

7.9.7.2. Input parameters

No forecast analyses were conducted.

7.9.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 11.

7.9.8. Scientific advice

7.9.8.1. Short term considerations

7.9.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.9.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.9.8.1.3. State of exploitation

SGMED-08-03 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.

7.9.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.10. Stock assessment of hake in GSAs 15 and 16

7.10.1. Stock identification and biological features

7.10.1.1. 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.

Eggs, larvae and post larvae of *M. merluccius* are pelagic. Eggs and larvae were preferentially associated with the shelf, peaking in abundance between 100 and 200 m isobaths. The transition from the pelagic to the benthic habitat occurs when young individuals are about 3 cm TL (Colloca, 1999).

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).

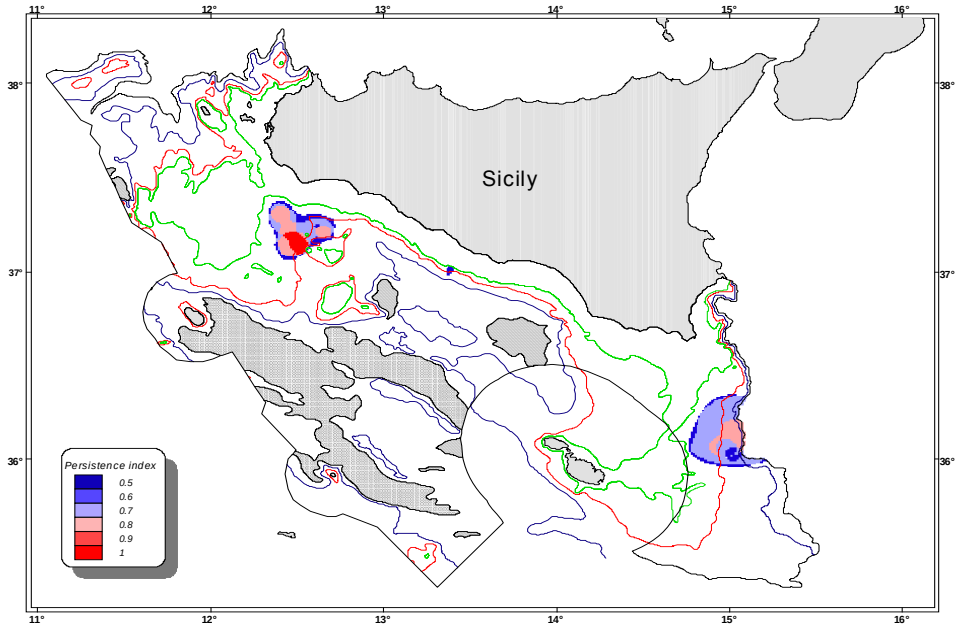


Figure 7.10.1.1.1 Areas showing stable presence of recruits of *M. merluccius* between 1994 and 1999 in GSA 15 and 16, excluding the Maltese Fisheries Management Zone (FMZ). The index of persistence ranges between 0 and 1, where 1 indicates stable nursery and 0 absence of nursery (modified from Fiorentino *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. 7.10.1.1.1).

Parameters of the length-weight relationship are listed in Table 7.10.1.1.1.

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).

Table 7.10.1.1.1 Parameters of length-weight relationships of hake in the GSAs 15 and 16.

Author	GSA	Sex	a	b
Andaloro *et al*., 1985	16	F+M+I	0.0060	3.1190
Cannizzaro *et al*., 1991	15 & 16	F	0.0069	3.0248
		M	0.0068	3.0222
		F+M+I	0.0066	3.0370
IRMA-CNR, 1999	15 & 16	F+M+I	0.0056	3.0831
CNR-IAMC, 2006	16	F	0.0041	3.1669
		M	0.0051	3.0916
		F+M+I	0.0046	3.1341
CNR-IAMC, 2007	16	F	0.0043	3.1525
		M	0.0049	3.1028

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).

7.10.1.2. 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).

The Von Bertalanffy Growth Function parameters by sex available for GSAs 15 and 16 are reported in Table 7.10.1.2.1.

Table 7.10.1.2.1 Von Bertalanffy growth function parameters in the strait of Sicily and adjacent seas.

Author	GSA	***Females***			**Males**			Remarks
		L∞	K	t_0	L∞	K	t_0	
Andaloro *et al*. (1985)	16	69.40	0.14	-0.35	57.1	0.16	-0.39	Otolith readings
IRMA-CNR, 1999	15&16	70.54	0.18	-0.1	49.37	0.29	-0.01	LFD analysis
SAMED, 2002	15&16	76.4	0.16	-0.2	44.9	0.28	-0.2	LFD analysis
Gangitano *et al*., 2007	16	82.60	0.12	-0.91	52.2	0.22	-0.83	Otolith reading
CNR_IAMC; 2007	16	81.54	0.15	-0.08	53.58	0.22	-0.13	Otolith readings and LFDA

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).

Recently, results given by otolith reading were considered as underestimating growth due to the presence of several checks, which can be confused with year rings. However the mean growth rates obtained for the first two years are consistent with those given by de Pontual *et al*. (2003), based on tagging experiments in the Bay of Biscay (0.84-0.99 cm per month in a size range of 21-40 cm TL).

7.10.1.3. 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*. (1998a), 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*., 2006b). 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 available estimates of length at first maturity for the Strait of Sicily are reported in Table 7.10.1.3.1.

Table 7.10.1.3.1 Length at first maturity, as L50% of maturity ogive, for hake in the Strait of Sicily and adjacent seas.

Author	GSA	Females		Males	
		L50%	g	L50%	g
Bouhlel, 1973	12 & 13	30.5	n.a.	28	n.a.
Mugahid & Hashem, 1982	21	24.5 (30)	n.a.	21	n.a.
Bouaziz *et al*., 1998	4	30.6	n.a.	21.5	n.a.
SAMED, 2002	15 & 16	33.5	n.a.	n.a.	n.a.
Gangitano *et al*., 2007	16	37.6	0.288	27.8	0.329
CNR_IAMC, 2007	15 & 16	35.6	0.29	24.6	0.23

7.10.2. Fisheries

7.10.2.1. 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. 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).

7.10.2.2. Management regulations applicable in 2007 and 2008

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. 7.10.1.1.1).

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.

7.10.2.3. Catches

7.10.2.3.1. 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.

Table 7.10.2.3.1.1 Landings (t) of hake by fishing technique by the Sicilian fleet (DTS=bottom trawler; HOK=…; PGP=…; PMP=….; PTS=….) (IREPA source).

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
HKE	15	MLT	Other gear						
HKE	15	MLT	OTB				4	5	6
HKE	15	MLT	LTL						
HKE	15	MLT	LLS				2	1	2
HKE	15	MLT	LLD						
HKE	15	MLT	LA						1
HKE	15	MLT	GTR						
HKE	15	MLT	GNS						
HKE	15	MLT	[SB] [SV]						
HKE	15	MLT	[LHP] [LHM]						
HKE	16	ITA	PTS	13	18		1		
HKE	16	ITA	PMP	52	23				
HKE	16	ITA	PGP	92	12		67	27	111
HKE	16	ITA	HOK			22	9	2	9
HKE	16	ITA	DTS	1716	1960	1927	1713	1597	1599
			Sum	1873	2013	1949	1796	1632	1728

Considering that overall yield of trawling was about 9,666 tons in the first year and 8,052 tons in the second one, hake landings representing about 14-15% of total yield in the area. On the basis of 2007 data, more than 93% of Sicilian landings are due to trawling (Table 7.10.2.3.1.1). 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. 7.10.2.3.1.1 as reported to SGMED-08-03 through the DCR. The data are listed in Table A3.1 of Appendix 3.

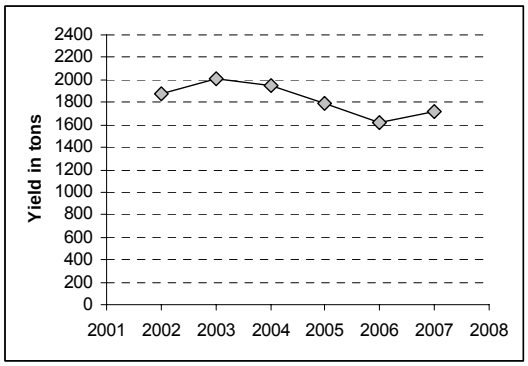


Figure 7.10.2.3.1.1 Hake landings in GSA 15 and 16 (IREPA source).

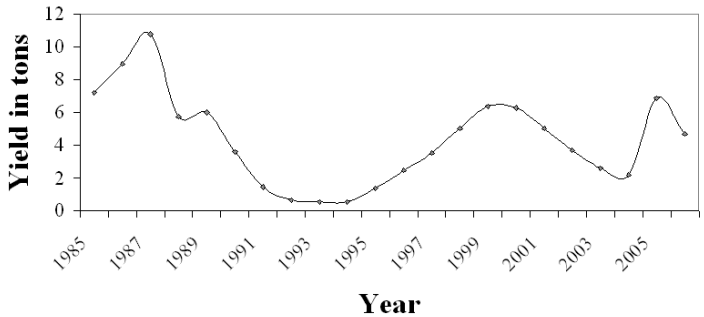


Figure 7.10.2.3.1.2 The Maltese hake yield (GSA 15; all gears combined).

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).

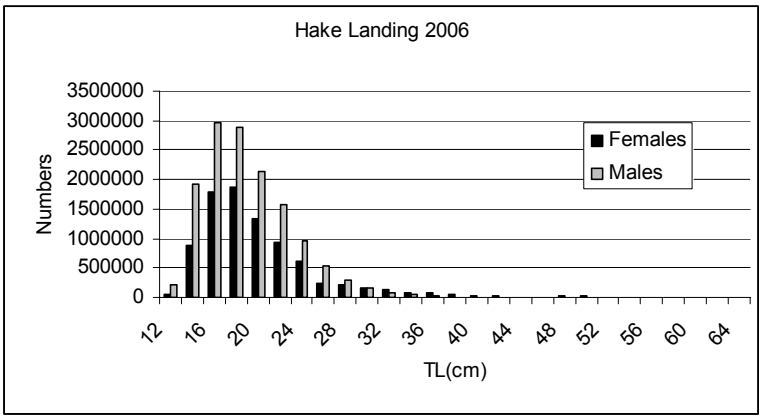


Figure 7.10.2.3.1.3 Yearly length structure of hake landings by sex in absolute numbers of Sicilian trawlers in 2006.

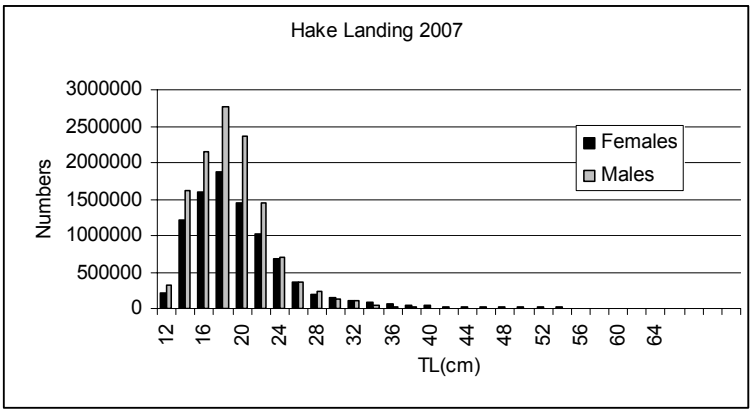


Figure 7.10.2.3.1.4 Yearly length structure of hake landings by sex in absolute numbers of Sicilian trawlers in 2007.

7.10.2.3.2. 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 54 tons in 2006. 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 A3.4 of Appendix 3.

7.10.2.3.3. Fishing effort

The trends in fishing effort by year and major gear type is listed in Tab. 7.10.2.3.3.1 and shown in Fig. 7.10.2.3.3.1 in terms of kW*days for the otter trawls. However, the effort of the main otter trawl fleet increased from 2004 to 2007 by 12%. The data are listed in Tables A3.5-A3.7 of Appendix 3.

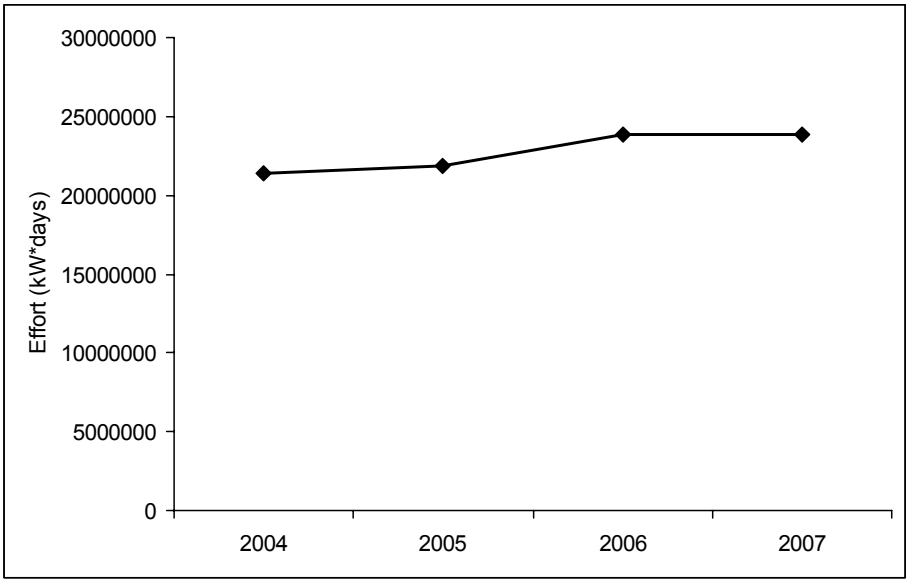


Fig. 7.10.2.3.3.1 Trend in annual effort (kW*days) of the otter trawlers operating in GSAs 15 and 16, 2004-2007.

Tab. 7.10.2.3.3.1 Trend in annual effort (days at sea, GT*days, kW*days) by country and gears in GSAs 15 and 16, 2004-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2004	2005	2006	2007
DAYS	15	MLT	[LHP] [LHM]		28		
DAYS	15	MLT	[SB] [SV]			73	59
DAYS	15	MLT	GNS		51		
DAYS	15	MLT	GTR		200	152	320
DAYS	15	MLT	LA			1116	1096
DAYS	15	MLT	LLD		3164	3159	2827
DAYS	15	MLT	LLS		1197	1466	1624
DAYS	15	MLT	LTL		263		
DAYS	15	MLT	OTB		421	404	688
DAYS	15	MLT	Other gear		64		
DAYS	16	ITA	DTS	81853	82557	89319	89164
DAYS	16	ITA	HOK	14856	11450	10272	9284
DAYS	16	ITA	PGP	118425	97285	85556	85298
DAYS	16	ITA	PMP	6939			
DAYS	16	ITA	PTS	4899	5476	7926	7032
GT*DAYS	15	MLT	[LHP] [LHM]		170		
GT*DAYS	15	MLT	[SB] [SV]			192	139
GT*DAYS	15	MLT	GNS		135		
GT*DAYS	15	MLT	GTR		1174	477	1023
GT*DAYS	15	MLT	LA			23999	29596
GT*DAYS	15	MLT	LLD		82011	72364	60606
GT*DAYS	15	MLT	LLS		16866	18866	18072
GT*DAYS	15	MLT	LTL		2539		
GT*DAYS	15	MLT	OTB		24878	34527	69268
GT*DAYS	15	MLT	Other gear		226		
GT*DAYS	16	ITA	DTS	6673029	6864030	7429483	7322198
GT*DAYS	16	ITA	HOK	764595	403669	507862	370612
GT*DAYS	16	ITA	PGP	249032	206056	192811	212519
GT*DAYS	16	ITA	PMP	20134			
GT*DAYS	16	ITA	PTS	224188	236435	352518	346405
KW*DAYS	15	MLT	[LHP] [LHM]		1880		
KW*DAYS	15	MLT	[SB] [SV]			3805	2507
KW*DAYS	15	MLT	GNS		2121		
KW*DAYS	15	MLT	GTR		13889	8391	20724
KW*DAYS	15	MLT	LA			203361	208456
KW*DAYS	15	MLT	LLD		554562	483437	449900
KW*DAYS	15	MLT	LLS		140846	159692	160914
KW*DAYS	15	MLT	LTL		26318		
KW*DAYS	15	MLT	OTB		129838	143909	240858
KW*DAYS	15	MLT	Other gear		3394		
KW*DAYS	16	ITA	DTS	21381964	21772464	23699835	23644626
KW*DAYS	16	ITA	HOK	3153486	1758722	2076446	1695903
KW*DAYS	16	ITA	PGP	2691324	2302777	2207660	2378933
KW*DAYS	16	ITA	PMP	223470			
KW*DAYS	16	ITA	PTS	962786	1063031	1592930	1431085

7.10.3. Scientific surveys

7.10.3.1. Medits

7.10.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 15 and 16 the following number of hauls were reported per depth stratum (s. Tab. 7.10.3.1.1.1).

Tab. 7.10.3.1.1.1. Number of hauls per year and depth stratum in GSAs 15 and 16, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA15_010-050									1	1	2	1	1	
GSA15_050-100									6	5	4	5	5	12
GSA15_100-200									12	13	13	13	13	12
GSA15_200-500									9	10	9	9	9	4
GSA15_500-800									17	16	15	17	16	17
GSA16_010-050	4	4	4	4	4	4	4	4	7	7	7	10	10	11
GSA16_050-100	8	8	8	8	8	8	7	8	11	12	12	20	22	23
GSA16_100-200	4	4	4	4	5	5	6	5	10	8	9	18	19	21
GSA16_200-500	10	11	11	12	11	11	11	11	19	18	19	28	31	27
GSA16_500-800	10	14	14	13	14	14	14	14	19	20	19	32	33	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.

7.10.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.10.3.1.3. 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 and Grund. Figure 7.10.3.1.3.1 and 7.10.3.1.3.2 display the estimated trend in hake abundance and biomass in GSAs 15 and 16, respectively.

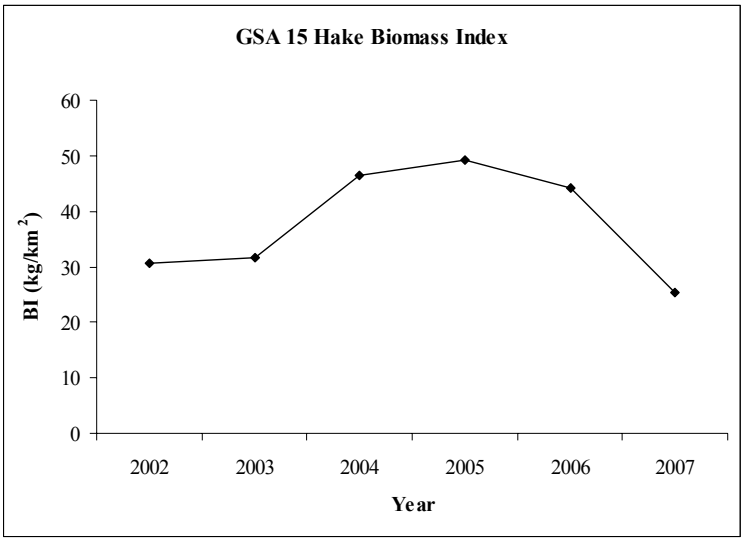


Fig. 7.10.3.1.3.1 Biomass indices (BI as kg per km^2) obtained during the MEDITS survey in GSA 15.

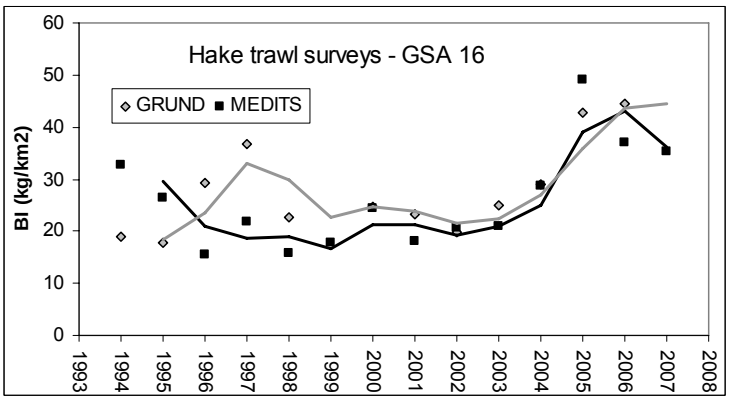


Fig. 7.10.3.1.3.2 Biomass indices (BI as kg per km^2) obtained during the MEDITS and GRUND surveys in GSA 16.

The biomass indices since 2002 for both GSAs 15 and 16 show a similar pattern with an increasing trend till 2005-2006 and decrease in 2006-2007.

The recruitment indices obtained during MEDITS surveys (Fig 7.10.3.1.3.3) ranged between 200 and 400 Recruits per km^2 from 1995 to 2000. High recruitment indices were obtained in 1994, 2003 and 2004 while the lowest values were obtained in 2001 and 2002.

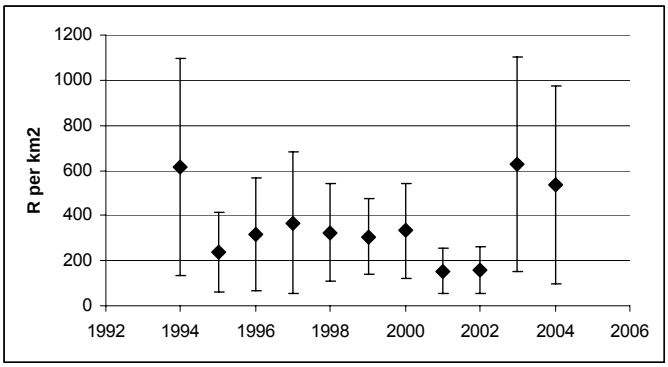


Fig. 7.10.3.1.3.3 Recruits per km^2 (MEDITS surveys), as overall mean±sd in GSA 16.

The trend in abundance and biomass as reestimated by SGMED-08-03 are shown in Figures 7.10.3.1.3.4 and 7.10.3.1.3.5 for GSAs 15 and 16. While the trend in GSA 15 is quite short, recent abundance and biomass indices (2005-2007) in GSA 16 appear at the highest level observed since 1994. Such analyses of Medits indices are considered preliminary.

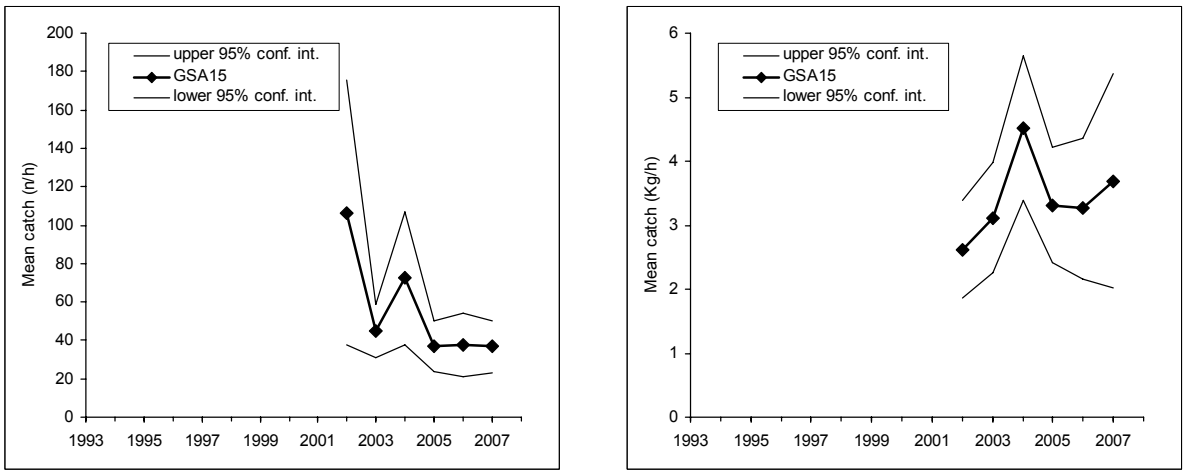


Fig. 7.10.3.1.3.4 Abundance and biomass indices of hake in GSA 15.

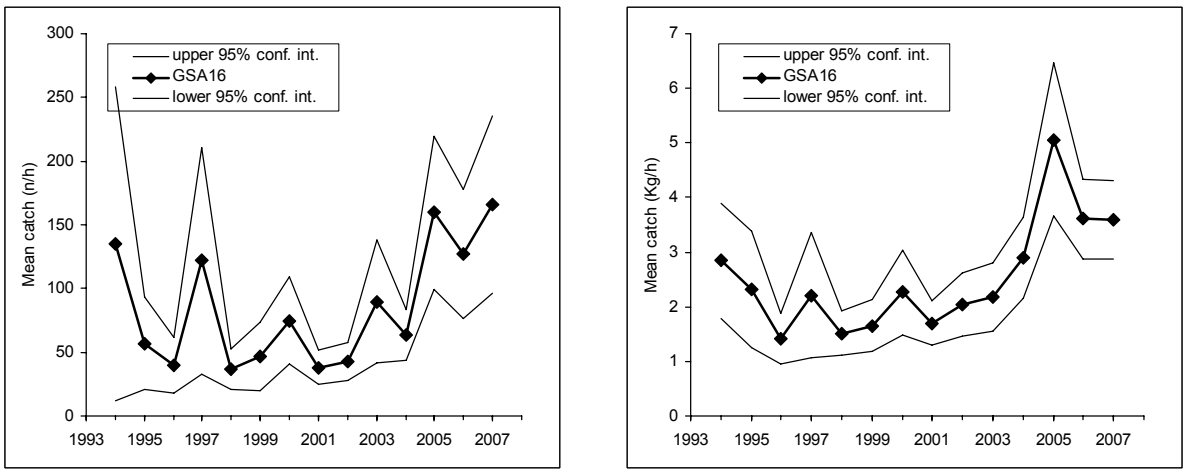


Fig. 7.10.3.1.3.5 Abundance and biomass indices of hake in GSA 16.

7.10.3.1.4. Trends in abundance by length or age

The following Fig. 7.10.3.1.4.1 displays the stratified abundance indices of GSA 15 in 2002-2007. These size compositions are considered preliminary.

The Figures 7.10.3.1.4.2 and 7.10.3.1.4.3 display the stratified abundance indices of GSA 16 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

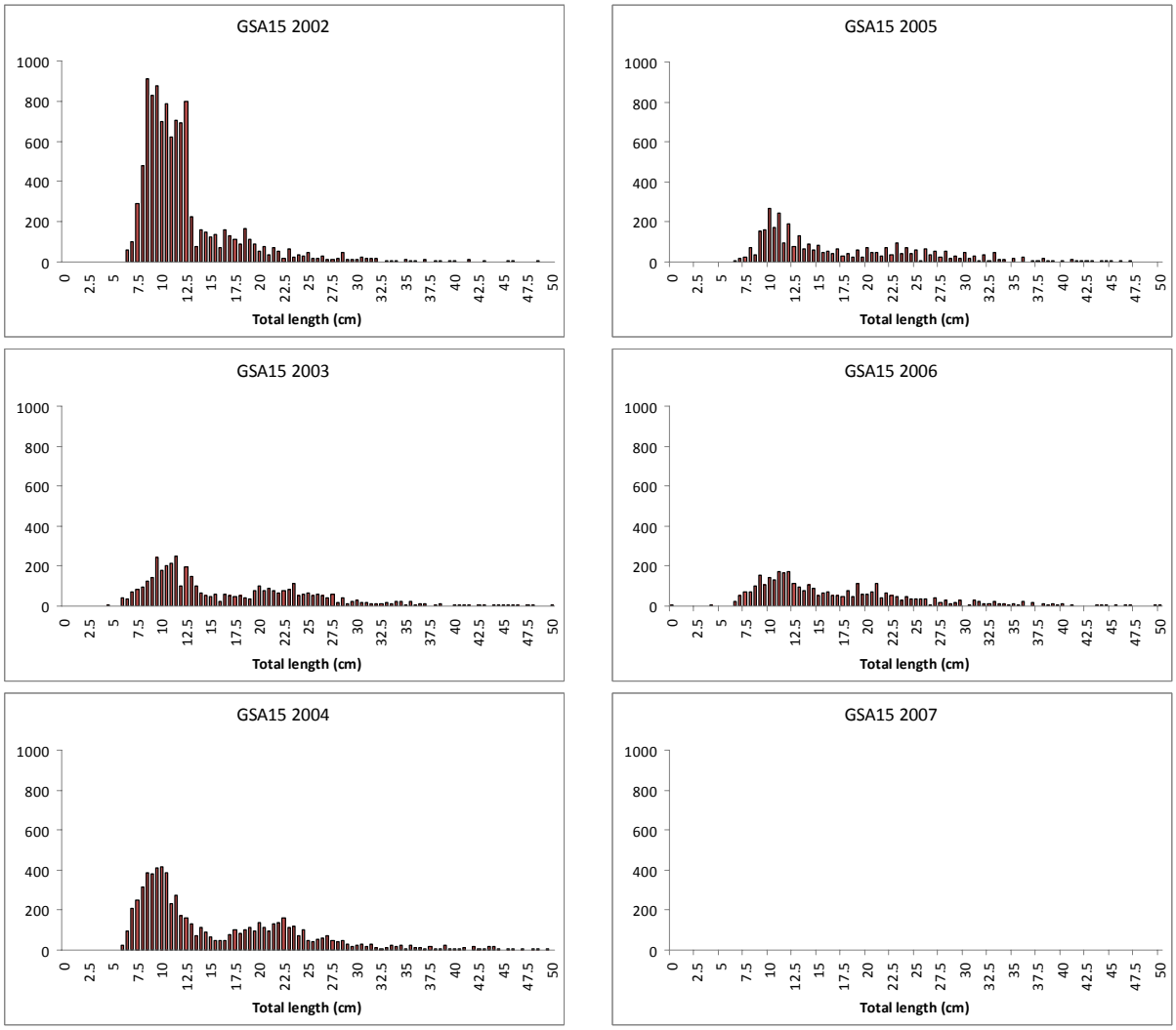


Fig. 7.10.3.1.4.1 Stratified abundance indices by size in GSA 15, 2002-2007.

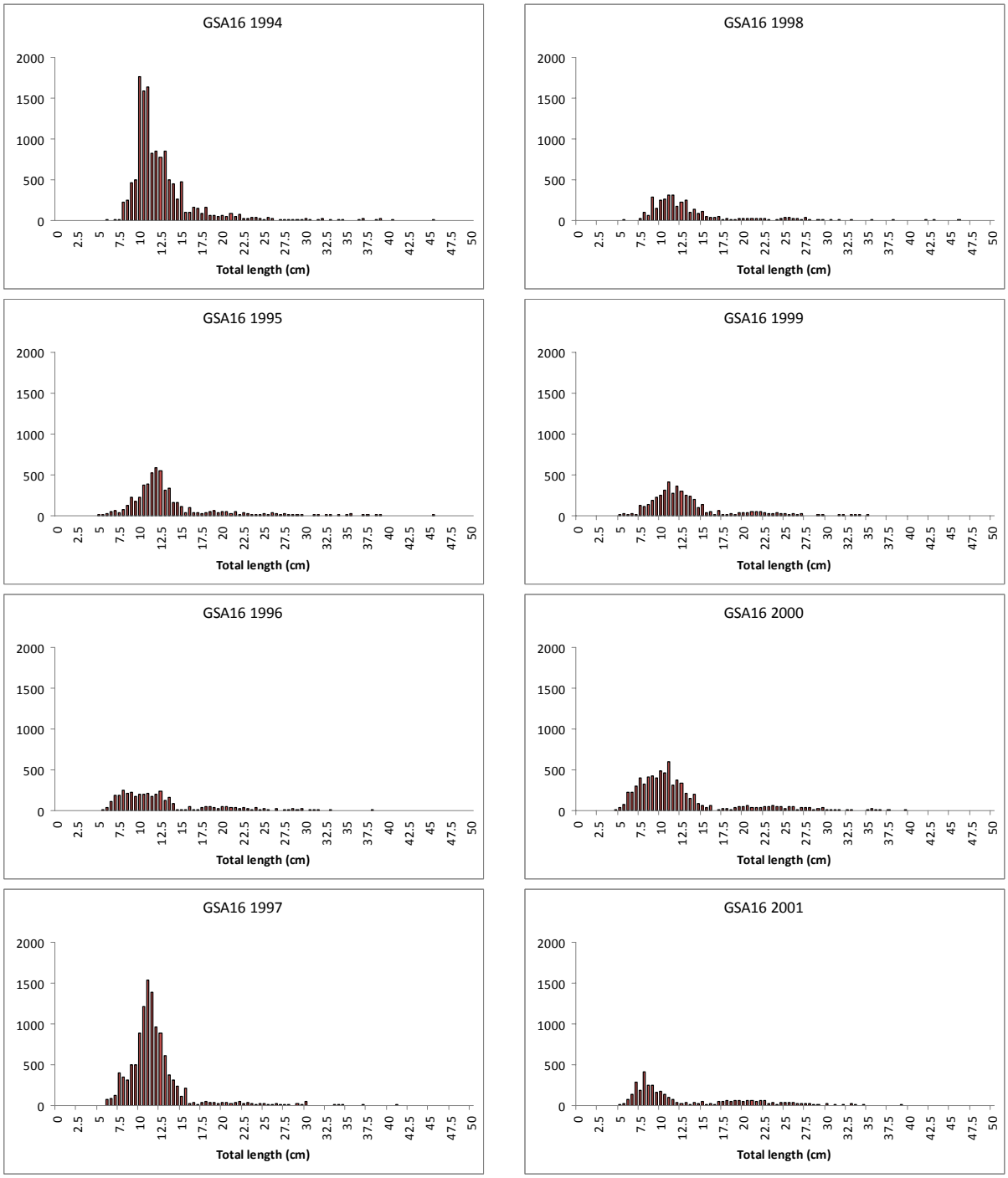


Fig. 7.10.3.1.4.2 Stratified abundance indices by size in GSA 16, 1994-2001.

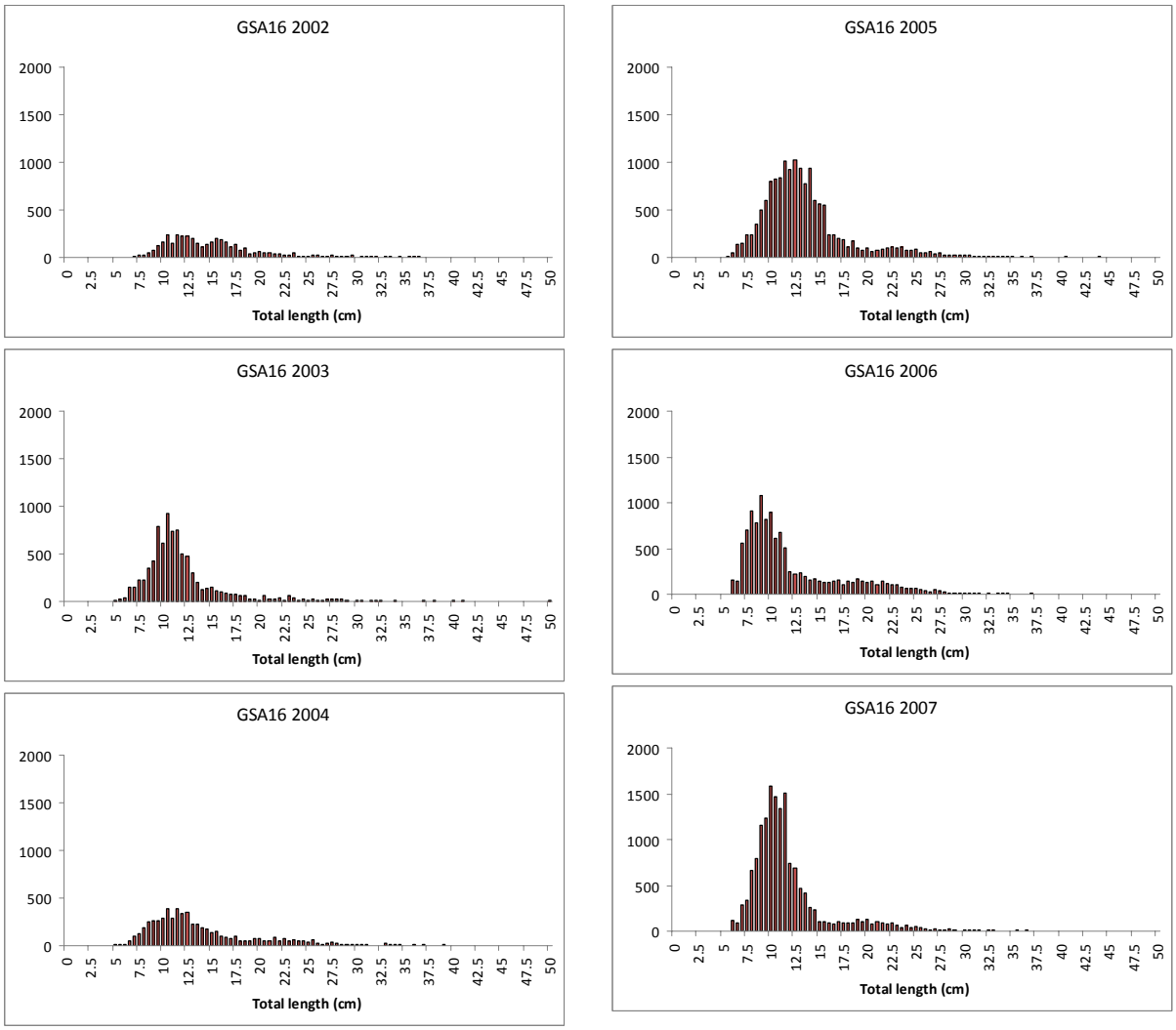


Fig. 7.10.3.1.4.3 Stratified abundance indices by size in GSA 16, 2002-2007.

7.10.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.10.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.10.4. Assessment of historic stock parameters

7.10.4.1. Method 1: Trends in LPUE

7.10.4.1.1. Justification

Trends in LPUE may provide insight into trends in stock size. SGMED-08-03 recommends that technological creep should be considered when trends in LPUE are interpreted.

7.10.4.1.2. Input parameters

Landings and effort for the Sicilian trawler fleet operating in GSAs 15 and 16 were used.

7.10.4.1.3. Results

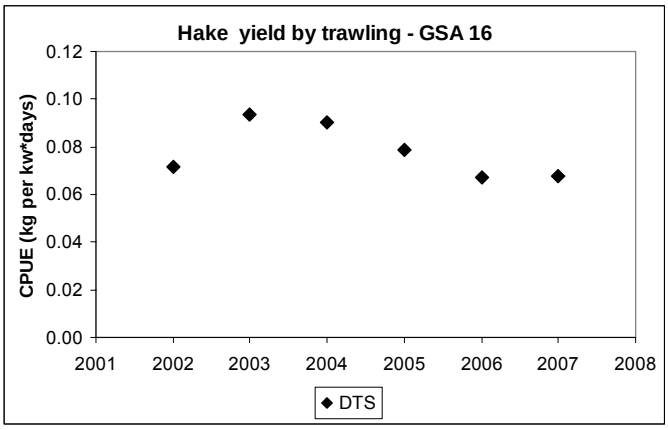


Figure 7.10.4.1.3.1 Landing per unit effort of commercial trawling by the Sicilian fleet (GSAs 16 and 15).

According to commercial data, a light decrease of hake landings per unit effort is occurring since 2003 (Fig. 7.10.4.1.3.1).

7.10.4.2. Method 2: SURBA

7.10.4.2.1. Justification

The availability of a long time series (1994-2007) of length frequency distribution (LFD) from trawl surveys data allows to reconstruct the evolution of fishing mortality rates of hake in the GSA 15 and 16 by using the SURBA software package. Firstly the LFD by sex from the MEDITS trawl surveys was corrected by including the data for the individuals with unidentified sexes. 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 at age using VBGF and a vectorial natural mortality at age (Abella and Caddy, 1999) for the SURBA software to run the analysis. Then the numbers at age were used to estimate time series of fishing mortality rates. This was done due to the difficulties in obtaining feasible information from commercial fisheries data especially from GSA 15 were length frequencies distributions do not exist from landings. Still for GSA 16 data from commercial fisheries were only available since 2002 with the start of the DCR regulation (EC 1639/01; EC 1581/04).

7.10.4.2.2. Input parameters

The VBGF parameters used for age slicing of LFD in both GSAs were obtained from CNR_IAMC (2007) for GSA 16 (Tab. 7.10.4.2.2.1).

Natural mortality rates by age were calculated according to the approach of Abella and Caddy (1999), minimizing the difference of proportion by size of numbers between LCA and surveys for full vulnerable range (Tab. 7.10.4.2.2.1).
Guess estimates of catchability by age are given in Tab. 7.10.4.2.2.1.

Tab. 7.10.4.2.2.1 Vector of natural mortality and catchability coefficient for hake (sex combined) in the Strait of Sicily (GSAs 15 and 16).

Age	0	1	2	3	4
Natural mortality (M_a)	0.9	0.5	0.4	0.3	0.3
Catchability coefficient (q_a)	1	1	1	0.75	0.5

7.10.4.2.3. Results

Trends in estimated fishing mortalities are plotted in Fig. 7.10.4.2.3.1.

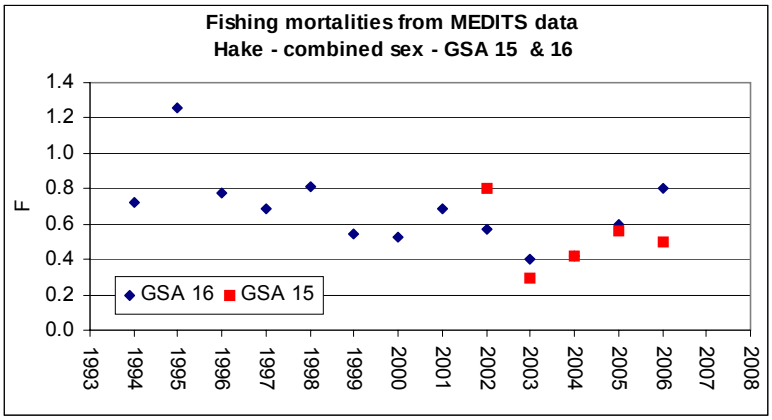


Figure 7.10.4.2.3.1 Fishing mortalities estimated by SURBA using trawl surveys age composition (MEDITS).

7.10.4.3. Method 3: VIT

7.10.4.3.1. Justification

Since only two complete years (2007-2008) of length frequency distribution of landing were available, an approach under steady state (pseudocohort) was used. Cohort (VPA equation) and Y/R analysis as implemented in the package VIT4win were used (Lleonart and Salat, 2000). Data were derived from DCR call for GSA.

7.10.4.3.2. Input parameters

Landing LFD by sex were converted in number by age using the growth parameters given in Tab. 7.10.1.2.1. The length-weight relationships and the maturity ogive are listed in tables Tab. 7.10.1.1.1 and Tab. 7.10.1.3.1 (CNR_IAMC, 2007).

Terminal F was fixed as equal to M (0.34 in females and 0.43 in males, from SAMED, 2002). No discard data were included.

7.10.4.3.3. Results

Mortality rates (Z and F) by sex and size of hake in GSA 16 are shown in Fig. 7.10.4.3.3.1.

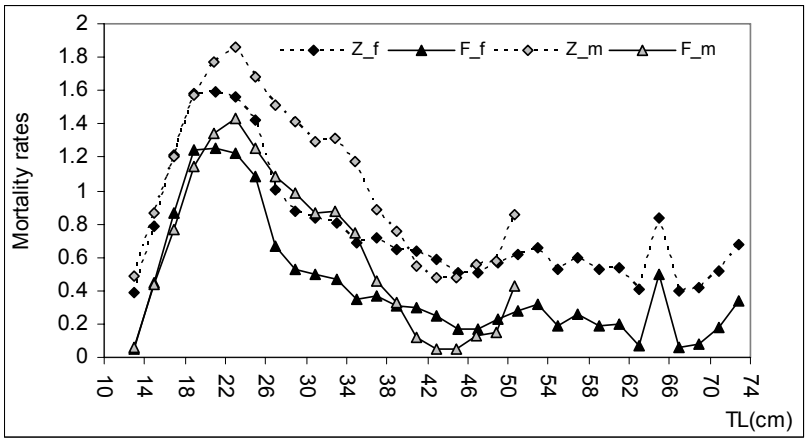


Fig. 7.10.4.3.3.1 Total (Z) and Fishing (F) mortalities rates by size and sex of Hake in GSA 16.

The reconstructed yield obtained by the VIT package (1,597 t) is virtually equal to the observed one (1,598 t). Absolute recruitment estimation and other main results of VIT, including the current mortality rates, are listed in table 7.10.4.3.3.1.

Table 7.10.4.3.3.1 The main results of VIT analysis.

Variables	Females	Males	Total
Observed Yield (tons)	……	……..	1598
Reconstructed Yield (tons)	796	802	1597
Recruits at 12 cm TL (millions)	13.5	21.2	34.7
Mean Z	0.659	0.859	
Mean F	0.319	0.429	
Global F	0.656	0.690	
Catch mean length (cm)	21.1	19.9	
Stock mean length (cm)	21.1	17.7	

7.10.5. Short term prediction for 2008 and 2009

7.10.5.1. Justification

No forecast analyses were conducted.

7.10.5.2. Input parameters

No forecast analyses were conducted.

7.10.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSAs 15 and 16.

7.10.6. Medium term prediction

7.10.6.1. Justification

The availability of a time series of total mortality rates and main relevant parameters allows to reconstruct the stock dynamics in the last years and to simulate the effects of management measures such as the reduction of fishing mortalities, increase of size at capture, seasonal closures and all the measures considered combined. Hence the Aladym simulation model (Lembo et al., …..) is a very useful tool to give practical management advice in order to improve the status of the stock. Since the indices from the trawl surveys of GSA 15 and 16 are complimentary and follow the same trend we have utilized only the data from GSA 16 to make the simulation since there is a longer time series and a more complete data set. This implies that any advice on management measures resulting from the Aladym simulation to improve the status of the hake stock would apply to both GSAs 15 and 16.

7.10.6.2. Input parameters

The input parameters used in the Aladym simulation for hake stock in the Strait of Sicily are reported in Tab. 7.10.6.2.1.

Tab. 7.10.6.2.1 Stock parameters used in Aladym model.

GSA 15 + 16		***M. merluccius***	
Parameters		**Females**	**males**
K (y)		0.16±0.01	0.27±0.01
L_∞ (mm)		760 ±14	450 ±14
t_0		-0.4 ±0.1	-0.4 ±0.1
a		0.000003248	0.00002118
b		3.1416	2.8684
Life span (y)		20	11
M		0.34	0.43
L_{mat} (mm)		320±20	270±20
Maturity range (L75-L25) (mm)		30	20
Sex ratio (F/F+M)		0.5	
L_{50} (mm); SR (mm)		95; 36 up to 2009	
		190; 86 from 2010	
D_{50} (mm)		500	
Activity coefficient/intensity		Tuned by month with commercial catches	
		From 2008 onward trawling ban between January and February	
Pre-recruits (initial number) and *ln*-normal distribution parameters		$59 \cdot 10^6$ (mean ln(R)=17.74; ds ln(R)=0.74)	
Spawning period (spawning peak)		January-September (February-May)	
Years of simulation		30	
proxy of *Z* (y)	1994-2006	1.65 (M) and 1.04 (F)	

Analysis aims to evaluate the effect of 5 different management scenarios on the hake stock in the Strait of Sicily. These scenarios are:

- 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.

7.10.6.3. Results

Yield of hake (landings data from DCR by IREPA in blue) of the Sicilian fleet based on GSA 16 data from 2004 to 2007 in comparison with the simulation obtained by the Aladym model (Catches Aladym in violet) are reported in Fig. 7.10.6.3.1.

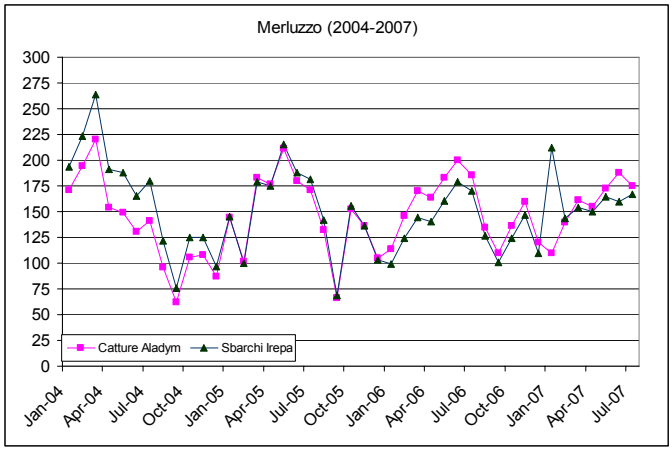


Fig. 7.10.6.3.1 Yield of hake (landings data from DCR by IREPA in blue) of the Sicilian fleet based on GSA 16 data from 2004 to 2007 with the catches (in violet) simulated by the Aladym model.

A good correspondence between the observed and reconstructed hake yield by the Sicilian fleet is evident. Effects of the different management scenarios, in terms of stock biomass, yield and ratio between exploited and virgin spawning stock biomass (ESSB/USSB) are shown in Fig. 7.10.6.3.2.

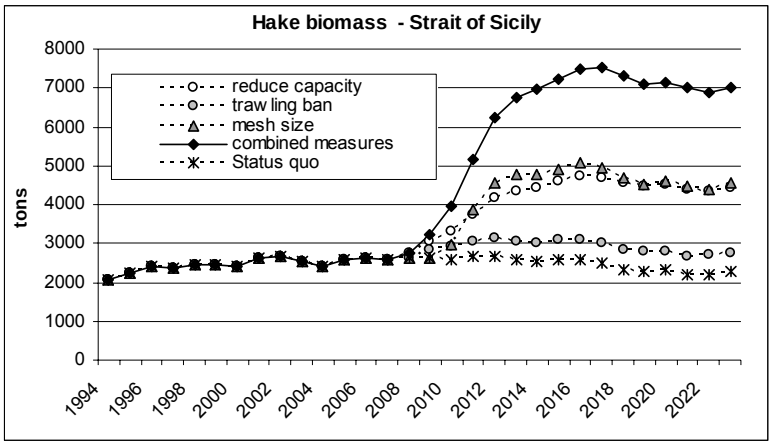


Fig. 7.10.6.3.2 Simulation of standing stock of hake under different management scenarios in the Strait of Sicily (GSA 16 and 15) according to Aladym model.

Considering the single measures, the increase of mesh size or the 25% decrease of fishing capacity would produce an important mean increase in biomass after 2013 ranging from 65 to 78% of the 2008 value. The trawling ban would produce a minor rise, corresponding to about 10%.

The three measures combined would cause in the long period (2013-2023) a mean increase in biomass of about 160% of the 2008 value, while maintaining the *status quo* would produce a mean decrease of about 9% in 2013-2023 period.

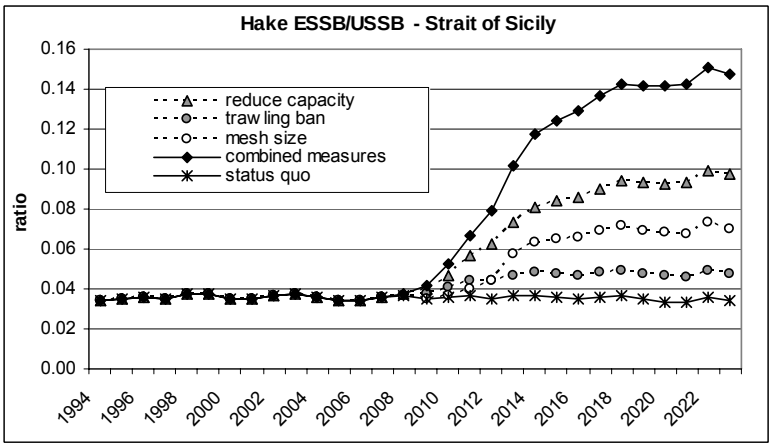


Fig. 7.10.6.3.3 Simulation of ratio exploited and unexploited SSB (ESSB/USSB) of female hake under different management scenarios in the Strait of Sicily according to Aladym model.

Under the scenario 4 (combined measures), the ratio ESSB/USSB in 2013-2023 period would increase in mean of about 260% the 2008 value, with an expected value of the ESSB being about the 15% of the USSB. A slight decrease of yield for the first two years after the change in mesh size is implemented is expected, but then it is followed by a mean increase in 2013-2023 of 40% (adoption of 50 mm mesh) and 18% (reduction of fleet capacity) of the 2008 value. The trawling ban would produce a negligible change, while '*status quo*' would produce in long time a mean reduction of total catches of about the 4%. It is worth noting that under the combined measures scenario yield is expected to increase in mean of about 60% of current value between 2013 and 2023.

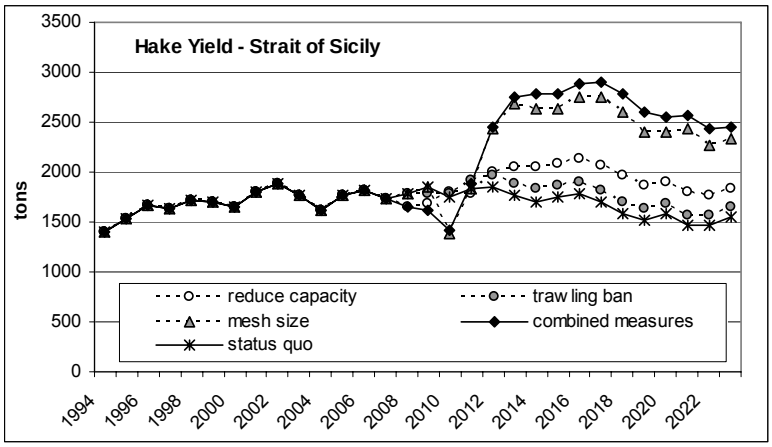


Fig. 7.10.6.3.4 Simulation of hake yield under different management scenarios in the Strait of Sicily according to Aladym model.

7.10.7. Long term prediction

7.10.7.1. Method 1: YPR

7.10.7.1.1. Justification

A classical YPR analysis has been applied in order to analyse the stock production with increasing exploitation under equilibrium conditions.

7.10.7.1.2. Input parameters

No input parameters have been presented to SGMED-08-03.

7.10.7.1.3. Results

Estimation of Biomass and Yield per recruit varying current fishing mortality (Fc) by a multiplicative factor is reported in Fig. 7.10.7.1.3.1.

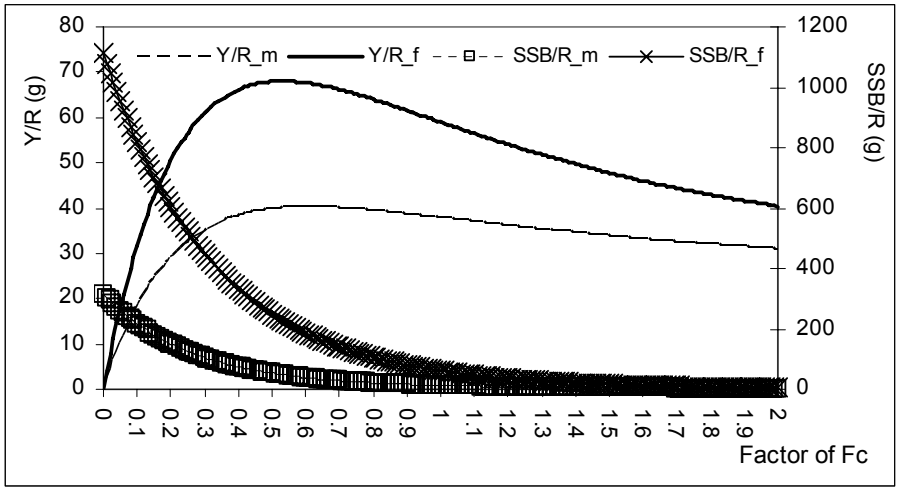


Fig. 7.10.7.1.3.1 Spawning Stock Biomass and Yield per recruit varying current fishing mortality (Fc) by a multiplicative factor according to the VIT package.

Assuming no variation in the exploitation pattern, the main result of Y/R analysis are reported in Tab. 7.10.7.1.3.1

Tab. 7.10.7.1.3.1 Estimation of yield (Y), biomass (B) and spawning stock biomass (SSB) per recruit (R) varying current fishing mortality (F) by a multiplicative factor.

Sex	Status	Factor	Y/R	B/R	SSB
Females	**F(Virgin)**	0	0	1390.59	1112.60
	F(0.1)	0.38	65.42	502.74	353.43
	F(Max)	0.54	67.99	346.98	228.03
	F(Current)	1.01	58.96	123.60	60.64
	F(Double)	2	40.40	29.03	4.48
Males	**F(Virgin)**	0	0	424.55	315.64
	F(0.1)	0.40	38.29	130.87	73.99
	F(Max)	0.62	40.20	80.88	37.02
	F(Current)	1.01	37.82	42.41	12.12
	F(Double)	2	30.88	19.52	2.10

A clear overfishing state is detected. Maintaining the current fishing pattern, a reduction of current effort of 60-62% and 38-46% is advisable to reach $F_{0.1}$ and F_{max} respectively.

7.10.7.2. Method 2: Y, B and SSB per recruit according to the Yield package

7.10.7.2.1. Justification

Availability of biological parameter with their uncertainty 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. It is also possible to estimate the probability distribution of main Biological Reference Point (F_{max}, $F_{0.1}$ and $F_{spr=0.3}$ and the corresponding Yield per Recruit) to assess the stock status.

7.10.7.2.2. Input parameters

Growth, length-weight relationship, natural mortality and maturity ogive the same used in the previous paragraph (VIT). Length at 50% capture was 14 cm TL.

A guess estimate of uncertainty in terms of coefficient of variation (CV) was added to each parameter.

Spawning stock-recruitmentent relationship was not used. Variables were estimated for 1 million young fish nominal recruitment. The recruitment variability among years was estimated as CV=0.45 from recruit indices obtained in trawl surveys.

7.10.7.2.3. Results

Estimation of Y and SSB per recruit are shown in Fig 7.10.7.2.3.1 (females) and 7.10.7.2.3.2 (males).

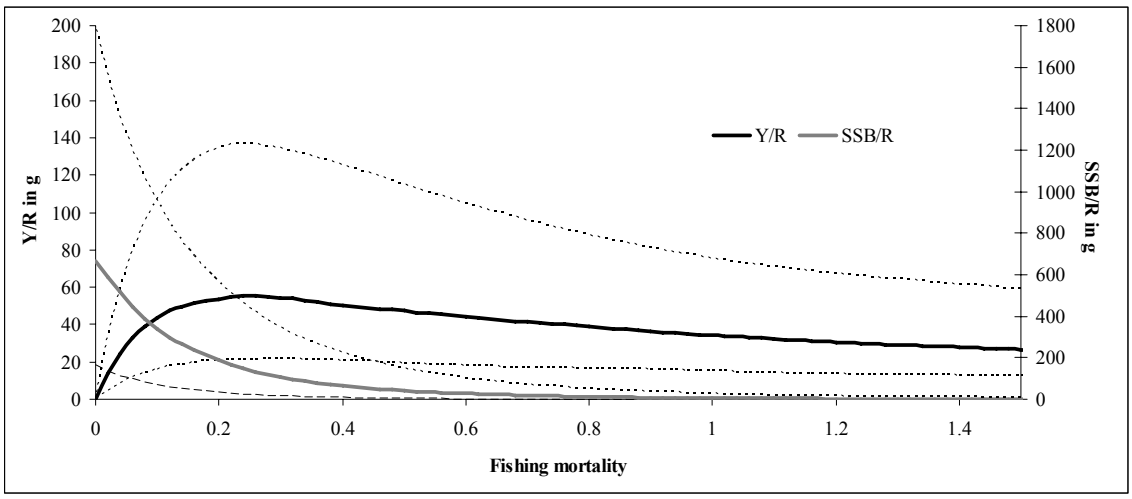


Fig. 7.10.7.2.3.1 Yield and spawning stock biomass per recruit and corresponding uncertainty of female hake in the GSA 15 and 16 according to the Yield Package.

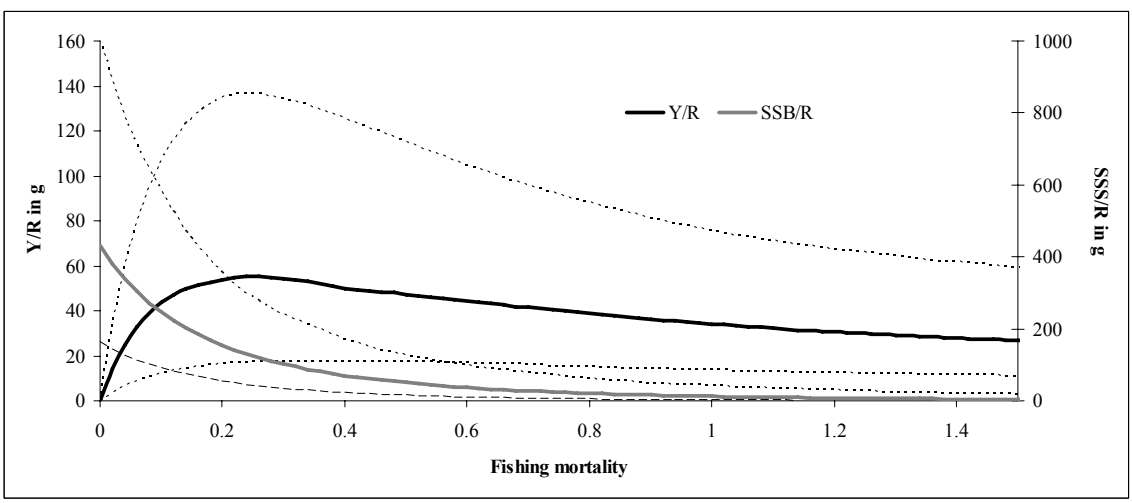


Fig. 7.10.7.2.3.2 Yield and spawning stock biomass per recruit and corresponding uncertainty of male hake in the GSA 15 and 16 according to the Yield Package.

Searching for biological reference points (BRP) through 1000 simulation produced the median values reported in table 7.10.7.2.3.1 Y/R_{max} and F_{max} should be considered as Limit Reference Points (LRP) whereas Y/R 0.1, F0.1, $Y/R_{SPR\_0.35}$ and $F_{SPR\_0.35}$ should be considered as Target reference points (TRP).

Tab. 7.10.7.2.3.1 Yield per recruit and fishing mortality based BRP of hake by sex for GSA 15 and 16 according to the Yield package.

Yield based RP	**female**	**male**	**F based RP**	**female**	**male**
Y/R_{max}	59.6	39.8	F_{max}	0.244	0.315
$Y/R_{F0.1}$	57.4	37.4	$F_{0.1}$	0.157	0.194
$Y/R_{SPR\_0.35}$	59.5	37.8	$F_{SPR\_0.35}$	0.154	0.202

7.10.7.3. Method 3: Surplus Production Composite Model

7.10.7.3.1. Justification

Availability of several couples of total mortality rates and biomass indices obtained by trawl surveys in two areas with similar ecological features but affected by different fishing pressure allows to adopt the composite approach as proposed by Abella et al. (1998). It is assumed that substantial changes in fishing pressure didn't occur along the considered period within each one of the considered areas.

7.10.7.3.2. Input parameters

Total mortality rates (Z) were estimated from a fixed value of natural mortality (mean of scalar M) and the fishing mortalities obtained by the SURBA analysis and biomass indices (kg per km^2) used to assess hake stock status in the GSA 15 & 16 are reported in Tab. 7.10.7.3.2.1.

Tab. 7.10.7.3.2.1 Total mortality rates (Z) and biomass indices (BI as kg per km^2) by area and year used to estimated the surplus production composite model.

Area	**Year**	**Z**	**BI**	**Area**	**Year**	**Z**	**BI**
GSA 15	2002	1.28	31.66	GSA 16	1998	1.29	17.77
GSA 15	2003	0.77	48.56	GSA 16	1999	1.02	24.46
GSA 15	2004	0.9	61.65	GSA 16	2000	1.01	18.01
GSA 15	2005	1.04	44.07	GSA 16	2001	1.17	20.59
GSA 15	2006	0.98	26.49	GSA 16	2002	1.05	21.06
GSA 16	1994	1.21	26.36	GSA 16	2003	0.88	28.83
GSA 16	1995	1.73	15.61	GSA 16	2004	0.9	49.13
GSA 16	1996	1.26	21.89	GSA 16	2005	1.07	37.05
GSA 16	1997	1.16	15.82	GSA 16	2006	1.29	35.19

7.10.7.3.3. Results

The composite biological production model under two steady state approaches (Schaefer and Fox) are reported in Fig. 7.10.7.3.3.1 and 7.10.7.3.3.2.

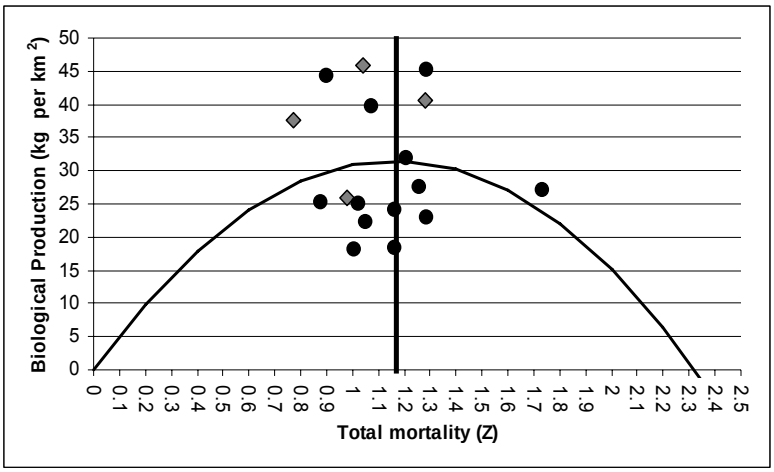


Fig. 7.10.7.3.3.1 Biological Production (BP) vs. Total mortality rates (Z) under the steady state assumption of Hake in GSA 15 (grey diamonds) and 16 (black circles) according to the composite model (Schaefer formulation). The Z_{MBP} (bold vertical line) was 1.16.

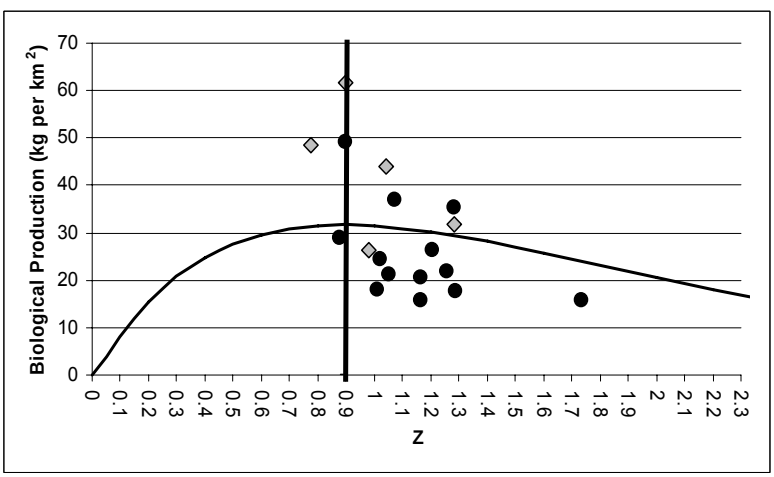


Fig. 7.10.7.3.3.2 Biological production (BP) vs. total mortality rates (Z) under the steady state assumption of Hake in GSA 15 (grey diamonds) and 16 (black circles) according the composite model (Fox formulation). The Z_{MBP} (bold vertical line) was 0.89.

In both GSAs the diagnosis is a situation of full to overexploitation. GSA16 appears more heavily exploited, with most of the observations positioned at levels of Z over the Z_{MBP}, in the case of the Fox model.

Considering the ZMBP as a limit reference points the hake stock appears fully to overexploited according both the Schaefer model and the Fox one, suggesting the need of a reduction of fishing effort for a better improvement of the stock in the medium to long term.

In particular $Z_{curr.}$ in GSA 15 (1.01) ranged from -13 (Fox) to +13% (Schaefer) the optimal one (Z_{MBP}), while in GSA 16 $Z_{curr.}$ (1.18) is from 1 (Schaefer) to 33% (Fox) higher than the optimal one (Z_{MBP}).

Some bias in Z estimation might be in early and late years of the time series considered due to poor performance of the F estimates by the SURBA software. Furthermore it is worth noting that the equilibrium assumption within each area considered could overestimate both MBP and corresponding Z values.

7.10.7.4. Method 4: Non equilibrium Surplus Production model

7.10.7.4.1. Justification

When commercial information is limited but long time series of Z and U proceeding from trawl surveys are available a variant of non-equilibrium surplus production model can be fitted (Abella, 2005).

The classical model requiring time series of index of abundance and effort is:

$$B_{t+1} = B_t + rB_t(1-(B_t / k)) - qfB_t$$

Since $qfBt = Y$, catch in weight (Yt) can be substituted by the classic Baranov catch equation:

$$Y=(F/Z)\ B(1-exp(-Z_t)$$

and the model can be written as:

$$B_{t+1} = B_t + rB_t(1-(B_t / k)) – (F/Z)\ B_t(1-exp(-Z_t)\ )$$

Z can be estimated by analysing the size structure of the surveys catches and F computed by subtraction if an estimate of M is available.

7.10.7.4.2. Input parameters

Data input is time series of biomass indices (kg per km^2 as overall mean) and total mortality rates (SURBA estimates) derived from MEDITS trawl surveys in GSA 16 (1994-2007). A scalar value of M=0.48 (mean of figures reported earlier) was used to estimate Z_{MBP} from F_{MBP}.

7.10.7.4.3. Results

Main model parameters are reported in Table 7.10.7.4.3.1.

Tab. 7.10.7.4.3.1 Main parameters of the surplus production model of hake in GSA 16.

Population growth rate (r)	0.790	F_{MBP} (r/2)	0.395
Maximum BI (k)	39.36	Z_{MBP} (F_{MBP}+M)	0.875

Observed and predicted values of biomass indices (kg per km^2) showed a good agreement (Fig. 7.10.7.4.3.1) and the distribution of the residuals is quite satisfying.

The surplus production model in terms of Biological production is shown in Fig. 7.10.7.4.3.2.

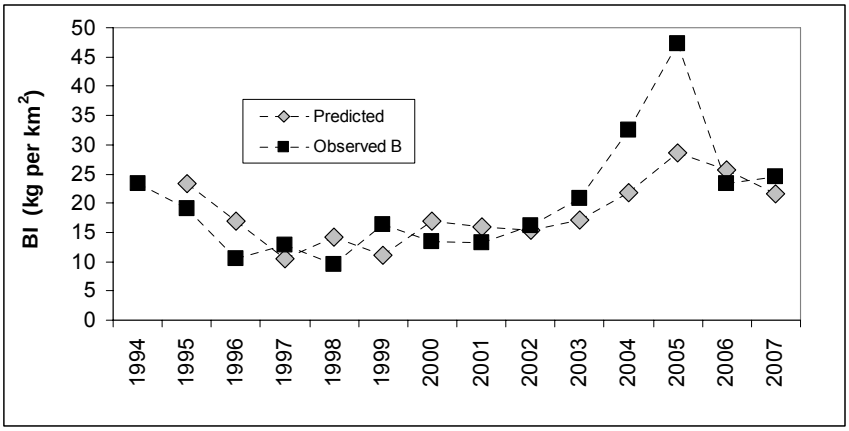


Fig. 7.10.7.4.3.1 Observed and predicted values of biomass indices (kg per km^2) according to the Surplus production model based on trawl surveys data (GSA 16).

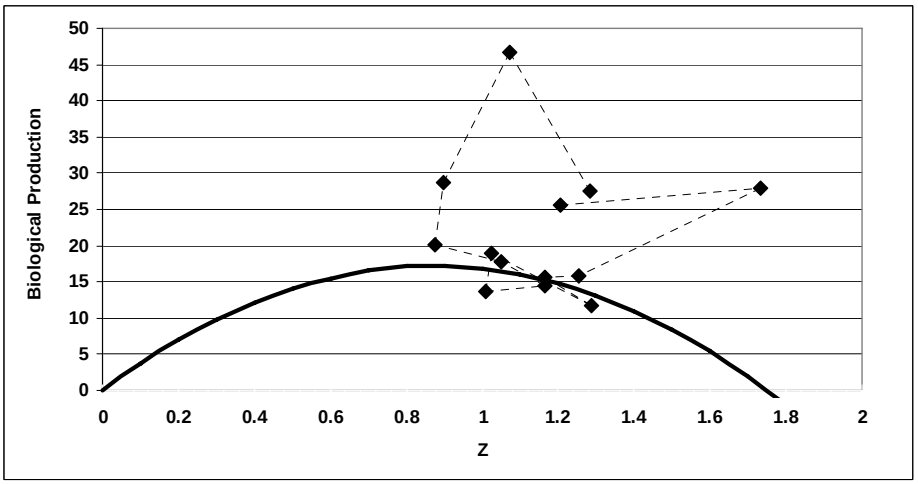


Fig. 7.10.7.4.3.2 Biological production (BP) vs. total mortality rates (Z) under the non-equilibrium state assumption of Hake in GSA 16.

The ratio of the mean Z of 2003, 2004 and 2005 obtained by SURBA and the natural mortality (Z= 0.950) and the optimal one (Z_{MBP}= 0.875) suggested an overfishing state ($Z_{curr.}/Z_{opt.}$=1.09). If an estimation of current F is obtained as Z-M, with M=0.48, the ratio between current F (0.47) and the optimal one (F_{MBP}=0.395) suggested a reduction of fishing mortality of 19% to improve the status of the stock.

7.10.8. Scientific advice

7.10.8.1. Short term considerations

7.10.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.10.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.10.8.1.3. State of exploitation

The current fishing mortality in females was estimated according different methods (Tab. 7.10.8.1.3.1):

- As global F from VPA according to VIT approach;
- Subtracting M=0.34 to Z value obtained with Beverton and Holt estimator on steady state LFD of MEDITS surveys from 2005 to 2007;
- As mean F from SURBA.

Different methods gave very few differences in identifying the current value of fishing mortality as is shown for GSA 16 in Tab. 7.10.8.1.3.1.

Tab. 7.10.8.1.3.1 Fishing mortality rates of hake in the GSA 16 estimated according different data and methods in the last years (2005-2007).

Method	F	Remarks
"VPA" on 2006 and 2007 landings (GSA 16)	0.66	Sum of catches/Sum of mean numbers (Females)
B & H estimator on MEDITS data 2005-2006-2007	0.76	Minimum length of fully recruitment (L') of 18 cm TL (Females) – scalar M
SURBA on MEDITS data Mean of 2005 and 2006	0.70	Mean of age class 1-4 (Combined sex) – vector M

7.10.8.2. Medium term considerations

Adopting the F value from SURBA and the BRP from YIELD packages respectively, a clear overfishing state is detected.

Maintaining the current fishing pattern, in GSA 15 (F=0.55) a reduction of current effort of about 63-73% and 44-56% is advisable to reach $F_{0.1}$ and F_{max} respectively. In GSA 16 (F=0.70) a corresponding reduction of current effort of 71-78% and 55-65% is advisable.

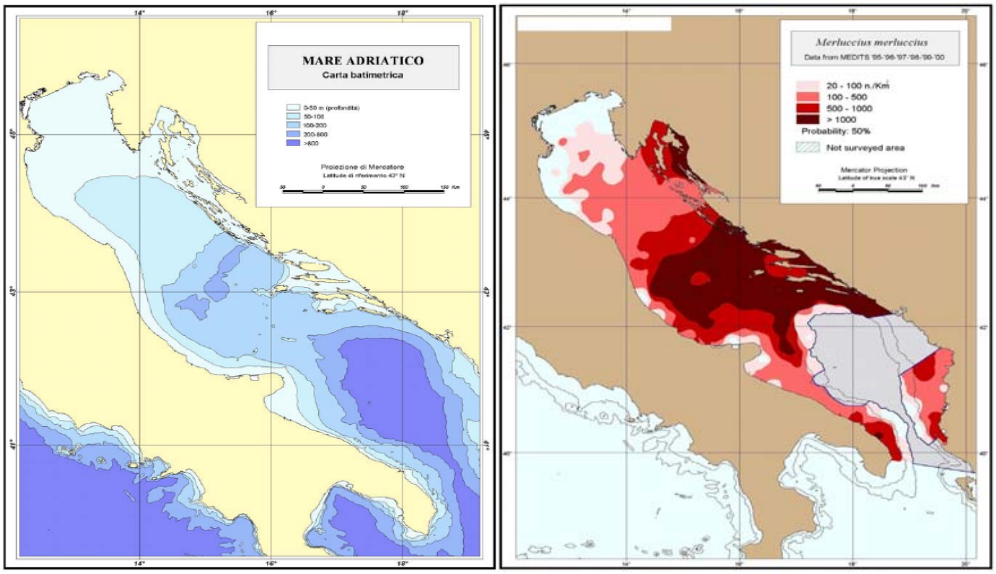
7.11. Stock assessment of hake in GSA 17

7.11.1. Stock identification and biological features

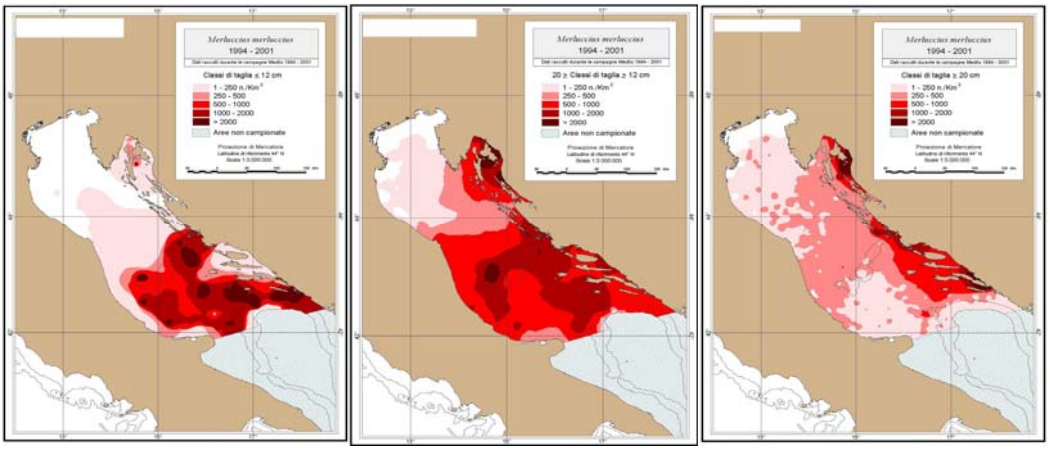
7.11.1.1. Stock Identification

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).

7.11.1.2. Growth

No information was documented during SGMED-08-03.

7.11.1.3. 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

On the basis of the maturity at length (and age) data collected through DCR in the year 2007, the proportion of females with mature stages (macroscopically measured) higher than 2 was equal to 0 in the length classes of 17 and 19 cm and fluctuated around 0.50 in the higher classes. The proportion of males was equal to 0.11 in the length class of 19 cm and fluctuated around 0.50 in the higher classes. These values seem to be consistent with those form Zupanovic and Jardas (1986) mentioned above.

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.

7.11.2. Fisheries

7.11.2.1. 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 (STECF, 2002).

7.11.2.2. Management regulations applicable in 2007 and 2008

According to Regulation (EC) 1967/2006 the minimum legal length for fishery is, for hake, equal to 20 cm.

7.11.2.3. Catches

7.11.2.3.1. Landings

On the basis of data collected for Italy through DCR from 2002 to 2007 (see the table below), landings are due, mainly, to bottom otter trawlers, which account for over 90% of the total. Longline catches are not observed in this data set (Tab. 7.11.2.3.1.1). The data are listed in Table A3.1 of Appendix 3.

Tab. 7.11.2.3.1.1. Total and bottom otter trawl hake landings in GSA 17, 2002-2007.

Year	Total fleet landings (t)	Bottom otter trawler catch (t)
2002	2637	2339
2003	2606	2387

2004	3045	2884
2005	3609	3403
2006	4395	4212
2007	3764	3586

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.

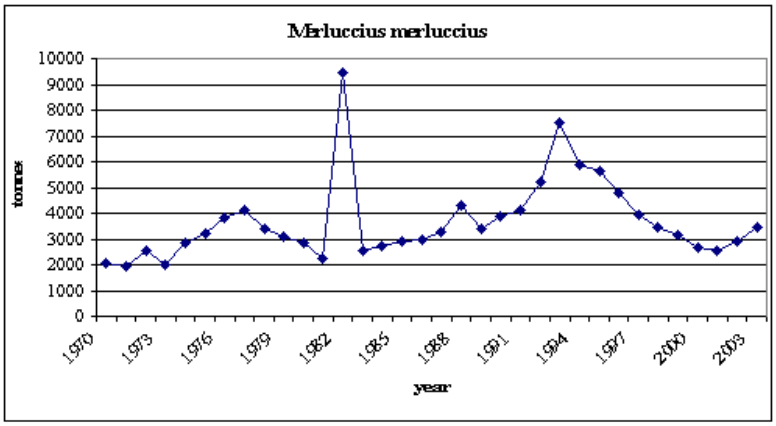


Fig. 7.11.2.3.1.1 FAO landing statistics 1970-2003.

7.11.2.3.2. Discards

Discards reported to SGMED-08-03 amount to 70 t in 2006, estimated for demersal otter trawls only. Discards as obtained through the DCR data call are listed in Table A3.4 of Appendix 3.

7.11.2.3.3. Fishing effort

Table 7.11.2.3.3.1 reveals an overall decreasing trend in effort of the major bottom otter trawl fleet.

Tab. 7.11.2.3.3.1. Trend in annual effort (days at sea, GT*days, kW*days) by country and gears in GSA 17, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	17	ITA	DRB	58297	69126	64120	54047	59099	70261
DAYS	17	ITA	DTS	124529	125106	134776	126013	114903	102270
DAYS	17	ITA	HOK			641	595	610	487
DAYS	17	ITA	PGP	335599	272040	287886	260459	233846	217661
DAYS	17	ITA	PMP	96386	98110	15512	12743		
DAYS	17	ITA	PTS	23522	25649	23387	22453	23104	22981
DAYS	17	ITA	TBB			12395	13166	12440	10901
GT*DAYS	17	ITA	DRB			858864	697091	792375	959807
GT*DAYS	17	ITA	DTS			5624744	5429766	4656664	4283788
GT*DAYS	17	ITA	HOK			9492	10510	10983	9150
GT*DAYS	17	ITA	PGP			518165	429665	444329	427962
GT*DAYS	17	ITA	PMP			73495	66778		
GT*DAYS	17	ITA	PTS			1516671	1472075	1557168	1646419
GT*DAYS	17	ITA	TBB			673656	701874	812298	747714
KW*DAYS	17	ITA	DRB	6381241	7517860	6982982	5884599	6421392	7575921
KW*DAYS	17	ITA	DTS	27568094	27486393	26771813	25026709	22118619	20619962
KW*DAYS	17	ITA	HOK			153794	148821	150195	121827
KW*DAYS	17	ITA	PGP	9297244	7646003	9120053	8011107	8568762	8638666
KW*DAYS	17	ITA	PMP	7989134	7039902	1072033	1032751		
KW*DAYS	17	ITA	PTS	7841347	7636049	6955633	6778783	6978292	7156333
KW*DAYS	17	ITA	TBB			3419642	3622199	3943318	3463256

7.11.3. Scientific surveys

7.11.3.1. Medits

7.11.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 17 the following number of hauls were reported per depth stratum (s. Tab. 7.11.3.1.1.1).

Tab. 7.11.3.1.1.1. Number of hauls per year and depth stratum in GSA 17, 2002-2006.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA17_010-050									59	45	47	63	49	
GSA17_050-100									54	37	37	62	38	
GSA17_100-200									50	26	22	43	21	
GSA17_200-500									9	7	5	7	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.

7.11.3.1.2. Geographical distribution patterns

See section 7.11.1.1.

7.11.3.1.3. 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 7.11.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 17.

The analyses of Medits indices are considered preliminary.

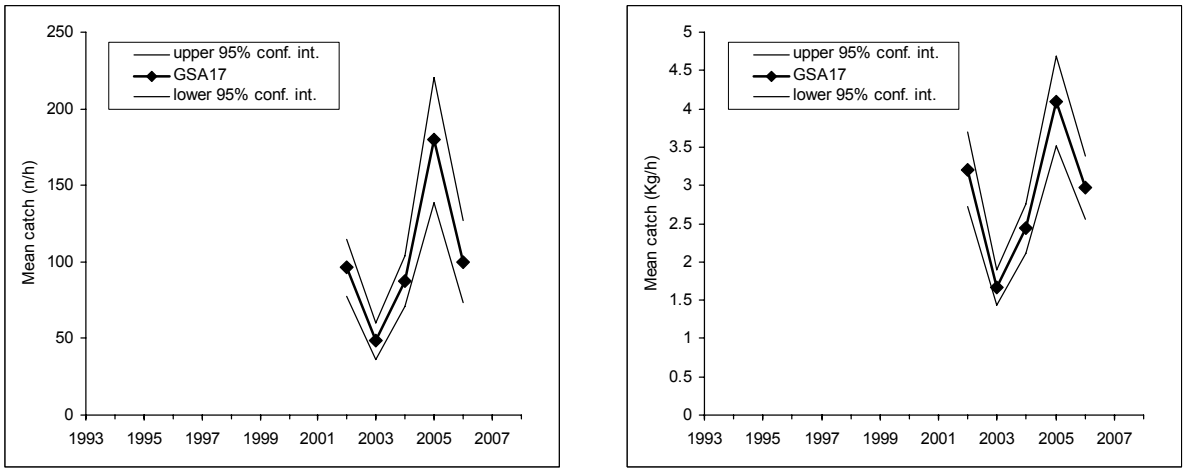


Fig. 7.11.3.1.3.1 Abundance and biomass indices of hake in GSA 17.

7.11.3.1.4. Trends in abundance by length or age

The following Fig. 7.11.3.1.4.1 displays the stratified abundance indices of GSA 17 in 2002-2006. These size compositions are considered preliminary.

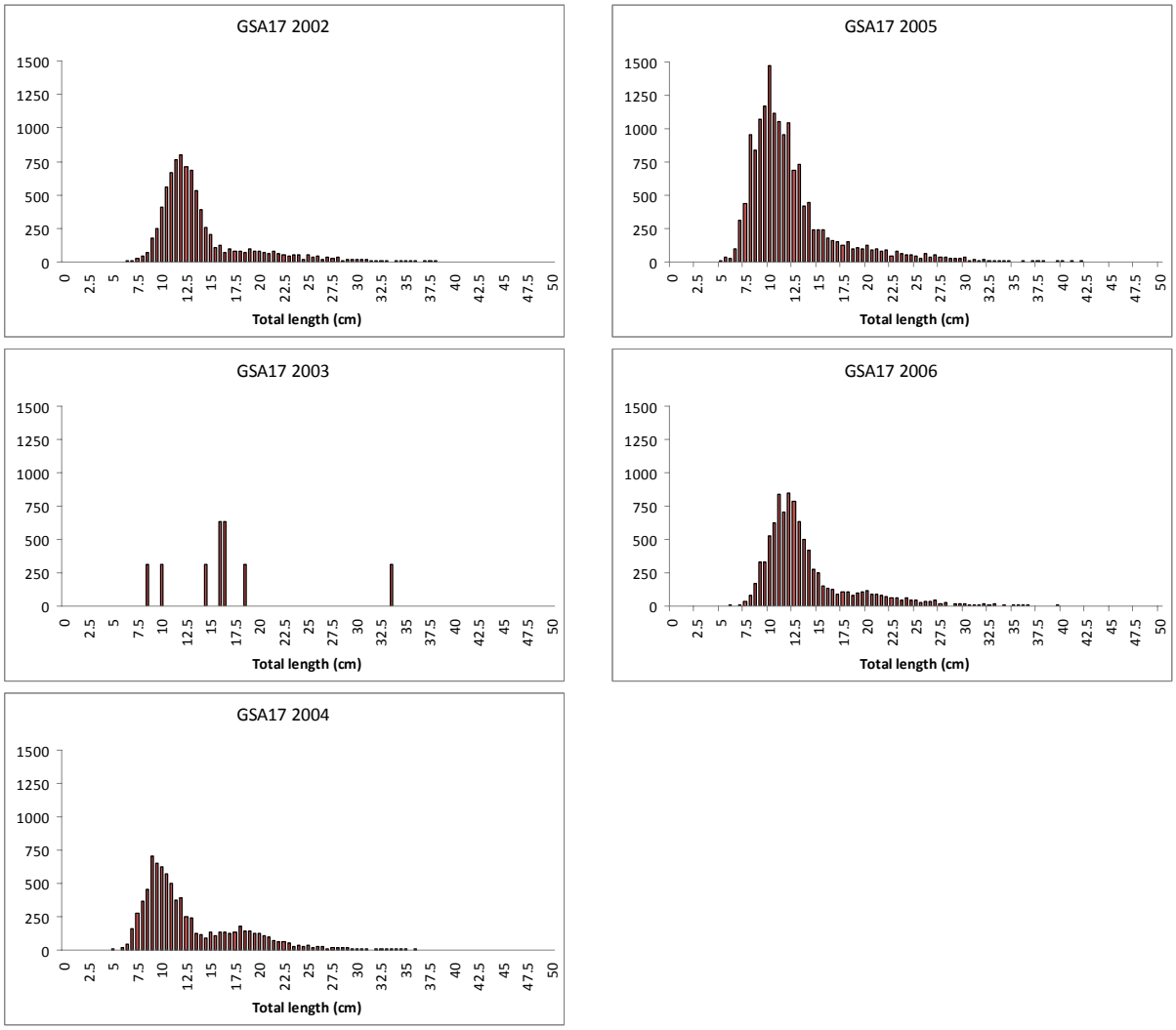


Fig. 7.11.3.1.4.1 Stratified abundance indices by size, 2002-2006.

7.11.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.11.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.11.4. Assessment of historic stock parameters

7.11.4.1. Method 1: LCA

7.11.4.1.1. Justification

Stock assessment was carried out by means of population dynamics methods, using data obtained through the DCR call. Due to the short time series of available data, Length Cohort Analysis (LCA) was selected.

The software packages used were VIT and VITM (Lleonart and Salat, 1997). The latter allowed the use of a different natural mortality rate, M, as a function of length.

7.11.4.1.2. Input parameters

The catch data used represented the Italian mean calculated for the years 2006 and 2007, 4,395 and 3,764 tonnes, respectively, as in the table above (column for the total fleet). The mean for the 2006-2007 period was 4,080 tonnes, thus slightly higher than the mean for the whole period 2002-2007, i.e. 3,343 tonnes.

The length frequency distributions obtained for Italy through DCR in 2006 and 2007 were used. They were relative to bottom otter trawlers and was thus assumed that these distributions were also representative for the other gears. As noted above, these other gears accounted for a small fraction of the total catch.

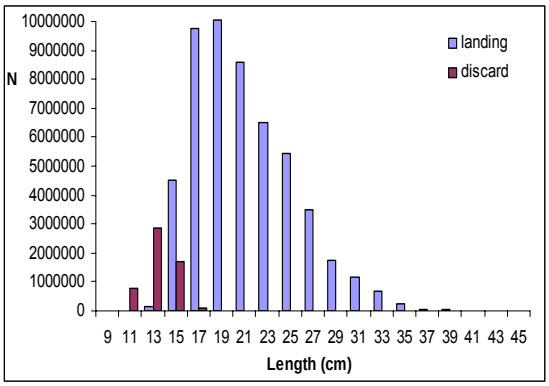
A longer times series (i.e. five - six years) of length frequency data would have been better for the stock assessment method being used.

The total number of caught individuals was distributed in the length classes 9, 11, 13,…, 39+ cm.

Females and males were used as combined.

The catch (landing in the figure below, on the left) was corrected to take into account discards at sea, using an estimate obtained through DCR for the year 2006. The amount of discards was relative to small sized fish and equal to 99 tonnes per year. Thus, the amount of catch used to obtain the number of caught individuals at length for LCA (s. Fig. 7.11.4.1.2.1) increased from 4,080 to 4,179 t.

This estimate of discards should be treated with caution. For example, in some estimates (Coll *et al*., 2007) based on information from a previous investigation (Wieczorek *et al*., 1999), the ratio between amounts of discarded and landed were higher than in the present evaluation, i.e. 0.02 (= 99 /4,080 tonnes) (it becomes higher when calculated for numbers of individuals). Data available from a previous EU report suggested the estimates from the DCR for hake could be taken like a minimum estimate and used to correct landings at length for LCA. Estimates of 48 and 22 t for the third and fourth quarter, respectively, on the basis of the same trip numbers.



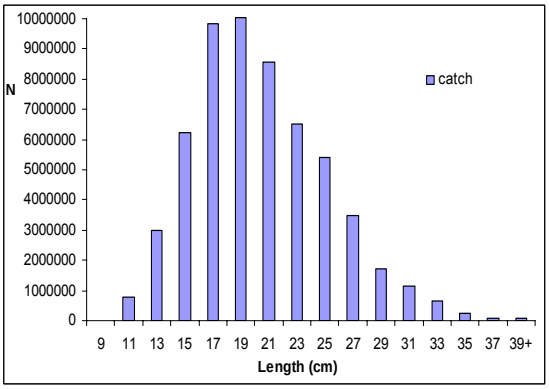


Fig. 7.11.4.1.2.1 Average size composition of hake catches in 2006 and 2007.

In order to calculate some parameters, the sex ratio Females/Total = 0.54 was used. It was calculated using the values of F/T at length obtained through DCR in the year 2007, which were weighted on the corresponding numbers of caught individuals at length. It is worth noting that the value of F/T obtained from the SAMED project (European Commission, 2002) for the GSA 17 was equal to 0.50.

The von Bertalanffy growth parameters used were: Linf = 78.5 (cm), k = 0.14 (year^{-1}), t_0 = 0.05 (year). These values were calculated as weighted means of the values for females and males, by using the mentioned sex ratio. The original values for females (Linf = 84.0, k = 0.13, t_0 = 0.102) and males (Linf = 72.0, k = 0.15, t_0 = -0.005) were estimated for the southern Adriatic Sea by Marano *et al.* (1998b,c) (mentioned in Vrgoc al., 2004).

The summary of the von Bertalanffy parameter values estimated for the Adriatic Sea was imported from Vrgoc *et al*. (2004) (see Tab. 7.11.4.1.2.1.). Here, the index Phi' is also shown.

Tab. 7.11.4.1.2.1. Summary of v. Bertalanffy parameters.

Author	Sex	L_∞ (cm)	K (yr^{-1})	t_0 (yr)	Φ'
Flamigni, 1983	M+F	85	0.12		6.77
Alegria Hernandez and Jukić, 1990	M+F	92.83	0.097	-0.629	6.73
Bolje, 1992	M+F	75	0.12		6.52
Vrgoč, 1995 ("Hvar")	M+F	83.27	0.125	-0.73	6.76
Ungaro *et al*., 1993	M+F	75.68	0.153	0.14	6.78
	F	82.63	0.126	-0.312	6.76
Marano, 1996	M	57	0.17	-0.83	6.31
	F	67.5	0.159	-0.436	6.59
	M+F	67.5	0.144	-0.807	6.49
	M+F(Bhat)	81	0.25	-	7.40
Marano *et al*., 1998b, c	M	72	0.15	-0.005	6.66
	F	84	0.13	0.102	6.82
	M+F	84	0.12	-0.14	6.74
	M+F(Bhat.)	62.2	0.23	-	6.79
	M+F(Surf.)	68	0.25	-	7.05
Vrgoč, 2000	M+F	77.95	0.130	-	6.67
EC XIV/298/96-EN, Ionian and Southern Adriatic	M+F	68.19	0.157	-	6.59
EC XIV/298/96-EN, Adriatic Sea	M+F	85	0.12	-	6.77

Most values of k - a parameter with relatively high influence on LCA results - are between 0.12 and 0.16, thus slightly below or above 0.14, which is the value employed in the present assessment.

The annual mortality rate M = 0.36 (year^{-1}) was used. This value was calculated as a weighted mean of the values for females and males, using the mentioned sex ratio. The original values of M for females (M = 0.34) and males (M = 0.38) were obtained from the SAMED project (European Commission, 2002) for the GSA 17. The corresponding Z was 1.73 (year^{-1}) and, thus, F (= Z – M) was 1.37 (year^{-1}).

The summary of the M values estimated for the Adriatic Sea was imported from Vrgoc *et al.* (2004), see Tab. 7.11.4.1.2.2.

Tab. 7.11.4.1.2.2. Summary of mortality parameters estimated.

Author	M (yr^{-1})	F (yr^{-1})	Z (yr^{-1})
Županović, 1967			0.90
Granić and Julić, 1982			0.77
Alegria Hernandez *et al.*, 1982	0.408	0.382	0.790
Flamigni and Giovanardi, 1984	0.25	0.75	0.92 – 1.05
Giovanardi *et al.*, 1986			0.88-1.37
Julić and Piccinetti, 1988			1.12
Marano,1993a; Ungaro *et al.*, 1993	0.29	0.81-1.40	1.11-1.69
Marano, 1996	0.38	1.14 F_{max} = 0.23-0.27	1.52(1.22-1.82)
GMS-GRUND, 1998			1.23
Marano *et al.*, 1998b, c	0.31	0.92 F_{max} = 0.23	1.23(1.02-1.43)
Vrgoč, 2000	0.25	0.80	1.05
EC XIV/298/96-EN (Ionian Sea and Southern Adriatic Sea)		0.46 – 0.68	
	0.32 (Pauly)	$F_{0.1}$ = 0.18	
	0. 25 (Djabali)	$F_{0.1}$ = 0.14-0.15	
EC XIV/298/96-EN (Adriatic Sea)		0.78-1.08	
	0.25 (Pauly)	$F_{0.1}$ = 0.14-0.17	
	0.21 (Djabali)	$F_{0.1}$ = 0.11-0.14	

It is worth noting that M = 0.36 is higher than the value M = 0.21 obtained using the relationship suggested by Jensen (1996, 2001), i.e. M = 1.5 k (with k = 0.14). Moreover, in the table from Vrgoc et al. (2004), most values are lower than 0.36. Thus, the most conservative M (i.e. lower M implies lower estimated biomass), among the possible values shown here, was not used in the present stock assessment.

A run of LCA was also carried out using a vector of M at length values. On the basis of the values derived from the SAMED project (European Commission, 2002) for the GSA 17 (estimated by means of the method of Chen and Watanabe), M was assumed to be equal to 0.62 for the length classes from 9 to 21 cm and equal to 0.35 for all the classes from 23 cm onwards.

Different values of the fishing mortality rate, F, for the last length class, 39+, were evaluated.

7.11.4.1.3. Results

The mean biomass at sea estimated by LCA was equal to 4,092 tonnes, when the scalar M = 0.36 was used. This estimate slightly increased when the M at length vector was used, i.e. 4,460 tonnes. Thus, the level of mean biomass calculated was similar to the catch value.

On the basis of the run with the scalar M value, the unweighted mean of F was equal to 1.22. When the mean F was weighted on the estimated mean numbers of fish at sea, the obtained value was 0.50.

The corresponding values of F/Z were 0.77 and 0.58, with unweighted and weighted F, respectively.

The values of both F and F/Z estimated for each length class are shown in the figure below, on the left. High values of F (around 1.0 and also higher than 1.5) are observed for some length classes. In Fig. 7.11.4.1.3.1 on the right, both F and F/Z are displayed as a function of age (transformation from length into age class was based on the same von Bertalanffy parameters used for LCA).

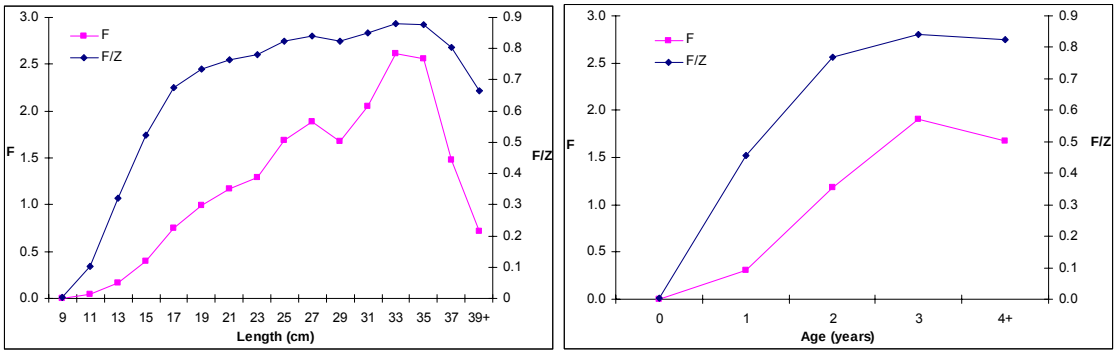


Fig. 7.11.4.1.3.1 Selection patterns (mean F and ration F/Z over length and age).

7.11.5. Short term prediction for 2008 and 2009

7.11.5.1. Justification

No forecast analyses were conducted.

7.11.5.2. Input parameters

No forecast analyses were conducted.

7.11.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSA 17.

7.11.6. Medium term prediction

7.11.6.1. Justification

No forecast analyses were conducted.

7.11.6.2. Input parameters

No forecast analyses were conducted.

7.11.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for hake in GSA 17.

7.11.7. Long term prediction

7.11.7.1. Justification

No forecast analyses were conducted.

7.11.7.2. Input parameters

No forecast analyses were conducted.

7.11.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 17.

7.11.8. Scientific advice

7.11.8.1. Short term considerations

7.11.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.11.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.11.8.1.3. State of exploitation

Given the values of F and F/Z (the latter one higher than 0.50), the stock of hake can be considered to be at least fully exploited. According to Mertz and Myers (1998), F/Z = 0.80 represents the maximum value which a demersal stock may endure, and the highest estimated value of F/Z (that based on unweighted F) was just slightly lower than 0.80. According to Rochet and Trenkel (2003), it would be safe to avoid F/Z higher than 0.50: the estimated value of F/Z based on weighted F was slightly lower than 0.60. Thus, a risk of overexploitation is real for hake in the GSA 17.

7.11.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.12. Stock assessment of hake in GSA 18

7.12.1. Stock identification and biological features

7.12.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.12.1.2. Growth

No information was documented during SGMED-08-03.

7.12.1.3. Maturity

No information was documented during SGMED-08-03.

7.12.2. Fisheries

7.12.2.1. 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 n° 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).

7.12.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.12.2.3. Catches

7.12.2.3.1. Landings

SGMED-08-03 received the following information about hake landings in GSA 18 through the official DCR data call (Tab. 7.12.2.3.1.1). The landings increased from 2,300 t in 2002 to 5,500 t in 2006 and decreased to 4,200 t in 2007. The landings are listed in Tab. A3.1 of Appendix 3. Landings by demersal trawlers dominate by far.

Tab. 7.12.2.3.1.1 Hake landings in GSA 18 by fishing technique, 2002-2007.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
HKE	18	ITA	DTS	2006	2899	2798	3275	4613	3497
HKE	18	ITA	HOK			140	439	721	607
HKE	18	ITA	PGP	26	199	175	70	172	51
HKE	18	ITA	PMP	277	1353	84			
HKE	18	ITA	PTS			7			
SUM				2309	4451	3204	3784	5506	4155

7.12.2.3.2. Discards

No information was documented during SGMED-08-03.

7.12.2.3.3. Fishing effort

Tab. 7.12.2.3.3.1 lists the fishing effort reported to SGMED-08-03 through the DCR data call. The overview is given in Tab. A3.5-A3.7 of Appendix 3 to this report. The dominant demersal otter trawl fleet decreased in effort since 2002.

Tab. 7.12.2.3.3.1 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
DAYS	18	ITA	DRB	11081	5890	3865	5776	7562	8132
DAYS	18	ITA	DTS	85424	71203	80259	84207	88418	73637
DAYS	18	ITA	HOK			1799	3053	4397	3190
DAYS	18	ITA	PGP	110621	63332	67232	80648	88583	68253
DAYS	18	ITA	PMP	53475	35980	3667			
DAYS	18	ITA	PTS	4140	4526	4679	4428	5291	6186
GT*DAYS	18	ITA	DRB			41347	62244	81590	87740
GT*DAYS	18	ITA	DTS			2568868	2592741	2632767	2275442
GT*DAYS	18	ITA	HOK			27800	58254	79940	58026
GT*DAYS	18	ITA	PGP			120701	146182	147150	115612
GT*DAYS	18	ITA	PMP			40920			
GT*DAYS	18	ITA	PTS			369876	360279	446754	516692
KW*DAYS	18	ITA	DRB	1100225	584801	381968	570792	746921	807073
KW*DAYS	18	ITA	DTS	17112022	14530793	14369490	14621928	14929696	12904532
KW*DAYS	18	ITA	HOK			284535	514377	778355	567996
KW*DAYS	18	ITA	PGP	1722336	1002933	1180371	1442219	1394671	1311109
KW*DAYS	18	ITA	PMP	7277279	4416994	351689			
KW*DAYS	18	ITA	PTS	1480945	1464793	1842716	1785787	2221605	2613654

7.12.3. Scientific surveys

7.12.3.1. Medits

7.12.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 18 the following number of hauls were reported per depth stratum (s. Tab. 7.12.3.1.1.1).

Tab. 7.12.3.1.1.1. Number of hauls per year and depth stratum in GSA 18, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA18_010-050	14	15	15	14	14	14	14	15	11	11	10	9	10	9
GSA18_050-100	14	14	14	15	15	15	15	14	13	13	15	15	14	14
GSA18_100-200	24	23	23	23	23	23	23	23	26	23	24	25	25	22
GSA18_200-500	10	10	10	10	10	10	10	10	8	8	8	9	9	6
GSA18_500-800	10	10	10	10	10	10	10	10	7	7	8	7	7	7

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.

7.12.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.12.3.1.3. 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 7.12.3.1.3.1 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.

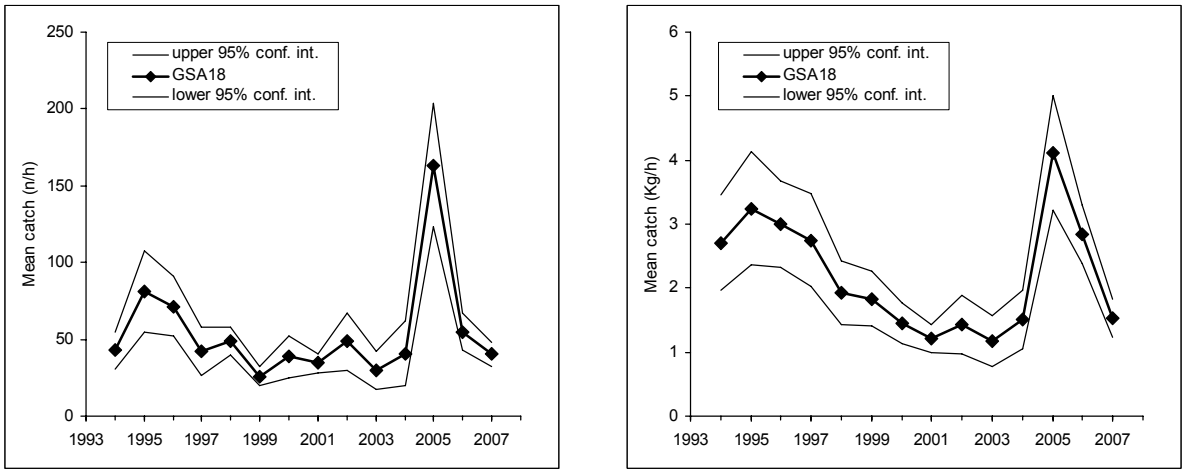


Fig. 7.12.3.1.3.1 Abundance and biomass indices of hake in GSA 18.

7.12.3.1.4. Trends in abundance by length or age

The following Fig. 7.12.3.1.4.1 and 2 display the stratified abundance indices of GSA 18 in 1995-2002 and 2003-2007. These size compositions are considered preliminary.

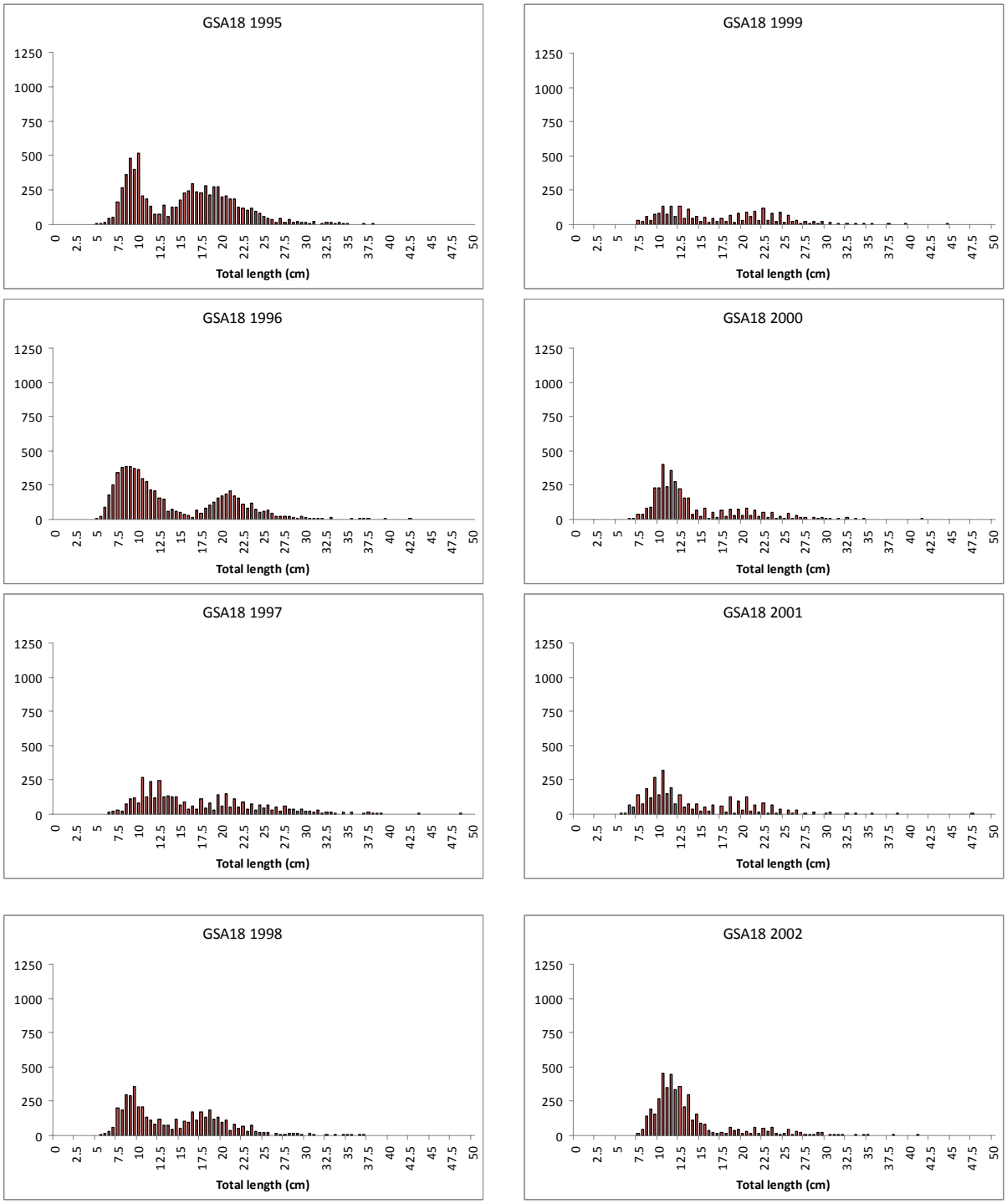


Fig. 7.12.3.1.4.1 Stratified abundance indices by size, 1995-2002.

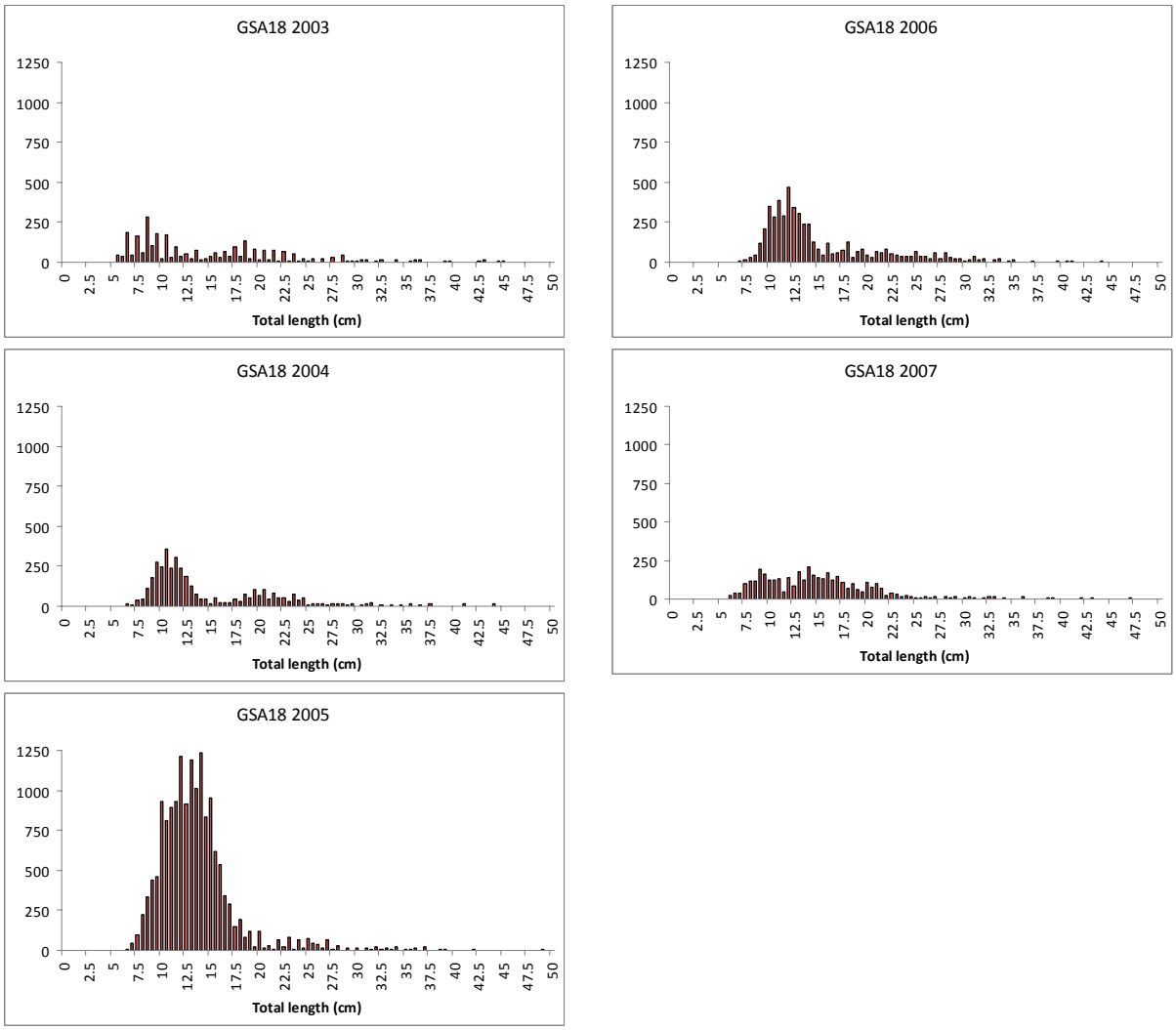


Fig. 7.12.3.1.4.2 Stratified abundance indices by size, 2003-2007.

7.12.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.12.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.12.4. Assessment of historic stock parameters

SGMED-08-03 did not undertake any analytical assessment.

7.12.5. Short term prediction for 2008 and 2009

7.12.5.1. Justification

No forecast analyses were conducted.

7.12.5.2. Input parameters

No forecast analyses were conducted.

7.12.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSA 18.

7.12.6. Medium term prediction

7.12.6.1. Justification

No forecast analyses were conducted.

7.12.6.2. Input parameters

No forecast analyses were conducted.

7.12.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for hake in GSA 18.

7.12.7. Long term prediction

7.12.7.1. Justification

No forecast analyses were conducted.

7.12.7.2. Input parameters

No forecast analyses were conducted.

7.12.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 18.

7.12.8. Scientific advice

7.12.8.1. Short term considerations

7.12.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.12.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.12.8.1.3. State of exploitation

SGMED-08-03 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.

7.12.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.13. Stock assessment of hake in GSA 19

7.13.1. Stock identification and biological features

7.13.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.13.1.2. Growth

No information was documented during SGMED-08-03.

7.13.1.3. Maturity

No information was documented during SGMED-08-03.

7.13.2. Fisheries

7.13.2.1. 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 Gallipoli, Taranto, Schiavonea and Crotone. The fishing pressure varies between fisheries and fishing grounds.

7.13.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.13.2.3. Catches

7.13.2.3.1. Landings

Since 2002 until 2006, landings as provided to SGMED-08-03 through the DCR data call varied among 1,300 and 1,600 t. In 2007, landings dropped significantly by about 50% to 883 t (Tab. 7.13.2.3.1.1). The data are listed in Tab. A3.1 of Appendix 3. Demersal otter trawls appear the major fishing gear.

Tab. 7.13.2.3.1.1 Hake landings in GSA 19 by fishing technique, 2002-2007.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
HKE	19	ITA	DTS	688	668	852	1077	1330	572
HKE	19	ITA	HOK			139	72	81	54
HKE	19	ITA	PGP	263	367	145	122	218	257
HKE	19	ITA	PMP	390	478	163	1		
HKE	19	ITA	PTS	16	1				
SUM				1357	1514	1299	1272	1629	883

7.13.2.3.2. Discards

Discards reported to SGMED-08-03 amount to 10 t in 2006, estimated for demersal otter trawls only. Discards as obtained through the DCR data call are listed in Table A3.4 of Appendix 3.

7.13.2.3.3. Fishing effort

Tab. 7.13.2.3.3.1 lists the fishing effort reported to SGMED-08-03 through the DCR data call. The overview is given in Tab. A3.5 of Appendix 3 to this report. The dominant demersal otter trawl fleet increased in effort since 2002.

Tab. 7.13.2.3.3.1 Fishing effort in different units by fishing technique deployed in GSA 19, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	19	ITA	DTS	31381	31586	37234	42413	42976	40423
DAYS	19	ITA	HOK			39190	43898	25644	17695
DAYS	19	ITA	PGP	233718	254881	225109	193806	217447	168411
DAYS	19	ITA	PMP	100208	122225	20325	6905		
DAYS	19	ITA	PTS	3458	7302	6605	5554	5507	4441
GT*DAYS	19	ITA	DTS			782163	884513	835267	800971
GT*DAYS	19	ITA	HOK			1015534	1091913	850691	710177
GT*DAYS	19	ITA	PGP			473727	438792	555916	483882
GT*DAYS	19	ITA	PMP			111129	34967		
GT*DAYS	19	ITA	PTS			195882	238105	188866	114537
KW*DAYS	19	ITA	DTS	5125805	5002396	5802023	6562337	6460683	6063817
KW*DAYS	19	ITA	HOK			6809150	7299195	5575566	4053202
KW*DAYS	19	ITA	PGP	4669873	9192254	4881153	4698292	6141378	5333724
KW*DAYS	19	ITA	PMP	13116917	9143878	1188078	341008		
KW*DAYS	19	ITA	PTS	978457	1629677	1105203	1026897	1008813	691704

7.13.3. Scientific surveys

7.13.3.1. Medits

7.13.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 19 the following number of hauls were reported per depth stratum (s. Tab. 7.13.3.1.1.1).

Tab. 7.13.3.1.1.1. Number of hauls per year and depth stratum in GSA 19, 2002-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA19_010-050									9	9	9	9	9	8
GSA19_050-100									8	8	8	8	8	9
GSA19_100-200									10	10	10	10	10	10
GSA19_200-500									14	14	14	15	14	14
GSA19_500-800									29	29	29	28	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.

7.13.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.13.3.1.3. 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 7.13.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 19.

The short time series of estimated abundance and biomass indices does not reveal any significant trends since 2002. The analyses of Medits indices are considered preliminary.

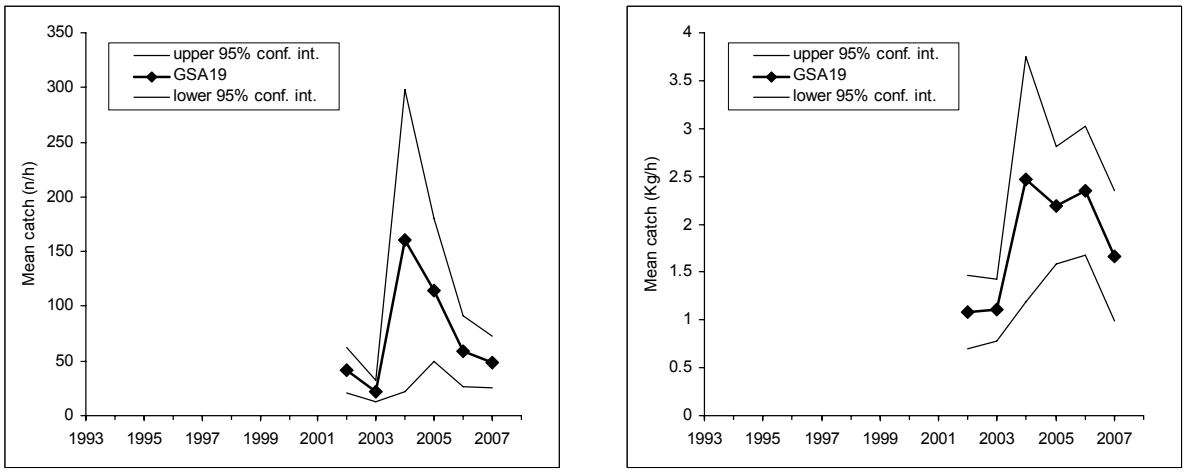


Fig. 7.13.3.1.3.1 Abundance and biomass indices of hake in GSA 19.

7.13.3.1.4. Trends in abundance by length or age

The following Fig. 7.13.3.1.4.1 displays the stratified abundance indices of GSA 19 in 2002-2007. These size compositions are considered preliminary.

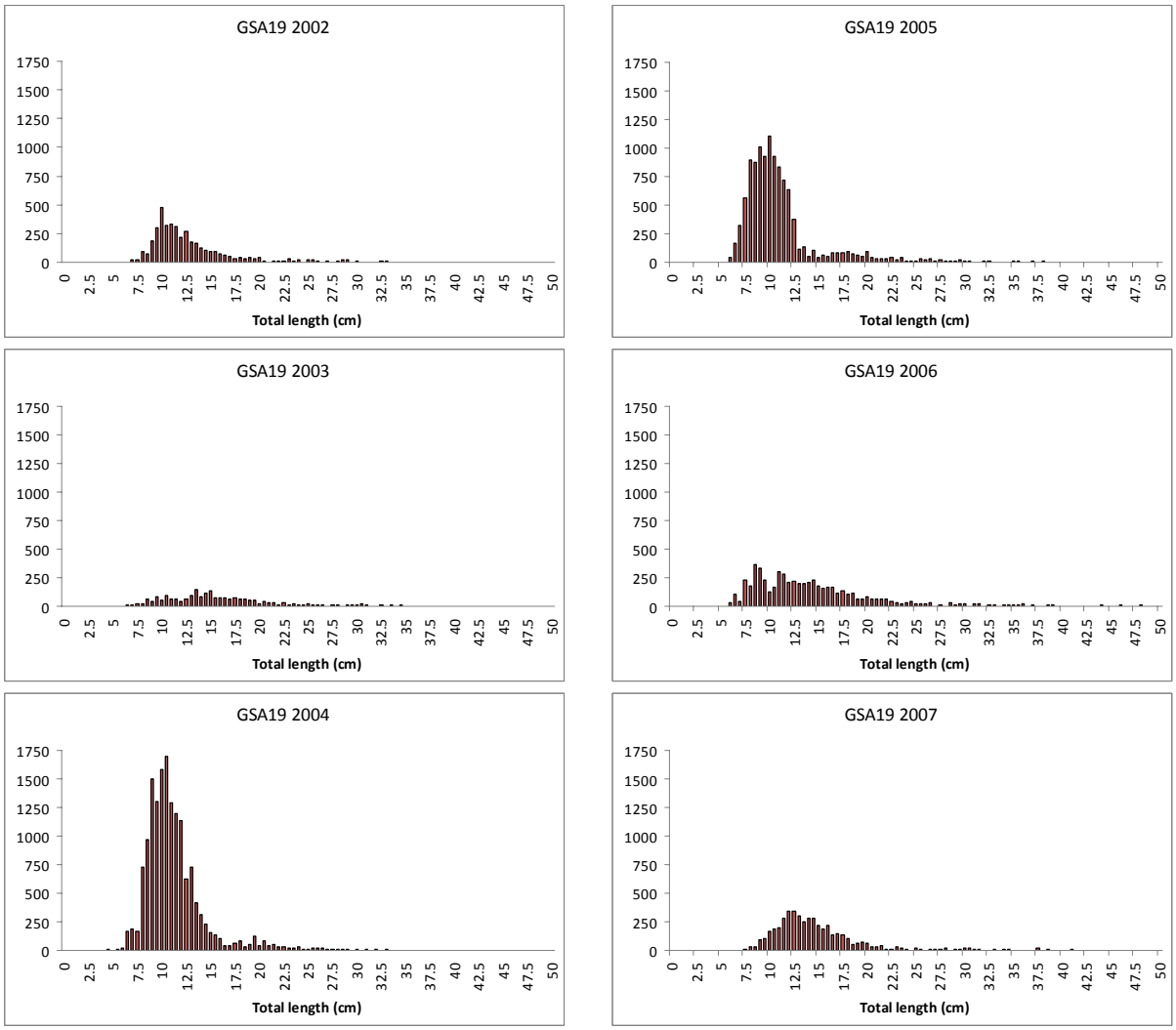


Fig. 7.13.3.1.4.1 Stratified abundance indices by size, 2002-2007.

7.13.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.13.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.13.4. Assessment of historic stock parameters

SGMED-08-03 did not undertake any analytical assessment.

7.13.5. Short term prediction for 2008 and 2009

7.13.5.1. Justification

No forecast analyses were conducted.

7.13.5.2. Input parameters

No forecast analyses were conducted.

7.13.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSA 19.

7.13.6. Medium term prediction

7.13.6.1. Justification

No forecast analyses were conducted.

7.13.6.2. Input parameters

No forecast analyses were conducted.

7.13.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for hake in GSA 19.

7.13.7. Long term prediction

7.13.7.1. Justification

No forecast analyses were conducted.

7.13.7.2. Input parameters

No forecast analyses were conducted.

7.13.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 19.

7.13.8. Scientific advice

7.13.8.1. Short term considerations

7.13.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.13.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.13.8.1.3. State of exploitation

SGMED-08-03 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.

7.13.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.14. Stock assessment of hake in GSA 20

7.14.1. Stock identification and biological features

7.14.1.1. 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.

7.14.1.2. Growth

Biological sampling was conducted in 4 fishing ports, which are the main landing ports of GSA 20. Landings from trawlers, nets and hooks were included in biological sampling. Sampling was conducted during different seasons, depending on the species life cycle, the size of local production and the temporal or spatial restrictions on the use of fishing gears.

The growth parameters for hake for each sex are given for GSA 20 in Figure 7.14.1.2.1. The age interpretation was done by otoliths reading. Sampling was conducted from 2003 to 2005.

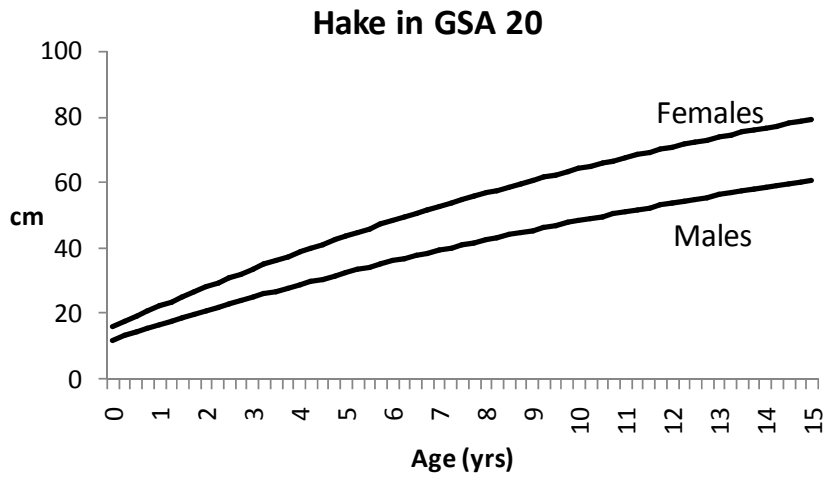


Fig. 7.14.1.2.1 Growth curves of male and female hake in GSA 20.

After studying the growth equations from each GSA, it was noticed that there is a big variability in growth parameters. The reason for this was more likely the uncertainty of hake age readings which has been documented by various researchers so far (Piñeiro and Saínza, 2002, 2003). Recent results from a tagging experiment in France have strongly suggested that those criteria may not be accurate and that they may lead to overestimation of ages (De Pontual et al., 2003). It was mentioned that a faster growth is expected for hake in the Mediterranean, as suggested by the tagging experiment conducted in France (Gulf of Lions), which validated hake age. Therefore the SGMED decided to perform hake assessments using the growth parameters according to the French tagging experiments. These parameters are given in the Tab. 7.14.1.2.1.

Tab. 7.14.1.2.1. Growth parameters of hake according to the French tagging experiments.

HAKE	L_∞ (cm)	k	t_0
Females	72.8	0.298	-0.383
Males	100.7	0.248	-0.35

7.14.1.3. Maturity

Biological sampling in order to define the maturity ogives and the reproduction cycle of the species was conducted as for sampling for growth parameters. Maturity was defined based on Nikolsky scale. All individuals with a maturity stage >3 were considered as mature (only reproductive months were taken into account). The percentage of mature individuals per length class was estimated. Data were provided only for females. However, it was pointed out that in other GSAs hake are considered mature at maturity stages >2 (on the Nikolsky scale). Thus, the estimated Lm_{50} was greater than that estimated in other GSAs that used the '>2' criterion. The estimated Lm_{50} might be an overestimation and the issue needs further consideration; standardisation among GSAs is needed.

The maturity curve was estimated by logistic regression (with non-linear least-squares) based on the official data provided. The estimated parameters of the curve are given in the Tab. 7.14.1.3.1 below.

Tab. 7.14.1.3.1 Parameters desribing the maturity at length.

	Estimations	SE	95% LL	95% UL
L_{50}	52.7	1.4	49.8	55.6
L_{75}-L_{25}	11.7	0.4	10.8	12.6

7.14.2. Fisheries

7.14.2.1. 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.

Bottom trawlers target hake at depths between 100 and 300 m, gill nets from 100-300 m, while long lines may reach 600 m. The mesh size of the cod end of bottom trawls is 40 mm whereas the mesh size of gill nets ranges from 52-64 mm. 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 6-18 cm are ~75% of the catch). The catch of gill nets comprises mainly of specimens with lengths between 20 and 40 cm, while longliners catch relatively large fish.

The bottom trawl fishery is a mixed fishery, operating 24hr per day. Apart from hake, important target species are shrimps, anglerfish, blue whiting, megrims, picarel and red mullet. Gillnet and especially longline fisheries have a relatively greater species and size selectivity. The fishing practice when targeting hake is to set nets in the morning (around 10:00 11:00) and to recover them the following day early in the morning (07:00 - 08:00). The main by catch species in the gill net fishery is horse mackerel.

An assessment of the historic trends (1991-2007) in the fleets exploiting hake in GSA 20 is provided in Fig. 7.14.2.1.1.

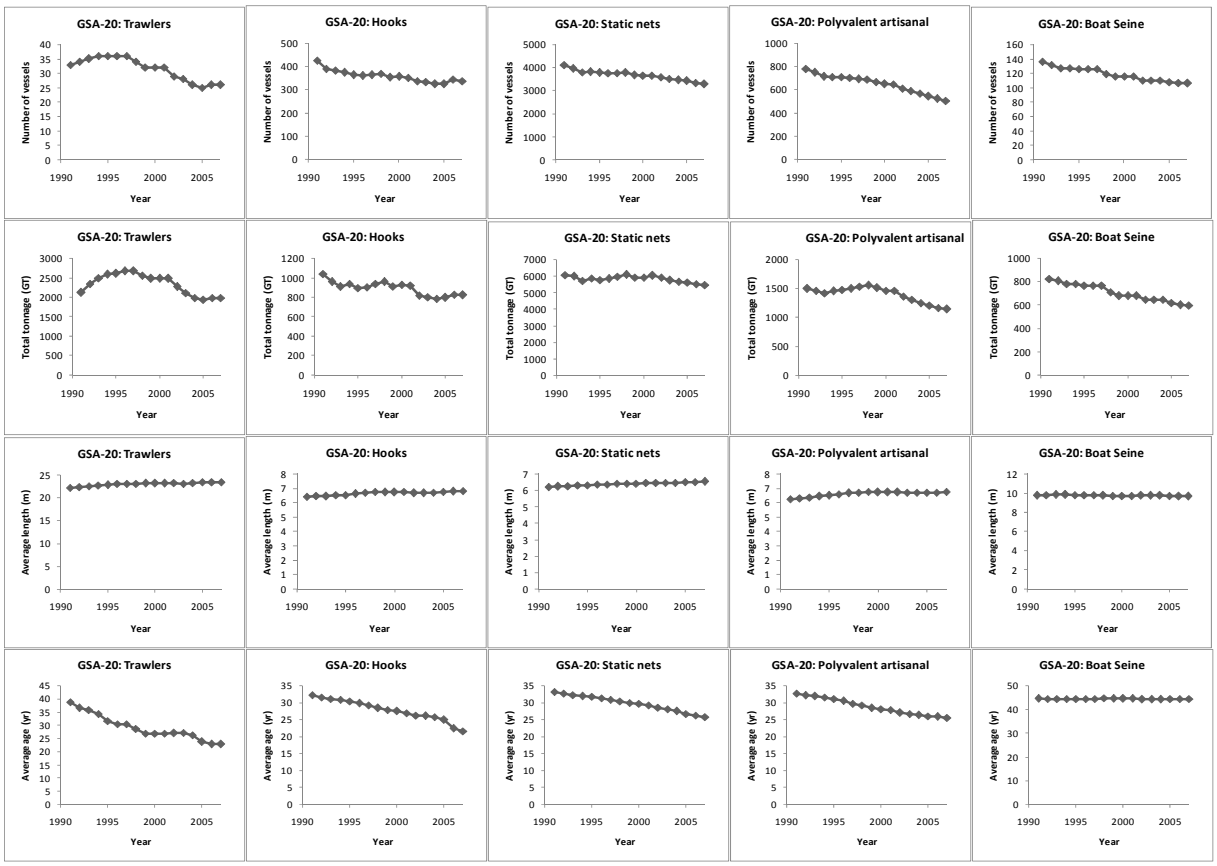


Fig. 7.14.2.1.1 Historical trends of fleets exploiting hake in GSA 20.

There was a general declining trend in the number of vessels in recent years in all fleet segments. Capacity generally declined, except in trawlers that had a peak of capacity in 1997, which then declined to approximately the same levels as in 1991. The average length slightly increased in all fleet segments, except

boat seiners. Average age substantially declined in all fleet segments except boat seiners where average age remained stable and was the highest among all fishing fleets.

7.14.2.2. Management regulations applicable in 2007 and 2008

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 2500 m.

7.14.2.3. Catches

7.14.2.3.1. 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. Number of fish landed was not reported.

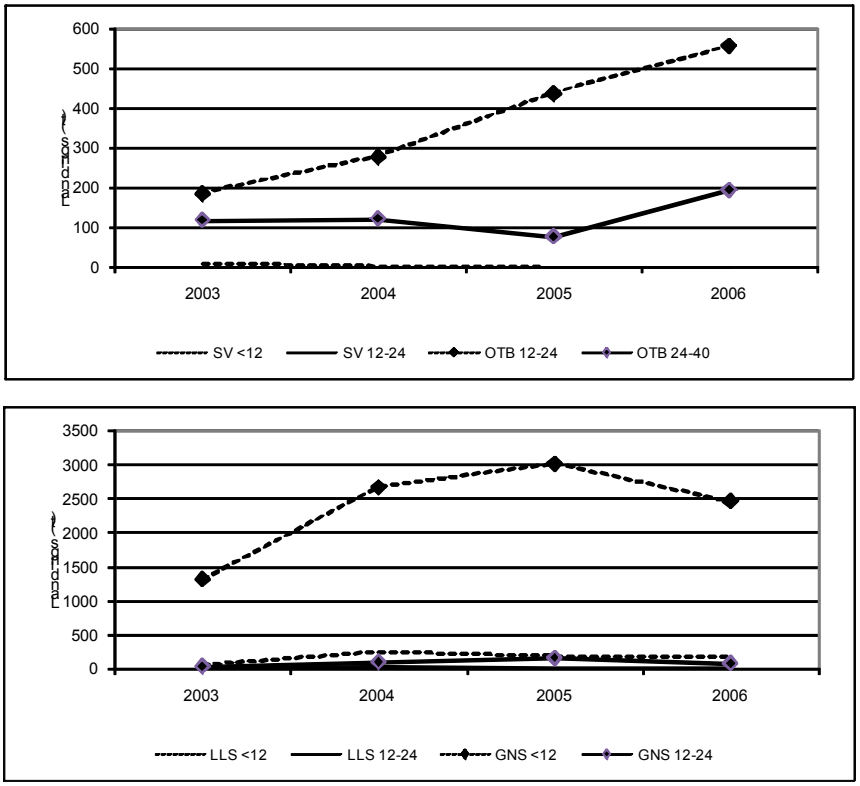


Fig. 7.14.2.3.1.1 Landings of hake in GSA 20 from 2003-2006.

The estimated landings of hake in GSA 20 are presented in Fig. 7.14.2.3.1.1. According to official data, the annual bottom trawl landings ranged from 310 to 750 t, the landings of the gill nets ranged from 1,370 to 3,200 t, whereas the landings of the long lines ranged from 70 to 300 t. The annual landings of the bottom trawl segment 12-24 m increased from 190 to 560 t.

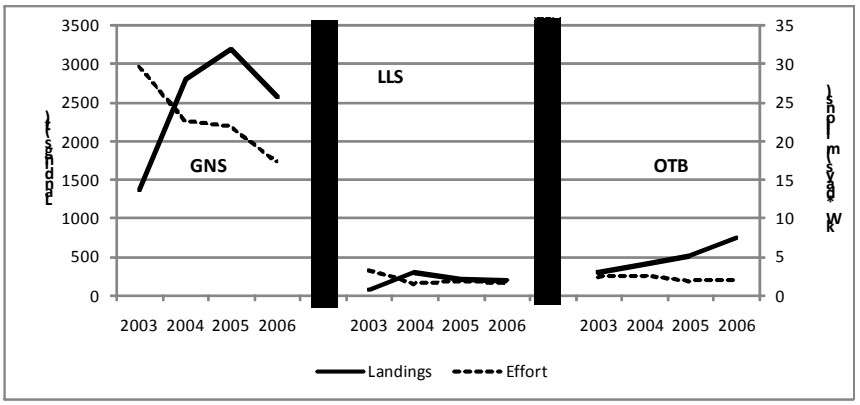


Fig. 7.14.2.3.1.2 Landings of hake and fishing effort per gear category in GSA 20.

The landings of hake and the fishing effort (kW*days at sea) of gill nets, long lines and bottom trawl are presented in Fig. 7.14.2.3.1.2. The high value of the fishing effort of the gill nets is expected because of the large number of vessels. Overall, for the period 2003-2006, 78% of the hake landings are attributed to gill nets, 15% to bottom trawls, and 6% to longlines.

Tab. 7.14.2.3.1.1 Landings (t) as reported to SGMED-08-03 through the DCR data call, 2003-2006. The data are listed in Tab. A3.1 of Appendix 3.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
HKE	20	GRE	GNS		1370	2796	3195	2568	
HKE	20	GRE	LLS		73	295	207	199	
HKE	20	GRE	OTB		307	403	515	753	
HKE	20	GRE	SV		11	3	0		
SUM					1761	3497	3917	3520	

Data on length and age composition were not available at the meeting.

7.14.2.3.2. Discards

In Greece, the discards and landings of trawlers, purse-seiners, coastal vessels, and drifting longliners were estimated based on onboard sampling. Three times every year, sampling was conducted in GSA 20. Each time, catch, discards, and landings were recorded for each gear type and fleet segment. Based on this sampling, total discards were estimated by species, gear type, and GSA (Fig. 7.14.2.3.2.1).

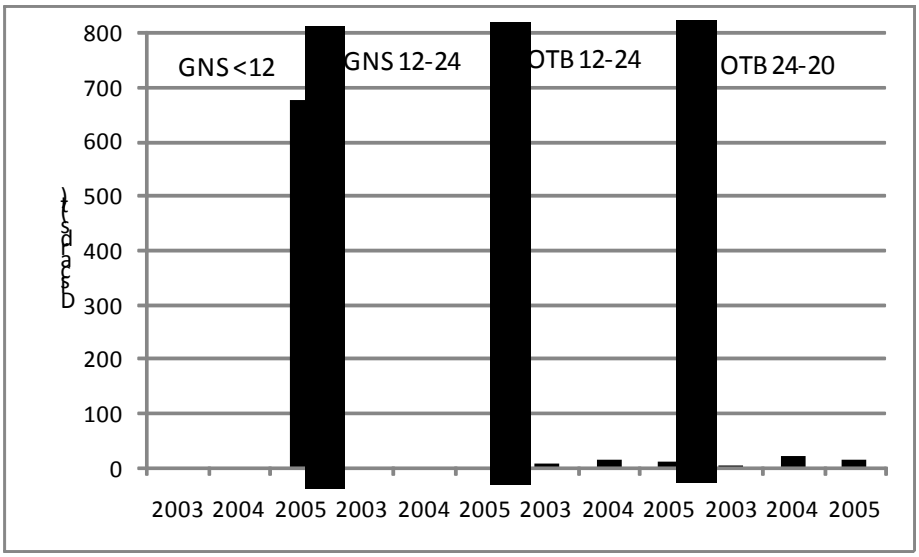


Fig. 7.14.2.3.2.1 Discards of hake in GSA 20 per fleet segment.

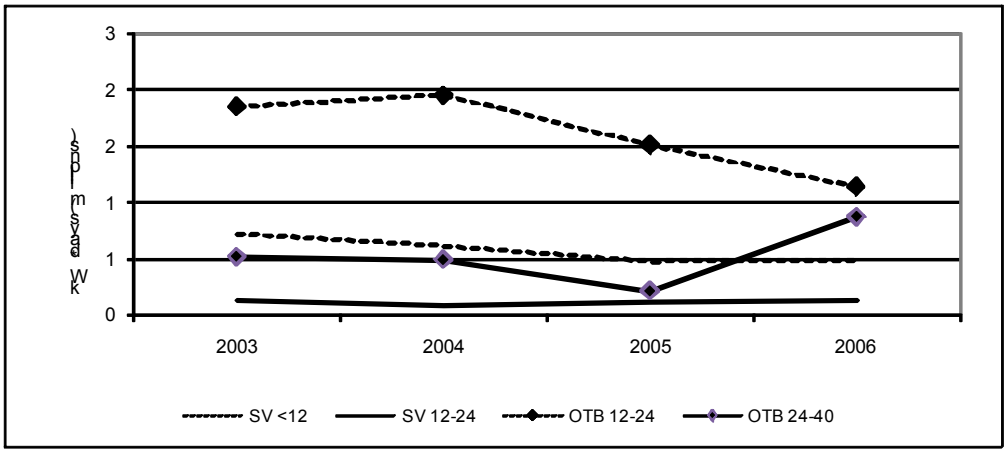
Discards of hake in bottom trawl fishery in GSA 20 were < 30 t in all years for both fleet segments. The proportion of discards to catch ranged from 0.05 to 0.8. An extremely high value for hake discards from gill nets was reported in 2005 (679 t discards). Discards reported to SGMED-08-03 throught the DCR data call are listed in Table A3.4 of Appendix 3.

No length distribution of discards was available for Greece at the meeting.

7.14.2.3.3. 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.



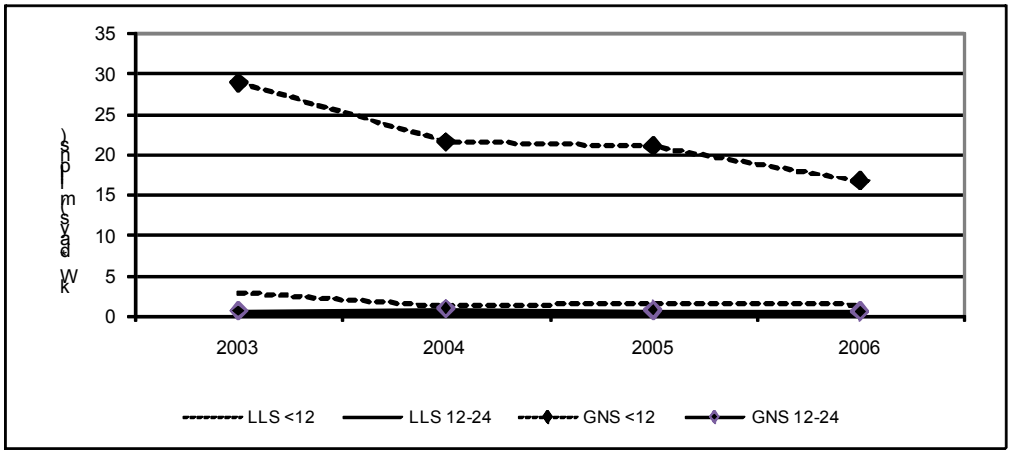


Fig. 7.14.2.3.3.1 Fishing effort per fleet segment in GSA 20.

The fishing effort of the gill nets <12 m and of the bottom trawls 12-24 m showed a significant reduction in GSA 20 from 2003 to 2006 (Fig. 7.14.2.3.3.1).

Tab. 7.14.2.3.3.1 lists the fishing effort reported to SGMED-08-03 through the DCR data call. The overview is given in Tab. A3.5 of Appendix 3 to this report.

Tab. 7.14.2.3.3.1 Fishing effort in different units by fishing technique deployed in GSA 20, 2003-2006.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	20	GRE	GNS		717773	634540	655783	588850	
DAYS	20	GRE	LLS		114160	79657	84159	73790	
DAYS	20	GRE	OTB		7810	7284	6279	6682	
DAYS	20	GRE	SV		13429	10902	10883	11363	
GT*DAYS	20	GRE	GNS		2885125	2548709	2611649	2210227	
GT*DAYS	20	GRE	LLS		436107	268489	203140	228351	
GT*DAYS	20	GRE	OTB		574443	580909	435054	565011	
GT*DAYS	20	GRE	SV		83099	62465	58441	57058	
KW*DAYS	20	GRE	GNS		29609039	22529478	21758835	17272519	
KW*DAYS	20	GRE	LLS		3247285	1435103	1823114	1448109	
KW*DAYS	20	GRE	OTB		2374841	2447515	1729664	2024955	
KW*DAYS	20	GRE	SV		863066	709465	604098	623628	

7.14.3. Scientific surveys

7.14.3.1. Medits

7.14.3.1.1. 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 2006, 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 and presented in section 11 of this report.

In GSA 20 the following number of hauls were reported per depth stratum (s. Tab. 7.14.3.1.1.1).

Tab. 7.14.3.1.1.1. Number of hauls per year and depth stratum in GSA 20, 1994-2006.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA20_010-050	2	2	2	2	4	3	3	3		3	3	3	3	
GSA20_050-100	3	4	8	7	11	10	11	9		10	10	10	9	
GSA20_100-200	1	3	4	2	5	6	5	6		6	6	5	6	
GSA20_200-500	2	3	4	4	7	7	7	8		8	9	8	8	
GSA20_500-800	3	2	4	3	5	5	5	5		5	3	5	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.

7.14.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.14.3.1.3. 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 7.14.3.1.3.1 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.

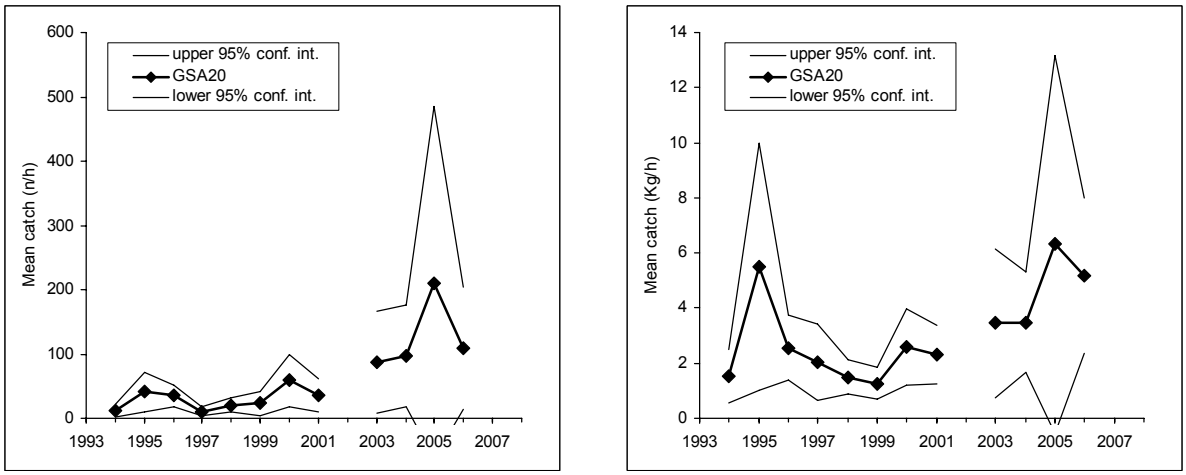


Fig. 7.14.3.1.3.1 Abundance and biomass indices of hake in GSA 20.

7.14.3.1.4. Trends in abundance by length or age

The following Fig. 7.14.3.1.4.1 and 2 display the stratified abundance indices of GSA 20 in 1994-2001 and 2003-2006. These size compositions are considered preliminary.

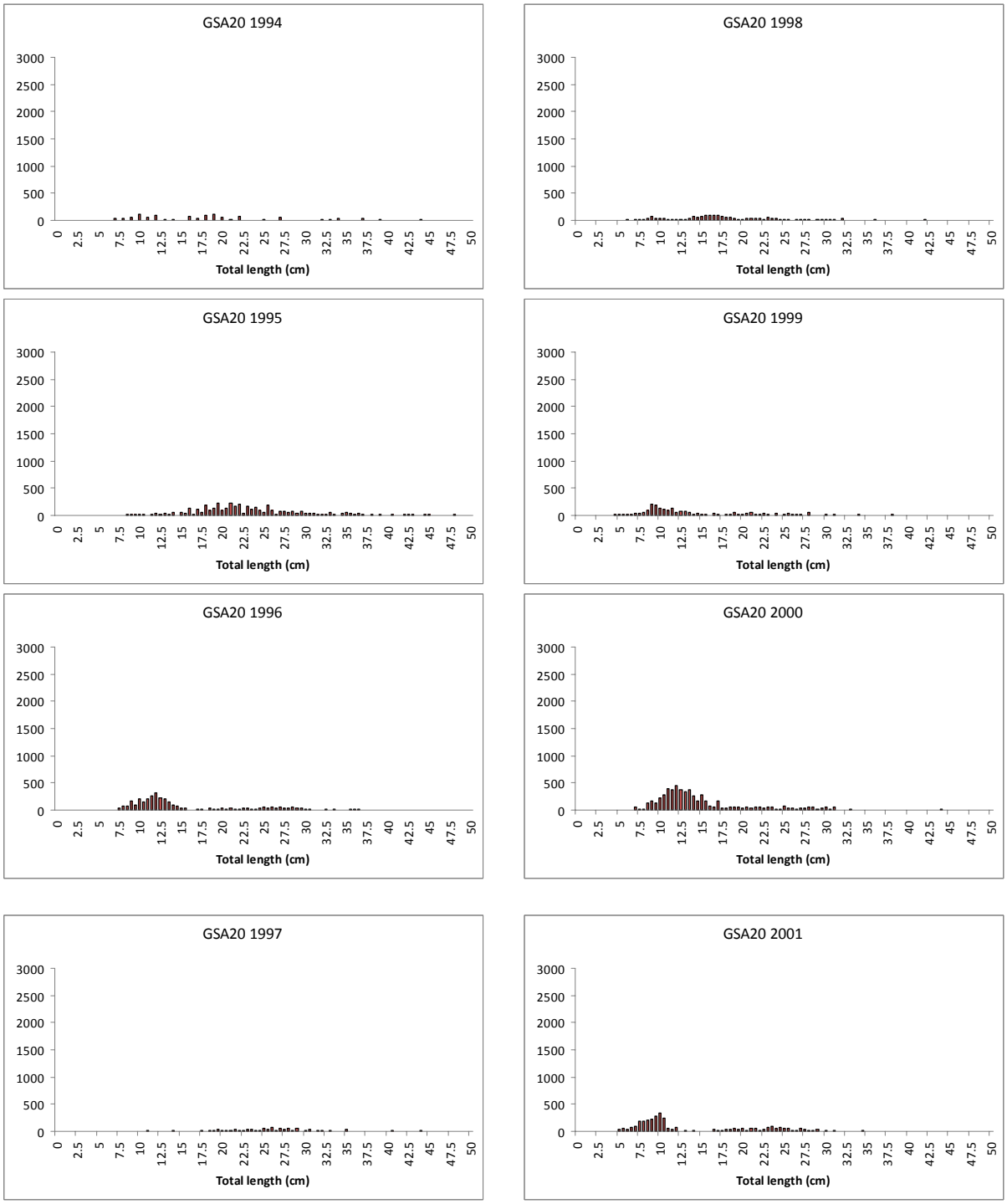


Fig. 7.14.3.1.4.1 Stratified abundance indices by size, 1994-2001.

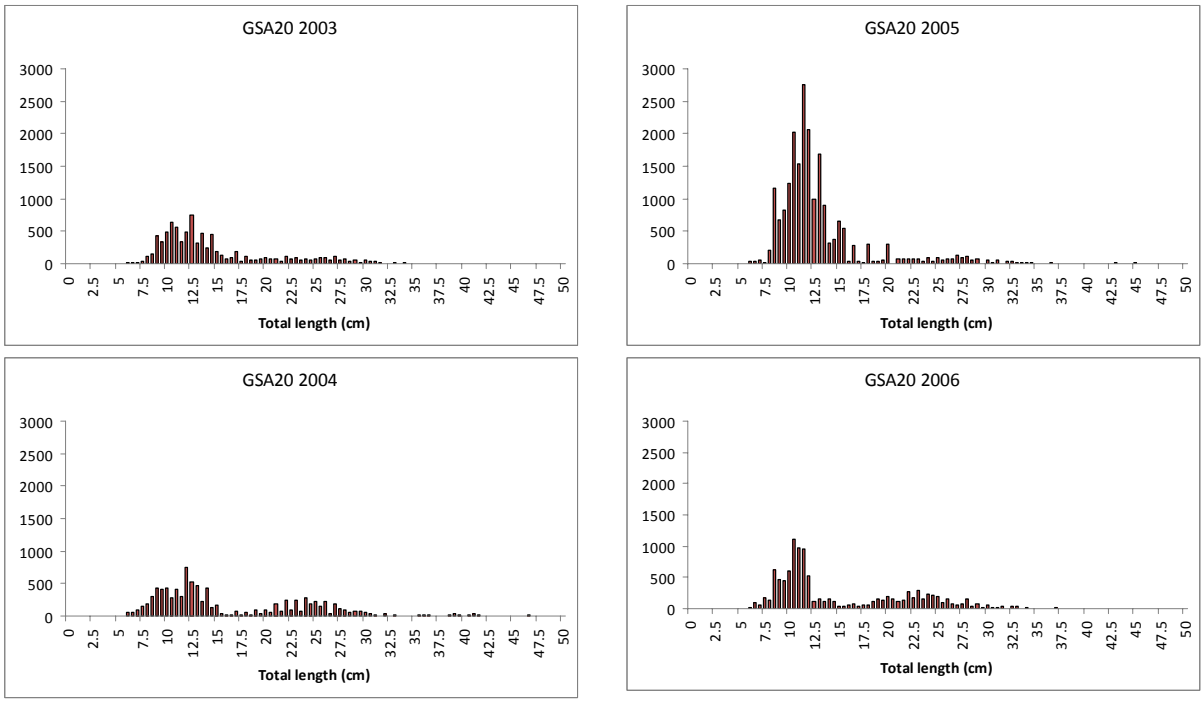


Fig. 7.14.3.1.4.2 Stratified abundance indices by size, 2003-2006.

7.14.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.14.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.14.4. Assessment of historic stock parameters

7.14.4.1. Method 1: SURBA (Survey Based Assessment)

7.14.4.1.1. Justification

Some of the requested data in the official data call were not provided by Greece in time for the meeting. No data on length distribution of the landings, age distribution of the landings, maturity ogive for males, sex ratio at length, and discards length distribution were available. Due to this lack of available data, many of the methods for stock assessment proposed in the previous meetings of SGMED could not be applied. Therefore, the MEDITS data (1994-2004) were surveyed with the use of the software SURBA.

SURBA 2.0 is a simple survey-based separable model of mortality. The package calculates relative indices regarding the stock status and not the actual number of individuals in the population or actual biomass. SURBA models include a simple, deterministic forecasting capability. This is done by rolling the survey-estimated population forward through time, assuming fixed geometric mean recruitment and the fitted year and age effects.

7.14.4.1.2. Input parameters

The data needed for SURBA are estimates of natural mortality at age, proportion mature at age, and stock weights at age. MEDITS survey data (1997-2006) were used to estimate F and relative SSB and abundance at age using SURBA 2.0 software. The variables used in the analysis were:

Growth parameters

L∞	100.7
k	0.248
to	-0.35

Weight-Length parameters

a (W-L)	0.0000019
b (W-L)	3.24

Length at age

1	28.65
2	44.48
3	56.82
4	66.46
5+	73.98

Mortality at age

	1	2	3	4	5
For all years	1.3	0.66	0.48	0.40	0.35

Mature at age

	1	2	3	4	5
For all years	0.06	0.3	0.5	0.7	1

7.14.4.1.3. Results

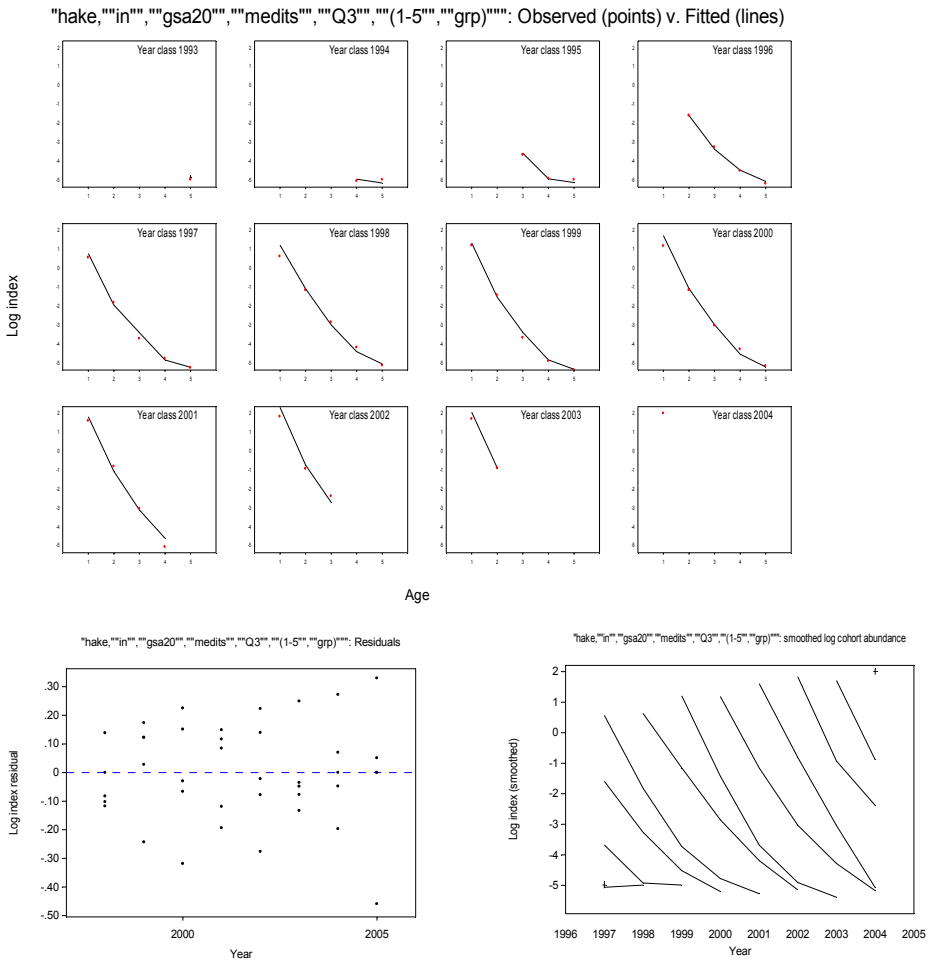


Fig. 7.14.4.1.3.1 Model diagnostics of the model fitted on hake in GSA 20.

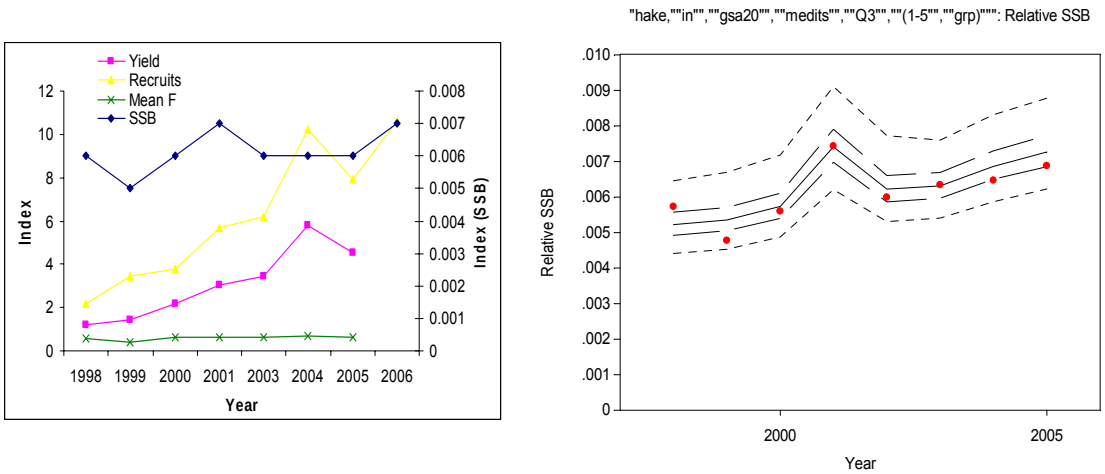


Fig. 7.14.4.1.3.2 Stock summary of the model fitted on hake in GSA 20.

Results obtained with SURBA 2.0 (Figures 7.14.4.1.3.1 and 7.14.4.1.3.2) showed an adequate fitting of the model in hake data in GSA 20.

Relative SSB index decreased until 1999 and then slightly increased. High values were recorded in 2001. An increase over time was evidenced in recruits and yield. Mean F decreased the first 2 years and then increased over the remaining study period.

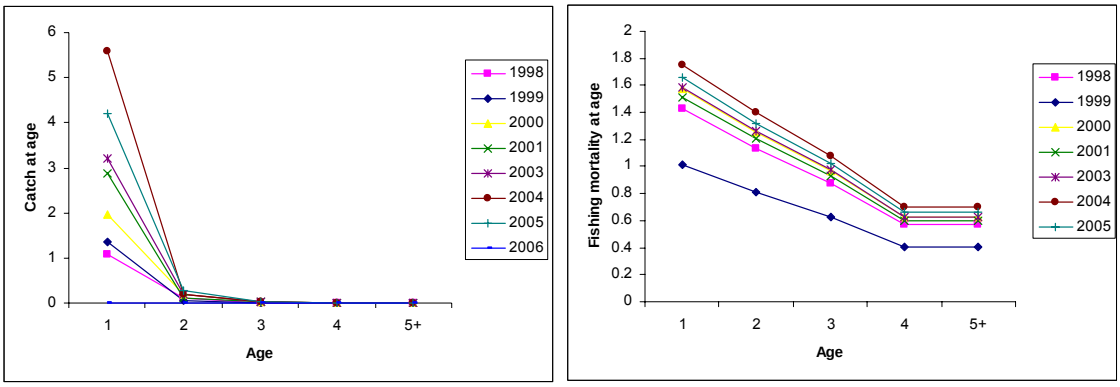


Fig. 7.14.4.1.3.3 Catch at age and fishing mortality at age of hake in GSA 20.

Most of hake was caught in the 1st age class when the fish were generally small and immature (Fig. 7.14.4.1.3.3). Fishing mortality decreased with age.

7.14.5. Short term prediction for 2008 and 2009

7.14.5.1. Justification

No forecast analyses were conducted.

7.14.5.2. Input parameters

No forecast analyses were conducted.

7.14.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSA 20.

7.14.6. Medium term prediction - Method 1: ALADYM

7.14.6.1. Justification

ALADYM (Age-Length Based Dynamic Model) is a simulation model, belonging to the group of dynamic pool models. The model simulates population dynamics of a single species following the simultaneous evolution of several cohorts at monthly intervals and accounting for sex differences in growth, maturity and mortality. It is a non-equilibrium approach capable of working also in the absence of fishery-dependent information in order to explore alternative management strategies and predict their consequences in the medium and long term. A summary of requirements, strengths, weaknesses, outputs, and several examples are provided in SGMED-08-01 and SGMED-08-02 reports.

7.14.6.2. Input parameters

The data needed for ALADYM are growth parameters, length-weight relationships, an initial estimate of total mortality, natural mortality, recruitment and spawning season and peak, stock recruitment relationship or a recruitment vector, selectivity parameters of the gears used by the fleet, a fishing activity coefficient by month.

The following input parameters were used:

	Females	Males	Comments
Linf	1007	728	French growth data
k	0.25	0.3	
to	min: -0.47 max: -0.34	min: -0.47 max: -0.34	
Lifespan	12	10	
a (W-L)	0.000001988	0.000002166	
b (W-L)	3.231	3.215	
M	Chen-Watanabe equation		
vector of offspring/month	.18 .19 .12 .05 .07 .09 .03 .03 .03 .03 .04 .15		based on GSI temporal variation
sex ratio	0.5		
gear selectivity	L50 = 123 mm L75 - L25 = 49 mm		selectivity experiment

Quarterly fishing coefficients (based on official catch data)				
year	**1st**	**2nd**	**3rd**	**4th**
2003	1.16	0.79	1.02	1.03
2004	0.87	1.36	0.96	0.80
2005	0.87	1.06	0.98	1.09
2006	1.11	1.16	0.82	0.91
average	1.00	1.09	0.95	0.96

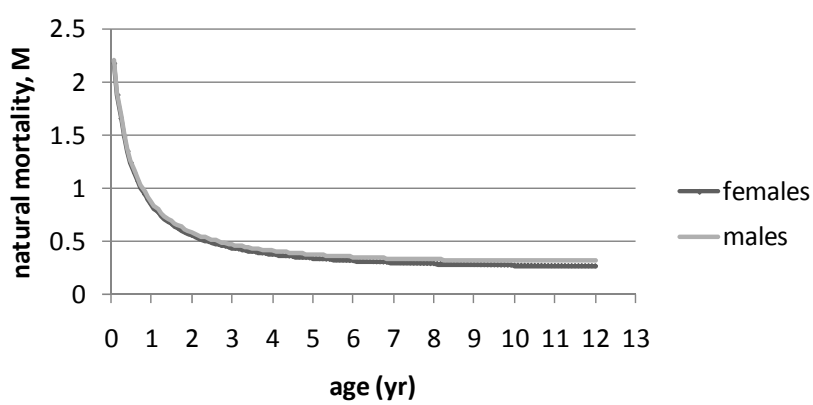


Fig. 7.14.6.2.1 Assumed natural mortality, based on the Chen-Watanabe equation

A constant recruitment was assumed, independent of stock size, i.e. the stock-recruitment relationship was assumed to be a horizontal line.

Simulations were based on 5 scenarios. In the 'present status' scenario all parameters were kept constant at current levels. In the other scenarios, a management action has been put forward, starting from year 2007. The quarterly fishing coefficients were taken as the average of the coefficients for the years 2003 to 2006. In the '20% pressure reduction scenario' it was assumed that fishing pressure was reduced by 20% (the fishing coefficients were reduced by 20%). In the 'increased mesh size' scenario, the selectivity pattern of the fishing gears was changed assuming an increase of Lc_{50} to a value of 200 mm, which is the minimum legal size of hake landings according to current legislation. In the 'summer closure' scenario, the fishery was

completely closed during the 3rd quarter (July to September). In the 'all measures' scenario, all the above measures were implemented simultaneously.

7.14.6.3. Results

The results of the Aladym model in terms of change/impact of main model-based indicators and reference points (biomass, yield, ESSB/USSB, Zfemale, mean age of the spawning stock) in the long-term are synthesised at annual time scale and reported in the following figures.

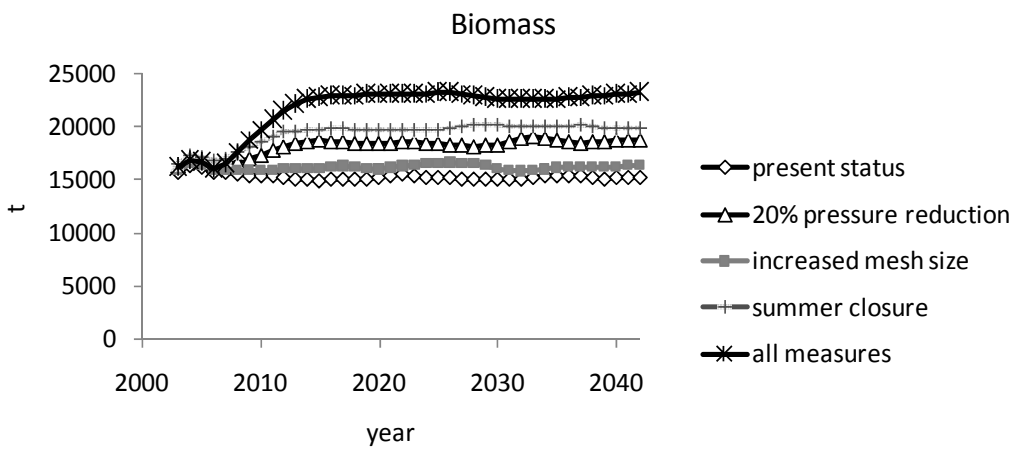


Fig. 7.14.6.3.1 Simulated time series of biomass by ALADYM, based on 5 scenarios.

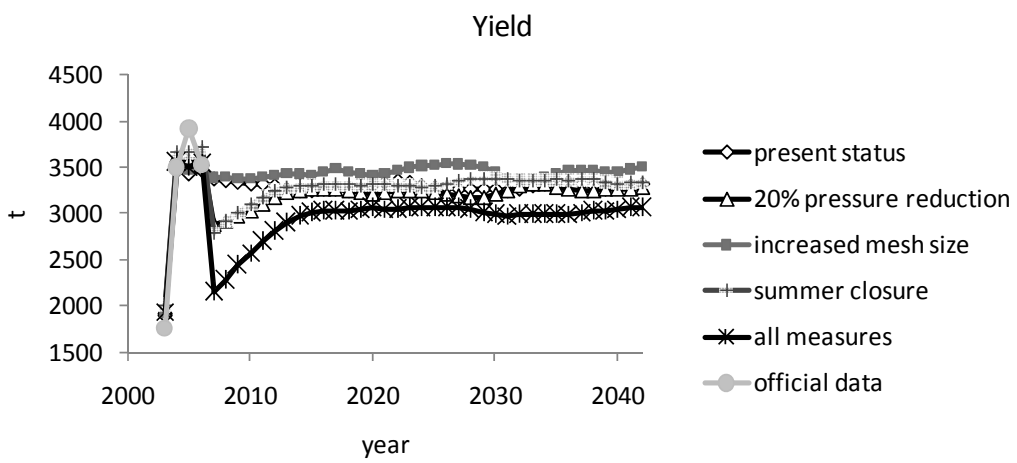


Fig. 7.14.6.3.2 Simulated time series of yield by ALADYM, based on 5 scenarios.

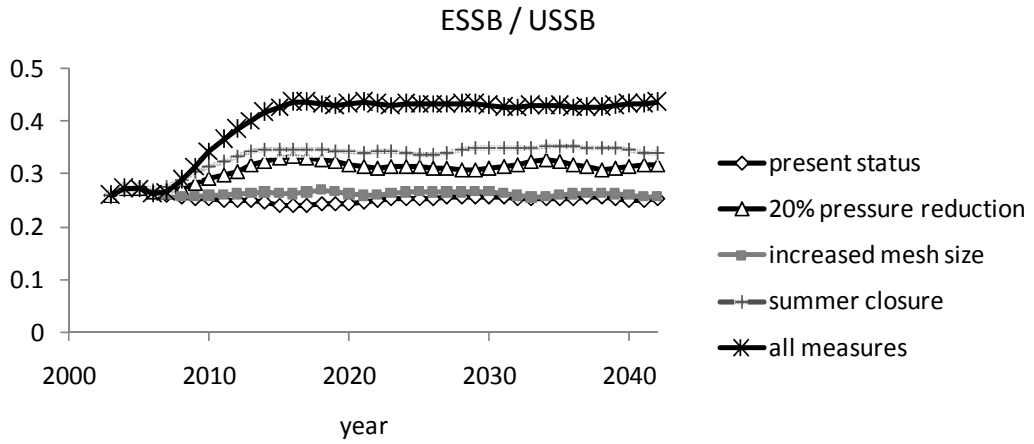


Fig. 7.14.6.3.3 Simulated time series of the ratio of exploited spawning stock biomass to unexploited spawning stock biomass by ALADYM, based on 5 scenarios.

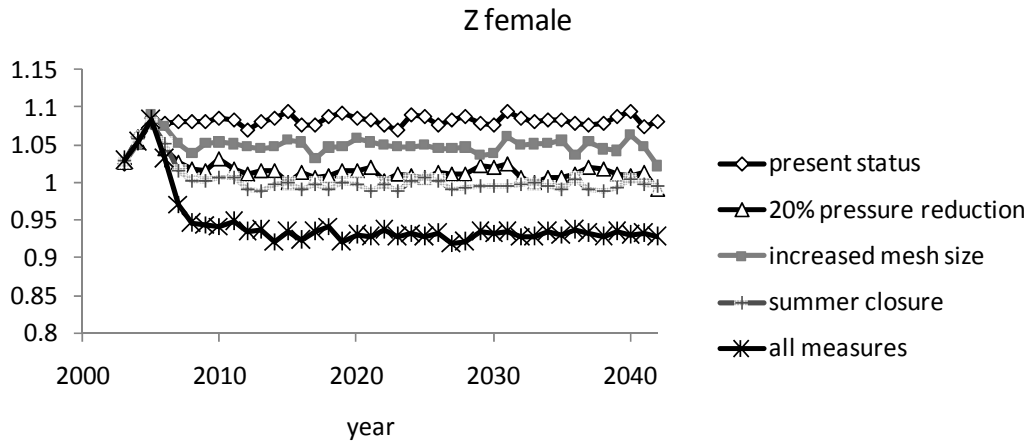


Fig. 7.14.6.3.4 Simulated time series of female mortality by ALADYM, based on 5 scenarios.

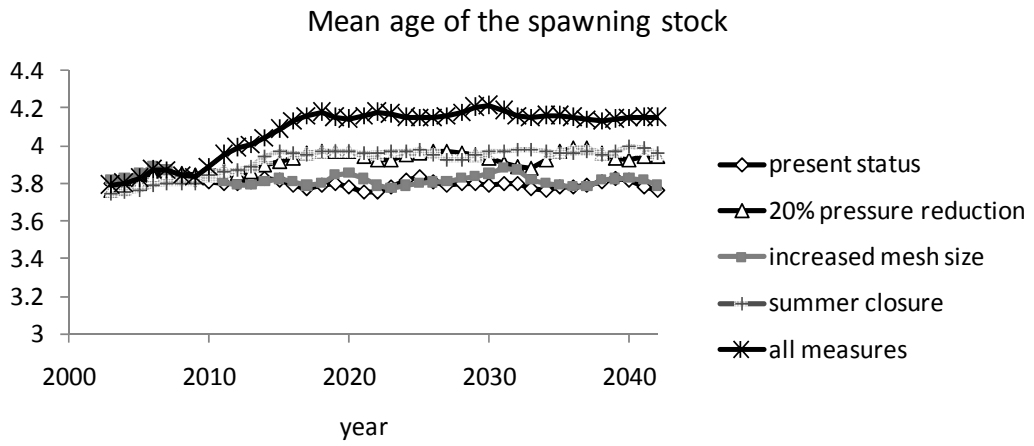


Fig. 7.14.6.3.5 Simulated time series of the mean age of the spawning stock by ALADYM, based on 5 scenarios.

Results highlighted that the current situation of hake stock exploitation would substantially be improved under some of the management scenarios tested. Biomass of the hake stock would increase with any of the three management measures; the highest increase would occur after a decision for a summer closure of the hake fishery and the lowest increase after a decision for a mesh size increase. The 'all measures scenario' would cause an increase of the stock biomass by more than 50% in the long term. Total mortality of the females would decrease under all scenarios; the highest decrease would occur with a summer closure of the fishery and the lowest decrease by increasing mesh size. Mean age of the spawning stock would not be substantially affected by increasing mesh size but would increase with all the other measures. Yield would decrease in the short term with all management scenarios in relation to the present status and this decrease would be more pronounced with the '20% pressure reduction' and the 'summer closure' scenarios. In the long term, yield would not substantially change with the '20% pressure reduction' or the 'summer closure' scenarios but it would slightly increase with the 'increased mesh size' scenario. However, the mixed scenario would cause a very large short-term reduction of yield as well as a long term reduction by 7.5%. The sustainability reference point ESSB/USSB would substantially rise in the long-term with all management scenarios, except for the 'increased mesh size' scenario.

7.14.7. Long term prediction

7.14.7.1. Justification

No forecast analyses were conducted.

7.14.7.2. Input parameters

No forecast analyses were conducted.

7.14.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSA 20.

7.14.8. Scientific advice

Based on MEDITS data, spawning stock biomass appeared stable, while yield and recruits had an increasing trend. Based on the official DCR data, landings had an overall increasing trend (but a slight decrease in 2006). Simulations in ALADYM, showed that with a decrease of effort or an increase in mesh size, the stock would improve but yield would either decrease or slightly increase, depending on the scenario. Thus, based on the data available on the conducted analyses, the stock of hake in GSA 20 appears to be stable and no signs of decline are visible.

However, in the absence of length and/or age distribution data, these results should be considered as preliminary (based on assumptions that need verification) and insufficient to form the basis for establishing long-term management plans. Such data should be made available in order to conduct more reliable stock assessment.

7.14.8.1. Short term considerations

7.14.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.14.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.14.8.1.3. State of exploitation

SGMED-08-03 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.

7.14.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.15. Stock assessment of hake in GSAs 22 and 23 combined

7.15.1. Stock identification and biological features

7.15.1.1. 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.

7.15.1.2. Growth

Biological sampling was conducted in 16 fishing ports, which are the main landing ports of the GSAs 22-23. Landings from trawlers, nets and hooks were included in biological sampling. Sampling was conducted during different seasons for each species depending on the life cycle of the species, the size of local production, and the temporal or spatial restrictions on the use of fishing gears.

The growth parameters for hake and for each sex are given for GSAs 22-23 in the following figure. The age interpretation was done by otolith reading. Sampling was conducted from 2003 to 2005. The growth curves are as shown in the Fig. 7.15.1.2.1.

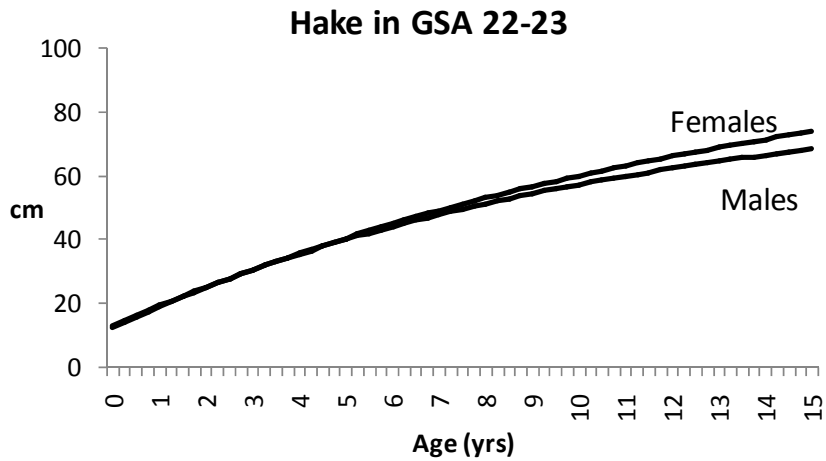


Fig. 7.15.1.2.1. Growth functions of hake in GSAs 22-23.

After studying the growth equations from each GSA, it was noticed that there is a big variability in growth parameters. The reason for this was likely the uncertainty of hake age readings, which has been documented by various researchers (Piñeiro and Saínza, 2002, 2003). Recent results from a tagging experiment in France have strongly suggested that those criteria may not be accurate and that they may lead to overestimation of ages (De Pontual et al., 2003). It was mentioned that faster growth is expected for hake in the Mediterranean, as suggested by the tagging experiment conducted in France (Gulf of Lions), which validated hake age. Therefore the SGMED decided to perform hake assessments using the growth parameters according to the French tagging experiments. These parameters are given in the table below.

Growth parameters of hake according to the French tagging experiments are listed in Table 7.15.1.2.1.

Tab. 7.15.1.2.1 Growth parameters of hke according to the French tagging experiments.

HAKE	**L_∞ (cm)**	**k**	**t_0**
Females	72.8	0.298	-0.383
Males	100.7	0.248	-0.35

7.15.1.3. Maturity

Biological sampling in order to define the maturity ogives and reproduction cycle of species was conducted as for the growth parameter sampling. Maturity was defined based on Nikolsky scale. All individuals with a maturity stage >3 were considered as mature (only reproductive months were taken into account). For each species, the percentage of mature individuals per length class was estimated. Data were only provided for females. However, it was pointed out that in other GSAs hake are considered mature at maturity stages >2 (on the Nikolsky scale). Thus, the estimated Lm_{50} was greater than that estimated in other GSAs that used the '>2' criterion. The estimated Lm_{50} might be an overestimation and the issue needs further consideration; standardisation among GSAs is needed.

The maturity curve was estimated by logistic regression (with non-linear least-squares) based on the official data provided. The estimated parameters of the curve are given in the table below.

Tab. 7.15.1.2.1 Parameters of maturity at length.

	Estimations	SE	95% LL	95% UL
L_{50}	43.7	1.9	39.9	47.4
L_{75}-L_{25}	12.8	0.8	11.3	14.4

7.15.2. Fisheries

7.15.2.1. 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.

Bottom trawlers are targeting hake at depths between 100 and 300 m, gillnets from 100-300 m and longlines may reach 600 m. The mesh size of the cod end of bottom trawl is 40 mm whereas the mesh size of the gillnets ranges from 52-64 mm. 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 6-18 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.

The bottom trawl fishery is a mixed fishery, operating 24hr per day. Especially for the offshore fisheries in the international waters, the duration of the trip could be more than 3 days. Important bycatch species are shrimps, anglerfish, blue whiting, Norway lobster, megrims, pickarel and red mullet. The gillnet and especially the longline fisheries have a relatively greater species and size selectivity.

An assessment of the historic trends (1991-2007) in the fleets exploiting hake in GSA 22-23 is provided in Figures 7.15.2.1.1a and b.

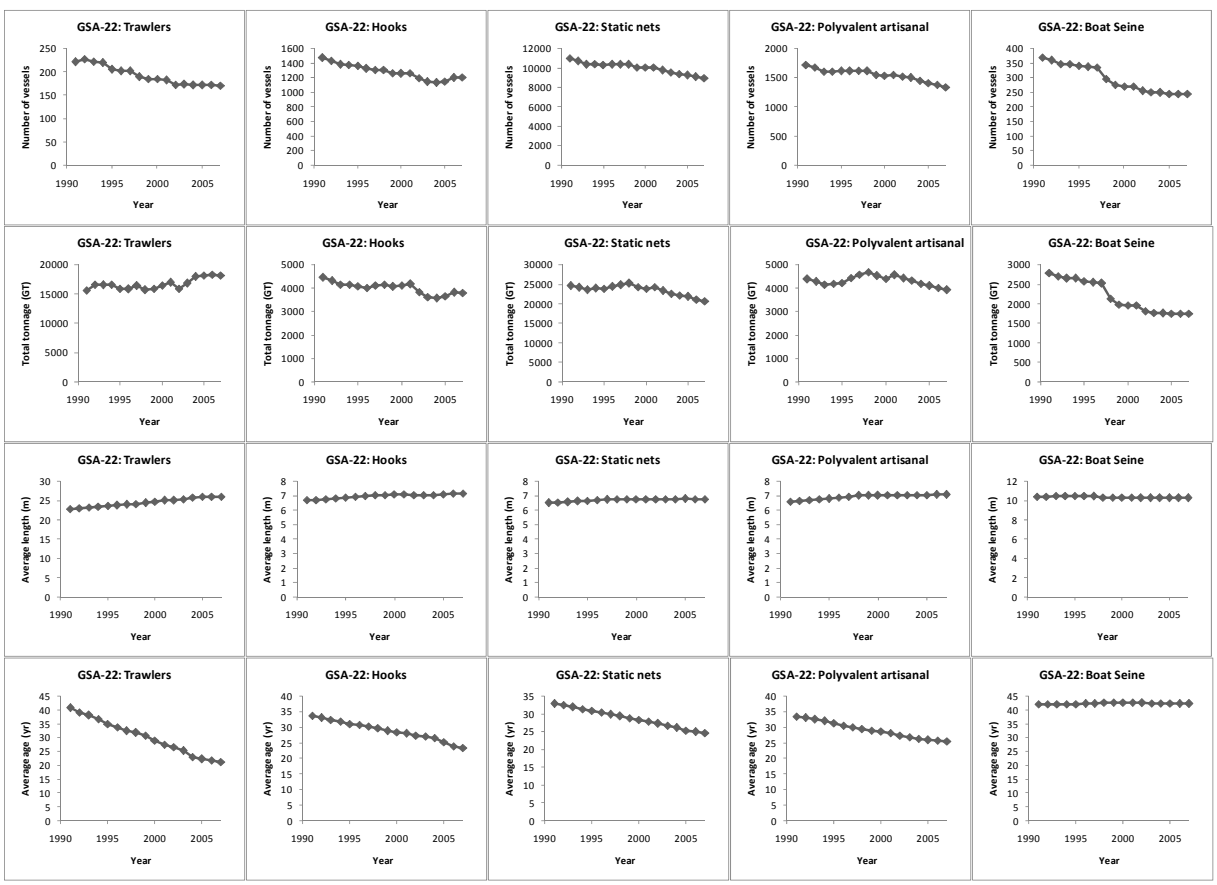


Fig. 7.15.2.1.1a. Historical trends of fleets exploited hake in GSA 22.

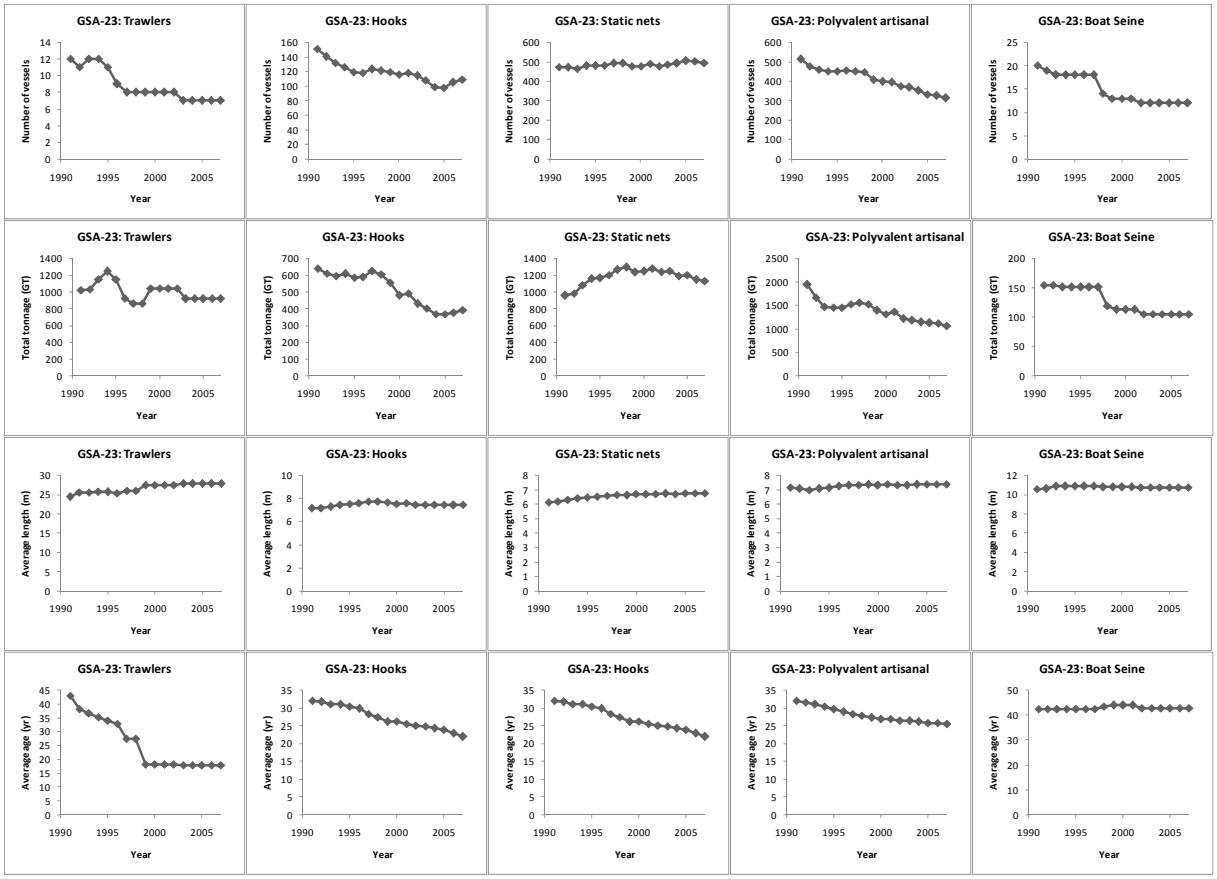


Fig. 7.15.2.1.1b Historical trends of fleets exploited hake in GSA 23.

There was a general declining trend in the number of vessels in recent years in all fleet segments. Capacity generally declined, except in trawlers where it increased. The average length slightly increased in all fleet segments, except boat seiners. Average age substantially declined in all fleet segments except boat seiners where average age remained stable and the highest among all fishing fleets.

7.15.2.2. Management regulations applicable in 2007 and 2008

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 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 (EU 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 Pagassitikos, S. Euboikos, Porto Lagos, Thessaloniki, part of the Saronicos Gulf, Oreon Channel trawling is prohibited all year around, while in the

Gulf of Kavala, Thermaikos Gulf, Strimonikos Gulf trawling is prohibited from 1st of April till the end of October.

The operation of the bottom set nets is subject to the following main restrictions:

(1) the maximum total length of the trammel length 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 2500 m.

7.15.2.3. Catches

7.15.2.3.1. 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. Number of fish landed was not reported. No data on length distribution were provided in time for the meeting.

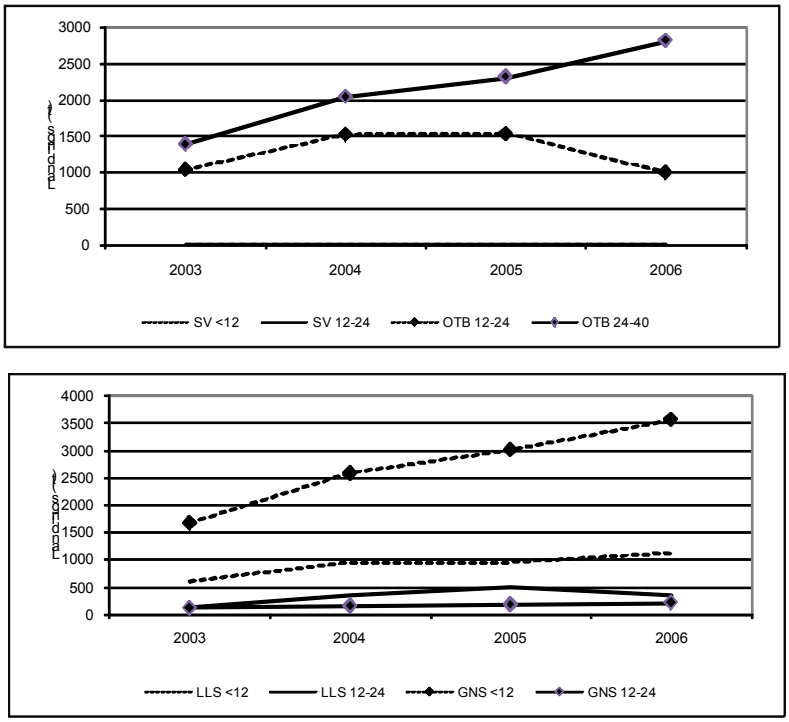


Fig. 7.15.2.3.1.1 Landings of hake in GSA 22-23s from 2003-2006.

The landings of hake in GSA 22-23 are presented in Fig. 7.15.2.3.1.1. According to official data, the bottom trawl catch ranged from 2,440 to 3,850 t, catches of gillnets ranged from 1,790 to 3,770 t, whereas the catches of the long lines ranged from 710 to 1,470 t.

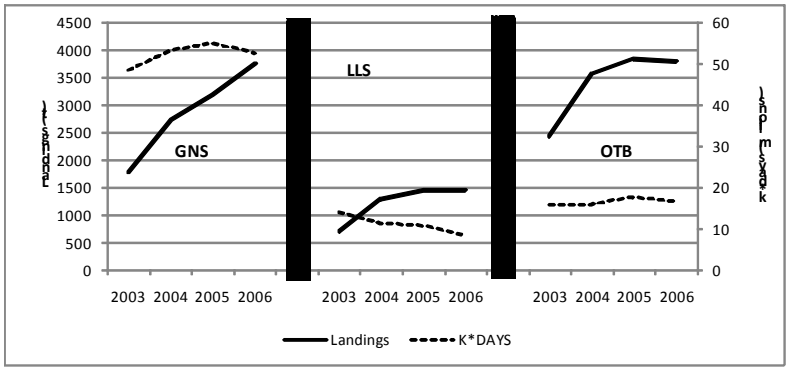


Fig. 7.15.2.3.1.2 Landings of hake and fishing effort per gear category in GSAs 22-23.

The landings of all gears increased in comparison with the landings in 2003 (Fig. 7.15.2.3.1.2). In particular, gillnets landings increased from 1,790 to 3,770 t. At the same time effort of gillnets and bottom trawls remained quite constant while effort of longlines decreased. The landings of bottom trawlers in this area is less than 50% of the total.

Tab. 7.15.2.3.1.1 Landings (t) as reported to SGMED-08-03 through the DCR data call, 2003-2006. The data are listed in Tab. A3.1 of Appendix 3.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
HKE	22+23	GRE	SV		13	4	7	15	
HKE	22+23	GRE	OTB		2443	3572	3856	3821	
HKE	22+23	GRE	LLS		712	1305	1460	1469	
HKE	22+23	GRE	GNS		1793	2732	3187	3771	
SUM					4961	7613	8510	9076	

Data on length and age composition were not available at the meeting.

7.15.2.3.2. Discards

In Greece, the discards and landings of trawlers, purse-seiners, coastal vessels, and drifting longliners were estimated based on onboard sampling. Three times every year, sampling was conducted in the northern and southern parts of GSA 22. Each time, catch, discards, and landings were recorded for each gear type and fleet segment. Based on this sampling, total discards were estimated by species, gear type, and GSA. No length distribution of discards was provided for GSAs 22-23.

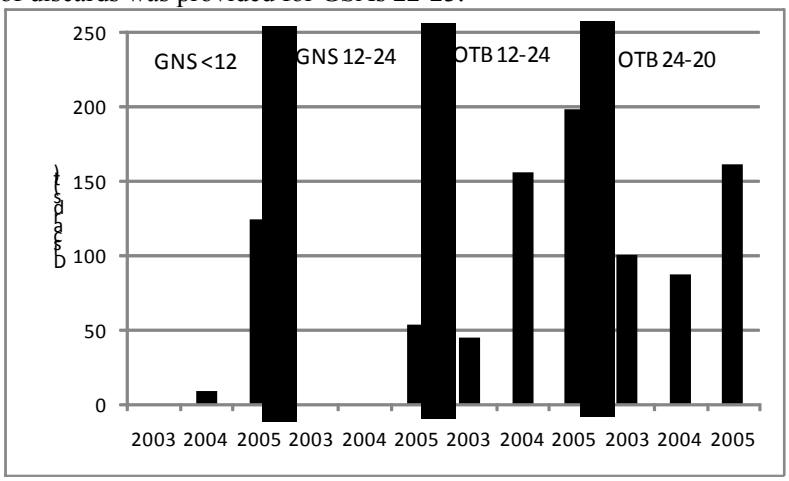


Fig. 7.15.2.3.2.1. Discards of hake in GSA 22-23 per fleet segment.

Discards of hake in bottom trawl fishery in GSAs 22-23 were estimated 147, 244 and 360 t for the years 2003, 2004 and 2005, respectively (Fig. 7.15.2.3.2.1). Discards for the gillnet fishery were reported in 2004 (9 t) for the segment <12 m and for 2005 (179 t) for both segments. The ratio of discards to total catch was less than 0.05 for the gill nets and ranged from 0.06 to 0.09 for bottom trawl. No discards from the longline fishery were reported.

7.15.2.3.3. 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.

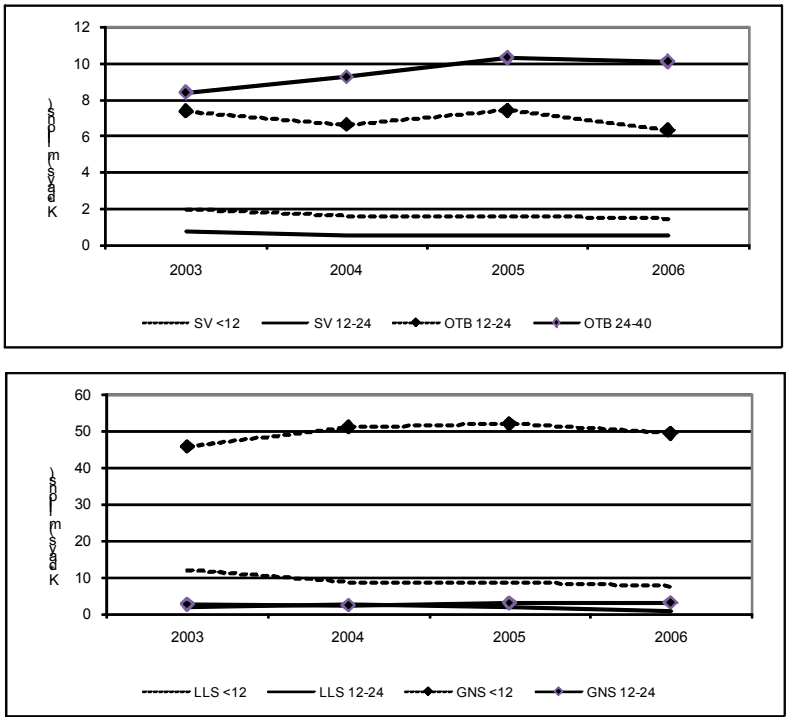


Fig. 7.15.2.3.3.1 Fishing effort per fleet segment in GSAs 22-23.

The fishing effort of the small bottom trawlers (12-24 m), of small gill netters (<12 m) and of the longliners decreased whereas the effort of the big bottom trawlers and gill netters increased (figure 7.15.2.3.3.1).

Tab. 7.15.2.3.3.1 lists the fishing effort reported to SGMED-08-03 through the DCR data call. The overview is given in Tab. A3.5 of Appendix 3 to this report.

Tab. 7.15.2.3.3.1 Fishing effort in different units by fishing technique deployed in GSAs 22 and 23, 2003-2006.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	22+23	GRE	GNS		1499507	1445880	1529002	1479134	
DAYS	22+23	GRE	LLS		381095	295005	315854	253335	
DAYS	22+23	GRE	OTB		52536	53389	56580	52831	
DAYS	22+23	GRE	SV		36266	31987	33200	30098	
GT*DAYS	22+23	GRE	GNS		5837915	5675508	5782002	5610405	
GT*DAYS	22+23	GRE	LLS		1762101	1660263	1602486	1323112	
GT*DAYS	22+23	GRE	OTB		4927349	4971783	5553804	5554194	
GT*DAYS	22+23	GRE	SV		294896	269645	276265	257271	
KW*DAYS	22+23	GRE	GNS		48227268	53304432	54981971	52423637	
KW*DAYS	22+23	GRE	LLS		14158502	11416302	10631705	8283337	
KW*DAYS	22+23	GRE	OTB		15792715	15877180	17730748	16402915	
KW*DAYS	22+23	GRE	SV		2775797	2206815	2193550	2022231	

7.15.3. Scientific surveys

7.15.3.1. Medits

7.15.3.1.1. 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 and presented in section 11 of this report.

In GSAs 22 and 23 the following number of hauls were reported per depth stratum (s. Tab. 7.15.3.1.1.1).

Tab. 7.15.3.1.1.1. Number of hauls per year and depth stratum in GSAs 22 and 23, 1994-2006.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA22+23_010-050	10	10	11	10	13	12	13	13		13	13	14	14	
GSA22+23_050-100	17	21	22	28	24	26	21	25		25	23	24	24	
GSA22+23_100-200	19	25	37	36	36	33	37	35		36	43	41	41	
GSA22+23_200-500	28	35	44	50	51	51	50	48		51	52	52	52	
GSA22+23_500-800	18	12	19	21	22	21	20	17		17	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 = $Yst \pm t(\text{student distribution}) * V(Yst) / n$

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.

7.15.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.15.3.1.3. 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. 7.15.3.1.3.1 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.

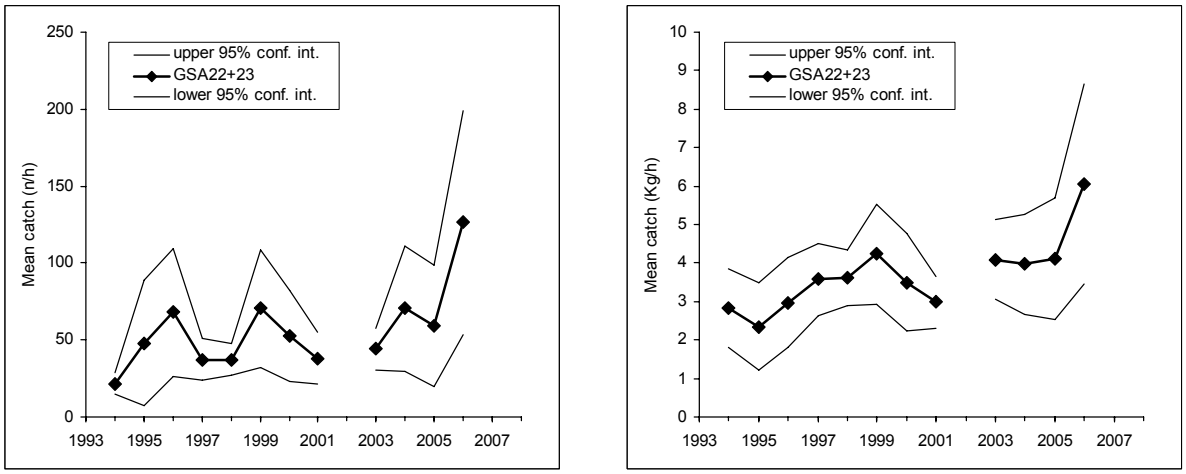
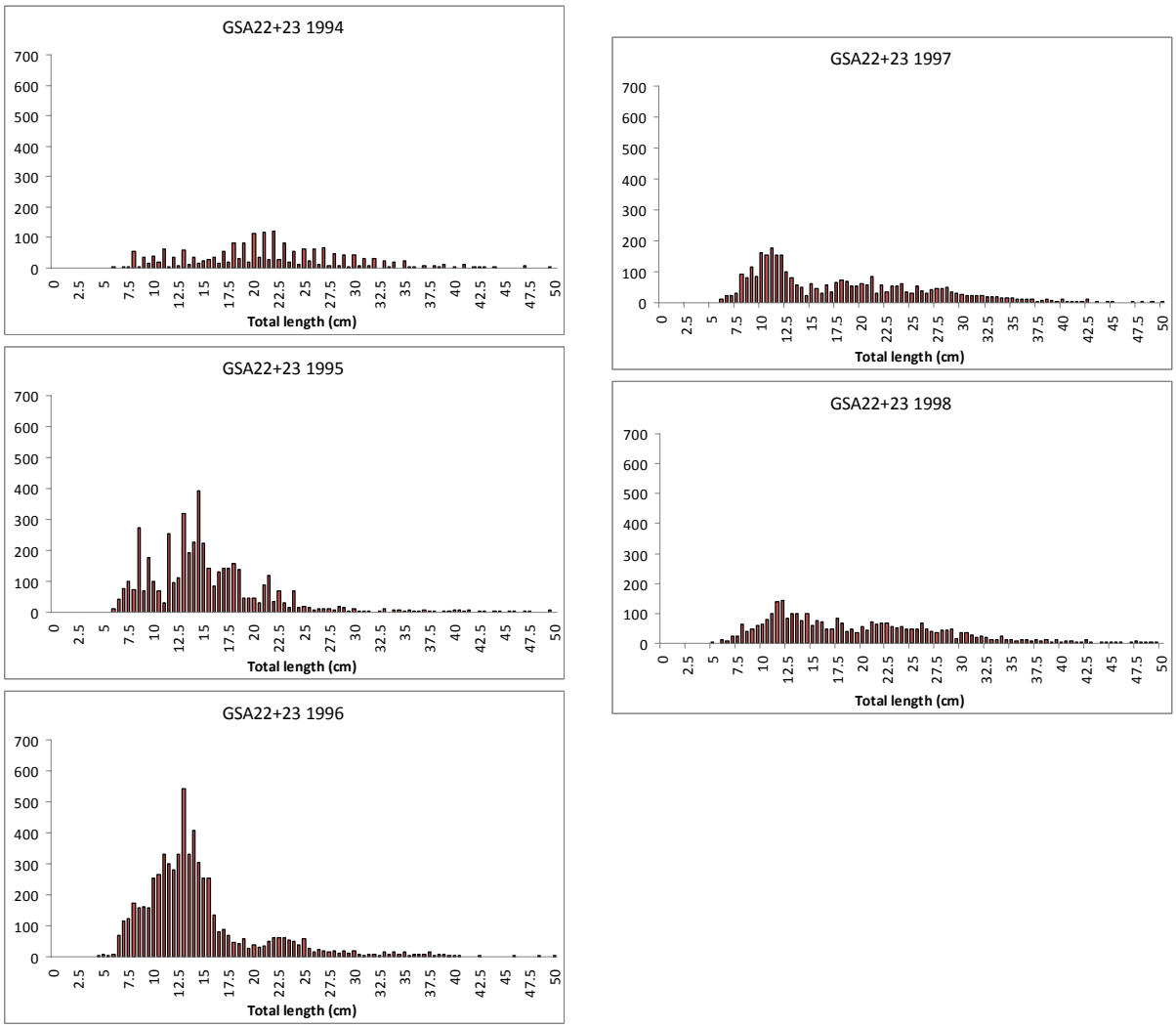


Fig. 7.15.3.1.3.1 Abundance and biomass indices of hake in GSAs 22 and 23.

7.15.3.1.4. Trends in abundance by length or age

The following Fig. 7.15.3.1.4.1 and 2 display the stratified abundance indices of GSAs 22and 23 combined in 1994-2001 and 2003-2006. These size compositions are considered preliminary.



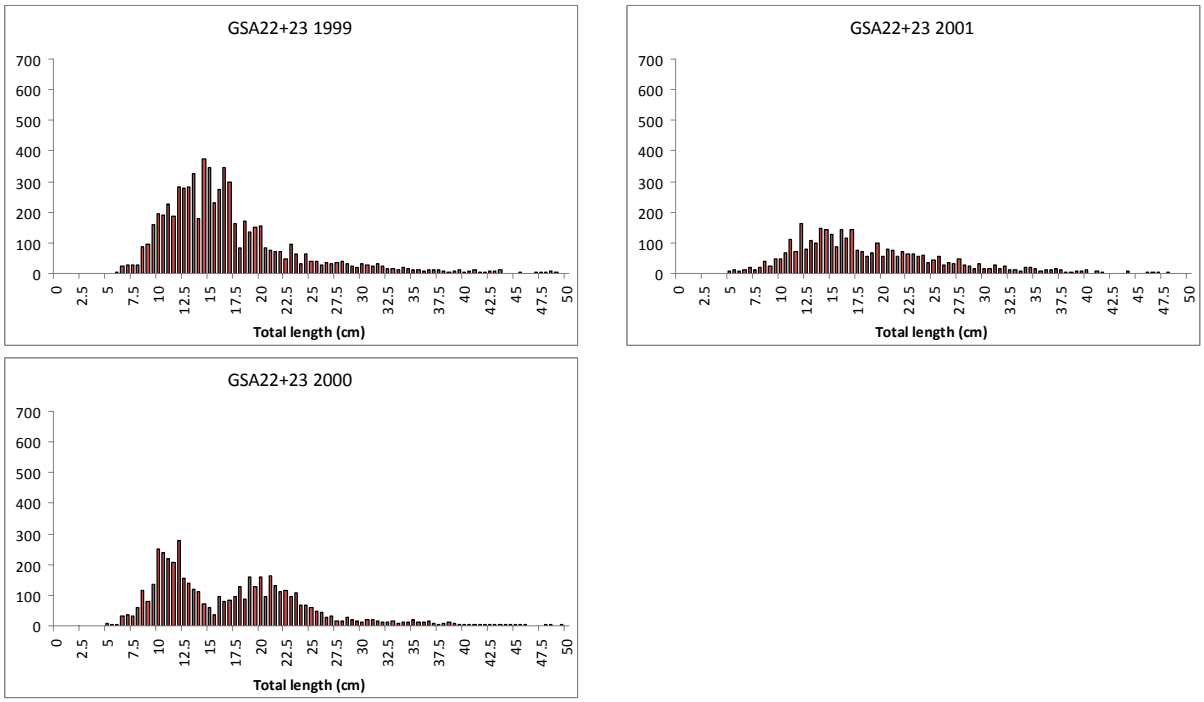


Fig. 7.15.3.1.4.1 Stratified abundance indices by size, 1994-2001.

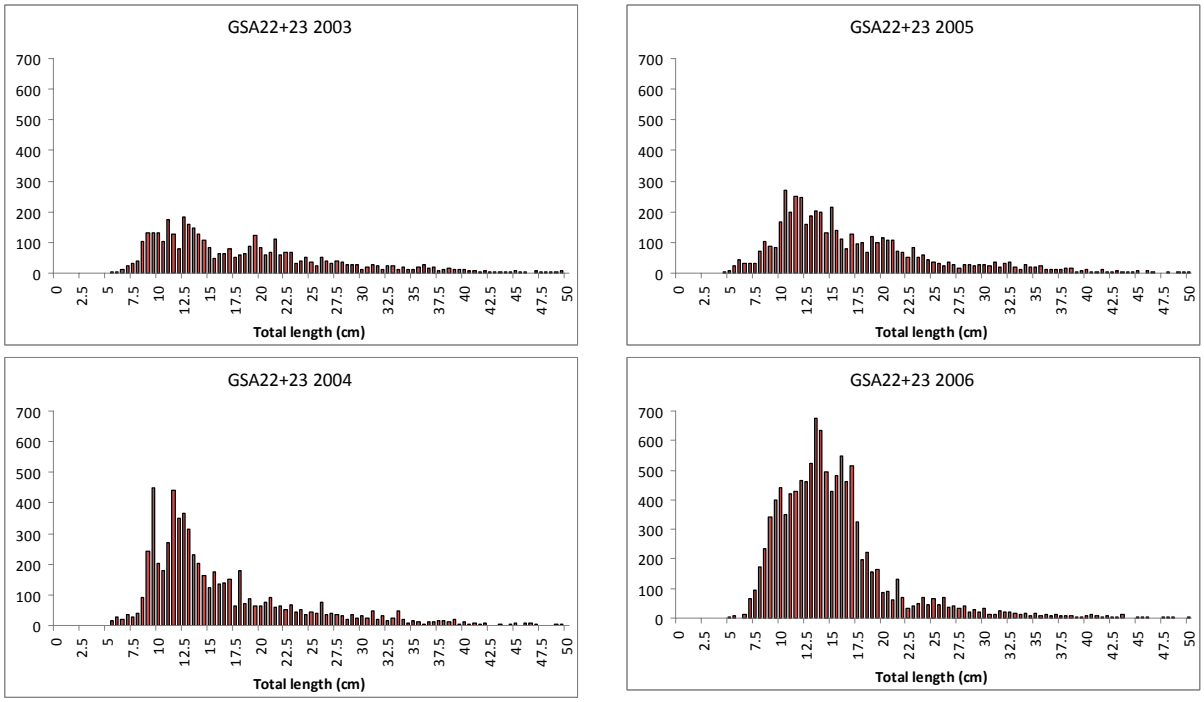


Fig. 7.15.3.1.4.2 Stratified abundance indices by size, 2003-2006.

7.15.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.15.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.15.4. Assessment of historic stock parameters

7.15.4.1. Method 1: SURBA (Survey Based Assessment)

7.15.4.1.1. Justification

Some of the requested data in the official data call were not available from Greece at the meeting. No data on length distribution of the landings, age distribution of the landings, maturity ogive for males, sex ratio at length, and discards length distribution were provided. Due to the lack of available data, many of the methods for stock assessment proposed in the previous meetings of SGMED were impossible to apply. The MEDITS data (1994-2004) were surveyed with the use of the software SURBA. ALADYM was also used to make simulations based on different management scenarios.

SURBA 2.0 is a simple survey-based separable model of mortality. The package calculates relative indices regarding the stock status and not the actual number of individuals in the population or actual biomass. SURBA models include a simple, deterministic forecasting capability. This is done by rolling the survey-estimated population forward through time, assuming fixed geometric mean recruitment and the fitted year and age effects.

7.15.4.1.2. Input parameters

The data needed for SURBA are estimates of natural morality at age, proportion mature at age and stock weights at age. MEDITS survey data (1994-2006) were used to estimate F and relative SSB and abundance at age using SURBA 2.0 software. The variables used in the analysis were:

Growth parameters (hake females)

Linf	100.7
k	0.248
to	-0.35

Weight-length relationship

a (W-L)	0.0000035
b (W-L)	3.196

Length at age

1	28.65
2	44.48
3	56.82
4	66.46
5	73.98
6+	79.85

Mortality at age

	1	2	3	4	5	6+
For all years	1.3	0.66	0.48	0.40	0.35	0.32

Mature at age

	1	2	3	4	56+
For all years	0.1	0.4	0.8	0.9	1

7.15.4.1.3. Results

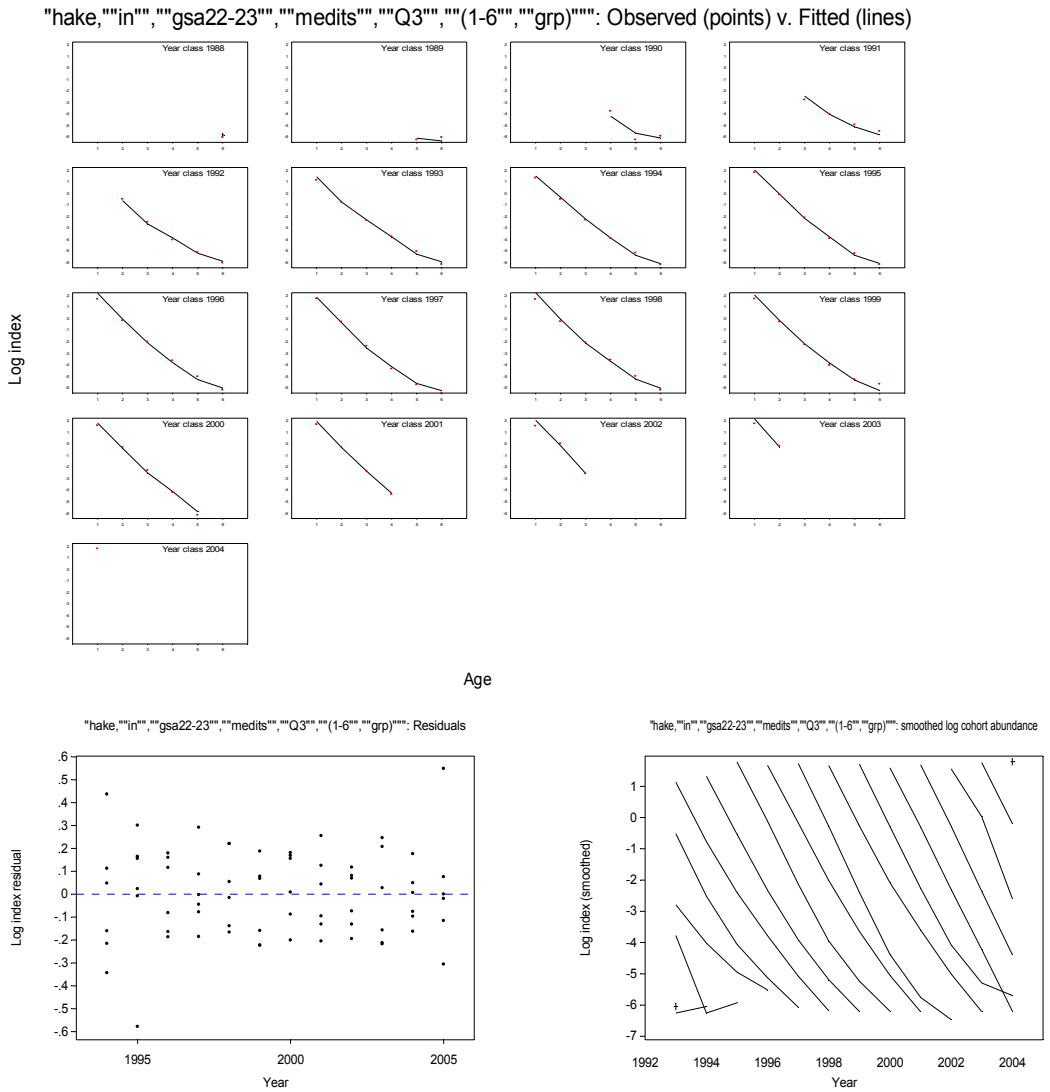


Fig. 7.15.4.1.3.1 Model diagnostics of the model fitted on hake (females) in GSAs 22 and 23.

Results obtained with SURBA 2.0 showed an adequate fitting of the model in hake (females) data in GSAs 22 and 23 (Fig. 7.15.4.1.3.1 and Fig. 7.15.4.1.3.2).

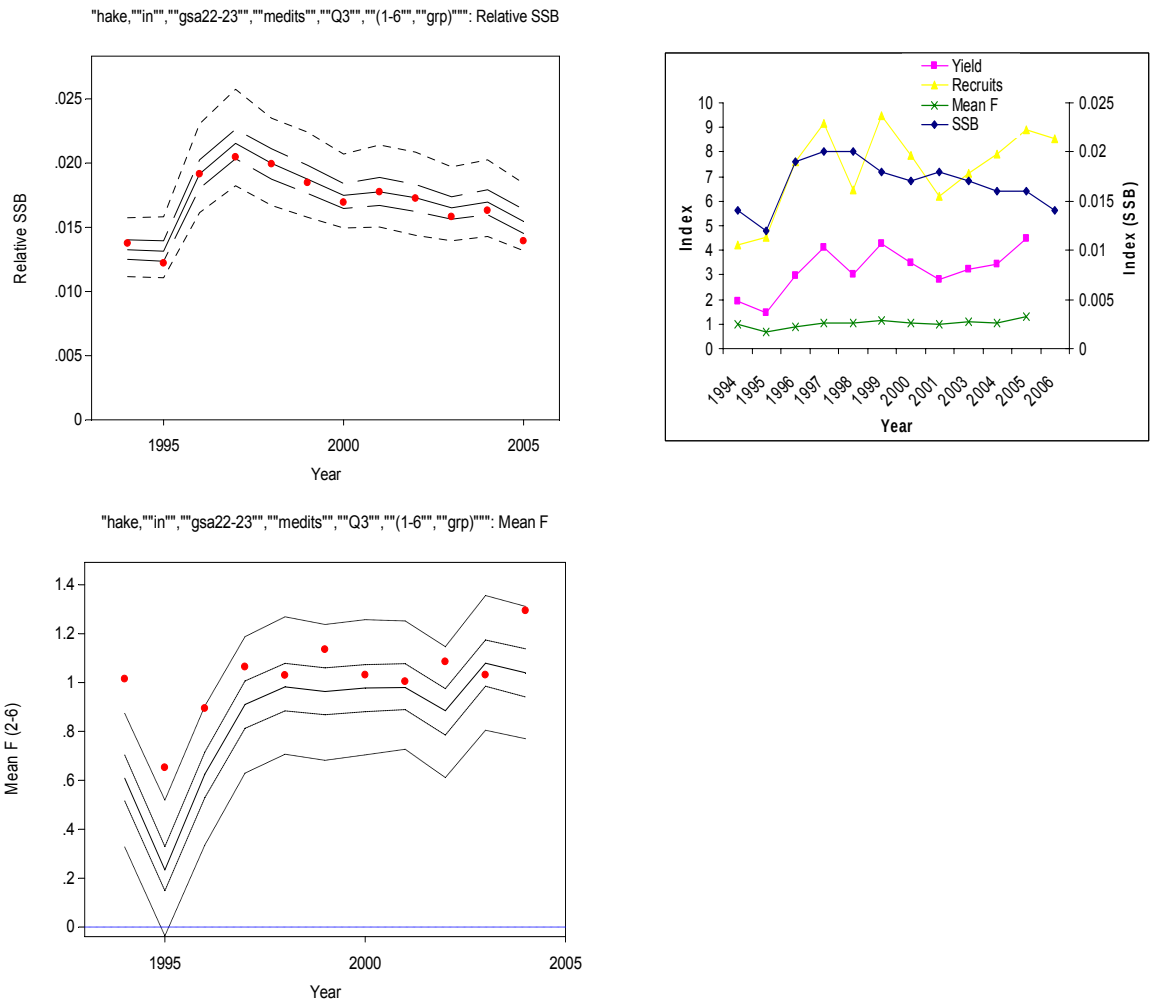


Fig. 7.15.4.1.3.2 Stock summary of the model fitted on hake (females) in GSAs 22 and 23.

An increase until 1998 and a decrease afterwards was recorded on relative SSB of hake. Recruits, yield and mean F showed an increase over time.

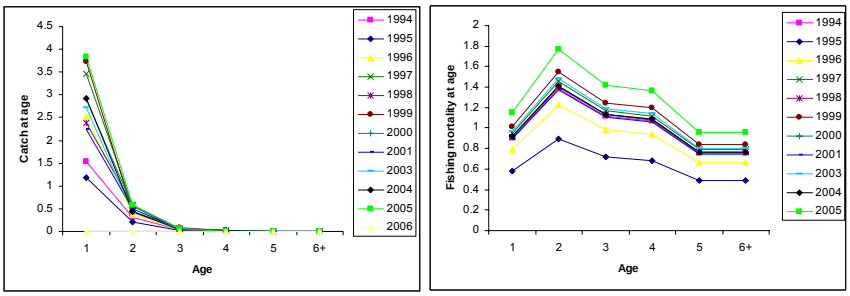


Fig. 7.15.4.1.3.3 Catch at age and fishing mortality at age of hake (females) in GSA 22, 23.

Most of hake was caught in the 1st age class when the fish were generally small and immature (Fig. 7.15.4.1.3.3).

7.15.5. Short term prediction for 2008 and 2009

7.15.5.1. Justification

No forecast analyses were conducted.

7.15.5.2. Input parameters

No forecast analyses were conducted.

7.15.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for hake in GSAs 22 and 23.

7.15.6. Medium term prediction Method 1: ALADYM

7.15.6.1. Justification

ALADYM is a simulation model, belonging to the group of dynamic pool models. The model simulates population dynamics of a single species following the simultaneous evolution of several cohorts at monthly intervals and accounting for sex differences in growth, maturity and mortality. It is a non-equilibrium approach capable of working also in the absence of fishery-dependent information in order to explore alternative management strategies and predict their consequences in the medium and long term. A summary of requirements, strengths, weaknesses, outputs, and several examples are provided in SGMED-08-01 and SGMED-08-02 reports.

7.15.6.2. Input parameters

The data needed for ALADYM are growth parameters, length-weight relationships, an initial estimate of total mortality, natural mortality, recruitment and spawning season and peak, stock recruitment relationship or a recruitment vector, selectivity parameters of the gears used by the fleet, and a fishing activity coefficient by month.

The following input parameters were used:

	Females	Males	Comments
Linf	1007	728	French growth data
k	0.25	0.3	
to	min: -0.47 max: -0.34	min: -0.47 max: -0.34	
Lifespan	12	10	
a (W-L)	0.000002377	0.000003489	
b (W-L)	3.196	3.122	
M	Chen-Watanabe equation		
vector of offspring/month	.18 .19 .12 .05 .07 .09 .03 .03 .03 .03 .04 .15		based on GSI temporal variation
sex ratio	0.5		
gear selectivity	L50 = 123 mm L75 - L25 = 49 mm		selectivity experiment

Quarterly fishing coefficients (based on official catch data)				
year	**1st**	**2nd**	**3rd**	**4th**
2003	1.01	1.14	0.69	1.15
2004	0.83	0.90	0.79	1.48
2005	1.05	1.08	0.62	1.25
2006	1.08	0.97	0.65	1.30
average	0.99	1.02	0.69	1.30

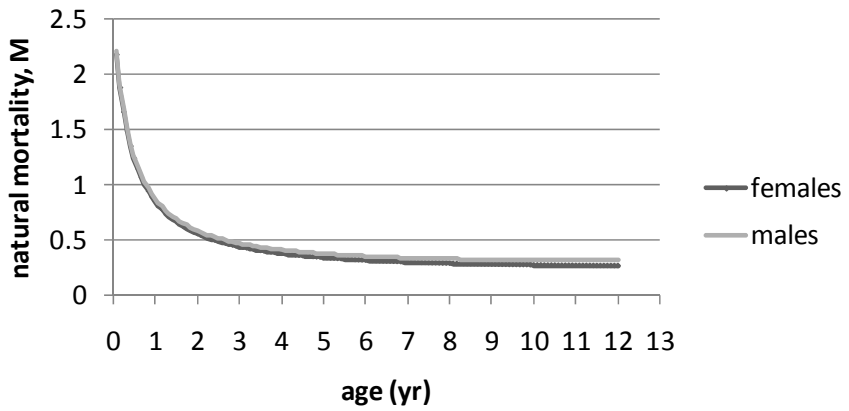


Fig. 7.15.6.2.1 Assumed natural mortality, based on the Chen-Watanabe equation

A constant recruitment was assumed, independent of stock size, i.e. the stock-recruitment relationship was assumed to be a horizontal line.

Simulations were based on 5 scenarios. In the 'present status' scenario all parameters were kept constant at current levels. In the other scenarios, a management action has been put forward, starting from year 2007. The quarterly fishing coefficients were taken as the average of the coefficients for the years 2003 to 2006. In the '20% pressure reduction scenario' it was assumed that fishing pressure was reduced by 20% (the fishing coefficients were reduced by 20%). In the 'increased mesh size' scenario, the selectivity pattern of the fishing gears was changed assuming an increase of Lc_{50} to a value of 200 mm, which is the minimum legal size of hake landings according to current legislation. In the 'summer closure' scenario, the fishery was completely closed during the 3rd quarter (July to September). In the 'all measures' scenario, all the above measures were implemented simultaneously.

7.15.6.3. Results

The results of the Aladym model in terms of change/impact of main model-based indicators and reference points (biomass, yield, ESSB/USSB, Zfemale, mean age of the spawning stock) in the long-term are synthesised at annual time scale and reported in the following figures.

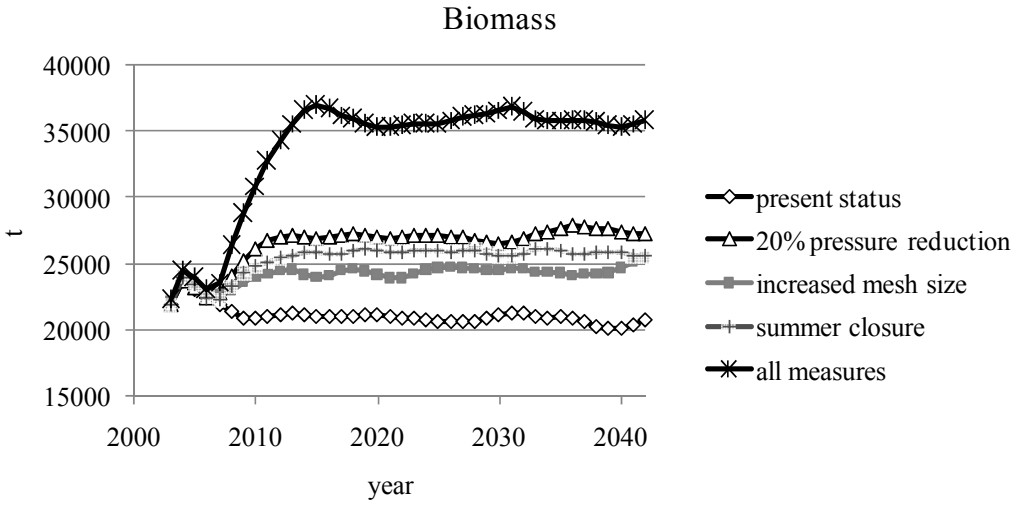


Fig. 7.15.6.3.1 Simulated time series of biomass by ALADYM, based on 5 scenarios

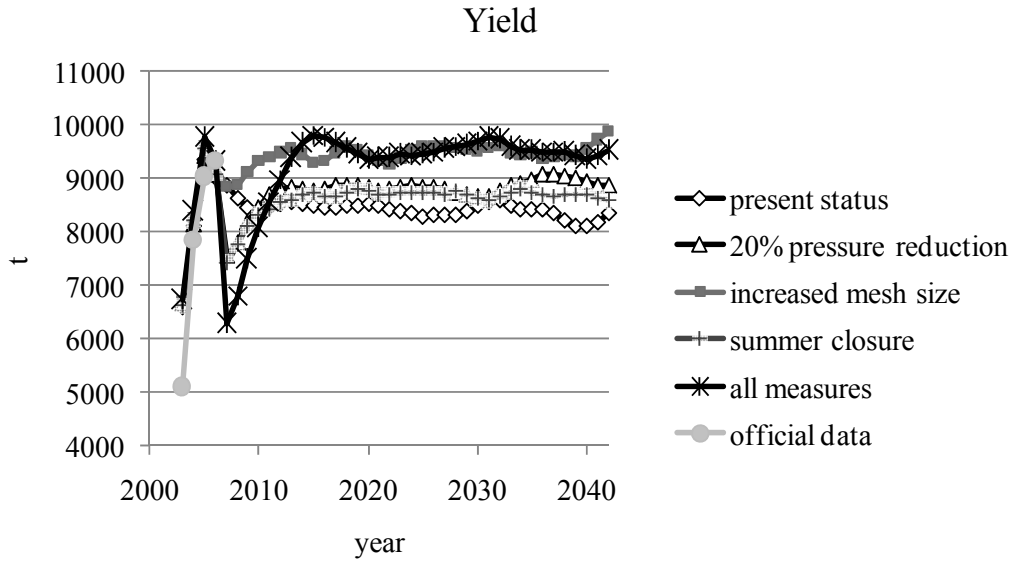


Fig. 7.15.6.3.2 Simulated time series of yield by ALADYM, based on 5 scenarios

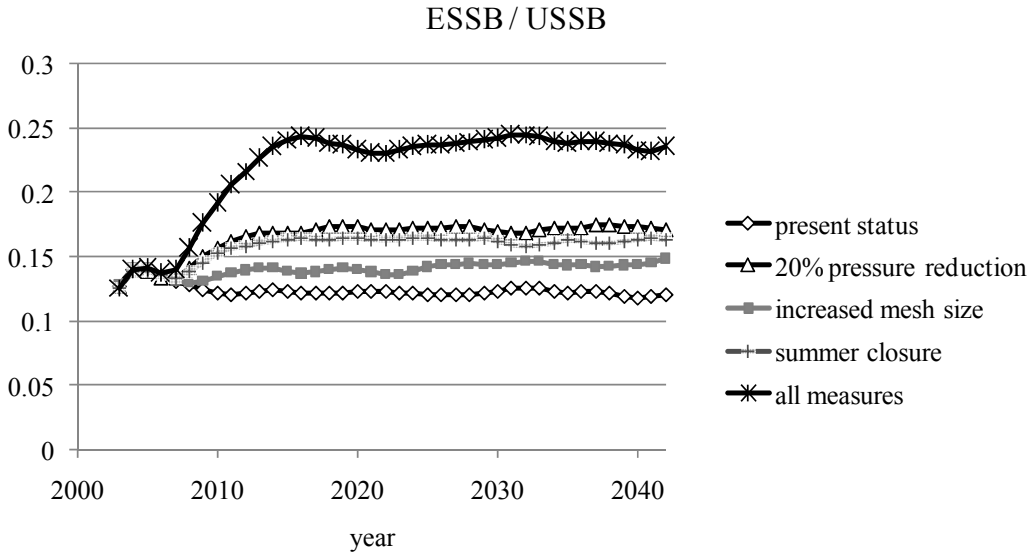


Fig. 7.15.6.3.3 Simulated time series of the ratio of exploited spawning stock biomass to unexploited spawning stock biomass by ALADYM, based on 5 scenarios

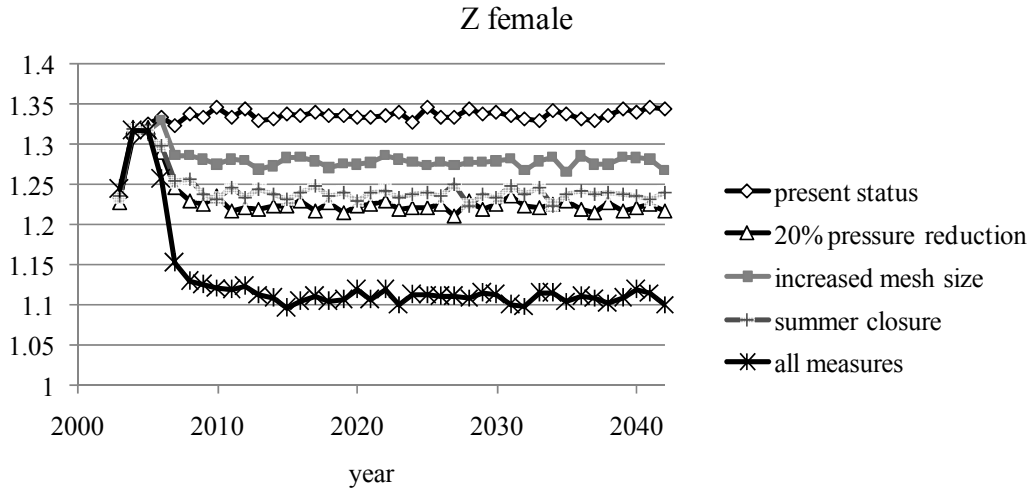


Fig. 7.15.6.3.4 Simulated time series of female mortality by ALADYM, based on 5 scenarios

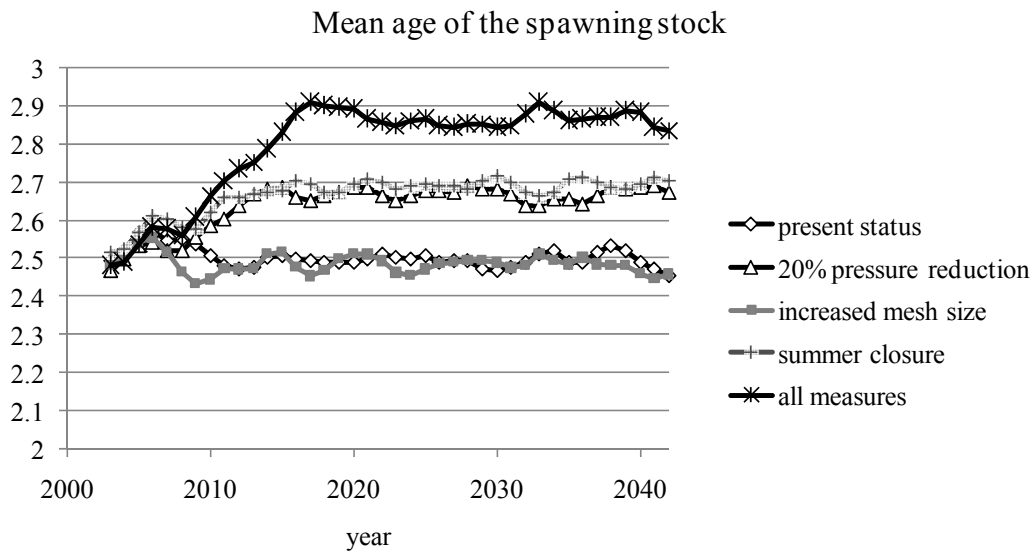


Fig. 7.15.6.3.5 Simulated time series of the mean age of the spawning stock by ALADYM, based on 5 scenarios

Results highlighted that the current situation of hake stock exploitation would substantially be improved under some of the management scenarios tested. The three basic scenarios ('20 % pressure reduction', 'increased mesh size, 'summer closure') are compared hereafter. Biomass of the hake stock would increase with any of the three management measures; the highest increase would occur after a decision for a 20% pressure reduction in the hake fishery and the lowest increase after a decision for a mesh size increase. The 'all measures scenario' would cause an increase of the stock biomass by more than 70% in the long term. Total mortality of the females would decrease under all scenarios; the highest decrease would occur with a 20% pressure reduction in the hake fishery and the lowest decrease by increasing mesh size. Mean age of the spawning stock would not be substantially affected by increasing mesh size but would increase with all the other measures. Yield would decrease in the short term with all management scenarios in relation to the present status and this decrease would be quite pronounced with the 'all measures' scenario. In the long term, yield would increase with all four management scenarios with a more pronounce increase with the 'increased mesh size' scenario. The sustainability reference point ESSB/USSB would substantially rise in the long-term under all management scenarios.

7.15.7. Long term prediction

7.15.7.1. Justification

No forecast analyses were conducted.

7.15.7.2. Input parameters

No forecast analyses were conducted.

7.15.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for hake in GSAs 22 and 23.

7.15.8. Scientific advice

Based on MEDITS data, yield and recruits appeared stable, while spawning stock biomass had a decreasing trend. Based on the official DCR data, landings had an overall increasing trend. Simulations in ALADYM showed that with a decrease of effort or an increase in mesh size, the stock would improve and yield would decrease in the short term but substantially increase in the long term. Based on the data available and on the conducted analyses, the stock of hake in GSAs 22 and 23 appears overexploited and management measures such as reduction of fishing effort or an increase in mesh size are recommended.

However, in the absence of length and/or age distribution data, these results should be considered as preliminary (based on assumptions that need verification) and insufficient to form the basis for establishing long-term management plans. Such data should be made available in order to conduct more reliable stock assessment.

7.15.8.1. Short term considerations

7.15.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.15.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.15.8.1.3. State of exploitation

SGMED-08-03 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.

7.15.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.16. Stock assessment of red mullet in GSA 01

7.16.1. Stock identification and biological features

7.16.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.16.1.2. Growth

No information was documented during SGMED-08-03.

7.16.1.3. Maturity

No information was documented during SGMED-08-03.

7.16.2. Fisheries

7.16.2.1. 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 1 there are 142 trawlers that land over 150 t by year.

7.16.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.16.2.3. Catches

7.16.2.3.1. Landings

Landings data were reported to SGMED-08-03 through the Data collection regulation and are listed in Table A3.1 of Appendix 3. Only landings by otter trawlers are considered, which increased from 68 t in 2002 to 138 t in 2007.

Table 7.16.2.3.1.1 Annual landings (t) by fishing technique as reported to SGMED-08-03 through the DCR data call.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	1	ESP	OTB	68	81	109	94	109	138

7.16.2.3.2. Discards

No information was documented during SGMED-08-03.

7.16.2.3.3. Fishing effort

No information was documented during SGMED-08-03.

7.16.3. Scientific surveys

7.16.3.1. Medits

7.16.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 01 the following number of hauls were reported per depth stratum (s. Tab. 7.16.3.1.1.1).

Tab. 7.6.3.1.1.1. Number of hauls per year and depth stratum in GSA 01, 1994-2007.

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

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

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

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

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

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

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± 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.

7.16.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.16.3.1.3. 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 7.16.3.1.3.1 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.

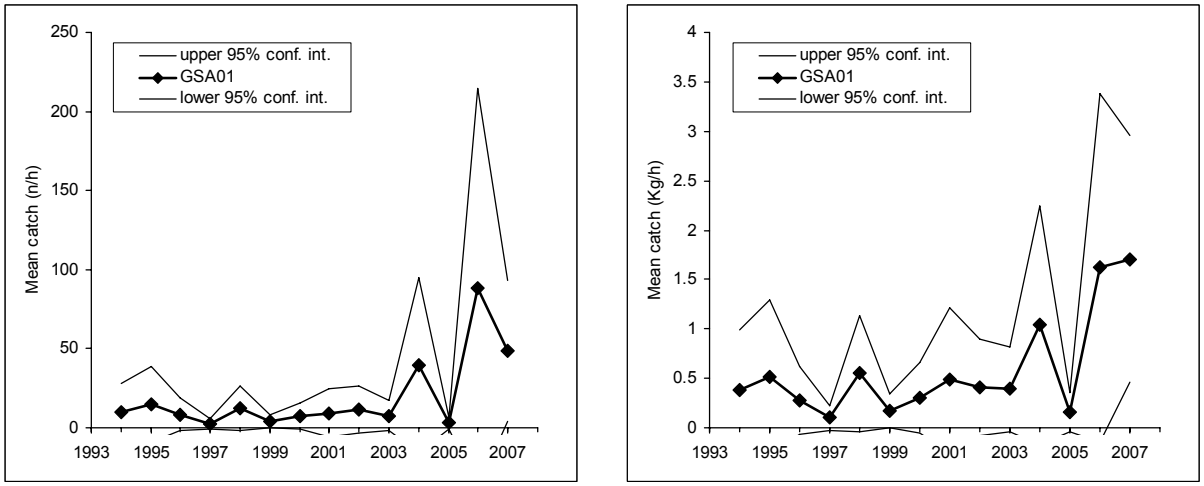


Fig. 7.16.3.1.3.1 Abundance and biomass indices of red mullet in GSA 01.

7.16.3.1.4. Trends in abundance by length or age

The following Fig. 7.6.3.1.4.1 and 2 display the stratified abundance indices of GSA 01 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

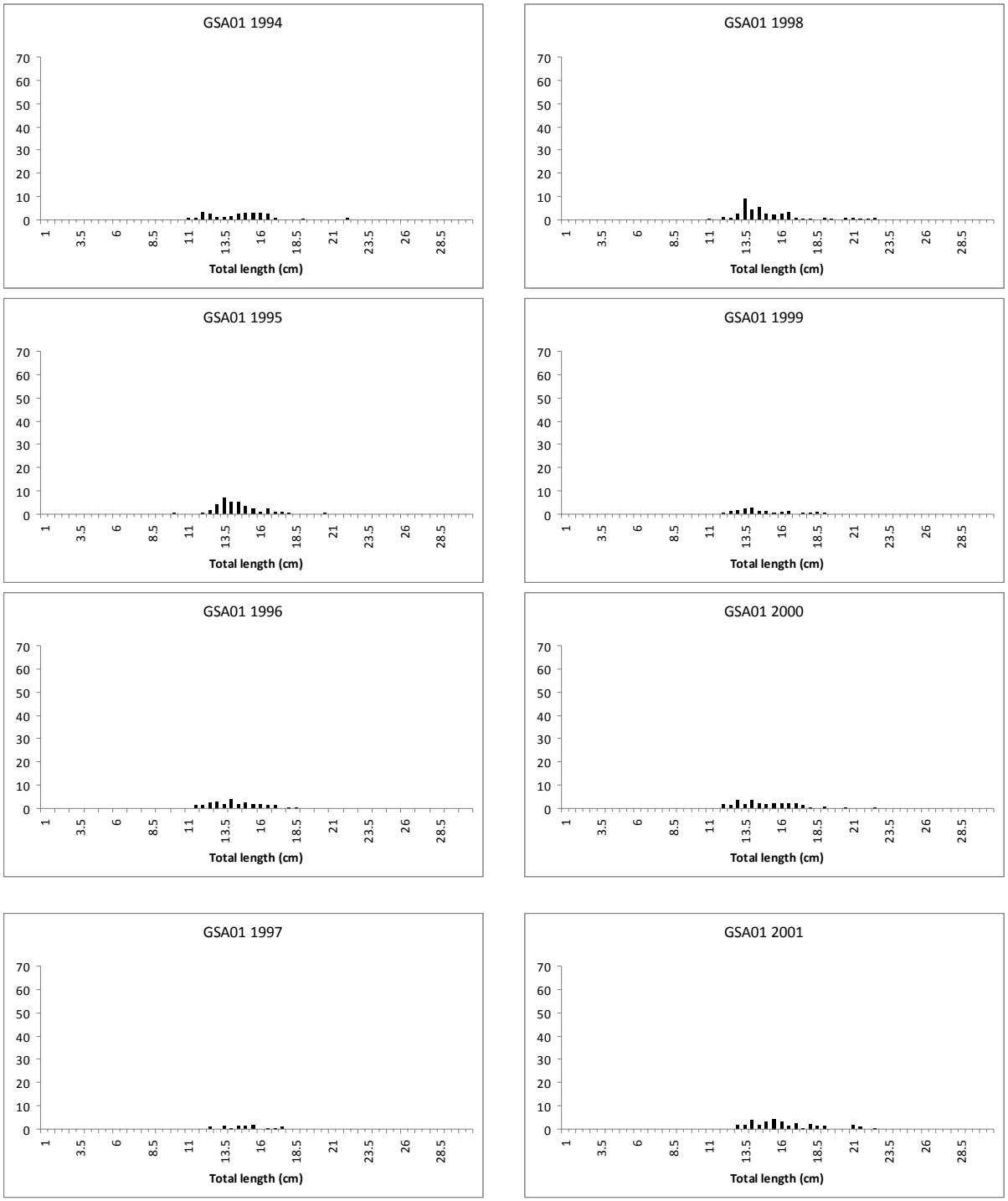


Fig. 7.16.3.1.4.1 Stratified abundance indices by size, 1994-2001.

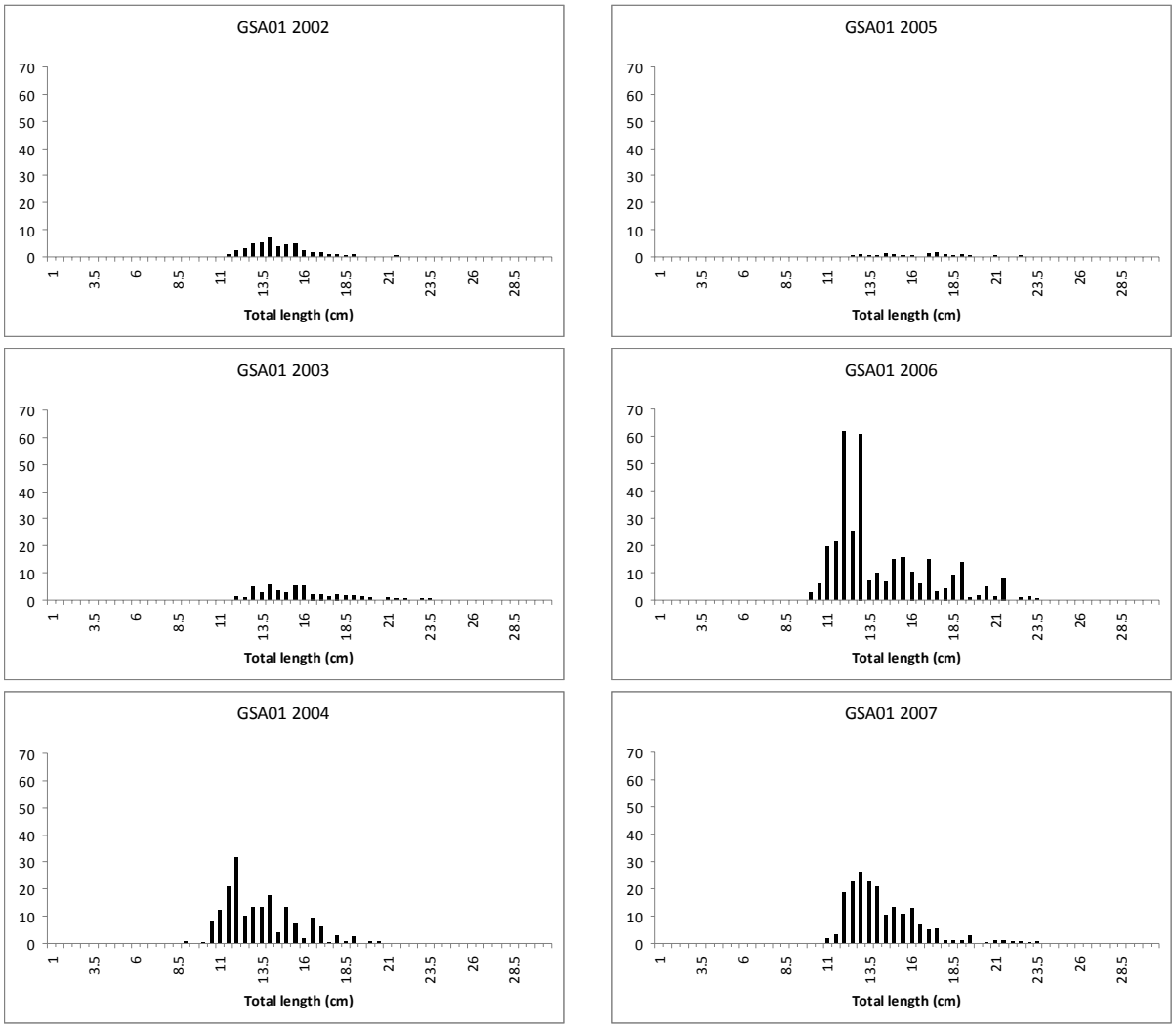


Fig. 7.16.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.16.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.16.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.16.4. Assessment of historic stock parameters

7.16.4.1. Method 1: VIT

7.16.4.1.1. Justification

The last assessment of this stock was presented in 2004 to the GFCM by Quetglas et al. It was performed a pseudocohort analysis using a single year (2003). Both a VPA and a yield per recruit (Y/R) analysis were

carried out using the VIT software (Lleonart and Salat 1992). The result of this assessment was that *Mullus barbatus* in GSA01 was overexploited. This does not agree with the results of the present assessment, but it must be taken into account that the size distributions used in both cases are very different. In Quetglas et al (2004) the modal size was 10 cm, while in the new data set this modal size increased up to 14-15 cm.

Since there are not data on length-frequency distributions for *M. barbatus* in GSA01 before 2005, this assessment using pseudocohort analysis may be considered as near definitive. Although the main work is done (pseudocohort and Y/R analyses), other procedures such as sensitivity analyses should be carried out.

Since only three years of data were available (2005–2007), a pseudocohort analysis was carried out. This pseudocohort is the mean number of individuals by age and mean catch from 2005–2007. Furthermore, a yield per recruit (Y/R) analysis was also performed. For both analyses, the VIT software (Lleonart and Salat 1992) was used.

7.16.4.1.2. Input parameters

The length frequency distributions used showed the same size range throughout the three years and seems appropriate for pseudocohort analysis, which assumes steady state.

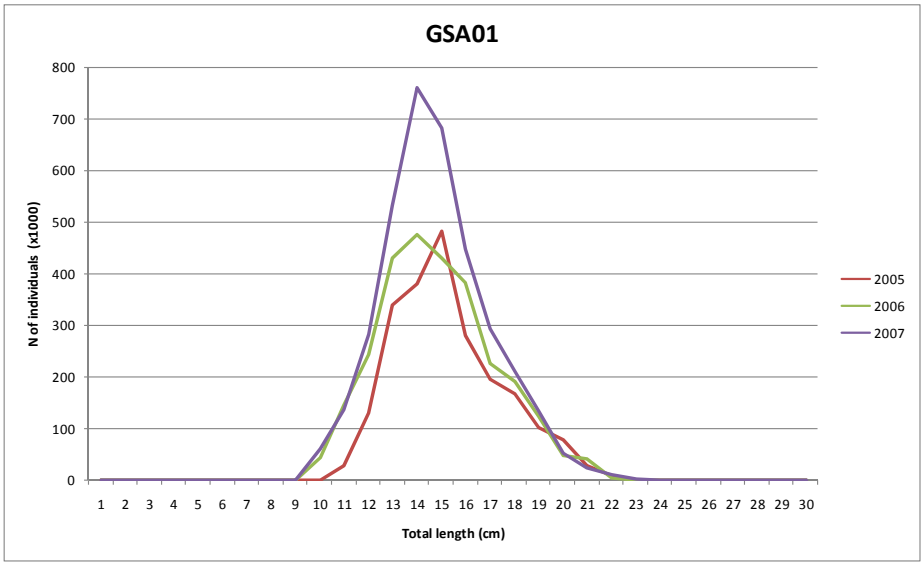


Fig. 7.16.4.1.2.1 Total landings at length showing an increasing trend from 2005 to 2007.

The biological parameters used were the following:

One of the sets of growth parameters accorded during the present meeting was used: Linf=26.0, K=0.41, t_0=-0.40.

Length-weight relationships: a=0.0062, b=3.1597; these data come from the Spanish National Data Collection.

Natural mortality by age was calculated using the PROBIOM spreadsheet (Abella et al. 1997), obtaining the following vector:

Age	0	1	2	3	4	5	Mean
M	0.8	0.5	0.3	0.3	0.3	0.2	0.4

Since the data series is too short (3 years) to calculate the terminal fishing mortality (F_t) from the catch curve, the same as the obtained in GSA06 was considered (F_t=1.42) because both areas have a similar exploitation pattern.

The maturity ogive used were obtained from the Spanish National Data Collection in GSA01.

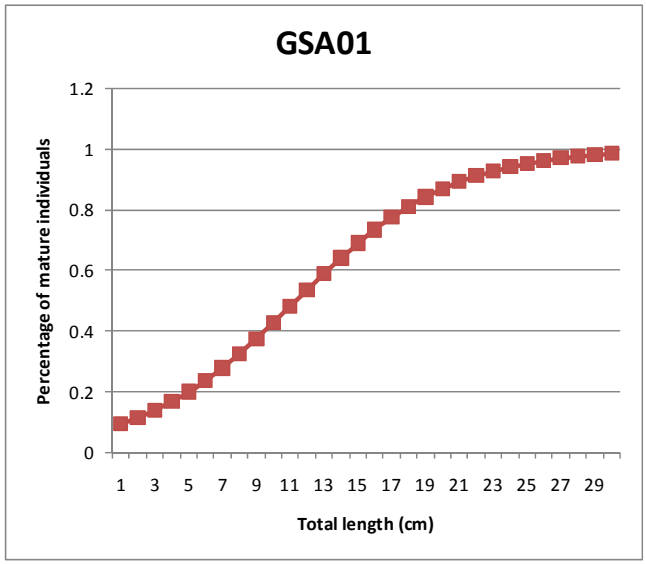


Fig. 7.16.4.1.2.2 Maturity ogive used were obtained from the Spanish National Data Collection in GSA01.

7.16.4.1.3. Results

The following Table 7.16.4.1.3.1 shows the summary results from the pseudocohort analysis. These results show that the actual level of exploitation is moderate and may be sustainable whenever the fishing effort is not increased. Both mean age and mean length are clearly higher in the catch (1.7 yr and 14.8 cm) than in the current stock (0.8 yr and 9.5 cm). Furthermore, the current stock biomass represents 21% of the virgin stock biomass. The figure below shows the vector of fishing mortality by age resulting from the pseudocohort analysis.

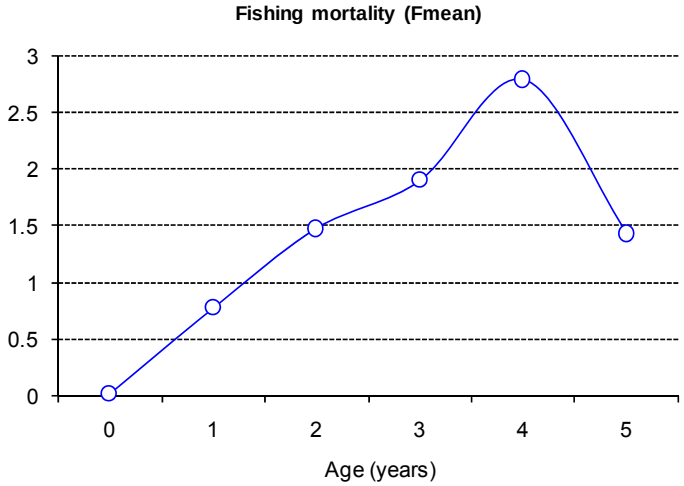


Table 7.16.4.1.3.1 Estimated exploitation pattern over age as derived from the VIT model.

Table 7.16.4.1.3.1 Summary results of stock parameters derived from the VIT model.

---	Total
Catch mean age	1.73
Catch mean length	14.75
Mean F	1.39
Global F	0.29
Total catch (tons)	113.61
Catch/D%	57.69
Catch/B%	80.28
Current Stock Mean Age	0.791
Current Stock Critical Age	1
Virgin Stock Critical Age	4
Current Stock Mean Length	9.51
Current Stock Critical Length	11.36
Virgin Stock Critical Length	21.72
Number of recruits, R ($x10^3$)	11626.97
Mean Biomass, B_{mean} (tons)	141.51
Spawning Stock Biomass, SSB (tons)	86.17
Biomass Balance, D (tons)	196.92
Natural death/D	42.31
B_{max}/B_{mean}	48.93
Turnover, D/B_{mean}	139.16
B_{now}/B_{virgin} (%)	20.7

7.16.5. Short term prediction for 2008 and 2009

7.16.5.1. Justification

No forecast analyses were conducted.

7.16.5.2. Input parameters

No forecast analyses were conducted.

7.16.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSA 01.

7.16.6. Medium term prediction

7.16.6.1. Justification

No forecast analyses were conducted.

7.16.6.2. Input parameters

No forecast analyses were conducted.

7.16.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSA 01.

7.16.7. Long term prediction

7.16.7.1. Justification

A Y/R analysis was conducted.

It was also simulated the evolution of the Y/R in the next ten years in case that the effort were reduced by 20%, i.e. reduction from 5 to 4 working days per week.

7.16.7.2. Input parameters

No input data were presented to SGMED-08-03.

7.16.7.3. Results

In the following Table 7.16.7.3.1 lists the results from the Y/R analysis, whereas in the Fig. 7.16.7.3.1 below shows the evolution of Y/R when the actual level of exploitation (factor=1) is doubled (factor=2). The figure indicates signs of overexploitation but it must be taken into account the minimal difference existing between the maximum Y/R (10.6 g) and the current Y/R (9.8 g). Owing to this, the status of this stock would be defined as fully exploited.

Tab. 7.16.7.3.1 Results of the Y/R analysis.

Phi	Factor	Y/R	B/R	SSB
Absence of fishing	0	0	58.85	51.11
$F_{0.1}$	0.26	9.99	28.63	22.24
Y/R_{max}	0.46	10.62	20.63	14.84
Current	1.01	9.77	12.17	7.41
Max factor	2	8.59	7.83	3.99

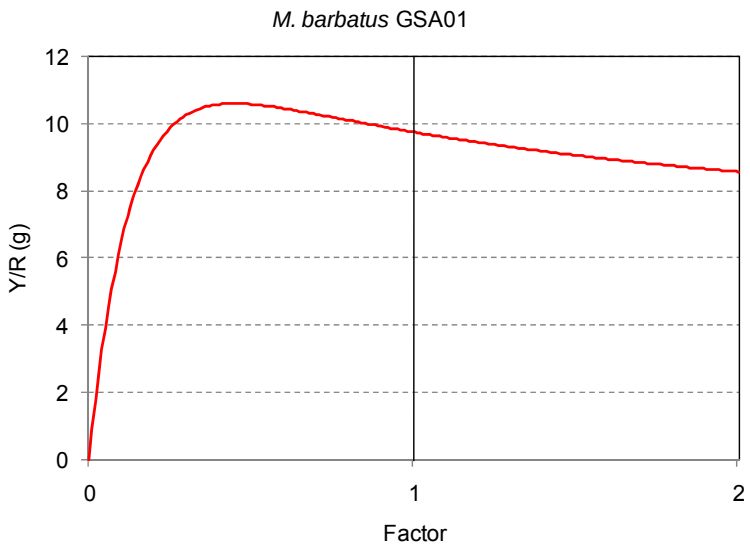
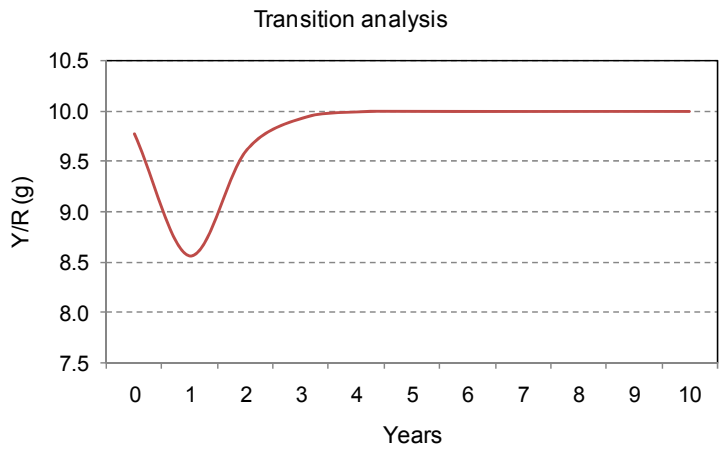


Fig. 7.16.7.3.1 Results of the Y/R analysis.

The analysis of a 20 percent reduction in effort showed a decrease in the first year and a recovery afterwards, but the Y/R maintains constant near the 10 g per recruit during the following years. However, the improvement in Y/R is very low, since it goes from about 9.7 g in the actual fishing level to 10.0 g when the measure in practice obtained their best results.



7.16.8. Scientific advice

7.16.8.1. Short term considerations

7.16.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.16.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.16.8.1.3. State of exploitation

SGMED-08-03 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.

7.16.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.17. Stock assessment of red mullet in GSA 06

7.17.1. Stock identification and biological features

7.17.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.17.1.2. Growth

No information was documented during SGMED-08-03.

7.17.1.3. Maturity

No information was documented during SGMED-08-03.

7.17.2. Fisheries

7.17.2.1. 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 6 (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.

7.17.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.17.2.3. Catches

7.17.2.3.1. Landings

Tab. 7.17.2.3.1.1 lists the trend in reported landings taken by trawlers (Spain only). The data were reported to SGMED-08-03 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. 7.17.2.3.1.1 Annual landings (t) by fishing technique (otter trawlers only) in GSA 06.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	6	ESP	OTB	1159	1004	958	1027	1437	1232

7.17.2.3.2. Discards

No information was documented during SGMED-08-03.

7.17.2.3.3. Fishing effort

No information was documented during SGMED-08-03.

7.17.3. Scientific surveys

7.17.3.1. Medits

7.17.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 06 the following number of hauls were reported per depth stratum (s. Tab. 7.17.3.1.1.1).

Tab. 7.17.3.1.1.1. Number of hauls per year and depth stratum in GSA 06, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA06_010-050	7	8	7	7	7	8	9	8	11	9	9	11	11	6
GSA06_050-100	19	26	26	26	28	29	29	31	36	38	31	32	34	27
GSA06_100-200	11	17	17	15	13	17	18	20	20	21	17	18	19	15
GSA06_200-500	10	12	10	12	7	13	12	16	17	18	16	15	18	11
GSA06_500-800	6	8	9	7	4	9	6	8	7	11	11	8	10	8

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.

7.17.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.17.3.1.3. 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 7.17.3.1.3.1 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.

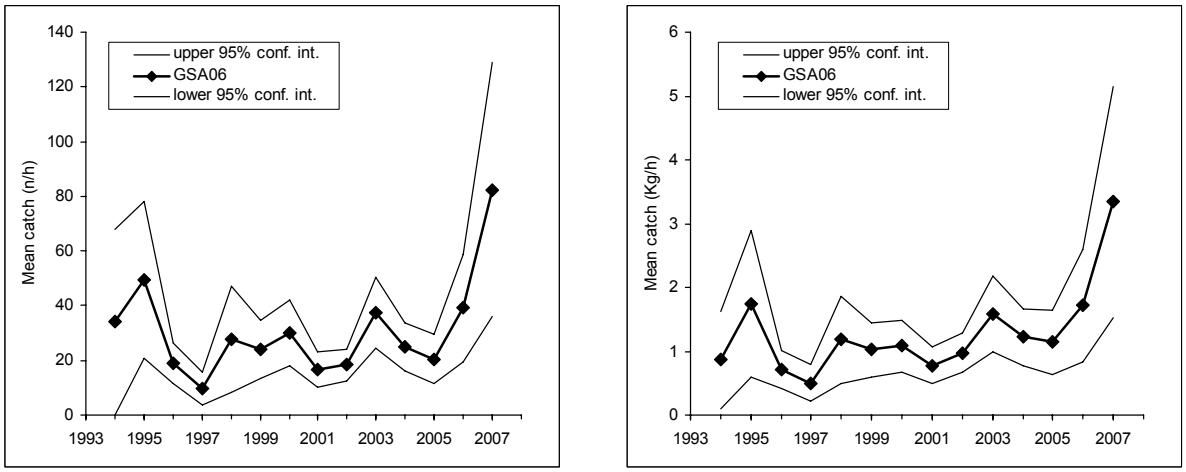


Fig. 7.6.3.1.3.1 Abundance and biomass indices of red mullet in GSA 06.

7.17.3.1.4. Trends in abundance by length or age

The following Fig. 7.17.3.1.4.1 and 2 display the stratified abundance indices of GSA 06 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

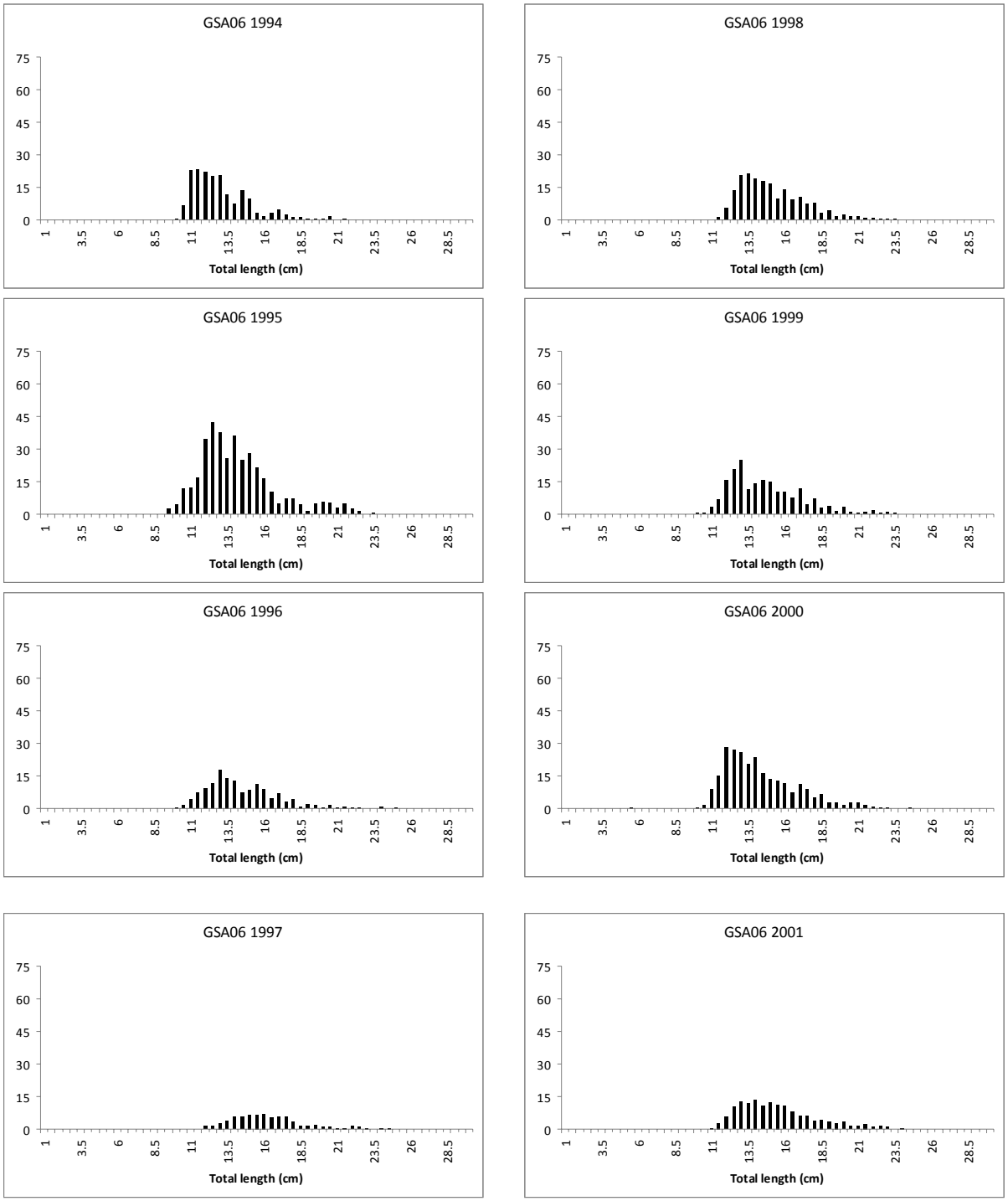


Fig. 7.17.3.1.4.1 Stratified abundance indices by size, 1994-2001.

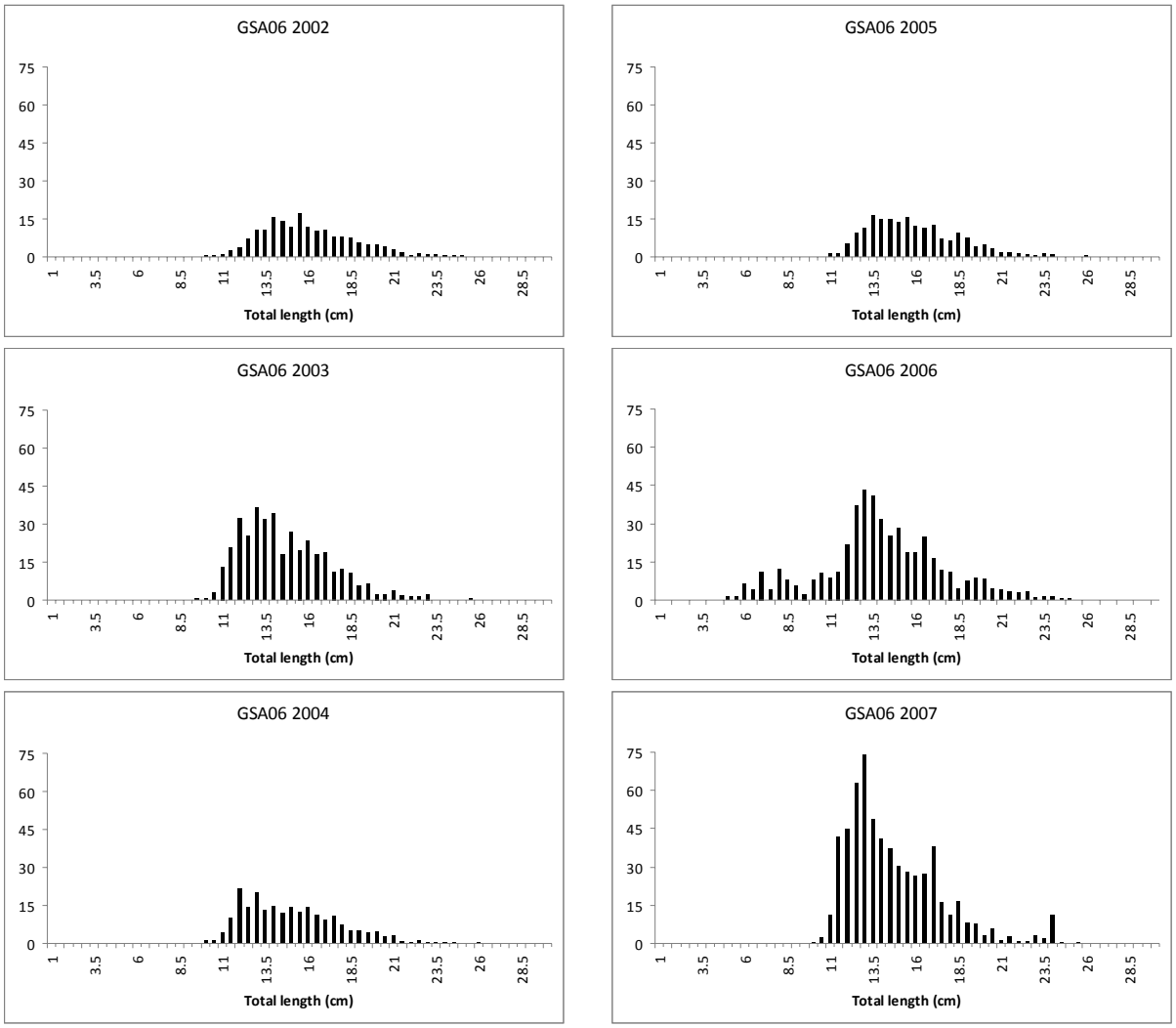


Fig. 7.17.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.17.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.17.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.17.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.17.5. Short term prediction for 2008 and 2009

7.17.5.1. Justification

No forecast analyses were conducted.

7.17.5.2. Input parameters

No forecast analyses were conducted.

7.17.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSA 06.

7.17.6. Medium term prediction

7.17.6.1. Justification

No forecast analyses were conducted.

7.17.6.2. Input parameters

No forecast analyses were conducted.

7.17.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSA 06.

7.17.7. Long term prediction

7.17.7.1. Justification

No forecast analyses were conducted.

7.17.7.2. Input parameters

No forecast analyses were conducted.

7.17.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 06.

7.17.8. Scientific advice

7.17.8.1. Short term considerations

7.17.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.17.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.17.8.1.3. State of exploitation

SGMED-08-03 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.

7.17.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.18. Stock assessment of red mullet in GSA 07

7.18.1. Stock identification and biological features

7.18.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.18.1.2. Growth

No information was documented during SGMED-08-03.

7.18.1.3. Maturity

No information was documented during SGMED-08-03.

7.18.2. Fisheries

7.18.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.18.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.18.2.3. Catches

7.18.2.3.1. Landings

Tab. 7.18.2.3.1.1 lists the trend in reported landings taken by trawlers (France only). The data were reported to SGMED-08-03 through the Data Collection Regulation and are listed in Table A3.2 of Appendix 3. Since 2006 the annual landings varied between 170 and 180 t.

Tab. 7.18.2.3.1.1 Annual landings (t) by fishing technique (otter trawlers only) in GSA 07.

No information was documented during SGMED-08-03.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	7	FRA	OTB					183	172

7.18.2.3.2. Discards

8 t of discards were reported to SGMED-08-03 and are listed in Table A.3.4 of Appendix 3.

7.18.2.3.3. Fishing effort

Tab. 7.18.2.3.2.1 lists the trends in fishing effort by fishing technique deployed in GSA 07, 2004 to 2006 (Tab. A3.5 IN Appendix 3). The data were reported to SGMED-08-03 trough the DCR data call.

Tab. 7.18.2.3.2.1 Trends in fishing effort by fishing technique deployed in GSA 07, 2004 to 2006.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	7	FRA	GNS			81460	76785	93193	
DAYS	7	FRA	LLS			6459	6593	5028	
DAYS	7	FRA	OTB			20561	19327	17991	
GT*DAYS	7	FRA	GNS			329230	305685	315704	
GT*DAYS	7	FRA	LLS			23742	23436	17232	
GT*DAYS	7	FRA	OTB			1610963	1480834	1322919	
KW*DAYS	7	FRA	GNS			7007171	5908142	88698170	
KW*DAYS	7	FRA	LLS			669338	716765	385004	
KW*DAYS	7	FRA	OTB			6361248	5923541	6127438	

7.18.3. Scientific surveys

7.18.3.1. Medits

7.18.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 07 the following number of hauls were reported per depth stratum (s. Tab. 7.18.3.1.1.1).

Tab. 7.18.3.1.1.1. Number of hauls per year and depth stratum in GSA 07, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA07_010-050	12	12	12	14	12	12	12	12	12	13	12	12	12	14
GSA07_050-100	32	32	32	35	39	32	32	32	31	38	31	30	33	31
GSA07_100-200	10	9	9	9	9	9	10	9	9	10	13	11	10	10
GSA07_200-500	6	6	5	5	5	5	5	6	4	5	5	5	5	5
GSA07_500-800	8	7	4	5	4	4	6	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.

7.18.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.18.3.1.3. 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 7.18.3.1.3.1 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.

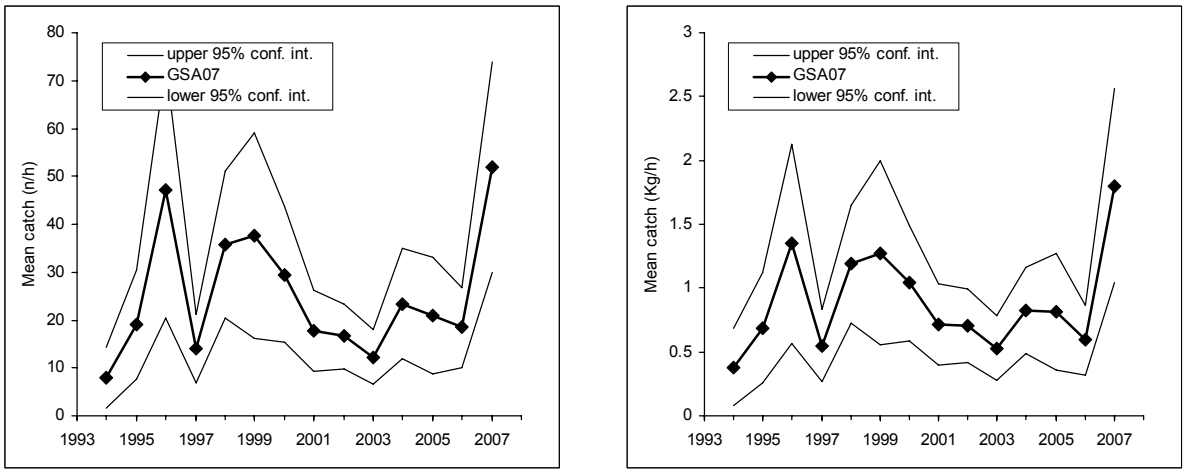


Fig. 7.6.3.1.3.1 Abundance and biomass indices of red mullet in GSA 07.

7.18.3.1.4. Trends in abundance by length or age

The following Fig. 7.18.3.1.4.1 and 2 display the stratified abundance indices of GSA 07 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

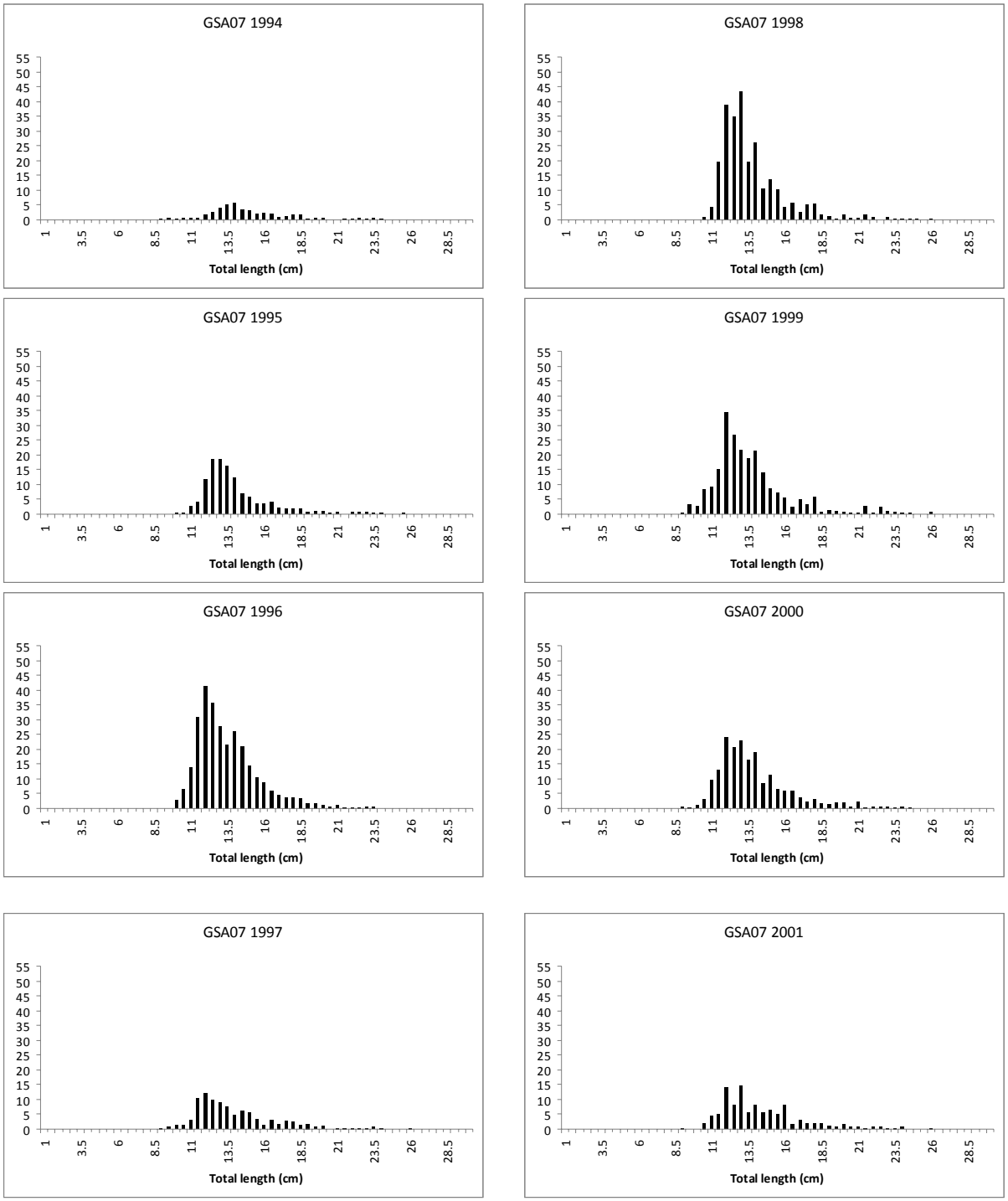


Fig. 7.18.3.1.4.1 Stratified abundance indices by size, 1994-2001.

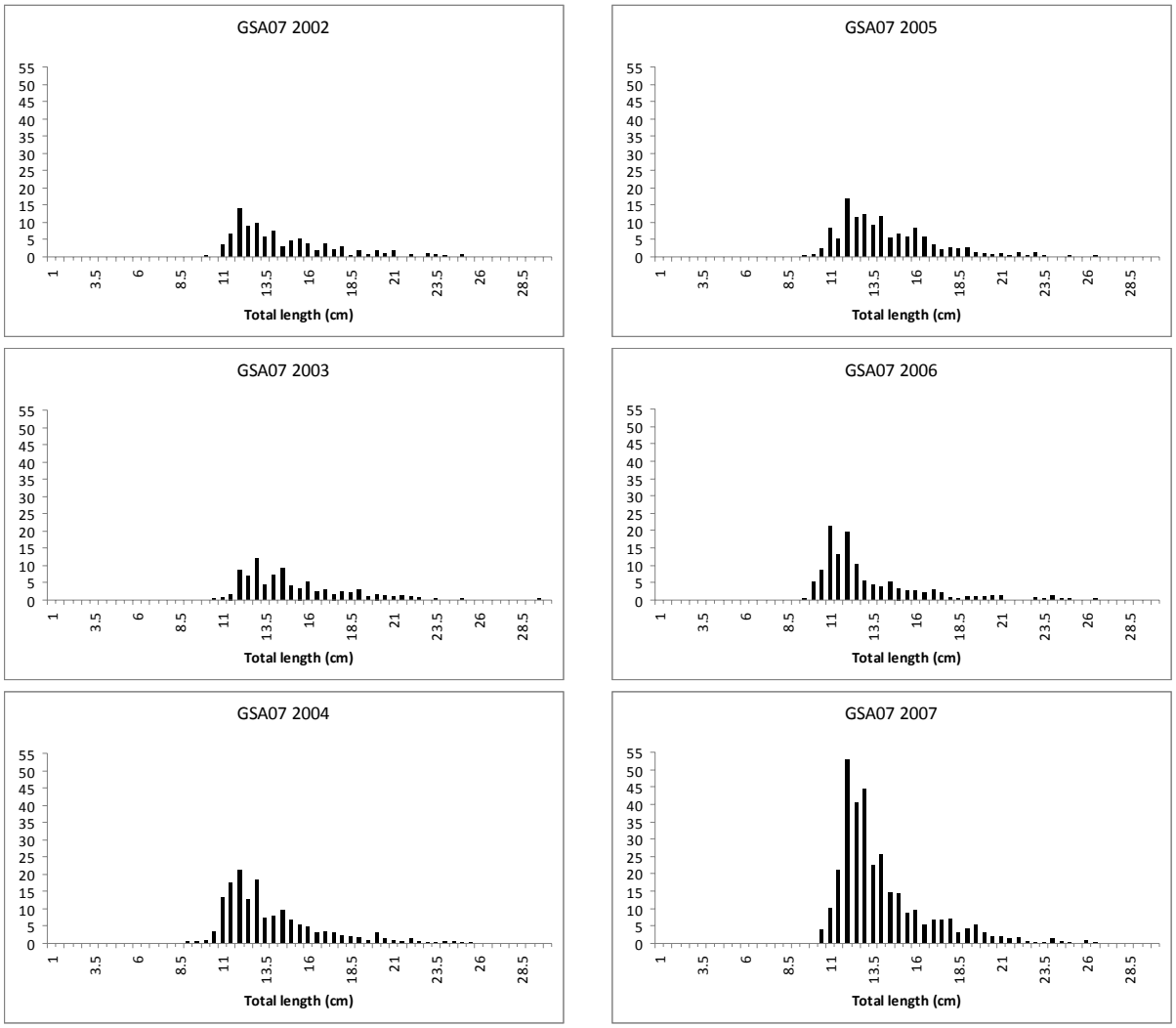


Fig. 7.18.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.18.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.18.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.18.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.18.5. Short term prediction for 2008 and 2009

7.18.5.1. Justification

No forecast analyses were conducted.

7.18.5.2. Input parameters

No forecast analyses were conducted.

7.18.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSA 07.

7.18.6. Medium term prediction

7.18.6.1. Justification

No forecast analyses were conducted.

7.18.6.2. Input parameters

No forecast analyses were conducted.

7.18.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSA 07.

7.18.7. Long term prediction

7.18.7.1. Justification

No forecast analyses were conducted.

7.18.7.2. Input parameters

No forecast analyses were conducted.

7.18.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 07.

7.18.8. Scientific advice

7.18.8.1. Short term considerations

7.18.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.18.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.18.8.1.3. State of exploitation

SGMED-08-03 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.

7.18.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.19. Stock assessment of red mullet in GSA 08

7.19.1. Stock identification and biological features

7.19.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.19.1.2. Growth

No information was documented during SGMED-08-03.

7.19.1.3. Maturity

No information was documented during SGMED-08-03.

7.19.2. Fisheries

7.19.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.19.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.19.2.3. Catches

7.19.2.3.1. Landings

No information was documented during SGMED-08-03.

7.19.2.3.2. Discards

No information was documented during SGMED-08-03.

7.19.2.3.3. Fishing effort

No information was documented during SGMED-08-03.

7.19.3. Scientific surveys

7.19.3.1. Medits

7.19.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

SGMED-08-03 notes that the reported Medits data in GSA 08 only cover the eastern coast of Corsica. In GSA 08 the following number of hauls were reported per depth stratum (s. Tab. 7.6.3.1.1.1).

Tab. 7.6.3.1.1.1. Number of hauls per year and depth stratum in GSA 08, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA08_010-050	3													
GSA08_050-100	6	5	8	4	8	6	5	5		6	6	8	8	5
GSA08_100-200	3	5	4	2	5	5	5	5	1	5	5	5	5	3
GSA08_200-500	9	11	12	8	12	10	11	10		10	10	10	11	8
GSA08_500-800	5	5	4	4	4	5	4	5		4	5	5	4	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.

7.19.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.19.3.1.3. 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-08-03 notes that the reported Medits data in GSA 08 only cover the eastern coast of Corsica. Figure 7.19.3.1.3.1 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.

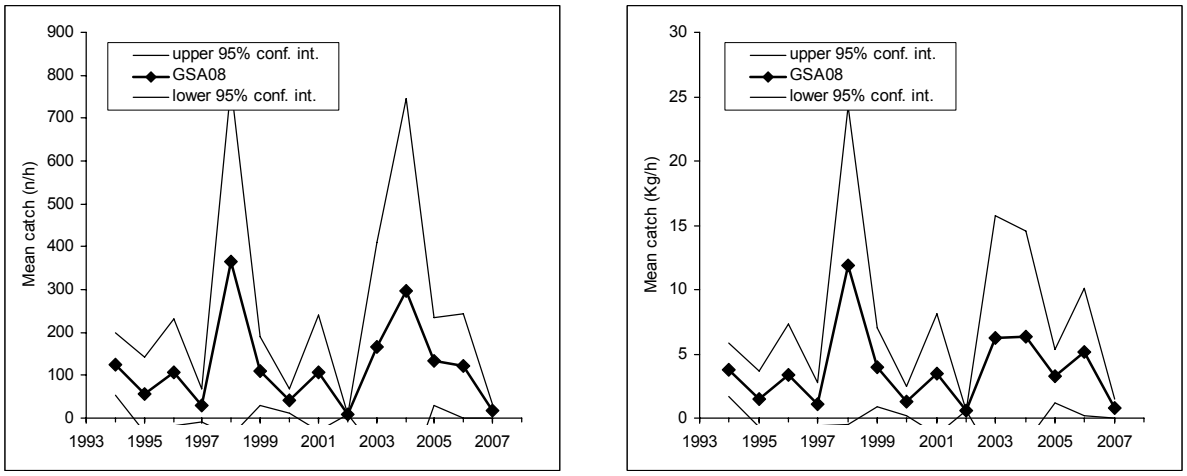


Fig. 7.19.3.1.3.1 Abundance and biomass indices of red mullet in GSA 08.

7.19.3.1.4. Trends in abundance by length or age

The following Fig. 7.19.3.1.4.1 and 2 display the stratified abundance indices of GSA 08 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

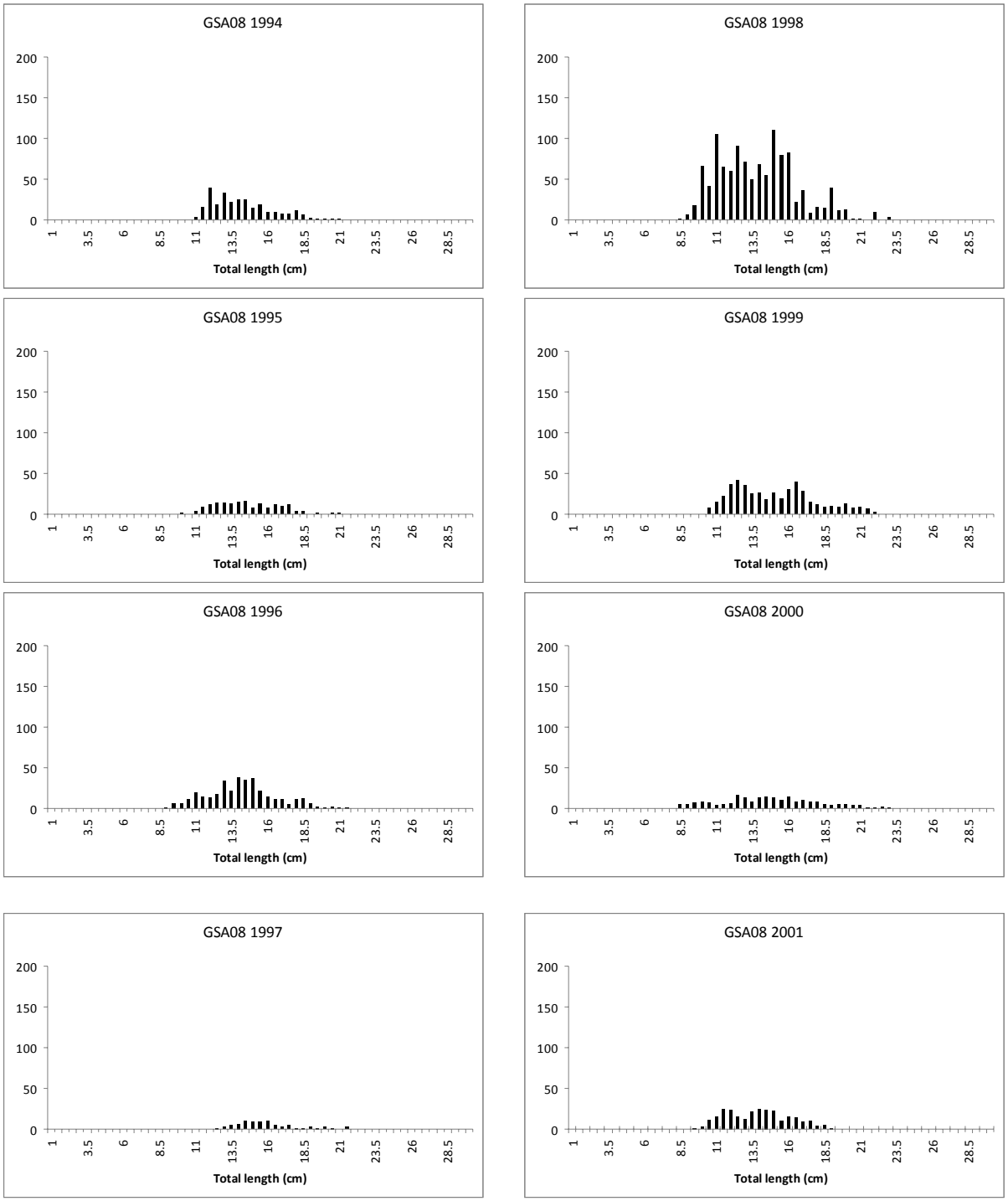


Fig. 7.19.3.1.4.1 Stratified abundance indices by size, 1994-2001.

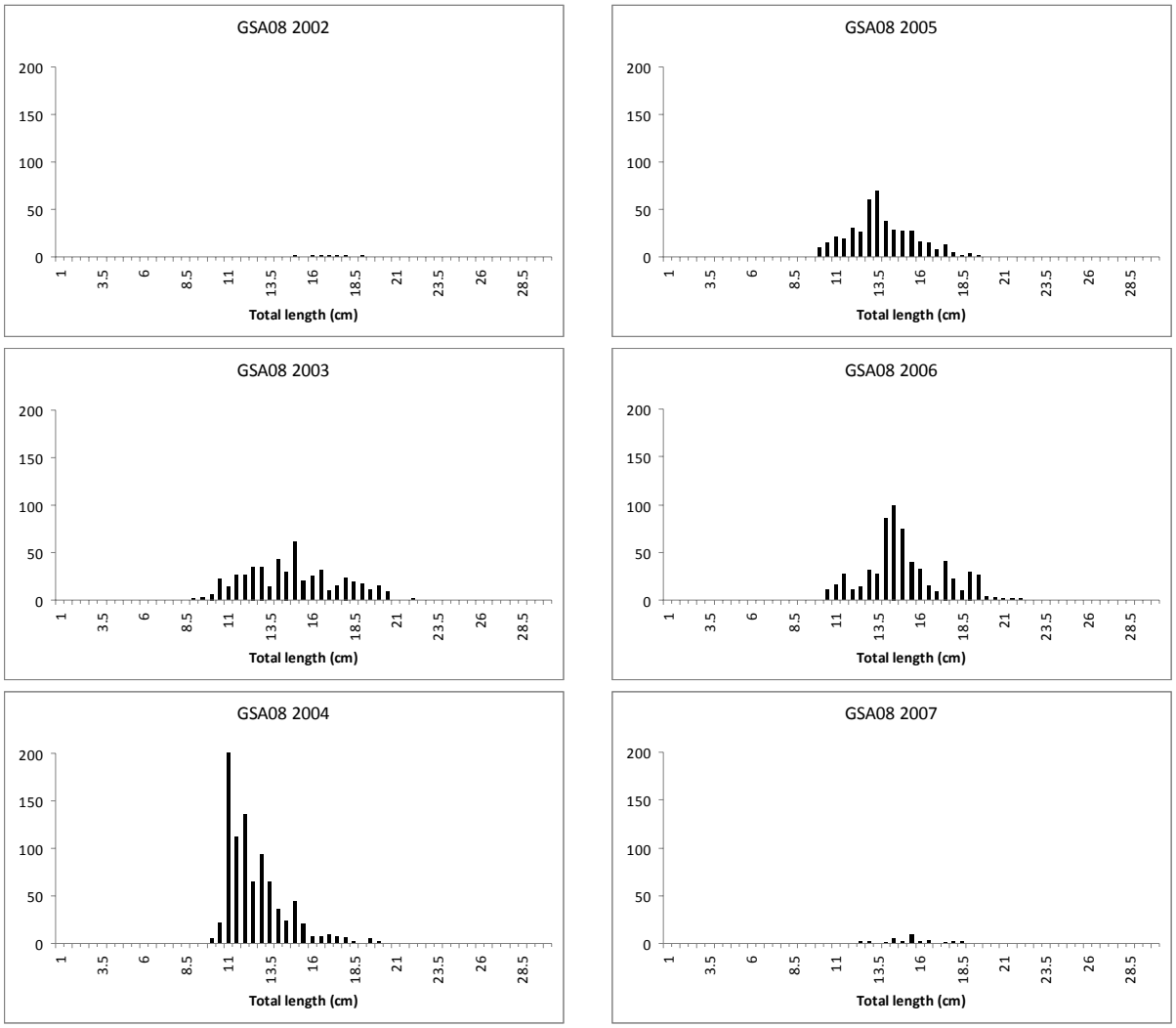


Fig. 7.19.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.19.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.19.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.19.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.19.5. Short term prediction for 2008 and 2009

7.19.5.1. Justification

No forecast analyses were conducted.

7.19.5.2. Input parameters

No forecast analyses were conducted.

7.19.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSA 08.

7.19.6. Medium term prediction

7.19.6.1. Justification

No forecast analyses were conducted.

7.19.6.2. Input parameters

No forecast analyses were conducted.

7.19.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSA 08.

7.19.7. Long term prediction

7.19.7.1. Justification

No forecast analyses were conducted.

7.19.7.2. Input parameters

No forecast analyses were conducted.

7.19.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 08.

7.19.8. Scientific advice

7.19.8.1. Short term considerations

7.19.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.19.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.19.8.1.3. State of exploitation

SGMED-08-03 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.

7.19.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.20. Stock assessment of red mullet in GSA 09

7.20.1. Stock identification and biological features

7.20.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.20.1.2. Growth

No information was documented during SGMED-08-03.

7.20.1.3. Maturity

No information was documented during SGMED-08-03.

7.20.2. Fisheries

7.20.2.1. General description of fisheries

STECF (second stock review in 2007) notes that *Mullus barbatus is* among the most commercially valuable species in the area and forms part of a species assemblage that is the target of the bottom trawling fleets that operate near shore and a specific target in some particular periods when the species is densely concentrated near the coast. It is caught mainly with three different variants of the bottom trawl net. The fishing pressure on this species varies between the different zones within sub-area 9 as the composition of the various fleets and their individual target species varies between sub-areas. *Mullus barbatus* catches are higher during the post-recruitment period (from September to November). About 350 trawlers and a small number of artisanal vessels exploit the species. Annual landings are around 700 t, mostly from trawlers. Discarding of undersized

individuals is in general negligible, due to the fact that immediately after recruitment, small sized individuals are still concentrated inside the 3 miles trawl exclusion zone. Illegal catches of juveniles do occur.

7.20.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.20.2.3. Catches

7.20.2.3.1. Landings

Landings data were reported to SGMED-08-03 through the Data collection regulation and are listed in Table A3.1 of Appendix 3. Since 2002 annual landings varied between 620 and 1,100 (Tab. 7.20.2.3.1.1). Demersal otter trawlers dominate the landings by far.

Table 7.20.2.3.1.1 Annual landings (t) by fishing technique as reported to SGMED-08-03 through the DCR data call.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	9	ITA	DTS	454	839	514	682	1033	1075
MUT	9	ITA	HOK				2		
MUT	9	ITA	PGP	14	44	49	28	17	22
MUT	9	ITA	PMP	150	174	16	3		
MUT	9	ITA	PTS	3	7	4			
SUM				621	1064	583	715	1050	1097

7.20.2.3.2. Discards

158 t of discards in 2006 were reported to SGMED-08-03 and are listed in Tab. A3.4 of Appendix 3.

7.20.2.3.3. Fishing effort

Tab. 7.20.2.3.3.1 lists the effort by fishing technique deployed in GSA 09 as reported to SGMED-08-03 throught the DCR data call and listed in Tab. A3.5 of Appendix 3. A minor decrease is observed for the main gear demersal otter trawl.

Tab. 7.20.2.3.3.1 Effort trends by fishing technique in GSA 09.

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

7.20.3. Scientific surveys

7.20.3.1. Medits

7.20.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 09 the following number of hauls were reported per depth stratum (s. Tab. 7.20.3.1.1.1).

Tab. 7.20.3.1.1.1. Number of hauls per year and depth stratum in GSA 09, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA09_010-050	19	18	18	18	19	18	18	18	13	13	13	14	13	13
GSA09_050-100	19	19	18	19	18	19	20	20	15	15	15	14	16	16
GSA09_100-200	35	35	36	35	35	35	34	34	26	27	26	27	25	26
GSA09_200-500	32	33	33	36	32	36	37	35	27	27	27	28	29	33
GSA09_500-800	31	30	32	28	30	28	27	29	24	22	21	20	20	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.

7.20.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.20.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 09 was derived from the international survey Medits. Figure 7.20.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 09.

The estimated abundance and biomass indices do not reveal any significant trends since 1994. However, the recent abundance and biomass indices since 2002 appear increased but are subject to high variation (uncertainty). The analyses of Medits indices are considered preliminary.

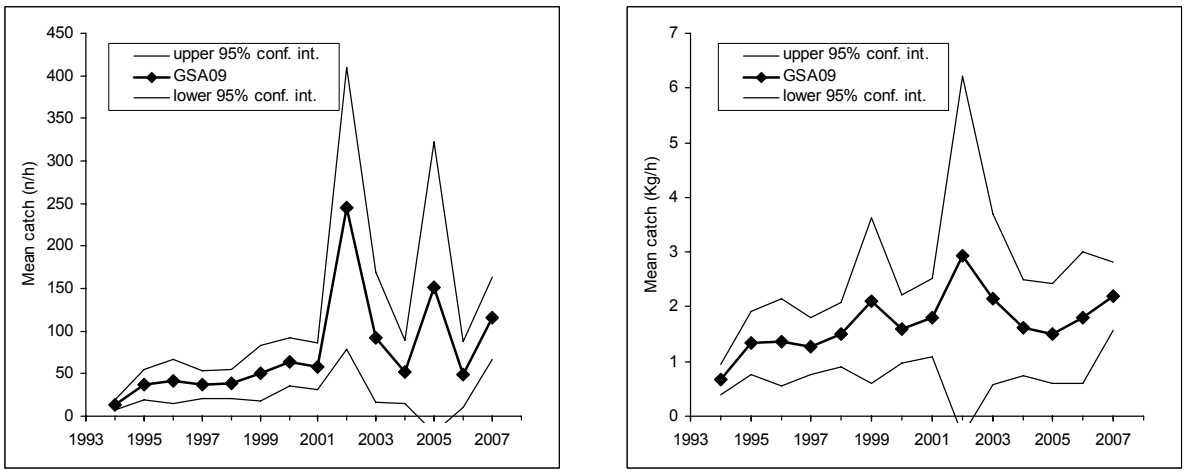


Fig. 7.20.3.1.3.1 Abundance and biomass indices of red mullet in GSA 09.

7.20.3.1.4. Trends in abundance by length or age

The following Fig. 7.20.3.1.4.1 and 2 display the stratified abundance indices of GSA 09 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

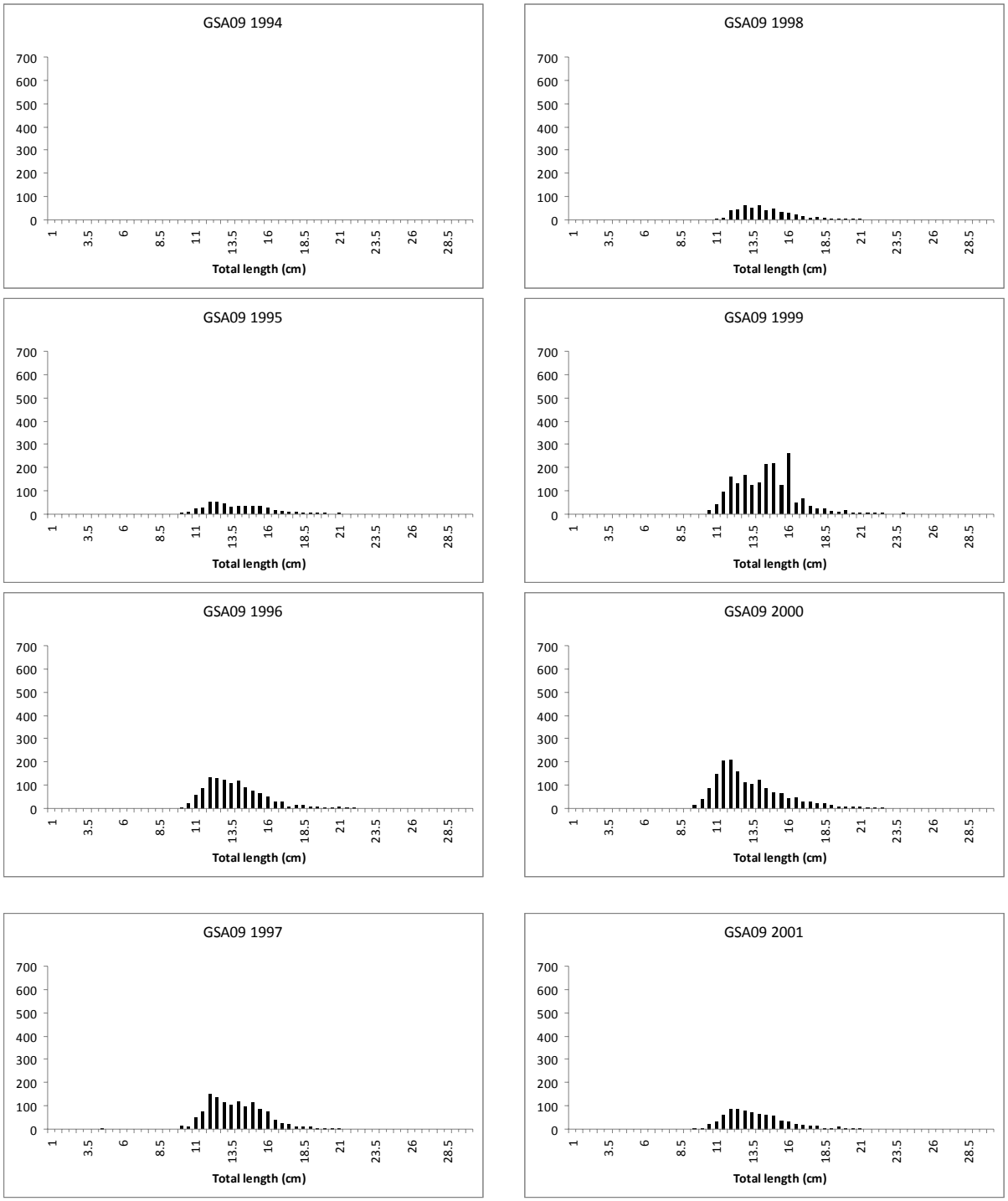


Fig. 7.20.3.1.4.1 Stratified abundance indices by size, 1994-2001.

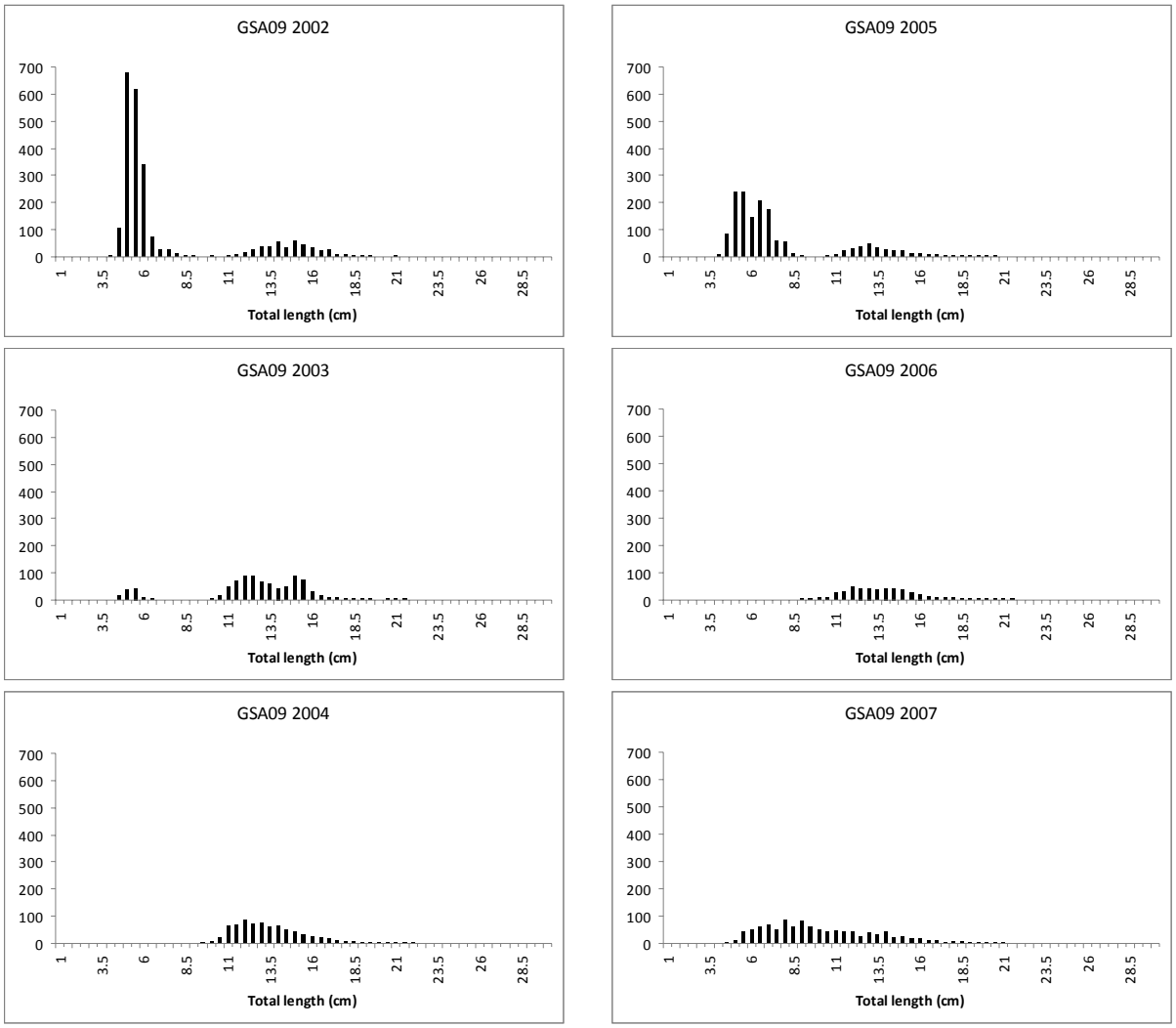


Fig. 7.20.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.20.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.20.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.20.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.20.5. Short term prediction for 2008 and 2009

7.20.5.1. Justification

No forecast analyses were conducted.

7.20.5.2. Input parameters

No forecast analyses were conducted.

7.20.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSA 09.

7.20.6. Medium term prediction

7.20.6.1. Justification

No forecast analyses were conducted.

7.20.6.2. Input parameters

No forecast analyses were conducted.

7.20.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSA 09.

7.20.7. Long term prediction

7.20.7.1. Justification

No forecast analyses were conducted.

7.20.7.2. Input parameters

No forecast analyses were conducted.

7.20.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 09.

7.20.8. Scientific advice

7.20.8.1. Short term considerations

7.20.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.20.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.20.8.1.3. State of exploitation

SGMED-08-03 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.

7.20.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.21. Stock assessment of red mullet in GSA 10

7.21.1. Stock identification and biological features

7.21.1.1. Stock Identification

Red mullet is with European hake and deep-water rose shrimp a key species of fishing assemblages in the central-southern Tyrrhenian sea (GSA 10). *M. barbatus* is mainly distributed on the continental shelf and is a small sized fast growing species, 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 nearshore 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. Three or four months after settlement, the species is spread up to depths of about 100 m.

7.21.1.2. 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=0.42 t_0= -0.4.

7.21.1.3. Maturity

Data available in the area indicate a size at first maturity of 13.0-14 cm for females and 10-11 cm for males that is when fish are aged 1 year.

7.21.2. Fisheries

7.21.2.1. General description of fisheries

Red mullet is mainly targeted by trawlers and also by small scale fisheries using trammel nets. The amount of catches of the artisanal fishery is low (less than 20% of the species catches) if compared with the landings of trawling. Fishing grounds are located along the coasts of the whole GSA, excluding the nearshore areas, offshore 50 m or 3 miles depth.

7.21.2.2. Management regulations applicable in 2007 and 2008

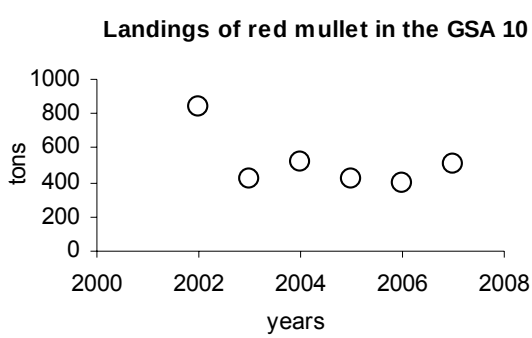
Management regulations are based on technical measures and do not differ from those applied in the previous years: closed number of fishing licenses, fishing forbidden within 50 m depth or 3 miles from the shore, depending on the zone. Along northern Sicily coasts two main gulfs (Patti and Castellammare) have been closed to the trawl fishery up 200 m depth,since 1990, and effects of protection have been also evaluated (Fiorentino *et al*., in press). Two closed areas have been also established since 2004 along the mainland, in front of Sorrento peninsula (Napoli Gulf) and Amantea (Calabrian coasts).

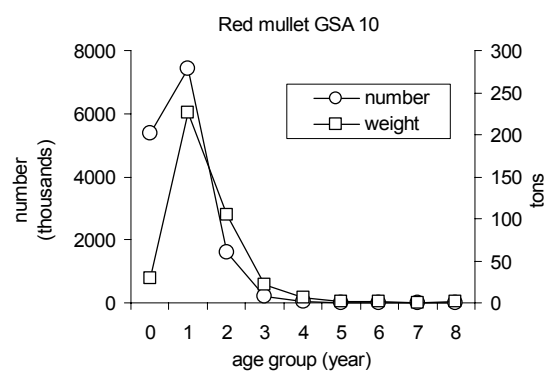
7.21.2.3. Catches

7.21.2.3.1. Landings

Available landing data are from DCR regulations and range from 839 tons in 2002 to 501 tons in 2007, being the lowest value of 393 tons registered in 2006 (Fig. 7.21.2.3.1.1). The length distribution of landings, for all the fleet segments, is an average of 2006 and 2007, as well as the age distributions of landings. Both number of individuals and weight are reported. The LFD in number is bi-modal, with two peaks at 11 and 15 cm, while the distribution of landings (tons) by length shows a peak at 15 cm (a proxy of the critical size). The distribution of landings by age highlights the relevant contribution of the age 1 group, both in terms of number and weight.

Tab. 7.21.2.3.1.1 lists the annual landings by major fisching techniques. Data are listed in Tab. A3.2 of Appendix 3.





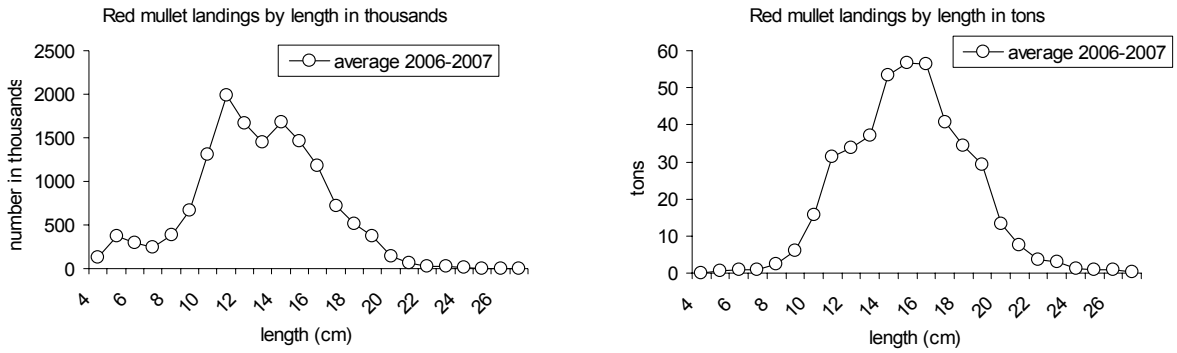


Fig. 7.21.2.3.1.1 Annual landings, and length and age composition of the landings in 2006 and 2007.

Tab. 7.21.2.3.1.1 Annual landings (t) by fishing technique, 2002-2007.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	10	ITA	DTS	446	265	370	249	289	265
MUT	10	ITA	HOK			2		0	
MUT	10	ITA	PGP	195	83	110	116	104	237
MUT	10	ITA	PMP	189	71	41	56		0
MUT	10	ITA	PTS	10		1			
SUM				840	419	524	421	393	502

7.21.2.3.2. 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 estimate 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 highlights the prevailing of the age 0 group; the average length was 8.7 cm (Fig. 7.21.2.3.2.1).

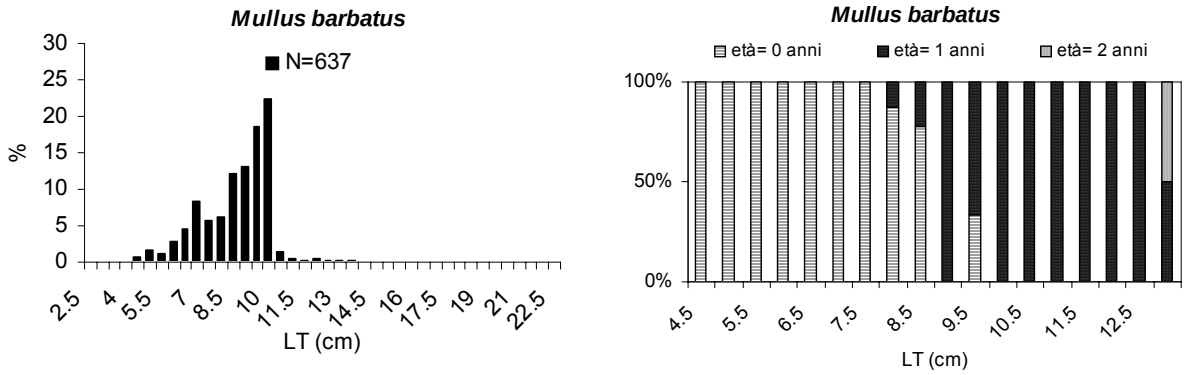


Fig. 7.21.2.3.2.1 Size and age composition of discards.

Only 3 t of discards in 2006 were reported to SGMED-08-03 (Tab. A3.4 of Appendix 3).

7.21.2.3.3. Fishing effort

The whole fishing effort (all segments of the fleet combined) in the GSA, targeting all the stocks, shows a decreasing trend from 2002 to 2006, at least in terms of combination of days at sea and fleet capacity or power.

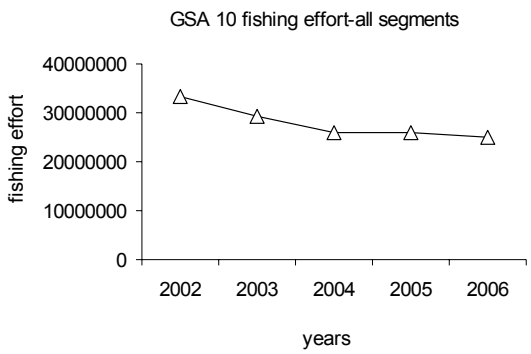


Fig.7.21.2.3.3.1 Trend in overall finshing effort, 2002-2006.

Tab. 7.21.2.3.3.1 lists the effort by fishing technique deployed in GSA 10 as reported to SGMED-08-03 throught the DCR data call and listed in Tab. A3.5 of Appendix 3.

Tab. 7.21.2.3.3.1 Effort trends by fishing technique in GSA 09.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	10	ITA	DRB	658	205	830	1776	1984	1040
DAYS	10	ITA	DTS	37949	38134	44087	46547	43848	40724
DAYS	10	ITA	HOK			20929	20418	8064	7043
DAYS	10	ITA	PGP	357895	311474	325523	268441	346849	311693
DAYS	10	ITA	PMP	105705	143062	62225	64177	10532	7261
DAYS	10	ITA	PTS	8258	9780	11792	11206	9332	9367
GT*DAYS	10	ITA	DRB			7968	17128	19136	9939
GT*DAYS	10	ITA	DTS			1337882	1622062	1331071	1266460
GT*DAYS	10	ITA	HOK			157882	143835	103111	82342
GT*DAYS	10	ITA	PGP			661958	534880	800036	693057
GT*DAYS	10	ITA	PMP			336053	333845	152717	110850
GT*DAYS	10	ITA	PTS			390096	468145	367417	280190
KW*DAYS	10	ITA	DRB	94663	29540	110899	244013	272628	142455
KW*DAYS	10	ITA	DTS	7344089	7231486	7883881	8467144	7596783	7105075
KW*DAYS	10	ITA	HOK			1654352	1413547	925244	794816
KW*DAYS	10	ITA	PGP	6440217	7222145	7056306	6018600	9486681	8397010
KW*DAYS	10	ITA	PMP	12686947	8003452	3588004	3728376	1404642	1003285
KW*DAYS	10	ITA	PTS	2631242	2930380	2308589	2434470	2016508	1680295

7.21.3. Scientific surveys

7.21.3.1. Medits

7.21.3.1.1. 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 and presented in section 11 of this report.

In GSA 10 the following number of hauls were reported per depth stratum (s. Tab. 7.21.3.1.1.1).

Tab. 7.21.3.1.1.1. Number of hauls per year and depth stratum in GSA 10, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA10_010-050	9	10	10	10	10	10	10	10	9	9	9	9	9	9
GSA10_050-100	12	12	12	12	12	12	12	12	10	10	10	10	10	10
GSA10_100-200	20	20	20	20	20	20	20	20	17	17	17	17	17	17
GSA10_200-500	26	27	26	26	27	26	26	28	22	22	22	22	22	22
GSA10_500-800	31	30	31	31	31	30	31	29	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.

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.

7.21.3.1.2. 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 (Fig. 7.21.3.1.2.1). The approach based on spatial indicators to characterise the spatial dynamics of red mullet life stages has been applied in the GSA 10 (Spedicato *et al.*, 2007), with the objective of identify areas where red mullet recruits are more concentrated, establish relationships with the adult distribution and detect the ability of spatial indicators to capture the stability of the spatial occupation of preferential sites across the years. Gravity centres by age groups across years highlight a less changing spatial location of the younger age (A1) compared to the older ones (A2 and A3) that are more dispersed in both the geographical sub-units 10a (mainland coasts) and 10b (north Sicily coasts). The spatial indices mainly used are the centre of gravity (CG), the inertia (I) and the global index of collocation (GIC). The approach of the spatial indicators enabled the identification the geographical zone (southwards in the study area, along the Calabrian coast) where recruits of red mullet are mainly distributed and to verify that these locations are rather stable across years.

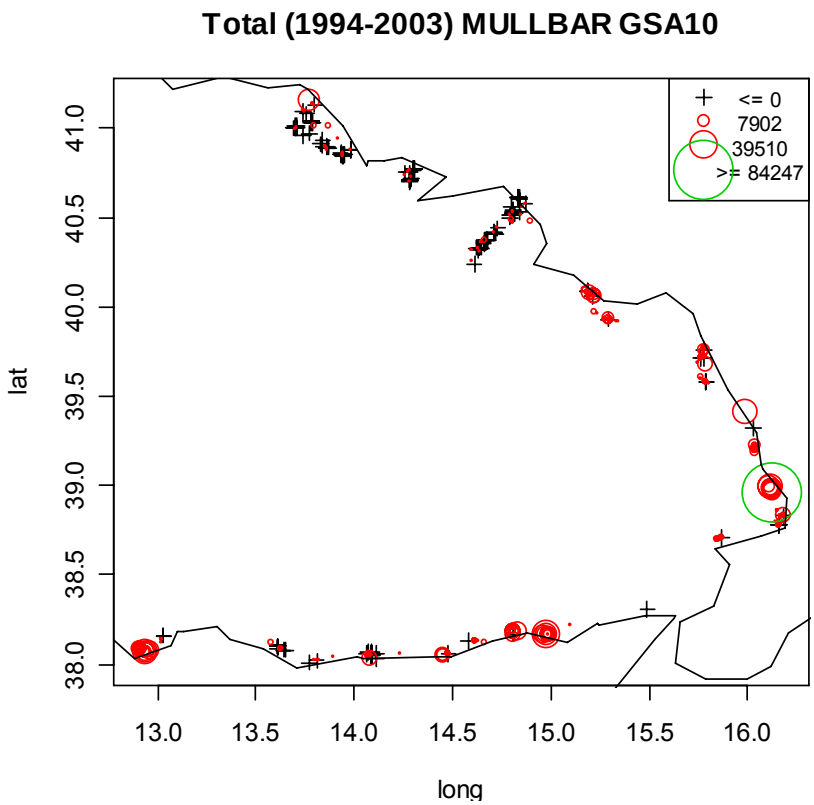


Fig. 7.21.3.1.2.1 Scaled survey catches of red mullet in GSA 10.

Fig. 7.21.3.1.2.2 shows a map of abundance of recruits (N/km^2) as estimated using Grund data and the ordinary kriging.

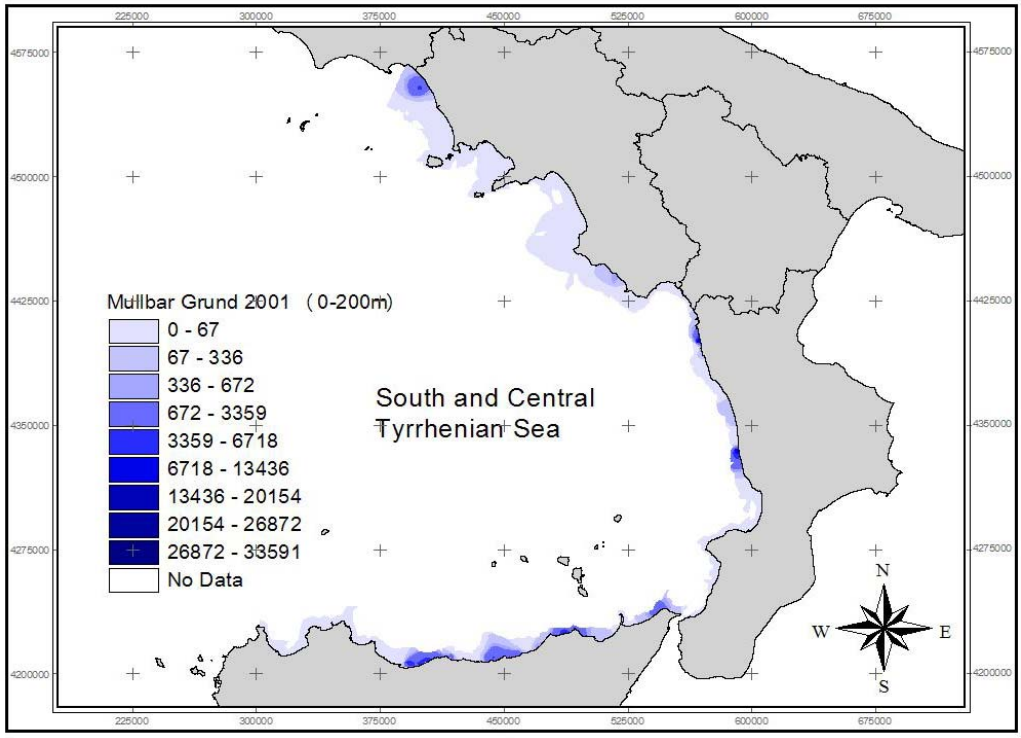


Fig. 7.21.3.1.2.2 Map of abundance of recruits (N/km^2) as estimated using Grund data and the ordinary kriging.

7.21.3.1.3. Trends in abundance and biomass

Indices from Medits trawl-survey show a decreasing pattern from 1999 onwards (significant for the biomass index). In the last year 2007, a rising of both indices was observed (Fig. 7.21.3.1.3.1).

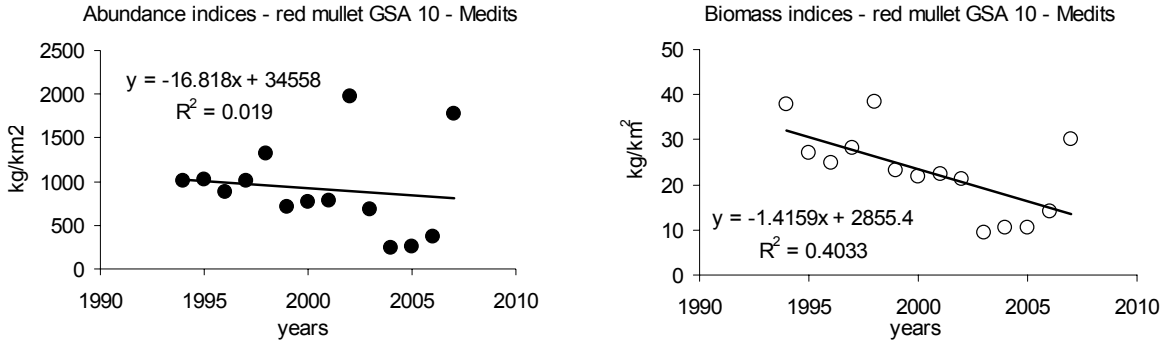


Fig. 7.21.3.1.3.1 Trends in survey abundance and biomass derived from Medits.

Fishery independent information regarding the state of the red mullet in GSA 10 was derived from the international survey Medits. Figure 7.21.3.1.3.2 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.

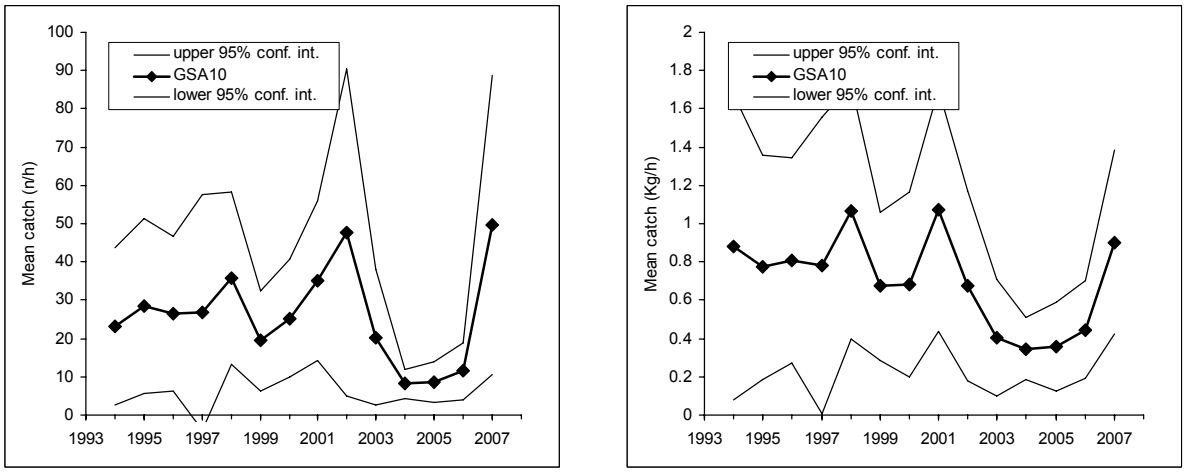


Fig. 7.21.3.1.3.2 Abundance and biomass indices of red mullet in GSA 10 derived from Medits.

Similar trends are derived from the GRUND survey and shown in Fig. 7.21.3.1.3.3.

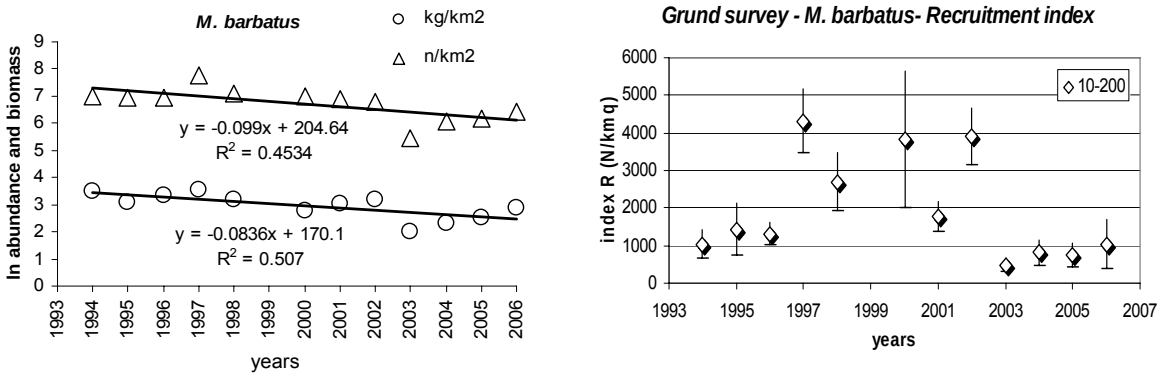


Fig. 7.21.3.1.3.3 Abundance and biomass indices of red mullet in GSA 10 derived from GRUND.

7.21.3.1.4. Trends in abundance by length or age

No trend in the mean length was observed in Medits survey.

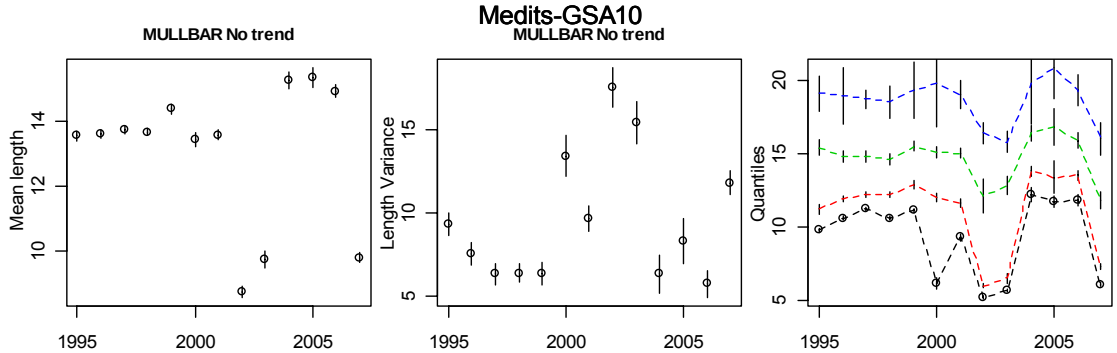


Fig. 7.21.3.1.4.1 Mean length, variance and quantiles derived from the Medits length compositions in 1995-2007.

The following Fig. 7.21.3.1.4.2 and 3 display the stratified abundance indices of GSA 08 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

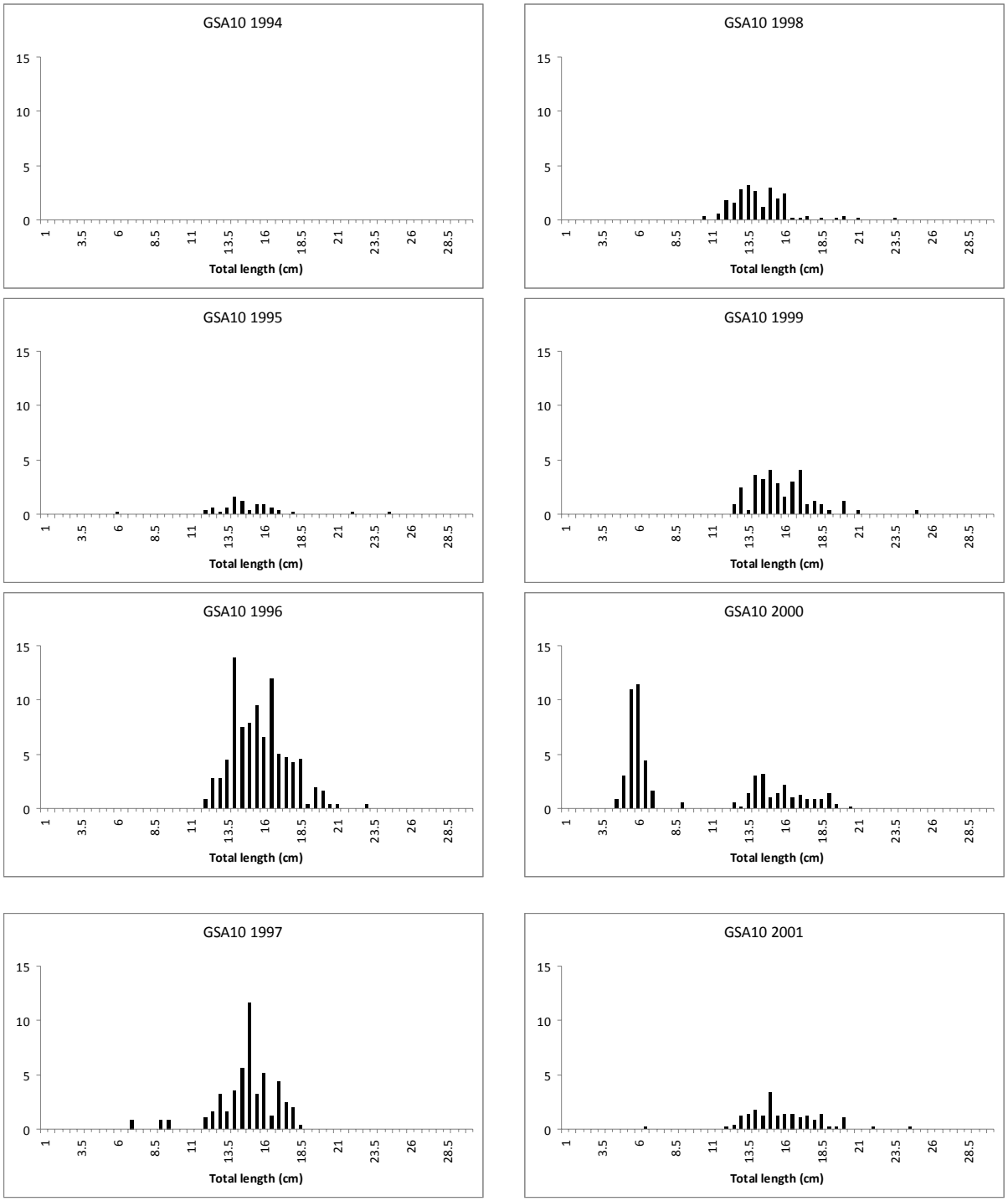


Fig. 7.21.3.1.4.2 Stratified abundance indices by size, 1994-2001.

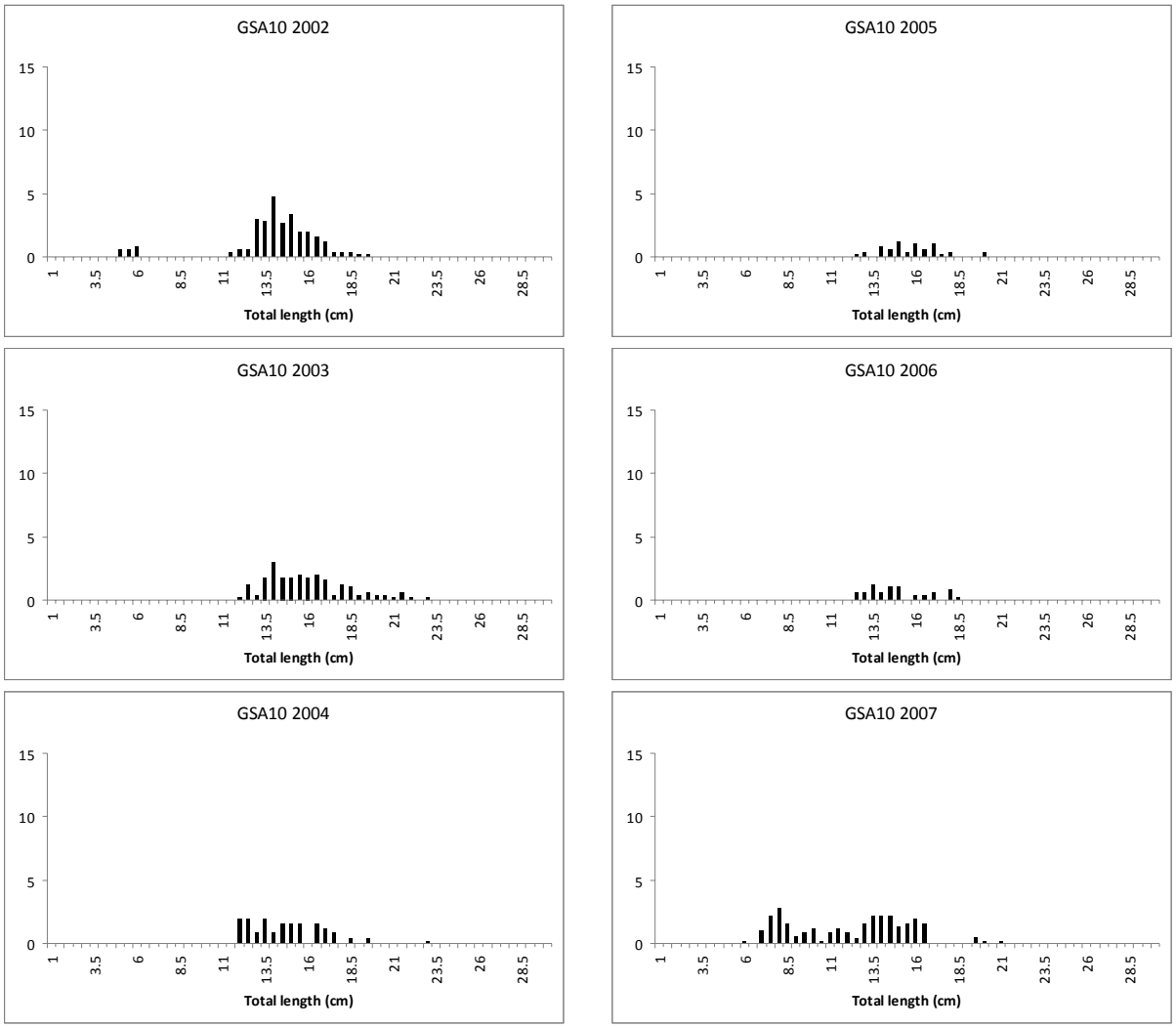


Fig. 7.21.3.1.4.3 Stratified abundance indices by size, 2002-2007.

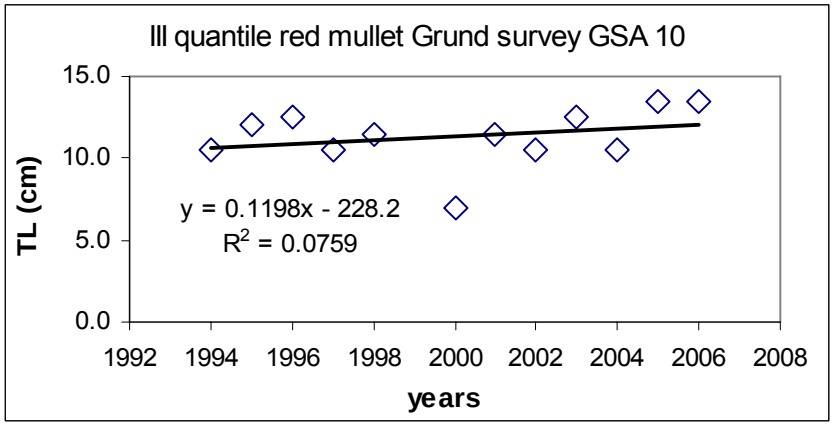


Fig. 7.21.3.1.4.4 III Quantile derived from the GRUND length compositions in 1994-2006.

7.21.3.1.5. Trends in growth

The occurrence of growth change along time was not fully explored during SGMED-08-03.

7.21.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.21.4. Assessment of historic stock parameters

7.21.4.1. Method 1: Aladym

7.21.4.1.1. Justification

Aladym model was used both for historic assessment, short-term and long-term prediction, including the effects of different management scenarios

7.21.4.1.2. Input parameters

V. Bertalanffy growth function and parameters used are shown in Fig. 7.21.4.1.2.1.

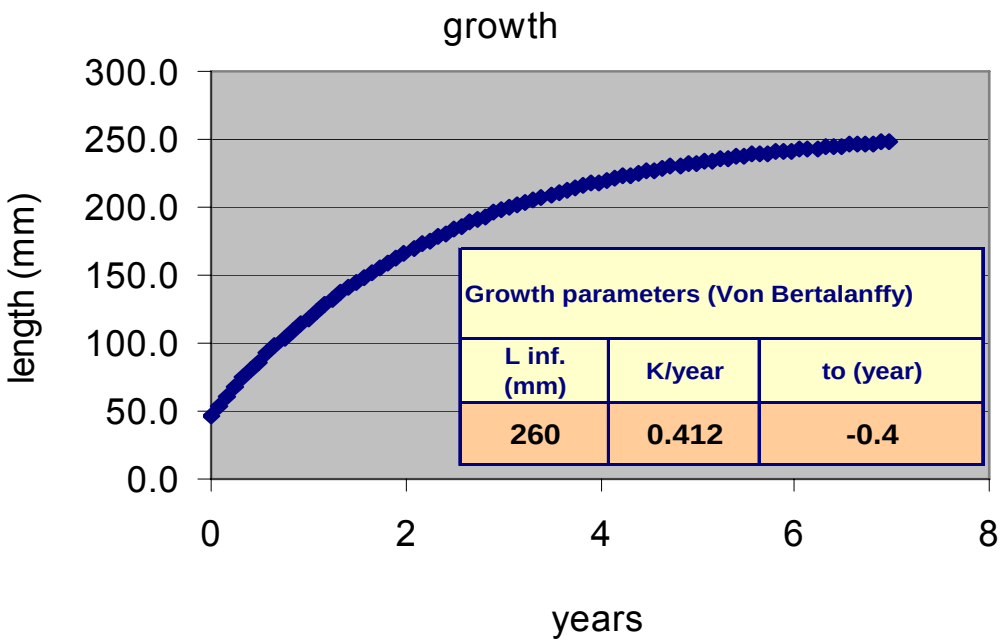


Fig. 7.21.4.1.2.1 V. Bertalanffy growth function and parameters

Logistic function of selection and maturation are used are shown in Fig. 7.21.4.1.2.2

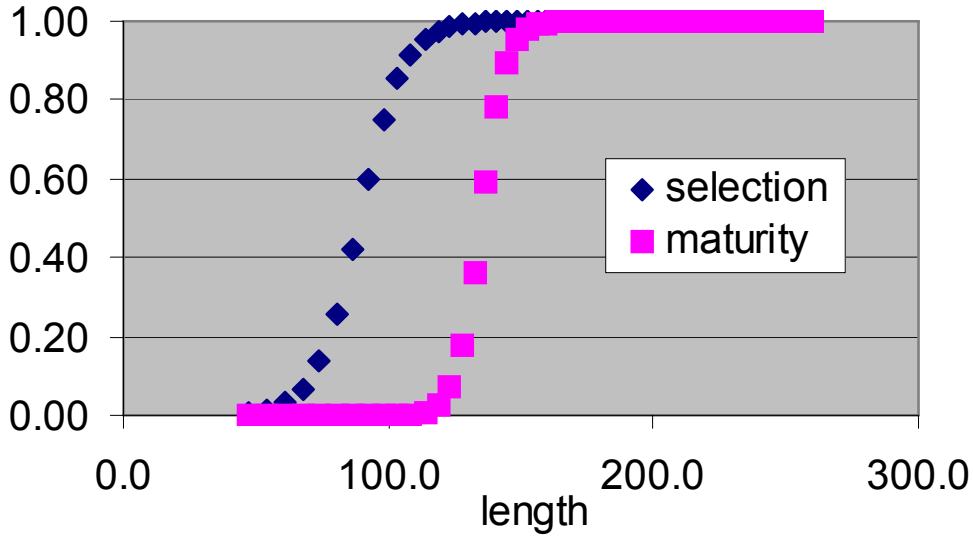


Fig. 7.21.4.1.2.2 Logistic function of selection and maturation.

7.21.4.1.3. Results

Resulting estimates of total mortality are shown in Fig. 7.21.4.1.3.1.

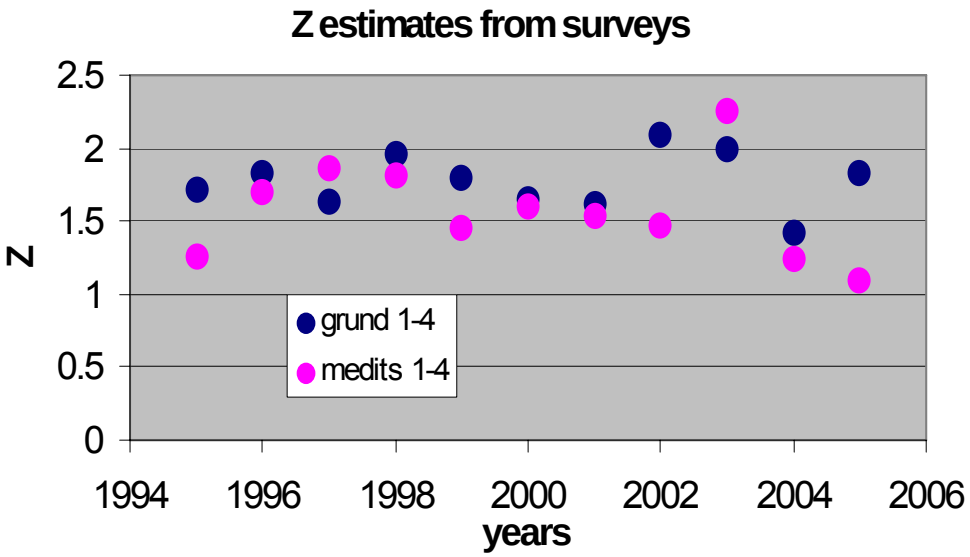


Fig. 7.21.4.1.3.1 Estimates of totat mortality Z based on MEDITS and GRUND data, 1995-2005.

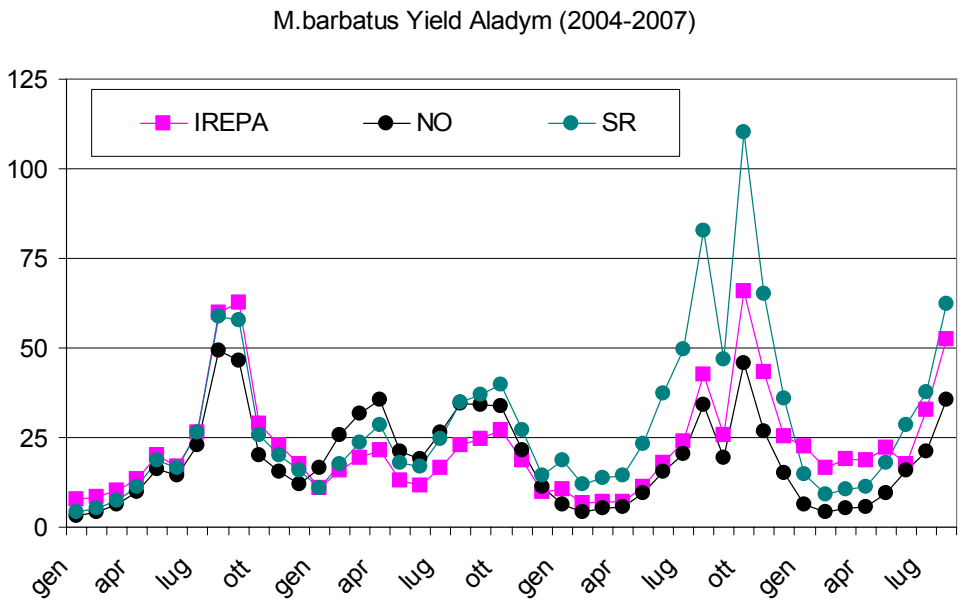


Fig. 7.21.4.1.3.2 Monthly trends in observed and estimated landings.

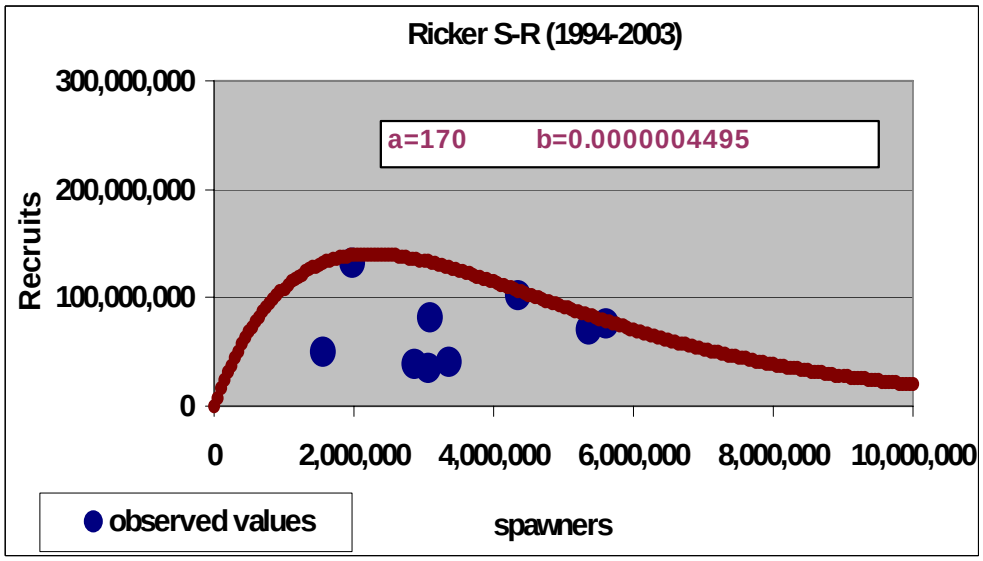


Fig. 7.21.4.1.3.2 Ricker function and observed values of estimated spawning stock and recruitment.

7.21.5. Short term prediction for 2008 and 2009

7.21.5.1. Justification

No forecast analyses were conducted.

7.21.5.2. Input parameters

No forecast analyses were conducted.

7.21.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSA 10.

7.21.6. Medium term prediction

7.21.6.1. Justification

No forecast analyses were conducted.

7.21.6.2. Input parameters

No forecast analyses were conducted.

7.21.6.3. Results

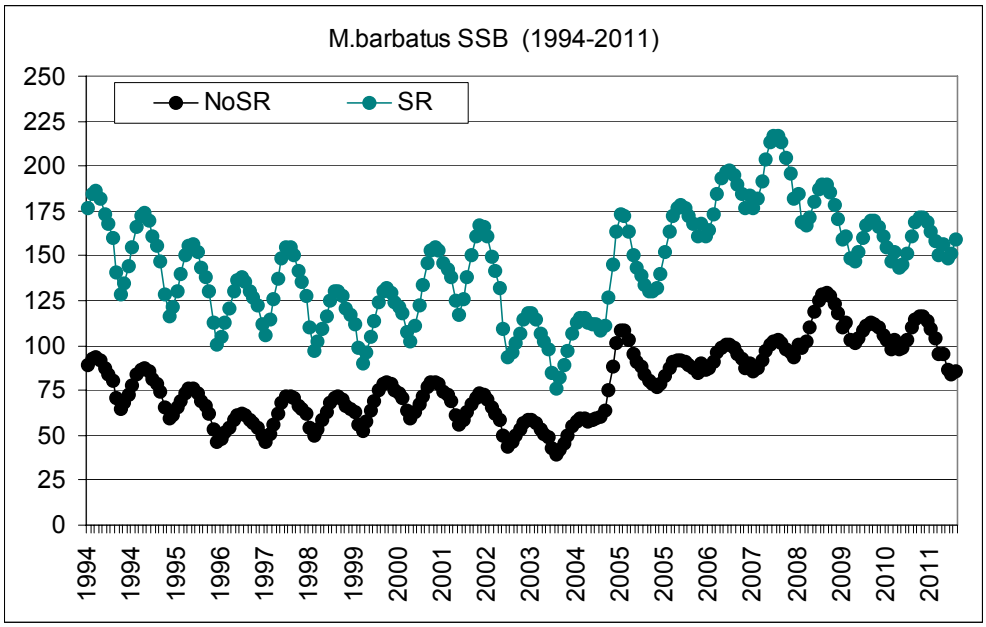
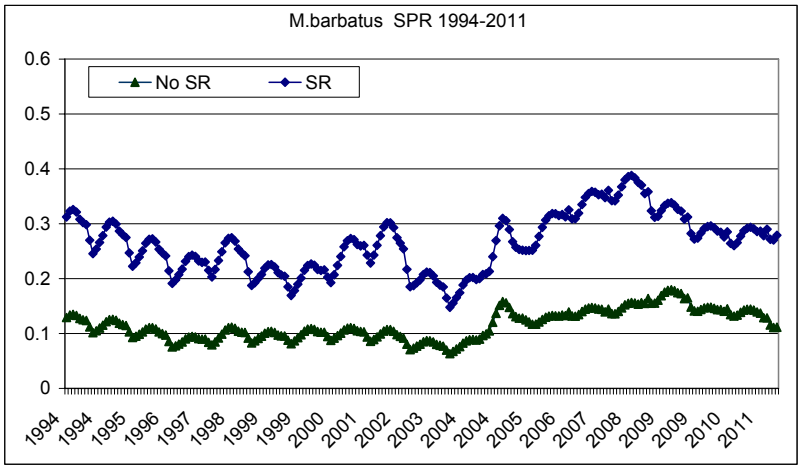


Fig. 7.21.6.3.1 Medium term simulation of spawning stock size and juveniles.



Fmsy	SPR
1.03	0.30
Zmbp	SPR
1.41	0.42

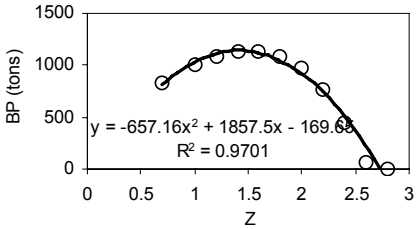


Fig. 7.21.6.3.1 Medium term simulation of what? Estimation of equilibrium biomass with increasing mortality..

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSA 10.

7.21.7. Long term prediction

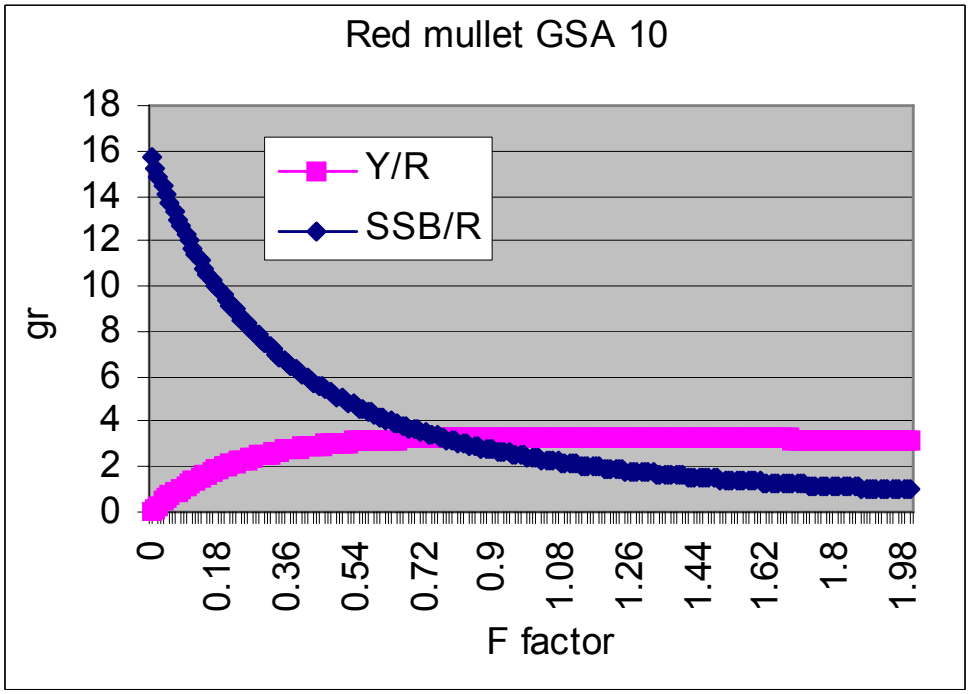
7.21.7.1. Justification

No forecast analyses were conducted.

7.21.7.2. Input parameters

No forecast analyses were conducted.

7.21.7.3. Results



F(0.1)	0.5	3.065	5.036
	1.01	3.325	2.417

Fig. 7.21.7.3.1 Yield and SSB per recruit analyses for red mullet in GSA 10.

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 10.

7.21.8. Scientific advice

7.21.8.1. Short term considerations

7.21.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.21.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.21.8.1.3. State of exploitation

SGMED-08-03 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.

7.21.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.22. Stock assessment of red mullet in GSA 11

7.22.1. Stock identification and biological features

7.22.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.22.1.2. Growth

No information was documented during SGMED-08-03.

7.22.1.3. Maturity

No information was documented during SGMED-08-03.

7.22.2. Fisheries

7.22.2.1. 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 fleets, which operate near shore. 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.

7.22.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.22.2.3. Catches

7.22.2.3.1. Landings

Tab. 7.22.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-08-03 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 taken by demersal otter trawls.

Tab. 7.22.2.3.1.1 Annual landings (t) by fishing technique in GSA 11.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	11	ITA	DTS	38	253	333	264	244	345
MUT	11	ITA	PGP	0		14	1	18	9
MUT	11	ITA	PMP	77	68				
SUM				115	321	347	265	262	354

7.22.2.3.2. Discards

7 t of discards in 2006 were reported to SGMED-08-03 through the DCR data call and are listed in Tab. A3.4 of Appendix 3.

7.22.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-08-03 are listed in Tab. 7.22.2.3.3.1 and in Tab. A3.5 of Appendix 3. The effort of the major trawler fleet has doubled during 2003-2004 and stayed at the high level thereafter.

Tab. 7.22.2.3.3.1 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
DAYS	11	ITA	DTS	14539	18957	28840	31993	26532	27374
DAYS	11	ITA	PGP	102826	126272	165945	151720	156269	155243
DAYS	11	ITA	PMP	57543	30879				
GT*DAYS	11	ITA	DTS			1598912	1881952	1437559	1486500
GT*DAYS	11	ITA	PGP			501550	484820	493411	495670
KW*DAYS	11	ITA	DTS	3679604	4652647	6711626	7736040	6017232	6340429
KW*DAYS	11	ITA	PGP	2865738	5099814	7105771	6996350	7234881	7398923

7.22.3. Scientific surveys

7.22.3.1. Medits

7.22.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 08 the following number of hauls were reported per depth stratum (s. Tab. 7.22.3.1.1.1).

Tab. 7.22.3.1.1.1. Number of hauls per year and depth stratum in GSA 11, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA11_010-050	16	18	21	21	21	20	19	17	20	18	17	17	19	19
GSA11_050-100	25	21	22	22	20	22	22	24	19	19	18	21	18	20
GSA11_100-200	20	23	30	31	31	30	29	30	24	24	24	24	24	24
GSA11_200-500	33	29	29	26	25	27	24	25	20	24	21	20	20	20
GSA11_500-800	23	16	21	25	25	24	27	26	16	14	15	14	16	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.

7.22.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.22.3.1.3. 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. Figure 7.22.3.1.3.1 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 (uncertainty). The analyses of Medits indices are considered preliminary.

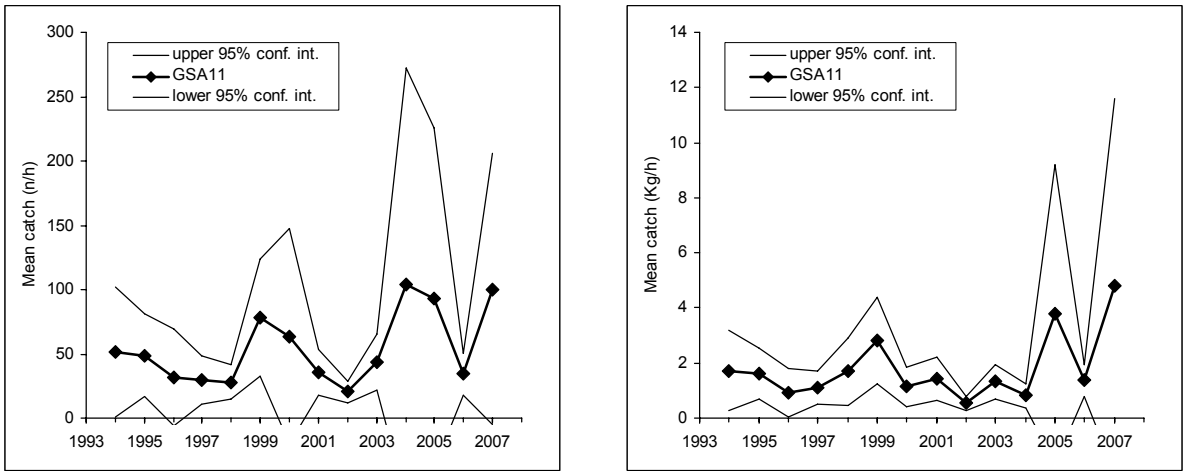


Fig. 7.6.3.1.3.1 Abundance and biomass indices of red mullet in GSA 11.

7.22.3.1.4. Trends in abundance by length or age

The following Fig. 7.22.3.1.4.1 and 2 display the stratified abundance indices of GSA 11 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

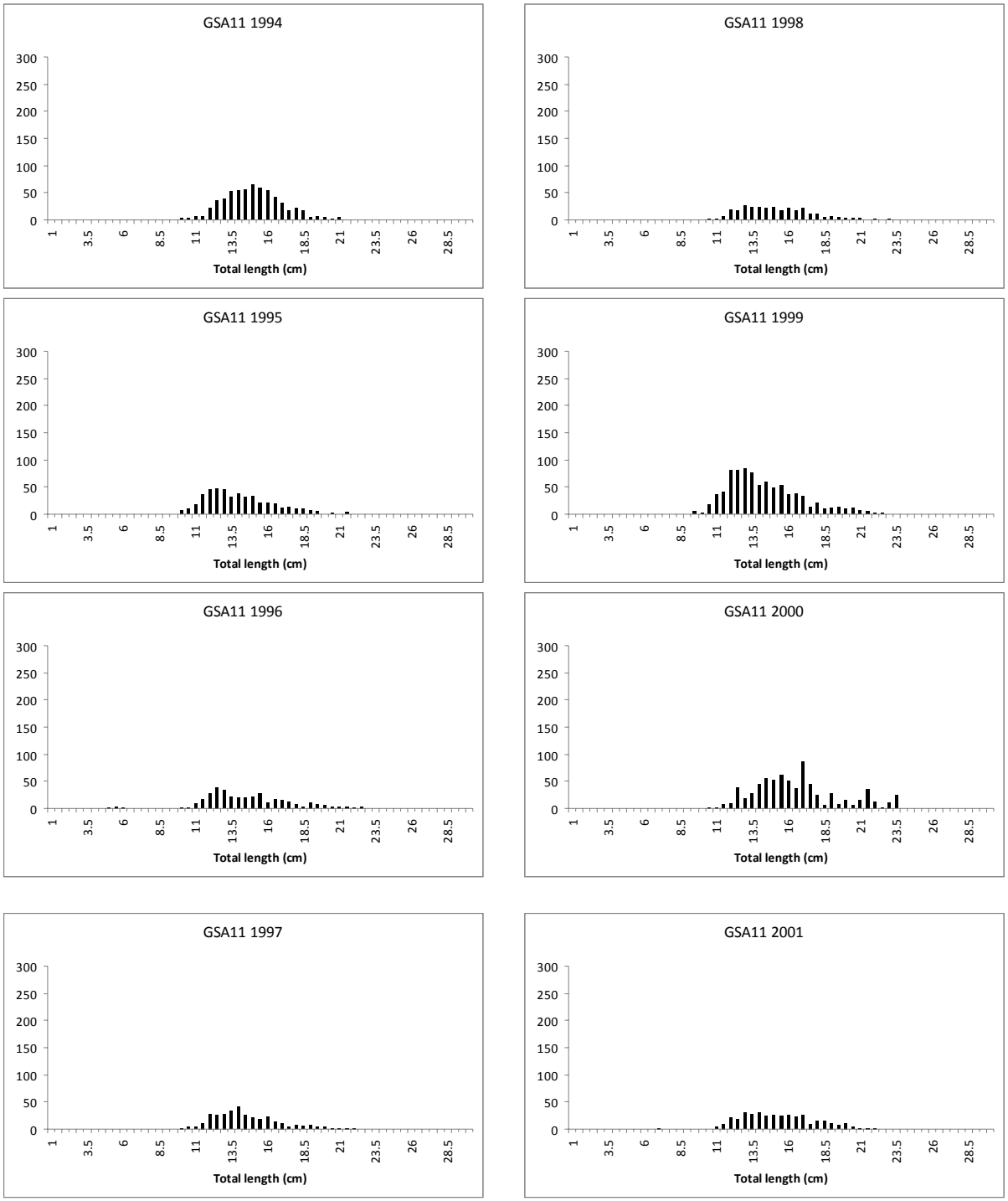


Fig. 7.22.3.1.4.1 Stratified abundance indices by size, 1994-2001.

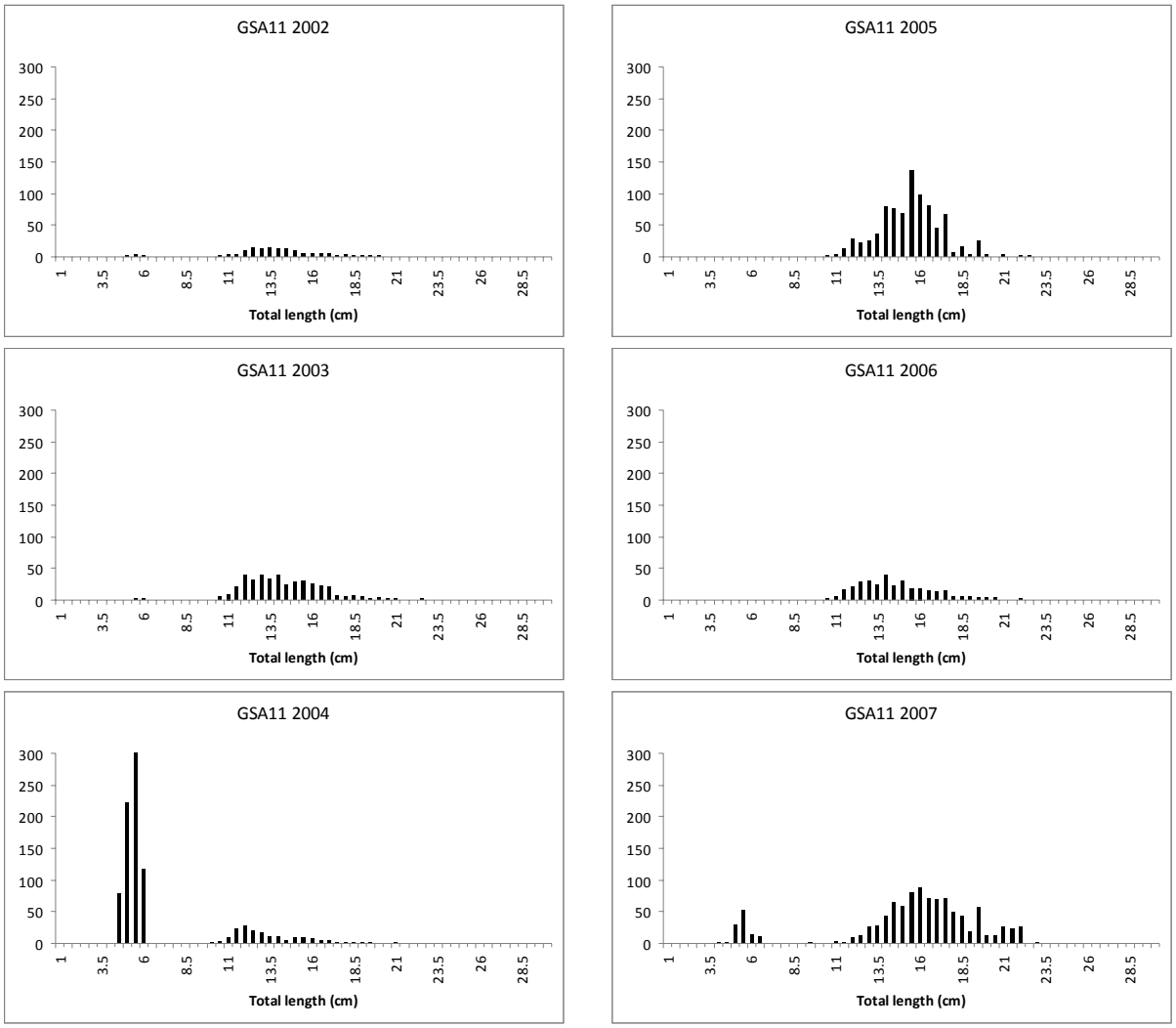


Fig. 7.22.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.22.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.22.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.22.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.22.5. Short term prediction for 2008 and 2009

7.22.5.1. Justification

No forecast analyses were conducted.

7.22.5.2. Input parameters

No forecast analyses were conducted.

7.22.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSA 11.

7.22.6. Medium term prediction

7.22.6.1. Justification

No forecast analyses were conducted.

7.22.6.2. Input parameters

No forecast analyses were conducted.

7.22.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSA 11.

7.22.7. Long term prediction

7.22.7.1. Justification

No forecast analyses were conducted.

7.22.7.2. Input parameters

No forecast analyses were conducted.

7.22.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 11.

7.22.8. Scientific advice

7.22.8.1. Short term considerations

7.22.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.22.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.22.8.1.3. State of exploitation

SGMED-08-03 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.

7.22.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.23. Stock assessment of red mullet in GSA 16

7.23.1. Stock identification and biological features

7.23.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.23.1.2. Growth

No information was documented during SGMED-08-03.

7.23.1.3. Maturity

No information was documented during SGMED-08-03.

7.23.2. Fisheries

7.23.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.23.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.23.2.3. Catches

7.23.2.3.1. Landings

Landings data were reported to SGMED-08-03 through the Data collection regulation and are listed in Table A3.1 of Appendix 3. Annual landings decreased from 3,380 t in 2003 to only 1,120 t in 2006 and increased to 1.320 in 2007 (Tab. 7.23.2.3.1.1). Demersal otter trawlers dominate the landings by far.

Table 7.23.2.3.1.1 Annual landings (t) by fishing technique as reported to SGMED-08-03 through the DCR data call.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	16	ITA	DTS	1924	3306	1541	1340	1086	1343
MUT	16	ITA	HOK			27	37	1	
MUT	16	ITA	PGP	169	27	58	29	37	37
MUT	16	ITA	PMP	52	47	0			
MUT	16	ITA	PTS	4	4				0
SUM				2149	3384	1626	1406	1124	1380

7.23.2.3.2. Discards

94 t of discards in 2006 were reported to SGMED-08-03 and are listed in Tab. A3.4 of Appendix 3.

7.23.2.3.3. Fishing effort

Tab. 7.23.2.3.3.1 lists the effort by fishing technique deployed in GSA 16 as reported to SGMED-08-03 throught the DCR data call and listed in Tab. A3.5 of Appendix 3. The main gear demersal otter trawl does not reveal any significant trend in effort deployed.

Tab. 7.23.2.3.3.1 Effort trends by fishing technique in GSA 16.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	16	ITA	DTS	87300	76233	81853	82557	89319	89164
DAYS	16	ITA	HOK			14856	11450	10272	9284
DAYS	16	ITA	PGP	146019	118660	118425	97285	85556	85298
DAYS	16	ITA	PMP	26655	34956	6939			
DAYS	16	ITA	PTS	8778	8568	4899	5476	7926	7032
GT*DAYS	16	ITA	DTS			6673029	6864030	7429483	7322198
GT*DAYS	16	ITA	HOK			764595	403669	507862	370612
GT*DAYS	16	ITA	PGP			249032	206056	192811	212519
GT*DAYS	16	ITA	PMP			20134			
GT*DAYS	16	ITA	PTS			224188	236435	352518	346405
KW*DAYS	16	ITA	DTS	23952310	20951845	21381964	21772464	23699835	23644626
KW*DAYS	16	ITA	HOK			3153486	1758722	2076446	1695903
KW*DAYS	16	ITA	PGP	3133993	4603457	2691324	2302777	2207660	2378933
KW*DAYS	16	ITA	PMP	2792612	2761842	223470			
KW*DAYS	16	ITA	PTS	2510582	1750128	962786	1063031	1592930	1431085

7.23.3. Scientific surveys

7.23.3.1. Medits

7.23.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 16 the following number of hauls were reported per depth stratum (s. Tab. 7.6.3.1.1.1).

Tab. 7.6.3.1.1.1. Number of hauls per year and depth stratum in GSA 16, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA16_010-050	4	4	4	4	4	4	4	4	7	7	7	10	10	11
GSA16_050-100	8	8	8	8	8	8	7	8	11	12	12	20	22	23
GSA16_100-200	4	4	4	4	5	5	6	5	10	8	9	18	19	21
GSA16_200-500	10	11	11	12	11	11	11	11	19	18	19	28	31	27
GSA16_500-800	10	14	14	13	14	14	14	14	19	20	19	32	33	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.

7.23.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.23.3.1.3. 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 7.23.3.1.3.1 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 conincides with the high landings recorded. The analyses of Medits indices are considered preliminary.

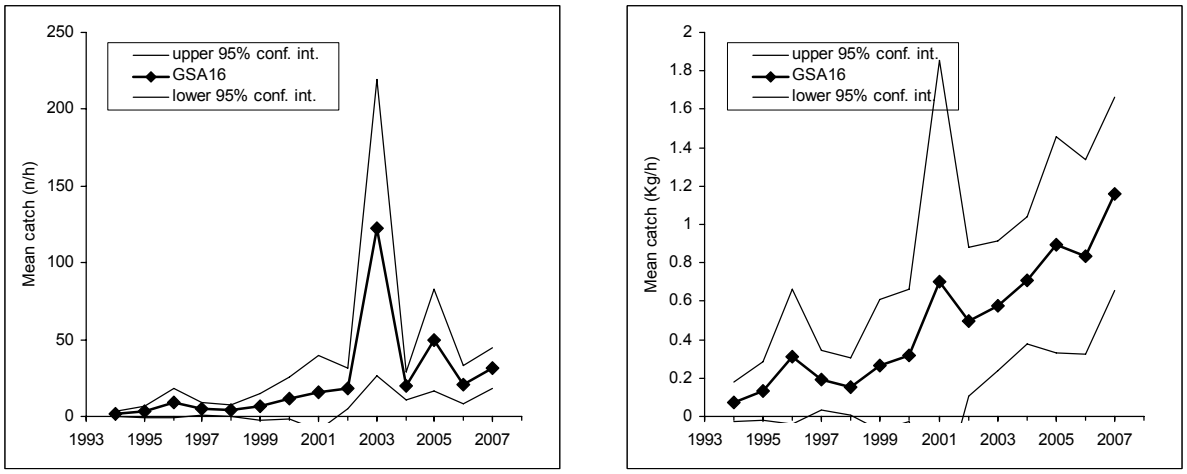


Fig. 7.23.3.1.3.1 Abundance and biomass indices of red mullet in GSA 16.

7.23.3.1.4. Trends in abundance by length or age

The following Fig. 7.23.3.1.4.1 and 2 display the stratified abundance indices of GSA 16 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

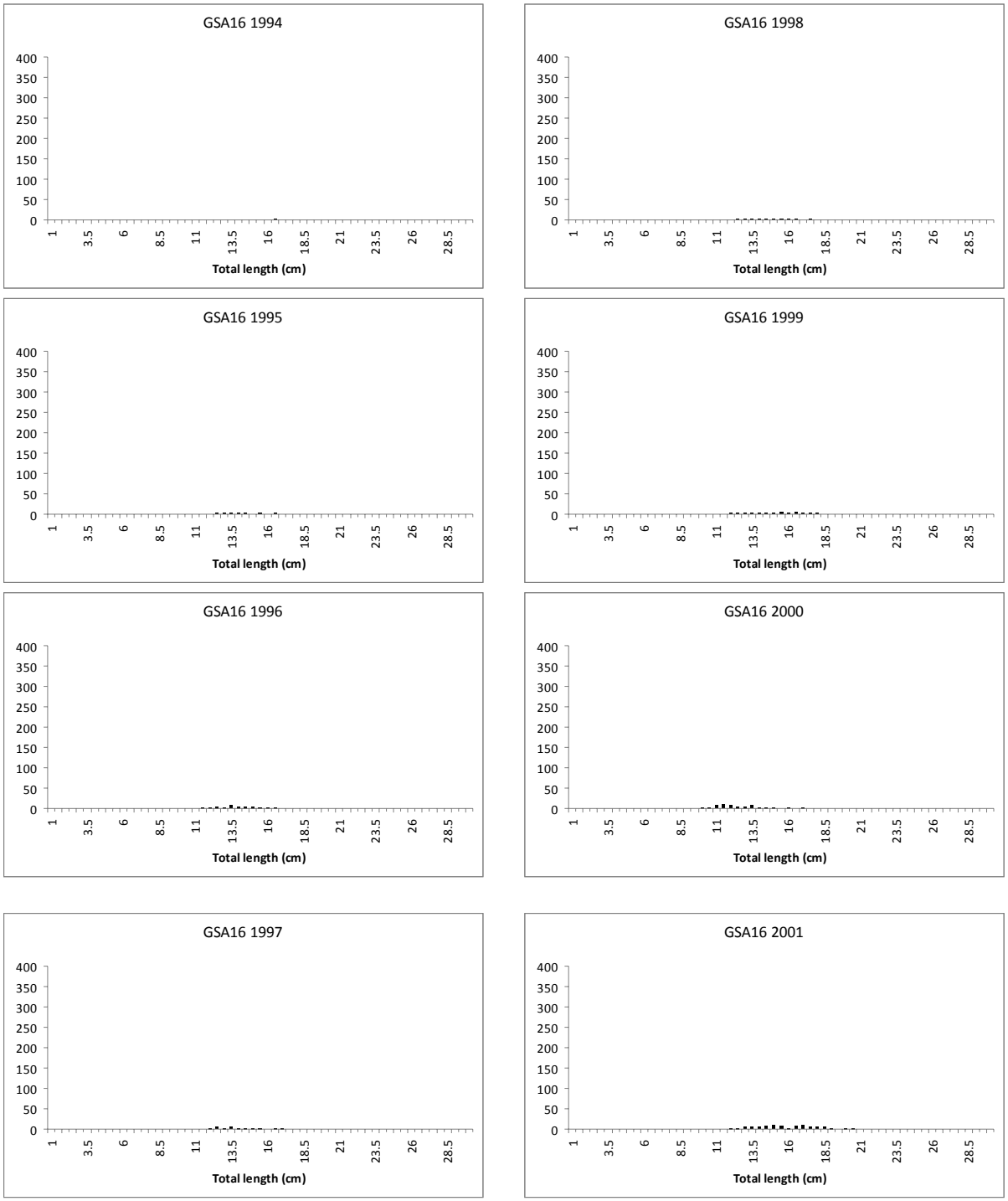


Fig. 7.6.3.1.4.1 Stratified abundance indices by size, 1994-2001.

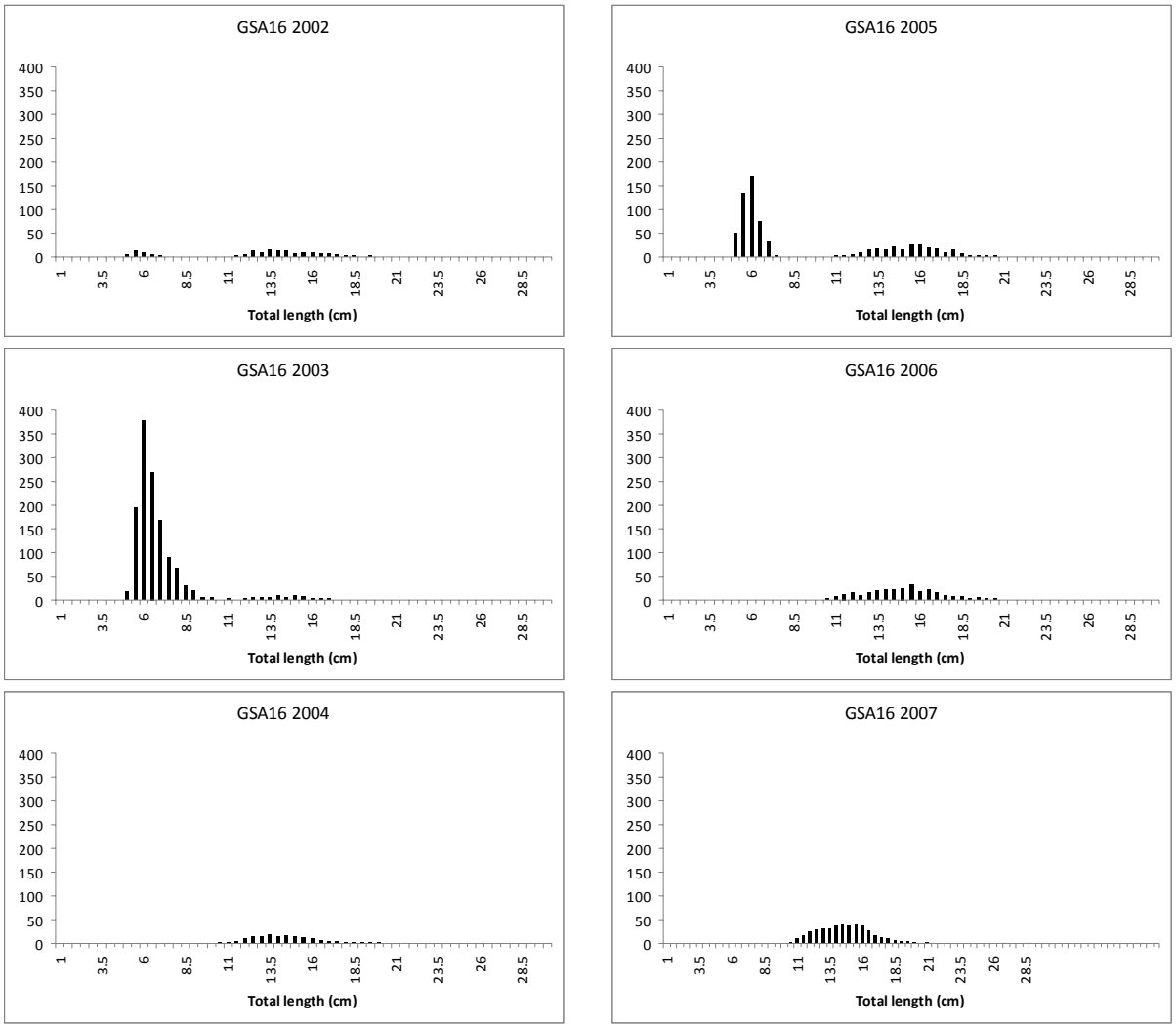


Fig. 7.6.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.23.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.23.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.23.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.23.5. Short term prediction for 2008 and 2009

7.23.5.1. Justification

No forecast analyses were conducted.

7.23.5.2. Input parameters

No forecast analyses were conducted.

7.23.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSA 16.

7.23.6. Medium term prediction

7.23.6.1. Justification

No forecast analyses were conducted.

7.23.6.2. Input parameters

No forecast analyses were conducted.

7.23.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSA 16.

7.23.7. Long term prediction

7.23.7.1. Justification

No forecast analyses were conducted.

7.23.7.2. Input parameters

No forecast analyses were conducted.

7.23.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 16.

7.23.8. Scientific advice

7.23.8.1. Short term considerations

7.23.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.23.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.23.8.1.3. State of exploitation

SGMED-08-03 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.

7.23.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.24. Stock assessment of red mullet in GSA 17

7.24.1. Stock identification and biological features

7.24.1.1. Stock Identification

Red mullet is found across the whole of 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; STECF, 2002; see also below).

The distribution of red mullet (*Mullus barbatus*) in the GSA 17, in spring-summer, is shown in the maps below (Fig. 7.24.1.1.1), 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 kilometre.

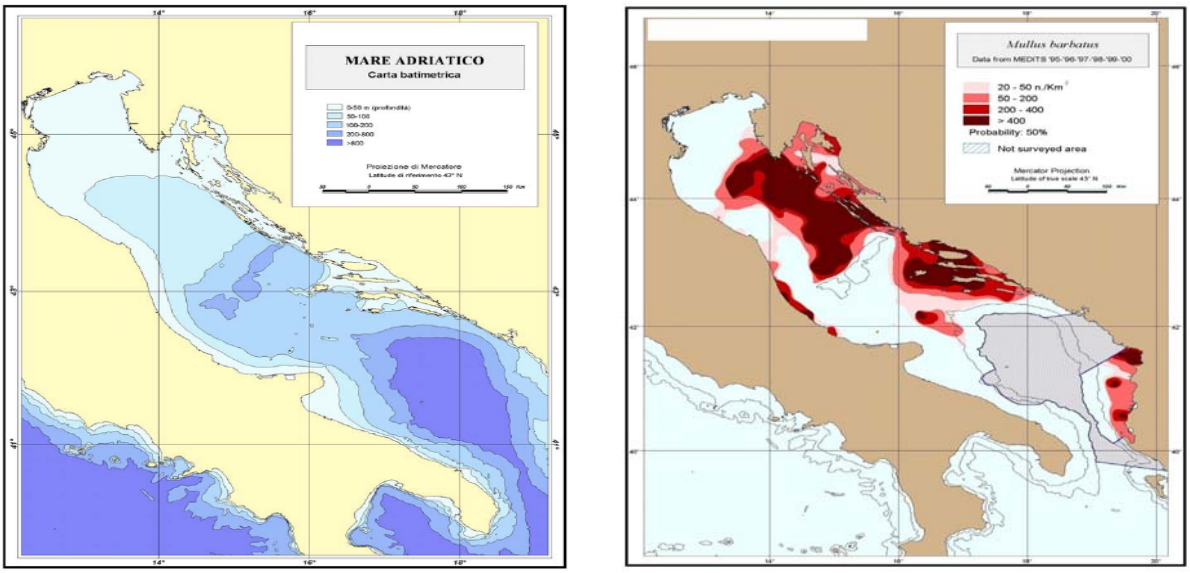


Fig. 7.24.1.1.1 Topography and geographical distribution patterns of red mullet in GSA 17.

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 (STECF, 2002).

7.24.1.2. Growth

No information was documented during SGMED-08-03.

7.24.1.3. 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 7.24.1.3.1.

Tab. 7.24.1.3.1 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	

7.24.2. Fisheries

7.24.2.1. 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 (STECF, 2002).

7.24.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.24.2.3. Catches

7.24.2.3.1. Landings

Landings data were reported to SGMED-08-03 through the Data collection regulation and are listed in Table A3.1 of Appendix 3. Annual landings increased to 3,880 t in 2004 and decreased to 3.425 t in 2007 (Tab. 7.24.2.3.1.1). Demersal otter trawlers dominate the landings by far.

Table 7.24.2.3.1.1 Annual landings (t) by fishing technique as reported to SGMED-08-03 through the DCR data call.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	17	ITA	DRB	29					
MUT	17	ITA	DTS	2475	2394	3620	3553	3180	3357
MUT	17	ITA	PGP	209	214	153	45	12	7
MUT	17	ITA	PMP	374	487	27	14		
MUT	17	ITA	PTS	11	16	4	5	1	
MUT	17	ITA	TBB			80	79	33	61
SUM				3098	3111	3884	3696	3226	3425

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. 7.24.2.3.1.1) were estimated to be over 2,000 tonnes in many years of the 1980s and 1990s. An increasing trend occurred over the 1990s.

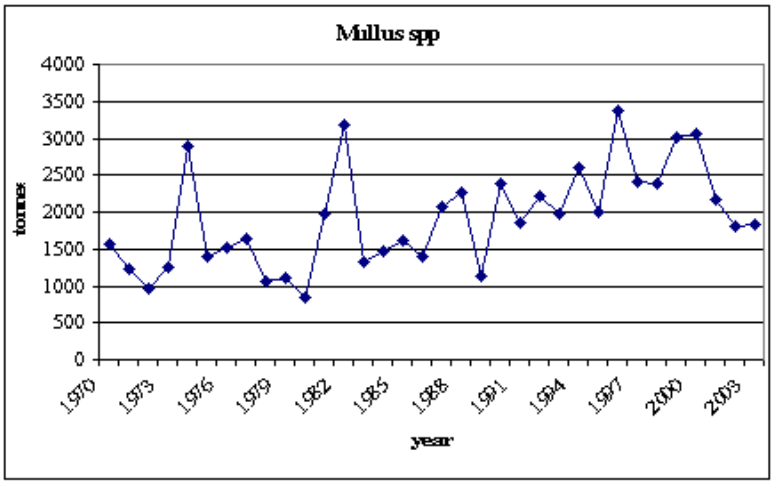


Fig. 7.24.2.3.1.1 Annual landings of red mullet in the northern and central Adriatic Sea according to FAO.

7.24.2.3.2. Discards

147 t of discards in 2006 were reported to SGMED-08-03 and are listed in Tab. A3.4 of Appendix 3.

7.24.2.3.3. Fishing effort

Tab. 7.24.2.3.3.1 lists the effort by fishing technique deployed in GSA 17 as reported to SGMED-08-03 throught the DCR data call and listed in Tab. A3.5 of Appendix 3. The main gear demersal otter trawl reveals a significant decreasing trend in effort deployed.

Tab. 7.24.2.3.3.1 Effort trends by fishing technique in GSA 17.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	17	ITA	DRB	58297	69126	64120	54047	59099	70261
DAYS	17	ITA	DTS	124529	125106	134776	126013	114903	102270
DAYS	17	ITA	HOK			641	595	610	487
DAYS	17	ITA	PGP	335599	272040	287886	260459	233846	217661
DAYS	17	ITA	PMP	96386	98110	15512	12743		
DAYS	17	ITA	PTS	23522	25649	23387	22453	23104	22981
DAYS	17	ITA	TBB			12395	13166	12440	10901
GT*DAYS	17	ITA	DRB			858864	697091	792375	959807
GT*DAYS	17	ITA	DTS			5624744	5429766	4656664	4283788
GT*DAYS	17	ITA	HOK			9492	10510	10983	9150
GT*DAYS	17	ITA	PGP			518165	429665	444329	427962
GT*DAYS	17	ITA	PMP			73495	66778		
GT*DAYS	17	ITA	PTS			1516671	1472075	1557168	1646419
GT*DAYS	17	ITA	TBB			673656	701874	812298	747714
KW*DAYS	17	ITA	DRB	6381241	7517860	6982982	5884599	6421392	7575921
KW*DAYS	17	ITA	DTS	27568094	27486393	26771813	25026709	22118619	20619962
KW*DAYS	17	ITA	HOK			153794	148821	150195	121827
KW*DAYS	17	ITA	PGP	9297244	7646003	9120053	8011107	8568762	8638666
KW*DAYS	17	ITA	PMP	7989134	7039902	1072033	1032751		
KW*DAYS	17	ITA	PTS	7841347	7636049	6955633	6778783	6978292	7156333
KW*DAYS	17	ITA	TBB			3419642	3622199	3943318	3463256

7.24.3. Scientific surveys

7.24.3.1. Medits

7.24.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 17 the following number of hauls were reported per depth stratum (s. Tab. 7.24.3.1.1.1).

Tab. 7.24.3.1.1.1. Number of hauls per year and depth stratum in GSA 17, 2002-2006.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA17_010-050									59	45	47	63	49	
GSA17_050-100									54	36	37	62	38	
GSA17_100-200									50	27	22	43	21	
GSA17_200-500									9	7	5	7	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.

7.24.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.24.3.1.3. 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 7.24.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 17.

The analyses of Medits indices are considered preliminary.

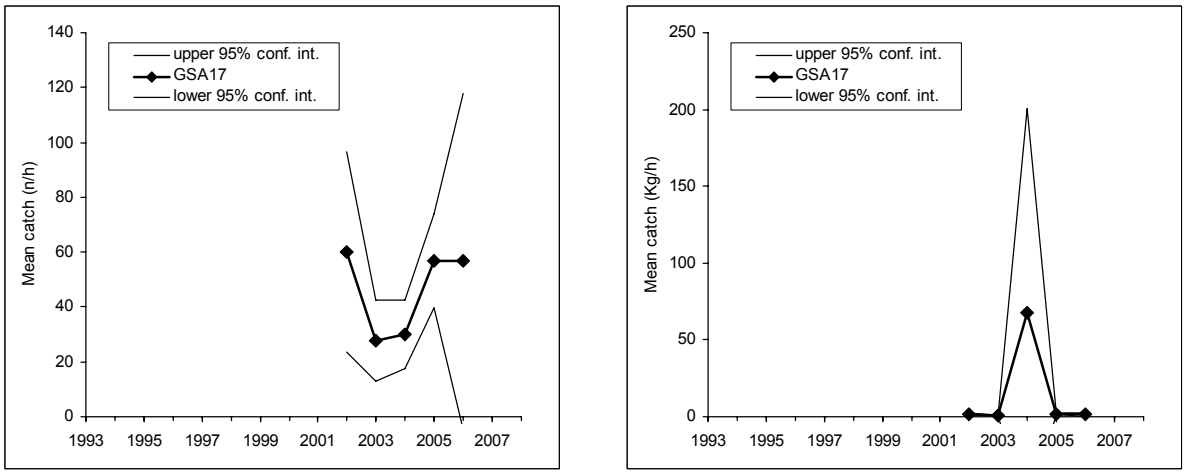


Fig. 7.24.3.1.3.1 Abundance and biomass indices of red mullet in GSA 17.

7.24.3.1.4. Trends in abundance by length or age

The following Fig. 7.24.3.1.4.1 displays the stratified abundance indices of GSA 17 in 2002-2007. These size compositions are considered preliminary.

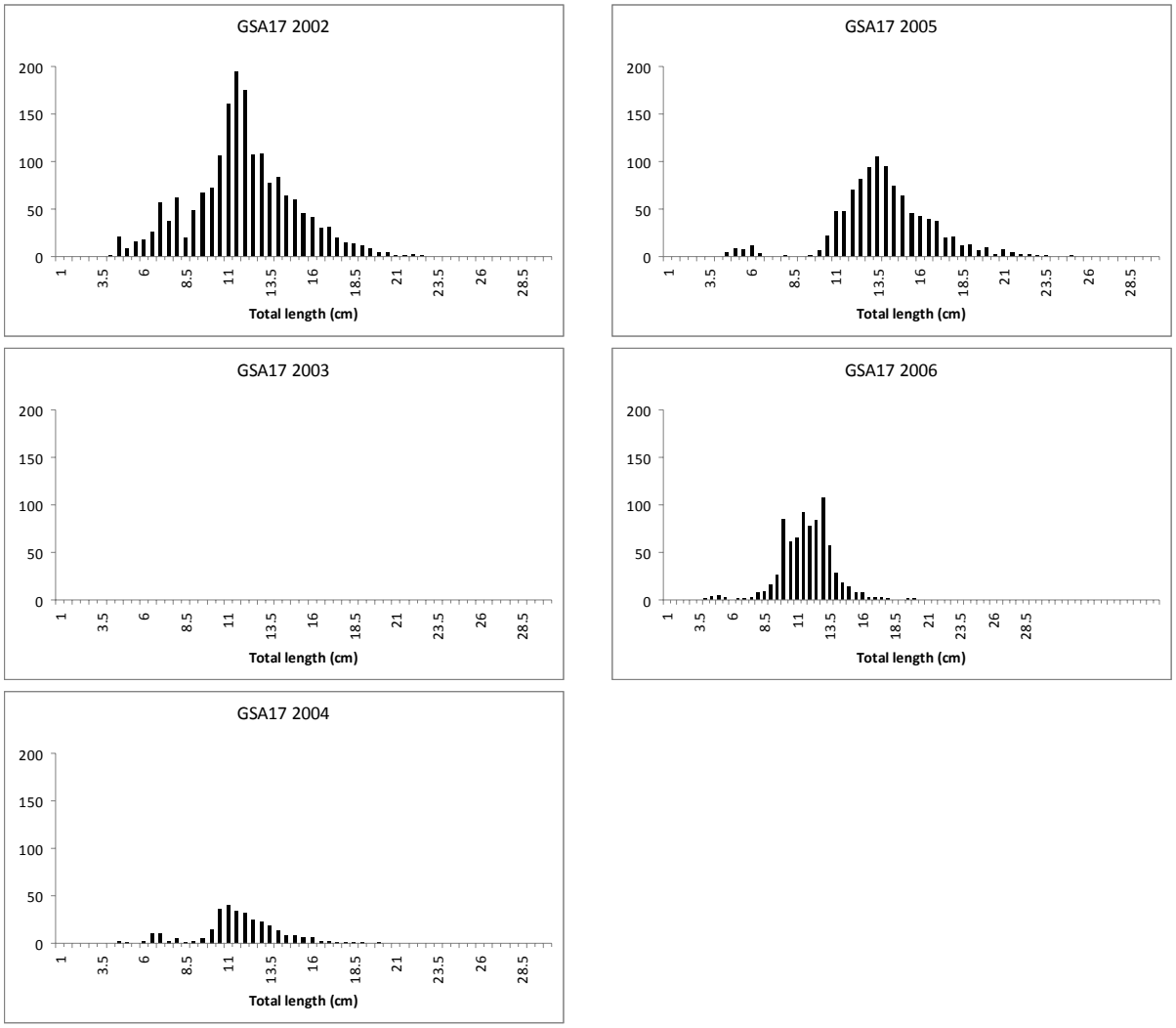


Fig. 7.24.3.1.4.1 Stratified abundance indices by size, 2002-2006.

7.24.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.24.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.24.4. Assessment of historic stock parameters

7.24.4.1. Method 1: LCA

7.24.4.1.1. Justification

Stock assessment was carried out by means of population dynamics methods. Due to the short time series of available data, Length Cohort Analysis (LCA) was selected. The software packages used were VIT and VITM (Lleonart and Salat, 1997). The latter allowed the use of a different natural mortality rate, M, as a function of length.

7.24.4.1.2. Input parameters

The landings used represented the Italian mean calculated for the years 2006 and 2007, 3,226 and 3,424 tonnes, respectively. These values are similar to those observed in the previous years from 2002 to 2005.

The length frequency distributions obtained for Italy through DCR in 2006 and 2007 were used. They were relative to bottom otter trawlers and was thus assumed that these distributions were also representative for the other gears. As noted above, these gears accounted for a small fraction of the catch.

A longer times series (i.e. five - six years) of length frequency data would have been better for the stock assessment method being used.

The total number of caught individuals was distributed in the length classes 9, 10, 11,…, 20+ cm.

Females and males were used as combined.

Though the DCR investigation carried out in 2006 indicated that discarding at sea of smaller size specimens (mostly between 9 and 13 cm) might occur, these estimated data were not used to correct landings, as there were concerns regarding their reliability. A strong fluctuation between estimated discards in the third and fourth quarter of 2006 was seen: 147 tonnes (with 19 trips on board) and 0 tonnes (with 92 trips) (0 and 2 trips were carried for the first and second quarter), although the large third quarter discards could be the result of young red mullet being caught in September. These data need further investigation.

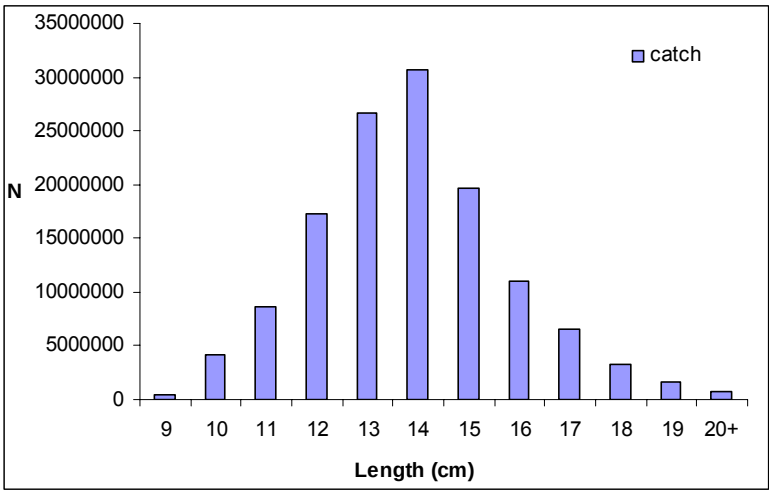


Fig. 7.24.4.1.2.1 Size composition of the landings used.

In order to calculate some parameters, the sex ratio Females/Total was assumed to be equal to 0.50. A quite similar value of F/T, 0.43, was estimated using the values of F/T at length obtained through DCR in the year 2007, which were weighted on the corresponding numbers of caught individuals at length.

The von Bertalanffy growth parameters used were L_∞ = 25.0 (cm), k = 0.42 (year^{-1}), t0 = -0.790 (year). They were calculated as weighted means of the values for females and males, by using the mentioned sex ratio.

The original values for females (L_∞ = 27.0, k = 0.40, t_0 = -0.780) and males (L_∞ = 23.0, k = 0.43, t_0 = -0.800) were obtained from the SAMED project (European Commission, 2002) for the GSA 17.

The summary of the von Bertalanffy parameter values estimated for the Adriatic Sea was imported from Vrgoc *et al.* (2004), as follows. Here, the index Phi' is also shown.

Tab. 7.24.4.1.2.1 Overview of v. Bertalanffy growth parameters.

Author	Sex	L_∞ (cm)	K (yr^{-1})	t_0 (yr)	Φ'
Scaccini (in Levi *et al.*, 1994)	M+F	27.49	0.5	-0.25	5.93
Jukić and Piccinetti, 1988	M+F	27.0	1.8		7.18
Marano, 1994; Ungaro *et al.*, 1994	M+F	19.70	0.360	-1.18	4.94
Vrgoč, 1995 ("Hvar")	M+F	27.75	0.274	-0.616	5.35
Marano, 1996; Marano *et al.*, 1998b, c	M	27	0.184	-1.92	4.90
	F	34.5	0.156	-1.53	5.22
	M+F	31.5	0.182	-1.45	5.19
	M+F (Bhatt)	26.3	0.45		5.74
Ardizzone, 1998	M+F	27.50	0.50		5.93
Marano, 1998b, c	M	22.5	0.24	-1.29	4.80
	F	26.2	0.23	-1.41	5.06
	M+F	22.5	0.38	-0.63	5.26
	M+F (Bhatt)	25.4	0.25		5.08
	M+F (Surf.)	23	0.52		5.62
Vrgoč, 2000	M+F	26.86	0.295		5.36
EC XIV/298/96-EN, Ionian and Southern Adriatic	M+F	21.72	0.31		4.99
EC XIV/298/96-EN, Adriatic Sea	M+F	27.5	0.50		5.94

The annual mortality rate M = 0.64 ($year^{-1}$) was used. It was calculated as weighted mean of the values for females and males, by using the mentioned sex ratio. The original values for females (M = 0.61) and males (M = 0.66) were obtained from the SAMED project (European Commission, 2002) for the GSA 17.

The summary of the M values estimated for the Adriatic Sea was imported from Vrgoc *et al.* (2004), as follows.

Tab. 7.24.4.1.2.2 Overview of values of natural mortality M and fishing mortaliy and total mortality Z.

Author	M (yr^{-1})	F(yr^{-1})	Z (yr^{-1})
Arneri and Jukić, 1986			2.47 –4.37 (age 0 – 1)
			1.64
Haidar, 1970	-	-	0.64
Jukić and Piccinetti, 1988			1.64
Piccinetti and Jukic, 1988			1.45-1.63
Marano *et al.*, 1994	0.43	0.10 – 0.64	0.53-1.07
Ungaro *et al.*, 1994	0.43		1.13 – 1.28
Marano, 1996	0.77	1.11 F_{max}=0.6-0.85	1.88(1.61-2.15)
Ardizzone, 1998	0.91 (Pauly) 0.51 (Djabali)	$F_{(obs)}$=2.60 $F_{(0,1)}$=1.00	
GMS-GRUND, 1998			2.99
Marano *et al.*, 1998b	0.31	0.92	1.23(1.02-1.43)
Marano *et al.*, 1998c	0.43-0.77		1.2-1.9
Vrgoč, 2000	0.58	0.90	0.61
EC XIV/298/96-EN (Ionian Sea and Southern Adriatic Sea)		$F_{(obs)}$=0.65-1.28	
	0.69 (Pauly)	$F_{(0,1)}$=0.6-1.63	
	0.41 (Djabali)	$F_{(0,1)}$=0.36-0.65	
EC XIV/298/96-EN (Adriatic Sea)		$F_{(obs)}$=0.91-4.09 (obs)	
	0.91 (Pauly)	$F_{(0,1)}$= 0.95-1.85	
	0.51 (Djabali)	$F_{(0,1)}$=0.52-0.79	

It is worth noting that M = 0.64 is slightly higher than the value (0.62) obtained by means of the relationship suggested by Jensen (1996, 2001), i.e. M = 1.5 k (with k = 0.42). Moreover, the value M = 0.64 is placed about in the middle of the range of values in the table from Vrgoc *et al.* (2004). Thus, the most conservative

M (i.e. lower M implies lower estimated biomass), among the possible values shown here, was not used in the present stock assessment.

Different input (start) values of the fishing mortality rate, F, for the last length class, 20+, were evaluated.

7.24.4.1.3. Results

The mean biomass at sea estimated by LCA was equal to 4,169 tonnes and, thus, slightly higher than the catch value.

The unweighted mean F was equal to 1.08. When the mean F was weighted on the estimated mean numbers of fish at sea, the obtained value was 0.62.

The corresponding values of F/Z were 0.63 and 0.50, with unweighted and weighted F, respectively.

The values of both F and F/Z estimated for each length class are shown in the Fig. 7.24.4.1.3.1. High values of F (higher than 1.0) are observed for some length classes. In the figure on the right, both F and F/Z are displayed as a function of age (transformation from length into age class was based on the same von Bertalanffy parameters used for LCA).

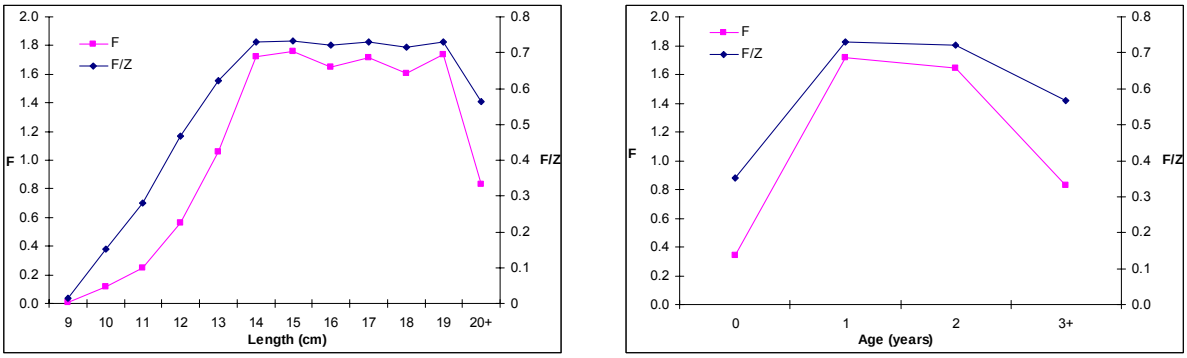


Fig. 7.24.4.1.3.1 Estimated exploitation patterns over length and ages.

7.24.5. Short term prediction for 2008 and 2009

7.24.5.1. Justification

No forecast analyses were conducted.

7.24.5.2. Input parameters

No forecast analyses were conducted.

7.24.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSA 17.

7.24.6. Medium term prediction

7.24.6.1. Justification

No forecast analyses were conducted.

7.24.6.2. Input parameters

No forecast analyses were conducted.

7.24.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSA 17.

7.24.7. Long term prediction

7.24.7.1. Justification

No forecast analyses were conducted.

7.24.7.2. Input parameters

No forecast analyses were conducted.

7.24.7.3. Results

Given the values of F and F/Z (the latter one equal to or higher than 0.50) the stock can be considered to be fully exploited. As said for the stock of hake, according to Rochet and Trenkel (2003), it would be safe to avoid F/Z higher than 0.50. Also, a high seasonal (from September to November) fishing mortality of red mullet has to be taken into account. Thus, there is some degree of risk of overexploitation for red mullet in the GSA 17.

According to R(CE) 1967/2006 the minimum legal length for fishery is, for red mullet, equal to 11 cm.

A reasonable value of length at the first sexual maturity for red mullet, in the GSA 17, is 12 cm for females and 10.5 cm for males, as reported by Haidar (1970) mentioned in Vrgoc *et al.* (2004).

In conclusion, a meaningful percentage of caught red mullet may have a length around the values of sexual maturity. This is a further reason for caution in managing this stock.

7.24.8. Scientific advice

7.24.8.1. Short term considerations

7.24.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.24.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.24.8.1.3. State of exploitation

SGMED-08-03 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.

7.24.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.25. Stock assessment of red mullet in GSA 18

7.25.1. Stock identification and biological features

7.25.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.25.1.2. Growth

No information was documented during SGMED-08-03.

7.25.1.3. Maturity

No information was documented during SGMED-08-03.

7.25.2. Fisheries

7.25.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.25.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.25.2.3. Catches

7.25.2.3.1. Landings

Tab. 7.25.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-08-03 through the Data Collection Regulation and are listed in Table A3.2 of Appendix 3. Since 2002 the annual landings decreased from 4,910 t to only 1,800 t in 2007. The landings were mainly taken by demersal otter trawls.

Tab. 7.25.2.3.1.1 Annual landings (t) by fishing technique in GSA 18.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	18	ITA	DTS	3114	1750	1817	1350	1804	1680
MUT	18	ITA	HOK				0		
MUT	18	ITA	PGP	90	312	205	99	130	123
MUT	18	ITA	PMP	1707	308	40			
MUT	18	ITA	PTS			2			
SUM				4911	2370	2064	1449	1934	1803

7.25.2.3.2. Discards

No information was documented during SGMED-08-03.

7.25.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-08-03 are listed in Tab. 7.25.2.3.3.1 and in Tab. A3.5 of Appendix 3. The effort of the major trawler fleet decrased form 2002 to 2007..

Tab. 7.25.2.3.3.1 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
DAYS	18	ITA	DRB	11081	5890	3865	5776	7562	8132
DAYS	18	ITA	DTS	85424	71203	80259	84207	88418	73637
DAYS	18	ITA	HOK			1799	3053	4397	3190
DAYS	18	ITA	PGP	110621	63332	67232	80648	88583	68253
DAYS	18	ITA	PMP	53475	35980	3667			
DAYS	18	ITA	PTS	4140	4526	4679	4428	5291	6186
GT*DAYS	18	ITA	DRB			41347	62244	81590	87740
GT*DAYS	18	ITA	DTS			2568868	2592741	2632767	2275442
GT*DAYS	18	ITA	HOK			27800	58254	79940	58026
GT*DAYS	18	ITA	PGP			120701	146182	147150	115612
GT*DAYS	18	ITA	PMP			40920			
GT*DAYS	18	ITA	PTS			369876	360279	446754	516692
KW*DAYS	18	ITA	DRB	1100225	584801	381968	570792	746921	807073
KW*DAYS	18	ITA	DTS	17112022	14530793	14369490	14621928	14929696	12904532
KW*DAYS	18	ITA	HOK			284535	514377	778355	567996
KW*DAYS	18	ITA	PGP	1722336	1002933	1180371	1442219	1394671	1311109
KW*DAYS	18	ITA	PMP	7277279	4416994	351689			
KW*DAYS	18	ITA	PTS	1480945	1464793	1842716	1785787	2221605	2613654

7.25.3. Scientific surveys

7.25.3.1. Medits

7.25.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 18 the following number of hauls were reported per depth stratum (s. Tab. 7.25.3.1.1.1).

Tab. 7.25.3.1.1.1. Number of hauls per year and depth stratum in GSA 18, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA18_010-050	14	15	15	14	14	14	14	15	11	11	10	9	10	9
GSA18_050-100	14	14	14	15	15	15	15	14	13	13	15	15	14	14
GSA18_100-200	24	23	23	23	23	23	23	23	26	23	24	25	25	22
GSA18_200-500	10	10	10	10	10	10	10	10	8	8	8	9	9	6
GSA18_500-800	10	10	10	10	10	10	10	10	7	7	8	7	7	7

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.

7.25.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.25.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 18 was derived from the international survey Medits. Figure 7.25.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 18.

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 (uncertainty). The analyses of Medits indices are considered preliminary.

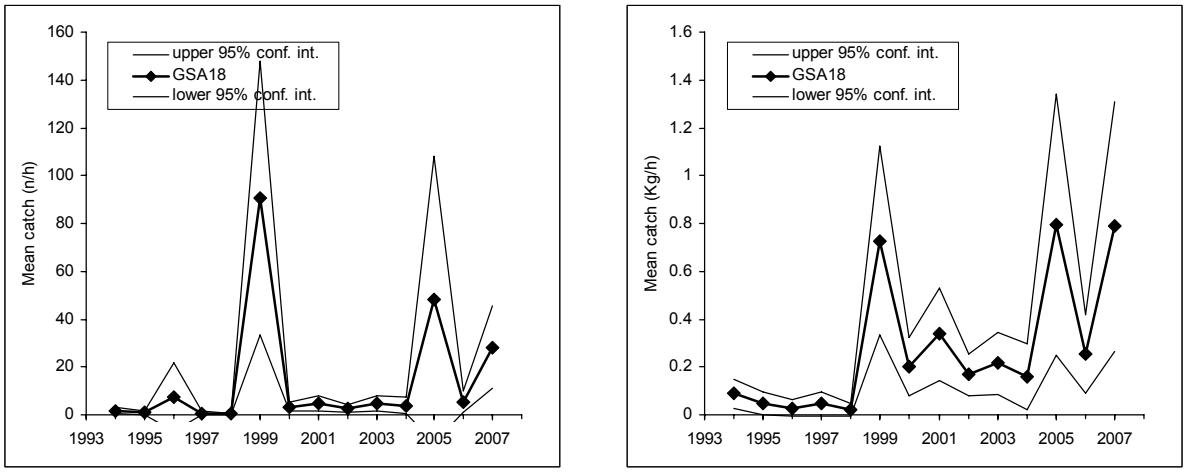


Fig. 7.25.3.1.3.1 Abundance and biomass indices of red mullet in GSA 18.

7.25.3.1.4. Trends in abundance by length or age

The following Fig. 7.25.3.1.4.1 and 2 display the stratified abundance indices of GSA 18 in 1995-2002 and 2003-2007. These size compositions are considered preliminary.

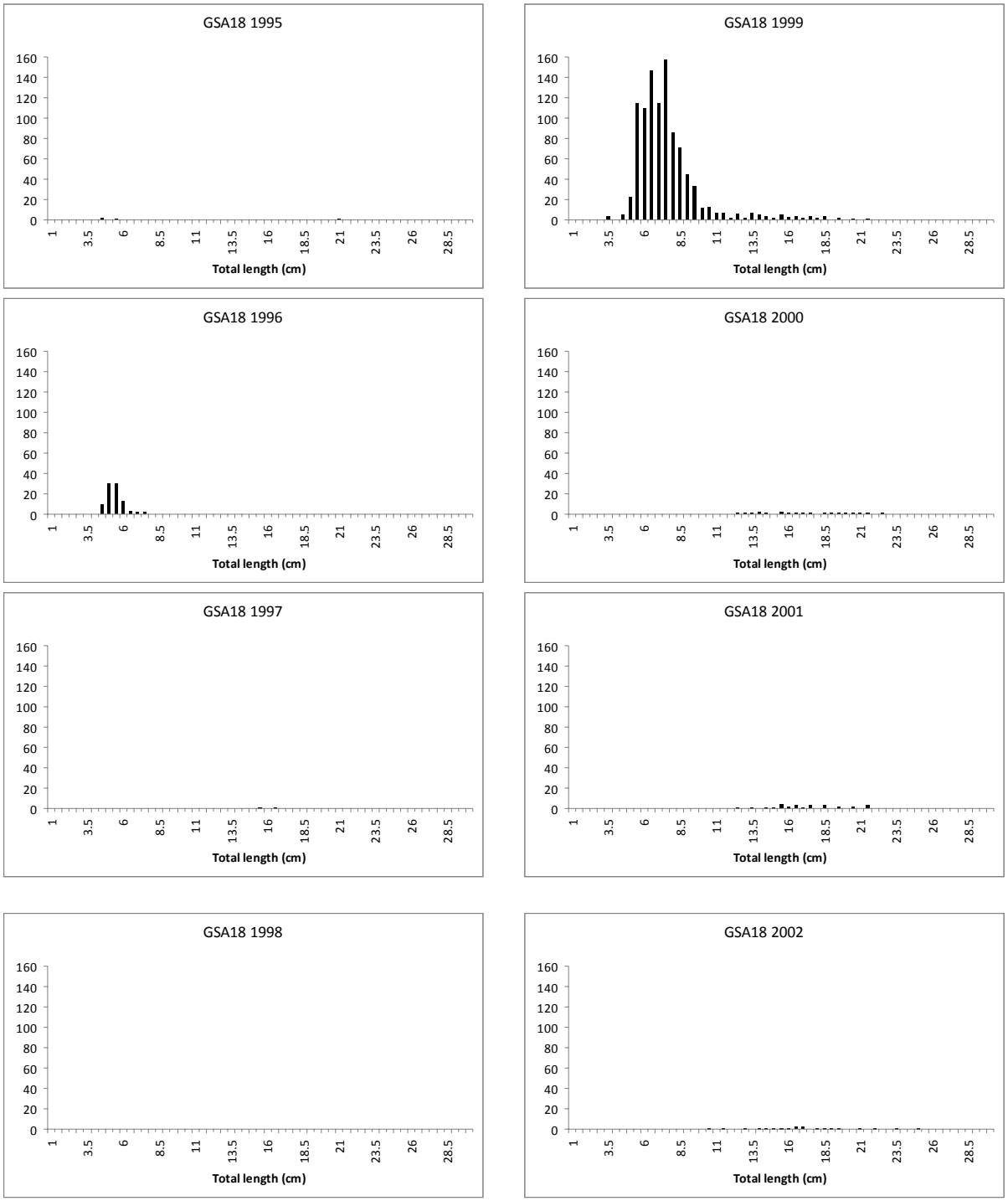


Fig. 7.25.3.1.4.1 Stratified abundance indices by size, 1995-2002.

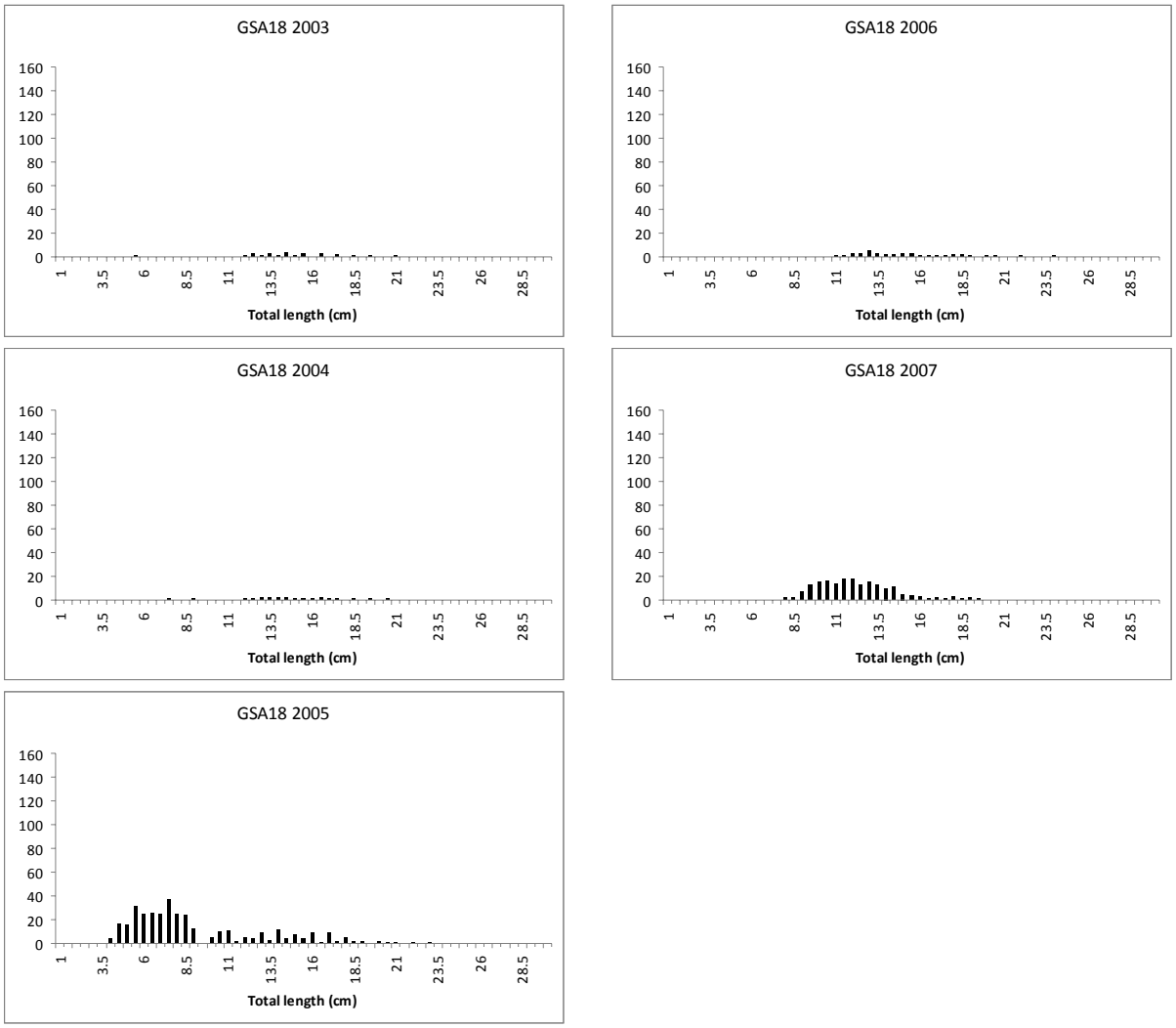


Fig. 7.25.3.1.4.2 Stratified abundance indices by size, 2003-2007.

7.25.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.25.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.25.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.25.5. Short term prediction for 2008 and 2009

7.25.5.1. Justification

No forecast analyses were conducted.

7.25.5.2. Input parameters

No forecast analyses were conducted.

7.25.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSA 18.

7.25.6. Medium term prediction

7.25.6.1. Justification

No forecast analyses were conducted.

7.25.6.2. Input parameters

No forecast analyses were conducted.

7.25.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSA 18.

7.25.7. Long term prediction

7.25.7.1. Justification

No forecast analyses were conducted.

7.25.7.2. Input parameters

No forecast analyses were conducted.

7.25.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 18.

7.25.8. Scientific advice

7.25.8.1. Short term considerations

7.25.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.25.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.25.8.1.3. State of exploitation

SGMED-08-03 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.

7.25.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.26. Stock assessment of red mullet in GSA 19

7.26.1. Stock identification and biological features

7.26.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.26.1.2. Growth

No information was documented during SGMED-08-03.

7.26.1.3. Maturity

No information was documented during SGMED-08-03.

7.26.2. Fisheries

7.26.2.1. 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.

7.26.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.26.2.3. Catches

7.26.2.3.1. Landings

Tab. 7.26.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-08-03 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 2007. Many geras contributed to the reported landings.

Tab. 7.26.2.3.1.1 Annual landings (t) by fishing technique in GSA 19.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	19	ITA	DTS	782	427	321	294	566	288
MUT	19	ITA	HOK			69	70		
MUT	19	ITA	PGP	243	1152	508	747	321	253
MUT	19	ITA	PMP	1242	870	53	2		
MUT	19	ITA	PTS	6	2				
SUM				2273	2451	951	1113	887	541

7.26.2.3.2. Discards

7 t of discards in 2005 were reported to SGMED-08-03 through the DCR data call and are listed in Tab. A3.4 of Appendix 3.

7.26.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-08-03 are listed in Tab. 7.26.2.3.3.1 and in Tab. A3.5 of Appendix 3.

Tab. 7.26.2.3.3.1 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
DAYS	19	ITA	DTS	31381	31586	37234	42413	42976	40423
DAYS	19	ITA	HOK			39190	43898	25644	17695
DAYS	19	ITA	PGP	233718	254881	225109	193806	217447	168411
DAYS	19	ITA	PMP	100208	122225	20325	6905		
DAYS	19	ITA	PTS	3458	7302	6605	5554	5507	4441
GT*DAYS	19	ITA	DTS			782163	884513	835267	800971
GT*DAYS	19	ITA	HOK			1015534	1091913	850691	710177
GT*DAYS	19	ITA	PGP			473727	438792	555916	483882
GT*DAYS	19	ITA	PMP			111129	34967		
GT*DAYS	19	ITA	PTS			195882	238105	188866	114537
KW*DAYS	19	ITA	DTS	5125805	5002396	5802023	6562337	6460683	6063817
KW*DAYS	19	ITA	HOK			6809150	7299195	5575566	4053202
KW*DAYS	19	ITA	PGP	4669873	9192254	4881153	4698292	6141378	5333724
KW*DAYS	19	ITA	PMP	13116917	9143878	1188078	341008		
KW*DAYS	19	ITA	PTS	978457	1629677	1105203	1026897	1008813	691704

7.26.3. Scientific surveys

7.26.3.1. Medits

7.26.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 19 the following number of hauls were reported per depth stratum (s. Tab. 7.26.3.1.1.1).

Tab. 7.26.3.1.1.1. Number of hauls per year and depth stratum in GSA 19, 2002-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA19_010-050									9	9	9	9	9	8
GSA19_050-100									8	8	8	8	8	9
GSA19_100-200									10	10	10	10	10	10
GSA19_200-500									14	14	14	15	14	14
GSA19_500-800									29	29	29	28	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.

7.26.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.26.3.1.3. 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 7.26.3.1.3.1 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 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.

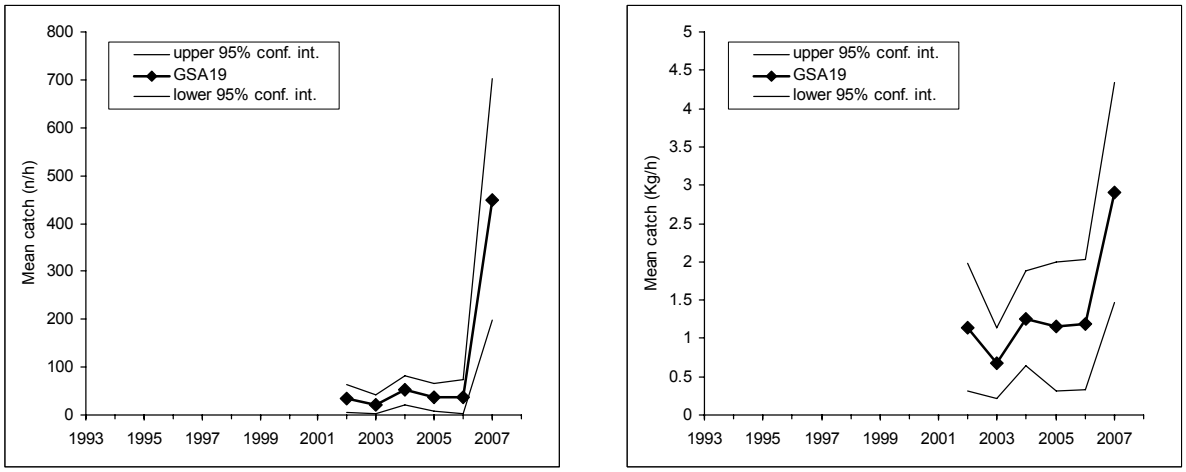


Fig. 7.26.3.1.3.1 Abundance and biomass indices of red mullet in GSA 19.

7.26.3.1.4. Trends in abundance by length or age

The following Fig. 7.26.3.1.4.1 display the stratified abundance indices of GSA 19 in 2002-2007. These size compositions are considered preliminary.

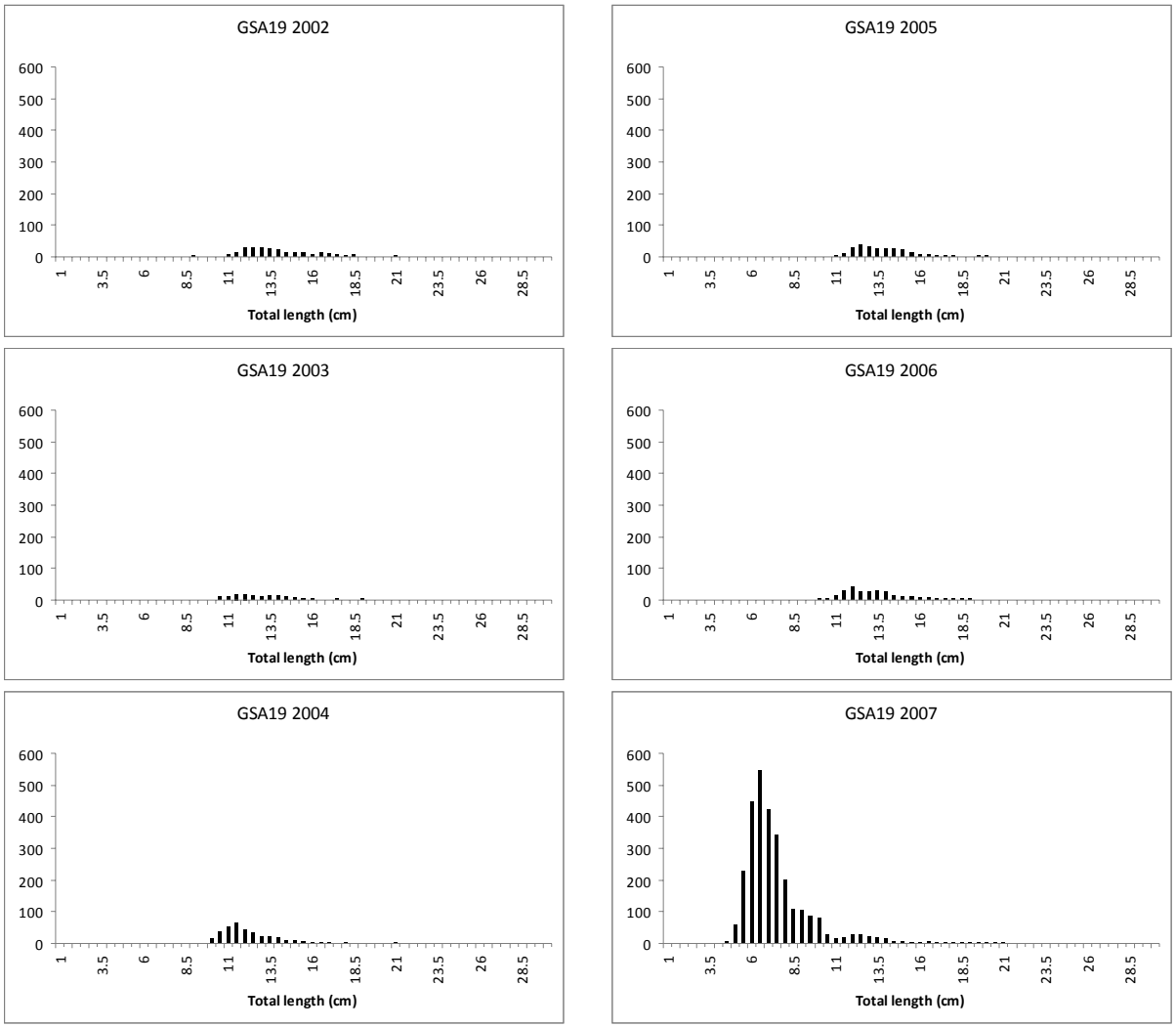


Fig. 7.26.3.1.4.1 Stratified abundance indices by size, 2002-2007.

7.26.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.26.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.26.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.26.5. Short term prediction for 2008 and 2009

7.26.5.1. Justification

No forecast analyses were conducted.

7.26.5.2. Input parameters

No forecast analyses were conducted.

7.26.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSA 19.

7.26.6. Medium term prediction

7.26.6.1. Justification

No forecast analyses were conducted.

7.26.6.2. Input parameters

No forecast analyses were conducted.

7.26.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSA 19.

7.26.7. Long term prediction

7.26.7.1. Justification

No forecast analyses were conducted.

7.26.7.2. Input parameters

No forecast analyses were conducted.

7.26.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 19.

7.26.8. Scientific advice

7.26.8.1. Short term considerations

7.26.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.26.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.26.8.1.3. State of exploitation

SGMED-08-03 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.

7.26.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.27. Stock assessment of red mullet in GSA 20

7.27.1. Stock identification and biological features

7.27.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.27.1.2. Growth

No information was documented during SGMED-08-03.

7.27.1.3. Maturity

No information was documented during SGMED-08-03.

7.27.2. Fisheries

7.27.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.27.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.27.2.3. Catches

7.27.2.3.1. Landings

Landings data were reported to SGMED-08-03 through the Data collection regulation and are listed in Table A3.1 of Appendix 3. Since 2003 annual landings decreased for 2,352 t to 609 t in 2006 (Tab. 7.27.2.3.1.1). Gill nets dominate the landings by far.

Table 7.27.2.3.1.1 Annual landings (t) by fishing technique as reported to SGMED-08-03 through the DCR data call, 2003-2006.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	20	GRE	GNS		2103	722	513	432	
MUT	20	GRE	OTB		163	179	225	153	
MUT	20	GRE	SV		86	26	36	24	
SUM					2352	927	774	609	

7.27.2.3.2. Discards

Reported discards from 2003 to 2005 were reported to SGMED-08-03 and are listed in Tab. A3.4 of Appendix 3. During this period, annual discards varied among 6 and 44 t (Tab. 7.27.2.3.2.1).

Table 7.27.2.3.2.1 Annual discards (t) by fishing technique as reported to SGMED-08-03 through the DCR data call, 2003-2005.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	20	GRE	GNS		38	3	38		
MUT	20	GRE	OTB		6	3	0		
SUM					44	6	38		

7.27.2.3.3. Fishing effort

Tab. 7.27.2.3.3.1 lists the effort by fishing technique deployed in GSA 20 as reported to SGMED-08-03 throught the DCR data call and listed in Tab. A3.5 of Appendix 3. A decrease is observed for the main fleet using gill nets.

Tab. 7.27.2.3.3.1 Effort trends by fishing technique in GSA 20.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	20	GRE	GNS		717773	634540	655783	588850	
DAYS	20	GRE	LLS		114160	79657	84159	73790	
DAYS	20	GRE	OTB		7810	7284	6279	6682	
DAYS	20	GRE	SV		13429	10902	10883	11363	
GT*DAYS	20	GRE	GNS		2885125	2548709	2611649	2210227	
GT*DAYS	20	GRE	LLS		436107	268489	203140	228351	
GT*DAYS	20	GRE	OTB		574443	580909	435054	565011	
GT*DAYS	20	GRE	SV		83099	62465	58441	57058	
KW*DAYS	20	GRE	GNS		29609039	22529478	21758835	17272519	
KW*DAYS	20	GRE	LLS		3247285	1435103	1823114	1448109	
KW*DAYS	20	GRE	OTB		2374841	2447515	1729664	2024955	
KW*DAYS	20	GRE	SV		863066	709465	604098	623628	

7.27.3. Scientific surveys

7.27.3.1. Medits

7.27.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 20 the following number of hauls were reported per depth stratum (s. Tab. 7.27.3.1.1.1).

Tab. 7.27.3.1.1.1. Number of hauls per year and depth stratum in GSA 20, 1994-2006.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA20_010-050	2	2	2	2	4	3	3	3		3	3	3	3	
GSA20_050-100	3	4	8	7	11	10	11	9		10	10	10	9	
GSA20_100-200	1	3	4	2	5	6	5	6		6	6	5	6	
GSA20_200-500	2	3	4	4	7	7	7	8		8	9	8	8	
GSA20_500-800	3	2	4	3	5	5	5	5		5	3	5	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.

7.27.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.27.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 09 was derived from the international survey Medits. Figure 7.27.3.1.3.1 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.

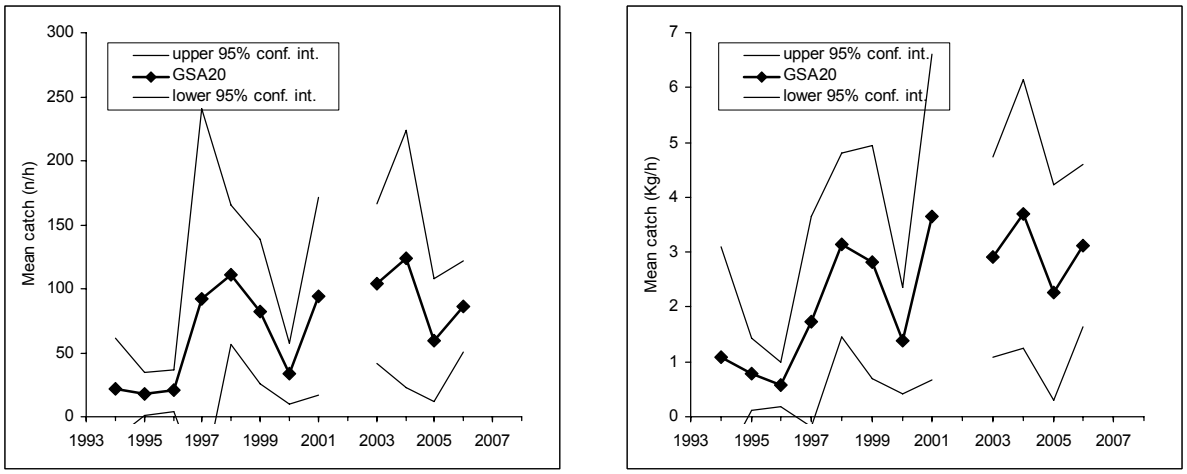


Fig. 7.27.3.1.3.1 Abundance and biomass indices of red mullet in GSA 20.

7.27.3.1.4. Trends in abundance by length or age

The following Fig. 7.27.3.1.4.1 and 2 display the stratified abundance indices of GSA 20 in 1994-2001 and 2003-2006. These size compositions are considered preliminary.

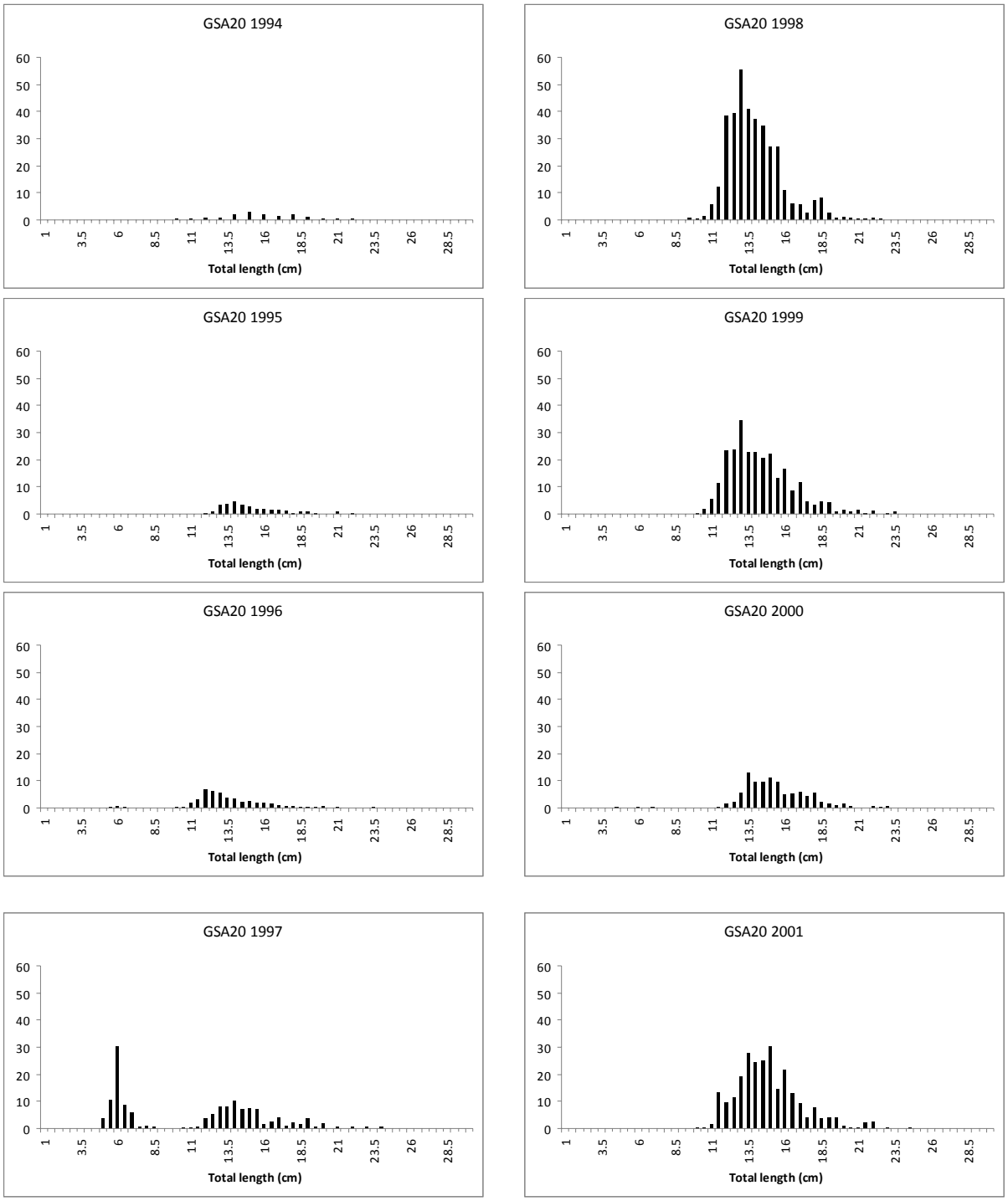


Fig. 7.27.3.1.4.1 Stratified abundance indices by size, 1994-2001.

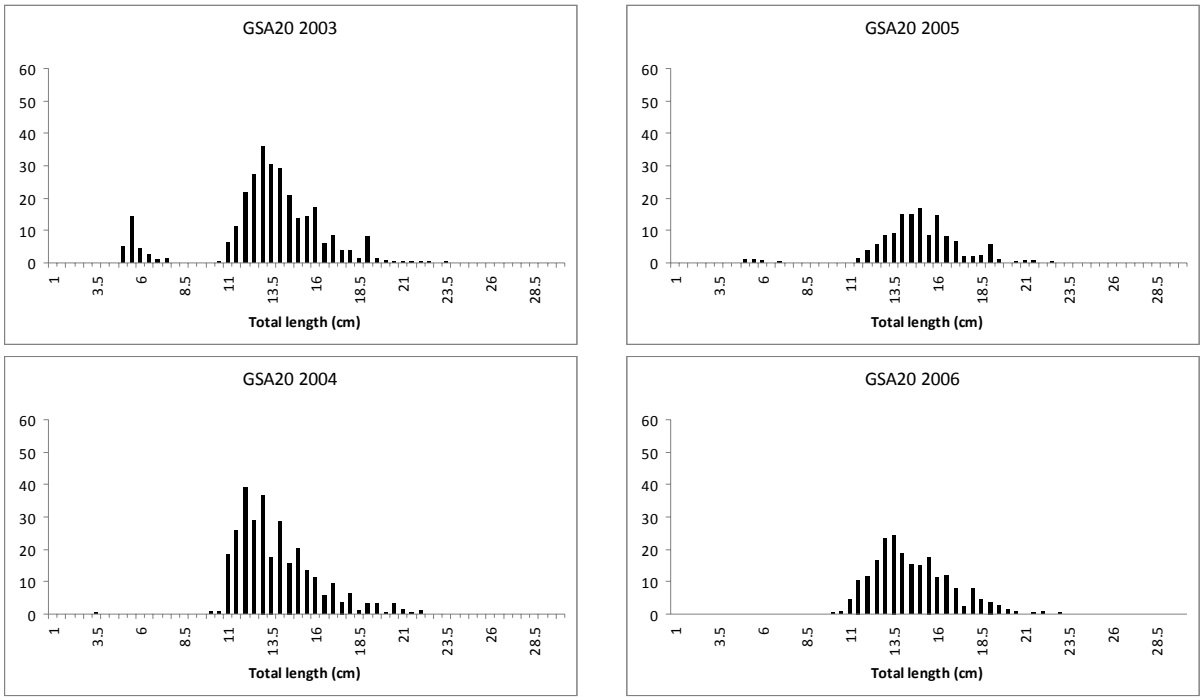


Fig. 7.27.3.1.4.2 Stratified abundance indices by size, 2003-2006.

7.27.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.27.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.27.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.27.5. Short term prediction for 2008 and 2009

7.27.5.1. Justification

No forecast analyses were conducted.

7.27.5.2. Input parameters

No forecast analyses were conducted.

7.27.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSA 20.

7.27.6. Medium term prediction

7.27.6.1. Justification

No forecast analyses were conducted.

7.27.6.2. Input parameters

No forecast analyses were conducted.

7.27.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSA 20.

7.27.7. Long term prediction

7.27.7.1. Justification

No forecast analyses were conducted.

7.27.7.2. Input parameters

No forecast analyses were conducted.

7.27.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 09.

7.27.8. Scientific advice

7.27.8.1. Short term considerations

7.27.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.27.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.27.8.1.3. State of exploitation

SGMED-08-03 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.

7.27.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.28. Stock assessment of red mullet in GSAs 22 and 23

7.28.1. Stock identification and biological features

7.28.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.28.1.2. Growth

No information was documented during SGMED-08-03.

7.28.1.3. Maturity

No information was documented during SGMED-08-03.

7.28.2. Fisheries

7.28.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.28.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.28.2.3. Catches

7.28.2.3.1. Landings

Landings data were reported to SGMED-08-03 through the Data collection regulation and are listed in Table A3.1 of Appendix 3. Since 2003 annual landings decreased from 4,320 t to 3,090 t in 2006 (Tab. 7.28.2.3.1.1). Gill nets and demersal otter trawlers dominate the landings.

Table 7.28.2.3.1.1 Annual landings (t) by fishing technique in GSAs 22 and 23 as reported to SGMED-08-03 through the DCR data call, 2003-2006.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	22-23	GRE	GNS		2364	1125	1587	1688	
MUT	22-23	GRE	OTB		1769	2152	1679	1179	
MUT	22-23	GRE	SV		184	166	285	218	
SUM					4317	3443	3551	3085	

7.28.2.3.2. Discards

Annual discards during 2003-2005 were reported to SGMED-08-03 and are listed in Tab. A3.4 of Appendix 3. Discards varied among 12 and 70 t per year (Tab.).

Table 7.28.2.3.2.1 Annual discards (t) by fishing technique in GSAs 22 ans 23 as reported to SGMED-08-03 through the DCR data call, 2003-2005.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	22-23	GRE	GNS		0	6	21		
MUT	22-23	GRE	OTB		70	6	20		
SUM					70	12	41		

7.28.2.3.3. Fishing effort

Tab. 7.28.2.3.3.1 lists the effort by fishing technique deployed in GSAs 22 and 23 as reported to SGMED-08-03 throught the DCR data call and listed in Tab. A3.5 of Appendix 3. During 2003-2006, the dominating gill nets and demersal otter trawls do not display a significant trend.

Tab. 7.20.2.3.3.1 Effort trends by fishing technique in GSAs 22-23, 2003-2006.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	22-23	GRE	GNS		1499507	1445880	1529002	1479134	
DAYS	22-23	GRE	LLS		381095	295005	315854	253335	
DAYS	22-23	GRE	OTB		52536	53389	56580	52831	
DAYS	22-23	GRE	SV		36266	31987	33200	30098	
GT*DAYS	22-23	GRE	GNS		5837915	5675508	5782002	5610405	
GT*DAYS	22-23	GRE	LLS		1762101	1660263	1602486	1323112	
GT*DAYS	22-23	GRE	OTB		4927349	4971783	5553804	5554194	
GT*DAYS	22-23	GRE	SV		294896	269645	276265	257271	
KW*DAYS	22-23	GRE	GNS		48227268	53304432	54981971	52423637	
KW*DAYS	22-23	GRE	LLS		14158502	11416302	10631705	8283337	
KW*DAYS	22-23	GRE	OTB		15792715	15877180	17730748	16402915	
KW*DAYS	22-23	GRE	SV		2775797	2206815	2193550	2022231	

7.28.3. Scientific surveys

7.28.3.1. Medits

7.28.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSAs 22 and 23 the following number of hauls were reported per depth stratum (s. Tab. 7.28.3.1.1.1).

Tab. 7.20.3.1.1.1. Number of hauls per year and depth stratum in GSAs 22 and 23, 1994-2006.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA22+23_010-050	10	10	11	10	13	12	13	13		13	13	14	14	
GSA22+23_050-100	17	21	22	28	24	26	21	25		25	23	24	24	
GSA22+23_100-200	19	25	37	36	36	33	37	35		36	43	41	41	
GSA22+23_200-500	28	35	44	50	51	51	50	48		51	52	52	52	
GSA22+23_500-800	18	12	19	21	22	21	20	17		17	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.

7.28.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.28.3.1.3. 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 7.28.3.1.3.1 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.

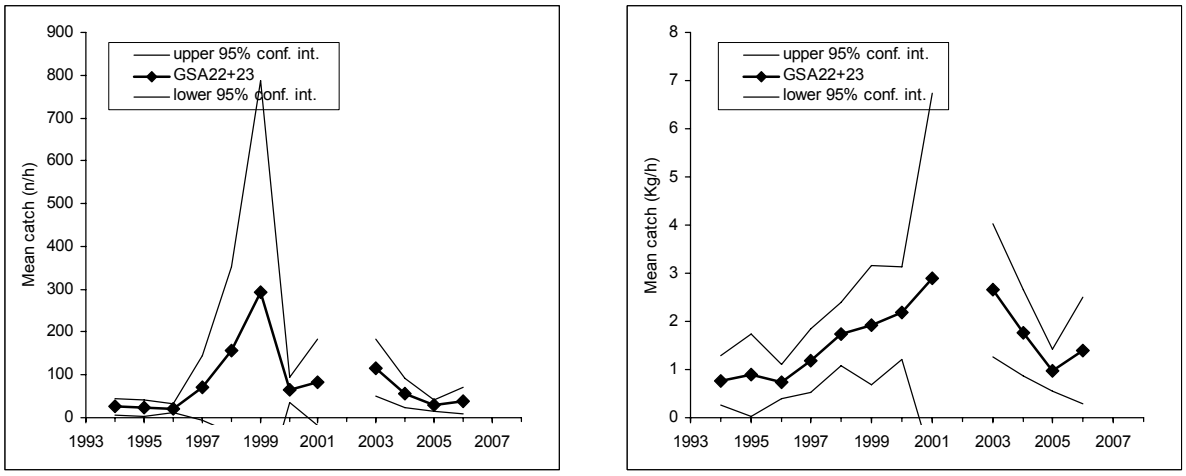


Fig. 7.20.3.1.3.1 Abundance and biomass indices of red mullet in GSAs 22 and 23.

7.28.3.1.4. Trends in abundance by length or age

The following Fig. 7.28.3.1.4.1 and 2 display the stratified abundance indices of GSAs 22 and 23 in 1994-2001 and 2002-2006. These size compositions are considered preliminary.

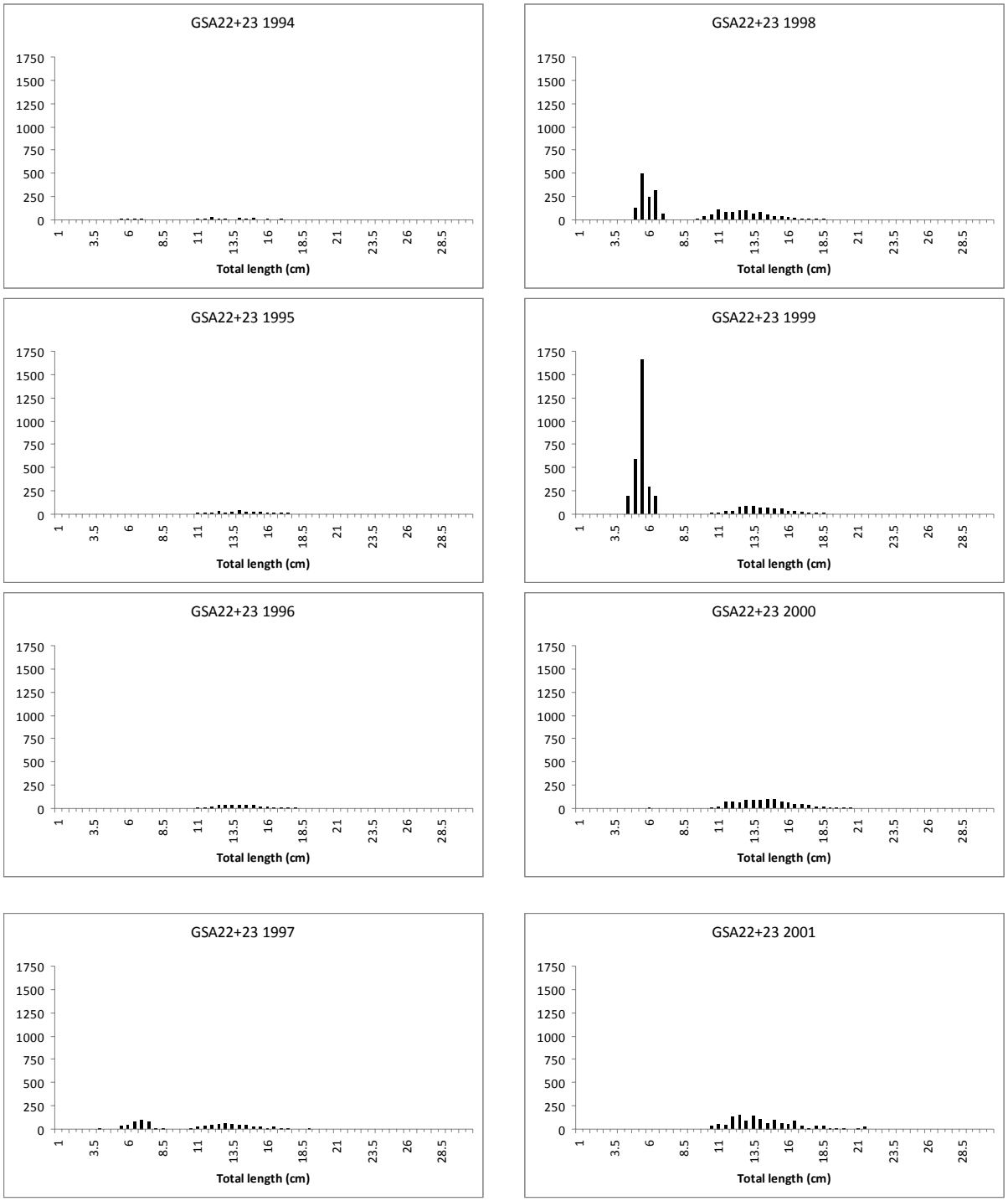


Fig. 7.28.3.1.4.1 Stratified abundance indices by size, 1994-2001.

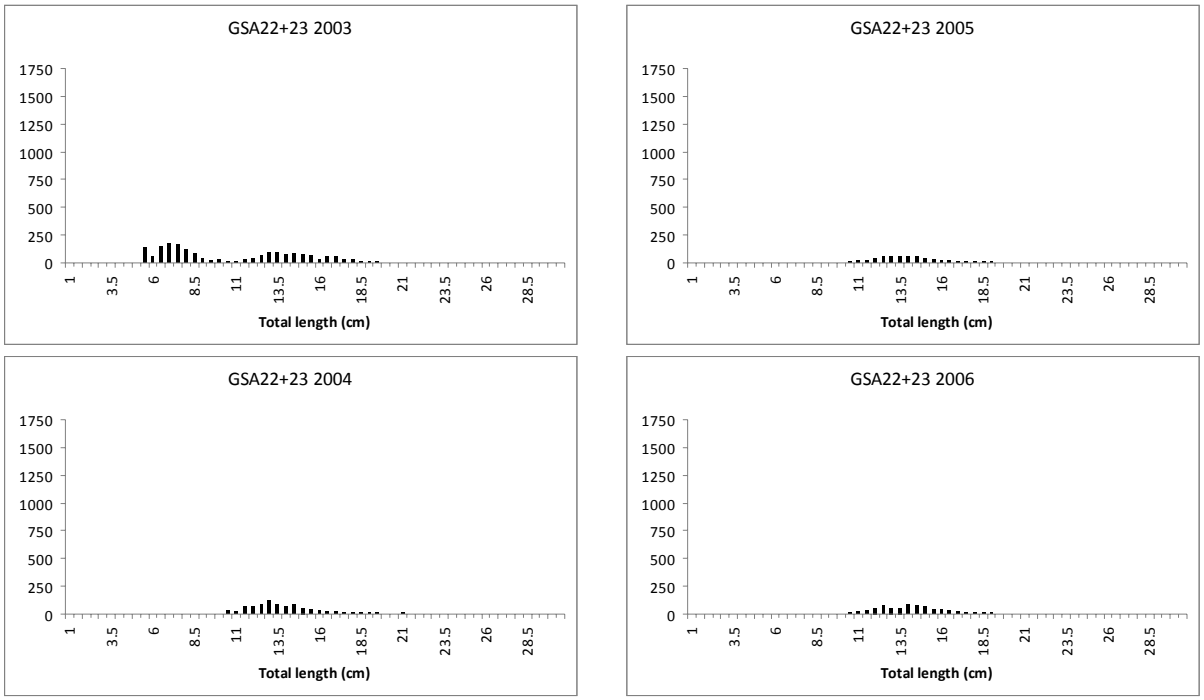


Fig. 7.28.3.1.4.2 Stratified abundance indices by size, 2003-2007.

7.28.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.28.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.28.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.28.5. Short term prediction for 2008 and 2009

7.28.5.1. Justification

No forecast analyses were conducted.

7.28.5.2. Input parameters

No forecast analyses were conducted.

7.28.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSAs 22 and 23.

7.28.6. Medium term prediction

7.28.6.1. Justification

No forecast analyses were conducted.

7.28.6.2. Input parameters

No forecast analyses were conducted.

7.28.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSAs 22 and 23.

7.28.7. Long term prediction

7.28.7.1. Justification

No forecast analyses were conducted.

7.28.7.2. Input parameters

No forecast analyses were conducted.

7.28.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSAs 22 and 23.

7.28.8. Scientific advice

7.28.8.1. Short term considerations

7.28.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.28.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.28.8.1.3. State of exploitation

SGMED-08-03 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.

7.28.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.29. Stock assessment of red mullet in GSA 25

7.29.1. Stock identification and biological features

7.29.1.1. Stock Identification

The red mullet is a common demersal fish in the Mediterranean Sea found in depths ranging from 10-200 meters. Inhabits sandy and muddy bottoms.

The fishing grounds of GSA 25 are characterized by a limited coastal shelf and a deep slope existing around most of the coast of Cyprus[2]. The substrate is characterized by various types of sediment; hard bottom predominates in the southwestern and eastern part of the island, while in the south-eastern part muddy and sandy bottoms are equally extensive. The salinity around Cyprus waters, as in the whole Levantine Sea, is about 39‰, the highest value in the Mediterranean and among the highest in the world.

Close to the surface, a seasonal pattern occurs with temperature reaching a maximum value of 29-30°C, during summer, and a minimum value of 16°C, during winter. The surface temperature remains stable around the island, except for an area at the south-western side, where waters during summer have an average temperature of 23-24 °C, possibly due to the existence of a local upwelling. In most areas a seasonal thermocline is formed during summer at a depth ranging from 20 to 30m. The temperature below the thermocline is around 18 °C.

The spawning season of red mullet in GSA 25 ranges from April to August with spawning peak in the months May-June[3].

7.29.1.2. Growth

The growth parameters of red mullet were provided by the Cyprus authorities, according to the data call[4]. It was decided during SGMED-08-03 that the biological parameters in regard to the different GSAs should be discussed. The growth parameters to be used in the assessment of red mullet were set during the meeting (see Tab. 7.29.1.2.1).

Table 7.29.1.2.1 V. Bertalanffy growth, length-weight relation parameters and coefficients of natural mortlity rates.

Species	Param.	L_{inf}	K	T_0	a	b	M

[2] Assessment of indicator trends related to exploited demersal fish populations and communities in the Mediterranean p.148, http://www.ifremer.fr/docelec/doc/2007/rapport-2198.pdf

[3] Data call 2008, Cyprus data (06_MED_GRO)

[4] Brussels, 15 May 2008,DGMARE (2008) n° 5332, Official call for data on landings, catches, length and age compositions, effort and trawl surveys in the Mediterranean

	set	(cm)					Djabali
M. barbatus	Upper	34.5	0.34	-0.143	0.0081	3.113	0,40644
	Lower	26.01	0.41	-0.4			0,22530
	Cyprus	26,01	0,2025	-1.688			0,48874

7.29.1.3. Maturity

The maturity of red mullet was provided[5] (see Fig. 7.29.1.3.1, Tab. 7.16.2). The method used was the Nikolski scale, (Individuals >stage 2 are considered mature, only reproductive months were taken into account. 2005 data derive only from Medits survey).

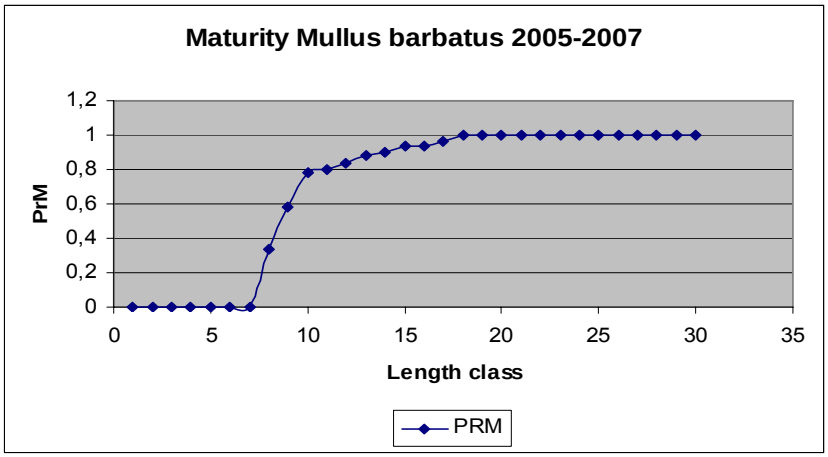


Fig. 7.29.1.3.1 Maturity at length of *Mullus barbartus*.

7.29.2. Fisheries

7.29.2.1. General description of fisheries

GSA 25 covers the area around the island of Cyprus (*official data available from areas under the control of the Cyprus Government*). It is noted that since 1974 important fishing grounds became inaccessible to the Government of the Cyprus Republic. The available fishing grounds were reduced from 846 to 507 square miles[6], leading to a dramatic increase of fishing intensity (fishing effort per square mile) in the remaining accessible fishing grounds.

The landing ports of Cyprus are categorized into ports and fishing shelters. The two main ports were catches of trawlers are landed are the ports of Larnaca and Limassol. Artisanal vessels (small scale inshore vessels) land their catch in fishing shelters.

The Cyprus fishing fleet operating in GSA 25 is categorized into the following segments:

- the small scale inshore boats,
- the polyvalent vessels,
- bottom trawlers,
- recreational vessels.

The small scale inshore boats, with an overall length between 6 - 12m, operate with passive polyvalent gears, mainly with bottom set nets and bottom longlines, targeting demersal species.

[5] Data Request Call (FILE 5-M05_MED_MAT, MATURITY_AT_LENGTH)
[6] **CYPRUS Management Plan for Bottom Trawling**

The polyvalent vessels have an overall length between 12 - 24 m and operate with passive polyvalent gears. The term "polyvalent vessels" is used because these vessels are engaged in two fisheries; mainly in the large pelagic fishery using drifting longlines and operating around Cyprus waters and the eastern Mediterranean (*targeting swordfish, bluefin tuna and albacore*), but also in the inshore demersal fishery using mostly bottom set nets and bottom longlines.

The bottom trawlers have an overall length between 21-27 m and are categorized, based on their type of license, in those fishing in the territorial waters of Cyprus and those fishing in international waters (eastern and central Mediterranean).

Recreational fishing vessels are not authorized to used various gear such as surface longlines, nets according to Article 17 "Leisure fisheries" of Council Regulation 1967/2006.

7.29.2.2. Management regulations applicable in 2007 and 2008

From November 2004, following the accession of Cyprus in the EU and the implementation of Community Law, the new fishing season included the requirements of the Mediterranean Regulation (EC) 1626/1994:

- minimum landing sizes,
- increase of cod-end mesh size from 34 mm (diamond shape) to 40 mm (diamond shape)

There is a closed trawling period applied for the territorial waters of Cyprus, from 1st of June to the 7th of November, set in the National Legislation. The closed period has been put into force since the mid `80s. All the minimum landing sizes provided by Annex III of the Mediterranean Regulation (EC) No 1967/2006 are applied. Furthermore, trawlers are not allowed to operate in waters that are shallower than 50 meters, as it was provided by the Mediterranean Regulation, 1626/1994. The fishing effort adjustment management plan is included during the Operational Program for Fisheries 2007 – 2013 having as a priority the withdrawal of all bottom trawlers that are active in the territorial waters of Cyprus.

There are no closed fishing periods for the artisanal vessels operating in the territorial waters of Cyprus.

7.29.2.3. Catches

7.29.2.3.1. Landings

The Cyprus bottom trawl, polyvalent and artisanal fishery target a mix of demersal species, as it is the case in all Mediterranean demersal fisheries. The exploited stocks are not shared with other counties' fleets. Landings[7] are mainly composed of *Spicara* spp., *Boops boops*, *Mullus barbatus*, *M. surmuletus*, *Pagellus erythrinus* and cephalopods (*Octopus vulgaris*, *Eledone moschata*, *Loligo vulgaris* and *Sepia officinalis*). The inshore fishery catches also catch quantities of *Diplodus* spp, *Sparisoma cretense* and *Siganus* spp.

The composition of the landings of the two fisheries during the last 5 years (2002-2006) is provided in Figure 7.29.2.3.1.1.

[7] **CYPRUS Management Plan for Bottom Trawling**

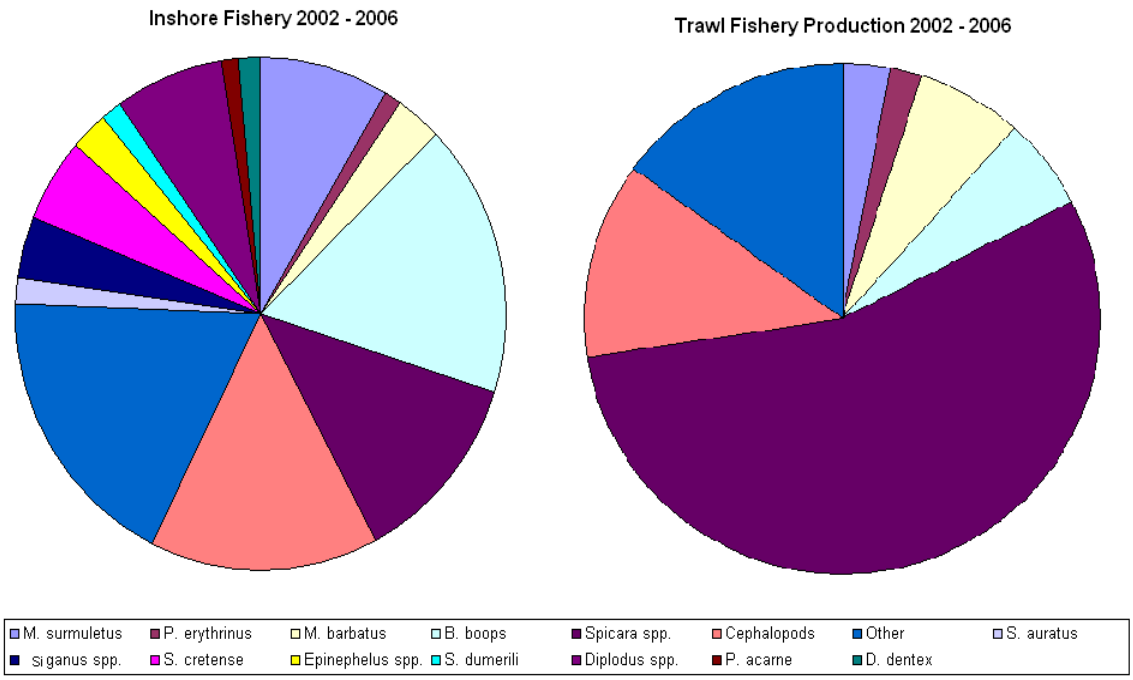


Figure 7.29.2.3.1.1 Composition of landings for the period 2002-2006.

The trends of the landings of red mullet by trawlers and artisanal vessels are illustrated in Fig. 7.29.2.3.1.2 below covering the period 1986-2006.

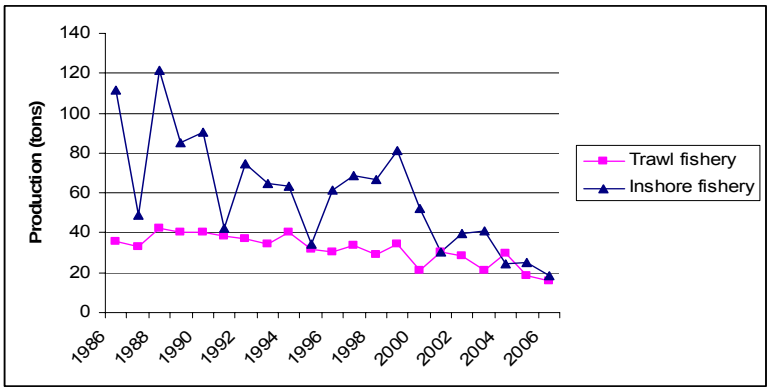


Figure 7.29.2.3.1.2 Landings of *Mullus barbatus* in GSA 25.

The evaluation of the species from the 1980s to 2004[8] (implementation of the 40mm diamond mesh size of trawl nets) from stock assessment studies performed by the Department of Fisheries and Marine Research suggested an over-exploitation of the red mullet stock. The Exploitation Rate (E) from the data analysis indicates a fluctuating E over the value of 0.5, and a high value of F of the older age groups (especially 3+ and 4+). Also, in some years a relatively significant F of the smallest age group (0+) is suggested (Data from the Department of Fisheries and Marine Research, DFMR).

[8] **CYPRUS Management Plan for Bottom Trawling**

The evaluation of the stock in 2005, the first year of implementation of the 40mm diamond mesh size of trawl net (fishing season staring in November 2004), indicated that the stock continued to be over-exploited, with an E value lower than the 2004 level (DFMR).

The data origin on catches of red mullet is based on the methodology for collecting data on catches and landings by the DFMR based on the following Data Collection Practices:

- Direct Reports given by the various segments of the Fishery
- Legislative procedures
- Interviews

Landings data were reported to SGMED-08-03 through the Data collection regulation and are listed in Table A3.1 of Appendix 3 (Tab. 7.29.2.3.1.1).

Table 7.29.2.3.1.1 Annual landings (t) by fishing technique as reported to SGMED-08-03 through the DCR data call, 2003-2007.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	25	CYP	GTR				25	18	25
MUT	25	CYP	OTB				18	16	23
SUM							43	34	48

7.29.2.3.2. Discards

Data on discard[9] (weight and numbers) were provided based on the results of the 2006 pilot study conducted[10] as part of the 2006 Cyprus National Fisheries Data Collection Programme under the EC Data Collection Regulation on-board bottom trawl vessels. The study suggests that total quantities discarded, including non-commercial species, represent 13% of the total catch[11]. Discards were raised by trip. The study also suggested that discard quantities are negligible for *Mullus barbatus*,.

- No data on length at age were provided.
- No data on length or age composition of discards.

7.29.2.3.3. Fishing effort

Fishing effort data on GSA 25 were provided according to the Official call for data on landings, catches, length and age compositions, effort and trawl surveys in the Mediterranean (FILE_2, M02_MED_EFF, EFFORT).

Tab. 7.27.2.3.3.1 lists the effort by fishing technique deployed in GSA 25 as reported to SGMED-08-03 throught the DCR data call and listed in Tab. A3.5 of Appendix 3.

Tab. 7.27.2.3.3.1 Effort trends by fishing technique in GSA 25, 2005-2007.

[9] Data call , File 08_MED_DIS
[10] Council Regulation 1543/2000, Commission Regulation 1639/2001, and Commission Regulation 1581/2004.
[11] CYPRUS Management Plan for Bottom Trawling

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	25	CYP	GTR				84706	89375	100103
DAYS	25	CYP	LLS				306	378	407
DAYS	25	CYP	OTB				1018	726	752
GT*DAYS	25	CYP	GTR				256436	275468	301864
GT*DAYS	25	CYP	LLS				2022	5245	6421
GT*DAYS	25	CYP	OTB				94561	72422	75036
KW*DAYS	25	CYP	GTR				3305514	3526850	3896835
KW*DAYS	25	CYP	LLS				21790	51626	57561
KW*DAYS	25	CYP	OTB				327616	231816	240182

7.29.3. Scientific surveys

7.29.3.1. Medits

7.29.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 20 the following number of hauls were reported per depth stratum (s. Tab. 7.29.3.1.1.1).

Tab. 7.29.3.1.1.1. Number of hauls per year and depth stratum in GSA 25, 2005-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA25_010-050												5	5	5
GSA25_050-100												8	8	8
GSA25_100-200												5	5	5
GSA25_200-500												3	3	3
GSA25_500-800												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

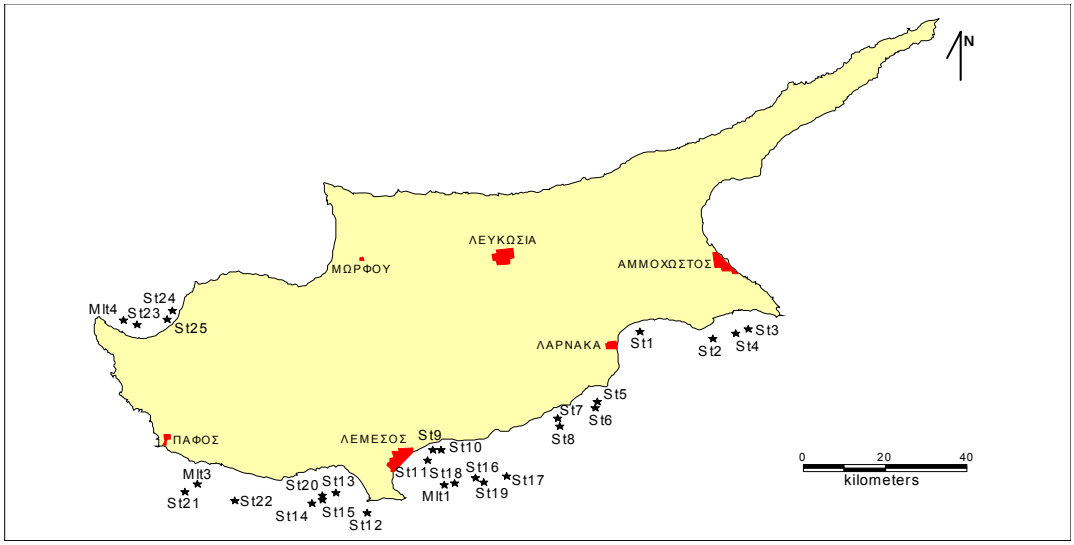
The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

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.

7.29.3.1.2. Geographical distribution patterns

The geographical distribution pattern of the Medits survey in area GSA 25 is illustrated below (Fig. 7.29.3.1.2.1, Medits stations Cyprus).



7.29.3.1.2.1 Medits stations Cyprus

7.29.3.1.3. 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-08-03 notes that the MEDITS survey does only cover the southern and north-western slopes off Cyprus. Figure 7.29.3.1.3.1 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). The analyses of Medits indices are considered preliminary.

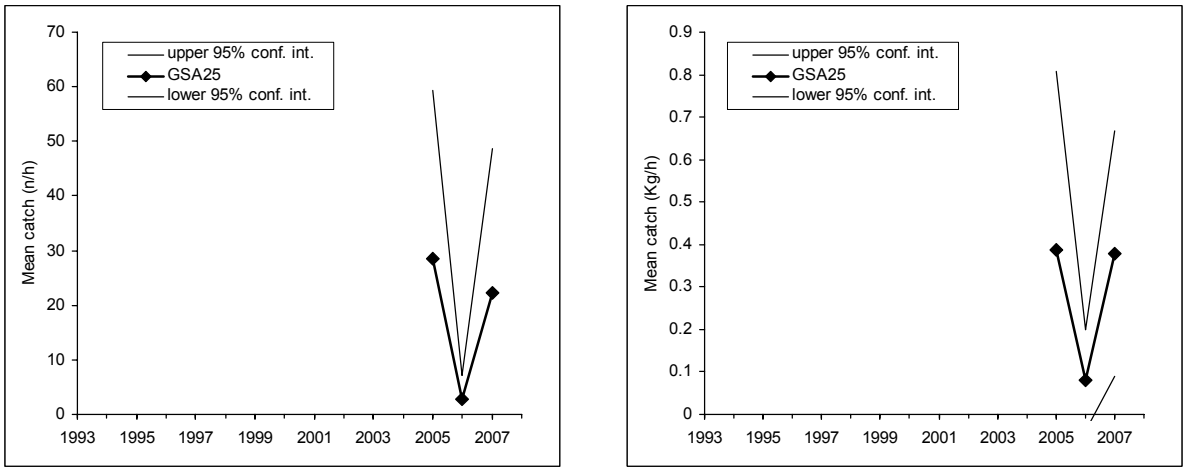


Fig. 7.27.3.1.3.1 Abundance and biomass indices of red mullet in GSA 25.

7.29.3.1.4. Trends in abundance by length or age

The following Fig. 7.29.3.1.4.1 displayS the stratified abundance indices of GSA 25 in 2005-2007. These size compositions are considered preliminary.

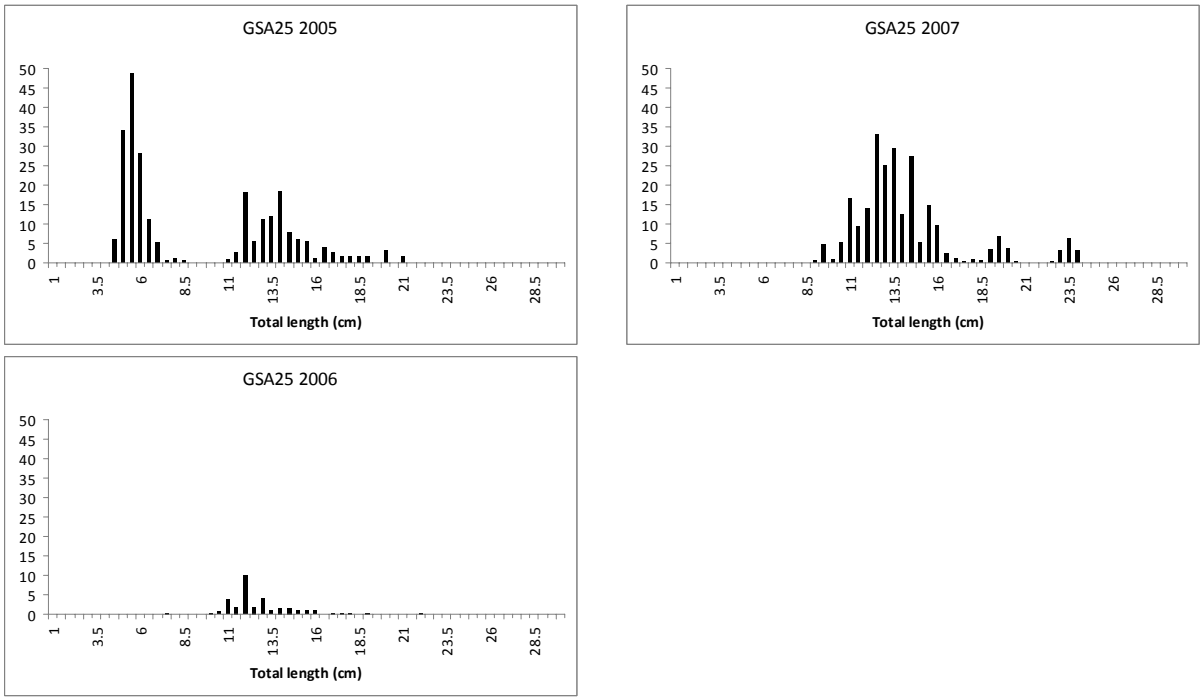


Fig. 7.29.3.1.4.1 Stratified abundance indices by size, 2005-2007.

7.29.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.29.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.29.4. Assessment of historic stock parameters

The assessment was performed using the VIT software[12]. The software was conceived for the analysis of fisheries where the time series of the information available is limited and where the technical interaction among fishing gears is an important factor to be accounted for. This program is often used to analyse Mediterranean fisheries. The program VIT was first published in Spanish (Lleonart and Salat 1992) and later in English as volume 11 of the FAO Computerized Information Series (FAO, 1997).

- Data used 2005-2007 catches in GSA 25 (limited information time series)
- Medits Survey 2005-2007

The program VIT[13] is designed for the analysis of marine populations, exploited by one or several gears, based on single species' catch data (structured by age or size). The main assumption underlying the model is that of steady state, because the program works with pseudo-cohorts and it is therefore not suitable for historical data series. The program uses the catch data and ancillary parameters for rebuilding the population of the species and the mortality vectors affecting it by means of Virtual Population Analysis (VPA). Once the virtual population has been rebuilt, an analysis of the fishery can be carried out with the aid of several tools: Comprehensive VPA results, Yield-per-Recruit analysis based on the fishing mortality vector, analysis of sensitivity to parameter values and transition analysis. The latter permits non-equilibrium analysis of how a shift in exploitation regime is reflected in the fisheries. All these tools can be applied to specific studies of competition among fishing gears.

7.29.4.1. Method 1: VIT

7.29.4.1.1. Justification

The stock assessment method used was the Length Cohort and Yield per Recruit Analysis (LCA & Y/R, VIT). Length frequency distributions of the catch by gear were available from the data submitted by Cyprus under the DCR call. Growth parameters were set by the SGMED plenary (see Table 7.29.4.1.2.1). The growth parameters provided by Cyprus were not used.

The VIT assessment method was used for the analysis due to the limited time depth information available and because the technical interaction among the fishing gears was an important factor to account for.

The Medits data provided by Cyprus were not adequate (short time series) for the use of the SUBRA assessment method.

7.29.4.1.2. Input parameters

The input parameters used were set at the plenary of the SGMED. The parameters that were used in the assessment were the 'Upper' parameters:

$$\mathbf{L_{inf} = 34.5,\ K= 0.34\ and\ \ t0= -\ 0.143.}$$

Table 7.29.4.1.2.1 Growth parameters set by the plenary

[12] http://www.faocopemed.org/es/activ/infodif/vit.htm
[13] http://www.faocopemed.org/es/activ/infodif/vit.htm

Species	Param. set	L_{inf} (cm)	K	T_0	Source
M. barbatus	Fast	34.5	0.34	-0.143	Length
	Slow	26.0	0.41	-0.4	Otoliths[14]
*M. merluccius**	Female	100.7	0.25	-0.35	Tagging
	Male	72.8	0.30	-0.38	Tagging
*P. longirostris***	High	4.2	0.62	-0.08	Length
	Low	4.5	0.34	-0.06	Length

* suggest generating size at length using sex ratio at length data
** Spanish figures – suggest using those figures most relevant to your GSA (e.g. Italian, Spanish)
NOTE: ensure related parameters (e.g. natural mortality) are consistent with growth parameters used

Natural mortality was calculated using the approach of Djabali:

logM = 0,0278-0,1172*log(linf)+0,5092 *log(K)

Table 7.29.4.1.2.2 Growth parameters set by the plenary, length-weight regression and estimated M.

Species	Param. set	L_{inf} (cm)	K	T_0	a	b	M
M. barbatus	Upper	34.5	0.34	-0.143	0,0081	3,113	0,40644
	Lower	26.01	0.41	-0.4			0,22530
	Cyprus	26,01	0,2025	-1.688			0,48874

The mean length composition of catch landings of red mullet for the period 2005-2007 was used:

- two gears Trawl (OTB) & Nets (GTR)
- Mean annual catch (tons)

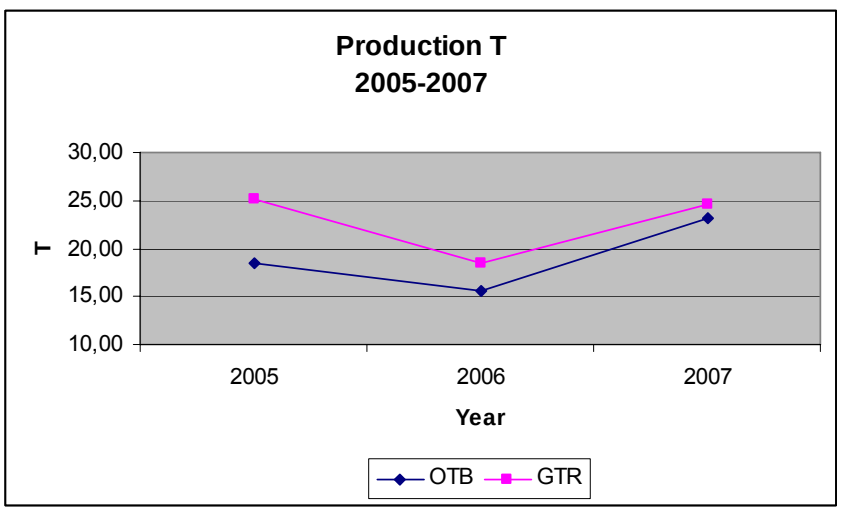


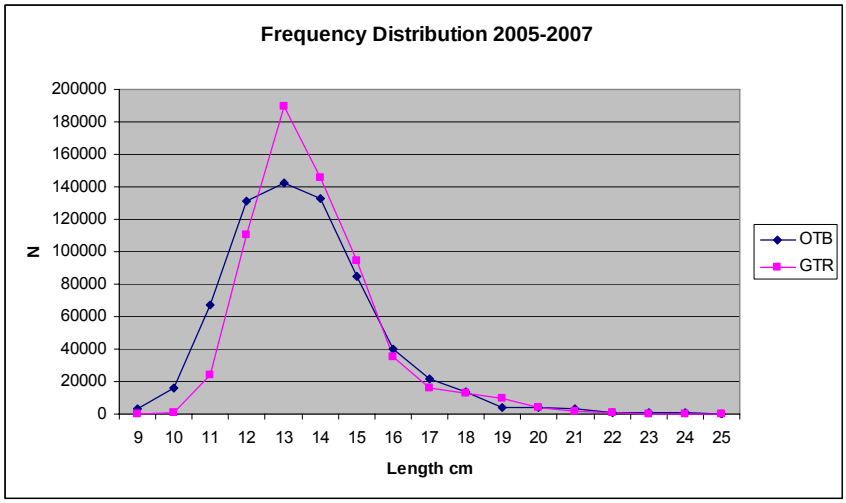
Fig. 7.29.4.1.2.1 Annual landings (t) by fishing techniques, 2005-2007.

Tab. 7.29.4.1.2.2 Estimated mean landings (g), 2005-2007.

AVERAGE 2005-2007

[14] GSA 9 and 10 combined, from otoliths

Trawl W	19064000	45,60%
Nets W	22743333	54,40%
Total	41807333	



7.29.4.1.2.2 Estimated size compositions of average landings by fishing technique, 2005-2007.

7.29.4.1.3. Results

Tab. 7.29.4.1.3.1 Estimated population parmaters, weights are in kg.

Parameters	**Upper (Growth)**	**Upper Growth (M- Pauly)**	**Lower Growth**	**Cyprus**
Spawning Stock Biomass, (SSB)	**26880**	**21571**	**34745542**	**1053217**
Biomass, (B)	**31176**	**28824**	**37684296**	**1115847**
Virgin biomass (V)	**248313**	**188924**	**846644**	**1438309**
B/V	**12,55%**	**15,25%**	**44,51**	**77,58**
Number of classes	**4**	**4**	**76**	**38**

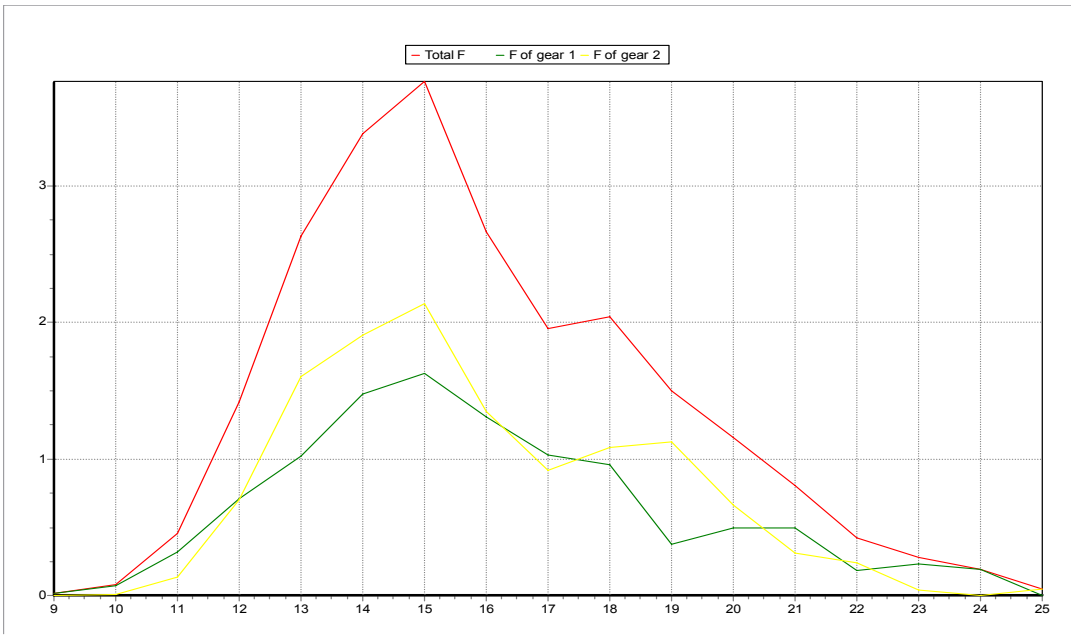


Fig. 7.29.4.1.3.1 Total fishing mortality and by gear at length estimated using VIT (SLOW GROWTH) parameters.

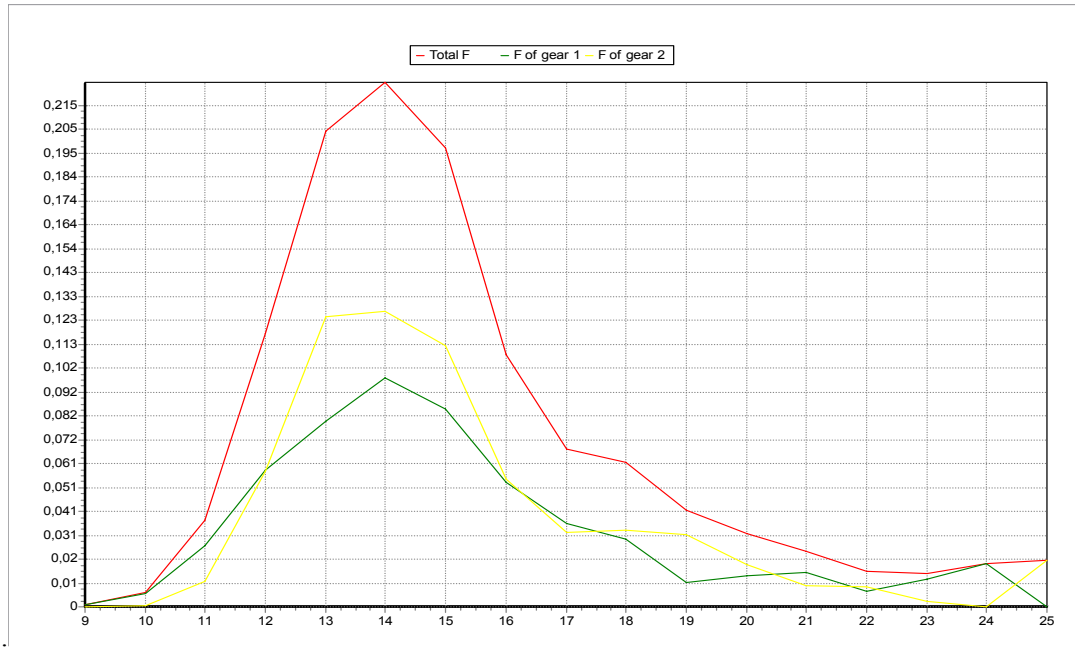


Fig. 7.29.4.1.3.2 Total fishing mortality and by gear at length estimated using VIT (SLOW GROWTH) parameters.

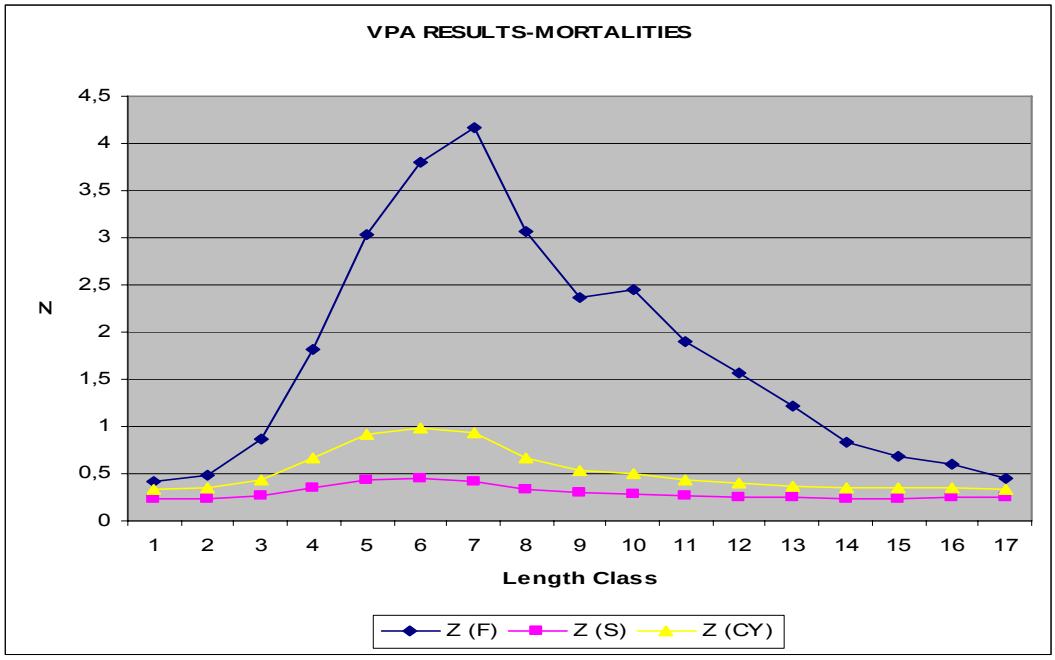


Fig. 7.29.4.1.3.3 VPA mortalities at length.

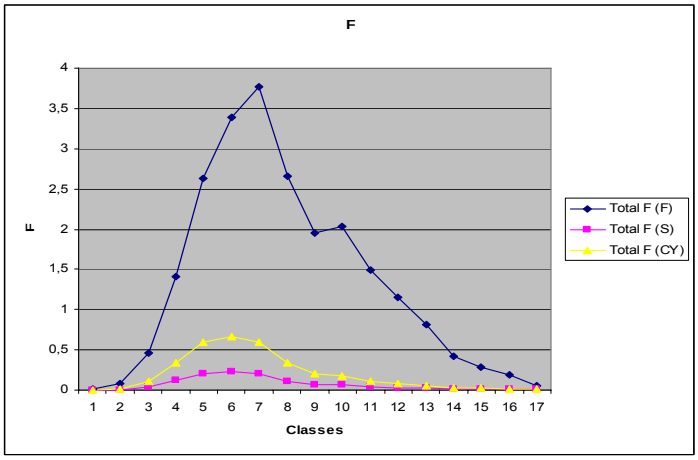


Fig. 7.29.4.1.3.4 VPA mortalities at length.

Fast Slow

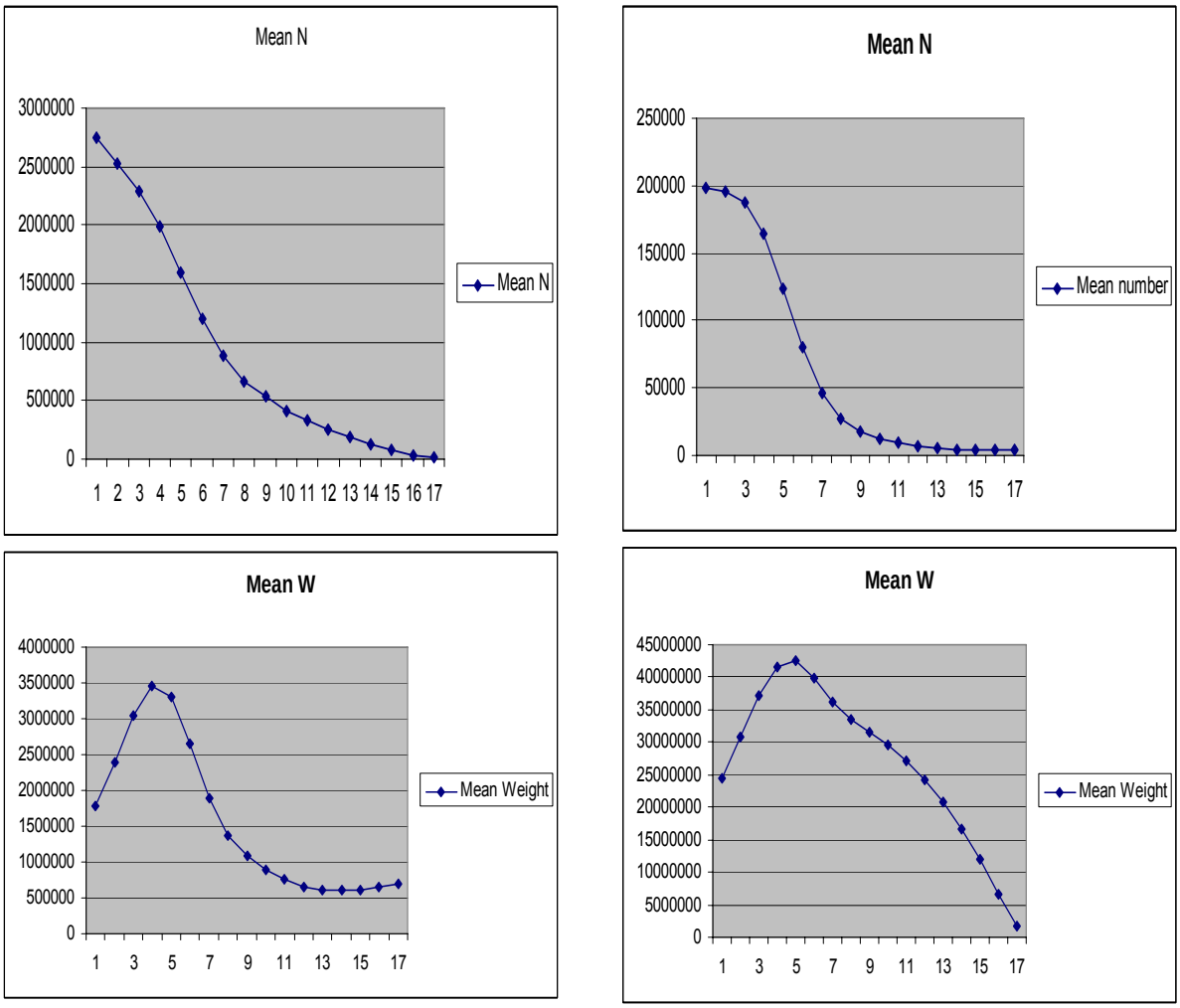


Fig. 7.29.4.1.3.5 Estimated length structure of the landings in terms of numbers and weight.

7.29.5. Short term prediction for 2008 and 2009

7.29.5.1. Justification

No forecast analyses were conducted.

7.29.5.2. Input parameters

No forecast analyses were conducted.

7.29.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for red mullet in GSA 25.

7.29.6. Medium term prediction

7.29.6.1. Justification

No forecast analyses were conducted.

7.29.6.2. Input parameters

No forecast analyses were conducted.

7.29.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for red mullet in GSA 25.

7.29.7. Long term prediction

7.29.7.1. Justification

VIT model was used to estimate yield per recruit.

7.29.7.2. Input parameters

Y/R was estimated using VIT parameters (FAST GROWTH).

7.29.7.3. Results

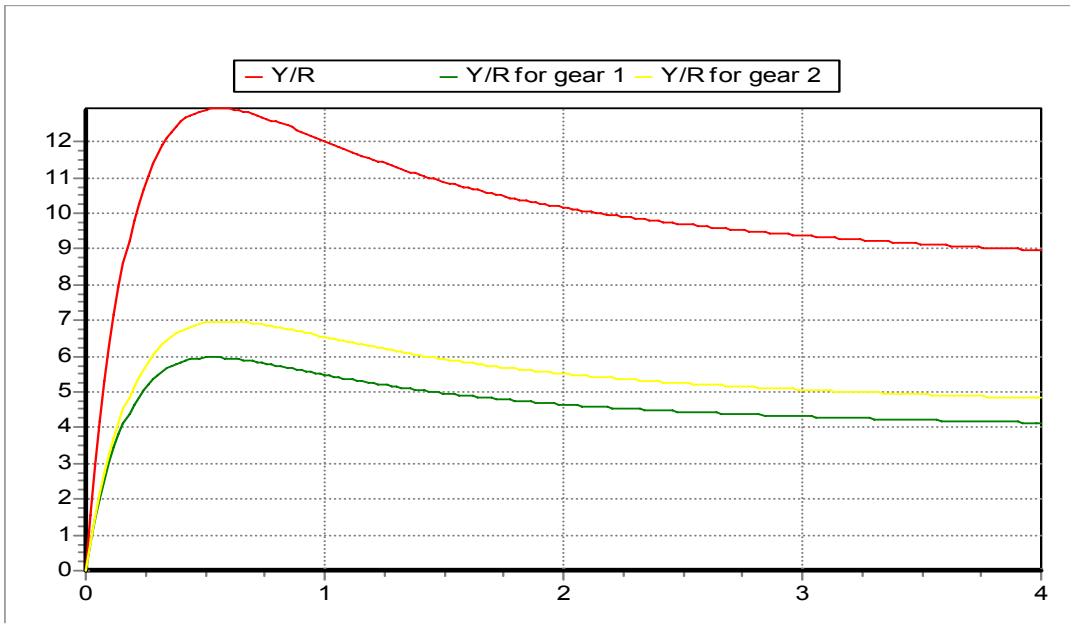


Fig. 7.29.7.3.1 Total yield per recruit (g.) and yield per recruit by fishing gear.

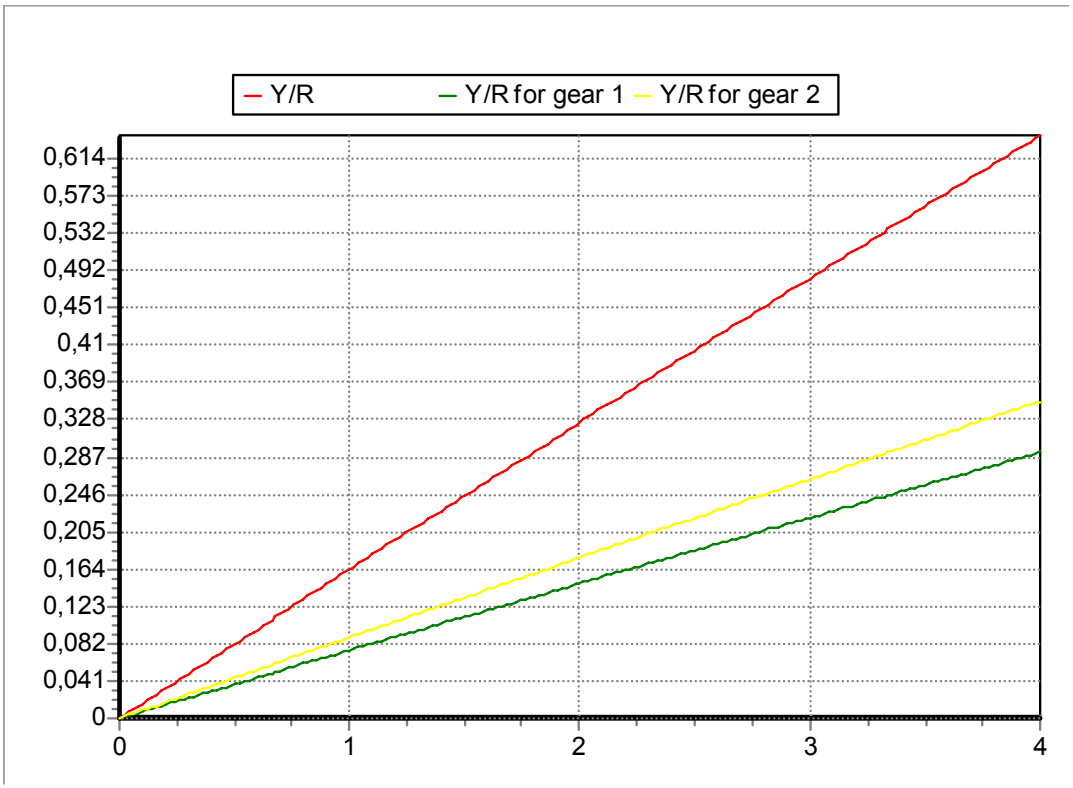


Fig. 7.29.7.3.2 Y/R estimated using VIT (SLOW GROWTH).

SGMED-08-03 explored and discussed technical changes and 20% reduction of fishing mortality but did so far not come to any final conclusions due to uncertainties in the data used.

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for red mullet in GSA 25.

7.29.8. Scientific advice

7.29.8.1. Short term considerations

7.29.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.29.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.29.8.1.3. State of exploitation

SGMED-08-03 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.

7.29.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.30. Stock assessment of pink shrimp in GSA 01

7.30.1. Stock identification and biological features

7.30.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.30.1.2. 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 GSA01, GSA05 and GSA06 also combined. Growth parameters were estimated through length frequency analysis, "Slow" for the period 2002-2004 and "Fast" parameters were estimated for the period 2005-2007.

Tab. 7.30.1.2.1 V. Bertalanffy growth parameters.

	L_{inf} (cm)	K	T_0	Source
Fast	4.2	0.62	-0.08	Length
Slow	4.5	0.34	-0.06	Length

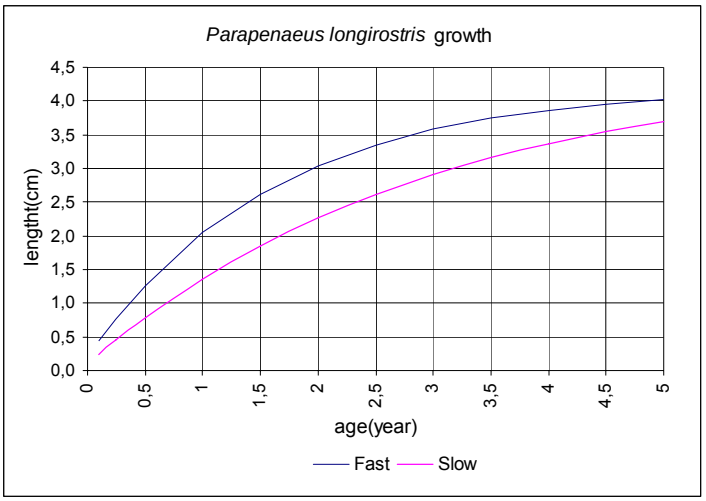


Fig. 7.30.1.2.2 Growth functions for the two fast and slow growth options.

Tab. 7.30.1.2.2 Length- weight relationship parameters, males and females combined

a	b	
0,8142	2,6013	fast growth set
0,8148	2,61	slow growth set

7.30.1.3. Maturity

Maturity for males and females combined (data obtained in the frame of the DCR).

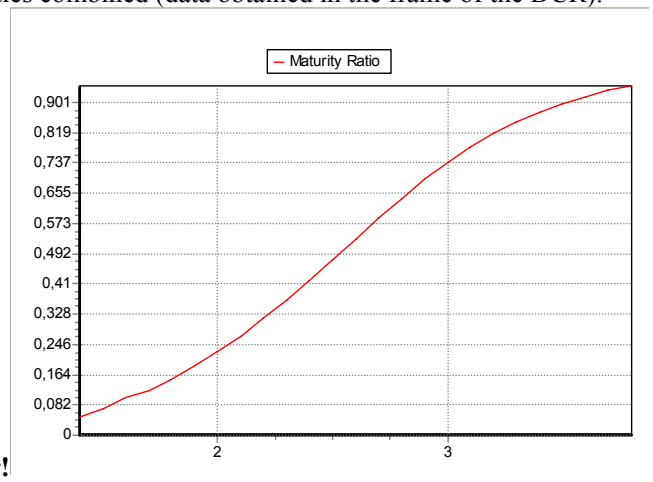


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Fig. 7.30.1.3.1 Logistic function of maturity at age.

7.30.2. Fisheries

7.30.2.1. General description of fisheries

The bottom trawl fishery in GSA 01 is multispecific, 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).

7.30.2.2. Management regulations applicable in 2007 and 2008

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.

7.30.2.3. Catches

7.30.2.3.1. Landings

Landings underwent a sharp decrease in the most recent years; current landings along the Spanish Mediterranean Coast are very low (Catalan Coast is the "northern" northern Spain, from the French border to the Delta of the Ebre River). Likewise, landings in other Mediterranean areas have shown notable interannual fluctuations, assumed to be due to the life cycle of the species (Sbrana *et al.* 2006). Data source: DCR and Fisheries Statistics by the Catalan Government; landings in tones are shown in Fig. 7.30.2.3.1.1.

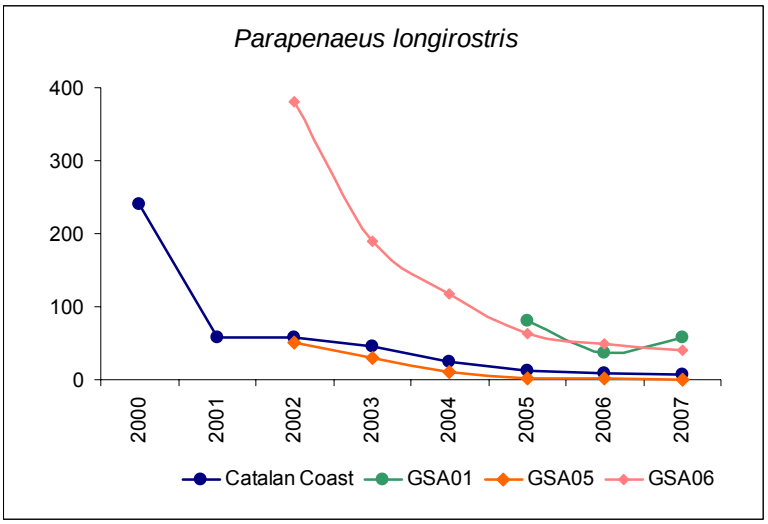


Fig. 7.30.2.3.1.1 *Parapenaeus longirostris* annual landings, in tonnes. Data source: DCR and Fisheries Statistics by the Catalan Government.

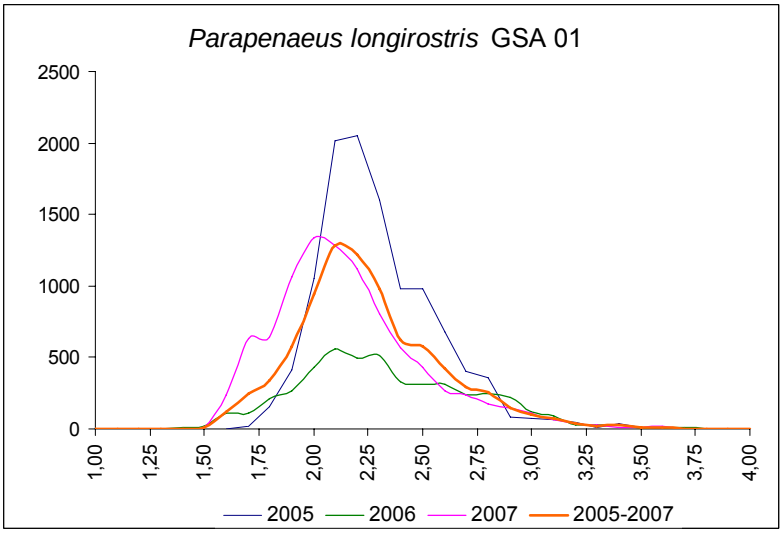


Fig. 7.30.2.3.1.2 *Parapenaeus longirostris* annual size distributions, CL in cm. In bold orange the "mean" size distribution over 2005-2007, which was used in the performance of length cohort analysis (pseudocohort) with VIT software.

The bulk of the landings ranged within 1.5 and 3.0 cm CL (Fig. 7.30.2.3.1.2). According to the "fast" growth scenario, this size range corresponds to an age of between 0.5 and 2 years and according to the "slow" growth scenario, this size range would correspond to an age of between 1-3 years.

Tab. 7.30.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-08-03 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. The landings were only taken by demersal otter trawls.

Tab. 7.30.2.3.1.1 Annual landings (t) by fishing technique in GSA 01.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DPS	1	ESP	OTB	173	123	117	81	37	58

7.30.2.3.2. Discards

Parapenaeus longirostris is not discarded.

7.30.2.3.3. Fishing effort

No information was documented during SGMED-08-03.

7.30.3. Scientific surveys

7.30.3.1. Medits

7.30.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 01 the following number of hauls were reported per depth stratum (s. Tab. 7.30.3.1.1.1).

Tab. 7.30.3.1.1.1. Number of hauls per year and depth stratum in GSA 01, 1994-2007.

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

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

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

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

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

Where:
A=total survey area
Ai=area of the i-th stratum

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

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± 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.

7.30.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.30.3.1.3. 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 7.30.3.1.3.1 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.

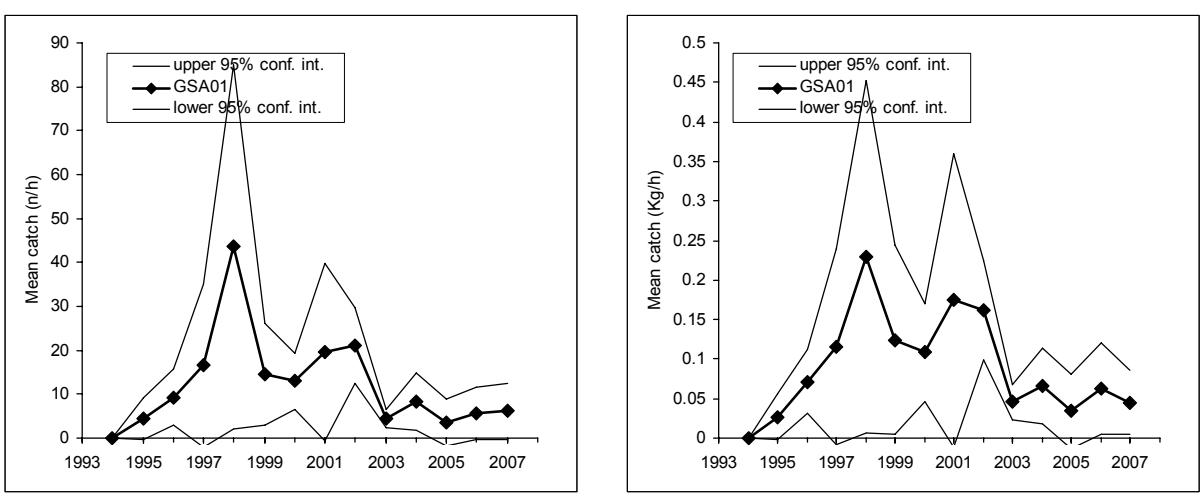


Fig. 7.25.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 01.

7.30.3.1.4. Trends in abundance by length or age

The following Fig. 7.25.3.1.4.1 and 2 display the stratified abundance indices of GSA 01 in 1995-2002 and 2003-2007. These size compositions are considered preliminary.

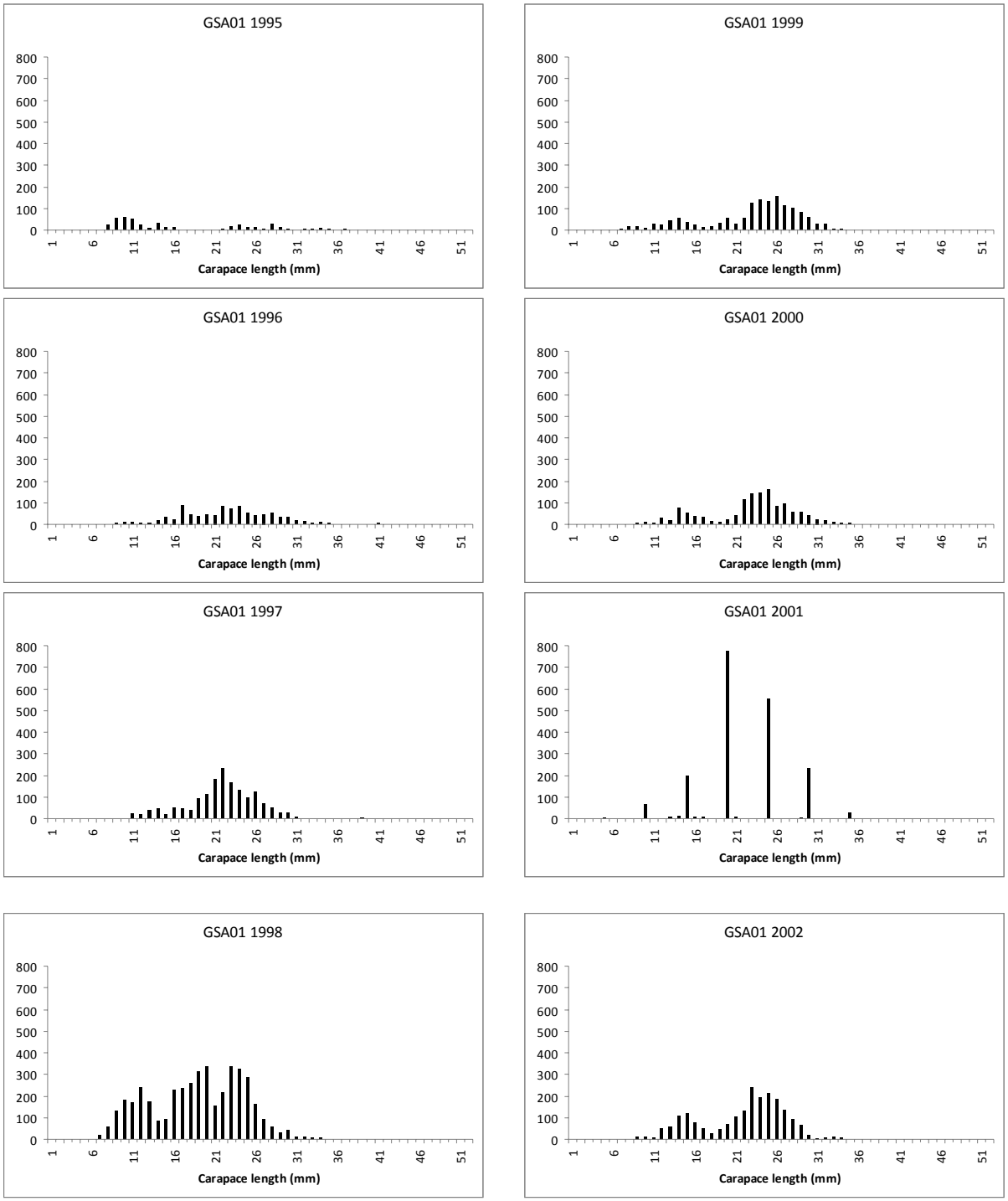


Fig. 7.25.3.1.4.1 Stratified abundance indices by size, 1995-2002.

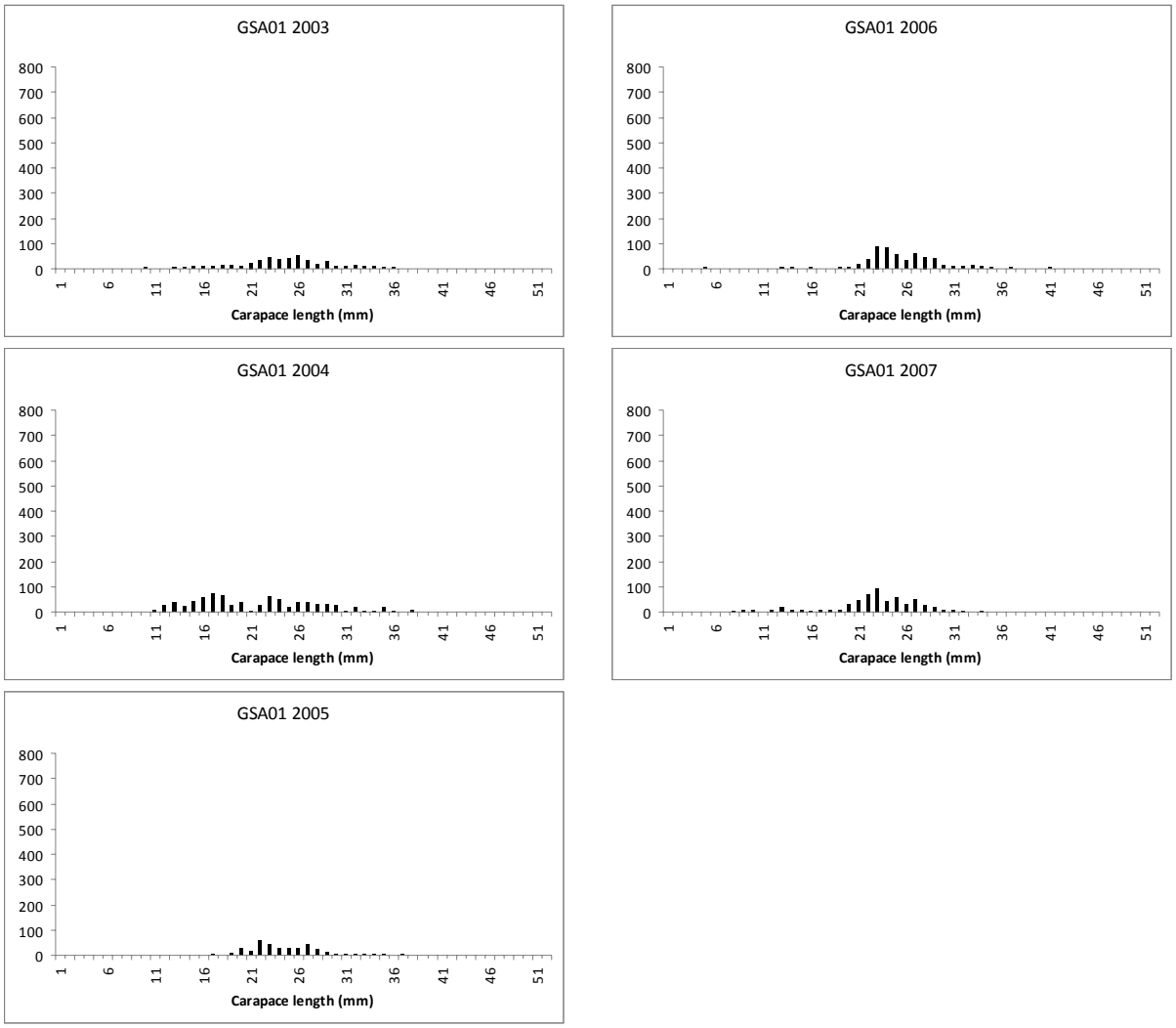


Fig. 7.25.3.1.4.2 Stratified abundance indices by size, 2003-2007.

7.30.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.30.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.30.4. Assessment of historic stock parameters

7.30.4.1. Method 1: VIT

7.30.4.1.1. Justification

Size distribution data were available only for 2005-2007. Since landings in GSA01 during 2005-2007 were at similar and low level, equilibrium was assumed and cohort analysis was performed using VIT.

7.30.4.1.2. Input parameters

Length composition of landings, pseudocohort, is shown in figure in section **Error! Reference source not found.**. The species is not discarded. No effort data were available. Weight at length and maturity at length in the stock as input; these data were transformed into ages during the analysis.

M constant, M= 1.25
Fterm= 0.5
M and Fterm taken from Pérez *et al*. 2007.

This value of M is similar to that used in other Mediterranean areas.

7.30.4.1.3. Results

This is the first assessment of *P. longirostris* in GSA01. We applied VIT, pseudocohort analysis and Y/R, under two different management scenarios, fast and slow growth. All the results refer to the observable range of length/ages. Since the analysis is based on pseudocohort analysis, it is not possible to present trends.

Tab. 7.30.4.1.3.1 Stock parameters estimated by VIT.

	FAST GROWTH	SLOW GROWTH
Biomass (B)	47609,23	109225,22
SSB	14379,37	30053,34
Virgin Biomass (V)	131760,56	183919,18
B/V (%)	36,13	59,39
Catch mean age	1,229	2,055
Catch mean length	2,296	2,296

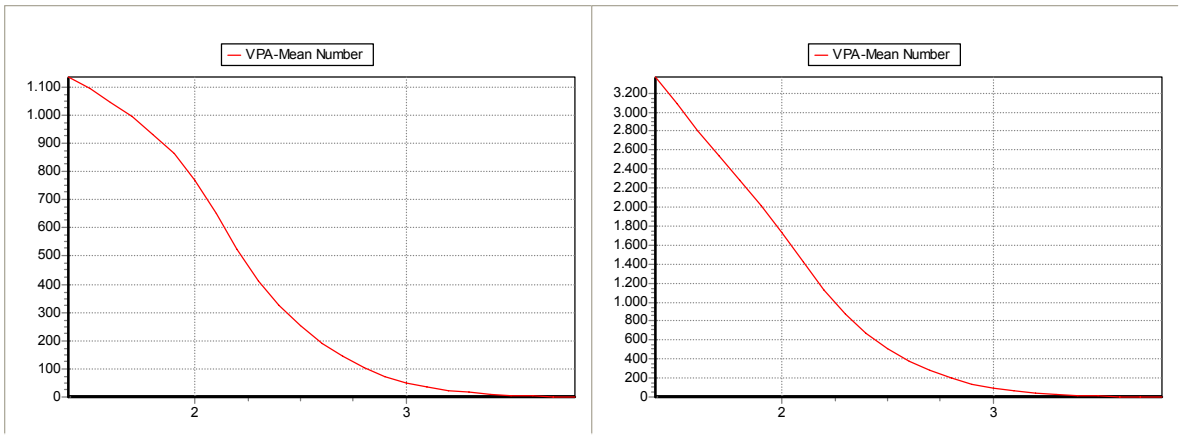


Fig. 7.30.4.1.3.1 Population size and structure at age as estimated by VIT for the the fast (left) and slow growth (right) scenarios.

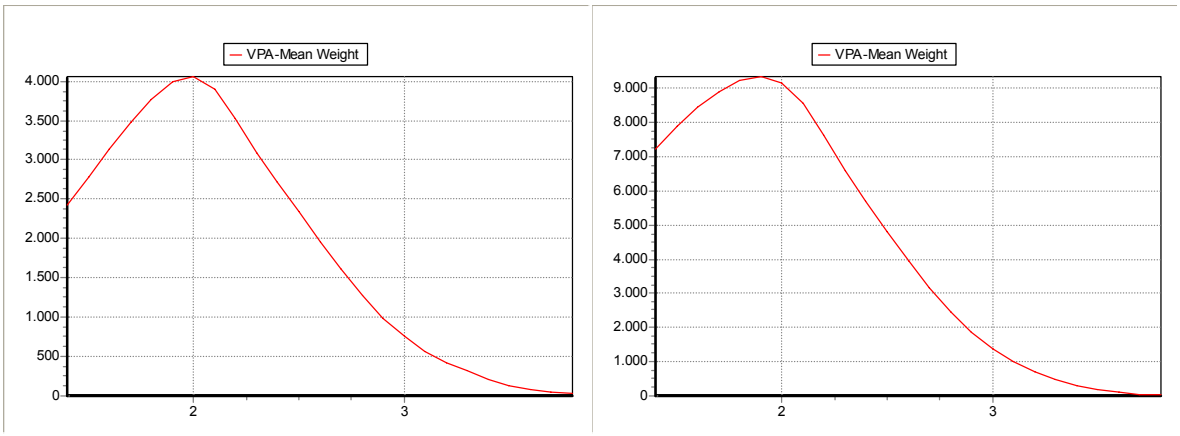


Fig. 7.30.4.1.3.2 Population size in weight and structure at age as estimated by VIT for the the fast (left) and slow growth (right) scenarios.

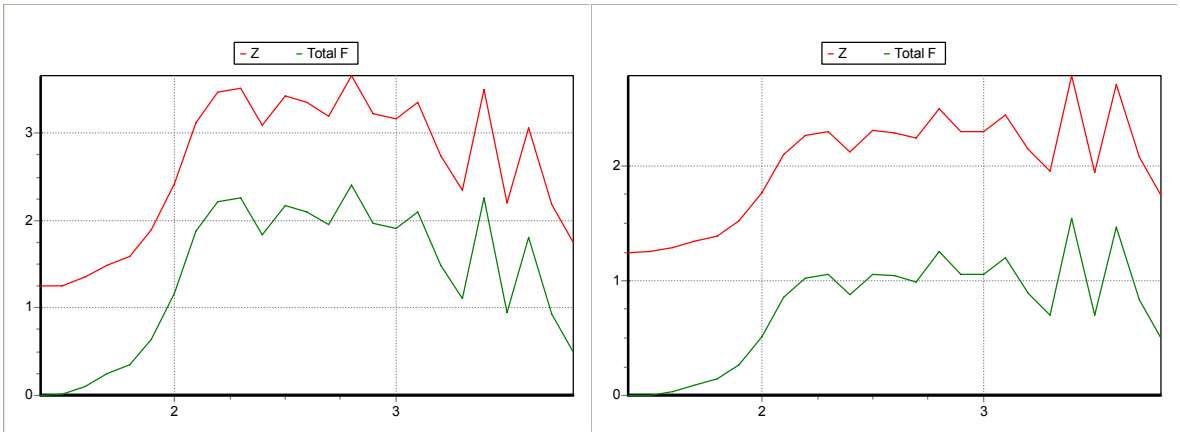


Fig. 7.30.4.1.3.2 Selection patterns over age as estimated by VIT for the the fast (left) and slow growth (right) scenarios.

7.30.5. Short term prediction for 2008 and 2009

7.30.5.1. Justification

No forecast analyses were conducted.

7.30.5.2. Input parameters

No forecast analyses were conducted.

7.30.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for pink shrimp in GSA 01.

7.30.6. Medium term prediction

7.30.6.1. Justification

No forecast analyses were conducted.

7.30.6.2. Input parameters

No forecast analyses were conducted.

7.30.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for pink shrimp in GSA 01.

7.30.7. Long term prediction

7.30.7.1. Justification

Yield per recruit was estimated.

7.30.7.2. Input parameters

VIT input parameters were applied.

7.30.7.3. Results

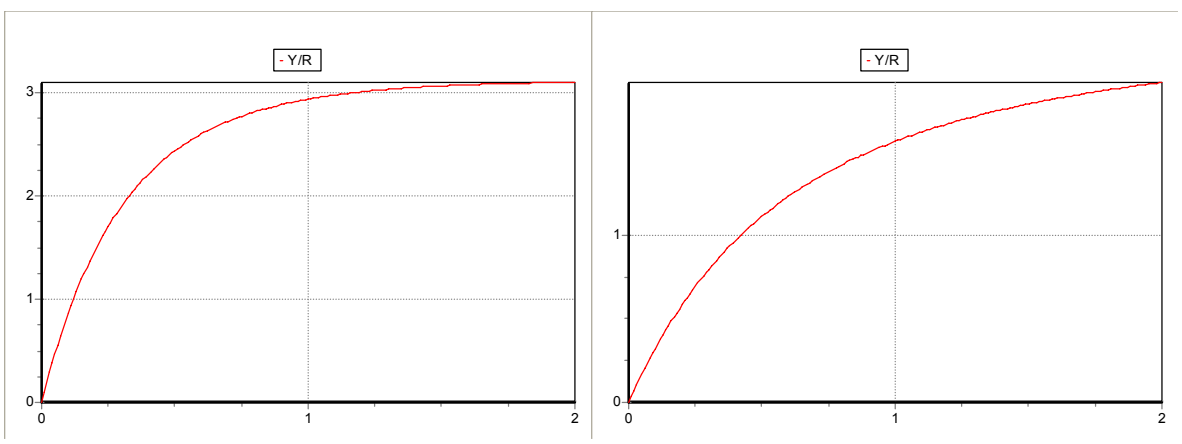


Fig. 7.30.7.3.1 Yield per recruit for fast (left) and slow growing scenrios (right) over a range of F multiplicators.

Current F is either near its optimum of exploitation or below, thus it seems advisable not to modify the current management for the the fast (left) and slow growth (right) scenarios

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for pink shrimp in GSA 01.

7.30.8. Scientific advice

7.30.8.1. Short term considerations

7.30.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.30.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.30.8.1.3. State of exploitation

SGMED-08-03 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.

7.30.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.31. Stock assessment of pink shrimp in GSA 06

7.31.1. Stock identification and biological features

7.31.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.31.1.2. Growth

No information was documented during SGMED-08-03.

7.31.1.3. Maturity

No information was documented during SGMED-08-03.

7.31.2. Fisheries

7.31.2.1. General description of fisheries

No information was documented during SGMED-08-03.

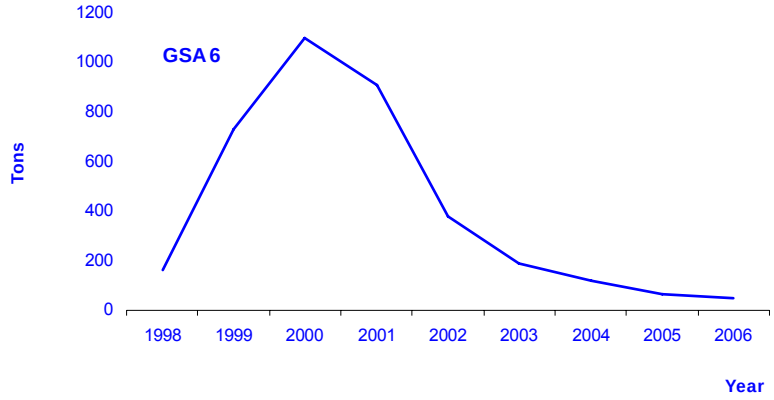
7.31.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.31.2.3. Catches

7.31.2.3.1. Landings

The Working Group members reviewed the assessment of *Parapenaeus longirostris* presented in GSA 06 at the 2007 GFCM meeting[15]. The steep decline in catches from 2000 was noted (Figure 7.31.1.2.3.1.1), which was matched by downward trends in survey abundance estimates.



Fig, 7.31.1.2.3.1.1 Landings as used by GFCM SAC in 2007.

Tab. 7.31.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-08-03 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 41 t in 2007. The landings were only taken by demersal otter trawls.

Tab. 7.25.2.3.1.1 Annual landings (t) by fishing technique in GSA 06.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DPS	6	ESP	OTB	380	190	117	63	49	41

7.31.2.3.2. Discards

No information was documented during SGMED-08-03.

7.31.2.3.3. Fishing effort

[15] SCSA/SAC/GFCM: http://www.icm.csic.es/rec/projectes/scsa/Demersals_2007/open documents.zip for GSA06 open Doc01-DPS0607Pér.xls

No information was documented during SGMED-08-03.

7.31.3. Scientific surveys

7.31.3.1. Medits

7.31.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 01the following number of hauls were reported per depth stratum (s. Tab. 7.31.3.1.1.1).

Tab. 7.31.3.1.1.1. Number of hauls per year and depth stratum in GSA 06, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA06_010-050	7	8	7	7	7	8	9	8	11	9	9	11	11	6
GSA06_050-100	19	26	26	26	28	29	29	31	36	38	31	32	34	27
GSA06_100-200	11	17	17	15	13	17	18	20	20	21	17	18	19	15
GSA06_200-500	10	12	10	12	7	13	12	16	17	18	16	15	18	11
GSA06_500-800	6	8	9	7	4	9	6	8	7	11	11	8	10	8

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.

7.31.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.31.3.1.3. 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 7.31.3.1.3.1 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.

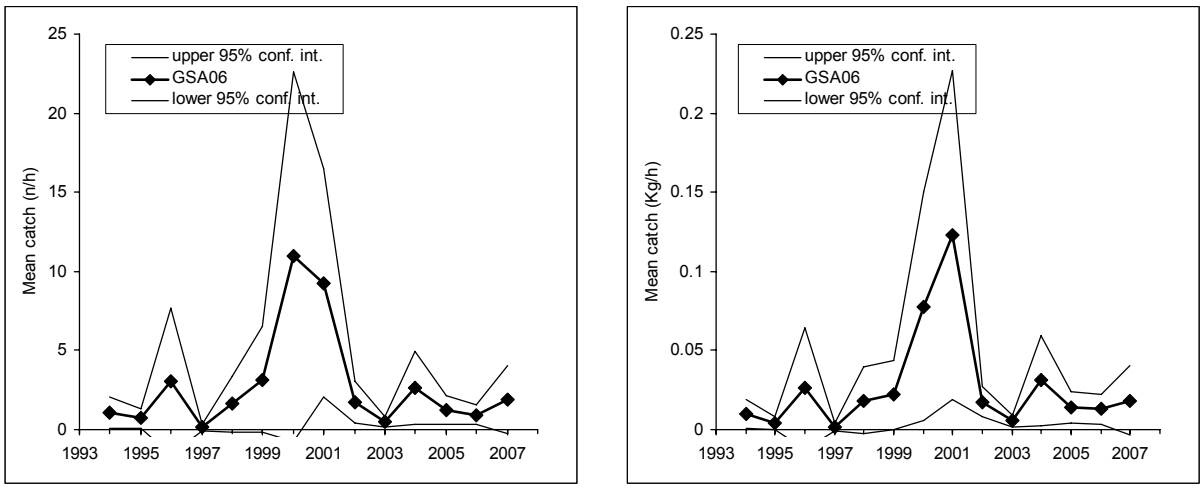


Fig. 7.25.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 06.

7.31.3.1.4. Trends in abundance by length or age

The following Fig. 7.31.3.1.4.1 and 2 display the stratified abundance indices of GSA 06 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

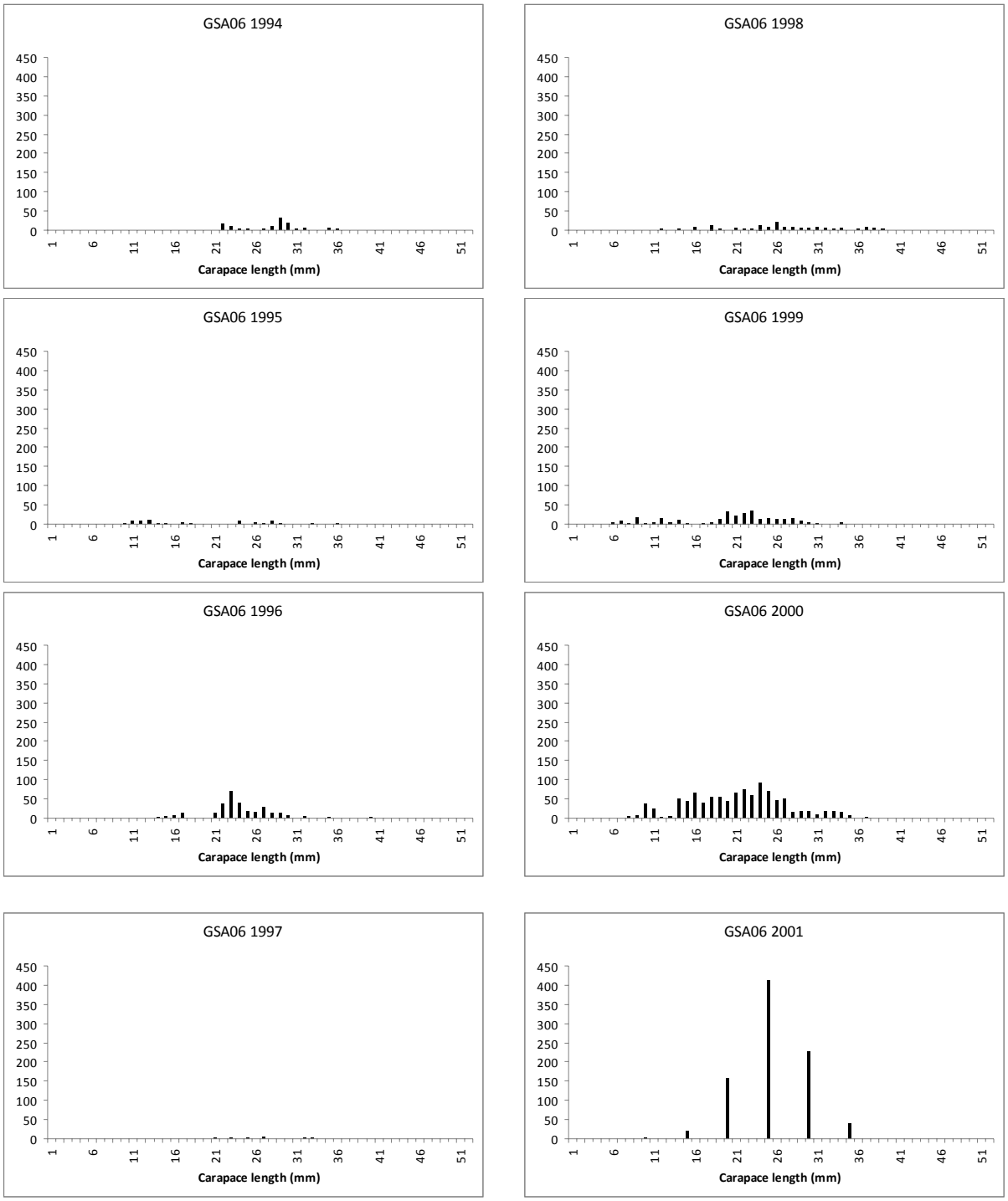


Fig. 7.31.3.1.4.1 Stratified abundance indices by size, 1994-2001.

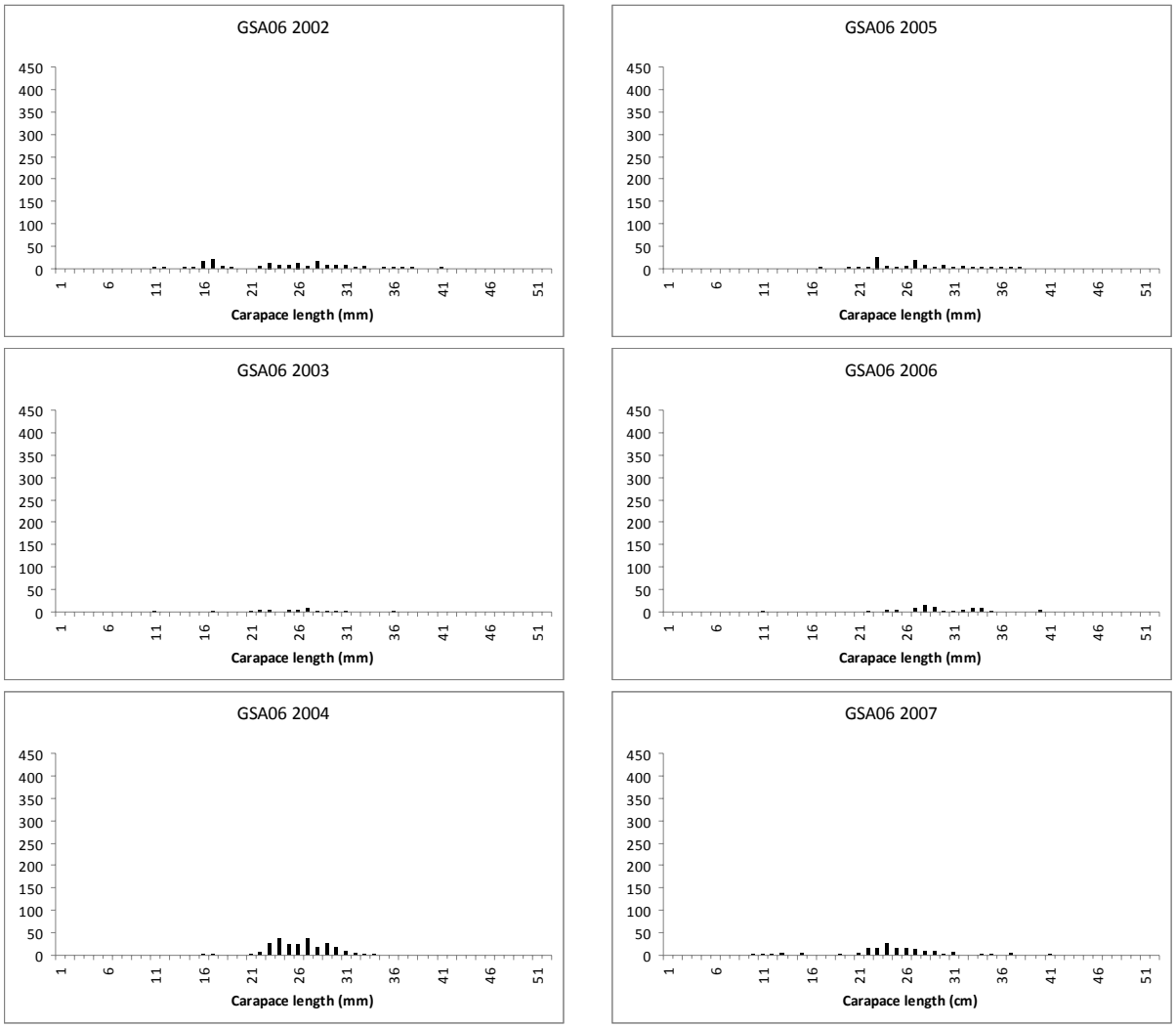


Fig. 7.31.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.31.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.31.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.31.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

The Working Group members reviewed the assessment of *Parapenaeus longirostris* presented in GSA 06 at the 2007 GFCM meeting[16]. The steep decline in landings from 2000 was noted, which was matched by

[16] SCSA/SAC/GFCM: http://www.icm.csic.es/rec/projectes/scsa/Demersals_2007/open documents.zip for GSA06 open Doc01-DPS0607Pér.xls

downward trends in survey abundance estimates. Assessment results suggested strong declines in both spawning stock biomass and recruitment since 2001 (first year of data within the XSA assessment). However, estimates of fishing mortality also showed a slight decline, which appeared inconsistent with the trends in biomass (Figure 7.31.3.1.6.1).

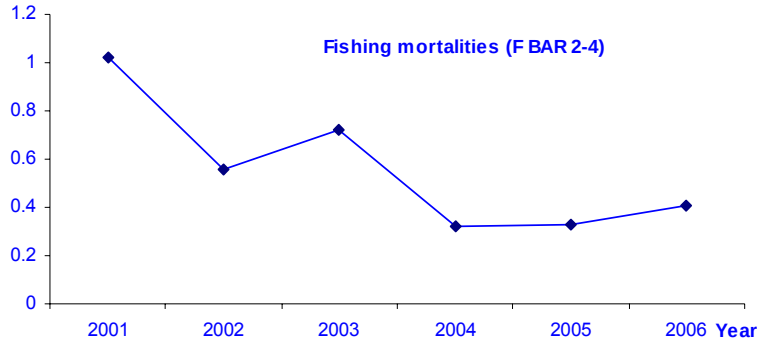


Fig. 7.31.3.1.6.1. Fishing mortality estimates from XSA assessment

The Working Group noted that is was difficult to perform a full review of the assessment, since the diagnostic information produced by XSA was not available in the GFCM report. As a result, the Group suggested that this assessment be re-analysed at SGMED-08-04, thereby allowing the Group to examine the issues further and learn from the experience. This is not a source of criticism of the original assessment, but the productive use of the SGMED framework to progress work intersessionally from GFCM meetings.

The Group noted that there appeared to be a mismatch within the biological parameters used – in particular a relatively low von Bertalanffy K value combined with a value of M of 1.25. The Group recommended that more consistent values of K be used (faster growth values of ~0.6 having been used in previous assessments).

The Group noted that the use of a constant natural mortality rate (a common assumption) which might affect the estimated pattern of fishing mortality over time. More critically, however, the Group noted that the last few years of fishing mortality estimated through XSA (and VPA in general) are the most uncertain, and hence the downward trend in fishing mortality cannot be confirmed.

7.31.5. Short term prediction for 2008 and 2009

7.31.5.1. Justification

No forecast analyses were conducted.

7.31.5.2. Input parameters

No forecast analyses were conducted.

7.31.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for pink shrimp in GSA 06.

7.31.6. Medium term prediction

7.31.6.1. Justification

No forecast analyses were conducted.

7.31.6.2. Input parameters

No forecast analyses were conducted.

7.31.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for pink shrimp in GSA 06.

7.31.7. Long term prediction

7.31.7.1. Justification

No forecast analyses were conducted.

7.31.7.2. Input parameters

No forecast analyses were conducted.

7.31.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for pink shrimp in GSA 06.

7.31.8. Scientific advice

7.31.8.1. Short term considerations

7.31.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.31.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.31.8.1.3. State of exploitation

SGMED-08-03 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.

7.31.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.32. Stock assessment of pink shrimp in GSA 09

7.32.1. Stock identification and biological features

7.32.1.1. Stock Identification

Stock delimitations are considered unknown.

The species shows a wide bathymetric distribution in the GSA9, 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.*, 2003).

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*., 1998). The main nurseries revealed a high spatio-temporal persistency (Fig. 7.20.1) 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 on deeper depths (Ardizzone *et al*., 1990).

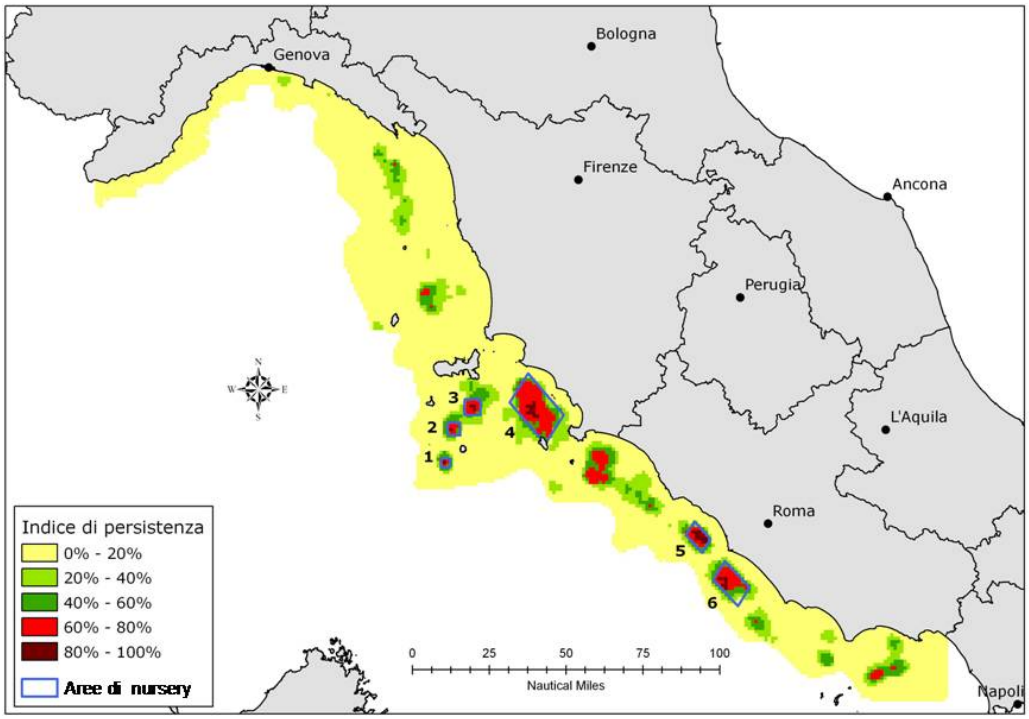


Fig. 7.32.1.1.1 Temporal persistence of *P. longirostris* nurseries in the GSA 09

7.32.1.2. 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: $L\infty = 43.5$, $K=0.74$, $t_o=-0.13$; Males: $L\infty = 33.1$, $K=0.93$, $t_o=-0.05$. The life cycle is of 3-4 years. Females grow faster than males attaining lager 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).

7.32.1.3. 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 maxima of 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).

7.32.2. Fisheries

7.32.2.1. General description of fisheries

In the GSA9 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 Tyrhhenian 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, *Nephropos norvegicus*, at greater depths (Biagi *et al.*, 2002; Colloca *et al.*, 2003; Sartor *et al*., 2003; Sbrana *et al*., 2006).

As concerns fishing activity, the majority of bottom trawlers of GSA 09 performs daily fishing trips; only some vessels (especially those of Porto Santo Stefano) can stay out of the port for two-three days, mainly in summer. The mean number of fishing days/year per vessel fishing days 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.

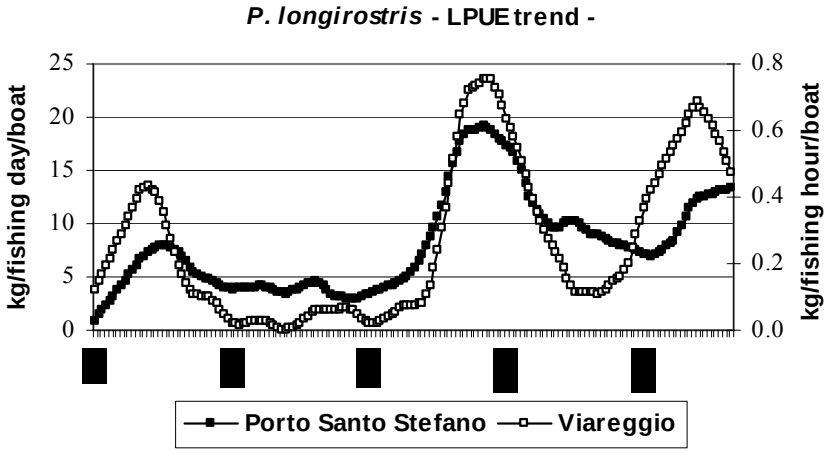


Fig. 7.32.2.1.1 *P. longirostris.* LPUE of P. S. Stefano and Viareggio trawlers since 1991 (bottom)

The size structure of the landings, according to the DCR data collected in 2006, shows that the most exploited sizes ranged from 24 and 40 mm CL (Fig. 7.32.2.1.2); the presence of specimens under the MLS (20 mm CL) is negligible. According to the growth pattern of the species, fishing exploits 1^+ - 3^+ shrimps.

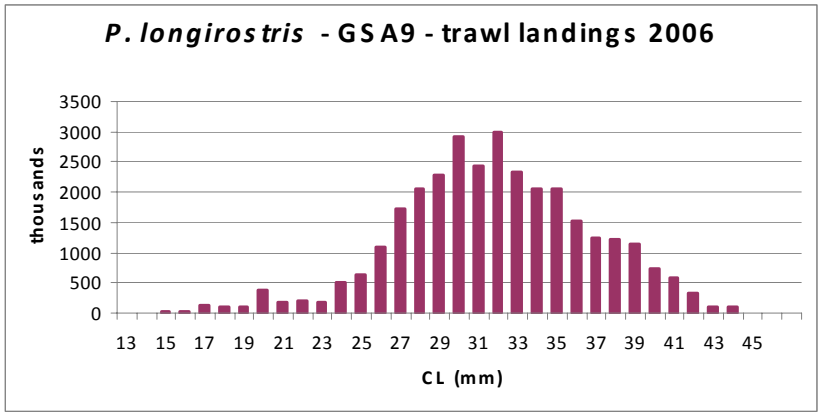


Fig. 7.32.2.1.2 Length frequency distribution of *P. longirostris* landed in the GSA 09.

7.32.2.2. Management regulations applicable in 2007 and 2008

The minimum legal landing sizes is 20 mm Carapace Length (EC regulation 1967/2006). The other management regulation are the same described for hake in the GSA 09.

7.32.2.3. Catches

7.32.2.3.1. Landings

Total landings of deep water rose shrimps fluctuated from 160 tons in 2002 to 220 tons in 2007, showing a peak in 2006 corresponding to 450 tons (Fig. 7.32.2.2.3.1). 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. 7.32.2.1.1). The values of the two fleets showed the same temporal pattern with maxima in 1992, 1999 and 2004.

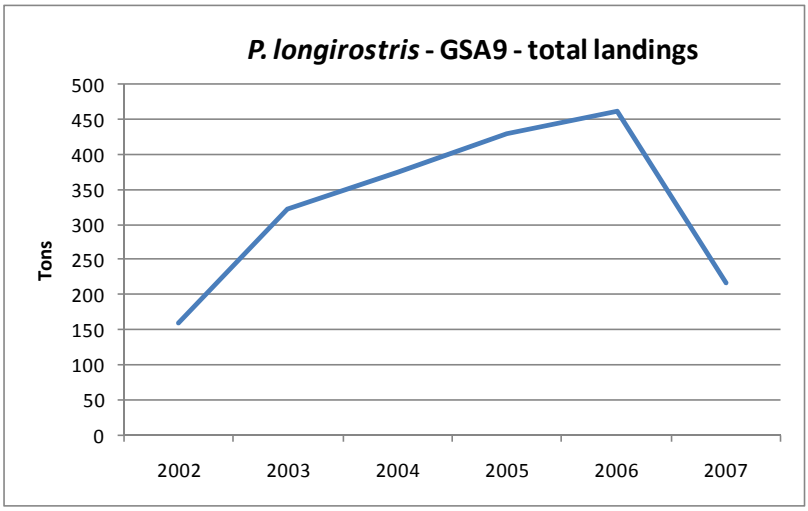


Fig. 7.32.2.2.3.1 Total landings in GSA 09.

Tab. 7.32.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-08-03 through the Data Collection Regulation and are listed in Table A3.3 of Appendix 3. Since

2002 annual landings increased from 160 t to 460 t in 2006 and decreased in 2007 to 220 t. The landings were mainly taken by demersal otter trawls.

Tab. 7.32.2.3.1.1 Annual landings (t) by fishing technique in GSA 18.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DPS	9	ITA	DTS	133	308	367	430	462	215
DPS	9	ITA	PGP		3	8	1		2
DPS	9	ITA	PMP	19	12	0			
DPS	9	ITA	PTS	9	0	1			
SUM				161	323	376	431	462	217

7.32.2.3.2. Discards

As a matter of fact, 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.

9 t in 2006 of discards were reported to SGMED-08-03 (Tab. A3.4 of Annex 3).

7.32.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-08-03 are listed in Tab. 7.32.2.3.3.1 and in Tab. A3.5 of Appendix 3. After 2006, the effort of the major demersal trawler fleet decrased slightly.

Tab. 7.32.2.3.3.1 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

7.32.3. Scientific surveys

7.32.3.1. Medits

7.32.3.1.1. 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 showing large fluctuations from year to year (Fig. 7.32.3.1.1.1). 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 thermopile species that could benefit by the ongoing climatic change in the Mediterranean region. Relationships between environmental variability and deep-sea pink shrimp population dynamic still needs to be investigated.

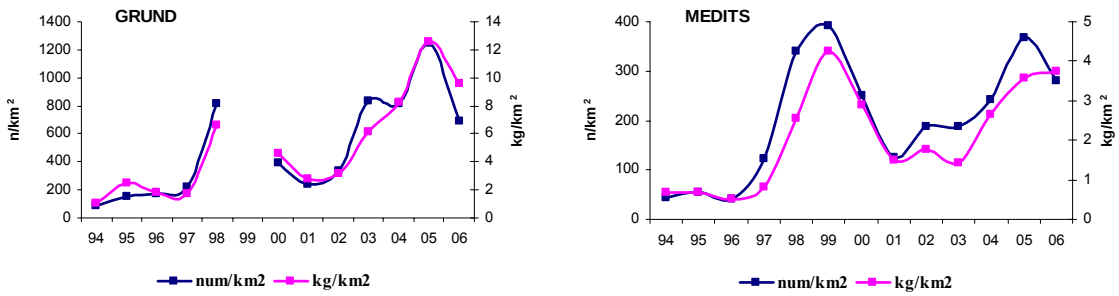


Fig. 7.32.3.1.1.1 *P. longirostris*: Grund and Medits trends in density and biomass from 1994 to 2006 in GSA 09.

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 09 the following number of hauls were reported per depth stratum (s. Tab. 7.32.3.1.1.1).

Tab. 7.32.3.1.1.1. Number of hauls per year and depth stratum in GSA 09, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA09_010-050	19	18	18	18	19	18	18	18	13	13	13	14	13	13
GSA09_050-100	19	19	18	19	18	19	20	20	15	15	15	14	16	16
GSA09_100-200	35	35	36	35	35	35	34	34	26	27	26	27	25	26
GSA09_200-500	32	33	33	36	32	36	37	35	27	27	27	28	29	33
GSA09_500-800	31	30	32	28	30	28	27	29	24	22	21	20	20	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.

7.32.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.32.3.1.3. 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 7.32.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSA 09.

The estimated abundance and biomass indices peaked in 1998-1999 and in 2004-2005. Recent abundance and biomass indices in 2007 appear low. The analyses of Medits indices are considered preliminary.

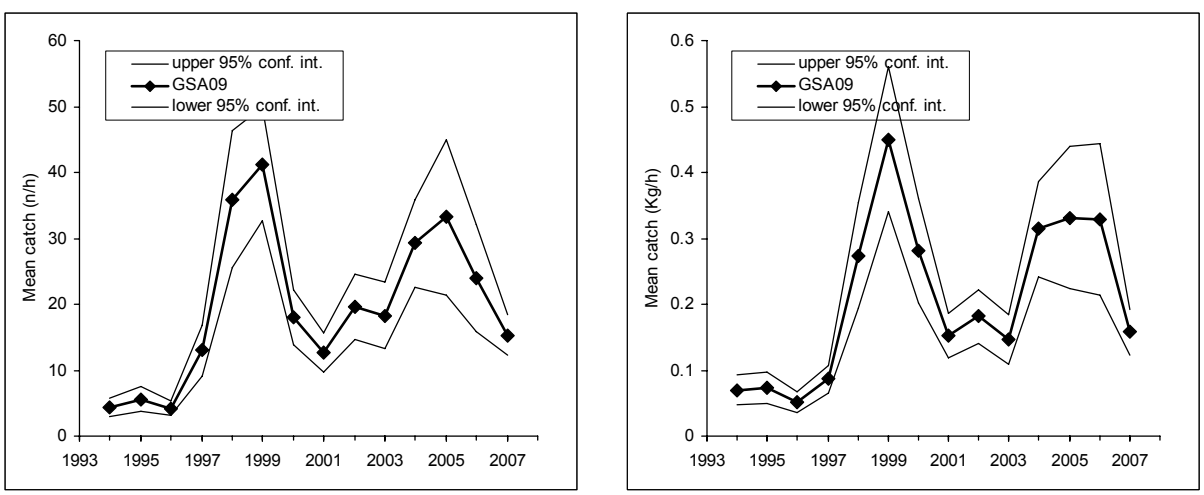


Fig. 7.25.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 09.

7.32.3.1.4. Trends in abundance by length or age

The following Fig. 7.32.3.1.4.1 and 2 display the stratified abundance indices of GSA 09 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

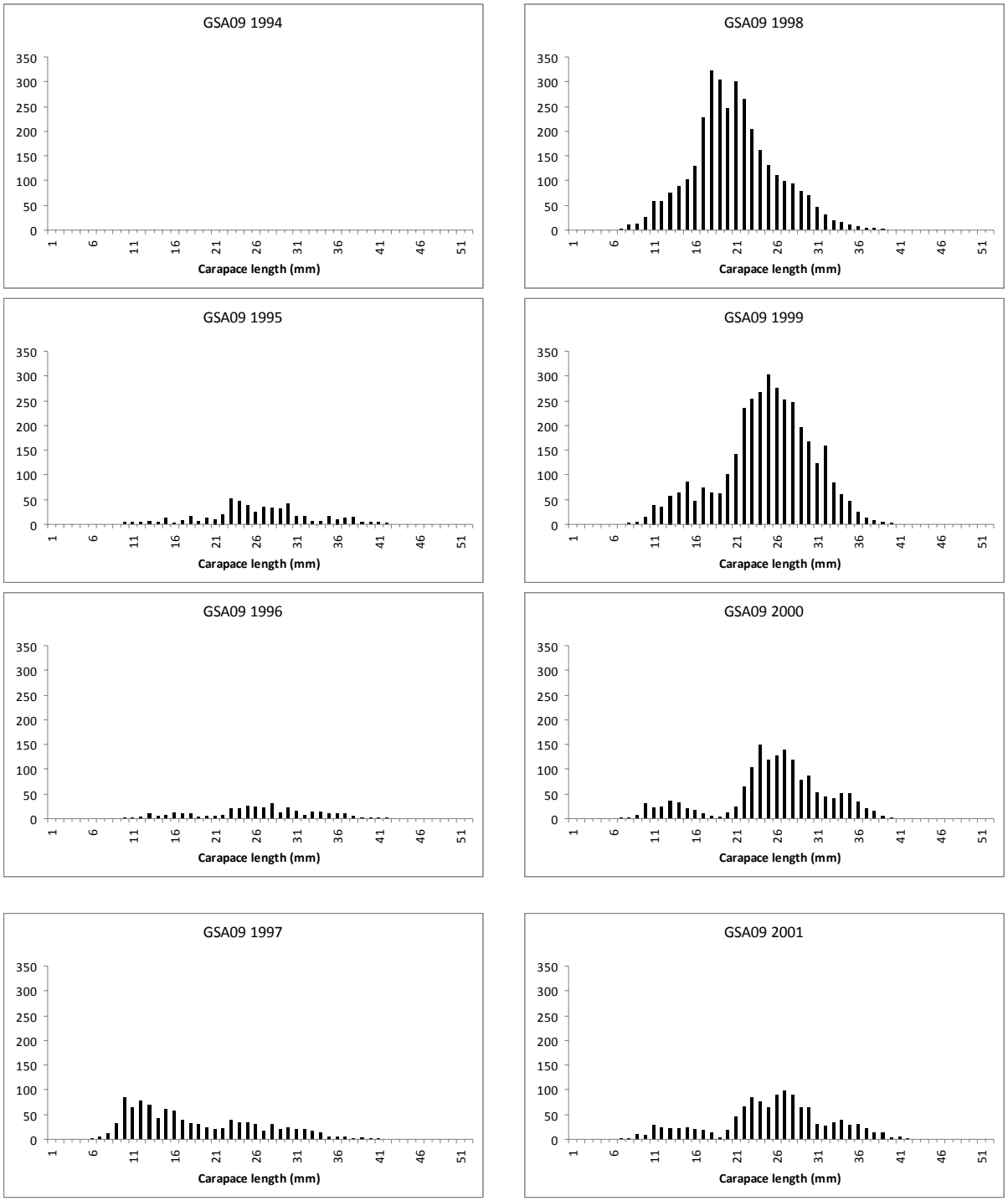


Fig. 7.32.3.1.4.1 Stratified abundance indices by size, 1994-2001.

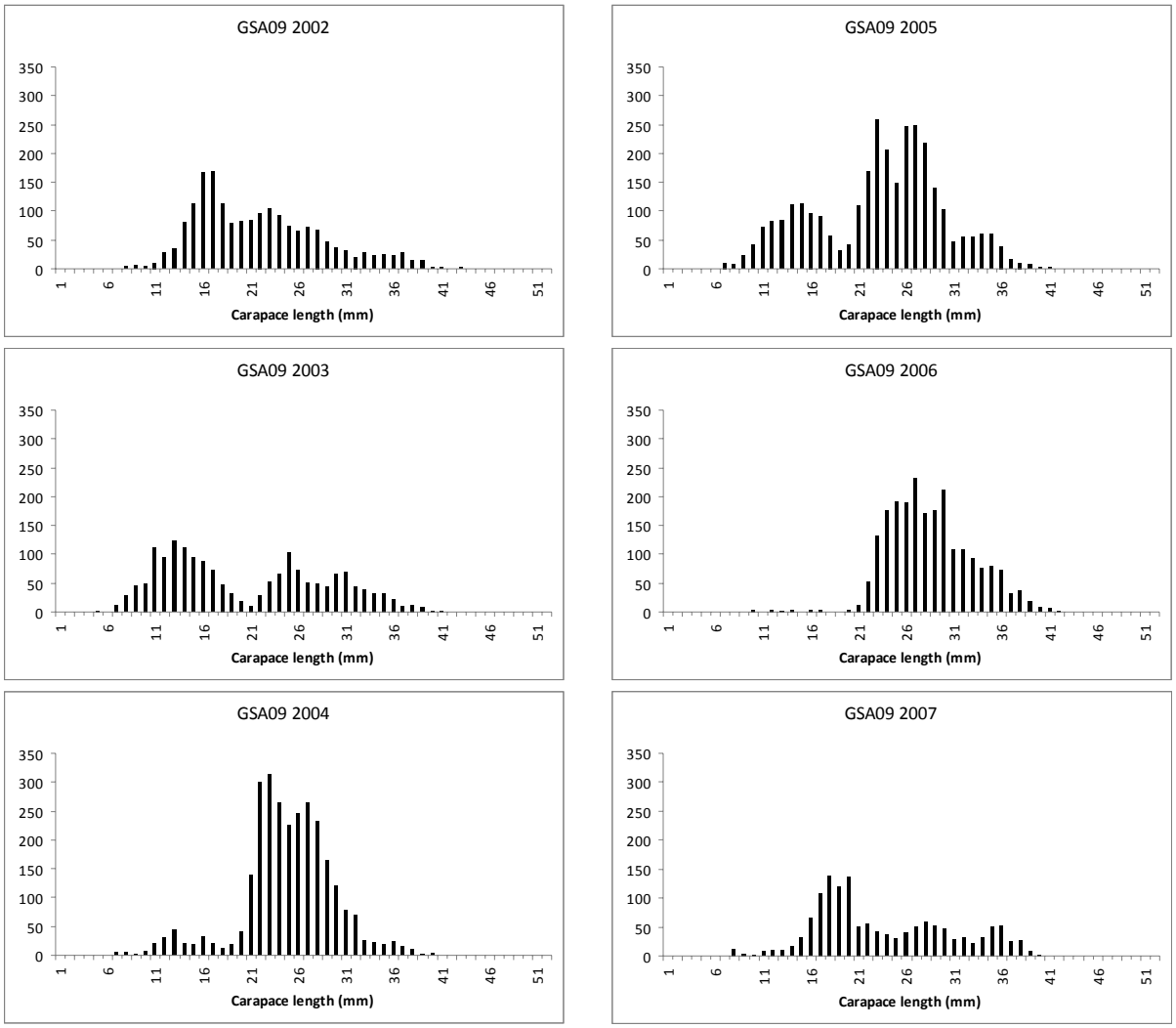


Fig. 7.32.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.32.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.32.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.32.4. Assessment of historic stock parameters

7.32.4.1. Method 1: SURBA

7.32.4.1.1. Justification

No information was documented during SGMED-08-03.

7.32.4.1.2. Input parameters

The Medits survey provided the longer standardized time-series data on abundance and population structure of *P. longirostris* in the GSA 09. The survey-based stock assessment model SURBA (Needle, 2003) was used to reconstruct trend in population structure and fishing mortality. The following set of parameters were used (Tab. 7.32.4.1.2.1).

Tab. 7.32.4.1.2.1 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 = 1.2 (Samed project, Beverton & Holt)
• **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. 7.32.4.1.2.1). The resulting age structures showed a very good internal consistency, thus showing the reliability of the growth parameters used (Fig. 7.32.4.1.2.1),

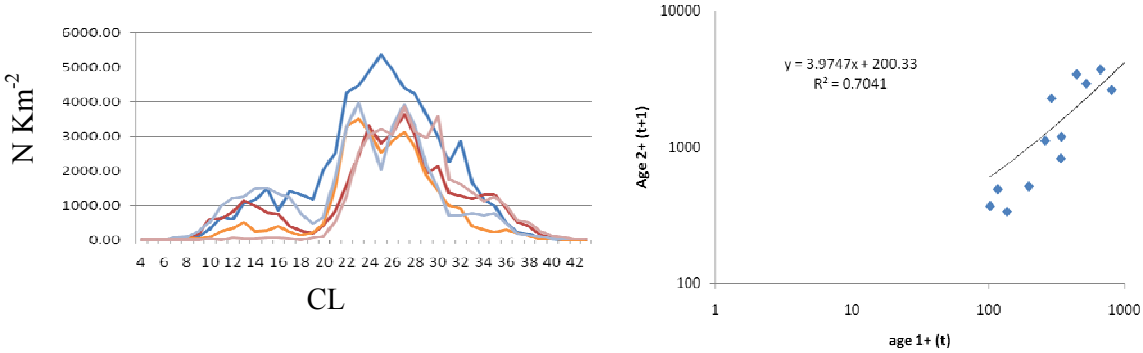


Fig. 7.32.4.1.2.1 Length frequency distributions of P. longirostris for 2000 to 2005 (left). Relationship between the estimated shrimp abundance at age 1 (time t) and age 2 (time t+1) (right).

Surba analysis was done excluding 0+ (TL < 20mm) specimens from the dataset due to their very low catchability with the Medits trawl net. A fixed M mortality value (M=1.2) obtained from literature was adopted .Temporal trend in F_{1-3} showed large fluctuations between 0.2 and 1.2 (Fig. 7.32.4.1.2.2).

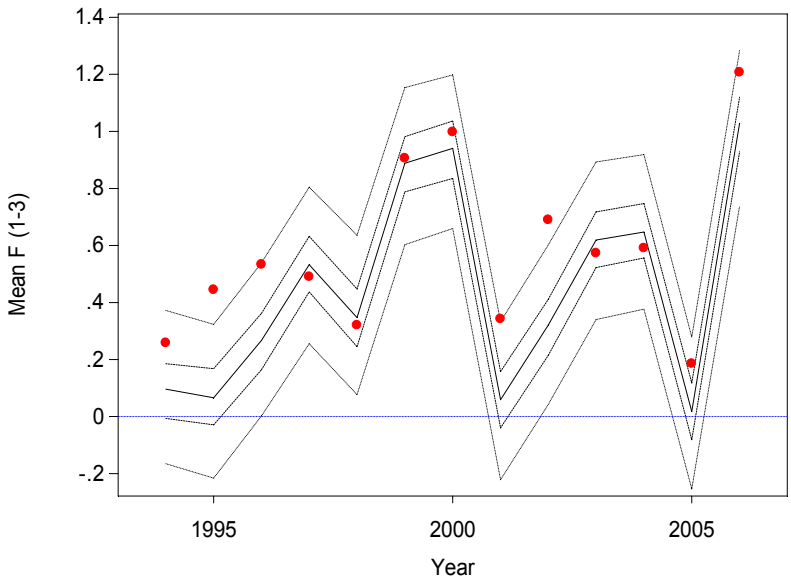


Fig. 7.32.4.1.2.2 Estimated trend in F_{1-3} for *P. longirostris* in the GSA 09.

A significant increasing trend in abundance was observed for age classes 1-3. SSB also showed a positive increasing trend during time (Fig. 7.32.4.1.2.3).

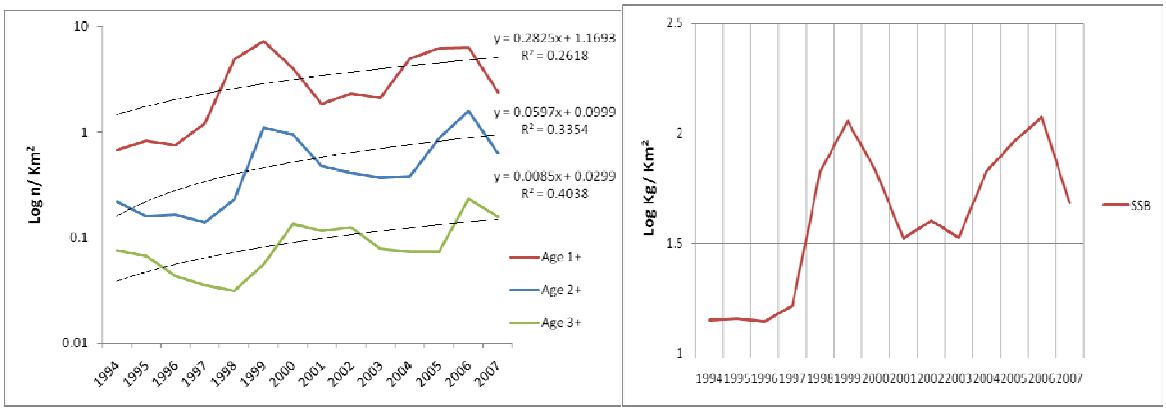


Fig 7.32.4.1.2.3 *P. longirostris*: mean-standardised Medits abundance indices by age and year-class and relative SSB in the GSA 09.

7.32.4.1.3. Results

This is the first assessm

7.32.5. Short term prediction for 2008 and 2009

7.32.5.1. Justification

No forecast analyses were conducted.

7.32.5.2. Input parameters

No forecast analyses were conducted.

7.32.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for pink shrimp in GSA 09.

7.32.6. Medium term prediction

7.32.6.1. Justification

No forecast analyses were conducted.

7.32.6.2. Input parameters

No forecast analyses were conducted.

7.32.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for pink shrimp in GSA 09.

7.32.7. Long term prediction

7.32.7.1. 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.

7.32.7.2. Input parameters

No forecast analyses were conducted.

7.32.7.3. Results

Fig. 7.32.7.3.1 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 0.8 and 1.8 (mean = 1.3) with an increased probability for values between 1.1 and 1.5.

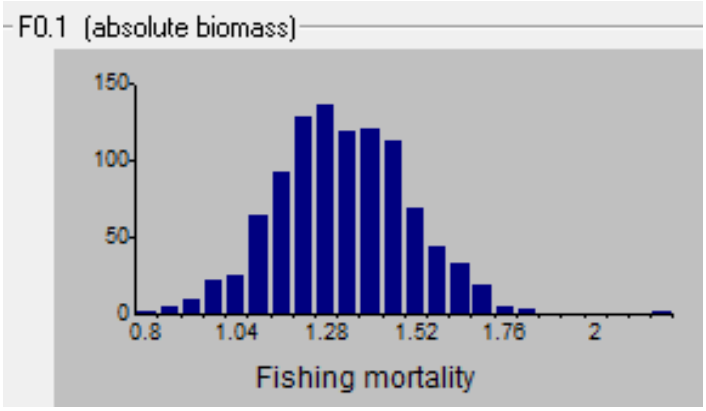


Fig. 7.20.8. Probability distribution of $F_{0.1}$ obtained using the Yield software

According to these $F_{0.1}$estimates, Fcurr was in most of the year lower than the minimum estimated $F_{0.1}$ value (0.8) and never exceeding the average $F_{0.1}$ value (1.3).

7.32.8. Scientific advice

7.32.8.1. Short term considerations

7.32.8.1.1. State of the spawning stock size

SSB showed an increasing trend during the last 13 years.

7.32.8.1.2. State of recruitment

Stock productivity does not appear to be impaired and it is able to produce large year classes.

7.32.8.1.3. State of exploitation

The stock appears able to face the current level of fishing effort in the GSA 09. In the period considered (1994-2007) it seemed to be in a underexploited to fully exploited status. However, the stock could be mostly driven by environmental factors rather than fishing and the relationships between stock (abundance and dynamic) and environmental fluctuations should be better investigated.

7.32.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.33. Stock assessment of pink shrimp in GSA 10

7.33.1. Stock identification and biological features

7.33.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.33.1.2. Growth

No information was documented during SGMED-08-03.

7.33.1.3. Maturity

No information was documented during SGMED-08-03.

7.33.2. Fisheries

7.33.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.33.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.33.2.3. Catches

7.33.2.3.1. Landings

Tab. 7.33.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-08-03 through the Data Collection Regulation and are listed in Table A3.3 of Appendix 3. Since 2002 the annual landings varied annually among 487 t and 1,861 t. The landings were mainly taken by demersal otter trawls.

Tab. 7.33.2.3.1.1 Annual landings (t) by fishing technique in GSA 10.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DPS	10	ITA	DTS	1452	416	488	695	1086	533
DPS	10	ITA	HOK			0		1	
DPS	10	ITA	PGP	2		0	0	1	
DPS	10	ITA	PMP	373	71	63	80	1	2
DPS	10	ITA	PTS	34		0			
SUM				1861	487	551	775	1089	535

7.33.2.3.2. Discards

1 t of discards in 2006 was reported to SGMED-08-03 through the DCR data call and is listed in Tab. A.3.4 of Appendix 3..

7.33.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-08-03 are listed in Tab. 7.33.2.3.3.1 and in Tab. A3.5 of Appendix 3.

Tab. 7.33.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSA 10, 2002-2007.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	10	ITA	DRB	658	205	830	1776	1984	1040
DAYS	10	ITA	DTS	37949	38134	44087	46547	43848	40724
DAYS	10	ITA	HOK			20929	20418	8064	7043
DAYS	10	ITA	PGP	357895	311474	325523	268441	346849	311693
DAYS	10	ITA	PMP	105705	143062	62225	64177	10532	7261
DAYS	10	ITA	PTS	8258	9780	11792	11206	9332	9367
GT*DAYS	10	ITA	DRB			7968	17128	19136	9939
GT*DAYS	10	ITA	DTS			1337882	1622062	1331071	1266460
GT*DAYS	10	ITA	HOK			157882	143835	103111	82342
GT*DAYS	10	ITA	PGP			661958	534880	800036	693057
GT*DAYS	10	ITA	PMP			336053	333845	152717	110850
GT*DAYS	10	ITA	PTS			390096	468145	367417	280190
KW*DAYS	10	ITA	DRB	94663	29540	110899	244013	272628	142455
KW*DAYS	10	ITA	DTS	7344089	7231486	7883881	8467144	7596783	7105075
KW*DAYS	10	ITA	HOK			1654352	1413547	925244	794816
KW*DAYS	10	ITA	PGP	6440217	7222145	7056306	6018600	9486681	8397010
KW*DAYS	10	ITA	PMP	12686947	8003452	3588004	3728376	1404642	1003285
KW*DAYS	10	ITA	PTS	2631242	2930380	2308589	2434470	2016508	1680295

7.33.3. Scientific surveys

7.33.3.1. Medits

7.33.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 10 the following number of hauls were reported per depth stratum (s. Tab. 7.33.3.1.1.1).

Tab. 7.33.3.1.1.1. Number of hauls per year and depth stratum in GSA 10, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA10_010-050	9	10	10	10	10	10	10	10	9	9	9	9	9	9
GSA10_050-100	12	12	12	12	12	12	12	12	10	10	10	10	10	10
GSA10_100-200	20	20	20	20	20	20	20	20	17	17	17	17	17	17
GSA10_200-500	26	27	26	26	27	26	26	28	22	22	22	22	22	22
GSA10_500-800	31	30	31	31	31	30	31	29	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.

7.33.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.33.3.1.3. 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 7.33.3.1.3.1 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 appear low, which appears consistent with the low landings in 2007. The analyses of Medits indices are considered preliminary.

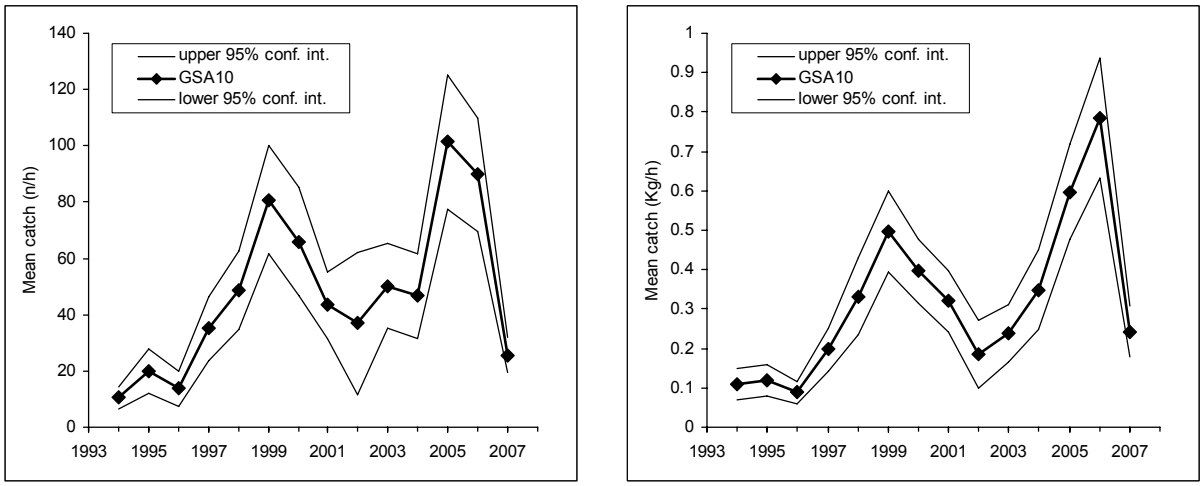


Fig. 7.33.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 10.

7.33.3.1.4. Trends in abundance by length or age

The following Fig. 7.33.3.1.4.1 and 2 display the stratified abundance indices of GSA 10 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

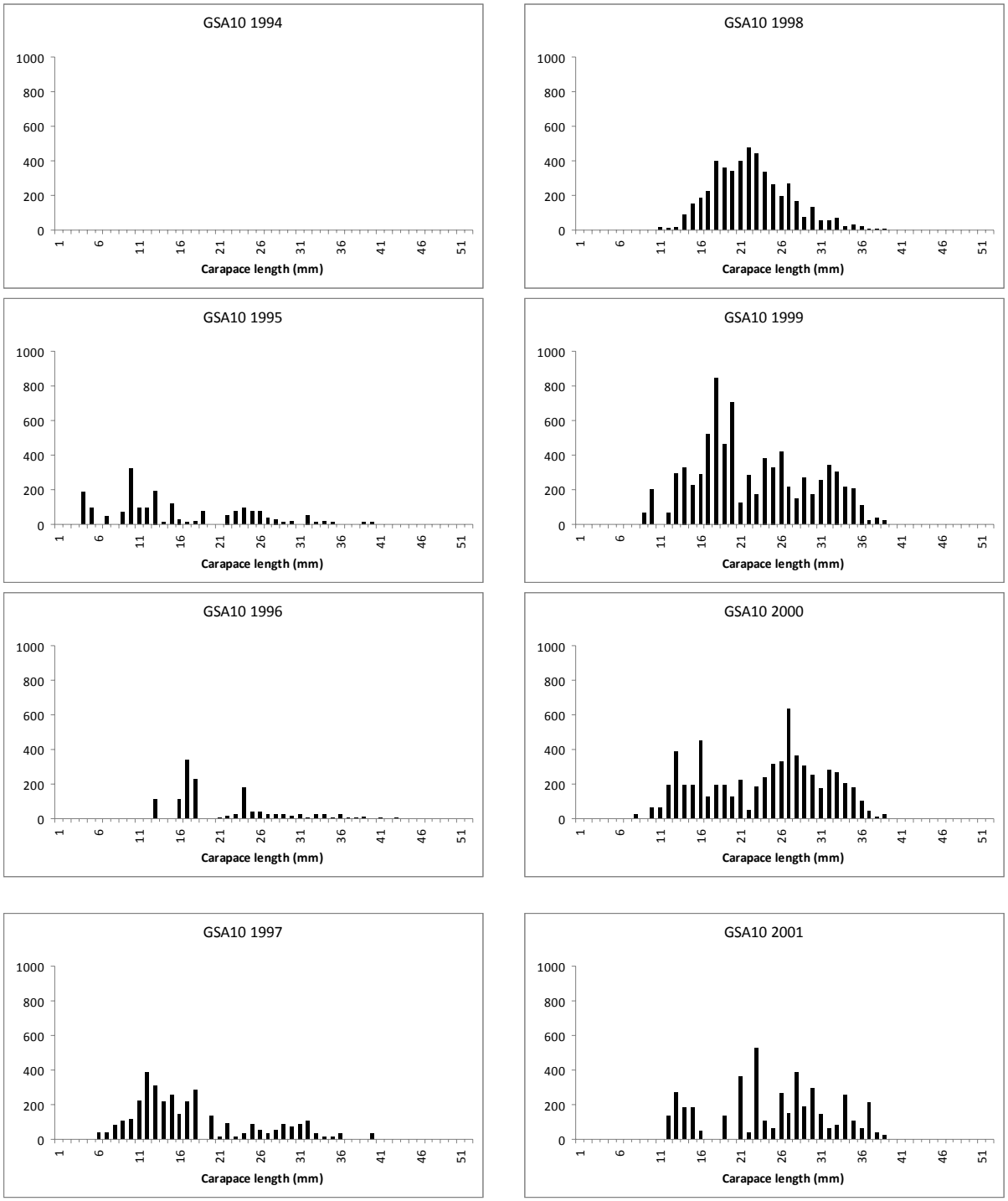


Fig. 7.33.3.1.4.1 Stratified abundance indices by size, 1994-2001.

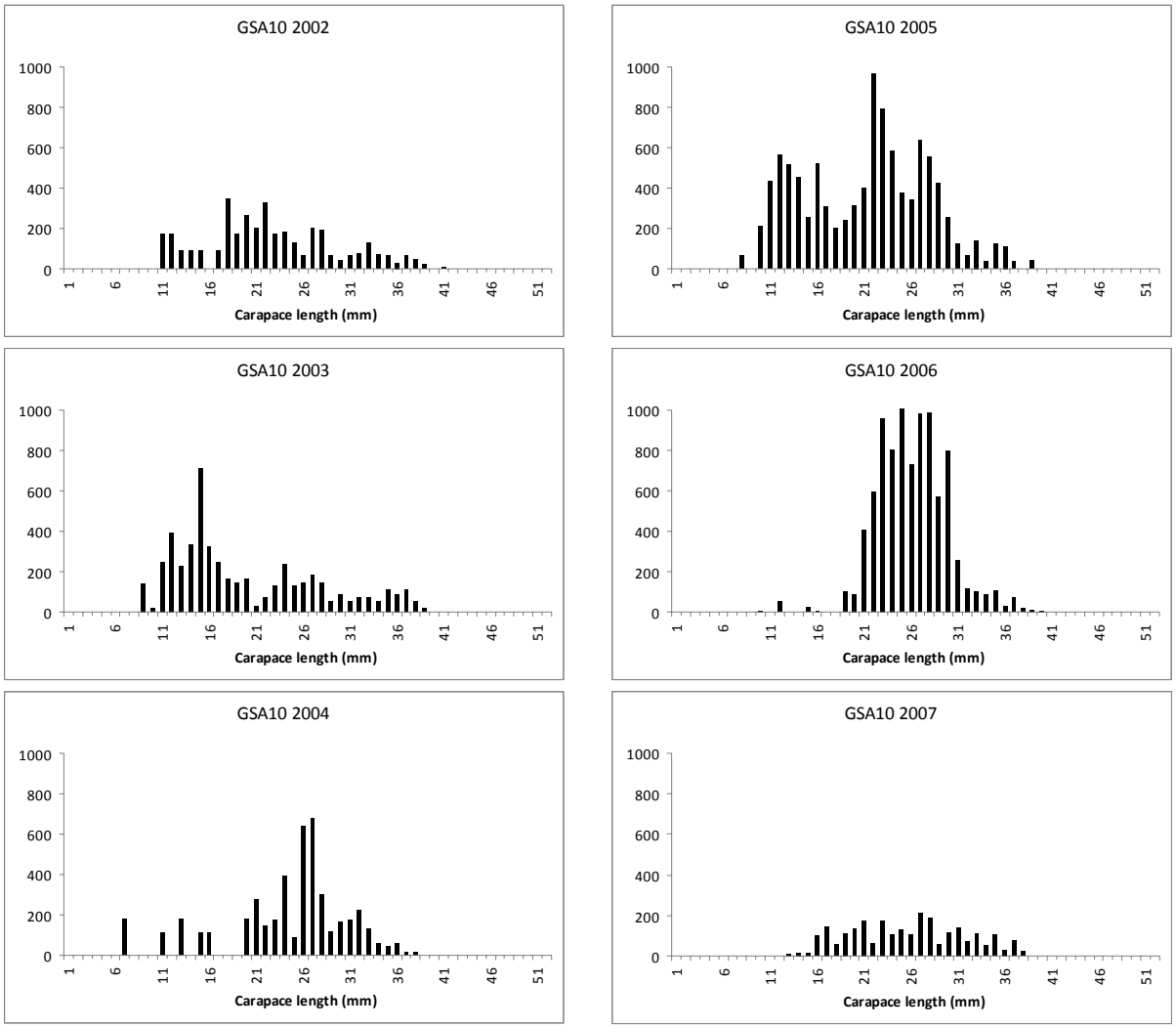


Fig. 7.33.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.33.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.33.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.33.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.33.5. Short term prediction for 2008 and 2009

7.33.5.1. Justification

No forecast analyses were conducted.

7.33.5.2. Input parameters

No forecast analyses were conducted.

7.33.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for pink shrimp in GSA 10.

7.33.6. Medium term prediction

7.33.6.1. Justification

No forecast analyses were conducted.

7.33.6.2. Input parameters

No forecast analyses were conducted.

7.33.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for pink shrimp in GSA 10.

7.33.7. Long term prediction

7.33.7.1. Justification

No forecast analyses were conducted.

7.33.7.2. Input parameters

No forecast analyses were conducted.

7.33.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for pink shrimp in GSA 10.

7.33.8. Scientific advice

7.33.8.1. Short term considerations

7.33.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.33.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.33.8.1.3. State of exploitation

SGMED-08-03 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.

7.33.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.34. Stock assessment of pink shrimp in GSA 11

7.34.1. Stock identification and biological features

7.34.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.34.1.2. Growth

No information was documented during SGMED-08-03.

7.34.1.3. Maturity

No information was documented during SGMED-08-03.

7.34.2. Fisheries

7.34.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.34.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.34.2.3. Catches

7.34.2.3.1. Landings

Tab. 7.34.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-08-03 through the Data Collection Regulation and are listed in Table A3.3 of Appendix 3. Since 2002 the annual landings varied annually among 13 t and 552 t. The landings were mainly taken by demersal otter trawls.

Tab. 7.33.2.3.1.1 Annual landings (t) by fishing technique in GSA 11.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DPS	11	ITA	DTS	38	13	232	551	124	79
DPS	11	ITA	PGP	1			1	6	
DPS	11	ITA	PMP	47					
SUM				86	13	232	552	130	79

7.34.2.3.2. Discards

No information was documented during SGMED-08-03.

7.34.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-08-03 are listed in Tab. 7.34.2.3.3.1 and in Tab. A3.5 of Appendix 3.

Tab. 7.34.2.3.3.1 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
DAYS	11	ITA	DTS	14539	18957	28840	31993	26532	27374
DAYS	11	ITA	PGP	102826	126272	165945	151720	156269	155243
DAYS	11	ITA	PMP	57543	30879				
GT*DAYS	11	ITA	DTS			1598912	1881952	1437559	1486500
GT*DAYS	11	ITA	PGP			501550	484820	493411	495670
KW*DAYS	11	ITA	DTS	3679604	4652647	6711626	7736040	6017232	6340429
KW*DAYS	11	ITA	PGP	2865738	5099814	7105771	6996350	7234881	7398923

7.34.3. Scientific surveys

7.34.3.1. Medits

7.34.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 34 the following number of hauls were reported per depth stratum (s. Tab. 7.34.3.1.1.1).

Tab. 7.34.3.1.1.1. Number of hauls per year and depth stratum in GSA 11, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA11_010-050	16	18	21	21	21	20	19	17	20	18	17	17	19	19
GSA11_050-100	25	21	22	22	20	22	22	24	19	19	18	21	18	20
GSA11_100-200	20	23	30	31	31	30	29	30	24	24	24	24	24	24
GSA11_200-500	33	29	29	26	25	27	24	25	20	24	21	20	20	20
GSA11_500-800	23	16	21	25	25	24	27	26	16	14	15	14	16	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.

7.34.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.34.3.1.3. 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 7.34.3.1.3.1 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.

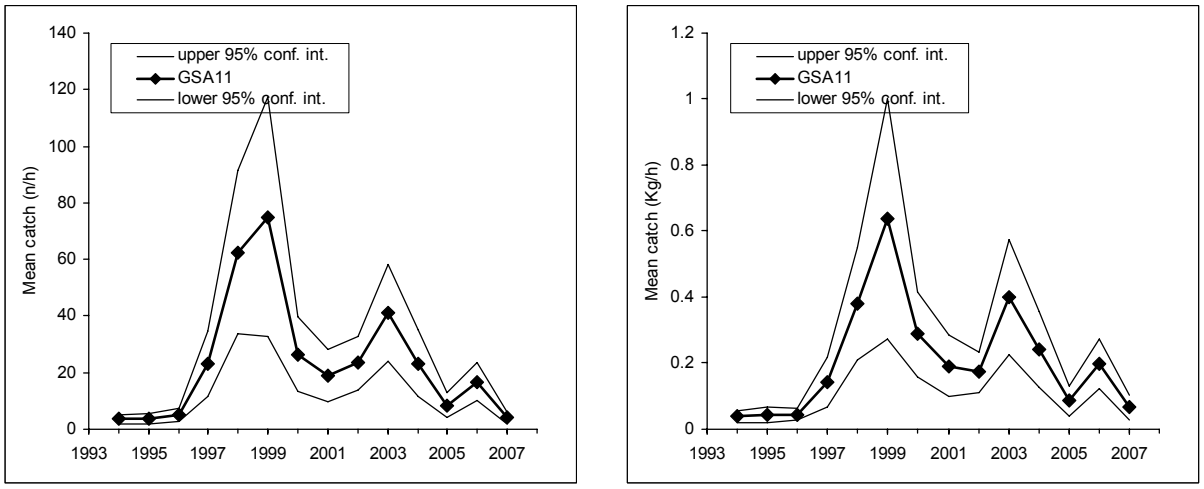


Fig. 7.34.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 11.

7.34.3.1.4. Trends in abundance by length or age

The following Fig. 7.34.3.1.4.1 and 2 display the stratified abundance indices of GSA 11 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

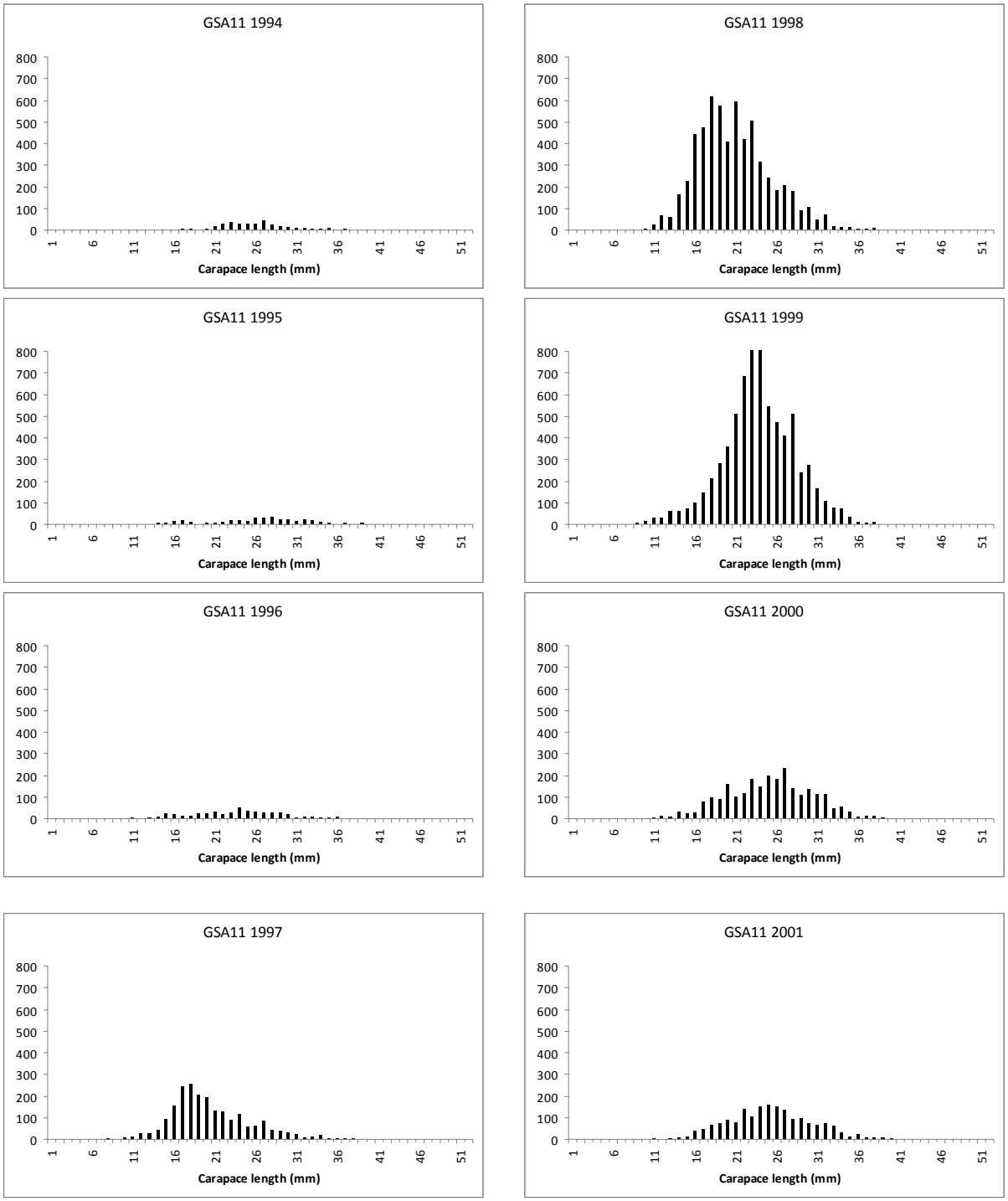


Fig. 7.343.3.1.4.1 Stratified abundance indices by size, 1994-2001.

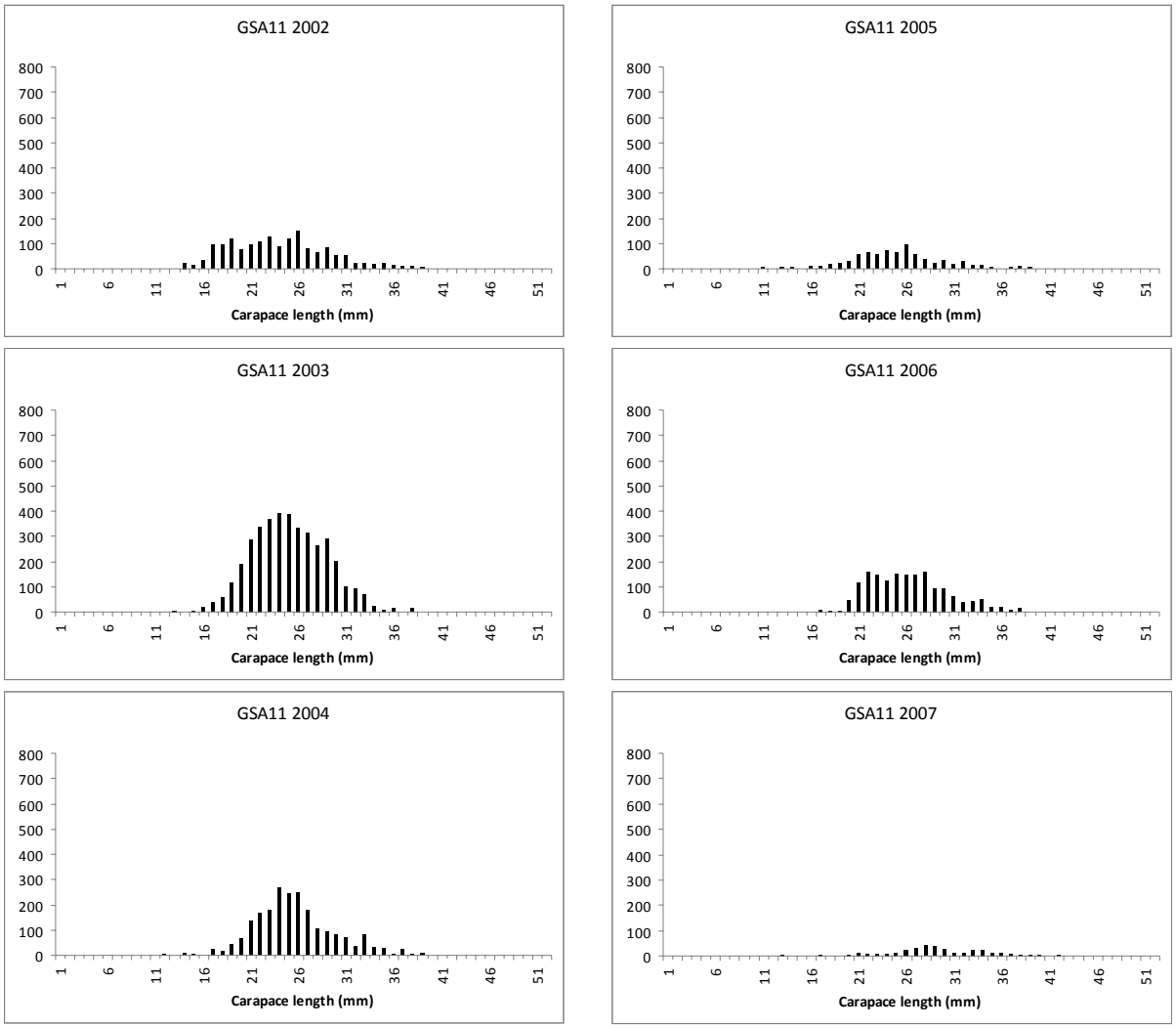


Fig. 7.33.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.34.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.34.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.34.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.34.5. Short term prediction for 2008 and 2009

7.34.5.1. Justification

No forecast analyses were conducted.

7.34.5.2. Input parameters

No forecast analyses were conducted.

7.34.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for pink shrimp in GSA 11.

7.34.6. Medium term prediction

7.34.6.1. Justification

No forecast analyses were conducted.

7.34.6.2. Input parameters

No forecast analyses were conducted.

7.34.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for pink shrimp in GSA 11.

7.34.7. Long term prediction

7.34.7.1. Justification

No forecast analyses were conducted.

7.34.7.2. Input parameters

No forecast analyses were conducted.

7.34.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for pink shrimp in GSA 11.

7.34.8. Scientific advice

7.34.8.1. Short term considerations

7.34.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.34.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.34.8.1.3. State of exploitation

SGMED-08-03 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.

7.34.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.35. Stock assessment of pink shrimp in GSA 16

7.35.1. Stock identification and biological features

7.35.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.35.1.2. Growth

No information was documented during SGMED-08-03.

7.35.1.3. Maturity

No information was documented during SGMED-08-03.

7.35.2. Fisheries

7.35.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.35.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.35.2.3. Catches

7.35.2.3.1. Landings

Tab. 7.35.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-08-03 through the Data Collection Regulation and are listed in Table A3.3 of Appendix 3. Since 2002 the annual landings varied annually among 5,970 t in 2007 and 8,580 t in 2005. The landings in 2007 represent the record low since 2002. The landings were mainly taken by demersal otter trawls.

Tab. 7.35.2.3.1.1 Annual landings (t) by fishing technique in GSA 16.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DPS	16	ITA	DTS	7463	7388	6606	8355	8455	5966
DPS	16	ITA	HOK			57	224		0
DPS	16	ITA	PGP	1	23	2		1	
DPS	16	ITA	PMP	101					
DPS	16	ITA	PTS	20	55		5		
SUM				7585	7466	6665	8584	8456	5966

7.35.2.3.2. Discards

25 t of discards in 2006 was reported to SGMED-08-03 through the DCR data call and is listed in Tab. A.3.4 of Appendix 3..

7.35.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-08-03 are listed in Tab. 7.35.2.3.3.1 and in Tab. A3.5 of Appendix 3.

Tab. 7.35.2.3.3.1 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
DAYS	16	ITA	DTS	87300	76233	81853	82557	89319	89164
DAYS	16	ITA	HOK			14856	11450	10272	9284
DAYS	16	ITA	PGP	146019	118660	118425	97285	85556	85298
DAYS	16	ITA	PMP	26655	34956	6939			
DAYS	16	ITA	PTS	8778	8568	4899	5476	7926	7032
GT*DAYS	16	ITA	DTS			6673029	6864030	7429483	7322198
GT*DAYS	16	ITA	HOK			764595	403669	507862	370612
GT*DAYS	16	ITA	PGP			249032	206056	192811	212519
GT*DAYS	16	ITA	PMP			20134			
GT*DAYS	16	ITA	PTS			224188	236435	352518	346405
KW*DAYS	16	ITA	DTS	23952310	20951845	21381964	21772464	23699835	23644626
KW*DAYS	16	ITA	HOK			3153486	1758722	2076446	1695903
KW*DAYS	16	ITA	PGP	3133993	4603457	2691324	2302777	2207660	2378933
KW*DAYS	16	ITA	PMP	2792612	2761842	223470			
KW*DAYS	16	ITA	PTS	2510582	1750128	962786	1063031	1592930	1431085

7.35.3. Scientific surveys

7.35.3.1. Medits

7.35.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 16 the following number of hauls were reported per depth stratum (s. Tab. 7.35.3.1.1.1).

Tab. 7.35.3.1.1.1. Number of hauls per year and depth stratum in GSA 16, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA16_010-050	4	4	4	4	4	4	4	4	7	7	7	10	10	11
GSA16_050-100	8	8	8	8	8	8	7	8	11	12	12	20	22	23
GSA16_100-200	4	4	4	4	5	5	6	5	10	8	9	18	19	21
GSA16_200-500	10	11	11	12	11	11	11	11	19	18	19	28	31	27
GSA16_500-800	10	14	14	13	14	14	14	14	19	20	19	32	33	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.

7.35.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.35.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the pink shrimp in GSA 16 was derived from the international survey Medits. Figure 7.35.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSA 16.

The estimated abundance and biomass indices peaked in 2004 and decreased thereafter. However, 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.

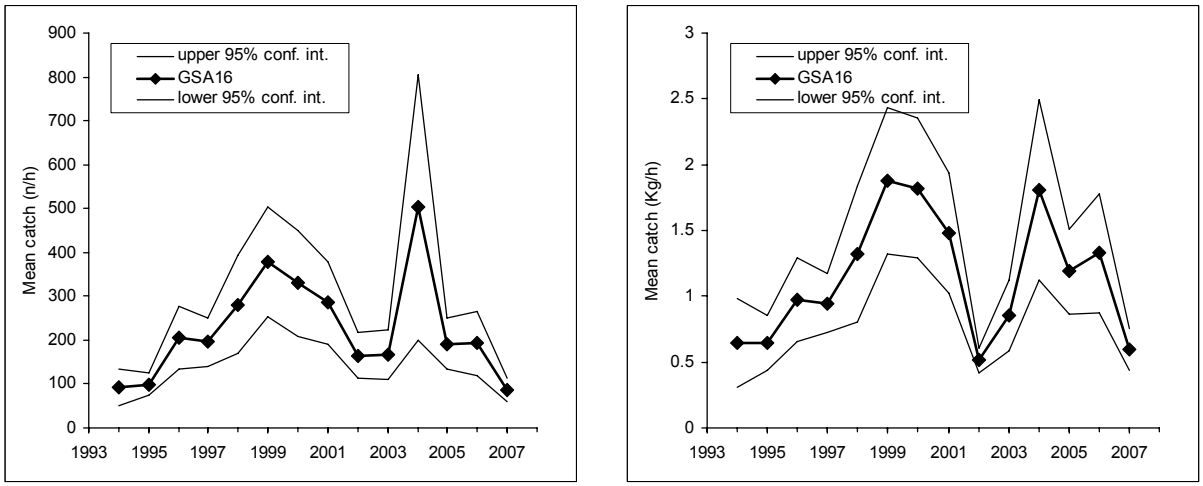


Fig. 7.35.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 16.

7.35.3.1.4. Trends in abundance by length or age

The following Fig. 7.35.3.1.4.1 and 2 display the stratified abundance indices of GSA 16 in 1994-2001 and 2002-2007. These size compositions are considered preliminary.

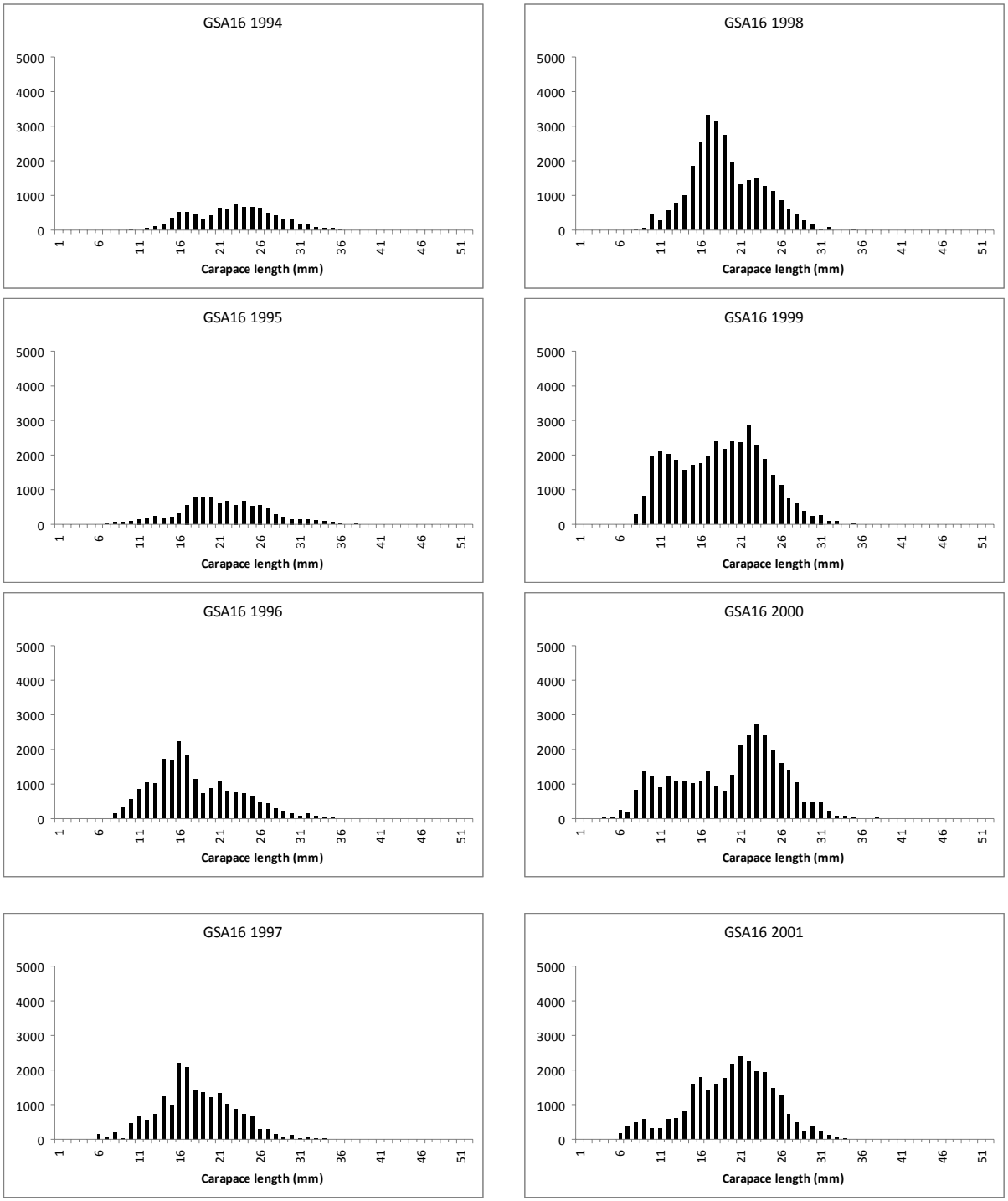


Fig. 7.35.3.1.4.1 Stratified abundance indices by size, 1994-2001.

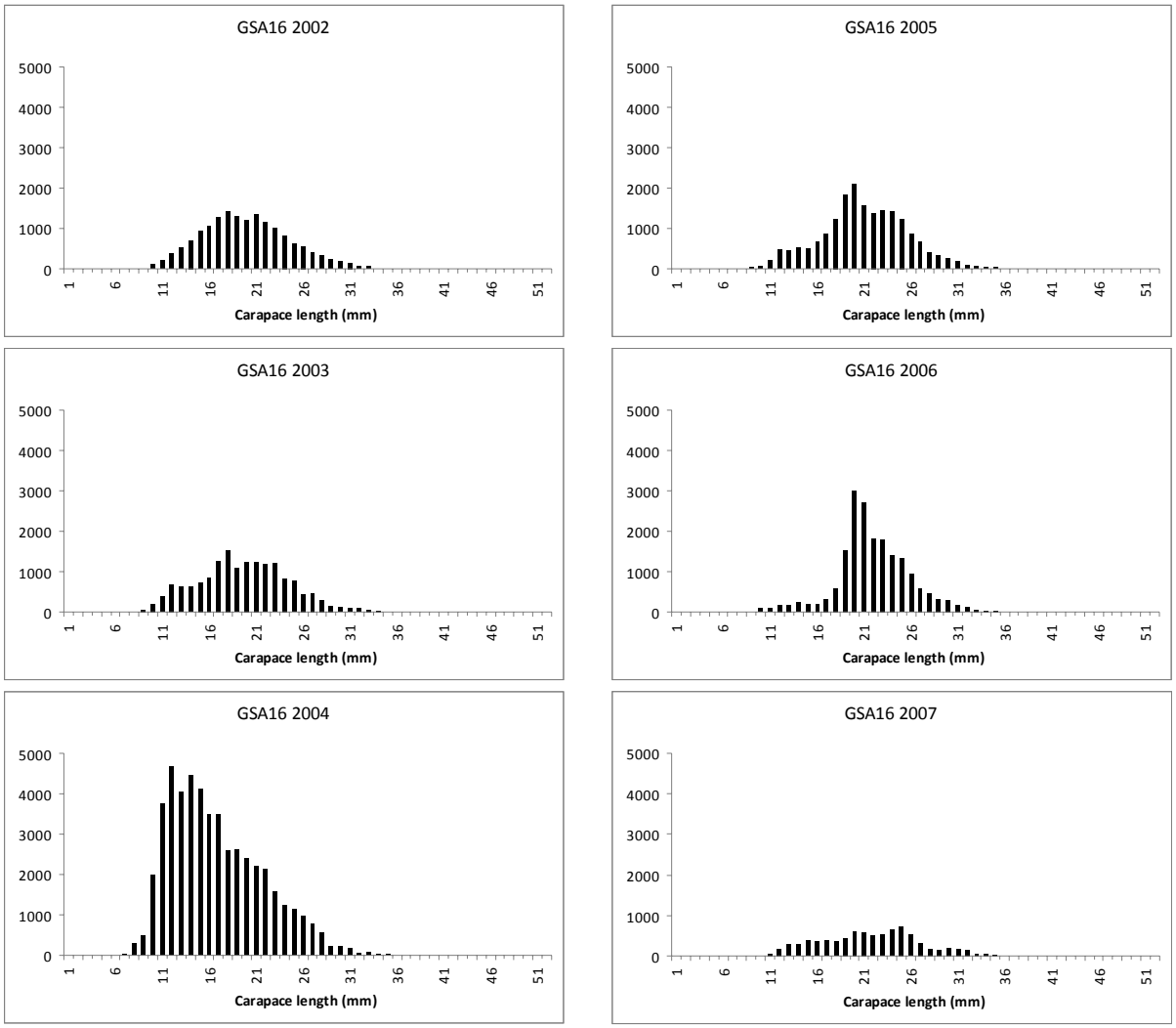


Fig. 7.35.3.1.4.2 Stratified abundance indices by size, 2002-2007.

7.35.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.35.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.35.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.35.5. Short term prediction for 2008 and 2009

7.35.5.1. Justification

No forecast analyses were conducted.

7.35.5.2. Input parameters

No forecast analyses were conducted.

7.35.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for pink shrimp in GSA 16.

7.35.6. Medium term prediction

7.35.6.1. Justification

No forecast analyses were conducted.

7.35.6.2. Input parameters

No forecast analyses were conducted.

7.35.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for pink shrimp in GSA 16.

7.35.7. Long term prediction

7.35.7.1. Justification

No forecast analyses were conducted.

7.35.7.2. Input parameters

No forecast analyses were conducted.

7.35.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for pink shrimp in GSA 16.

7.35.8. Scientific advice

7.35.8.1. Short term considerations

7.35.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.35.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.35.8.1.3. State of exploitation

SGMED-08-03 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.

7.35.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.36. Stock assessment of pink shrimp in GSA 18

7.36.1. Stock identification and biological features

7.36.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.36.1.2. Growth

No information was documented during SGMED-08-03.

7.36.1.3. Maturity

No information was documented during SGMED-08-03.

7.36.2. Fisheries

7.36.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.36.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.36.2.3. Catches

7.36.2.3.1. Landings

Tab. 7.36.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-08-03 through the Data Collection Regulation and are listed in Table A3.3 of Appendix 3. Since 2002 the annual landings varied annually among 860 t in 2007 and 1,860 t in 2004. The landings in 2007 represent the record low since 2002. The landings were mainly taken by demersal otter trawls.

Tab. 7.36.2.3.1.1 Annual landings (t) by fishing technique in GSA 18.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DPS	18	ITA	DTS	903	1253	1742	1181	1473	863
DPS	18	ITA	PGP		67	95			
DPS	18	ITA	PMP	244	496	20			
DPS	18	ITA	PTS			0			
SUM				1147	1816	1857	1181	1473	863

7.36.2.3.2. Discards

No information was documented during SGMED-08-03.

7.36.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-08-03 are listed in Tab. 7.36.2.3.3.1 and in Tab. A3.5 of Appendix 3.

Tab. 7.36.2.3.3.1 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
DAYS	18	ITA	DRB	11081	5890	3865	5776	7562	8132
DAYS	18	ITA	DTS	85424	71203	80259	84207	88418	73637
DAYS	18	ITA	HOK			1799	3053	4397	3190
DAYS	18	ITA	PGP	110621	63332	67232	80648	88583	68253
DAYS	18	ITA	PMP	53475	35980	3667			
DAYS	18	ITA	PTS	4140	4526	4679	4428	5291	6186
GT*DAYS	18	ITA	DRB			41347	62244	81590	87740
GT*DAYS	18	ITA	DTS			2568868	2592741	2632767	2275442
GT*DAYS	18	ITA	HOK			27800	58254	79940	58026
GT*DAYS	18	ITA	PGP			120701	146182	147150	115612
GT*DAYS	18	ITA	PMP			40920			
GT*DAYS	18	ITA	PTS			369876	360279	446754	516692
KW*DAYS	18	ITA	DRB	1100225	584801	381968	570792	746921	807073
KW*DAYS	18	ITA	DTS	17112022	14530793	14369490	14621928	14929696	12904532
KW*DAYS	18	ITA	HOK			284535	514377	778355	567996
KW*DAYS	18	ITA	PGP	1722336	1002933	1180371	1442219	1394671	1311109
KW*DAYS	18	ITA	PMP	7277279	4416994	351689			
KW*DAYS	18	ITA	PTS	1480945	1464793	1842716	1785787	2221605	2613654

7.36.3. Scientific surveys

7.36.3.1. Medits

7.36.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 18 the following number of hauls were reported per depth stratum (s. Tab. 7.36.3.1.1.1).

Tab. 7.36.3.1.1.1. Number of hauls per year and depth stratum in GSA 18, 1994-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA18_010-050	14	15	15	14	14	14	14	15	11	11	10	9	10	9
GSA18_050-100	14	14	14	15	15	15	15	14	13	13	15	15	14	14
GSA18_100-200	24	23	23	23	23	23	23	23	26	23	24	25	25	22
GSA18_200-500	10	10	10	10	10	10	10	10	8	8	8	9	9	6
GSA18_500-800	10	10	10	10	10	10	10	10	7	7	8	7	7	7

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.

7.36.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.36.3.1.3. 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 7.36.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSA 18.

The estimated abundance and biomass indices peaked in 2005 after some years of relatively high abundance. However, 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.

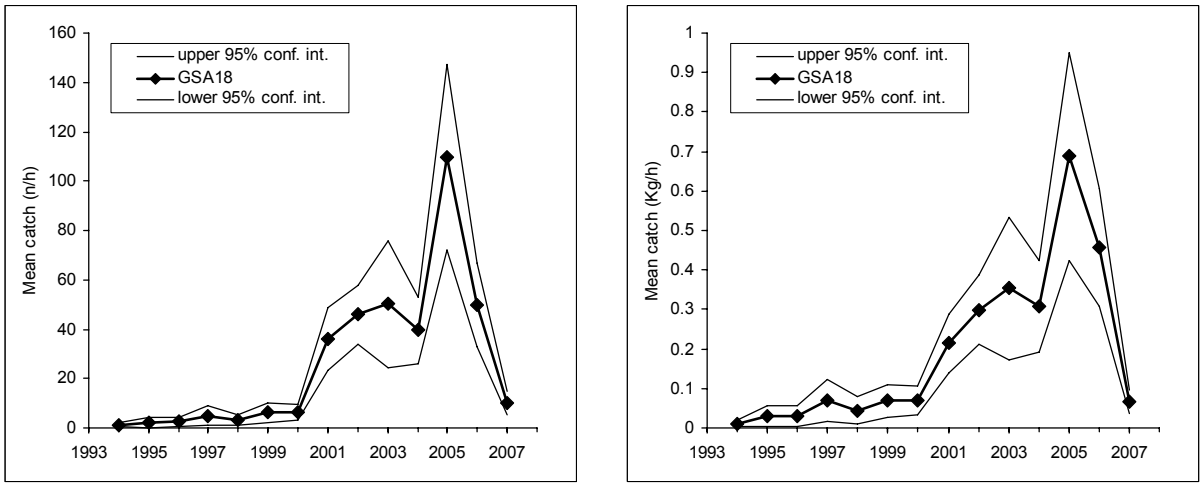


Fig. 7.36.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 18.

7.36.3.1.4. Trends in abundance by length or age

The following Fig. 7.36.3.1.4.1 and 2 display the stratified abundance indices of GSA 18 in 1995-2002 and 2003-2007. These size compositions are considered preliminary.

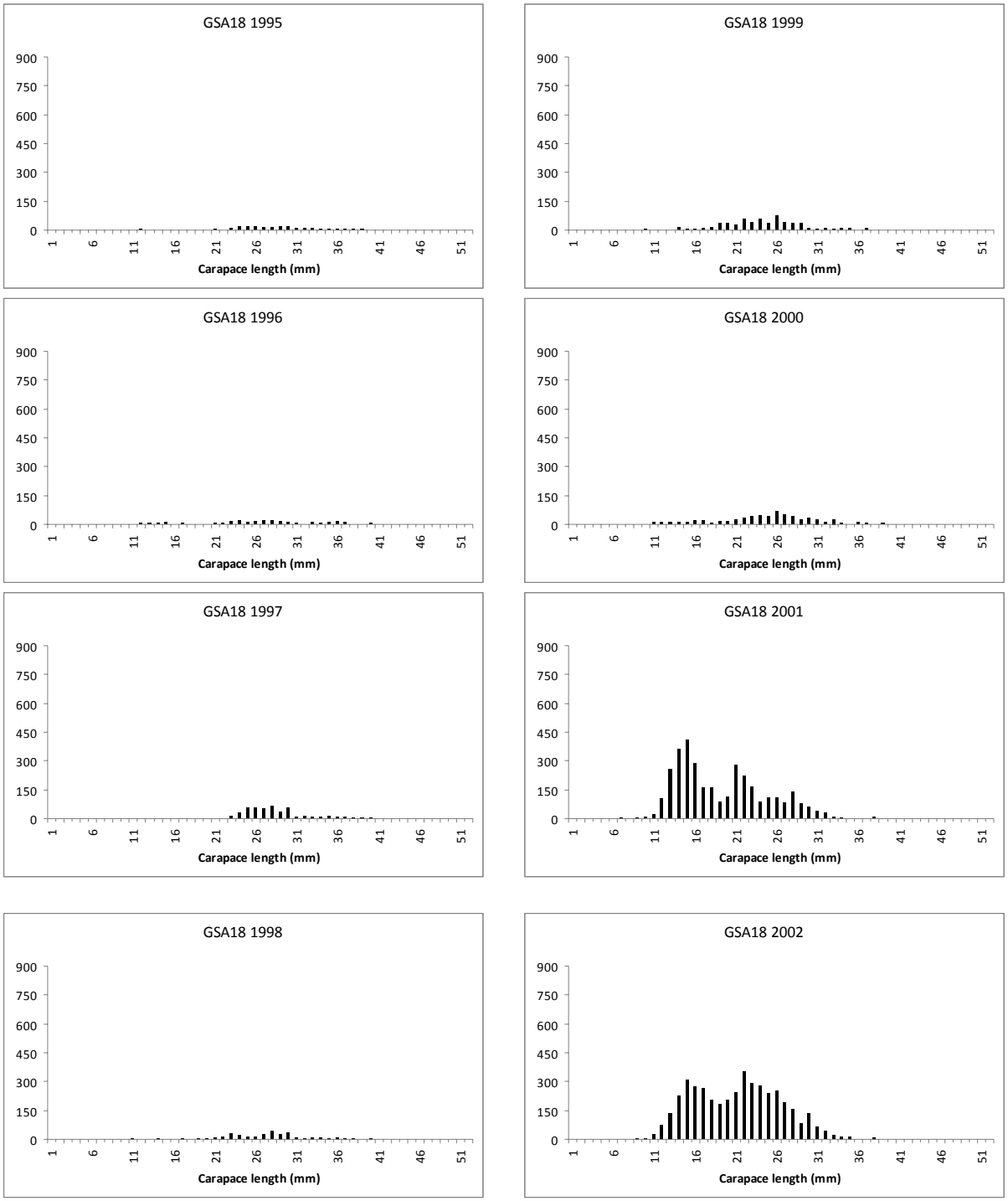


Fig. 7.36.3.1.4.1 Stratified abundance indices by size, 1995-2002.

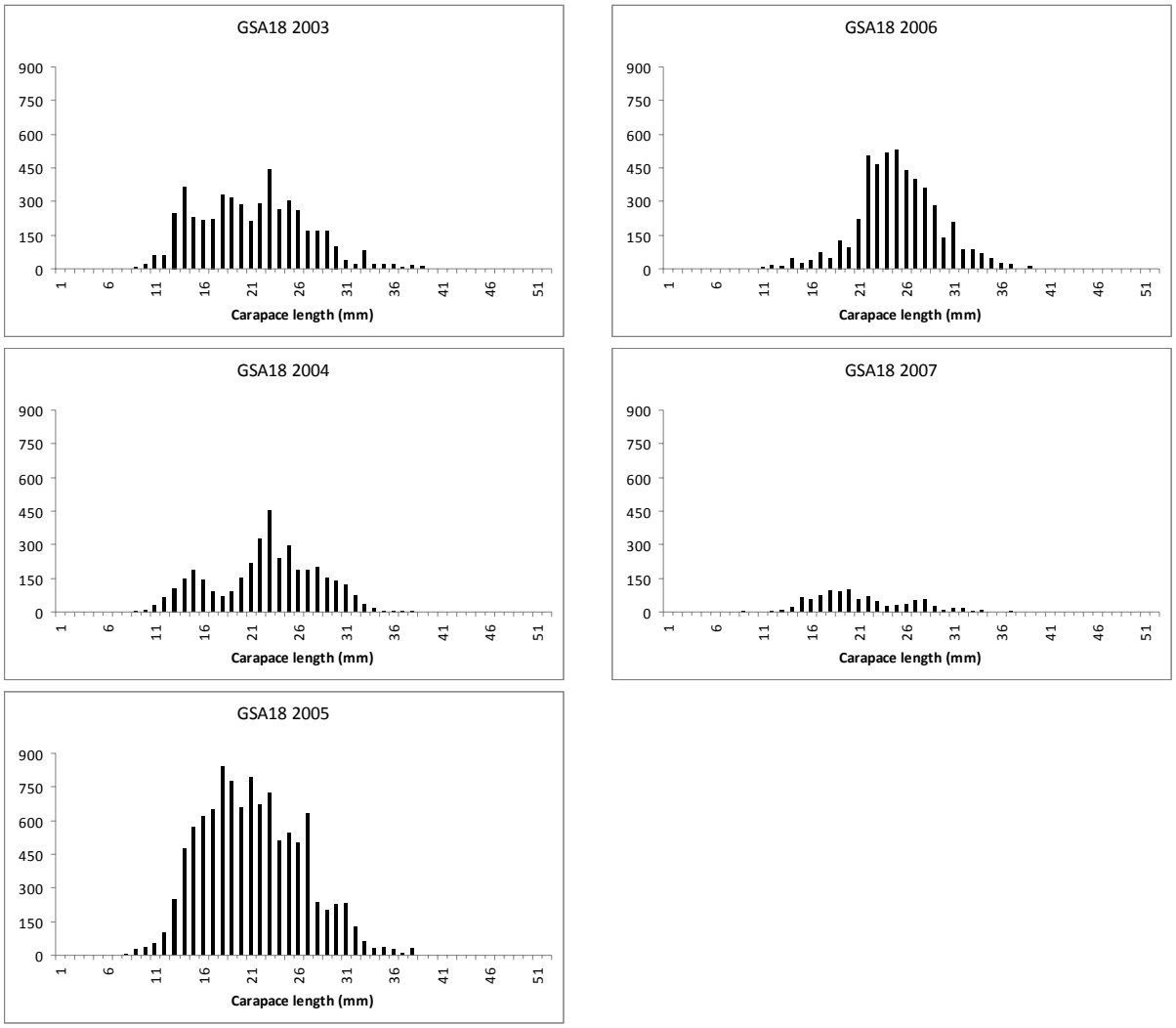


Fig. 7.36.3.1.4.2 Stratified abundance indices by size, 2003-2007.

7.36.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.36.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.36.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.36.5. Short term prediction for 2008 and 2009

7.36.5.1. Justification

No forecast analyses were conducted.

7.36.5.2. Input parameters

No forecast analyses were conducted.

7.36.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for pink shrimp in GSA 18.

7.36.6. Medium term prediction

7.36.6.1. Justification

No forecast analyses were conducted.

7.36.6.2. Input parameters

No forecast analyses were conducted.

7.36.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for pink shrimp in GSA 18.

7.36.7. Long term prediction

7.36.7.1. Justification

No forecast analyses were conducted.

7.36.7.2. Input parameters

No forecast analyses were conducted.

7.36.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for pink shrimp in GSA 18.

7.36.8. Scientific advice

7.36.8.1. Short term considerations

7.36.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.36.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.36.8.1.3. State of exploitation

SGMED-08-03 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.

7.36.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.37. Stock assessment of pink shrimp in GSA 19

7.37.1. Stock identification and biological features

7.37.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.37.1.2. Growth

No information was documented during SGMED-08-03.

7.37.1.3. Maturity

No information was documented during SGMED-08-03.

7.37.2. Fisheries

7.37.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.37.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.37.2.3. Catches

7.37.2.3.1. Landings

Tab. 7.37.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-08-03 through the Data Collection Regulation and are listed in Table A3.3 of Appendix 3. Since 2002 the annual landings varied annually among 608 t in 2007 and 1,390 t in 2003. The landings in 2007 represent the record low since 2002. The landings were mainly taken by demersal otter trawls.

Tab. 7.37.2.3.1.1 Annual landings (t) by fishing technique in GSA 19.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DPS	19	ITA	DTS	738	646	1037	1242	1245	608
DPS	19	ITA	HOK			34			
DPS	19	ITA	PGP	3		77	1		
DPS	19	ITA	PMP	365	745	53	1		
DPS	19	ITA	PTS	20					
SUM				1126	1391	1201	1244	1245	608

7.37.2.3.2. Discards

4 t of discards in 2006 was reported to SGMED-08-03 through the DCR data call and is listed in Tab. A.3.4 of Appendix 3..

7.37.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-08-03 are listed in Tab. 7.37.2.3.3.1 and in Tab. A3.5 of Appendix 3.

Tab. 7.37.2.3.3.1 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
DAYS	19	ITA	DTS	31381	31586	37234	42413	42976	40423
DAYS	19	ITA	HOK			39190	43898	25644	17695
DAYS	19	ITA	PGP	233718	254881	225109	193806	217447	168411
DAYS	19	ITA	PMP	100208	122225	20325	6905		
DAYS	19	ITA	PTS	3458	7302	6605	5554	5507	4441
GT*DAYS	19	ITA	DTS			782163	884513	835267	800971
GT*DAYS	19	ITA	HOK			1015534	1091913	850691	710177
GT*DAYS	19	ITA	PGP			473727	438792	555916	483882
GT*DAYS	19	ITA	PMP			111129	34967		
GT*DAYS	19	ITA	PTS			195882	238105	188866	114537
KW*DAYS	19	ITA	DTS	5125805	5002396	5802023	6562337	6460683	6063817
KW*DAYS	19	ITA	HOK			6809150	7299195	5575566	4053202
KW*DAYS	19	ITA	PGP	4669873	9192254	4881153	4698292	6141378	5333724
KW*DAYS	19	ITA	PMP	13116917	9143878	1188078	341008		
KW*DAYS	19	ITA	PTS	978457	1629677	1105203	1026897	1008813	691704

7.37.3. Scientific surveys

7.37.3.1. Medits

7.37.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 19 the following number of hauls were reported per depth stratum (s. Tab. 7.37.3.1.1.1).

Tab. 7.37.3.1.1.1. Number of hauls per year and depth stratum in GSA 16, 2002-2007.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA19_010-050									9	9	9	9	9	8
GSA19_050-100									8	8	8	8	8	9
GSA19_100-200									10	10	10	10	10	10
GSA19_200-500									14	14	14	15	14	14
GSA19_500-800									29	29	29	28	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.

7.37.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.37.3.1.3. 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 7.37.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSA 19.

The estimated abundance and biomass varied without a clear trend. However, 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.

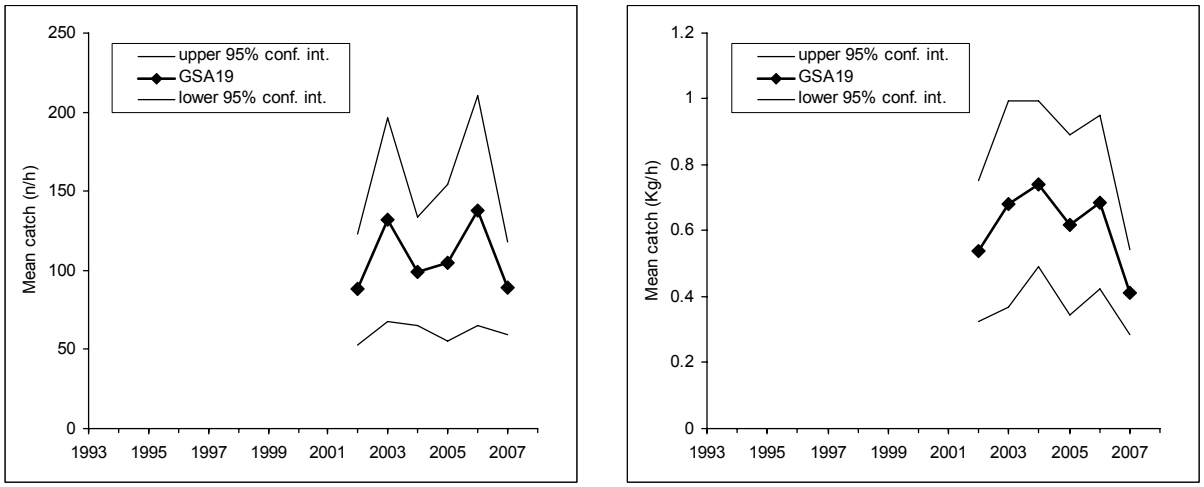


Fig. 7.37.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 19.

7.37.3.1.4. Trends in abundance by length or age

The following Fig. 7.37.3.1.4.1 and 2 display the stratified abundance indices of GSA 19 in 2003-2007. These size compositions are considered preliminary.

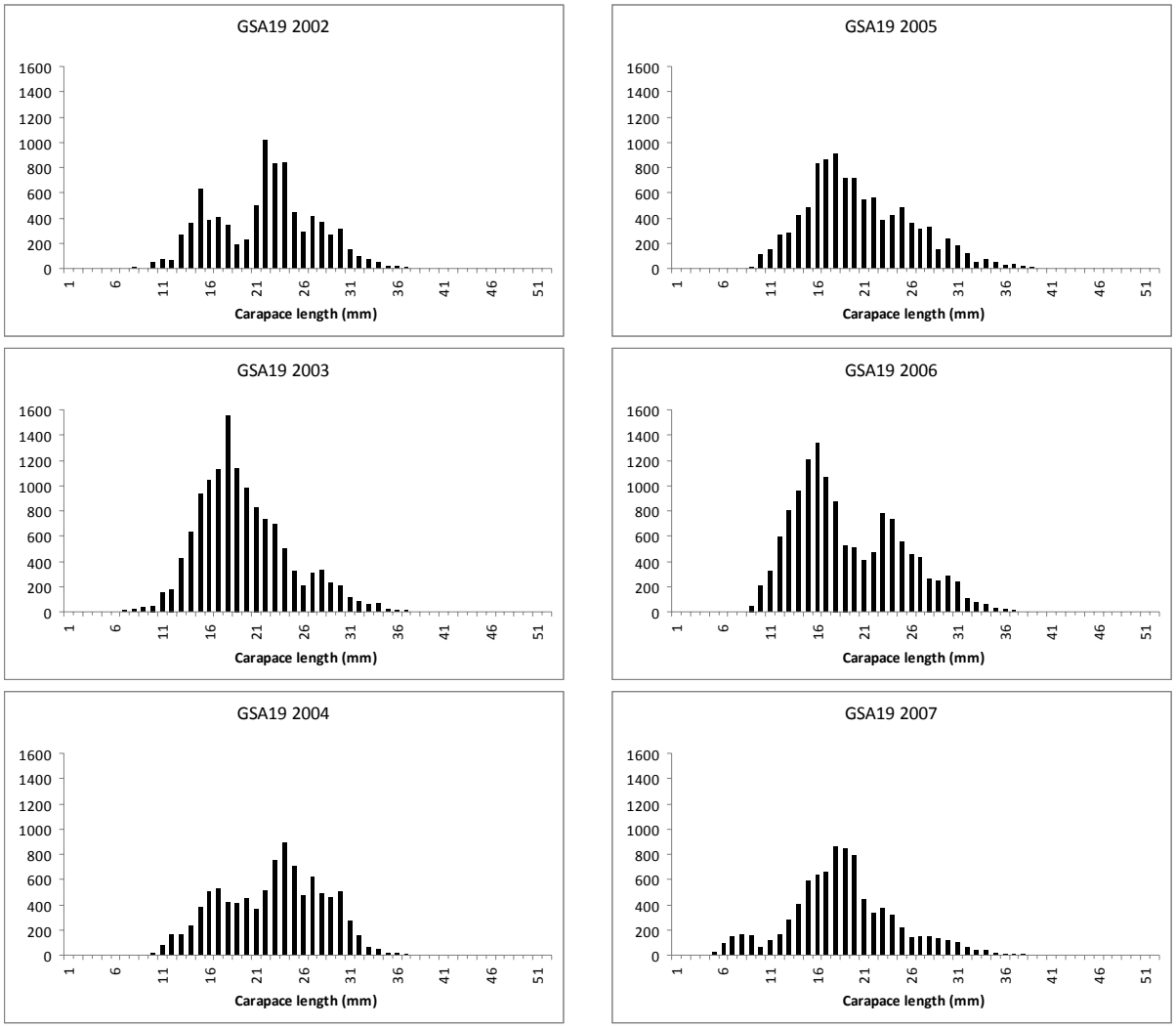


Fig. 7.37.3.1.4.1 Stratified abundance indices by size, 2002-2007.

7.37.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.37.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.37.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.37.5. Short term prediction for 2008 and 2009

7.37.5.1. Justification

No forecast analyses were conducted.

7.37.5.2. Input parameters

No forecast analyses were conducted.

7.37.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for pink shrimp in GSA 19.

7.37.6. Medium term prediction

7.37.6.1. Justification

No forecast analyses were conducted.

7.37.6.2. Input parameters

No forecast analyses were conducted.

7.37.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for pink shrimp in GSA 19.

7.37.7. Long term prediction

7.37.7.1. Justification

No forecast analyses were conducted.

7.37.7.2. Input parameters

No forecast analyses were conducted.

7.37.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for pink shrimp in GSA 19.

7.37.8. Scientific advice

7.37.8.1. Short term considerations

7.37.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.37.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.37.8.1.3. State of exploitation

SGMED-08-03 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.

7.37.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.38. Stock assessment of pink shrimp in GSAs 22-23

7.38.1. Stock identification and biological features

7.38.1.1. Stock Identification

No information was documented during SGMED-08-03.

7.38.1.2. Growth

No information was documented during SGMED-08-03.

7.38.1.3. Maturity

No information was documented during SGMED-08-03.

7.38.2. Fisheries

7.38.2.1. General description of fisheries

No information was documented during SGMED-08-03.

7.38.2.2. Management regulations applicable in 2007 and 2008

No information was documented during SGMED-08-03.

7.38.2.3. Catches

7.38.2.3.1. Landings

Tab. 7.38.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to SGMED-08-03 through the Data Collection Regulation and are listed in Table A3.3 of Appendix 3. Since 2003 the annual landings increased significantly from 1,070 t in 2003 and 4,175 t in 2006. The landings were mainly taken by demersal otter trawls.

Tab. 7.38.2.3.1.1 Annual landings (t) by fishing technique in GSAs 22 and 23.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DPS	22-23	GRE	GNS		206	97	71	123	
DPS	22-23	GRE	OTB		865	3257	3925	4052	
SUM					1071	3354	3996	4175	

7.38.2.3.2. Discards

Annual discards were reported to SGMED-08-03 through the DCR data call and is listed in Tab. A.3.4 of Appendix 3. The annual discards varied between 83 and 455 t.

Tab. 7.38.2.3.2.1 Annual landings (t) by fishing technique in GSAs 22 and 23

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DPS	22-23	GRE	OTB		83	455	188		

7.38.2.3.3. Fishing effort

The trends in fishing effort by fishing technique reported to SGMED-08-03 are listed in Tab. 7.38.2.3.3.1 and in Tab. A3.5 of Appendix 3.

Tab. 7.38.2.3.3.1 Trends in annual fishing effort by fishing technique deployed in GSAs 22 and 23, 2003-2006.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	22-23	GRE	GNS		1499507	1445880	1529002	1479134	
DAYS	22-23	GRE	LLS		381095	295005	315854	253335	
DAYS	22-23	GRE	OTB		52536	53389	56580	52831	
DAYS	22-23	GRE	SV		36266	31987	33200	30098	
GT*DAYS	22-23	GRE	GNS		5837915	5675508	5782002	5610405	
GT*DAYS	22-23	GRE	LLS		1762101	1660263	1602486	1323112	
GT*DAYS	22-23	GRE	OTB		4927349	4971783	5553804	5554194	
GT*DAYS	22-23	GRE	SV		294896	269645	276265	257271	
KW*DAYS	22-23	GRE	GNS		48227268	53304432	54981971	52423637	
KW*DAYS	22-23	GRE	LLS		14158502	11416302	10631705	8283337	
KW*DAYS	22-23	GRE	OTB		15792715	15877180	17730748	16402915	
KW*DAYS	22-23	GRE	SV		2775797	2206815	2193550	2022231	

7.38.3. Scientific surveys

7.38.3.1. Medits

7.38.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSAs 22 and 23 the following number of hauls were reported per depth stratum (s. Tab. 7.38.3.1.1.1).

Tab. 7.38.3.1.1.1. Number of hauls per year and depth stratum in GSAs 22 and 23, 1994-2006.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA22+23_010-050	10	10	11	10	13	12	13	13		13	13	14	14	
GSA22+23_050-100	17	21	22	28	24	26	21	25		25	23	24	24	
GSA22+23_100-200	19	25	37	36	36	33	37	35		36	43	41	41	
GSA22+23_200-500	28	35	44	50	51	51	50	48		51	52	52	52	
GSA22+23_500-800	18	12	19	21	22	21	20	17		17	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.

7.38.3.1.2. Geographical distribution patterns

No analyses were conducted during SGMED-08-03.

7.38.3.1.3. 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. Figure 7.38.3.1.3.1 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.

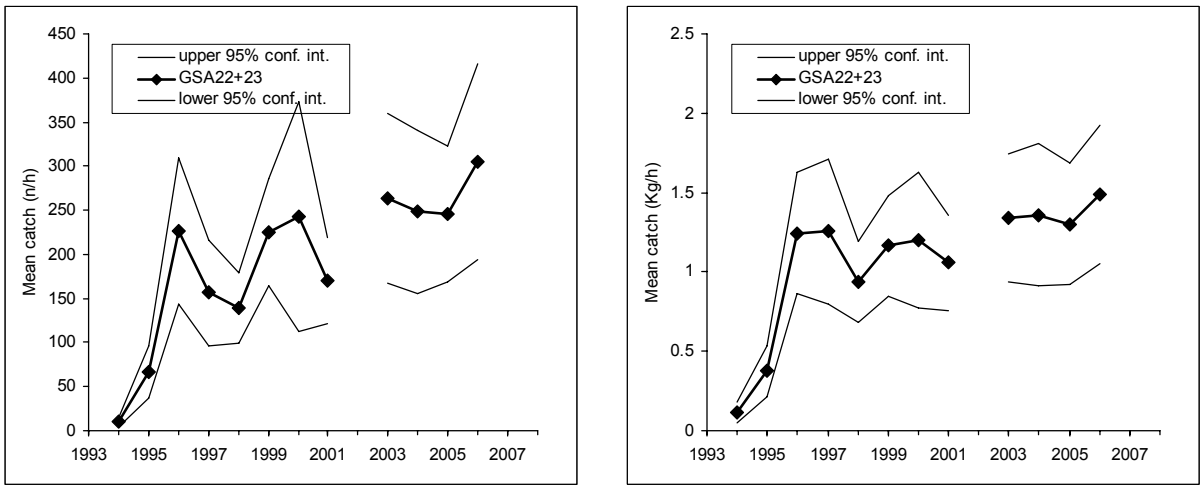


Fig. 7.38.3.1.3.1 Abundance and biomass indices of pink shrimp in GSAs 22 and 23.

7.38.3.1.4. Trends in abundance by length or age

The following Fig. 7.38.3.1.4.1 and 2 display the stratified abundance indices of GSAs 22 and 23 in 1994-2001 and 2003-2006. These size compositions are considered preliminary.

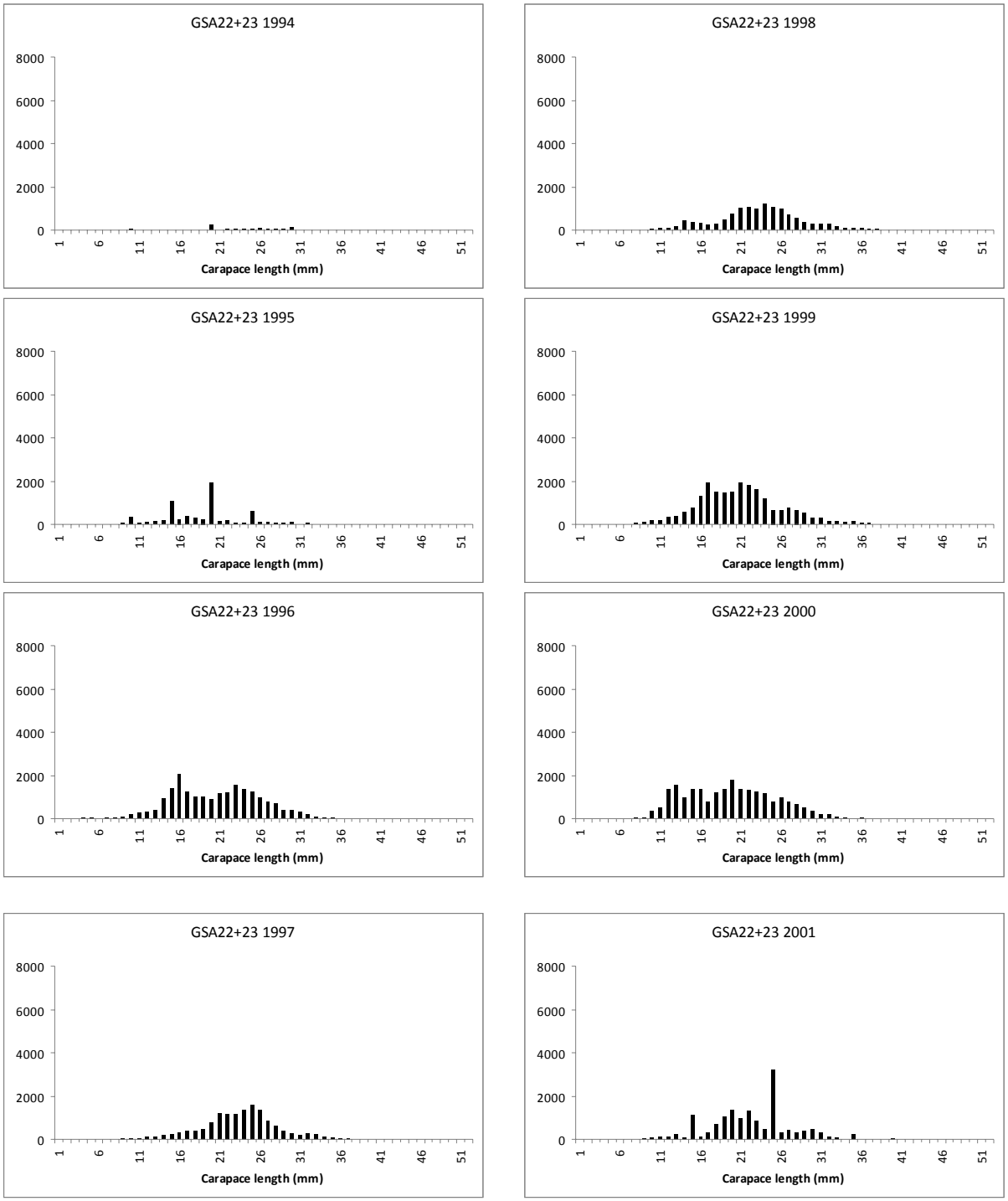


Fig. 7.38.3.1.4.1 Stratified abundance indices by size, 1994-2001.

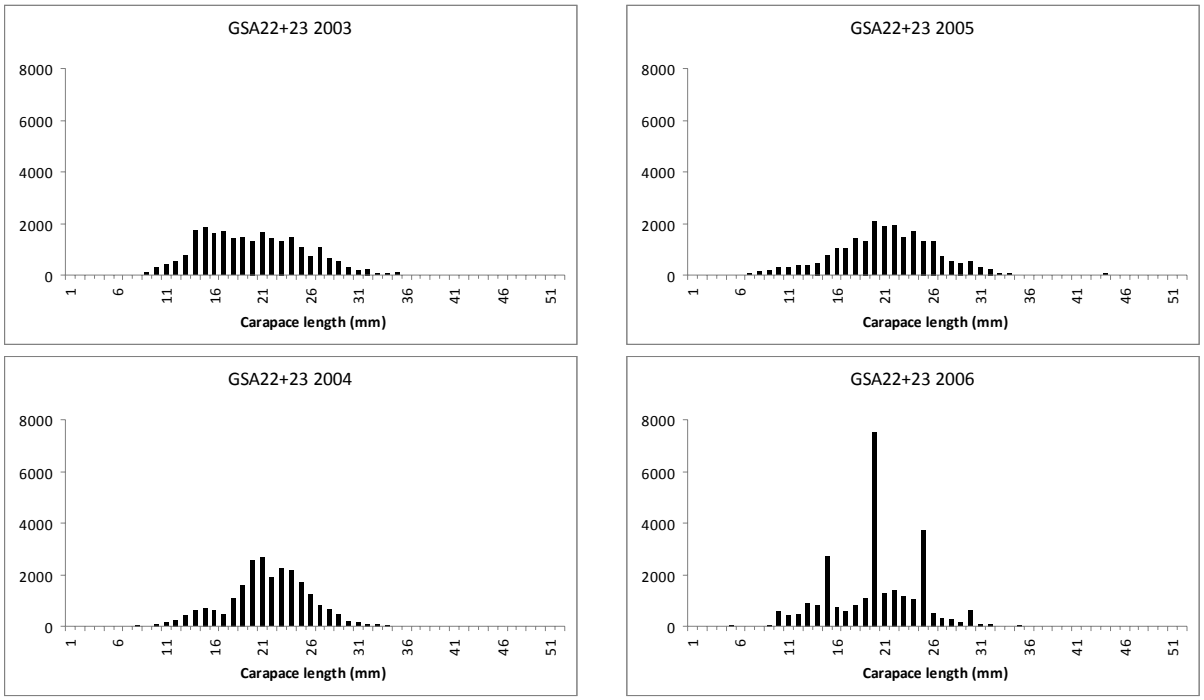


Fig. 7.38.3.1.4.2 Stratified abundance indices by size, 2003-2006.

7.38.3.1.5. Trends in growth

No analyses were conducted during SGMED-08-03.

7.38.3.1.6. Trends in maturity

No analyses were conducted during SGMED-08-03.

7.38.4. Assessment of historic stock parameters

SGMED-08-3 did not undertake any analytical assessment.

7.38.5. Short term prediction for 2008 and 2009

7.38.5.1. Justification

No forecast analyses were conducted.

7.38.5.2. Input parameters

No forecast analyses were conducted.

7.38.5.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a short term prediction of catch and stock biomass for pink shrimp in GSAs 22 and 23.

7.38.6. Medium term prediction

7.38.6.1. Justification

No forecast analyses were conducted.

7.38.6.2. Input parameters

No forecast analyses were conducted.

7.38.6.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a medium term prediction of catch and stock biomass for pink shrimp in GSAs 22 and 23.

7.38.7. Long term prediction

7.38.7.1. Justification

No forecast analyses were conducted.

7.38.7.2. Input parameters

No forecast analyses were conducted.

7.38.7.3. Results

Given the preliminary state of the data and analyses SGMED-08-03 is not in the position to provide a long term prediction of catch and stock biomass for pink shrimp in GSAs 22 and 23.

7.38.8. Scientific advice

7.38.8.1. Short term considerations

7.38.8.1.1. State of the spawning stock size

SGMED-08-03 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.

7.38.8.1.2. State of recruitment

SGMED-08-03 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses.

7.38.8.1.3. State of exploitation

SGMED-08-03 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.

7.38.8.2. Medium term considerations

SGMED-08-03 is unable to provide any scientific advice given the preliminary state of the data and analyses.

7.39. Stock assessment of sprat in GSA 29

7.39.1. Introduction

The Black Sea Sprat (*Sprattus sprattus phalericus*) is a key species in the Black Sea ecosystem (Raykov, 2007). Sprat is a marine pelagic schooling species, sometimes entering in the estuaries (especially the juveniles) and tolerating salinities as low as 4‰. In the daytime, it keeps to bigger depths and in the night moves near the surface. It forms big schools and undertakes seasonal movements between foraging (inshore) and spawning (open sea) areas (Ivanov and Beverton 1985). Adults tend to remain under the seasonal thermocline, penetrating above its only during the spring and autumn homothermia. Juveniles are distributed in a larger area near the surface. Sexual maturity is attained at the age of 1 year and length of 7 cm. In Turkey it was found that males reached maturity at 7.5 cm and females at 7.8 cm at age 1 year (Avşar&Bingel, 1994).

Sprat is one of the most important fish species, being fished and consumed traditionally in the Black Sea countries. It is most abundant small pelagic fish species in the region, together with anchovy and horse mackerel and accounts for most of the landings in the north-western part of the Black Sea. Whiting is also taken as a by-catch in the sprat fishery, although there is no targeted fishery beyond this (Raykov, 2006).

Sprat fishing takes place on the continental shelf on 40-100 m of depth. The harvesting of the Black Sea sprat is conducted during the day time when its aggregations become denser and are successfully fished with trawls. The main fishing gears are mid-water otter trawl and uncovered pound nets.

7.39.2. Data

Catches
Total international catches are presented in Table 7.21.1

Table 7.21.1. Official landings (t) of sprat in the Black Sea (FAO Fishstat). Before 1991 data for Russia, Georgia and Ukraine – YugNIRO data.

Year	Bulgaria	*Bulgaria	Romania	Romania*	Ukraine	Turkey	Georgia	Russian Federation	Total
1970	1407		2678		353	0	0		4438
1971	2473		2517		846	0	0		5836
1972	2962		23		884	0	0	16	3885
1973	3383		22		878	0	0	22	4305
1974	4468		1245		477	0	0	23	6213
1975	5565		731		787	0	0	43	7126
1976	7199		161		1594	0	0	16	8970
1977	8754		1463		4346	0	0	2354	16917

Year	Bulgaria	*Bulgaria	Romania	Romania*	Ukraine	Turkey	Georgia	Russian Federation	Total
1978	10596		149		1949	0	1	3317	16012
1979	13541		2269		36757	0	3466	17700	73733
1980	16568		989		47635	0	4571	14687	84450
1981	1888		2283		49175	0	5781	20165	79292
1982	16524		3004		3862	0	2462	15266	41118
1983	12023		3406		20755	0	886	3843	40913
1984	13921		4456		18021	0	847	5270	42515
1985	15924		6836		23657	0	1817	3365	51599
1986	1169		8979		33147	0	2939	7010	53244
1987	10979		9474		43158	0	697	8972	73280
1988	6199		6454		39835	0	7172	7157	66817
1989	7403		8911		63239	0	9708	16045	105306
1990	2651		3198		33174	0	6895	6955	52873
1991	271		729		11094	0	2313	2675	17082
1992	2353		2074		11492	0	830	3221	19970
1993	2174		2439		9154	640	32	694	15133
1994	22		2203		12615	700	308	1013	16861
1995	2874		1982		15218	157	288	1263	21782
1996	3535		2014		20720	937	185	1537	10280
1997	3646		3318		20208	468	85	706	28431
1998	3275		3293		30282	1236	24	1243	39353
1999	3595		1933		29238	421	45	4473	39705
2000	1737		1803		32644	6225	42	5543	47994
2001	695		1792		48938	1008	40	11122	63595
2002	11595		1617		45430	1965	34	11218	30972
2003	9155		1219		31366	5775	2	204	47721
2004	2889	7997*	135		30891	5186	12	143	39256
2005	2575	6500*	1487		35707	5271	19	1316	46375
2006	2655	8183*	492	1400*	21308	6681		8157	39293
2007	2559	2984.6	208	400*	18013	July 2008**		6077	26857

*Expert assessments ** To be delivered till

Commercial CPUE

CPUE data from selected Bulgarian, Romanian and Ukrainian pelagic trawl fisheries are presented in Tables 7.21.2-4. These data were used for tuning the catch-at-age assessment models.

Table 7.21.2. Trends in commercial Catch per unit effort in Bulgarian waters.

	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
1996		394	423	441
1997	196	416	315	268
1998	200	589	501	358
1999	209	532	482	288
2000	336	457	1090	507
2001	200	635	712	266
2002	200	618	966	385
2003	258	622	877	420
2004	211	543	845	287
2005	226	534		322
2006		488	787	

2007

Table 7.21.3. Romanian commercial fleet fishing effort and CPUE t/h by years

Years	Catch (t)	No. vessel	*E F F O R T* No. day	No hour	No. hauls	Depth (m)	*C.P.U.E.* t/vessel	t/day	t/hour	t/haul
1981	77	2	235	1.028	634	20 - 40	38.5	0.32	0.07	0.12
1982	664	3	346	1.543	951	20 - 40	221.3	1.92	0.43	0.70
1983	1.344	11	767	4.132	2.663	20 - 55	122.2	1.75	0.32	0.50
1984	2.946	11	1.030	5.650	3.466	20 - 60	267.8	2.86	0.52	0.85
1985	4.266	15	980	5.885	3.840	20 - 50	284.4	4.35	0.72	1.11
1986	5.954	14	1.709	8.756	5.456	20 - 60	425.3	3.48	0.68	1.09
1987	6.090	14	1.589	8.235	4.986	20 - 65	435.0	3.83	0.74	1.22
1988	4.661	14	1.317	7.559	4.806	20 - 70	332.9	3.54	0.62	0.97
1989	7.055	20	1.400	5.850	3.897	20 - 65	352.8	5.04	1.20	1.81
1990	2.105	13	650	3.503	1.964	20 - 65	161.9	3.24	0.60	1.07
1991	145	7	117	264	616	20 - 60	20.7	1.24	0.55	0.23
1992	1.087	8	310	1.553	936	20 - 65	135.5	3.49	0.69	1.16
1993	1.297	8	632	2.856	1.700	20 - 40	162.1	2.05	0.45	0.76
1994	1.340	8	664	3.024	1.589	20 - 45	167.5	2.02	0.44	0.84
1995	1.715	9	784	2.349	1.535	20 - 50	190.6	2.19	0.73	1.12
1996	1.658	11	1.112	4.521	3.245	23 - 97	150.7	1.49	0.37	0.51
1997	3.225	13	2.160	4.259	6.352	20 - 80	248.1	1.49	0.75	0.50
1998	3.201	14	959	4.404	3.515	20 - 70	228.6	3.33	0.72	0.91
1999	1.892	14	692	3.086	2.085	20 - 68	135.1	2.73	0.61	0.91
2000	1.750	12	646	2.984	2.028	20 - 68	145.8	2.71	0.58	0.86
2001	1.722	7	678	3.498	2.422	20 - 60	246.0	2.54	0.49	0.71
2002	1.443	7	878	2.922	1.971	20 - 68	206.2	1.64	0.49	0.73
2003	1.124	9	743	2.067	2.848	20 - 70	124.9	1.52	0.54	0.39
2004	1.255	8	762	2.035	2.675	20 - 60	156.9	1.64	0.62	0.47
2005	1.394	9	788	2.110	2.805	20 - 65	154.9	1.77	0.66	0.50
2006	430	8	760	2.020	2.605	20 - 70	53.8	0.56	0.21	0.17
2007	158	3	290	1.000	746	20 - 68	52.7	0.55	0.16	0.21

Table 7.21.4. Ukrainian commercial fleet CPUE t/h by years

Year	CPUE kg/h
1992	0.95
1993	0.86
1994	0.95
1995	1.00
1996	0.82
1997	0.72
1998	0.92
1999	1.02
2000	1.81
2001	1.31
2002	1.78
2003	0.91
2004	0.96
2005	0.97
2006	1.07

2007	0.97

7.39.3. Scientific surveys

Bulgaria

Bulgarian research trawl surveys are conducted on annual basis. The techniques applied is a "swept area" trawl survey usin a standard mid-water trawl with following dimensions: OTM –pelagic otter trawls with dimensions: 26m long. 8 m height. mesh size of codend 6.5mm;"effective" horizontal opening – 16 m. Stratified sampling is applied (Sparre&Venema. 1998). The area is divided to sub areas "strata" depending on the depth: first stratum is 35- 50 m.. second 50-75m. and third 75-100m. The examined area is divided to 55 equally sized fields; each sector was assessed as 63 км^2 (5' Latitude × 5' Longitude). The trawling activities are carried out in meridian (north-south) direction. The duration of each trawling is between 30 and 60 min. average velocity 2.3 and 2.9 knots (3.889 to 5.37 km/h). In 2007 trawl survey in Bulgarian waters was carried out using mid-water otter trawl in 32 areas (STECF 2007). In 2008 the trawl survey was conducted in the 36 areas divided to sub areas "strata" depending on the depth: first stratum is 35- 50 m. second 50-75m. and third 75-100m. The techniques applied is a "swept area" trawl survey using a standard mid-water trawl with following dimensions: OTM –pelagic otter trawls with dimensions: 26m long. 8 m height. mesh size of codend 6.5mm;"effective" horizontal opening – 16 m. The duration of each trawling is 60min with velocity 2.6 – 2.7 knots.

- Results from trawl survey conducted in June 2007

The total catch during the survey was 7047 kg. 7825 individuals were processed for analysis of the population parameters. Minimum catch was registered in area G14 from 75-100m strata: CPUE = 1kg/h. CPUA = 13.499 kg/km^2. In the same area the lowest level of the biomass was registered: 844.8 kg. Maximum catch (in weight) was taken in area N2 (strata: 50-75м - 1000 kg). CPUE = 1333.33 кg/h and CPUA: 16 056.5 kg/km^2. Similar catch figure were recorded in area E19. 30-50m strata: catch = 880 kg; CPUE = 1313.4 kg/h; CPUA = 16 417.9 kg/km^2. and D17 strata 50-75m: catch = 660 kg CPUE= 985.07 kg/h. CPUA = 12 313.4 kg/km^2).The average catch from all areas was 220.2 kg. average CPUE from all areas was 336.5 kg/h and average CPUA = 4262.05 kg/km^2. The calculated biomass in Bulgarian Black Sea marine area (2007) was 29 189.9 t. (Raykov, 2008).

Table 7.21.5. CPUA kg/km^2 and biomass of sprat agglomerations 2007

CPUA kg/km^2	Strata (m dept)	Biomass kg	Area km^2	No. Area
3548	30-50	6438805	1815	29
6214	50-75	17109272	2754	44
2254	75-100	5641787	2503	40
Total		29 189.864	7072	

- Results from trawl survey conducted in May 2008

The catch varied from 0 kg (75-100m) to 1650 (30-50m). In May 2008. the greatest agglomerations and highest CPUE kg/h. and was detected in 30-50 stratum, respectively. In stratum 50-75 m. two areas show high values of CPUE (750 and 744 kg/h) and in 75-100 m. stratum only one area with CPUE = 984 kg/h was detected.

Table 7.21.6. CPUA kg/km^2 and biomass of sprat agglomerations 2008

CPUA average		B (kg)	Ax	№ Fields
6891.066	30-50	12506044.99	1814.82	29
4260.709	50-75	11731948.71	2753.52	44
1886.895	75-100	4723276.417	2503.20	40
		28 961.270	7071.54	

The highest values of CPUA kg/m^2 was established in 30-50 m stratum.The biomass of the sprat agglomerations in May 2008 in front the Bulgarian Black Sea coast was assessed as 28 961.270 tons.

Romania

Romanian scientific trawl surveys are not age disaggregated. but provide trends in relative indices in stock biomass and juvenile sprat abundance (Table 7.21.7 & 7.21.8). The techniques used for the standard survey are described as follows.

The sprat biomass and distribution is explored using the mid water trawl with a rigging system insuring it work near bottom. The number of the hauls is of 15-20 for each survey depending on weather conditions.

Romania also conducts a juvenile survey targeting the 0-groupusing a special juvenile trawl manufactured in NIMRD. The trawling is carried out at the surface. at a speed of 1.5 knots for 15 min. with a horizontal opening of the trawl of 14m. After each haul. the samples are qualitatively and quantitatively analyzed. or are preserved with formaldehydes for laboratory analysis. The results (Table 7.21.8) are used to estimate the relative size of sprat annual recruitment.

Table 7.21.7 Biomass of sprat in Romanian waters estimated from trawl suveys

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Biomass t 10^{-3}	40	45	35	35	30	45	45	65	19	60

Table 7.21.8. Relative abundance and density of juvenile sprat (0-group) from Romanian waters.

	May	May	July	July	Aug-Sept	Aug-Sept
	Abundance (10^{-6})	Density (ex/m^2)	Abundance (10^{-6})	Density (ex/m^2)	Abundance (10^{-6})	Density (ex/m^2)
1995	29.9135	0.0071				
1996	15.3737	0.0037269				
1997	0.95	0.00032				
1998	9.797	0.001349				
1999	15.411	0.0016				
2001	52.666	0.0063			0.6888	0.000237
2002	5.3099	0.00218591			0.04322	0.000064
2003	10440.65	2.073	1.006	0.00034		
2004					0.457	0.000264
2005	8.9037	0.001475				
2006	180	0.0227			0.345	0.0001025
2007	8.15	0.001213004			0.175	0.000128026

Table 7.21.9. Assessment of the sprat agglomerations in May 2008

No. polygon	**Polygon area (Nm^2)**	**Range (t/Nm^2)**	**Average (t/Nm^2)**	**Total tons in polygon**	**Total on the shelf (t)**
1	108	4.86	4.86	524.88	
2	70	0.97	0.97	67.9	
3	63	0.97	0.97	61.11	9285
4	264	0.03	0.03	7.92	
5	84	8.36	8.36	700.56	
6	84	1.493	1.493	125.41	
Total	673			1487.78	

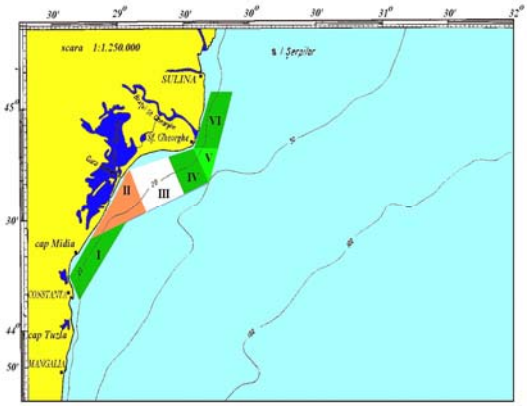


Fig.7.21.1 Distribution and abundance of jellyfish agglomerations in May 2008

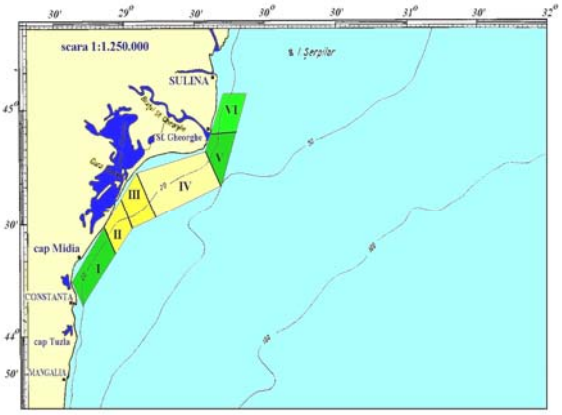


Fig. 7.21.2 Distribution and abundance of the sprat agglomerations in May 2008

Biomass of the sprat agglomerations in 2008 computed for a surveyed area of 673 Nm^2 was of 1488 tons. extrapolated to 9.285 tons for shelf area up to 50 Nm from seashore.

Given the period 2007, in May 2008 the fishing agglomerations have been influenced considerably by the jellyfish agglomerations. The situation was the same as in 2006. For surveyed area, the jellyfish biomass was estimate as 2744 t, extrapolated to 17 313 t for shelf area up to 50 nm from seashore.

Ukraine, Turkey and Russia do not conduct research surveys for sprat stock assessment in the Black Sea.

Catch at age

Catch at age data were used as inputs for stock assessment (Tables 7.21.10 & 7.21.11). To obtain the annual catch at age numbers monthly catches were divided by monthly mean body weight and then distributed by age according to monthly age compositions. Monthly catch at age numbers were then summed to obtain annual catches. Monthly length-age keys from Bulgaria were applied to Ukrainian length composition in order to obtain the needed age compositions.

Table 7.21.10. Aggregated Catch at age in number 10^{-3} of Bulgaria. Romania and Ukraine (north-western Black Sea).

Age	0	1	2	3	4
1994	8636	599224	3261789	813301	11023
1995	41846	2353666	2297110	362622	11846
1996	16747	3118918	2306451	725076	28710
1997	199007	4652851	2062680	486649	30667
1998	391586	3480913	3685494	651672	33849
1999	65786	8593904	2121969	254456	3610
2000	539857	6929215	3250213	562470	79961
2001	2334661	6916181	2249026	404163	50926
2002	103970	5530776	3283019	483479	36382
2003	1157592	5844662	4690326	1429668	153831
2004	1724391	4741090	1719104	233995	6808
2005	107577	221295	1180661	226183	12269
2006	418818	3493927	1184825	213702	13888
2007	2917535	2920875	306490	91329	9233

Table 7.21.11. Catch at age in number 10^{-3} of Turkey (southern Black Sea)

Age Year	0	1	2	3	4	Sum
1993	4134	41775	66119	15691	281	128000
1994	271	16312	95871	27136	410	140000
1995	1044	80707	200946	30340	963	314000
1996	490	85983	79918	19781	1228	187400
1997	612	12847	50776	20800	6729	91765
1998	1734	129588	61977	41173	6934	241406
1999	711	13275	45516	13987	1422	74911
2000	21784	930772	453504	77234	5941	1489234
2001	0	92343	54233	17589	4397	168562
2002	6611	267729	175181	24239	5509	479268
2003	100174	596690	378920	156794	47909	1280488
2004	13894	388196	943122	56840	3368	1405420
2005	46962	515406	373347	130319	14089	1080123
2006	66480	763931	597698	99910	4320	1532339
2007	Official fisheries statistics are still not published					

Weight-at-age in the stock

Weight-at-age in the stock were based on Bulgarian landings data from November of year *y-1* to February of year *y*.

Table 7.21.13. Individual Weight-at-age (in kg) in the Stock on the 1st of Jan

Year	AGE				
	0	1	2	3	4
1994	0.001	.0035	.0041	.0048	.0062
1995	0.001	.0033	.0043	.0048	.0055
1996	0.001	.0028	.0043	.0047	.0053
1997	0.001	.0027	.0047	.0057	.0069
1998	0.001	.0034	.0046	.0064	.0082
1999	0.001	.0025	.0047	.0059	.0073
2000	0.001	.0032	.0044	.0056	.0072
2001	0.001	.0035	.0044	.0052	.0067
2002	0.001	.0036	.0045	.0061	.0074
2003	0.001	.0035	.0044	.0059	.0074
2004	0.001	.0034	.0044	.0060	.0072
2005	0.001	.0036	.0046	.0061	.0074
2006	0.001	.0036	.0046	.0057	.0074
2007	0.001	.0036	.0047	.0063	.0076

Maturity at age

The maturity ogive applied is a knife edge assumed to reach 100% at age 1.

Natural Mortality at age

The natural maturity is derived from Daskalov 1998.
Age 0.5 year = 0.64, and ages 1-5 years =0.95 for all years.

Input data for stock assessment using ICA are presented in Annex I.

7.39.4. Assessment of historical parameters – Methods: ICA

We used Integrated Catch-at-age Analysis (ICA; Patterson and Melvin, 1996). ICA is a statistical catch-at-age method based on the Fournier and Deriso models (Deriso et al., 1985). It applies a statistical optimization procedure to calculate population numbers and fishing mortality coefficients-at-age from data of catch numbers-at-age and natural mortality. The dynamics of a cohort (generation) in the stock are expressed by two non-linear equations referred to as a survival equation (exponential decay) and a catch equation:

$$N_{a+1,y+1} = N_{a,y} * \exp(-F_{a,y} - M),$$

$$C_{a,y} = N_{a,y} * [1 - \exp(-F_{a,y} - M)] * F_{a,y} / (F_{a,y} + M),$$

where C, N, M, and F are catch, abundance, natural mortality, and fishing mortality, respectively, and a and y are subscript indices for age and year.

The algorithm initially estimates population numbers and fishing mortality fitting a separable model, when F is assumed to conform to a constant selection pattern (fishing mortality-at-age), but fishing mortality by year is allowed to vary. The F matrix is then modelled as a multiplication of the year-specific F and the specified selection pattern (Pope and Shepherd, 1982). This procedure substantially diminishes the number of parameters in the model.

In its second stage, the ICA algorithm minimizes the weighted sum of square residuals of observed and modelled catch and relative abundance indices (CPUE), assuming Gaussian distribution of the log residuals:

$$\min [\text{åa,y } pca_{,y} (\log C_{a,y} - \log \hat{C}_{a,y})2 + \text{åa,y,f } pia_{,f} (\log I_{a,y,f} - \log \hat{I}_{a,y,f})2,$$

where C, Ĉ, I, and Î are observed and estimated catch and age-structured index, respectively, and a, y, and f are subscript indices for age, year, and fleet, respectively. Weights associated with catches and different indices (pc, pi) are ideally set equal to the inverse variances of catch and index data, and can be calculated based on the residuals between modelled and observed values. However, weights are usually set by the user on the basis of some information about the reliability of different indices and current experience with modelling the stock. Indices are defined as related to population numbers by the equations:

$$\hat{I}_{a,y} = N_{a,y} * \exp(-F_{a,y} - M)$$
$$\hat{I}_{a,y} = q_a * N_{a,y} * \exp(-F_{a,y} - M)$$
$$\hat{I}_{a,y} = q_a * (N_{a,y} * \exp(-F_{a,y} - M))^k a .$$

The two unknown parameters (qa, an age-specific catchability, and k, a constant) are estimated according to the assumed relationship between the population and the abundance index, which has to be specified as being one of the above – identity, linear, or power, respectively.

The method has previously been successfully applied to sprat by Daskalov (1998a), Daskalov et al. (2007a), and Daskalov & Mamedov (2007).

Results and discussion

During the meeting the WG made a very good progress in compiling operational input data (Annex I). Initial runs of the integrated age-structured model (ICA) were performed, but more work with different model options are needed before achieving reliable estimates of abundance and fishing mortality.

During the initial runs with ICA performed by the WG the model did not converged and further runs and adjustments of the model parameters need to be done until the model fit and diagnostics become acceptable. In order to assess the status of the stock the WG analysed the trends in catches, indices and preliminary results from the assessment, as well as absolute biomass estimates from pelagic trawl surveys in Bulgarian and Romanian waters in 2007 and 2008. Given the present state of the assessments the WG cannot yet provide a conclusive figure of the present state of the stock or short and medium term forecasts, but only a relative information about the trends in abundance and fisheries.

- Trends in catches and abundance indices

Catches and relative abundance indices were analysed by the WG (Figs 7.21.3 & 7.21.4). Bulgarian, Ukrainian and Turkish catches show consistent trends. The trend in Romanian catches is different probably due to specific environmental conditions in Romanian waters (north-western shelf, Fig. 7.21.3). The abundance indices based on Bulgarian and Ukrainian commercial CPUE show more consistent trends (Fig 7.21.4A), but Romanian commercial CPUE and biomass survey are different (Fig 7.21.4B). Previous cooperative acoustic surveys have shown inverse changes in abundance due to schools' movements across the shelf between Ukrainian and Romanian waters.

A possible interpretation of these trends is that catches and CPUE in Bulgarian, Ukrainian and Turkish waters do reflect the annual changes in the stock abundance, whereas catch and abundance indices in Romanian waters predominantly reflect changes in stock distribution related to environmental conditions.

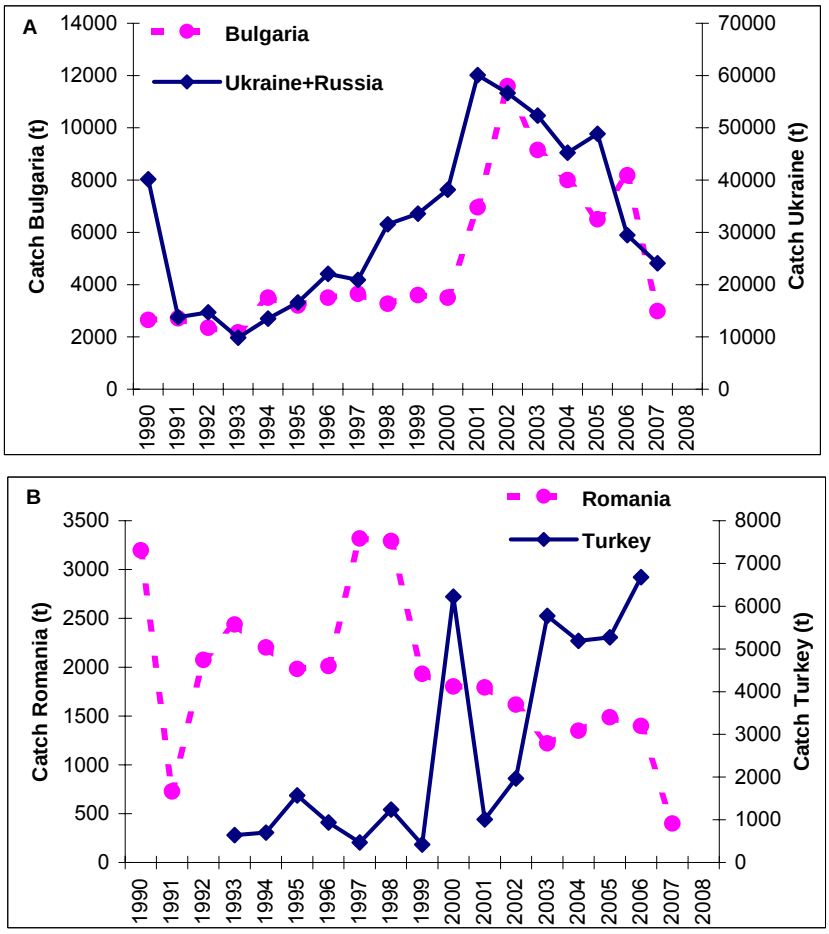


Fig. 7.21.3 Trends in sprat catches: A. Bulgaria and Ukraine(+Russia), B. Romania and Turkey

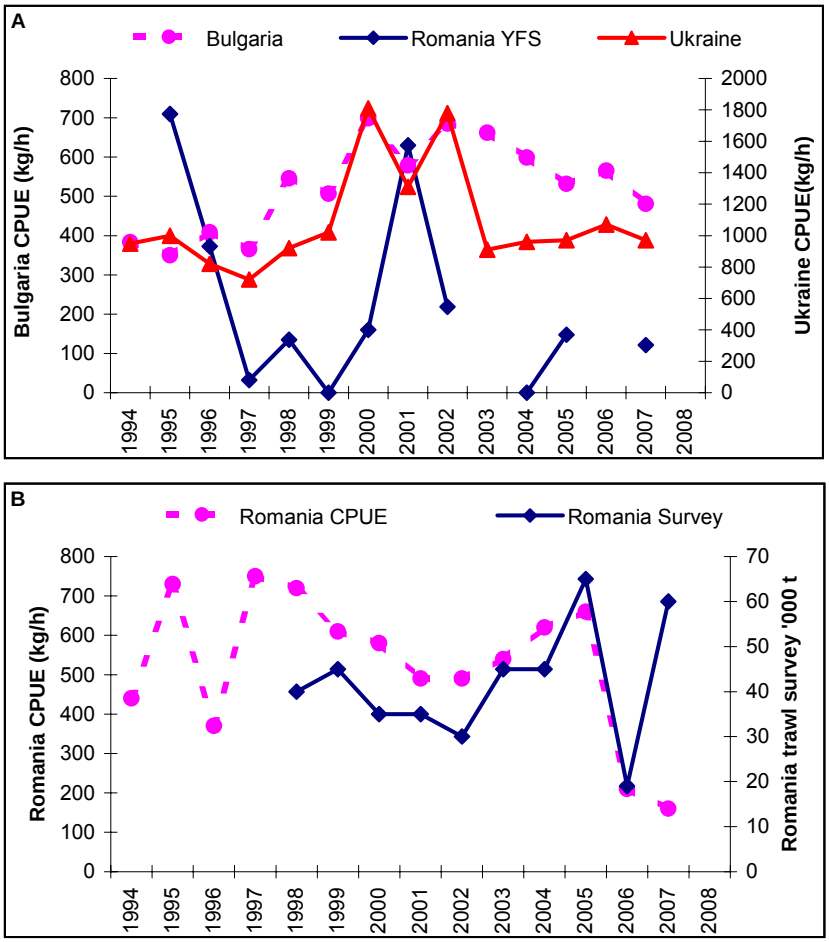


Fig. 7.21.4 Trends in sprat biomass indices: A. Bulgarian CPUE, Ukrainian CPUE, and Romanian Juvenile Survey (in specimens $10^5/m^2$, B. Romanian CPUE and absolute biomass (estimated from trawl survey. STECF 2007)

The juvenile survey index is weakly correlated with CPUE (Fig 7.21.4A) and estimated recruitment from ICA (at present not tuned to the index, Fig. 7.21.6A). It possibly reflects the abundance of juveniles in the sea. The juvenile survey index is very important for estimating the recruitment in the current year and needs a special attention in planning of future sampling programmes. Juvenile surveys need also to be performed in Bulgarian waters (and if possible in Ukrainian and Turkish waters) in order to evaluate, through comparative studies, the best survey design, which would assure producing accurate indices of juvenile abundance.

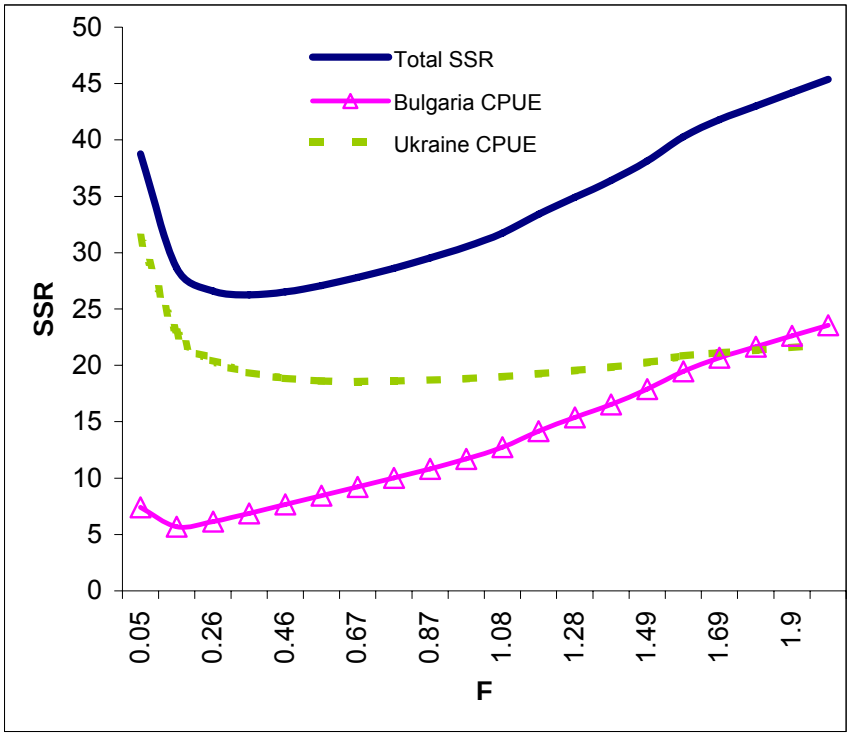


Fig. 7.21.5 Trajectories of the total Sum of Squared Residuals (SSR) and the partial SSRs of the two tuning fleets as functions of the STANDARD F

- Age structured model (ICA)

During the initial runs with ICA performed by the WG the model had some optimisation problems and although the sums of squared residuals (SSR) finally have shown pronounced single minima (Fig 7.21.5, Annex I) further runs and adjustments of the model parameters need to be done until the model fit and diagnostics become acceptable. Input data and preliminary results are presented in Annex I. Although final estimates may differ in terms of absolute abundance and fishing mortality the WG believes that the stock trajectories (Fig. 7.21.6) possibly reflect in relative terms the stock evolution over the last decade.

The analyse of the main population parameters (abundance, catch, fishing mortality, Fig. 7.21.6, Annex I) reveals that the sprat stock has recovered from the depression in the early 1990s due to good recruitment in 1996-2001 and the biomass and catches have gradually increased over the early 1990s and early 2000s. The stock estimates, however, confirm the cyclic nature the sprat population dynamics. The year with relatively strong recruitment were followed by years of low to medium recruitment which leads to a relative decrease of the Spawning Stock Biomass (SSB). High fishing mortalities (F_{2-4}) were observed in 1998, 2003 and 2005.

The WG must warn, however, that the interpretation of these very preliminary results can substantially change if final results show substantial differences in stock evolution, that is possible especially for the recent years in the analysis. The present results are entirely inconclusive and cannot be used for the aims of the management advice.

To compare the stock estimate with previous analyses (Daskalov et al. 2007a) in order to evaluate the state of the stock on a wider temporal scale (since 1945) the WG needs to complete the ICA analyses and obtain reliable estimate of absolute abundance and fishing mortality.

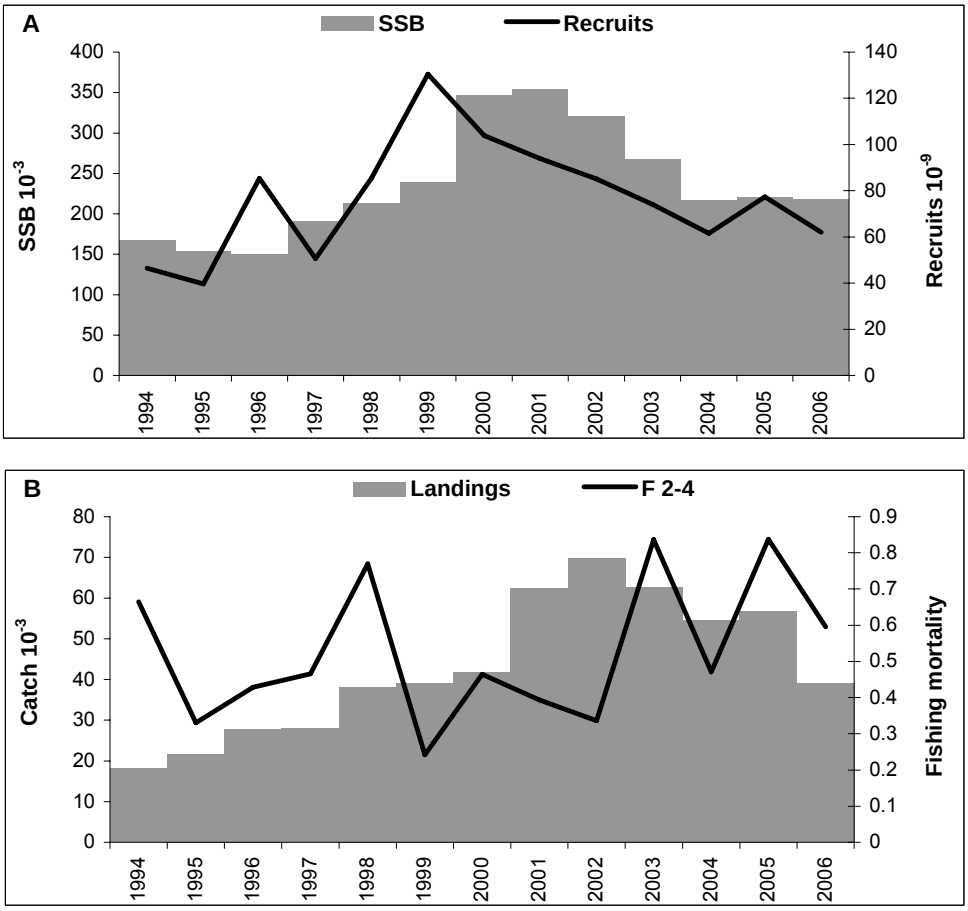


Fig. 7.21.6 Time-series of sprat population estimates: A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 2–4, line).

Research surveys of absolute biomass in 2007 and 2008
In Bulgarian waters, the swept area survey based estimates of absolute exploitable biomass were 29.2 and 29 thousand t in 2007 and 2008 respectively (STECF 2008). The swept area survey estimate in Romanian waters was 60 thousand t in 2007 (Table 7.21.7). In May 2008 the trawling in Romanian waters was obstructed by dense swarms of jellyfishes and the survey results were not accepted as representative.

7.39.5. Conclusions and recommendations

The state of data
The WG has assessed the sprat catch and age data to be of acceptable quality. The problems of fitting the ICA model can be due to errors in the compilation of the catch-at- age, which need to be checked. Because of the internal variability of the age structure a flexible separable model may need to be used in ICA.

Biomass indices
In contrast of previous year when several CPUE indices from commercial fleets and research survey were available (Daskalov 1998) in the present runs the WG has used only CPUE from Ukrainian and Bulgarian commercial fleets. These data seem to reflect the relative dynamics of the stock, but more research survey indices are needed in future in order to produce reliable assessments. Specifically the WG would encourage the undertaking of acoustic and juvenile research surveys covering the areas of the main stock distribution.

Age-structured model (ICA)

The WG cannot use the preliminary results from the integrated age-structured assessment (ICA) for evaluation of the stock status and short and medium forecasts. Further work with the model and data is needed until more acceptable results and diagnostics are obtained.

From the analyses of the relative trends in data, indices and preliminary assessment results, it appears that during early 2000s the sprat stock has recovered from the low state that occurred in the early 1990s. The stock seems to have reached a maximum in 2000-2003. The present biomass is possibly lower, but the stock does not seem to be threatened by overfishing because of the relatively low level of exploitation. The results from the research surveys in 2007 and 2008, as well as figures from commercial CPUE indices also do not indicate a stock decline.

Given the information available, the WG suggests keeping the level of exploitation in Bulgarian and Romanian waters bellow 15 000t.

Ecosystem considerations

The WG discussed some ecosystem considerations which apply to the state of the sprat stock. From the analysed information it appears that the distribution and school behaviour on the north-western shelf and specifically in Romanian waters vary to a great extend depending on the environmental conditions. Sprat schools tend to be negatively affected by jellyfish swarms. Previous studies have found that sprat stock dynamics is related to climate fluctuations (Daskalov 1999), trophic interactions and other environmental factors (Daskalov 2003, Daskalov et al. 2007a, b, Raykov et al., 2007, Mihneva et al., 2007). An important investigation on the influence of environmental conditions on ichtyoplankton community distribution (Radu et.al., 2004, 2006a, b, 2007) and evolution of the Black Sea fisheries correlated with ecological conditions and fishing effort (Radu et al., 2006) along the Black Sea coast have been carried out. In future, environmental influences and ecosystem interactions need to be taken into account when suggesting reference levels for the sprat fishery.

7.40. Stock assessment of turbot in GSA 29

7.40.1. Introduction

Turbot (*Psetta maxima*) occurs all over the shelf area of all Black Sea coastal states at depths of about 100 m -140 m in the North-Western Black Sea area and makes grouped local shoals. Turbot inhabits sandy, mixed bottoms or mussel beds. It is a large-size fish with long life cycle, which reaches length of 85 cm, weight of 12 kg and age of more than 17 years in the Black Sea. Turbot mature at the age of 3-5 years. Adults feed mainly on fish, both demersal: whiting, red mullet and gobies, and pelagic species: anchovy, sprat, horse mackerel, shad. The diet of turbot also includes crustaceans (shrimps, crabs, etc.), mollusks and polychets. Turbot does not undertake distant transboundary migrations. Local migrations (spawning, feeding and wintering) have a general direction from the open sea towards the coast and vice versa.

In all Black Sea countries turbot is one of the most valuable targets for the fisheries. Apart of the specialized fisheries on turbot it is also caught as a by-catch other fisheries using trawls, long-lines and purse seines (e.g. the sprat fishery). In order to protect turbot stock in EU waters and improve the stock reproductive capacity, the mesh size of gillnets have been synchronised between Bulgaria and Romania.

7.40.2. Data

Catches

The officially reported turbot landings by countries during the period 1989 – 2007 are given in Table 7.22.1. The WG agreed that landings are underreported during last years. The turbot fishery is conducted mainly by specialized bottom gillnets, but there is a difference by countries.

Table 7.22.1. Official turbot landings by countries and areas (t).

Year	Bulgaria	Romania	Ukraine west	Ukraine east	Turkey west	Turkey east	Russian Federation	Georgia	Black Sea total	Black Sea west
1989	0.9	0	2	0	448	1001	0	8	1459.9	450.9
1990	0	0	9	0	908	475	0	1	1393	917
1991	0	2	17	1	600	315	0	0	935	619
1992	0	1	18	1	308	110	1	0	439	327
1993	0	6	10	0	400	1185	2	0	1603	416
1994	0	6	18	1	1293	821	5	0	2144	1317
1995	60	4	10	0	2006	844	19	0	2943	2080
1996	62	6	37	2	1414	510	17	0	2048	1519
1997	60	1	40	2	777	134	11	0	1025	878
1998	64	0	40	2	1056	412	14	0	1588	1160
1999	54	2	69	4	1579	225	15	5	1953	1704
2000	55.1	2	76	4	2321	318	4	9	2789.1	2454.1
2001	56.5	13	123	6	2169	154	24	11	2556.5	2361.5
2002	135.5	17	99	5.47	193	142	15	11	617.97	444.5
2003	40.8	24	118	5.876	126	93	15	1	423.676	308.8
2004	16.2	42	126	7.157	118	116	2	7	434.357	302.2
2005	12.69	37	123	6	273	275	15	6	747.69	445.69
2006	14.81	32	154	8	266	481	7		962.81	466.81
2007	66.8	45	205	10.8	Statistics not published		7		334.85	327.85

Commercial CPUE

Commercial CPUE data are available for Romanian and Ukrainian gill nets fisheries.

The total number of vessels involved in Romanian turbot fishery is 4 trawlers and 134 boats, which operate about 4000 gillnets and 10 beach seines. The data about CPUE from commercial landings is given on Table 7.22.2.

Table 7.22.2. Turbot catches (t), fishing effort and CPUE for the fisheries along the Romanian coast.

Years	Catch (t)	***E F O R T*** Number gill net	Number days	Number hours	***C.P.U.E.*** t /gill net	t / day	t / hour
2001	13.00	980	100	2.400	0.018	0.131	0.005
2002	17.00	1.267	125	3.000	0.013	0.136	0.005
2003	24.00	2.765	150	3.600	0.009	0.160	0.006
2004	42.00	4.350	225	5.400	0.009	0.186	0.007
2005	37.00	3.856	205	4.920	0.009	0.193	0.007
2006	32.00	3.794	192	4.608	0.008	0.166	0.007
2007	45.00	3.789	250	6.000	0.012	0.180	0.007

The CPUE of commercial fleet operated in Ukrainian waters are given in Table 7.22.3.

Table 7.22.3. Effort (number of gill nets) and CPUE (kg/gill net) of Ukrainian fishing fleet in Crimean waters working on turbot fishery.

Year	Effort	CPUE
1991	950	2.1
1992	2140	4.2
1993	1066	8.6
1994	1482	11.6

Year	Effort	CPUE
1995	1571	6.2
1996	1331	27.3
1997	1500	25.6
1998	1792	20.5
1999	2000	32.1
2000	1937	24.6
2001	4728	24.8
2002	3006	23.3
2003	3913	20.9
2004	3840	21.8
2005	8097	15.9
2006	7044	23.0

7.40.3. Scientific surveys

The scientific surveys for turbot stock assessment are made mainly by swept area method with some peculiarities by countries. CPUE from research surveys in Bulagaria and Romania is given in Tables 7.22.4 & 7.22.5. Estimates of absolute abundance are given in Table 7.22.4.

Table 7.22.4. CPUE (kg/hour) of turbot trawl catches from research surveys along the Bulgarian coast.

Year	**CPUE(kg/hour)**
2006	7.87
2007	9.46

Table 7.22.5. CPUE (kg/hour) of turbot trawl catches from research surveys along the Romanian coast.

Year	**CPUE**
2003	4.9
2004	7.1
2005	7.9
2006	8.4
2007	9.8

Table 7.22.6. Biomass assessments performed using trawl survey and VPA: A. in Ukrainian and former USSR waters (catchability or efficiency coefficient of the trawl equal to 1.0); B. in Bulgarian and Romanian waters.

A.

Year	$Y_{official}$. tons		SURVEYs. tons		$B_{VPA.\ tons}$
	Black Sea total	Western part of Black Sea	Former USSR waters	Ukrainian waters	
1977	1912		2000	1320	24400
1978	2028		2200	1450	24800
1979	5327		5400	3560	25800
1980	2723		2800	1850	23100
1981	3155		3300	2180	21700
1982	4552		4700	3100	20000
1983	5226		5300	3500	15900
1984	2802		4700	3100	10700
1985	467				8000
1986	418				7500

1987	839			7000
1988	1116			6100
1989	1450	451		
1990	1383	917		
1991	919	619		
1992	427	327	2080	
1993	1609	416	1640	
1994	2139	1317	1640	
1995	2924	2080		
1996	2031	1519		
1997	1014	878		
1998	1574	1160	1680	
1999	1933	1704		
2000	2776	2454		
2001	2522	2362	1980	
2002	592	445	2000	
2003	408	209	2000	
2004	465	342	1700	
2005	727	446	2040	
2006			2080	

B.

Year	Bulgaria		Romania	
	SURVEYs. tons	$B_{VPA.\ tons}$	SURVEYs. tons	$B_{VPA.\ tons}$
1992	100			
1993				
1994				
1995				
1996				
1997				
1998				
1999				
2000				
2001				
2002		761.7 – 866.7		
2003			1066	
2004			980	
2005			1080	
2006	447.38- 1441.06		1150	
2007	1778.76 - 1896.56		1300	

Bulgaria

To establish the exploited turbot stock in front of the Bulgarian Black Sea coast swept area method and standard methodology for stratified sampling was employed (Gulland, 1966; Sparre, Venema, 1998; Sabatella Franquesa, 2004). The region was divided in three strata according to depth – stratum 1 (35 – 50 m). stratum 2 (50 – 75 m) and stratum 3 (75 – 100 m). The study area was partitioned into 128 equal in size, but not overlying fields situated at depth 15 - 100 m, of which 70 in the Northern region and 58 in the Southern region. In the Northern region for the aims of the study additional forth stratum was introduced, which covered depths between 15 and 35 m because is this area the bottom structure allows bottom trawling in shallow waters as distinguished from Southern region. At 42 - 44 of the fields chosen at random, sampling by means of bottom trawling is carried out.

The seabed area covered during a single haul represents a basic measurement unit, which is very small compared to the total study area. nevertheless deemed representative since turbots do not aggregate in dense assemblages (Martino, Karapetkova 1957). Each field is a rectangle with sides 5' Lat × 5' Long and area around 62.58 km^2 (measured by application of GIS). large enough for a standard lug extent in meridian direction to fit within the field boundaries. The fields are grouped in larger sectors – so called strata, which

geographic and depth boundaries are selected according to the density distribution of the species under study. As a result of the trawling survey a biomass index was calculated. The time for a haul is between 1.5 – 2 hours with velocity 1.6 – 1.8 knots. The trawl employed has horizontal opening of 12 m an vertical opening – 1.5 m, mesh size – 10 cm.

The trawl surveys, carried out during spring and autumn seasons of 2007 in front of Bulgarian Black Sea coast, estimated that turbot exploited biomass varied between 1778.76 and 1896.56 tons (Panayotova et.al., 2007, 2008). The average CPUE range is between 8.89 and 10.03 kg/hour and correspondingly CPUA vary at average from 216.72 to 256.91 kg/km^2. The spring survey in 2008 assessed turbot exploited biomass at 1966.19 t., CPUE – 9.32 kg/hour and CPUA – 233.06 kg/km^2, respectively (Panayotova et.al., 2007, 2008).

According to the results from trawl surveys carried out during the period 2006 – 2008 along the Bulgarian Black Sea coast, the relatively stable trend in stock abundance index was observed.

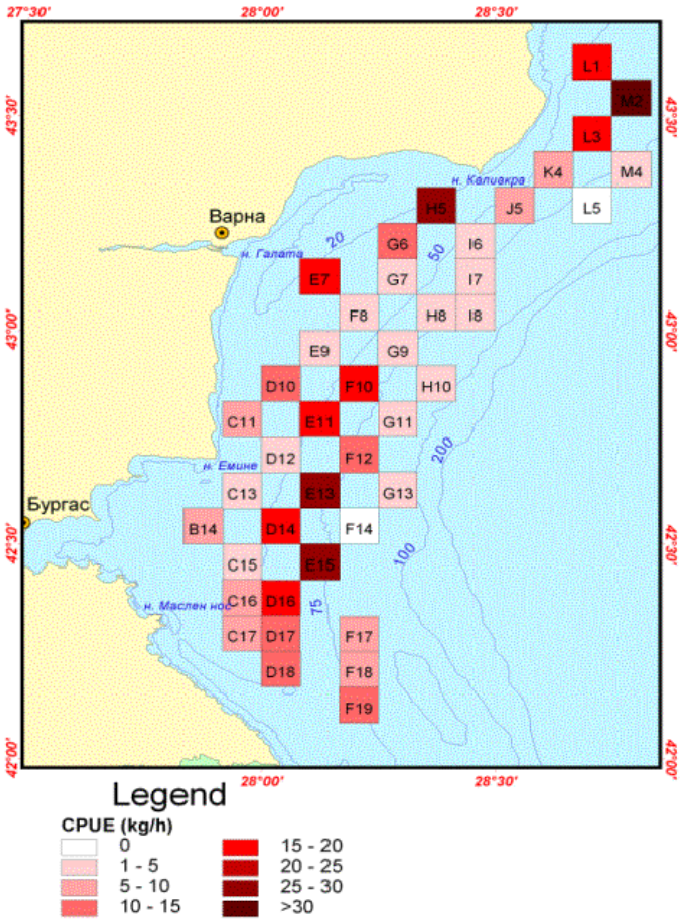


Fig. 7.22.1. Distribution of CPUE from research survey along the Bulgarian Black Sea coast. (autumn, 2007)

Romania

The research surveys in Romania cover the following activities and have been conducted from April to November, as follows:

- stationary fishing using traps net and gill nets – practiced in three locations along the Romanian seashore: in 2 Mai – Vama Veche, Constanța/Tăbăcărie and Cap Midia – Vadu sectors
- fishing using beach seine – practiced from April to July. in two sectors: 2 Mai – Vama Veche and Constanța – Cap Midia,

- fishing using bottom trawl – practiced from April to November by organizing four expeditions on sea on the whole continental shelf up to 80 meters depth, practiced between Sulina and Vama Veche

Between 2003 – 2006 four research cruises were organized (in April – May, July - November) (Maximov, 2003, 2004, 2006). Over 50 hauls were made at different depths (10, 20, 30, 40, 50, 60 and 70 meters). The trawling duration was of 60, 120 and 180 minutes, with a trawling speed of 3 – 3.3 N/h and a trawl opening of 20 meters. The research area covers the whole Romanian continental platform between Sulina and Mangalia.

In May 2007, for surveyed surface of 450Nm^2, the turbot biomass was apreciated at 144 tons, extrapolated to 1300 tons for shelf area up to 50 Nm from seashore. Important values of the catches have been realized between isobaths of 20 and 30m (Table 7.22.7, Fig.7.22.2).

Table 7.22.7. Assessment of the turbot agglomerations in May 2007, fishing gear-commercial bottom trawl

No. polygon	Polygon area (Nm^2)	Average (t/Nm^2)	Range (t/Nm^2)	Total tons in polygon (t)
1	106.25	0.0	0.0	0.0
2	318.75	0.358	0.17 - 0.57	114.11
3	25	1.18	1.18	29.5
Total	**450**			**143.6**

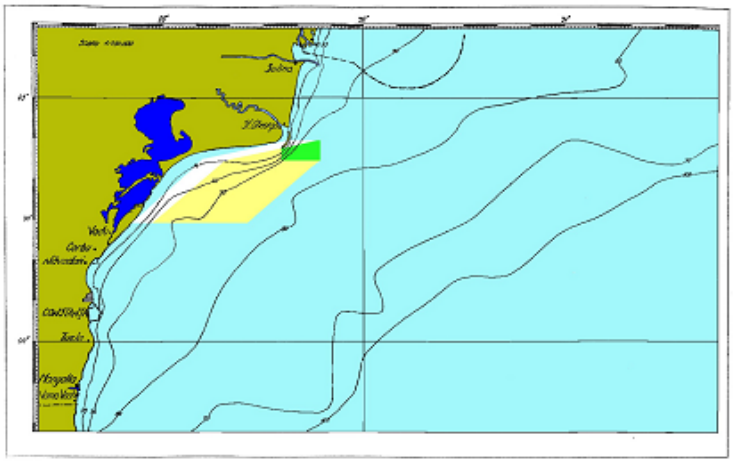


Fig. 7.22.2. Distribution of the turbot in May 2007.

In May 2008, for surveyed surface of 673Nm^2, the turbot biomass was apreciated at 80.8 tons, extrapolated to 504.2 tons for shelf area up to 50 Nm from seashore (Table 7.22.8, Fig. 7.22.3)

Table 7.22.8. Assessment of the turbot agglomerations in May 2008, fishing gear-commercial bottom trawl

No. polygon	Polygon area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total tons in polygon	Total on the shelf (t)
1	673	0.113 – 0,129	0.12	80.8	
Total					**504.2**

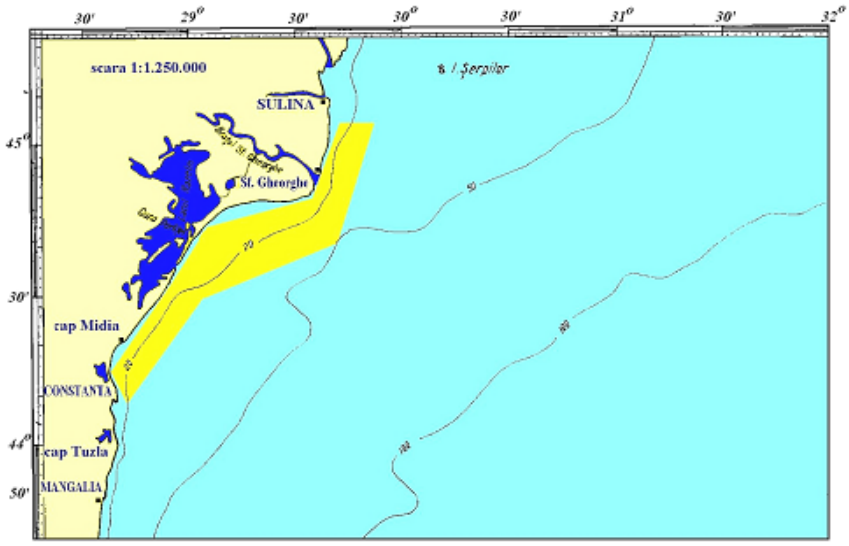


Fig. 7.22.3. Distribution and abundace of the turbot agglomerations in May 2008

After analyzing the obtained data, the following conclusions can be drawn:
The biomass values of the analysed species presented seasonal oscillations, their fishing agglomerations being influenced by the fluctuation of the environmental factors.

The turbot, the most important economically species, achieved fishing agglomerations whose biomass oscillated in 2003 among 247 and 1,066 tons, the highest values being obtained in November, when the distribution area was largest also. In may 2007, the biomass was appreciated at 1300 tons . In May 2008, the assessed biomass was 504 tons.

Turkey
Field studies were carried out in the Eastern Turkish Black Sea coasts from 1990 to 1993. Monthly surveys were conducted to gather basic fishery data in three stations up to 100 m depth by a research vessel (RV-1 Central Fisheries Research Institute) between 1990 and 1993 (Figure 10). Samples were taken by bottom trawl nets with mesh size 14 mm using 30 min standard hauls. Sub-sampling strategy (Holden ve Raitt, 1974) could not be applied due to insufficient amount of catch. so all the turbot caught treated as sample. All fish were measured and aged using the otholits (Chugonova, 1963). In order to determine a common hatching day and to prevent confusions age readings were given full cohort (Williams and Beford, 1974).

Using these vital data as an input. some basic fishery parameters such as length and age distribution according to depths up to 100 m and years. mortality and survival rates and exploitation rate were estimated. Two different methods were used for estimating the mortality rates (Ricker 1975; Sparre and Venema 1992). Exploitation rate (E) was calculated by the empirical equation derived by Pauly (1980).

“Sub Area Biomass Estimation” method was employed to assess the turbot stocks in the South-eastern Black Sea (Sparre et al.. 1989). Trawl surveys had been conducted at eight sub regions and two sub layers as 0-50 and 50-100 m depths in the area between Cape Sinop and Georgian border from 1990 to 1993 (Figure 10). It was intended to include both juvenile and adult stock to the samples. So operations mainly carried out in autumn season. Catchability coefficient (q) of the trawl net used for the sub layers assumed as one in the method of “swept area” (Bingel, 1985). Opening rate of the buoy line was taken as 0.5 (Pauly, 1980). Trawl operation (hauling) time was limited by 30 minutes with the fixed speed of 1.5 (1.4-2.2) knots. Maximum sustainable yield (MSY) or the potential yield (Pauly, 1980; Sparre vd. 1989) was estimated by the equation proposed by Gulland (1975) which consists of natural mortality and total biomass parameters (Gulland, 1975).

Exploitable turbot biomasses during autumn seasons were estimated as 686, 250, 222 and 134 tons from 1990 to 1993 respectively (Table 7.22.9, Figure 7.22.4). Highest biomass was observed in 0-50 m depth contour with the combined data for all years. Mean turbot biomass was 128.3 kg per square km for 0-50 m

and 44.1 kg per square km for 50-100 m. These results showed that both recruited juveniles and adult stocks were found together at the shallow waters in the littoral zone in autumn (Zengin and Düzgüneş. 2000).

Figure 7.22.4. Study area along South-Eastern Black Sea coast of Turkey.

Table 7.22.9. Turbot catches by trawl net in the South-Eastern Black Sea during the autumn season 1990-1993 (M: instantaneous natural mortality rate. Py: potential yield. n: operation number)

Years	Layer (m)	Mean Yield (kg/km^2)	[1]Biomass (kg)	M	[2]Py (kg)
	0-50	269.6±56.4 (n=25)	484558.7		
1990	50-100	54.8±15.6 (n=13)	100094.8	0.28	96081.1
	0-100	179.4±34.9 (n=38)	686293.4		
	0-50	118.2±50.9 (n=29)	152153.8		
1991	50-100	57.6±21.8 (n=24)	75841.6	0.21	26294.1
	0-100	95.4±41.9 (n=53)	250419.6		
	0-50	68.5±13.2 (n=26)	132110.4		
1992	50-100	60.8±18.2 (n=21)	101913.3	0.22	24467.9
	0-100	59.9±9.5 (n=47)	222436.0		
	0-50	56.7±23.2 (n=26)	94970.9		
1993	50-100	3.1±3.6 (n=22)	2622.5	0.23	15415.1
	0-100	37.5±13.6 (n=48)	134044.5		

1: Biomass estimation model in stratified sampling commented by Sparre et al. (1989)

($B = \sum B_i = \sum_{i=1}^{n} (cwi / ai * qi) * Ai$; B: Biomass of total area (kg). Bi: Biomass of layer i (kg). cwi: mean biomass of sub layer i. ai: swept area in sub layer i. (m^2). qi: catchability coefficient of the trawl net in layer i. Ai: area of sublayer i (m^2))

2: (Py=0.5*M*Bv; M: instantaneous natural mortality rate. Bv: less or never exploited stock) as commented by Gulland (1975)

The average stock size as 323.3 tons in this area from 1990 to 1993 was very close to the estimation of 433 tons obtained from the study carried out by Bingel et al. (1995). On the other hand. comparing the estimates of two previous surveys which were 180 tons (for 1969/1973; Kutaygil and Bilecik, 1979) and 130 tons (in 1990; Bingel et al. 1995) less than current estimations it is very clear that Eastern sublittoral zone appears to be more productive than the Western Black Sea areas.

Mean biomass abundance was 323 tons and calculated optimum potential yield (Py) was 40.8 tons for 1990/1993 but the actual catch was realized more than 8 fold of the expected amount. Another useful approach is the exploitation rate (E=F/Z) and all the rates calculated for the period of 1990 to 2000 are given in Table 23, which has minimum in 1995 (0.61) and maximum in 2000 (0.77). Values are higher than optimum level (E_{opt}=0.5) for all years and it is another evidence sign of over fishing due to high fishing

intensity on turbot stocks during these years in the Southeastern Black Sea. These results were also reflected to the landing statistics . In this area the turbot catch was 1300 tons in 1980's it decreased almost half of this level in 1990's with the exceptions 1993, 1994 and 1995.

Age of the oldest turbots in the samples was 9^{+}. while the age of recruitment (Tr) was estimated as 2 using the survival rate equation of Ricker (1975) (Table 7.22.10). Instantaneous total mortality rate was Z = 0.61-1.13 for turbot which are well known as long lived species. Survival rate was very low. S_{mean}=0.47 (ranged between S= 0.35 - 0.55) (46 % of turbot population can survive). It is also another indication of the negative effect of the high fishing (F) and natural mortality (M).

Table 7.22.10. Some population parameters of the turbot stock in 1990-2000 (Tr: age of recruitment S: survival rate. M: instantaneous natural mortality rate. F: instantaneous fishing mortality rate. Z: instantaneous total mortality rate. E: exploitation rate)

Years	[1]Age Interval	[1]Tr	[2]S	M	[3]F	[3]Z	[4]E
1990	1-8	3	0.44	0.28	0.57	0.85	0.67
1991	0-8	3	0.50	0.21	0.55	0.76	0.72
1992	0-7	2	0.49	0.22	0.55	0.77	0.71
1993	0-9	2	0.38	0.23	0.71	0.93	0.76
1994	2-6	3	0.53	0.30	0.49	0.79	0.62
1995	1-7	2	0.35	0.25	0.69	1.13	0.61
1996	0-8	1	0.55	0.20	0.41	0.61	0.67
2000	0-9	-	0.54	0.14	0.47	0.61	0.77
Overall	0-9	2	0.47	0.23	0.56	0.81	0.69

1: Smaller fish at lengths which are not available for commercial fish nets
2: Relationship between the survival rate and total mortality; Ricker (1975); $S=e^{-Z}$
3: Two different method used for to estimate M; Ricker (1975). and Sparre and Venema (1992) then average is taken.
4: According to Pauly (1983); if E=F/Z ‹ 0.5 stock is under exploited. if E=F/Z=0.5 it is exploited on optimum level and if E=F/Z › 0.5 stock is over exploited.

Ukraine and former USSR

For turbot stock assessment independently from commercial catches in Ukraine and Russia, the area method are employed (practically identical with swept area method) (Mayskiy V. N. 1939 – On methods of the fish stock estimation in the Azov Sea. Journal "Fish Industry of Ukraine". #3. 33 – 34. *(in Russian)*.

After 2001 the turbot reserch area in Ukrainean waters covers 17.300 km^2 (Fig.7.22.5). The whole area is divided into two subregions (North-Western and North - Eastern + South coast of Crimea). Each subregion includes two layers with corresponding depth ranges: 0 – 50 m and 51 – 100 m. During the years one or two turbot stock assessment (or demersal fishes) surveys were carried out annually. The bottom trawl employed during the surveys has 24.6 m horizontal opening and codend mesh size 6.5 mm (sometimes trawls have headrope 31 – 32 m long). The trawl is towed by average tonnage vessel with speed of 2.8 – 3.2 knots. In Table 7.22.11 for Ukraine are given assessments of turbot stock by trawl surveys with catchability coefficient between 0.1 – 0.3, average 0.2. In table 16 are given Ukrainian turbot stock assessments without applying catchability coefficient. i.e., the coefficient value is equal to 1.0 (like assessments in Bulgaria. Romania and Turkey).

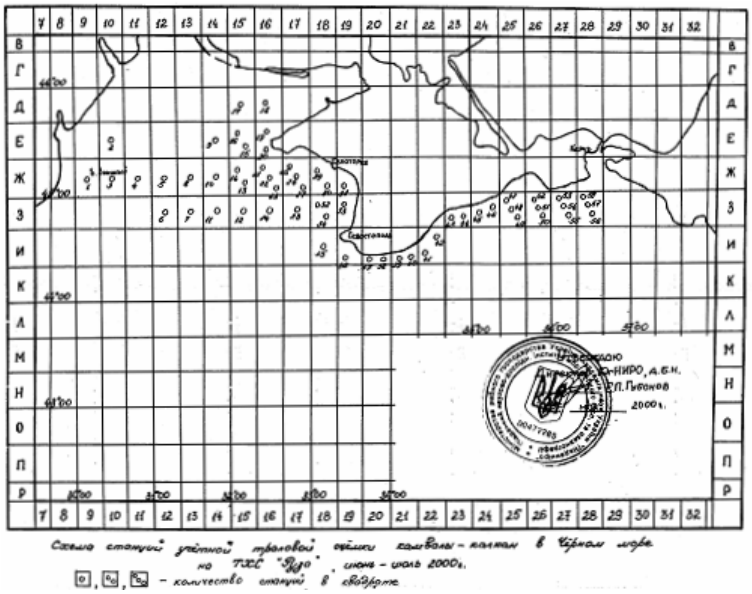


Figure. 7.22.5. Research area for turbot stock assessment in Ukrainian waters.

The accuracy of turbot stock assessments is estimated by standard algorithms (Gasukov P. S. .1979. – Methodical recomendations for processing results from trawl surveys – Kaliningrad. AtlantNIRO: 27 pp.). For example, for 2006 the following results were obtained after turbot stock assessments in Ukrainean waters:

Abundance index according to trawl surveys
Species: Black Sea turbot (**North – Western part of The Black Sea. Ukraine.** Demersal fishes survey. June 2006)
Group 1
Number of Layers: 2
Number of hauls: 48
Area/ S 1 haul per group: .8650000E+05
Abundance Index: .109888E+02
Index variance: .190981157E+01
Standard deviation: .1458322E+01
Variation coefficient: .1271511E+00
Confidence Interval. Lower limit: .8369963E+01
Confidence Interval. Upper limit: .1432384E+02
Stock assessment in weight. . t: .724001E+07 .950531E+07 .1177061E+08
Stock assessment in numbers: .219396E+07 .2880394E+07 .3566970E+07

Abundance index according to trawl surveys
Species: Black Sea turbot in Ukrainean waters. Demersal fishes survey . October. 2006)

Group 1
Number of Layers: 2
Number of hauls: 22
Area/ S 1 haul per group: .4937500E+04
Abundance Index: .2005507E+02
Index variance: .2117913E+02
Standard deviation: .4602079E+01
Variation coefficient: .2294722E+00
Confidence Interval. Lower limit: .1085091E+02
Confidence Interval. Upper limit: .2925922E+02
Stock assessment in weight. . t: .5357635E+0 .9902188E+06 .1444674E+07

Stock assessment in numbers: .2130625E+06 .3943520E+06 .5753365E+06

7.40.4. Assessment of historic stock parameters – Method 1: XSA

The WG prepared data for two separate analyses to be conducted by means of VPA 3.1 (Lowestoft), as follows:

On the stock of turbot in the Western part of the Black Sea - based on data from Bulgaria, Romania, Western Ukraine and Western sub-area of Turkey
On the stock of turbot in whole Black Sea - based on data from Bulgaria, Romania, Ukraine and Turkey

We applied Extended Survivors Analysis (XSA) (Shepherd, 1992). The method fits regressions between abundance-at-age and CPUE for multi-fleet tuning data, assuming power functional relationship for recruitment and a constant catchability with respect to time for fully recruited age groups. XSA is less rigid than VPA about constant exploitation pattern assumption, setting down the catchability to be constant (independent of age) above a certain age. Catchability estimated at a certain age is then used to derive abundance estimates to all subsequent ages including the oldest one. The fleet derived population abundance-at-age is used to estimate survivors at the end of the year for each cohort, which later initiate a modified cohort analysis in each iteration. XSA is considered to be superior than VPA in assuming the error in the catch data and being less sensitive to the last year data quality. In addition it uses an year-class-strength-dependent model to tune recruitment.

The technique called "shrinkage to the mean" could be used in order to stabilize additionally the analysis. It takes into account the mean F (or N) over the recent years in the calculation of the last year F's or N's, which means an additional constraint on the last year estimates. In the case of VPA the last year F 's are shrunk to the arithmetic mean of the previous years F's for each age. In XSA two shrinkage options are available: shrinkage to the population mean or N shrinkage applied to recruitment and shrinkage to the mean F (F shrinkage) which is applied to all last year F's as well as to the oldest age F's. A shrinkage coefficient of variation (CV) has to be supplied by the user in order to weight the F shrinkage mean (by the inverse variance). The N shrinkage mean is weighted by the inverse of the variance of weighted geometric mean. Within XSA, when the analysis is extended to past years not covered by tuning data , it is necessary in most cases to use F shrinkage to the oldest age F, that is equivalent to the backward extension constraint used in VPA.

CAA estimates simultaneously abundance (N)- and fishing mortality (F)-at-age, and one of the problems with these models is the over parameterisation. XSA deals with over parameterisation in two ways. One way is to decrease the number of parameters estimated by CAA e.g. to assume a constant exploitation pattern for the oldest ages (see below), another way is to estimate some parameters (e.g. the last year fishing mortality) using additional information (CPUE, survey indices): to estimate F in the terminal year

The method has previously been successfully applied to sprat and whiting by Daskalov (1998) and ICES area (ICES 2007)

7.40.5. Results and discussion

During the meeting the WG made a very good progress in compiling operational input data (Annex II). Initial runs of the integrated age-structured model (XSA) were performed, but more work with different model options are needed before achieving reliable estimates of abundance and fishing mortality.

The initial results with XSA were not stable and further runs and adjustments of the model parameters need to be done until the model fit and diagnostics become acceptable. In order to assess the status of the stock the WG analysed the trends in catches, indices and preliminary results from the assessment, as well as absolute biomass estimates from pelagic trawl surveys in Bulgarian and Romanian waters in 2007 and 2008. Given the **present state of the assessments the WG cannot yet provide a conclusive figure of the present state**

of the stock or short and medium term forecasts, but only a relative information about the trends in abundance and fisheries.

Trends in catches and abundance indices

Catches and abundance indices of turbot were analysed by the WG (Figs 7.22.6 & 7.22.7). Landing figures show different trends (Fig. 7.22.8, Table 7.22.11) which may be caused by variety of causes including misreporting. Reported landings in Bulgaria and Turkey (Fig 7.22.6A) look consistent as well as those of Romania and Ukraine. On the other hand Turkish landings which form the majority of the total catch also differ between the eastern and western Turkish coasts (Table 7.22.6). In future the WG will need more information in order to be able to interpret variable dynamics of catches.

Long term Ukrainian survey (Fig. 7.22.7A) exhibits an increase in relative biomass in 1989 after which the biomass level do not show significant increases or decreases. Ukrainian commercial CPUE show an increase in 1996 and stays on the nearly same level (Fig. 7.22.6A). Ukrainian commercial CPUE was presented in kg/net and the values of the index for 1991-1995 are not consistent with the research survey index (Fig. 7.22.7A). This index probably needs to be re-estimated in kg per hour of fishing. The Romanian commercial CPUE index has been estimated since 2001 (Fig. 7.22.6B). I show a relative increase in 2004-2007. Both Romanian and Bulgarian research surveys show increasing trend in the last years (Fig. 7.22.7B).

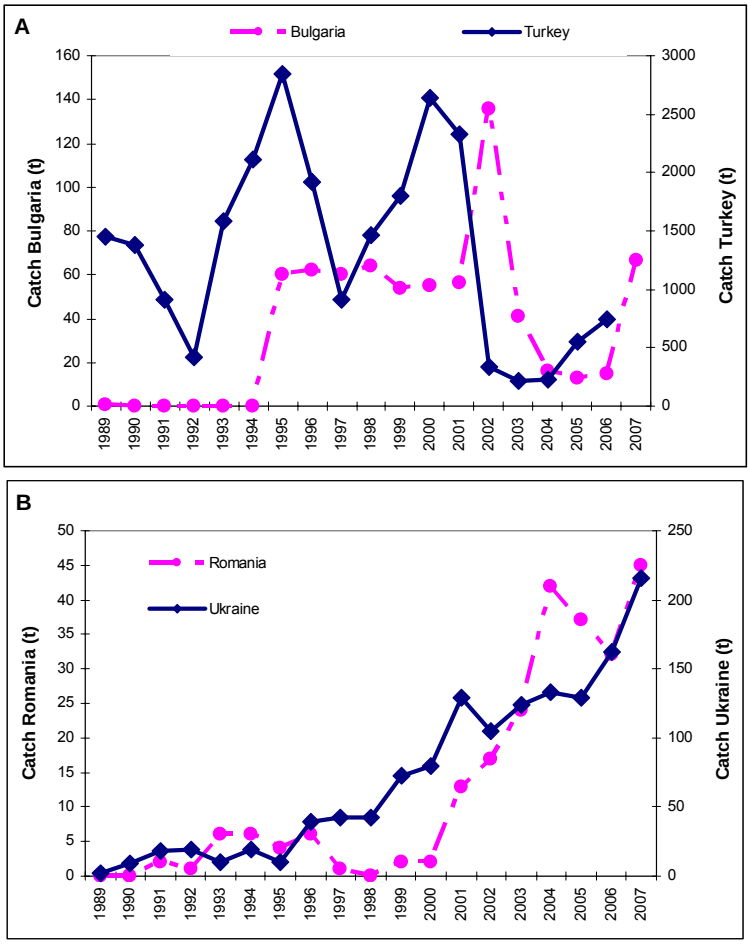


Fig. 7.22.6. Trends in turbot catches: A. Bulgaria and Turkey, B. Romania and Ukraine (STECF 2008)

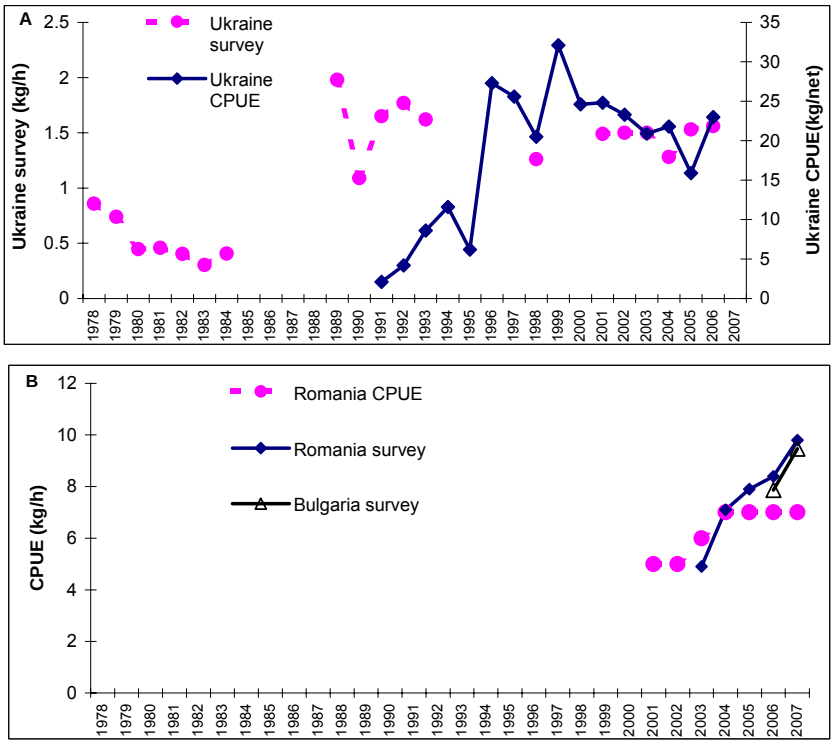


Fig. 7.22.7 Trends in turbot biomass indices: A. Ukrainian bottom trawl survey, Ukrainian commercial CPUE; B. Romanian commercial CPUE, Romanian bottom trawl survey, Bulgarian bottom trawl survey (STECF 2008).

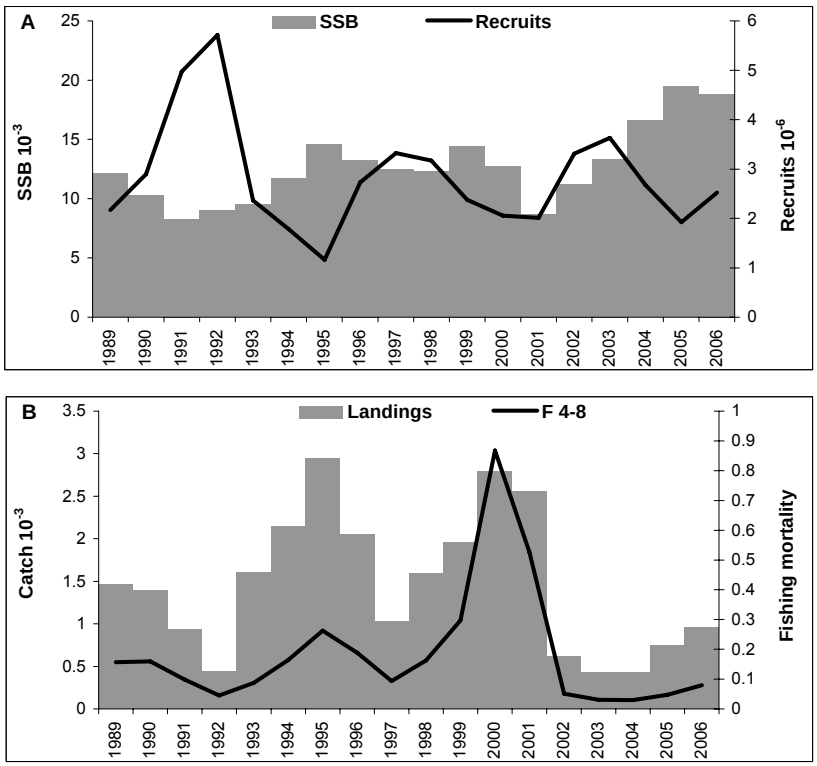


Fig. 7.22.8. Time-series of turbot population estimates of total stock in the Black Sea (XSA version without terminal F shrinkage, Annex II): A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 4-8, line).

Age structured model (XSA)

Initial runs with XSA were performed by the WG on the total catch at age and separately on the catch at age of western stock component (STCF 2008, Fig, Annexes II and III). Trajectories of abundance and fishing mortality of the total stock and the western component are very similar in relative terms (rescaled for the size of the catch, Annex III) and here we will discuss only the figures produced from analyses of the total catch at age (Figs 7.22.8 & 7.22.9).

Two versions of the assessment model were produced during the WG meeting, which substantially differ one from another and for this reasons cannot be used to give a firm conclusion about the state and dynamics of the stock.

The first version was produced by tuning the model using Romanian and Ukrainian age disaggregated research survey CPUE without shrinkage to the mean terminal Fs (Annexes II & III, Fig. 7.22.8). According to this version recruitment peaks in 1991-1992, 1997-1998, and 2002-2003. The SSB increases from 1991 to 1999 then drops in 2001, and increases again in 2005-2006 up to ~20 000 t. For most of the time the average fishing mortality F_{4-8} is between 0.1 and 0.3 with a peak of 0.5-0.9 in 2000-2001 when catches as high as 3000 t have been reported.

In the second version (Fig. 7.22.9) we applied shrinkage to the mean terminal Fs. The results are radically different from the version without shrinkage. In this version recruitment vary between 0.5 and 3.7 10^{-6} compared to the version without shrinkage where recruitment is estimated to be between 1 to 5.7 10^{-6} (~2 times greater), and SSB in the second version vary between 2000 and 5000 compared to the version without shrinkage – 10 000-20 000 (~4 times greater). Here the SSB increases from 1991 to 1999 to ~ 5000 t, then in 2000-2002 drops to ~2000 t and remains at a low level until 2006. Fishing mortality F_{4-8} is also ~ 2 time greater but follows a similar trajectory with a peak in 2000-2001.

The difference between the two assessment versions (Figs 7.22.8 & 7.22.9) is considerable, and does not allow to make an unequivocal conclusion about the state and dynamics of the stock. It seems the difference is mainly due to the estimation of the last year terminal Fs, which for such a long lived species substantially influence the estimates of stock size in the previous ~10 years, and if a constant exploitation pattern is assumed (as in XSA) will influence also the last age terminal Fs. The last year terminal Fs differ considerably between the two assessments (10 times on average!, Figs 7.22.8 & 7.22.9). Major uncertainties in catches (due to misreporting), and possibly in the tuning data make these assessment even more subtle.

The WG consider these preliminary results as a useful and necessary first step in the analysis. Further experimentation with data and model options are needed before more acceptable model versions are produced. **However the present results are entirely inconclusive and cannot be used for the aims of the management advice.**

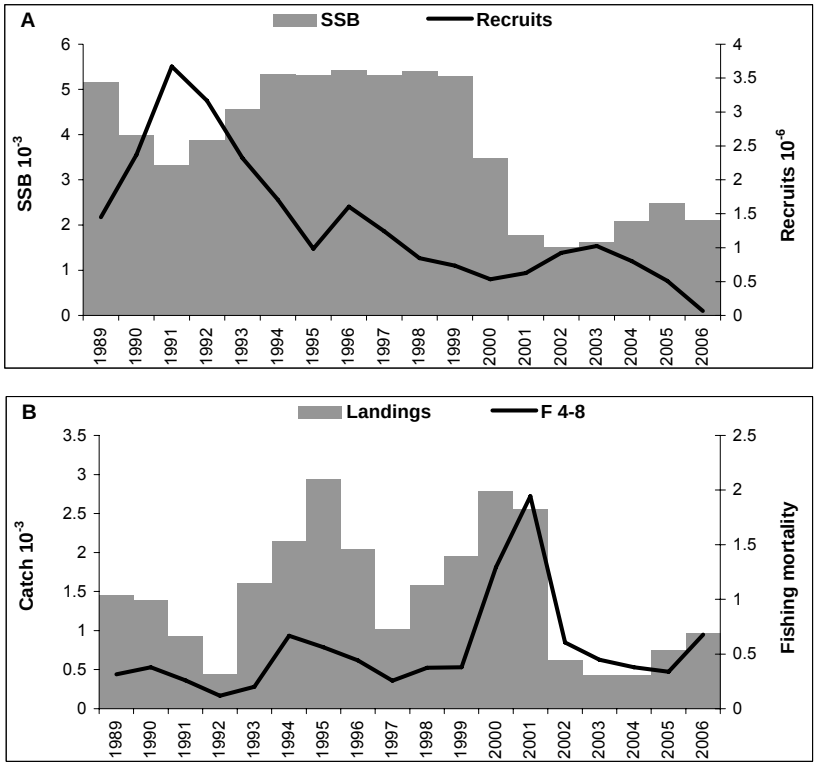


Fig. 7.22.9. Time-series of turbot population estimates of total stock in the Black Sea (XSA version with terminal F shrinkage, Annex II): A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 4-8, line).

Research surveys of absolute biomass in 2007 and 2008

In Bulgarian waters, the swept area survey based estimates of absolute exploitable biomass was 1800 t in 2007 (Table) and in Romanian waters – 1300 t and 504 t in 2007 and 2008 respectively. Different relative abundance indices show no decline in the stock

7.40.6. Conclusions and recommendations

The state of data

Catch data of turbot are very problematic. Official landings from different countries show divergent trends that can be due to various causes including misreporting. In future the WG will need more information on how catches are reported to allow plausible interpretation of the variable dynamics of catches.

Biomass indices
Both CPUE from commercial catches and biomass estimates from research swept area surveys were available to the WG. Most of them, however do not show consistent trends and are difficult to interpret and use for tuning of the age-structured assessment models (XSA). Further attempt will be made to choose the best data and parameter options for tuning XSA or a similar model (e.g. APAPT). A dynamic production model assessment (e.g. ASPIC) could also be tried, but it will be difficult to choose biomass indices for model adjustment.

Age-structured model (XSA)
The WG cannot use the preliminary results from the integrated age-structured assessment (XSA) for evaluation of the stock status and short and medium forecasts. Further work with the model and data is needed until more acceptable results and diagnostics are obtained.

Because of the controversial results produced with different settings of the assessment model, at this stage it is impossible to make a firm judgement about the absolute biomass or trend of the stock in the last years. However, given the indications from the research swept area surveys, the WG can assume that the state of the stock have improved since the collapse in the 1990s (at least in Bulgarian and Romanian waters).

Given the available information, the WG suggests a conservative approach i.e. to keep the exploitation level in Bulgarian and Romanian waters below the current TAC of 100t.

8. GENERAL RECOMMENDATIONS FROM THE SGMED WORKING GROUP FOR STOCK ASSESSMENTS

During the Working Group, a number of specific recommendations were made for future assessments.

As already noted, the layout of the assessment report forms (section 7) was designed to allow scientists and managers to review the data underlying the assessments presented, the issues encountered during the assessment and the assumptions made, the assessment outputs and subsequent management advice, in a consistent way. The intention was not to complete the template fully during the SGMED-08-03 meeting, but for this structure to be completed over time during future meetings.

As noted, despite excellent efforts by the attendees at the Working Group, the sheer number of proposed assessments for SGMED-08-03 could not be achieved with the relatively limited number of assessment scientists at the meeting and within the length of the meeting.

It must be re-iterated that those assessments performed during the meeting were considered preliminary. The Working Group noted that there was insufficient time to perform the comprehensive list of assessments suggested (see Table 2) given the number of assessment scientists attending SGMED-08-03 and the time taken to receive and collate data from the DCR call. The Working Group request that further time be provided at SGMED-08-04 in order to continue with these demersal assessments.

Working Group members discussed the potential uncertainties resulting from the use of equilibrium approaches. These approaches were necessary given the relatively short time series of data available from the DCR call. It was noted that when changes were occurring within the fishery (e.g. the trends in fishing effort seen in many cases), the assumptions of equilibrium models would be violated, and their results must be viewed with caution. This notwithstanding, trials of the equilibrium LCA model VIT were performed using historical North Sea cod data from XSA assessments. Historical data from the converged part of the XSA output were assumed to represent 'reality'. The VIT estimates of fishing mortality based upon corresponding length data tended to be lower than those from XSA, by up to ~30%, while estimates of spawning stock biomass were comparable. The trends in the fishing mortality estimates were also comparable to those from XSA, suggesting that VIT can provide reasonable relative estimates of this value. This supports the results of previous trials performed by GFCM.

While the data obtained through the DCR call was extremely useful during the meeting, it was noted that scientists were not constrained to the use of DCR data alone. The use of existing local data sets, potentially with a longer time series, was encouraged. As noted in the SGMED-08-02 report, the available data did not allow the calculation of partial fishing mortalities on individual species. This style of analysis would require data at a much finer level of aggregation (e.g. level 6 or 7?). There remain significant difficulties, furthermore, due to the multispecific targeting of most fisheries, the use of many gears to capture a species, and the difficulties collecting representative data on total catches, effort and size composition given the large number of fishing ports and landing sites.

The Working Group discussed the biological parameters to be used within assessments. Where estimates were uncertain, the use of alternative values was suggested to examine the sensitivity of assessment results to this uncertainty. The general results appeared consistent. An age-specific estimate of natural mortality was generally used, as recommended at SGMED-08-02. As noted in the report of that meeting, however, knowledge of the stock-recruitment relationship is needed to appropriately define MSY (although proxies can be used). As shown in the assessment of hake in GSA 9 (section **Error! Reference source not found.**), the results of future projections are reliant on the values selected. Indeed, if stocks recover from what has been described as a current state of 'sustainable overfishing', where productivity is lower than that which could be achieved with reduced fishing pressure, estimates of future status using current parameters may be increasingly uncertain as stocks move out of the range of states seen within existing the data sets.

Some inconsistencies in the estimation of biological parameters were noted during the Working Group. For example, maturity estimates in Greece (GSAs 20, 22, 23) used different assumptions of the maturity scale point considered to be mature, when compared to other areas. This requires further consideration.

There was a need to ensure the basis of the estimates of mortality was given in assessment reports. Z could be estimated in a number of ways, both in terms of the methodology (e.g. catch curves, VIT, etc.) and data (e.g. single years, average of data over a number of years) used. This has been made clear within the description of assessment results.

The use of survey data (e.g. MEDITS, GRUND) was suggested as a tuning index, as well as for direct use in assessment approaches such as SURBA (as used in many of the assessments described). In a number of GSAs, it was noted that the number and distribution of survey stations had been changed over time, particularly in the early years of the time series, or shifts in the timing of the survey during the year. This often led to a poor fit by the assessment method to the data, or use of a truncated data set. The Working Group suggested that the data be standardised over time using GLMs to take account of these changes and allow improved assessments to be performed.

In relation to assessment results, particularly from surveys, the Working Group recommended that when graphing abundance information over time, some estimates of variability (e.g. standard deviation or CV) be provided for each data point, to allow the significance of any data trends to be identified.

Although intended for the meeting, the examination of alternative reference point levels was not fully undertaken during SGMED-08-03, due to time constraints. However, discussion did re-iterate the need to compare stock assessment results to potential maximum production levels (e.g. MSY or appropriate proxy values). The Working Group recommends that this be continued in future SGMED meetings.

All participants found the Working Group an excellent opportunity for exchange of ideas, approaches and skills. 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 suggested that inter-sessional workshops or training courses be pursued to expand the number of scientists fully able to undertake assessments within the Mediterranean region.

9. GENERAL CONCLUSIONS AND RECOMMENDATIONS FROM THE BLACK SEA WORKING GROUP

During the meeting in Ispra 2008 the WG made a very good progress in assembling and reviewing the available data, and compiling data in operational format for application of integrated stock assessment models (ICA and XSA).

The WG performed initial runs with the stock assessment models (ICA and XSA). Although initial results are very preliminary, and at this stage cannot be used for assessing the stocks' state and dynamics, they represent a necessary background for further assessment refinement, which will hopefully bring stable results and improved model diagnostics.

Having said that, the WG will further need more time and resources to complete the historical assessments of sprat and turbot, which especially for turbot could be quite complicated, because the large uncertainties in catches, age composition and abundance indices.

The WG also needs to build capacity in quantitative stock assessment and will request from the STCEF Secretariat to organise a population dynamics and stock assessment training course.

The WG found the state of catch and age data for sprat stock assessment acceptable.

In future, a cross-examination of the sprat fisheries information (catches, effort and CPUE) would greatly improve the reliability of input data.

The state of the abundance indices in sprat is not as good as it used be in previous years, when several CPUE indices from commercial fleets and research surveys were available. At present the WG has used only CPUE from Ukrainian and Bulgarian commercial fleets. These data seem to reflect the relative dynamics of the stock, but in future, more research survey indices are needed in order to produce reliable assessments.

Specifically, the WG would encourage the undertaking of acoustic and juvenile research surveys covering the areas of the main stock distribution.

A juvenile survey is already taking place in Romania for several years (and previously in Ukraine), but it needs to be extended, initially at least in Bulgarian waters in order to produce more reliable estimates. This index is very important for estimating the strength of recruitment in the current year and needs a special attention in planning of the future sampling programmes.

Gathering experience with the acoustic survey, which is expected to start in Bulgarian waters will hopefully provide a reliable biomass index.

From the analyses of relative trends in data, indices and preliminary assessment results, it appears that during early 2000s the sprat stock has recovered from the low state which occurred in the early 1990s. The stock seems to have reached a maximum in 2000-2003. The present biomass is possibly lower, but the stock does not seem to be threatened by overfishing, because of the relatively low level of exploitation.

Given the available information, the WG suggests to keep the catch in Bulgarian and Romanian waters bellow 15 000t.

Catch data of turbot are very problematic. Official landings from different countries show divergent trends, which can be due to various causes including misreporting. In future the WG will need more information on how catches are reported to allow plausible interpretation of the variable dynamics of catches.

Both CPUE from commercial catches and biomass estimates from research swept area surveys were available to the WG, but most of them, unfortunately, do not show consistent trends and are difficult to interpret and use for tuning of assessment models. Further attempt will be make to chose the best data and models to perform satisfying assessments.

Provided that turbot fisheries and survey information is quite contradictory, a cross-examination of different sources is needed to find out which part of the information is more reliable and can be used.

Future turbot assessments need to rely more on standardized biomass surveys and improved catch reporting.

Because of the controversial results produced with different settings of the assessment model, ate this stage it is impossible to make a firm judgement about the absolute biomass or trend of the stock in the last years. However, given the indications from the research surveys, the WG can assume that the state of the stock have improved since the collapse in the 1990s (at least in Bulgarian and Romanian waters).

Given the available information, the WG suggests to keep the exploitation level in Bulgarian and Romanian waters bellow the current TAC of 100t.

The WG discussed some ecosystem considerations which apply to the state and dynamics of the fish stocks in the Black Sea. It appears that the distribution and behaviour of sprat on the north-western shelf and specifically in Romanian waters vary to a great extend depending on the environmental conditions. Sprat schools tend to be negatively affected by jellyfish swarms. Previous studies have found that stock dynamics is related to climate fluctuations, trophic interactions and other environmental factors. Predators such as bonito in the pelagic system, and Rapa whelk (*Rapana thomasiana*) in the benthic system can have significant effects on abundance and behaviour of their prey populations, as well as through trophic cascades - at the ecosystem level. In future, environmental influences and ecosystem interactions need to be taken into consideration when suggesting reference levels for the fisheries and designing management procedures.

The question of assessing other stock in the Black Sea was discussed throughout the meeting. The WG recognised the need to undertake assessments of other important species such as anchovy, horse mackerel, bonito, and Rapa whelk. However, the WG admitted the insufficient capacity to undertake all these assessments simultaneously, and **the need to first complete and refine the ongoing historical assessments of sprat and turbot**.

10. REVIEW OF SOCIO-ECONOMIC REFERENCE POINTS (TOR I)

An indicator has been defined as: "a variable, pointer, or index related to a criterion. Its fluctuation reveals variations in key elements of sustainability in the ecosystem, the fishery resource or the sector and social and economic well-being. The position and trend of an indicator in relation to reference points indicate the present state and dynamics of the system. Indicators provide a bridge between objectives and actions" (FAO, 1999a).

Indicators are useful to draw an accurate picture of fisheries from a biological, economic and social point of view. Moreover, an evaluation of the state of fisheries through time can be obtained by comparing indicators to appropriate reference points. As reported in Caddy and Mahon (1999), these values should be associated with either a critical or an optimal state, where the former identifies a limit which is necessary to avoid (limit reference points) and the latter a target to be attained by the system (target reference points). Nevertheless, limit and target reference points are not identifiable for many indicators, or the data needed for estimation are not available in many fisheries.

An attempt to define a general list of indicators and reference points in fishery was made by FAO in the Technical Guidelines for Responsible Fisheries (FAO, 1999b). Among the reference points proposed, only in a few cases were target reference points defined in accordance to general concepts in fishery sustainable literature, such as MSY (Maximum Sustainable Yield) and MEY (Maximum Economic Yield), while the majority were defined by the indicators' historical level. However, the use of historical levels represents a very suitable method for highlighting the presence of trends and evaluating the state of fisheries through time.

10.1. Socio-economic indicators considered at STECF level

The STECF has not established the socio-economic indicators to be used. Notwithstanding, some recent meetings have focus on the identification of useful indicators for management purposes. SGRST-07-05 and SGECA/SGRST-08-01 (follow-up to SGECA-SGRST-07-02) were required to identify quantitative indicators to improve the qualitative assessment of the balance between fishing capacity and fishing opportunities either at Member State or at the Commission level.

The Annual Economic Report (AER), nowadays prepared under the SGECA-08-02, calculates several socio-economic indicators using DCR data.

10.1.1. SGRST-07-05 and SGECA/SGRST-08-01

Results from SGRST-07-05 and SGECA/SGRST-08-01 recommended the use of two economic (Return on Investment and Ratio between Current Revenue and Break-Even Point) and two social indicators (Average Wage per Full-Time Equivalent and Gross Added Value). The specifications of all the indicators were detailed on the SGMED-08-01 report, and are attached on ANNEX A.

10.1.2. SGECA-08-02

The main socio-economic indicators calculated in the Annual Economic Report (AER), nowadays prepared under the SGECA-08-02, are the Cashflow, Breakeven Revenue, Profit and the Gross Value Added.

These indicators are calculated in the AER using DCR data for all countries and fleets that submit data under the DCR framework.

10.2. Other socio-economic indicators calculated at the Mediterranean level

At the second meeting of a GFCM working group on Fishery economy and statistics in 1998, a document was presented[17], which was the first pointing out the utility of socio-economic indicators in the Mediterranean context, and where a first set of indicators and information sources were proposed.

At the 25th Session of the GFCM (September 2000) it was recommended that the SCESS would develop and use homogenous socio-economic indicators in each of the GFCM management units.

However, at the GFCM level there is no official list of socio-economic indicators to be estimated. Different case studies (most of them funded by the CopeMed and AdriaMed projects) have therefore been using different sets of indicators.

10.2.1. Socio-economic indicators used during the CopeMed project

On the session of June 1999, it was agreed that CopeMed should finance a pilot study on socio-economic indicators[18]. This was adopted by the GFCM Plenary[19] one month later.

The study[20] was presented and discussed at the SCESS on April 2000[21] and in May 2000 to the SAC[22].

Later studies, also funded by the CopeMed project, have been performed in the Gulf of Gabes[23], North Tunisia, Algeria and Libya, and were presented at the GFCM. All of them have been compiled in Franquesa *et al*. (2005).

CopeMed's socio-economic (and technical) indicators were presented on SGMED-08-01, and are again detailed on Annex B.

10.2.2. Socio-economic indicators used during the AdriaMed project

As described in SGMED-08-02 report, a list of 24 socio-economic indicators was proposed by the FAO-AdriaMed project in 2006. Economic indicators include 6 indicators on economic performance, 8 on productivity, 4 on costs and prices, and one general indicator summarising economic sustainability. From the social point of view, 4 indicators plus one general indicator summarising social sustainability are defined.

AdriaMed's socio-economic (and technical) indicators were presented on SGMED-08-02, and are again detailed on Annex C.

10.2.3. Socio-economic indicators used at other sources

There are studies using socio-economic indicators for Mediterranean fisheries that have not been funded under the CopeMed or AdriaMed projects.

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[17] Franquesa, R. & Bailly, D. 1997. Les indicateurs de tendance socio-économique dans le processus d'aménagement des pêches en Méditerranée. GFCM: WP/97/3, CGPM, FAO, Rome

[18] Point 65 of the declaration. GFCM, Report of the Second Session of the Scientific Advisory Committee (SAC), Rome, Italy, 7-10 June, FAO, Rome, 1999.

[19] Point 14 of the declaration. GFCM, Report of the Extraordinary Session, Alicante, Spain, 7-9 July 1999, FAO, Rome, 1999.

[20] Franquesa, R.; Malouli, M & Alarcón, JA, 2001. Feasibility assessment for a database on socio-economic indicators for Mediterranean Fisheries. GFCM Studies and reviews No. 73.

[21] GFCM, Scientific Advisory Committee - Sub-Committee on Economic and Social Sciences (SCESS) - First Session. Madrid, Spain, 26-28 April 2000

[22] GFCM, Report of the third session of the Scientific Advisory Committee. Madrid, Spain, 2-5 May 2000.

[23] Scander Ben Salem, Ramon Franquesa, Amor El Abed, Indicadores socioeconómicos para la pesca en el Golfo de Gabés (Túnez). Estudio de caso, INSTM, FAO-COPEMED 15 March 2002.

Ünal (2006) calculated socio-economic indicators for 6 Mediterranean fishing cooperatives in Turkey, using some of the CopeMed socio-economic indicators and their methodology (See Annex D). Moreover, Ünal (2006) also calculated 9 socio-economic-demographic indicators (See Annex E). Ünal & Franquesa (forthcoming) also use a similar methodology, but results are not yet available.

Nieto (2008) using some of the CopeMed socio-economic indicators and their methodology, analysed the artisanal and industrial fleets in Palamós (one of the main fishing cooperatives in the Spanish Mediterranean) (See Annex F). Cambie (2008) also analysed the socio-economic performance of the Italian fleets in the Calabrese region using the CopeMed socio-economic indicators and their methodology.

However, it is difficult to identify the existence of studies that are not performed under the umbrella of large projects or not published in the main scientific journals. Therefore, it is likely that there are more studies on socio-economic indicators in the Mediterranean, even though they may not be detailed here.

10.3. Comparison of socio-economic indicators from STECF working groups and the ones from other sources for the Mediterranean

Comparing all sources of socio-economic indicators, it can be seen that there are no major incompatibilities between them, in both their definitions and their calculations.

CopeMed and AdriaMed studies offer a larger set of socio-economic indicators than the ones used in both STECF subgroups. Indicators from CopeMed and AdriaMed studies are quite similar and no major divergences are found. One divergence is that in AdriaMed there are landings and revenues per day indicators, while CopeMed indicators of landings and revenues are per hour. This divergence can be explained by the larger number of countries analysed within CopeMed studies. When more countries are analysed a greater range of fishing patterns and regulations are found. In this sense, for example, Spainish trawlers can only be out of port a maximum of 12 hours per day (even less in certain ports), while in other countries trawlers can be out fishing all the 24 hours of the day.

"Return on Investment" as proposed by the SGRST-07-05 and SGECA/SGRST-08-01 working groups is the same indicator that in the CopeMed frame is called "Profit Rate" and in the AdriaMed project "Return on Investment". While at the AER only the profits indicator is calculated; so it is not divided by the total capital. However, this calculation is quite simple to perform as data is available from the DCR. The main concern with this indicator, as already stated during PLEN-08-01, is that the opportunity costs should not be deducted from profits when calculating this indicator.

The "Ratio between Current Revenue and Break-Even Point" proposed by the SGRST-07-05 and SGECA/SGRST-08-01 working groups does not appear among the CopeMed and AdriaMed's socio-economic indicators, but could be easily calculated by the requested variables. While at the AER only the break-even revenue indicator is calculated; but not directly compared with current revenues. However, this calculation is quite simple to perform as data is available from the DCR. A consistent methodology for the break-even calculation should be ensured.

The "Average Wage per Full-Time Equivalent" proposed by SGRST-07-05 and SGECA/SGRST-08-01 working groups and the CopeMed's "Average Wage" and AdriaMed's "Salary per crew" are similar, but the former is considering the employment on a Full-Time Equivalent basis, while the latter does not specify this issue. The main concern with this indicator is that the parameter "crew costs" collected by the DCR is often used on its elaboration; however, under "crew costs" include other costs than just the salaries (social security, for example).

The "Gross Added Value" indicator is identically defined at both STECF working groups and CopeMed and AdriaMed frame.

Finally, the cashflow indicator used at the AER was not proposed by SGRST-07-05 and SGECA/SGRST-08-01 working groups and is also not used in the CopeMed and AdriaMed work frames.

10.4. Reference points for socio-economic indicators

Reference points are useful to evaluate the state of fisheries economic and social performance. The actual performance of the fisheries illustrated by the socio-economic indicators can then be compared with some desired performance identified by the reference points.

Reference points can be drawn up either by considering an external value or by considering historical values or from other areas/fleets.

The reference point for the **Return on Investment (ROI)** indicator is the interest rate free of risk (normally the national government bonds). The Return on Investment is measured as the ratio between profits (positive or negative) and the total capital invested for a given period. It should be noted that this ratio is often expressed as a percentage, and so multiplied by 100.

When the opportunity costs are deducted from profits when calculating this indicator (not desirable as stated in PLEN-08-01), then the reference point for this indicator is 0.
So:

- A result higher than the interest rate (or 0) show that the fishery is profitable for the companies.
- A result lower than the interest rate (or 0) show that the fishery is not profitable for the companies.

This can be explained since in a regulated access fishery[24], when profits are equal to the interest rate, no extraordinary profits are generated, or alternatively is 0 when the opportunity costs are included in total costs when calculating ROI.

The opportunity cost is the value of the most valuable forgone alternative activity. It is often considered the retribution of capital in a non risk asset. By including the interest rate in the reference point, we include the minimum required rate of return on investment, which is the same as ordinary profit. Extraordinary profits are generated when the return on invested capital is greater than the opportunity cost of the second best alternative. As already discussed, any investment under equilibrium conditions tends to return a profit equal to zero. This profit is additional income that exceeds the average capital earnings in a given economy (e.g. the high interest savings account). Hence, a sector or fishery with extraordinary profits will attract investments from other economic activities and or fisheries with lower profits.

The ROI indicator, when employed in the AdriaMed project has been compared with the average rate of the Italian Treasury securities with a long term maturity (Buoni del Tesoro Pluriennali (BTP)). When CopeMed has employed this indicator it has been compared with the countries' national government bonds. While in his study, Ünal (2006), used the imputed interest rate (real interest rate) (Davidse et al., 1993). This rate is the difference between the rate for Government Bonds and the inflation rate.

The **Ratio between current revenue and break even revenue** gives an indication of the economic sustainability of the fishing fleet. This break even revenue point is defined as the revenue point at which the gross cash flow equals the fixed costs. However, the problem with this indicator is that it is not useful in telling us whether the fishery is overcapitalised (it only identifies when the fishery is overexploited, not when it is not). It should also be taken into account that this ratio can be expressed as a percentage, and so multiplied by 100.

[24] In theory, in an open access fishery, vessels enter the fishery when there are profit opportunities and exit the fishery when losses occur until extraordinary profits are zero. In the case of regulated fisheries, there would be higher pressures to increase effort levels, because by increasing effort (and hence catches), individual profits increase. Therefore, fisheries managers may introduce some kind of mechanism (e.g. resource tax) to capture some of these extraordinary profits, a way of conducting part of the resource rents to society. In open access fisheries it is impossible to earn extraordinary profits in the long run because of the common pool problem, while in a regulated fishery it is possible to earn extraordinary profits in the long run, because of the restrictions imposed through the introduction of ownership rights and or entry/exit schemes, etc.

The reference point for this indicator could be 1 (and/or previous years results).

- When the indicator equals 1, then the break-even revenue point equals the current revenue. As capital costs are not taken into account, overcapitalisation would be present in the fishery.
- For values lower than 1, current revenue value is lower than the break-even revenue, so the current revenues cannot meet fishing costs. Then, the activity is not sustainable under current conditions, so it presents signs of over-capitalisation.
- If the indicator is greater than 1, the current revenue is higher than the break-even revenue point, implying that the activity is sustainable, as the current revenues are higher than the fixed and operating costs. However, as capital costs are not taken into account, when this indicator is below 1 it cannot be identified whether overcapitalisation in the fishery is present or not.

The **Average Wage per Full-Time Equivalent** gives a reference based on the salary that the crew receives. This indicator, when employed in the AdriaMed project has been compared with the minimum salary stipulated by the Italian laws (Contratto Collettivo Nazionale di Lavoro (CCNL)). When CopeMed has employed this indicator it has been compared with each country's national minimum salary. When this minimum wage was not available it was compared with the mean salary from other sectors (especially agriculture).

The use of the minimum wage on the country (as well as previous years results and wage from other sectors) seems reasonable as a reference point for this indicator. A reduction in wage (or in the proportion to the minimum wage) could imply a reduction in the purchasing power and so a worse situation, even though the indicator could be higher than the minimum wage.

However, it should be considered that only wages should be considered in this indicator, and not other costs, like social security. It should be also taken into account that often the salary for captains differs strongly with the salary for the crew; hence, Cambie (2008) calculated this indicator and then recalculated it differencing both crew levels.

Alternatively, the **Gross Added Value** expresses how much the activity contributes to the economy. The added value is expressed as income minus operative costs.

The reference point for this indicator could be 0 (and/or previous years results).

- A result higher than 0 show that the fishery is profitable for the society.
- A result lower than 0 show that the fishery is not profitable for the society.

For other indicators, limit and target reference points are not easily identifiable, and their estimation generally requires the use of specific tools and data, which are not available for many fisheries. Nevertheless, very simple and immediate reference points can be calculated by considering the indicator historical levels or values coming from other areas or fleets.

Trends of these indicators in the AdriaMed project are analysed using the so-called Traffic Light system. This is set according to their percentile values in the following series: > 66th percentile, 66th-33rd, and < 33rd percentile. Based on each specific indicator, the three standard colours of the Traffic Light system, green, yellow, and red, are assigned to the three areas defined by the reference values at 33rd and 66th percentiles.

10.5. Data sources for the elaboration of socio-economic indicators: DCR & GFCM economic data collections and their compatibility

In the past, most socio-economic indicators studies were elaborated from sporadic data collections, mainly under particular research projects. However, this is changing thanks to the periodical data collection programs from the European Commission's DCR and in the future from the GFCM. Moreover, the periodical publication of the AER provides data and indicators for the main European fleets.

From the new DCR there should be no problems in the calculation of all socio-economic indicators proposed. Under the current DCR there were found some minor problems, especially when calculating the average wage, as already explained.

On SGMED-08-01 the economic variables to be collected under the GFCM and the new DCR and their compatibility was analysed. The text is included in Annex G.

10.6. Calculation of socio-economic indicators using AER data for selected Mediterranean fleets

We calculate the Return on Investment, Ratio between Current Revenue and Break-Even Point and Average Wage per Full-Time Equivalent from the AER data and the Cashflow, Breakeven Revenue, Profit and Gross Value Added indicators published on the AER for European Mediterranean fleets where hake, red mullet and deep-water rose shrimp are one of their main species in value terms.

When calculating these indicators several complications with the use of them and the AER information to perform economic assessments of the fleets in parallel with the stock assessments were found. This would have given complementary information on the situation of the resource and the fleets fishing them, which would have enriched the discussion of possible scenarios depending on the management decisions.

First of all, the Spanish and French data are not divided between Atlantic and Mediterranean, which could easily give a distorted vision of the real situation in the Mediterranean. Fortunately, with the new DCR the data would be separated by region (being Mediterranean one region).

However, for those countries where data for the Mediterranean was available, the data are not separated by GSA (geographical sub area), which is the level at which most stocks are assessed. Unfortunately, the new DCR, would not provide data by GSA.

Moreover, current fleet segmentation would be changed, which would allow more precise analyses.

The fleets for Cyprus, Italy and Malta where hake, red mullet or surmullet or deep-water rose shrimp was one of the 5 species providing the majority of revenues were chosen. However for Greece, species were not detailed, and so two different fleets were chosen for the analysis. For Spain three demersal trawler segments are also presented.

A further problem was that in many cases information was missing, due to different reasons.

Next there are presented the Return on Investment, Ratio between Current Revenue and Break-Even Point, Average Wage per Full-Time Equivalent, Cashflow, Breakeven Revenue, Profit and Gross Value Added indicators for 21 fleets.

Return on investment (%) indicators:

	2006	2005	2004	2003
Cyprus				
DTS1224	-	-	-	-
PG0012	-	-	-	-
PGP1224	-	-	-	-
Italy				
DTS0012	67.1	-	-	-
DTS1224	31.2	-	-	-
DTS2440	2.1	-	-	-
DTS40XX	-	-	-	-
HOK0012	88.6	-	-	-
HOK1224	61.1	-	-	-

PGP0012	89.6	-	-	-
PGP1224	41.4	-	-	-
PTS2440	62.4	-	-	-
Malta				
DFN0012	-	-	-	-
DFN1224	-	-	-	-
DFN2440	-	-	-	-
DTS1224	-	-	-	-
Greece				
TBB2440	326.3	129.7	28.0	-
TBB1224	98.6	212	49.3	-
Spain				
DTS1224	-	-	-	-
DTS2440	-	-	-	-
DTS40XX	-	-	-	-

From previous indicators it can be seen that all fleets are profitable. Moreover, figures show really high results, which is contrary to what was expected.

A change in the methodology to estimate the value of the fleet may have had a positive impact on 2006 results, for those countries that have already adapted it (which is the case of Italy).

Only the Italian large (larger than 40 meters) demersal trawler fleet is obtaining a return lower than the interest rate (but positive), which is the reference point. Thus this is the only fleet here analysed that has some poor performance.

Ratio between current revenue and break-even revenue indicators:

	2006	2005	2004	2003
Cyprus				
DTS1224	-	-	-	-
PG0012	-	-	-	-
PGP1224	-	-	-	-
Italy				
DTS0012	2.3	-	-	-
DTS1224	1.8	-	-	-
DTS2440	1.1	-	-	-
DTS40XX	-	-	-	-
HOK0012	3.5	-	-	-
HOK1224	2.6	-	-	-
PGP0012	2.9	-	-	-
PGP1224	2.2	-	-	-
PTS2440	2.6	-	-	-
Malta				
DFN0012	-	0.8	-	-
DFN1224	-	-	-	-
DFN2440	-	-	-	-
DTS1224	-	2.4	-	-
Greece				
TBB2440	11.7	6.2	1.9	-
TBB1224	3.9	7.9	2.5	-
Spain				
DTS1224	-	-	-	-
DTS2440	-	-	-	-
DTS40XX	-	-	-	-

The reference point for this indicator is 1. Hence it can be seen that this indicator is lower only for a Maltese fleet. This means that the revenue of this fleet could not meet the unavoidable costs to continue the activity.

This result would need a deeper analysis as it is a fleet composed of small boats (lower than 12) and probably the owner is part of the crew, and so may receive a salary, which prevents him from leaving the activity.

Average wage (in euros) indicators:

	2006	2005	2004	2003
Cyprus				
DTS1224	4754.1	5446.4	-	-
PG0012	145.8	575.6	-	-
PGP1224	3918.9	16250.0	-	-
Italy				
DTS0012	13493	8824	12045	20238
DTS1224	20203	17549	17124	16787
DTS2440	22155	18802	18173	25161
DTS40XX	-	-	-	-
HOK0012	24343	7729	10275	-
HOK1224	16478	14818	12360	-
PGP0012	11046	7959	6170	6845
PGP1224	11387	10905	8080	10925
PTS2440	32887	20550	20242	24872
Malta				
DFN0012	-	-	-	-
DFN1224	-	-	-	-
DFN2440	-	-	-	-
DTS1224	-	-	-	-
Greece				
TBB2440	10559	9582	9752	4876
TBB1224	9455	9943	9619	6132
Spain				
DTS1224			14370	13039
DTS2440		13392	16763	13621
DTS40XX		22987	10563	26021

It should be noted that social security is included in the estimated indicator, so real wages would be lower. With the new DCR the social security costs would be provided independently. It should also be noted that expressing this figure in a monthly basis (divided by 12) would help to view its performance.

Gross Added value (in million euros) indicators:

	2006	2005	2004	2003
Cyprus				
DTS1224	1.88	0.72	-	-
PG0012	4.91	0.23	-	-
PGP1224	0.77	0.68	-	-
Italy				
DTS0012	6.4	3.6	2.1	1.3
DTS1224	298.9	275.9	231.2	210.7
DTS2440	84.9	80.9	75.2	115.4
DTS40XX	-	-	-	-
HOK0012	5.4	7.5	10.7	-
HOK1224	49.1	47.1	41.0	-
PGP0012	281.2	240.5	225.7	252.4

PGP1224	25.3	22.9	18.8	42.5
PTS2440	44.6	17.9	22.2	42.7
Malta				
DFN0012	-	0.08	-	-
DFN1224	-	-	-	-
DFN2440	-	-	-	-
DTS1224	-	1.11	-	-
Greece				
TBB2440	90.0	41.5	15.8	-
TBB1224	-	-	-	-
Spain				
DTS1224	-	-	71.0	74.3
DTS2440	-	-	91.3	91.3
DTS40XX	-	79.8	19.4	73.2

All fleets show a positive gross added value, which means that they provide some value to society.

Cash flow indicators:

	2006	2005	2004	2003
Cyprus				
DTS1224	1.59	0.11	-	-
PG0012	4.77	-0.28	-	-
PGP1224	0.48	-0.35	-	-
Italy				
DTS0012	3.27	1.81	0.54	0.43
DTS1224	150.53	140.67	101.60	97.10
DTS2440	42.95	41.62	35.67	54.48
DTS40XX	-	-	-	-
HOK0012	3.02	3.98	5.48	-
HOK1224	30.39	27.54	24.87	-
PGP0012	161.76	135.65	133.12	150.07
PGP1224	14.99	13.03	9.67	27.30
PTS2440	22.49	8.15	11.35	19.27
Malta				
DFN0012	-	0.06	-	-
DFN1224	-	0.96	-	-
DFN2440	-	-	-	-
DTS1224	-	-	-	-
Greece				
TBB2440	-	-	-	-
TBB1224	13.90	29.32	6.76	-
Spain				
DTS1224	-	-	7.98	13.15
DTS2440	-	-32.66	-29.92	-48.09
DTS40XX	-	15.07	-43.99	2.06

Breakeven revenue (in million euros) indicators:

	2006	2005	2004	2003
Cyprus				
DTS1224	-	-	-	-
PG0012	-	-	-	-
PGP1224	-	-	-	-

Italy				
DTS0012	5.52	-	-	-
DTS1224	301.16	-	-	-
DTS2440	153.01	-	-	-
DTS40XX	-	-	-	-
HOK0012	2.08	-	-	-
HOK1224	28.68	-	-	-
PGP0012	133.19	-	-	-
PGP1224	16.51	-	-	-
PTS2440	24.35	-	-	-
Malta				
DFN0012	-	0.22	-	-
DFN1224	-	0.72	-	-
DFN2440	-	-	-	-
DTS1224	-	-	-	-
Greece				
TBB2440	-	-	-	-
TBB1224	9.65	7.12	13.16	-
Spain				
DTS1224	-	-	-	-
DTS2440	-	-	-	-
DTS40XX	-	-	-	-

The AER beak-even revenue indicator has been used in the ratio between current revenue and break-even revenue. The ratio between current revenue and break-even revenue offers a better understanding than the beak-even revenue indicator itself.

Profits in million euros indicators:

	2006	2005	2004	2003
Cyprus				
DTS1224	-	-	-	-
PG0012	-	-	-	-
PGP1224	-	-	-	-
Italy				
DTS0012	2.30	-	-	-
DTS1224	81.32	-	-	-
DTS2440	3.35	-	-	-
DTS40XX	-	-	-	-
HOK0012	2.26	-	-	-
HOK1224	20.79	-	-	-
PGP0012	121.88	-	-	-
PGP1224	9.03	-	-	-
PTS2440	16.00	-	-	-
Malta				
DFN0012	-	-0.02	-	-
DFN1224	-	0.62	-	-
DFN2440	-	-	-	-
DTS1224	-	-	-	-
Greece				
TBB2440	-	-	-	-
TBB1224	12.71	28.32	5.66	-
Spain				
DTS1224	-	-	-	-
DTS2440	-	-	-	-
DTS40XX	-	-	-	-

Only a Maltese fleet had negative profits (losses) in 2005. 2006 data was not available for Malta.

10.7. Other interesting indicators that may be useful for assessment

Other indicators can be calculated from the AER and DCR data. Usefulness of the indicators may depend on the objectives of analysis. So, indicators other than the ones here explained and calculated could be more suitable for certain analyses.

Here we use 5 more indicators (Days per vessel, Landings mean Price, Kg per vessel, Employment per vessel and Fuel cost per vessel and day) that may prove useful for socio-economic assessments in certain studies. These 5 indicators are shown for two Greek and three Spanish fleets.

	2003	2004	2005	2006
Greece		TBB2440		
Days per vessel	247.5	271.3	254.7	269.5
Landings mean Price	-	1.8	2.0	3.4
Kg per vessel	223443	250345	257222	272698
Employment per vessel	6.96	7.29	7.40	7.25
Fuel cost per vessel a day	53.0	754.4	322.8	383.7
Greece		TBB1224		
Days per vessel	241.5	275.6	266.5	263.4
Landings mean Price	0.8	1.4	2.2	2.1
Kg per vessel	172437	226000	225221	187216
Employment per vessel	5.97	6.50	6.26	6.25
Fuel cost per vessel a day	99.2	344.9	301.9	314.3
Spain		DTS1224		
Days per vessel	-	-	-	-
Landings mean Price	-	-	-	-
Kg per vessel	5422	6347	5045	2557
Employment per vessel	4.60	4.33	-	-
Fuel cost per vessel a day	-	-	-	-
Spain		DTS2440		
Days per vessel	156.9	163.7	165.0	168.2
Landings mean Price	-	-	-	-
Kg per vessel	110286	124198	151402	154082
Employment per vessel	19.49	13.50	19.34	-
Fuel cost per vessel a day	993	925	1368	-
Spain		DTS40XX		
Days per vessel	152.3	138.3	145.6	-
Landings mean Price	-	-	-	-
Kg per vessel	310123	263864	308182	318140
Employment per vessel	33.73	68.17	32.00	-
Fuel cost per vessel a day	2119	2638	2995	-

10.8. Final considerations

As discussed in SGMED-08-01, different approaches have been applied in the definition and collection of economic data at GFCM and STECF level, but the variables are similar and have no major incompatibilities.

The main difference is related to the geographical level of aggregation. Nevertheless, the differences relate to the data collection, while the definition of a list of indicators and reference points can be considered as independent on the data quality.

All socio-economic indicators[25] described above can be estimated using data collected both under the new DCR Regulation and under GFCM data collection. However, as biological assessment is performed at GSA level or by combined GSAs, economic and social indicators should also be estimated at least at the same geographical level. In actual fact, economic data under DCR Regulation are collected at country level and hence so are the economic indicators reported above. As economic profitability can vary significantly between GSAs, indicators by country cannot be considered representative of fisheries by GSA. This is particularly true for countries whose territorial waters consist of a number of GSAs, like Italy, Spain and Greece.

The socio-economic indicators recommended by the SGRST-07-05 and SGECA/SGRST-08-01 (Return on Investment and Ratio between Current Revenue, Break-Even Point, Average Wage per Full-Time Equivalent and Gross Added Value) and the ones calculated for the Annual Economic Report (AER), by the SGECA-08-02 (Cashflow, Breakeven Revenue, Profit and Gross Value Added) working groups compared with appropriate reference points are useful to provide a general overview of the status of fisheries.

Notwithstanding, they cannot be used alone to perform a socio-economic analysis and to identify potential causes of social and economic unsustainability.

In this sense, the larger number of socio-economic indicators from CopeMed and AdriaMed provide a more detailed indication of fisheries performance, and would be useful to accomplish a socio-economic analysis and identify potential causes of social and economic unsustainability.

However, even though they provide a broad image, they should not be used to perform assessments on the impact that management measures and the evolution of resources may have on fleets. In this case bio-economic models are the desired tools.

[25] With the exception of the socio-economic demographic indicators from Ünal (2008) that are detailed on Annex E.

11. REVIEW OF POPULATION AND COMMUNITY INDICATORS (TOR J)

11.1. Introduction

The main focus of the meeting was on the development of new stock assessments for the three species (ToR A:H). As a result, there was insufficient time at the meeting to complete ToR J.

During the meeting, the MEDITS data were collated within an Microsoft Access database for easy interrogation. Following the meeting, preliminary analysis of the MEDITS data obtained through the DCR was undertaken. The results presented in this section have not yet been confirmed, and uncertainties within the data have been noted. Therefore, the results should be taken as indicative of potential analyses, and viewed with caution.

11.2. Methods

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). Summary data are presented in Appendix

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[26]:

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

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

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

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

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

[26] 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)).

11.3. Results

11.3.1. Catch rates by species

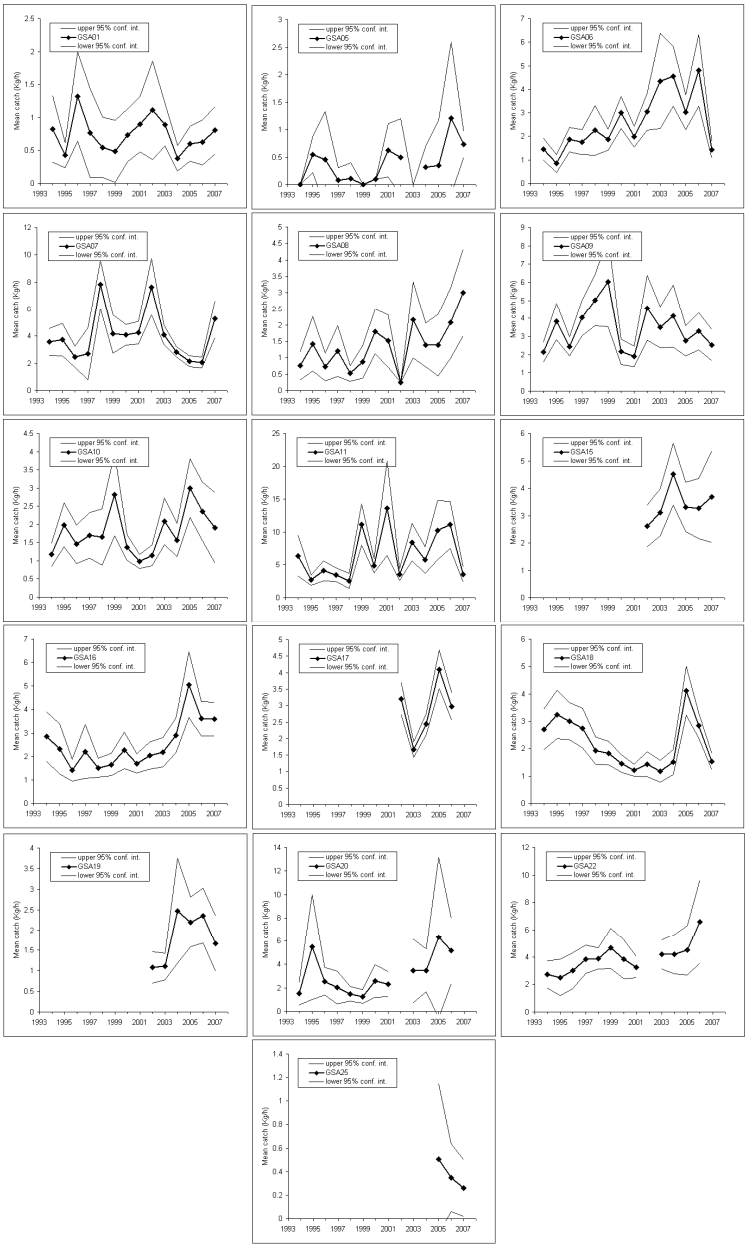

Figure 11.1. Catch rates of *Merluccius merluccius* over time by GSA

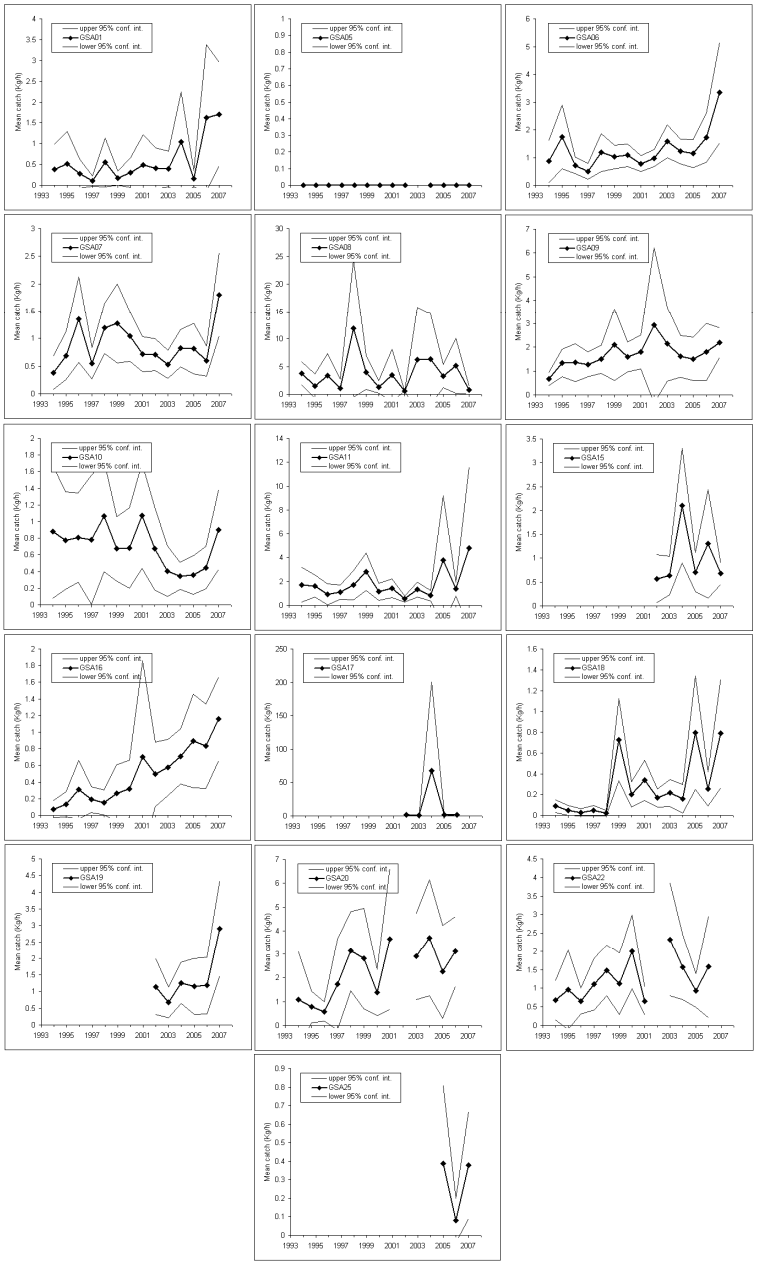

Figure 11.2. Catch rates of *Mullus barbatus* over time by GSA

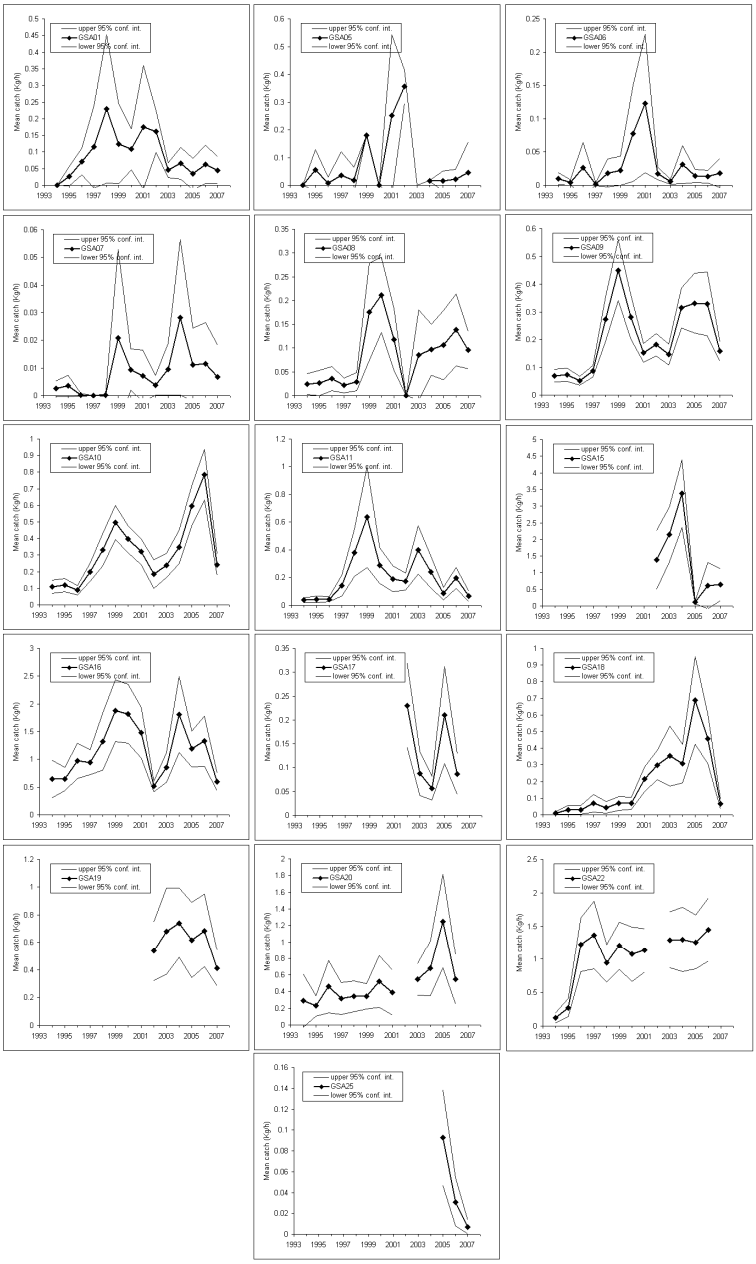

Figure 11.3. Catch rates of *Parapenaeus longirostris* over time by GSA

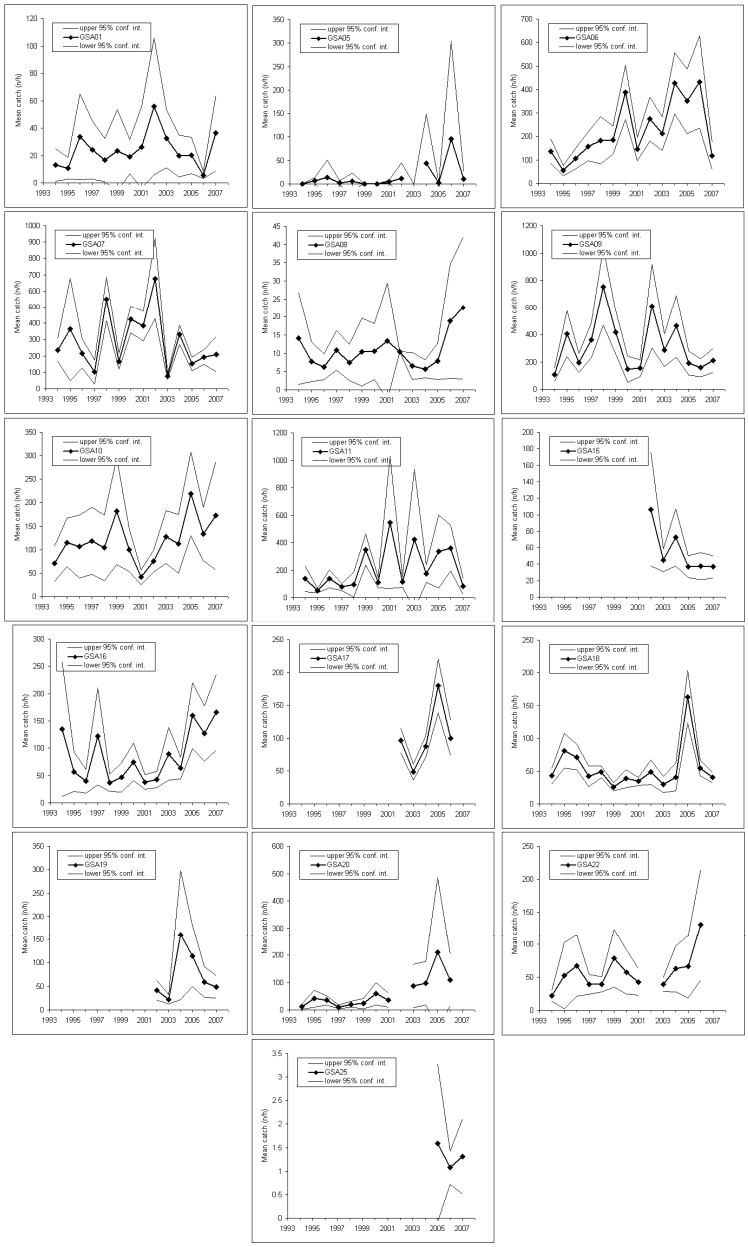

Figure 11.4 Abundance of *M. merluccius* over time by GSA

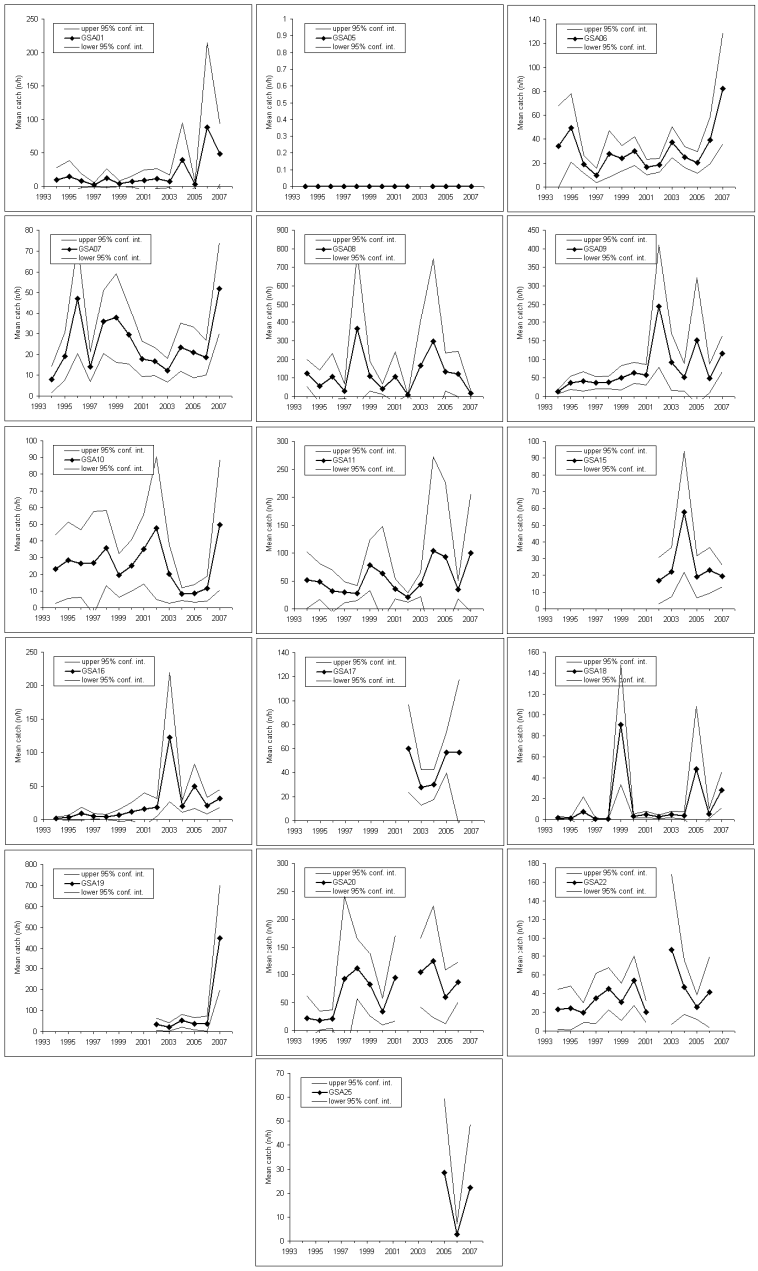

Figure 11.5 Abundance of *M. barbatus* over time by GSA

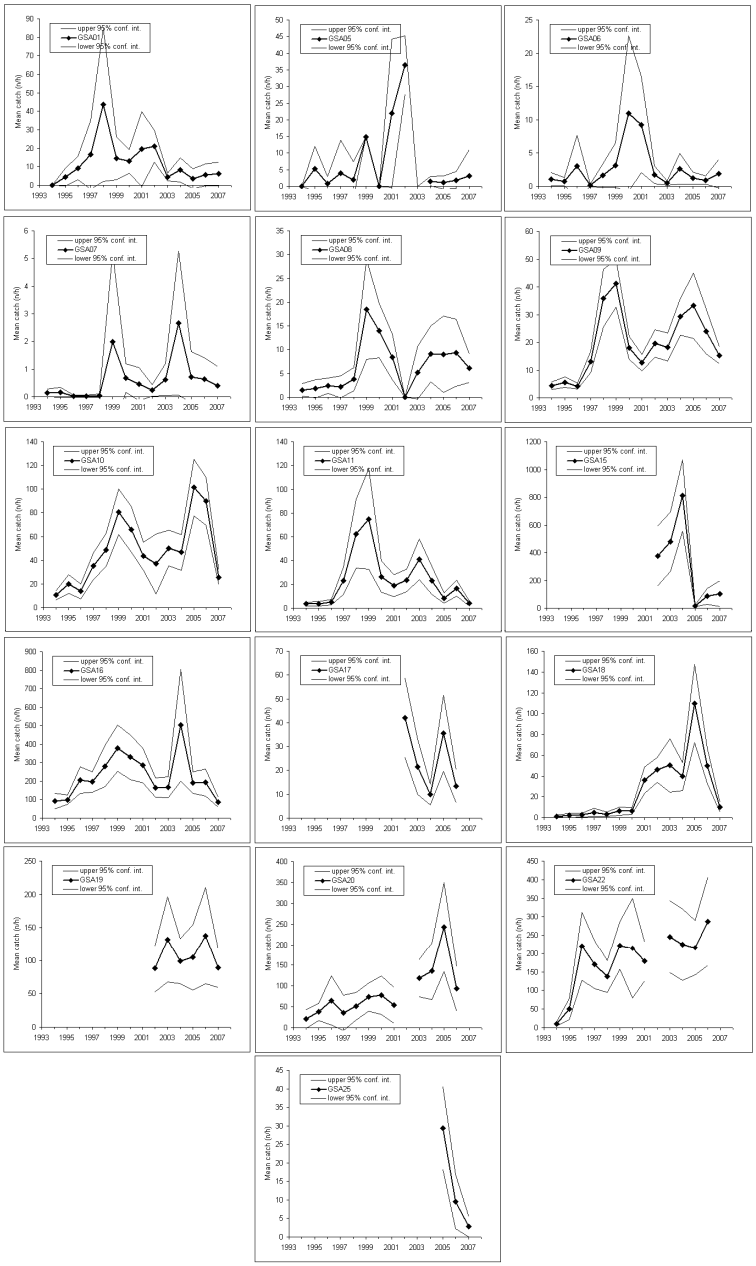

Figure 11.5 Abundance of *P. longirostris* over time by GSA

11.4. Discussion

The plots of abundance over time and length frequency distributions generated considerable discussion within the group. This discussion is ongoing and the Working Group suggests that these be continued at SGMED-08-04.

12. SUMMARY AND RECOMMENDATIONS

12.1. Summary

12.1.1. SGMED-08-03 - Mediterranean

The Terms of Reference for SGMED-08-03 were extensive, and required up to 38 stock assessments to be performed during the meeting. Given the number of stock assessment scientists at the meeting, the length of the meeting, the timing of the arrival of the DCR data, and the time needed during the meeting to check and collate these data, this was not feasible, despite the excellent efforts by the attendees at the Working Group.

During the meeting, assessments for 17 species/GSA combinations were initiated (ToR A-H; see Section 7). It must be noted that **ALL** assessments must be viewed as provisional at this stage. Further improvements to these assessments will be made during future SGMED meetings. The layout of the assessment report forms was designed to facilitate this process and allow scientists and managers to review the data underlying the assessments presented, the issues encountered during the assessment and the assumptions made, the assessment outputs and subsequent management advice, in a consistent way.

The preliminary results from the assessments performed are presented below.

Species	GSA	Assessment methods						Reference point	Comments
		Trawl survey (MEDITS/GRUND)			Commercial data				
		SURBA	ALADYM	Tuning data	LCA	XSA	YPR		
Hake	1				x		x	F_{MAXYPR}, SSB/SSB_0	$F>F_{MAXYPR}$, SSB $<7\%SSB_0$, scenarios for effort reduction show increase in catch and stock biomass possible.
	9	x						B_{lim}, F_{MSY}	Overexploited. SSB=5% of that at F_{MSY}, but still able to produce recruits. HCR analysis performed.
	11	x	x					FMAXYPR SSB/SSB_0	Overexploited, $F>F_{MAXYPR}$, $SSB<12\%\ SSB_0$
	15 & 16	x	x		x		x	$F_{0.1}$, $F_{0.35}$, F_{MAXYPR}, SSB/SSB_0,, Y/Rmax, Y/RF0.1 Y/RSPR_0.35 Zmbp Fmbp	The stock is overfished and to reach a target such as $F_{0.1}$. The reduction of current F should be of about 60%
	17				x			F/Z ratio	Risk of overexploitation, juvenile fish caught.
	20	x	x					Model-based	Stable SSB with some increase, recruits increasing. Potential to improve stock status with management

	22/23	x		x				Model-based	SSB decreasing, recruits and yield stable. Potentially overexploited. Potential to improve stock status with management
Red mullet	1					x	x	F_{MAXYPR}, SSB/SSB_0	$F>F_{MAXYPR}$, SSB ~ 21%SSB_0, exploitation considered moderate. Effort reduction scenarios suggest a small increase in YPR possible
	5				x	x	x	x	F_{MAXYPR}, SSB/SSB_0	XSA: Fishing mortality constant, slight decline in SSB over time. $F>F_{MAXYPR}$, SSB ~ 25% SSB_0, moderate to fully exploited. Little increase in YPR with effort reduction
	6									For the next meeting
	10			x		x			F_{MAXYPR} SSB/SSB_0	Overexploited
	11	x		x					F_{MAXYPR} SSB/SSB_0	Slightly increasing yield and SSB over last years, $F>F_{MAXYPR}$, SSB~29%SSB_0, moderate to fully exploited.
	17					x			F/Z ratio	Fully exploited, degree of risk of overexploitation
	25					x		x	F_{MAXYPR}, SSB/SSB_0	$F> F_{MAXYPR}$, SSB ~ 12-15%SSB_0. Effort reduction could increase YPR
Pink shrimp	1					x		x	F_{MAXYPR}	$F<= F_{MAXYPR}$, F ~ optimum
	9	x							$F_{0.1}$	Near fully or underexploited, F_{curr} $<F_{0.1}$
Sprat	29					ICA				Low level of exploitation. Keep Bulgarian and Romanian catch <15,000t
Turbot	29					x				Stock improvement since 1990s. Keep Bulgarian and Romanian catch <100t

The economist members of the Working Group reviewed social and economic reference points appropriate for Mediterranean fisheries (section 10). It was noted that the range of socio-economic indicators described could be estimated using data collected both under the new DCR Regulation and under GFCM data collection. However, these data are collected at the country scale, and hence cannot be related to biological assessments that are performed at the GSA level (either individually or combined). As economic profitability can vary significantly between GSAs, indicators by country cannot be considered representative of fisheries

by GSA. This is particularly true for countries whose territorial waters consist of a number of GSAs, like Italy, Spain and Greece.

The socio-economic indicators recommended by the SGRST-07-05 and SGECA/SGRST-08-01 and those calculated for the Annual Economic Report (AER), by the SGECA-08-02 working groups compared with appropriate reference points provide a useful overview of the status of fisheries. However, they cannot be used on their own to perform a socio-economic analysis and to identify potential causes of social and economic unsustainability. The larger number of indicators from the CopeMed and AdriaMed projects would be more useful for this. However, they should not be used to perform assessments on the impact that management measures and the evolution of resources may have on fleets. In this case bio-economic models are the desired tools.

Finally, preliminary analysis of the MEDITS data made available through the DCR call was initiated at the meeting (ToR J; see section 11). While issues remain with the information (e.g. particular values need to be checked and confirmed), an analysis of catch rates by species and GSA was performed to stimulate discussion.

12.1.2. SGMED-08-03 Black Sea Sub-group

The Terms of Reference for the Sub-Group on the Black Sea were also extensive. During the meeting in Ispra 2008 the WG made a very good progress in assembling and reviewing the available data, and compiling data in operational format for application of integrated stock assessment models (ICA and XSA).

The WG performed initial runs with the stock assessment models (ICA and XSA). Although initial results are very preliminary, and at this stage cannot be used for assessing the stocks' state and dynamics, they represent a necessary background for further assessment refinement, which will hopefully bring stable results and improved model diagnostics.

Having said that, the WG will further need more time and resources to complete the historical assessments of sprat and turbot, which especially for turbot could be quite complicated, because the large uncertainties in catches, age composition and abundance indices.

The WG found the state of catch and age data for sprat stock assessment acceptable.

The state of the abundance indices in sprat is not as good as it used be in previous years, when several CPUE indices from commercial fleets and research surveys were available. At present the WG has used only CPUE from Ukrainian and Bulgarian commercial fleets. These data seem to reflect the relative dynamics of the stock, but in future, more research survey indices are needed in order to produce reliable assessments.

A juvenile survey is already taking place in Romania for several years (and previously in Ukraine), but it needs to be extended, initially at least in Bulgarian waters in order to produce more reliable estimates. This index is very important for estimating the strength of recruitment in the current year and needs a special attention in planning of the future sampling programmes. Gathering experience with the acoustic survey, which is expected to start in Bulgarian waters will hopefully provide a reliable biomass index.

From the analyses of relative trends in data, indices and preliminary assessment results, it appears that during early 2000s the sprat stock has recovered from the low state which occurred in the early 1990s. The stock seems to have reached a maximum in 2000-2003. The present biomass is possibly lower, but the stock does not seem to be threatened by overfishing, because of the relatively low level of exploitation.

Catch data of turbot are very problematic. Official landings from different countries show divergent trends, that can be due to various causes including misreporting. In future the WG will need more information on how catches are reported to allow plausible interpretation of the variable dynamics of catches.

Both CPUE from commercial catches and biomass estimates from research swept area surveys were available to the WG, but most of them, unfortunately, do not show consistent trends and are difficult to interpret and use for tuning of assessment models. Further attempt will be make to chose the best data and models to perform satisfying assessments.

Provided that turbot fisheries and survey information is quite contradictory, a cross-examination of different sources is needed to find out which part of the information is more reliable and can be used.

Future turbot assessments need to rely more on standardized biomass surveys and improved catch reporting.

Because of the controversial results produced with different settings of the assessment model, at this stage it is impossible to make a firm judgement about the absolute biomass or trend of the stock in the last years. However, given the indications from the research surveys, the WG can assume that the state of the stock have improved since the collapse in the 1990s (at least in Bulgarian and Romanian waters).

The WG discussed some ecosystem considerations that apply to the state and dynamics of the fish stocks in the Black Sea. It appears that the distribution and behaviour of sprat on the north-western shelf and specifically in Romanian waters vary to a great extend depending on the environmental conditions. Sprat schools tend to be negatively affected by jellyfish swarms. Previous studies have found that stock dynamics is related to climate fluctuations, trophic interactions and other environmental factors. Predators such as bonito in the pelagic system, and Rapa whelk (*Rapana thomasiana*) in the benthic system can have significant effects on abundance and behaviour of their prey populations, as well as through trophic cascades - at the ecosystem level.

The question of assessing other stock in the Black Sea was discussed throughout the meeting. The WG recognised the need to undertake assessments of other important species such as anchovy, horse mackerel, bonito, and Rapa whelk. However, the WG admitted the insufficient capacity to undertake all these assessments simultaneously, and **the need to first complete and refine the ongoing historical assessments of sprat and turbot**.

12.2. Recommendations

12.2.1. SGMED-08-03 - Mediterranean

During the Working Group, a number of specific recommendations were made for future assessments.

- It must be re-iterated that assessments performed during the meeting were considered preliminary. **The Working Group request** that further time be provided at SGMED-08-04 in order to continue with these demersal assessments.

- Some inconsistencies in the estimation of biological parameters were noted during the Working Group (e.g. methods to define the point of maturity on maturity scales). **The Working Group suggest** that this requires further consideration, particularly where assessments move toward the estimation of stock-recruitment relationships.

- The use of survey data (e.g. MEDITS, GRUND) was suggested as a tuning index, as well as for direct use in assessment approaches such as SURBA (as used in many of the assessments described). Changes in the design and execution of surveys were noted over time **The Working Group suggested** that the data be standardised over time using GLMs to take account of these changes and allow improved assessments to be performed.

- Although intended for the meeting, the examination of alternative reference point levels was not fully undertaken during SGMED-08-03, due to time constraints. However, discussion did re-iterate the need to compare stock assessment results to potential maximum production levels (e.g. MSY or

appropriate proxy values). **The Working Group suggests** that this be continued in future SGMED meetings.

- All participants found the Working Group an excellent opportunity for exchange of ideas, approaches and skills. 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.

Overall the SGMED framework has so far represented an excellent forum to support stock assessment and advice within the region. While the work performed at SGMED-08-03 did not complete the extensive terms of reference set for the meeting, it has built the foundations upon which further work can be successfully undertaken.

12.2.2. SGMED-08-03 Black Sea Sub-group

During the Black Sea sub-group meeting, a number of recommendations were made:

- The Working Group needs to build capacity in quantitative stock assessment. Therefore, **the Working Group suggests** that a population dynamics and stock assessment training course be arranged.

- **The Working Group suggests** that in future, a cross-examination of the sprat fisheries information (catches, effort and CPUE) would greatly improve the reliability of input data.

- **The Working Group suggests** and encourages the undertaking of acoustic and juvenile research surveys covering the areas of the main stock distribution.

- Given the available information, **the Working Group suggests** that the catch of sprat in Bulgarian and Romanian waters is kept below 15 000t.

- Given the available information, **the Working Group suggests** that the exploitation level of turbot in Bulgarian and Romanian waters be kept below the current TAC of 100t.

- Noting the influence of environment and species-interactions on stock biomass levels, **the Working Group suggests** that in future, environmental influences and ecosystem interactions need to be taken into consideration when suggesting reference levels for the fisheries and designing management procedures.

- The Working Group recognised the need to undertake assessments of other important species such as anchovy, horse mackerel, bonito, and Rapa whelk. However, **the Working Group suggests** that there is insufficient capacity currently to undertake all these assessments simultaneously, and the priority is to first complete and refine the ongoing historical assessments of sprat and turbot.

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14. 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[27].

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.

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

[27] 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

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[28]. 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[29], as well as the report of the STECF working group on balance between fishing capacity and fishing opportunities[30].

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;

- 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

[28] 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

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

[30] 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.

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.

15. APPENDIX 2. SGMED-08-03 AND BLACK SEA LIST OF PARTICIPANTS

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16. 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.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
HKE	1	ESP	OTB	353	201	374	208	212	220
HKE	5	ESP	OTB	91	44	57	86	102	72
HKE	6	ESP	OTB	3195	3411	3441	3363	3864	3701
HKE	7	FRA	GNS	177	248	99	255	299	168
HKE	7	FRA	LLS	5					
HKE	7	FRA	OTB	2163	2029	1018	995	1011	1277
HKE	9	ITA	DTS	508	1148	540	1040	1180	1026
HKE	9	ITA	HOK			1	2	38	
HKE	9	ITA	PGP	154	659	626	858	1112	727
HKE	9	ITA	PMP	236	258	16	19		
HKE	9	ITA	PTS	7	15	12			
HKE	10	ITA	DTS	515	425	446	595	758	638
HKE	10	ITA	HOK			58	96	111	41
HKE	10	ITA	PGP	225	329	694	484	663	578
HKE	10	ITA	PMP	246	322	123	303	12	12
HKE	10	ITA	PTS	27	21	17	7		
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				
HKE	15	MLT	[LHP] [LHM]				0		
HKE	15	MLT	[SB] [SV]						0
HKE	15	MLT	GNS				0		
HKE	15	MLT	GTR				0	0	0
HKE	15	MLT	LA						1
HKE	15	MLT	LLD				0		0
HKE	15	MLT	LLS				2	1	2
HKE	15	MLT	LTL				0		
HKE	15	MLT	OTB				4	5	6
HKE	15	MLT	Other gear				0		
HKE	16	ITA	DTS	1716	1960	1927	1713	1597	1599
HKE	16	ITA	HOK			22	9	2	9
HKE	16	ITA	PGP	92	12		67	27	111
HKE	16	ITA	PMP	52	23				
HKE	16	ITA	PTS	13	18	0	1		0
HKE	17	ITA	DRB	56				0	
HKE	17	ITA	DTS	2339	2387	2884	3403	4212	3586
HKE	17	ITA	PGP	1	7	57	45	55	28
HKE	17	ITA	PMP	216	179	6	34		
HKE	17	ITA	PTS	26	33	12	12	1	1
HKE	17	ITA	TBB			86	115	128	150
HKE	18	ITA	DTS	2006	2899	2798	3275	4613	3497
HKE	18	ITA	HOK			140	439	721	607
HKE	18	ITA	PGP	26	199	175	70	172	51
HKE	18	ITA	PMP	277	1353	84			
HKE	18	ITA	PTS			7			
HKE	19	ITA	DTS	688	668	852	1077	1330	572
HKE	19	ITA	HOK			139	72	81	54
HKE	19	ITA	PGP	263	367	145	122	218	257
HKE	19	ITA	PMP	390	478	163	1		
HKE	19	ITA	PTS	16	1				
HKE	20	GRE	GNS		1370	2796	3195	2568	
HKE	20	GRE	LLS		73	295	207	199	
HKE	20	GRE	OTB		307	403	515	753	
HKE	20	GRE	SV		11	3	0		
HKE	22	GRE	GNS		1793	2732	3187	3771	
HKE	22	GRE	LLS		712	1305	1460	1469	
HKE	22	GRE	OTB		2443	3572	3856	3821	
HKE	22	GRE	SV		13	4	7	15	
HKE	25	CYP	GTR				0	0	0
HKE	25	CYP	LLS				1	2	1
HKE	25	CYP	OTB				1	1	2

Table A3.2 Landings data (tons) for red mullet by GSA.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
MUT	1	ESP	OTB	68	81	109	94	109	138
MUT	5	ESP	OTB	14	11	20	13	11	14
MUT	6	ESP	OTB	1159	1004	958	1027	1437	1232
MUT	7	FRA	OTB					183	172
MUT	9	ITA	DTS	454	839	514	682	1033	1075
MUT	9	ITA	HOK				2		
MUT	9	ITA	PGP	14	44	49	28	17	22
MUT	9	ITA	PMP	150	174	16	3		
MUT	9	ITA	PTS	3	7	4			
MUT	10	ITA	DTS	446	265	370	249	289	265
MUT	10	ITA	HOK			2		0	
MUT	10	ITA	PGP	195	83	110	116	104	237
MUT	10	ITA	PMP	189	71	41	56		0
MUT	10	ITA	PTS	10		1			
MUT	11	ITA	DTS	38	253	333	264	244	345
MUT	11	ITA	PGP	0		14	1	18	9
MUT	11	ITA	PMP	77	68				
MUT	15	MLT	GTR						0
MUT	15	MLT	OTB				2	7	0
MUT	16	ITA	DTS	1924	3306	1541	1340	1086	1343
MUT	16	ITA	HOK			27	37	1	
MUT	16	ITA	PGP	169	27	58	29	37	37
MUT	16	ITA	PMP	52	47	0			
MUT	16	ITA	PTS	4	4				0
MUT	17	ITA	DRB	29					
MUT	17	ITA	DTS	2475	2394	3620	3553	3180	3357
MUT	17	ITA	PGP	209	214	153	45	12	7
MUT	17	ITA	PMP	374	487	27	14		
MUT	17	ITA	PTS	11	16	4	5	1	
MUT	17	ITA	TBB			80	79	33	61
MUT	18	ITA	DTS	3114	1750	1817	1350	1804	1680
MUT	18	ITA	HOK				0		
MUT	18	ITA	PGP	90	312	205	99	130	123
MUT	18	ITA	PMP	1707	308	40			
MUT	18	ITA	PTS			2			
MUT	19	ITA	DTS	782	427	321	294	566	288
MUT	19	ITA	HOK			69	70		
MUT	19	ITA	PGP	243	1152	508	747	321	253
MUT	19	ITA	PMP	1242	870	53	2		
MUT	19	ITA	PTS	6	2				
MUT	20	GRE	GNS		2103	722	513	432	
MUT	20	GRE	OTB		163	179	225	153	
MUT	20	GRE	SV		86	26	36	24	
MUT	22	GRE	GNS		2364	1125	1587	1688	
MUT	22	GRE	OTB		1769	2152	1679	1179	
MUT	22	GRE	SV		184	166	285	218	
MUT	25	CYP	GTR				25	18	25
MUT	25	CYP	OTB				18	16	23

Table A3.3 Landings data (tons) for pink shrimp by GSA.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DPS	1	ESP	OTB	173	123	117	81	37	58
DPS	5	ESP	OTB	36	22	6	2	1	1
DPS	6	ESP	OTB	380	190	117	63	49	41
DPS	9	ITA	DTS	133	308	367	430	462	215
DPS	9	ITA	PGP		3	8	1		2
DPS	9	ITA	PMP	19	12	0			
DPS	9	ITA	PTS	9	0	1			
DPS	10	ITA	DTS	1452	416	488	695	1086	533
DPS	10	ITA	HOK			0		1	
DPS	10	ITA	PGP	2		0	0	1	
DPS	10	ITA	PMP	373	71	63	80	1	2
DPS	10	ITA	PTS	34		0			
DPS	11	ITA	DTS	38	13	232	551	124	79
DPS	11	ITA	PGP	1			1	6	
DPS	11	ITA	PMP	47					
DPS	15	MLT	LA						1
DPS	15	MLT	OTB				1	11	7
DPS	16	ITA	DTS	7463	7388	6606	8355	8455	5966
DPS	16	ITA	HOK			57	224		0
DPS	16	ITA	PGP	1	23	2		1	
DPS	16	ITA	PMP	101					
DPS	16	ITA	PTS	20	55		5		
DPS	17	ITA	DRB	6					
DPS	17	ITA	DTS	49	49	58	77	67	67
DPS	17	ITA	PGP	1				1	
DPS	17	ITA	PMP	3		0			
DPS	17	ITA	PTS	25	1	0	1		
DPS	17	ITA	TBB			4	4	1	
DPS	18	ITA	DTS	903	1253	1742	1181	1473	863
DPS	18	ITA	PGP		67	95			
DPS	18	ITA	PMP	244	496	20			
DPS	18	ITA	PTS			0			
DPS	19	ITA	DTS	738	646	1037	1242	1245	608
DPS	19	ITA	HOK			34			
DPS	19	ITA	PGP	3		77	1		
DPS	19	ITA	PMP	365	745	53	1		
DPS	19	ITA	PTS	20					
DPS	20	GRE	GNS		4	3	7	13	
DPS	20	GRE	OTB		272	418	93	306	
DPS	20	GRE	SV		5				
DPS	22	GRE	GNS		206	97	71	123	
DPS	22	GRE	OTB		865	3257	3925	4052	

Table A3.4 Discards data (tons) by species and GSA.

SPECIES	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DPS	1	ESP	OTB				1		
DPS	5	ESP	OTB	0	0		0		
DPS	6	ESP	OTB				0		
DPS	9	ITA	OTB					9	
DPS	10	ITA	OTB					1	
DPS	16	ITA	OTB					25	
DPS	19	ITA	OTB					4	
DPS	20	GRE	OTB		441	15	6		
DPS	22	GRE	OTB		83	455	188		
DPS	25	CYP	OTB					0	
HKE	1	ESP	OTB				6		
HKE	5	ESP	OTB	10	5		6		
HKE	6	ESP	GNS						0
HKE	6	ESP	OTB				80		
HKE	7	FRA	GNS			7			
HKE	7	FRA	OTB		16		33	56	31
HKE	9	ITA	OTB					467	
HKE	10	ITA	OTB					6	
HKE	11	ITA	LLS				15		
HKE	11	ITA	OTB					63	
HKE	16	ITA	OTB					54	
HKE	17	ITA	OTB					70	
HKE	19	ITA	OTB					10	
HKE	20	GRE	GNS				679		
HKE	20	GRE	OTB		28	20	42		
HKE	22	GRE	GNS		0	9	179		
HKE	22	GRE	OTB		147	244	360		
HKE	25	CYP	OTB					0	
MUT	1	ESP	OTB				0		
MUT	5	ESP	OTB	0	0		0		
MUT	6	ESP	GTR						0
MUT	6	ESP	OTB				9		
MUT	7	FRA	OTB						8
MUT	9	ITA	OTB					158	
MUT	10	ITA	OTB					3	
MUT	11	ITA	OTB					7	
MUT	16	ITA	OTB					94	
MUT	17	ITA	OTB					147	
MUT	19	ITA	GTR				7		
MUT	19	ITA	OTB					0	
MUT	20	GRE	GNS		38	3	38		
MUT	20	GRE	OTB		6	3	0		
MUT	22	GRE	GNS		0	6	21		
MUT	22	GRE	OTB		70	6	20		
MUT	25	CYP	OTB					0	

Table A3.5 Effort in days by GSA and fleet.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
DAYS	7	FRA	GNS			81460	76785	93193	
DAYS	7	FRA	LLS			6459	6593	5028	
DAYS	7	FRA	OTB			20561	19327	17991	
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
DAYS	10	ITA	DRB	658	205	830	1776	1984	1040
DAYS	10	ITA	DTS	37949	38134	44087	46547	43848	40724
DAYS	10	ITA	HOK			20929	20418	8064	7043
DAYS	10	ITA	PGP	357895	311474	325523	268441	346849	311693
DAYS	10	ITA	PMP	105705	143062	62225	64177	10532	7261
DAYS	10	ITA	PTS	8258	9780	11792	11206	9332	9367
DAYS	11	ITA	DTS	14539	18957	28840	31993	26532	27374
DAYS	11	ITA	PGP	102826	126272	165945	151720	156269	155243
DAYS	11	ITA	PMP	57543	30879				
DAYS	15	MLT	[LHP] [LHM]				28		
DAYS	15	MLT	[SB] [SV]					73	59
DAYS	15	MLT	GNS				51		
DAYS	15	MLT	GTR				200	152	320
DAYS	15	MLT	LA					1116	1096
DAYS	15	MLT	LLD				3164	3159	2827
DAYS	15	MLT	LLS				1197	1466	1624
DAYS	15	MLT	LTL				263		
DAYS	15	MLT	OTB				421	404	688
DAYS	15	MLT	Other gear				64		
DAYS	16	ITA	DTS	87300	76233	81853	82557	89319	89164
DAYS	16	ITA	HOK			14856	11450	10272	9284
DAYS	16	ITA	PGP	146019	118660	118425	97285	85556	85298
DAYS	16	ITA	PMP	26655	34956	6939			
DAYS	16	ITA	PTS	8778	8568	4899	5476	7926	7032
DAYS	17	ITA	DRB	58297	69126	64120	54047	59099	70261
DAYS	17	ITA	DTS	124529	125106	134776	126013	114903	102270
DAYS	17	ITA	HOK			641	595	610	487
DAYS	17	ITA	PGP	335599	272040	287886	260459	233846	217661
DAYS	17	ITA	PMP	96386	98110	15512	12743		
DAYS	17	ITA	PTS	23522	25649	23387	22453	23104	22981
DAYS	17	ITA	TBB			12395	13166	12440	10901
DAYS	18	ITA	DRB	11081	5890	3865	5776	7562	8132
DAYS	18	ITA	DTS	85424	71203	80259	84207	88418	73637
DAYS	18	ITA	HOK			1799	3053	4397	3190
DAYS	18	ITA	PGP	110621	63332	67232	80648	88583	68253
DAYS	18	ITA	PMP	53475	35980	3667			
DAYS	18	ITA	PTS	4140	4526	4679	4428	5291	6186
DAYS	19	ITA	DTS	31381	31586	37234	42413	42976	40423
DAYS	19	ITA	HOK			39190	43898	25644	17695
DAYS	19	ITA	PGP	233718	254881	225109	193806	217447	168411
DAYS	19	ITA	PMP	100208	122225	20325	6905		
DAYS	19	ITA	PTS	3458	7302	6605	5554	5507	4441
DAYS	20	GRE	GNS		717773	634540	655783	588850	
DAYS	20	GRE	LLS		114160	79657	84159	73790	
DAYS	20	GRE	OTB		7810	7284	6279	6682	
DAYS	20	GRE	SV		13429	10902	10883	11363	
DAYS	22	GRE	GNS		1499507	1445880	1529002	1479134	
DAYS	22	GRE	LLS		381095	295005	315854	253335	
DAYS	22	GRE	OTB		52536	53389	56580	52831	
DAYS	22	GRE	SV		36266	31987	33200	30098	
DAYS	25	CYP	GTR				84706	89375	100103
DAYS	25	CYP	LLS				306	378	407
DAYS	25	CYP	OTB				1018	726	752

Table A3.6 Effort in GT*days by GSA and fleet.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
GT*DAYS	7	FRA	GNS			329230	305685	315704	
GT*DAYS	7	FRA	LLS			23742	23436	17232	
GT*DAYS	7	FRA	OTB			1610963	1480834	1322919	
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
GT*DAYS	10	ITA	DRB			7968	17128	19136	9939
GT*DAYS	10	ITA	DTS			1337882	1622062	1331071	1266460
GT*DAYS	10	ITA	HOK			157882	143835	103111	82342
GT*DAYS	10	ITA	PGP			661958	534880	800036	693057
GT*DAYS	10	ITA	PMP			336053	333845	152717	110850
GT*DAYS	10	ITA	PTS			390096	468145	367417	280190
GT*DAYS	11	ITA	DTS			1598912	1881952	1437559	1486500
GT*DAYS	11	ITA	PGP			501550	484820	493411	495670
GT*DAYS	15	MLT	[LHP] [LHM]				170		
GT*DAYS	15	MLT	[SB] [SV]					192	139
GT*DAYS	15	MLT	GNS				135		
GT*DAYS	15	MLT	GTR				1174	477	1023
GT*DAYS	15	MLT	LA					23999	29596
GT*DAYS	15	MLT	LLD				82011	72364	60606
GT*DAYS	15	MLT	LLS				16866	18866	18072
GT*DAYS	15	MLT	LTL				2539		
GT*DAYS	15	MLT	OTB				24878	34527	69268
GT*DAYS	15	MLT	Other gear				226		
GT*DAYS	16	ITA	DTS			6673029	6864030	7429483	7322198
GT*DAYS	16	ITA	HOK			764595	403669	507862	370612
GT*DAYS	16	ITA	PGP			249032	206056	192811	212519
GT*DAYS	16	ITA	PMP			20134			
GT*DAYS	16	ITA	PTS			224188	236435	352518	346405
GT*DAYS	17	ITA	DRB			858864	697091	792375	959807
GT*DAYS	17	ITA	DTS			5624744	5429766	4656664	4283788
GT*DAYS	17	ITA	HOK			9492	10510	10983	9150
GT*DAYS	17	ITA	PGP			518165	429665	444329	427962
GT*DAYS	17	ITA	PMP			73495	66778		
GT*DAYS	17	ITA	PTS			1516671	1472075	1557168	1646419
GT*DAYS	17	ITA	TBB			673656	701874	812298	747714
GT*DAYS	18	ITA	DRB			41347	62244	81590	87740
GT*DAYS	18	ITA	DTS			2568868	2592741	2632767	2275442
GT*DAYS	18	ITA	HOK			27800	58254	79940	58026
GT*DAYS	18	ITA	PGP			120701	146182	147150	115612
GT*DAYS	18	ITA	PMP			40920			
GT*DAYS	18	ITA	PTS			369876	360279	446754	516692
GT*DAYS	19	ITA	DTS			782163	884513	835267	800971
GT*DAYS	19	ITA	HOK			1015534	1091913	850691	710177
GT*DAYS	19	ITA	PGP			473727	438792	555916	483882
GT*DAYS	19	ITA	PMP			111129	34967		
GT*DAYS	19	ITA	PTS			195882	238105	188866	114537
GT*DAYS	20	GRE	GNS		2885125	2548709	2611649	2210227	
GT*DAYS	20	GRE	LLS		436107	268489	203140	228351	
GT*DAYS	20	GRE	OTB		574443	580909	435054	565011	
GT*DAYS	20	GRE	SV		83099	62465	58441	57058	
GT*DAYS	22	GRE	GNS		5837915	5675508	5782002	5610405	
GT*DAYS	22	GRE	LLS		1762101	1660263	1602486	1323112	
GT*DAYS	22	GRE	OTB		4927349	4971783	5553804	5554194	
GT*DAYS	22	GRE	SV		294896	269645	276265	257271	
GT*DAYS	25	CYP	GTR				256436	275468	301864
GT*DAYS	25	CYP	LLS				2022	5245	6421
GT*DAYS	25	CYP	OTB				94561	72422	75036

Table A3.7 Effort in kW*days by GSA and fleet.

TYPE	AREA	COUNTRY	FT_LVL4	2002	2003	2004	2005	2006	2007
KW*DAYS	7	FRA	GNS			7007171	5908142	88698170	
KW*DAYS	7	FRA	LLS			669338	716765	385004	
KW*DAYS	7	FRA	OTB			6361248	5923541	6127438	
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
KW*DAYS	10	ITA	DRB	94663	29540	110899	244013	272628	142455
KW*DAYS	10	ITA	DTS	7344089	7231486	7883881	8467144	7596783	7105075
KW*DAYS	10	ITA	HOK			1654352	1413547	925244	794816
KW*DAYS	10	ITA	PGP	6440217	7222145	7056306	6018600	9486681	8397010
KW*DAYS	10	ITA	PMP	12686947	8003452	3588004	3728376	1404642	1003285
KW*DAYS	10	ITA	PTS	2631242	2930380	2308589	2434470	2016508	1680295
KW*DAYS	11	ITA	DTS	3679604	4652647	6711626	7736040	6017232	6340429
KW*DAYS	11	ITA	PGP	2865738	5099814	7105771	6996350	7234881	7398923
KW*DAYS	11	ITA	PMP	7159338	3245118				
KW*DAYS	15	MLT	[LHP] [LHM]				1880		
KW*DAYS	15	MLT	[SB] [SV]					3805	2507
KW*DAYS	15	MLT	GNS				2121		
KW*DAYS	15	MLT	GTR				13889	8391	20724
KW*DAYS	15	MLT	LA					203361	208456
KW*DAYS	15	MLT	LLD				554562	483437	449900
KW*DAYS	15	MLT	LLS				140846	159692	160914
KW*DAYS	15	MLT	LTL				26318		
KW*DAYS	15	MLT	OTB				129838	143909	240858
KW*DAYS	15	MLT	Other gear				3394		
KW*DAYS	16	ITA	DTS	23952310	20951845	21381964	21772464	23699835	23644626
KW*DAYS	16	ITA	HOK			3153486	1758722	2076446	1695903
KW*DAYS	16	ITA	PGP	3133993	4603457	2691324	2302777	2207660	2378933
KW*DAYS	16	ITA	PMP	2792612	2761842	223470			
KW*DAYS	16	ITA	PTS	2510582	1750128	962786	1063031	1592930	1431085
KW*DAYS	17	ITA	DRB	6381241	7517860	6982982	5884599	6421392	7575921
KW*DAYS	17	ITA	DTS	27568094	27486393	26771813	25026709	22118619	20619962
KW*DAYS	17	ITA	HOK			153794	148821	150195	121827
KW*DAYS	17	ITA	PGP	9297244	7646003	9120053	8011107	8568762	8638666
KW*DAYS	17	ITA	PMP	7989134	7039902	1072033	1032751		
KW*DAYS	17	ITA	PTS	7841347	7636049	6955633	6778783	6978292	7156333
KW*DAYS	17	ITA	TBB			3419642	3622199	3943318	3463256
KW*DAYS	18	ITA	DRB	1100225	584801	381968	570792	746921	807073
KW*DAYS	18	ITA	DTS	17112022	14530793	14369490	14621928	14929696	12904532
KW*DAYS	18	ITA	HOK			284535	514377	778355	567996
KW*DAYS	18	ITA	PGP	1722336	1002933	1180371	1442219	1394671	1311109
KW*DAYS	18	ITA	PMP	7277279	4416994	351689			
KW*DAYS	18	ITA	PTS	1480945	1464793	1842716	1785787	2221605	2613654
KW*DAYS	19	ITA	DTS	5125805	5002396	5802023	6562337	6460683	6063817
KW*DAYS	19	ITA	HOK			6809150	7299195	5575566	4053202
KW*DAYS	19	ITA	PGP	4669873	9192254	4881153	4698292	6141378	5333724
KW*DAYS	19	ITA	PMP	13116917	9143878	1188078	341008		
KW*DAYS	19	ITA	PTS	978457	1629677	1105203	1026897	1008813	691704
KW*DAYS	20	GRE	GNS		29609039	22529478	21758835	17272519	
KW*DAYS	20	GRE	LLS		3247285	1435103	1823114	1448109	
KW*DAYS	20	GRE	OTB		2374841	2447515	1729664	2024955	
KW*DAYS	20	GRE	SV		863066	709465	604098	623628	
KW*DAYS	22	GRE	GNS		48227268	53304432	54981971	52423637	
KW*DAYS	22	GRE	LLS		14158502	11416302	10631705	8283337	
KW*DAYS	22	GRE	OTB		15792715	15877180	17730748	16402915	
KW*DAYS	22	GRE	SV		2775797	2206815	2193550	2022231	
KW*DAYS	25	CYP	GTR				3305514	3526850	3896835
KW*DAYS	25	CYP	LLS				21790	51626	57561
KW*DAYS	25	CYP	OTB				327616	231816	240182

17. APPENDIX 4. ANNEXES TO SECTION 10.

17.1. Annex A. SGRST-07-05 and SGECA/SGRST-08-01's socio-economic indicators

The **Return on Investment (ROI)** was the preferred economic indicator. It is measured as the ratio between profits (positive or negative) and the total capital invested for a given period. Normaly, this ratio is multiplied by 100, and then expressed as a percentage. This indicator is extremely important as it provides an indication on the profitability of the fishery and a good understanding of the economic performance of fishing vessels/segments.

The reference point for this indicator could be 0 or the interest rate (and/or previous years results).

- A result higher than 0 shows that the fishery is profitable for the companies.
- A result lower than 0 shows that the fishery is not profitable for the companies.

Alternatively, the **Ratio between Current Revenue and Break-Even Point** was chosen as a second best indicator. The Ratio between current revenue and break even revenue gives an indication of the economic sustainability of the fishing fleet. This break even revenue point is defined as the revenue point at which the gross cash flow equals the fixed costs. However, the problem with this indicator is that it is not useful in telling us whether the fishery is overcapitalised (it only identifies whether the fishery is overexploited). This ratio can be multiplied by 100, and then expressed as a percentage.
The reference point for this indicator could be 1 (and/or previous years results).

- When the indicator equals 1, then the break-even revenue point equals the current revenue.
- For values lower than 1, then the current revenue value is lower than the break-even revenue, so the current revenues cannot meet the fishing costs. Then, the activity is *not* sustainable at current conditions, so it presents signs of over-capitalisation.
- If the indicator is higher 1, the current revenue is higher than the break-even revenue point, implying that the activity is sustainable, as the current revenues are higher than the fixed and operating costs. However, as capital costs are not taken into account, when this indicator is below 1 it cannot be known whether overcapitalisation in the fishery is present or not.

While from a more social point of view the **Average Wage per Full-Time Equivalent** was found to be the preferred indicator. The reference point for this indicator could be the minimum wage on the country (and/or previous years results).

Alternatively, the **Gross Added Value** expresses how much the activity contributes to the Economy. The added value is expressed as income minus operative costs.

The reference point for this indicator could be 0 (and/or previous years results).

- A result higher than 0 show that the fishery is profitable for the society.
- A result lower than 0 show that the fishery is not profitable for the society.

Table 1: STECF working groups' socio-economic indicators and their formulas

Indicator	Abbreviation	Formula	Units
Return on Investment	ROI	(LV-((LV-VC)*SS) - VC-YFC-D))/IC	%
Ratio between Current Revenue and Break-Even Point	RCRBEP	LV-YFC	%
Gross Added Value	GAV	LV-VC-YFC	Money
Average Wage per Full-Time Equivalent	AWFTE	(LV-VC)*SS /FTE	Money

17.2. Annex B. CopeMed's socio-economic (and technical) indicators

17.2.1. Technical indicators

- Vessel Physical Productivity (VFP), shows the average production of each vessel in terms of weight of landings.
- Capacity Physical Productivity (CFP), indicates average production in terms of weight of landings for each capacity unit (GT) of the vessels.
- Power Physical Productivity (PFP), shows the average production in terms of weight of landings for each power unit (HP) of the vessels.
- Per vessel Hour Physical Productivity (HFP), indicates the average production in terms of weight of landings for each full fishing hour. The total fishing time (T) results from multiplying the number of fishing hours by working days and then by the number of working days in one year (TD).
- Man Physical Productivity (MFP), shows the average production in terms of weight of landings for each man employed.

17.2.2. Economic Indicators

- Capacity Productivity (PGT), shows average production in terms of market value in the first sale for each capacity unit installed (GT) in the vessels.
- Vessel Productivity (PV), shows average production in terms of market value in the first sale for each vessel.
- Power Productivity (PP), shows the average production in terms of market value in the first sale for each power unit (HP) of the vessels.
- Per Vessel Hour Productivity (PVH), shows the average production in terms of market value in the first sale for each fishing hour.
- Man Productivity (MP) shows average production in terms of value in the first sale for each man used.
- Invested Capital (IC) shows the current value of the whole of the vessels. Invested capital is very difficult to measure in the Mediterranean Sea.
- Opportunity Cost (OP) shows the yields that the owner could obtain should he invest his money in National Debt instead of investing in his business. This means that the owner is relinquishing that potential income. There is a profit in its economic sense when the yields of the invested capital surpass the opportunity cost.
- Gross Estimated Profit (GEP), which indicates the total profits obtained by the whole of the vessel owners, once the operating costs have been deducted. Such costs include: Salary Cost (SC), Opportunity Cost (OP), Costs related to Fishing (CDxTD) and Yearly Fixed Costs (YFC). How to calculate CD and YFC is explained below.
- Net Estimated Profit (NEP), which shows the total earnings obtained by the whole of the owners, once the depreciation cost has been deducted from the GEP. This cost is calculated following the criterion that the shelf life of a vessel is 10 years. In fact, the shelf life of vessels is normally longer, but in that subsequent period repair costs equal the value of a new vessel.
- Profit Rate (PR), which indicates the percent ratio of yearly net profits plus the opportunity cost in relation with the investment. It should be borne in mind that this figure does not include the additional earnings obtained by the owner as an employee in artisanal fisheries.
- Gross Added Value (GAV), which expresses the Added Value that the segment in question contributes to the National Economy. This includes: salaries, profits, opportunity cost and depreciations.
- Landing Prices (LP) represents the average market price of landings per kilo.

17.2.3. Social indicators

- Average Wage (AW) indicates the average salary obtained by each man employed.
- Salary Cost (SC) indicates the fishermen's income. To measure the salary cost, we must bear in mind the parts in which landings of each kind of fleet are divided. This indicator tends to underestimate the actual figures, since fishermen usually keep a small part of landings as salary in kind. Often, in artisanal fisheries, each fisherman's earnings depend on his condition, i.e., whether he

is a sailor (salary) or the owner (salary plus profits). For the purposes of making an economic analysis, we should make a distinction between the natures of each distinctive part of the income.

Next table summarizes main CopeMed socio-economic indicators and their formulas.

Table 2: CopeMed' socio-economic indicators and their formulas

Indicator	Abbreviation	Formula	Units
Vessel Physical Productivity	VFP	LW/N	Kg
Capacity Physical Productivity	CFP	LW/GT	Kg/GT
Power Physical Productivity	PFP	LW/HP	Kg/HP
Per Vessel Hour Physical Productivity	HFP	LW/T	Kg/hour
Man Physical Productivity	MFP	LW/E	Kg/man
Vessel Productivity	PV	LV/GT	Money
Capacity Productivity	PGT	LV/N	Money/GT
Power Productivity	PP	LV/HP	Money/HP
Per Vessel Hour Productivity	PVH	LV/T	Money/hour
Man Productivity	MP	LV/E	Money/man
Invested Capital	IC	VV*N	Money
Opportunity Cost	OP	IC*R	Money
Gross Estimated Profit	GEP	LV-SC-(CD*TD)-YFC-OP	Money
Net Estimated Profit	NEP	GEP-(IC/10)	Money
Profit Rate	PR	(NEP+OP)/IC	%
Gross Added Value	GAV	GEP+OP+SC	Money
Average Wage	AW	SC/E	Money
Salary Cost	SC	(LV-CD*TD)*SS	Money
Landing Prices	LP	LV/LW	Money

Where the data to calculate the GFCM and STECF working groups socio-economic indicators is detailed on next table.

Table 3: Basic data to build up the socio-economic indicators

Code	Data	Units
LW	Landings Weight	Tonnes
LV	Landings Value (current revenue)	Money
VC	Variable Costs (CD*TD)	Money
DC	Daily Costs (Variable costs by day)	Money
IC	Invested Capital (Total value of all vessels in the fleet)	Money
D	Depreciation: IC/life years	Money
YFC	Yearly Fixed Costs	Money
TD	Total Days	Money
SS	Salary Share	%
E	Fishing Sector Employment	People
FTE	Fishing Sector Employment on a Full Time Equivalent basis	People
R	Yearly interest rate	%
N	Number of vessels	Vessels
GT	Gross Tonnage (total)	GT

HP	Horse Power (total)	HP
T	Time in hours	hours
IR	Inflation rate	%

17.3. Annex C. AdriaMed's socio-economic indicators

A list of 24 socio-economic indicators was proposed by FAO project AdriaMed for the analysis of demersal and pelagic fisheries in the Northern and Central Adriatic Sea (GSA 17). The list of indicators and methodology for its analysis was developed as contributions respectively for the AdriaMed Working Group on Biological and Economic Indicators for Adriatic Sea Demersal Fisheries, held in Fano, Italy, in 2005, and for the AdriaMed Working Group on Small Pelagic Fisheries Resources of Adriatic Sea, held in Ancona, Italy, in 2006.

A socio-economic analysis of demersal fisheries in the Italian GSA 17 by using the same list of indicators has been published in Accadia and Spagnolo (2006). The same socio-economic indicators together with a list of biological indicators have been used to analyse demersal fisheries in the Italian GSA 18 in Ceriola *et al*. (in press).

The approach followed in all these works suggests distinguishing indicators to evaluate the status of the fisheries from indicators to measure fisheries sustainability. The economic (Return on Investment and Ratio between Current Revenue and Break-Even Point) and social (Average Wage per Full-Time Equivalent and Gross Added Value) indicators recommended by the working groups SGRST-07-05 and SGECA/SGRST-08-01 belong to the second group of indicators.

Table I displays the list of the economic indicators on the status of fisheries proposed by AdriaMed project and their description. They include 6 indicators on economic performance, 8 on productivity and 4 related to the market (costs and prices). As for the evaluation of economic performance, traditional indicators based on the return on capital invested and indicators related to the quota of revenues directed to production factors are used. A number of indicators are also used in the evaluation of productivity. They can be divided into two groups, physical and economic productivity indicators, where the former are expressed in terms of landings and the latter in terms of revenues. The last four economic indicators, related to market variables, are to measure the evolution of landings prices and of the most relevant costs in demersal fisheries, specifically maintenance and fuel costs.

The indicator summarising economic sustainability is obtained comparing the profitability of investments in fishery (by the return on capital invested (ROI)) to the average rate of the Italian Treasury securities with a long term maturity (Buoni del Tesoro Pluriennali (BTP)). The rate of Italian BTP are used here as a limit reference point. It is one of the two economic indicators recommended by the working groups SGRST-07-05 and SGECA/SGRST-08-01.

From a social point of view, 4 indicators have been defined. As listed in Table II, two indicators on labour productivity, an indicator on the number of people employed and one on their average salary are used for the analysis of social aspects of Italian fisheries.

The indicator summarising social sustainability is obtained as a difference between the average salary per man employed and the minimum salary stipulated by Italian laws (Contratto Collettivo Nazionale di Lavoro (CCNL)). This level of salary can be considered as a limit reference point from a social point of view. It is one of the two social indicators recommended by the working groups SGRST-07-05 and SGECA/SGRST-08-01.

Trends of these indicators have been analysed using the 'Traffic Light' system. Reference values are set according to their percentile value in the following series:

- 66th percentile
    - for productivity and performance indicators – 'good', green colour assigned
    - for costs indicators, 'bad', red colour
- 66th - 33rd, 'intermediate', yellow colour, and
- < 33rd percentile
    - for productivity and performance indicators – 'bad', red colour
    - for costs indicators – 'good', green colour assigned.

Some results obtained for demersal and pelagic fisheries in the Italian GSA 17 are reported in Tables III-VI. The analysis has been performed by using data available from the IREPA monitoring system along the Italian coastline for the period 1996 - 2004.

Table I: Economic indicators on the status of fisheries and description.

INDICATOR	DESCRIPTION
Added Value/Revenue	percentage of revenues which is directed to salary, profit, opportunity cost and depreciation.
Gross Operative Margin/Revenue	percentage of revenues which is directed to profit, opportunity cost and depreciation.
ROS (Return on Sale)	percentage of revenues which is directed to profit and opportunity cost.
ROI (Return on Investment) (%)	percent ratio of net profit plus the opportunity cost in relation with the investment.
Revenue/Invested Capital (%)	percent ratio of revenues in relation with the investment.
Net Profit per vessel (000 €) *	average net profit of each vessel.
Landings per vessel (ton)	average production of each vessel in terms of weight of landings.
Landings per GRT (ton)	average production in terms of weight of landings for each capacity unit (GRT) of the vessels.
Landings per day (ton)	average production in terms of weight of landings for each day at sea.
CPUE (kg)	average production of each effort (GRT*days/N.vessels) unit in terms of weight of landings.
Revenue per vessel (000 €) *	average production of each vessel in terms of market value.
Revenue per GRT (000 €) *	average production in terms of market value for each capacity unit (GRT) of the vessels.
Revenue per day (000 €) *	average production in terms of market value for each day at sea.
RPUE (€) *	average production of each effort (GRT*days/N.vessels) unit in terms of market value.
Average price (€/kg)	average market price of landings.
Fuel cost per vessel (000 €) *	average fuel cost of each vessel.
Fuel cost per day (000 €) *	average fuel cost for each day at sea of a vessel.
Maintenance cost per vessel (000 €) *	average maintenance cost of each vessel.

* Deflated by Italian consumer price index for the entire community.

Table II – Social indicators on the status of fisheries and description.

INDICATOR	DESCRIPTION
Landings per crew (ton)	average production in terms of weight of landings for each man employed.
Revenue per crew (€) *	average production in terms of market value for each man employed.
Crew/GRT	ratio between man employed and GRT employed.
Salary per crew (000 €) **	average salary obtained by each man employed.

* Deflated by Italian consumer price index for the entire community.
** Deflated by Italian consumer price index for workers and employees.

Table III – Economic indicators for demersal fisheries in GSA 17

INDICATORS	1996	1997	1998	1999	2000	2001	2002	2003	2004
Economic sustainability (ROI - Risk_free_rate) (%)	4.68	7.35	5.57	1.23	6.25	8.27	5.68	6.00	8.54
•Added Value/Revenue	0.68	0.68	0.66	0.60	0.59	0.59	0.60	0.60	0.57
•Gross Operative Margin/Revenue	0.30	0.31	0.26	0.19	0.24	0.26	0.25	0.27	0.29
•ROS (Return on Sale)	0.25	0.25	0.21	0.13	0.20	0.21	0.19	0.19	0.22
•ROI (Return on Investment) (%)	13.74	14.11	10.49	5.94	11.84	13.44	10.63	10.28	12.82
•Revenue/Invested Capital (%)	55.30	55.58	50.89	46.21	60.65	64.43	55.19	54.02	58.00
•Net Profit per vessel (000 €)	43.88	50.34	38.14	17.88	34.38	40.49	31.85	28.95	33.72
•Landings per vessel (ton)	49.16	53.95	49.52	40.10	43.39	44.06	33.87	30.58	35.37
•Landings per GRT (ton)	1.23	1.28	1.23	1.01	1.32	1.27	0.98	0.91	1.18
•Landings per day (ton)	0.31	0.34	0.31	0.30	0.28	0.25	0.21	0.20	0.24
•LPUE (kg)	7.75	8.02	7.61	7.69	8.47	7.25	6.09	5.90	7.99
•Revenue per vessel (000 €)	204.94	214.05	196.75	162.27	185.54	202.57	174.85	161.63	157.97
•Revenue per GRT (000 €)	5.13	5.08	4.88	4.07	5.64	5.84	5.05	4.80	5.27
•Revenue per day (000 €)	1.29	1.33	1.22	1.23	1.18	1.15	1.11	1.07	1.07
•RPUE (€)	32.29	31.83	30.25	31.11	36.23	33.31	31.42	31.16	35.67
•Average price (€/kg)	4.34	4.21	4.30	4.45	4.82	5.33	6.13	6.45	5.57
•Fuel cost per vessel (000 €)	27.45	29.00	28.31	28.83	39.60	41.40	34.38	30.96	36.33
•Fuel cost per day (000 €)	0.17	0.18	0.17	0.22	0.25	0.23	0.22	0.20	0.25
•Maintenance cost per vessel (000 €)	7.71	9.56	9.47	7.25	8.55	9.31	8.88	8.01	8.23

Table IV – Social indicators for demersal fisheries in GSA 17

INDICATORS	1996	1997	1998	1999	2000	2001	2002	2003	2004
Social sustainability (Salary - Minimum_salary) (000 €)	12.14	10.62	9.90	6.88	9.28	10.07	8.41	8.58	6.43
•Employed persons GSA 17 (num.)	11305	10693	11862	12290	10839	10061	9477	9226	8596
•Landings per crew (ton)	14.27	14.10	12.50	10.01	12.34	12.06	9.25	9.10	11.67
•Revenue per crew (000 €)	59.48	55.95	49.68	40.52	52.76	55.45	47.78	48.11	52.15
•Salary per crew (000 €)	22.45	20.62	19.58	16.50	18.24	18.44	16.73	16.46	14.86

Table V – Economic indicators for pelagic fisheries in GSA 17

INDICATORS	1997	1998	1999	2000	2001	2002	2003	2004
Economic sustainability (ROI - Risk_free_rate) (%)	3.57	1.74	0.89	8.80	10.10	8.87	12.09	14.24
•Added Value/Revenue	0.67	0.66	0.63	0.68	0.66	0.65	0.65	0.63
•Gross Operative Margin/Revenue	0.30	0.23	0.20	0.30	0.28	0.29	0.30	0.31
•ROS (Return on Sale)	0.23	0.16	0.14	0.25	0.23	0.24	0.24	0.26
•ROI (Return on Investment) (%)	10.33	6.66	5.60	14.39	15.27	13.82	16.37	18.52
•Revenue/Invested Capital (%)	44.75	41.71	41.27	56.51	65.11	58.12	66.95	71.21
•Net Profit per vessel (000 €)	60.79	38.82	27.19	82.79	68.94	62.69	63.94	71.61
•Landings per vessel (ton)	340.26	306.99	296.37	358.09	310.86	287.09	276.34	283.38
•Landings per GRT (ton)	4.49	4.31	4.16	4.95	5.59	5.15	5.73	5.88
•Landings per day (ton)	2.02	1.83	1.97	2.05	1.67	1.60	1.75	1.84
•LPUE (kg)	27.55	26.22	28.62	29.09	31.21	29.91	35.16	38.48
•Revenue per vessel (000 €)	291.38	268.84	239.86	337.87	302.82	274.30	267.73	280.90
•Revenue per GRT (000 €)	3.85	3.77	3.37	4.67	5.44	4.92	5.55	5.83
•Revenue per day (000 €)	1.73	1.60	1.59	1.94	1.63	1.53	1.69	1.83
•RPUE (€)	23.59	22.96	23.17	27.45	30.40	28.58	34.06	38.15
•Average price (€/kg)	0.91	0.95	0.89	1.06	1.13	1.14	1.18	1.24
•Fuel cost per vessel (000 €)	37.63	35.87	38.08	47.71	44.76	40.40	39.69	43.92
•Fuel cost per day (000 €)	0.22	0.21	0.25	0.27	0.24	0.23	0.25	0.29
•Maintenance cost per vessel (000 €)	11.92	11.26	9.18	11.78	11.48	10.72	10.76	14.14

Table VI – Social indicators for pelagic fisheries in GSA 17

INDICATORS	1997	1998	1999	2000	2001	2002	2003	2004
Social sustainability (Salary - Minimum_salary) (000 €)	4.56	6.00	5.20	10.56	11.03	7.54	8.21	6.35
•Employed persons GSA 17 (num.)	1178	1109	997	837	762	744	876	915
•Landings per crew (ton)	46.81	42.37	43.40	54.34	51.82	45.90	47.00	47.07
•Revenue per crew (000 €)	40.08	37.11	35.13	51.27	50.48	43.86	45.54	46.66
•Salary per crew (000 €)	14.89	15.96	14.97	19.39	19.27	16.00	16.15	14.80

17.4. Annex D. Ünal (2006)'s socio-economic indicators

Table XX: Socio-economic indicators for 6 Mediterranean fishing cooperatives in Turkey (Ünal, 2006)

	Foca	Karabn	Mordog	Akyaka	Akcapinr	Marmaris
Vessel Physical Productivity (kg)	725.9	388.4	1583.1	1199.3	416.4	492.1
Power Physical Productivity (kg/HP)	108.6	68.6	212.2	156.9	51.2	73.9
Capacity Physical Productivity (kg/length)	36.4	41.2	57.1	101.0	25.7	39.5
Per Vessel Day Physical Productivity (kg/day)	3.9	2.0	7.2	5.3	2.2	4.0
Man Physical Productivity (kg/man)	483.9	286.2	855.7	1139.3	257.8	445.2
Landing Prices ($)	5.7	5.1	5.1	6.4	7.0	5.7
Man Productivity ($/Man)	2,770.9	1,456.6	4,355.6	7,248.7	1,804.2	2,549.5
Invested capital ($)	88,817.5	20,518.4	94,29	40,241.4	75,234.0	25,099.2
Oportunity cost ($)	2,486.9	574.5	2,640.1	1,126.8	2,106.6	702.8
Capacity Productivity ($/length)	622.1	349.0	1,080.1	998.4	358.5	422.9
Vessel Productivity ($)	4,156.4	1,976.9	8,057.8	7,630.2	2,914.4	3,346.2
Power productivity ($/HP)	208.6	209.7	290.6	642.9	179.8	226.4
Per Vessel Day Productivity ($/day)	22.5	10.3	36.8	34.0	15.7	22.6

17.5. Annex E. Ünal (2006)'s socio-economic-demographic indicators

Table XXX: Socio-economic-demographic indicators for 6 Mediterranean fishing cooperatives in Turkey (Ünal, 2006)

	Foca	Karabn	Mordog	Akyaka	Akcapinr	Marmaris
Age of fishermen	47.9	56.5	44.5	43.2	45	45.9
Experience of fishermen (year)	26.2	31.7	26.5	23.4	23.5	28.1
Household population	4.1	4.3	3.8	4.4	4.3	4.4
Dependent family members	2.5	1.9	2.6	2.4	2.6	2.2
Defining fishery as a main occupation (%)	53	13	67	95	100	100
Fishermen declared fishery as his only income source (%)	34	none	57	63	46	56
Having social Security (%)	37	93	24	58	77	75.5
House Owner (%)	40	100	73	62	8	21
Married (%)	95	100	96	77	89	82

17.6. Annex F. Nieto (2008)'s socio-economic indicators

Table XXXX: Socio-economic indicators for artisanal and semi-industrial fleets in a fishing cooperative in Catalonia (Spanish Mediterranean) (Nieto, 2008).

Indicator	2006	2002	art. 2006	art. 2002	s-in 2006	s-in 2002
Vessel Physical Productivity	778.49	9398.3	3780.9	4120.7	17568	19954
Capacity Physical Productivity	1812.2	1940	2102.4	2291.4	1606.3	1824.5
Power Physical Productivity	165.55	178.45	140.03	152.62	168.92	191.86
Per Vessel Hour Physical Productivity	6.67	7.71	2.72	3.06	17.71	20.79
Man Physical Productivity	4709.9	5286.6	2835.7	3090.5	6587.9	7482.6
Vessel Productivity	55158	42654	21510	22380	118912	83203
Capacity Productivity	11673	8804.1	11961	12445	10873	7607.8
Power Productivity	1066.4	809.89	796.66	828.88	1143	800
Per Vessel Hour Productivity	43	35	15.5	16.6	119.87	86.67
Man Productivity	30337	23993	16132	16785	44592	31201
Invested Capital	73909		36142		560000	
Gross Estimated Profit	-10000		-3652		-1306	
Net Estimated Profit	-91300		-17452		-47306	
Profit Rate	-0.11		-0.08		-0.03	
Gross Added Value	266343		65474		165887	
Average Wage	13874		16365		11362	
Salary Cost	22972		20318		32462	
Landing Prices	6.44	4.54	5.69	5.43	6.77	4.17

17.7. Annex G. Compatibility analysis of the economic variables to be collected under the GFCM and the new DCR

Next, there are compared the economic variables to be collected under the GFCM (Task 1.3) and the new DCR. The economic variables recommended being collected under the GFCM and the new DCR are detailed below. Comparing both sources, GFCM and the new DCR, the variables are similar and have no major incompatibilities. However, as a general rule, the new DCR is demanding economic variables at higher level of detail and they are more precisely defined (due to a more similar economic frame).

Some economic variables to be collected under the GFCM do not appear on the economic variables to be collected under the new DCR, as they are considered as transversal variables (variables of interest for both biologic and economic issues). While other economic variables to be collected under the new DCR do not appear on the economic variables to be collected under the GFCM, as they belong to other Tasks than Task 1.3.

Main divergences are:

- Employment: the GFCM requests the total number of people employed on fishing vessels belonging to the given Fleet Segment, allowing the possibility to estimate them on a full time equivalent (FTE) basis. While it in the new DCR is required to obtain economic variables for the Engaged crew and its value on FTE for both the EU level (with a 2000 hours a year threshold) and national level (to be set by each country if wanted).
- Wages and salaries of crew: while the GFCM requests for the salary share, which is the percentage of the revenues for the crew (after discounting commercial costs, daily costs and fuel costs), distributed as salary. The new DCR asks for the labour costs compounded by the actual payments to vessel crew, together with the imputed cost of the labour of the vessel owner and relatives if applicable (where this is not included in actual crew payments) and should also consider social security payments.
- Variable costs: at the new DCR the variable costs are required on a year basis, while at the GFCM the variable costs are required by fishing day per vessel. Fuel, repair and maintenance costs are not included in the new DCR variable costs parameter, as they are considered independently. It is not specified if repair and maintenance costs are included in the variable costs at the GFCM level. Both GFCM and STECF are working to establish which costs should be included on the list, so certain degree of cooperation in their elaborations would be desirable.
- Fuel costs: at the new DCR the fuel costs are required as a total amount, while at the GFCM the energy costs are required as a percentage of total variable costs.
- Fixed/Non-variable costs: at the new DCR the fixed (non-variable) costs are required on a year basis, while at the GFCM the fixed costs are required by fishing day per vessel. The GFCM parameter refers that this amount is inevitable to pay, while the new DCR does not consider it inevitable as it can also consider leased equipment. Both GFCM and STECF are working to establish which costs should be included on the list, so certain degree of cooperation in their elaborations would be desirable.
- Vessel value: at the GFCM the vessel value (for the total Fleet) is defined as present value of the total invested capital (value of hull, engine, gear and equipment) allowing using the replacement-value method to estimate this parameter (in current year local currency), while the new DCR estimate should be based on the methodology from the Evaluation of the Capital Value, Investments and Capital cost in the fisheries sector (Study N° FISH/2005/03) and detailed in the National Plan.

Effective fishing effort measures are proposed in GFMC 2007 recommendations. However, the issue of appropriate effective fishing effort units is still under consideration. The experts noted that the DCR defined the kW*days as a measure of nominal effort across all fleets. While this measure is quite useful for the economic analysis, the experts noted that other parameters are necessary to better assess some fisheries or métier (e.g.: length of the net for gillnets, number of hooks for longlines, number of pods, etc.) As no major incompatibilities have been found between both sets of variables, next there are identified and compared the socio-economic indicators at the fleet level used by STECF and GFCM.

17.7.1. Economic variables to be collected under GFCM and the new DCR.

The SCESS (Sub-Committee on Economic and Social Sciences of the GFCM) recommended minimum indicators (variables) to be used within Task 1 (Report of the 8th Meeting of the SCESS in Kavala, Greece, September 2007). Resolution GFCM/2007/1 on the implementation of GFCM Task 1 Statistical Matrix, agrees on the economic variables to be collected (task 1.3). Between the recommended variables by the SCESS and the ones adopted by the GFCM only fuel costs (% of V.C. from fuel costs) are missing.

These economic variables are defined on the following table.

Table 1: Economic components variables used at the GFCM

Data	Description	Sources
Gross Tonnage	Total gross tonnage of fishing vessels belonging to the given Fleet Segment.	Census
Horse Power	Total engine power of fishing vessels belonging to the given Fleet Segment.	Census
Employment	Total number of people employed on fishing vessels belonging to the given Fleet Segment. The number of crew members can be estimated on a full time equivalent (FTE) basis.	Surveys
Salary Share %	Percentage of the revenues (after discounting commercial costs, daily costs and fuel costs) that pertain to the crew. It will be distributed among the crew as salary.	Surveys
Landing weight	Total landings in weight. (tonnes live weight)	Auctions – Surveys
Landing value	The volume of landed fish valued against actual market prices. It equals to quantities landed multiplied by the landing average price (current year local currency)	Auctions – Surveys
Vessel value of total Fleet	This is defined as present value of the total invested capital - value of hull, engine, gear and equipment. The replacement-value method can be used to estimate this parameter (current year local currency).	Surveys
Fishing days/year per vessel	Number of fishing days per year for each vessel (average).	Surveys
Fishing hours/day per vessel	Number of fishing hours per day (average) including the time of work in harbour preparing the trip, the trip and commercialization.	Surveys
Costs of fishing/day per vessel	These include daily expenses incurred in fishing activity, such as fuel, lubricants, etc. They are variable costs that depend on the time spent in fishing. (Completed list to be added).	Surveys
% of V.C. from fuel costs	The percentage of total variable costs from fuel costs	Surveys
Yearly fixed costs per vessel.	These comprise costs not directly connected with operational activity, such as non-routine maintenance, vessel insurance, taxes and dues, etc. The fixed costs are all the costs that are inevitable to pay yearly, independently from the time spent to fish. (Completed list to be added).	Surveys

While the SGECA 08-01 Report on the Proposal for Economic Parameters for the Fishing, Aquaculture and Processing Sectors to be Collected through the New Data Collection Framework (Lisbon, January 2008) identifies and characterised the economic variables to be collected under the new DCR. These variables are shown on table 2.

Table 2: Economic variables for the new DCR

Variable group	Variable

Turnover	Gross value of landings
	Income from leasing out, quota or other fishing rights
	Subsidies
	Other income
Labour costs	Wages and salaries of crew
	Imputed value of unpaid labour
	Social security costs
Energy costs	Energy costs
Repair and maintenance costs	Repair and maintenance costs
Other operational costs	Variable costs
	Non-variable costs
	Lease/rental payments for quota or other fishing rights
Capital costs	Depreciation of physical capital
	Opportunity costs
Capital value	Value of physical capital: depreciated replacement value
	Value of physical capital: depreciated historical value
	Value of fishing rights
Investments	Investments in physical capital
	Net investments in permanent quota or other permanent fishing rights
Production value per species	Value of landings per species
	Average price per species
Financial position	Total equity
	Total liabilities (debt)
Employment	Engaged crew
	FTE National
	FTE European
Fleet	Number
	Mean LOA
	Mean GT
	Mean kW
	Mean age
Effort	Days at sea
	Energy consumption
Number of fishing companies	Number of fishing companies

18. APPENDIX 5. SUMMARY OF MEDITS DATA AVAILABLE THROUGH THE DCR

Number of hauls per stratum per year

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GSA01_010-050	2	1	2	2	2	2	2	3	3	3	3	2	3	3
GSA01_050-100	5	4	5	5	5	7	6	4	6	10	7	7	6	6
GSA01_100-200	3	3	3	5	5	5	5	4	8	6	5	6	5	6
GSA01_200-500	7	9	11	10	7	11	12	10	11	11	13	11	11	11
GSA01_500-800	6	9	12	10	12	12	9	13	13	14	13	11	15	10
GSA02_050-100													1	1
GSA02_100-200													1	1
GSA02_200-500	1						1						2	2
GSA02_500-800	2						3						4	3
GSA05_100-200		1				1		1			1		1	1
GSA05_200-500		4	2	2	2	1		5	2		2	2	4	3
GSA05_500-800	1	5	3	2	2	3	1	2	2		2	2	2	2
GSA06_010-050	7	8	7	7	7	8	9	8	11	9	9	11	11	6
GSA06_050-100	19	26	26	26	28	29	29	31	36	38	31	32	34	27
GSA06_100-200	11	17	17	15	13	17	18	20	20	21	17	18	19	15
GSA06_200-500	10	12	10	12	7	13	12	16	17	18	16	15	18	11
GSA06_500-800	6	8	9	7	4	9	6	8	7	11	11	8	10	8
GSA07_010-050	12	12	12	14	12	12	12	12	12	13	12	12	12	14
GSA07_050-100	32	32	32	35	39	32	32	32	31	38	31	30	33	31
GSA07_100-200	10	9	9	9	9	9	10	9	9	10	13	11	10	10
GSA07_200-500	6	6	5	5	5	5	5	6	4	5	5	5	5	5
GSA07_500-800	8	7	4	5	4	4	6	5	4	5	5	5	5	5
GSA08_010-050	3													
GSA08_050-100	5	5	7	3	7	6	5	5		6	6	7	7	5
GSA08_100-200	3	5	4	2	5	5	5	5	1	5	5	5	5	3
GSA08_200-500	9	11	12	8	12	10	11	10		10	10	10	11	8
GSA08_500-800	5	5	4	4	4	5	4	5		4	5	5	4	5
GSA09_010-050	19	18	18	18	19	18	18	18	13	13	13	14	13	13
GSA09_050-100	19	19	18	19	18	19	20	20	15	15	15	14	16	16
GSA09_100-200	35	35	36	35	35	35	34	34	26	27	26	27	25	26
GSA09_200-500	32	33	33	36	32	36	37	35	27	27	27	28	29	33
GSA09_500-800	31	30	31	28	30	28	27	29	24	22	21	20	20	17
GSA10_010-050	9	10	10	10	10	10	10	10	9	9	9	9	9	9
GSA10_050-100	12	12	12	12	12	12	12	12	10	10	10	10	10	10
GSA10_100-200	20	20	20	20	20	20	20	20	17	17	17	17	17	17
GSA10_200-500	26	27	26	26	27	26	26	28	22	22	22	22	22	22
GSA10_500-800	31	30	31	31	31	30	31	29	26	26	26	26	26	26
GSA11_010-050	16	18	21	21	21	20	19	17	28	18	17	17	19	19
GSA11_050-100	25	21	22	22	20	22	22	24	25	19	18	21	18	20
GSA11_100-200	20	23	30	31	31	30	29	30	32	24	24	24	24	24
GSA11_200-500	33	29	29	26	25	27	24	25	32	24	21	20	20	20
GSA11_500-800	23	16	21	25	25	24	27	26	27	14	15	14	16	17
GSA15_010-050									1	1	2	1	1	
GSA15_050-100									6	5	4	5	5	12
GSA15_100-200									12	13	13	13	13	12
GSA15_200-500									9	10	9	9	9	4
GSA15_500-800									17	16	15	17	16	17
GSA16_010-050	4	4	4	4	4	4	4	4	7	7	7	10	10	11
GSA16_050-100	8	8	8	8	8	8	7	8	11	12	12	20	22	23
GSA16_100-200	4	4	4	4	5	5	6	5	10	8	9	18	19	21
GSA16_200-500	10	11	11	12	11	11	11	11	19	18	19	28	31	27
GSA16_500-800	10	14	14	13	14	14	14	14	19	20	19	32	33	38
GSA17_010-050									59	45	47	63	49	
GSA17_050-100									54	37	37	62	38	
GSA17_100-200									50	26	22	43	21	
GSA17_200-500									9	7	5	7	5	
GSA17_500-800									1	1				
GSA18_010-050	14	15	15	14	14	14	14	15	11	11	10	9	10	9
GSA18_050-100	14	14	14	15	15	15	15	14	13	13	15	15	14	14
GSA18_100-200	24	23	23	23	23	23	23	23	26	23	24	25	25	22
GSA18_200-500	10	10	10	10	10	10	10	10	8	8	8	9	9	6
GSA18_500-800	10	10	10	10	10	10	10	10	7	7	8	7	7	7
GSA19_010-050									9	9	9	9	9	8
GSA19_050-100									8	8	8	8	8	9
GSA19_100-200									10	10	10	10	10	10
GSA19_200-500									14	14	14	15	14	14
GSA19_500-800									29	29	29	28	29	29
GSA20_010-050	2	2	2	2	4	3	3	3		3	3	3	3	
GSA20_050-100	3	4	8	7	11	10	11	9		10	10	10	9	
GSA20_100-200	1	3	4	2	5	6	5	6		6	6	5	6	
GSA20_200-500	2	3	4	4	7	7	7	8		8	9	8	8	
GSA20_500-800	3	2	4	3	5	5	5	5		5	3	5	4	
GSA22_010-050	8	8	10	9	11	10	11	9		10	10	11	11	
GSA22_050-100	15	19	19	25	21	23	17	20		20	20	20	20	
GSA22_100-200	17	20	32	32	31	28	33	31		31	36	34	34	
GSA22_200-500	23	32	38	45	46	46	45	44		45	46	46	46	
GSA22_500-800	17	12	19	21	22	21	20	17		17	16	17	16	
GSA23_010-050	2	2	1	1	2	2	2	4		3	3	3	3	
GSA23_050-100	2	2	3	3	3	3	4	5		5	3	4	4	
GSA23_100-200	2	5	5	4	5	5	4	4		5	7	7	7	
GSA23_200-500	5	3	6	5	5	5	5	4		6	6	6	6	
GSA23_500-800	1													
GSA25_010-050												5	5	5
GSA25_050-100												8	8	8
GSA25_100-200												5	5	5
GSA25_200-500												3	3	3
GSA25_500-800												4	4	4

19. APPENDIX 6 FLEET SEGMENTATION IN THE MEDITERRANEAN SEA

(copied from SGMED-08-01 report).

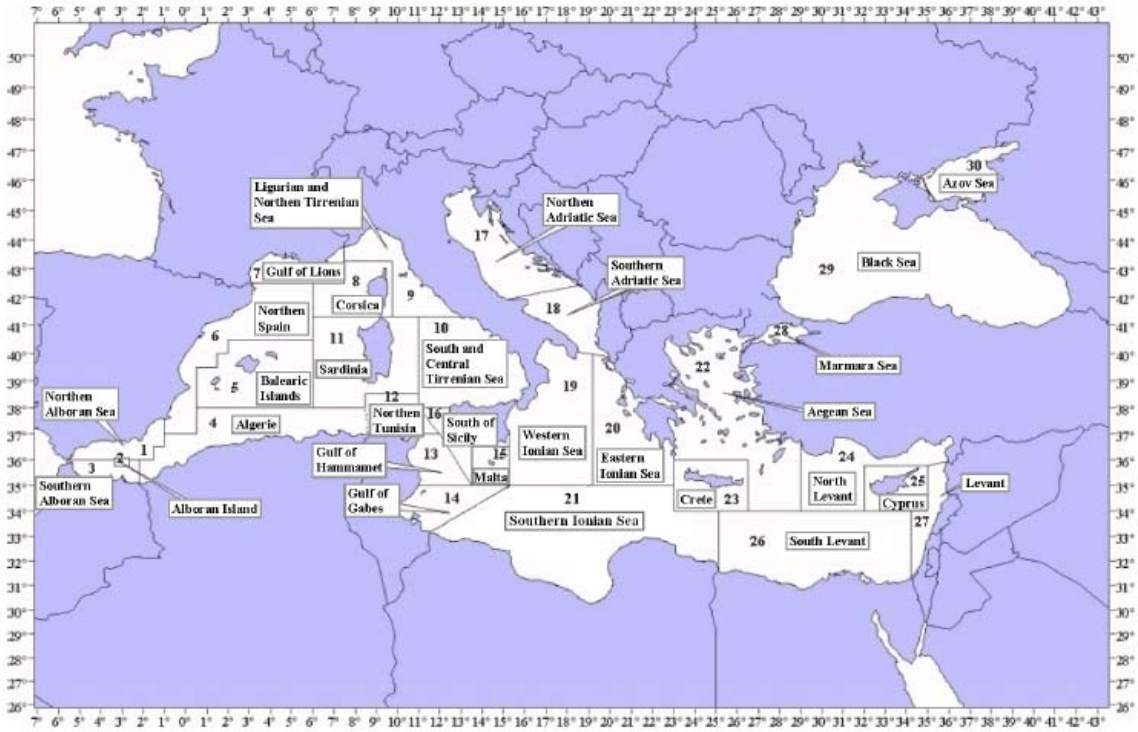
Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	LOA classes					
Activity	Gear classes	Gear groups	Gear type	Target assemblage	Mesh size and other selective devices	< 6	6-12	12-18	18-24	24-40	> 40
Fishing activity	Dredges	Dredges	Boat dredge [DRB]	Molluscs	(a)						
	Trawls	Bottom trawls	Bottom otter 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.

20. APPENDIX 7. GFCM GSAS



21. APPENDIX 8. ANNEXES TO THE BLACK SEA SUBGROUP ASSESSMENTS

Annexes to the Black Sea sub-group assessments are available on the STECF website.

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-08-03 Working Group on the Mediterranean Part III Joint Black Sea working Group was held during 9-13 June 2008 in Ispra, Italy. Data were officially called by the European Commission, and the data call was served by the JRC. All of the fish stock assessments presented in this report are considered provisional and should not be used for management purposes. STECF reviewed the report during its plenary meeting during 7-11 July 2008.

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