November 2009

GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN
COMMISSION GÉNÉRALE DES PÊCHES POUR LA MÉDITERRANÉE

GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN

SCIENTIFIC ADVISORY COMMITTEE (SAC)

Meeting of the Sub-Committee on Stock Assessment (SCSA)
Malaga, Spain, 30 November – 3 December 2009

DRAFT REPORT OF THE SCSA WORKING GROUP ON STOCK ASSESSMENT OF SMALL PELAGIC SPECIES*

Ancona, Italy, 26-30 October 2009

* Only available in English

1. Introduction

During its Thirty third session, the General Fisheries Commission for the Mediterranean endorsed the proposal of its Scientific Advisory Committee (SAC) aimed to reconsider the functioning of the Workings Groups on stock assessment of demersal and small pelagic species. Under this new vision, the Working group on small pelagic species carried out its work on sardine and anchovy, dealing exclusively with practical stock assessments using standard methodologies. It is understood that the outcome of the assessments already undertaken by national experts including with the support of FAO Regional projects and/or other international initiatives would be presented directly to the Sub-Committee on Stock Assessment (SCSA) meeting for review.

The Working Group on stock assessment of small pelagic species of the Sub-Committee on Stock Assessment, took place in Ancona, Italy, from 26 to 30 October 2009, at the head quarters of the Consiglio Nazionale delle Ricerche CNR-ISMAR, with the following

The objectives are to undertake stock assessment of anchovy and sardine in different GSAs by compiling all data available from fisheries and direct surveys; to use the suitable models and software to assess the different stocks and to formulate scientific advice for each stock assessed.

2. Opening of the meeting and Adoption of the Agenda

The tenth meeting of the SCSA Working Group on Small Pelagic species (WG) was held in Ancona, Italy, from 26 to 30 October 2009 at CNR-ISMAR. It was attended by 26 participants from France, Italy, Croatia, Montenegro, Slovenia, Albany, Greece, Turkey, Egypt and Algeria as well as representatives of FAO and the GFCM Secretariat (see list of participants in Appendix A).

Mr. Abdellah Srour, Executive Secretary *ad interim* of the General Fisheries Commission for the Mediterranean (GFCM), welcomed the participants and thanked the CNR-ISMAR representative for their kindness in hosting and arranging the meeting. He called for a more active participation of national scientists to the working group meetings and stressed the importance to feed the WG's work by the required data and information.

Ms. Constantina Karlou_Riga, FAO SCSA coordinator, introduced the meeting and objectives.

Mr. Andrés Uriarte chaired the meeting and acted as Rapporteur.

A new version of the agenda (Annex I) was presented and adopted by the WG as follows:

3. Assessments and Advice by Sub-regional Areas and stocks

The Working Group reviewed works related to 12 anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*) stocks, covering 7 GSAs (Table 1). Six assessments were performed and concluded during the meeting and their results were discussed in the Plenary; these were those of the two species in GSA 07, 116 and 22. For the remainder areas data was considered to be not suitable for carrying out an assessment. The data of GSA 17 (assessed in previous years) is subject to a detailed revision by which an international data base is being built up (for both GSA 17 and 18), but as such revision was not completed by the time of the meeting. Thus the WG meeting did not carry out any new assessment solely based on the Italian series available. An assessment of the two anchovy and sardine Adriatic stocks is expected to be delivered directly to SCsA to be held in Malaga, Spain (30 November-3 December. 2009).

Table 1. Assessments by species and Geographical Subarea (GSA)

Sps\areas	GSA 07 Gulf of Lion	Gsa 16 South of Sicily	GSA 17 and 18 Adriatic	GSA 22 Aegean	GSA 24 Turkish waters	GSA 26 Egypt area	GSA 4 Algeria
Sardine	R	R	+	R	+	R	+
Anchovy	R	R	+	R	+	-	-

- No work examined, + Work examined, R assessment reported

3.1 Sardine (*Sardina pilchardus*) in GSA07 (Gulf of Lions)

by J-L. Bigot and D. Roos (IFREMER Sete).
Document: GFCM_SCSA_Pil_gsa07_2009.xls

3.1.1 Stock Unit basis or definition

GSA07 gulf of Lion. There seems to be connections in the egg distributions and drifting between the Gulf of Lion and the northern coasts of the Catalonian area in Spain (Sabatés et al. 2007).

3.1.2 Fishery

3.1.2.1 Catches (total tonnes) and trends in catches

Catches ranged between about 13,000 t (2007) and 6700 t (2008).
Catches are produced by two fleets Trawlers and Purse seines, the former produced larger catches than the purse seines.

Table 3.1.2.1.1: Catches of Sardine in the Gulf of Lion since 1997, by gears

Year*	1997	1998	1999	2000	2001	2002
Catch Trawl	8590	8050	7850	9650	10337	7036
Catch Purse Seine	2410	1950	2150	2350	1611	727

Year	2003	2004	2005	2006	2007	2008
Catch Trawl	6106	6825	7435	8301	10340	4740
Catch Purse Seine	1005	668	2037	2083	3000	2000

3.1.2.2 Fleets and trends in fleets

Catches are produced by two fleets Trawlers and Purse seines. . A mean of 50 trawler boats in the last years are targeting these pelagic species. There is also 14 purse seiners in the south of gulf of Lion that catch also these species. Some purse seine boats from Spain come in the area to fish mainly sardine.

Table 3.1.2.2.1: Total fleet since 1998

Year*	1997	1998	1999	2000	2001	2002
Fleet		113	113	113	113	123 (56)

Year	2003	2004	2005	2006	2007	2008
Fleet	123 (50)	121 (50)	114 (50)	111 (50)	101 (50)	90 (41)

3.1.3 Source of management advice (Inputs)

3.1.3.1 Biological data: Growth, maturity and natural mortality

Growth parameters are recorded in the assessment forms reporting by sexe: K about 0.31-0,34 and Linfinity around 20 cm
Length at first maturity is about 13 cm, (BUT THE AGE IS NOT REPORTED)
In acoustics Length/weight relationship are splitted in little sardine (<13cm) and big sizes of sardine

3.1.3.2 Catch Inputs: Landing and discards (Tonnes),
No discards are reported

Length distributions are reported in the assessment forms.
Catches are mostly based on individuals bigger than 13 cm, so almost entirely mature.
Catches at age only available for the most recent years.
An example follows below for the last period 2004-2005

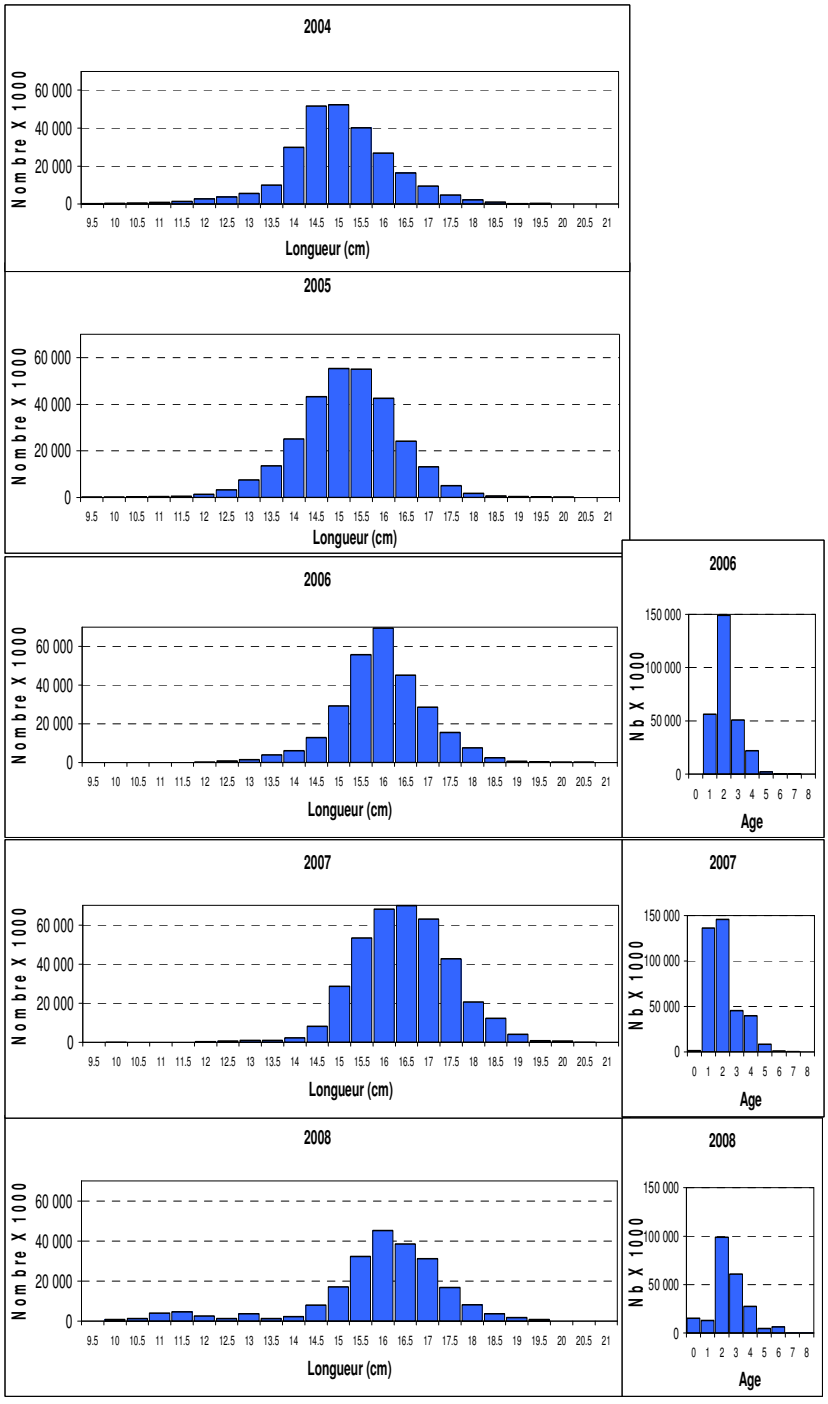

Figure 3.1.3.2.1: Catches at length since 2004 (and at age since 2006) See complete figures in the assessment forms.

3.1.3.3 Catch per unit effort for operational units (OU)
Not available

3.1.3.4 Direct monitoring Acoustic survey: Series of Survey index in tonnes
Biomass, Length and age composition

The stocks of the main species of small pelagics in the gulf of the Lion are evaluated annually by acoustics since 1993 (Survey PELMED carried out in July). The survey data is described in the sheet "Other" of the assessment forms.
The pelagic species studied are anchovy and sardine in priority but also mackerels, horse mackerels, sardinella and sprat when present. The different species don't have the same biology and behaviour (life span, reproduction period, habitat,…). The survey reports total biomass by species and for sardine length and age distribution. Transects are prospected, perpendicular to the coast at a speed of 8 knots, from 15-20m depth until the offshore break. Pelagic and bottom trawling operations are performed to identify species met along transects. Population structures are identified by size and age.

The global species biomass estimated during Pelmed surveys showed strong fluctuations according to years. In 2005, the level of accessible biomass of small pelagic fishes (all species) was around 472000 tons, highest level of 1993–2008 period. Mainly, the presence of a rich inshore zone of small sardines and an offshore zone of anchovy and biggest sardines was observed.

After an upward trend of sardine from 2003 to 2005, up to 231000 MT, sardine biomass return at a mean level in 2006 with 83000 MT, 56300 MT in 2007 and 86100 MT in 2008.

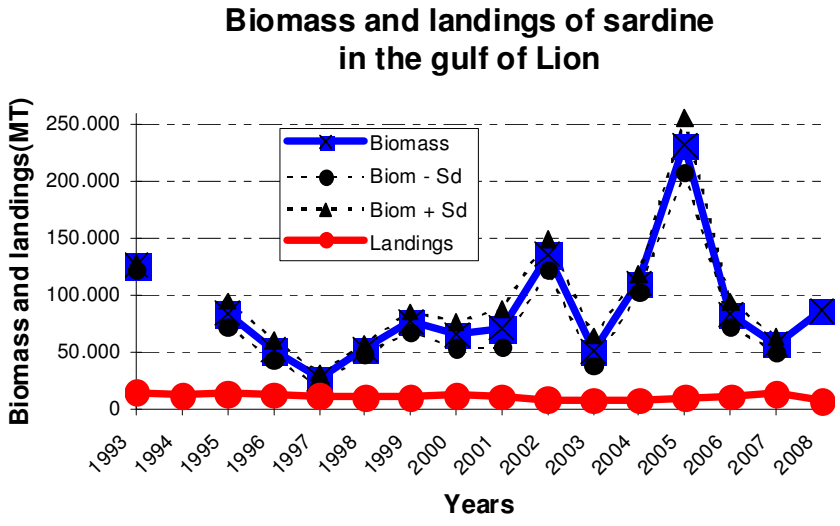

Figure 3.1.3.4.1: Series of acoustic total Biomass (including Juveniles) and catches of sardine in the Gulf of Lion.

In 2008 there was a lot of young sardine (<13cm, less than one year old).

If we see only the assessment of the adults, the trend is very different.

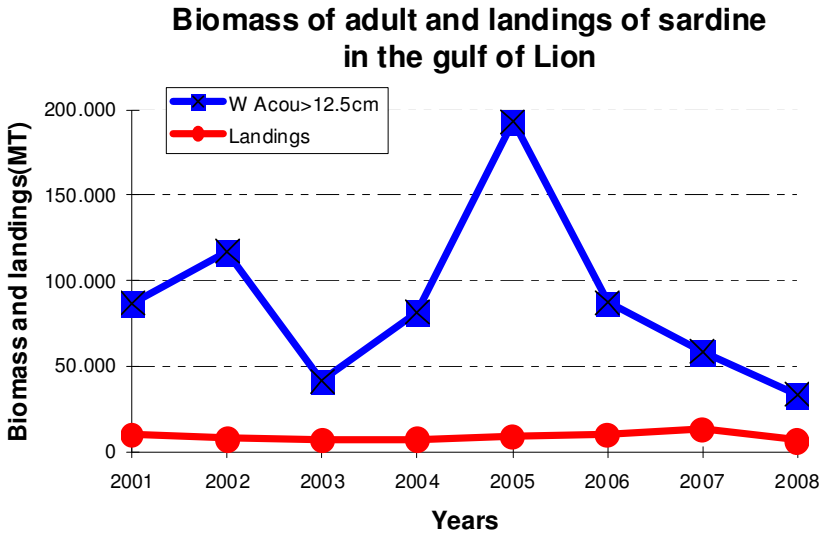

Figure 3.1.3.4.2: Series of acoustic adult Biomass and catches of sardine in the Gulf of Lion.

But the ratio Catch/Acoustic adult biomass stay low

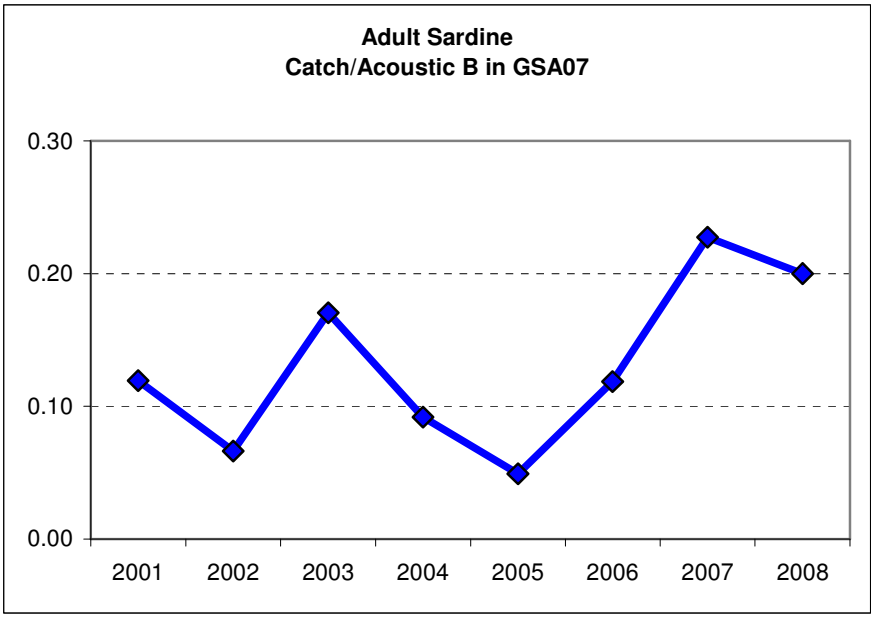

Figure 3.1.3.4.3: Ratio of sardine annual catches over the Acoustic biomass of sardine (in July) as indicator of harvest rate in the Gulf of Lion.

Biomass, Length composition

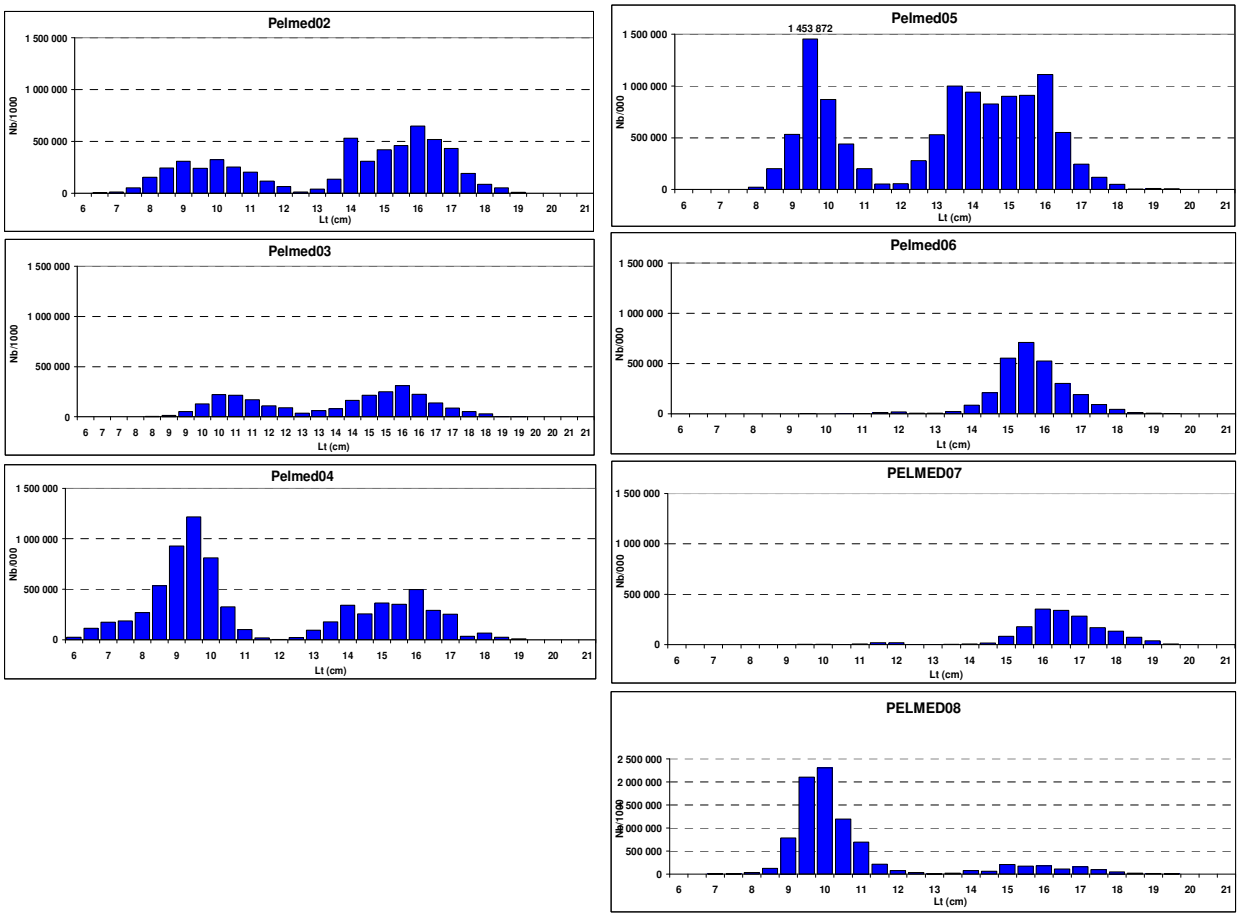

Figure 3.1.3.4.4: Series of acoustic estimates of the population of sardine in numbers at length (including Juveniles) in the Gulf of Lion.

3.1.3.5 Series of DEPM surveys: Biomass estimates

Not available

3.1.4 Assessment:

3.1.4.1 Exploratory Assessment analysis (full description of the essays)

No exploratory assessment

3.1.4.2 Adopted assessment method (brief reference to the standard method)

Acoustic assessment method with MEDIAS protocol and direct comparison of the level of catches on adults and the acoustic estimates of those adults (see figure 3.1.3.4.3).

3.1.5 Diagnostic

3.1.5.1 Assessment results (current stock and exploitation status)

Figure 3.1.4.1.3 summarise the assessment as the ratio of catches of adult sardine over the total acoustic biomass of the same fraction of the population.

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The assessment provided here is entirely dependent on the assumption of Acoustic survey providing unbiased estimates of the absolute level of biomass at sea. The perception of moderate harvest rates is based on the assumption of unbiased estimates of biomass by acoustic. For that reason current results should be taken with caution and the WG think that the current assessment should not be taken as an indication of space for increasing current fishing levels of effort.

As biomass estimation for 2006-2008 remains lower than the 2005 estimate, it is recommended not to increase the fishing effort, although the amount of juveniles in 2008 was bigger that recent year, about 50000 t.

3.1.5.2 Current state of the population levels or exploitation in relation to Reference points

The global species biomass estimated during Pelmed surveys showed strong fluctuations according to years. In 2005, the level of accessible biomass of small pelagic fishes (all species) was around 472000 tons, being the highest level for the period of 1993-2008. IN 2005 that high value was due to the presence of a rich inshore zone of small sardines.

The average ratio of catches to acoustic adult biomass for the last 3 years is 0.18, there is a moderate fishing effort but the stock abundance is low.

3.1.6 Management advice and recommendations

As biomass estimation for 2006-2008 remains lower than in former years, it is recommended not to increase the fishing effort, despite the fact that the amount of juveniles in 2008 was bigger than in recent years (50000 t). This recommendation is coherent with the advice given for anchovy for the same fishery in this area, as this a mixed fishery.

Scientific recommendation for the advice with the aim of assessing shared stocks, re-enforce of the cooperation between France and Spain to actualise biological data as well as catch and effort data collection for the boats of the two countries catching sardine in the Gulf of Lion is desirable.

3.2 Anchovy (*Engraulis encrasicolus*) in GSA07 (Gulf of Lions)

by J-L. Bigot and D. Roos (IFREMER, Sete).
Document: GFCM_SCSA_Ane_gsa07_2009.xls

3.2.1 Stock Unit basis or definition

GSA07 gulf of Lion. There seems to be connections in the egg distributions and drifting between the Gulf of Lion and the northern coasts of the Catalonian area in Spain (Sabatés et al. 2007) and the dynamics of anchovy in these areas has been parallel over the last decade are revealed by the pallelism of direct acoustic biomass estimates in these two areas.

3.2.2 Fishery

3.2.2.1 Catches (total tonnes) and trends in catches

Some French purse seine catches occasionally anchovy (25 tons/year).
2 to 6 Spanish purse seine catch also anchovy in the gulf of Lion (mean 600 tons/year and only 200 tons for the 3 last years).

Almost the entire catch are produced by the trawlers

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Catch	10000	8000	5000	6000	4769	6941	7073	4497	2249	2125	4133	4003

3.2.2.2 Fleets and trends in fleets

Catches are produced essentially by trawlers. A mean of 50 trawler boats in the last years are targeting anchovy.

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Fleet		113	113	113	113	56	50	50	50	50	50	41

3.2.3 Source of management advice (Inputs)

3.2.3.1 Biological data: Growth. maturity and natural mortality

Growth parameters are recorded in the assessment forms: K=0.35, Linfinity=19.1
Length at first maturity is about 11 cm
We make Length/weight relationship each year
In 2008 a=0.0056, b=3.03

3.2.3.2 Catch Inputs: Landing and discards (Tonnes),

No discards are reported
Length and age distributions are reported in the assessment form

3.2.3.3 Catch per unit effort for operational units (OU)
Not available

3.2.3.4 Direct monitoring: Acoustic survey

The stocks of the main species of small pelagics in the gulf of Lion are evaluated annually by acoustics since 1993 (Survey PELMED carried out in July). The survey data is described in the sheet “Other” of the assessment forms.
The pelagic species studied are anchovy and sardine in priority but also mackerels, horse mackerels, sardinella and sprat. The different species don’t have the same biology and behaviour (life span, reproduction period, habitat, …). The survey reports total biomass by species and for anchovy and sardine length and age distribution.
Transects are prospected, perpendicular to the coast at a speed of 8 knots, from 15-20 m depth until the offshore break. Pelagic and bottom trawling operations are performed to identify species met along transects. Population structures are identified by size and age.
The acoustic assessment results are completed by an analysis of catches and fishing effort to improve the fisheries diagnoses. In the current assessment just a direct comparison of the level catches to the level of biomass of the stock was carried out.
Also, the catches data and specific fishing effort collected by producer organisations are not sufficiently precise to permit an indirect approach of the stock assessments. Nevertheless some additional exploratory analysis based on the population at age estimates from the survey and the age composition of catches is presented in the sheet "Other" of the assessment form, but those results were considered too preliminary as to be adopted.

The global species biomass estimated during Pelmed surveys showed strong fluctuations according to years. In 2005, the level of accessible biomass of small pelagic fishes (all species) was around 472000 tons, highest level of 1993–2008 period. Mainly, the presence of a rich inshore zone of small sardines and an offshore zone of anchovy and biggest sardines was observed.

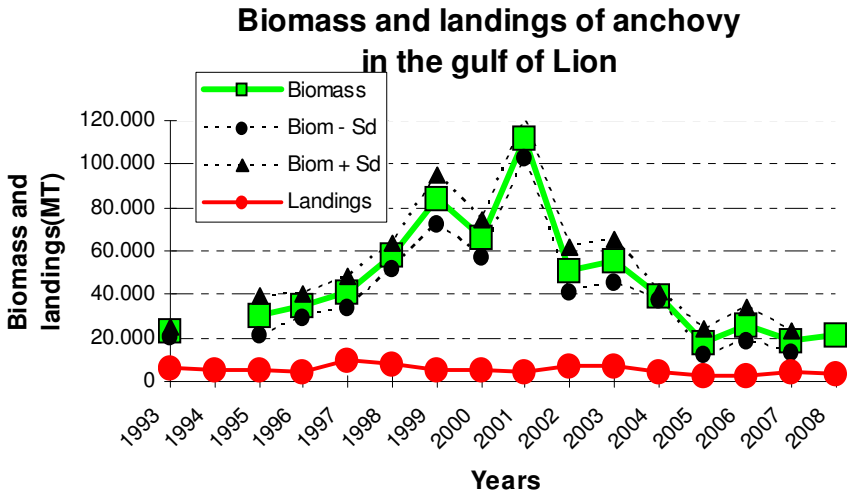


Figure 3.2.3.4.1: Evolution of biomass and landings of anchovy in GSA07

After a downward trend from 2001 peak until 2005 (18000 MT), anchovy biomass increased a little in 2006 to 26000 MT and drop down again with 18500 MT in 2007 and 21700 MT in 2008.

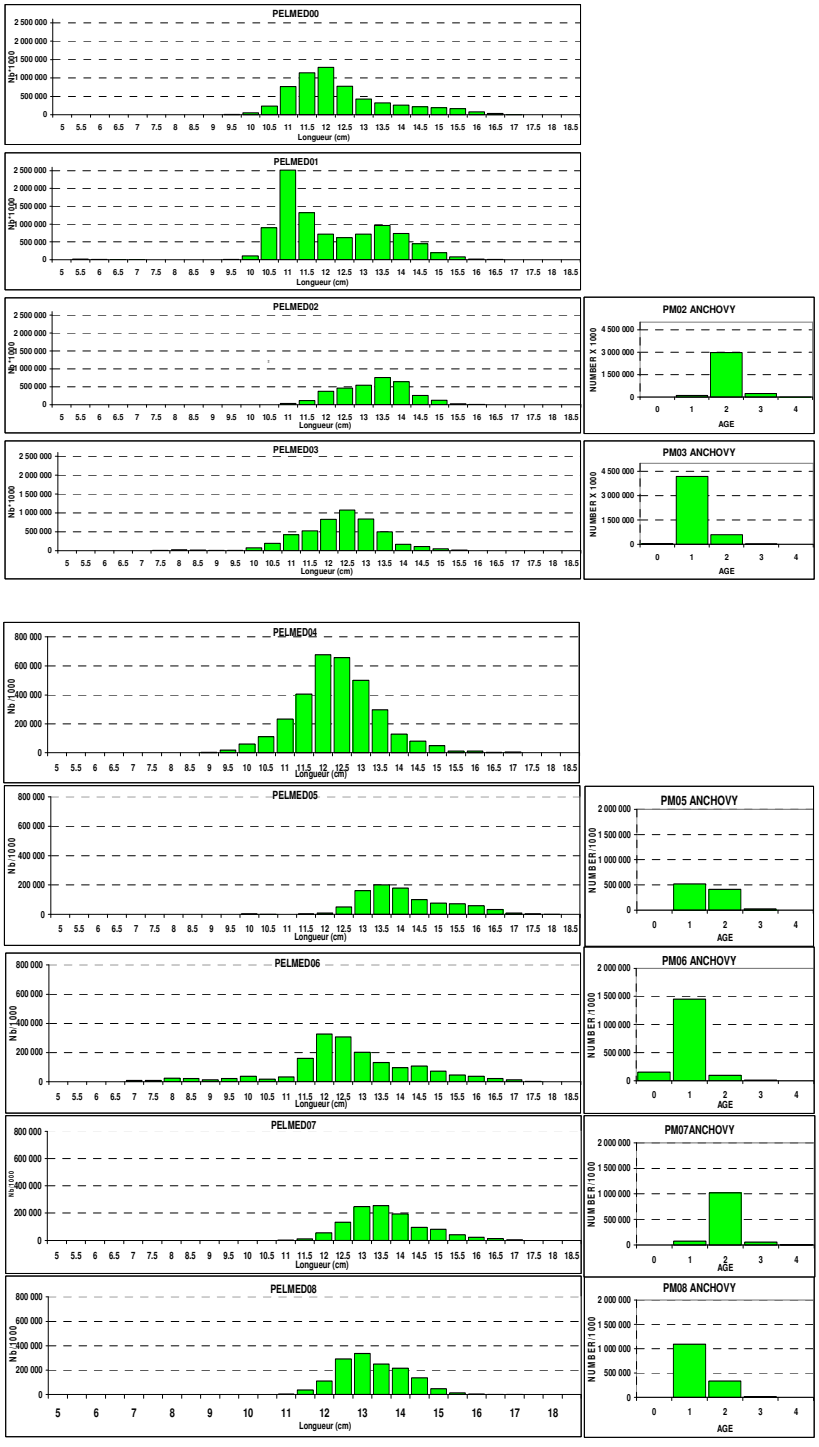


Figure 3.2.3.4.2: Anchovy population Length and age composition from PELMED in the gulf of Lion

3.2.3.5 Series of DEPM surveys: Biomass estimates

A DEPM survey carried out in June 2007 on the Gulf of lion by Palomera et al (2008) gave a spawning biomass of about 21000 t, a value very close to the acoustic biomass estimate provided by PELMED for that year.

3.2.4 Assessment:

3.2.4.1 Exploratory Assessment analysis (full description of the essays)

Exploratory analysis based on the population at age estimates from the survey and the age composition of catches is presented in 2nd page of Sheet other of the assessment form. A direct minimization of the catches at age and the population at age estimates (in log scales) was produced, in a way similar as the ICA (Patterson and Melvin) including in addition minimization to the total numbers in the population and the catches and to the total biomass and catches in tonnes. For the minimization of squared residuals the totals in numbers and biomass were weighted 5 times higher than the age structured so as to assure successful fitting to the total biomass values. Acoustic biomass is assumed to be an estimator of biomass in absolute terms.

The fitting to the spawning biomass was successfully achieved, and the decreasing tendency in biomass in the first period of the series is explained by the big recruitment occurring in 2002, not followed by any of comparable level (Figure 3.2.4.1.1). A selectivity at age 1 of about 0.8 is found relative to that of age 2. And fishing mortality in recent years might have increased. The absolute level of mean fishing mortality (for age 1 to 3) is low (ranging between 0.1 and 0.25) and as expected similar to the ratio between catches and total acoustic biomass.

However residuals to both the catches and population at age estimates were very high. Other fittings not giving higher weights to the biomass residuals resulted also in poor fitting of the catches and population at age. Therefore the analysis was considered to be still too noisy and preliminary as to be adopted

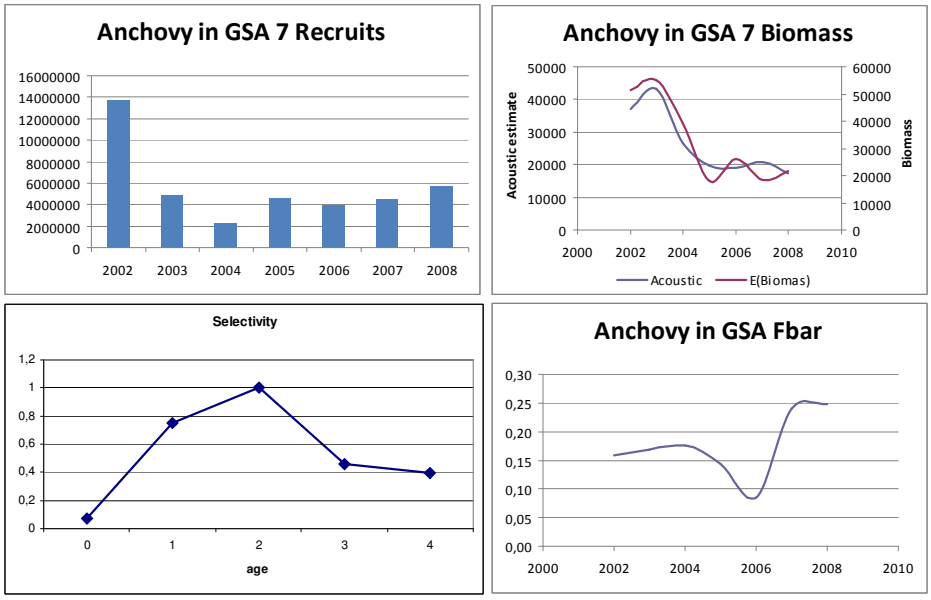


Figure 3.2.4.1.1: Exploratory assessment of the series of Recruitment, Adult biomass, selectivity at age and fishing mortality (ages 1-3).

3.2.4.2 Adopted assessment method

Acoustic method with MEDIAS protocol.

3.2.5 Diagnostic

3.2.5.1 Assessment results (current stock and exploitation status)

The assessment provided here is entirely dependent on the assumption of Acoustic biomass providing unbiased estimates of the absolute level of biomass at sea. In support of the catchability assumption it is worthwhile mentioning however that a DEPM carried out in June 2007 on the Gulf of lion by Palomera et al (2007) gave a spawning biomass of about 21000 t, a value very close to the acoustic biomass estimate provided by PELMED for that year.

The average ratio of catches to acoustic biomass for the last 3 years is 0.16, there is a moderate harvest rate but the stock abundance is low.

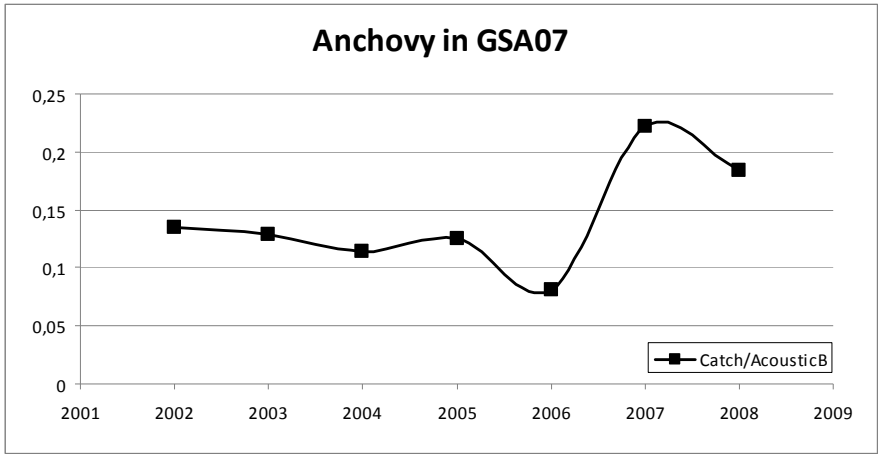


Figure 3.2.5.1: Ratio of anchovy annual catches over the Acoustic biomass of anchovy (in July) as indicator of harvest rate in the Gulf of Lion.

Nevertheless, the perception of moderate harvest rate is based on the assumption of unbiased estimates of biomass by acoustic. For that reason current results should be taken with caution and the WG think that the current assessment should not be taken as an indication of space for increasing current fishing levels of effort.

3.2.5.2 Current state of the population levels or exploitation in relation to Reference points

The average ratio of catches to acoustic biomass for the last 3 years is 0.16, there is a moderate harvest rate but the stock abundance is low.

3.2.6 Management advice and recommendations

The current biomass levels are low regarding the total series of acoustic biomass available and follow a decreasing trend since 2001. Therefore the advice, despite the apparent moderate level of harvest rate is to not allow any further increase of effort.

The evolution of the biomass of this population provided by acoustic is entirely similar to that being recorded in GSA06 by the acoustic survey (ECOMED) and to the tendencies in catches in that area (with minima in the most recent years)(SGMED-09-02 June 2009 WG report). Given the uncertainties about the potential connection of the anchovy population in these two GSA areas and the parallel decrease of anchovy biomass in the two regions a warning on the state of these populations has to be admitted. And for that reason the WG suggest not to increase the fishing effort on anchovy in this regions GSA07

3.3 Sardine, *Sardina pilchardus* - GSA16 (South of Sicily)

By Basilone G., Quinci E. M., Mazzola S.
Document: GFCM_SCSA_AssessmentForms_filled_SARDINE_09_rev1.xls

3.3.1 Stock Unit basis or definition

The main distribution area of the anchovy stock in GSA 16 is the narrow continental shelf area between Mazara del Vallo and the southernmost tip of Sicily, Cape Passero (Patti et al., 2004). Concerning the potential relationship of this sardine population with those inhabiting adjacent areas, insufficient information is available. No ichthyoplankton data across the Sicily Straits are available for sardine.

3.3.2 Fishery

Small pelagic fleets in GSA 16 are mainly concentrated in Sciacca port. As a result, catches are mainly landed in this port. Information collected in the framework of CA.SFO. study project (Patti et al., 2007) showed that landings in Sciacca port account for about 2/3 of the total landings in GSA 16. Two operational units (OUs) are presently active in Sciacca port, purse seiners and pelagic pair trawlers. In both OUs anchovy represents the main target species due to the higher market price compared to sardine.

3.3.2.1 Catches (total tonnes) and trends in catches

Average sardine landings over the period 1998-2008 were about 1,500 metric tons, with a general decreasing trend but large inter annual fluctuations (Fig. 3.3.2.1).
It is worth noting that, even though midwater pair trawlers are present in Sciacca port only, they contribute significantly to the total sardine landings.

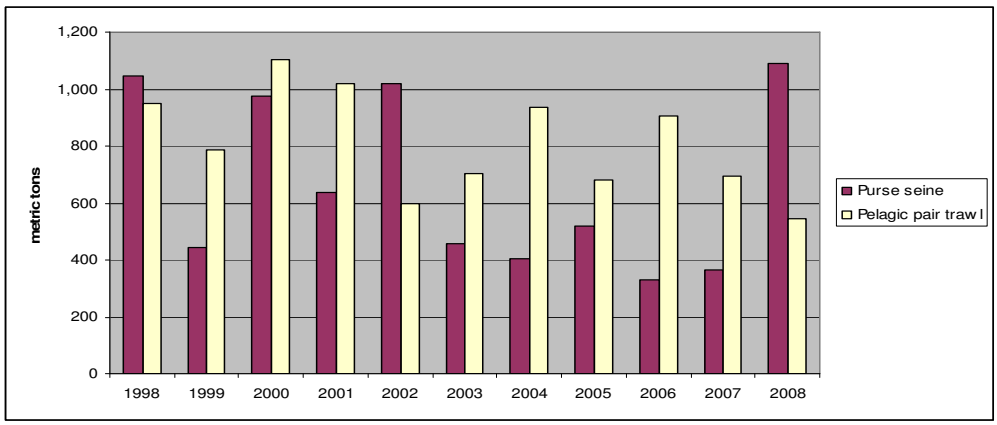


Fig. 3.3.2.1 Landings data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2008.

3.3.2.2 Fleets and trends in fleets

During the last decade the importance of pelagic pair trawl has gained importance compared to the traditional purse seine fishing activity (Fig. 3.3.2.2.1), which in turn exhibited no significant trend in terms of fishing effort.

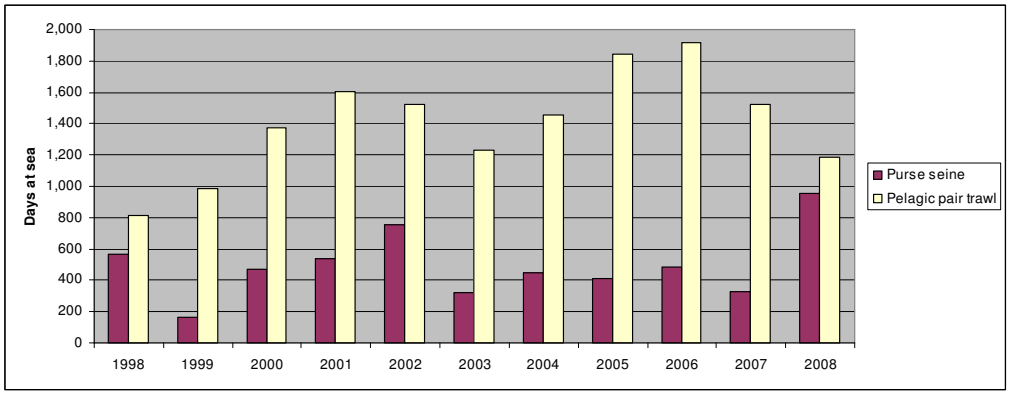


Fig. 3.3.2.2.1 Effort data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2008.

3.3.3 Source of management advice

3.3.3.1 Biological data: Growth. maturity and natural mortality

In this context, i.e. to the aims of the present stock assessment, growth parameters, taken from Basilone et al. (2004), were only used in order to estimate natural mortality using Pauly (1980) empirical relationship (M=0.51).

3.3.3.2 Catch inputs

Catch (landings) data herein used are from census data for Sciacca port (1998-2008) and from sampling data of DCR programme for the landings of the whole GSA16 (2006-2008). Catch at age data ranging from 2004 to 2008 were also used for the exploratory assessment analysis reported below (section 3.3.4.1).

3.3.3.3 Catch per unit effort for operational units (OUs)

Not used for the present assessment.

3.3.3.4 Direct monitoring: Acoustic survey

Biomass evaluations from echo-surveys carried out from 1998 to 2008 in GSA 16 show that sardine population experienced quite large inter-annual fluctuations, from about 36,000 t in 2000 to 6,000 t in 2002 (Fig. 3.3.3.4.1). Latest biomass estimates (2006-2008 surveys) are intermediate level compared to the rest of time series.

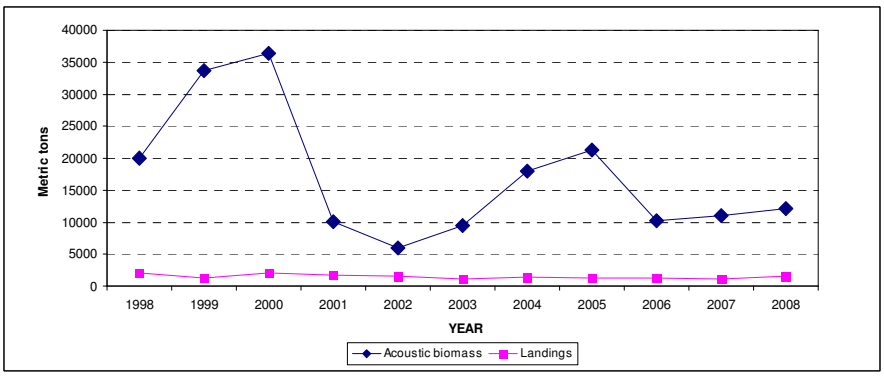


Fig. 3.3.3.4.1 Time series for sardine landings in Sciacca port (GSA 16) and acoustic biomass estimates (1998-2008).

Population at age data were also used for the tentative run of the exploratory assessment analysis reported below (section 3.3.4.1).

3.3.3.5 Direct Monitoring: Series of DEPM surveys

Not available.

3.3.4 Assessment

3.3.4.1 Exploratory Assessment analysis

An attempt to fit an XSA model was performed using FLR library in R environment. However, mainly due to the short length of the available time series, the obtained results were considered as very preliminary and were not used for the present assessment.

3.3.4.2 Adopted assessment method

The present assessment is based on the comparison of acoustic biomass estimates and estimated landings. Specifically, the average value over the last three years (2006-08) of the estimated harvest rates calculated as the ratio between total landings and acoustic biomass was used. Therefore, the assessment entirely relies on the assumption of acoustic surveys providing absolute estimates of biomass at sea (tonnes).

3.3.5 Diagnostic

3.3.5.1 Assessment results

Harvest rate (ratio between total landings and acoustic biomass estimates): harvest rate (average ratio for the last three years -2006-2008) is about 0.19.

Stock abundance (acoustic biomass estimate): intermediate abundance.

Sardine biomass, estimated by acoustic methods, ranged from a minimum of 6,000 tons in 2002 to a maximum of about 36,000 tons in 2000 over the last decade (1998-2008). During the same period landings did not exceed 2,300 tons.

Taking into account that fishing effort was relatively stable in last decade, and the moderate harvest rates experienced over the last decade, results would suggest the importance of environmental factors variability on yearly recruitment success.

Since 2006 biomass estimates have been at moderate level.

3.3.5.2 Current state of the population levels or exploitation in relation to Reference points

The yearly harvest rates, as estimated by the ratio between total landings and biomass, indicates moderate fishing mortality levels. Assuming Catch/Biomass as a rough indicator of the exploitation rate (F/Z) - assumption globally valid for low ratio Catch/Biomass values- then the fishing mortality level corresponding to F/Z=0.19 (the average E value over the last three years) is F=0.12 (For a M=0.51, estimated with Pauly (1980) empirical equation).

3.3.6 Management advice and recommendations

Current exploitation level seems to be moderate. Given the multispecies nature of this fishery, and in agreement with the recommendations concerning anchovy, the WG recommends that the fishing effort should not be allowed to increase.

As the exact impact of fry fishery on this population is not known, the WG also recommends a close monitoring of this fishery (catches and biological features).

3.4 Anchovy (*Engraulis encrasicolus*) in GSA16 (South of Sicily)

By Basilone G., Quinci E. M., Mazzola S.

Document: GFCM_SCSA_AssessmentForms_filled_ANCHOVY_09_rev1.xls

3.4.1 Stock Unit basis or definition

The main distribution area of the anchovy stock in GSA 16 is the narrow continental shelf area between Mazara del Vallo and the southernmost tip of Sicily, Cape Passero (Patti et al., 2004). Ichthyoplankton surveys were also carried out starting from 1998, giving also information on spawning grounds and retention areas for larval stages. Concerning the potential connections of this anchovy with that inhabiting adjacent areas, evidences from summer ichthyoplankton surveys suggest that anchovy population can be considered as an unique stock between GSA 16 (south of Sicily) and 15 (Malta), as there is not any discontinuity in egg distribution between the two GSAs. Conversely, no apparent connection in terms of spawning grounds appears to be between GSAs 15-16 and GSA 12-13-14 (Tunisian waters).

3.4.2 Fishery

Small pelagic fleets in GSA 16 are mainly concentrated in Sciacca port. As a result, catches are mainly landed in this port. Information collected in the framework of CA.SFO. study project (Patti et al., 2007) showed that landings in Sciacca port account for about 2/3 of the total landings in GSA 16. Two operational units (OUs) are presently active in Sciacca port, purse seiners and pelagic pair trawlers. In both OUs anchovy represents the main target species due to the higher market price.

3.4.2.1 Catches (total tonnes) and trends in catches

Average anchovy landings over the last decade (1997-2008) were about 1,600 metric tons, with large inter-annual fluctuations (Fig. 3.4.2.1.1). General trend is slightly increasing for both the OUs. It worth noting that, even though midwater pair trawlers are present in Sciacca port only, they contribute significantly to the total anchovy landings.

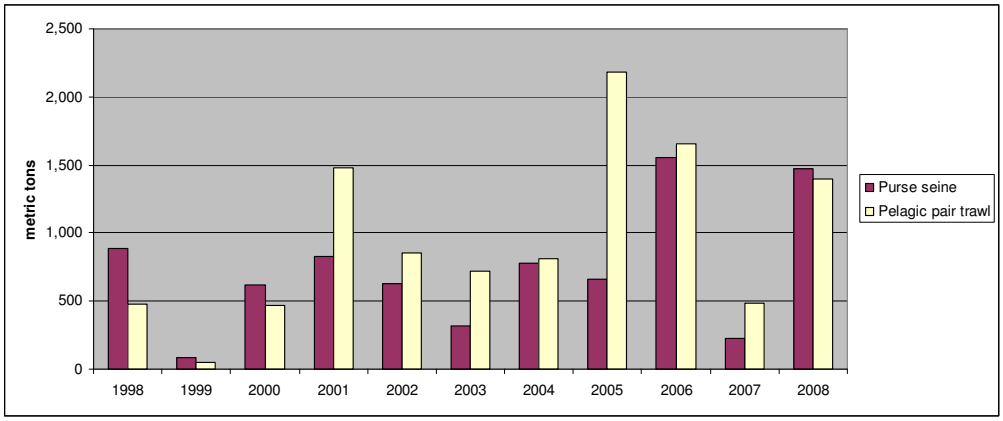


Fig. 3.4.2.1.1. Landings data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2008.

3.4.2.2 Fleets and trends in fleets

During the last decade the importance of pelagic pair trawl has gained importance compared to the traditional purse seine fishing activity (Fig. 3.4.2.2.1), which in turn exhibited no significant trend in terms of fishing effort.

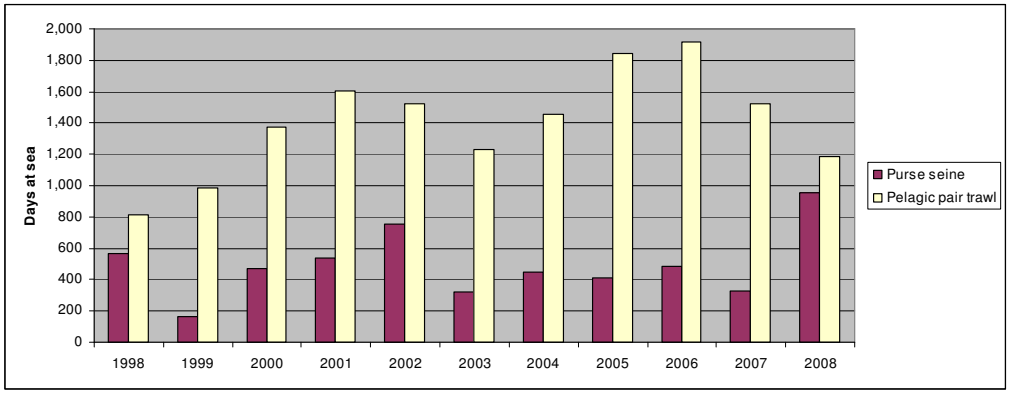


Fig. 3.4.2.2.1. Effort data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2008.

3.4.3 Source of management advice

3.4.3.1 Biological data: Growth. maturity and natural mortality

In this context, i.e. to the aims of the present stock assessment, growth parameters, taken from Basilone et al. (2004), were only used in order to estimate natural mortality using Pauly (1980) empirical relationship (M=0.66).

3.4.3.2 Catch inputs

Catch (landing) data herein used are from census data for Sciacca port (1998-2008) and from sampling data of DCR programme for the landings of the whole GSA16 (2006-2008).

3.4.3.3 Catch per unit effort for operational units (OUs)

Not used for the present assessment.

3.4.3.4 Direct monitoring: Acoustic survey

Biomass evaluations from echo-surveys carried out from June 1998 to August 2008 in the Strait of Sicily show that anchovy population experienced quite large inter-annual fluctuations, from a maximum of about 23,000 t in 2001 to a minimum of 3,100 t in 2008 (Fig. 3.4.3.4.1). Latest biomass estimates (2006-2008 surveys) are the lowest of the series.

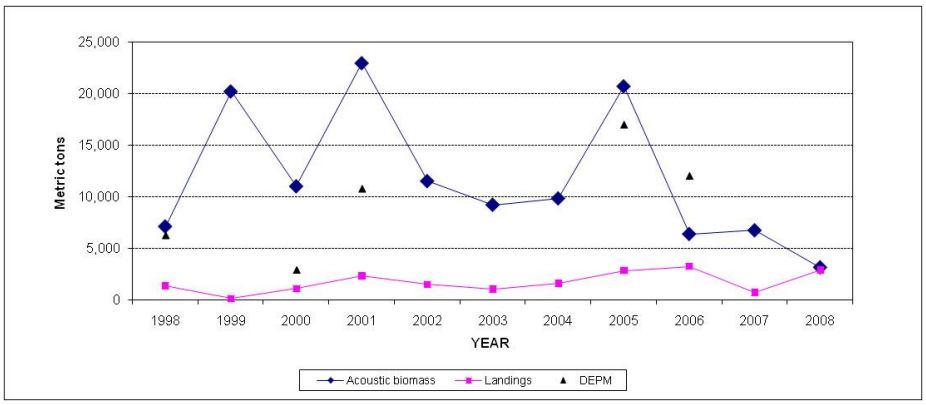


Fig. 3.4.3.4.1 Time series for landings in Sciacca port (GSA 16) and acoustic biomass estimates (1998-2008). Available DEPM estimates were also given for comparison purposes.

3.4.3.5 Series of DEPM surveys

Some DEPM biomass estimates available for the anchovy population in GSA 16 were also reported for comparison purposes, in order to show that they are in the same order of magnitude of acoustic biomass estimates (see Fig. 3.4.3.4.1).

3.4.4 Assessment

3.4.4.1 Exploratory Assessment analysis

No exploratory assessment analysis was carried out for the anchovy stock in GSA 16.

3.4.4.2 Adopted assessment method

The present assessment is based on the comparison of acoustic biomass estimates and estimated landings. Specifically, the average value over the last three years (2006-08) of the estimated exploitation rates calculated as the ratio between total landings and acoustic biomass was used. Therefore, the assessment entirely relies on the assumption of acoustic surveys providing absolute estimates of biomass at sea (tonnes). This assumption can be partly tested by confronting those estimates with the DEPM estimates for some years. In general DEPM estimates were quite close to the acoustics except for one year. So the former assumption is considered to be globally acceptable.

3.4.5 Diagnostic

3.4.5.1 Assessment results

Harvest rate (the ratio between total landings and biomass estimates): high fishing mortality is deduced for recent years as the average ratio between total Catch in GSA16 of anchovy and the acoustic biomass over the last 3 years (2006-2008) is about 0.75.

Stock abundance (acoustic biomass estimate): very low abundance.

Acoustic biomass evaluations show that anchovy population experienced quite large inter-annual fluctuations over the last decade. Taking into account that fishing effort was relatively stable in last decade, whereas CPUE trend was even increasing, results would suggest the importance of environmental factors variability on yearly recruitment success and/or a possible increase in the vulnerability of the resource.
However, the latest biomass estimates (2006-2008 surveys) are the lowest of the series. The stock biomass did not recover from the 2006 drop in biomass (-69% from July 2005 to June 2006), and also further decreased (-53%) in 2008. This fact, along with the quite high and increasing level of exploitation rates but with high variability experienced over the last years, give a warning about the sustainability of current levels of fishing effort.

3.4.5.2 Current state of the population levels or exploitation in relation to Reference points

The high and increasing yearly harvest rates, as estimated by the ratio between total landings and biomass, indicates high fishing mortality levels. The working group decided to make an average of the last 3 years catch/biomass ratios as a way to cancel individual observation survey errors, for that reason the last point is just averaged with the 2 precedent ones.

3.4.6 Management advice and recommendations

Given that biomass was very low for three consecutive years (2006, 2007 and 2008) and the increasing trend in exploitation rate, fishing effort should not be allowed to increase. The fry fishery for sardine should not be extended after March so as to avoid additional mortality of juvenile anchovy.

3.5 Anchovy and Sardine stock assessment in GSA 17 and 18 (Adriatic Sea)

by E. Arneri

Document: No StockAssessmentForms was laid down.

The Adriatic group convened two days in advance of the official GFCM-SAC WG on small pelagics in the ambit of the Sub-Regional Project AdriaMed. The aim of this pre session work was to be able to prepare a shared Adriatic dataset on small pelagic as a basic prerequisite of joint stock assessment activities to be performed during the SAC WG.

DATA

The Adriatic common data set obtained is based on the following data series:

3.5.1 Landings of anchovy and sardine

GSA 17: Landings data yearly for the interval 1975-2008 (all countries: Croatia, Italy and Slovenia) the collection is ongoing for all countries
GSA 18: Landings data yearly for the interval 2000-2008 (Italy and Montenegro) and 2001-2005 (Albania).

3.5.2 Length frequency distribution (LFD) of the landings anchovy and sardine

GSA 17 Croatia 1998-2008, collection ongoing
GSA 17 Italy 1975-2008 with two year, 1982 and 1983, missing but reconstructed, collection ongoing

GSA 17 Slovenia 2005-2008, collection ongoing
GSA 18 Albania 2001-2006, collection ongoing
GSA 18 Italy 2003-2008, collection ongoing
GSA 18 Montenegro landings negligible so no ongoing LFD data collection

3.5.3 Age data to be used as age-length key for an age frequency distribution of landings
GSA 17 Croatia 2001-2008, collection ongoing
GSA17 Italy 2001-2008, collection ongoing plus a series of years in the period 1975-2000
GSA 17 Slovenia 2006-2008, collection ongoing
GSA 18 Albania 2001-2006, collection ongoing
GSA 18 Montenegro no biological sampling (but see length frequency data),
GSA 18 Italy GSA 2003-2008, collection ongoing

3.5.4 Effort data
GSA 17 Italy CPUE data series for Porto Garibaldi fleet 1975-2008, ongoing, plus total effort data as foreseen by DCR 2002-2008, ongoing
GSA 17 Slovenia total effort data as foreseen by DCR 2005-2008, ongoing
GSA 18 Italy, total effort data as foreseen by DCR 2002-2008, ongoing

3.5.5 Echo survey data
GSA 17 Croatia, 2003-2008 yearly survey covering all eastern GSA 17, ongoing activity, total biomass data by species
GSA17 Italy, 1976-2008 (with interruptions) yearly survey covering all western GSA 17, ongoing activity, total biomass data by species for each year, and numbers at length (and at age) data for years 1997-2008.
GSA 17 Slovenia 2007-2008, ongoing activity, total biomass data by species, and numbers at length (and at age) data for 2007-2008
GSA 18 Albania 2008, total biomass data by species, ongoing
GSA 18 Montenegro 2002, 2004, 2005, 2008, total biomass data by species, ongoing
GSA 18 Italy 1987-2008 (with some interruptions), yearly survey covering all western GSA 18, ongoing activity, total biomass data by species, ongoing

3.5.6 Daily Egg Production Method data
GSA 18 Montenegro 2005, 2008 total spawning biomass of anchovy

3.5.7 Other:
MEDITS data (abundance index from standardised international trawl surveys covering all areas)
GSA 17 Croatia, Italy and Slovenia, 1994-2008 ongoing
GSA 18 Albania and Italy 1994-2008, (Montenegro from 2008), ongoing

3.5.8 SOURCE OF MANAGEMENT ADVICE
It has been decided to proceed in two ways, to have an assessment for anchovy and sardine for GSA 17 and to also make an assessment pooling together GSA 17 and 18, as stock boundaries are uncertain in the Adriatic in relation to the subdivision in GSAs.
It has been agreed to pool all the biomass from the echo surveys for all GSA 17 for the years when they are available. The same will be made (with some interpolation of missing

years) also for GSA 18 in order to have a common data series for GSA 17 and 18 for both species.

It has been agreed to build an overall length and age frequency distribution of commercial landings in order to run in conjunction with the acoustic estimate two different stock assessment methods: Laurec-Shepherd tuned VPA as traditionally carried out in previous SAC WGs using acoustic numbers at age as tuning series, and Integrated Catch at Age Analysis also using the overall biomass values obtained from acoustic surveys. The data interval to be used will be initially set for 1998-2008. Alternatively catch at age data ranging from 1975 to 2008 could be used as in previous year's assessment. In the past the biological data used to split the catches into age classes were relative to the Italian fleet. Since the fishing area of this fleet is very wide the assumption of using the Italian data was considered sensible. Now that the international catches at age will be available for the most recent period, the past assumption can be checked and refined if necessary.

The work could not be finished in the time frame of the GFCM-SAC WG on small pelagics, it will continue at sub-regional level and complete assessments including all the relevant stock assessment forms should be produced for the forthcoming Stock Assessment Sub Committee Meeting.

3.6 Sardine, *Sardina pilchardus* - GSA22 (Aegean Sea-NW part)

by Giannoulaki M., Somarakis S., Machias A., Kallianiotis A., Siapatis A., Papaconstantinou C.

Document: GFCM_SCSA_StockAssessmentForms GSA22 sardine 2009.xls

3.6.1 Stock Unit definition

This assessment is referring to the sardine stock in GSA 22 based on information derived from the Greek part of the Aegean Sea (GSA 22). The main distribution area of the sardine stock in Aegean Sea is located in the continental shelf of the northern Aegean Sea (Giannoulaki et al., 2004; Somarakis et al., 2007; Giannoulaki et al., 2008a).

3.6.2 Fishery

3.6.2.1 Catches (total tonnes) and trends in catches

In GSA 22 (Greek part) sardine is almost exclusively exploited by the purse seine fleet. Pelagic trawls are banned and benthic trawls are allowed to fish small pelagic fish in percentages less than 5% of their total catch. Regarding the regulations enforced they concern a closed period from the mid December till the end of February and technical measures such as minimum distance from shore, gear and mesh size, engine, GR. There is a minimum landing size at 9 cm. Discards values are less than 1%, reaching approximately 0.3% data for GSA 22.

The trend in reported landings (from Greek purse seiners fleet) is shown in Figs. 3.6.2.1.1 and 3.6.2.1.2. Landings were obtained within the framework of the Hellenic Centre for Marine Research data collection system that covers the Greek part of GSA 22. A slight decrease in sardine landings has been observed in 2007 and 2008. Data of the landings per vessel class indicate that small vessels (12-24 m) (Fig. 2.2) are mainly responsible for sardine catches (>88% of sardine catches).

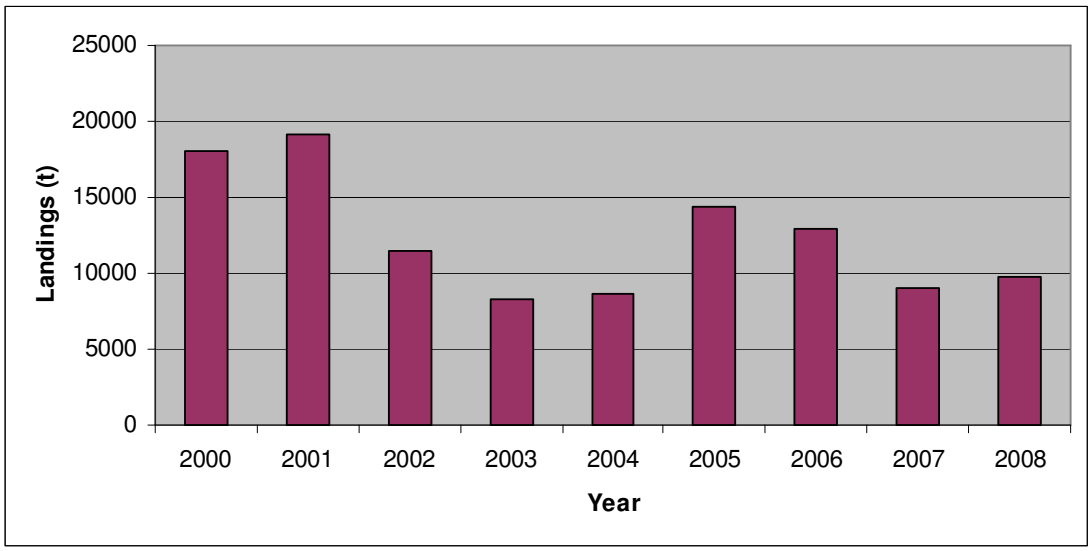


Fig. 3.6.2.1.1 Annual sardine landings (t) in the Greek part of GSA 22 for 2000-2008.

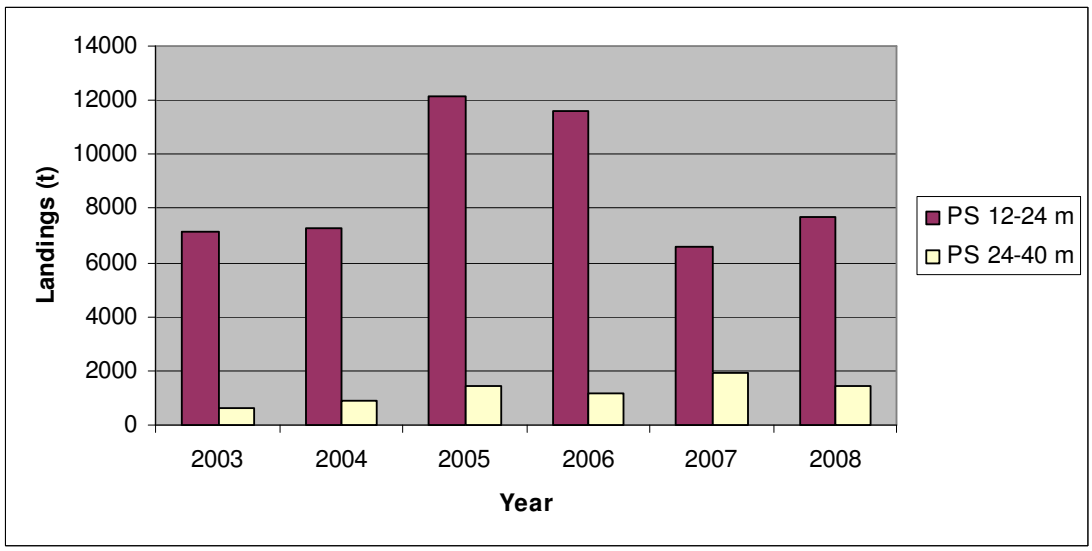


Fig. 3.6.2.1.2 Annual sardine landings (t) in the Greek part of GSA 22 per fleet size.

3.6.2.2 Fleets and trends in fleets

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

Year	PS 12-24 m	PS 24-40 m	PS 12-24 m	PS 24-40 m
	Days at Sea	*Days at Sea*	Days at Sea x KW	Days at Sea x KW
2003	41539	2942	8709727	679624

Year	PS 12-24 m	PS 24-40 m	PS 12-24 m	PS 24-40 m
2004	39783	3989	8111571	1029410
2005	42520	5690	8123673	1532790
2006	37255	5619	7386042	1606608
2007	31492	5338	6511187	1528440
2008	35090	4938	6898061	1335582

3.6.3 Source of management advice (Inputs)

3.6.3.1 Biological data: Growth. maturity and natural mortality

The following maturity at age ogive was used for sardine assessments in GSA 22 as estimated from biological sampling based on length at first maturity estimated approximately at 115mm (Machias et al., 2001; Machias et al., 2007) in Aegean Sea. The sardine spawning period in GSA 22 extends from November to April with maximum in December-January.

Table 3.6.3.1 Maturity ogives at age for female sardine in GSA 22.

Year	Age 0	Age 1	Age 2	Age 3	Age 4
2003	0	0.5	1	1	1
2004	0	0.5	1	1	1
2005	0	0.5	1	1	1
2006	0	0.5	1	1	1
2007	0	0.5	1	1	1
2008	0	0.5	1	1	1

Fast growth parameter was considered and parameters are shown in Table 3.6.3.1.2. No sex discrimination was applied. Natural mortality M was estimated based on ProBiom (Abella *et al.*, 1997).

Table 3.1.2. Growth parameters (v. Bertalanffy) for sardine in GSA 22.

	Fast growth Unsexed	Units
Linf	195	cm
K	0.39	$year^{-1}$
t0	-0.48	year
a	0.00003	gr
b	3.2144	
Mage0	1.5	$year^{-1}$
Mage1	0.96	$year^{-1}$
Mage2	0.69	$year^{-1}$
Mage3	0.61	$year^{-1}$
Mage4	0.57	$year^{-1}$

3.6.3.2 Catch Inputs: Landing and discards (Tonnes)

The trend in reported landings (from Greek purse seiners fleet) was shown in Fig. 3.6.2.1.1.

Annual lengths of landings are shown in Fig. 3.6.3.2.1 and catches at age in Fig. 3.6.3.2.2.

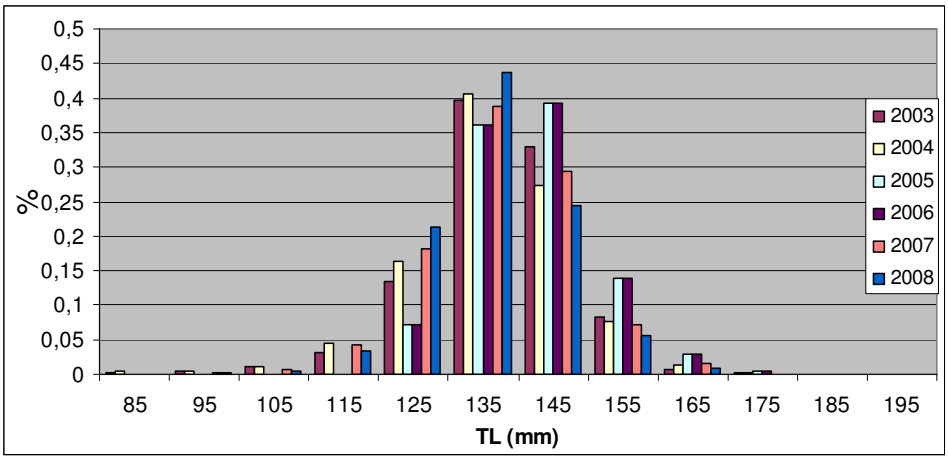


Fig. 3.6.3.2.1. Annual length frequency distribution of sardine landings (t) in GSA 22 for 2003-2008.

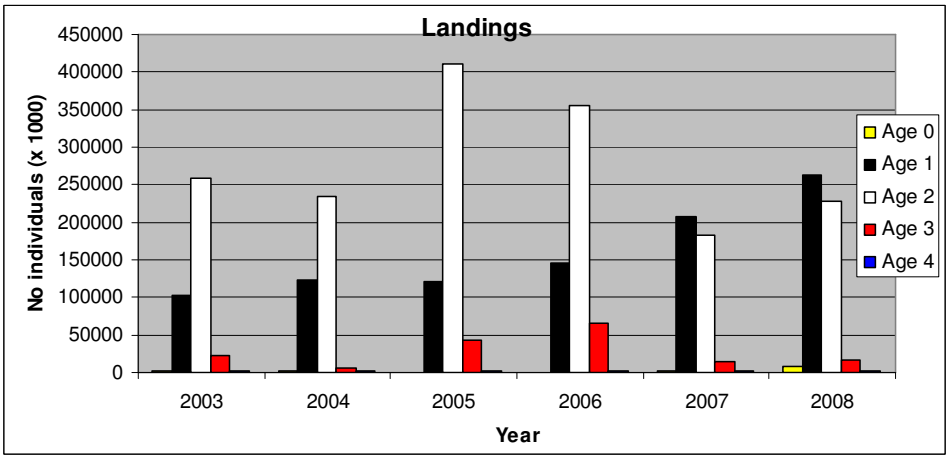


Fig. 3.6.3.2.2 Sardine landings per age group (No of individuals in thousands) in GSA 22 for 2003-2008.

3.6.3.3 Catch per unit effort for operational units (OU)

Not available

3.6.3.4 Direct monitoring Acoustic Surveys

Acoustic surveys for 2003-2006 and in 2008 have been used as fishery independent methods for the direct monitoring of the sardine population in the Greek part of GSA 22. They have been taking place in northern Aegean Sea where the main fishing ground of sardine in Aegean Sea is located.

Figure 3.6.3.4.1 displays the estimated trend in sardine Total Biomass.

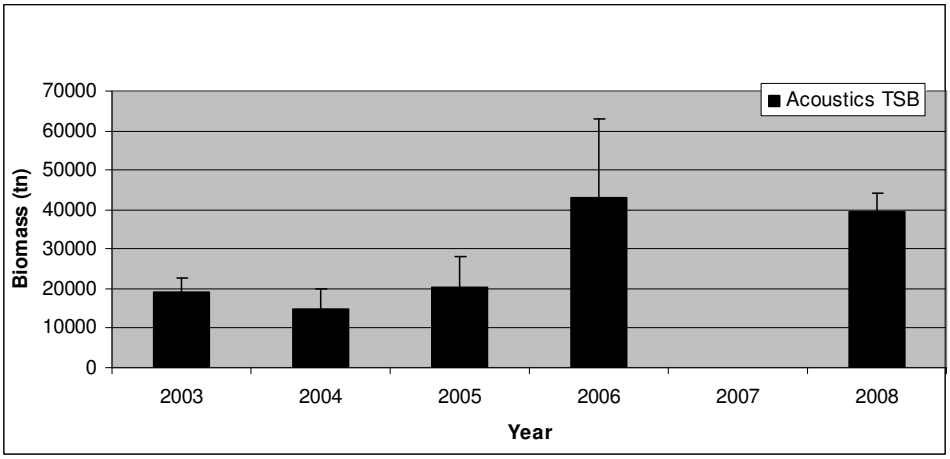


Fig. 3.6.3.4.1: Estimated sardine biomass indices from acoustics for GSA 22, 2003-2006 and 2008.

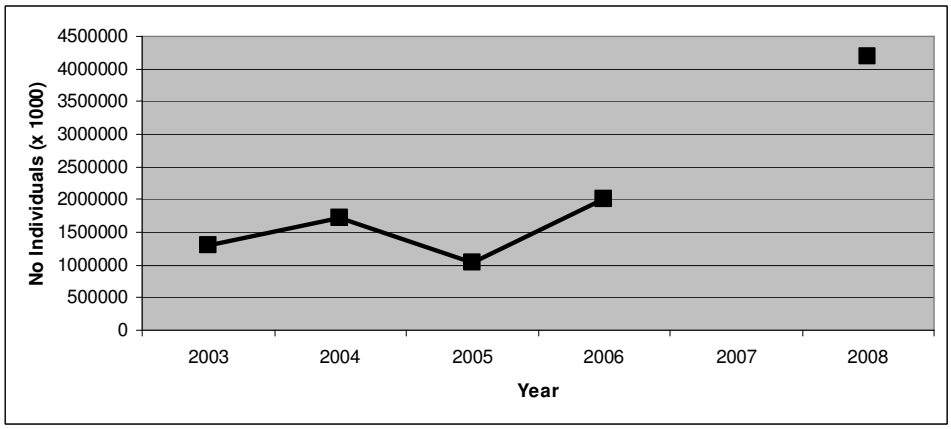


Fig. 3.6.3.4.2: Estimated sardine abundance indices for GSA 22, 2003-2006 and 2008.

An increasing trend was observed in both biomass and abundance indices since 2005 based on acoustic surveys estimates (Fig. 3.6.3.4.1 and Fig. 3.6.3.4.2).
Fig. 3.6.3.4.3 and Fig. 3.6.3.4.4 display the length frequency composition and the age composition of the sardine stock respectively as derived from the acoustic surveys in GSA 22.

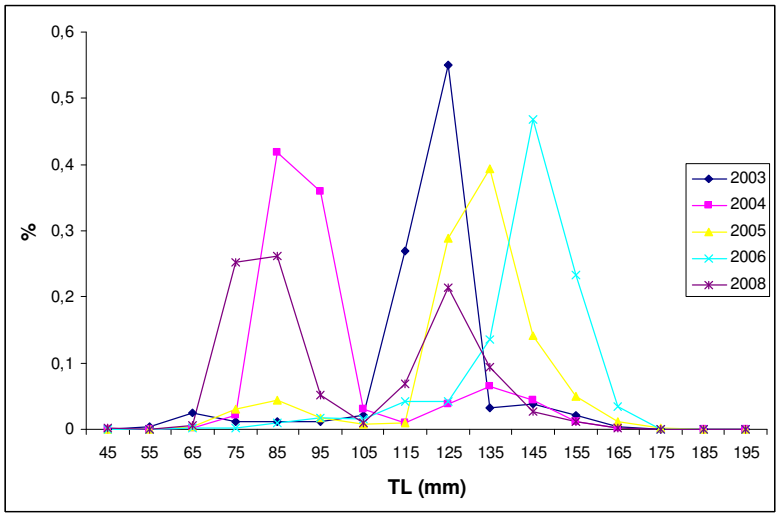


Fig. 3.6.3.4.3. Estimated size compositions for sardine stock in GSA 22 for 2003-2006 and 2008.

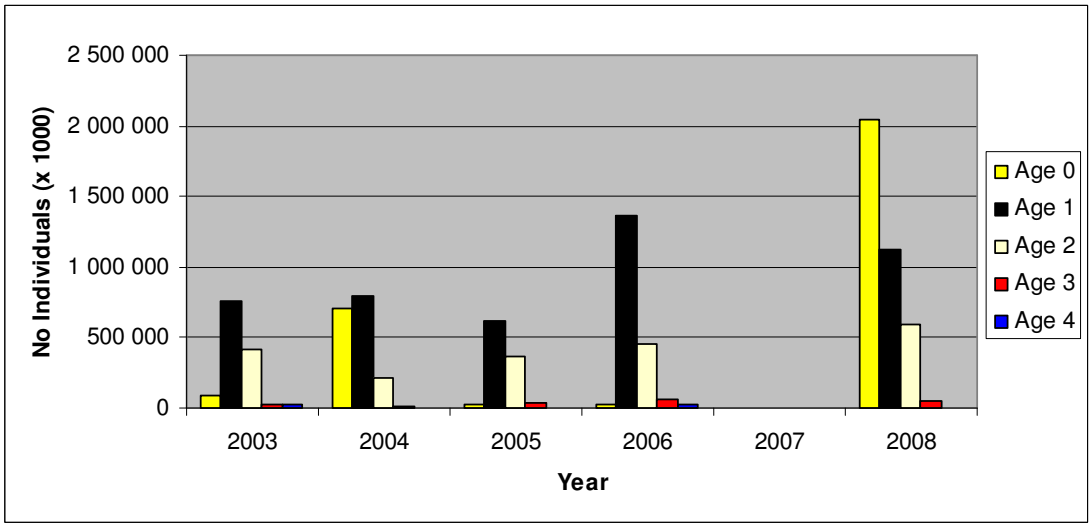


Fig. 3.6.3.4.4. Sardine Abundance indices by age for 2003-2006 and 2008.

3.6.4 Assessment:

3.6.4.1 Exploratory Assessment analysis.

None

3.6.4.2 Adopted assessment method

Integrated Catch at Age (ICA) analysis for stock assessment (Patterson and Melvin, 1998) was applied. Integrated Catch at age analysis (Patterson and Melvin 1996) uses separable virtual population analysis (VPA) (Pope & Shepherd, 1985) with weighted tuning indices. ICA was based on commercial catch data (2000-2008) and as tuning indices were used the biomass estimates from acoustic surveys over the period 2003-2006 and 2008. Sardine data

concerned annual sardine landings, annual sardine catch at age data (2000-2008), mean weights at age, maturity at age and the results of acoustic surveys (2003-2006 and 2008). Age-Length-Key was applied in a semester basis to convert length distribution into age distribution. In addition discards were taken into account. Specifically, according to unreported data obtained within the framework of the Hellenic Centre for Marine Research data collection system that covers the entire Greek part of GSA 22, discards are estimated to less than 1%, consisting 0.3% of the purse seine fishery total catch. Although considered negligible they were taken into account for the assessment as a percentage to reported landings.
Acoustic estimates were used as an index for the numbers at age of the population. Reference age for the fishery was age group 2, as fully exploited and fully recruited. Eight years separability was selected. The age groups 0, 4 and 5 were underweighted in the analysis based on their percentage in the catch. Age 1 was also underweighted in the acoustic surveys (0.5). Linear catchability relationship is assumed for the acoustic surveys. Different natural mortality values were applied per age group but constant for all years based on ProdBiom (Abella *et al.*, 1997). Concerning the lack of acoustic information for 2007, average values were used concerning the maturity o give and the weight at age in the stock.

3.6.5 Diagnostic

3.6.5.1 Assessment results.

The graphical diagnostics of the model are shown in Figs. 3.6.5.1.1. to 3.6.5.1.4, indicating generally good model fit besides year 2002 and age 4 probably because they are poorly sampled. This further justifies the down weighting of age 4 in the model. Residual plots for recent years showed no strong deviations from separability. However the high residuals for certain years for age 1 and age 3 could be reduced through a re-evaluation of the ALK.

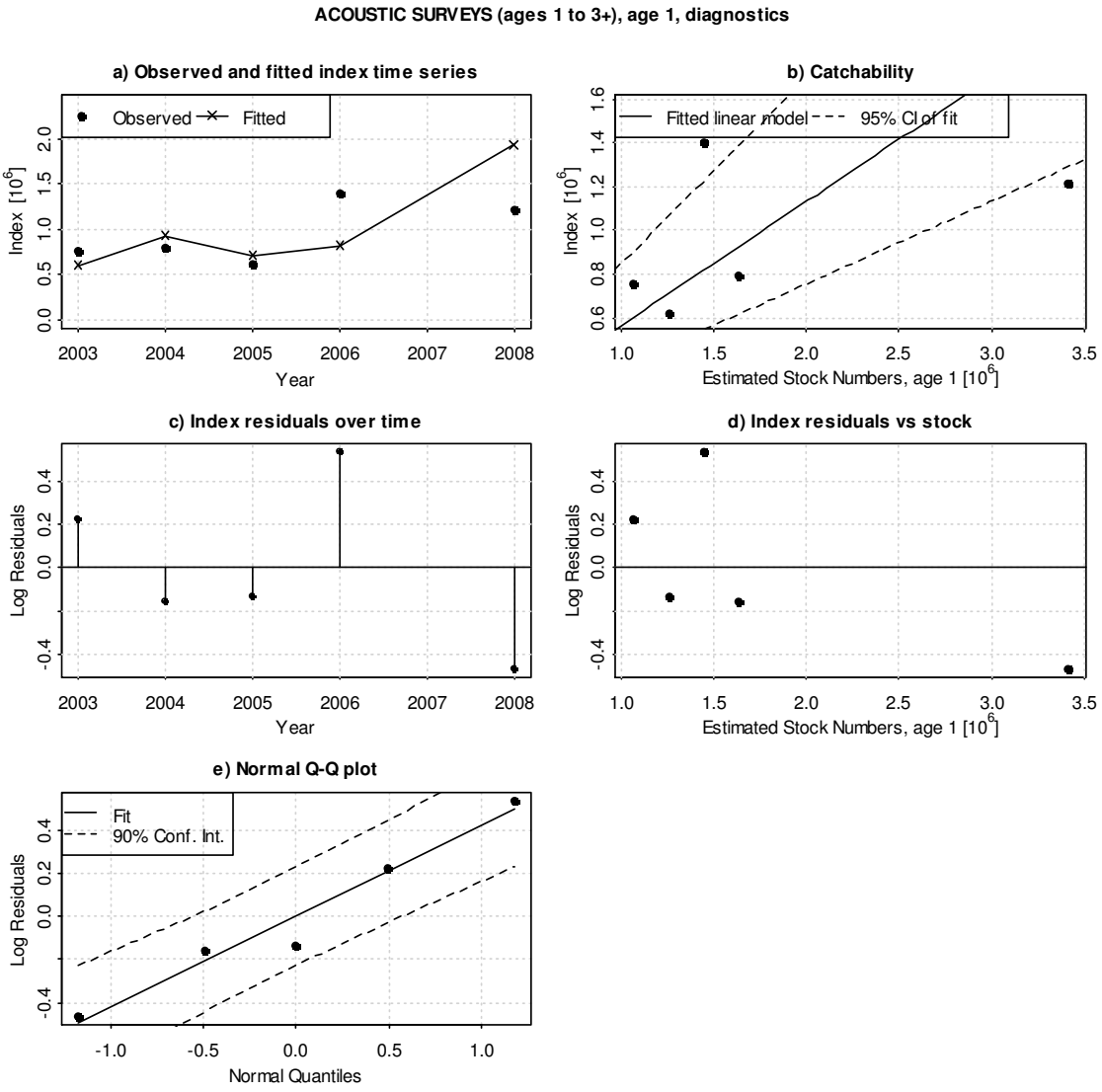


Fig. 3.6.5.1.1 Residual plots for age 1 indices of sardine ICA model for GSA 22 (2000-2008)

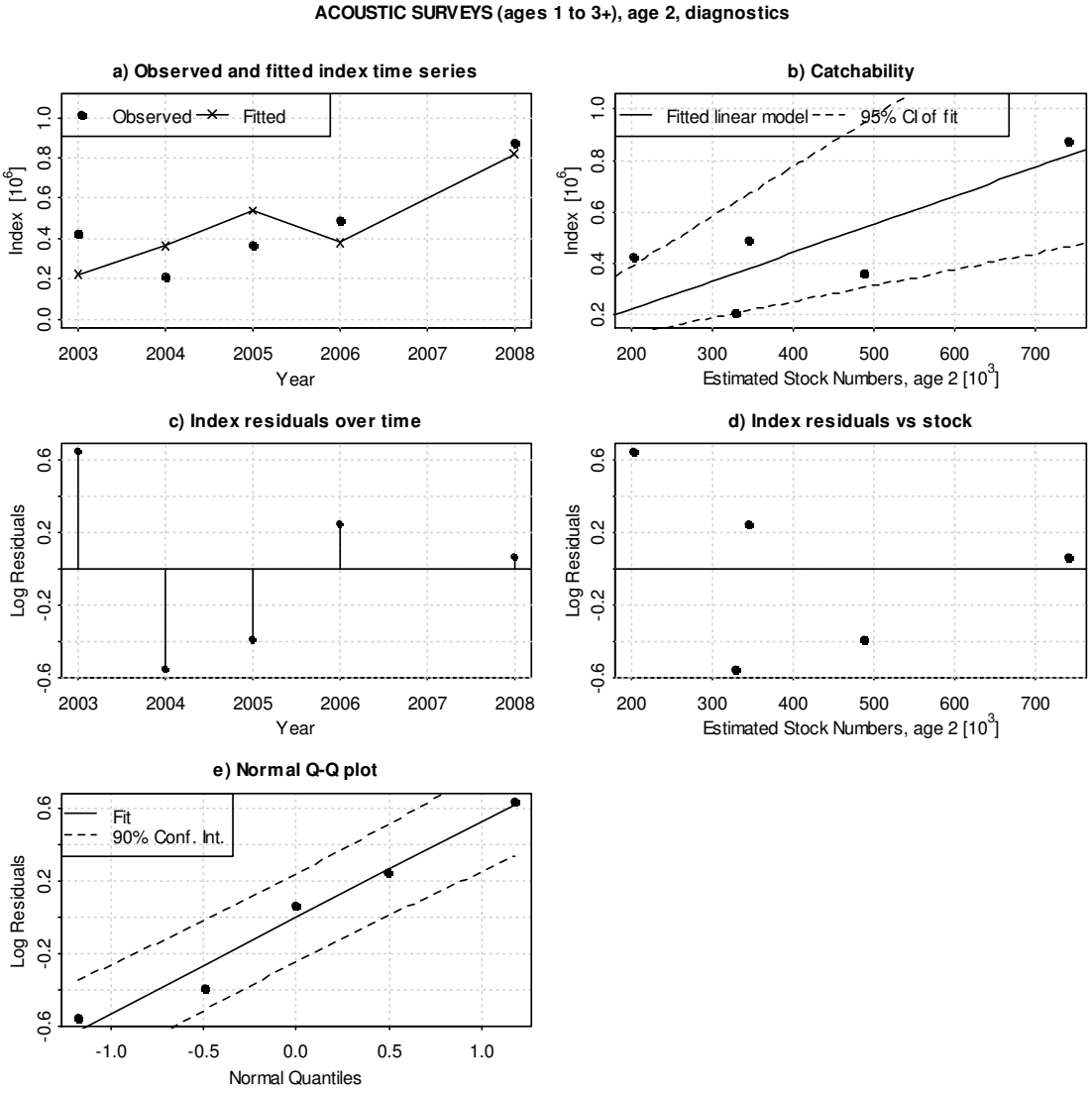


Fig. 3.6.5.1.2 Residual plots for age 2 indices of sardine ICA model for GSA 22 (2000-2008)

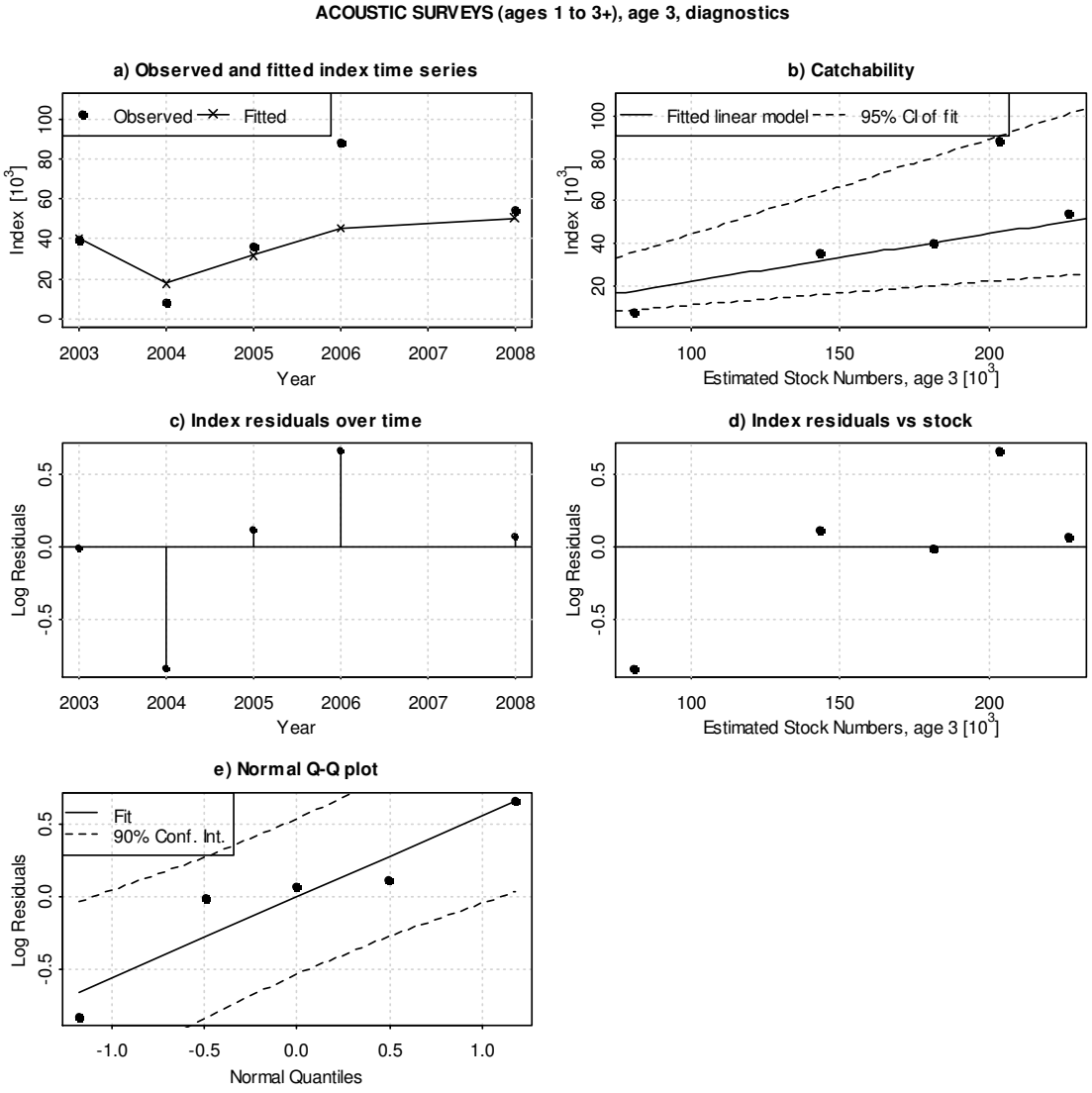


Fig. 3.6.5.1.3 Residual plots for age 3 indices of sardine ICA model for GSA 22 (2000-2008)

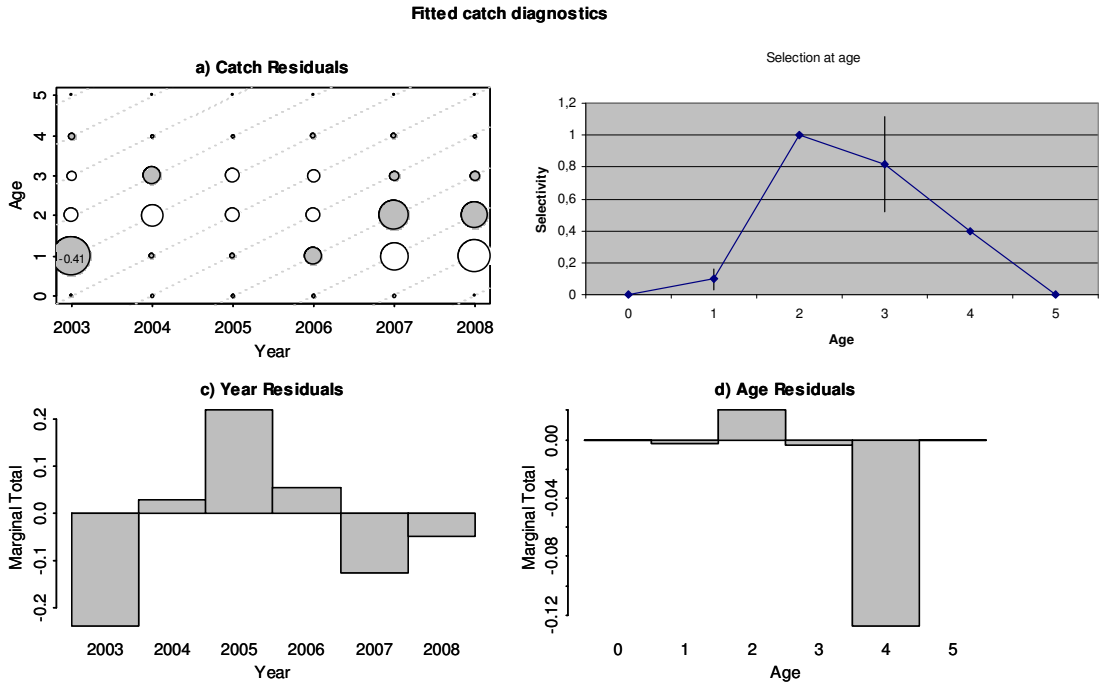
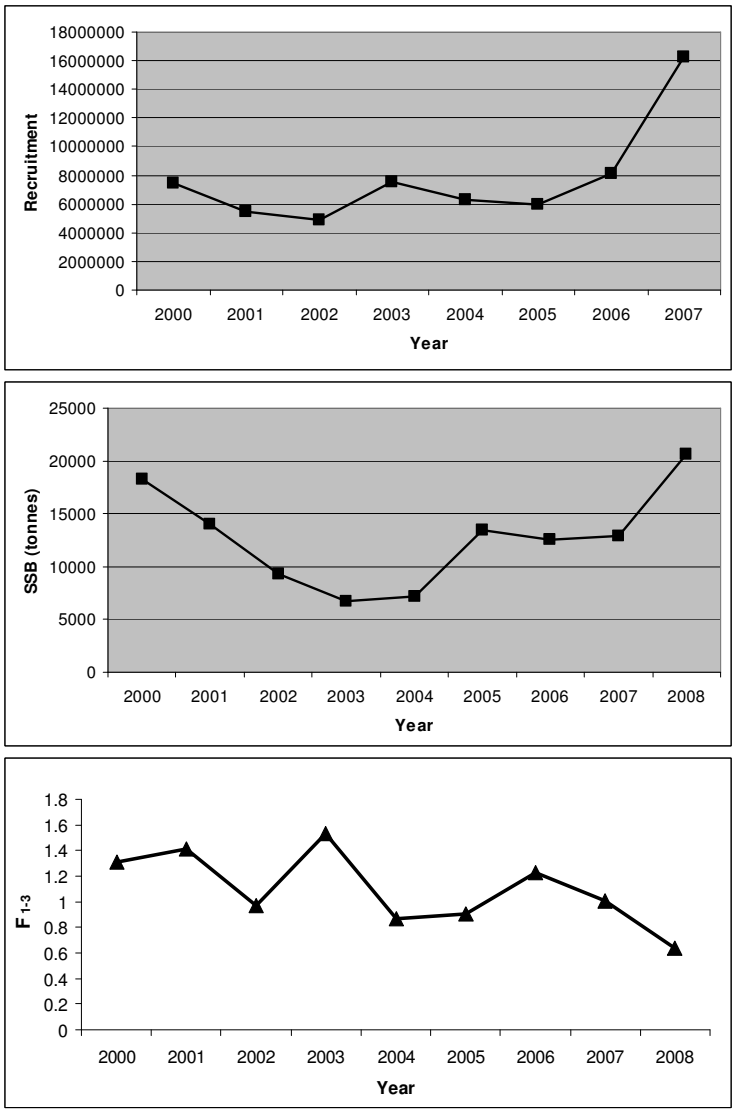


Fig. 3.6.5.1.4. The catch at age residuals of sardine ICA model for GSA 22 (2000-2008)

ICA model results for sardine stock in GSA 22 are shown in Fig. 3.6.5.1.5, indicating an increasing trend for recruitment in 2008. Last year (2008) ICA recruitment estimation was considered overestimations (as very little information about it is available in the input data - just catches at age 0 in 2008) and therefore not taken into consideration. An increase in biomass estimates has also been observed since 2004. F mean (ages 1 to 3) shows a decrease since 2006.



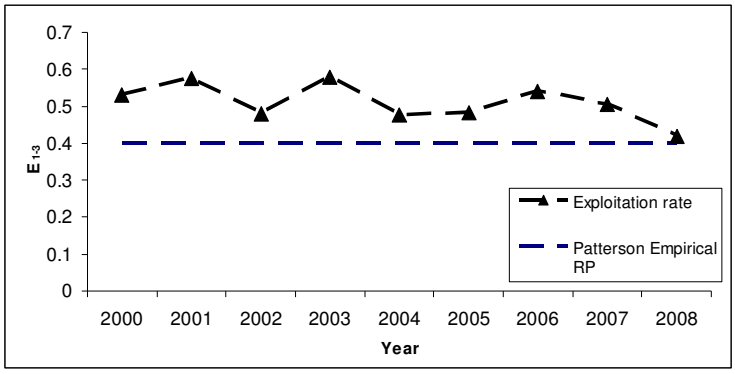


Fig. 3.6.5.1.5 Sardine ICA Model (M per age group based on ProBiom estimates, Acoustics linear indicator) results: Recruitment, SSB, exploitation rate (F/Z), F mean for ages 1-3.

3.6.5.2 Current state of the population levels or exploitation in relation to Reference points

This assessment should be taken as cautionary, as this ICA assessment for this area it is based on a short time series of data. Due to the short time series available no biomass reference point could be suggested by the GFCM WG. The current assessment of ICA for sardine indicated higher levels of exploitation rate, above the empirical level for stock decline (E>0.4, Patterson 1992) for small pelagic (Fig. 3.6.5.1.5). The average exploitation rate (E=0.484) for the recent five years of the time series available was suggested in order to advice on the exploitation status of the stock.

Based on this assessment results and the aforementioned parameters this stock is considered to be harvested sustainably, operating close but over an optimal yield level, with no expected room for further expansion.

3.6.6 Management advice and recommendations

Based on ICA results, the mean F (for ages 1 to 3), after an initial decrease between 2000 and 2003, shows a rather plane pattern at a lower level in recent years.

Conclusions: The assessment should be considered cautionary, as it is based on a short time series of data, not suitable to suggest reference points of Blim. Taking into account that sardine is a short living species characterized by high fluctuations in abundance and recruitment strongly depending on environmental conditions, it is advisable that current results are used for management advice.

The precautionary empirical level for stock decline (E<0.4, Patterson 1992) for small pelagics is suggested as the reference point to assess the current status of the exploitation of the stock. This value of exploitation rate for the recent five years of the time series is E=0.484. Based on this assessment results and the aforementioned parameters this stock is considered to be harvested sustainably, operating above but close to an optimal yield level, with no expected room for further expansion. However this has to be confirmed in

following years and the sardine stock should be monitored in an annual basis with direct assessment surveys.

Moreover, the likely consequences of changing the closed period for the purse seine fishery should be analysed. Since the fishery is considered a multispecies fishery targeting both anchovy and sardine, a shift in the closed fishing period (present middle December till the end of February) towards the recruitment period of anchovy (October to December) or the recruitment period of sardine (February to April) should be examined.

3.7 Anchovy, *Engraulis encrasicolus* - GSA22 (Aegean Sea-NW part)

by Giannoulaki M., Somarakis S., Machias A., Kallianiotis A., Papaconstantinou C.
Document: GFCM_SCSA_StockAssessmentForms GSA22 anchovy 2009.xls

3.7.1 Stock Unit definition

This assessment is referring to the anchovy stock in GSA 22 based on information derived from the Greek part of the Aegean Sea (GSA 22). The main distribution area of the anchovy stock in Aegean Sea is located in the continental shelf of the northern Aegean Sea (Giannoulaki et al., 2004; Somarakis et al., 2007; Giannoulaki et al., 2008a).

3.7.2 Fishery

3.7.2.1 Catches (total tonnes) and trends in catches

In GSA 22 (Greek part) anchovy is almost exclusively exploited by the purse seine fleet. Pelagic trawls are banned and benthic trawls are allowed to fish small pelagics in percentages less than 5% of their total catch. Regarding the regulations enforced they concern a closed period from the mid December till the end of February and technical measures such as minimum distance from shore, gear and mesh size, engine, GR. There is a minimum landing size at 9 cm. Discards values are less than 1%, reaching approximately 0.06% data for GSA 22.

The trend in reported landings (from Greek purse seiners fleet) is shown in Figs. 3.7.2.1.1 and 2. Landings were obtained within the framework of the Hellenic Centre for Marine Research data collection system that covers the Greek part of GSA 22. An increasing trend in anchovy landings has been observed. Data of the landings per vessel class indicate that small vessels (12-24 m) (Fig. 3.7.2.1.2) are mainly responsible for anchovy catches (>70% of anchovy catches).

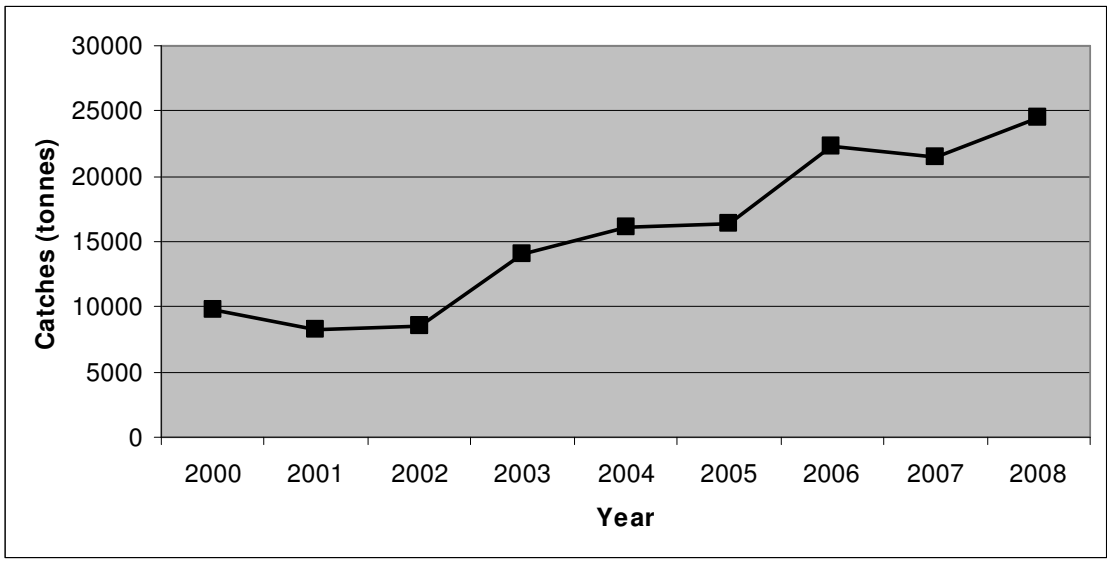


Fig. 3.7.2.1.1 Annual anchovy landings (t) in the Greek part of GSA 22 for 2000-2008.

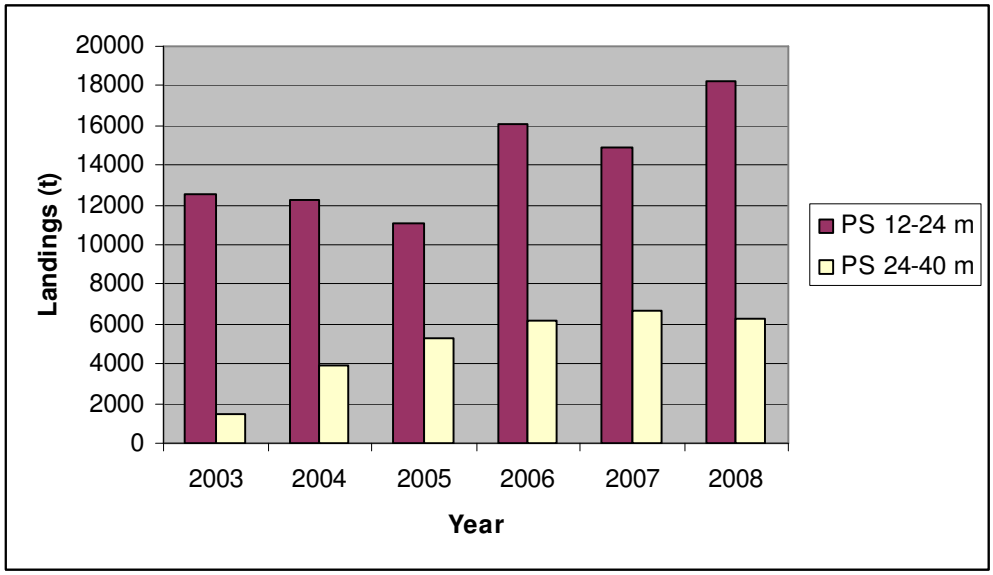


Fig. 3.7.2.1.2 Annual anchovy landings (t) in the Greek part of GSA 22 per fleet size.

3.7.2.2 Fleets and trends in fleets

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

Year	PS 12-24 m	PS 24-40 m	PS 12-24 m	PS 24-40 m
	Days at Sea	*Days at Sea*	Days at Sea x KW	Days at Sea x KW

Year	PS 12-24 m	PS 24-40 m	PS 12-24 m	PS 24-40 m
2003	41539	2942	8709727	679624
2004	39783	3989	8111571	1029410
2005	42520	5690	8123673	1532790
2006	37255	5619	7386042	1606608
2007	31492	5338	6511187	1528440
2008	35090	4938	6898061	1335582

3.7.3 Source of management advice (Inputs)

3.7.3.1 Biological data: Growth. maturity and natural mortality

The following maturity at age ogive was used for assessments in GSA 22 estimated from biological sampling and the DEPM surveys (Somarakis *et al.*, 2004; Somarakis et al., 2007). Length at first maturity is estimated approximately at 105mm (Somarakis *et al.*, 2004; Somarakis et al., 2007) in Aegean Sea. The anchovy spawning period in GSA 22 extends from May to August with a peak in June-July. The major spawning grounds of anchovy in the Aegean Sea are located in areas characterized by wide continental shelf and enrichment processes associated with the outflow from large rivers or the Black Sea Water (BSW) in the northern Aegean Sea. Consequently, the highest egg densities have been typically observed over the northern Aegean Sea continental shelf.

Table 3.7.3.1.1 Maturity ogives at age for female anchovy in GSA 22.

Year	Age 0	Age 1	Age 2	Age 3	Age 4
2003	0	0.62	0.99	1	1
2004	0	0.67	0.99	1	1
2005	0	0.46	0.98	1	1
2006	0	0.40	0.98	1	1
2007	0	0.40	0.98	1	1
2008	0	0.40	0.98	1	1

Fast growth parameter was considered and parameters are shown in Table 3.7.3.1.2. No sex discrimination was applied. Natural mortality M was estimated based on ProBiom (Abella *et al.*, 1997).

Table 3.7.3.1.2. Growth parameters (v. Bertalanffy) for anchovy in GSA 22.

	Fast growth Unsexed	Units
Linf	191	cm
K	0.385	$year^{-1}$
t0	-1.559	year
a	0.00004	gr
b	3.1157	

M age 0	1.5	year^{-}
M age 1	1	year^{-}
M age 2	0.72	year^{-}
M age 3	0.66	year^{-}
M age 4	0.62	year^{-}

3.7.3.2 Catch Inputs: Landing and discards (Tonnes)

The trend in reported landings (from Greek purse seiners fleet) was shown in Figs. 3.7.3.2.1. Landings were obtained within the framework of the Hellenic Centre for Marine Research data collection system that covers the Greek part of the entire GSA 22. An increasing trend in anchovy landings has been observed. Discards were also included within this assessment representing however only 0.06 % of total landings.

Annual lengths of landings are shown in Fig. 3.2.1 and catches at age in Fig. 3.7.3.2.2

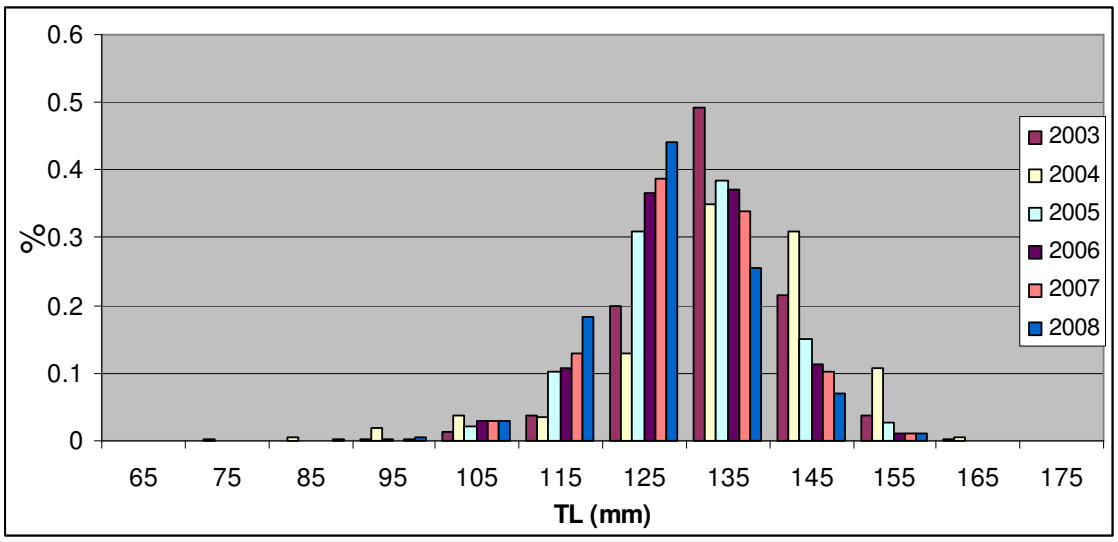


Fig. 3.7.3.2.1. Annual length frequency distribution of anchovy landings (t) in GSA 22 for 2003-2008.

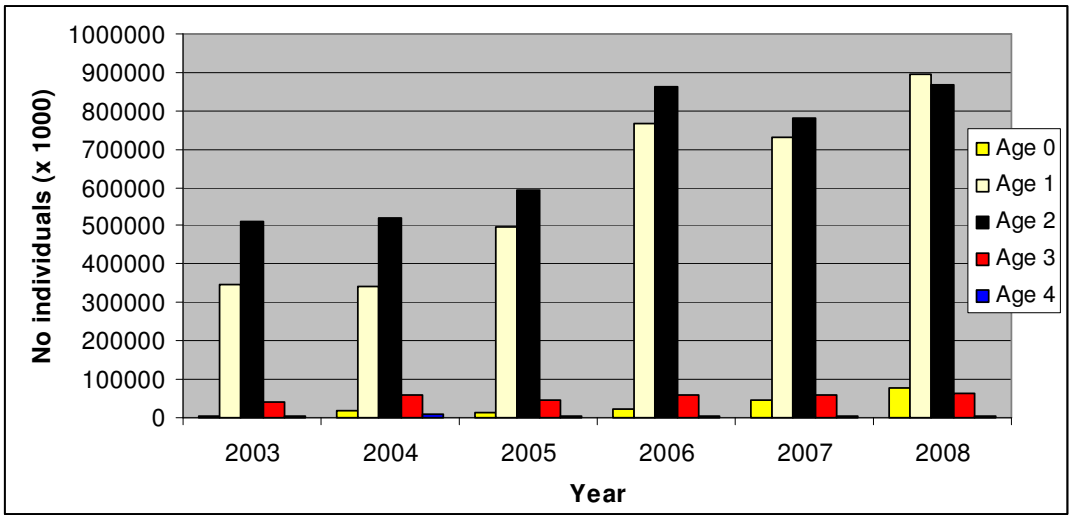


Fig. 3.7.3.2.2 Anchovy landings per age group (No of individuals in thousands) in GSA 22 for 2003-2008.

3.7.3.3 Catch per unit effort for operational units (OU)

Not available

3.7.3.4 Direct monitoring: Acoustic & DEPM survey

Acoustic surveys and DEPM surveys for 2003-2006 and in 2008 have been used as fishery independent methods for the direct monitoring of the anchovy population in the Greek part of GSA 22. They have been taking place in northern Aegean Sea where the main fishing ground of anchovy in Aegean Sea operates.

Figure 3.7.3.4.1. displays the estimated trend in anchovy Total Biomass (estimated by acoustics) and Spawning Stock Biomass (estimated by DEPM).

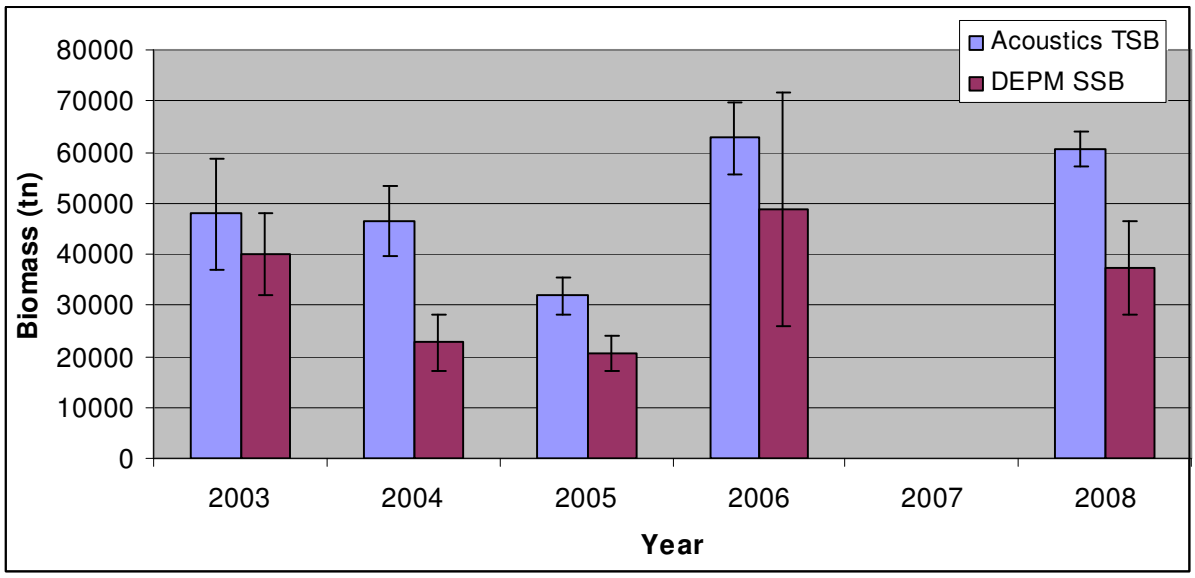


Fig. 3.7.3.4.1. Estimated anchovy biomass indices from acoustics and DEPM for GSA 22, 2003-2006 and 2008.

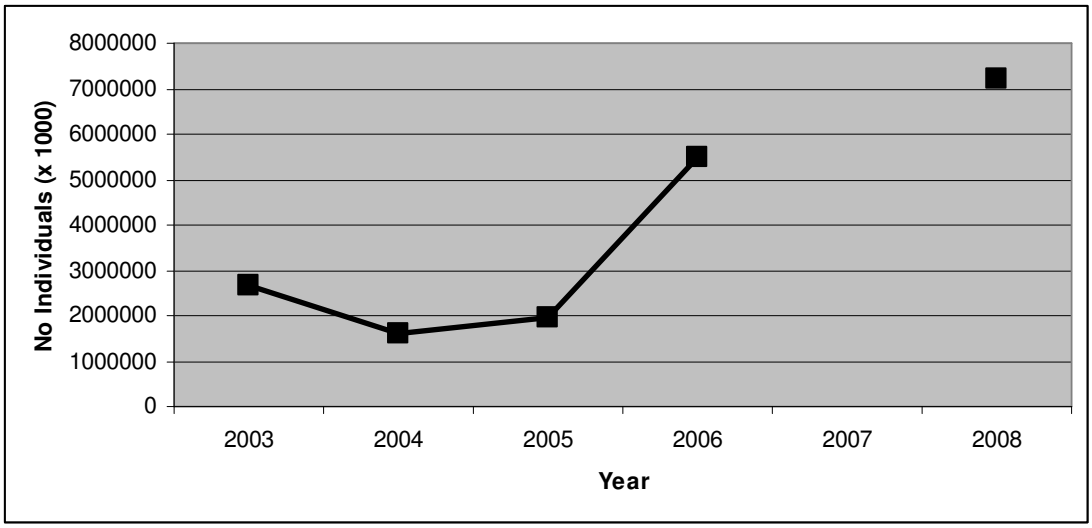


Fig. 3.7.3.4.2. Estimated abundance indices for GSA 22, 2003-2006 and 2008.

An increasing trend was observed in both biomass and abundance indices towards 2006 that tends to stay in a similar biomass and abundance level in 2008 (Fig. 3.7.3.4.1., Fig. 3.7.3.4.2). Fig. 3.7.3.4.3. displays the length frequency composition of the anchovy stock as derived from the acoustic surveys in GSA 22.

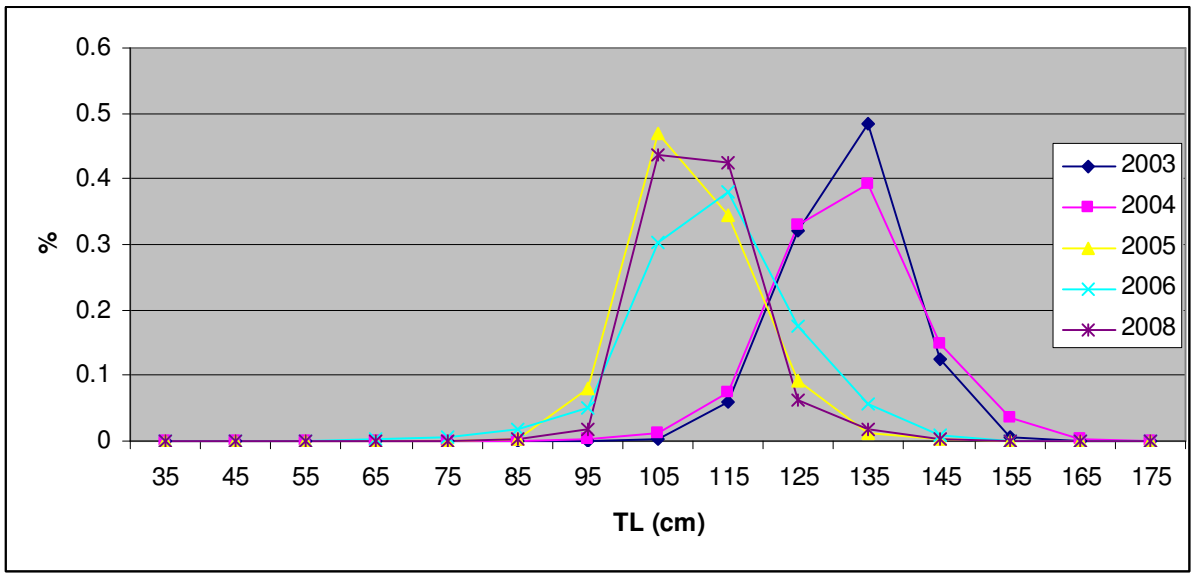


Fig. 3.7.3.4.3. Estimated changes in size compositions for GSA 22 for 2003-2006 and 2008.

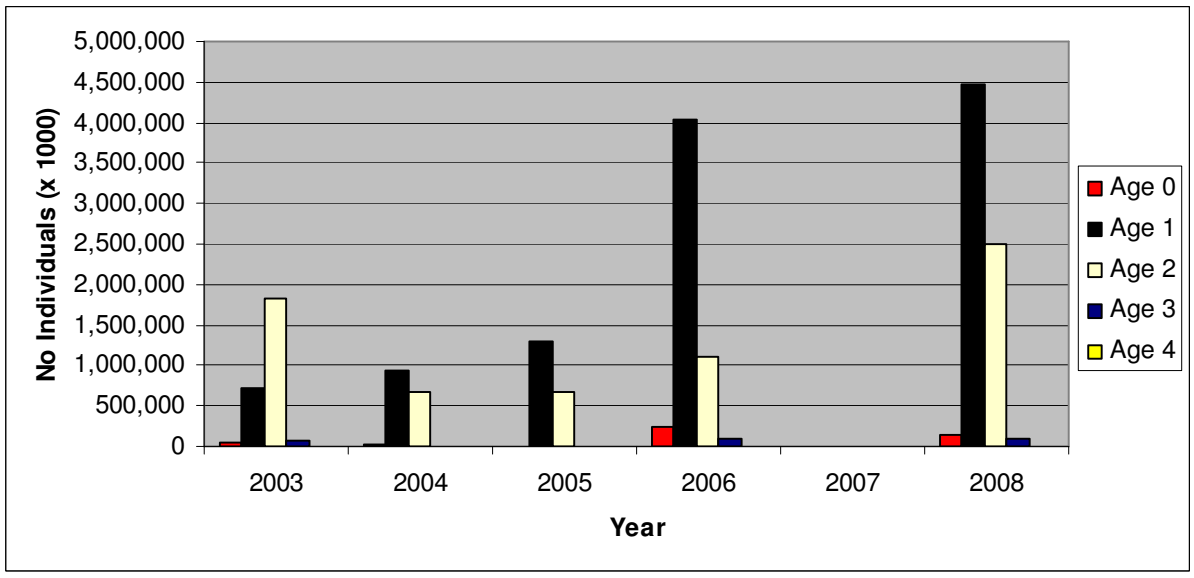


Fig. 3.7.3.4.4. Abundance indices by age for 2003-2006 and 2008.

3.7.4 Assessment:

3.7.4.1 Exploratory Assessment analysis.

None

3.7.4.2 Adopted assessment method

Integrated Catch at Age (ICA) analysis for stock assessment (Patterson and Melvin, 1998) was applied. Integrated Catch at age analysis (Patterson and Melvin 1996) uses separable virtual population analysis (VPA) (Pope & Shepherd, 1985) with weighted tuning indices. ICA was based on commercial catch data (2000-2008) and as tuning indices were used the biomass estimates from acoustic surveys and the Daily Egg Production Method (DEPM) estimates over the period 2003-2006 and 2008. Anchovy data concerned annual anchovy landings, annual anchovy catch at age data (2000-2008), mean weights at age, maturity at age and the results of acoustic and DEPM surveys (2003-2006 and 2008). Age-Length-Key was applied in a semester basis to convert length distribution into age distribution. In addition discards were taken into account. Specifically, according to unreported data obtained within the framework of the Hellenic Centre for Marine Research data collection system that covers the entire Greek part of GSA 22, discards are estimated to less than 1%, consisting 0.06% of the purse seine fishery total catch. Although considered negligible they were taken into account for the assessment as a percentage to reported landings.
Since, acoustics and DEPM are being applied at the same time and with the same research vessel in Aegean Sea, acoustic estimates were used as an index for the numbers at age of the population and DEPM estimates as stock spawning biomass estimates. Reference age for the fishery was age group 2, as fully exploited and fully recruited. Eight years separability was selected. The age groups 0, 4 and 5 were underweighted in the analysis based on their percentage in the catch. Age 1 was also underweighted in the acoustic surveys (0.5). Catchability for the DEPM index is assumed as absolute indicator of Biomass, linear catchability relationship is assumed for the acoustic surveys. Different natural mortality values were applied per age group but constant for all years based on ProBiom (Abella *et al.*, 1997). Concerning the lack of acoustic and DEPM information for 2007, average values were used concerning the maturity o give and the weight at age in the stock.

3.7.5 Diagnostic

3.7.5.1 Assessment results (current stock and exploitation status)

The graphical diagnostics of the model are shown in Figs. 3.7.5.1.1 to 5.1.5 indicating generally showed good model fit besides year 2002 and age 4 probably because they are poorly sampled. This further justifies the down weighting of age 4 in the model. Residual plots for recent years showed no strong deviations from separability. However the high residuals for certain years for age 1 and age 3 could be reduced through a re-evaluation of the ALK.

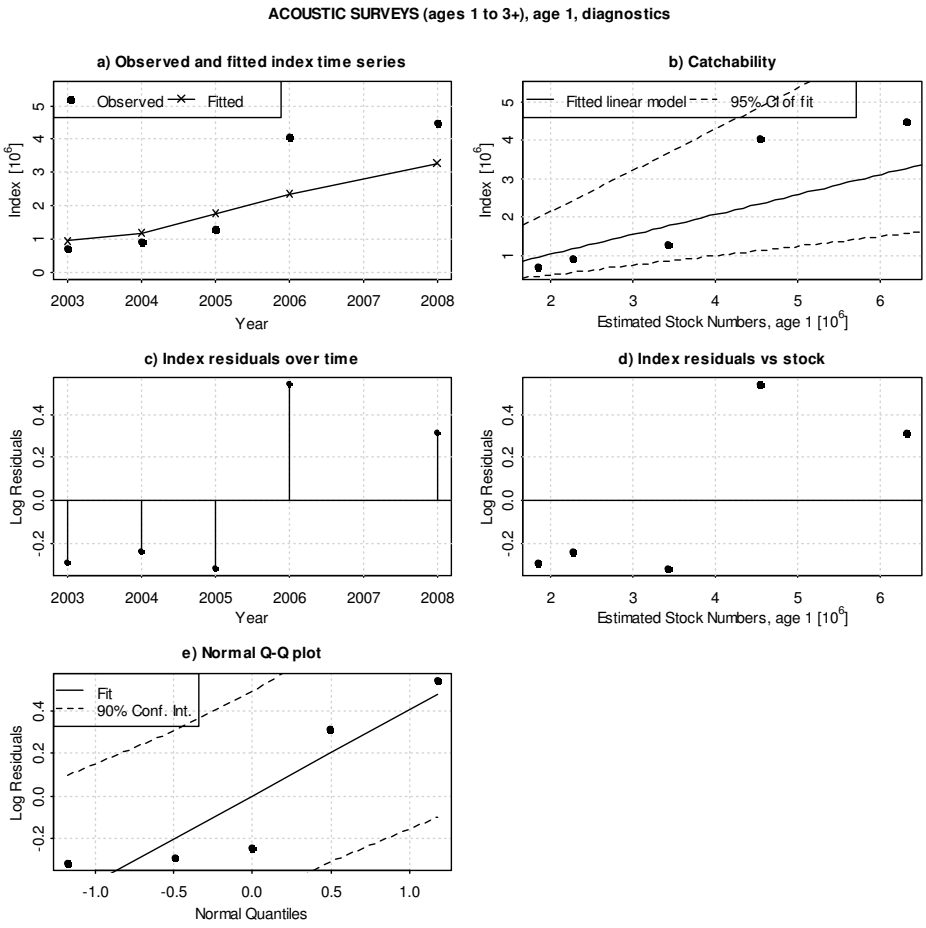


Fig. 3.7.5.1.1 Residual plots for age 1 indices of anchovy ICA model for GSA 22 (2000-2008)

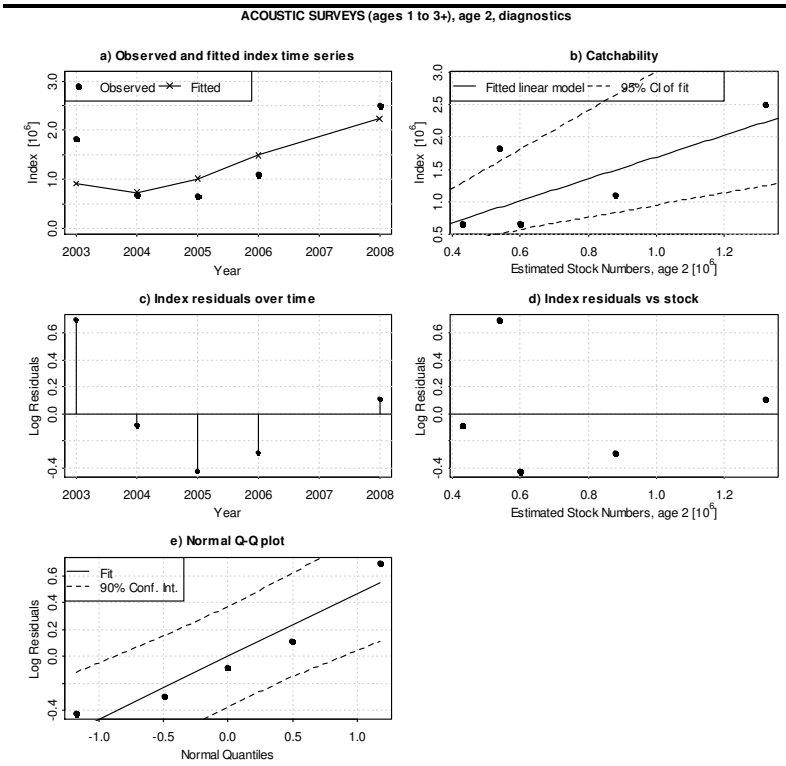


Fig. 3.7.5.1.2 Residual plots for age 2 indices of anchovy ICA model for GSA 22 (2000-2008)

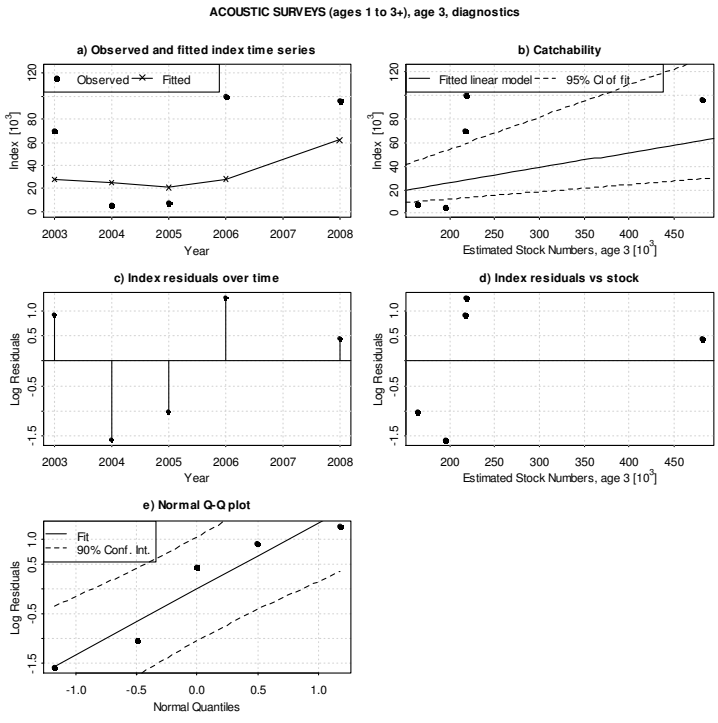


Fig. 3.7.5.1.3 Residual plots for age 3 indices of anchovy ICA model for GSA 22 (2000-2008)

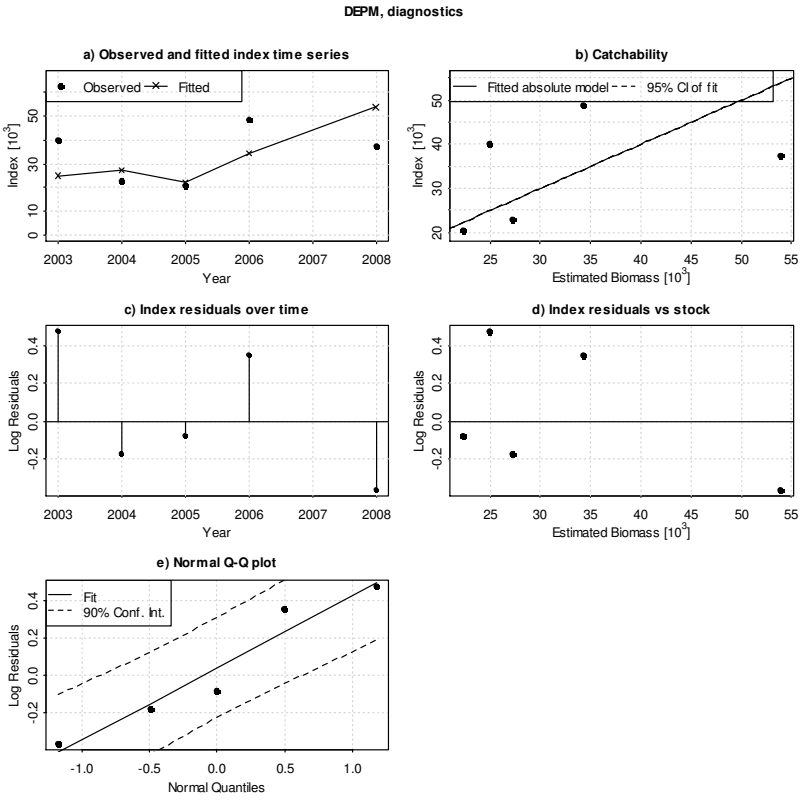


Fig. 3.7.5.1.4 Residual plots for SSB indices of anchovy ICA model for GSA 22 (2000-2008)

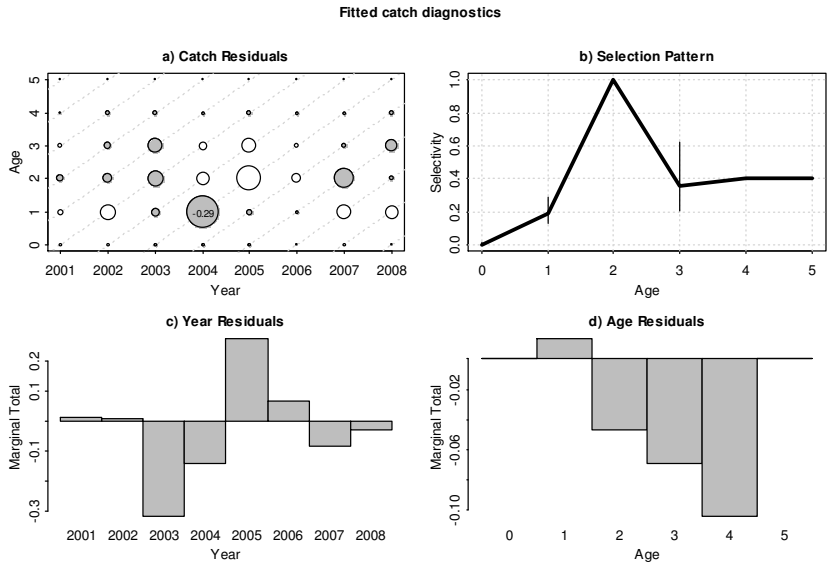


Fig. 3.7.5.1.5 The catch at age residuals of anchovy ICA model for GSA 22 (2000-2008)

ICA model results for anchovy stock in GSA 22 are shown in Fig. 3.7.5.1.6, indicating an increasing trend for recruitment since 2004. An increase in SSB estimates has also been observed since 2005. Average fishing mortality for ages 1 to 3 (which are target ages for the fishery) seems to stabilize at a lower level since 2004.

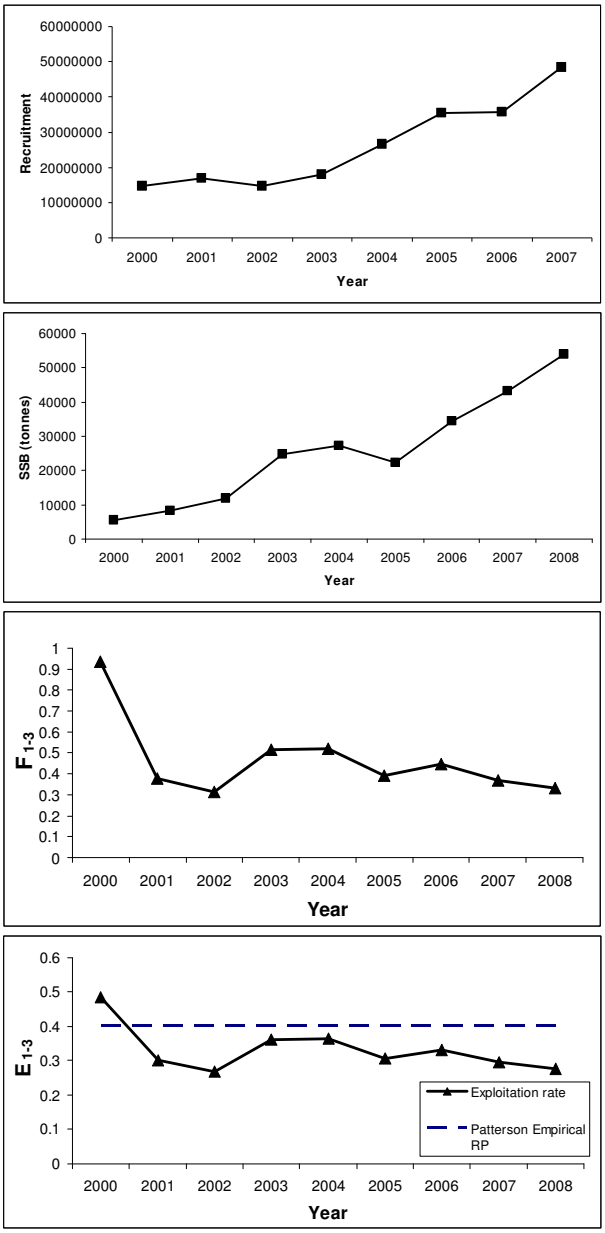


Fig. 3.7.5.1.6 Anchovy ICA Model (M per age group based on ProBiom estimates, DEPM absolute indicator, Acoustics linear) results: Recruitment, SSB, exploitation rate (F/Z), F mean for ages 1-3.

3.7.5.2 Current state of the population levels or exploitation in relation to Reference points

This assessment should be taken as cautionary, as this ICA assessment for this area it is based on a short time series of data. Due to the short time series available no biomass reference point could be suggested by the GFCM WG. The current assessment of ICA for anchovy indicated levels of exploitation rate just below the empirical level for stock decline (E>0.4, Patterson 1992) for small pelagic. The average exploitation rate (E=0.349) for the recent five years of the time series available was suggested in order to advice on the exploitation status of the stock.

Based on this assessment results and the aforementioned parameters this stock is considered to be harvested sustainably, operating below but close to an optimal yield level, with no expected room for further expansion.

3.7.6 Management advice and recommendations

Based on ICA results, the mean F (for ages 1 to 3), after an initial decrease between 2000 and 2003, shows a rather plane pattern at a lower level in recent years.

Conclusions: The assessment should be considered cautionary, as it is based on a short time series of data, not suitable to suggest reference points of Blim. Taking into account that anchovy is a short living species characterized by high fluctuations in abundance and recruitment strongly depending on environmental conditions, it is advisable that current results are used for management advice.

The precautionary empirical level for stock decline (E<0.4, Patterson 1992) for small pelagics is suggested as the reference point to assess the current status of the exploitation of the stock. This value of exploitation rate for the recent five years of the time series is E=0.349. Based on this assessment results and the aforementioned parameters this stock is considered to be harvested sustainably, operating below but close to an optimal yield level, with no expected room for further expansion. However this has to be confirmed in following years and the anchovy stock should be monitored in an annual basis with direct assessment surveys.

In addition the likely consequences of changing the closed period for the purse seine fishery should be analysed. A shift in the closed fishing period (present middle December till the end of February) towards the recruitment period of anchovy (October to December) or the recruitment period of sardine (February to April) could be examined.

3.8 Small pelagics in GSA24 (Turkey)

by Serdar Sakinan.

Document: No StockAssessmentForms was laid down.

A work about the Small Pelagics in GSA_24 (Turkish waters) was presented by Serdar Sakinan to the working group.

The abstract of the presentation follows:

Despite its oligotrophic character, the carrying capacity of the ecosystem for small pelagics is assumed to be improving because of the man-induced eutrophication in coastal waters of southern Turkey (GSA 24). Small pelagics had not been commercially important in the area before 1980's or at least their importance was not known because fishery was concentrated on highly commercial peneaid crustaceans.

After 1980, the small pelagics which had been only treated as "bait-fish" has begun gaining sudden importance. This importance is reflected in the landings and also in the number of purse-seiners which did not exist before 1980's. Until very recently the scientific studies on the small pelagics in GSA 24 were restricted to checklists, new records and to some biological aspects of the major species such as rounded sardine. Therefore it is not known whether the increase of landings was simply due to the increase in the purse seine fleet or the carrying capacity of the small pelagic stocks have also increased due to changes in the coastal ecosystem.

In contrary to small pelagics, the demersal stocks have been studied quite intensely since 1950's. The time series data of the trawl surveys suggest an increase in the small pelagics after 1990's when quite a significant quantities of small pelagic fishes, which very seldom caught by a bottom trawl comprised significant part of the samples.

The land around GSA 24 holds one of the most productive agricultural regions of Turkey. There are 4 important rivers passing by and washing away agricultural wastes to the sea. At the same time Mersin is the fastest growing city near Mediterranean in Turkey with minor concern in waste water treatment. Consequently, the oligotrophic character in the coastal waters has turned to severe eutrophication in 1990's.

Besides the effect of eutrophication, removal of the predators could be another factor for the increasing small pelagics population. Demersal fish assemblage is largely dependent on small pelagics. The earlier studies state that the main food source of the major piscivours such as hake and lizardfish were mullids. Later mullids were significantly declined due to overfishing and small pelagic became the main food sources. The model results indicate that the 65% of the food requirement of the piscivourous fishes are met by small pelagics. The overfishing is removing the predators of small pelagics from the systems. System could be switched to top down control and resulted increase in population.

The spatial partitioning of small pelagic fish which was formerly constituted by *Sardinella aurita* and *Sardina pilchardus* alone has been changed with the recent establishment of *Etrumeus teres* and *Dussumeria elipsoides* stocks, and with the sudden increase of *Engraulis encrasicholus*. This increase in number of species could be a result on fluctuations of temperature regime.

An extensive study using fisheries acoustics has been started in 2009 on the small pelagic fish stocks by Middle East technical University – Institute of Marine Sciences. The data is being collected within a project supported by Turkish Scientific and Technological Research Council, TUBITAK. Current study is not designed to assess pelagic stocks but to

understand the ecology of the small pelagic fish in the GSA 24. The scope of the research covers characterization of the species composition and spawning and over wintering habitat partitioning of small pelagics in the area. The aim is to obtain an analysis of fish movements, in response to environmental parameters; mainly temperature and primary production.

In the scope of the project, acoustic surveys, CTD castings, satellite data, and trawl samplings are being conducted. The biological parameters like, length –weight relationship, gonadosomatic index, condition and maturity index are also being evaluated.
As of October 2009, the preliminary results show that there seems a direct and evident relation with the primary production. The NASC values are high in the areas where fluorescence is the highest. There are also some very strong clues that the hydrological conditions and different water masses covering the region are the fundamental factor determining the distribution of the fishes.
The research project is going to be finished at the end of 2011. The next steps of the project are going to include the adoption of the surveys to the MEDIAS protocol which brings standards to the acoustic surveys conducted in the Mediterranean Sea. The final aim is to determine the essential habitats of the small pelagic including spawning, feeding and nursery grounds, and give recommendations to the related ministries for management and conservation.

WG comments:
The WG welcome the information provided to the meeting on the ecology of the small pelagics in this region. The work was considered very valuable and the WG endorses the continuity of those studies. However as the nature of the data do not allow to make any assessment of the pelagic resources and the fisheries in the area, the WG would encourage the provision of data about the monitoring of the pelagic fisheries and about direct estimation of pelagic resource in future meetings.

3.9 Round sardine, *Sardinella aurita* – GSA 26 (Egyptian Mediterranean waters)

by Sahar Fahmy Mehanna

Document: GFCM_SCSA_StockAssessmentForms_Egypt.xls

3.9.1 Fishery description

The Egyptian Mediterranean coast is about 1100 km extending from El-Sallum in the West to Taba city in the East. The mean annual fish production from this area is about 50 thousand ton. There are three fishing methods conducted in the Egyptian Mediterranean; trawling, purse-seining and artisanal fishery (especially long and hand lining). The fishing grounds along the Egyptian Mediterranean coast divided into four regions; Western region (Alexandria and El-Mex, Abu-Qir, Rosetta, El-Maadiya and Mersa Matruh), Eastern region (Port Said and El-Arish), Demietta region and Nile Delta region (GAFRD annual reports during 1984-2007).

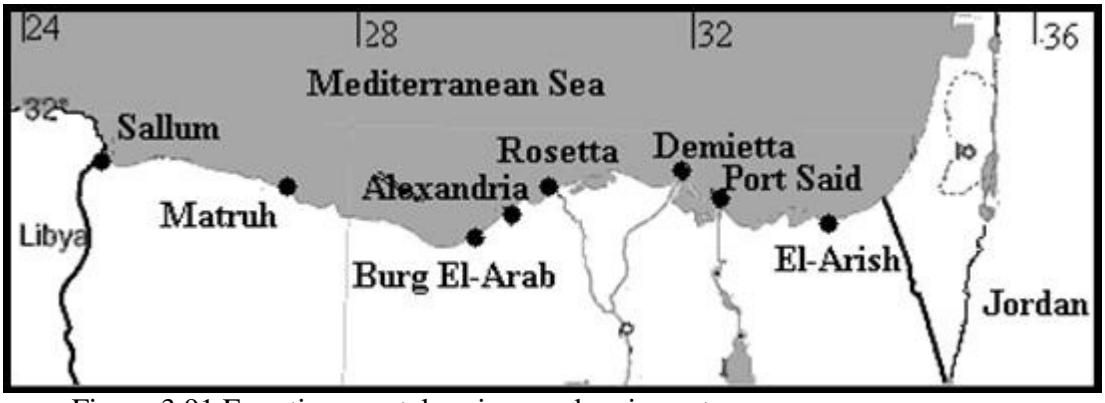


Figure 3.91 Egyptian coastal regions and main ports.

Sardines represent one of the most important fishes in the Egyptian sector of the Mediterranean Sea fisheries forming about 30% of the total fish production in Mediterranean (1997-2007). They mainly caught by purse-seiners and form about 63% of the total purse-seine catch. The sardine catch in Egyptian Mediterranean consists of at least six species of which Sardinella aurita is the most common one. The sardine catch fluctuated between a minimum of 10270 ton during 2003 and a maximum of 39563 ton during 1999.

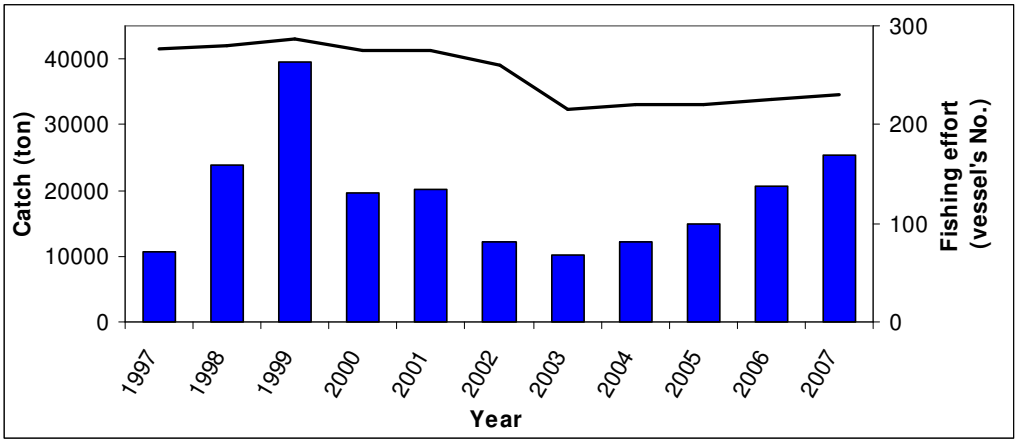


Figure 3.9.2 Egyptian Catches of round sardine and fishing fleet.

The number of purse- seiners in Egyptian Mediterranean varied between 215 (2003) and 286 (1999) vessels. The vessel's length ranged between 15 and 20 meter and its width of about 5 to 7 meter. They are powered by engines of 100 to 500 hp but the majority are of 150 hp. The purse-seiners are operated at night using lighted dinghies. All fishing ceases during an approximately ten days during each month, when the moon is full. The crew number ranged between 15 and 25 persons. The fishing trip takes one to two days duration. The purse-seine fishery contributed about 57% of the total fish production.

Catch composition

The dominant fish families in the purse-seine catch of Egyptian Mediterranean are family: *Clupeidae* which commonly known as sardines and herring; family: *Carangidae* (horse mackerel, scads and jacks); family: *Scombridae* (mackerels, bonitos and tunas) and family: *Pomatomidae* (blue fish). The species of lesser importance or unsorted species were grouped as "others". Sardine fisheries were highly important to the Egypt economy where sardines are the most popular fish there and have a reasonable market price.

Before the construction of Aswan High Dam, the sardine accounted for about 40% of the total landed catch of the Egyptian Mediterranean waters. By that time fisheries of Sardine were mainly operated during autumn (Faltas, 1983). This was due to the effect of arrival of Nile waters rich in nutrients and which therefore flourished the phytoplankton there (Halim, 1960), sardine aggregated in huge shoals on the coastal Egyptian waters for feeding where they were captured by gillnets. After the construction of High Dam, a serious decline in sardine catch was observed.

3.9.2 Source of management advice (Inputs and assessment methods)

Length-frequency data of S. aurita were collected monthly from the commercial catches for four years (2005-2008). The sampling were conducted at three landing sites where more than 70% of sardine catch landed; Alexandria, Port Said and El-Arish. The total lengths of 6543 fish were measured in the size range 6.6 – 24.9 cm TL and the weight range was 3 - 82 g. The data were then pooled annually and subsequently grouped into classes of one centimetre intervals. The data were analyzed using the FiSAT (Gayanilo et al., 1997) and VIT software (LIeonart and Salat, 1997). Sex, maturity stage and otoliths were taken for each specimen of S. aurita.

Annual rings on otoliths were counted using optical system consisting of Nikon Zoom - Stereomicroscope focusing block, Heidenhain's electronic bidirectional read out system V R X 182, under transmitted light. The total radius of the otolith "S" and the distance between the focus and the successive annuli were measured to the nearest 0.001 mm. Lengths by age were back - calculated using Lee's (1920) equation.

The relation between the total length (L) and total weight (W) was computed using the formula $W = a\ Lb$ where "a" and "b" are constants whose values were estimated by the least square method. The back-calculated lengths were used to estimate the growth parameters ($L\infty$ & K) of the von Bertalanffy growth model by fitting the Ford (1933) and Walford (1946) plot.

The growth performance (ø) of S. aurita population in terms of length growth was computed using the index of Pauly and Munro (1984) as $ø = \text{Log } K + 2 \text{ Log } L\infty$.

The total mortality (Z) was estimated using the length converted catch curve method of Pauly (1983). The natural mortality coefficient (M) was calculated using PRODBIOM (Abella et al., 1997). The fishing mortality coefficient F = Z – M and the exploitation rate E was estimated as E = F/Z.
The length at first capture Lc was estimated by the analysis of catch curve using the method of Pauly (1984) while the length at first sexual maturity Lm was estimated by fitting the maturation curve.
Relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R) were estimated using the model of Beverton and Holt (1966) as incorporated in FiSAT software, while Spawning Stock Biomass (SSB) and Yield per Recruit (Y/R) were estimated using VIT program (Lleonart and Salat, 1997).

3.9.3 Assessment Results

3.9.3.1 Growth and Mortality

Age of S. aurita was determined based on the eoliths and the results showed five age groups for S. amrita. The mean back-calculated lengths were 8.12, 13.48, 18.22, 21.85 and 23.96 cm at ages 0, I, II, III and IV, respectively.

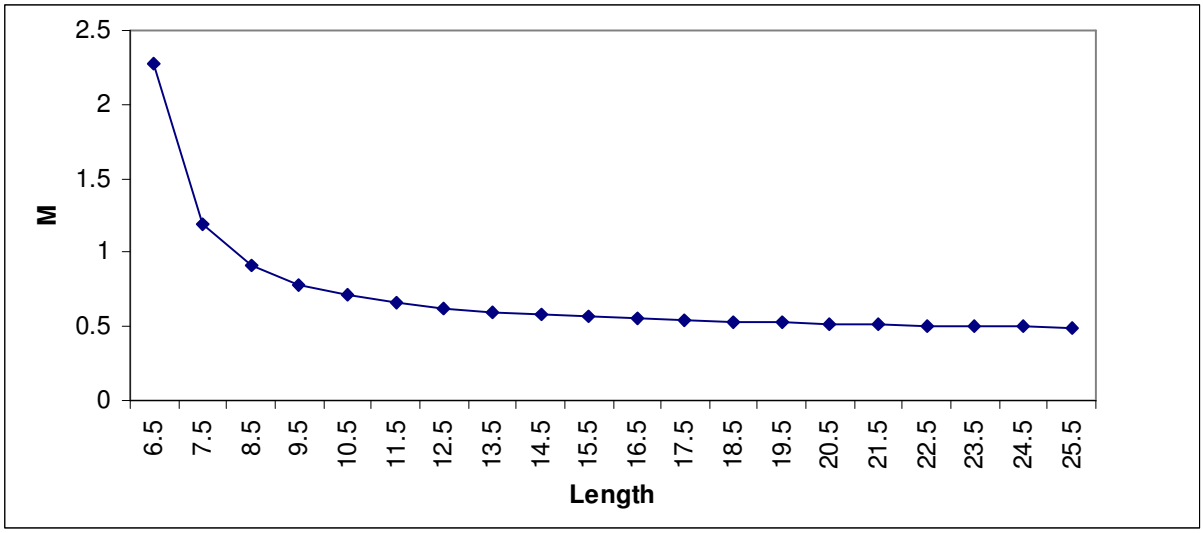


Figure 3.9.3.1 Natural Mortality by length (using PRODBIOM (Abella et al., 1997)).

3.9.3.2 Population parameters

Parameter	value
L∞	29.11 cm TL
K	0.37 yr-1
to	-0.6 yr
Ø	2.50
Lr	6.0 cm
Lc	10.7 cm
L50	13.12 cm
Z	1.69

M	0.55
F	1.14
E	0.68
a	0.007
b	2.912

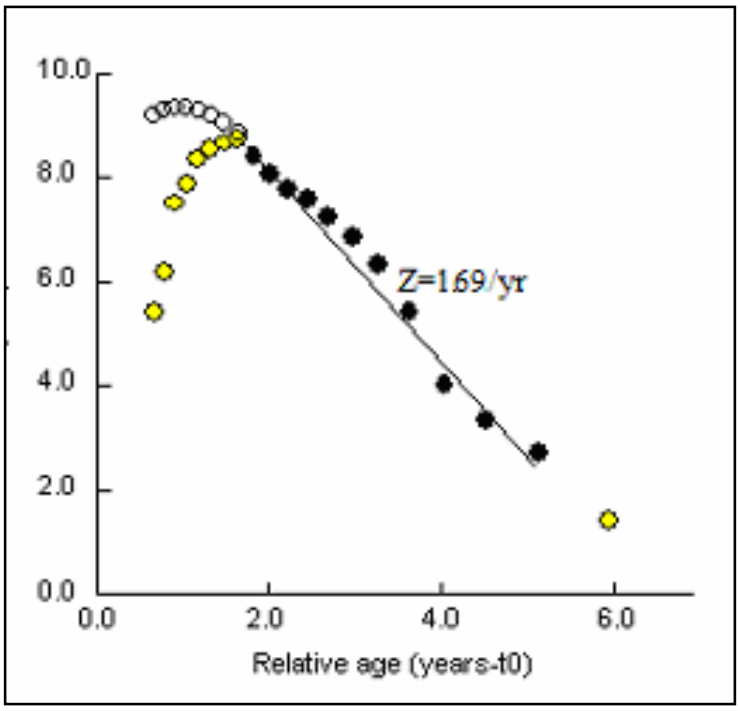


Figure 3.9.3.2.1 Z-estimation for *Sardinella aurita*

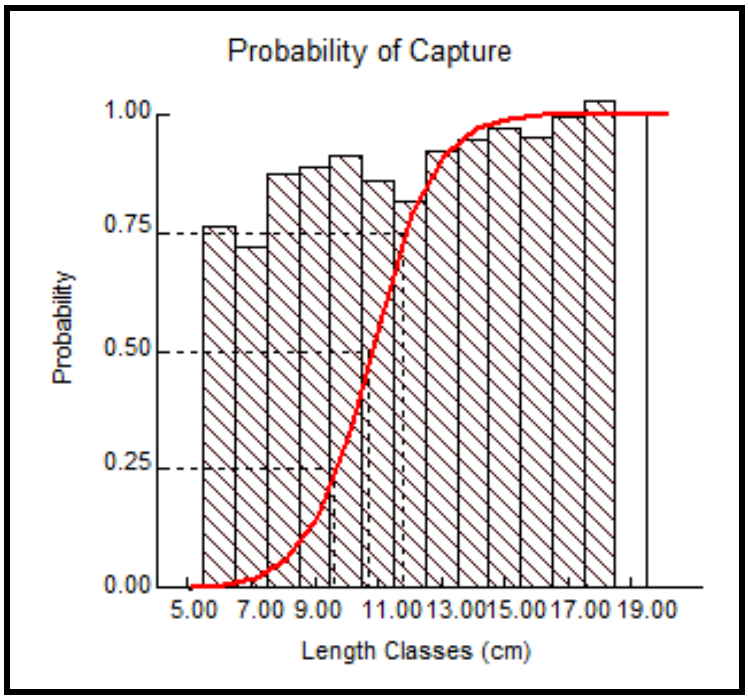


Figure 3.9.3.2.2 Lc-estimation for *Sardinella aurita*

The main results of the Yield per recruit (VIT analysis).

Variables	Value	
	Terminal F=0.4	Terminal F=0.2
Current Y/R (g)	5.57	5.52
Maximum Y/R (g)	5.66	5.55
Fmax F0.1 Fcurr	0.82 0.52 1.1	0.9 0.49 1.1
Mean Z	1.434	1.294
Mean F	0.832	0.691
Global F	0.408	0.399
Catch mean length (cm)	14.41	14.41
Stock mean length (cm)	10.9	10.97
Current stock critical length (cm)	13	13

The main results of relative yield per recruit analysis.

Parameters	Values at current Lc	Values at Lc= Lm
Emax	0.577	0.63
E0.1	0.5	0.55
E0.5	0.33	0.35
Ecurr	0.71	0.71

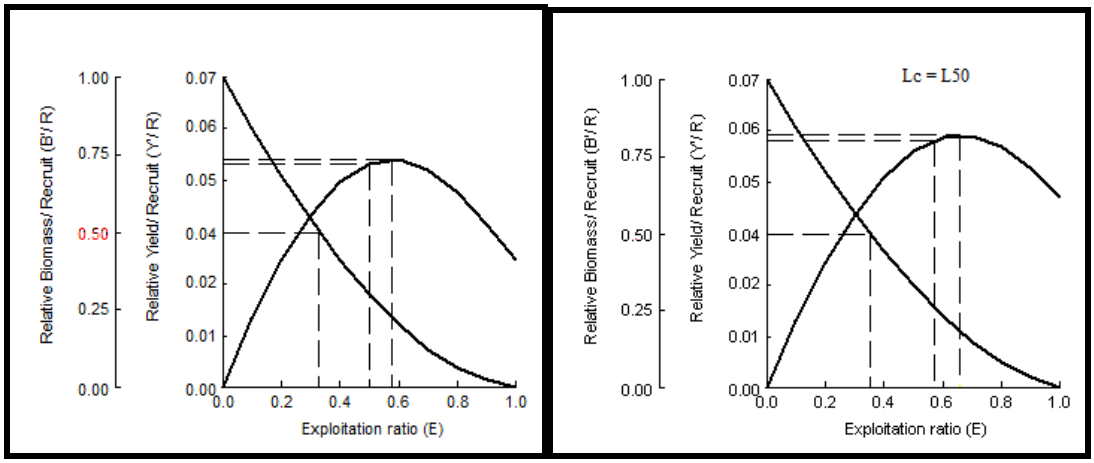


Figure 3.9.3.2.3: Relative yield per recruit analysis for *Sardinella aurita* with current Lc (Left) and Relative yield per recruit analysis for *Sardinella aurita* with Lc = Lm (Right)

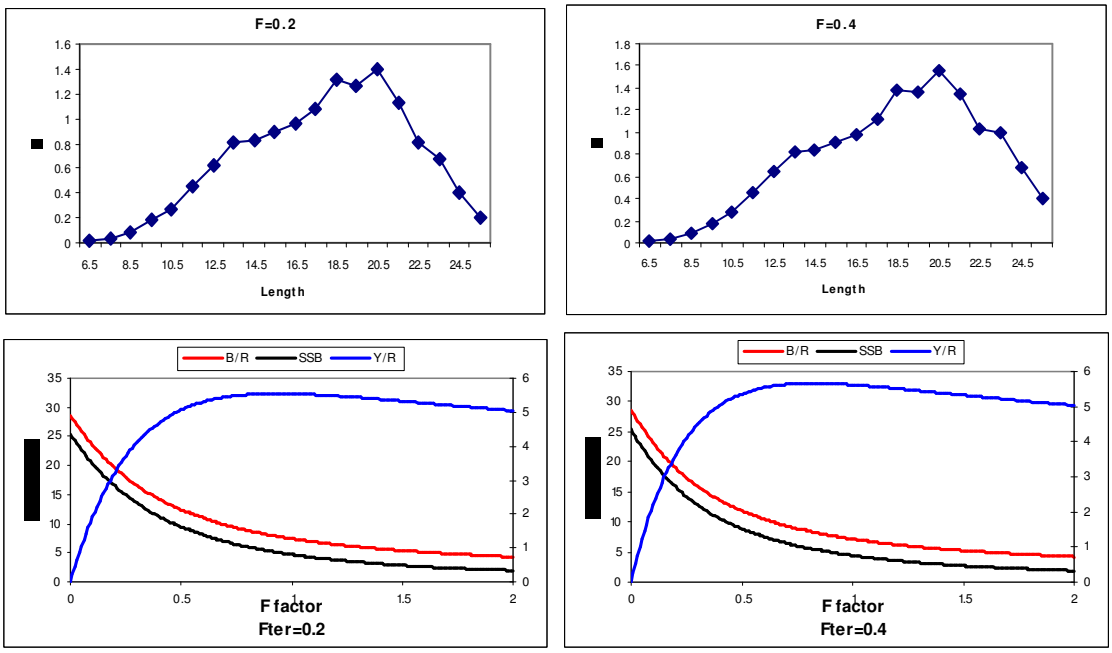


Figure 3.9.3.2.4: Fishing mortality by length and Yield per recruit analysis (With VIT) for *Sardinella aurita* with current Lc for a terminal F of 0.2 (Left) and of 0.4 (Right)

3.9.4 Management advice and recommendations

The stock of round sardine in the Egyptian Mediterranean seems to be overexploited and needs to reduce the fishing mortality by an amount between 50% and 30%- to achieve F0.1, depending on the method used either Pauly's catch curve or VIT approach). The same conclusion was obtained from the relative yield per recruit analysis where the exploitation rate should be reduced by about 30%- 25% to achieve E0.1 or by about 52% to conserve the spawning stock biomass per recruit at 50% of that achievable without exploitation. Also, the nursery grounds should be identified and protected from illegal fishing and pollution.

Generally we recommend:
The necessity to make an accurate data base about our fisheries involving good records for fishery statistics and good monitoring system.
An acoustic survey of pelagic resources in the Egyptian Mediterranean is required to improve the current assessment
With possible support of regional projects
The necessity to work in order to provide a common management information system for the Mediterranean countries.
The necessity to standardize the stock assessment methods to facilitate the comparison between species in different areas.

3.10 Sardine, *Sardina pilchardus* – GSA 04 (gulf of Annaba, East Algerian)

by Assia Bedairia

A preliminary analysis of state of exploitation of the sardine, *Sardina pilchardus* (Walbaum, 1792), in the gulf of Annaba, East Algerian, was presented by Assia Bedairia

The Abstract of the presentation follows:
This study was performed on 2859 specimens of sardine, *Sardina pilchardus* collected biweekly from November 2006 to October 2007. Samplings were carried out at the fishing port of Annaba where purse-seine methods are used for small-scale fishing at depths from 15 to 30m. Data concerning the exploitation of catches were analysed by means of 2 software packages: i) FiSAT (2004), which we used to determine the essential parameters for the study of dynamics; and ii) VIT (2000), the most suitable tool for the stock assessment based on the application of Length Cohort Analysis (LCA) together with a Yield per Recruit Analyses (Y/R) based on short series of data. This software VIT (2000) assumes steady state and functions with pseudo-cohorts, requiring knowledge of the catches over 1 year only instead of a historical series of several years. The results of this application revealed that the exploitable average biomass of the sardine stock, composed of 28 length sizes from 6.5 to 20 cm with a step of 0.5 cm, was around 4778.93 tons of which 2513 tons (53%) were spawning stock . The size and the average age of the sardine stock were 12.5 cm and 2.7 years. Total Biomass balance (D) is estimated at 5508.64 tons. This corresponded to growth in weight of 4453.77 tons, (80.85%), as compared to recruitment of only 1054.86 tons (19.15%). Losses were caused mainly by natural mortality (M), estimated at 3823.14 tons, and accounting for 69.40 %, This was higher than fishing mortality (F) which was 1685.5 tons, that is, 30.60 %. We estimated the yield per recruit (Y/R) of sardine at 2.682 g. This value was lower than the threshold of maximum yield per recruit at 3.413 g. Though preliminary, these results indicate that the sardine population can be considered to be in a situation of under-exploitation in this area. Considering the shape of the Y/R, the 0.1 reference point must be added as a priority strategy. In general, sardine stock analysed is: (1) moderately exploited with reference to Y/R0.1. (2) under-exploited with reference to Y/R max. Under the precautionary principle, fishing efforts should not increase and we recommend limiting fishing to current levels. However, we suggest monitoring both the fishing strategy. Moreover we recommend annual monitoring of the evolution of catches.

Working Group comments:
The WG acknowledge the importance of the study on the sardine fishery in the Eastern part of Algeria. And the WG encourages its continuity expanding if possible to the rest of the Algerian coasts. Nevertheless due to the limited period of sampling and geographical area covered in the study, as well as the need for improvements in biological parameters, results were considered too preliminary. Improvements were suggested in the scheme of sampling for length and in the study of the biological parameters of the stock. Concerning the assessment of the stock expansion of the data series for several years would be very valuable and in particular complementing the monitoring of the fishery with direct acoustic surveys.

4 Assessment related documents and presentations

The following presentations were made to the Working Group

J-L. Bigot and D. Roos: Small pelagics in the Gulf of Lion (GSA 07).

B. Patti & E. Quinci G.S.A. 16, South of Sicily; Trends in anchovy and sardine populations (1998-2008) I.A.M.C. C.N.R. – Mazara del Vallo (Italy)

E. Arneri et al. 3.5: ANCHOVY and SARDINE in GSA 17 and 18 (Adriatic Sea) progress of work.

Giannoulaki M., Machias A., Somarakis S., Kallianiotis A., Papaconstantinou C. Stock assessesment of anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*) in the greek part of Aegean Sea (GSA 22).

Serdar Sakinan: Small Pelagic Fish on The Continental Shelf of The Northeastern Levant Sea: Preliminary Results of Acoustic Surveys

Sahar Fahmy Mehanna: Stock assessment of the round sardine, *sardinella aurita* from the Egyptian Mediterranean waters (GSA 26)

B. Assia : Estimation de la biomasse exploitable de sardine, *Sardina pilchardus* du golfe d'Annaba, Est Algérien

5 Conclusions and Summary scientific Advice of the Working group

GSA	STOCK	Stock Status	WG Management Advice	Comments
7	Sardine	Moderately exploited but Biomass at intermediate abundance	As biomass estimation for 2006-2008 remain lower than the 2005 estimate, it is recommended not to increase the fishing effort.	Mixed fishery: Advice coherent with that for anchovy. Assesment rely on the assumption of unbiased estimates of biomass by acoustics
7	Anchovy	Moderately exploited but Biomass at low stock abundance	Given the low levels of biomass for the last 4 years in comparison with the series of acoustic biomass available, the WG recommends not to allow any increase in fishing effort.	Mixed pelagic fishery. Assesment rely on the assumption of unbiased estimates of biomass by acoustics (which is consistent with a DEPM estimate). Parallel decreasing tendency in GSA06 & 07
16	Sardine	Moderately exploited but Biomass at intermediate abundance	Medium biomass levels in 2006-2008 at moderate fishing levels. In coherence with anchovy, the WG recommends not to increase the fishing effort.	Mixed fishery: Advice coherent with that for anchovy. Assesment rely on the assumption of unbiased estimates of biomass by acoustics
16	Anchovy	High fishing mortality at low stock abundance	Given that biomass was very low for three consecutive years (2006, 2007 and 2008) and the increasing trend in exploitation rate, fishing effort should not be allowed to increase.	Mixed fishery with sardine. Assesment rely on the assumption of unbiased estimates of biomass by acoustics (which is consistent with several DEPM estimates). Harvest rates average the last 3 years (to cancel observation errors)
22	Sardine	Fully exploited	harvested sustainably, operating above but close to an optimal yield level, with no expected room for further expansion.	Mixed fishery. ICA Assessment should be taken with caution given the short time series available. Increasing trend in the estimates of SSB since 2004. Fishing mortality high but at a lower stage since 2004.
22	Anchovy	Fully exploited	harvested sustainably, operating just below but close to an optimal yield level, with no expected room for further expansion.	Mixed fishery. ICA Assessment should be taken with caution given the short time series available. Increasing trend in the estimates of SSB since 2004. Average Exploitation rate (last 5 years) = 0.35, just below the empirical level for stock decline (E<0.4, Patterson 1992)
26	Round sardine	Overexploited. High fishing mortality	reduction of fishing effort by about 50% - 30%	Length based analysis: Concrete Fishing effort reduction to achieve F0.1 depends upon the method used either Pauly's catch curve or VIT approach. The same conclusion was obtained from the relative yield per recruit analysis. Direct acoustic assessment of the stock would greatly improve the assessment.

6 Scientific Recommendations for improvements:

a) The standard assessment forms in Excel require improvements in order to adapt to the type of inputs usually needed for the assessment of pelagic stocks, in particular to expand them to allow properly inputting the results concerning the direct acoustic or DEPM surveys. In general a complete revision of the assessment forms can be designed by consultation with interested of the pelagic domain.

b) Several of the stocks assessed in this Working Group may be dynamically related with the populations found in adjacent areas and further research is required in order to verify the existence of those connections which might affect the stock unit definitions and the assessments performed on the current GSA area basis. In this context, the following non complete list of areas and stocks may benefit of those type of researches:

- Sardine and anchovy between GSA 04 and 05.
- Sardine and anchovy between GSA 06 and 07.
- Both species between GSA 12, 13, 14, 15 and 16
- Both species in GSA 17 and 18
- GSA 22 Greek and Turkish waters

c) The assessment of sardine and anchovy stocks entirely depends on the application of direct assessment methods by acoustic and DEPM surveys (as little benefit from the convergence properties of a VPA like assessment can be expected). The WG strongly recommends the continuation of these survey implementations is all areas already applying them and encourages the incorporation of these direct monitoring systems in the remaining Mediterranean areas.
d) The revision of the axiom for constant Natural mortality to a pattern of natural mortality at age according to growth parameters makes compulsory to assure the quality of the growth parameters, as the age structured assessments depends heavily on the natural mortality values. Therefore the WG recommends to verify the basis of those growth parameters as a way to assure quality in the age structured assessments.
e) With the aim of assessing shared stocks, re-enforce of the cooperation between France and Spain to actualise biological data as well as catch and effort data collection for the boats of the two countries catching sardine in the Gulf of Lion is desirable.
f) For the South of Sicily the WG recommends a close monitoring of the fry fishery (catches and biological features) as the impact on the sardine fishery is unknown.
g) The WG on small pelagics recommends finalising the construction of the common data base for the sardine and anchovy fisheries and direct monitoring in the Adriatic at sub-regional level and to complete assessments for the forthcoming Stock Assessment Sub Committee Meeting in December 2009.
h) For the Aegean sea, the likely consequences of changing the closed period for the purse seine fishery should be analysed. A shift in the closed fishing period (present middle December till the end of February) towards the recruitment period of anchovy (October to December) or the recruitment period of sardine (February to April) could be examined.
i) Very little is known about the sardine in GSA 24 . Adoption of MEDIAS protocols in the individual acoustic studies conducted by Turkish scientist on that area would be complimentary.
j) Concerning Egyptian fisheries: the WG supports the obtention of an accurate data base about their fisheries involving good records for fishery statistics and good monitoring system. An acoustic survey of pelagic resources in the Egyptian Mediterranean is recommended to improve the current assessment, with possible support of regional projects.
k) For Algerian pelagic fisheries, the WG recommends expansion of the data series for several years and in particular complementing the monitoring of the fishery with direct acoustic surveys.

7 Date and venue for the Next meeting:

The working group took note of the suggestion made by Mr Bernardo Patti to host the next coming meeting on Small Pelagic species in the CNR institute at Mazara del Vallo (Sicily, Italy). The date will be defined at later stage.

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Annex I

Agenda

1. Review of available data and information by areas and stock basis (Monday and Tuesday Morning) With subsequent discussion of the methodologies to be used.

2. Performance of joint assessments (Tuesday afternoon to Wednesday) by subgroups including:
    - Finalization of "stock Assessment forms"
    - Review and analysis of the results of different assessments
    - Formulation of conclusions and management advice
    - Preparation of the texts for the report

3. Plenary Discussion of stock assessment forms and adoption of the management advice to be submitted to the SCSA (Thursday and Friday)

4. Compilation of the sections on assessments and advice by areas and stocks for the final report (Friday).

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