November 2010

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

Viale delle Terme di Caracalla, 00153 Rome, Italy. Tel: + 39 0657055730. www.gfcm.org

---

GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN
SCIENTIFIC ADVISORY COMMITTEE (SAC)
Thirteenth Session
Marseille, France, 7-11 February 2011
REPORT OF THE WORKING GROUP ON STOCK ASSESSMENT OF SMALL PELAGIC SPECIES
Campobello di Mazara, (Italy), 1– 6 November 2010

INTRODUCTION

1.   The Working Group on stock assessment of small pelagic species of the Sub-Committee on Stock Assessment, took place in Campobello di Mazara, Sicily, Italy, from 1 to 6 November 2010 at the section of CNR-IAMC of Capo Granitola.

2.   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.

OPENING OF THE MEETING AND ADOPTION OF THE AGENDA

3.   The eleventh meeting of the SCSA Working Group on Small Pelagic species (WG) was attended by 21 participants from Albany, Croatia, France, Italy, Montenegro, Morocco, Spain and Turkey, and as well as representatives of FAO and the GFCM Secretariat (see list of participants in Appendix A).

4.   Ms Pilar Hernández from GFCM Secretariat welcomed the participants. The agenda for the meeting was adopted (see Appendix B).

5.   Mr Dankert Skagen chaired the meeting and acted as rapporteur.

ASSESSMENTS AND ADVICE BY SUBREGIONAL AREAS AND STOCKS.

6.   The Working Group reviewed data and assessments for the stocks in the text table below.

GSA	Species	Analytic assm.	Qualitative assm.	Status
01	Anchovy	Provisional	Yes	Moderately exploited Sustainable
01	Sardine	Provisional	Yes	Fully exploited Sustainable
03	Sardine		Yes	Fully exploited Uncertain biomass
06	Anchovy	Provisional	Yes	Avoid further reduction in SSB
06	Sardine	Provisional	Yes	Overexploited
07	Anchovy		Yes Acoustic survey	Fully exploited Low biomass
07	Sardine		Yes Acoustic survey	Moderately exploited Severely reduced production capacity
16	Anchovy		Yes Acoustic survey	Increasing exploitation rate Low biomass
16	Sardine		Yes Acoustic survey	Moderate fishing Intermediate biomass
17	Anchovy	Yes	Yes	Moderately exploited Intermediate abundance
17	Sardine	Yes	Yes	Moderately exploited Low abundance
18	Anchovy		Yes	Uncertain exploitation Probably intermediate biomass

7.   In addition, very preliminary studies on the horse mackerel in the Marmara Sea were presented. The WG encouraged such studies, and gave some suggestions for future work, but did not consider any advice on this stock.

8.   The main body of information is contained in the Stock Assessment Forms for each stock. The present report is a summary of that information for each stock. The names of all the authors of the assessments are in the Stock Assessment Forms available at the GFCM web site. The names showed in this report are those of the scientist who did the presentation at the meeting.

9.   It was realized that an acceptable analytic assessment could only be obtained for a small number of stocks. As outlined in the discussion section, this led to a strategy for formulating advice that relied mostly on qualitative evaluation of the available information rather than on relating assessment results to formal reference points.

GSA01 Engraulis encrasicolus **Northern Alboran Sea**
(By Luis Fco. Quintanilla)

Fishery

Anchovy in GSA01 is exploited by purse seine fleet. This exploitation is based on the first age classes (mainly 0 and 1). Purse seine fleet mainly target on anchovy and sardine but other species with lower commercial value as horse mackerel, mackerel and gilt sardine are also caught.

According to official data, purse seine fleet in GSA01 has been continuously decreasing from more than 230 vessels in 1980 to 113 vessels in 2009 (20 smaller than 12 m and 93 between 12 and 24 m). This fleet operates exclusively on the continental shelf, fishing 12 hours per day and 5 days a week, with temporary fishing closures between March and April. The minimum landing size is 9 cm.

Data and parameters

Official landings time series 2002-2009 is available from all fishery ports in GSA01. In the commercial landings, length distribution and biological sampling are available from 2003 to 2009 from IEO sampling network and Spanish National Data Collection. For 2002, length distributions estimated in 2003 were applied. Acoustic surveys have been performed, but they are incomplete and fragmented. The natural mortality vector (M) was derived from PROBIOM (Caddy and Abella, 1999).

Assessment method

Extended Survivor Analysis (XSA), Yield per recruit (Y/R) and Annual Exploitation Rate (E=F/Z).

Model performance

The XSA analysis does not provide a reliable assessment due to the lack of reliable tuning data in terms of coverage and age-length keys. Tuning data series from acoustic surveys (ECOMED and MEDIAS) in the GSA01 is incomplete and fragmented: there are no survey data from 2000, 2001, 2002, 2007 and 2009, and incomplete coverage in 2003, 2006, 2008 and 2010. Acoustic estimates by age are not coherent with catches by age due to ALK problems.

Results

Catches are quite stable or slightly going down, the stock seems to be in a relatively comfortable situation, with good signs of recruitment and good amount of survivors, according to the size distributions.

Stock status

Fully exploited, with moderate fishing mortality and intermediate abundance.

Advice and recommendation

Not increase the fishing effort.
The management of anchovy fisheries needs to account the multi-species effects, mainly the interaction with sardine.

Discussion

The WG considers the XSA analysis as provisional and found it unacceptable as basis for advice. The main shortcoming of the analysis is the lack of reliable tuning data.
The WG also would recommend that further consideration is given to the assumptions about natural mortality.

The WG endorses the assessment and the related recommendations.

GSA01 Sardina pilchardus **Northern Alboran Sea**
(By L.Quintanilla))

Fishery

Sardine in GSA01 is exploited by purse seine fleet. This exploitation is based on the first age classes (mainly 0 and 1). Purse seine fleet mainly target on sardine and anchovy but other species with lower commercial value as horse mackerel, mackerel and gilt sardine are also caught. According to official data, the purse seine fleet in GSA01 has continuously decreased from more than 230 vessels in 1980 to 113 vessels in 2009 (20 smaller than 12 m and 93 between 12 and 24 m). This fleet operates exclusively on the continental shelf, fishing 12 hours per day and 5 days a week, with temporary fishing closures between March and April. The minimum landing size is 11 cm.

Data and parameters

Official landings time series 2000-2009 is available from all fishery ports in GSA01. In the commercial landings, length distribution and biological sampling are available from 2003 to 2009 (combined for 2000-2002) from IEO sampling network and Spanish National Data Collection. Acoustic surveys have been performed, but they are incomplete and fragmented. The natural mortality vector (M) was derived from PROBIOM (Caddy and Abella, 1999).

Assessment method

Extended Survivor Analysis (XSA), Yield per recruit (Y/R) and Annual Exploitation Rate (E=F/Z).

Model performance
The XSA analysis does not provide a reliable assessment due to the lack of reliable tuning data (coverage and age-length keys). The tuning data series from acoustic surveys (ECOMED and MEDIAS) in the GSA01 is incomplete and fragmented: no survey data from 2000, 2001, 2002, 2007 and 2009, and incomplete coverage in 2003, 2006, 2008 and 2010. Acoustic estimates by age are not coherent with catches by age due to ALKs problems.

Results
The total catch has been relatively stable along the time series (2000-2009) but the fraction of young fish seems to have decreased since 2004.

In the first years covered by the XSA analysis where the estimate of the fishing mortality is less sensitive to the survey information it appears that the fishing mortality has been in the order of 0.2 to 0.43 suggesting a moderate fishing mortality in those years. The Yield per Recruit analysis indicates F0.1 at 0.23.
The change in the age composition in the catches in the last three years may suggest lower recruitment than in the past.

Stock status

Fully exploited, with moderate fishing mortality, intermediate abundance and some concerns about the recruitment.

Advice and recommendation
Not increase the fishing effort.
The management of sardine fisheries needs to account for the multi-species effects, mainly the interaction with anchovy.

Discussion
The WG considers the XSA analysis as provisional and found it unacceptable as basis for advice. The main shortcoming of the analysis is the lack of reliable tuning data.
The WG also would recommend that further consideration is given to the assumptions about natural mortality.

The WG endorses the assessment and the related recommendations.

GSA03 Sardina pilchardus. **Moroccan Mediterranean coast**
(By O. Kada)

Fishery
The fisheries of small pelagic are an important component of inshore fishing on the the Moroccan Mediterranean coast. For these fisheries, the activity of fishing is executed only by Moroccan seiners targeting mainly sardine, anchovy and horse mackerel. Bogue and sardinella are also caught. For several decades, the sardine constituted between 50 and 70% of the total landings of small pelagic of the Moroccan Mediterranean. However, the production of sardine declined during the last years, because of the increase in the fishing effort exerted by the sardine fleet on this resource. The landings

of sardine in the Moroccan Mediterranean varies between 10.000 and 25.000 tonnes/year. In the years 2000 to 2009, the annual average landings of sardine were approximately 14.020 tons.

The fishing of small pelagic is by a fleet of approximately 140 units, that is to say 20% of the operational coastal fleet in the Moroccan Mediterranean. The sardine boats of the Mediterranean are based mainly with Me diq (35%), Nador (27%) et al. Hoceima (25%). It should be noted that these units can carry out displacements towards the ports of the Atlantic, in particular the port of Larache. The sardine and the anchovy constitute the target species towards which the fishing effort of the sardine boats is directed; the sardine for its remarkable abundance compared to the other species and anchovy for its high commercial value. The time series of the captures of sardine since the year 2000 has important fluctuations, but with a stable general tendency. The evolution of the captures shows a reduction of the captures between 2000 and 2003, followed by an increase between 2004 and 2006 and then a new reduction in 2007 and 2008 and an increase in 2009.

Data and parameters

The fishing effort (expressed as number of positive exits X Tjb) exerted on the sardine stock between 2000 and 2009 was generally stable with peaks in 2002 and 2005, while the CPUE was declining. The CPUE was relatively high in 2000 and 2001, then it fell to the half in 2002. A clear improvement was observed in 2004 and 2006 followed by an important fall in 2008 and a clear rise in the outputs in 2009.

Statistics of the landings of sardine in weight and the fishing effort of the sardine boats (number of exits) are obtained monthly starting from the National office of Fishings (ONP). The biological data obtained for the evaluation of the state of exploitation of sardine are those of the years 2000 to 2009 from the ports of Nador, of Short-nap cloth Kebdana and from Al Hoceima. The data of landings and fishing effort come from the ports from the Moroccan Mediterranean except that from Tangier since the captures of this port are carried out in the Atlantic.

The parameters of growth used in this study (L∞, K and to) and the parameters a and b in the length-weight relationship $w = a*L^b$ are presented in the table below:

Species	a	b	L∞ (cm)	K (cm/year)	to (years)	Référence
Sardine	0,0066	3,0582	21,3	0,56	-0,67	INRH-Nador

The value of natural mortality selected is 0,5. It is supposed to be constant for all the classes of size. The terminal value of fishing mortality used was Fterm= 0,4.

Assessment method

By means of the Software LIVES (Lleonart and Salat, 2000), an analysis of pseudo-cohort was made on the average of the frequencies of sizes of sardine balanced at the whole zone of the Moroccan Mediterranean during the three last years to know 2007 to 2009. The level of exploitation of the stock of sardine is given through the curve of yield per recruit analyzes and the reference points F0.1 and/or Fmax.

Results and Discussion
Most of the catches are of large sardine. However, the analysis of the frequencies of size also shows a considerable portion of young sardine, below the size of the first sexual maturity (13.3 cm). These captures are carried out especially during May and come primarily from the area of Short-nap cloth Kebdana, located at the easternmost part of the Moroccan Mediterranean.

The fishing mortalities by length show that the main fishing is on the adults, between 16 and 19 cm. Yield per recruit analyzes indicates Fmax/Fact at 1,86 and F0.1/Fact at 0.62. One could conclude with a situation from full exploitation from stock from sardine.

Stock status
The analysis of the outputs by recruit indicates a state of full exploitation of the sardine stock in the Moroccan Mediterranean.

Advice and recommendation
Taking into account the likely state of the stock and in order to ensure a rational and durable exploitation of Moroccan Mediterranean sardine, it is recommended that:
- To maintain the current fishing effort;
- To reduce the mortality of fishing on the spawning fish, it is recommended to introduce seasonal closure during January which coincides with the peak of the spawning;
- To prohibit fishing during May near Short-nap cloth Kebdana to preserve the stock of the young fish.

The WG endorses the assessment and the related recommendations.

GSA06 Engraulis encrasicolus Western Mediterranean
(By E.García)

Fishery
Anchovy in GSA06 is exploited by purse seiners. Three fleet segments, distinguished by vessel size are recorded. The catch (landings) is not split by Fleet segments. It comprises 9814 tonnes in 2009 for the three Operational Units.
The exploitation is based on the first age classes 0, 1 and 2. Purse seine fleet mainly target on anchovy and sardine but other species with lower commercial value as horse mackerel, mackerel and gilt sardine are also caught. The number of vessels in the fleet has declined slightly over time, but has been stable at 132 vessels since 2007.

Data and parameters
Official landings time series 2002-2009 is available from all fishery ports in GSA01. In the commercial landings, length distribution and biological sampling are available from 2003 to 2009 from IEO sampling network and Spanish National Data Collection. For 2002, length distributions estimated in 2003 were applied. Length distributions were converted to age using a combined ALK 2003-2009, for all the years. Biological

sampling 2003-2009 was used for Maturity at age and Weight-Length relationships. Acoustic surveys have been performed, but they apparently only cover the youngest age. The natural mortality vector (M) was derived from PROBIOM (Caddy and Abella, 1999).

Assessment method

Extended Survivor Analysis (XSA), Yield per recruit (Y/R) and Annual Exploitation Rate (E=F/Z).

Model performance

The provisional XSA analysis was not accepted as a basis for advice. The main reasons were the use of a common ALK for all years, and doubts about the natural mortality.

Results

The catches have had a strong downwards trend throughout the time series (which goes back to 2008. The exception is 2009, where the catches increased markedly. In the length composition in the catches, the balance between small and large fish has been relatively stable, except in 2009, where the peak in the distribution is at 14 cm, and the distribution stops abruptly above that.

The survey appears only to reflect the recruitment (age 0 abundance). According to the survey, the recruitment has declined gradually since 2003, but with a strong year class in 2008 and an intermediate year class in 2009.

Stock status

The evidence points in the direction of the recruitment as the main driving force in the population dynamics, where the stock and catches have declined as a result of a declining recruitment. There is no clear evidence of an expansion of the fishery and exploitation level. The stock biomass in itself is not known, but it seems likely that it has declined in line with the decline in the catches and biomass. The length distribution in the 2009 catches raises some concern, as the large fish are poorly represented in the catch that year. Hence, it is unclear how this fishery has depleted the spawning biomass.

Hence, the stock abundance is considered as low, while the exploitation rate is uncertain.

 Advice and recommendation

In this situation, a precautionary approach to the management would be to avoid depleting the spawning stock to levels below the recent years, since a lower spawning biomass may not be able to respond to favourable environmental conditions.

Discussion

The WG considers the XSA analysis as provisional and found it unacceptable as basis for advice. The main shortcomings of the analysis were the use of a common ALK for all years, and doubts about the natural mortality.

The WG endorses the assessment and the related recommendations.

GSA06 Sardina pilchardus **Western Mediterranean**
(By E.García)

Fishery

Sardine in GSA06 is exploited by purse seiners. Three fleet segments, distinguished by vessel size are recorded. The catch (landings) is not split by Fleet segments. It comprises 9814 tonnes in 2009 for the three Operational Units.

The exploitation is based on the first age classes 0, 1 and 2. Purse seine fleet mainly target on anchovy and sardine but other species with lower commercial value as horse mackerel, mackerel and gilt sardine are also caught. The number of vessels in the fleet has declined slightly over time, but has been stable at 132 vessels since 2007.

Data and parameters

Official landings time series 2002-2009 is available from all fishery ports in GSA01. In the commercial landings, length distribution and biological sampling are available from 2003 to 2009 from IEO sampling network and Spanish National Data Collection. For 2002, length distributions estimated in 2003 were applied. Length distributions were converted to age using a combined ALK 2003-2009, for all the years. Biological sampling 2003-2009 was used for Maturity at age and Weight-Length relationships. Acoustic surveys have been performed since 2003. The natural mortality vector (M) was derived from PROBIOM (Caddy and Abella, 1999).

Assessment method

Extended Survivor Analysis (XSA), Yield per recruit (Y/R) and Annual Exploitation Rate (E=F/Z).

Model performance

The XSA analysis does not provide a reliable assessment due to the lack of reliable tuning data (age-length keys).

Results

The catches have had a strong downwards trend throughout the time series (which goes back to 1994.) The 2009 catch is the lowest on record. In the length composition in the catches, the balance between small and large fish has been relatively stable, except in 2009, it si strongly skewed towards small fish.

According to the survey, the recruitment has declined gradually since 2003, but with a stronger year class in 2009. Fish from age 1 and upwards has been almost absent in the survey since 2007, and has virtually disappeared in 2009

Stock status

This evidence points in the direction of the recruitment as a main driving force in the population dynamics, where the stock and catches have declined as a result of a declining recruitment. In addition, the length distributions and age distributions indicate that older fish is depleted more rapidly in recent years, in particular after 2007. The reason for that is not clear, but the fishery must be at least partly responsible. Migration to other areas is not likely as the same trends are seen in GSA07.

The stock biomass in itself is not known, but it seems likely that it has declined in line with the decline in the catches and survey index. Although the recruitment in 2009 is encouraging, the incoming year class now dominates the stock almost completely. The exploitation rate is not known, but it is likely that it is high, as the year classes are depleted rapidly.

Advice and recommendation
The stock has declined over many years, partly due to reduced recruitment and partly to poor survival of the recruits. Most likely, the stock has been increasingly overexploited in recent years. The 2009 year class looks promising, but it is necessary to preserve that year class to restore a normal stock structure and facilitate better future recruitments. Unless the recruitment levels increase in the near future, this fishery will be exploited at above a level which is believed to be sustainable in the long term, with no potential room for further expansion and a higher risk of stock depletion/collapse. Therefore, a substantial reduction in exploitation is advised.

Discussion
The WG considers the XSA analysis as provisional and found it unacceptable as basis for advice. The main shortcoming of the analysis is the lack of reliable tuning data.
The WG also would recommend that further consideration is given to the assumptions about natural mortality.

The WG endorses the assessment and the related recommendations.

GSA07 Engraulis encrasicolus Gulf of Lions
(By D. Roos)

Fishery
The fishery is almost exclusively by trawlers, targeting anchovy and sardine. Since 2002, the number of vessels targeting anchovy has gone down from 56 to 20. The number of vessels in the whole trawler fleet remains stable at around 100. The catches went down from 8000 tonnes in 1998 to 2249 tonnes in 2005, and has fluctuated around 2500 to 4000 tonnes since then. The catch in 2009 was 2460 tonnes.

Data and parameters
The available data are annual catches, length and age distributions in the catches, and regular acoustic surveys (PELMED survey in July).

The main source of information is the acoustic survey. The catches data and specific fishing effort collected by producer organisations are not sufficiently precise to permit an indirect approach of the stock assessments. Exploratory analysis based on the population at age estimates from the survey and the age composition of catches was used to support the advice.

Assessment method
The solution chosen for the gulf of Lion is to use direct assessment method of stocks by echo - integration while completing them with indicators of the fishing activity. At this

end, PELMED surveys are performed at daytime in July. 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 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.

Results

The global pelagic 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 472,000 tons, highest level of 1993–2010 period. From 2005 till 2010, anchovy biomasses levels were at the lowest but into the regular range of the time series for the Gulf of Lion (between 20,000T and 33,000T). Previously, it was a sequence with higher range of biomasses (40,000 T to 80,000 T from 1997 till 2004).
Modal length class progressively decrease from 2005 to 2010 to reach to 10-13 cm in 2009-2010 (vs. 13-14.5 cm before). Large anchovy (>15 cm) quasi disappeared in the same period, which was common before 2007 (maximum length observed in the gulf of Lion**:** 18 cm).
In 2009, a lot of fish from age 1 was found and it seems the same happened in 2010 except that age 2+ was poorly represented, or absent.

Fishery exploitation rates of acoustic estimated biomasses were moderate and stable around 10% in the time series, except 18-20% for 2007-2008 years.
Trawlers targeted fishes size >13 cm before 2007, corresponding to age 1+, with annual variability. Current modal class in catches was < 13cm from 2009. Age 0 was not targeted, except in 2007 (25% of landing). Trawlers effort and catches were progressively reduced from 2005 to 2010. Most of them stopped their activity at the end of 2009. Current fishery effort on anchovy was limited to a exploratory activity in 2010. Catches were characterized by stable CPUE. From 2009, low commercial value for anchovy combined with mixed catches (small anchovy with a lot of small sprat) reduce the attractiveness for anchovy. The amount of sprat in the area has increased remarkably in the most recent years.

Population, demographic and biological parameters obtained in 2009 and 2010 periods present some alterations for anchovy: More 80 % of biomasses was composed by age 1. Age 1 in 2008-2009 do not produce abundances as high as expected for age 2 and 3 in 2009-2010 period.

Few fishes had survived after 2 years in 2010 (<1%). Condition index, growth rate, and size at first maturity decrease significantly and quickly these 3 last years. Only small adult anchovy are available to constitute the spawning biomass : low fecundity versus high recruitments levels observed in this stock since 2008, suggest an external spawning biomass contribution to Gulf of Lion.

Stock status
Regarding the acoustic survey biomass estimate as an unbiased measure of the absolute abundance, the exploitation rate (catch/biomass) is moderate. The current biomass

levels are low regarding the total series of acoustic biomass available. The biomass decreased after a peak in 2001, and has been stable at the lowest level in the series since 2005.

The stock seems to be highly unbalanced in 2009 and 2010, with a very low abundance of commercial-sized anchovy (groups 2+). Even if total biomass was not very much lower than the average level of the last six years (20,000 – 30,000 T), most of the recorded biomass consisted of 1-group anchovy, and even these showed a mean size and condition factors appreciably below the values usually found for this stock.

These signs indicate that the production capacity of the stock, and its potential to sustain an economic activity, is severely hampered, and it is essential to allow it to recover, by preventing the addition of additional sources of mortality to this already depleted population

Advice and recommendation

Therefore, the WG recommends:
- To reduce fishing effort on anchovy in the Gulf of Lion, such as the case already applied by the fishery in an adaptive behaviour in the first six month of 2010,
- To respect the European regulation on minimum length size of catch (> 9 cm, UE 1976/2006) to protect age 1, until there is evidence of a balanced stock balanced stock, and significant anchovy biomass in age 2+ (by growth and/or immigration).

Gulf of Lion small pelagic fisheries are multispecies and effort on anchovy cannot be separated from effort on sardine, so that most of the management decisions have to be taken, considering both species.

The WG endorses the assessment and the related recommendations.

GSA07 Sardina pilchardus **Gulf of Lion**
(By David Roos)

Fishery

The fishery is mostly by trawlers, targeting anchovy and sardine. Some catches are also taken by a smaller purse seine fleet. Since 2002, the number of trawlers targeting sardine (and anchovy) has gone down from 56 to 20. The number of vessels in the whole trawler fleet remains stable at around 100 vessels. Since 1998, the catches have fluctuated around 6,000 to 11,000 tonnes. In 2008, the catches went down to 5,740 tonnes and in 2009 to 2,720 tonnes.

Data and parameters

The available data are annual catches, length and age distributions in the catches, and regular acoustic surveys (PELMED survey in July).

The main source of information is the acoustic survey. The catches data and specific fishing effort collected by producer organisations are not sufficiently precise to permit an indirect approach of the stock assessments. Exploratory analysis based on the

population at age estimates from the survey and the age composition of catches was used to support the advice.

Assessment method

The solution chosen for the Gulf of Lion is to use direct assessment method of stocks by echo - integration while completing them with indicators of the fishing activity. At this end, PELMED surveys are performed at daytime in July. 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 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. The assessment provided here is entirely dependent on the assumption of Acoustic biomass providing unbiased estimates of the absolute level of biomass at sea.

Results

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 472,000 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. But for some years this spatial distribution did not occur.

Estimated total biomasses was around 50,000 T for both 2009 and 2010 surveys. These biomasses levels were into the regular range of the time series for the Gulf of Lion (between 50,000 T and 100,000 T in 1993-2010 period, excepted in 2005 (up to 230,000 T)). Large sardine biomasses (breeder >12.5 cm) dramatically decrease since 2005 (> 200 000 T) to reach its lower level in 2010 (<5,000 T). Small sardine (<12.5 cm) showed important recruitment since 2008 and they represent in 2009 and 2010 more than 80% of biomasses.

Fishery exploitation rates of acoustic estimated biomasses varied annually between 5 to 25% during the last ten years. Trawlers targeted fishes size >14.5 cm corresponding to groups 2+. Trawlers effort and catches were progressively reduced in the first half of 2009 period, and most of them stopped their activity at the end of 2009, until July 2010. In 2010, fishery effort on sardine was limited to an exploratory activity. Catches were characterized by low CPUE. Quite as the anchovy, small sardines was mixed with a lot of small sprats. The landings had low commercial values, which limited fishing effort. Population, demographic and biological parameters obtained in 2009 and 2010 periods present some alterations: Eighty percent of biomasses was composed by age 0. Groups 0 and 1 in 2008-2009 don't produced abundances as high as expected for age 1 and 2 in 2009-2010 period. Few fish survived after 2 years in 2010 (<1%).Condition index, growth rate, and size at first maturity decrease sensitively and quickly these 3 last years. Very low and depleted biomass of adult (age 1+) wasn't in accordance with high recruitments levels observed in this stock since 2008, suggesting an important external spawning biomass contribution to Gulf of Lion.

Stock status

The stock seems to be highly unbalanced in 2009 and 2010, with a very low abundance (less than 10% of the total biomass) of commercial-sized sardines (groups 1+). Even if total biomass was not very much lower than the average level of the last decade, most of the recorded biomass consisted of 0-group sardines, and even these showed a mean size and condition factor appreciably below the values usually found for this stock. Besides, for two years in a row, these recruits have almost completely disappeared from the stock, with very few survivors the following year.

The system of the Gulf of Lyons shows important signs of des-equilibrium since 2008, with important reductions and changes in structure of the stocks of sardine and anchovy, and an unusually high abundance of sprat.

The same patterns are found in the commercial activity. The fleet does not manage to capture any significant amounts of sardine, and the commercial activity has almost stopped since the end of 2009, being limited to an exploratory activity in 2010.

All these signs indicate that the production capacity of the stock, and its potential to sustain an economic activity, is severely hampered, and it is essential to allow it to recover, by preventing the addition of additional sources of mortality to this already depleted population.

Advice and recommendation

Therefore, the WG recommends:
-   To strongly reduce fishing effort on sardine in the Gulf of Lion, such as the case already applied by the fishery in an adaptive behaviour in the first six month of 2010,
-   To formalize and establish a protocol of "sentinel" activity for fishermen, and produce monthly spatio-temporal observations to describe the evolution of the system,
-   To respect the European regulation on minimum length size of catch (11cm, UE 1976/2006) to protect age 0, until there is clear evidence of a balanced stock, and significant sardine biomass in age 1+ (by growth and/or immigration)

Gulf of Lion small pelagic fisheries are multispecies and effort on sardine cannot be separated from effort on anchovy, so that most of the management decisions have to be taken, considering both species.

The WG endorses the assessment and the related recommendations.

GSA16 Engraulis encrasicolus South of Sicily

(By B.Patti)

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.

During the last decade the importance of pelagic pair trawlers has increased compared to the traditional purse seine fishing activity, which in turn showed no significant trend in terms of fishing effort.

A fry fishery is also operating in GSA16 for two months, during the winter (approximately during February-March).

Data and parameters

Catch (landing) data herein used are from census data for Sciacca port (1998-2009) and from sampling data of DCR programme for the landings of the whole GSA16 (2006-2009). Landing data from Sciacca port were used to support the present assessment because of its importance in GSA 16 and the availability of a longer time series (1998-2009) compared to the official data for the whole GSA 16 (2002-2009).

Biomass evaluations used for the analysis are from echo-surveys carried out from 1998 to 2009 in the Strait of Sicily. Some DEPM biomass estimates available for the anchovy population in GSA 16 (years 1998, 2000-2001, 2005-2006) were also reported for comparison purposes, in order to show that they are in the same order of magnitude of acoustic biomass estimates.

Assessment method

The present assessment is based on the comparison of acoustic biomass estimates and estimated landings. Specifically, the average value over the last four years (2006-09) of the estimated exploitation rates calculated as the ratio between total landings and acoustic biomass was used. The assessment 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. So the former assumption is considered to be globally acceptable.

Results

The general results are similar to those obtained in previous assessments. Average anchovy landings over the last decade (1997-2009) were about 1,700 metric tons (Sciacca port only), with large inter-annual fluctuations. General trend in landings is slightly increasing for both the OUs. It worth noting that, even though mid-water pair trawlers are present in Sciacca port only, they contribute significantly to the total anchovy landings.

The series of acoustic biomass estimates for the anchovy population show a marked decreasing trend, despite quite large inter-annual fluctuations, from a maximum of about 22,900 t in 2001 to a minimum of 3,100 t in 2008. Latest biomass estimates (2006-2009 surveys) are the lowest of the series. The estimated average exploitation over the last four years (2006-2009) is high (0.79).

Stock status

Exploitation rate (ratio between total landings and biomass estimates): high fishing mortality.

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

The high and increasing yearly exploitation rates, as estimated by the ratio between total landings and biomass, indicates high fishing mortality levels.

The latest biomass estimates (2006-2009 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 catches and exploitation rates but with high variability experienced over the last years, give a warning about the sustainability of current levels of fishing effort.

Advice and recommendation

Given that the biomass has been very low for four consecutive years (2006, 2007, 2008 and 2009) and with the increasing trend in catches and in exploitation rate, fishing effort should not be allowed to increase. In addition, the possible impact of fry fishery may have to be taken into account. Specifically, fry fishery for sardine should not be extended after March so as to avoid additional mortality of juvenile anchovy.

Discussion

Negative effects on these populations could result from pressure of other fishing gears on pre-juvenile stages (locally known as "bianchetto" or "neonata"). This fishing activity is allowed for two months during the winter (February-March), so it essentially affects sardine but it may also be relevant for anchovy if seasonal restrictions are not properly enforced.

The WG endorses the assessment and the related recommendations.

References

Patti, B., Bonanno, A., Basilone, G., Goncharov, S., Mazzola, S., Buscaino, G., Cuttitta, A., García Lafuente, J., García, A., Palombo, V. and Cosimi, G. (2004). Interannual fluctuations in acoustic biomass estimates and in landings of small pelagic fish populations in relation to hydrology in the Strait of Sicily. Chemistry and Ecology, 20(5), 365-375.

Patti, B., Venezia, S., Piazza, I., Basilone, G., Patti, C., Caruana, L. and Mazzola, S. (2007). Final Report of Project CAS.FO. "Cattura e sforzo di piccoli pelagici nel Canale di Sicilia per la gestione delle risorse pescabili". In Italian. Regolamento C.E.E. n. 1263/99 – SFOP – Misura n 4.17 – Sottomisura B.

GSA16 Sardina pilchardus **South of Sicily**

(By B.Patti)

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. During the last decade

the importance of pelagic pair trawlers has gained importance compared to the traditional purse seine fishing activity, which in turn exhibited no significant trend in terms of fishing effort.

A fry fishery is also operating in GSA16 for two months, during the winter (approximately during February-March).

Data and parameters

Catch (landing) data herein used are from census data for Sciacca port (1998-2009) and from sampling data of DCR programme for the landings of the whole GSA16 (2006-2009). Landing data from Sciacca port were used to support the present assessment because of its importance in GSA 16 and the availability of a longer time series (1998-2009) compared to the official data for the whole GSA 16 (2002-2009).

Biomass evaluations used for the analysis are from echo-surveys carried out from 1998 to 2009 in the Strait of Sicily.

Assessment method

The present assessment is based on the comparison of acoustic biomass estimates and estimated landings. Specifically, the average value over the last four years (2006-09) of the estimated exploitation rates calculated as the ratio between total landings and acoustic biomass was used. Therefore, the assessment relies on the assumption of acoustic surveys providing absolute estimates of biomass at sea (tonnes).

Model performance

Not applicable

Results

The general results are similar to those obtained in previous assessments. Average sardine landings over the period 1998-2009 were about 1,400 metric tons (Sciacca port only), with a general decreasing trend but large inter-annual fluctuations. It worth noting that, even though mid-water pair trawlers are present in Sciacca port only, they contribute significantly to the total sardine landings.

Biomass evaluations from echo-surveys carried out from 1998 to 2009 in GSA 16 show that sardine population experienced quite large inter-annual fluctuations (Patti et al. 2004), from a maximum of about 36,300 t in 2000 to a minimum of 6,000 t in 2002. Latest biomass estimates (2006-2009 surveys) are at intermediate/low level (on average about 10,000 tonnes, just above the first quartile of the series) compared to the rest of time series. The estimated average exploitation over the last four years (2006-2009) is relatively low (0.20).

Stock status

Exploitation rate (ratio between total landings and biomass estimates): moderate fishing.
Stock abundance (acoustic biomass estimate): low/intermediate abundance.

The yearly exploitation rates, as estimated by the ratio between total landings and biomass, indicates moderate fishing mortality levels.

Advice and recommendation

Assuming acoustic evaluations as an unbiased estimate of the absolute biomass of the population, the current exploitation seems to be tolerable. 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 impact of fry fishery on this population is not known, a proper quantification of the catches in the fry fishery is mandatory.

Discussion

Acoustic biomass evaluations show that sardine population experienced quite large inter-annual fluctuations over the period 1998-2009. Over the last four years the population appears to be stable though at a relatively low level. However, taking into account the moderate exploitation rates experienced, results would suggest the stock being able to tolerate the current level of exploitation.
In addition, negative effects on these populations could result from pressure of other fishing gears on pre-juvenile stages (locally known as "bianchetto" or "neonata"). In GSA16 this fishing activity is commonly allowed for two months during the winter period (February-March).

The WG endorses the assessment and the related recommendations.

References
Patti, B., Bonanno, A., Basilone, G., Goncharov, S., Mazzola, S., Buscaino, G., Cuttitta, A., García Lafuente, J., García, A., Palombo, V. and Cosimi, G. (2004). Interannual fluctuations in acoustic biomass estimates and in landings of small pelagic fish populations in relation to hydrology in the Strait of Sicily. Chemistry and Ecology, 20(5), 365-375.

Patti, B., Venezia, S., Piazza, I., Basilone, G., Patti, C., Caruana, L. and Mazzola, S. (2007). Final Report of Project CAS.FO. "Cattura e sforzo di piccoli pelagici nel Canale di Sicilia per la gestione delle risorse pescabili". In Italian. Regolamento C.E.E. n. 1263/99 – SFOP – Misura n 4.17 – Sottomisura B.

GSA17 Engraulis encrasicolus **Northern and Central Adriatic Sea**
(By A. Santojani)

Fishery
Anchovy are fished by purse seiners, attracting fish by light, and pelagic trawlers belonging to Italy, Croatia and Slovenia. The fishery takes place all year round: a closure period is observed from the Italian pelagic trawlers on August, while from 15th December to 15th January in Croatia.
Exploitation is based on all the age classes from 0 to 4+.

The Italian catches of anchovy represent the greater part of the total catches of anchovy, while the eastern small pelagic fishery concentrate mainly on sardine.

The Italian fleet is composed of about 65 pairs of mid-water trawlers and about 45 purse seiners (with quite different tonnage), with the former being predominant on the latter ones.

In Croatia, small pelagics (mainly sardine) are fished by purse seiners. On the other hand, in Slovenia, mid-water trawlers gradually caused the disappearance of purse seiners since 1991.

Data and parameters

The data used for the present assessment derive from the catch recorded for the fleets of Italy, Croatia and Slovenia, from 1975 to 2009. The biological information needed to distribute numbers of caught individuals into age class are available since 1975 for the western side, and from the 2001 for the eastern one.

Echo-survey abundance index was used to tune the VPA. The echo-surveys were carried out for both the western and eastern sides from 2004 onwards. Western echo-survey abundances were split into age classes by means of length frequency distribution coming from the western echo-survey and age-length key coming from the Italian commercial fleet. Eastern echo-survey abundance was distributed into age classes by the means of length frequencies and age-length key coming from the Croatian commercial fleet.

Split year was used, by fixing the birthday date on the first of June, according to the biology of the species in the Adriatic Sea.

The natural mortality rate M was taken as variable over age and was calculated using the Gislason's equation. The growth parameters required by this method were derived from the biological sampling of the Italian catches.

Assessment method

Virtual Population Analysis (VPA) with Laurec-Shepherd tuning.

Model performance

The fishing mortality rates F on the oldest age were fixed to avoid not reliable estimates of abundance in some years. Shrinkage for F was also applied, in order to avoid steep increase in the biomass of recent years.

Results

The trend in biomass resulted from the performed VPA put in evidence the collapse that took place in the 1987 with consequent crisis of the Italian fishery. Another decrease occurred from 1999 to 2001 and was even evident in the VPA runs without fixed F on the oldest age: however, there's no evidence of this collapse from the echo-survey estimates and from the recorded catches. After the true collapse in 1987, the biomass shows a slow but constant recovery, reaching a level of biomass as high as the values registered at the beginning of the time series. This trend is reflected in the biomass estimated by the echo-survey from both the west and east part of the Adriatic.

The exploitation rate F/Z was estimated over the Patterson's threshold 0.4 before the collapse and in the years of the "apparent collapse", while, recently, was under this threshold.

Stock status
The stock at the present level of biomass can be considered as moderately exploited.

Advice and recommendation
Despite the positive trends showed from the analysis performed, since this stock can have large fluctuations associated with recruitment fluctuations, the advice is to not increase the fishing effort.

Discussion
It should be noted that Adriatic small pelagic fishery is multispecies and effort on sardine stock cannot be separated from effort on stock of anchovy. Hence, management decisions have to be taken considering both species.
In the present assessment, important improvements were made regarding the echo-survey data used as tuning index for VPA: in particular, for the first time, biological data from the western Adriatic were used to split into age classes only the abundance estimated by the western echo-survey, while biological data from the eastern Adriatic were applied to the eastern echo-survey abundance.
The Daily Egg Production Method (DEPM) is being developed to estimate the spawning stock biomass of the entire GSA 17.

The WG endorses the assessment and the related recommendations.

GSA17 Sardina pilchardus Northern and Central Adriatic Sea
(By A. Santojani)

Fishery
Sardine are fished by purse seiners, attracting fish by light, and pelagic trawlers belonging to Italy, Croatia and Slovenia. The fishery takes place all year round: a closure period is observed from the Italian pelagic trawlers on August, while from 15th December to 15th January in Croatia.
Exploitation is based on all the age classes from 0 to 6+.
The Croatian catches of sardine represent the great part of the total catches, while the Italian small pelagic fishery concentrate mainly on anchovy (though high amounts were caught by the Italian fleet in the past).
The Italian fleet is composed of about 65 pairs of mid-water trawlers and about 45 purse seiners (with quite different tonnage), with the former being predominant on the latter ones.
In Croatia, small pelagics (mainly sardine) are fished by purse seiners. On the other hand, in Slovenia, mid-water trawlers gradually caused the disappearance of purse seiners since 1991.

Data and parameters
The data used for the present assessment derive from the catch recorded for the fleets of Italy, Croatia and Slovenia, from 1975 to 2009. The biological data of the species (available since 1975 for the western and from the 2001 for the eastern side) were used to obtain the age distribution in the catches.
Echo-survey abundance index was used to tune the VPA. The echo-surveys were carried out for both the western and eastern sides from 2004 onwards.
Echo-survey abundance index was used to tune the VPA. The echo-surveys were carried out for both the western and eastern sides from 2004 onwards. Western echo-

survey abundances were split into age classes by the means of length frequency distribution coming from the western echo-survey and age-length key coming from the Italian commercial fleet. Eastern echo-survey abundance was distributed into age classes by the means of length frequencies and age-length key coming from the Croatian commercial fleet.

Calendar year was used, by fixing the birthday date on the first of January, according to the biology of this species in the Adriatic Sea.

The natural mortality rate M was taken as variable over age and was calculated using the Gislason's equation. The growth parameters required by this method were derived from the biological sampling of the Croatian catches.

Assessment method

Virtual Population Analysis (VPA) with Laurec-Shepherd tuning.

Model performance

Shrinkage for F was applied, in order to avoid steep increase in the biomass of recent years.

The age class 0 was not included into the analysis since the value of M = 2.51 obtained for this age class would have implied too high and thus not conservative estimates of abundance at sea; also, the age class 0 is not substantial in the total catch at age.

Results

The trend in biomass of sardine obtained by VPA method fluctuated over the time interval examined, with a high peak in the middle of the 1980s. After the mentioned peak, biomass of sardine continuously decreased due to a drop in the recruitment, which most likely was caused by environmental influence. A slow but continuous recovery has started since 2000. This trend is also reflected in the biomass estimated by the echo-survey from both the west and east part of the Adriatic.

The fishing mortality is moderate (about 0.3) but higher than before the period with low recruitment. The exploitation rate F/Z was estimated over the Patterson's threshold 0.4 between 2000 and 2002. In recent years, the exploitation rate was under this threshold.

Stock status

The stock at the present level of biomass can be considered as moderately exploited.

Advice and recommendation

Since this stock can have large fluctuations associated with recruitment fluctuations, the advice is to not increase the fishing effort.

Discussion

It should be noted that Adriatic small pelagic fishery is multispecies and effort on sardine stock cannot be separated from effort on stock of anchovy. Hence, management decisions have to be taken considering both species.

In the present assessment, important improvements were made regarding the echo-survey data used as tuning index for VPA: in particular, for the first time, biological data from the western Adriatic were used to split into age classes only the abundance estimated by the western echo-survey, while biological data from the eastern Adriatic were applied to the eastern echo-survey abundance.

The Daily Egg Production Method (DEPM) is being developed to estimate the spawning stock biomass of the entire GSA 17.

The WG endorses the assessment and the related recommendations.

GSA18 Engraulis encrasicolus **South Adriatic Sea**
(By M. Mandić)

In the scope of AdriaMed Project, in cooperation between Institute of Marine Sciences (ISMAR-CNR Ancona, Italy), Institute of Marine Biology (Kotor, Montenegro) and Aquaculture and Fishery Laboratory (Durres, Albania) joint surveys have recently been conducted in GSA 18 with application of two independent methods simultaneously - acoustic method (all GSA 18) and Daily Egg Production Method (DEPM) in SE Adriatic Sea (Montenegrin and Albanian territorial and adjacent international waters).

Fishery in Italy
Anchovy is exploited by pelagic trawl, purse seine and to a lower level by bottom trawl. Highest landings in weight are those of pelagic trawling followed by purse seine. Fishing is carried out five days a week. Exploitation is mainly based on age classes 1 and 2. Purse seiners during most of the fishing season operate in GSA 17. Pelagic trawlers mainly fish small individuals (bianchetto) in the allowed period (February-March).

From official data, the pelagic trawl and purse seine fleet of the geographical sub-area 18 (South-Western Adriatic Sea) is made up by 40 boats.

Fishery in Montenegro
At present time, there is only one active vessel (purse seine) that exploiting those resources in Montenegro but the catches are poor, probably because of unskilful crew and some technical problems. Even when catches are accomplished big problem is its sale because of unorganized market.

So, anchovy is targeted mostly by small scale fisheries. Fishing grounds are located along the coast, and also in the Boka Kotorska Bay. In small scale fishery almost all types of nets are used (gillnet, purse seines, trammel net etc. and long lines). With this type of fishery, a lot of economically important fishes are caught but there are no precise data about its amount.

Fishery in Albania
There are 5 pelagic vessels in Albania which are active from 3 - 5 month during the year. On next table catches for the period January- March 2010 are presented:

Month	Sardine (kg)	Anchovy (kg)
January	5668	23880
February	2928	6504
March	1200	23935

The half of this catches goes to export and another part for conservation in Industry.

Data and parameters
Data concerning Italian official commercial landings come from IREPA.
Data used for anchovy biomass assessment (eastern side of GSA 18) by DEPM are from the AdriaMed eggs and larvae survey that was conducted simultaneously with application of acoustic method from 12th to 20th July of 2008.
Acoustic survey was performed in all GSA 18, while DEPM was performed in Montenegrin and Albanian territorial and adjacent international waters (eastern side of GSA 18).
Reproductive parameters of adult population were processed directly onboard (total length (TL), weight with and without gonads, sex ratio and maturity stages), while relative batch fecundity (Frb) and spawning frequencies (f) were analysed in the laboratory.
Plankton samples were processed in the laboratory using methodology given by Regner (1985). Developmental time from fertilization to hatching (D) was analyzed, instantaneous mortality rates of eggs, average and total daily egg production.

Assessment method
- Acoustic survey
- DEPM

Results of acoustic method
The average value of anchovy biomass estimations in the Western part for the studied period (1987-2009) is 27,1 t/nm^2. From the very low levels of abundance at the beginning of the historical series we assist to a recovery since 1994; after that the stock maintained good levels of abundance from 1997 to 2002. In these last years, anchovy biomass in this area presents strong fluctuations with two minima (2005, 2008) and two maxima (2006, 2009). In 2009 biomass density was estimated in 41,4 t/nm^2, more than 50% of the average value.

First biomass assessment of small pelagic fish species in Montenegrin territorial waters was performed in the frame of AdriaMed project applying acoustic method from 2002.
Echo-surveys were performed in August 2002, July 2004 and August 2005 on 37 transects on area from Boka Kotorska Bay entrance to the border of Albanian territorial waters (total surface was 1746 Nm2). In 2005, for the first time, two direct methods were applied simultaneously, acoustic method and DEPM.

Since 2004 there was no commercial catching of small pelagic fishes in Montenegro so it wasn't possible to estimate biomass or MSY from commercial landings data. Based on acoustic method, estimated biomass of anchovy varied from 90383 tons in 2002, 3454 tons in 2004 and 23220 tons in 2005, while estimated biomass of anchovy by DEPM in 2005 was 3842 t (6,05 times lower compared to acoustic estimation).

Results of DEPM
Total surface of surveyed area was 14 446.76 km^2 (4 212 nm^2). The surface of anchovy spawning area was 8 786.8 km^2 (2 561.8 nm^2), that is 60.82% of total area surveyed.
Number of eggs produced under m^2/day for every station was estimated. Average egg production was 110,16 eggs/day in entire positive area which was 8786.8 km^2. Daily egg production in entire spawning area was 9.67964E+11 eggs per day.

Estimate of anchovy's gonad – free spawning biomass, using Parker's (1980) equation was 52 273.2 tonnes.

Objective analysis, obtained by KRIGING method, showed that anchovy's spawning area stretched along the inner part of the surveyed area, between the coastline and approximately 100 m isobath. The distribution of egg production showed two areas of more intensive spawning. One was the north-western part, in Montenegrin waters, and the other in southern part of the surveyed area.

In this survey acoustic estimate of total small pelagic was 278 310 tonnes, and biomass of anchovy was 60 950 tonnes. After estimate by DEPM, the biomass was 52 273.2 tonnes. This time the difference between two methods was only 8676.8 tonnes, or 14.24%.

As far as Montenegrin waters are concerned, estimated biomass of anchovy by acoustic method was 22 834 tonnes, and by DEPM 21 014.6 tonnes.
Such a good accordance between two methods can be explained by age structure of anchovy stock. Analysis of anchovy's age and weight stock structure showed that juveniles made only 10.39% of acoustic biomass estimate.

Stock status

In the eastern side of GSA 18 acoustic biomass estimation of anchovy was 60 950 tonnes. After estimate by DEPM, the biomass was 52 273.2 tonnes. Difference between two methods was only 8676.8 tonnes, or 14.24%. Such a good accordance between two methods can be explained by age structure of anchovy stock. Comparisons of the present results to those obtained in 2005 by the same method (only in Montenegrin waters –eastern side of GSA18) indicate an important increase in anchovy biomass and also in egg production.

Estimations of anchovy biomass by acoustic method in western side of GSA 18 in recent years shows known fluctuations in population dynamic of anchovy biomass, but also indicated that stock is in the stable level.
Advice and recommendation

Lack of long time series of data on anchovy catches in all GSA 18 precludes a real judgment on stock status. Even though the catch records are incomplete, biomass assessments by acoustic and DEPM method shows that most likely stock can sustain the current fisheries in GSA 18.

It is recommended to continue with application of two methods (acoustic and DEPM) I all GSA 18 and to obtain data on anchovy catches from all countries from GSA 18.

The WG endorses the assessment and the related recommendations. The WG regards the developing cooperation and coordination between nations around the South Adriatic Sea as very promising and encourages its further development. This will be essential to provide a basis for rational exploitation of the small pelagic resources in the future.

GENERAL DISCUSSION AND RECOMMENDATIONS FOR IMPROVEMENTS

10.   Assessment and management advice for small pelagic in the Mediterranean is still in an early phase of development. Future directions were discussed by the WG. There is considerable progress on several aspects, in particular there is increasing cooperation between scientists and institutions throughout the area. The WG regards this as a very welcome development. Below, some fields are discussed where progress could be made. In all these fields, harmonization and coordination between institutes is a key factor. These suggestions to some extent overlap ongoing projects, and the WG emphasizes that the intention with the suggestions here is not to undermine these projects, rather, it would like to see more of that kind.

Understanding stock identity and migrations.

11.   The stock units in use are largely defined by national borders. The links between fish in the various areas are not clear, but it is not unlikely that stock units are different from management units.

12.   A good deal understanding can be achieved by comparing data from adjacent areas, with respect to strong and weak year classes, concentrations across borders, fishing areas with mainly small and large fish, seasonal variations and other evidence for migrations, as well as meristic characters. There is also a potential for further identification of spawning grounds. A further indication could come from comparing single area assessment with joint assessments over wider areas, once comprehensive catch and survey data are in place. A crucial issue is to collect data in the various areas in such a way that they are comparable, which is best achieved by harmonization of sampling and survey strategies through close cooperation between institutions.

13.   Genetic studies can also be useful, but are quite demanding with respect to competence, and also with respect to planning and careful selection of samples, and the results sometimes are disappointing if there is some exchange between stock units.

14.   One matter of concern is the deep-water parts of the Mediterranean. These are normally not surveyed. It is commonly assumed that no small pelagic fish are present there, and that these parts act as barriers between stocks. This may be true, but needs to be verified.

Biological sampling.

15.   To understand the impact of the fishery, good data from the fishery are essential. The first step is reliable statistics of landings, which still may be a problem, in particular in small scale fisheries. Secondly, there may be a potential for improvement in the sampling for length, weight and age. Some of the proposed analytic assessments were rejected because the landings had been converted to numbers at age using age-length keys averaged over several years or taken from other years. Likewise, one should aim at getting weights at length directly from samples rather than by applying standard formulas, sometimes with parameters taken from the literature or from neighboring stocks. Length based assessment methods require estimates of growth parameters as input. The results may be quite sensitive to the assumed values of these parameters. These values should come from fitting to direct measurements rather than from the literature, and both length-weight relationships and growth parameters may not be the same every year.

Surveys.

16.   Surveys, notably acoustic surveys, are the other key to assessing the stocks and following their dynamics. Again, these surveys are mostly national. That implies a strong need to ensure that the results are directly comparable. This can be achieved by cooperative surveys, or by harmonizing survey design, equipment, routines for interpreting the echograms and sampling. Ideally, proper inter-calibrations should be conducted to ensure that surveys really are comparable. Furthermore, workshops to agree on standards can be a good way forward.

17.   If survey results are used as absolute measures of the stock, as is the case in several of the stocks covered by this WG, it is essential that the calibration is verified as far as possible. In some stocks, egg surveys have been conducted (DEPM method) with reassuring results. Further verification can be achieved by comparing length distributions from surveys with the length distributions one would expect with the catch rate derived from the survey and the landings.

Processes across the Mediterranean.
18.   Most likely, processes that influence stock productivity are common to several stock units, and can only be understood if a broader view is taken. As a first step it is proposed to assemble time series related to productivity that can be compared across areas. The WG noted indications of recruitment (in a broad sense) as one possible approach and proposes to assemble indicators of strong and weak year classes, either from survey information or from age and/or length distributions in catches for as many areas as possible, and look for common trends and/or 'waves' across the Mediterranean. It was not possible to do so during the meeting, but it is recommended to organize this inter-sessionally.

Assessment methods
19.   The standard age-based type of methods for analytical assessment that are currently attempted are not ideal for most of the pelagic stocks in the Mediterranean. Such methods rely heavily on following year classes over several years, and infer the mortality from the rate at which the year classes are depleted in the fishery and surveys. Likewise, equilibrium methods, although useful as a guidance, are not suited to follow trends in productivity.

20.   The short life span implies that the usefulness of analytic assessments of the VPA type is limited, since each year class is only encountered in a small number of years. Then, the relative occurrence in catches and surveys at the older ages will have a large impact on the results. For the older ages in particular, both sampling and sometimes ageing typically are imprecise, and even though the numbers are small in absolute terms the relative abundance will have a major impact on the assessment. Length based methods may be a good alternative, but easily become very sensitive to numbers at length near the maximum length and to assumptions about growth parameters. Likewise, the natural mortality is a large part of the total mortality. The natural mortality is poorly known and difficult to estimate. Formulas to derive natural mortalities form growth parameters exist in the literature and are used for several of the stocks in this WG. However, the applicability to short lived species is unclear and the values derived for natural mortality become very sensitive to e.g. assumptions about growth parameters. In some cases, natural mortalities derived this way were rejected as unrealistic.

21.   Therefore, methods for analytical assessment of small pelagic in the Mediterranean should be adapted to characteristics such as:
  • Each year class is hardly represented more than 1-2 years with reliable data.
  • Disaggregated data (on age and even on length) may be less reliable than aggregated data on biomass.
  • High and uncertain natural mortality
  • Most comprehensive data series are short.

- Acoustic survey data and sometimes DEPM estimates of spawning biomass are commonly available.
- The stocks have strong dynamics and may have periods with high and low productivity.

22.   Various methodological approaches for such situations appear around the world, but no standard approach has emerged. Rather, methods have been adapted to prevailing conditions, both with respect to data and to management. This may be the way forward also for Mediterranean small pelagic, which means that methods from other areas may be useful as guidelines, but they cannot be adapted directly. Hence, there is a scope for a development process on stock assessment methodology, which should include both international expertise and experience and local insight. Such work should also include developing a test bench for evaluating methods and performance of management actions. This is best done by incorporating stock assessment tool development in a management plan evaluation framework, as it is done in several other places in the world. How such work is best organized is still an open question.

Management.

23.   Assessment work cannot be seen in isolation from the management that it is supposed to serve. The management of Mediterranean fishery on small pelagic fish is mostly by technical measures like access control, minimum landing size, and closed areas and seasons. TAC management is not practiced in the area.

24.   Both sardine and anchovy are short lived species with rapid dynamics large driven by variable recruitment. There are several examples of longer periods with good and poor recruitments, or strong trends over time in the recruitment. The driving forces for such fluctuations are not well known. Variations in the natural environment is generally believed to be the main driving force, but the exact environmental factors and the mechanisms by which they influence the stock are not well understood. The role of the stock biomass in determining recruitment success is probably minor in most cases. However, as recruitment obviously requires a spawning stock, a too strong reduction in the spawning stock is bound to have detrimental consequences for the recruitment. Therefore, a stock abundance should be ensured that is sufficient for the stock to respond to favorable environmental conditions once such conditions appear. Lacking other evidence, a minimum standard when advising according to trends in biomass indicators should therefore be to keep the stock above the lowest level where it historically has produced a good recruitment.

25.   Lacking reliable analytic assessments and having data of quite variable quality, the WG considered ways to provide a meaningful and constructive advice based on the evidence that was available. Such evidence typically included trends in biomass indicators from surveys, trends in catches, changes in size and/or age distributions in surveys and in catches, and developments in the fishery. Relying on formal reference points (targets and limits) was considered less useful, as both defining reference points and relating the present state to such reference points was generally out of reach. Rather, it decided to consider the following possible alternative scenarios:

(a) The stock is clearly underexploited and the fishery can safely be expanded.
(b) The stock is probably near fully exploited, but seems to tolerate this exploitation, and no special action seems necessary at present.

(c) The stock is developing in an unfavorable way. Action should be taken to reduce the fishing pressure.

(d) The stock is in deep crisis, and no fishing should be permitted.

26.   None of the stocks were clearly in the first or last category. Therefore, the outstanding question became if the fishery can continue as in recent years, or if action is needed to reduce the fishing pressure, and if so, what action would be needed. To answer that question, the available evidence was assembled, and an advice for action was given if the arguments were considered sufficiently severe. In those cases, the actual measures that were advised were adapted to the perception of the severity of the situation.

27.   Hence, the core of the assessment included:
(a) Listing the evidence that is available.
(b) Outline the state of the stock in qualitative terms according to that evidence
(c) Proposal for advice on management actions if required.

28.   In the report, this is assembled towards the end of each stock section. In the Assessment forms, the evidence is largely assembled in Sheet D together with the classification of the stock, and the proposed advice is in Sheet Z. Additional comments are in Sheet C if needed.

Summary of recommendations for further development.
(a) Exchange of comparable data across the Mediterranean as a first step to facilitate understanding of the impact of environmental processes common to the whole area.
(b) Assemble information across areas that can improve the understanding of stock identities.
(c) Harmonization and coordination of surveys across areas. Coordination in time and space, common standards for instrumentation and interpretation of echograms, general exchange of insight and experience.
(d) Representative sampling from catches. (Not only ad hoc on the market). The EU data collection is a good guidance, but nations outside the EU may also need to improve standards.
(e) Development of suitable analytic assessment tools to analyze the data, provide a simulation test bench for management strategies and reference points and other guidance for management. Small, short-lived pelagic species with highly variable recruitment are not suited for standard age-based assessment tools.
(f) Development of guidance for management suited to short lived species with strong and rapid dynamics, including suitable reference points.

List of Participants

Annalisa ALESSI
IAMC-CNR
Via del Mare, 3
91021 Torretta Granitola,
Campobello di Mazara,
(TP) Italy
Tel: +39 0924 40645
Fax: +39 0924 40445
Mobile: +39 328 2238334
Email: annalisa.alessi@iamc.cnr.it

Enrico ARNERI
FAO AdriaMed and MedSudMed
Projects
Viale delle Terme di Caracalla,1
00153 Rome Italy
Tel: + 39 06 57056092
Fax: + 39 06 57056500
E-mail: Enrico.arneri@fao.org

Pedro BARROS
FAO,
Viale delle Terme di Caracalla,1
00153 Rome Italy
Tel: + 39 06 57056469
E-mail: pedro.barros@fao.org

Jean Louis BIGOT
IFREMER
bd Jean Monnet, BP171,
34203 Sete Cedex, France
Tel: +33 (0)499 573206
Fax: +33 (0)499 57 32 95
E-mail: jean.louis.bigot@ifremer.fr

Fabio CAMPANELLA
CNR-ISMAR
Largo Fiera della Pesca 2,
60125 Ancona, Italy
Tel: +39 071 2078834
Mobile: +39 3204236478
E-mail:
fabio.campanella@an.ismar.cnr.it

Piera CARPI
CNR-ISMAR
Largo Fiera della Pesca 2,
60125 Ancona, Italy
Tel: +39 071 2078826
Mobile: +39 340 2705573
E-mail: piera.carpi@an.ismar.cnr.it

Vanja ČIKEŠ KEČ
Institute of Oceanography and
Fisheries
Šet.I. Meštrovića 63,
Split, Croatia
Tel: +38 521 408005
Email: cikes@izor.hr

Dankert SKAGEN
Fjellveien 96, N-5019
Bergen, Norway
Tel: +47 932 57452
E-mail: dankert@dwsk.net

Nazli DEMIREL
Istanbul University,
Institute of Marine Sciences
and Management
Muskule Sok 1, Vefa,
34116 Istanbul, Turkey
Tel: +90 532 4855000
Fax: +90 212 5268433
E-mail:
ndemirel@istanbul.edu.tr

Rosalia FERRERI
IAMC-CNR Capo Granitola /
Ca'Foscari University, Venice,
via del Faro 4, Torretta Granitola,
Campobello di Mazara (TP), Italy
E-mail: rossella.ferreri@iamc.cnr.it

Encarnación GARCÍA RODRÍGUEZ
Instituto Español de Oceanografía,
Centro Costero de Murcia,
C/ Varadero nº 1, 30740 San Pedro
del Pinatar, Murcia, España
Tel.: +34 968 180511 / 500
Fax: +34 968 184441
E-mail:
encarnacion.garcia@mu.ieo.es

Pilar HERNANDEZ
Information Management Officer
GFCM Secretariat
Fisheries and Aquaculture
Department
Viale delle Terme di Caracalla,1
00153 Rome Italy
Tel: + 39 06 57054617
Fax: + 39 06 57056500
E-mail: pilar.hernandez@fao.org

Omar KADA
Institut National
de Recherche Halieutique (INRH),
Centre Régional de Nador,
BP 493, Boulevard Zerktoni,
Nador, Maroc
E-mail: inrhomarkada@yahoo.fr

Jerina KOLITARI
Aquaculture and Fishery Laboratory
University of Tirana
L. 4, Rr. Skenderbeg,
Durres, Albania
Tel: +355 068 6076121
E-mail: jerina-juka@hyahoo.com

Gildas LE CORRE
IFREMER
Bd. Jean Monnet, BP171,
34203 Sete Cedex, France
Tel: +33 (4) 99 573200
E-mail: gildas.le.corre@ifremer.fr

Milica MANDIĆ
Institute of Marine Biology
Dobrota bb, 85330
Kotor, Montenegro
Tel: +382 032 69264793
Fax: +382 032 334570
E-mail: mamilica@ac.me

Elif MURAT DALKARA
Istanbul University,
Institute of Marine Sciences
and Management,
Muskule Sok 1, Vefa,
34116 Istanbul, Turkey
Tel: +90 532 6958963
Fax: +90 212 5268433
E-mail: elfmurat@yahoo.com

Bernardo PATTI
IAMC-CNR Capo Granitola
via del Faro 4, Torretta Granitola,
Campobello di Mazara (TP), Italy
E-mail: bernardo.patti@cnr.it

Enza Maria QUINCI
IAMC-CNR Capo Granitola /
Ca'Foscari University, Venice,
via del Faro 4, Torretta Granitola,
Campobello di Mazara (TP), Italy
E-mail:
**   enzamaria.quinci@iamc.cnr.it**

Luis F.QUINTANILLA HERVÁS
Instituto Español De Oceanografía
(C.O. Málaga – Fuengirola),
Puerto Pesquero S/N
29640 Fuengirola, Spain
Tel: +34 952 47 19 07
Fax: +34 952 46 38 08
E-mail:
luis.quintanilla@ma.ieo.es

David ROOS
IFREMER, bd. Jean Monnet, BP171,
34203 Sete Cedex, France
Tel: +33 (4) 99 573212
E-mail: david.roos@ifremer.fr

Alberto SANTOJANNI
CNR-ISMAR
Largo Fiera della Pesca 2,
60125 Ancona, Italy
Tel: +39 071 207881 (2078858)
Mobile: +39 338 4751919
Fax: +39 071 55313
E-mail: a.santojanni@ismar.cnr.it

Barbara ZORICA
Institute of Oceanography and
Fisheries
Šet. I. Meštrovića 63,
Split, Croatia
Tel: +38 521 408005
E-mail: zorica@izor.hr

<div align="right">**Appendix B**</div>

<div align="center">**Agenda**</div>

1. **Opening, arrangement of the meeting and adoption of the agenda**

2. **Admission of documents and review of available data**

3. **Performance of joint assessments by GSA or a group of GSAs.**

   3.1. Realization of stock assessments
   3.2. Review and analysis of the results of different assessments

4. **Presentation and discussion of new assessments carried out before the working group meeting**

5. **Presentation and discussion of assessment related works**

6. **Formulation of conclusions, recommendations and management ad vice**

7. **Any other matters**

8. **Conclusions and scientific advice to be transmitted for the consideration by the SCSA and the SAC.**

9. **Date and venue of next meeting**

10. **Adoption of the report**