GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN

COMMISSION GÉNÉRALE DES PÊCHES POUR LA MÉDITERRANÉE

Scientific Advisory Committee (SAC)
Subcommittee on Stock Assessment (SCSA)
Report of the Working Group on Stock Assessment of Small Pelagic Species (WGSASP)
Rome, Italy, 24–27 November 2014

OPENING OF THE WORKING GROUPS ON STOCK ASSESSMENT (WGSAs)

1. The meetings of the SCSA Working Group on Stock Assessment of Demersal Species (WGSAD) and Small Pelagic Species (WGSASP) were held at the GFCM headquarters in Rome, Italy, from 24 to 27 November 2014. The first day was dedicated to a joint session on methodologies for data-limited stocks.

2. Ms Pilar Hernandez and Mr Miguel Bernal, GFCM Secretariat, welcomed the participants to both Working Groups on Stock Assessment of Demersal (WGSAD) and Small Pelagic Species (WGSASP) and provided background information on the meetings and related logistics. They also acknowledged the presence of the Scientific Technical and Economic Committee for Fisheries (STECF) Secretariat and of the European Commission (EC) at the working groups.

SESSION ON METHODOLOGIES FOR DATA-LIMITED STOCKS

3. The GFCM Secretariat opened the session "Methodologies for data-limited stocks" which was a joint session for the two working groups. They then introduced Mr Giacomo Chato Osio from the EC Joint Research Centre (JRC).

4. The GFCM Secretariat reviewed the status of the Mediterranean stocks, highlighting the need to increase the number of stocks assessed in the Mediterranean and Black Sea, and therefore to extend the assessment methods to fisheries for which information is limited. It was pointed out that most of the stocks were overexploited and that it was important to have some indicators on the health of the stock (either based on age or, most likely, on length).

5. A discussion was raised on the urgent need to integrate the information coming from other independent working groups (e.g. STECF) and participants underlined the need to optimize the use of experts' time and effort. However, a final conclusion on how to take advantage of the work undertaken by the various external working groups was not reached.

6. Mr Chato Osio delivered a presentation entitled "Assessment of limited or data limited stocks in the Mediterranean: what to do?". He described the productivity and susceptibility analysis" (PSA) methodology that was recently applied at the Mediterranean level. He suggested that this analysis would allow for the prioritization of stocks in term of vulnerability. He also presented some of the outcomes from a FAO working group on catch-only models, where simulations were carried out to test the performances of four

different methods, i.e., the modified panel regression model (mPRM), the catch-MSY (CMSY) model, the catch-only model – sampling importance resampling (COM-SIR), and state-space catch-only model (SSCOM) (Rosemberg *et al*., 2014).

7. The GFCM Secretariat presented the GFCM framework for providing advice on stock status and related management actions. Specific reference was made to promoting the use, whenever possible, of both biomass and fishing mortality reference points. Participants were also introduced to the GFCM Data Collection Reference Framework (DCRF). The presentation emphasized the minimum set of indicators of 'good environmental status' agreed upon during the MedSuit Regional Workshop (FAO headquarters, November 2014) i.e., total landings, SSB, fishing mortality, effort, bycatch of vulnerable species. Tentative indicators to be further tested were biomass index, the large fish indicator, optimal length and mean trophic level.

8. Mr Chato Osio, in the capacity of STECF Secretariat, presented a summary of the stock assessment results of the last Expert Working Group -14-09-SGMED. Of the 13 stocks assessed, 11 were defined as overexploited, while for two, there was insufficient data to be able to carry out a reliable assessment. The presentation was followed by a discussion on how to link information provided by STECF working groups to GFCM procedures. The WGSASP acknowledged the opportunity presented by the presence of the STECF Secretariat at the meeting to start a common discussion on the issue. One major concern raised by the scientists was that not all GFCM experts also take part in the STECF-EWG. As such, participants suggested establishing a clear procedure on how to use STECF results.

9. Participants of both the WGSAD and WGSASP agreed on a set of general conclusions and recommendations from the session on "Methodologies for data-limited stocks". This is included in the conclusions section of this report.

OPENING AND ARRANGEMENTS OF THE WORKING GROUP ON STOCK ASSESSMENT OF SMALL PELAGICS (WGSASP)

10. The WGSASP meeting was held at the GFCM headquarters in Rome, Italy, from 24 to 27 November 2014. It was attended by 25 fisheries experts from thirteen GFCM Member States, together with representatives of the FAO regional projects, the STECF Secretariat, the European Commission and the GFCM Secretariat (the full list of participants is provided in Appendix B of this report). The WGSASP was chaired by Ms Piera Carpi.

11. The agenda was introduced by the chair and adopted by the WG with some changes, i.e. the inclusion of the presentation "Small pelagic body condition in the Mediterranean and Black Sea", a presentation on the assessment of small pelagics in GSA 04, and a presentation on acoustic biomass estimation in GSA 9/10 (the agenda is provided in Appendix A of this report).

12. Ms Claire Saraux and Mr Enrico Arneri were designated as rapporteurs for the sessions.

13. All stock assessment forms presented and finalized during the WG are available on the GFCM SharePoint site of the expert groups (https://gfcm.sharepoint.com/EG).

PROGRESS ON PREVIOUS YEAR'S RECOMMENDATIONS

14. The chair recapped the conclusions and recommendations of the previous WGSASP session (Montenegro, February 2014), and summarized the assessments presented on that occasion. Two main points were raised: i) the need to establish a routine whereby the stock assessment model and reference points used to provide advice on a given stock are kept stable (except in the case of serious concerns being raised) for a given period of time, and then revised at a dedicated (benchmark) session; and ii) the need to consider the scientific advice of the WG in the context of the management plan already in place.

15. The GFCM Secretariat presented the items for discussion on the management of small pelagic fisheries in the Adriatic Sea as provided by the thirty-eighth session of the Commission to the SAC, and which should be addressed by the WGSASP. Those items included: i) the identification of the most suitable

model for anchovy and sardine stock assessment in GSA 17 and providing reference points for these two stocks; and ii) ii) to evaluate ways to reduce the amount of time between the acoustic survey and the availability of data for stock assessment. In addition, the GFCM Secretariat presented the terms of reference included within Recommendation GFCM/38/2014/1 that also needed to be addressed by the WGSASP, in particular the item related to the review of the biomass reference points for anchovy and sardine in GSA 17.

JUSTIFICATION OF WGSASP 2014 SESSION 2 PROCEDURES

16. The WG based its advice on the framework for describing stock status and providing management advice, approved by the sixteenth session of the SAC (March 2014), and in addition used the following approach to maintain consistency in the advice provided across the various stocks evaluated:

- Where possible, the following preferred reference points were used for advice: the precautionary fishing mortality reference point was based on Patterson's criterion (F/Z = 0.4), while B_{lim} and $B_{threshold}$ were based on an empirical analysis of the biomass estimate time series.
- Consistent with the guidelines from the previous year, B_{loss} was used as a proxy for B_{lim}; B_{loss} is defined as the lowest biomass level from which a stock recovery has been confirmed. B_{loss} is estimated from an analysis of biomass estimate time series. Time series should be sufficiently long and the reference point should only be considered if the analysis provides a consistent perspective in the historical and recent part of the time series . As a precautionary approach, where similar minima that meet the required criteria (recovery) exist in the time series, the upper value should be selected. The threshold reference point (or precautionary reference point; referred to in this report as B_{pa}) is defined as a point at which the probability of the stock being below B_{lim} is lower than 5%. In order to estimate this reference point, a log-normal distribution of B_{lim} is assumed, with a coefficient of variation of 40%. This results in approximately $B_{pa} = 2 * B_{lim}$.

17. For those stocks for which reference points were not available – and in line with the precautionary approach which dictates providing advice with the available data – the WG followed the approach used in previous years, i.e.:

- When long time series of estimates were available, the status of the biomass and the evaluation of current fishing mortality levels were carried out in relation to the abundance and fishing mortality levels observed in the time series. The main criteria to assess the status of both stocks and fishing mortality using the time series were: i) the stability of stock biomass levels; ii) signs of changes in growth and/or age/length composition; iii) signs of recruitment impairment; and iv) changes in fishing mortality levels.
- When analyzing time series of stock status, the WG adopted a regime-specific harvest rate (RSHR – Polovina, 2005; King *et al.*, 2010) conceptual approach; it was recognized that small pelagic fishes may show medium-term fluctuations in productivity due to environmental limitations. Therefore, the possibility of each stock having different equilibrium biomass levels (and therefore surplus biomass and maximum sustainable yield) at different ecosystem states was acknowledged. In cases where various productivity phases were identified, stability - as defined in the point above - was evaluated in relation to each phase.
- Where no extra information was available to evaluate the productivity of the stock in each of the potential high or low abundance phases, the stability of stock characteristics in the time series was used as a guideline.
- Where no long time series of estimates or reference points were available, harvest rates (proportion of catch to biomass) and comparison with biomass levels of other stocks of the same species across the Mediterranean, as well as rough estimates of stock unit were used to provide a rough evaluation of stock status.

OVERVIEW OF ASSESSMENTS PERFORMED AND STOCK STATUS

18. Information on a total of 18 stocks were presented to the WGSASP, and an assessment was attempted for 12 of them (see Appendix E of this report). Management advice was provided for a total of 10 stocks, seven of which were based on a validated assessment and in the other 3 cases, advice was based on the precautionary principle.

19. In terms of spatial extent, the WG meeting covered 10 GSAs: five of those areas (GSAs 3, 6, 7, 16 and 17) were formally assessed (and the assessment was validated by the WG), GSA 4 had three preliminary assessments, GSA 16 had one assessment considered as preliminary, GSA 01 had both the assessments rejected by the WG and for GSAs 9/10 and 18 there was only a presentation on the data available but stocks in these GSAs were not formally assessed.

20. With the exception of GSA 04, where *Sardinella aurita* was also considered in the preliminary analysis, all stocks assessed by this WG were either sardine or anchovy.

21. Fishery-independent estimates of biomass (based on acoustic surveys) were used for seven of the formally-assessed stocks, either as a tuning index for analytical assessment or as the only estimate of biomass. For other two of the formally assessed stocks, non-standardized CPUE data were used as a tuning index. However, these two assessments were rejected by the WG.

22. Both age-based cohort analysis and biomass (surplus) models were used as assessment models.

23. Two of the assessments presented (anchovy and sardine in GSA 01) were rejected by the WG due to uncertainty in the assessment. More specifically, the WG pointed out the existence of contradictory signals between the catch data and the survey data, as well as a number of methodological problems in the application of the surplus production model.

24. A proposal for the assessment of anchovy in GSA 16 was provided within a draft stock assessment Form. However, the proposed assessment had the same shortcoming identified during the previous session of the WGSASP (January 2014) and the assessment was therefore considered preliminary. The assessments of anchovy, sardine and sardinella in GSA 4 were also regarded as preliminary, since the assessments only covered a part of the fleet (purse seiners) that was exploiting these resources and only covered a part of the stocks' spatial distribution.

25. The sardine stock in the southern Alboran Sea (GSA 3) was considered to be sustainably exploited. Anchovy in northern Spain (GSA 6) and sardine in the north Adriatic Sea (GSA 17) were classified as "in overexploitation" with the biomass level above reference points. Anchovy in the north Adriatic Sea (GSA 17) was considered to be overexploited and "in overexploitiation". The sardine stock in northern Spain (GSA 6) was considered to be depleted and fishing mortality was reported to be low. Stocks of anchovy and sardine in the Gulf of Lion (GSA 7) were reported to be respectively low in biomass and unbalanced. The status of the stock for both anchovy and sardine in GSA 1 and for anchovy, sardine and sardinella in GSA 4 was uncertain. Despite having its analytical assessment rejected, the stock of sardine in GSA 16 did not exhibit signs of overexploitation and, based on the acoustic estimates, its Bcurrent value was greater than Bpa.

26. In accordance with the advice on stock status as described in the previous paragraph, the recommendation for each of the stocks was to either reduce the current level of fishing mortality, or to maintain it. Where necessary, recommendations also included implementation of a recovery plan.

27. Ms Claire Saraux delivered a presentation entitled "Small pelagic body condition in the Mediterranean and Black Sea". The authors of this study compared the body condition index between different Mediterranean stocks of anchovy and sardine, using both landings and acoustic survey data for the estimations. The signal between the two sources of data was similar for some stocks (i.e., anchovy and sardine in GSA 07), while different for other stocks (i.e., those in GSA 17). Some of the experts involved in the assessment of Adriatic Sea small pelagic species suggested that the discrepancy was probably due to a lack of data from the eastern side of the Adriatic basin. In response, colleagues working on that side of the Adriatic expressed their willingness to provide the necessary data. The invitation to provide additional data was also extended to the other participants of the WG who had demonstrated interest in the project.

28. The WG highly valued the exercise on body condition index. In particular, the group highlighted the importance of using indicators of stock health to assist in issuing advice on stock status. The WG suggested that the methods and analysis used in the project presented by Ms Saraux would provide a good foundation for the establishment of common indicators on stock health across the Mediterranean and Black Sea. The indicators presented could be associated with recruitment, and therefore could be used to evaluate the extent to which reproductive capacity would be affected. This in turn could support the effective application of management measures. The WGSASP suggested that the project presented should be supported by the GFCM; for example, by facilitating communications and exchange of information in order to incorporate data from all stocks in the Mediterranean and Black Sea.

STOCK ASSESSMENTS BY AREA AND SPECIES

29. The WGSASP critically analysed each stock assessment presented, which included reviewing both the input data and the basic assumptions. For every new model, the WG requested an explanation of the rationale behind it. Furthermore, the results and diagnostics of each stock assessment were scrupulously inspected.

30. The WG recognized some difficulties for the acoustic characterization of anchovy and sardine in GSA01, where fish, in the season of the survey, tend to stay closer to the shore and out of reach from the gears used. The Spanish scientist participating to the WG, informed the WG that the Spanish MEDIAS group is looking for a solution to the problem and informed that the same issues seem to interest also Morocco and Algeria. The WG also noticed that the fishery seemed to depend on juveniles, and that no adults were found; it therefore strongly encouraged to continue the exercise started a few years before of a joint assessment between Morocco and Algeria.

31. The WG welcomed the presentation of assessments for sardine stocks in Moroccan waters (GSA 3) which was in response to the suggestion formulated by the WGSASP during its previous session (January 2014). The previous session had recommended presenting this assessment to the WGSASP for validation. Moreover, the WG highlighted the exercise for improving the estimation of natural mortality (M) using Gislason's methodology, that was carried out during the meeting. Given the increased amount of data available to it, the WG encouraged testing out more complex stock assessment models in order to overcome the limitations of VIT. The WG also suggested considering the use of acoustic survey data as a tuning index.

32. Length-frequency distribution of monthly catches were presented for both anchovy and sardine in GSA 06. During these presentations, the WG noted pronounced differences in the age-length structure of these stocks compared to other Mediterranean stocks of the same species (e.g., a high proportion of age 0 specimens, even for large-sized classes). The WG encouraged to continue the otolith exchange for anchovy already taking place within DCF and to extend that exercise to sardine as well.

33. The WG noted a number of problems associated with the estimates of anchovy biomass and distribution emanating from surveys in GSA 6 carried out by MEDIAS in the 1990s. Firstly, the survey reported a biomass level lower than the total catch itself. This is likely due to the fact that the survey was carried out during the winter months, i.e., before the addition of the newest generation of juvenile recruits, which form a large proportion of the catch.

34. Scientists presented acoustic survey data for GSAs 9 and 10, which the WG gladly welcomed and strongly recommended to keep surveying the area. Additionally, the WG suggested trying to combine information from acoustic surveys with landing data and to carry out an analytical assessment of the status of small pelagic stocks in those GSAs.

35. The WG invited the experts from GSA 16 to present all the available information at the next sessions of the WG and incorporate it into the assessment. Given that the European Union's Data Collection Framework (DCF) has been in force for a number of years, the data required to carry out a detailed assessment should be available. Therefore, analytical models should be, at the very least, attempted.

36. The exercise of revision of some basic parameters in the assessment of anchovy and sardine in GSA17 was carried out during the session. The WG noticed that some instabilities still characterized the assessment of these stocks in the historical part of the time series: in particular, estimates of maximum sardine biomass and of minimum anchovy biomass were instable between different model runs and/or in the

restrocpective analysis of the assessment models. A complete revision of the input data was still in progress in order to solve the issues identified during the previous session of the WG, therefore the WG suggested to plan a benchmark assessment for these stocks for the next year. Due to the inconsistencies described above, it was not possible to confirm the biomass reference points proposed during the previous session of the WG for anchovy , since these were based on the minimum value of the time series; on the other hand it was possible to confirm those for sardine.

37. The WG expressed concerns on the use of CPUE data as the only index of tuning in the assessment of small pelagic stocks. The issue was raised with regard to the assessment carried out for anchovy and sardine in both GSA01 and GSA06. The exercise of re-running the assessments of anchovy and sardine in GSA06 using the acoustic survey as tuning index were carried out during the session, and the advice was based on this model. Nevertheless, notwithstanding the tuning index used, the WG expressed doubts on the reliability of the biomass model for these stocks, and suggested to test alternative biomass models (e.g. Bayesian biomass delay models) or age structured models.

38. The WG discussed the issue of how to deal with anchovy and sardine stocks in the Adriatic Sea (GSA 17-18). On this topic, the WGSASP suggested using all the information available from GSA 18 (including acoustic survey data) to run the model for combined GSAs 17-18 in time for its next session.

39. The WG recognized the importance of strengthening scientific cooperation towards standardization of acoustic surveys in the Mediterranean. Such cooperation, that would involve both North African and European countries (especially those involved in MEDIAS) could be facilitated by the FAO regional projects (CopeMed II, MedSudMed and EastMed) in collaboration with SAC-GFCM activities.

INDIVIDUAL STOCK SUMMARIES

GSA 01 – Northern Alboran Sea

Sardine (*Sardina pilchardus*)

Authors: Authors: Torres, P., A. Giráldez, M. Iglesias, M. González, N. Díaz, M.J. Meléndez and A. Ventero

Fishery

The current fleet in GSA 01 the Northern Alborán Sea is composed by 91 units, characterised by small vessels, average TJB 23.8. 16% of them are smaller than 12 m (operational Unit 1), 84% > 12 m (operational Unit 2), and no one bigger than 24m. The purse seine fleet has been continuously decreasing in the last two decades, from more than 230 vessels in 1980 to 91 in 2013. A strong reduction of larger vessels occurred from 1985 onwards, possibly linked to a decreasing in anchovy catches in Northern Morocco, where a part of that fleet fished under agreement between the countries. Subsequently the fleet continued to decline but more slowly.

Although sardine has a lower price than anchovy, it is an important support to the fishery as it is the most fished species. Catches in the period 1990–2013 has been highly variable, with a minimum of 3 000 tonnes in 1997. Higher catches occurred in 1992 (11 000 tonnes). All period average is about 6 000 tonnes.
The two operational units fish the same species, being sardine the most important one in terms of landings. There is however a slight difference in the percentage of mackerel catches, as bigger ships are able to fish those species that have a higher swimming ability.

Species with a lower economical value are also captured, sometimes representing a high percentage of landings: horse mackerel (Trachurus spp.), mackerel (Scomber spp.), and gilt sardine (*Sardinella aurita*). The interest about some of these species has been increasing because of a new market: in fact gilt sardine in particular, but also mackerel, are sold for tuna farming. This sales require a higher yield per fishing day, due to its low economic value.
The CPUE series shows a very similar profile to catches.

Data and parameters

The input data used for the adopted modelling approach was total yearly catch (tonnes) and CPUE (Catch per unit effort, kg fished considering all trips of the gear) as an index of abundance over the period (2003–2012).
Von-Bertalanffy growth parameters, necessary for the calculation of natural mortality, were estimated with DCF data collected in GSA01 in 2012, running the last version of the program INBIO 2.0 (Sampedro *et al*., 2005, updated 2012 pers. Comm.). Natural mortality was estimated following Pauly (1980); exploitation rate equal to 0.4 was used as reference point (Patterson, 1992).

Assessment method

A modelling approach based on the fitting of a non-equilibrium surplus production model (BioDyn package; FAO, 2004) on the series of observed abundance indexes was used. This model allows for the optional incorporation of an environmental index, so that the r and/or K parameters of each year can be considered dependent on the corresponding value of the applied index. Two different environmental indexes were tested: average chlorophyll-a concentration over the continental shelf and North Atlantic Oscillation (NAO), but neither of them showed any improvement in the model fit.

Model performance

The quality of input data is excellent and the obtained output is satisfactory. Hence the results of the adopted modeling approach are consistent with the trend of the longer landing series.

The goodness of fit of the best model obtained using the surplus production modeling approach is also satisfactory (RpearsonIndex=0.62). Pearson linear regression coefficient will not detect a non-linear relation, but will measure how closely the predicted abundance indices follow the observed ones.

Results

The results based on the implementation of a non-equilibrium logistic surplus production model were rejected by the working group as there is uncertainty in the assessment and methodological problems, such as the use of CPUE as a tuning index.

Diagnosis of stock status

Uncertain, with high fluctuations and population concentrated on first age classes.

Exploitation rate		Stock Abundance	
2003-2013		2003-2013	
	No fishing mortality		Virgin
	Low fishing mortality		High abundance
	Sustainable Fishing Mortality		Intermediate abundance
	High fishing mortality		Low abundance
x	Uncertain/Not assessed		Depleted
		x	Uncertain / Not assessed

Advice and recommendations

Reduce the fishing mortality.

GSA 01 – Northern Alboran Sea

Anchovy (*Engraulis encrasiclous*)

Authors: Giráldez A., P. Torres, M. Iglesias, M. González, N. Díaz, M.J. Meléndez and A. Ventero

Fishery

The current fleet in GSA 01 the Northern Alborán Sea is composed by 91 units, characterised by small vessels, average TJB 23.8. 16% of them are smaller than 12 m (operational Unit 1), 84% > 12 m (operational Unit 2), and no one bigger than 24m. The purse seine fleet has been continuously decreasing in the last two decades, from more than 230 vessels in 1980 to 91 in 2012. A strong reduction of larger vessels occurred from 1985 onwards, possibly linked to a decreasing in anchovy catches in Northern Morocco, where a part of that fleet fished under agreement between the countries. Subsequently the fleet continued to decline but more slowly.

Anchovy is the main target species of the purse seine fleet in Northern Alboran Sea, due to its high economic value, although its abundance is low and very local. Catches in the period 1990-2013 has been highly variable, with a minimum of 157 tonnes in 1993. Higher catches occurred in 1996, 2001, 2002 and 2013, when catches between 2000 and 3200 tonnes were recorded. The average catches for the whole period is 886 tonnes. In the early twenties of the last century, anchovy was fished all around the Alboran Sea, but currently Málaga Bay is the only area where anchovy is fished throughout all the year and where more than 80% of catches are located. The fishery of anchovy in the Malaga Bay is exclusively focused on individuals from early age classes since older age classes are not found: almost all the catch correspond to class 0 and 1. Years with higher catches are usually correlated with a successful and high recruitment period, while unsuccessful recruitment in a given year is correlated with a low level of catch.

The two operational units fish the same species, being sardine the most important one in terms of landings. There is however a slight difference in the percentage of mackerel catches, as bigger ships are able to fish those species that have a higher swimming ability.

Species with a lower economical value are also fished, sometimes representing a high percentage of landings: horse mackerel (Trachurus spp.), mackerel (Scomber spp.), and gilt sardine (*Sardinella aurita*). The interest about some of these species has been increasing because of a new market: in fact gilt sardine in particular, but also mackerel, are sold for tuna farming. This sales require a higher yield per fishing day, due to its low economic value.
The CPUE series shows a very similar profile to catches.

Data and parameters

The input data used for the adopted modelling approach was total yearly catch (tonnes) and CPUE (Catch per unit effort, kg fished considering effective trips for the species) as an index of abundance over the period (2003-2013).

Von-Bertalanffy growth parameters, necessary for the calculation of natural mortality, were estimated with DCF data collected in GSA01 in 2013, running the last version of the program INBIO 2.0 (Sampedro et al., 2005, up dated 2012 pers. Comm.). Natural mortality was estimated following Pauly (1980) and exploitation rate equal to 0.4 was used as reference point (Patterson, 1992).

Assessment method

A modelling approach based on the fitting of a non-equilibrium surplus production model (BioDyn package; FAO, 2004) on the series of observed abundance indexes was used. This model allows for the optional incorporation of an environmental index, so that the r and/or K parameters of each year can be considered dependent on the corresponding value of the applied index. Two different environmental indexes were tested : average chlorophyll-a concentration over the continental shelf and North Atlantic Oscillation (NAO), but neither of them showed any improvement in the model fit.

Model performance

The goodness of fit of the best model obtained using the surplus production modeling approach is satisfactory (RpearsonIndex=0.73). Pearson linear regression coefficient will not detect a non-linear relation, but will measure how closely the predicted abundance indices follow the observed ones.

Results

The results based on the implementation of a non-equilibrium logistic surplus production model were rejected by the working group as there is uncertainty in the assessment and methodological problems, such as the use of CPUE as tuning index.

Diagnosis of stock status

Uncertain, with high fluctuations and population concentrated on first age classes.

Exploitation rate		Stock Abundance	
2003-2013		2003-2013	
	No fishing mortality		Virgin
	Low fishing mortality		High abundance
	Sustainable Fishing Mortality		Intermediate abundance
	High fishing mortality		Low abundance
x	Uncertain/Not assessed		Depleted
		x	Uncertain / Not assessed

Advice and recommendations

N/A

GSA 03 – Southern Alboran Sea

Sardine (*Sardina pilchardus*)

***Authors*:** J. Settih, M.H. Idrissi, O. Kada

Fishery:

The current fleet in GSA 03 in the Southern Alboran Sea (Moroccan Mediterranean sea) is composed by 140 units, characterized by small vessels, average TJB 47. 8% of them are smaller than 12 m (operational Unit 1), 82% of them are between 12 m and 24 m (operational Unit 2), and 8% are bigger than 24m. The purse seine fleet has been stabilizing in the last decades, due to a lot of the investement by the state. Seiners active in Moroccan Mediterranean are based mainly in 3 important ports, i.e. M'diq (35%), Nador (27%) and Al Hoceima (25%).

Landings of small pelagics are composed by sardines, sardinella, anchovy, horse mackerel, chub mackerel and others. Sardines and anchovy are the target species on which the effort of seiners is oriented: sardines for its abundance and anchovy for its high commercial value.

In the last decade, the production of sardines in the Mediterranean Moroccan sea fluctuated between 7000 and 16000 tonnes/year. Between the years 2005 and 2013, the annual average production of sardines was about 11000 tonnes.

The analysis of time series of catches of sardines since 2005 highlights significant fluctuations from one year

to another. The general trend in sardine catches between 2005 and 2008 tended to decline. Since 2011, catches tend to increase.

The analysis of the evolution of fishing effort (expressed as number of positive outputs) exerted on the sardine stock between 2005 and 2013 shows that fishing effort is variable from one year to another. This is linked to climatic conditions and abundance of the resource.

Catch per unit effort (CPUE) generally varies between 890 and 2090 kg/day with an average of 1372 kg/day

Data, parameters and assessment method:

The evaluation of the status of sardine stock was conducted with an analytical approach, i.e. a Length Cohort Analysis (LCA). The input data used were catch size class structured from 2005 to 2013.

Von-Bertalanffy growth parameters, necessary for the calculation of natural mortality, were estimated with DCF data collected in GSA03 in 2002, running the last version of the program INBIO 2.0 (Sampedro *et al*., 2005, updated 2012 pers. Comm.). Natural mortality was estimated using Gislason model (Gislason et al, 2010); exploitation rate equal to 0.4, together with F_{max} and $F_{0.1}$, was used as reference point (Patterson, 1992).

Results:

The level of exploitation of the stock was determined by analyzing the curve of yield per recruit and calculating biological reference points F_{max} and $F_{0.1}$.

Since the value of Fcurr is equal to 0.99, lower than the estimated $F_{0.1}$ equal to 1.13, and since the exploitation rate is 0.35, lower than the Patterson's reference point of 0.4, the stock of sardine is to be considered sustainably exploited.

Table 1. Reference points 2012

Model	F0.1	E	Fcur/F0.1	Status
LCA	1.13	0.35	0.88	Sustainably exploited

Advice and recommendations:

Not to increase fishing mortality

GSA 04 – Western Algeria-Alboran Sea

Sardine (*Sardina pilchardus*), Anchovy (*Engraulis encrasicolus*), Sardinella (*Sardinella aurita)*

***Authors*:** Bennoui A., S. Bensmail, K. Ferhani and A. Tifoura.

Fishery

Fishing fleet, in the western region of the GSA04 (western Algeria), is composed by of 311 units (158 trawlers and 253 purse seiners). Trawlers have an average of 64.20 GRT Tx for an average power of 507.3 hp. Purse seiners are characterized by an average of 36.6 Tx GRT and an average drive power 326.3 hp. Over 60% of the landings of small pelagic fish comes from the active seiners. It should be noted that most of the pelagic trawlers capture small pelagics as secondary species. The landings of the 3 species in exam indicate a significant decline, especially for sardines, which rose from 23030 tons in 2006 to 3849 tonnes in 2012 and it is 11054 tonnes in 2013. The average production, from 2006 to 2013, is 12630 tonnes of sardine, 21524 tonnes for anchovy and 2062 tonnes for sardinella.

Data and Parameters

Data were collected from scientific investigations on the landings of commercial fishing seiner. The structures of the landing sizes for the year 2013 have been identified for three species (Sardine, Anchovy and Sardinella). The data collected were treated under the FISAT software for calculation of growth and mortality parameters. The estimated biomass was carried out under the VIT Software (LCA by age).

Results The WG did not use the results of the VIT software to provide a diagnosis of the stock status, since the assessment only covered part of the fishing fleet and part of the spatial distribution of the stocks. However, it considered the assessment as an usefull exploration of the fishery, and therefore used the information provided to give an indication on the stock status.

Diagnose of stock status

Uncertain, but the current fishing mortality seems too high.

Advices and recommendations:

The suggestion is to reduce fishing mortality since the fishery seems to have a high pressure on all the three stocks.

GSA 06 – Northern Spain

Sardine (*Sardina pilchardus*)

***Authors*:** Torres, P., A. Giráldez, M. Iglesias, M. González, N. Díaz, M.J. Meléndez and A. Ventero

Fishery

The current fleet in GSA 06 (Northern Spain) is composed by 130 units (average GT 38.9), 3% of them are smaller than 12 m (operational Unit 1), 97% > 12 m (operational Unit 2) and 13% are over 24m. The purse seine fleet has been continuously decreasing in the last two decades, from 222 vessels in 1990 to 119 in 2013, loosing the smallest units.

Sardine, although with a lower price than anchovy, was an important support to the fishery until 2009 as it was the most fished species. In the period between 1990 and 2013 sardine landings showed a negative trend, going from 53000 t in 1994 to 9700 t in 2013. The average for the whole period is 30000 t.

The catches evolution is consistent with result of acoustic assessments.

Data and parameters

The input data used for the adopted modelling approach was total yearly catch (tonnes) and a series of abundance indices (acoustic biomass estimates) over the period (1996-2013).
Von-Bertalanffy growth parameters, necessary for the calculation of natural mortality, were estimated with DCF data collected in GSA06 in 2013, running the last version of the program INBIO 2.0 (Sampedro *et al.*, 2005, last update 2012 pers. Comm.). Natural mortality was estimated following Pauly (1980); exploitation rate equal to 0.4 was used as reference point (Patterson, 1992).
The biomass data series comes from the acoustic surveys MEDIAS and Ecomed.

Assessment method

A modelling approach based on the fitting of a non-equilibrium surplus production model (BioDyn package; FAO, 2004) on the series of observed abundance indexes was used. This model allows for the optional incorporation of an environmental index, so that the r and/or K parameters of each year can be considered dependent on the corresponding value of the applied index. Two different environmental indexes were

tested: average chlorophyll-a concentration over the continental shelf and North Atlantic Oscillation (NAO), but neither of them showed any improvement in the model fit.

Model performance

The quality of input data and the obtained output are satisfactory.
The goodness of fit of the best model obtained using the surplus production modeling approach is also satisfactory (RpearsonIndex=0.91). Pearson linear regression coefficient will not detect a non-linear relation, but will measure how closely the predicted abundance indices follow the observed ones.

Results

The results based on the implementation of a non-equilibrium logistic surplus production model are consistent with the previous considerations about trends observed in the acoustic surveys. For 2013 the model predicts a current stock of 55391 tonnes and the acoustic survey sees a biomass of 41 871 tonnes. The estimated B_{MSY} is equal to 108930 and the ratio B_{Curr}/B_{MSY} is respectively 0.51 and 0.71 if the biomass from model or the biomass from the acoustic are used: therefore the stock is to be considered overexploited. Also, the ratio $F_{curr}/F_{0.1}$ is equal to 0.60indicating for this stock a low fishing mortality.

Table 1. Reference points 2013

MSY	BMSY	FMSY	F0.1	FCur	BCur/BMSY	Fcur/FSYCur	Fcur/FMSY	FCur/F0.1
35567	108930	0.33	0.29	0.18	0.51	0.36	0.54	0.60

Table 2. Acoustics biomass and abundance

	Biomass in metric tonnes	Fish numbers
Sardine	41871	6651 millions

Diagnosis of stock status

Overexploited with a low fishing mortality. $B_{current}$ is below B_{MSY} (Bcur/BMSY=0.51).

Exploitation rate		Stock Abundance	
1990-2013		1990-2013	
	No fishing mortality		Virgin
x	Low fishing mortality		High abundance
	Sustainable Fishing Mortality		Intermediate abundance
	High fishing mortality	**x**	Low abundance
	Uncertain/Not assessed		Depleted
			Uncertain / Not assessed

Biomass trends		Recruitment trends	
1990-2013		1990-2013	
[Range]		[Range]	
	Stable		Stable
	Increasing		Increasing
x	Decreasing	**x**	Decreasing

Advice and recommendations

Reduce fishing mortality. Implement a recovery plan.

GSA 06 – Northern Spain

Anchovy (*Engraulis encrasiclous*)

Authors: Giráldez A., P. Torres. M. Iglesias, M. González, N. Díaz, M.J. Meléndez and A. Ventero

Fishery

The current fleet in GSA 06 (Northern Spain) is composed by 130 units, average GB is 38.9. About 3% of them are smaller than 12 m (operational Unit 1), 97% > 12 m (operational Unit 2) and 13% are over 24m. The purse seine fleet has been continuously decreasing in the last two decades, from 222 vessels in 1990 to 130 in 2012, loosing the smallest units.

Anchovy is the main target species of the purse seine fleet in Northern Spain due to its high economic value. Catches in the period 1990-2013 has been highly variable, with a minimum of 1900 tonnes in 2007 and an average of 11700 tonnes. Higher catches occurred in the period 1990-94, when were caught between 17000 and 22000 tonnes. Thereafter it has been continuously decreasing with three recoveries in 2002, 2009 and 2012. 2013 shows higher catches (17178 t), similar to the ones in 1990, but still lower than the peak of landings occurred between 1991 and 94. Years with higher landings are usually correlated with a successful and high recruitment period, while unsuccessful recruitment in a given year is correlated with a low level of landings.

The catches evolution is consistent with the result of acoustic assessments.

Data and parameters

The input data used for the adopted modelling approach were total yearly catch (tonnes) and a series of abundance indices (acoustic biomass estimates) over the period (1996-2013).
Von-Bertalanffy growth parameters, necessary for the calculation of natural mortality, were estimated with DCF data collected in GSA06 in 2013, running the last version of the program INBIO 2.0 (Sampedro *et al*., 2005, last update 2012 pers. Comm.). Natural mortality was estimated following Pauly (1980); exploitation rate equal to 0.4, together with F_{MSY} and $F_{0.1}$, was used as reference point (Patterson, 1992).
The biomass data series comes from the acoustic surveys Medias and Ecomed.

Assessment method

A modelling approach based on the fitting of a non-equilibrium surplus production model (BioDyn package; FAO, 2004) on the series of observed abundance indexes was used. This model allows for the optional incorporation of an environmental index, so that the r and/or K parameters of each year can be considered dependent on the corresponding value of the applied index. Two different environmental indexes were tested: average chlorophyll-a concentration over the continental shelf and North Atlantic Oscillation (NAO), but neither of them showed any improvement in the model fit.

Model performance

The quality of input data is excellent and the obtained output is satisfactory. Hence the results of the adopted modeling approach are consistent with those ones obtained from the acoustic surveys series.
The goodness of the fit obtained using the surplus production modeling approach is also satisfactory (RpearsonIndex=0.60). Pearson linear regression coefficient will not detect a non-linear relation, but will measure how closely the predicted abundance indices follow the observed ones.

Results

The results based on the implementation of a non-equilibrium logistic surplus production model are consistent with the previous considerations about trends observed in the acoustic surveys. For 2013 BioDyn shows a current stock of 24423 tonnes while the biomass estimated from the acoustic survey are equal to 44874 tonnes: the biomass is higher than the biomass reference point of BMSY (BMSY=24463). Furthermore, the exploitation rate corresponding to F=0.70 and M=0.71, estimated with Pauly (1980)

empirical equation, is E= 0.50 which is a higher than the reference point for the exploitation rate of 0.4 suggested by Patterson (1992), so this stock would be considered as being in overexploitation and with a fishing mortality higher than the previous year. The ratio F_{cur}/F_{MSY} is equal to 1.52, meaning an intermediate overfishing for 2013 (it was 0.78 for 2012).

Table 1. Reference points 2013

MSY	BMSY	FMSY	F0.1	FCur	BCur/BMSY	Fcur/FSYCur	Fcur/FMSY
11294	24463	0.46	0.42	0.70	1	1.52	1.52

Table 2. Acoustics biomass and abundance

	Biomass in metric tonnes	Fish numbers
Sardine	44874	5940 millions

Diagnosis of stock status

Biomass above reference point and in overexploitation . Increasing trend in landings and biomass from acoustic survey. Fcurrent (0.70) is higher than Fmsy reference point (0.46). Exploitation rate is higher than the Patterson's reference point (E=0.50). Current biomass is above BMSY.

Exploitation rate		Stock Abundance	
1996-2013		1996-2013	
	No fishing mortality		Virgin
	Low fishing mortality		High abundance
	Sustainable Fishing Mortality	**x**	Intermediate abundance
x	High fishing mortality		Low abundance
	Uncertain/Not assessed		Depleted
			Uncertain / Not assessed

Biomass trends		Recruitment trends	
1990-2013		1990-2013	
[Range]		[Range]	
x	Stable	**x**	Stable
	Increasing		Increasing
	Decreasing		Decreasing

Advice and recommendations

Reduce fishing mortality.

GSA 07 - Proposal for a common project on small pelagic body condition at the Mediterranean and Black Sea scales

***Authors*:** C. Saraux, P. Brosset, J. Lloret (as well as all data providers, i.e. MEDIAS group and I. Palomera and P. Carpi).

Body condition is a key variable widely used in ecological studies particularly on fish, mammals and birds to define the nutritional or physiological status of an individual (Bolger and Connolly, 1989; Stevenson and Woods, 2006). Commonly, body condition is defined as the quantity of nutrient reserves, which represent the quantity of metabolizable tissues exceeding those required for daily nutritional demands (Schamber *et al*., 2009; Schulte-Hostedde et al., 2001). Condition indices thus inform on the quantity of

energy extracted from the environment and can give important insights on foraging behavior or prey distribution for instance (Lloret *et al*., 2013). Body condition indices are also used as indicators of an individual's well-being which can affect its future performances (Stevenson and Woods, 2006; Wilson and Nussey, 2010). For example, individuals with larger nutritional reserves may have a greater survival rate, a larger reproductive success and a higher growth (Millar and Hickling, 1990), ultimately resulting in a link between body condition and fitness for several species (Jakob *et al*., 1996). Measuring body condition is thus of outmost importance for physiologists and ecologists to understand population dynamics affected by mortality and reproduction (Schulte-Hostedde *et al*., 2005). This could also be a really helpful indicator to provide management advice by giving independent information on the stock's health.

A large number of condition indices are available from the literature. In particular, morphometric indices are based on the assumption that for a given size, heavier individuals are in a better condition (Green, 2001). They are extensively used because of their simplicity; and have been selected a lot to monitor fish health (Lambert and Dutil, 1997), investigate marine pollution (Bervoets and Blust, 2003) or manage fisheries (Cone, 1989). Because most surveys or landing samplings collect size and weight measurements of small pelagic species, it offers a unique opportunity to compare body condition between areas of the Mediterranean and Black Sea and to better understand how it fluctuates with the environment.

In this project, we propose in a first step to build morphometric body condition indices for all GSA in the Mediterranean and Black Sea, to compare between areas and relate it to environmental conditions and a measure of habitat quality. This index may also be of great importance to measure the health of a stock and the production of time series of such indicator to incorporate in stock assessments may help refining stock status and management advice proposed in the regional organisations such as GFCM. As such, the international MEDIAS group, as well as several countries already agreed on sharing the data for this project and time series of body condition have been produced for some GSA. However, those mostly result from scientific surveys and information from landings could help getting the only available information in some GSA, especially in the South of the Mediterranean where data are scarce. In addition to the use of landing data will allow to build much longer time series in most GSAs. Further studies on the link of body condition with reproduction or recruitment might help understanding whether this index might be a good predictor of population recruitment and dynamics.

GSA 07 - Gulf of Lion

Sardine (*Sardina pilchardus*)

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Fisheries

The fishing pressure is very low, landings being lower than 1000 t. Trawlers landed a bit more sardines than last year, but purse seiners decreased their effort. We estimated the number of boats as the number of boats landing more than 1t during the year. Only one of these 14 trawlers seems to fish small pelagic fish all along the year (though anchovy is its main target), the 13 others alternate with demersal species as well. The landings of the purse seines are also very seasonal, one season offshore Marseille from January to May (with most landings in April-May) and one season of Port-Vendres in July-August. This activity is very opportunistic and none of these boats are focusing on sardines all throughout the year, the landings per boat vary between 1 and 100 t. Most regulations (no fishing activity during the week-end, length of trawlers, etc.) are fully respected, the limitation of engine power for trawlers being the only one not to.

Biological data and parameters

Morphometric parameters were obtained directly onboard during the scientific survey, while samples were taken back to the lab for age determination and reproductive parameter analysis. Length-weight relationships were thus obtained. Further samples from the fisheries are collected all year round to assess the health of the

stock. The current situation shows small individuals, as a result of a lower growth and the disappearance of old individuals. Individuals are also in a poor body condition (i.e. low reserves).

Assessment method: Direct method by acoustics.

Sampling was performed in July along 9 parallel and regularly interspaced transects (inter-transect distance = 12 nautical miles). Acoustic data were obtained by means of echosounders (Simrad ER60) and recorded at constant speed of 8 nm.h-1. The size of the elementary distance sampling unit (EDSU) is 1 nautical mile. Discrimination between species was done by a combination of echo trace classification and trawls output. Indeed, each time a fish trace was observed for at least 2 nm on the echogram, the boat turned around to conduct a 30 min-trawl at 4 nm.h-1 in order to evaluate the proportion of each species (by randomly sampling and sorting of the catch before counting and weighing each individual species). A total of 23 trawls were conducted. While all frequencies were visualized during sampling and helped deciding when to conduct a trawl, only the energies from the 38kHz channel were used to estimate fish biomass.

Acoustic data were preliminarily treated with Movies + software in order to perform bottom corrections and to attribute to each echotrace one of the 5 different echotypes previously defined. Acoustic data analyses (stock estimation, length-weight relationships, etc.) were later performed using R scripts. A combination of two methodologies (assessment by mean weight and length or by size class) and 2 echotrace allocation scenarios have been tested, enabling us to assess some error associated with our estimation. Due to really bad weather during the survey, less trawls than usual were conducted, resulting in a much higher difference between the near trawl and expert trawl allocation than usual (CV of 17% for anchovies compared to < 5 % the other years). Using the near trawl had a tendency to overestimate anchovies and underestimate sardines, sprats being quite consistent between the two. Because the near trawl allocation resulted in some trawls being used for very different depth strata and very different echotraces, we decided to retain the expert trawl allocation as the result of the assessment. Finally, fewer trawls were performed as a general but also close to the coast, where small sardines (i.e. recruitment) are usually found. This might have affected our ability to estimate recruitment correctly.

Results

	Biomass in metric tonnes	Fish numbers	Blim (t)	Bpa (t)
Sardine	62 458	5 612 181 051		
Anchovy	30 939	3 829 437 957	22 889	45 778
Sprat	27 149	4 827 349 951		

Biomass is slightly lower than last year, but the important information of the year is the quasi absence of recruitment. The size distribution of sardines is usually bimodal during the PELMED July survey. However, this year the first peak (between 8 and 10cm) was totally missing. Similar observations were made on sprats for which the first peak was barely visible. This suggests poor environmental conditions for recruits of winter spawners and is worrying for the sardine population in the next 1 or 2 years. Indeed, recruitment had been surprisingly high these last years, preventing the population from getting depleted, while the big and old individuals disappeared. This year, some large individuals were observed but still very few compared to a decade ago. Further, the body condition index (as for anchovies) is at its worse. All these signs show that the population has not yet recovered, so that poor (if not null) recruitment might have important consequences on the future. The fishing pressure being still very low (landings < 1000 t), this situation is believed to be a consequence of unfavourable environmental conditions.

However, it is important to note that the error associated with this year assessment might be higher than usual due to poorer sampling this year. Indeed, the survey suffered from very bad weather conditions, decreasing the number of trawls conducted to identify fish associated with different echotraces. This applied also close to the coast, where small sardines (i.e. recruitment) are usually found. This might have affected our ability to estimate recruitment correctly.

Diagnosis of stock status:

The stock is judged to be unbalanced due to its lack of old individuals and problems of growth and body condition. The exploitation level is almost null, while the biomass is intermediate.

Advice and recommendations

The working group recommends not to increase fishing mortality.

GSA 07 - Gulf of Lion

Anchovy (*Engraulis encrasicolus*)

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Fisheries

The number of pelagic trawlers strongly decreased a few years ago. While 12 trawlers landed more than 1 t of anchovies, only 1 targets small pelagics all year round, the others alternating between small pelagics and demersal species. As a consequence, the total catches remained low in 2013. They have been fluctuating around 2000 t for the last 5 years. Most regulations (no fishing activity during the week-end, length of trawlers, etc.) are fully respected, the limitation of engine power for trawlers being the only one not to.

Biological parameters

Morphometric parameters were obtained directly onboard during the scientific survey, while samples were taken back to the lab for age determination and reproductive parameter analysis. Length-weight relationships were thus obtained. Further samples from the fisheries are collected all year round to assess the health of the stock. A slight increase in the size distribution during the survey was noted this year, but the condition index (both morphometric index and lipid content estimation) is at its worse, meaning that anchovies have very low reserves.

Assessment method: Direct method by acoustics

Sampling was performed in July along 9 parallel and regularly interspaced transects (inter-transect distance = 12 nautic miles). Acoustic data were obtained by means of echosounders (Simrad ER60) and recorded at constant speed of 8 nm.h-1. The size of the elementary distance sampling unit (EDSU) is 1 nautical mile. Discrimination between species was done by a combination of echo trace classification and trawls output. Indeed, each time a fish trace was observed for at least 2 nm on the echogram, the boat turned around to conduct a 30 min-trawl at 4 nm.h-1 in order to evaluate the proportion of each species (by randomly sampling and sorting the catch before counting and weighing each individual species). A total of 23 trawls were conducted.

While all frequencies were visualized during sampling and helped deciding when to conduct a trawl, only the energies from the 38kHz channel were used to estimate fish biomass. Acoustic data were preliminarily treated with Movies + software in order to perform bottom corrections and to attribute to each echotrace one of the 5 different echotypes previously defined. Acoustic data analyses (stock estimation, length-weight relationships, etc.) were later performed using R scripts. A combination of two methodologies (assessment by mean weight and length or by size class) and 2 echotrace allocation scenarios have been tested, enabling us to assess some error associated with our estimation. Due to really bad weather during the survey, less trawls than usual were conducted, resulting in a much higher difference between the near trawl and expert trawl allocation than usual (CV of 20% for anchovies compared to < 5 % the other years). Using the near trawl had a tendency to overestimate anchovies and underestimate sardines, sprats being quite consistent between the two. Because the near trawl allocation resulted in some trawls being used for very different

depth strata and very different echotraces, we decided to retain the expert trawl allocation as the result of the assessment.

Results

	Biomass in metric tonnes	Fish numbers	B_{lim} (t)	B_{pa} (t)
Anchovy	30 939	3 829 437 957	22 889	45 778
Sardine	62 458	5 612 181 051		
Sprat	27 149	4 827 349 951		

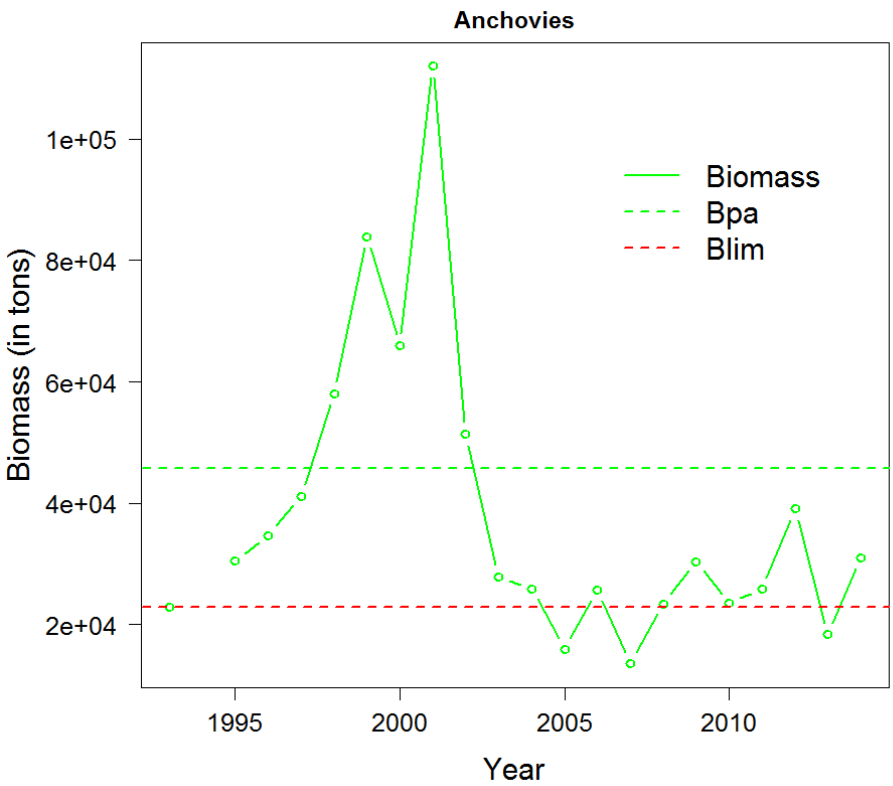

Figure: trend in biomass (tons) estimated from acoustic survey for anchovy in GSA07 from 1993 to 2014. Blim (red) and Bpa(green) are shown as well.

Biomass is higher than last year, but still below B_{pa}. Landings seem to have stabilized around 2000 t for the last 5 years. The fishing effort is much more opportunistic than before and only 1 boat has kept small pelagics as its only target. The total number of boats landing anchovies is not negligible. However, all but 1 of them fish only at given periods. Further, biological parameters show that anchovies were slightly larger than the previous year, but their condition was even poorer, suggesting that they have not recovered from poor exogenous environmental factors yet.

Diagnosis of Stock status

The stock is judged of low biomass (situated between B_{lim} and B_{pa}). The exploitation level is low and the declining trend in biomass and landings is supposed to be driven mainly by exogenous environmental factors.

Advice and recommendations

The working group recommends to reduce fishing mortality.

GSA 09-10 – Acoustic biomass estimation of anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*) in the GSAs 9 and 10 (Thyrrenian Sea)

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The acoustic estimation of biomass and distribution of small pelagic fish species is one of the activities planned in the EU Data Collection Framework (Reg. Ce. N° 199/2008, N° 665/2008 and Commission decision N° 949/2008). In this context, since 2009 the European countries (Spain, Italy, Greece, Malta, France, Slovenia and Croatia) that perform acoustic surveys in the Mediterranean waters participate to the MEDIAS project (Mediterranean International Acoustic Survey). In the Italian waters, only the Sicily Channel (GSA 16) and the western part of the Adriatic Sea (GSAs 17 and 18) have been regularly investigated over the last decade, and are now included in the MEDIAS program. Conversely, in the past the Tyrrhenian area was surveyed only two times (in 1986 and 1991) for the abundance evaluation of anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*). In summer 2009 a research group of IAMC-CNR started to collect acoustic data for estimating biomass and distribution of small pelagics, mainly anchovy and sardine, in the Ligurian and Tyrrhenian seas (GSAs 9 and 10). In particular, four summer acoustic surveys (2009, 2011, 2013 and 2014) were carried out in the GSA 10 and three summer surveys (2009, 2011 and 2014) in the GSA 9. Large biomass fluctuation has been observed both for *Engraulis encrasicolus* and *Sardina pilchardus*. In particular, in the GSA 9 anchovy biomass was in the range 1570 – 35780 tonnes, while sardine biomass was in the range 8306 – 18290 tonnes. In the GSA 10 anchovy biomass oscillated between 24048 and 46897 tonnes, while sardine biomass was in the range 5900 – 14421 tonnes.

GSA 16 – Southern Sicily

Sardine (*Sardina pilchardus*)

***Authors*:** Patti B., Quinci E.M., Bonanno A., Basilone G., Mazzola S.

Fisheries: Purse seiners, pelagic pair trawlers

In GSA 16, two operational units for small pelagics are present, mainly based in Sciacca port (accounting for about 2/3 of total landings): purse seiners (lampara vessels, locally known as “Ciancioli”) and midwaters pair trawlers (“Volanti a coppia”). Midwaters trawlers are based in Sciacca port only, and receive a special permission from Sicilian Authorities on an annual basis. In both OUs, anchovy represents the main target species due to the higher market price. Another fleet fishing on small pelagic fish species, based in some northern Sicilian ports, was used to target on juvenile stages (mainly sardines). However this fishery, which in the past was allowed for a limited period (usually one or two months in the winter season) by a special Regional law renewed year by year, was no more authorized starting from 2010 and it is presently stopped.

Average sardine landings in Sciacca port over the period 1998-2013 were about 1,450 metric tonnes, with a general decreasing trend. The production dramatically decreased in 2010 (-70%), but increased again above the average over the period 2011-2013. Fishing effort remained quite stable over the last decade. Sardine biomass, estimated by acoustic methods, ranged from a minimum of 6,000 tonnes in 2002 to a maximum of about 36,000 tonnes in 2000. Current (2013) acoustic biomass is at intermediate level (18,165 tonnes; average 1998-2013: 16,099).

Landings data from Sciacca port were used for the stock assessment because of their importance (they accounts for about 2/3 of total landings; Patti et al., 2007) in GSA 16 and the availability of a longer time series (1998-2013) compared to the official DCF data for the whole GSA 16 (2006-2013).

Biological parameters

Landings data for GSA16 were obtained from DCF for the years 2006-2013 and from census information (on deck interviews) in Sciacca port (1998-2013). Acoustic data were used for fish biomass evaluations over the period 1998-2013. Von-Bertalanffy growth parameters, necessary for the calculation of natural mortality,

were estimated by FISAT with DCF data collected in GSA16 over the period 2007-2008. Natural mortality was estimated following Pauly (1980) and by the Beverton & Holt's Invariants (BHI) method (Jensen, 1996). For the BHI method, the equation M = β * k was applied, with β set to 1.8 and k = 0.40. Gislason (2010) was also applied for M estimation, using 2012 data for the calculation of average total length by age class (0-3), as required by this method, and the « fishmethods » R package.

The input data used for the stock was total yearly catch estimates, and a series of abundance indices (acoustic biomass estimates) over the period 1998-2013. Available data were used to estimate yearly and average (2009-2013) exploitation rates starting from the estimation of harvest ratios (catches/biomass from survey), and as input for the fitting of a non-equilibrium surplus production model.

The scientific surveys, mainly carried during early summer of each year, were considered to represent the stock abundance the same year including part of the recruitment. In addition, an enviromental index, the satellite-based estimate of yearly average chlorophyll-a concentration over the continental shelf off the southern sicilian coast, was used in the attempt of improving the performance of the model fitting.

Assessment method

An empirical approach based on estimation of yearly and average (2009-2013) exploitation rates starting from the estimation of harvest ratios (catches/biomass from survey) has been used.

This approach is based on the analysis of the harvest rates experienced in the available time series over the last years and on the related estimate of the current exploitation rate. Actually, as long as this estimate of harvest rate can be considered as a proxy of F obtained from the fitting of standard stock assessment models (assuming survey biomass estimate as a proxy of mean stock size), this index can also be used to assess the corresponding exploitation rate E=F/Z, provided that an estimate of natural mortality is given. Sardine biomass estimates are based on acoustic surveys carried out during the summer and, as in general they would include the effect of the annual recruitment of the population, they are possibly higher than the average annual stock sizes. This in turn could determine in an underestimation of the harvest rates and of the corresponding exploitation rates.

Results

Annual harvest rates, as estimated by the ratio between total landings and stock sizes, indicated relatively low fishing mortality during the last decade.

The current (year 2013) harvest rate is 10.0 % (DCF data were used for landings). The estimated average value over the years 2009-2013 is 12.3%.

The exploitation rate (E) corresponding to F=0.123 is E=0.14, if M=0.77, estimated with Pauly (1980) empirical equation, is assumed, and E=0.15 if M=0.72, estimated with Beverton & Holt's Invariants method (Jensen, 1996), is used instead. The application of Gislason (2010) method for M estimation produced similar results (geometric mean of 0-3 age classes: M=0.66; E=0.16). In relation to the above considerations on the possible overestimation of mean stock size in harvest rate calculation, it is worth noting that, even if the harvest rates were twice the estimated values, the exploitation rates would continue to be lower than the reference point (0.4) suggested by Patterson (1992). Thus, using the exploitation rate as a target reference point, the stock of sardine in GSA 16 would be considered as being sustainably exploited.

Acoustics biomass and abundance

	Biomass in metric tonnes (MEDIAS 2013 data)	**Fish numbers (MEDIAS 2013 data)**	B_{lim}	B_{pa}	B_{MSY}
Sardine	18165	1097832678	7274	18185	35492

Diagnosis of stock status

The present diagnosis of stock status is based on the evaluation of current exploitation pattern, and on biomass levels estimated from direct method. The adopted reference points (RP) for fishing mortality were E=0.4 (Patterson), whereas for biomass level the WG proposed the use of Blim and Bpa as defined below.

The stock in 2012 only partially recovered from the high decrease in biomass occurred in 2006 (-52% from July 2005 to June 2006), and this fact, along with the general slight decreasing trend in landings, also suggests questioning about the sustainability of current levels of fishing effort.

A tentative B_{lim} was discussed and adopted by the WG as the minimum value of the last years (2009 value: 8028 tonnes). Similarly, Bpa was established as 2* Blim. Using the above reported RPs, the current biomass estimate (18,165 tonnes, 2013 value) is higher than Bpa (16,056 tonnes), and well above the estimated Blim (8,028 tonnes) (Fig. 1).

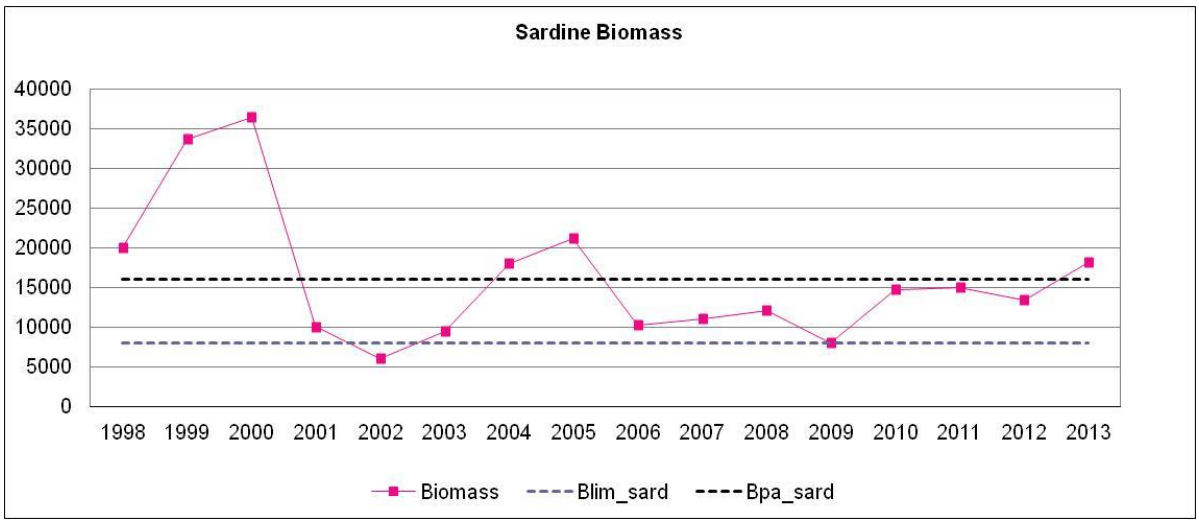

Fig. 1: Trends in sardine biomass (tonnes), years 1998-2013. Blim=min[last years of time series] and Bpa=2*Blim are also indicated

Advice and recommendations

Exploitation rate		Stock Abundance	
1996-2013		1996-2013	
	No fishing mortality		Virgin
	Low fishing mortality		High abundance
	Sustainable Fishing Mortality	**x**	Intermediate abundance
	High fishing mortality		Low abundance
x	Uncertain/Not assessed		Depleted
			Uncertain / Not assessed

Advice and recommendations

Not to increase fishing mortality.

GSA 17 – Northern Adriatic Sea

Sardine (*Sardina pilchardus*)

***Authors*:** FAO-Adriamed

Fishery

Sardines are fished by purse seiners 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 for purse seiners in Croatia. In 2011 the closure season for the Italian fleet was extended to 60 days (August and September) while in 2013 it was around 42 days.

Exploitation is based mostly on the age classes from 1 to 3.

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 55 pairs of mid-water trawlers and about 30 purse seiners (with quite different tonnage), with the former being predominant on the latter ones.

In Croatia, small pelagic (mainly sardine) are fished by purse seiners (about 204). Slovenia had 4 actively fishing purse seiners in 2013.

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 2013. 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. The period covered by the present assessment goes from 1975 to 2013.

Echo-survey abundance index was used to tune the models. The echo-surveys were carried out for both the western and eastern side from 2004 onwards. Western echo-survey abundances were split into age classes by the means of length frequency distribution and age-length key coming from the western echo-survey. On the other hand, eastern echo-survey biomass was distributed into age classes by the means of proportion at length from the 2009 eastern echosurvey and age-length keys from the Croatian commercial fleet.

The 2011-2012 eastern echo-survey covered only about 50% of the total area: for this reason, an average percentage of the biomass in that area from the previous years (2004-2010) was estimated, and by that raised to the whole eastern area.

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 (Gislason, 2009). The growth parameters required by this method were derived from Sinovcic (1984).

Assessment method

State-Space Assessment Model (SAM).

Results

The average fishing mortality for ages 1-3 starts increasing in 1996, reaching the maximum value of 0.743 in 2002. The estimate for 2013 is equal to 0.629. The mid year spawning stock biomass fluctuates from the highest values in 1984 (about 390,000 tonnes) to a minimum in 1999 of 57,000 tonnes. After that the stock is constantly increasing: in 2013 reach the highest value registered in the last 15 years (154,199 tonnes). The recruitment (age 1) fluctuates around a minimum value of 2,409,669 thousands specimen in 1999, to a maximum value of 16,062,533 thousands specimens in 1984. From 1999 the estimated recruitment is constantly increasing: the value for 2013 is equal to 11,524,664 thousands specimen.

Diagnosis of stock status

The estimated biomass (B_{curr}=154,199 tonnes) is above both B_{lim} (62,505 tonnes) and B_{pa} (125,010 tonnes) estimated in 2012 and the trend is increasing. Nevertheless, since the exploitation rate $E_{(1-4)}$ = 0.53 is higher than the empirical reference point of 0.4, the stock is to be considered "in overexploitation".

Exploitation rate		Stock Abundance	
1975-2012		1975-2012	
	No fishing mortality		Virgin
	Low fishing mortality		High abundance
	Sustainable Fishing Mortality	X	Intermediate abundance
X	High fishing mortality		Low abundance
	Uncertain/Not assessed		Depleted
			Uncertain / Not assessed

Biomass trends		Recruitment trends	
1975-2012		1975-2012	
[2010-2012]		[2010-2012]	
	Stable		Stable
X	Increasing	X	Increasing
	Decreasing		Decreasing

Advice and recommendations
The advice for sardine stock in GSA17 is to reduce fishing mortality.

GSA 17 – Northern Adriatic Sea

Anchovy (*Engraulis encrasicolus*)

***Author(s)*:**

Fishery

Anchovies are fished by purse seiners 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 Croatian purse seiners. In 2011 the closure season for the Italian fleet was extended to 60 days (August and September) while in 2013 it was around 42 days.

Exploitation is based on all the age classes from 0 to 3+. The Italian small pelagic fishery concentrates mainly on anchovy, while the Croatian catches mainly represent sardine.

The Italian fleet is composed of about 55 pairs of mid-water trawlers and about 30 purse seiners (with quite different tonnage), with the former being predominant on the latter ones.

In Croatia, small pelagic (mainly sardine) are fished by purse seiners (about 204). Slovenia had 4 actively fishing purse seiners in 2013.

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 2013. The biological data of the species (available since 1976 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 models. 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 and ALK coming from the western echo-survey. On the other

hand, eastern echo-survey biomass was distributed into age classes by the means of proportion at length from the 2009 eastern echosurvey and age-length keys from the Croatian commercial fleet.

The 2011 and 2012 eastern echo-survey covered only about 50% of the total area: for this reason, an average percentage of the biomass in that area from the previous years (2004-2010) was estimated and by that raised to the whole eastern area.

Split year was used, by fixing the birthday date on the first of June, 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 (Gislason, 2010). The growth parameters required by this method were derived from Sinovcic *et al.* (2000).

Assessment method

State-Space Assessment Model (SAM).

Results

The average fishing mortality for ages 1-2 started increasing in 1988, reaching the maximum value of 1.29 in 2011. The estimate for 2013 is equal to 0.69.

The mid-year spawning stock biomass fluctuated from the highest values in the late 70th (about 47,544 tonnes) to a first drop in the 1987 with a biomass of 95,703 tonnes. After that the stock recovered to about 197,403 tonnes in 1995 and then decreased again to a minimum of 105,030 tonnes in 1999. A third phase saw a new recovery up to 322,546 tonnes in 2005. In 2012 the estimated SSB is around 154,972 tonnes, and in 2013 around 163,407 t.

The recruitment fluctuates around a maximum value of 170,000,000 in 1978 and a minimum value of 22,000,000 thousands specimen in 1986. A second peak was registered in 2005, with a value of 127,000,000 thousand specimens. The current value (2013) is 56,514,059 and the trend is decreasing.

The CIs for all the variables in the last couple of years increase significantly, in particular for the estimation of F. Besides, the drop in F from 2011 to 2013 needs further investigations.

Diagnosis of stock status

The estimated biomass for 2013 is still low, being around the 30th percentile. The exploitation rate is equal to 0.51, therefore higher than the reference point of 0.4. applied to F and E. At the present the stock can be considered as "overexploited and in overexploitation".

Exploitation rate		Stock Abundance	
1976-2013		1976-2013	
	No fishing mortality		Virgin
	Low fishing mortality		High abundance
	Sustainable Fishing Mortality		Intermediate abundance
X	High fishing mortality	X	Low abundance
	Uncertain/Not assessed		Depleted
			Uncertain / Not assessed

Biomass trends		Recruitment trends	
1976-2013		1976-2013	
[2010-2013]		[2010-2013]	
X	Stable		Stable
	Increasing		Increasing
	Decreasing	X	Decreasing

Advice and recommendations:
The advice for anchovy stock in GSA17 is to reduce immediately fishing mortality.

GSA 18 – Southern Adriatic Sea

Anchovy (*Engraulis encrasicolus*)

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Biomass of small pelagic fish species has been monitored by means of acoustic methodology since 1987 in western GSA 18 by CNR-ISMAR of Ancona in the framework of several MIPAAF and EU projects; since 2009 these surveys are included in the MEDIAS framework (pan-MEDIterranean Acoustic Surveys). Since 2002 acoustic surveys were carried out over the shelf area of Montenegro through some projects supported by Montenegro government and FAO AdriaMed project. An extension to Albania was realized in 2008 supported by FAO AdriaMed project and Italian CNR. These surveys in South Adriatic sea have seen in the last years the active cooperation of CNR-ISMAR of Ancona (Italy), IBM of Kotor (Montenegro) and University of Tirane (Albania).

In 2013 35% of the total pelagic biomass in south western Adriatic sea (SWA) was constituted by anchovy, while 58% was sardine; in south eastern Adriatic sea (SEA) 11% of the total biomass was anchovy and 82% sardine. Anchovy biomass per length class in SWA showed a bimodal distribution with peaks at 10 and 12 cm, while sardine distribution was unimodal at 12.5 cm; anchovy biomass per length class in SEA resulted bimodal at 11.5 and 13 cm, and also sardine distribution was bimodal too at 10 and 13.5 cm. The trend of anchovy in SWA in the period 1987-2013 starts with very low levels of abundance increasing significantly from 1997; in the last years (2005-2013) anchovy stock presents several fluctuations with a tendency towards average values. Sardine stock shows good levels of biomass, even if not constant, until 1996; in the following years biomass decline at very low values increasing again after 2006 and reaching two relevant peaks in 2011 and 2013. In SEA in the first years of monitoring the area was limited to Montenegro shelf only; results show a good biomass level for anchovy in 2002, while in 2004-05 both anchovy and sardine show rather low abundances. Since 2008 the whole area between Boka Kotorska and Valona was monitored; results show at first a good level of biomass for sardine and after that a declining trend for both anchovies and sardines.

GENERAL DISCUSSION

Hands-on data session

40. During the hands-on data session, the WGSASP was able to thoroughly examine some of the input data used in most of the presented assessments. In particular:

i) The WG was able to re-run the assessment for both stocks of GSA 06 using the acoustic survey

time series data as a tuning index instead of the CPUE data (for which, doubts as to its efficacy as a tuning index, were raised).

ii) Major differences were identified in the age-at-length structure of anchovy and sardine stocks in GSA 06 compared to the age-at-length structure of the same species in other Mediterranean areas. One such difference was the fact that in GSA 06, despite the high number of individuals of sizes commonly attributed to old age, the majority of specimens were considered to be of age 0 or 1. Therefore, the WG suggested carrying out a joint exercise between GSAs in order to harmonize the assignment of ages.

iii) The WG re-ran the assessment of anchovy and sardine in GSA 17 in order to use more coherent model parameters in terms of F_{bar} and the plus group; the new proposed age groups for F and the plus group are considered appropriate and therefore the WG propose to keep them for the benchmark assessment.

iv) The WG suggested harmonizing the natural mortality estimator between GSAs. For this purpose, the use of Gislason's methodology was preferred, since this method seemed to be more suitable than ProdBiom for short-lived species. Following this approach, Gislason's equation was applied to sardine stocks in GSA 03 and then the final assessment was re-run.

Common problems shared by some stocks

41. The review of the input data showed a number of issues with the assignment of ages for some of the stocks.

42. The WG pointed out the delay between the assessment reference year and the management measure being implemented. In this respect, the WG recognized the importance of having the results from the acoustic survey by the end of the calendar year in order to be able to provide relevant indications on the stock status that are based upon the most up-to-date information. The WG then discussed the most efficient way of incorporating this information into a management advice, whilst taking into account the availability of an analytical assessment.

43. The WG agreed that a regular revision process of the reference points should be established. On the one hand, the group recommended that the reference points are maintained stable for a number of years, unless serious concerns are raised. This would be in order to avoid incorporating too much uncertainty from changes in the the assessment model and for stock assessments to correspond to multi-annual management plans. On the other hand, the WG also recommended revising the reference points at dedicated meetings, or at regular meetings in which the revision of the reference points is included in the terms of reference.

Assessment models to-do-list and potential alternative assessment models

44. As on previous occasions, the issue of using only an age- or length-based model for short-lived species with variable growth was raised. Six applications of biomass models were presented during the WG (BioDyn) and the group encouraged, whenever possible, carrying out a comparative analysis between the performance of existing biomass models (e.g., the two-stage Bayesian biomass model) and analytical assessment models.

45. The WG agreed, and strongly encouraged all participants, to use the most complete dataset available to run the assessment. WGSASP members were invited to attend the sessions with all the information available for the assessed stock in the area.

46. The WG recommended that the experts participating in the WGSASP provide all the information required to provide advice using the new stock assessment forms (metadata, summary file, Word document with the description of the analysis and Excel file with the input data required to recreate the analysis). In addition, participants were encouraged to have all biological data related to the stocks available for discussion during the session. Those participants using scripts to carry out the analysis (e.g., R scripts) were encouraged to share their scripts using the software library incorporated in the WG SharePoint workspace.

Long-term management of small pelagic fish stocks

47. The WG highlighted the need to establish indicators of environmental stress. A recommendation to progress in this direction has been completed, which is coherent with the proposed use of the "traffic light approach" recommended by the SAC.

CONCLUSIONS AND RECOMMENDATIONS – JOINT WGSAs SESSION ON DATA-LIMITED STOCKS

48. At the joint session on data-limited stocks, the WGSAs agreed on the importance of continuing to pursue a strategy for increasing the percentage of the catches being assessed in the Mediterranean and Black Sea. The session also voiced a desire to have stock assessments covering the various sub-regions in a more even fashion. In line with these stated objectives the WGSAs concluded the following:

a. Attempts should be made at conducting a productivity susceptibility analysis (PSA) for various fisheries (in particular, artisanal fisheries, small pelagic fisheries and crustacean-oriented fisheries). The aim of this is to provide additional useful information which can assist in identifying priorities for stock assessment and management;
b. For stocks where there is only catch data ("catch-only data") available, methods for providing advice are still being tested; therefore, these methods may not yet be reliable. Similarly, simple harvest control rules pertaining to indicators of stock health are also being tested. It is possible that the indicators being developed by the SAC could be used for this purpose;
c. There are a number of stocks in the Mediterranean for which information on catch, length/age structure, fishing effort and some indicator of biomass (from surveys or CPUE) may be available. For those stocks, VPA-based methods or the statistical catch-at-age approach could be applied.

49. The WGSAs encouraged taking the following steps: a) carrying out a PSA for select fisheries, with the possibility of jointly developing them in collaboration with the European Commission Joint Research Centre; b) adding more stocks for which VPA or statistical catch-at-age models could be applied; and c) investigating management measures and harvest control rules that could be applied together with indicators of stock health as defined by the SAC.

50. The WGSAs warmly welcomed the presence of a representative of the STECF Secretariat and his presentation on the work deployed by the STECF Expert Working Group on stock assessment for the Mediterranean Sea (STECF-14-09). The representative summarized the advice issued by the STECF on those stocks not included in the agenda for the WGSAs (the complete report of the STECF meetings on the Mediterranean and Black Sea is available at http://stecf.jrc.ec.europa.eu/reports/medbs). Previous requests made by a number of experts in the WGs (who are also members of the STECF-EWGs) were touched upon with a view to improving coordination between the SAC and the STECF and optimizing the overall efficiency of the stock assessments carried out in the Mediterranean and Black Sea.

51. Members of the WGs expressed concern with the sizeable workload currently facing the WGSAs. WG members also echoed the wish to increase the area covered by stock assessments in the Mediterranean Sea through improved cooperation and coordination amongst experts. The WGSAs suggested focusing their intersessional work on a series of 'priority stocks', whilst striving to establish a procedure for presenting, discussing and eventually incorporating the advice provided by other expert groups on Mediterranean stocks (including the STECF). The WGSAs agreed that this procedure should include clear indications on the information that needs to be reported (e.g., final reports, databases used, scripts, etc.), the format to be followed, the deadline for submission of information and any other aspect that can help experts to fully understand the stock assessments carried out by an external scientific body.

52. In order to implement the procedure discussed in the point above, the WGSAs could propose draft terms of reference (ToRs) which would include a list of priority stocks, for finalization and endorsement by the SCSA and the SAC. In turn, the agendas of the WGSAs would focus on the ToRs provided by the SAC. Such agendas could include a brief dedicated session for revising and eventually incorporating the advice provided by other expert groups into the draft advice to be provided to the SCSA and the SAC. To facilitate

this task, the WGSAs agreed to explore ways of harmonizing the existing tools for reporting to the WGSA and the STECF EWGs.

GENERAL CONCLUSIONS OF WGSASP

53. The WGSASP analyzed stock assessment information for a total of 18 stocks, and provided advice on 12 of these stocks: sardine in GSAs 1, 3 and 16, sardine and anchovy in GSAs 4, 6, 7 and 17 and sardinella in GSA 04. Advice for anchovy and sardine in GSA 07 is based on a direct assessment of the biomass (acoustic survey), advice on sardine stock in GSAs 1 and 16 and anchovy, sardine and sardinella in GSA 04 is based on a precautionary approach using empirical observations on the status of the stocks. Advice for the rest of the stocks is based on validated analytical assessment models.

54. The WGSASP advice on the status of the stocks assessed, including WGSASP comments and recommendations are included in Appendix D.

55. For the specific cases of sardine and anchovy in GSA 17, the WGSASP carried out an in-depth analysis of the input data and the assessment models, in response to the ToRs provided by the thirty-eighth session of the Commission (Appendix C). Sardine was considered to be 'in overexploitation' and with biomass above reference points and anchovy was considered overexploited and 'in overexploitation'. The full advice based on the chosen assessment model is provided in Appendix D. The WGSASP concluded that there were a number of potential issues in the input data used for assessment of the stock that should be addressed in the near future, namely:

i. Inconsistent age-reading for sardine in the eastern and western sections of GSA 17, as highlighted both by the large differences in proportion by age in the surveys and catches, and also supported by the lack of agreement in a cross-reading experiment;

ii. Discrepancies in the database and historical time series of landings and biological parameters considered (1975-2000), in both the eastern and western sections of GSA 17.

56. In relation to the possibility of carrying out a joint assessment for GSAs 17 and 18, as requested by the the ToRs provided by the thirty-eighth session of the Commission, the WGSASP concluded the following:

i. Information from GSA 18 appeared to be somehow fragmented, with differences in coverage and time series between the eastern and western areas;

ii. The bulk of the catches for both sardine and anchovy, as well as indications from the acoustic surveys, were concentrated in GSA 17, so a joint assessment would be mainly driven by the catches and biological information available in GSA 17;

iii. In order to incorporate information from GSA 18, a number of steps should be taken to prepare the input data for a joint assessment, as detailed in Appendix D; and

iv. The WGSASP agreed to maintain the biomass reference points proposed in its previous session. For the case of sardine in GSA 17, the WG confirmed the reference points proposed in the last session of the WGSAs and for the case of anchovy in GSA 17, the WG could not provide an updated reference point, due to the instability of the historical minimum on biomass in the mid-late 1980's provided by the stock assessment models attempted.

GENERAL RECOMMENDATIONS FROM THE WGSASP

57. The WGSASP made the following recommendations:

i. To continue the effort of increasing the number of stocks analyzed by the WG. The WG encouraged to present the existing information on the status of small pelagic stocks collected in different GSAs throughout the Mediterranean during the session;

ii. To continue to explore the definition and estimation of reference points for the main small pelagic stocks. In line with this, to hold benchmark sessions to obtain reference points by stock, as necessary. This is in addition to discussing the timeframe for the revision of reference points for those stocks for which they have been established;

iii. To carry out an in-depth revision of the input data for the stock assessment of sardine and anchovy in GSAs 17 and 18 to be ready before the next sessions of the WGSAs, and revising the stock status and reference points for these stocks during the next session;

iv. To prepar the input data required to carry out a joint assessment of GSAs 17 and 18, following the recommendations included in Appendix D and attempt a joint assessment including information from both GSAs during the next session of the WGSASP;

v. To prepare the input data and organize a dedicated session to test the following assessment models for the stated stocks:

   a. two-stage biomass model for sardine and anchovy in GSAs 1, 6, 16, 17, 18;

   b. VPA and catch-at-age models as alternatives to VIT for sardine in GSA 03, and sardine and anchovy in GSA 04;

vi. To invite experts participating in the WG to provide all information required to formulate advice, in advance of the meeting, including input data (and if relevant R scripts), and the draft stock assessment form;

vii. To hold the next session of the WGSAs in November 2015 in Rome; and

viii. To use the proposed ToRs as included in Appendix C (prepared during the WG in question and to be revised by the SCSA and the SAC) for the following session.

ELECTION OF THE CHAIR

58. WGSASP participants expressed unanimous appreciation of the efforts of Ms Carpi in her capacity as chair of the WG for three years. On behalf the GFCM Secretariat, Mr Bernal thanked Ms Carpi for her dedication and for the advancement and progress experienced by the WGSASP under her supervision.

59. The WGSASP unanimously selected Ms Claire Saraux to be the next chair of the WGSASP and submitted such a proposal to the SCSA and the SAC for their approval.

ADOPTION OF THE REPORT AND OF THE RECOMMENDATIONS FROM THE GROUP

60. The conclusions and recommendations of this WG meeting were adopted on 27 November 2014. The whole report was adopted after revisions and amendments by electronic correspondence.

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Appendix A

Agenda

1. **Opening session (joint session for the two Working Groups on Demersal and Small Pelagic Species)**
2. **Workshop on Methodologies for data-limited stocks**
   1. Introduction of GFCM strategy towards wider advice on status of Mediterranean and Black Sea stocks (GFCM Secretariat)
   2. Stock Assessment Methods for Data Limited Stocks (JRC)
   3. Discussion on a Roadmap for the implementation of DLS methods in the GFCM area of competence
3. **Common session on proceedings for this year WGs.**
   1. Summary of the SAC framework for advice and introduction of procedures for this year WGs. (GFCM Secretariat)
   2. Summary of stock assessments discussed in the STECF (STECF)
   3. Overview of the new structure of DCRF and proposed Indicators of Good Environmental Status of exploited populations. (GFCM Secretariat)
4. **Introductory session for the WG on Small Pelagic species**
5. **Presentation and discussion of draft assessments**
   - Body condition of small pelagics in the Mediterranean Sea (C. Saraux)
   - Anchovy (Engraulis encrasicolus) Stock Assessment in the GFCM GSA01, Northern Alborán Sea (A. Giráldez, P. Torres., M. Iglesias, M. González, N. Díaz, M.J. Meléndez and A. Ventero)
   - Sardine (Sardina pilchardus) Stock Assessment in the GFCM GSA01, Northern Alborán Sea (P. Torres., A. Giráldez, M. Iglesias, M. González, N. Díaz, M.J. Meléndez and A. Ventero)
   - Stock Assessment of Anchovy in GSA07 (J.-L. Bigot, J.-H. Bourdeix, C. Saraux)
   - Stock Assessment of Sardine in GSA07 (J.-L. Bigot, J.-H. Bourdeix, C. Saraux)
   - Anchovy (Engraulis encrasicolus) Stock Assessment in the GFCM GSA06, Northern Spain (A. Giráldez, P. Torres., M. Iglesias, M. González, N. Díaz, M.J. Meléndez and A. Ventero)
   - Presentation on acoustic surveys in GSA 09 and 10 (A. Bonano)
   - Sardine (Sardina *pilchardus*) Stock Assessment in the GFCM GSA06, Northern Spain (P. Torres., A. Giráldez, M. Iglesias, M. González, N. Díaz, M.J. Meléndez and A. Ventero)
   - Stock Assessment of Sardine in the North Adriatic Sea GSA17 (FAO-AdriaMED)
   - Stock Assessment of Anchovy in the North Adriatic Sea GSA17 (FAO-AdriaMED)
   - Hands on data session on stock assessment for sardine in GSA17
   - Etat d'exploitation du stock de sardine en mediterranee marocaine (J. Settih)
   - Stock assessment of *Sardina pilchardus*, *Engraulis encrasicolus* and *Sardinella aurita* in GSA04 (Bennoui, Neghli, Menad, Ben Smail, Ferhani and Tifoura)
   - Small pelagic biomass evaluation in Southern Adriatic sea - GSA 18 (Iole Leonori, Andrea De Felice, Milica Mandic, Ana Pesic, Sladjana Gvozdenovic, Jerina Kolitari, Gulielm Kroqi, Ilaria Biagiotti, Fabio Campanella, Giovanni Canduci, Claudio Vasapollo, Sara Malavolti, Rocco De Marco and Ilaria Costantini)
   - Progress in DEPM methodology in GSA18 (FAO-AdriaMED)

- Stock assessment of anchovy and sardine in GSA 16 (South of Sicily) (D. Patti, E.M. Quinci, A. Bonanno, G. Basilone and S. Mazzola)
- Hands on data session on stock assessment for sardine in GSA03

6. Hands on data session on stock assessment for selected stocks

7. General discussion on the advice to SAC from the WGSASP

8. Formulation of conclusions, recommendations and management advice to be transmitted for the consideration by the SCSA and SAC

9. Closing session

Appendix B

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Appendix C

Terms of reference for the
SCSA Working Groups on Stock Assessment for Demersal and Small Pelagic Species

One of the objectives of the Sub-Committee on Stock Assessment (SCSA) is to progress in the enhancement of joint practical stock assessment. "Joint" refers to the participation of scientists from different countries providing their data and sharing them with their colleagues, using a standard method and analyzing together the results and options for fisheries management.

The main objective of the annual meetings of the two Working Groups is to give advice on those stocks that are well assessed, "well" meaning agreed by the group on the type of data, on the parameters used and on the methodology applied. Specifically, the group will, on a stock by stock basis:

1. Analyse the data sets provided by the participants (Sampling frequency, time series, age structured, commercial vs surveys data, …)
2. Check parameters used and methodology applied on the assessments already done "at home".
3. Resume the performance of the methods through sensitivity tests and residuals analysis.
4. Run stock assessments on the cases not previously done with the data sets available and with the agreed methodology on a practical session.
5. Get the actual values of the biological reference points (BRP) and compare with those agreed at the 13th SAC meeting, namely FMSY or its proxy $F_{0.1}$ as the Target Reference Point and F_{max} as provisional Limit Reference Point.
6. In cases where BRP cannot be obtained use an empirical approach based on standing stock as stock status indicator, the harvest ratio (catch/biomass from survey) as fishing impact, and some indicators (SST, Chlorophyll, condition factor,…) of environmental stress.
7. Produce diagnoses on the status of the stocks.
8. Present and discuss assessment related woks.
9. Complete the filling up of the SCSA stock assessment forms including, when available, those for direct methods.
10. Evaluate the new assessment forms provided this year, in relation to the recommendations provided by the 2011 Assessment Working Groups and the SAC.
11. Suggest management advice to the SAC considering different alternatives

Appendix D

WG advice on the status of the stocks analyzed, including WG comments and recommendations

GSA	Species	Methodology used	Stock status	Management advice	WG comments
GSA 01 (Northern Alboran Sea)	Anchovy, *Engraulis encrasiclous*	Indirect method: BioDyn (Surplus production Model)	Uncertain	-	The WG highlight that there are differences in the ALK between these stock and those for similar stock in the med Sea. Therefore the WG recommends a in depth analysis of the age reading. The assessment was not accepted as there is uncertainty in the assessment and methodological problems; the model only relies on CPUE, which is very similar to the landings. The survey does not cover the coastal areas where most of the catches come from (less than 20 meters depth). The WG suggests to evaluate the trend in effort data and that CPUE is evaluated independently to its performance in the production model. The WG suggests to test also the performances of alternative production or age structured model.
GSA 01 (Northern Alboran Sea)	Sardine, *Sardina pilchardus*	Indirect method: BioDyn (Surplus production Model)	Uncertain	Due to the decrease trend in landings, the advice is to reduce the fishing mortality.	The WG highlight that there are differences in the ALK between these stock and those for similar stock in the med Sea. Therefore the WG recommends a in depth analysis of the age reading. The assessment was not accepted as there is uncertainty in the assessment and methodological problems; the model only relies on CPUE, which is very similar to the landings. The survey does not cover the coastal areas where most of the catches come from (less than 20 meters depth). The WG suggests to evaluate the trend in effort data and that CPUE is evaluated independently to its performance in the production model. The WG suggests to test also the performances of alternative production or age structured model.
GSA 03 (Southern Alboran Sea)	Sardine, *Sardina pilchardus*	Indirect method: VIT	Sustainable exploited Increase in landings since 2011. Fcurrent is lower than FMSY.	Not to increase fishing mortality	The WG suggests the use of more complex size or age structured models since the amount of data is increasing. Fishing mortality is high for big sizes. The WG supports the suggestions from the national scientist of the closure of some areas to selectively reduce fishing pressure on large sizes.
GSA 04 (only Western Algeria-Alboran Sea)	Sardine, *Sardina pilchardus* Anchovy, *Engraulis encrasicolus* Sardinella *Sardinella aurita*	Indirect method: VIT	Uncertain, but the current fishing mortality seems too high.	The suggestion is to reduce fishing mortality since the fishery seems to have a high pressure on all the three stocks.	The group regards this exercise as an important exploration of the fishery, however only part of the fleet (purse seiners) exploiting this resources and part of the spatial distribution of the stocks were covered. The WG suggest to continue this effort to incorporate all of the fleet and to pursue a joint assessment of the small pelagics in Alboran Sea. The WG also suggest to try to use mortality by length class or age in the VIT. An attempt of using Gislason provided too high natural mortality estimates, therefore further analysis on growth parameters should be done. Also, the WG suggests to apply VIT to more than one year to confirm the results and evaluate the possibility to use length or age structured models.

GSA 06 (Northern Spain)	Anchovy, *Engraulis encrasiclous*	Indirect method: BioDyn (Surplus production Model)	Biomass above reference point and In Overexploitation Increasing trend in landings and biomass from acoustic. F current (0.7) is higher than Fmsy reference point (0.46). Current biomass is above BMSY.	Reduce fishing mortality	The WG highlight that there are differences in the ALK between these stock and those for similar stock in the med Sea. Therefore the WG recommends a in depth analysis of the age reading. The acoustic survey in the nineties should be revised since the estimated biomass levels are around the same magnitude of the catches. The WG recommends also to try other models, such as two stage biomass model.
GSA 06 (Northern Spain)	Sardine, *Sardina pilchardus*	Indirect method: BioDyn (Surplus production Model)	Depleted with low fishing mortality. Both landings and acoustic are decreasing. Fcurrent is lower than FMSY Bcurrent is half BMSY (Bcurr/BMSY=0.51).	Reduce fishing mortality and implement a recovery plan.	The WG highlight that there are differences in the ALK between these stock and those for similar stock in the med Sea. Therefore the WG recommends a in depth analysis of the age reading. Althought the model is optimisitic in the recent years, the biomass is still low compared to the reference points, therefore management actions to allow the biomass to recover should still be adopted.
GSA 07 - Gulf of Lion	Anchovy, *Engraulis encrasiclous*	Direct method by acoustics	Low biomass The body condition index is low, although the mean length in 2014 increased. Trend in biomass is fluctuating since 2004. Current biomass is below Bpa (45,778 t) and slightly above Blim (22,889 t)	Reduce fishing mortality.	Biomass is more or less stable in this stock since 2004, In 2013 the stock is higher than 2012 estimates but lower than 2011 ones. Condition of anchovy remains low but the average size increased in 2014. The weather during the survey was rough, therefore about only half the hauls have been performed (about 20).
GSA 07 - Gulf of Lion	Sardine, *Sardina pilchardus*	Direct method by acoustics	Unbalanced Landings continue decreasing since 2007, the biomass is stable in the last 7 years, the fish are small and in poor conditions. The recruitment in 2014 was low.	Fishing mortality should not be allowed to increase, monitoring of changes in the fishing effort/gears required.	Almost no recruitment was detected from the acoustic survey. Measures of effort should be improved (e.g. number of “fishing sets” for purse seiners). The weather during the survey was rough, therefore about only half the hauls have been performed and this may have affect the estimation of the recruitment.

GSA 16 – Southern Sicily	Sardine, *Sardina pilchardus*	Direct method by acoustic)	No signal of overexploitation Bcurrent is above Bpa	Not to increase fishing mortality	Further information for this stock should be available as collected through DCF and more complex model should be used to assess this stock using all the information available. The BioDyn model applied was rejected since it does not seem appropriate to assess the state of this stock. Some inconsistencies between the length and age structure of the survey were detected, therefore the WG suggest to look in depth into the data.
GSA 16 – Southern Sicily	Anchovy, *Engraulis encrasiclous*	-	-	-	An update version of last year model was provided in a written form. The assessmetn suffers the same shortcoming identified last year. Therefore this assessment is considered preliminary and the WG strongly recommend that Further information for this stock should be available as collected through DCF and more complex model should be used to assess this stock using all the information available.
GSA 17 – Northern Adriatic Sea	Sardine, *Sardina pilchardus*	SAM tuned by acoustic	Biomass above reference point and in overexploitation Exploitation rate is higher than the Patterson's reference point ($E_{(1-4)}$= 0.53). $B_{current}$ is above both the limit and the precautionary reference point.	Reduce fishing mortality	The WG agreed on the improvement of some parameters in the assessment with respect to last yearIn particular, the F_{bar} was set equal to 1-3, the plus group was set at age 4 and the two series of survey were used separately. These changes did not affect the assessment. The reference points remain the same as the ones proposed atn the last session of the WG. The WG recommends a revision of the basic input data (e.g., age structure) including testing the use of recent biological data (length structure and ALKs) from the eastern area in the older part of the eastern landings time series.
GSA 17 – Northern Adriatic Sea	Anchovy, *Engraulis encrasicolus*	SAM tuned by acoustic	Overexploited and in overexploitation Exploitation rate is higher than the Patterson's reference point (E=0.50). Biomass level is low (30th percentile),	Reduce fishing mortality immediately	The WG agreed on the improvement of some parameters in the assessment with respect to last year. In particular, the F_{bar} was set equal to 1-2, the plus group was set at age 4+. The results are consistent with last year's estimations from the SAM model. Due to an unclear historical perspective, reference points cannot be updated. Advice is therefore provided on a precautionary basis (exploitation rate and biomass percentiles). The WG recommends a revision of the basic input data (e.g. age structure) including testing the use of recent biological data (length structure and ALKs) from the eastern area in the older part of the eastern landings time series.