GCP/RER/010/ITA/OM-156

Meeting Memorandum

Ancona, Italy, 15th to 19th May 2006

AdriaMed Working Group on Shared Small Pelagic Fisheries Resources

Introduction

The meeting of the AdriaMed Working Group on Small Pelagic Fisheries Resources in the Adriatic Sea (henceforth referred to as WG) was held at ISMAR-CNR of Ancona (Italy) from 15th to 19th May 2006. The meeting was attended by 26 participants (Annex 1) from Albania, Croatia, Italy, Serbia-Montenegro and Slovenia, the President of the GFCM-SAC, the Deputy Secretary of the GFCM and staff of FAO FI Projects. The director of the host institute ISMAR-CNR, Enrico Arneri, acted as Chairman.

Within the framework of the FAO AdriaMed Project activities, the aim of the meeting was to contribute to a comprehensive approach to the management of the Adriatic small pelagic fisheries resources on the basis of the best available scientific information. The Agenda is given in Annex 2.

It was arranged over four days (15th-18th June) during which presentations were made that focused on the appraisal of the Adriatic small pelagic fishery resources, the use of biological indicators, an economic perspective of the sector and the applicability of Operational Units to Adriatic Sea small pelagic fisheries. A final day (19th June) was dedicated to reflection and discussion of the outcome of the WG.

A summary of the meeting's discussion and outcome is given hereunder:

The Adriatic Sea is the Mediterranean area where the greatest amount of research has taken place aimed at providing sound scientific advice to fishery management on small pelagic resources. This is reflected historically by the important contributions presented at the various FAO GFCM Technical Consultations for the Adriatic from the mid 1970s onwards. This has continued with the

participation in the activities of the Sub-Committee for Stock Assessment of the GFCM SAC where, thanks also to the collaboration of AdriaMed, the contributions coming from the Adriatic have always been very important in terms of their quantity and scientific level.

Since the beginning of its activities, AdriaMed has given great attention to the small pelagic fisheries resources. In particular, during the First Meeting of the AdriaMed Working Group on Small Pelagic Resources (Split, October 2000), a series of priorities for scientific cooperation in research activities were identified and discussed and as follow up of the meeting they were implemented in the Adriatic Sea. It was thus possible to carry out the following programmes: the "Small pelagic data collection and biological sampling system in the Adriatic Sea – AdriaMed SP", the "Combined echo-survey and environmental parameters monitoring exercise in the northern part of the Adriatic Sea", the "Inter-ship calibration exercise to compare acoustic estimations of small pelagic fish in the Adriatic Sea". Four training courses on data collection and biological sampling and on fish age determination by otolith reading were also carried out.

Such activities were possible thanks to the cooperation and support of the research institutions present in the area, in particular the Fishery Research Institute of Durres (Albania); the Institute of Oceanography and Fisheries of Split (Croatia), ISMAR-CNR (Ancona), the Laboratory of Marine Biology and Fisheries in Fano and the Laboratory of Marine Biology in Bari (Italy), the Institute of Marine Biology of Kotor (Serbia-Montenegro) and the Fisheries Research Institute of Slovenia in Ljubljana (Slovenia). These institutes have made their expertise and equipment available for international cooperation in the Adriatic**,** and have shared the results of research programmes implemented at national level so far. In this context, more than ten technical documents have been prepared and widely distributed to the scientific community, as well as presented to the Sub-Committee on Stock Assessment of the SAC as scientific contributions within the GFCM framework.

It can be said that in the last 35 years all methodologies relevant to biomass estimation and stock assessment have been applied to Adriatic small pelagic fish, building up a strong scientific community. Some scientific issues still await discussion. In this respect, the issue of small pelagic resource assessment was discussed during the recent GFCM SAC Sub-Committee meeting on Stock Assessment (Rome, September 2005), at the 7th AdriaMed Coordination Committee meeting (Ljubljana, October 2005) and at the 8th SAC Session (Tirana, October 2005).

The WG represents the follow up to a specific request of the AdriaMed Coordination Committee meeting that called for "*..a longer working group that aims among other tasks to discuss the best scientific available information for small pelagic fisheries resources in order to establish a comprehensive approach for the fishery managers.*"

Current status of knowledge on the small pelagic fisheries resources in the Adriatic Sea.

The WG was informed on the main recommendations emerging from the first meeting of the GFCM Permanent Working Group on the Stock Assessment Methodologies (PWGAM) held in Istanbul, 8-10 March 2006: on the use of different methods for demersal resource assessment, on the comparison of small pelagic stock assessment methodologies, on the exploration and application of ecological and bioeconomic models and on growth parameters in the Mediterranean. In particular

for the demersal resources, the use of composite models and direct survival analysis are encouraged. These methods allow the use of independent data from trawl surveys. For this purpose the organization of training courses/workshops dealing with both theoretical background and case studies to be presented to the SCSA were recommended.
The recommendations of the PWGAM meeting held in Istanbul pointed out the need to use, whenever possible, VPA (Virtual Population Analysis), echosurvey and DEPM (Daily Egg Production Method), paying attention to identifying the reasons for occasional discrepancies. The discussion was strongly directed towards the identification of these discrepancies and the proposal of actions to eliminate them in the future.

The AdriaMed WG appreciated the progress made in the standardisation of echosurvey procedures and pointed out the need for further work in terms of the timing of the survey within each GSA and the joint analysis of the data. Efforts will be made to conduct the surveys in GSA 17 at the same time of the year. The distribution of the hauls used to determine species composition should be improved. For GSA 18, the availability of the research vessels is the main limiting factor. The need to cover all the eastern side of GSA 18 (Serbia-Montenegro and Albania) is a priority. To date, monitoring has been carried out by R/V Dallaporta of CNR ISMAR (Italy) which is the same vessel covering the western parts of GSA 17 and GSA 18 and, more recently, the eastern part of GSA 18.

A general overview of the elementary data on anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*) populations in Albania was presented by the Fisheries Research Institute of Durres (Albania). The work was based on biological sampling of commercial landings in three ports between 2001 and May 2006. Information was given regarding length-frequency distributions, length-at-age distributions, sex-ratios and spawning periods for the two species. In addition, monthly CPUE data from two Albanian ports in the years 2002-2004 were presented.

The results of the anchovy biomass survey carried out in the waters of Serbia and Montenegro in 2005 were presented by the Institute of Marine Biology of Kotor (Montenegro). For the first time in the Adriatic Sea, anchovy biomass was estimated by two methods simultaneously: DEPM and the acoustic method (echo-survey). In addition, oceanographic data (temperature, salinity and other parameters) were collected and pelagic trawl was used to collect adult specimens. The work was carried out in cooperation with ISMAR-CNR, Ancona and the Ministry of Agriculture Forestry and Water Management of Montenegro on board R/V "G. Dallaporta". Daily egg production was estimated for the area, revealing two main spawning areas. Trawl data and DEPM data were combined to estimate average spawning biomass. These results were compared with the anchovy biomass estimate obtained from the echo-survey. The biomass estimated by the acoustic survey was six times higher than that estimated by the DEPM. This difference was discussed and evaluated in a second presentation. It was pointed out how estimates by DEPM, unlike those by total egg production method, are usually lower than those yielded by the acoustic method. The reason for this difference is that acoustic surveys estimate total biomass, whilst DEPM estimate (gonad-free) spawning biomass alone. Correction for this showed that both methods yielded correct biomass estimates. The great difference between estimates was due to the presence of a huge number of juveniles, which were not detected by the DEPM because not spawning. Suggestions were made for future similar surveys.

The results presented by scientists from Serbia-Montenegro pointed out the possibility of carrying out echosurvey and DEPM surveys simultaneously, at least for anchovy. This will have two

advantages: saving vessel costs and providing an additional independent estimate of spawning stock biomass at sea at the same time the echosurvey is conducted

ISMAR-CNR Ancona presented the results of the 2005 small pelagic (anchovy, sardine and sprat) biomass assessments in the north-western and south-western Adriatic Sea by means of acoustic methods. Anchovy dominated both sectors in terms of density and percentage biomass estimated. The spatial distribution of the biomass of anchovy and sardine in the south and anchovy, sardine and sprat in the north of the Adriatic up to the mid-line were illustrated. The trends of estimated biomass from 1976 for the three species (GSA 17) and from 1987 for anchovy and sardine (GSA 18) were discussed. In GSA 17, recent anchovy estimates were slightly below the mean value of the historical series, sardine exhibited stable very low levels since 1998 and sprat estimates oscillated below the mean value for their series. In GSA 18, anchovy showed a significant decrease since 2000, whilst sardine estimates also oscillated below the mean value for their series.

The methodology used and results of the echo-survey carried out in 2004 within the Eastern part of the Adriatic Sea by the Institute of Oceanography and Fisheries (Croatia) in cooperation with the Fisheries Directorate of the Croatian Ministry of Agriculture, Forestry and Water Management were presented. The estimated biomass of small pelagic species was substantial and, overall, was dominated by sardine. The spatial distribution of the biomass of anchovy, sardine and sprat in the Eastern part of Adriatic Sea up to the mid-line was illustrated.

Possible methodological errors and biases were generally discussed. Emphasis was placed on the fact that research efforts accounting for the environmental component in the pelagic ecosystem should be included within stock assessments. It was advised that future management actions take this into consideration.

ISMAR-CNR Ancona presented the results of the stock assessments of anchovy and sardine in GSA 17, carried out for the period 1975-2005. The assessments were based on the application of Virtual Population Analysis (VPA) on total catches relative to the fleets of Italy, Slovenia, Croatia and also former Yugoslavia (1975-1990). Two different data sets were employed for the tuning of VPA: a) the Porto Garibaldi CPUE as in the past assessments and b) abundance index from echo-survey. This represents an attempt to improve the VPA calculations, which otherwise would be exclusively based on fishery-dependent input data. The anchovy biomass estimates were high compared to total catches; whilst for sardine the stock appeared to be in decline, and the most optimistic scenario (obtained by tuning the VPA on echo-survey data) showing only a slight increase in recent years following many years of decline.

A review of the different methods employed for the estimation of natural mortality (M) as well as review of different estimates of M for small pelagic fish in Adriatic Sea, was provided. The pros and cons of each method were discussed, as was the fact that the choice of method may significantly influence final stock assessment results. The importance of harmonising approaches to the estimation of M amongst fisheries scientists was highlighted.

The importance of tuning VPA also with fishery-independent data was stressed. This allows for the improvement of the method by combining fishery dependent with fishery independent data. In particular, in the future the tuning should be done including the widest possible area (i.e. Western and Eastern data). Thus, the necessity to carry out an annual echosurvey in entire Adriatic and to

continue the biological sampling carried out within the AdriaMed framework is stressed. VPA tuned with echosurvey data is an important step towards the integration of methodologies. The values of natural mortality used were discussed, the way to overcome this problem is by conducting sensitivity analysis with respect to different values, as is currently done in VPA stock assessments.

It was stressed that the different methodologies yield different kinds of information. Echosurvey and DEPM give instantaneous information on the level of biomass in the investigated area and period. VPA provides long term trends, essential in determining the increase or decline of a stock. Both types of information are vital for fisheries management.

An analysis of time series of sardine landings (from 1873 to 1990) was presented by the Institute of Marine Biology of Kotor (Montenegro). The fluctuations of the sardine landings between 1873 and 1972 were described. Its possible relation to environmental variables was discussed. Taking into consideration the pattern of sardine landings fluctuations, a forecast trend for the period 1950-2050 was done. The observed catch values from 1950 to 1990 are closely related to the model estimates. The model also predicted the decrease of the sardine biomass observed in recent years. These results would indicate that the effects of environmental factors have been more influential on the biomass size of sardine than has fishing pressure. Reasons for fluctuations in small pelagic populations were discussed following the presentation. Investigation regarding long term and short term fluctuations based on cyclic events and/or climatic modification is to be encouraged.

Preliminary results were presented concerning a pilot project for a monitoring system of the fleet using GPS linked to an electronic logbook on each vessel. It was stressed that these data could be a source of additional information for echosurvey, in order to verify species composition in certain areas. Moreover, the possibility of integrating the acoustic data with simultaneous experimental pair mid-water trawling activity was deemed useful in order to gain additional information on species identification.

It was recalled that in the past extensive research on eggs and larvae of small pelagic fish was conducted jointly in GSA 17. At present this activity is limited to anchovy in GSA 18 and needs to be widened further.

The need to work towards an ecosystem approach to fishery management has been pointed out and some preliminary work is currently being carried out. The ecosystem approach is generally based on the use of a wide array (in time and space) of environmental and ecological data. For the future this, again, will have to rely on extensive international scientific cooperation.

In the past 30 years the total landings of the Adriatic small pelagic commercial capture fisheries of Albania, Croatia, Italy, Slovenia, Federal Republic of Yugoslavia (FRY) and ex-Yugoslavia reached their maximum in 1981 and 1986. However the results obtained for GSA 17 can be distinguished between western and eastern coast of Adriatic Sea. Sardine catches have strongly decreased on the western coast, whilst no negative trend has been observed on the eastern coast in the last ten years (according to the official FAO statistics).

There is wide consensus among the experts that the fluctuations of small pelagic fish stocks biomass has been affected mainly by environmental factors.

A socio-economic analysis of the small pelagic fishery in the western coast of Adriatic Sea (GSA 17 and GSA 18) through the use of 25 indicators (19 economic, 6 social) was presented by IREPA (Italy). Trends of these indicators between 1997 and 2004 were analysed using the Traffic Light method. Overall, productivity indicators showed an increasing trend in both GSAs. Economic performance indicators showed a strong increasing trend (from 2000 for GSA 17 and from 2002 for GSA 18) and economic sustainability was highlighted.

The Consorzio Pesca (Fisheries Consortium) of Ancona, Italy, illustrated the activity of the small pelagic fish market in Ancona. The vessels in the Ancona fleet and the marketing of their product are managed, respectively, through a cooperation between a Producers' Association ("Associazione Produttori") and a fisheries consortium ("Consorzio Pesca"). The aim of this cooperation is to sett rules regarding resource management (fishing area, quotas, fishing time) and marketing (price) of the product landed by the vessels associated to these organisations. Since 2000, the politics of the producers association and the consortium have changed with the aim of ensuring the quality of the product landed and marketed in view of a wider buyers' market (e.g. supermarkets and hypermarkets in Spain). The positive aspects (increased revenue and quality) and negative aspects of this enterprise were illustrated with special emphasis placed on the fact that there should be concerted action within the entire Adriatic towards a greater coordination between single markets and producers.

An analysis of the dynamics of the economic characteristics of the small pelagic fishery in the western Adriatic Sea was illustrated by the Università Politecnica delle Marche (Ancona, Italy). Particular attention was paid the ports of Cesenatico and Ancona. The results of the time series analyses applied to a number of parameters (e.g. price) revealed the positive effects of the establishment of the consortium and the producers association in Ancona, as outlined by the consortium.

The need and importance of economic data collection in the entire Adriatic Sea was reiterated by the participants. This is also in consideration of the data collection activity required by the EU. The implementation of a multiple socio-economic indicator system in GSAs 17 and 18 should be considered and this could be helpful towards the description of the economic activity. The fact that, although pertaining to shared stocks, the economic indicators should take into consideration the economic differences in the Adriatic region countries was remarked. In this context the traffic light approach can be useful because, among other things, it provides information on economic, social and biological aspects in a single, simple framework. There may be the need to make available both biological and socio-economic indicators to appraise the status of the small pelagic resources.

The resulting compilation of bio-economic indicators could constitute an application of the Operational Unit concept. After having briefly reviewed the work promoted by the Project on this issue so far, following a recommendation from GFCM-SAC, the fact that the initial objective of establishing the OU concept was related to the GFCM decision to manage the Mediterranean fisheries by fishing effort was recalled. Discussion was held on the application of the OU concept in the Adriatic Sea for the small pelagic fisheries resources and in particular for the identification of fishing fleets coming seasonally from other GSAs.

Identification and discussion of common and priority issues highlighted during the discussion of the Meeting

On the basis of the available scientific information presented on the stock status of the small pelagics in the Adriatic Sea towards a possible common scientific advice and on the basis of the discussion held, the WG identified some common priority issues.

A summary of this discussion and the list of these priorities are given hereunder:

Results from the stock assessment and biomass evaluation presented show that the situation of the two main stocks appears quite different, at least for GSA 17.
The anchovy stock shows a rather healthy situation in the entire Adriatic Sea.
The sardine stock shows, at least for the western part, a strong decreasing trend with all the methodologies employed. Acoustic estimates made in the period 2002-2004, as well as catch statistics data show a rather stable sardine stock biomass on the eastern part of GSA 17. Nevertheless this drop of sardine biomass for the western part should be taken into account. Reasons for this decline could be multiple and the WG feels that the environment is probably the first cause, as fishing effort has been quite constant in the last twenty years and taking into account the fact that small pelagic fish species tend to fluctuate alternately.
Furthermore a series of scientific priorities were identified as follows:

- To improve the integration of the different methodologies for tuning, as is already partially being carried out in the Adriatic between VPA and Echosurvey.

- To create reliable time data series the existing research activities should be continued and extended;

- To strengthen the cooperation among the scientific institutions on data analysis;

- To plan and organize a joint survey exercise using both acoustic methods and DEPM covering the entire Adriatic Sea area.

- To strengthen the standardization of the methodologies and scientific protocols of echosurvey and DEPM (converge area and time), to be used in the region. Particular attention should be paid to the possibility of carrying out DEPM and echo-survey simultaneously. The priority identified by the WG is to cover the entire Adriatic with an echo-survey and to establish a team for DEPM (at least locally). Vessel logistics and human resources should be taken into account when considering DEPM and echosurveys to be carried out simultaneously.

- To continue developing the socio-economic data collection in the area also taking into consideration the recent EU regulations.

- To create a multiple biological and socioeconomic indicator system in GSA 17 and GSA 18 which could be helpful in the creation of a monitoring scheme in support of the decision making process. The indicator system should also take into consideration the environmental parameters to be coherent with the ecosystem approach to fisheries management.

Finally the WG, discussed and agreed on the creation of a document entitled “Research on small pelagic fisheries resources - Recommendations on the integration of methodologies and assessment ” in which pragmatic suggestions and indications should be put forward for management purposes.
In particular in the document for each research activity useful indications should be given such as the methodology to apply for reading the echograms, the period and the time during which DEPM surveys should be carried out (e.g. yearly basis, biannual basis), the utility to carry out simultaneously DEPM and echosurveys, the involvement at national level or at regional level of VPA data analysis (Technical annex).

Moreover technical specifications regarding the implementation of methodologies and research should be indicated (e.g training requirements, establishment of WG for data analysis). This practical scientific protocol for monitoring should also incorporate economic monitoring. EU regulations could help to guide the collection of economic data.

Annex 1

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Annex 2

Agenda

1. Opening of the Meeting
2. Objectives of the Meeting
3. Adriatic Sea small pelagic fisheries resources evaluation
4. Identification of biological indicators
5. Review of the small pelagic fisheries sector in the Adriatic Sea: the economic perspective
6. Identification of priorities
7. Small pelagic fisheries resources management in the Adriatic Sea
8. Other matters

Technical Annex:

Recommendations for the implementation of monitoring small pelagic resources of the Adriatic

1. Introduction

Following the discussion held on the last day of the workshop on small pelagic resources in the Adriatic, this synthetic document has been prepared with the aim of summarising current situation and possible improvement of research activities towards a better management of the fishery.

2. Points emerging from the workshop

Three main methods are currently used in the Adriatic to assess small pelagic resources: Echosurvey, Virtual Population Analysis (VPA) and Daily Eggs Production Method (DEPM); moreover a system of monitoring of commercial catches (FOS – Fishery Observing System) by means of Electronic Logbooks filled in by commercial vessels is implemented experimentally on the western side of the Adriatic.

The methods have different characteristics, provide different kinds of information and have been applied on different spatial and temporal scales in the Adriatic. The need for a stronger coordination and collaboration between the countries and the investigating institutions of the Adriatic area clearly emerges from these considerations.

The methods are reviewed below highlighting the necessary improvements.

3. Review of methods and suggested improvements

Method	Echo survey
Description	Biomass and density evaluation using acoustic systems carried out by research vessels, together with sampling by means of a pelagic trawl
Outputs expected	Estimates of target species abundance (anchovy, sardine and sprat) and OPS (Other Pelagic Species), as biomass and density by area at a given time. Like any other survey, a temporal series including more years gives an added value to them and allows the estimation of trends.
Pros	• Fast and efficient, provides quick answers to managers. • Standard procedure in many small pelagic stocks in the world • Provides fishery independent multi-species biomass estimates in a single survey • Results can be very helpful in conjunction with analytical methods (e.g.VPA) to improve the overall quality of the scientific advice
Cons	• Uncertainty in species identification and target strength; • Expensive (research vessels, electronic equipment, skilled personnel), • Need for a (more or less) simultaneous coverage of the whole investigated area, • Need for calibration if different research vessels are used
Current situation	• Echosurveys conducted systematically on the north-western half of the Adriatic (Italy) almost every year since 1976 (Northern and Central Adriatic) and since 1987 on the south western half of the Adriatic. • Eastern half of Adriatic (Croatia) covered systematically since 2002; • Montenegro covered in 2002, 2004 and 2005; • Albania never investigated (lack of specialists).
Recommended improvements	• To conduct a coordinated regional (international) acoustic survey covering the whole Adriatic every year in summer. • To establish a permanent scientific committee with the aim of coordinating the surveys, and to develop a single methodology for data collection and analysis. • Scientific committee should be responsible for a complete joint analysis of the data and the dissemination of the results.
Pragmatic solution for the financial planning of recommended activities	1. There is a total need for about 50-60 research vessel days (to cover the whole Adriatic), between mid July and end of September, this will allow the execution (if due) of DEPM sampling as well (see box on DEPM). 2. Survey effort can be shared between Italian and Croatian research vessels. Ideally one only vessel could be used with an international scientific crew. 3. Scientists from Albania, Montenegro and Slovenia will be trained and will participate in the cruises and in the analysis of results.

Method	**Virtual Population Analysis (VPA), also called Cohort Analysis**
Description	From catch-at-age data and some parameters, VPA reconstructs the past history of the stock in terms of number of individuals and fishing mortalities.
Outputs expected	• Numbers of individuals and biomass at sea by year and age (thus series of recruitment, total biomass at sea, spawning biomass) • Fishing mortality by year and age
Pros	• Relatively inexpensive if a system of data collection from the commercial fishery is set up • It allows simulations of future scenarios under different levels of fishing effort and/or recruitment strength • Catch at age data collected could also be used for alternative stock assessment methods which includes results from echosurvey and DEPM (e.g. Integrated Catch Analysis)
Cons	• Results sensitive to assumed values of natural mortality(*M*) • Results sensitive to inaccuracies in statistical data from commercial fishery • CPUE at age series and/or independent biomass estimates (echosurvey) required for "tuning" to properly estimate fishing mortality (F) • Results available with some time delay
Current situation	• VPA estimates available for Northern and Central Adriatic (GSA 17) since 1975 based on commercial catch data from the whole area (including Croatia and Slovenia) and CPUE from Porto Garibaldi Fleet. Recently, use of echosurvey data for tuning has started. • Data collection in GSA 18 Southern Adriatic is routinely implemented in Puglia (Italy) and in Albania
Recommended improvements	VPA assessment relates to the whole stock of anchovy and sardine, therefore: • It must continue to be carried out at regional level, pooling all the available data, "national" estimates are meaningless. • Data collection should be built upon and maintained also by all Adriatic countries. For Italy and Slovenia this is already an obligation to the European Union • Tuning with Echosurvey results should be improved through the improvement of the echosurvey planning (see box) • Other CPUE data series from other fleets from various part of the Adriatic should be included in the assessment.
Pragmatic solution for the financial planning of recommended activities	1. Continue with VPA assessment with participation of all Adriatic Countries 2. Link with the Echosurvey (and DEPM) results to obtain uniform scientific advice for management for the region through an integration of the assessment techniques

Method	Daily Egg Production Method (DEPM)
Description	Spawning stock biomass evaluation by means of a survey estimating the quantity of eggs present in the sea and the proportion of the stock which is spawning in the survey period. Particularly applicable to small pelagics
Outputs expected	• Biomass of the spawning stock • Egg mortality
Pros	• Particularly suitable for small pelagic fish, standard procedure in many small pelagic stocks in the world • Provides fishery independent estimates which can be used in conjunction with analytical methods (e.g.VPA) to improve the overall quality of the scientific advice
Cons	• Rather sophisticated technique, needs a research vessel able to sample ichthyoplankton and fish • Expensive for vessel and for scientific and technical manpower (e.g.analysis of ichthyopalnkton samples and gonad samples of spawners) • Only one species can be assessed with one survey: anchovy if the survey is in summer, sardine (and sprat) if the survey is in winter
Current situation	• Some DEPM estimates are available locally for anchovy in Montenegro and in Western Southern Adriatic in the past. No current monitoring based on this methodology is ongoing
Recommended improvements	• Taking advantage of the echosurvey cruise taking place in summer all over the Adriatic, it would be important to conduct a DEPM investigation for anchovy, ideally every year but more realistically every three years in order to have a further calibration of the echosurvey and VPA estimates. • A DEPM survey for sardine should take place in winter, this poses a series of logistic problems, but given the current debate on the state of the sardine stock it could be advisable to conduct this survey at least every three years
Pragmatic solution for the financial planning of recommended activities	If a decision to implement the DEPM monitoring in the Adriatic is taken, it would be wise to create an international team, lead by Dr Regner . There is obviously a need for some training and for funding of the sampling activity in the various countries. The summer survey (for anchovy) does not need much extra vessel time, if echosurvey is conducted. The winter survey budget should include at least 40 days of research vessel time.

Fishery Observing System (FOS) for small pelagic fish in the Adriatic

This is still in development under UE and National Italian Funding and cannot be proposed yet as a proper standardised assessment method. Nevertheless the data collected are complementary to the above described methodologies. In particular, estimates of local abundance (obtained from the commercial fleet) and species composition of the catch could improve some echosurvey results, and some well tested CPUE series could help the VPA assessment.

4. Conclusions

- The results of all the single research activities must be reported to an Adriatic scientific forum (ADRIAMED) to provide an overall scientific advice
- If possible the three methods should be implemented in the Adriatic: the same procedure is carried out in the Bay of Biscay where a stock of small pelagic fish of comparable size to the Adriatic is monitored annually through Echosurvey, DEPM and Catch Data
- Ideally also DEPM should be performed annually and for both stocks, anchovy and sardine. It is more realistic to think on a triennial basis.
- It is of vital importance that a single international (or regional) coordinating team is established for the common echosurvey in the Adriatic Sea. This will make the echosurvey in the Adriatic eligible for EU funding under the future Data Collection Regulation
- Incorporate economic monitoring, because there are some aspects of productivity that can be explained only by integrating economic data with biological data to have an overall picture of the state of the fishery. EU regulations for the collection of economic data could be used as a basis for this.
- Research efforts accounting for the environmental component in the pelagic ecosystem should be included within stock assessment research activities.
- Training: all the Adriatic countries should build up an expertise in echosurvey, analytical assessment and daily egg production method, in order to participate in a constructive way to the single assessment activities and to the production of the general scientific advice to management.