Report of 7th meeting for MEDiterranean International Acoustic Surveys (MEDIAS)

in the framework of European Data Collection Framework (DCF)

Iraklion, Crete, Greece, 8-11 April 2014

Steering Committee Report

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Introduction

The MEDIAS (MEDiterranean International Acoustic Surveys) Steering Committee met in Iraklion, Crete, Greece, 8-11 April 2013, hosted by HCMR and chaired by Angelo Bonanno from IAMC-CNR. Participants in the meeting were representatives from all European Union countries involved in acoustic surveys in the Mediterranean Sea (i.e. Greece, Spain, Croatia, France and Italy). One scientist from Morocco working on fisheries acoustics in Mediterranean and Atlantic Sea, and one scientist from Turkey working on fisheries acoustics in the Black Sea were invited to participate (see list of participants in Annexes I and II).

The main aims of the meeting were:

a) to present the results from the Mediterranean International Acoustic Surveys (MEDIAS) carried out in 2013;

b) to coordinate the MEDIAS to be performed in 2014;

c) to improve and update the common Protocol for the MEDIAS that is incorporated in the DCF framework and reflected in the MEDIAS Handbook;

d) to revise the ToRs from 2014 and to establish the ToRs for 2015.

The agenda of the 7th MEDIAS Meeting (see ANNEX III) was adopted by the participants. Following the agenda, during the first day results from the 2013 MEDIAS acoustic surveys, carried out by the MEDIAS partners (Figure 1), were presented, as well as results from acoustic surveys carried out by Morocco in the Atlantic and Mediterranean Sea and Turkey in the Black Sea (Figure 2).
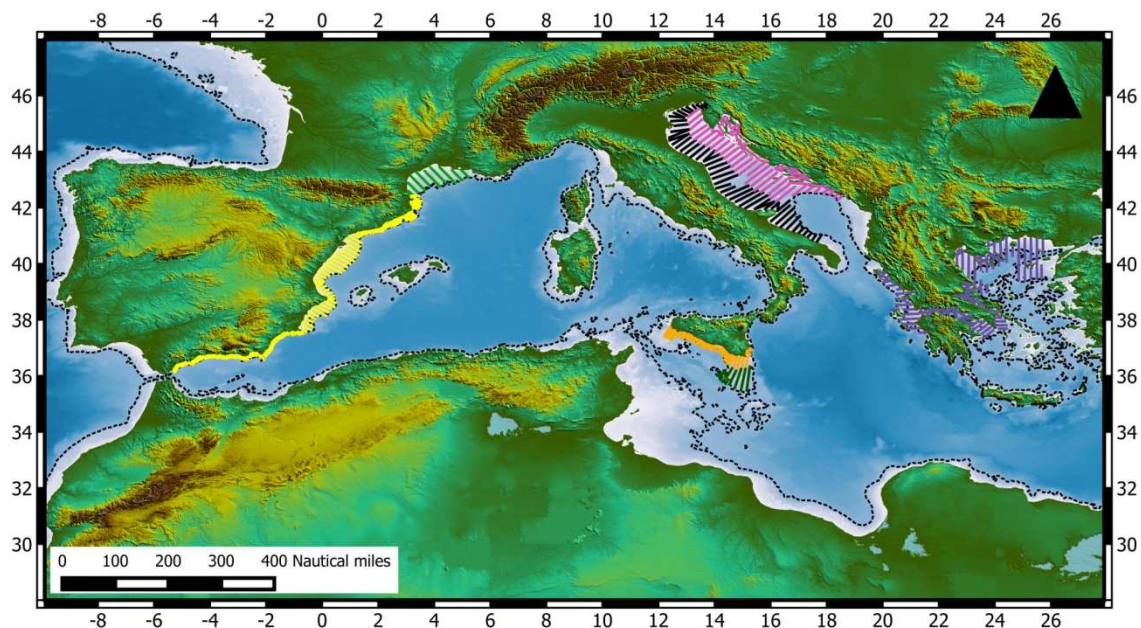
Figure 1: MEDIAS acoustic surveys design.

In the second and third day of the meeting a workshop on the standardization of the allocation of trawl catches on acoustic data and a workshop on the CV estimation with different procedures were carried out.
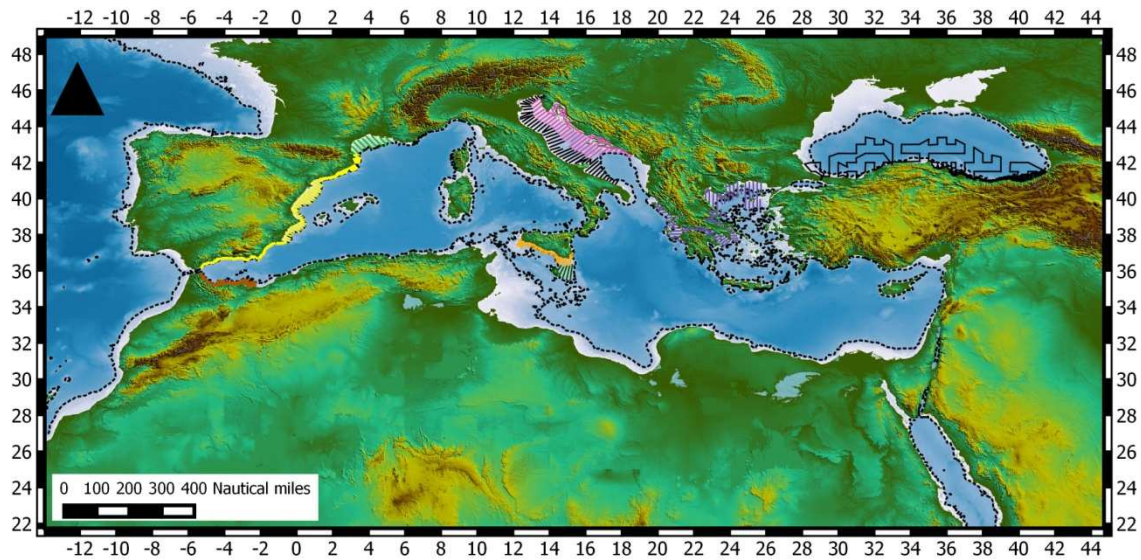
Figure 2: Acoustic surveys performed in 2013 in Mediterranean sea and Black sea.

The main objectives of the first workshop were to describe the procedures used by the MEDIAS group towards the adoption of a common approach for the allocation of trawl catches on acoustic data.

In a similar way, the main aim of the second workshop was to discuss different procedures for CV evaluation in order to define a common procedure for the MEDIAS group.

A general discussion on the next joint meeting with ICES WGACEGG on November 2014 was carried out. In addition, the MEDIAS website design was presented and discussed.

During the fourth day, the revision of the common MEDIAS protocol and an update of the MEDIAS handbook were carried out. Part of the day was dedicated also to define the Terms of Reference (ToRs) for the next year (2015), and to discuss and propose common studies in the framework of MEDIAS.

Results of surveys held in 2013 in the framework of the Mediterranean International Acoustic Surveys (MEDIAS)

a)   **MEDIAS GSA 17 and GSA 18 Assessment of small pelagic fish biomass by means of acoustic methods in the western Adriatic Sea** (Iole Leonori, Andrea De Felice, Ilaria Biagiotti, Fabio Campanella, Giovanni Canduci, Claudio Vasapollo, Sara Malavolti, Rocco De Marco and Ilaria Costantini).

The 2013 acoustic survey was carried out in July in GSA 18 and in September in GSA 17 including territorial waters of Slovenia (Dr. Tomaz Modic took part in the cruise in Slovenia waters). Acoustic data were logged over a grid of systematic parallel transects perpendicular to coastline/ bathymetry for a total of 1869 nautical miles, identifying an area of about 13200 square nautical miles in the western part of Adriatic Sea. Acoustic survey in western GSA 18 was carried out from 16 to 23 July 2013; area coverage was 100%, 503 nautical miles were monitored and 15 pelagic trawls were conducted. 65 ichthyoplankton stations to apply Daily Egg Production Method were made; 46 out of 65 stations had also CTD sampling, 39 out of 65 had also mesozooplankton sampling.

Acoustic survey in western GSA 17 was conducted from 3 to 27 September 2013; the coverage of the area was 100%, 1366 nautical miles were monitored and 43 pelagic trawls were conducted. 101 CTD stations were made and in 46 stations out of 101 mesozooplankton sampling by means of WP2 net (mesh size 200 μm) were made in collaboration with OGS of Trieste (Italy).

Biomass estimations of anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*) stocks in western Adriatic Sea show a significant increase in sardine biomass in 2013 similar to what was already registered in 2011, while anchovy presents a slight decrease respect to 2012.

Anchovy length distribution in north-western Adriatic Sea presents a bimodal distribution with peaks at 8 and 11.5 cm; dominant age classes in terms of number of individuals are age 0 and age 1 classes. Sardine length distribution is unimodal at 12.5 cm; age 1 and age 0 classes are the dominant ones in terms of numbers.

Anchovy length distribution in mid-western Adriatic Sea presents a trimodal distribution with peaks at 8, 10.5 and 12.5 cm; dominant age class in terms of number of individuals is age 0 class. Sardine length distribution is bimodal at 11.5 and 13.5 cm; age 0 and age 1 classes are the dominant ones in terms of numbers.

Anchovy length distribution in south-western Adriatic Sea presents a unimodal distribution at 10 cm; dominant age classes in terms of number of individuals are age 0 and age 1 classes. Sardine length distribution is trimodal at 9, 12.5 and 14.5 cm; age 0 and age 1 classes are the dominant ones in terms of numbers.

b) **Gulf of Lion survey** (Jean-Louis Bigot, Jean-Herve Bourdeix, Claire Saraux).

Pelmed surveys cover the Gulf of Lions (3300 nm²) and have been performed annually in July since 1995 with R/V L'Europe to estimate the spatial distribution and abundance of all small pelagic fish, including anchovy and sardine which are the target species. Since 2008, the survey has also been covering the north Catalan Sea as part of MEDIAS protocol. The survey design is made of parallel transects perpendicular to the coastline and 12 nm apart, from the 20 m isobath to the 200 m one. The EDSU is 1 nm. The surveying acoustic vessel speed is 8 knots. Echotraces are identified with a pelagic haul. Acoustic recording and trawl hauls are performed during day time and the survey lasts approximately 26 days. The split beam echo sounder used is SIMRAD ER60, with the 38, 70, 120 and 200 kHz frequencies. The pulse duration is 1024 ms. The echo sounder is calibrated at each survey. Acoustic data are saved both in HAC and RAW format. The threshold for acquisition is –80 dB and that for processing for the assessment (38 KHz) is –60 dB.

Sardine biomass stabilized at a similar intermediate level as last year. Yet, this level is still low compared to what had been observed in the past, while anchovy biomass was at its lowest this year. Generally, the fishing effort has again been decreasing, but this had not enabled the stocks to recover yet. It has to be noted though that the fishing effort on sardines has changed, as most sardines were landed by purse seines instead of trawlers this year. While the trawl effort has largely decreased, the number of purse-seiners landing sardines has increased.

Further, a retrospective work on biological parameters collected during all PELMED surveys (from 1993 to 2012) showed that anchovies and sardines were presently smaller, grew less and were in poorer condition than before (Van Beveren et al., 2014 on Marine Biology). Similar signals in both species suggest that it may translate changes in the whole ecosystem coming from the environment. Sardines are also younger than before. In particular, the population is now composed almost only by age 0 and 1 individuals. High recruitment levels for the last years have enabled the biomass to stabilize at intermediate levels. However, the truncation of the age structure and problems in growth and body condition indicate a stock in a poor state. Finally, one particularity of the 2013 survey is the high energy detected close to the surface. Unfortunately, due to the difficulty to conduct surface trawls, we only had two successful ones, making the allocation of this energy difficult. We tried different scenarios of allocation for this energy surface to have an idea of the uncertainty associated with our biomass estimates. Also we believe that biomass could be slightly underestimated as more energy than usual was detected close to the surface and that surface energy is not well estimated due to the small angle of the acoustic sounder.
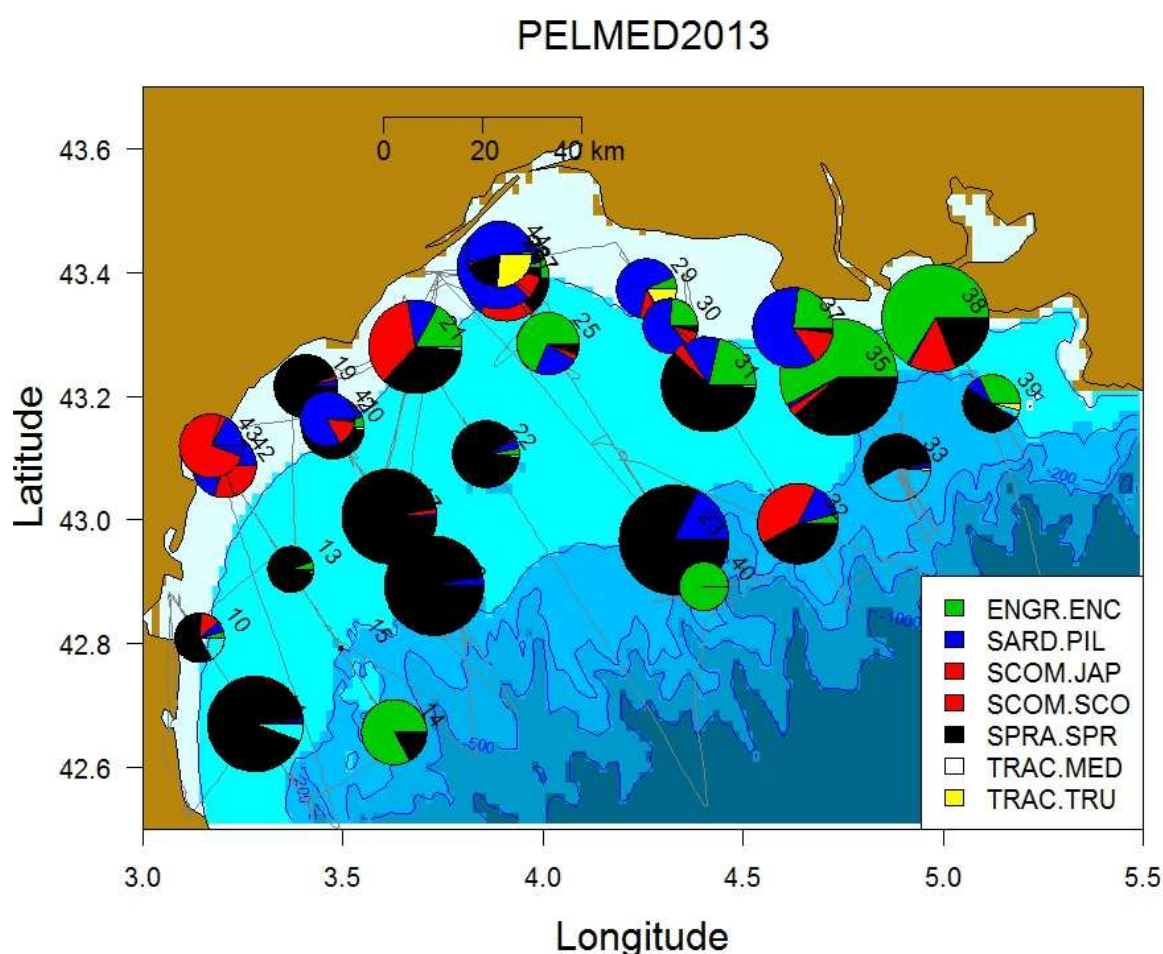
Figure 3. Map of the assessed area and sampling design. 2013 survey is used as an example to show the trawl positions and species composition.

c) **Acoustic survey in the Strait of Sicily - GSA 16** (Angelo Bonanno, Gualtiero Basilone, Simona Genovese, Rosalia Ferreri, Marco Barra)

Acoustic data were collected during the echosurvey carried out in the period 10-20 June 2013 on board the R/V "G. Dallaporta" in the GFCM Geographical Sub-Area 16 (GSA 16 – South of Sicily).

Acoustic biomass estimates and spatial distribution of sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*) for the year 2013 are presented.

The level of total biomass of the anchovy stock has decreased but remained above the estimated values in 2009 and 2011. It should however be pointed out that the period of the Ancheva 2013 survey (11-20 June) was anticipated in comparison to previous years (July). This means that the survey took place before the peak of reproduction resulting in a reduction of the presence of juveniles. The age structure showed a large overlap with the previous year in which the abundance and biomass were significantly

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lower. However, compared to 2011, the biomass of age class 2+3 has doubled from about 2,000 tons in 2011 (1500 in 2009 , 5000 in 2010), to about 4000 tons.
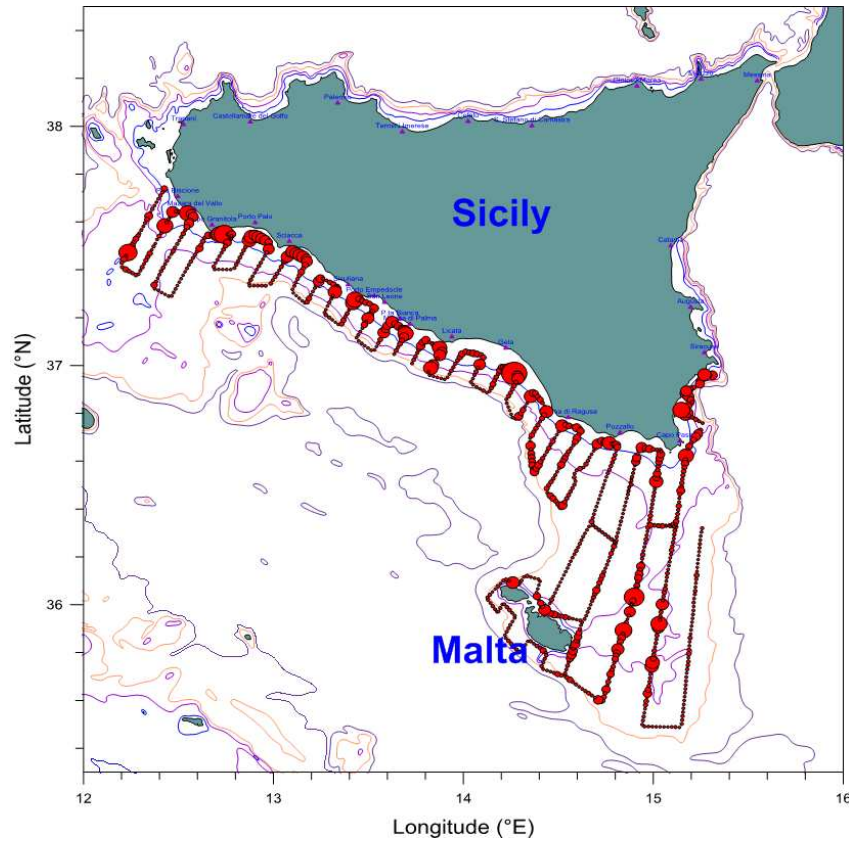
Figure 4. Fish NASC estimated in the Maltese and Sicilian continental shelves.

In the case of sardine population the biomass in 2013 increased in comparison to that estimated in previous years, at levels very similar to those in observed in the period 2004-2005 (17000-20000 t). However, the distribution of biomass among age classes shows a breakdown of the population mainly in two age classes (0 and 1). Although the increase in biomass levels over the previous year constitutes a positive signal, one cannot certify that the state of the stock is improving. In fact, the risk of collapse of sardines in the Strait of Sicily could be referable not only to the age structure, but also to a decline in the total biomass of the stock shown by the estimates obtained in recent years.
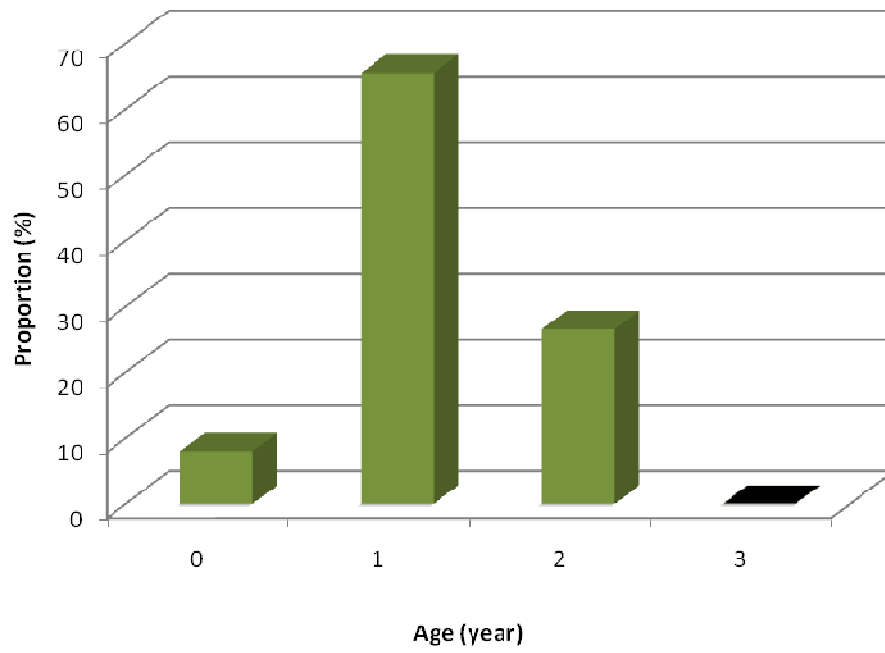
Figure 5. Anchovy age classes distribution (%).
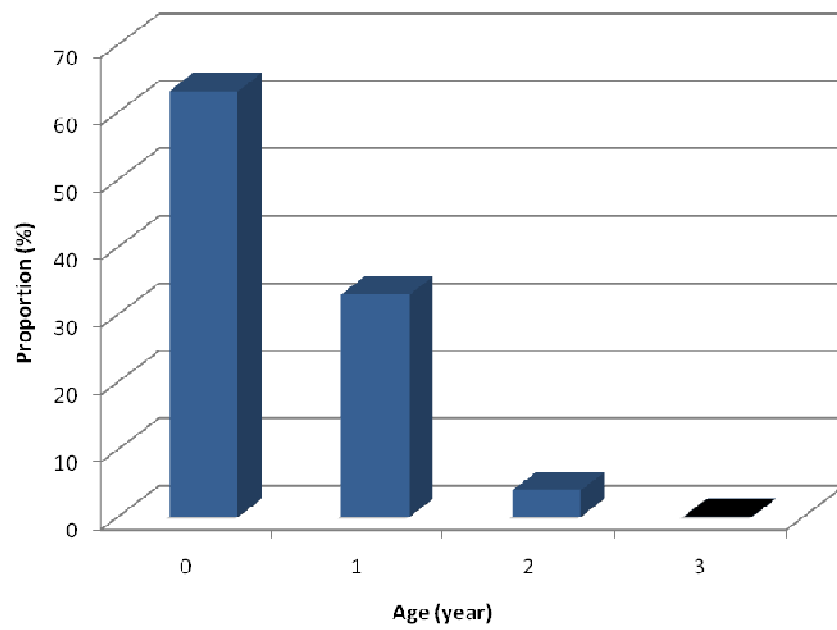
Figure 6. Sardine (*S. pilchardus*) age classes distribution (%).

d) **Maltese waters survey in GSA 15** (Roberta Mifsud, Angelo Bonanno, Reno Micallef, Gualtiero Basilone, Simona Genovese, Rosalia Ferreri, Marco Barra)

The echosurvey in the Maltese waters was carried out in summer 2013 in the period 21-27 June on board the RV "G. Dallaporta" in collaboration with the Italian colleagues of IAMC-CNR. The survey track was 333 nm long and covered an area of 1861 nm^2; 28 CTD stations and 7 pelagic hauls were completed during such survey. The sardine biomass was estimated to be 4763 t while a very low anchovy abundance of (2.1 t) was recorded. The NASC Fish distribution shown in the previous figure 4 evidences the presence of pelagic fish only east of Malta located in the central part and on the Maltese shelf. The pelagic trawl hauls permitted to recognise the presence mainly of sardine and other pelagic fish species (*Trachurus trachurus* and *Boops boops*).

e) **Greek acoustic survey in GSAs 20 and 22** (Athanassios Machias, Marianna Giannoulaki, Konstantinos Tsagarakis, Maria Myrto Pyrounaki, Stylianos Somarakis, Nikos Nikolioudakis, Eudoxia Schismenou)

The echosurvey in the Greek waters was carried out in September –October 2013 on board the RV "PHILIA". The survey design is made of parallel transects perpendicular to the isobath from 10 m to 200 m depths. The inter-transect distance is 10 nm. The EDSU is 1 nm. The average surveying acoustic vessel speed is 7.5 knots. Echotraces were identified based on the catch composition of the pelagic haul. Acoustic recording was performed by day time. The survey covered North Aegean Sea, North and South Evoikos gulfs, Saronikos gulf and the eastern part of Ionian Sea including Patraikos and Amvrakikos gulfs. The survey track involved 88 acoustic transects (Fig. 7), that covered an area of 10330 NM^2 in North Aegean Sea and 22 transects that covered an area of 1729 NM^2 in Ionian Sea. In addition 123 CTD Stations in Aegean and 41 in Ionian Sea as well as 158 zooplankton sampling stations were completed during the survey.

The anchovy biomass was estimated to be 88818 t in North Aegean Sea and 37424 t in the East Ionian Sea. The sardine biomass was estimated to be 44781 t in North Aegean Sea and 20653 t in East Ionian Sea. The biomass distribution of each species is shown.

No comparison with previous years was made since the sampling took place during early autumn in 2013 which is not the standard period for the acoustic survey in Greek waters (early-middle summer). The length composition for anchovy and sardine are shown in Figs. 10 and 11.
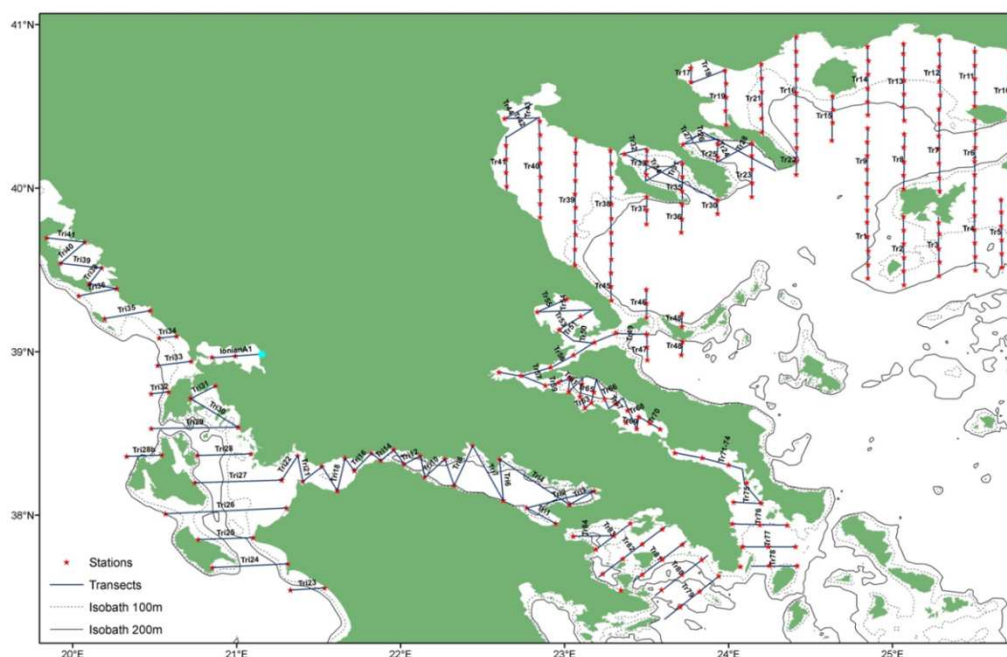
Figure 7. Map of the survey area and the survey design in the Greek acoustic survey in 2013.
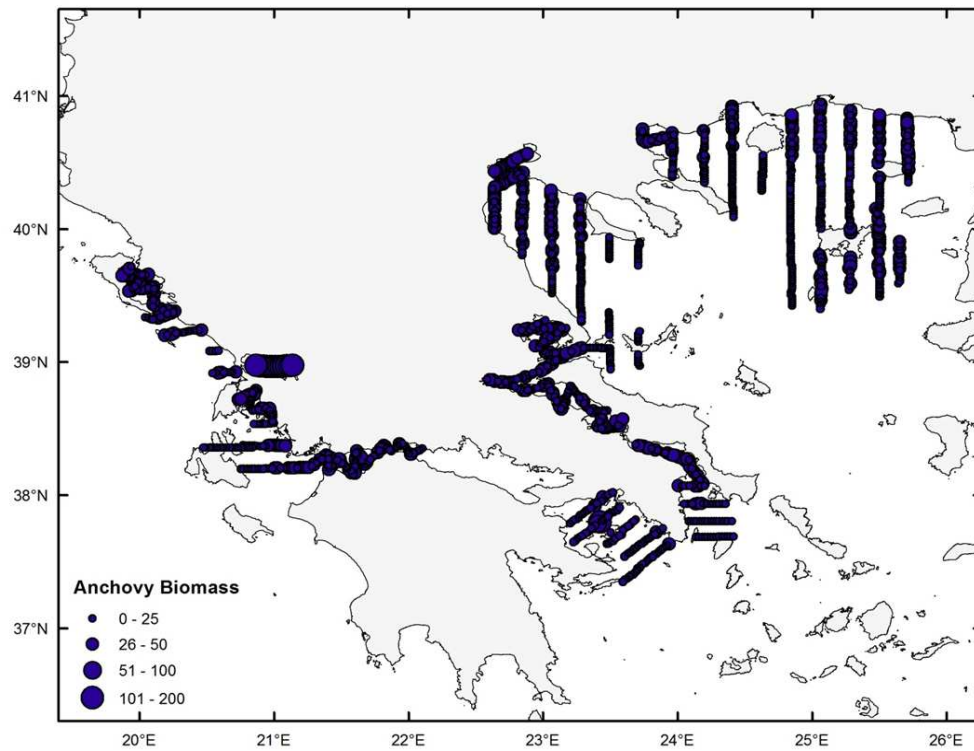
Figure 8. The distribution of anchovy biomass as estimated in the Greek Survey in 2013.
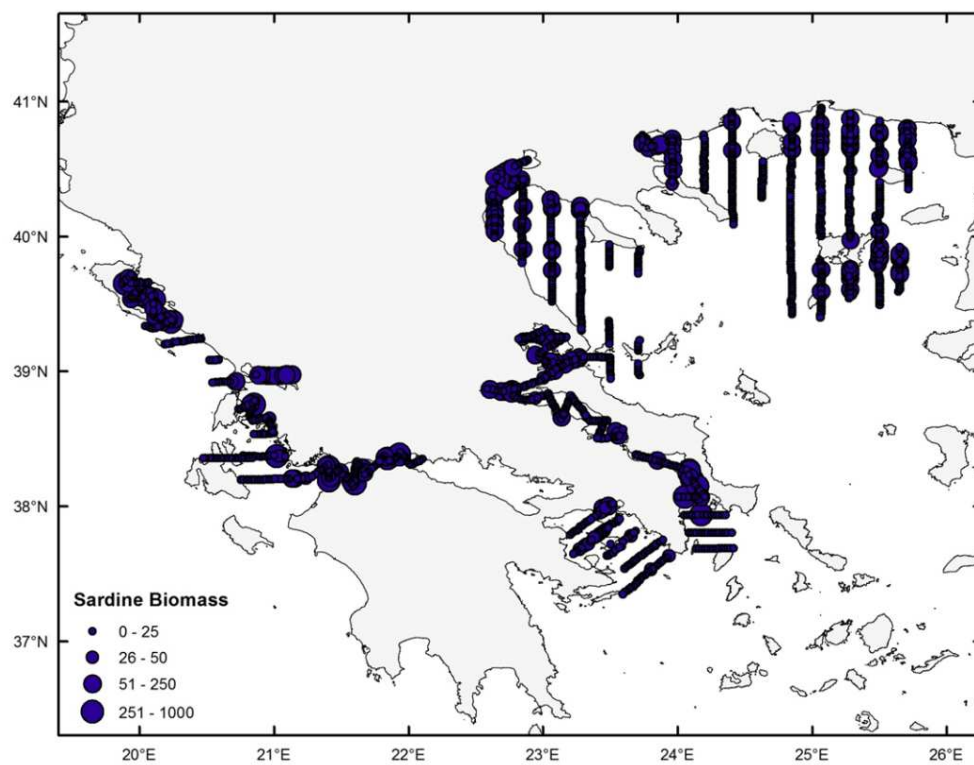
Figure 9. The distribution of sardine biomass as estimated in the Greek Survey in 2013.
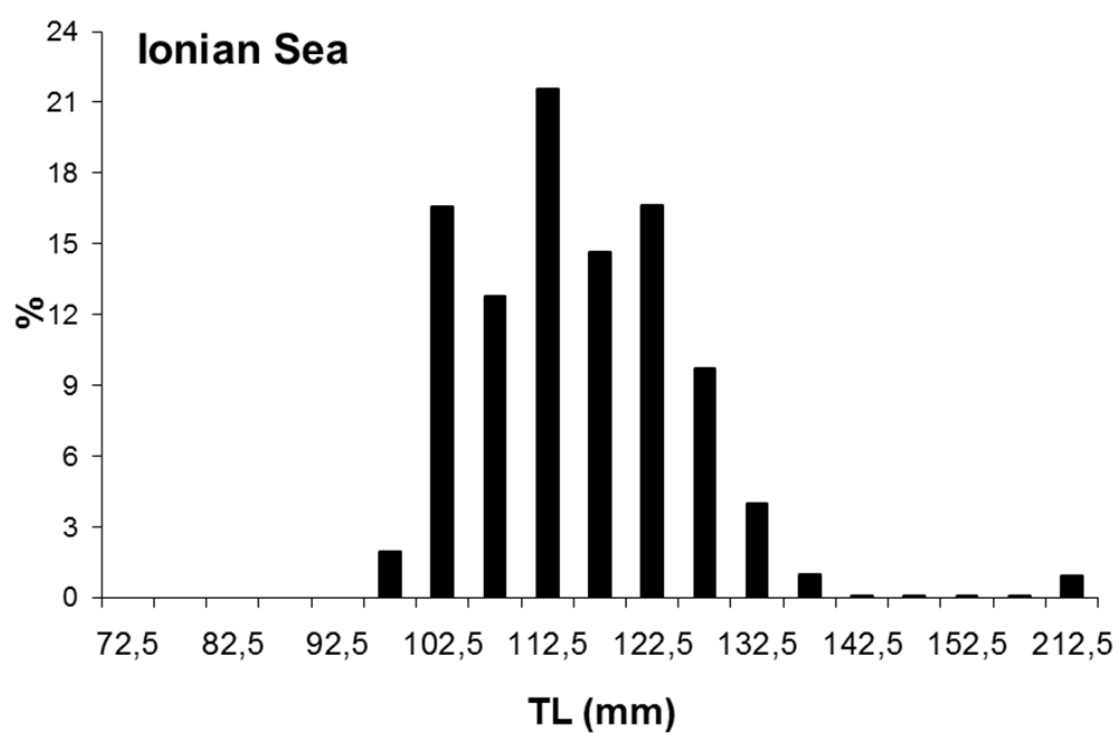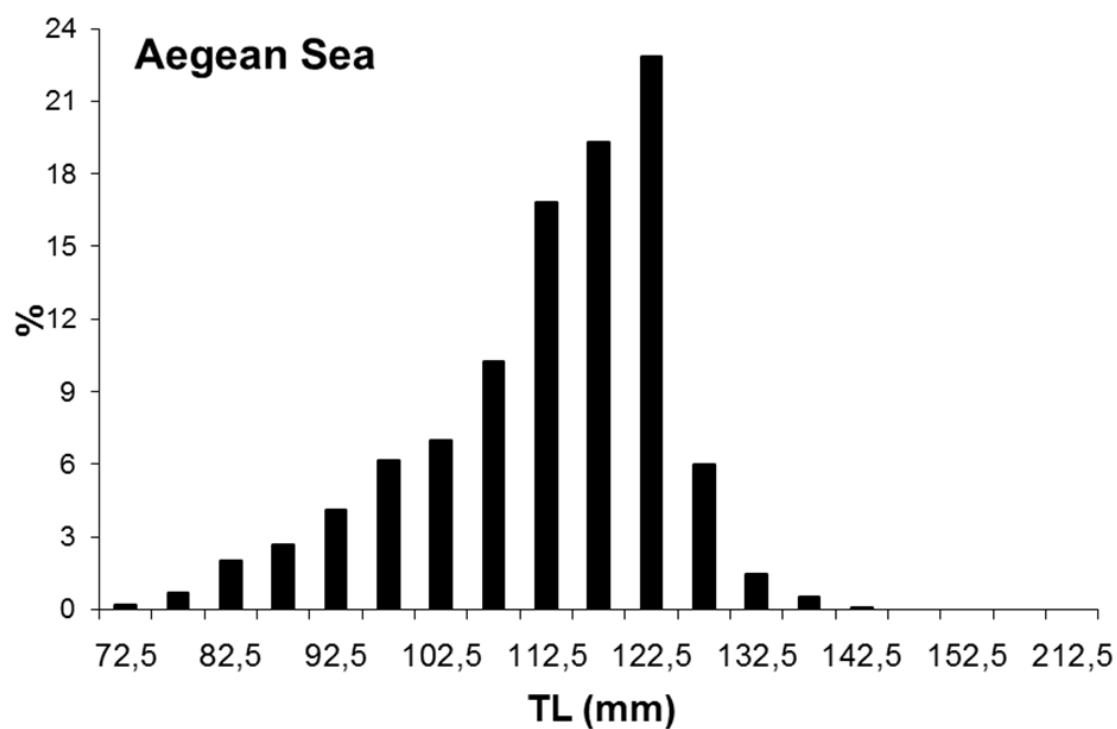
Figure 10. Length frequency distribution of sardine catch during the survey in Greek Waters in 2013.
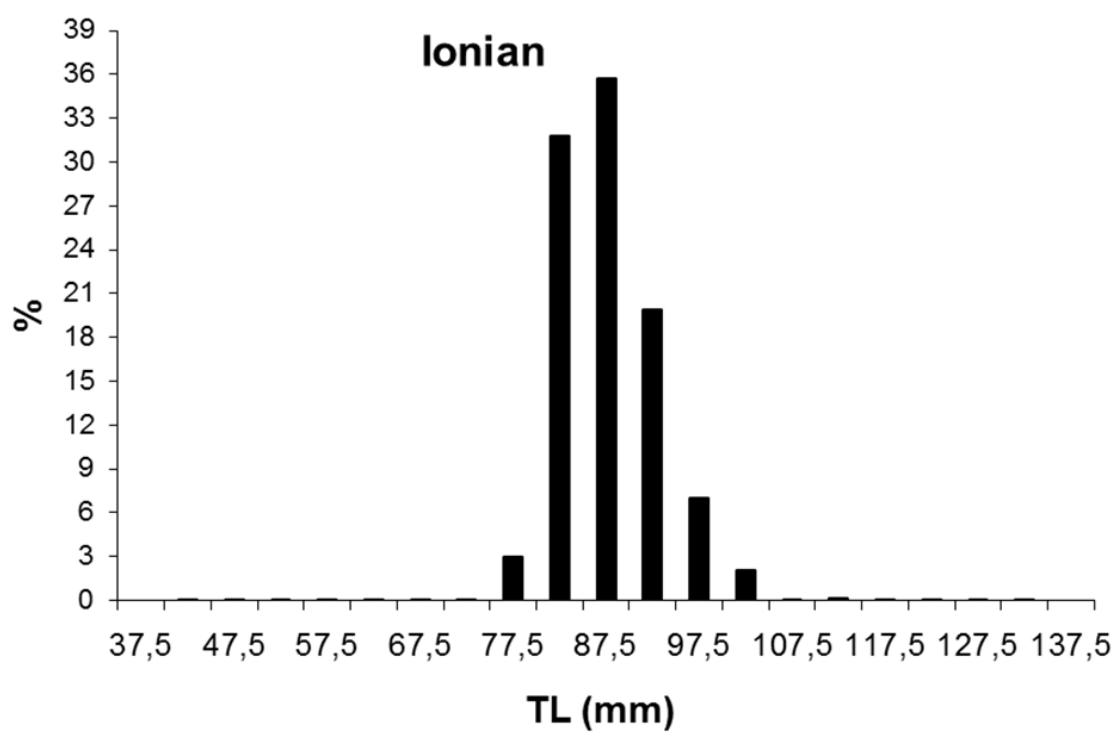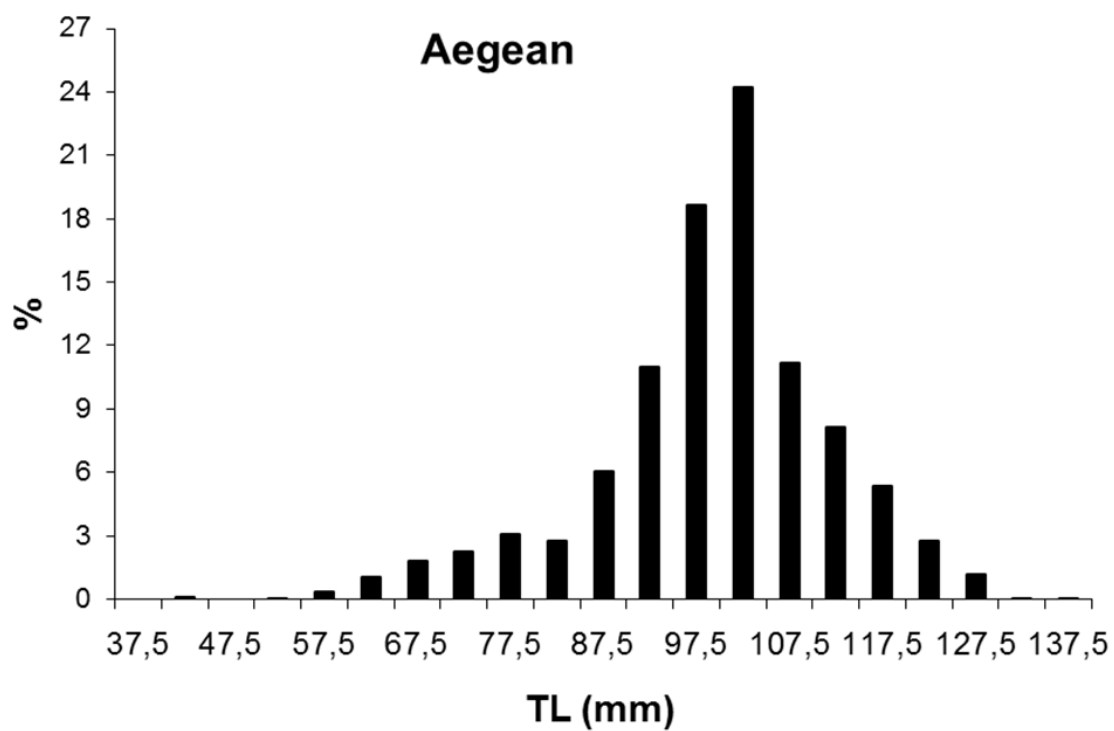
Figure 11. Length frequency distribution of anchovy catch during the survey in Greek Waters in 2013.

f) Iberian acoustic survey (Magdalena Iglesias, Ana Ventero, Joan Miquel, D. Oñate, N. Díaz)

The MEDIAS 2013 acoustic survey was carried out in the Mediterranean Spanish waters from 29th June to 31th July 2013 on board the R/V "Cornide de Saavedra" (67 m long). Acoustic data were collected over 1292 nautical miles, corresponding to 128 tracks (GSA06 and GSA01 areas) and 58 pelagic trawls were used to scrutinize the echograms. Moreover, 90 CTD stations were performed and 429 CUFES (Continuous Underway Fish Egg Sampler) stations were analyzed. The most abundant species in the pelagic trawls were sardine (*Sardina pilchardus*), anchovy (*Engraulis encrasicolus*) and horse mackerel (*Trachurus trachurus*), but other important pelagic species were sprat (*Sprattus sprattus*), Mediterranean horse mackerel (*Trachurus mediterraneus*), bogue (*Boops boops*) and blue horse mackerel (*Trachurus picturatus*). Biomass and abundance of sardine and anchovy were estimated (Fig. 12).

In GSA06 it was detected in 2013 the best recruitment for sardine for the MEDIAS series (2009-2013) (Fig. 13).
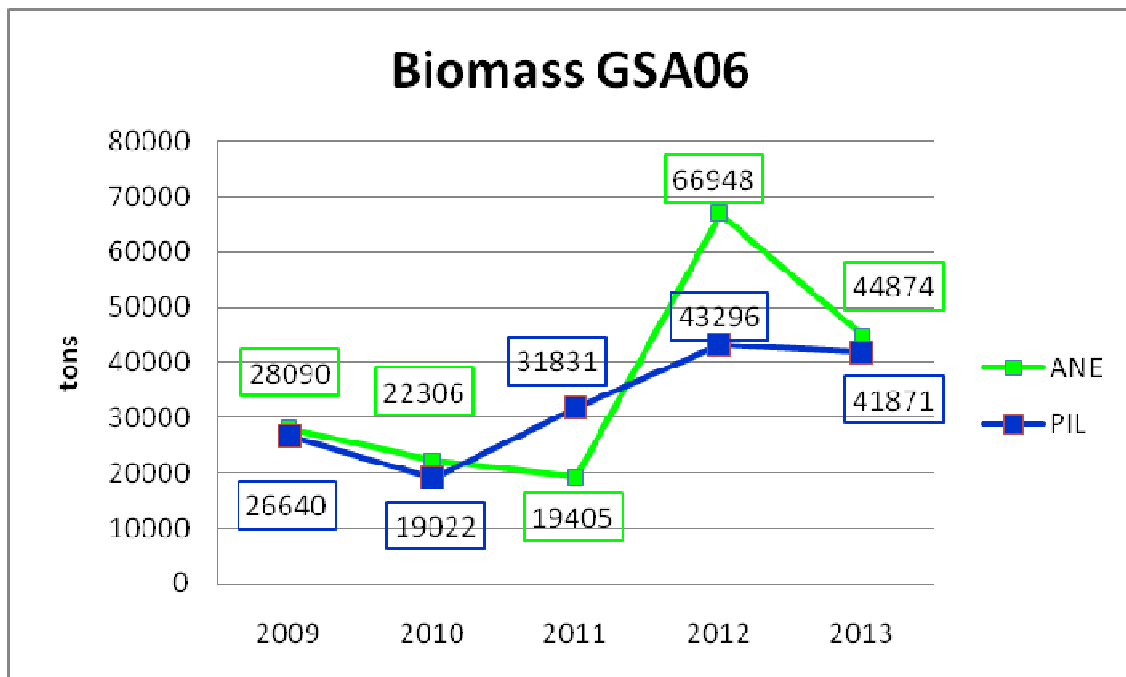
Figure 12. Anchovy (ANE) and sardine (PIL) biomass in GSA 6 in the period 2009-2013.
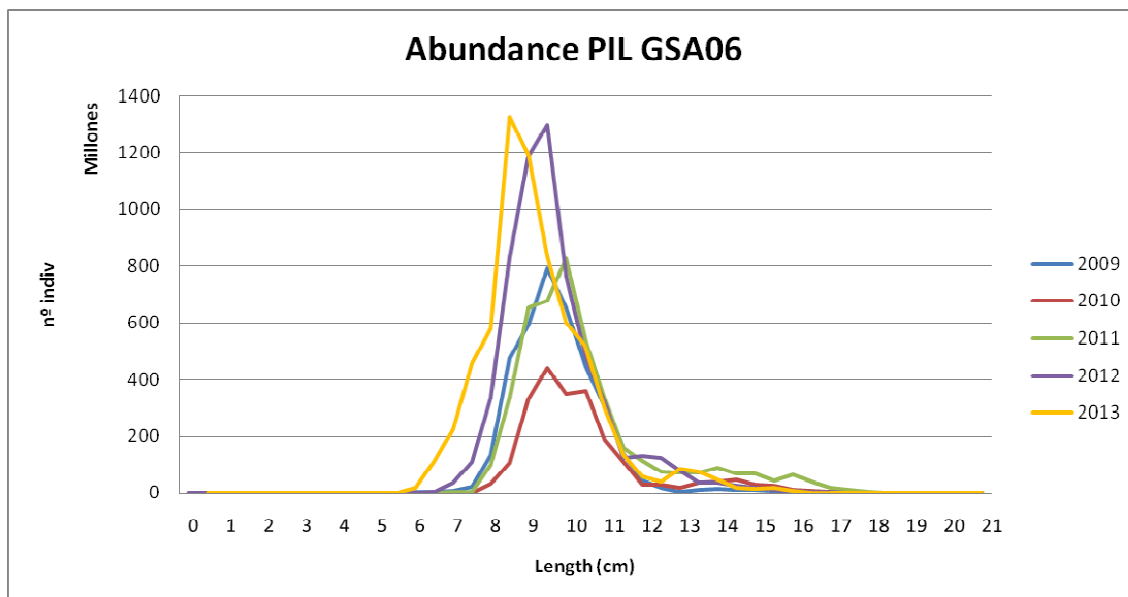
Figure 13. Sardine (PIL) abundance in GSA06 detected during the MEDIAS 2013 acoustic survey in summer in the period 2009-2013.

g)   **MEDIAS in the eastern part of GSA 17 - Croatian survey** (Vjekoslav Ticina, Danijela Bogner)

The 1st EU-MEDIAS acoustic survey in eastern part of GSA 17, after accession of Croatia to EU, has been carried out during September 2013. This survey was carried out with Croatian research vessel "BIOS DVA", and harmonized with Italian acoustic survey in the Adriatic Sea that was contemporary carried out in the western part of GSA 17. In total, 30 vessel days were used to perform this acoustic survey in the eastern part of GSA 17.

Area covered by EU-MEDIAS acoustic survey in eastern part of GSA 17 is 13,578 nm^2, and for the purpose of this survey it has been divided in five sub-areas named as: open sea – northern part, open sea – middle part, open sea – southern part, channel waters – northern part and channel waters – southern part (Fig. 14).

Acoustic sampling strategy include 30 parallel transects in the open sea areas, and 2 transects in the channel areas, adapted to geomorphology of these areas (Fig. 15).
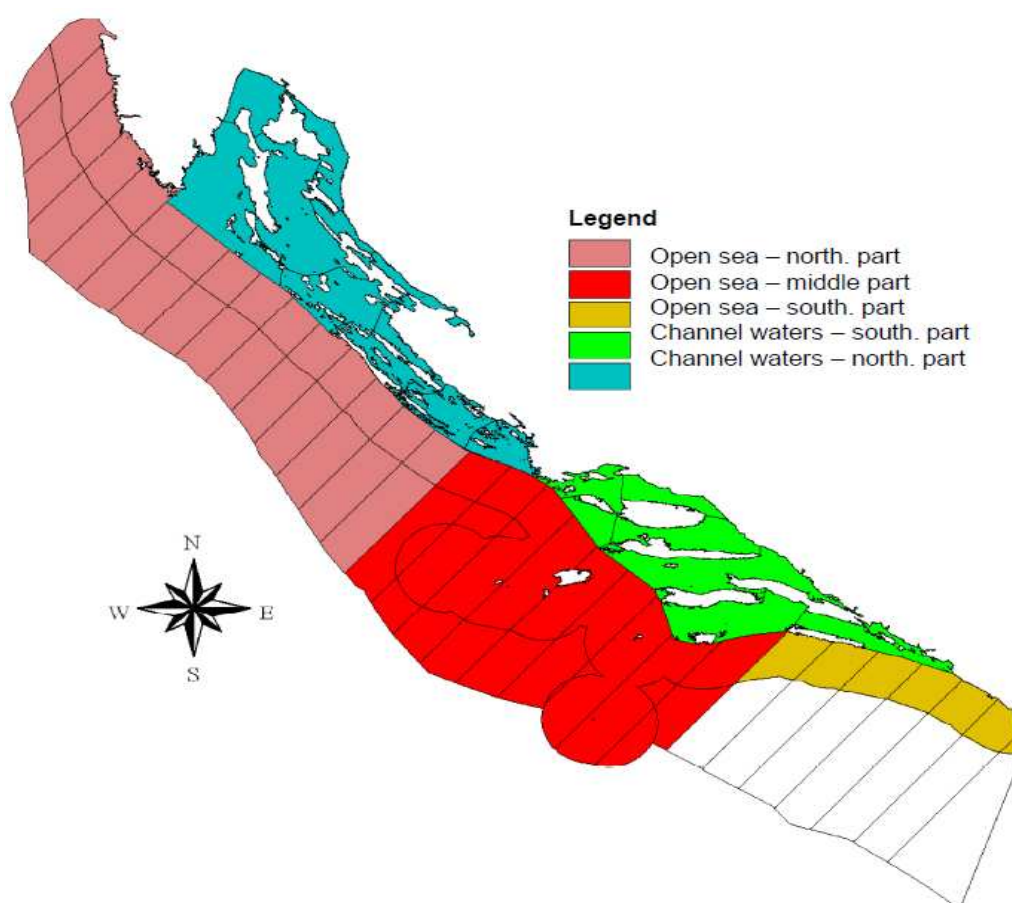
Figure 14. Area covered by EU-MEDIAS acoustic survey in the eastern part of GSA 17.
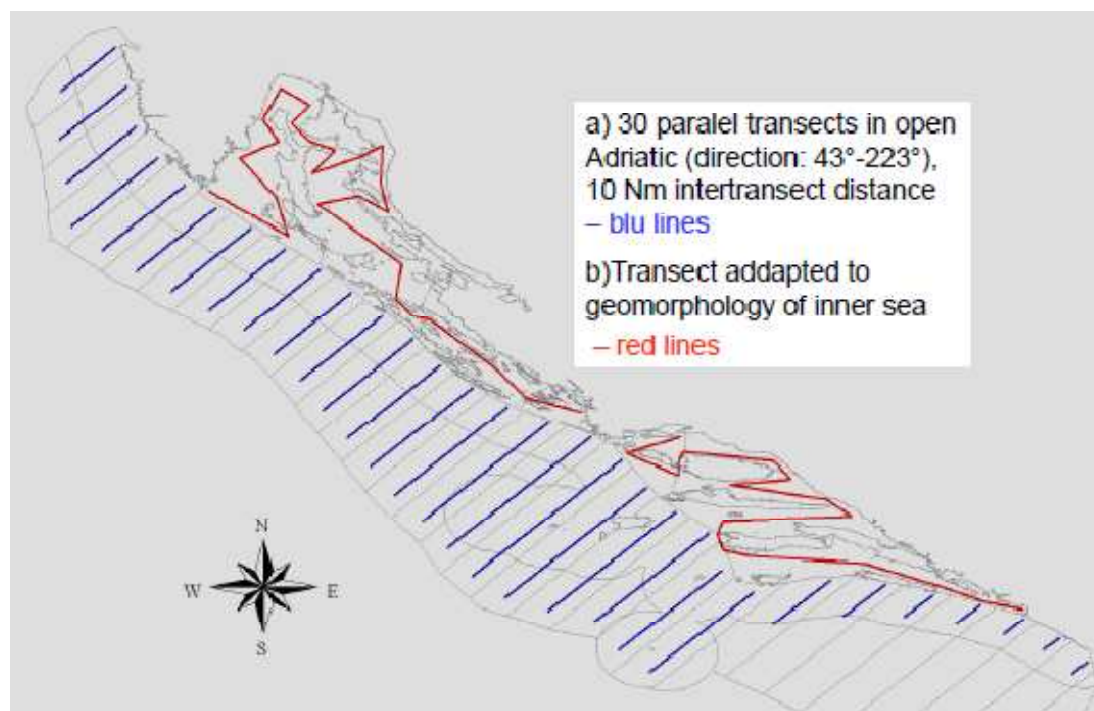
Figure 15. Acoustic sampling strategy in the eastern part of GSA 17.

Collection of abiotic and biotic data during acoustic survey has been done in accordance with MEDIAS working protocol and EU – Data Collection Framework requirements, along the acoustic transects. In total, samplings included 88 CTD stations, 51 biological samplings with mid-water trawl and acoustic sampling made within 1426 EDSU.

Acoustic data for abundance analyses have been collected during daytime only. Fisheries independent abundance indices for target species (anchovy and sardine) have been estimated and data outputs prepared according to templates: Abundance_medbs.xls, Biomass_medbs.xls and Abund_Bio_medbs.xls.

Fishery independent abundance estimates, spatial distributions, length-weight relationships, length structure, sex structure and age structure of part of anchovy and sardine populations present in the eastern part of GSA 17 during September 2013, as well as oceanographic description of area surveyed, have been analyzed and presented (see presentation).

Results of acoustic surveys from non EU countries

a) Turkish Black Sea Acoustic Surveys (Ali Cemal Gucu)

In 2011 Turkey launched a new anchovy monitoring program to monitor the anchovy within the Turkish EEZ in the Black Sea by acoustic and ichthyoplankton surveys. In 2013, two cruises have been carried out. The first one was in spawning season (July 2013) and covered the Turkish EEZ in the Black Sea. The second survey was conducted during the onset of the fishing season when the Black Sea anchovy begins to form schools (November 2013). The survey in July 2013 indicates that the anchovy stocks in the Black Sea, *Engraulis encrasicolus ponticus* in particular, has undergone remarkable changes. Basically, the number of anchovy aggregated and spawned in the southern part of the Black Sea seems to increase significantly in the last decades. These findings, along with the sharp decline in the anchovy landings of the countries located on the migration route of the species, point to a possible change in the migration pattern of anchovy. Moreover, abnormal distribution during spawning and before the overwintering migration may recall stock collapses associated with disruption of the biological mechanisms that sustain life-cycle closure of intrapopulation contingents experienced elsewhere (Petitgas *et al.*, 2010).
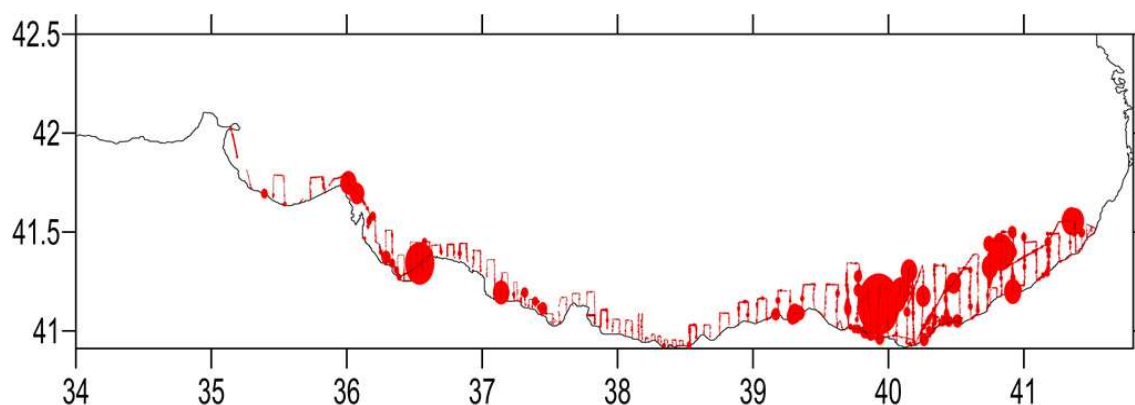
Figure 16. Echosurvey in the Black sea in November 2013.
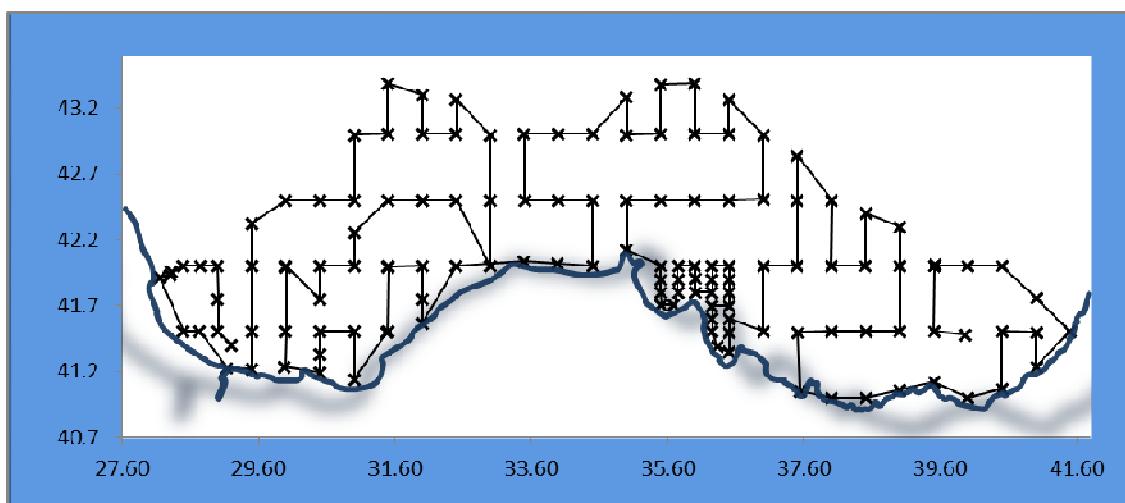
Figure 17. Echosurvey in the Black sea in July 2013.

b) Acoustic surveys in Morocco (Salaheddine El Ayoubi)

The two acoustic surveys that have been planned for the assessment of pelagic stock in the Moroccan Mediterranean Sea during spring and autumn 2013 were not conducted due to technical constraints related to the dry docking of the research vessel "Al Amir Moulay Abdallah". Only the acoustic survey carried out in the Mediterranean Sea in autumn 2012 was presented. About the dry docking, the research vessel has left its home port in Agadir towards Huelva in Spain, on the 7th April 2014, to carry out the dry dock servicing.

The presented 2012 Mediterranean survey is the first part of the national acousticcoverage for the pelagic stocks prospection in autumn season (Table 1).

Table 1. Indicators of the autumnal acoustic coverage 2012

Survey	Date	Track NM*	Fishing stations	Océano. stations	Sizes mesur.	Biology
Med	13 – 24 october	725	27	42	4688	900
Atl-North	07 – 24 november	1 265	40	41	11235	2510
Atl-Center	13 déc – 18 jan	2 345	106	76	26104	5761
Atl-South	21 jan – 16 fév (2013)	2 005	75	34	10377	998
TOTAL		6 340	248	193	52404	10169

(* without navigation)

The 2012 Mediterranean autumn survey was based on parallel transects perpendicular to the coast line and spaced by 5 nautical miles. The acoustic prospection was conducted by 10 knots speed, covering the area from 20 m up to 500 m depth. The

echograms were collected only during the day, by two Simrad echosoundersoperating at 38 and 120 kHzfrequencies. The echosounders were calibrated before the start of the surveys, in addition to the transducers, propeller and water intakes were thoroughly cleaned. The acoustic data were analyzed and processed using the post-processor BI500 and Echoview.

Fishing operations were carried out regularly to serve the identification of echo traces and collect biological data needed to study the conditions of reproduction, growth and feeding. Studies of the physico-chemical and biological oceanography wee performed in parallel according to a specific sampling plan.

On the other hand, samples of small pelagic fish were collected and transferred to the various laboratories of the INRH for further studies in acoustics, genetics, bio- ecology, biotechnology and ecotoxicology.

During the MEDIAS meeting, were presented maps the spatial distribution of small pelagics and the results of biology and indices of biomass and abundance.

MEDIAS website design (Marco Barra)

During the previous MEDIAS coordination meeting held in Capo Granitola a preliminary structure of the MEDIAS website, hosted on a test server, was presented and discussed by all MEDIAS partner. Particularly, during the discussion all partners agreed about the need of an authentication system allowing a more flexible management of the contents. Furthermore, most of the participants were in favour to add a media gallery showing pictures or videos related to the work carried out during the surveys.

Based on the above mentioned discussion, the website was updated and all improvements presented at the 7th MEDIAS meeting. Particularly, in finalizing the work done, the website was moved from the test server to the production one. A new domain was activated and actually the website is available on the net following the link www.medias-project.eu.
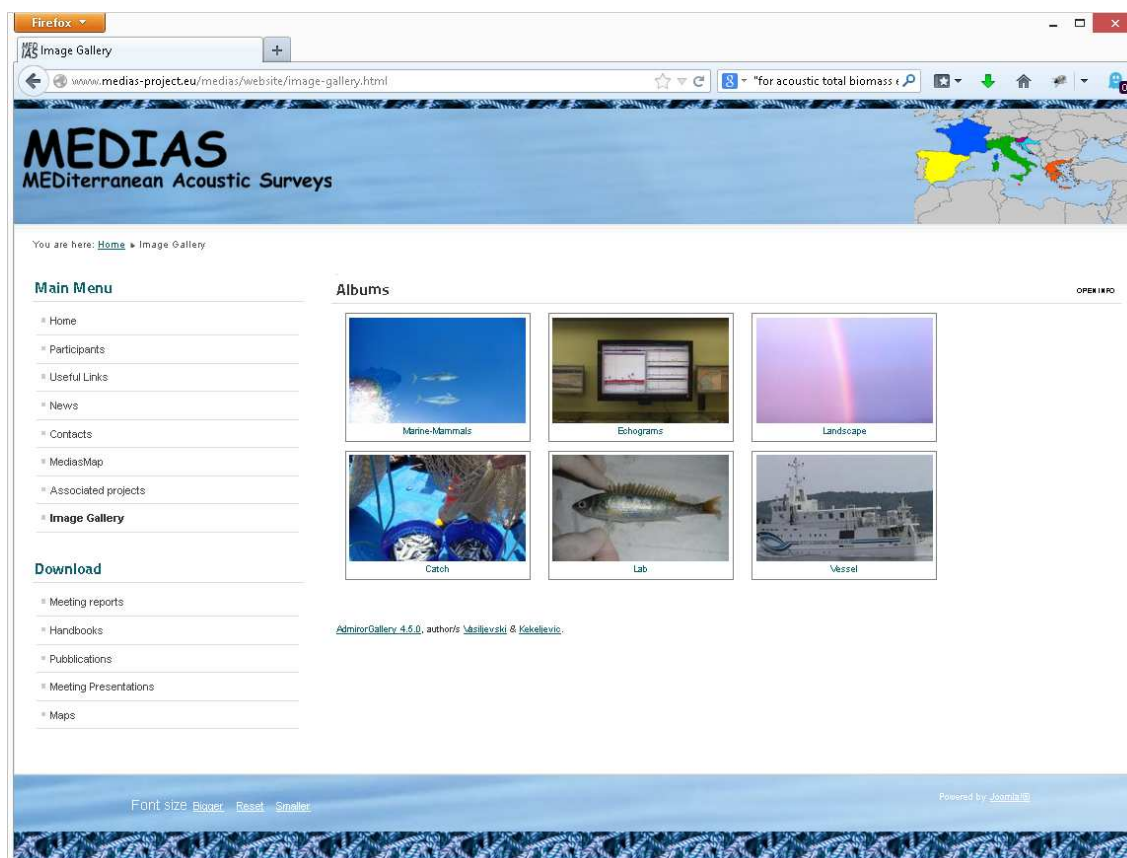
Figure 18. The media gallery collecting images of the work done during the surveys.

Concerning the login system, it was implemented in order to allow all people to register on the website but to enable only registered users belonging to a specific system group to access some private folders and/or documents. Based on such rule, all

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participants agreed that publications, presentations and other documents will be available only to people involved in the project or invited to meetings. A media gallery has been added to the website collecting images from all people involved in the project (Fig. 18).

Finally, regarding the WEB-GIS application showing a dynamic map of the survey carried out in Mediterranean and Black Sea waters (Fig. 19), it was modified in order to allow the users to switch on/off the layers. In this way a better organization of the information provided by the application was achieved.
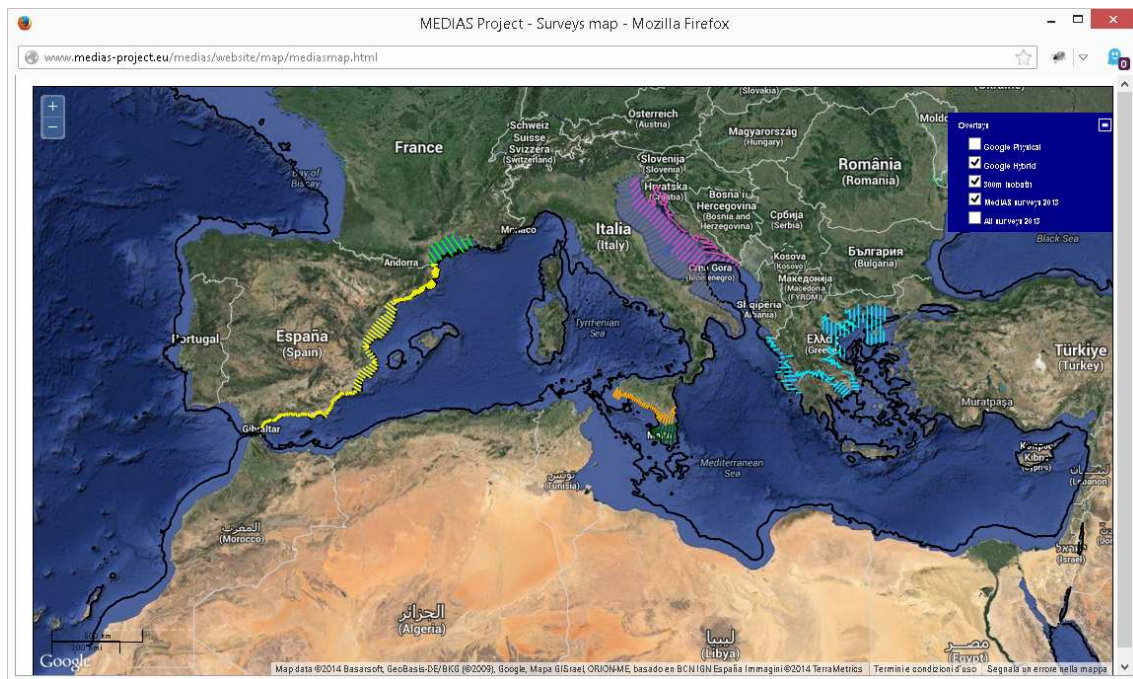
Figure 19. WEB-GIS application showing a dynamic map of the survey carried out in the Mediterranean and the Black Sea.

Plan for future activity on the realization of the MEDIAS database on the basis of the RCMMED&BS 2013 meeting
(Andrea De Felice, Rocco De Marco)

In the previous years of MEDIAS the Steering Committee group has been working in the framework of the AcousMed project (Contract MARE/2009/09 SI2.557652) in the "Standardization of a common format for an acoustic database". During the last meeting of the MEDIAS Steering Committee a roadmap for building the MEDIAS database was proposed.

The first step was the identification of a working group that aims to support the following actions: data structure planning, definition of data access/use rules, definition of data input/output procedures, database development and user interface. The following researchers are in the working team:

1. Magdalena Iglesias - Ana Ventero Martín

2. Andrea De Felice - Rocco De Marco

3. Vjekoslav Ticina

4. Athanassios Machias

5. Claire Saraux - Mathieu Doray

6. Marco Barra - Gualtiero Basilone

During the discussion some useful tools have been showed by Rocco De Marco and Andrea De Felice: postgis (spatial rDBMS), geoserver (a web based map engine), web2py (python based web development framework).

The Steering Committee decided to start with a database using a reduced dataset, developed by Rocco De Marco that will deploy a working demo to be evaluated.

There are still some infrastructure issues to be considered: define the final datacentre place, server management, developer staff.

Particular care must be given to the data access policy, defining a clear disclaimer. Concerning this specific aspect, the MEDIAS chair contacted the Med&BS-RDB chair (Mr. Paolo Carpentieri) for obtaining information on other similar initiatives. During the meeting the final report of the 1st Steering Committee Meeting for the Mediterranean & Black Sea Regional DataBase (Med&BS-RDB; Rome 29-30 November 2012) was distributed to the participants in order to be informed on the data policy procedures adopted in the Med&BS-RDB.

During the MEDIAS meeting, a draft text of the "REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the European Maritime and Fisheries Fund (EMFF)" was distributed to participants. The main idea was to evaluate possible steps to be taken to submit a project proposal for realizing the database. In this context the

working group will draft a proposal to submit to next calls for obtaining some funds for the development of the MEDIAS database.

During the meeting it was also proposed to discuss the EchoR database with dr. Mathieu Doray in the next WGACEGG 2014 meeting, in order to see if such package could be reused by the MEDIAS group.

Workshop on the standardization of the allocation of trawl catches on acoustic data.

Each participant presented the procedures for the allocation of specific proportions of catches on the acoustic data. This very delicate and subjective step has a large impact on the estimation results of pelagic stocks. All acoustics are unanimous on the sensitivity of the impact of fisheries data, which themselves are conditioned by several factors related to the trawl catchability and selectivity with respect to the species and size, avoidance of species, etc. For this reason particular attention is given to the sampling of pelagic species and subsequently sharing acoustic densities between different species caught.

At the end of the discussion, it was concluded that the EchoR program, developed by IFREMER, is a good platform that can be generalized, but adjustments are needed to simplify scripts and adapt them to common file formats of the various institutions of the region.

It is foreseen that every two years the MEDIAS participants take part to the WGACEGG (Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VII, VIII and IX). Such a workshop will take place in Vigo, 17-21 November 2014.

Before the WGACEGG a specific one day workshop will be proposed to the French experts who developed the EchoR package, in order to check if such program can be used in the MEDIAS.

Workshop on the CV with different procedures

When dealing with spatial data the presence of autocorrelation must be taken into account for a rigorous statistical treatment of data, especially if a reliable estimate of spatially distributed property is needed. Since datasets obtained from echo-survey are characterized by underlying spatial structure it must be considered in calculating the confidence intervals related to biomass estimates. Furthermore, due to the complex procedures involved in calculating the total biomass, different sources of error are present.

During the workshop each participant presented the procedures for CV estimation currently applied in different areas.

Athanassios Machias presented the CV estimation currently used in Greek acoustic surveys. This is based on the mean and variance estimates suggested by Pennington (1983) after a Log - transformation. In the Pennington algorithms the new estimators for mean and variance take into account that a) The fish occur in patches; b) The PDF is stationary within each patch. According to the suggested algorithms the estimators of the mean and the variance are modified to take into account the proportion of zeros in the data. The algorithm is incorporated in the database used in Greek waters and a brief example was presented to the participants.

Andrea De Felice reported that CNR-ISMAR in the past used a mean square error relative to the interpolation algorithm (IDW) to be associated to biomass estimates; only the interpolation process was considered source of error and gave values around 15-20% of the biomass estimate over the years. More recently, a CV estimate as described in Jolly & Hampton (1990) and in Coombs & Cordue (1995) was applied for specific purposes (AcousMed, Marine Strategy Framework Directive).

Claire Saraux showed the computation of CV estimations concerning errors associated with the acoustic procedure rather than with the spatial autocorrelation. In particular, the idea was to test for different trawl allocation scenarios and for 2 different calculations of biomass from TS equations. One calculation was based on the mean length of the trawl associated with the EDSU, while the other one used the entire size distribution of the trawl instead of the mean. Biomasses were then estimated for both types of calculations and each scenario. A mean biomass and associated CV could then be produced.

Marco Barra showed the computation of confidence limits for acoustic biomass estimates using Geostatistical Simulations. In particular, the approach proposed in two papers by Woillez (2009) and Walline (2007) was briefly presented. Both procedures rely on the use of geostatistical simulations but differ in the strategy adopted to treat zero values. The procedure proposed by Walline was applied in a simplified way (working directly on density values) on acoustic datasets collected in GSA 16 and results were briefly presented.

During the workshop all participants agreed on the need to adopt a standard procedure for the CV estimation, but it was clear that further research is necessary. Consequently, it was decided to keep the subject on CV estimation on the agenda of the next MEDIAS meeting.

References

Walline, P. D. (2007). Geostatistical simulations of eastern Bering Sea walleye pollock spatial distributions, to estimate sampling precision. ICES Journal of Marine Science, 64: 559–569.

Woillez, M., Rivoirard, J., and Fernandes, P. G. (2009). Evaluating the uncertainty of abundance estimates from acoustic surveys using geostatistical simulations. ICES Journal of Marine Science, 66: 1377–1383.

Proposal of new research activities in the framework of MEDIAS.

Before the proposal of new research activities to be performed in the framework of MEDIAS, it was agreed by the Steering Committee to present again to the RCM the proposal for an inter-calibration exercise among the research vessels involved in the MEDIAS. In the following a brief description of the proposed study is reported:

Inter-calibration exercise of the MEDIAS research vessels

The MEDIAS project aims to join and harmonize the six ongoing acoustic surveys in the Mediterranean Sea and should give information for management decisions and provide input to assessment for stocks which are managed internationally.

The MEDIAS survey is a multi-vessel survey that target mainly sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*) Mediterranean stocks and each research vessel covers most part of the distribution area of sardine and anchovy. In order to obtain comparable results and be able to produce one single estimate of target species abundance it is necessary to inspect and calibrate any possible differences in the respective research vessels measurement capabilities.

An important step towards the progress of the harmonization of the MEDIAS survey is to carry out an inter-calibration between the research vessels used by the different Institutes (Ifremer, France; IEO, Spain; CNR, Italy; HCMR, Greece; IOF, Croatia) in order to test the overall performance of the acoustic and hauling equipments of the vessels in the field.

These inter-ship comparisons is necessary to be done in a suitable area with known small pelagic fish aggregation characteristics, having substantial quantities of fish in layers and dispersed aggregations of varying density. Results of each research vessel will be analyzed, compared and evaluated for the selected area in terms of echo-integration of the water column (fish density) and/or concerning the bottom echo-integration.

Duration: 18 months.

Intercalibration planning
Place: Central Mediterranean and tentative regions: the Sicilian/Maltese continental shelf or the Tunisian continental shelf.

Experiments duration:
- 2/3 days (depending on the country) to go to the working area (Greece to Sicily; France/Spain to Sicily) + 3 days back;
- 4 days for sampling (4 repetitions of the experiment);
- 2 day as backup (e.g. bad weather, other unexpected problems).

Total 12 days (this could be also different from partner to partner).

Total Budget requested: To be defined.

Daily Egg Production Method (DEPM) application on anchovy in the central Mediterranean Sea (Rosalia Ferreri)

The most common direct methods to estimate the small pelagic stock biomass are acoustic surveys and Daily Egg Production Method (DEPM; Parker 1980). Since 1998, they are applied simultaneously in the Strait of Sicily, during the anchovy (*Engraulis encrasicolus*) spawning season. The DEPM application allows to estimate the Spawning Stock Biomass (SSB) and the relative CV by a direct assessment method; to collect information on reproductive ecology of the target species; to identify spawning and nursery areas; to assess the reproductive potential for stock assessment models implementation and, finally, to give management indications for sustainable fishery, according to EUMarine Strategy Framework Directive (2010/477/EU).

The DEPM surveys are split in adult and eggs samplings. The former provides data on spawning phases reached by each adult specimen by means of histological analysis. The eggs sampling is carried out by CalVET net and provides data on age, density and mortality of spawned eggs. The DEPM surveys may also provide additional information about stock habitat (i.e., oceanographic features) and about reproductive potential parameters (i.e., somatic condition indices, presence of atresia). Preliminary results on reproductive potential of anchovy in the Strait of Sicily showed the importance of parental care, highlighting the positive relationship between fecundity and total length of mature females. A positive correlation has been observed also among food availability (zooplankton density) and several reproductive potential parameters (fecundity, spawning fraction and condition factor). Finally, results from DEPM application provided information about the spawning behaviour, allowing to identify the daily active spawning period by the presence of active spawning females and suggesting the separation of spawning females, which show a preferential depth compared with the rest of stock.

Proposal for a common project on small pelagic body condition at the Mediterranean and Black Sea scales (Claire Saraux).

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). 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 MEDIAS surveys all 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. It could also help understanding the relative population trends observed in the different areas. In this project, we propose in a first step to build morphometric body condition indices over the whole Mediterranean and Black Sea, to compare among 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 advices proposed in the regional organisations such as GFCM. Further studies on the link of body condition with reproduction or feeding behavior or even age structure of the population may also be considered.

Presentation of the report of the ICES in 2013 on daily growth rings of anchovy and sardine: WKMIAS "Workshop on Micro daily growth increment in European Anchovy and Sardine" (Gualtiero Basilone)

The Workshop on Micro increment daily growth in European Anchovy and Sardine (WKMIAS) took place for the first time on 21-25 October 2013 in Mazara del Vallo, Sicily (CNR-IAMC). The meeting was chaired by Gualtiero Basilone (CNR-IAMC, Italy), Begoña Villamor (IEO, Spain) and Mario La Mesa (CNR-ISMAR, Italy). Twenty-two participants represented six nations in the workshop.

WKMIAS was proposed by the Planning Group on Commercial Catches, Discards and Biological Sampling (PGCCDBS) 2012. Although multiple age reading workshops at annual scale have been made under the ICES, this was the first time that a workshop was exclusively dedicated to age reading at daily scale. The objectives of the workshop were to define and standardize methods, reading criteria and protocols of anchovy and sardine daily growth in different developmental stages (larvae and juveniles), and validate the first annual ring of these species to improve annual age estimates.

Given the terms of reference and objectives, the daily growth of these species is dealt with the following geographical areas/stocks/ecosystems: Bay of Biscay, Atlantic Iberian Peninsula (sardine only), Western Mediterranean, Strait of Sicily, Adriatic Sea and North Aegean Sea.

Before the workshop a questionnaire was prepared in order to collect information from the different laboratories on own method of preparation and interpretation of anchovy and sardine otolith microstructure. All the information was reviewed and summarized, so obtaining a common protocol during the workshop regarding the methods and techniques of preparation of the otoliths. However, there was not agreement in relation to daily increment interpretation criteria.

The workshop also was preceded by an otolith image exchange, which was undertaken using EARF in the months prior to the workshop. The exchanged otolith collection included 81 images (41 for anchovy and 40 for sardine) distributed in 10 sets from different anchovy and sardine distribution areas. In the case of sardine, also a small otoliths collection (5) of known age (obtained from Aquaculture) was used. The exchange proved the existence of differences between readers and areas of both species, with a precision ranging from 9.0 to 34.9% CV for anchovy, and from 9.4 to 18.0% CV for sardine.

The comparison with the actual age of sardine (known from marine culture) showed that sardine readers are generally in good agreement; nevertheless all readers underestimated the older fish.

During the workshop a reading exercise on live images of anchovy and sardine otolith thin section was carried out. The main aim of such exercise was to increase the agreement among readers and to highlight differences due to the interpretation

criteria adopted, or due to the differences in the growth pattern among areas. There were two criteria for interpreting the anchovy and sardine daily Micro increments according to double bands (called GBR) or individual bands (IMR) form. The application of these criteria was recurrently discussed during the workshop, not being possible to reach a unanimous agreement on standardization. So it was agreed to use the GBR in all areas, except for the Strait of Sicily and Adriatic Sea.

Another main issue of the workshop was to identify the position of the first annual ring (annulus) in the otoliths of these species, since it is one of the main sources of error that affects the precision of age. Based on different daily growth studies presented at this workshop, the position of the first annual ring is validated on anchovy in the Bay of Biscay and the position of the first ring false or check is corroborated in the sardine of North Adriatic Sea, providing a series of recommendations to the annual ageing readers of these species.

A reference collection of otolith images was also provided for larvae and juveniles of anchovy and sardine from each area. Finally, a literature review of recent research related daily growth of these species was performed and a new Workshop on Micro increment daily growth in European Anchovy and Sardine was proposed for 2017.

More details can be found in the WKMIAS report, available on the ICES Website at http://www.ices.dk/community/groups/Pages/WKMIAS.aspx.

Terms of Reference for the "MEDIAS 2015"

General:

- o to join and harmonize the ongoing acoustic surveys in the Mediterranean Sea and Black Sea
- o to provide information for management decisions
- o to provide input for stock assessment purposes concerning the stocks which are managed internationally.

Specific:

- o Update MEDIAS handbook
- o Update the MEDIAS Website
- o Update the structure of the common database
- o Update the workflow for the analysis of the echograms
- o To work on the standardization of the allocation of trawl catches on acoustic data using EchoR
- o To work on acoustic data analysis for the estimation of CV in a standardized way, taking into account indetermination linked to biological and acoustic spatial sampling
- o To work on Marine Strategy Framework Directive for ecosystem descriptors and to evaluate the contribution of MEDIAS

Conclusions and decisions of the MEDIAS Steering Committee

In the 7th MEDIAS meeting the results of the Mediterranean International Acoustic Surveys carried out in 2013 were presented by participants of the seven countries working in MEDIAS: Spain, Greece, Italy, Malta, France, Slovenia and Croatia. Moreover, results from the acoustic surveys carried out in 2012 by Morocco and in 2013 by Turkey were also presented.

During the workshop on CV estimation different procedures were presented and discussed by the participants to the meeting. The Steering Committee agreed on the need to adopt a standard procedure for the CV estimation, but it was clear that further research is necessary. Consequently, it was decided to keep the subject on CV estimation also for the agenda of the next 8th MEDIAS meeting.

After having presented the different procedures adopted by the different research groups of MEDIAS for the allocation of trawl catches on acoustic data, the Steering Committee decided to propose to the French experts, who developed the EchoR package, to dedicate a specific one day workshop in order to verify if such program can be used in the MEDIAS. The aim is to adopt a standardized procedure for this specific topic. The workshop should be carried out before or during the next meeting of WGACEGG (Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VII, VIII and IX) that will take place in Vigo (Spain) on 17-21 November 2014.

Only few steps were made by the MEDIAS group in the development of the workflow for the analysis of the echograms. So it was decided to continue the work on a common workflow for acoustic data processing and to discuss the progresses during the next meeting of the ICES WGACEGG in Vigo.

During the meeting a roadmap for building the MEDIAS database was proposed. Moreover a working group, composed of participants from different countries, was identified in order to support the actions to be undertaken for building the database. The Steering Committee agreed on the need to construct soon the MEDIAS database but all the participants highlighted the importance to obtain additional funding for the completion of the database.
During the meeting a draft text of the "REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the European Maritime and Fisheries Fund (EMFF)" was distributed to participants in order to evaluate possible steps to be taken to submit a project proposal for constructing a common database. In this context the working group will draft a proposal to submit to next calls for obtaining some funds for the development of the MEDIAS database.

Some new research activities, to be performed in the framework of MEDIAS, were proposed and discussed during the meeting. The Steering Committee decided to resubmit to the next RCMMed&BS 2014 the proposal for a study "Inter-calibration exercise of the MEDIAS research vessels", taking into account the importance of such study for the entire MEDIAS group.

Due to the Commission's decision to postpone the DCF 2011-2013 also to the period 2014-2016, the surveyed area of MEDIAS was not enlarged to the GSAs 9 and 10. The Steering Committee decided to reiterate its proposal to include in the new DCF the acoustic surveys in the Tyrrhenian and Ligurian seas (GSAs 9 and 10).

The development of the MEDIAS website has been discussed by the MEDIAS group. Marco Barra, from CNR-IAMC, presented the updated structure of the MEDIAS website (http://www.medias-project.eu). It was also proposed to use the website for selecting the MEDIAS logo. To this aim, different images were proposed for the logo and all the participants were invited to choose the preferred logo through the website.

Concerning the MEDIAS HANDBOOK, the MEDIAS group has been working on it, updating some subjects according to what was agreed during the meeting. An updated copy has been included in this report (Annex IV). It was confirmed that this handbook, as well as the MEDIAS website, will be updated and improved according to the outcomes and changes developed by the MEDIAS partners on an annual basis.

The MEDIAS Steering Committee approved the Terms of Reference for "MEDIAS 2015".

Finally, the Steering Committee concluded for the 8th MEDIAS meeting to take place in Sète, France, in the period 24-27 March 2015.

Annex I: List of participants

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Annex II: Institutions Acronyms

IEO: Instituto Español de Oceanografía, Spain

HCMR: Hellenic Center of Marine Research, Greece

IFREMER: Institut Français de Recherche pour l'exploitation de la Mer, France

IAMC-CNR: Istituto per l'Ambiente Marino Costiero. Consiglio Nazionale delle Ricerche. Sicily, Italy

ISMAR-CNR: Istituto di Scienze Marine. Consiglio Nazionale delle Ricerche. Ancona, Italy

MSDEC-DFA: Ministry for Sustainable Development, the Environment and Climate Change - Department of Fisheries and Aquaculture. Marsa, Malta

FRIS: Fisheries Research Institute of Slovenia. Ljubljana, Slovenia

IOF: Institute of Oceanography and Fisheries. Split, Croatia.

INRH: Institut National de recherche halieutique. Morocco.

METU, IMS: Middle East Technical University, Institute of Marine Sciences. Turkey

Annex III: Agenda of the 7th MEDIAS Coordination Meeting

(Mediterranean International Acoustic surveys)

Iraklion, Crete, Greece 8-11/04/2014

Agenda

Tuesday 8/04/2014

09.00-09.30:   Opening of the meeting & welcome. Adoption of the agenda.

09.30-09.45:   Presentation of the Adriatic survey (Iole Leonori, Andrea De Felice).

09.45-10.00:   Presentation of the Gulf of Lions survey (Jean-Louis Bigot, Claire Saraux).

10.00-10.15:   Presentation of the Iberian survey (Magdalena Iglesias, Ana Ventero).

10.15-10.30:   Presentation of Aegean survey (Marianna Giannoulaki, Athanassios Machias).

10.30-10.45:   Presentation of Morocco survey (Salaheddine El Ayoubi).

10.45-11.00:   Presentation of Croatian survey (Danijela Bogner).

11.00-11.30:   Coffee break

11.30-11.45:   Presentation of Turkish Acoustic Surveys (Ali Cemal Gucu).

11.45-12.00:   Presentation of the Echosurveys in GSAs 15 and 16 (Angelo Bonanno, Gualtiero Basilone).

12.00-13.00:   General discussion

13:00-14:30:   Lunch break

14.30-15.30:   General Discussion, suggestions on 2014 surveys. Discussion on the potential of the joint meeting with ICES WGACEGG on November 2014.

15.30-16.00:   MEDIAS website design: presentation, comments, suggestions, approval. (Marco Barra).

16:00-16:30:   Coffee break

16.30-17.30:   Plan for future activity on the realization of the MEDIAS database on the basis of the RCMMED&BS 2013 meeting (Andrea De Felice, Rocco De Marco).

Wednesday 9/04/2014

09:00-16.00:   Workshop on the standardization of the allocation of trawl catches on acoustic data.

11.00-11.30:   Coffee break

13:00-14:30:   Lunch break

16:00-16:30:   Coffee break

16.30-17.30:   General discussion and revision of the common MEDIAS protocol.

Thursday 10/04/2014

09:00-13.00:   Workshop on the CV with different procedures

13:00-14:30:   Lunch break

14.30-16.00:   Workshop on acoustic data analysis and update of the common workflow suggested by Toby Jarvis last year.

16:00-16:30:   Coffee break

16.30-17.30:   Proposal of new research activities in the framework of MEDIAS.

Friday 11/04/2014

09.00-10.00:   General discussion and revision of the common MEDIAS protocol.
10.00-11.00:   Discussion on proposals for common studies and manuscripts.

11:00-11:30:   Coffee break

11:30-12:30:   Terms of reference for the next meeting (2015).
12.30-13.00:   Adoption of the report.

Annex IV - MEDIAS HANDBOOK

Common protocol for the Pan-MEditerranean Acoustic Survey (MEDIAS)

The geographical areas that will be covered by the MEDIAS surveys and the respective days at sea per survey are presented in the following Table 1 and Figure 1.

Table 1.- The size of the geographical area that is covered by each Institute in the Mediterranean Sea and in the Black Sea. (Note that it should be updated on an annual basis). **Day night sampling.

Country	Institute	Geographical area	Size of area	Duration of survey (days)
Greece	HCMR	Aegean Sea	9000 NM^2	40
Greece	HCMR	eastern Ionian Sea	2800 NM^2	30
France	IFREMER	Gulf of Lions	3300 NM^2	30
Slovenia	FRIS	Adriatic Sea (Slovenia)	117 NM^2	1**
Italy	CNR-ISMAR	Adriatic Sea (Italy)	13200 NM^2	40**
Italy - Malta	CNR- IAMC/FCD-MRRA	Sicily Channel	2700 NM^2	16
Spain	IEO	Iberian coast	8829 NM^2	33
Croatia	IOF	Adriatic Sea (Croatia)	13578 NM^2	30
Bulgaria	Institute of Oceanology – BAS	Black Sea	3400 NM^2	20
Romania	NIMRD "Grigore Antipa"	Black Sea	4300 NM^2	20
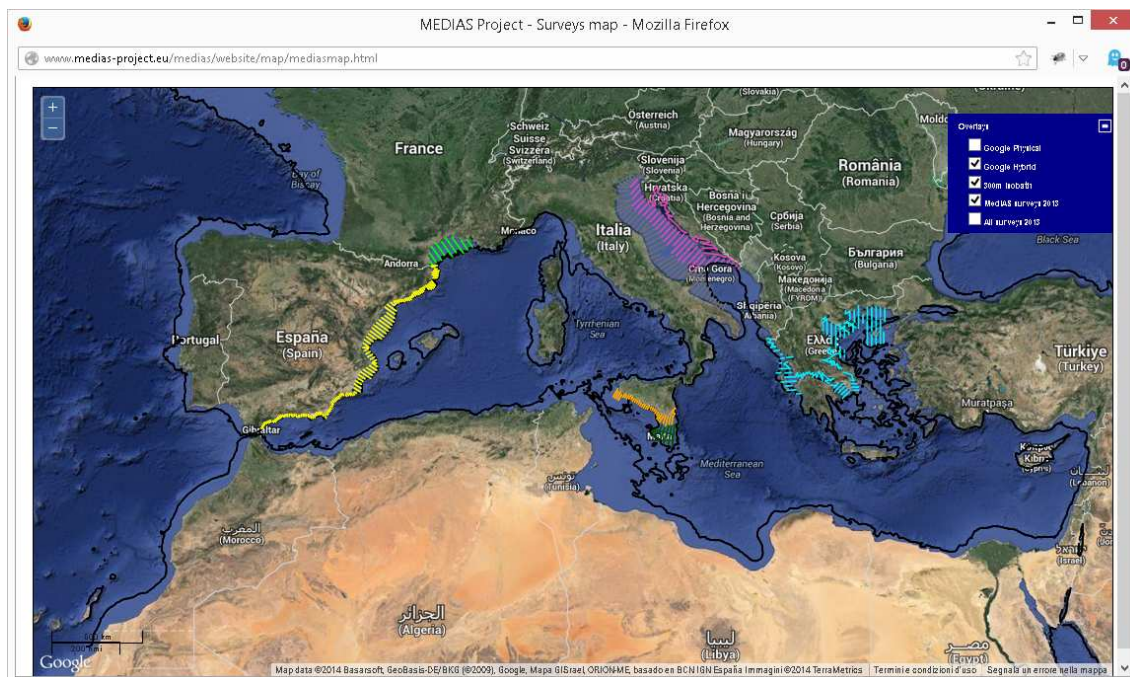
1. Survey Identity

In the report of the DCF each Institute should report, the geographical area, the size of the area covered, the days at sea, as well as the period and dates in which the survey took place. In addition the follow vessel characteristics should be reported: Name of vessel, vessel length and vessel HP.

2. Echo sounder parameters

A variety of equipment with specific characteristics could be considered as adequate for the assessment of small pelagic. A split beam echo–sounder should be used for the echo–sampling. The angle beam, Athwart Beam Angle (in degrees), Along Beam Angle, and Ping rate of the echo–sounder should be reported. The frequency for assessment should be the 38 kHz, while the 120 and/or 200 kHz can operate as complementary frequencies, depending on the research vessel used.

The pulse duration should be 0.5 or 1 ms depending on the technical specifications of each echosounder and it should be reported. The threshold for assessment should be -70 to -60 depending on the survey and the ecosystem and should be reported. As the main objective is the optimum discrimination between fish and plankton,, the background noise should be removed and in a next step based on the available frequencies used in each survey, a frequency response based mask should be developed to split the acoustic backscattering between fish and plankton. Whenever

this cannot apply, the threshold for assessment should be set at -70 to -60 dB, depending a) on noise level (-60 dB in case of high noise); b) the peculiarities of each area regarding school morphology and plankton density (-60 when plankton is dense, but -70 dB when small schools dominate the area); c) echo-sounder features; d) time of day that echo acquisition is carried out.

The ping rate should be set as fast as possible depending on depth, in order to assure good echo discrimination. At least one calibration of echo-sounder should be held per survey based on the procedure described in the manual of each echosounder and according to the principles described by Foote *et al.* (1987). The calibration parameters and the results of the acoustic equipment should be reported by survey according to the following Table.

Table 2. Calibration report

Calibration report	
Frequency (kHz)	
Echosounder type	
Transducer serial no.	
Vessel	
Date	
Place	
Latitude	
Longitude	
Bottom depth (m)	
Temperature (^{o}C) at sphere depth	
Salinity (psu) at sphere depth	
Speed of sound (ms^{-1})	
TS of sphere (dB)	
Pulse duration (s)	
Equivalent 2-way beam angle (dB)	
Default TS transducer gain	
Iteration no.	
Time	
Range to sphere (m)	
Ping rate	
Calibrated TS transducer gain	
Time (GMT)	
RMS	
sA correction	

3. Survey Design

The survey design for the acoustic sampling should take into account the characteristics of the spatial structures of small pelagic fish in each area as well as the peculiarities in the topography of each area. Transects should be run perpendicular to the greatest gradients in fish density, which is often related to gradients in bottom topography, meaning that transects will normally run perpendicular to the coastline/bathymetry. Inter-transect distance should be adjusted to achieve the minimization of the coefficient of variation of the acoustic estimates for the target species in each area but also take into account survey duration. In cases that topography is complex like in the case of semi-closed gulfs transect design could be decided otherwise. The survey design in each area should be reported. Based on some preliminary studies of the spatial structure characteristics of small pelagics in the Mediterranean Sea (WKACUGEO 2010; MEDIAS 2011) the inter-transect distance should not exceed 12 NM

Specifically, within certain common workshops that were held in the framework of the AcousMed project and past MEDIAS meetings, the existing survey design at different areas has been reviewed along with area peculiarities (e.g. size of the area, topography, survey duration). In the framework of these workshops, geostatistical analysis was applied on historical acoustic data under a common protocol and different survey designs were evaluated towards optimization, taking into account the spatial characteristics of small pelagic fish aggregations, The optimum inter-transect distance in each area has been identified and proposed. The results have been adopted at the 5th MEDIAS coordination meeting. However, in order to achieve the optimization of the survey design in each area, a workshop with this specific Terms of Reference should be regularly held within the framework of the MEDIAS annual meetings.

Vessel speed during acoustic sampling should be adjusted depending on vessel noise as set by the ICES-WGFAST (WGFAST 2006). The working group agreed that vessel speed of 8-10 knots is adequate for a split beam echo sounder of 38 kHz. At higher speeds, problems might be encountered with engine noise or propeller cavitations.

It was strongly recommended that if species identification depends on the recognition of schools based on the echograms, the survey will have to take place only during daytime, being interrupted during periods in the 24-hour cycle when the schools disperse. Otherwise, if available survey time does not permit this, echo sampling might be extended. In this case, echo allocation into species will not be based on school shape identification and justification should be given in the report that this does not affect the accuracy of the estimations. In the framework of the AcousMed project appropriate acoustic data from daytime and nighttime have been analyzed in order to determine the degree of error. Results indicated that night estimates can be higher or lower compared to daytime estimates largely depending on the area characteristics

and especially the local plankton and fish densities. However, results showed that correction is possible and it is advisable when night sampling is inevitable.

Transects should be extended as close to the coast as possible in order to cover adequately the spatial distribution of sardine. The minimum distance from the shore largely depends on the size of the research vessel used. In any case, the Distance of acoustic sampling from the coast in respect to the Bottom depth should always cover the 20 m isobath or less, reaching the 10 m isobath whenever this is possible. In each case the minimum bottom depth of each survey should be reported. The maximum echo-sounding depth should be 200 m and the minimum echo-sounding depth should be reported as it depends on the draught of the research vessel.

The Elementary Distance Sampling Unit (EDSU) for echo integration should be 1 nautical mile (NM), excluding "bad data". The acoustic energy in the inter-transect tracks will not be taken into account for assessment purposes. The working group concluded that the target species of the survey will be anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*).

The echo partitioning into species should be based on echogram visual scrutinisation. This will be done either by direct allocation based on the identification of individual schools and/or allocation on account of representative fishing stations.

Target Strength (TS) equations: In the Mediterranean Sea, different species specific TS equations are currently applied depending on the area. The application of common TS equations should ideally derive from *in situ* estimations of TS, preferably based on acoustic data from the Mediterranean Sea. For this purpose specific workshops were held in the framework of AcousMed project as well as DCF and MEDIAS coordination meetings but largely based on the analysis of available historical data. Based on these results, the 5th MEDIAS coordination meeting agreed to apply for sardine the following TS-TL equation this point forward:

$$TS = 20\log(TL) - 72.6 \text{ dB}$$

Where TS=Target Strength, TL=Total Length. The coordination meeting also agreed that IFREMER should continue to use a b_{20}=-71.2 dB in the Gulf of Lions, for compatibility reasons to the long time-series available, as well as because the available data analyzed from the area of Gulf of Lions were very limited.

Analysis results concerning anchovy indicated large differences between areas. For this purpose MEDIAS partners concluded that further analysis using more data from all areas is needed and agreed not to propose a single TS equation and b20 value for anchovy. It was suggested that the work regarding anchovy TS should continue within the framework of specific MEDIAS workshops, using available data from additional areas, such as Croatia. Thus it was agreed that for the time being, the historical Target

Strength equations for anchovy will be maintained in each area and the applied TS equation should be reported.

Acoustic data processing for the assessment of the target species, Myriax Echoview or alternative Movies + software should be used for acoustic data analysis and the estimation of abundance. For compatibility reasons, raw data should be available into a common *.hac file format. Due to the large file size raw data will be stored within the responsibility of each Institute. The common *hac format will be also available for the requirements of the Data Collection Framework (DCF) upon request.

4. Workflow for acoustic data processing

During the 6th MEDIAS meeting the Steering Committee agreed on a common workflow for acoustic data processing, which is structured in the following four steps:

a. Load and view data
   The acoustic data acquired by echosounder during the survey are loaded in a software environment for visual exploration in terms of echograms and maps.

b. Calibrate
   The results of calibration procedure, carried out on board the vessel, are installed in order to convert the raw acoustic data into absolute backscattering measurements. Such step includes also the installation of correct settings of transducers position referred to GPS antenna.

c. Remove background noise
   Before analysing the acoustic data any ambient noise present in the underwater environment has to be removed.

d. Detect and filter
   The step includes the use of grid, lines, regions and mathematical operators for excluding from the collected acoustic data any backscattering signal not linked to the presence of fish and/or plankton. Specific aspects are:
   Intermittent noise removal
      Evaluate possible interferences that may produce artefacts in the echograms, and adopt a procedure for removing them;
   Surface and seafloor exclusions
      Use lines for correctly separating the backscattering signals from surface and bottom.
   Single targets estimation
      In case of organisms scattered in the water column, typical of nighttimes data acquisition, adopt the necessary procedure for separating fishes from planktonic organisms.

Schools estimation

Use regions and/or mathematical operators for estimating backscattering signal due to fish aggregations.

5. Abundance indices

The following abundance indices should be estimated and reported in the DCF within the framework of MEDIAS:

The Total fish NASC per EDSU, as well as Point maps of total fish NASC should be available.

The target species of MEDIAS for assessment purposes will be anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*). The abundance indices estimated by all MEDIAS parties provided in the DCF report should include both NASC and Biomass estimations, for the whole area. Specifically, for the two target species abundance estimates provided in the report are: NASC/EDSU; Biomass/EDSU; Number of fish/EDSU; Number/age and per length class; Biomass/age and per length class. Point maps of anchovy and sardine in NASC/mile; biomass/mile should also be available. In addition, abundance indices could be given for all pelagic species in the community which are important in each area.

The catch compositions of the hauls: pie-charts indicating biomass per species.

6. Fish sampling

According to the standard methodology followed in acoustics, species allocation of the acoustic records is impossible if trawl information is not available. Fish sampling is required to collect representative samples of the fish population in order to identify echoes. The main objectives of trawling in an acoustic survey are a) to obtain a sample from the school or the layer that appears as an echo trace on the sounder for echo trace identification and allocation into species and b) to get biological information and evaluation of the size distribution of each species. Therefore, the trawling gear used is of no importance as long as it is suitable to catch a representative sample of the target-school or layer. In the framework of the AcousMed project available past data from different areas in the Mediterranean were analysed based on a common protocol. Results showed no significant differences between day and night sampling. The coordination meeting based on these results concluded that samples collected during both day and night in the same survey could be merged and used for the necessary estimations.

In addition, the sampling intensity of the hauls cannot be pre-determined because of the objectives of the acoustic survey *per se*. The sampling intensity in an acoustic survey depends on the size of the area covered, the frequency of occurrence of

different echo traces on the sounder screen and the spatial characteristics of fish aggregations. In addition, the geographical coordinates or the sampling depth of the hauls cannot be pre-determined because pelagic species execute extended horizontal and vertical movements. Schools morphometry and energetic characteristics might change depending on the area, the time period or even the fishing pressure. Therefore, the sampling strategy has to be adaptive depending on the school characteristics per area, time period and year.

Taking into account within a common protocol, the different research vessels used and the peculiarities of each area the following points have been agreed:

- A pelagic trawl will be used in all areas for biological sampling.

- Maximum codend mesh size should be equal to 24 mm (side of mesh equal to 12 mm). The codend and the trawl characteristics used in each area will be reported.

- The vertical opening of the pelagic hauls along with the netsounder used should be reported.

- The duration of hauls should be no less than 30 min for unknown echoes and when multi-species scattered echoes are being fished.

- Vessel speed during fishing should be 3.5–4.5 knots.

- It is widely accepted that in the framework of an acoustic survey a standard total number of hauls cannot be set because this depends on the fish distribution and abundance found in each survey. However, in any case the haul number must be adequate in order to a) ensure identification of echo traces; b) obtain a representative length structure of the population for each target species; c) obtain species composition and biological samples.

Target species of the MEDIAS surveys are anchovy and sardine, but biological data for all species in the pelagic community regarding Length frequency distribution and Length-Weight relationships should also be acquired.

7. **Biological and oceanographic parameters.**

The following biological parameters should be estimated in each survey.

The Length frequency distribution (0.5 cm) should be estimated from a representative sample for each fish species per haul. Total length will be measured for all species. The Length– Weight relationship for all pelagic species will be estimated and reported. The

size of each sample should be set at minimum the one described in the respective protocol of the Data Collection Framework (DCF).

For the two target species, anchovy and sardine, the mean Total Length at age should be estimated, as well as the Age-Length-Key used for the conversion of abundance indices to abundance-at-age. Data should be provided according to the DCF instructions.

Since the environmental parameters are very important for small pelagic fish, a minimum of 3 CTD stations should be held per transect or a grid of stations with density adequate to describe the oceanography of the surveyed area. Temperature and salinity are the hydographic parameters that should be measured in the entire water column at each station.

Furthermore, the need for a common database has been concluded. The need for collaboration with the respective surveys in the Atlantic region (e.g. Bay of Biscay) has also been discussed and agreed. In the framework of this collaboration, information and experience will be exchanged.

8. Data Base

In the framework of the AcousMed project as well as a MEDIAS workshop, a common database design has been concluded for all MEDIAS surveys (See ANNEX B). The 6th MEDIAS coordination meeting agreed to use this data base framework to store acoustic and biological data collected within the acoustic surveys in the Mediterranean Sea.

9. Tables

The data and the common format of the Tables that will regularly be provided to the DCF are the following:

TABLE 1

COUNTRY	AREA	YEAR	NAME_OF_SURVEY	SPECIES	SEX	LENGTH_CLASS	NUMBER	BIOMASS(Kg)
				ANE				
				ANE				
				PIL				
				PIL				
				PIL				

TABLE 2

COUNTRY	AREA	YEAR	NAME_OF_SURVEY	SPECIES	SEX	AGE_CLASS	NUMBER	BIOMASS (Kg)
				ANE		0		
				ANE		1		
				ANE		2		
				ANE		3		
				ANE		4		
				PIL		0		
				PIL		1		
				PIL		2		
				PIL		3		
				PIL		4		

TABLE 3

COUNTRY	AREA	YEAR_PERIOD	SPECIES	SEX	LENGTH_CLASS	PRM	METHOD_USED
			PIL	F	0		
			PIL	F	0.5		
			PIL	F	1		
			PIL	F	1.5		
			PIL	F	2		
			…	…	….		
			PIL	M	0		
			PIL	F	0.5		
			PIL	F	1		
			PIL	F	1.5		
			PIL	F	2		
			ANE	F	0		
			ANE	F	0.5		
			ANE	F	1		
			ANE	F	1.5		
			…		….		
			ANE	M	0		
			ANE	F	0.5		
			ANE	F	1		
			ANE	F	1.5		

Summary of the common protocol for the Pan-MEDIterranean Acoustic Survey (MEDIAS).

Survey Identity	
Geographic area	Should be reported
GSA area	Should be reported
Size of Area to be covered (NM^2 / km^2)	Should be reported
Days at sea	Should be reported
Vessel	Should be reported
Vessel length	Should be reported
Vessel HP	Should be reported
Period of survey	Should be reported
Echo sounder parameters	
Echo sounder	Split beam
Frequency for assessment (kHz)	38
Complementary frequencies (kHz)	70, 120, 200 depending on availability.
Pulse duration (ms)	0.5 or 1 ms, should be reported
Beam Angles (degrees) Athw. Beam Angle, Alog. Beam Angle	Should be reported
Ping rate	Maximum depending on depth
Calibration (No per survey)	A calibration report should be given One calibration per survey
Threshold for acquisition (dB)	-80
Threshold for assessment (dB)	-70 to -60 (reported)
Survey design	
Transects design	Perpendicular to the coastline/bathymetry, otherwise depending on topography The survey design according to the MEDIAS conclusion for each area and should be reported.
Inter-transect distance (NM)	Max <=12 NM. The inter-transect distance should be according to the MEDIAS conclusion for each area and should be reported
Time of day for acoustic sampling	Day time. Otherwise, in cases of time limitation and if echo allocation into species does not depend on school

	shape identification (in this case justification of the accuracy of results will be presented)
EDSU (nm)	1 NM
Distance from the coast according to the Bottom depth (min, m)	At least 20 m bottom depth, minimum 10 m of echo-sampling.
Echo sounding depth (min, m)	Depending on the draught of RV. Should be reported
Echo sounding depth (max, m) recording.	200 m
Vessel speed	8-10 knots
Software for analysis	Movies and/or Echoview
File format	*.hac
Inter - transect	Acoustic energy in the inter-transect track will not be taken into account
Applied TS (dB)	Sardine: -72.6 db, See also hand book Other species: Keep historical TS equations.
Echo partitioning into species	Echo trace classification based on echogram visual scrutinisation • Direct allocation and • allocation on account of representative fishing station
Abundance estimates	
Abundance indices estimated	ν Total fish NASC per EDSU ν Anchovy, Sardine NASC per EDSU ν Anchovy, Sardine Biomass per EDSU ν Anchovy, Sardine Numbers per EDSU ν Anchovy, Sardine Number/age and per length class ν Anchovy, Sardine Biomass/age and per length class
Maps and charts	ν Point maps of total fish NASC ν Point maps of target species in NASC/mile; biomass / mile. ν Catch compositions of the hauls, pies charts indicating biomass per species
Fish sampling	
Target species	Anchovy, Sardine
Other species	Biological data for all species in the pelagic

	community: Length-Weight relationships; Length distribution.
Fishing gear, codend mesh size	Pelagic trawl, Codend and trawl characteristics should be reported. Max Codend mesh size = 24 mm (side of mesh = 12 mm).
Vertical opening of the pelagic trawl	Should be reported
Netsounder used	Should be reported
Duration of haul	Minimum 30 min for unknown echoes
Time of sampling	Both daytime and night time biological samples from the same survey will be used.
Vessel speed during fishing	3.5 – 4.5 knots
Sampling intensity, no of hauls	The total number of hauls has to be adequate to - ensure identification of echo traces - obtain length structure of the population - obtain species composition - get biological samples
Biological and oceanographic parameters	
Length	All species: Total length (TL), Length frequency distribution (0.5 cm)
Age readings, ALK	Sardine, Anchovy: Mean TL at age Sample sizes according to the new DCR.
Length - Weight	All pelagic species
Oceanographic. Parameter (CTD)	Minimum 3 CTD per transect or grid of stations with density adequate to describe the oceanography of the surveyed area. Minimum variables: T, S

The Common Database structure for Acoustics adopted in the 5th MEDIAS meeting.

The major fields agreed are associated to:

1. input information related to export data from acoustic software (Figs. B2 & B3),

2. input information related to biological sampling and environmental data sampling (Figs. B4 & B5)

3. queries-calculations to fulfill DCF requirements (Fig. B6)

4. queries-calculations to facilitate abundance/biomass estimates (Fig. B6)

5. echosounder calibration report (Fig. B7)

6. data input validation and control checks

7. up to date demands related to surveys and the Ecosystem Approach to Fisheries (Figs. B5 & B6)

Acoustic Data

Echo sounder parameters
Type of echo sounder
Frequency for assessment (kHz)
Complementary frequencies (kHz)
Pulse duration (ms)
Beam Angles (degrees) Athwartship Beam Angle Alongship Beam Angle
Threshold for acquisition (dB)
Threshold for assessment (dB)

Survey design
Transects design
Inter-transect distance (NM)
Time of day for acoustic sampling
EDSU (nm)
Distance from the coast according to the Bottom depth (min, m)
Vessel speed
Software for analysis
Applied TS (dB)   etc...

Processed acoustic data
Latitude, longitude per EDSU
Transect Nº
NASC fish per EDSU
Target species NASC per EDSU
Target species biomass per EDSU
Target species numbers per EDSU etc…

Survey Identity
Geographic area
GSA area
Size of Area to be covered (NM² / km²)
Size of Area effectively covered (NM² / km²)
Vessel (Horse power, noise level, draft)
N° of hauls
N° of CTDs
Total number of EDSU processed
Dates of survey

CTD data
Latitude, longitude
Station
CTD temperature profiles
CTD fluorescence profiles
CTD salinity profiles
Continuous profilers
Data visualization (maps)

Satellite data
Latitude, longitude
Satellite variables per EDSU
Data visualization (maps)
Grid resolution
Data source
Sensor/ model

Environmental Data

Output

Trawl description
Trawl code
Codend mesh size
Net design - figures
Breastlines length
Headrope & footrope length
Net monitoring system

Haul general information
Position
Date
Hour (start, end)
Duration
Average fishing speed
Net horizontal & vertical opening
Net position in the water column (start, end) etc…

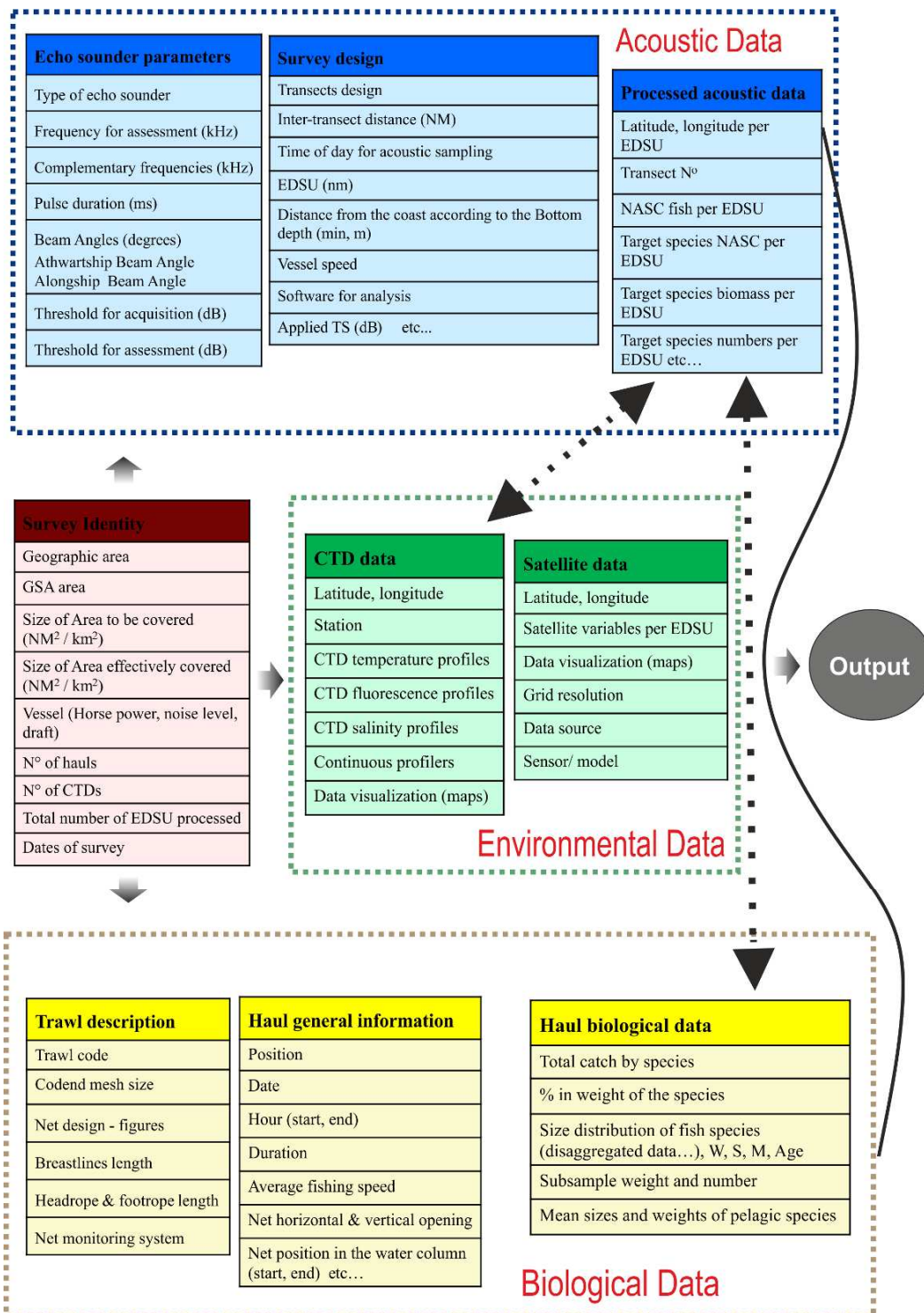| Haul biological data |
| --- |
| Total catch by species |
| % in weight of the species |
| Size distribution of fish species (disaggregated data…), W, S, M, Age |
| Subsample weight and number |
| Mean sizes and weights of pelagic species |

Biological Data

Figure B1. General outline of a database for acoustic surveys.

Analytical info per database field are presented below.

Survey Identity
Geographic area
GSA area
Size of Area to be covered (NM² / km²)
Size of Area effectively covered (NM² / km²)
Vessel (Horse power, noise level, draft)
N° of hauls
N° of CTDs
Total number of EDSU processed
Dates of survey

Figure B2. Fields associated with the typical input info about the survey

Figure B3. Fields associated with input info on Acoustic Data

Specific routines that are useful for a database dealing with acoustic survey data are outlined below:

1. Sub-area creation: query that allows the selection of a sub-area along with the underlined acoustic data (i.e. referring to whole transects or parts of transects) and the respective hauls based on certain criteria (e.g. depth, etc.), possibly through a GIS software that will be linked to the database
2. Calculation of NASC average values and standard error in a sub-area

3. Merge haul information in a sub-area: calculation of the mean size by species and the percentage in terms of weight and number of the species composition

4. Biomass estimation per species in a sub-area: using the average NASC value per species and composition information from hauls otherwise through direct allocation of NASC to species.

Trawl description	Haul general information	Haul biological data
Trawl code	Position	Total catch by species (or group of species for cephalopods, crustaceans, demersal fish)
Codend mesh size	Date	% in weight of the species (or group of species for cephalopods, crustaceans, demersal fish) => link to GIS software
Net design - figures	Hour (start, end)	
Breastlines length	Duration	Size distribution of fish species (disaggregated data…), W, S, M, Age
Headrope & footrope length	Average fishing speed	Subsample weight and number
Net monitoring system	Net position in the water column (start, end)	Mean sizes and weights of pelagic species
	Net horizontal opening	
	Net vertical opening	**Biological Data**
	Bottom depth (start, end)	

Figure B4. Fields associated with input info on Biological Data related to acoustic surveys

CTD data	Satellite data
Latitude, longitude	Latitude, longitude
Station	Satellite variables per EDSU
CTD temperature profiles	Data visualization (maps)
CTD fluorescence profiles	Grid resolution
CTD salinity profiles	Data source
Continuous profilers	Sensor/ model
Data visualization (maps)	

Environmental Data

Figure B5. Fields associated with input info on Environmental Data related to acoustic surveys
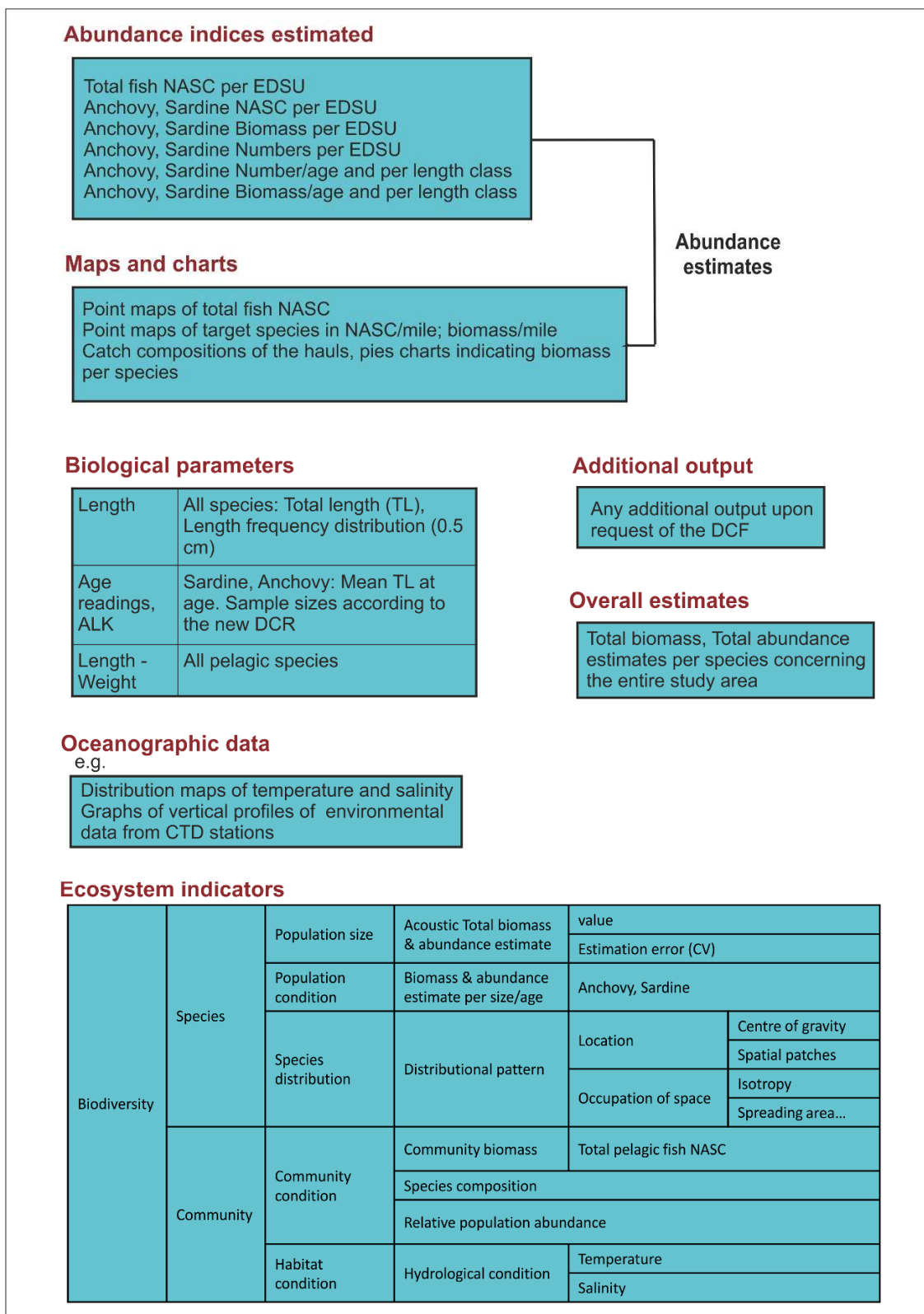
Abundance indices estimated

Total fish NASC per EDSU
Anchovy, Sardine NASC per EDSU
Anchovy, Sardine Biomass per EDSU
Anchovy, Sardine Numbers per EDSU
Anchovy, Sardine Number/age and per length class
Anchovy, Sardine Biomass/age and per length class

Abundance estimates

Maps and charts

Point maps of total fish NASC
Point maps of target species in NASC/mile; biomass/mile
Catch compositions of the hauls, pies charts indicating biomass per species

Biological parameters

Length	All species: Total length (TL), Length frequency distribution (0.5 cm)
Age readings, ALK	Sardine, Anchovy: Mean TL at age. Sample sizes according to the new DCR
Length - Weight	All pelagic species

Additional output

Any additional output upon request of the DCF

Overall estimates

Total biomass, Total abundance estimates per species concerning the entire study area

Oceanographic data

e.g.

Distribution maps of temperature and salinity
Graphs of vertical profiles of environmental data from CTD stations

Ecosystem indicators

Biodiversity	Species	Population size	Acoustic Total biomass & abundance estimate	value	
				Estimation error (CV)	
		Population condition	Biomass & abundance estimate per size/age	Anchovy, Sardine	
		Species distribution	Distributional pattern	Location	Centre of gravity
					Spatial patches
				Occupation of space	Isotropy
					Spreading area...
	Community	Community condition	Community biomass	Total pelagic fish NASC	
			Species composition		
			Relative population abundance		
		Habitat condition	Hydrological condition	Temperature	
				Salinity	

Figure B6. Fields associated with potential acoustic database output.

Calibration report

Frequency (kHz)	*	Speed of sound (ms^{-1})	*	
Echosounder type	*	TS of sphere (dB)	*	
Transducer serial no.	*	Pulse duration (s)	*	
Vessel	C	Equivalent 2-way beam angle (dB)	*	
Date	*	Default Sv transducer gain	*	
Place	C	Iteration no.	C	
Latitude	C	Time	*	
Longitude	C	Range to sphere (m)	*	
Bottom depth (m)	C	Ping rate	C	
Temperature (ºC) at sphere depth	C	Calibrated Sv transducer gain	*	
Salinity (psu) at sphere depth	C	Time (GMT)	*	

*.- Data you can find in the EK60 report sheet.

Figure B7. Database Fields related to electro-acoustic calibration report.