Report of 12th meeting for MEDiterranean International Acoustic Surveys (MEDIAS)

in the framework of European Data Collection Framework (DCF)

Athens, Greece, 9-11 April 2019

Steering Committee Report

Contents

Introduction

The MEDIAS (MEDiterranean International Acoustic Surveys) Steering Committee met in Athens, Greece, on 9-11 April 2019, hosted by HCMR and chaired by Andrea De Felice from CNR-IRBIM. Meeting participants were representatives from the European Union countries involved in acoustic surveys in the Mediterranean Sea (i.e. Spain, Croatia, Italy, Greece and France) and in the Black Sea (i.e. Romania, Bulgaria, Turkey) (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 2018;
b) to coordinate the MEDIAS surveys to be performed in 2019;
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 2019 and to establish the ToRs for 2020.

The agenda of the 12th MEDIAS Coordination Meeting (see ANNEX III) was adopted by the participants. Following the agenda, during the first day results from the 2018 MEDIAS acoustic surveys, carried out by the MEDIAS partners (Fig. 1), were presented, as well as results from the survey carried out by Romania, Bulgaria and Turkey in the Black Sea.

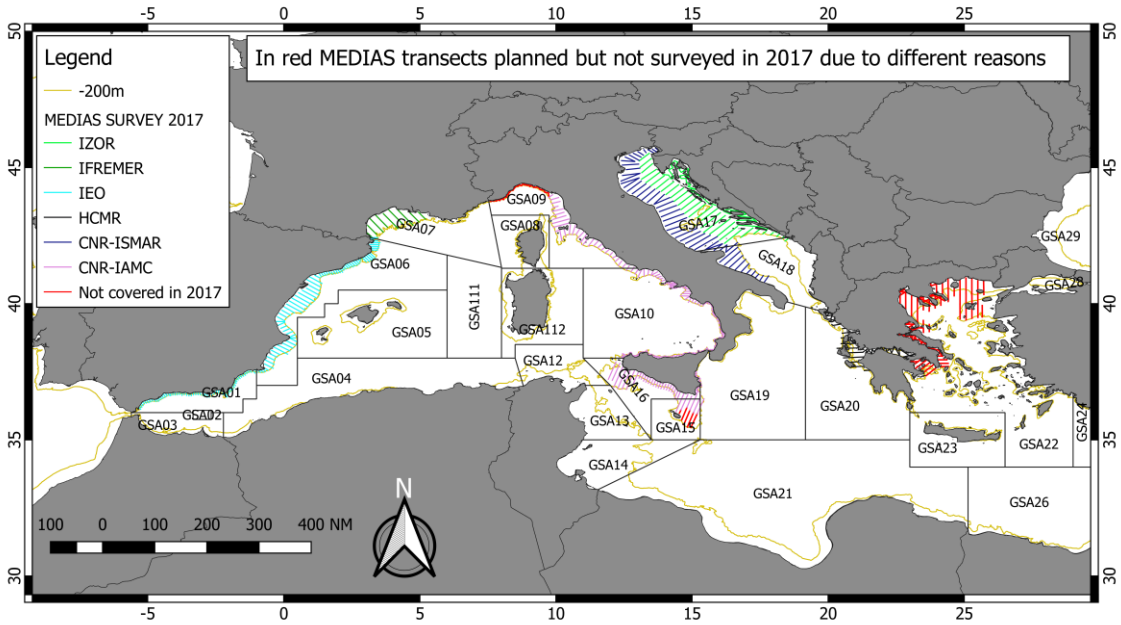


Figure 1: Acoustic surveys in MEDIAS framework in 2017

Other matters of discussion were related to the revision of UE DST tables to be used for surveys evaluation in specific JRC EWG meetings, and the progress on R scripts useful for biomass estimation and for relative the CV estimation. During the second day of the meeting Dr. Andrea De Felice reported briefly the content of some presentations held at WG ACEGG 2018, during the Joint session with MEDIAS, that were of interest for the group. After that there was an extensive

discussion on the possible contributions to the Special Issue dedicated to MEDIAS surveys in "Mediterranean Marine Science" journal foreseen for 2020.
During the third day, the revision of the common MEDIAS protocol and an update of the MEDIAS handbook were carried out. There was also a discussion on otolith reading related issues. Finally, after the election of a new Chairman for next three years, the Terms of Reference (ToRs) for the next year (2020) were defined together with dates and venue for 2020 MEDIAS Coordination Meeting.

Results of the surveys carried out in 2018 in the framework of the Mediterranean International Acoustic Surveys (MEDIAS)

a) Italian Acoustic survey in Adriatic Sea - MEDIAS in the western part of GSA 17 and GSA 18
(Iole Leonori, Andrea De Felice, Ilaria Biagiotti, Giovanni Canduci, Ilaria Costantini, Sara Malavolti)

The 2018 acoustic survey was carried out in June-July in western part of GSA 17 and GSA 18 including territorial waters of Slovenia (Dr. Tomaz Modic took part in the cruise in Slovenian waters). Acoustic data were logged over a grid of systematic parallel transects perpendicular to coastline/bathymetry. Inter-transect distance was 8-10 nmi. Acoustic monitoring was done during daytime (6:00 am – 7:00 pm). Scientific echosounder: Simrad EK60 equipped with 38 and 200 kHz and EK80 with 70 and 120 kHz split beam transducers hull-mounted. The research vessel was "G. Dallaporta" (built 2001, 35.30 m, 285 GT, 1100 CV). Vessel speed during acoustic survey was 9.5 knots. The acoustic system was calibrated in July 2018 using the standard sphere method (Foote et al., 1987; Demer et al., 2015). Elementary Sampling Distance Unit (EDSU) was 1 nmi, minimum bottom depth 10 m, pulse duration 1 ms for all frequencies and ping rate was set to maximum.

Table A1. Calibration results in 2018

Frequency	Beam Angles (deg)	Athw. Beam Angles (deg)	Athw. Offset Beam Angles (deg)	Along. Beam Angles (deg)	Along. Offset Beam Angles (deg)	Trasducer Gain (dB)	Sa Correction (dB)	RMS (dB)
38 kHz	7	7.09	-0.05	7.02	0.05	25.22	0.0401	0.1190
70 kHz	7	6.89	-0.06	6.81	0.12	25.37	-0.0825	0.1666
120 kHz	7	6.19	-0.08	6.16	-0.06	26.14	0.2069	0.1848
200 kHz	7	5.64	-0.02	6.06	0.01	26.01	-0.0512	0.4658

In the western part of GSA 17 total nautical miles effectively used for acoustic analysis (minus pelagic trawls tracks and linking transects) were 1085 for a total area of 10636 nmi^2, in western part of GSA 18 total nautical miles effectively used for acoustic data elaboration were 261 for a total area of 2510 nmi^2. Total area extension was about 13200 square nautical miles in the western part of Adriatic Sea.

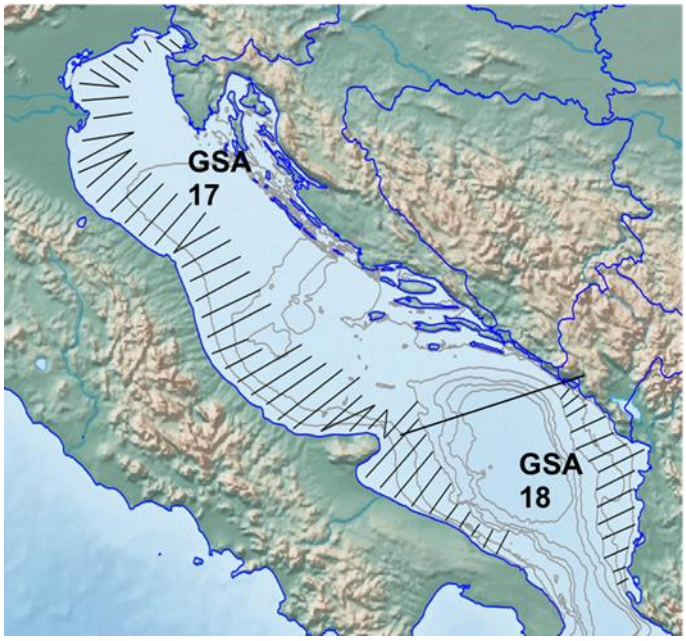


Figure A1. Acoustic survey route plan in western part of GSA 17 and GSA 18

In detail, the MEDIAS acoustic survey in western part of GSA 17 was conducted in June-July 2018; the coverage of the area was 100%, 35 pelagic trawls were conducted, 81 CTD stations were made and in 45 stations out of them plankton sampling by means of WP2 net (mesh size 200 µm) was carried out.

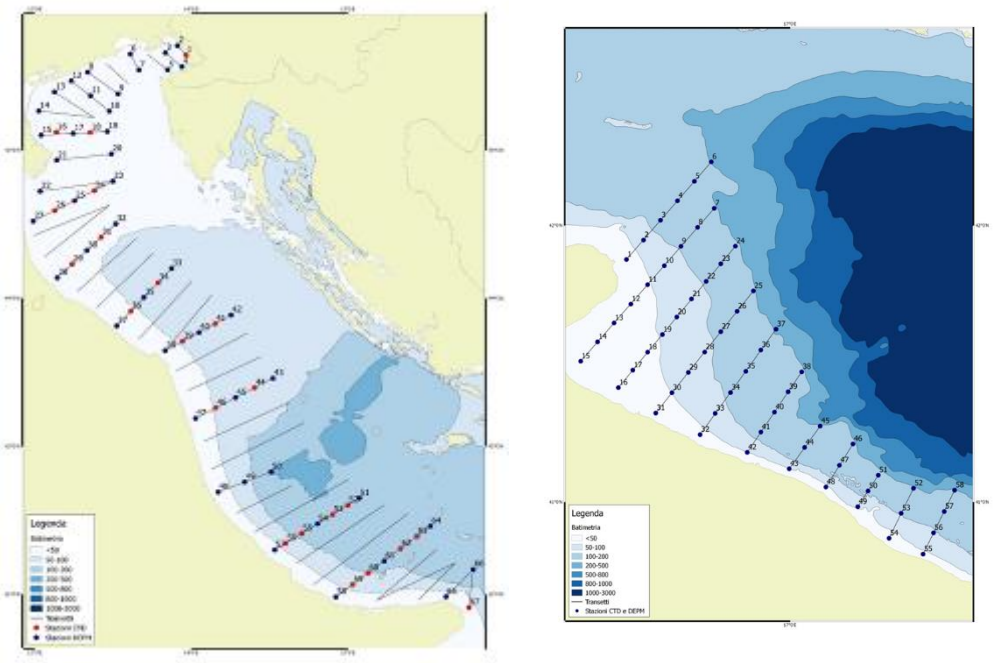


Figure A2. Acoustic survey route plan in western GSA 17 and western GSA 18. The positions of prefixed stations of CTD & plankton sampling are shown (in blue CTD&plankton stations, in red only CTD stations)

The MEDIAS acoustic survey in western part of GSA 18 was carried out in July 2018; area coverage was 100%, 11 pelagic trawls were conducted and 58 ichthyoplankton stations to apply Daily Egg Production Method were made, combining CTD and plankton net sampling. MEDIAS extension in eastern part of GSA 18 could not be covered in July 2018 for the small amount of days of ship availability last year.

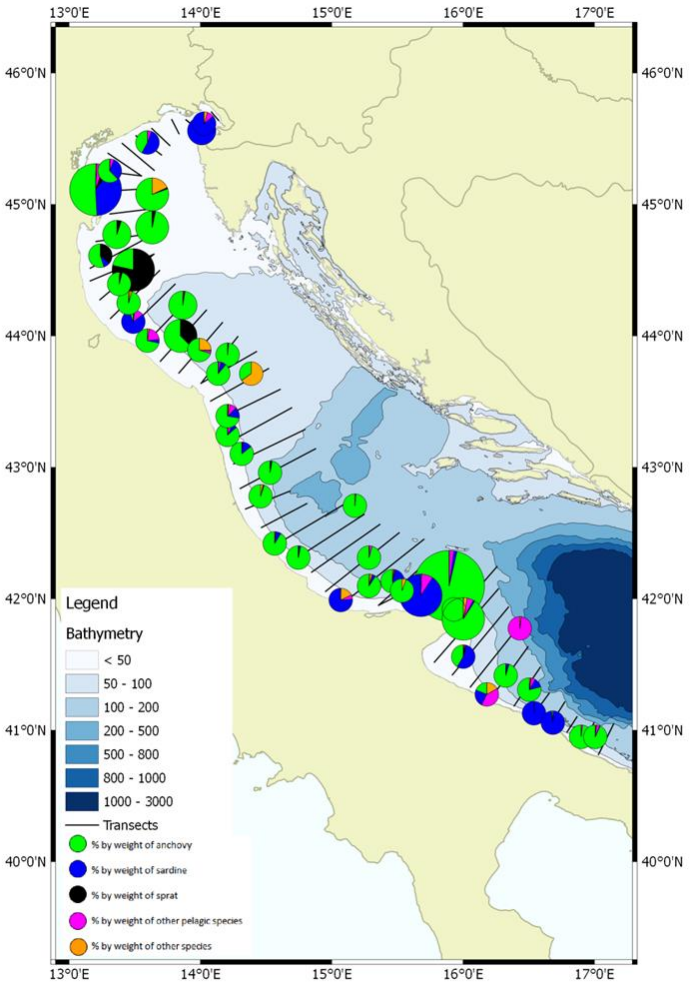


Figure A3. Acoustic survey route plan in western GSA 17 and western GSA 18. The catch composition of net samplings carried out in 2018 are reported. Size of pie charts is proportional to total catch

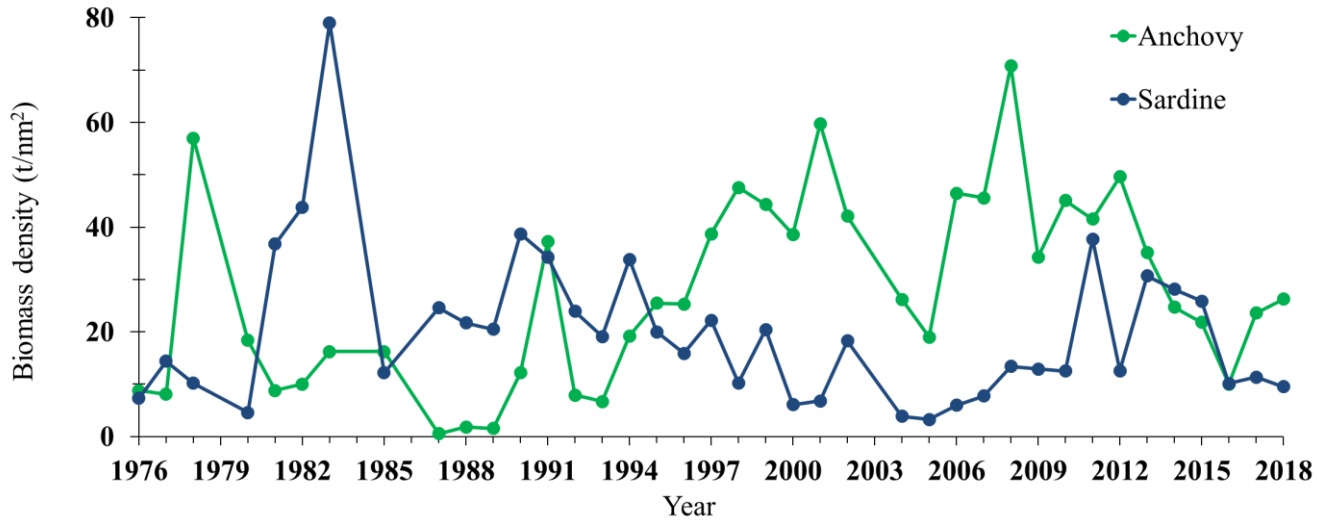


Figure A4. Trends of anchovy and sardine in western part of GSA 17

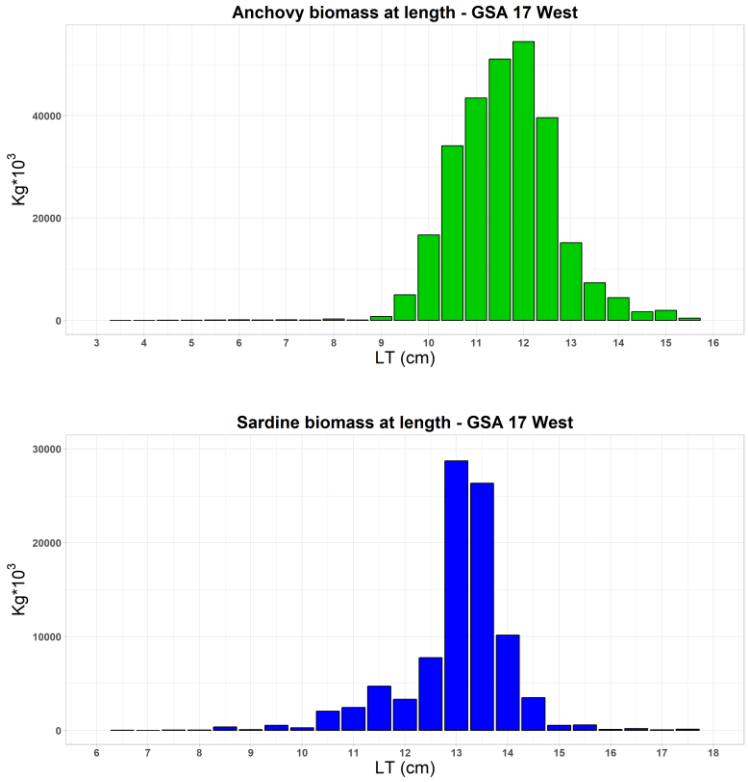


Figure A5. Anchovy and sardine biomass per length class in western part of GSA 17 in June-July 2018

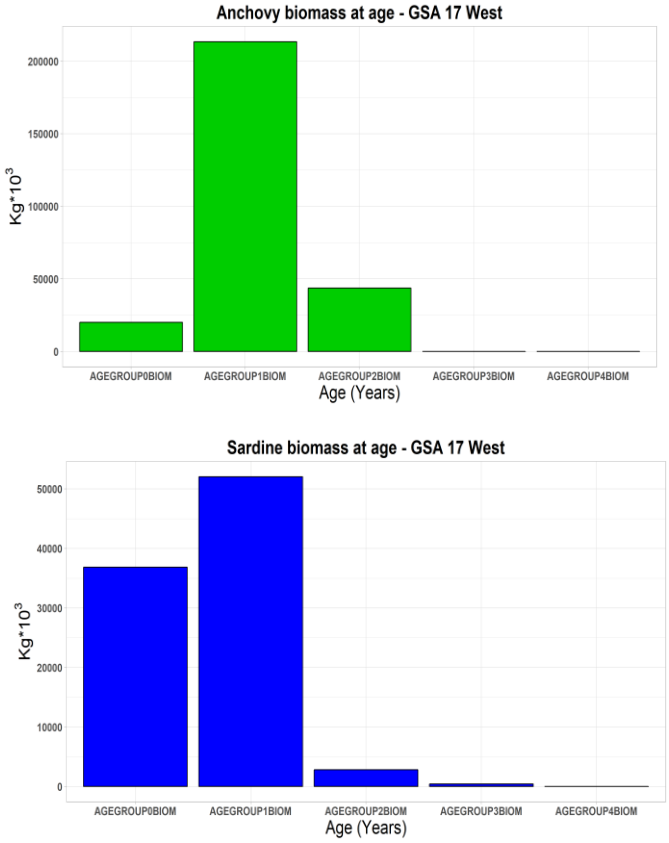


Figure A6. Anchovy and sardine biomass per age group in western part of GSA 17 in June-July 2018

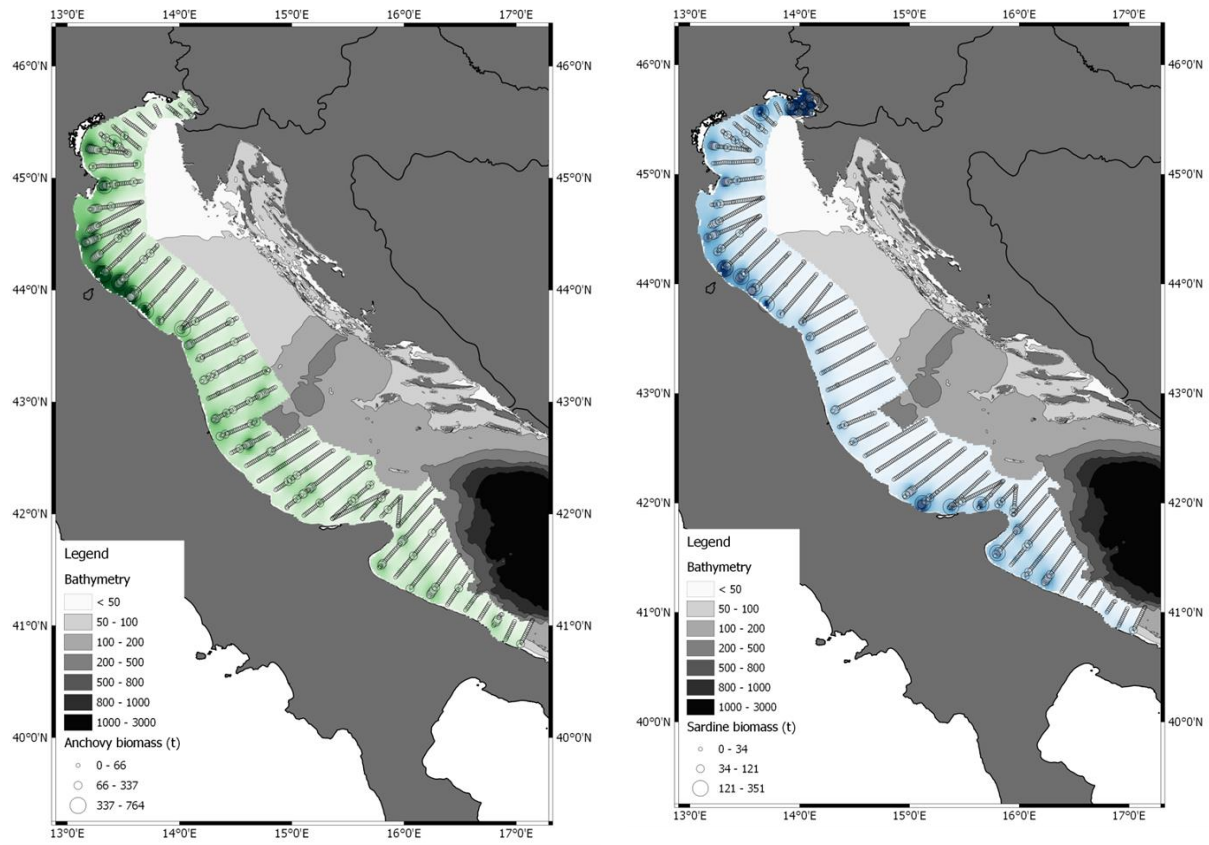


Figure A7. Anchovy and sardine spatial distribution in western part of the Adriatic Sea in June-July 2018

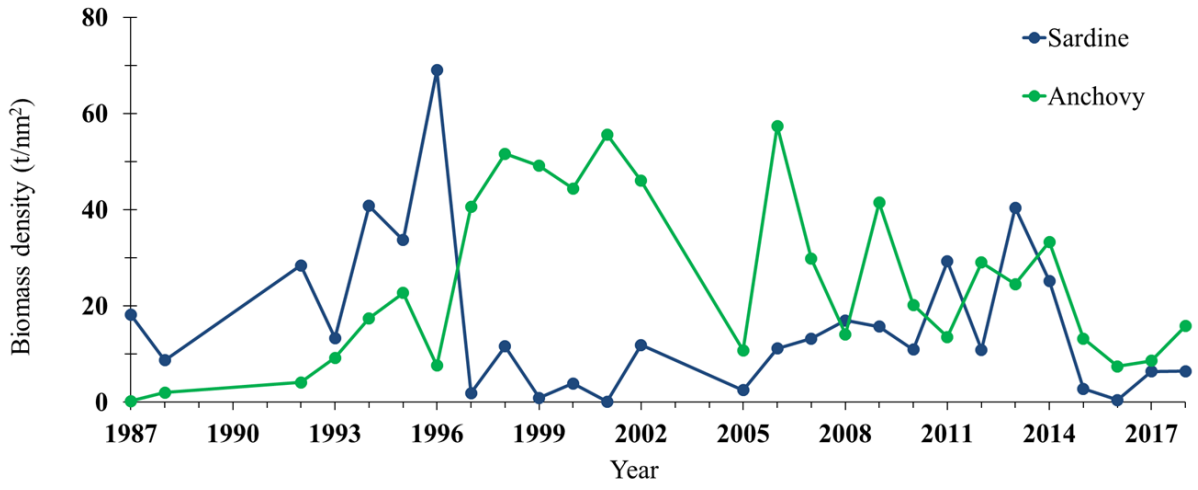


Figure A8. Trends of anchovy and sardine in western part of GSA 18

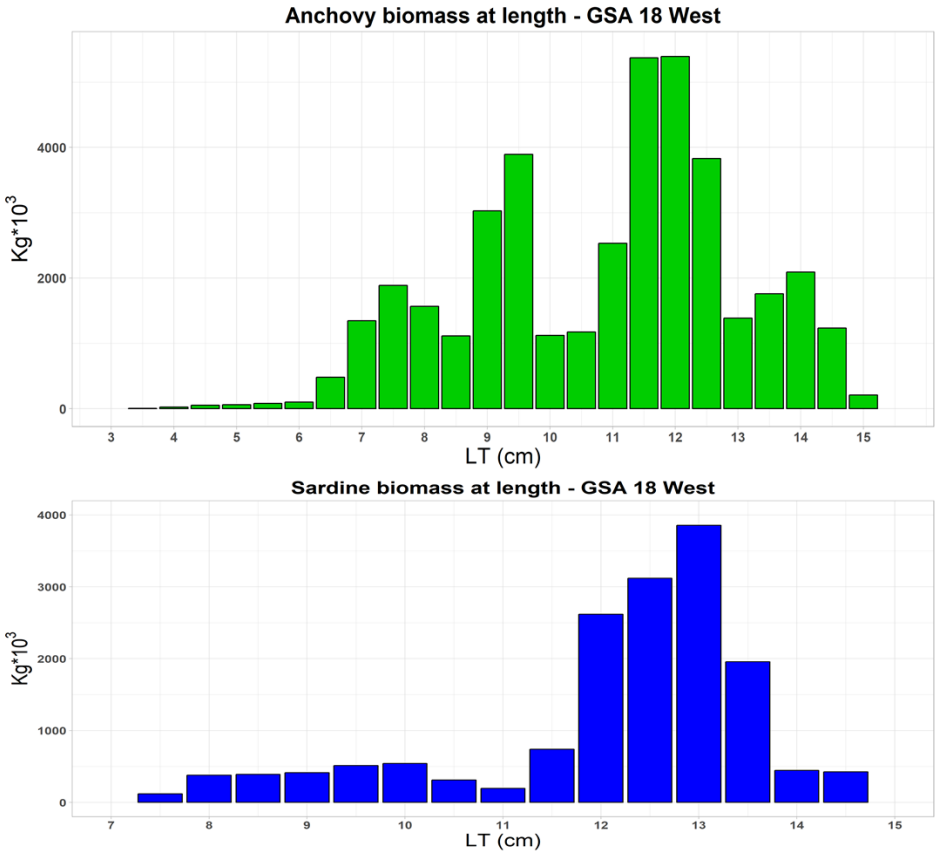


Figure A9. Anchovy and sardine biomass per length class in western part of GSA 18 in June-July 2018

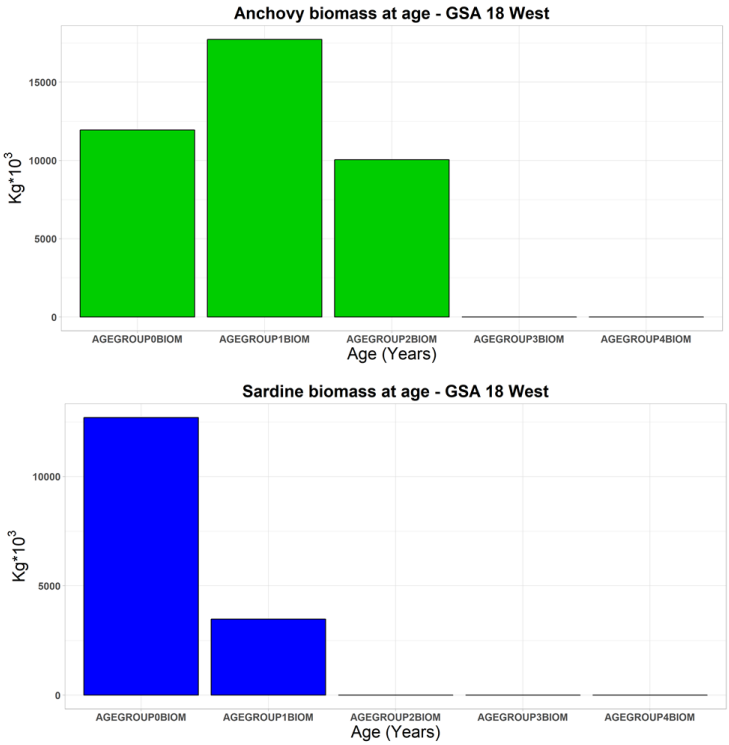


Figure A10. Anchovy and sardine biomass per age group in western part of GSA 18 in June-July 2018

In the last period, biomass estimations of anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*) stocks in western Adriatic Sea saw severe decreases both in GSA 17 in 2016 and in GSA 18 in 2015. While anchovy in west GSA 17 in 2017-18 presents an increase up to 2014-15 levels, sardine remains at rather low biomass values as in 2016 and in the years before 2011. In western GSA 18 after the decrease of 2016 for both species, anchovy registers an evident increase especially in 2018, while sardine biomass remain low since 2015 even if a slight increase is recorded in 2017-18.

Spatial distribution of anchovy and sardine in western Adriatic Sea in 2018 was mainly coastal, especially for sardine, with higher values in the northern area for both species.

b) **Adriatic survey in the eastern part of GSA17** (Vjekoslav Tičina, Grbec Branka, Dadić Vlado, Pallaoro Armin, Bogner Danijela, Pikelj Kristina, Matić Frano, Muslim Stipe, Gašparević Denis, Juretić Tea, Jelavić Dalibor, Vučić Ivan)

Since 2013, the 6th acoustic survey in eastern part of the Adriatic Sea (GSA 17) have been carried out by Croatia within EU-Data Collection Framework (DCF), as a part of international Pan European Mediterranean acoustic surveys (MEDIAS). Acoustic survey carried out in the period 29 Aug. – 23 Sept. 2018 successfully covered 100% of total area of eastern part of GSA 17 that need to be covered within Croatian DCF (>13,500 nm^2); in total, 26 working days of R/V "BIOS DVA" were used for this purpose. Since 2017, no single person has been formally nominated as national responsible scientist for MEDIAS in Croatia, as it was before. Different problems in MEDIAS related to logistic constraints (personnel, technical and financial), as reported last year, still exist.

Acoustic sampling have been carried out along transects in Croatian territorial waters, as well as within Croatian protected ecological-fishery zone (Fig.1.). In total, acoustic data were collected in 1438 EDSU. Fish sampling has been attempted 61 times, obtaining 50 hauls with fish sampled (Fig 2). Oceanographic properties of survey area during survey period were described based on 88 CTD stations. Data collection during acoustic survey has been done in accordance to the MEDIAS Handbook (March, 2017).

Based on survey data collected and analysed, survey indices for anchovy indicate increase in abundance, biomass and body condition in August-September 2018 compared to August-September 2017 in eastern part of GSA17. However, the recruitment index has been the lowest since 2013. Biomass structured by age consist of two categories only – 0 and 1. Anchovy from Age group 1 were dominant; as well as in 2017. Spatial distribution of anchovy in 2018 indicated very low abundance in the area along western Istrian coast where unusual occurrence of ctenophora *Mnemiopsis leidyi* has been observed for two consecutive years.

In the same time, according to results obtained for sardine, abundance, biomass and body condition indices indicated significant increase in August-September 2018 compared to August-September 2017 in the eastern part of GSA17. Biomass by age was distributed within

three age groups (0, 1 and 2), and the highest portion in biomass consisted of fish from Age group 0. However, recruitment index in 2018 was lower than recruitment in 2017 (scarce presence of small fish). Most of fish detected by survey were adults (i.e. 12 cm or larger), and consequently sardine SSB present in the eastern part of GSA 17 in September 2018 indicated significant increase in comparison to sardine SSB in September 2017.

Spatial distributions (GIS analyses) of anchovy and sardine stock within study area (Fig. 3 and 4), as well as recruitment index (Fig. 5) and size structured abundances of anchovy and sardine populations on eastern part of GSA17 in September 2018 (Fig.6) were presented.

In general, results of acoustic survey, as obtained from the eastern part of GSA17 during September 2018, give us a perception of significant increase in overall biomass of target species (anchovy & sardine).

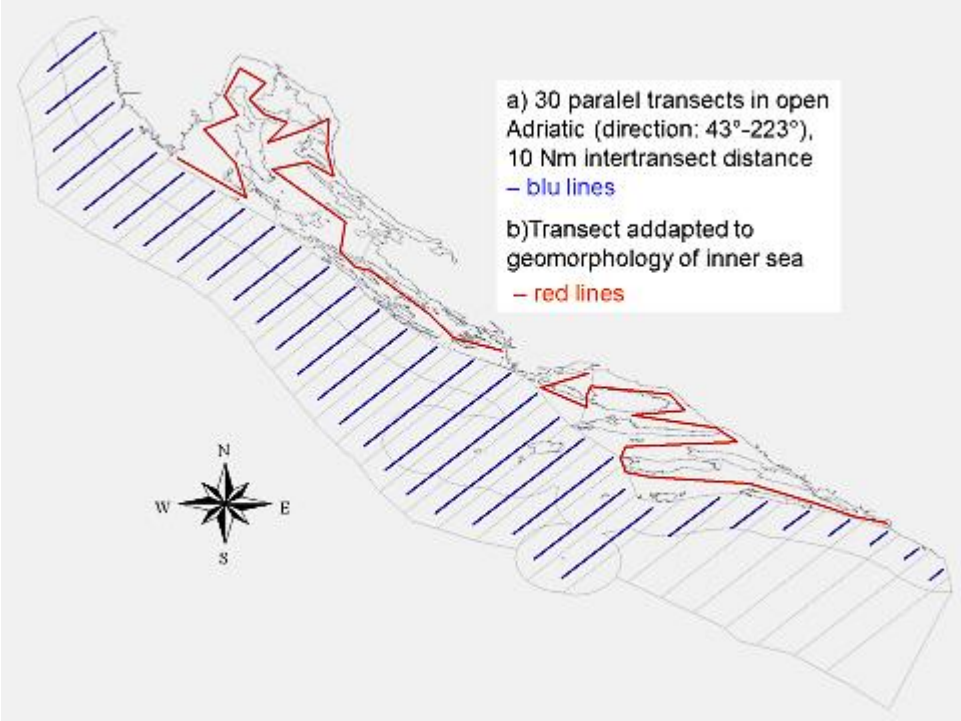


Figure B1. Survey design of acoustic transects in the eastern part of GSA 17.

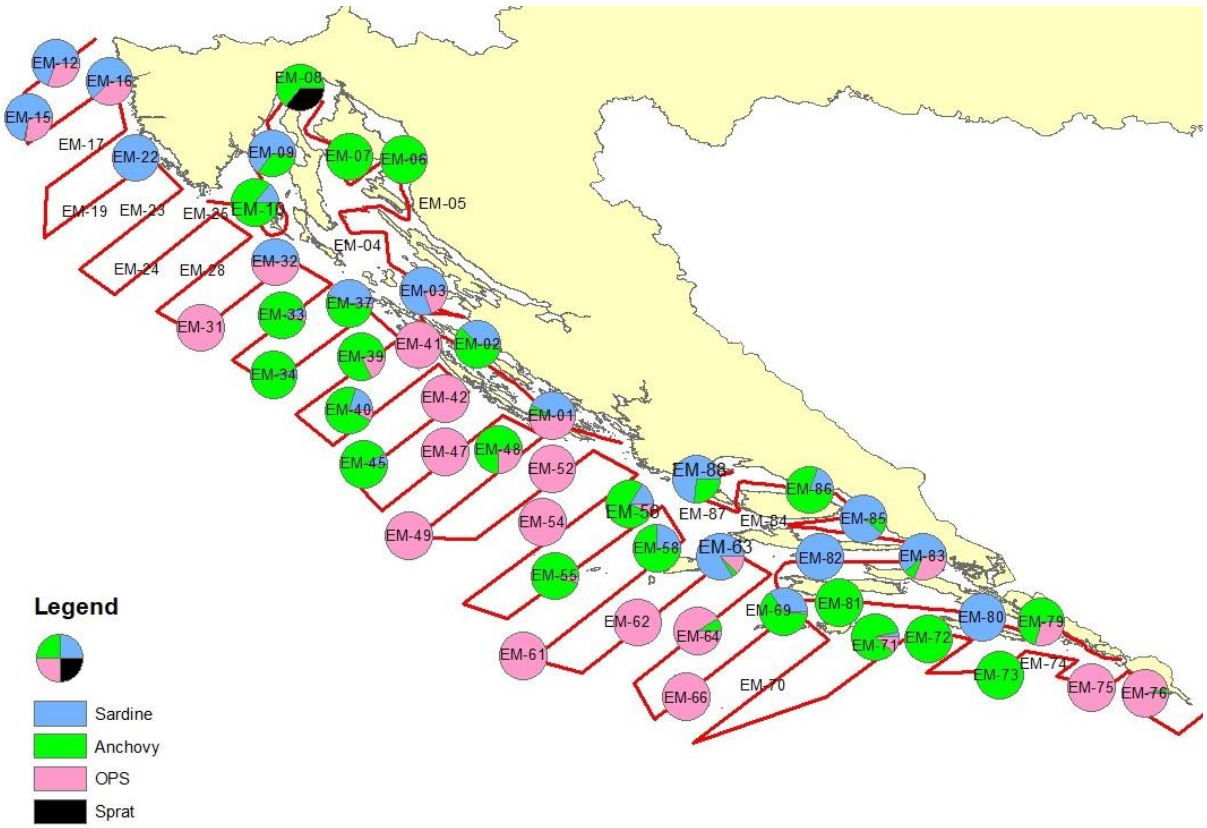


Figure B2. Compositions of pelagic fish assemblages in the eastern part of GSA 17 in September 2018.

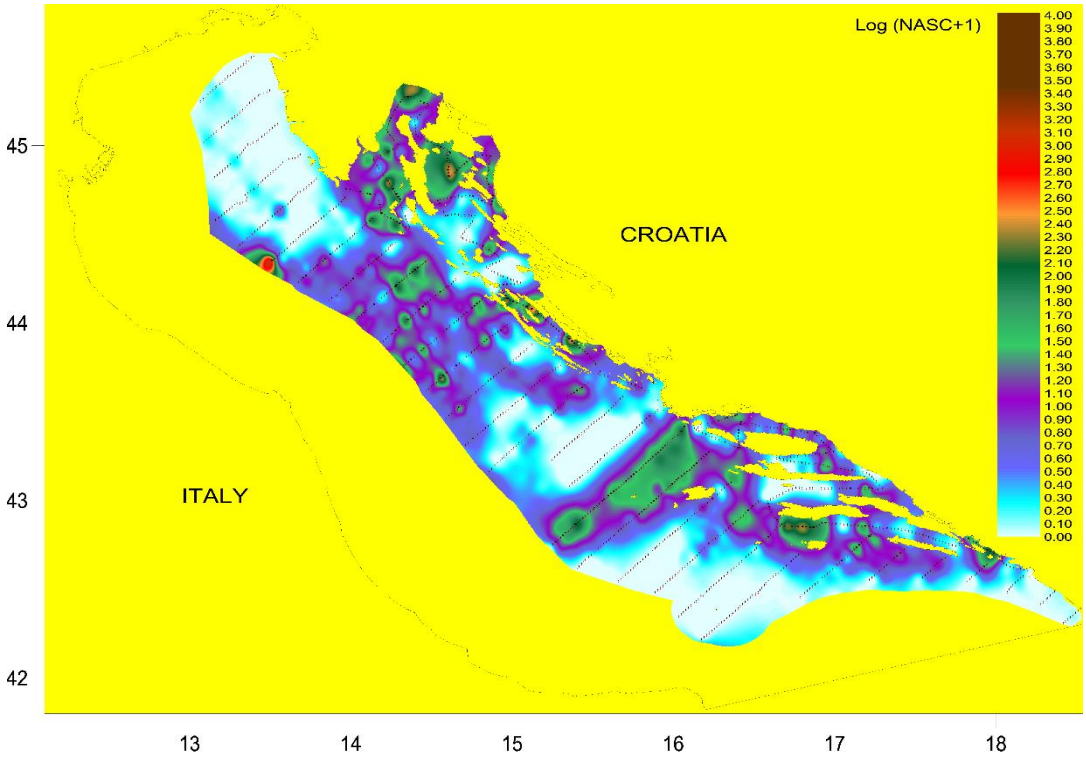


Figure B3. Spatial distribution (GIS analyses) of anchovy within survey area (September, 2018).

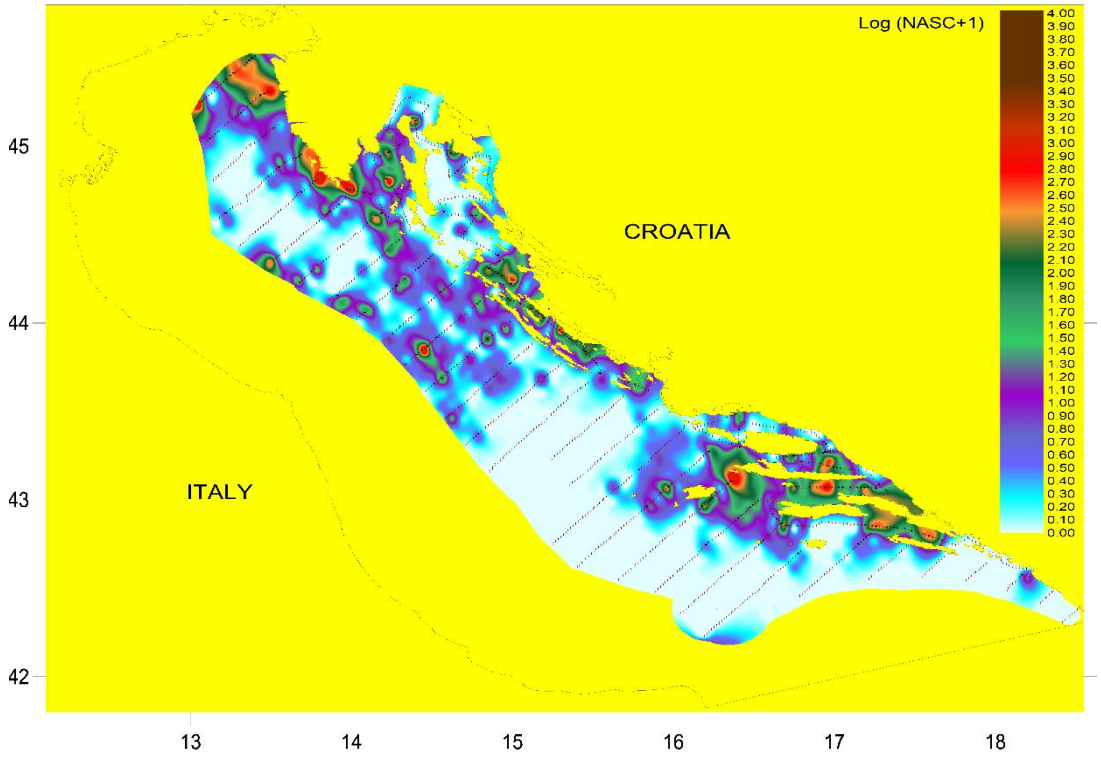


Figure B4. Spatial distribution (GIS analyses) of sardine within survey area (September, 2018).

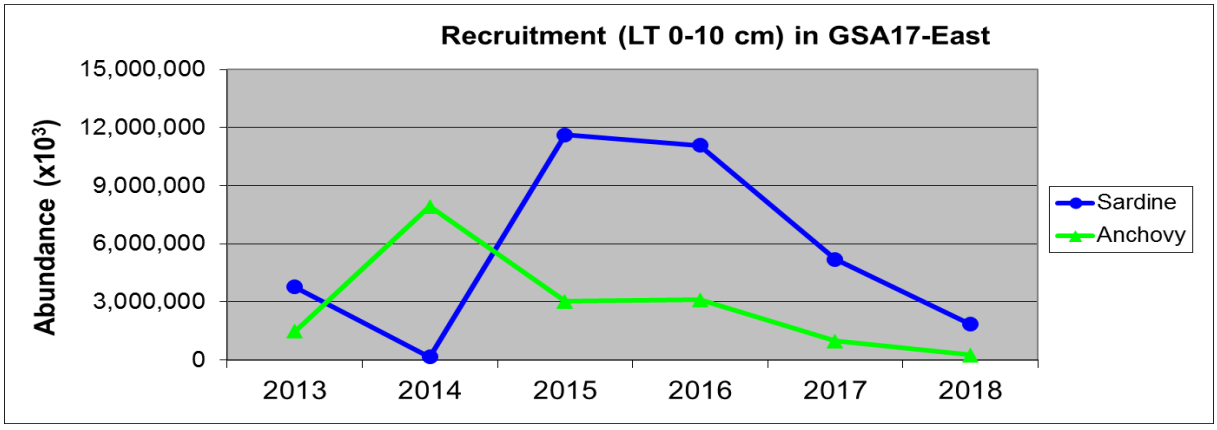


Figure B5. Recruitment indices as obtained by acoustic surveys from the eastern part of GSA17 (survey period: September).

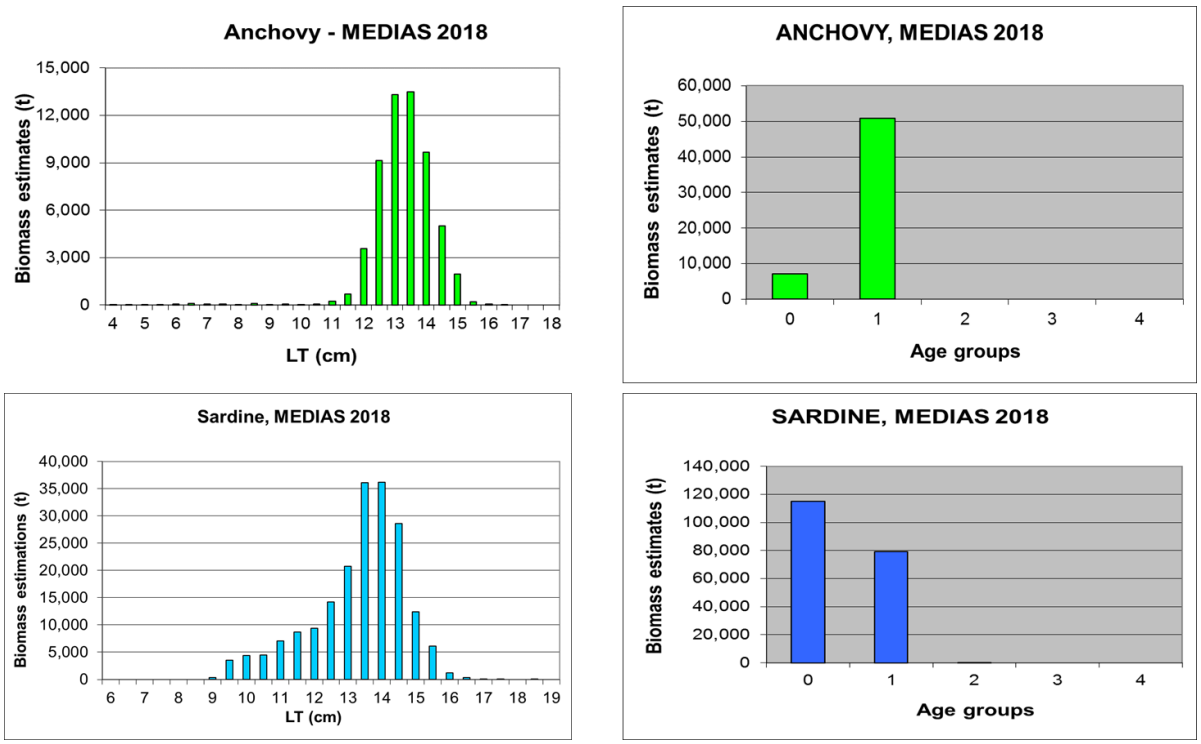


Figure B6. Size and age structured biomass estimates of anchovy and sardine in September 2018 (GSA17-eastern part).

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

The acoustic survey was carried out in the period 29 July – 08 August 2018 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 2018 are presented. In order to obtain a more complete picture on the spatial distribution of the two species on the continental shelf in south of Sicily, the survey covered also of the continental shelf in the western part of GSA 19 and part of the continental shelf in the GSA 15. This latter part of the survey was carried out in the framework of the CALYPSO-South Project, funded by the Italy-Malta Interreg Program.

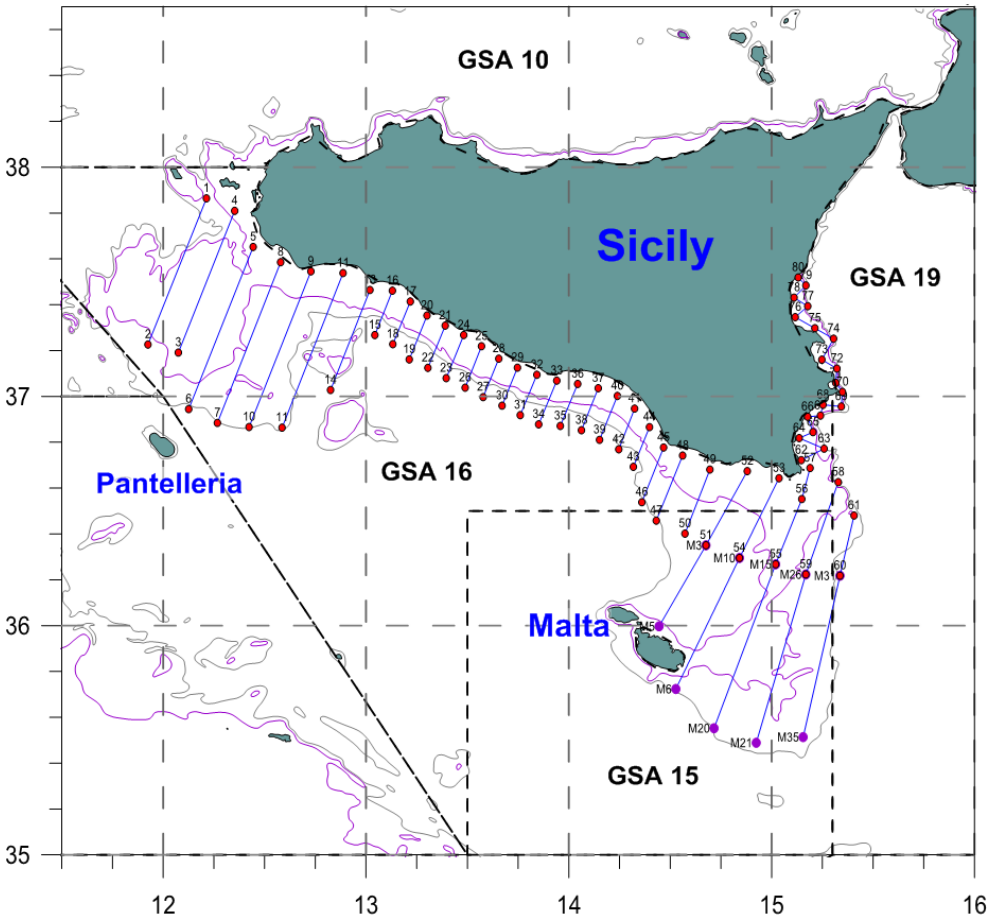


Figure C1. Acoustic survey design in summer 2018.

The total biomass of anchovy stock was 4568.1 t in the GSA 16 (surveyed area of 3462 nm^2) and 1286.3 t in the western Ionian waters (surveyed area of 127.8 nm^2). The spatial distribution showed that anchovy was mainly concentrated in the central part of the study area in the Strait of Sicily and in the western Ionian Sea. The age structure, while confirming the typical presence of age classes 1 and 2, highlighted lower percentage of age 0 and age 3 specimens.

In the case of sardine population, the biomass in 2018 was 5229.9 t in GSA 16 and 928.6 t in the western Ionian Sea. The distribution of biomass among age classes showed a breakdown of the population in two age classes (0 and 1) with higher percentage of age 1 specimens.

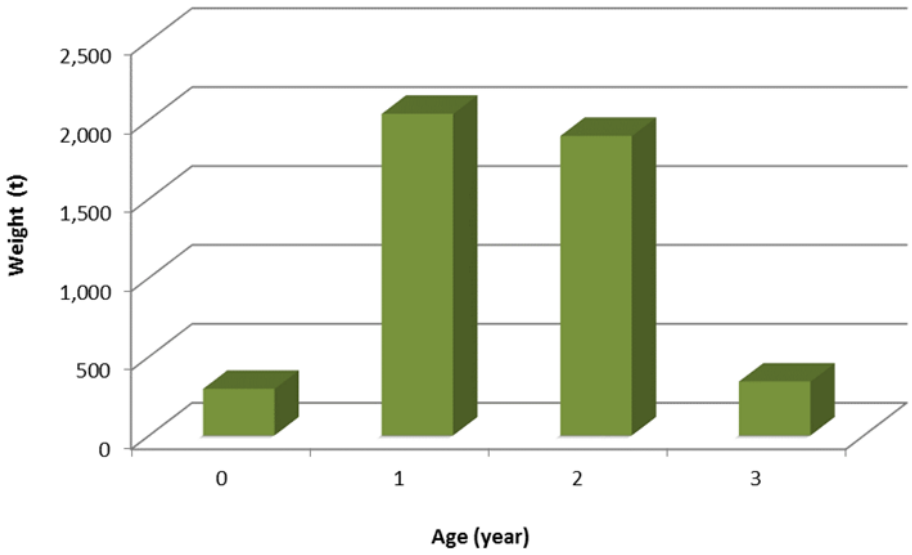


Figure C2. Anchovy (*Engraulis encrasicolus*) *age* classes distribution (%) – Echosurvey 2018.

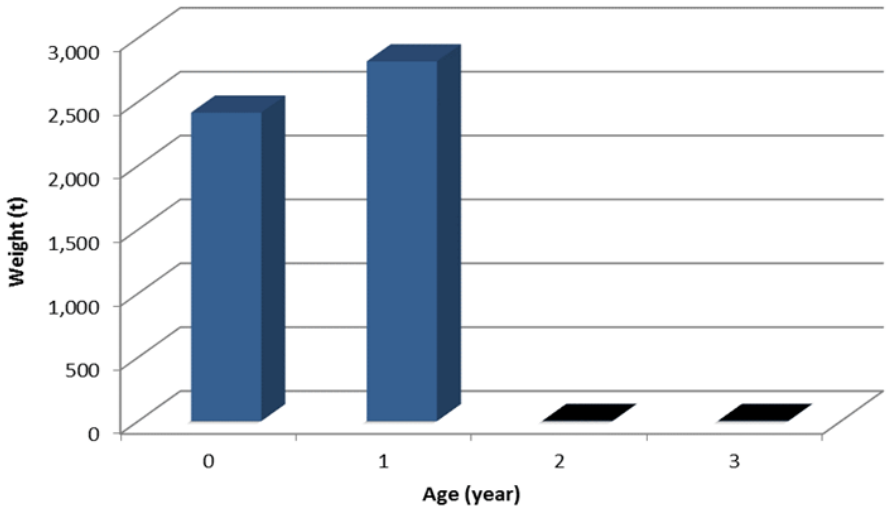


Figure C3. Sardine (*Sardina pilchardus*) age classes distribution (%) – Echosurvey 2018.

d) **Acoustic survey on small pelagics in the GSAs 9 and 10 in summer 2017** (Angelo Bonanno, Gualtiero Basilone, Simona Genovese, Rosalia Ferreri, Marco Barra)

The echosurvey on small pelagics in the GSAs 9 and 10 in summer 2018 was performed in the framework of the Italian National Program (Commission Decision C(2016) 8906 of December 19, 2016). The survey was carried out in the period 09 August – 06 September 2018. The track length was 1933 nm for a surveyed area of about 6256 nm^2. During the survey, 46 trawl hauls were completed and 256 CTD casts were collected with a SBE 911 plus multiparametric probe.

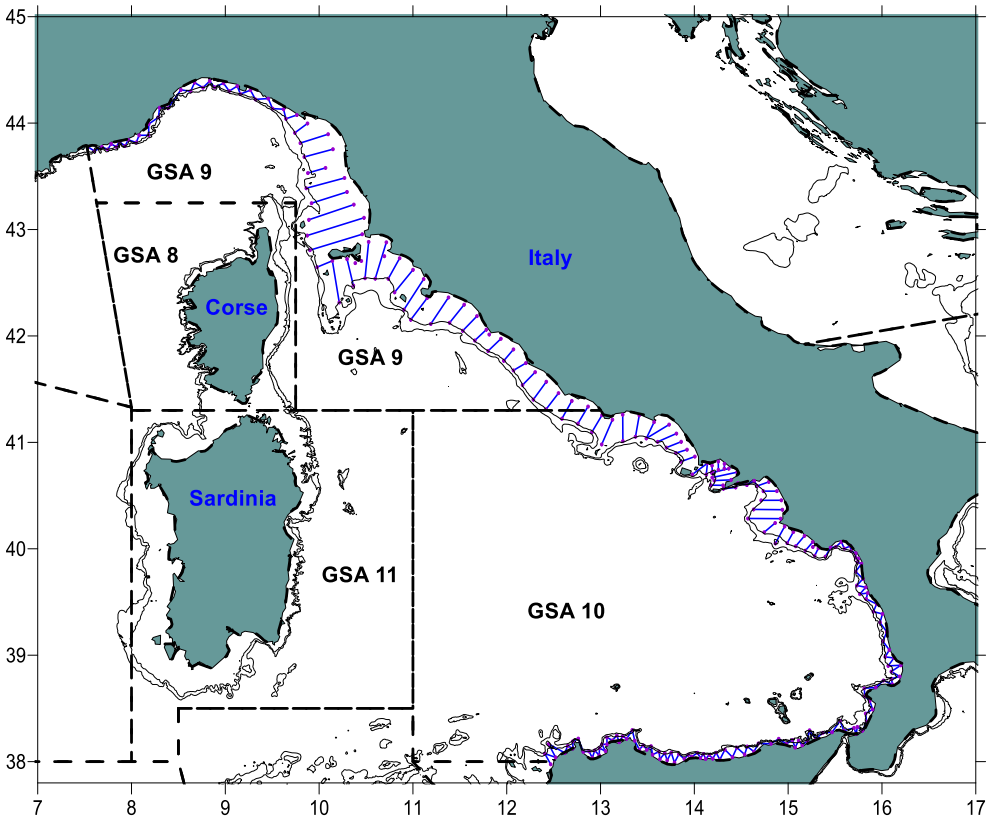


Figure D1. Map of the survey design in GSAs 9 and 10 adopted during the survey in summer 2018.

The spatial distribution of both anchovy and sardine confirmed the previously observed patterns for the two species.

During the survey both species were more abundant in GSA 9 than in GSA 10. In particular, the biomass of *Engraulis encrasicolus* was estimated to be 43282.3 t in GSA 10, while in GSA 9 it was 43988.0 t. The *Sardina pilchardus* biomass was 27259.5 t in GSA 9 and 15647.9 t in GSA 10.

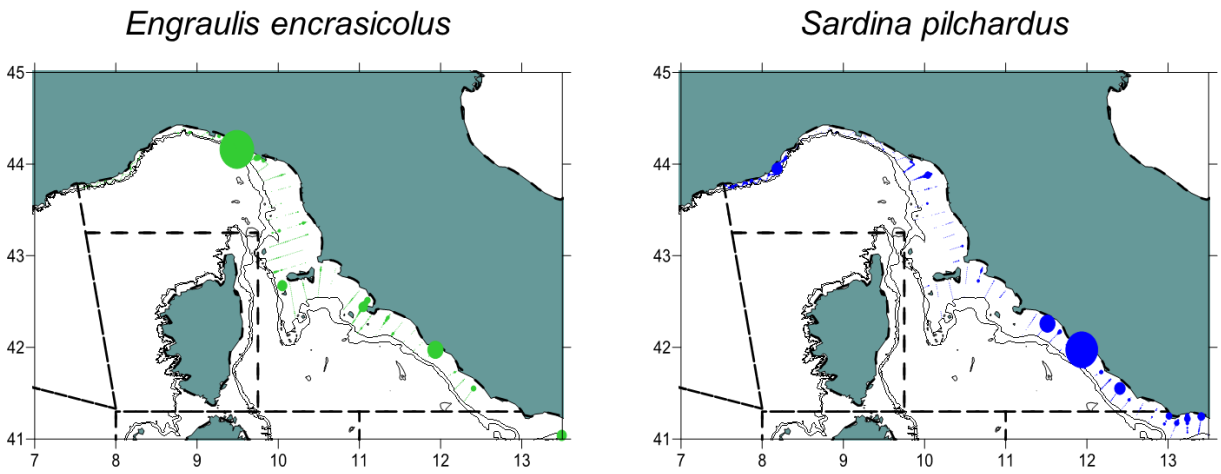


Figure D2. Spatial distribution of anchovy and sardine in the GSA 9 during the survey in 2018.

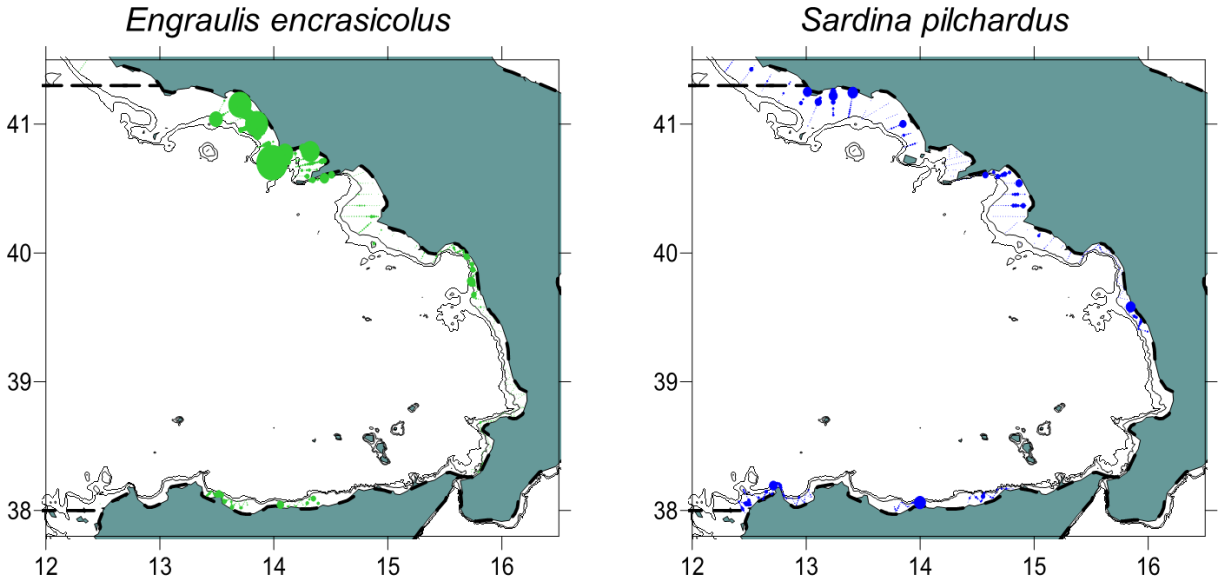


Figure D3. Spatial distribution of anchovy and sardine in the GSA 10 during the survey in 2018.

The age structure revealed similar patterns in both GSAs for anchovy, highlighting also a high percentage of age 1 specimens for both species. For sardine in GSA 10, the age structure showed a high percentage of age 0 class, while in GSA 9 the first two age classes (0 and 1) had similar percentage.

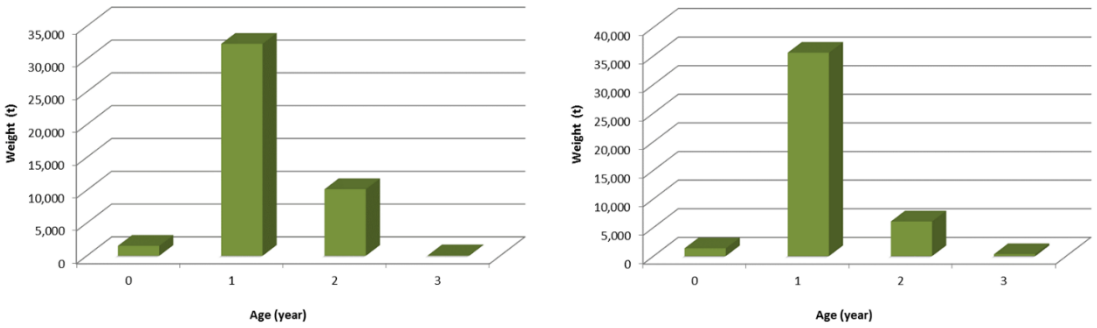


Figure D4. Anchovy age classes distribution in GSA 9 (left) and GSA 10 (right) – Echosurvey 2018.

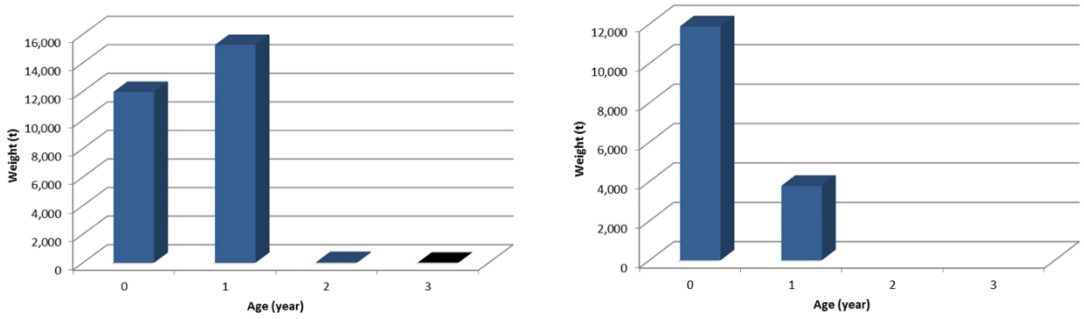


Figure D5. Sardine age classes distribution in GSA 9 (left) and GSA 10 (right) – Echosurvey 2018.

e) **Greek acoustic survey in eastern Ionian Sea (GSA 20) during November 2018** (Marianna Giannoulaki, Athanassios Machias, Konstantinos Tsagarakis, Maria Myrto Pyrounaki, Zacharias Kapelonis, Spyros Stamatas, Stylianos Somarakis)

The echosurvey in the Greek waters covered only the eastern Ionian Sea (GSA 20) on board the RV "PHILIA". No survey took place in Aegean Sea in 2018 as the RV PHILIA was not operational prior to October 2018. 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 8 knots. Echotraces were collected with a Simrad EK80 split beam echosounder (ES38-7, ES120-7C, ES200-7C, ES333-7C) and echotraces identified based on the catch composition of the pelagic haul. Acoustic recording was performed by day time. The survey covered the eastern part of Ionian Sea including Patraikos and Amvrakikos gulfs. The survey track involved 44 acoustic transects that covered an area of 9785 NM2 in Ionian Sea (Fig. E1). In addition 80 CTD Stations were completed during the survey. Calibration results are shown in Table E1.

Table E1. Calibration results in 2018.

	38 kHz	**120 kHz**	**200 kHz**
Gain adjust (dB)	0.43	1.12	1.92
Sa correction (dB)	-0.04	-0.01	-0.11
RMS TS error (dB)	0.03	0.04	0.73

The anchovy and sardine biomass in eastern Ionian Sea was estimated at 23274 t and 2886.29 t, respectively. The biomass distribution of each species is shown (Fig. E2). The length composition for anchovy and sardine are also shown in Figs. E3 and E4.

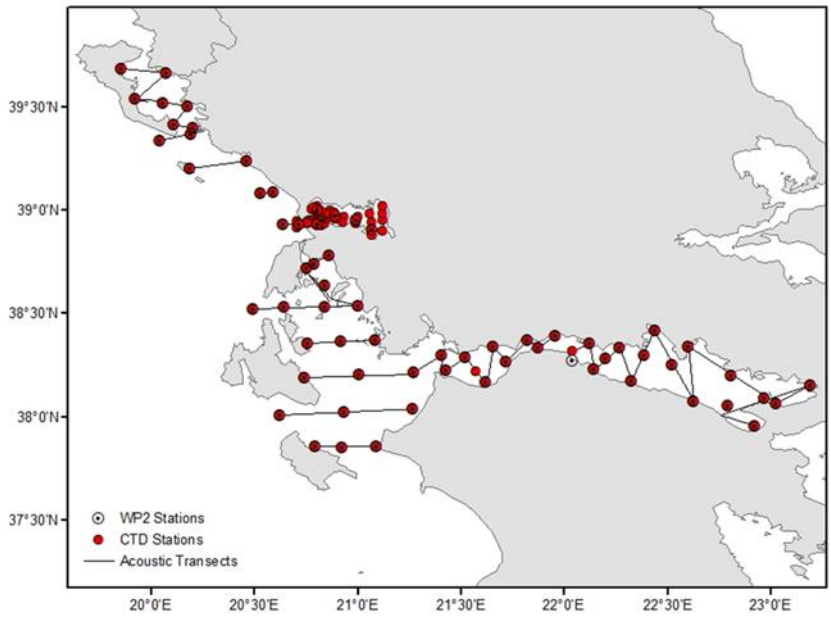


Figure E1. Map of the survey area and the acoustic survey design in eastern Ionian Sea in November 2018.

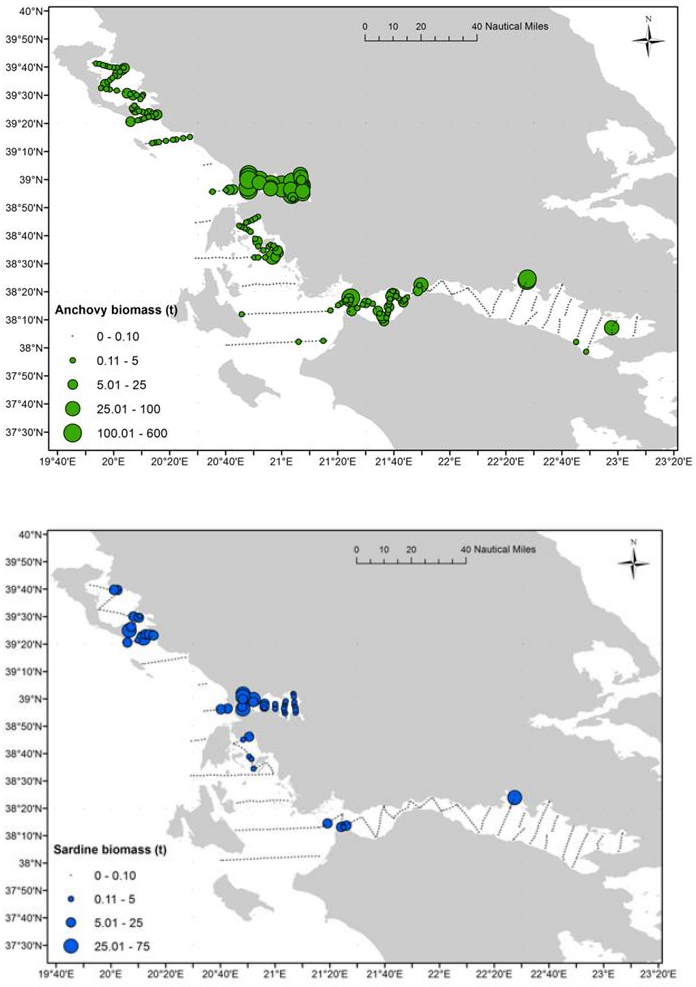


Figure E2. The distribution of anchovy biomass (t) and sardine biomass (t) per EDSU in eastern Ionian Sea during November 2018, respectively.

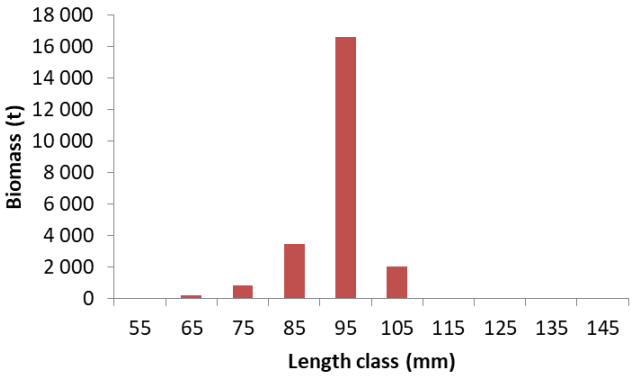


Figure E3. Length frequency distributions of anchovy catch during the acoustic survey in eastern Ionian Sea in November 2018.

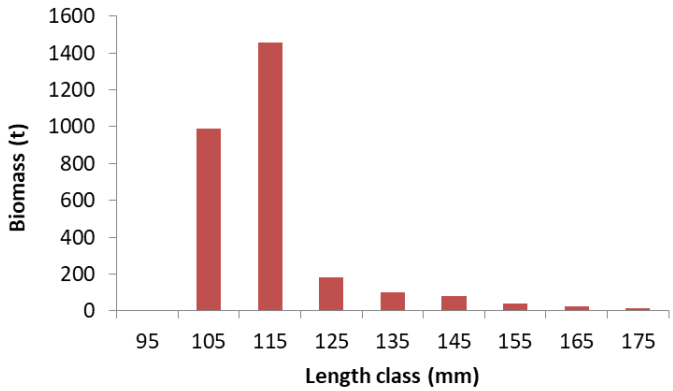


Figure E4. Length frequency distributions of sardine catch during the acoustic survey in eastern Ionian Sea in November 2018.

f) **Results from Iberian survey MEDIAS 2018** (Magdalena Iglesias, Ana Ventero, Pilar Córdoba)

MEDIAS 2018 acoustic survey was carried out in the Mediterranean Spanish waters (GSA06 and GSA01) from 26th June to 28th July 2018 (33 days) on board the R/V "Miguel Oliver" (70 m long). Acoustic data were collected during daytime (6:00 am -8:00 pm) over a grid of systematic parallel transects perpendicular to coastline/bathymetry (Fig. 1). Inter-transect distance was 8 nmi in GSA06 and 4 nmi in GSA01. Vessel speed during acoustic survey was 10 knots.

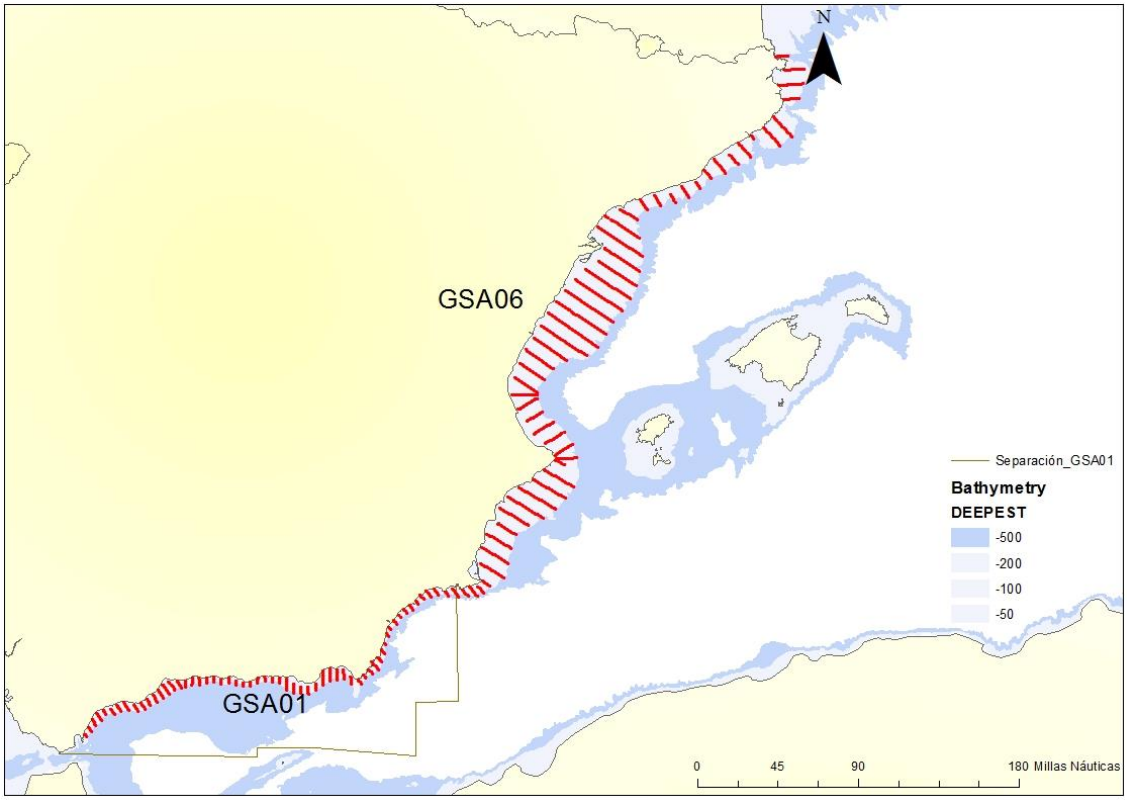


Figure F1. Survey design of acoustic transects (111) in GSA06 and GSA01.

The acoustic system was calibrated at the beginning of the survey using the standard sphere method (Demer et al., 2015) (Table 1). Elementary Sampling Distance Unit (EDSU) was 1 nmi, minimum bottom depth 20 m, pulse duration 1 ms for all frequencies and ping rate was set to maximum.

Table F1. Calibration results in 2018.

	Transducer 18 kHz	Transducer 38 kHz	Transducer 70 kHz	Transducer 120 kHz
Gain (dB)	23.00	24.89	27.00	26.56
$S_{a\ corr}$ (dB)	-0.83	-0.57	-0.39	-0.36
$RMS_{beam\ m}$ (dB)	0.16	0.14	0.24	0.38
$RMS_{polyn\ m}$ (dB)	0.12	0.10	0.21	0.34

Acoustic data were collected over 1120 nautical miles (nmi), corresponding 841 nmi to GSA06 and 279 nmi to GSA01. Forty (40) pelagic hauls were carried out in GSA06 and thirteen (13) in GSA01 to be used for the scrutinizing of the echograms (Fig. 2). 116 CTD stations were performed in GSA06 and 49 in GSA01 (Fig. 3).

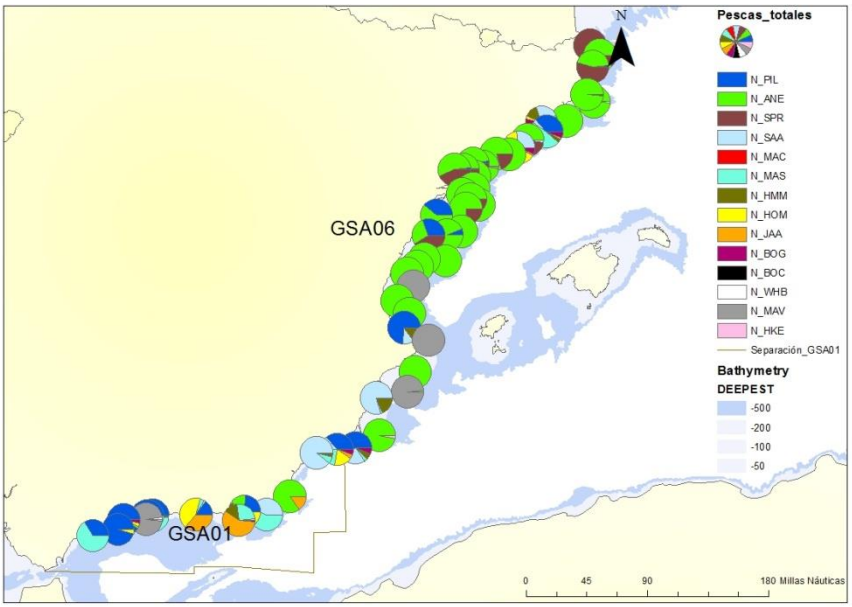


Figure F2. Pelagic hauls (53) composition carried out during the Spanish acoustic MEDIAS 2018 survey.

Figure F3. CTD stations (165) carried out during the Spanish acoustic MEDIAS 2018 survey.

Biomass (tons) of sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*) were estimated by GSA (Fig. 4 & 5). In GSA06, it has been detected a high increase in anchovy biomass and a decrease in sardine biomass. In GSA01, the biomass of both species has increased with sardine presenting higher abundance compared to anchovy.

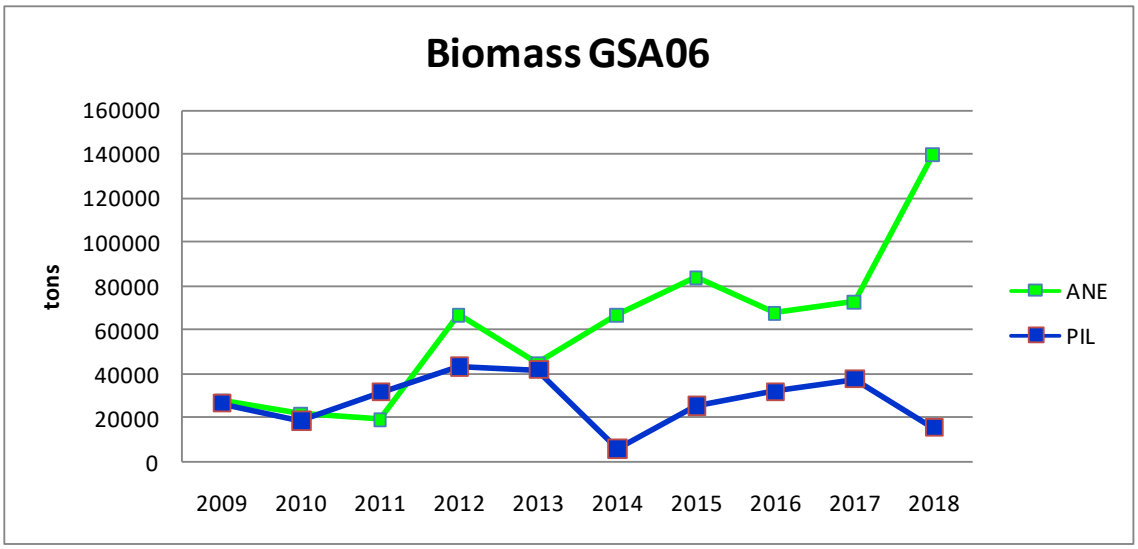


Figure F4. Anchovy (ANE) and sardine (PIL) biomass (tons) in GSA 06 in the period 2009-2018.

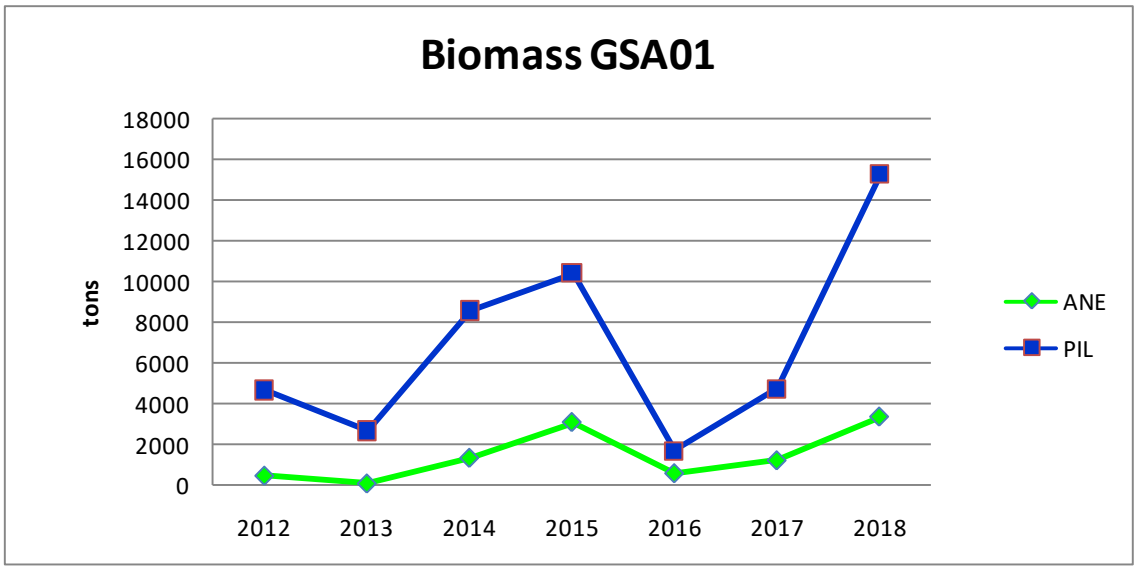


Figure F5. Anchovy (ANE) and sardine (PIL) biomass (tons) in GSA 01 in the period 2012-2018.

Spatial distribution of sardine and anchovy in GSA06 and 01 in 2018 (Figure 6 & 7) was mainly coastal for sardine, with higher values for anchovy in both areas.

The fish pelagic community detected and estimated during this survey includes sardinella (*Sardinella aurita*), sprat (*Sprattus sprattus*), horse mackerel (*Trachurus trachurus*, *T. mediterraneus* and *T. picturatus*), bogue (*Boops boops*), and (*Scomber colias*) and blue whiting (*Micromesistius poutassou*).

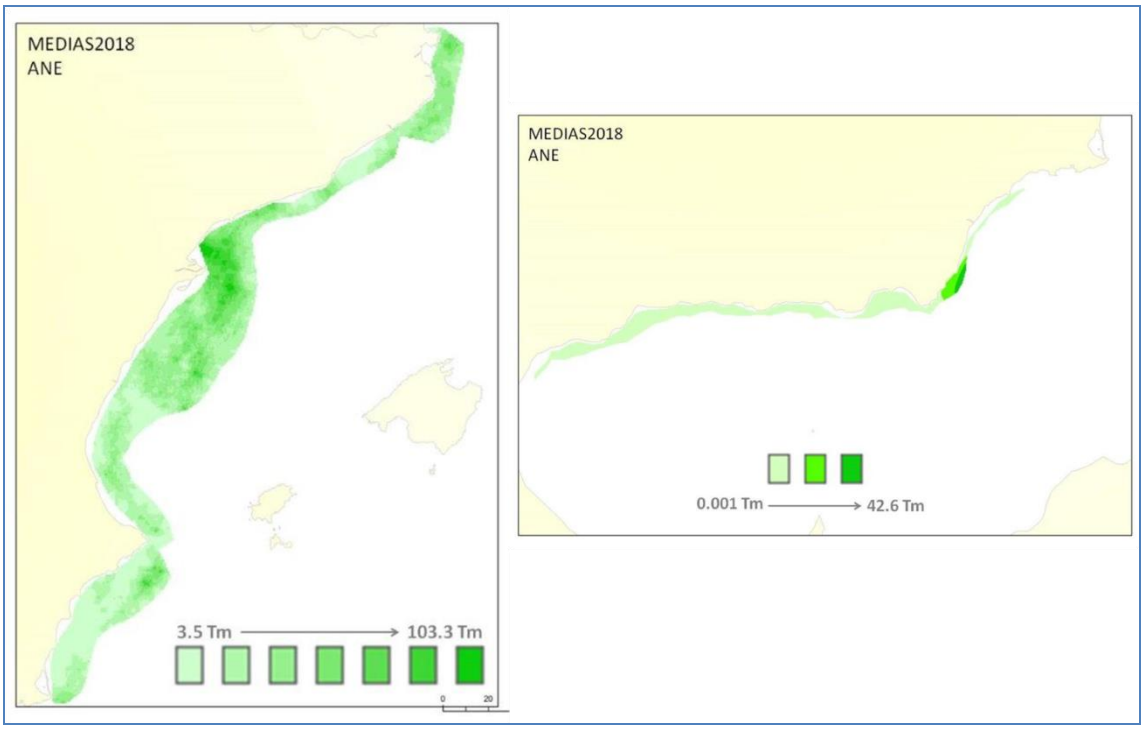


Figure F6. Anchovy (ANE) spatial distribution in GSA06 (left) and 01 (right) in MEDIAS 2018.

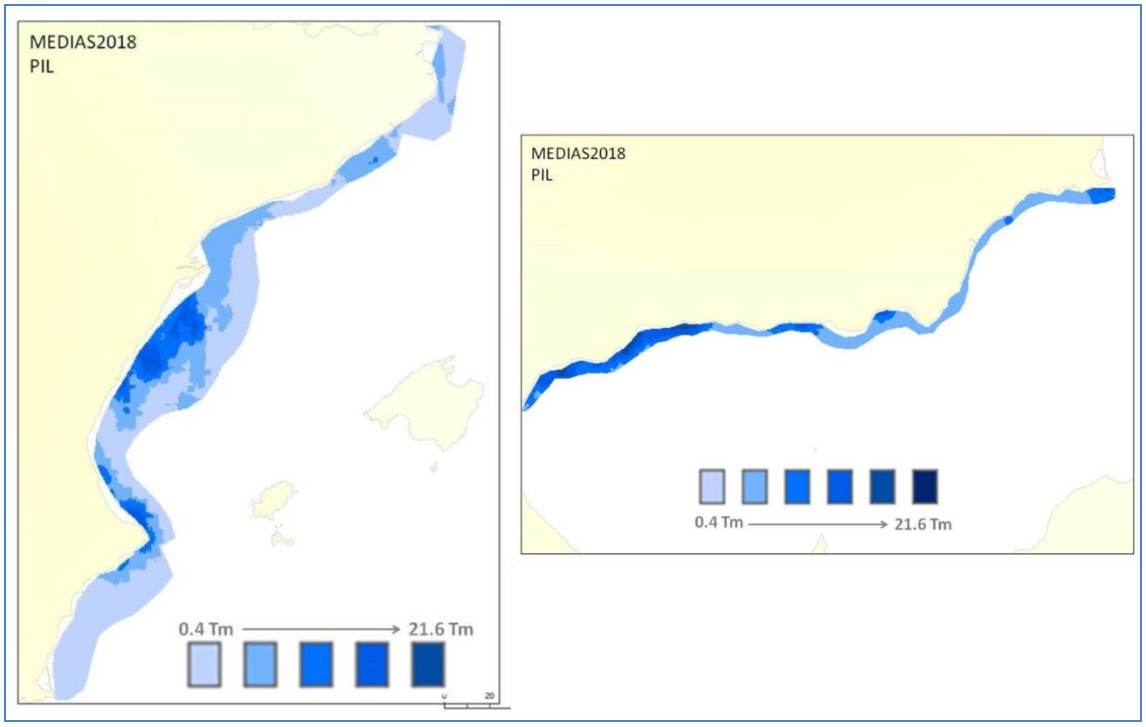


Figure F7. Sardine (PIL) spatial distribution in GSA06 (left) and 01 (right) in MEDIAS 2018.

g) **Pelagic Surveys at the Romanian Black Sea Coast (GSA 29), in 2018** (Valodia Maximov and George Tiganov)

Description of the Fisheries

The Romanian fishing fleet is operating in the area of competence of the Regional Fisheries Management Organisations - G.F.C.M., Area 37 - Mediterranean and Black Sea, Sub-area 37.4., Division 37.4.2, GSA 29. The Romanian fishing area is comprised between Sulina and Vama Veche; coastline extends for over 240 km, which can be divided into two main geographical and geomorphologic sectors:

- the northern sector (about 158 km in length) lies between the secondary delta of the Chilia branch and Constantza, constituted of alluvial sediments;
- the southern sector (about 85 km in length) lies between Constantza and Vama Veche characterised by promontories with active, high cliffs, separated by large zones with accumulative beaches often protecting littoral lakes.

In the coastal zone of the Romanian marine sector with small depth, fishing with fixed gear is characterized by the concentration of activity mainly in the first six-seven months of the season (March-September), when usually the species migrates to the coastal area for reproduction and other species migrate for feeding. In generally, total fishing season being of about eight months. The capture level and the level of fishing productivity differs from one year to another, depending on the fishing effort (number of pound nets and effective fishing days), and also depends on the

evolution of hydro climatic conditions and at last but not least, the state of fish stocks. The structure of species in the catches mirrored only partly the composition of Black Sea ichtyofauna from the Romanian sector, because of the type of gear used, hydroclimatic conditions and the ratio between the different fish species. As a general rule, the pelagic species, small-sized and short life cicle keep continue to be dominant in catches.

Pelagic Survey 2018:

- period: 05 – 12 June and 01 - 09 October 2018
- type of fishing vessel: B-410 (***STEAUA DE MARE 1***);
- characteristics: pelagic trawls: 36/26-59 m; horizontal trawl opening - 20 m; vertical trawl opening 11-12 m; no. trawls: 32 + 31; drepth 20.1 - 66.4 m; trawl speed 3.2 knots; time trawling 30 min; catch 50 – 2,000 kg.
- for estimating the fishable sprat crowds biomass, the holistic method of survey trawling was used and the pelagic trawl was used for sampling.

In pelagic fishing conducted with pelagic trawl in the Romanian Black Sea waters, other complementary fish species beside sprat have occurred (the total number of identified species was 21): sprat (*Sprattus sprattus L.*); European anchovy (*Engraulis encrasicolus L.*); Mediterranean horse mackerel (*Trachurus mediterraneus S*); whiting (*Merlangius merlangus ponticus* N.); picked dogfish (*Squalus acanthias* L.); red mullet (*Mullus barbatus ponticus*); Caspian shad (*Alosa tanaica G*); bluefish (*Pomatomus saltatrix L.*); flathead grey mullet (*Mugil cephalus* L); jellyfish (*Aurelia aurita L.*); knout goby (*Mesogobius batrachocephalus* L.); turbot (*Psetta maxima maeotica L.*); rapa whelk (*Rapana venosa*); common shrimp (*Cragon crangon L.*); other species.

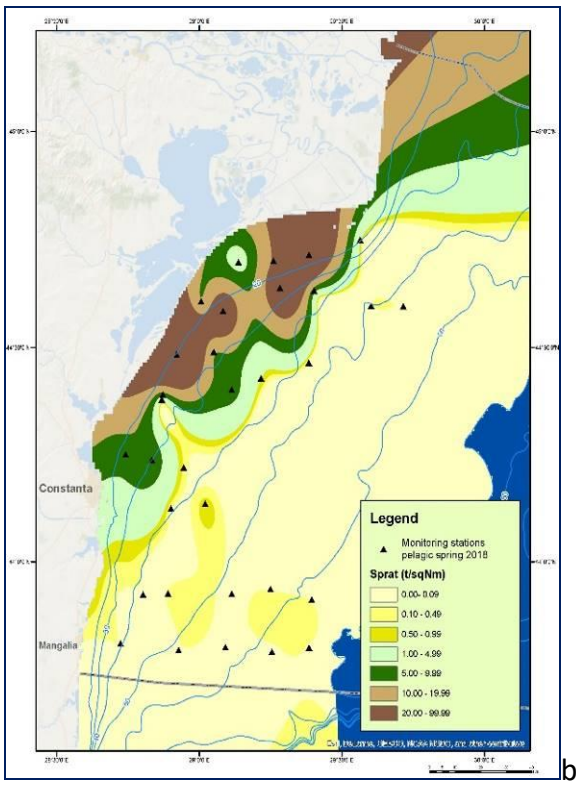
Estimated total biomass:

a. ***Sprattus sprattus*** (european sprat):

Spring - in the **32** sample trawlings made with the pelagic trawl, on an area of **2,800** Nm², the average values of the catches were of about **0.01-68.6** t/Nm². The maximum value was recorded in the Constanta-Sf. Gheorghe sectors (0-50 m). The estimated biomass for sprat crowds, in the research a area, was of about **42,599 tons** (Fig. 1 a)**.**

Assessment of sprat agglomerations (tons), in June 2018

Depth range (m)	***0 – 30 m***	***30 – 50 m***	***50 - 70 m***	***Total***
Investigated area (Nm^2)	575	1000	1225	2800
Variation of the catches (t/ Nm^2)	1.372 - 68.6	0 - 8.86	0 - 0.069	0 - 68.6
Average catch (t/ Nm^2)	26.451	2.451	0.0283	8.52
Biomass of the fishing agglomerations (t)	**15209**	**2451**	**34.70**	**23855**
Biomass extrapolated the Romanian shelf (t)				**42,599**

a. 

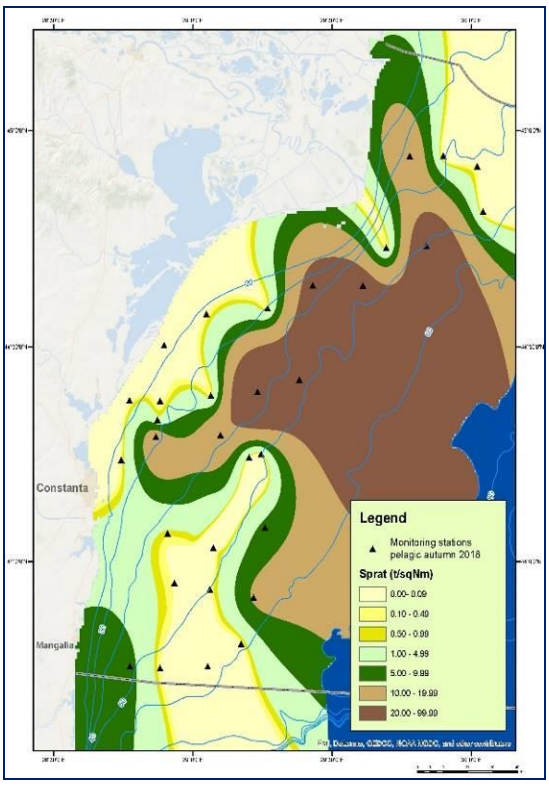
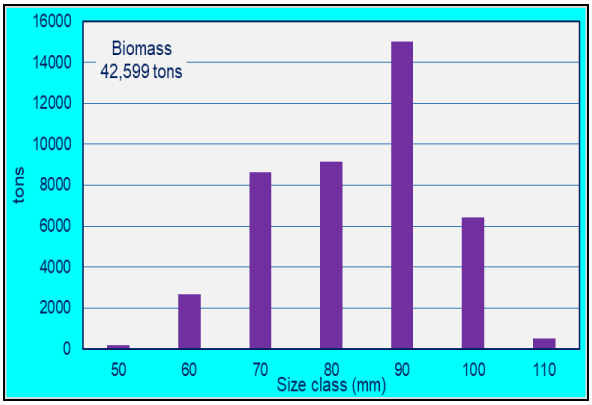
b. 

Figure G1. The distribution of the sprat agglomerations in spring (a) and autumn period (b), pelagic trawl survey, in Romanian área

Biomass (t) and abundance (thousands of individuals) of sprat

Spring survey 2018

Structure of biomass and abundance by length distribution (Fig. 2)

a. 

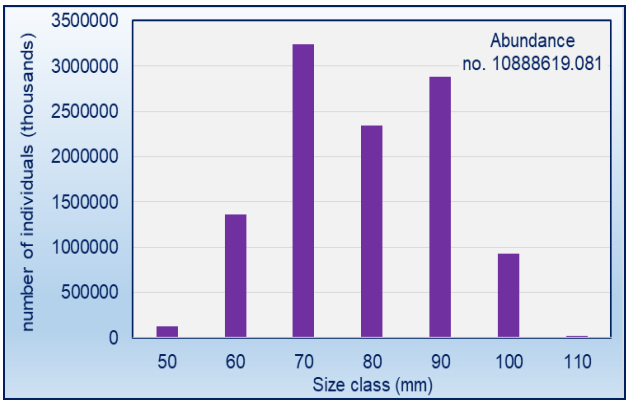
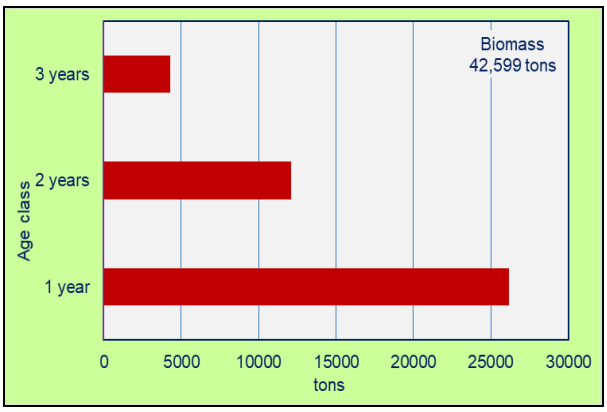
b. 

Figure G2. Structure by lengths of biomass (a) and abundance (b) of sprat during spring survey

Structure of biomass (a) and abundance (b) by age distribution (Fig. 3)

a. 

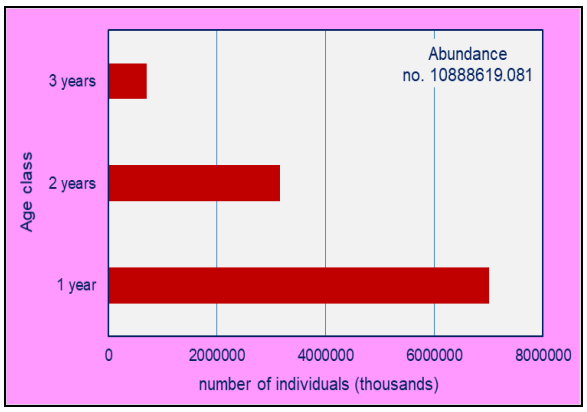
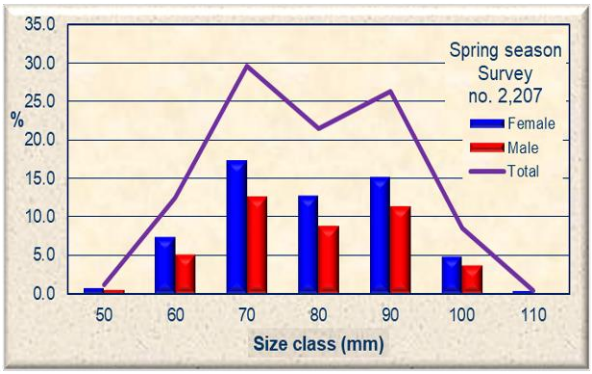
b. 

Figure G3. Structure by age of biomass (a) and abundance (b) of sprat during spring survey

The analysis of structure by lengths and mass of sprat during survey, has highlighted the presence of mature specimens and a high homogeneity of cards. The length of sprat individuals are within the limits of classes of length 50.0-115.0 mm / 0.73 – 10.06 g. The dominant classes are those of 70.0 - 90.0 mm / 2.48 – 4.96 g (Fig. 4a). The dominant females 58.18.18 %, males (41.82 %). The average body length was 83.44 mm and the average mass of 3.90 g. Age composition of sprat catches indicates the presence of individuals from 1 to 3 years. Most of the individuals caught are 1 years old (61.5 % of all specimens analyzed), followed closely by those of 2 years (28.4 %) and 3 years (10.1 %)(Fig. 4b).

a.



b.

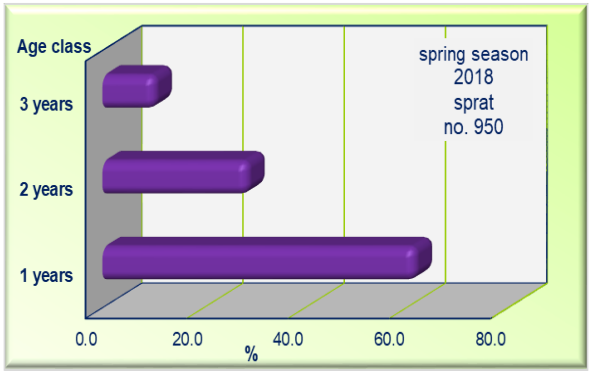


Figure G4. Structure by lengths (a) and age (b) of sprat during spring survey

Autumn - in the **31** sample trawlings made with the pelagic trawl, on an area of **2,038** Nm², the average values of the catches were of about 0-43.908 t/Nm². The maximum value was recorded in the Sf. Gheorghe - Mangalia (30 - 70 m) sectors. The estimated biomass of sprat was about **36,801 tons** (Fig. 1b).

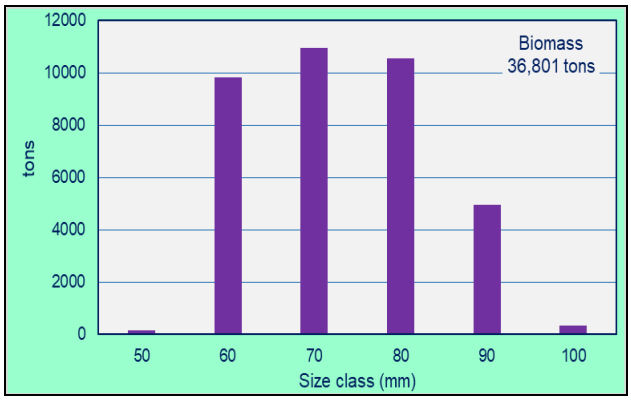
Assessment of sprat agglomerations (tons) in October 2018

Depth range (m)	***0 – 30 m***	***30 – 50 m***	***50 - 70 m***	***Total***
Investigated area (Nm^2)	**625**	**1112.5**	**300**	**2037.5**
Variation of the catches (t/ Nm^2)	0	0 - 43.908	0 - 31.079	0 - 43.908
Average catch (t/ Nm^2)	0	10.08	6.749	7.36
Biomass of the fishing agglomerations (t)	0	11219	2024	16983
Biomass extrapolated the Romanian shelf (t)				**36,801**

Biomass (t) and abundance (thousands of individuals) of sprat

Autumn survey 2018

Structure of biomass and abundance by length distribution (Fig. 5)

a. 

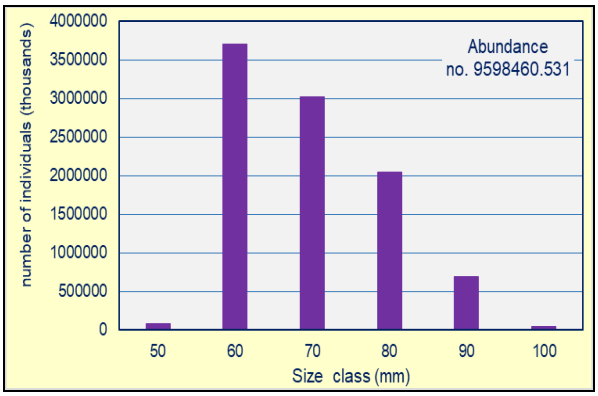
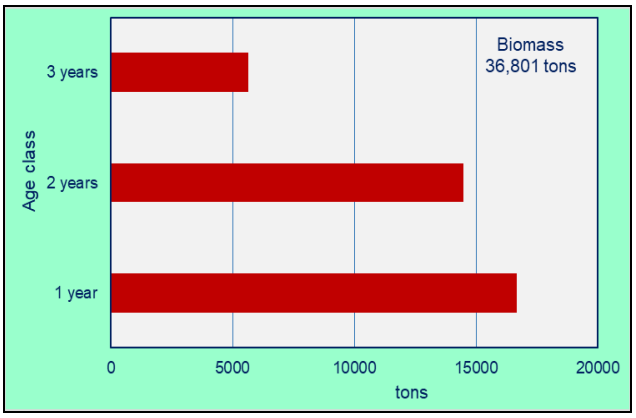
b. 

Figure G5. Structure by lengths of biomass (a) and abundance (b) of sprat during autumn survey

Structure of biomass (a) and abundance (b) by age distribution (Fig. 6)

a. 

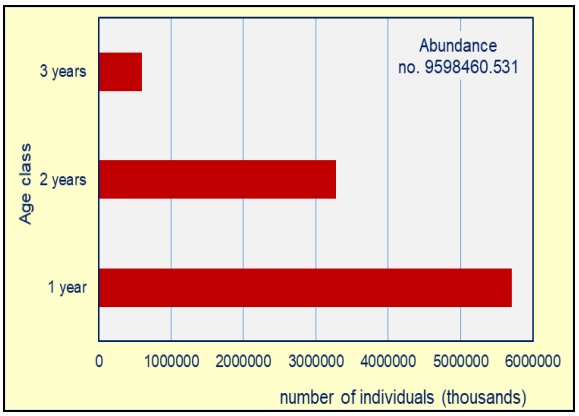
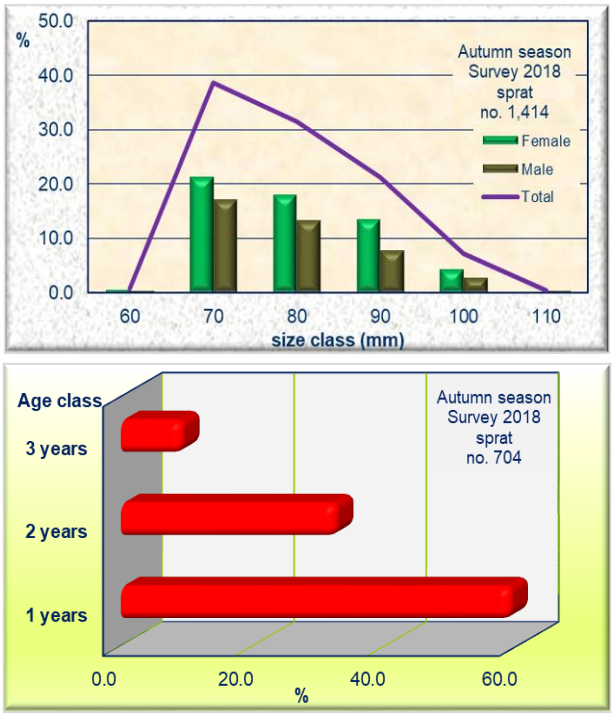
b. 

Figure G6. Structure by age of biomass (a) and abundance (b) of sprat during autumn survey

The length of sprat individuals are within the limits of classes of length 65.0-115.0 mm / 1.85 – 8.12 g. The dominant classes are those of 75.0 - 90.0 mm / 2.77 – 4.87 g (Fig. 7a). The dominant females 58.13 %, males (41.87 %). The average body length was 84.84 mm and the average mass of 3.84g. Age composition of sprat catches indicates the presence of individuals from 1 to 3 years. Most of the individuals caught are 1 years old (58.7 % of all specimens analyzed), followed closely by those of 2 years (32.4 %) and 3 years (8.9 %)(Fig. 7b).

a. 

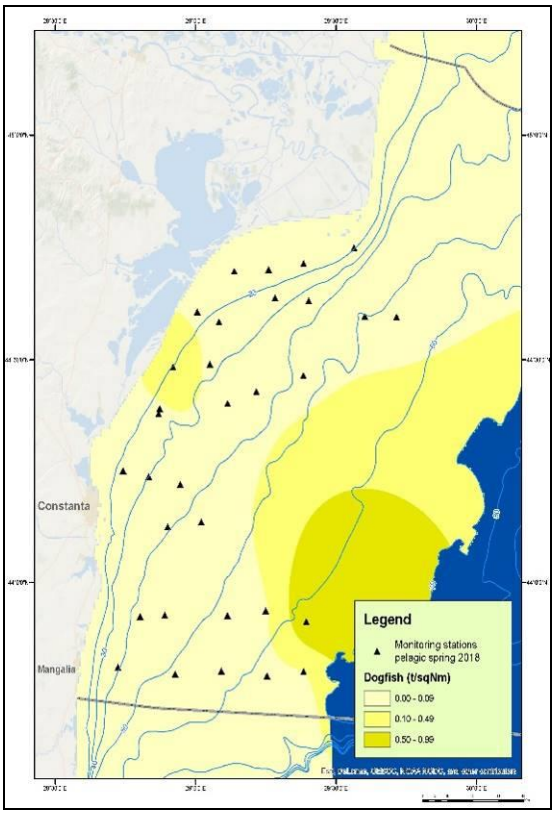
b.

Figure G7. Structure by lengths (a) and age composition (b) of sprat during autumn survey

b. ***Squalus achanthias*** (picked dogfish)

Spring - in the 32 sample trawlings made with the pelagic trawl, on a surface of **2,800** Nm^2, the average values of the catches were of about **0-0.926 t**/Nm^2. The maximum value was recorded in the Constanta - Cape Tuzla sectors (50-70 m)(Fig. 8 a). The estimated biomass in the research area was of about **223** tons.

a.



b.

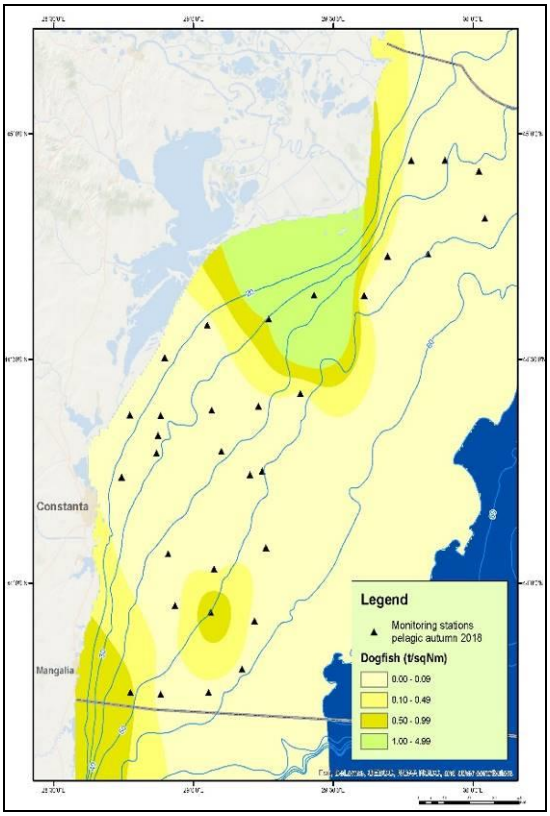


Figure G8. The distribution of the picked dogfish agglomerations in the spring (a) and autumn (b) period, pelagic trawl survey, in Romanian area.

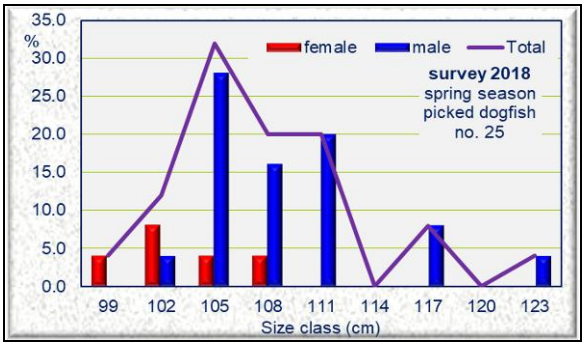
Assessment of dog fish agglomerations (tons), in June 2018, Romanian area

Depth range (m)	***0 – 30 m***	***30 – 50 m***	***50 - 70 m***	***Total***
Investigated area (Nm^2)	575	1000	1225	2800

Variation of the catches (t/ Nm^2)	0-0.473	0	0-0.926	0-0.926
Average catch (t/ Nm^2)	0.0525	0	0.106	0.045
Biomass of the fishing agglomerations (t)	30	0	130	125
Biomass extrapolated the Romanian shelf (t)				**223.00**

The length of picked dogfish individuals are within the limits of classes of length 99.0-123.0 mm / 4,10–7,80 g. The dominant classes are those of 102.0-111.0 cm/4,60–5,66 g (Fig. 9a). The dominant males (80.0 %). The average body length was 109.38 cm and the average mass of 5,383 g. Age composition of sprat catches indicates the presence of individuals from 12 to 14 years. Most of the individuals caught are 13 years (68.0 % of all specimens analyzed) and 112 years old (20.0 %), and 14 years (12.0 %)(Fig. 9 b).

a.



b.

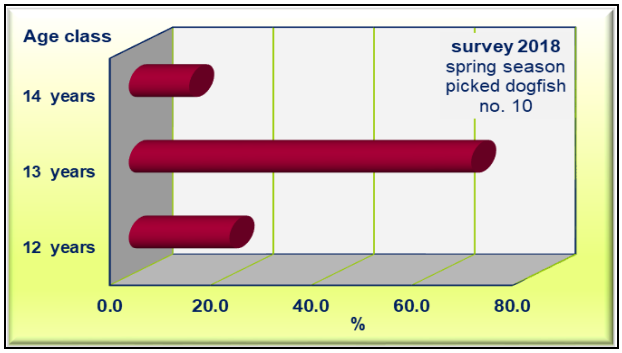


Figure G9. Structure by lengths (a) and age composition (b), of picked dogfish, during spring survey

Autumn **-** in the 31 sample trawlings made with the pelagic trawl, on a surface of 2.038 Nm², the average values of the catches were of about 0-13.721 t/Nm². The maximum value was recorded in

the Mangalia - Saturn sectors (30 - 50 m) and Gura Portița - Sf. Gheorghe sectors (30 - 70 m)(Fig. 8 b). The estimated biomass for the dogfish crowds, in the research area, was of about **1,040** tons**.**

Assessment of dogfish agglomerations (tons), in Octomber 2018, in Romanian area

Depth range (m)	***0 – 30 m***	***30 – 50 m***	***50 - 70 m***	***Total***
Investigated area (Nm^2)	625	1112.5	300	2037.5
Variation of the catches (t/ Nm^2)	0	0-4.289	0-0.549	0-4.289
Average catch (t/ Nm^2)	0	0.339	0.0686	0.208
Biomass of the fishing agglomerations (t)	0	378	21	480
Biomass extrapolated the Romanian shelf (t)				**1,040.0**

The length of dogfish individuals are within the limits of classes of length 108.0-1231.0 mm / 5,745 – 8,150 g. The dominant classes are those of 111.0 - 120.0 cm / 6,287 – 7,650 g (Fig. 10 a). The dominant males (100.0 %). The average body length was 115.71 cm and the average mass of 6,738 g. Age composition of sprat catches indicates the presence of individuals from 13 to 14 years. Most of the individuals caught are 13 years (68.0 % of all specimens analyzed) and 14 years old (32.0 %), (Fig. 10 b).

a.

b.

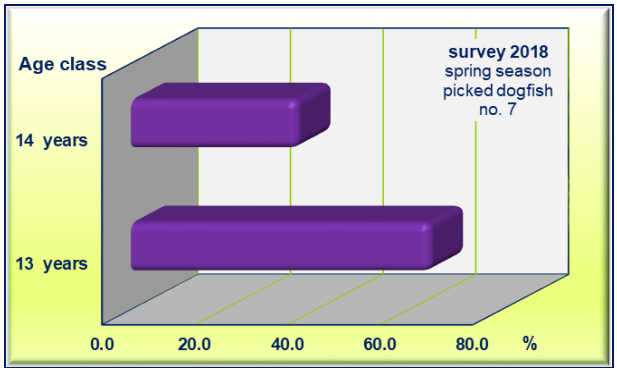


Figure G10. Structure by lengths (a) and age composition (b), of picked dogfish, during autumn survey

c. *Aurelia aurita* (jellyfish)

Spring - sweeping area procedures were conducted on an surface of **2,800** Nm^2. The average values of jellyfish catches were situated in the limits between 0,685-41.164 t/Nm^2. They revealed that jellyfish had a flat distribution in large area between Sulina - Gura Portița sectors (0.685-41.164 t/Nm^2/depth 0 - 50 m and Cape Midia - Mangalia sectors (3.436-20.582 t/Nm^2/depth 30 - 50 m (Fig. 11 a). The estimated biomass for the Romanian shelf was about **43,736** t.

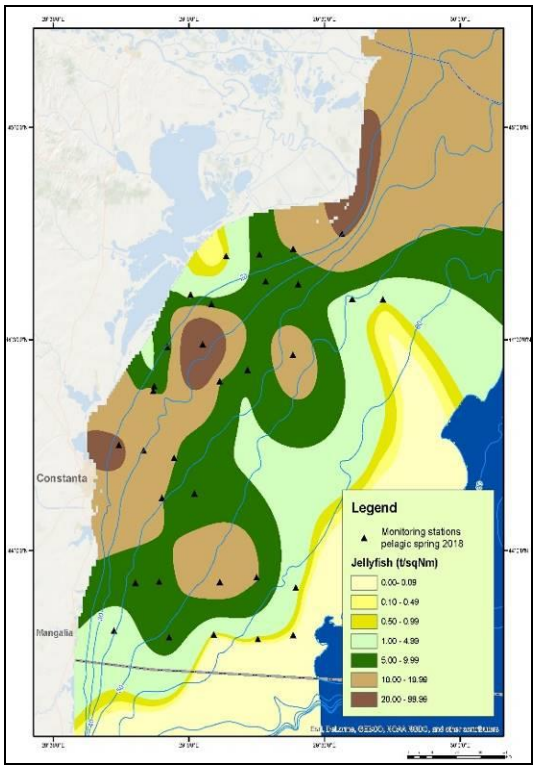
Autumn - in the **31** sample trawlings made with the pelagic trawl, on a surface of **2,038** Nm^2, the average values of the catches were of about **0 - 14.888** t/Nm^2. The maximum value was recorded in the Sf. Gheorghe - Managalia sectors (50 - 70 m)(Fig. 11 b). The estimated biomass for the jellyfish crowds, in the research area, was of about **10,999 tons**.

Assessment of jellyfish agglomerations (tons), in June 2018, Romanian area

Depth range (m)	***0 – 30 m***	***30 – 50 m***	***50 - 70 m***	***Total***
Investigated area (Nm^2)	575	1000	1225	2800
Variation of the catches (t/ Nm^2)	0.685-	3.436-	0.686-	0.685-

	41.164	20.582	13.721	41.164
Average catch (t/ Nm^2)	11.510	9.85	4.268	8.747
Biomass of the fishing agglomerations (t)	6618	9850	5229	24492
Biomass extrapolated the Romanian shelf (t)				**43,736.0**

a.



b.

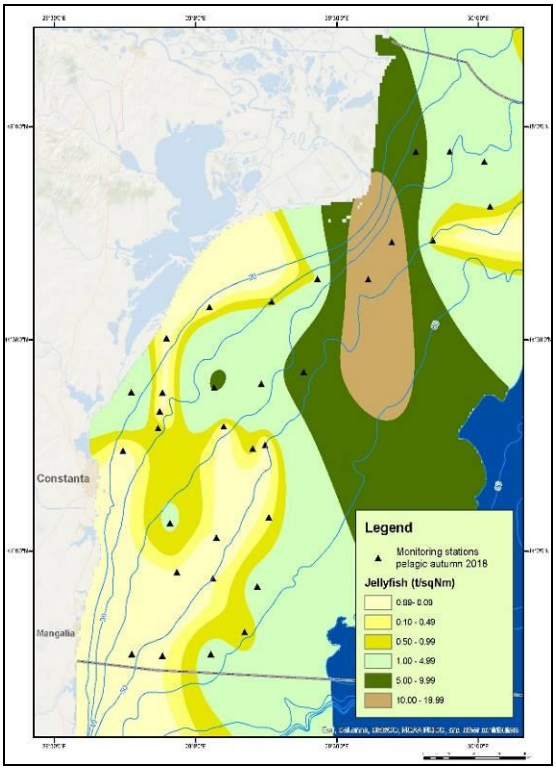


Figure G11. The distribution of the jellyfish agglomerations in the spring (a) and autumn (b) period, pelagic trawl survey, in Romanian area.

Assessment of jellyfish agglomerations (tons), in October 2018, Romanian area

Depth range (m)	*0 – 30 m*	*30 – 50 m*	*50 - 70 m*	*Total*
Investigated area (Nm^2)	625	1112.5	300	2037.5
Variation of the catches (t/ Nm^2)	0-3.308	0-14.888	0-1.425	0-14.888
Average catch (t/ Nm^2)	0.551	3.478	0.559	2.2
Biomass of the fishing agglomerations (t)	345	3869	168	5076
Biomass extrapolated the Romanian shelf (t)				**10,999.0**

The agglomeration biomass of the main species from Romanian littoral

The swept area method is used for assessment of the biomass of fishing agglomerations of sprat, whiting and picked dogfish based on the statistic processing of productivity data obtained in sampling trawling and industrial trawling. The calculated biomasses by swept area for main species at the Romanian littoral ranged between: sprat (30,917 tons and 68,887 tons); whiting (6,565 t and 26,171 t) and dogfish (223 t and 5,635 t) (Fig. 12).

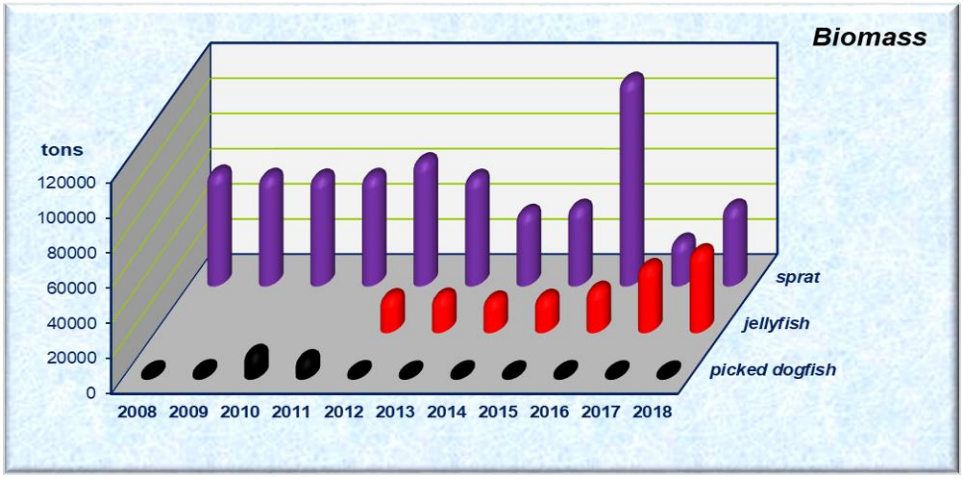


Figure G12. The agglomeration biomass of the main pelagic species from Romanian littoral

h) **Gulf of Lion survey** (Tarek Hattab & Jean Hervé Bourdeix).

Pelmed surveys cover the Gulf of Lions (3300 nm^2) 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. The survey design is made of 9 parallel transects perpendicular to the coastline and 12 nm apart, from the 20 m isobath to the 200 m one. The surveying acoustic vessel speed is 8 knots. In 2018 total nautical miles effectively used for acoustic analysis (minus pelagic

trawls tracks and linking transects) were 271. Echotraces are identified with a pelagic haul. Discrimination between species was done by a combination of echo trace classification and trawls output. Indeed, each time a fish trace was observed for at least 2 nm on the echogram, the boat turned around to conduct a 30 min-trawl at 4 knots in order to evaluate the proportion of each species (by randomly sampling and sorting of the catch before counting and weighing each individual species). Acoustic recording and trawl hauls are performed during day time and the survey lasts 34 days. The split beam echo sounder used is SIMRAD ER60, with the 38, 70, 120, 200 and 333 kHz frequencies. The threshold for acquisition is –80 dB and that for processing for the assessment (38 KHz) is –60 dB. The pulse duration is 1024 ms. Additionally, the use of a multi-beam echo sounder SIMRAD ME70 enables us to visualize 3D echos and helps in species allocation.

In GSA07 44 pelagic hauls were carried out to be used for the scrutinizing of the echograms (Figure 1). On top of fish parameters, 53 hydrological stations have been conducted. Zooplankton was sampled through WP2 vertical nets and bongo diagonal nets, while phytoplankton was sampled through Niskin bottles in subsurface and at the maximum of chlorophyll depth. Seabirds and marine mammals are also observed all along the survey.

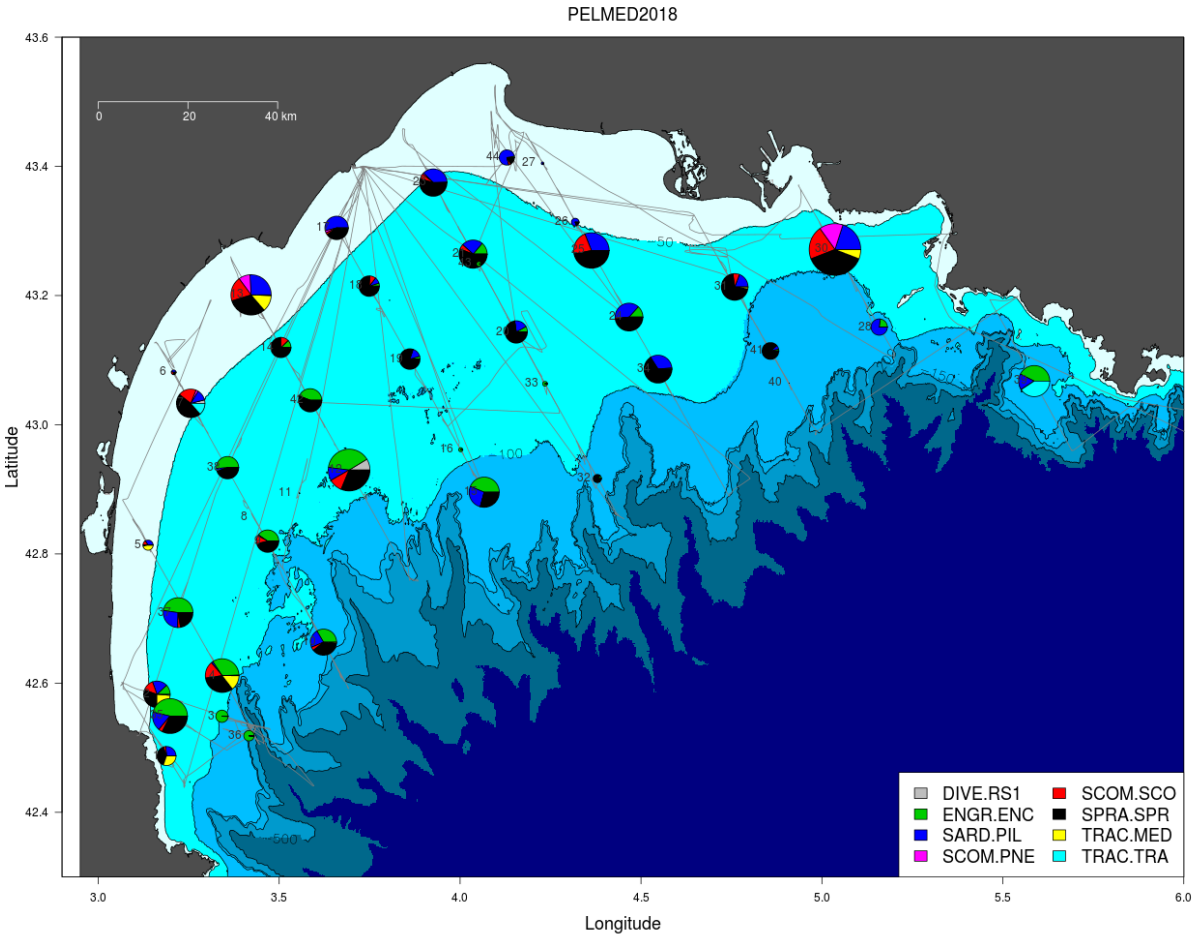


Figure H1. Map of the assessed area and sampling design. 2018 survey is used as an example to show the trawl positions and species composition.

Acoustic data analyses (stock estimation, length-weight relationships, etc.) were performed using R scripts (EchoR package). The sardine and anchovy biomasses were estimated to be respectively 49 748 t and 45 778 t in 2018. Biomass trends and the spatial distribution of each species is shown in Figure 2 and 3 respectively.

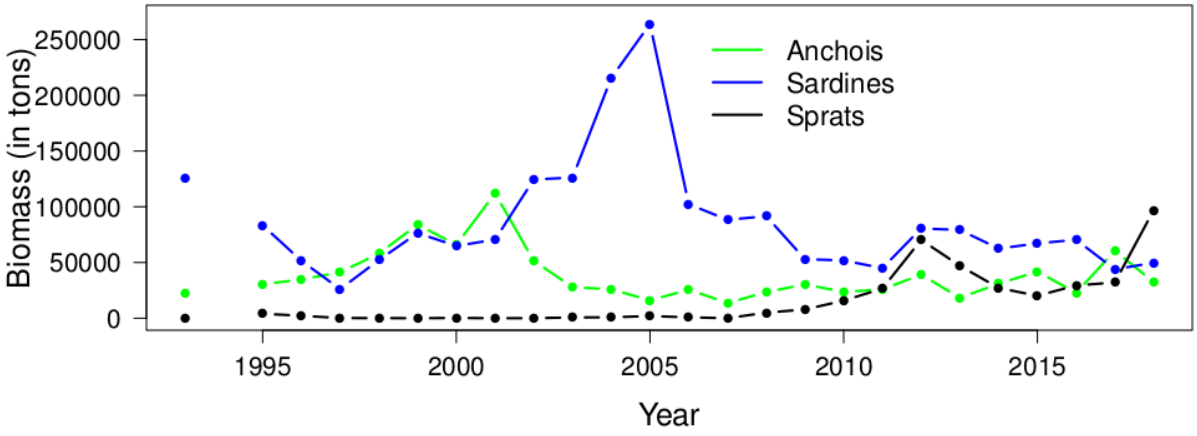


Figure H2. Direct assessment of biomass since the start of the PELMED acoustic survey.

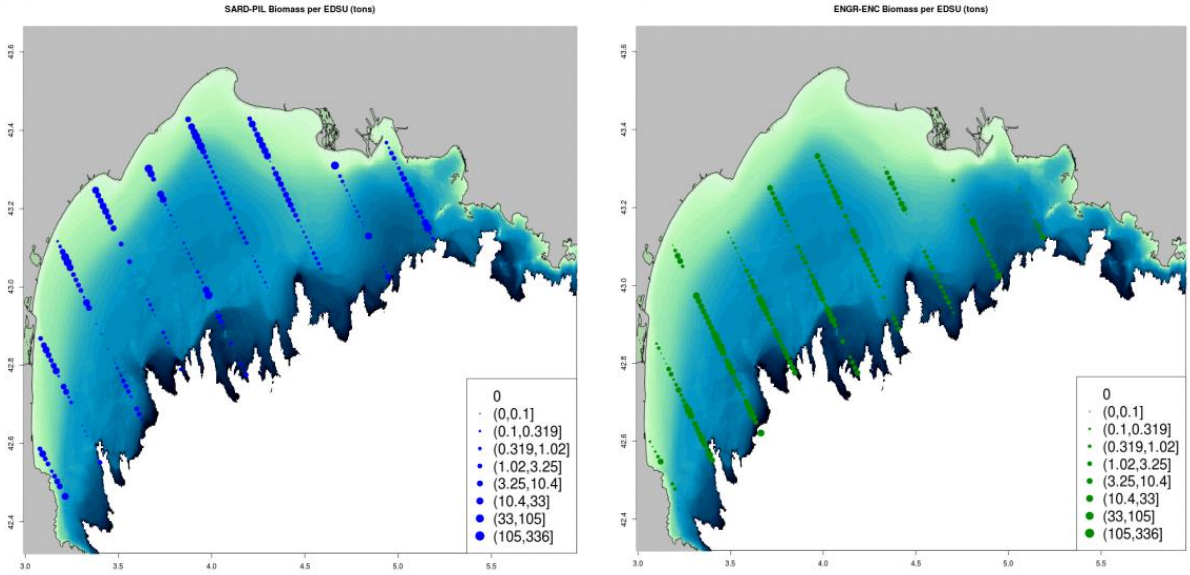


Figure H3. Sardine and anchovy biomasses distribution in 2018 observed all along the survey.

Age was estimated for sardine and anchovy by counting growth rings on the otoliths and age-length key calculated (Fig. 4).

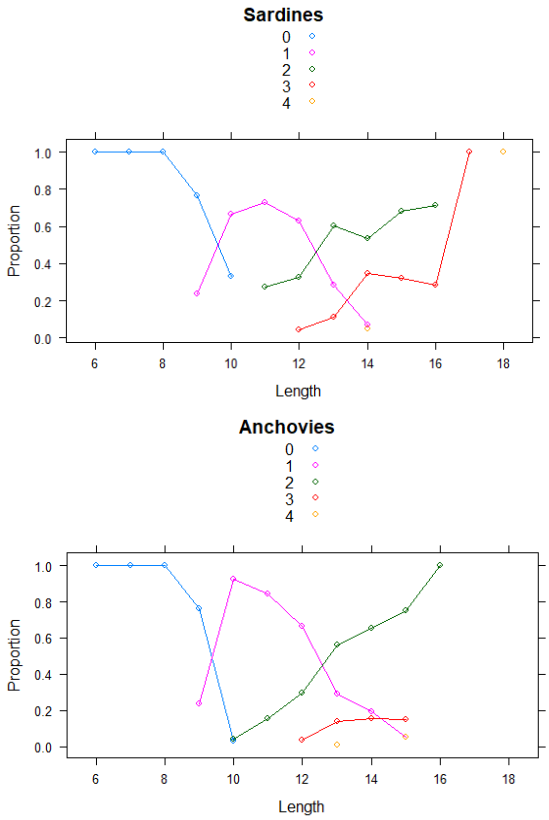


Figure H4. Sardine and anchovy age-length key in MEDIAS 2018 in GSA07.

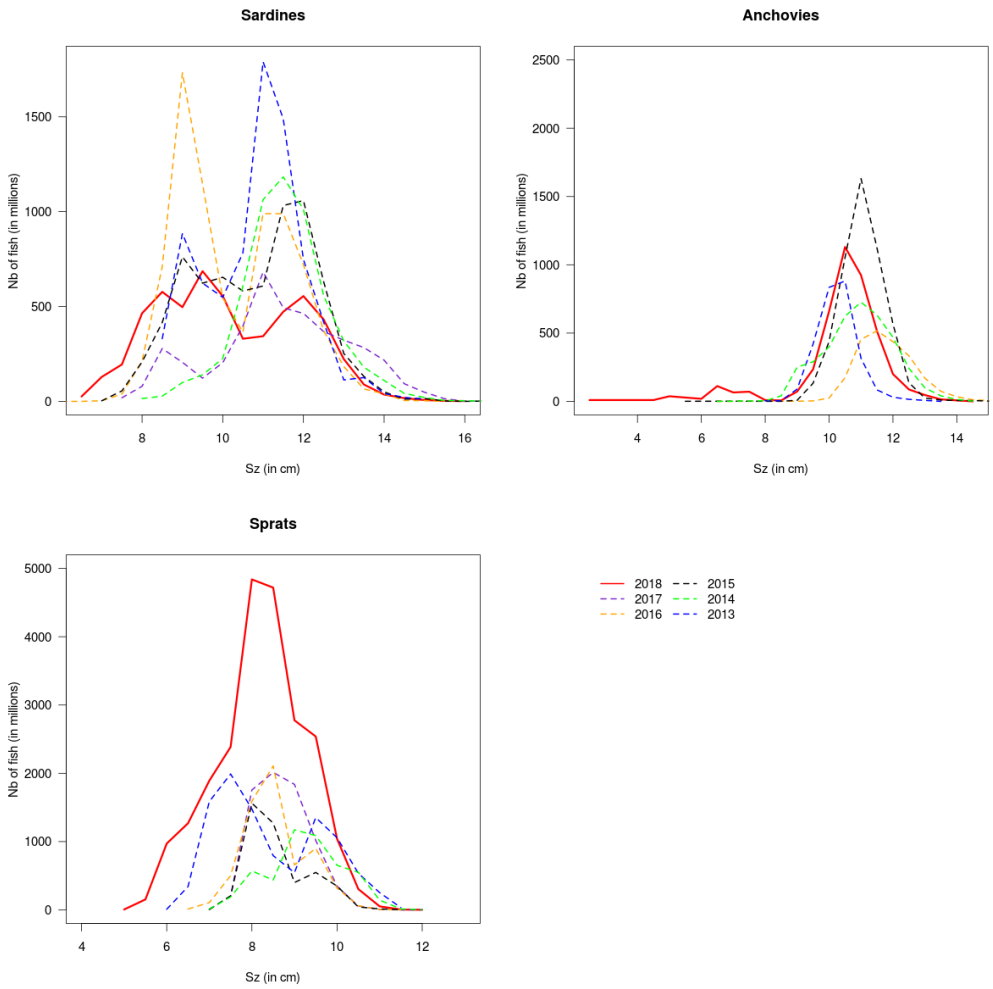


Figure H5. Size distribution of anchovies, sardines and sprats between 2013 and 2018.

i) **Pelagic trawl surveys in Bulgarian marine area** (Violin Raykov, Maria Yankova, Petya Ivanova, Veselina Mihneva, Dimitar Dimitrov, Kremena Stefanova, Elitsa Stefanova, Ilian Kotsev, Nina Dzembekova, Nelly Valcheva, Dobroslav Dechev, Hristina Stamatova, Svetla Koleva, Peter Trandafilov)

Pelagic Trawl Survey was accomplished in November-December 2018 in the Bulgarian Black Sea area. Scientific team has produced a biological analysis of the results obtained in the marine area.

The pelagic survey was carried out in November-December 2018 in the Bulgarian Black Sea area. Biological analysis was based on the biomass of the species found during the

study. In addition, an analysis of the distribution and presence of the other species caught as by-catch is presented. The Black Sea Sprat (*Sprattus sprattus*) is a key species for the Black Sea ecosystem. Together with the anchovy, sprat is one of the most abundant, planktivorous, pelagic species. The level of its stocks depends on the conditions of the environment mainly and on the fishing effort.

The changes in the environment due to anthropogenic influence, affect the dry land as well as the world ocean. The level of the sea pollution and its "self-purifying" ability are completely different. There is a clear indication of changes in the nature equilibrium in the corresponding ecological niches.

The greatest impact in the world ocean has the commercial fishery, which directly devastates a significant part of the given species populations. As a result of this some of the species stocks are declined or depleted.

As a result of the excessive exploitation, altered habitats and climatic variations numerous of the commercial species are critically endangered or vulnerable.

The abundance of the given fish species generations is dependent on different abiotic and biotic factors. With great importance are: the level of fishing mortality, changes in trophic levels due to mass occurrence of the ctenophore *Mnemiopsis leidyi*, algal blooms which lead to hypoxia in the shallower waters with mass mortality of the bottom dwelling organisms and etc.

Recent state of the sprat stock biomass (aggregations) off Bulgarian Black sea coast show relative stability i.e. taking into consideration almost constant level of exploitation (in western and north-western part of the Black Sea) in the last years the stock possibly is underexploited yet. Estimates of the numbers and size distributions of fish stocks based on experimental trawling have become a necessity in fisheries management (Godø, 1990). The main assumption in these studies is that the level of catches are constant, no matter how long the trawling is. Any deviation from the linear dependence between the catch and the magnitude of the effort applied to the fishery can have a significant impact on the composition of the catches and the estimates of the numbers and to deviate from the results of the trawl studies (Wassenberg et al., 1998). The duration of the fishing effort during the trawling period may last up to 200 min (Godø, 1990), but for economic reasons, together with the need for multiple reps and maintaining statistical validity, the duration of trawling is reduced. Thus, the standard trawl duration varies from 30 to 120 minutes for each selected station. Some authors (Godø, 1990; Wassenberg et al., 1998; Somerton et al., 2002) allow larger specimens to swim in the trawl without entering the bag and that trawls of varying lengths may affect the levels the catches and the size distribution of the trawl. In this way, some size groups may not be captured in short-haul trawls. The average catch (in units of weight or in units) per unit of effort or per unit area is the inventory of the

stock (assumed to be proportional to the stock). This index can be converted into an absolute measure for biomass by the so-called Area Method ". The "area method" is the so-called holistic methods (www.fao.org).

All analyses are based on the biomass and density estimates and by geographical strata. All the teams calculated their standard statistical estimates using the same software.

This report presents successively the results obtained at these two levels. The regional reports are presented in an order following the coast, from the northern to southern part of the Black Sea. The document is completed by a series of tables and figures related to the biomass/abundance indices and length frequency distributions of the species included in the reference list.

Figure I1. Catches in trawl codend (credit: V. Raykov)

Pelagic Trawl survey was accomplished with accordance with National Programs for Data Collection in Fisheries sector of Bulgaria for 2015. The study held during the period of December 2015, in the area enclosed between Durankulak and Ahtopol (Bulgaria) with total length of coastline of 370 km. Study area encloses waters between 42o05’ and 43o45’ N and 27o55 and 29o55 E.

During the survey, total 36 mid-water hauls were carried out in Bulgarian area (November- December 2018). The survey undergoes during the day and the following types of data were collected:

- Coordinates and duration of each trawl
- Sprat total catch weight
- Separation of the by-catch by species
- Composition of by-catch
- Conservation of the samples

Presentation on the acoustic surveys conducted within the framework of GFCM - BlackSea4Fish project and the planned GFCM joint surveys in the Mediterranean (Ali Cemal Gücü)

Within 2018, two hydro-acoustic surveys were conducted in the Black Sea. The first was conducted with RV BILIM-2 of the Middle East Technical University and the survey covered the entire Turkish EEZ. Unlike previous surveys conducted in the Turkish EEZ, the survey also aimed at developing a common hydro-acoustic protocol for the Black Sea. To this end, experts from five of the six Black Sea countries participated in the survey within the framework of the GFCM's newly launched BlackSea4Fish project. The survey was basically carried out in accordance with the principles of MEDIAS. One of the topics discussed was to identify the causes of the difference between the acoustic records collected day and night and the methods that could be applied to standardize them. It was noted that, during the day, the target species, the Black Sea anchovy in particular, come together to form very dense aggregations, so the probability of encountering these aggregations is reduced, and the schools encountered are represented by very high NASC values. At night, aggregations are dispersed and the probability of encountering fish is increased remarkably, but the NASC values of the schools are much lower than those recorded during the day. Different statistical models were used for standardization of day and night recordings, but results were not found satisfactory.

The second survey was conducted with a Turkish research, RV SURAT-1 of SUMAE within the Georgian territorial waters upon the invitation of the Georgian Ministry of Environmental Protection and Agriculture of Georgia, with the support of the GFCM-BlackSea4Fish project. The biomass and distribution of the Black Sea anchovy overwintering in Georgian territorial waters was estimated during the survey. The comparison of the behavior of the overwintering anchovies in the Turkish and

Georgian waters displayed significant differences, especially with respect to aggregations formed during the day time.

In addition to the two surveys conducted with the framework of GFCM's midterm strategy, one more joint hydro-acoustic survey covering the Algerian waters is planned for the near future.

Discussion on issues related to UE Decision Support Tool (DST) tables

An extensive discussion took place on some issues arisen after revision of DST tables requested to the MEDIAS group by DG-MARE in the period prior to this meeting and aimed at defining these tables that should be used to evaluate the surveys already in place and the new ones proposed for the future.

In particular the discussion considered the aspects of international coordination of the MEDIAS surveys, MEDIAS data accessibility, possible implementations of MEDIAS surveys and MEDIAS expansions in GSA 11 and 19.

Following a summary of the main conclusions:

International coordination of MEDIAS surveys

The MEDIAS group adopted a common protocol since the beginning of the coordinated acoustic surveys in 2009.

The main objectives of standardization already achieved by the group are:

-Survey design was revised based on the output of geostatistical analysis (in the ambit of the AcousMed project aiming the standardization of acoustic surveys in the Mediterranean)

-Defined anchovy and sardine as target species in all areas

-Agreed on a common Target Strength for European sardine (in the ambit of AcousMed project)

-Agreed that all acoustic data collection for echo integration and assessment purposes should be carried out during day time

-A minimum number of CTD casts was agreed on for collecting environmental parameters and calibrate acoustic instruments

-Defined 38 kHz as the leading frequency for assessment

-Defined June to September as the common survey season

- Agreed on standardized otolith reading criteria for age estimation of target species, in accordance to the ICES WKARA2 2016 report

- Agreed on the maturity stage determination in accordance with the ICES WKSPMAT 2009 report

-Achieved the production of joined studies and scientific publications at Mediterranean Sea level

-Institution of a Joint Session every two years with ICES WGACEGG in order to share experience between experts working in the Atlantic Ocean and those working in the Mediterranean Sea

Coordination activities in progress at the moment are:

- Definition of a common TS for anchovy

Data accessibility

-MEDIAS results per survey are presented in the Annual MEDIAS report which is available in the MEDIAS website

-Overall biomass and abundance estimates are available through the DCR Data Call

As the MEDIAS Steering Committee acknowledges the need for MEDIAS data and outputs accessibility it was decided to:

-include annual distribution maps along with the respective metadata information

-Due to the peculiarities of acoustic surveys direct downloading of georeferenced data by third-parties is not possible. In a further step, detailed data per EDSU could be available to third parties through a GEOportal. The third party should send a request and present to the Steering Committee the type of data requested, the purpose for which data are needed and exchange ideas for collaboration

Currently available technical resources in all member states are not adequate to produce a standardized biomass estimate based on acoustics, for the MEDIAS non-target species.

Possible implementation of MEDIAS surveys

If adequate funding becomes available, MEDIAS acoustic surveys could be improved in the future in technology, involving the use of a wider range of frequencies and broadband technology for a better discrimination of pelagic organisms and better results in single target analyses aimed at Target Strength estimation of species of interest. Other possible improvements concern the development of a common database that would respect acoustic data peculiarities and the format and data typology already defined by the MEDIAS group. Another possible improvement could come from plankton sampling for a better knowledge of pelagic ecosystem through an ecosystem approach and also to improve acoustic data analysis through the knowledge of plankton main classes from biological sampling. It would also be possible to study more in detail spawning and nursery areas of target species of MEDIAS surveys.

MEDIAS expansion in GSA 11 and 19

Information on the state of small pelagic fish species is becoming more and more crucial in the Mediterranean Sea, given the overexploitation conditions that most of the pelagic stocks are facing in this area. The possibility to expand the areas explored by acoustic surveys, covering those GSAs that by now are still uncovered, have been stressed several times at EU and GFCM level in order to fill the gaps in the spatial distribution of the stocks, giving a clearer picture of the situation for the whole Mediterranean Sea. In this ambit, considering the extensive shorelines of EU countries involved in MEDIAS project GSA 11 (Sardinia) and GSA 19 (western Ionian Sea) remained uncovered until now. The MEDIAS Steering Committee feels that coverage of these new areas will improve the general knowledge on these species and may help in the interpretation of what is happening in the neighbor areas.

Remarks

The MEDIAS Steering Committee wants to point out that conditions to carry out the activities are not always optimal in terms of bureaucracy at MS level (e.g. authority response times, signed contracts, timely funding, etc.) and available facilities (in particular the research vessel time). At the same time, acoustic research should be carried out with adequately equipped vessels only. Such vessels currently cannot be found within the Mediterranean commercial vessel fleet. These problems sometimes can prevent a satisfactory conduction of the activities with delays or working in not very good conditions.

Biomass estimation and relative CV calculation with EchoR

Tests in EchoR concerning biomass and relative CV estimation were done and presented at the meeting.

HCMR used EchoR both in the Aegean Sea (GSA 22) and in the Eastern Ionian Sea (GSA 20). They used a single depth layer, single species approach, haul merging when needed to calculate biomass per size/age and finally calculations where divided by sub-areas.

The two methodological approaches of “nearest haul” and “haul decided by operator” were tested and gave provided similar results. It was clear that in areas with peculiar topography like the eastern Ionian Sea and the Aegean Sea, EchoR should be used by splitting the total area into sub-areas. For example, Amvrakikos Gulf in eastern Ionian Sea should be estimated separately as high abundances of anchovy and sardine are observed in this area.

EchoR presents big advantages regarding the fast spatial representation of the results and identifying inter-annual differences, having also the possibility to represent spatial distribution of biomass per age class.

In general, the impression is that estimates in EchoR differs from traditional calculation of abundance in case of huge differences in abundance among sub-areas, thus in this case working in sub-areas is recommended. CV values reflects the uncertainty of sampling design respect to the spatial aggregation patterns of the target species, rather than the uncertainty of total abundance estimates.

Biomass calculation with EchoR was also tested in GSA 1 and 6 by IEO. Anchovy biomass estimated via EchoR resulted similar to traditional calculation, but not numerical abundance, while for sardine and other species, scarce in the area, the results were different. Length frequency distributions were similar for anchovy, but different for sardine. Estimates for *Scomber colias* were similar, while *Trachurus trachurus* differed for the bigger individuals, while juveniles were similar. The main issue with the use of EchoR is in the use of the routines due to the scarce documentation available. However, the group encouraged the use of EchoR.

Summary of joint session WGACEGG/MEDIAS 2018

Andrea De Felice reported a summary of the main topics of interest arising from last Joint Session of WGACEGG/MEDIAS held in Nantes in November 2018.

There were presentations of Atlantic and Mediterranean surveys; in particular for the Mediterranean Sea: Aegean Sea, Eastern Ionian Sea, Western Adriatic Sea surveys (via Skype call) and Eastern Adriatic Sea acoustic surveys were presented. CNR-IRBIM (Ancona) and CNR-IAS (Capo Granitola) followed the discussions via Skype.

Among all the activities presented at the meeting some aspects particularly interesting for the MEDIAS group that were discussed concerned: 1) ecosystem approach of many surveys held in the Atlantic Ocean, 2) effect of ping rate on biomass estimation of anchovy juveniles biomass (Boyra et al.), 3) use of additional purse seiners to the research vessel *Noruega* in use during PELAGO survey (Angelico et al.), 4) study on surface schools in spring in Bay of Biscay with implications on biomass estimation, 5) *ex situ* TS measurement in anchovy in an harbor cage (Sobradillo and Boyra), 6) Echosonde and Phoenix projects aimed at the study of the impact at sea from large scale offshore windfarms using innovative broadband technology (SIMRAD EK80) (Doray et al.).

Discussion and definition of the contributions for the MEDIAS Special Issue 2020 on Mediterranean Marine Science

An extended discussion took place concerning the Special Issue dedicated to MEDIAS research in the journal “Mediterranean Marine Science”. The topics defined included:

- History of acoustic surveys in the Mediterranean Sea
- Biogeography of the Mediterranean Sea derived from pelagic hauls during acoustic surveys
- Anchovy TS study from monospecific hauls data
- The characteristics of small pelagic fish aggregations as determined by acoustic surveys

- Density dependent effects on small pelagic fish spatial distribution
- Comparison of daytime and nighttime acoustic data
- Study on small pelagic fish aggregations in relation to density and environmental conditions
- zooplankton determination by means of acoustics
- Stock structure and genetic diversity in Adriatic Sea anchovy
- Essential fish habitat for horse mackerel juveniles
- Environmental indices and spatial structure of oceanographic parameters and sound fields in different MEDIAS areas
- Use of data from acoustic survey for seabed mapping
- Space occupation dynamics for horse mackerel in the Mediterranean Sea
- Study on length at first maturity of anchovy in the Mediterranean Sea based on acoustic survey biological sampling
- Study on temporal trends of *Sprattus sprattus* and *Sardinella aurita* in relation with environmental parameters in the Mediterranean Sea
- Study on interactions between invasive ctenophore (comb jelly) *Mnemiopsis leidyi* and anchovy's spatial distributions obtained by acoustic surveys

General plans for data preparation and submission by each involved group and data analysis were drafted, with the aim to complete articles by the 15th of January 2020.

Discussion on the results of otolith reading intercalibration exercise by experts working in the Mediterranean Sea and Atlantic Ocean

An intercalibration exercise on anchovy age readings was held in 2018.
The main aim was to check the adoption of the protocol proposed during WKARA2 Meeting and verification of age readings correspondences among different groups.
One possible cause of problems has been identified in the possibility that growth factors may change in time bringing to differences in the link between age and length.
The highest percentages of agreement were identified in area expert readers regarding their own samples; whereas the main problems were found for anchovy adults readings in the Bay of Biscay, maybe due to problems related to growth patterns.
The most critical ages were found to be ages 4 and 5. In general agreement was low and similar to the exercise held in 2014.
The preparation of a set of validated otolith readings per area was recommended and also frequent exchanges among readers; one other useful element would be to strengthen knowledge of daily rings readings.
Another exercise is foreseen for 2021.

MEDIAS Handbook updates

The group discussed some improvements to be introduced to MEDIAS Handbook. These updates were directly put in the last version of the Handbook in appendix to this report.

Terms of Reference for the “MEDIAS 2020”

General:

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

Specific:

- Update MEDIAS handbook;
- Update the MEDIAS Website;
- To update the common work on the Special Issue in Mediterranean Marine Science foreseen for 2020;
- Work on geostatistical scripts to produce standardized NASC maps at the Mediterranean scale;
- Work/Update on EchoR adaptation and application by MEDIAS groups.

Conclusions and decisions of the MEDIAS Steering Committee

In the 12th MEDIAS meeting the results of the acoustic surveys carried out in 2018 were presented by participants of all the countries working in MEDIAS: Spain, Greece, Italy, France, Slovenia and Croatia. Moreover, results from the surveys carried out in 2018 by Romania, Bulgaria and Turkey in the Black Sea were also presented.

EchoR

After presentations of the work done in some areas to compare original workflows by MEDIAS groups and biomass estimation with EchoR, it was decided to continue with the efforts to translate workflows adopted by MEDIAS groups into the software developed by IFREMER.

CV estimation

As this issue was considered very important and urgent, the adoption of the script developed by Marco Barra for CV estimation based on geostatistics was endorsed by the Steering Committee and agreed that this will be used whenever CV of biomass estimations will be requested.

MEDIAS proposals

MEDIAS group agrees to continue submitting its proposals at RCG meetings, but evaluate also the possibility to look for other ways to proceed with the proposals with specific projects at various levels or under the umbrella of GFCM activities.

MEDIAS group is proposing the building of a **common database** through a specific project, based on the past decisions concerning the common format of the database during AcousMed project and during some of the previous MEDIAS Coordination Meetings. Another proposal is the **intercalibration exercise** among the MEDIAS groups to be conducted at a unique location with all the research vessels and equipment in use during MEDIAS surveys. MEDIAS group proposes also the introduction of a **plankton monitoring** activity synoptically with MEDIAS acoustic surveys to be added to the DCF to improve the knowledge useful for acoustic signals discrimination (mainly fish from plankton) and to improve ecosystem knowledge by adding information on small pelagic fish preys in an ecosystem approach perspective. See Annex B for further details.

MEDIAS international coordination, data accessibility, implementations and proposal for expansion in uncovered areas

The conclusions relative to this section have been exposed in detail in the dedicated chapter above. A paragraph on MEDIAS data availability has been added in MEDIAS Handbook (see Annex IV).

Journal Special Issue

Several proposals for articles to be submitted for inclusion in the Special Issue dedicated to MEDIAS foreseen in 2020 in ”Mediterranean Marine Science” were illustrated and general plans for data preparation and analysis were defined. Work will continue by mail and eventually by Skype calls throughout the year in order to prepare the articles by January 2020.

MEDIAS website

It was decided to prepare maps of anchovy and sardine spatial distribution, as ICES WGACEGG is doing from several years, at MEDIAS level. Maps will be at Mediterranean scale and divided by period: 1) June-July and 2) September-October. A preliminary test will be made with 2018 data.

MEDIAS handbook

Some aspects of MEDIAS Handbook were updated in the last version of the Handbook in appendix to the report (Annex IV) on the base of the discussion during the meeting.

The MEDIAS Steering Committee approved the Terms of Reference for “MEDIAS 2020”.

Dr. Vjekoslav Ticina was elected new Chairman of MEDIAS.

Finally, the location for the 13th MEDIAS meeting will be probably Ljubljana, Slovenia, even if it has to be confirmed; dates will be 31 March - 2 April 2020.

Annex I: List of participants

Name	e-mail	Country	Institution
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Zakarias Kapelonis	zkapelonis@hcmr.gr	Greece	HCMR

Annex II: Institutions Acronyms

FRIS: Fisheries Research Institute of Slovenia. Ljubljana, Slovenia

HCMR: Hellenic Center of Marine Research, Greece

CNR-IAS: Consiglio Nazionale delle Ricerche. Istituto per lo studio degli impatti Antropici e Sostenibilità in ambiente marino (IAS). Capo Granitola, Italy

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

IEO: Instituto Español de Oceanografía. Spain

IO-BAS: Institute of Oceanology - Bulgarian Academy of Sciences. Bulgaria

IOF: Institute of Oceanography and Fisheries. Split, Croatia

INRH: Institut National de recherche halieutique. Morocco

INSTM: Institut National des Sciences et Technologies de la Mer. Tunisia

CNR-IRBIM: Consiglio Nazionale delle Ricerche. Istituto per le Risorse Biologiche e le Biotecnologie Marine. Ancona, Italy

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

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

NIMRD: National Institute for Marine Research and Development "GRIGORE ANTIPA". Romania

Annex III: Agenda of the 12th MEDIAS Coordination Meeting (Mediterranean International Acoustic surveys)

Athens, Greece, 9-11 April 2019

Draft Agenda

Tuesday 9/04/2019

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

09.30-09.50: Presentation of the Adriatic acoustic survey in the eastern part of GSA 17 (Vjekoslav Tičina et al.)

09.50-10.10: Presentation of the Adriatic acoustic surveys in the western part of GSAs 17 and 18 (Iole Leonori, Andrea De Felice, Giovanni Canduci, Ilaria Biagiotti, Ilaria Costantini, Sara Malavolti)

10.10-10.30: Presentation of the Iberian acoustic survey (Magdalena Iglesias, Ana Ventero, Pilar Cordoba)

10.30-10.50: Presentation of Eastern Ionian acoustic survey (Athanassios Machias, Marianna Giannoulaki, Maria-Myrto Pyrounaki, Aris Kapelonis)

10.50-11.10: Presentation of the acoustic surveys in GSA 16 (Angelo Bonanno, Gualtiero Basilone, Marco Barra, Simona Genovese, Rosalia Ferreri, Roberta Mifsud, Reno Micallef)

11.10-11.40: *Coffee break*

11.40-12.00: Presentation of the acoustic surveys in GSAs 9 and 10 (Angelo Bonanno, Gualtiero Basilone, Marco Barra, Simona Genovese, Rosalia Ferreri)

12.00-12.20: Presentation of the acoustic survey in the Gulf of Lion (Tarek Hattab, Jean Herve Bourdeix)

12.20-12.40: Presentation of Romania survey in the Black Sea (Valodia Maximov et al.)

12.40-13.00: Presentation on the acoustic surveys conducted within the framework of GFCM - BlackSea4Fish project and the planned GFCM joint surveys in the Mediterranean (Ali Gucu et al.)

13.00-14.30: *Lunch break*

14.30-14.50: Pelagic trawl surveys in Bulgarian area (Raykov et al.)

14.50-16.00: Discussion on issues related to UE DST tables for surveys evaluation

16.00-16.30: *Coffee break*

16.30-18.00: Work on R script for CV estimation for MEDIAS surveys

Wednesday 10/04/2019

09.00-10.00: Summary of Joint Session ICES WG ACEGG-MEDIAS 2018

10.00-11.00: Discussion and definition of the contributions for the MEDIAS Special Issue 2020 on Mediterranean Marine Science

11.00-11.30: *Coffee break*

11.30-13.00: Discussion and definition of the contributions for the MEDIAS Special Issue 2020 on Mediterranean Marine Science (continues)

13.00-14.30: *Lunch break*

14.30-16.00: Discussion and definition of the contributions for the MEDIAS Special Issue 2020 on Mediterranean Marine Science (continues)

16.00-16.30: *Coffee break*

16.30-18.00: Discussion and definition of the contributions for the MEDIAS Special Issue 2020 on Mediterranean Marine Science (continues)

Thursday 11/04/2019

09.00-10.00: General discussion and revision of the common MEDIAS protocol – presentation on otolith readings (Walter Basilone)

10.00-11.00: Update of MEDIAS Handbook

11.00-11.30: *Coffee break*

11.30-12.00: Election of a new Chair

12.00-13.00: Terms of reference for the next meeting (2020); dates and venue of next meeting

13.00-14.30: *Lunch break*

14.30-16.00: Draft report and 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.

References can also be found on MEDIAS website:

http://www.medias-project.eu/medias/website/

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). NM = nautical miles

Country	Institute	Geographical area	Size of area	Standard number of days
Greece	HCMR	Aegean Sea	9000 NM^2	40
Greece	HCMR	Eastern Ionian Sea	2800 NM^2	30
France	IFREMER	Gulf of Lion	3300 NM^2	30
Slovenia	CNR-IRBIM/FRIS	Adriatic Sea (Slovenia)	117 NM^2	1*
Italy	CNR-IRBIM	Adriatic Sea (Italy)	13200 NM^2	40
Italy	CNR-IAS	Sicily Channel	4300 NM^2	16**
Italy	CNR-IAS	Tyrrhenian Sea	6644 NM^2	30
Spain	IEO	Iberian coast	8829 NM^2	33
Croatia	IOF	Adriatic Sea (Croatia)	13578 NM^2	30
Bulgaria	IO – BAS	Black Sea	3400 NM^2	20

Romania	NIMRD "Grigore Antipa"	Black Sea	4300 NM^2	20

* There is an agreement between Italy and Slovenia to extend the Italian acoustic survey in Slovenian waters

** This area includes both Sicily Channel and Maltese waters (GSA 15) due to an agreement between Italy and Malta

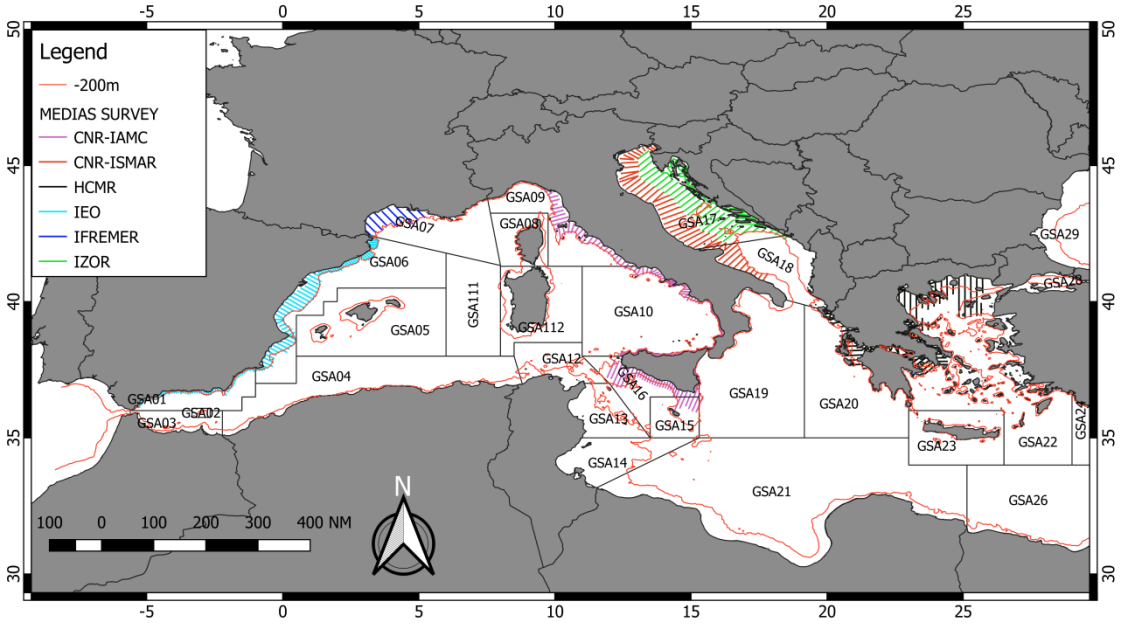

Figure 1: Surveys design in the MEDIAS.

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 following vessel characteristics should be reported: name of vessel, vessel length and vessel HP.

2. Echo sounder parameters

A variety of equipments with specific characteristics could be considered as adequate for the assessment of small pelagics. 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 18, 70, 120, 200 and 333 kHz can operate as complementary frequencies, depending on the research vessel used.

The pulse duration should be 1 ms; a pulse duration of 0.5 ms will be used only in case of Target Strength specific experiments. The threshold for assessment should be -70 to -60 dB 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 echo-sounder and according to the principles described by Demer *et al.* (2015). 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)	
Echo-sounder 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	

Calibration report	
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 along 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 (Anonymous, 2012) 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 day-time, 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:

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

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 Lion 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 b_{20} 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, Echoview or alternative Movies 3D 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.

A script in R to calculate geostatistical CV associated with biomass estimates from acoustic survey, based on Walline et al. (2007), has been created by Marco Barra (CNR) and tested by all MEDIAS groups. This script is considered mandatory to calculate geostatistical CV to be provided along with acoustic estimates.

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 echo-sounder 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 grids, 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 night-time 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 percentage by weight 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 (Machias et al., 2013). 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 interval 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 hauls 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.

Otolith reading criteria for anchovy and sardine should be in accordance with ICES WKARA2 report (2016) and follow the recommendation of that meeting. In particular the 1st of January should be considered the birthdate for anchovy from an assessment point of view in relation to time-steps in the assessment.

It is strongly recommended the use of ICES WKSPMAT report (2009) scale during the lab processing for classifying the reproductive phase for anchovy and sardine, particularly for identifying mature/immature which are very relevant to stock assessment purposes, in order to obtain the L_{50} estimation. This scale allows reaching a higher accuracy since it has been developed specifically for small pelagics (indeterminate spawners).

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 hydrographic 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. Database

In the framework of the AcousMed project as well as a MEDIAS workshop, a common database design has been decided 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. Ecosystem Indicators related to acoustic surveys

The abilities of currently applied MEDIAS surveys to contribute towards an ecosystem based management approach in relation to the current and the future DCF requirements was extensively discussed by the MEDIAS partners. In the following table the ecosystem indicators that can derive from acoustic surveys (based on data regularly collected and analyzed) are reported.

Good Environmental Status indicators	Spatial/temporal strata	Spatial strata	GSA				
			Acoustic survey				
		Time periods	Season (Summer/Autumn depending on the area)				
	Taxonomic levels	Community	Pelagic fish (Species composition, occurrence in pelagic hauls)				
		Target Species	Adult	Anchovy			
				Sardine (for Mediterranean)			
				Sprat (for Black Sea)			
	Indicators	Biodiversity	Species	Population size	Acoustic estimates	Total biomass & abundance estimates for target species	
						Estimation error (CV) (i.e. as agreed based on a common estimation procedure, see ToRs)	
				Population condition	Biomass & abundance estimate per size/age	Anchovy, Sardine, Sprat (Black Sea)	
					Recruitment index	Sardine (i.e. Number at Age 0 of the population based on summer surveys)	
				Habitats	Habitat condition	Hydrological condition	Temperature (i.e. SST: average at 10m, estimated as the interpolated mean value for the whole area)
							Salinity (i.e. SSS: average at 10m, estimated as the interpolated mean value for the whole area))
			Community	Fish Community condition	Community Synthesis	Total pelagic fish NASC	
					Species composition (i.e. percentage in terms of weight of pelagic trawls per hour)*		
			Age and size distribution	95% percentile of the population length distribution for the target species			
				Proportion of fish larger than L50 (length at first maturity estimated based on collected data or defined based on literature)			

10. Tables for DCF Data Call

The data and the common format of the Tables for MEDIAS Data Call (e. g. year 2015), regularly provided to the DCF, are the following:

TABLE 1 - BIOMASS medbs.xlsx – biomass per species per sex and length class

COUNTRY	YEAR	START_DAY	END_DAY	START_MONTH	END_MONTH	AREA	NAME_OF_SURVEY	SPECIES	SEX	UNIT	LENGTHCLASS0	LENGTHCLASS1	LENGTHCLASS2	LENGTHCLASS3	LENGTHCLASS4	LENGTHCLASS5	LENGTHCLASS6	LENGTHCLASS7	...
		1<= INTEGER <=31	1<= INTEGER <=31	1<= INTEGER <=12	1<= INTEGER <=12			2015 Data Call. ANNEX 1- Appendix 1.7											
ESP	2014					SA 1, 6	any text of max 10 characters		F	mm									
FRA	2014					SA 7			M	cm									
GRC	2014					SA 19, 22			U										
HRV	2014					SA 17			C										
ITA	2014					SA 16, 17, 18													
MLT	2014					SA 15													
SVN	2014					SA 17													
BUL	2014					SA 29													
ROM	2014					SA 29													

TABLE 2 - ABUNDANCE medbs.xlsx – abundance (in number) per species per sex and length class

COUNTRY	YEAR	START_DAY	END_DAY	START_MONTH	END_MONTH	AREA	NAME_OF_SURVEY	SPECIES	SEX	UNIT	LENGTHCLASS0	LENGTHCLASS1	LENGTHCLASS2	LENGTHCLASS3	LENGTHCLASS4	LENGTHCLASS5	LENGTHCLASS6	LENGTHCLASS7	...
		1<= INTEGER <=31	1<= INTEGER <=31	1<= INTEGER <=12	1<= INTEGER <=12			2015 Data Call. ANNEX 1- Appendix 1.7											
ESP	2014					SA 1, 6	any text of max 10 characters		F	mm									
FRA	2014					SA 7			M	cm									
GRC	2014					SA 19, 22			U										
HRV	2014					SA 17			C										
ITA	2014					SA 16, 17, 18													
MLT	2014					SA 15													
SVN	2014					SA 17													
BUL	2014					SA 29													
ROM	2014					SA 29													

TABLE 3 - ABUND_BIO medbs.xlsx – abundance and biomass per species per sex and age class

COUNTRY	YEAR	START_DAY	END_DAY	START_MONTH	END_MONTH	AREA	NAME_OF_SURVEY	SPECIES	SEX	AGEGROUP0ABUND	AGEGROUP0BIOM	AGEGROUP1ABUND	AGEGROUP1BIOM	AGEGROUP2ABUND	AGEGROUP2BIOM	AGEGROUP3ABUND	AGEGROUP3BIOM	...
		1<= INTEGER <=31	1<= INTEGER <=31	1<= INTEGER <=12	1<= INTEGER <=12			2015 Data Call. ANNEX 1- Appendix 1.7										
ESP	2014					SA 1, 6	any text of max 10 characters		F									
FRA	2014					SA 7			M									
GRC	2014					SA 19, 22			U									
HRV	2014					SA 17			C									
ITA	2014					SA 16, 17, 18												
MLT	2014					SA 15												
SVN	2014					SA 17												
BUL	2014					SA 29												
ROM	2014					SA 29												

11. Common format for presentations at MEDIAS Coordination Meetings

- GSA number and general information on the GSA; map and general information on the acoustic survey
- Type of echosounder and frequencies in use
- Calibration results
- Survey design
- Number of nautical miles effectively processed for biomass estimation
- Biomass estimation results in tons by GSA and graphs in terms of biomass density
- Headline, footrope length of the pelagic net, side lines dimensions, mesh size
- CTD stations map
- Biomass per length classes (0.5 cm) and per age classes in tons
- Graphs of Age Length Keys
- Maps of anchovy and sardine spatial distribution
- Map with pie charts reporting percentages in weight of anchovy, sardine and other species

Other results of interest from acoustic surveys could be also reported but they are not mandatory.

12. Data accessibility

As the MEDIAS Steering Committee acknowledges the need for MEDIAS data and outputs accessibility it was agreed to:

-MEDIAS results per survey are presented in the Annual MEDIAS report which is available in the MEDIAS website
-Overall biomass and abundance estimates are available through the DCR Data Call
-Include annual distribution maps of NASC per species along with the respective metadata information in a GEOportal
-Detailed data per EDSU could be available to third parties through the GEOportal. The third party should send a request and present to the Steering Committee the type of data requested, the purpose for which data are needed and exchange ideas for collaboration.

13. References

Anonymous 2012. “AcousMed: Harmonization of the Acoustic Data in the Mediterranean 2002-2006”. Final Report. MARE/2009/09, 212 pp.

Demer, D.A., Berger, L., Bernasconi, M., Bethke, E., Boswell, K., Chu, D., Domokos, R., et al. 2015. Calibration of acoustic instruments. ICES Cooperative Research Report No. 326. 133 pp.

Machias A., Pyrounaki M.M., Leonori I., Basilone G., Iglesias M., De Felice A., Bonanno A., Giannoulaki M. 2013. Catch of pelagic hauls in Mediterranean acoustic surveys: Is it the same between day and night ? Scientia Marina, 77(1): 69-79.

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.

ANNEX A

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)	18, 70, 120, 200, 333 depending on availability
Pulse duration (ms)	1 ms, 0.5 ms in case of TS experiments
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
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, pie-charts indicating percentage by weight 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
Net-sounder 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 relationships	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

ANNEX B

MEDIAS group proposals:

1) Intercalibration exercise

An intercalibration exercise involving all the MEDIAS groups is proposed. One of the MEDIAS study areas could be selected to host the intercalibration and all the involved research vessels, together with personnel and equipment in use during acoustic surveys should converge there. The procedure to conduct the intercalibration could be the one described in Simmonds and Mac Lennan (2005). Due to the fact that there are more than two vessels operating in MEDIAS surveys, the calibration should proceed in pair (two vessels at a time) conducting more trials.

2) MEDIAS database

MEDIAS group planned the development of a common database for all the partners involved in the project, that would be highly beneficial concentrating the information on small pelagic stocks of different areas of the Mediterranean in the same structure with a standardized format. In order to proceed in this way a proper financial support was requested in order to buy hardware components and software adequate for this aim and contracts for the database technical developers.

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

The major fields agreed were 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. echo-sounder 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)

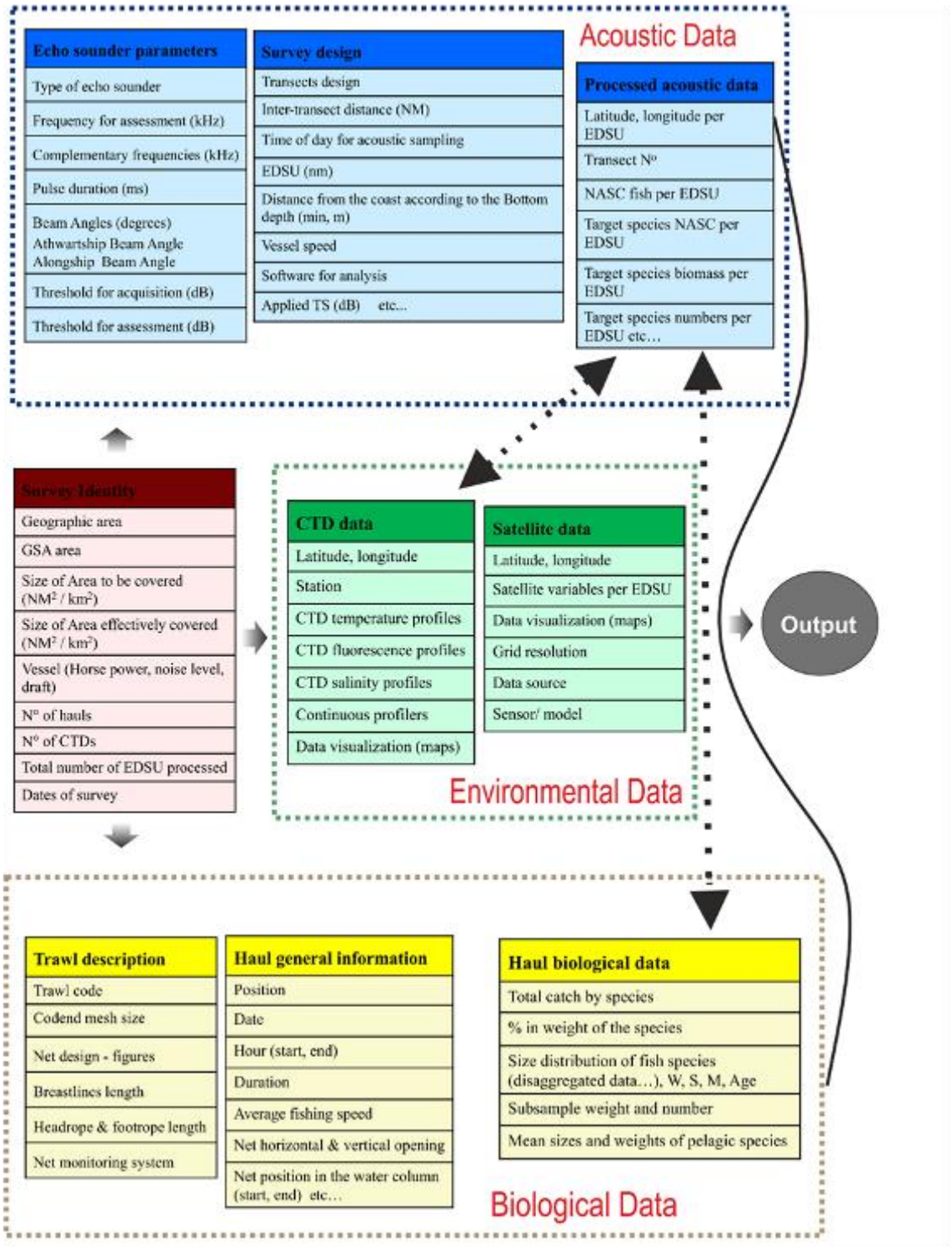

Figure B1. General outline of a database for acoustic surveys

Analytical info per database field are presented below.

Survey Identity
Geographic area
GSA area
Size of Area to be covered (NM^2 / km^2)
Size of Area effectively covered (NM^2 / km^2)
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

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)
Echo sounding depth (min, m)
Echo sounding depth (max, m) recording.
Vessel speed
Software for analysis
File format
Applied TS (dB)

Acoustic Data

Processed acoustic data
Latitude, longitude per EDSU
Transect Nº
NASC fish per EDSU
Target species (i.e. anchovy, sardine) NASC per EDSU
Target species biomass per EDSU
Target species numbers per EDSU
Echogram figures especially related to hauls

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.

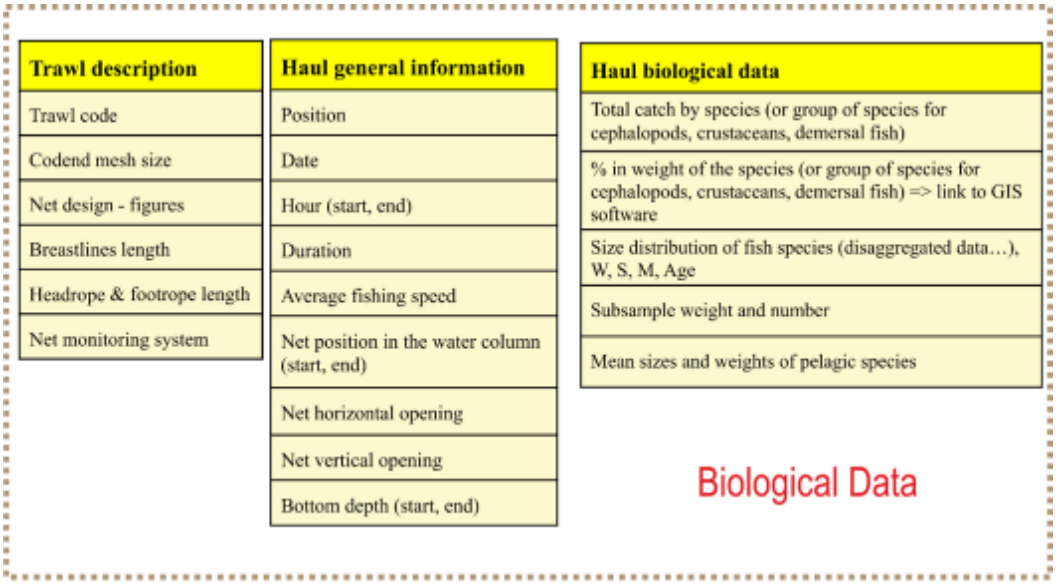

Figure B4. Fields associated with input info on Biological Data related to acoustic surveys

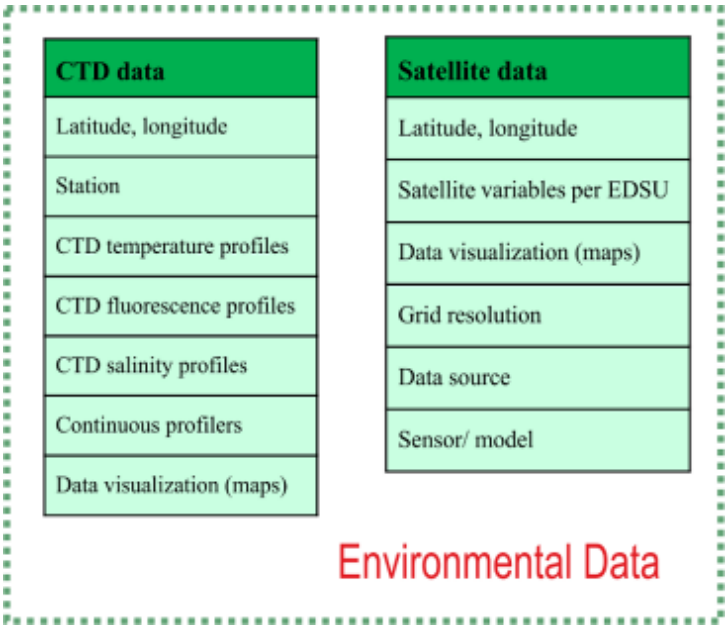

Figure B5. Fields associated with input info on Environmental Data related to acoustic surveys

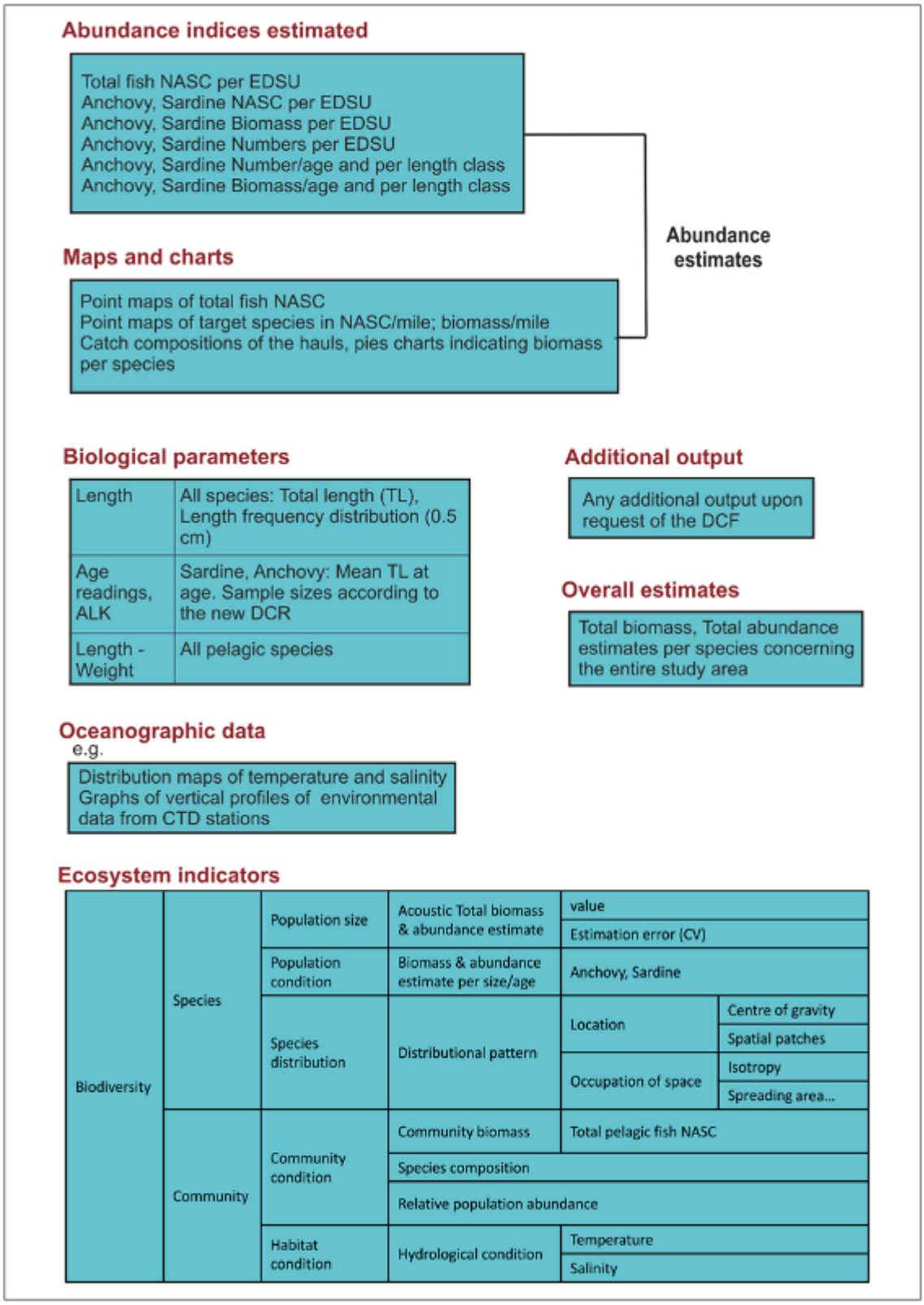

Figure B6. Fields associated with potential acoustic database output

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.

3) Mesozooplankton sampling synoptic with acoustic survey

The MEDIAS Steering Committee discussed in many occasions about the importance to add a sampling on zooplankton to the already foreseen MEDIAS routine activities at sea, and finally agreed to propose that this research topic could be incorporated into the DCF for what concerns acoustic surveys. The reasons for this proposal are numerous. First of all, by knowing plankton abundance it is possible to have an index of productivity, and thus prey availability, that is important in the study of small pelagic fish abundance over the years and of their spatial distribution; this ecosystem indicator could also be important in the Marine Strategy Framework Directive.

Another important element is given by the fact that the sampling activity on plankton would produce a ground truth of some targets in the acoustic data, so that, during the acoustic processing, these targets could be discarded with a higher degree of certainty, while separating the small pelagic fish echoes from unwanted plankton echoes. The accuracy of this process could be further enhanced through the knowledge of the kind of planktonic organisms that are prevalent in a certain area, derived from sample collection by means of the plankton net, due to the fact that different planktonic organisms for anatomic and physiologic characteristics give different responses in multifrequency during the acoustic survey.

The analysis on plankton can also give information on the ichthyoplankton fraction; in this way a deeper knowledge on spawning (from collected eggs) and nursery areas (from collected larvae), at least for anchovy (*Engraulis encrasicolus*), given the survey period, could be gained.

This fact would potentially allow the possibility to explore new management scenarios in the Mediterranean Sea, eventually based on local closures in correspondence of spawning and nursery areas.

The analysis on plankton can also give additional information on the pelagic ecosystem structure and function. The knowledge on zooplankton component in pelagic ecosystem is particularly important because it represent a link between the lowest trophic level (i.e. primary production - phytoplankton) and higher trophic levels (i.e. fish) in the marine food web. Such improved knowledge on marine ecosystem can be considered as necessary precondition in applying ecosystem based management (EBM) in the future, in line with the new CFP.

This proposal concerns the MEDIAS surveys that are held along the Iberian coast (GSA 1 and 6) carried out by IEO (Spain), Gulf of Lion (GSA 7) by IFREMER (France), Sicily Channel (GSA 16) and Tyrrhenian Sea (GSA 9 and 10) by CNR-IAMC (Italy), western Adriatic Sea (GSA 17 and 18) by CNR-ISMAR (Italy), eastern Adriatic Sea (GSA 17) by IOF (Croatia) and eastern Ionian Sea and Aegean Sea (GSA 20 and 22) by HCMR (Greece). All these surveys are conducted in the period June-September.

A proper number of stations (depending on transect length) could be performed along dedicated transects in order to collect information on mesozooplankton with an appropriate resolution.

Most of the MEDIAS groups are already collecting plankton samples, but lack money to produce advanced analyses that could bring to the production of information such as:

- Spawning and nursery areas for anchovy and possibly gilt sardine
- Plankton spatial distribution from acoustic data
- Ecosystem approach, adding information on preys to that of biomass of small pelagic fish

These results could only be achieved with a proper financial support because this analyses need more manpower, more days at sea, specific sampling material etc.