Report of 14th meeting for MEDiterranean International Acoustic Surveys (MEDIAS)

in the framework of European Data Collection Framework (DCF)

Zoom, 20-22 April 2021

Steering Committee Report

Contents

1. Introduction

Due to difficulties caused by COVID-19 that prevented organization of physical 14th annual meeting from being organized in Ljubljana, Slovenia, in April 2021, the MEDIAS (MEDiterranean International Acoustic Surveys) Steering Committee decided to have a virtual meeting. The meeting was held from 20 to 22 April 2021, virtually hosted by Tomaž Modic (FRIS) on Zoom platform and chaired by Vjekoslav Tičina (IOF).

Meeting participants were experts from 8 European Union member states involved in acoustic survey's related activities in the Mediterranean Sea (i.e., Croatia, France, Greece, Italy, Slovenia and Spain) and in the pelagic trawl surveys performed in the Black Sea (i.e. Romania and Bulgaria). In total, 32 participants attended the meeting (see list of participants in Annex I and Institute's acronims in Annex II).

The agenda of the 14th virtual MEDIAS Coordination Meeting (see Annex III) was adopted by all participants.

In accordance to the Agenda adopted, the main aims of the meeting were:

to present the results from the MEDiterranean International Acoustic Surveys (MEDIAS) carried out in 2019 and 2020;

to review information provided by EC representative;

to coordinate and harmonize the acoustic survey's activities to be performed in 2021;

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

to review progress on geostatistical scripts for standardized NASC maps at the Mediterranean scale;

to review progress on EchoR;

to establish the ToRs for 2022.

Following the agenda, during the first day results from the 2019 and 2020 MEDIAS acoustic surveys, carried out by the MEDIAS partners (Fig. 1.1), were presented, as well as results from the pelagic trawl surveys carried out by Romania and Bulgaria in the Black Sea.

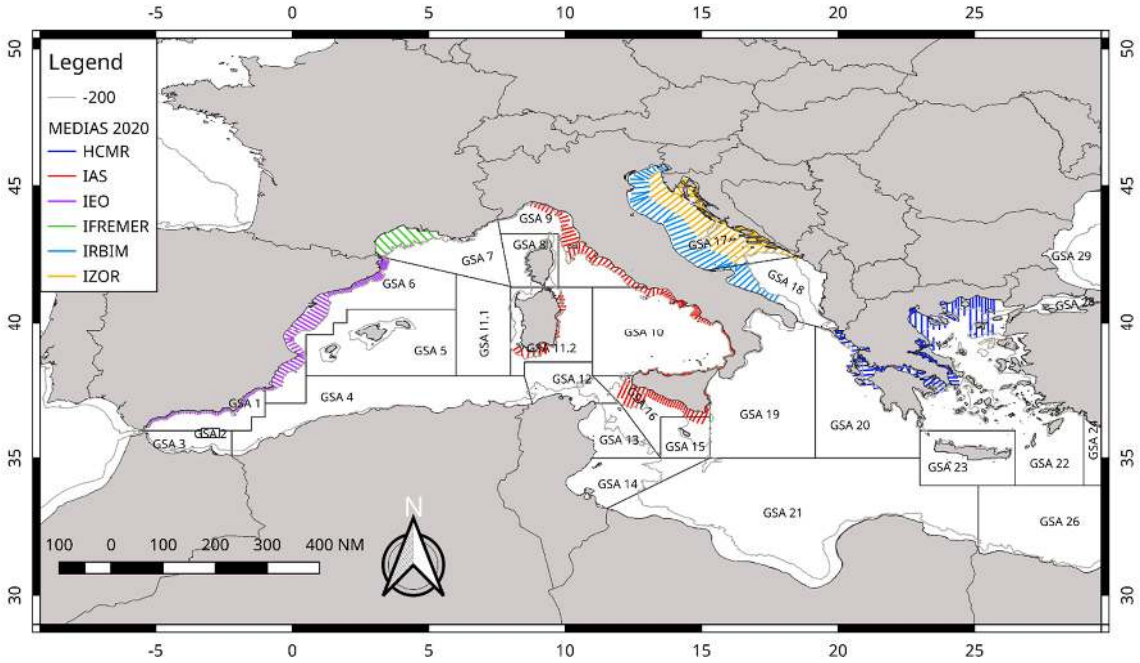


Figure 1.1 Acoustic surveys in the MEDIAS framework during 2020.

2. Results of the surveys carried out in 2019 and 2020 in the framework of the Mediterranean International Acoustic Surveys (MEDIAS)

2.1 MEDIAS 2019 in Iberian coast (ESP): GSA 1 - Northern Alboran Sea and GSA 6 - Northern Spain (Magdalena Iglesias, Ana Ventero, Pilar Córdoba, Pablo Quelle, Nuria Zaragoza, IEO.)

a) General information on the survey

MEDIAS 2019 acoustic survey was carried out in the Mediterranean Spanish waters (GSA06, Northern Spain and GSA01, Northern Alboran Sea) from 27th June to 29th July 2019 (33 days) on board the R/V "Miguel Oliver" (70 m long). Target species were European anchovy (*Engraulis encrasicolus*) and European sardine (*Sardina pilchardus*).

b) Type of echosounders and frequencies in use

The equipment was composed by an EK60 (SIMRAD) scientific echosounder equipped with five frequencies (18, 38, 70, 120 and 200 kHz); a pelagic trawl (15-18 m vertical opening and 20 mm codend), equipped with an FS20/25 (SIMRAD) netsonder and a MARPORT catch sensor placed on the top of the trawl codend. Moreover, two CTD (Seabird 19 plus) were used to collect temperature, salinity, fluorescence and dissolved oxygen data from the water column.

c) Calibration results

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 2.1.1 Calibration results in MEDIAS 2019.

Frequency (kHz)	18 (kHz)	38 (kHz)	70 (kHz)	120 (kHz)	200 (kHz)
Echo-sounder type	EK60	EK60	EK60	EK60	EK60
Transducer type	ES18-11	ES38B	ES70-7C	ES120-7C	ES200-7C
Transducers Serial no.	No data	No data	No data	No data	No data
Vessel	Miguel Oliver	Miguel Oliver	Miguel Oliver	Miguel Oliver	Miguel Oliver
Date	28/06/2019	28/06/2019	28/06/2019	28/06/2019	28/06/2019
Place	Bahía de Palma	Bahía de Palma	Bahía de Palma	Bahía de Palma	Bahía de Palma
Bottom depth (m)	40	40	40	40	40
Temperature (˚C) at sphere depth	23	23	23	23	23
Salinity (psu) at sphere depth	37.4	37.4	37.4	37.4	37.4
TS of sphere (dB)	-34.52	-42.34	-41.66	-39.94	-38.8
Pulse duration (ms)	1024	1024	1024	1024	1024
Ping rate	0.5	0.5	0.5	0.5	0.5
RMS beam	0.19	0.18	0.28	0.25	0.4
Transducer Gain (dB)	22.79	24.32	26.99	27.18	27.31
Sa corr (dB)	-0.7	-0.56	-0.34	-0.25	-0.21
Beam width atwarth(˚)	11.09	6.76	6.24	6.32	5.9
Beam width along(˚)	11.04	6.98	6.53	6.37	6.08
Atwarth offset(˚)	0.05	0.03	-0.01	-0.07	-0.13
Along offset(˚)	0.11	-0.05	0.04	-0.02	-0.12

d) Survey design

Acoustic data were collected during daytime (6:00 am-8:00 pm) over a grid of systematic parallel transects perpendicular to coastline/bathymetry, covering the continental shelf (20-200 m depth) (Fig. 2.1.1). Inter-transect distance was 8 nmi in GSA06 and 4 nmi in GSA01. Vessel speed during acoustic survey was 10 knots.

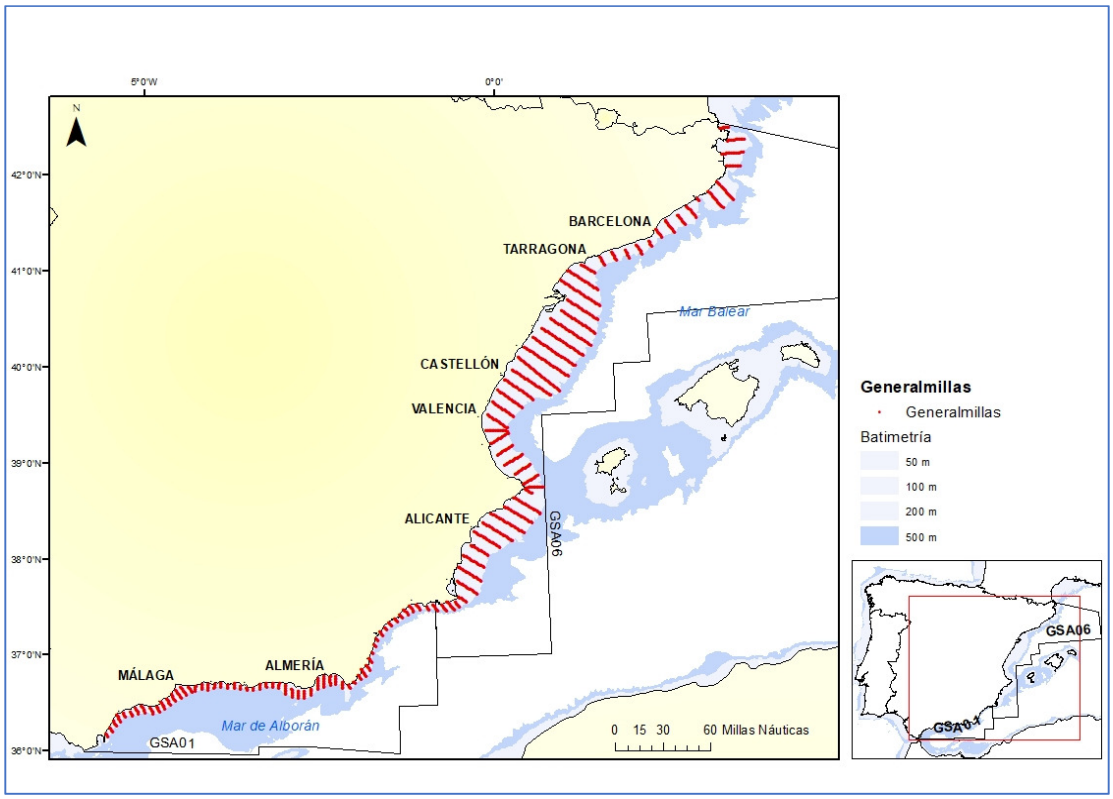


Figure 2.1.1. Acoustic survey design (111 transects, in red); 52 in GSA06 and 59 in GSA01. MEDIAS 2019.

Acoustic data were collected over 1143 nautical miles (nmi) corresponding only to the transects. 865 nmi from GSA06 and 278 nmi to GSA01 (Fig. 2.1.1) were processed.

e) Fish sampling

Forty-one (41) pelagic hauls were carried out in GSA06 and fourteen (14) in GSA01 for the scrutinizing of the echograms (Fig. 2.1.2).

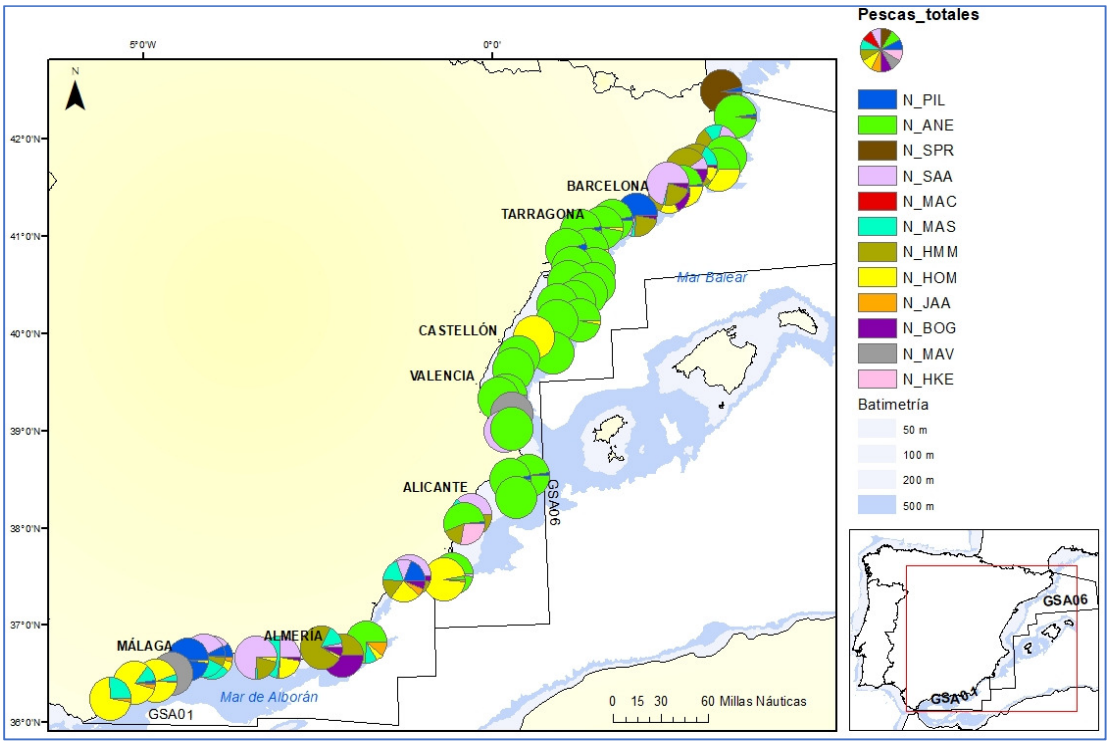


Figure 2.1.2.- Pelagic hauls (55) composition carried out during the Spanish acoustic survey MEDIAS 2019.

f) <u>Oceanographic parameters</u>

In total, 118 CTD stations were performed in GSA06 and 45 in GSA01 (Fig. 2.1.3).

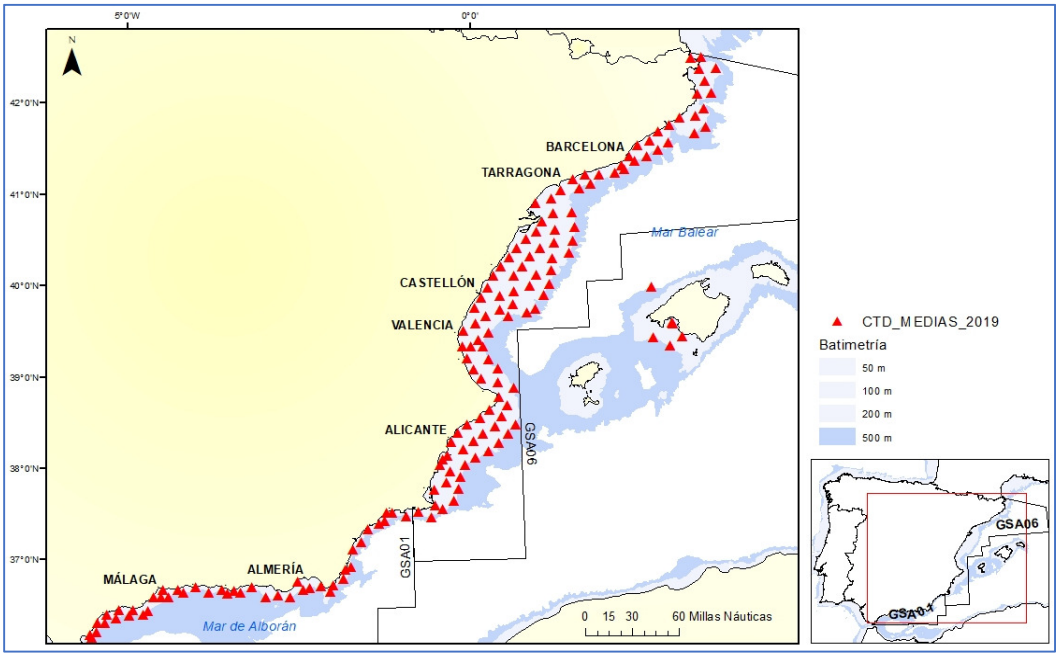


Figure 2.1.3.- CTD stations (163) carried out during the Spanish acoustic survey MEDIAS 2019.

g) Biomass estimations of target species

Biomass of sardine (*Sardina pilchardus*) (Fig. 2.1.4a, b) and anchovy (*Engraulis encrasicolus*) (Fig. 2.1.5a, b) were estimated by GSA: 7036 tons (CV 9) in GSA06 and 1107 tons (CV 13) in GSA01. Recruitment of sardine was low in GSA06 (Fig. 2.1.4a) and it was not detected in GSA01 (Fig. 2.1.4b). Lengths were higher in GSA01 for the same age.

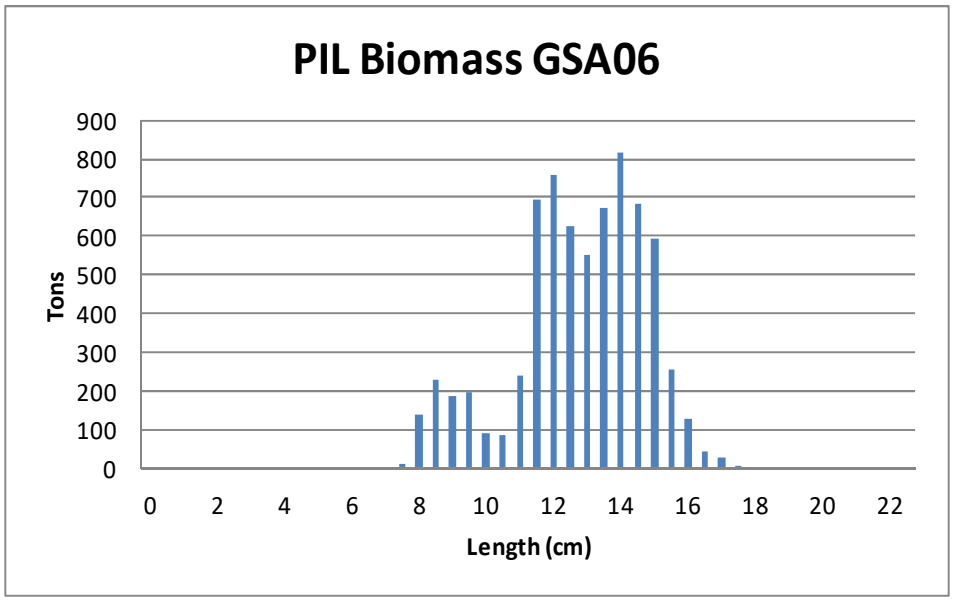


Figure 2.1.4a. Sardine (PIL, FAO code) biomass in tons by length (LFD) in GSA06. MEDIAS 2019.

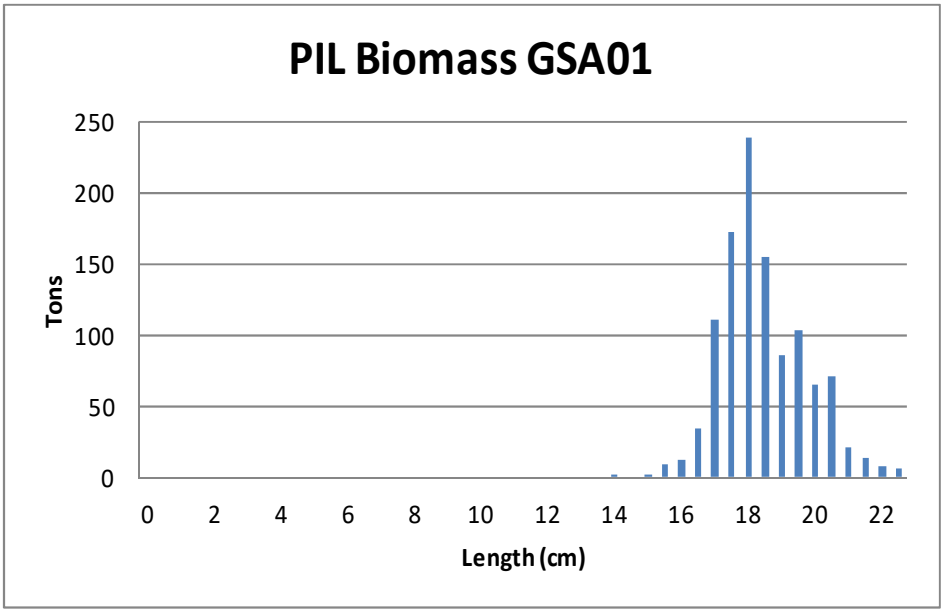


Figure 2.1.4b. Sardine (PIL, FAO code) biomass in tons by length (LFD) in GSA01. MEDIAS 2019.

Biomass of anchovy (*Engraulis encrasicolus*) (Fig. 2.1.5a, b) was estimated by GSA: 82951 tons (CV 7) in GSA06 and 1421 tons (CV 14) in GSA01. Anchovy length frequency distribution was unimodal, both in GSA06 and

GSA01, corresponding to the spawning stock biomass, principally. Lengths were higher in GSA01 than in GSA01, for the same age (Fig. 2.1.5a; 2.1.5b).

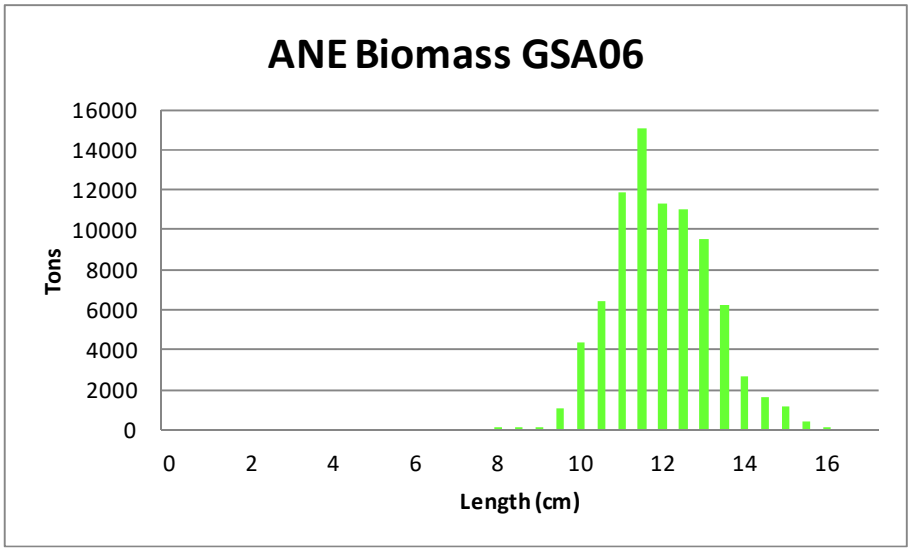


Figure 2.1.5a. Anchovy (ANE) biomass in tons by length (LFD) in GSA06. MEDIAS 2019.

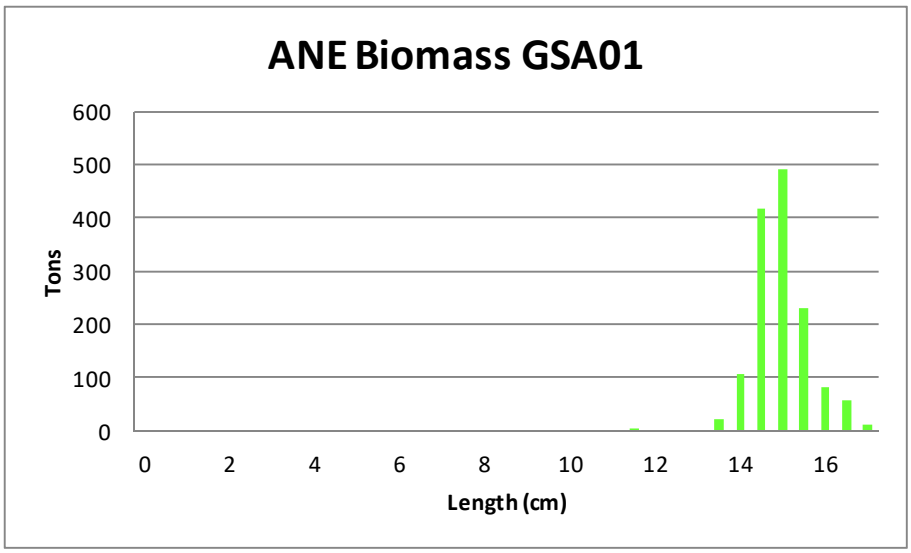


Figure 2.1.5b. Anchovy (ANE) biomass in tons by length (LFD) in GSA01. MEDIAS 2019.

Age length key (ALK) for sardine in GSA06, MEDIAS 2019, was composed by 5 years classes. The number of otoliths readings was 874 (individuals) (Fig. 2.1.6a). In GSA01, the number of sardine otoliths readings was low (252) (Fig. 2.1.6b), the number of age classes were 5, but with a very low number of individuals of age 0 (no recruits).

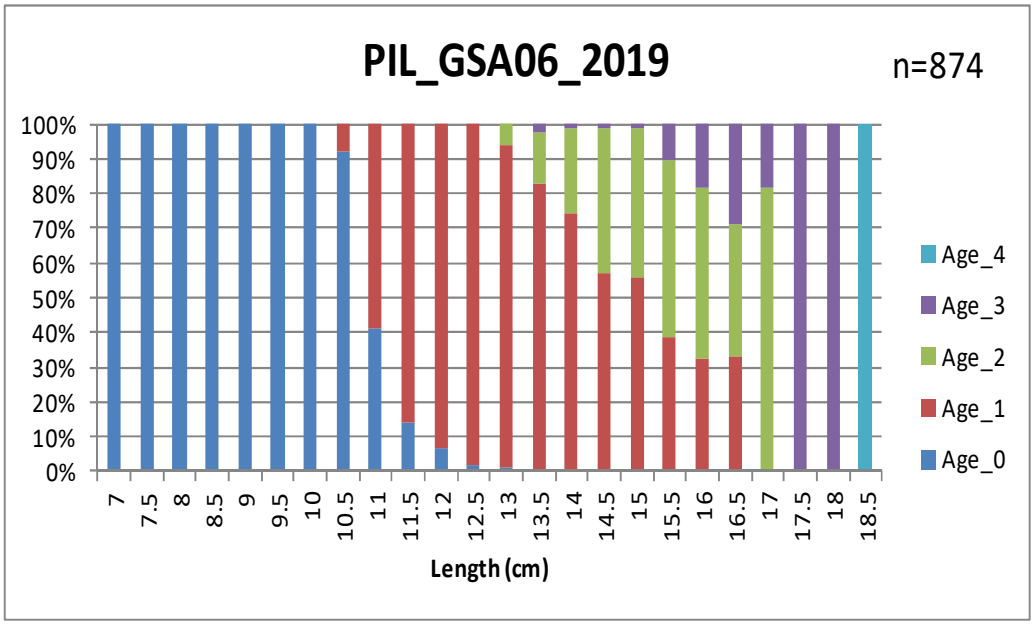


Figure 2.1.6a. Sardine ALK GSA06, MEDIAS 2019.

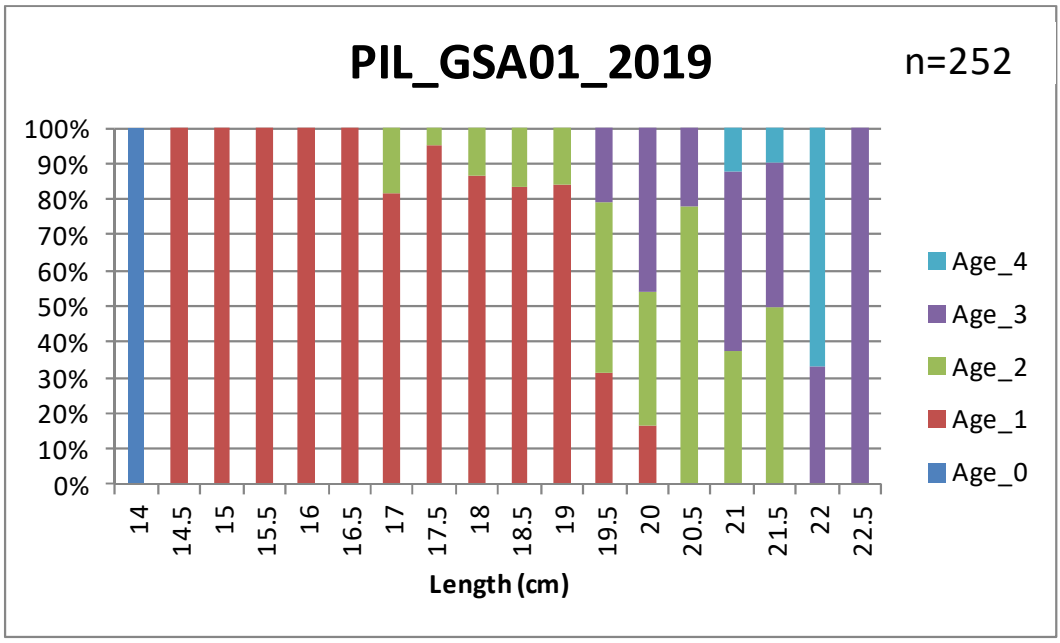


Figure 2.1.6b. Sardine ALK GSA01, MEDIAS 2019.

Anchovy ALK in GSA06, MEDIAS 2019, was represented by 4 year classes (924 pair of otoliths) (Fig. 2.1.7a), and only 3 year classes (0 to 2) were detected in GSA01, with a lower number of otoliths readings (86) (Fig 2.1.7b).

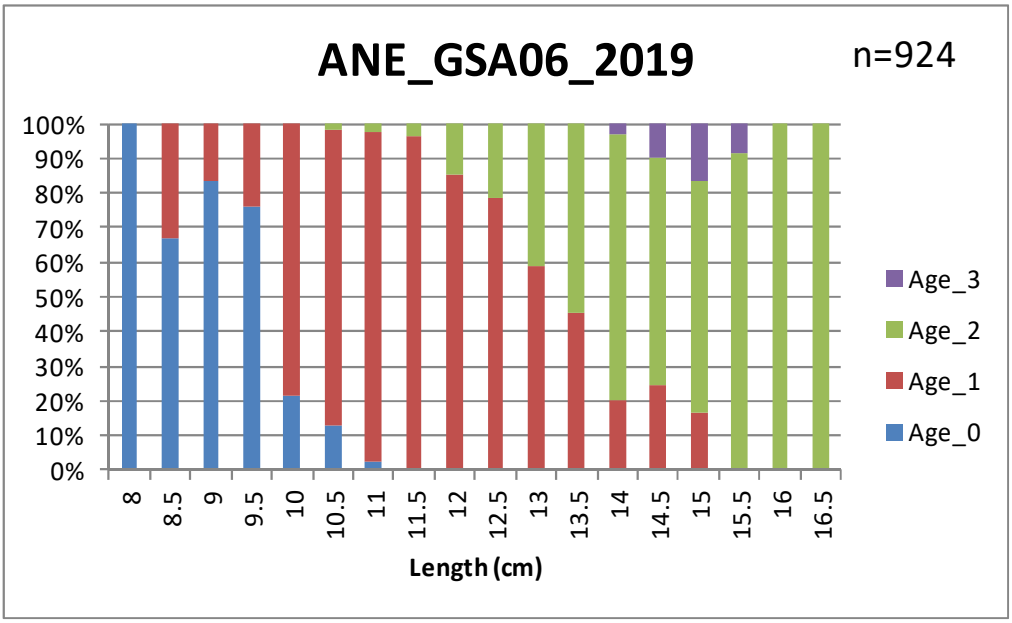


Figure 2.1.7a.- Anchovy AKL GSA06, MEDIAS 2019.

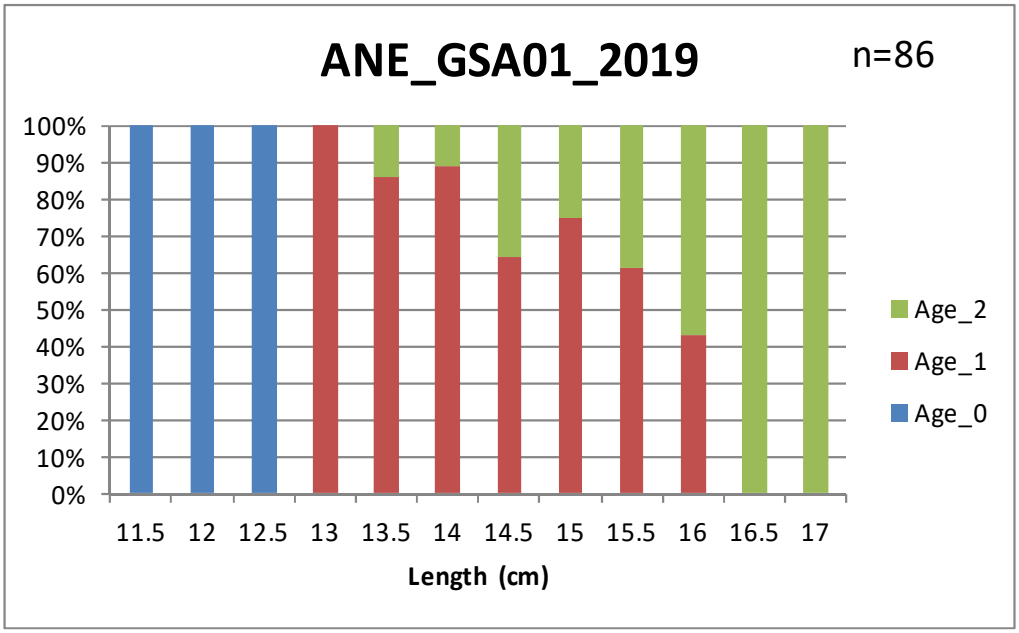


Figure 2.1.7b.- Anchovy AKL GSA01, MEDIAS 2019.

h) Abundance indices of target species

Spatial distribution of sardine and anchovy in GSA 06 and 01 in 2019 (Figure 2.1.8a, b and 2.1.9a, b) was mainly coastal for sardine, and covering all the continental shelf depth for anchovy in both areas.

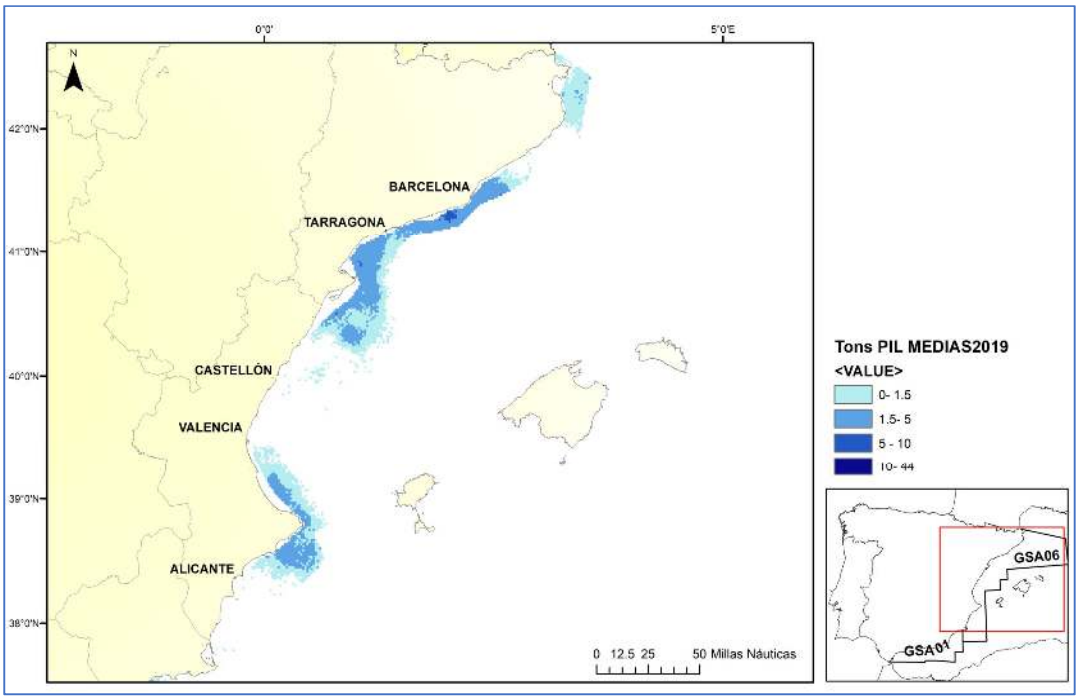


Figure 2.1.8a. Sardine (PIL) spatial distribution in GSA06 in MEDIAS 2019.

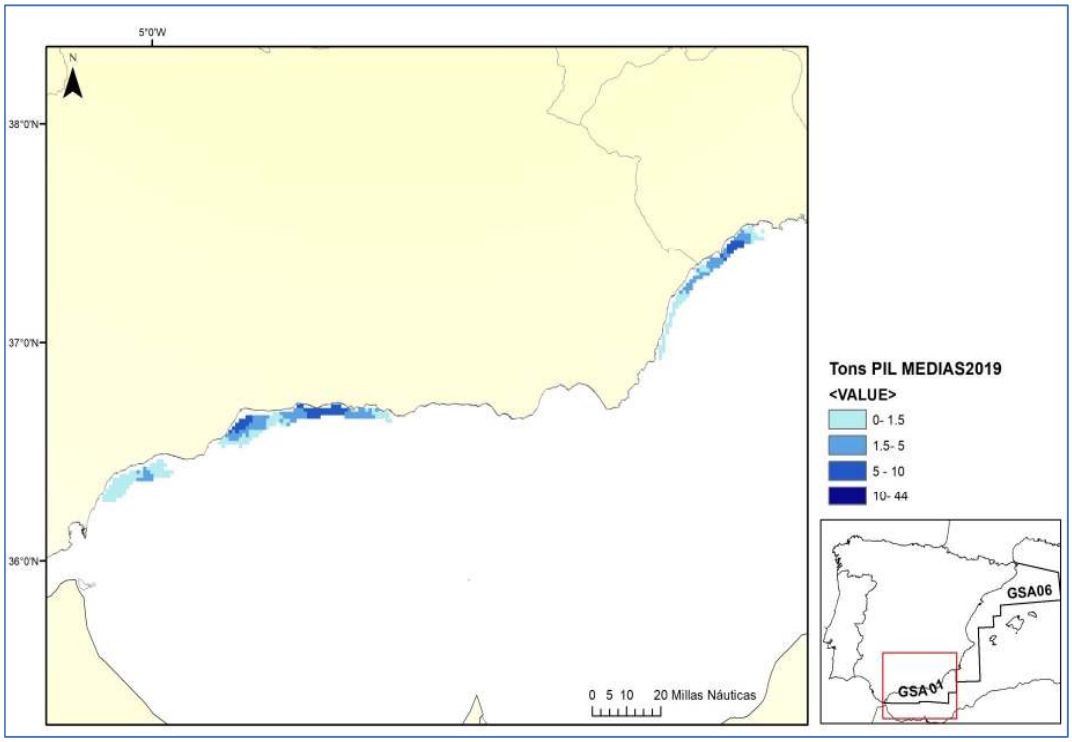


Figure 2.1.8b. Sardine (PIL) spatial distribution in GSA01 in MEDIAS 2019.

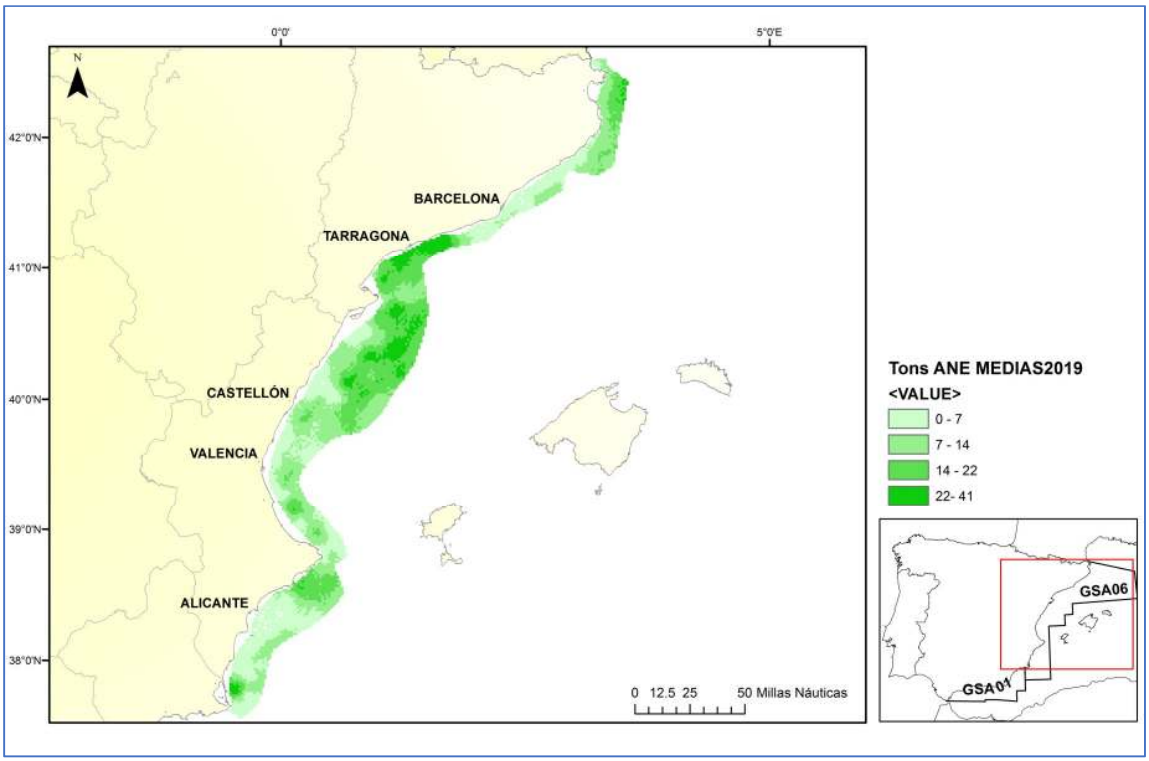


Figure 2.1.9a. Anchovy (ANE) spatial distribution in GSA06 in MEDIAS 2019.

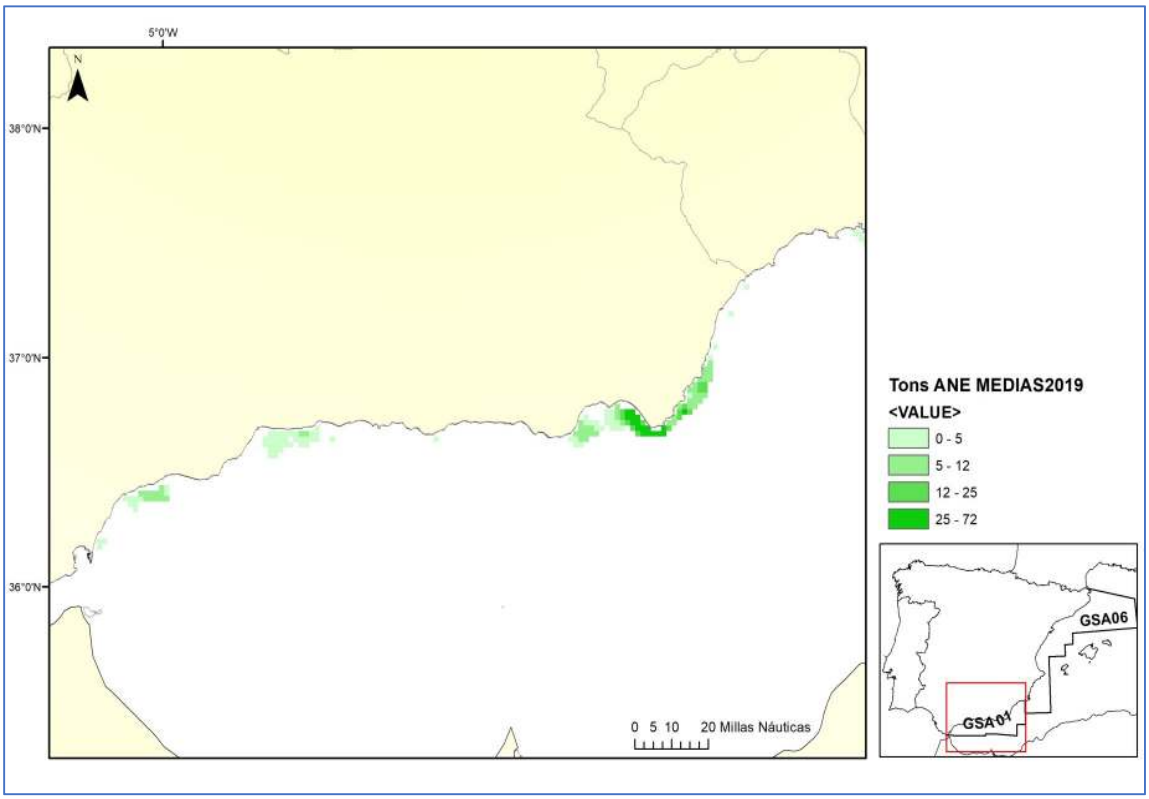


Figure 2.1.9b. Anchovy (ANE) spatial distribution in GSA01 in MEDIAS 2019.

2.2 MEDIAS 2020 in Iberian coast (ESP): GSA 1 - Northern Alboran Sea and GSA 6 - Northern Spain (Magdalena Iglesias, Ana Ventero, Pilar Córdoba, Pablo Quelle, Nuria Zaragoza, IEO.)

a) General information on the survey

MEDIAS 2020 acoustic survey was carried out in the Mediterranean Spanish waters (GSA06, Northern Spain and GSA01, Northern Alboran Sea) from 27th June to 28th July 2020 (32 days) on board the R/V "Miguel Oliver" (70 m long). Target species were European anchovy (*Engraulis encrasicolus*) and European sardine (*Sardina pilchardus*). Problems caused by the Coronavirus pandemic situation, made the realization of the survey very complicated.

b) Type of echosounders and frequencies in use

The equipment was composed by an EK60 (SIMRAD) scientific echosounder equipped with five frequencies (18, 38, 70, 120 and 200 kHz); a pelagic trawl with a 15-18 m vertical opening and a 20 mm codend, an FS20/25 (SIMRAD) netsonder, and a ---sensor MARPORT. Two CTD (Seabird 19 plus were used to collect temperature, salinity, fluorescence and dissolved oxygen data from the water column.

c) Calibration results

The acoustic system was calibrated at the beginning of the survey using the standard sphere method (Demer et al., 2015) (Table 2.2.1). 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 2.2.1.- Calibration results in MEDIAS 2020.

Frequency (kHz)	18 (kHz)	38 (kHz)	70 (kHz)	120 (kHz)	200 (kHz)
Echo-sounder type	EK60	EK60	EK60	EK60	EK60
Transducer type	ES18-11	ES38B	ES70-7C	ES120-7C	ES200-7C
Transducers Serial no.	No data	No data	No data	No data	No data
Vessel	Miguel Oliver	Miguel Oliver	Miguel Oliver	Miguel Oliver	Miguel Oliver
Date	27/06/2019	27/06/2019	27/06/2019	27/06/2019	27/06/2019
Place	Bahía de Palma	Bahía de Palma	Bahía de Palma	Bahía de Palma	Bahía de Palma
Bottom depth (m)	35.07	35.07	35.07	35.07	35.07
Temperature (˚C) at sphere depth	24.29	24.29	24.29	24.29	24.29
Salinity (psu) at sphere depth	37.462	37.462	37.462	37.462	37.462
TS of sphere (dB)	-34.53	-42.32	-41.66	-39.99	-38.82
Pulse duration (ms)	1024	1024	1024	1024	1024
Ping rate	0.5	0.5	0.5	0.5	0.5
RMS beam	0.3	0.15	0.23	0.41	0.72
Transducer Gain (dB)	22.95	24.47	27.21	27.88	26.23
Sa corr (dB)	-0.77	-0.54	-0.34	-0.26	-0.3
Beam width atwarth(˚)	10.86	6.77	6.33	5.9	5.86
Beam width along(˚)	10.86	6.89	6.43	6.03	6.18
Atwarth offset(˚)	0.04	0.02	-0.03	-0.06	-0.28
Along offset(˚)	0.13	-0.08	-0.03	-0.28	-0.25

d) Survey design

Acoustic data were collected during daytime (6:00 am -8:00 pm) over a grid of systematic parallel transects perpendicular to coastline/bathymetry, covering the continental shelf (20-200 m depth) (Fig. 2.2.1). Inter-transect distance was 8 nmi in GSA06 and 4 nmi in GSA01. Vessel speed during acoustic survey was 10 knots.

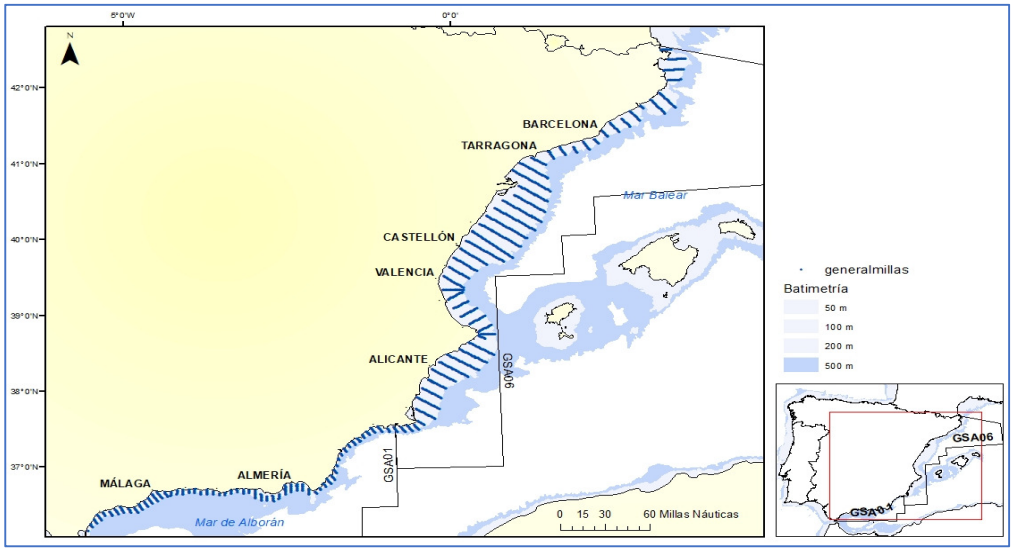


Figure 2.2.1 MEDIAS 2020 survey design of acoustic transects (111); 52 in GSA06 and 59 in GSA01.

Acoustic data were collected over 1117 nautical miles (nmi) corresponding to the design tracks; 843 nmi from GSA06 and 274 nmi to GSA01 were processed.

e) Fish sampling

Thirty-seven (37) pelagic hauls were carried out in GSA06 and eighteen (18) in GSA01 to be used for the scrutinizing of the echograms (Fig. 2.2.2).

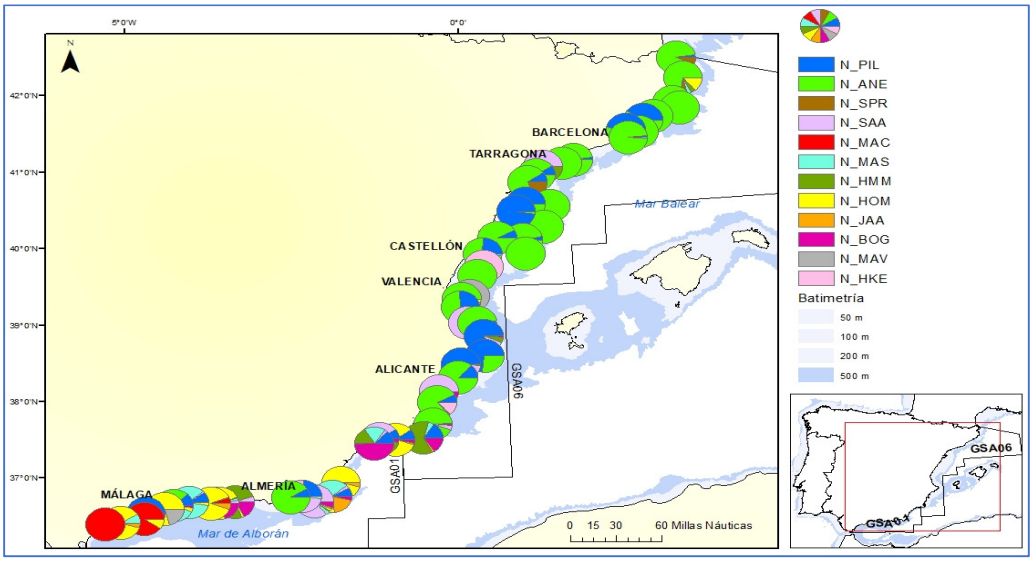


Figure 2.2.2 Pelagic hauls (55) composition obtained during the Spanish acoustic MEDIAS 2020 acoustic survey.

f) Oceanographic parameters

In total, 104 CTD stations were performed in GSA06 and 50 in GSA01 (Fig. 2.2.3).

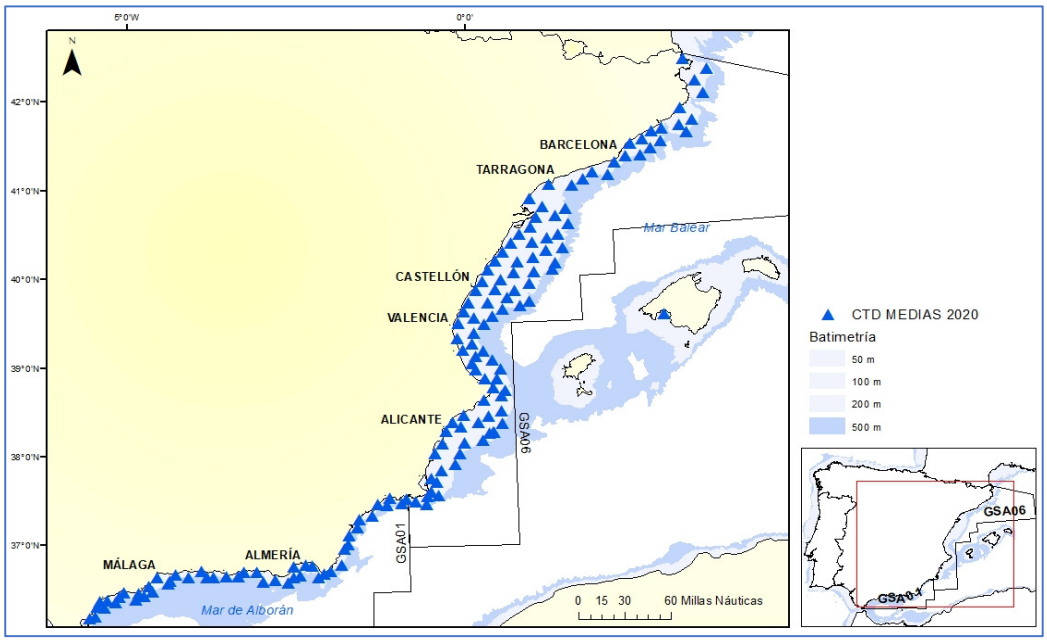


Figure 2.2.3 CTD stations (154) carried out during the Spanish acoustic MEDIAS 2020 acoustic survey.

g) Biomass estimations of target species

Biomass (tons) of sardine (*Sardina pilchardus*) (Fig. 2.2.4a, b) was estimated by GSA. In GSA06, 19838 tons (CV 9) and in GSA01 1812 tons (CV 17) were evaluated. LFD were bimodal in both GSA's, corresponding the first mode to the sardine recruitment, and the second mode to the sardine adult individuals (Fig. 2.2.4a, b). Sardine length was higher in GSA01 for the same age class.

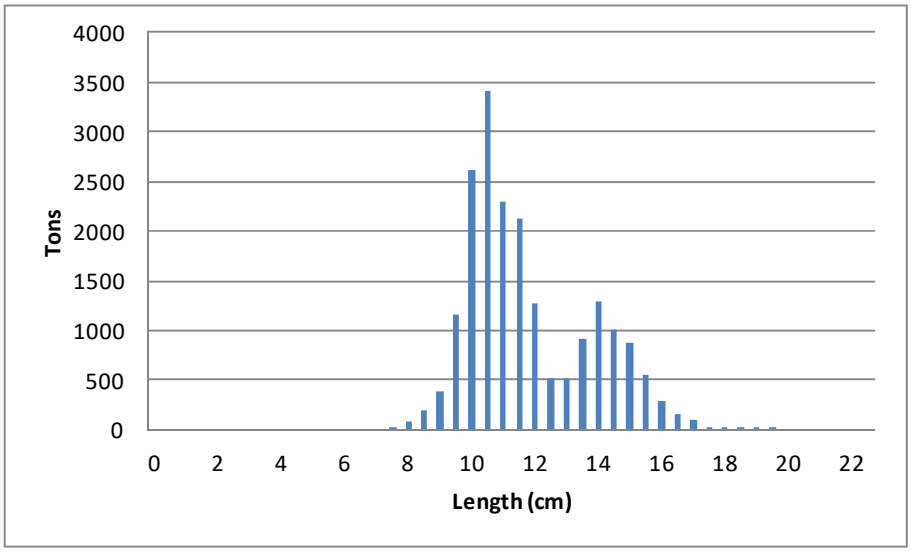


Figure 2.2.4a Sardine (PIL, FAO code) biomass in tons by length (LFD) in GSA06. MEDIAS 2020.

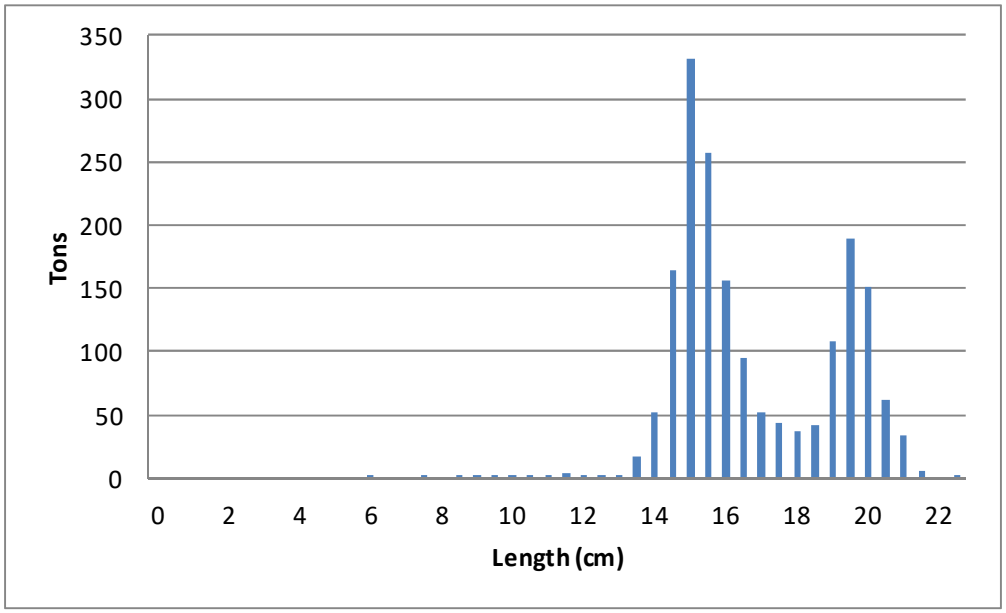


Figure 2.2.4b Sardine (PIL, FAO code) biomass in tons by length (LFD) in GSA01. MEDIAS 2020.

Biomass (tons) of anchovy (*Engraulis encrasicolus*) (Fig. 2.2.5) was estimated by GSA. In GSA06, 47562 tons (CV 7) and in GSA01 2118 tons (CV 17). LFD were unimodal in both GSA's, corresponding to the anchovy spawning stock, principally (Fig, 2.2.5a, b). Anchovy length was higher in GSA01 for the same age class.

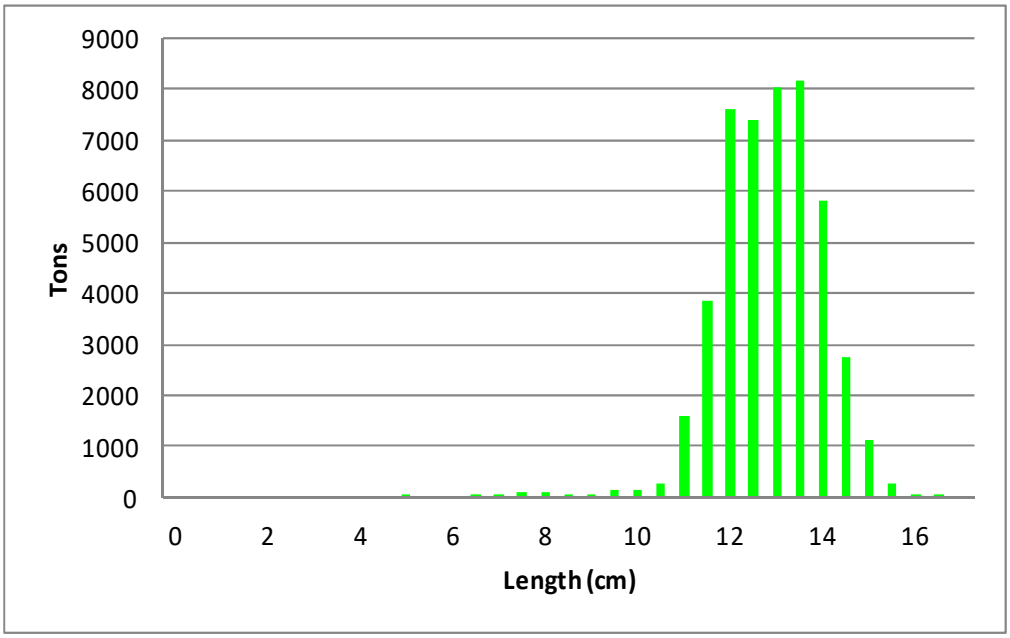


Figure 2.2.5a Anchovy (ANE) biomass in tons by length (LFD) in GSA06. MEDIAS 2020.

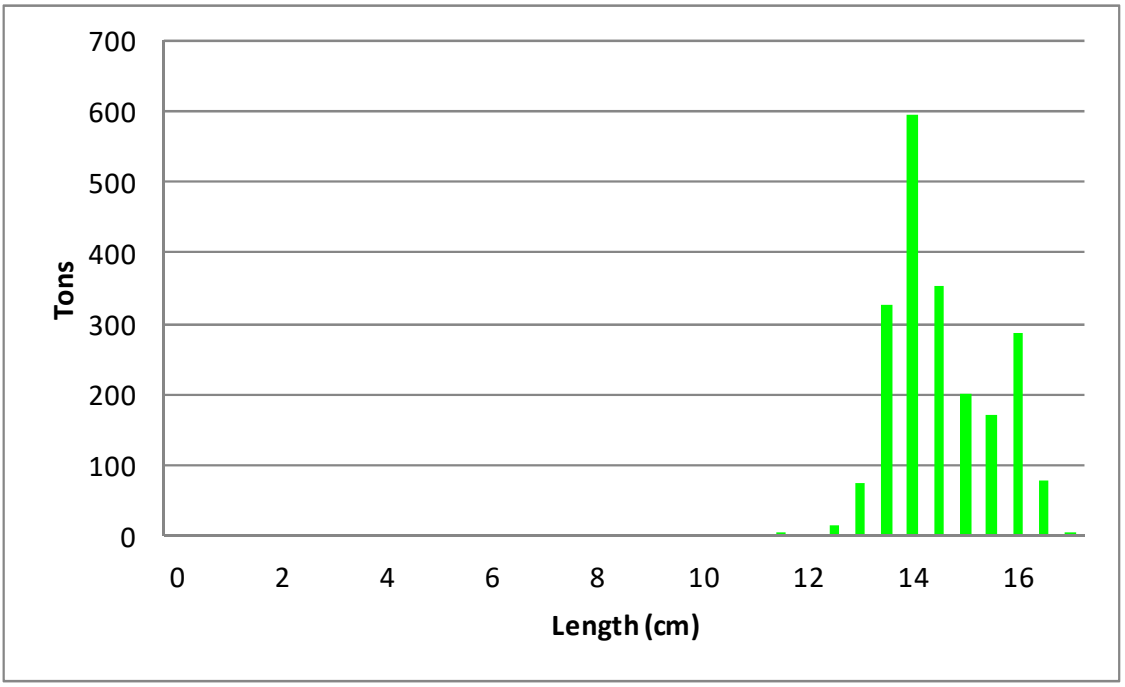


Figure 2.2.5b Anchovy (ANE) biomass in tons by length (LFD) in GSA01. MEDIAS 2020.

Age length key (ALK) for sardine in GSA06, MEDIAS 2020, was composed by 4 years classes. The number of otoliths readings was 767 (individuals) (Fig. 2.2.6a). In GSA01, the number of sardine otoliths readings was 364, the number of age classes were 5, with a very high number of recruits, individuals of age 0 (Fig. 2.2.6b).

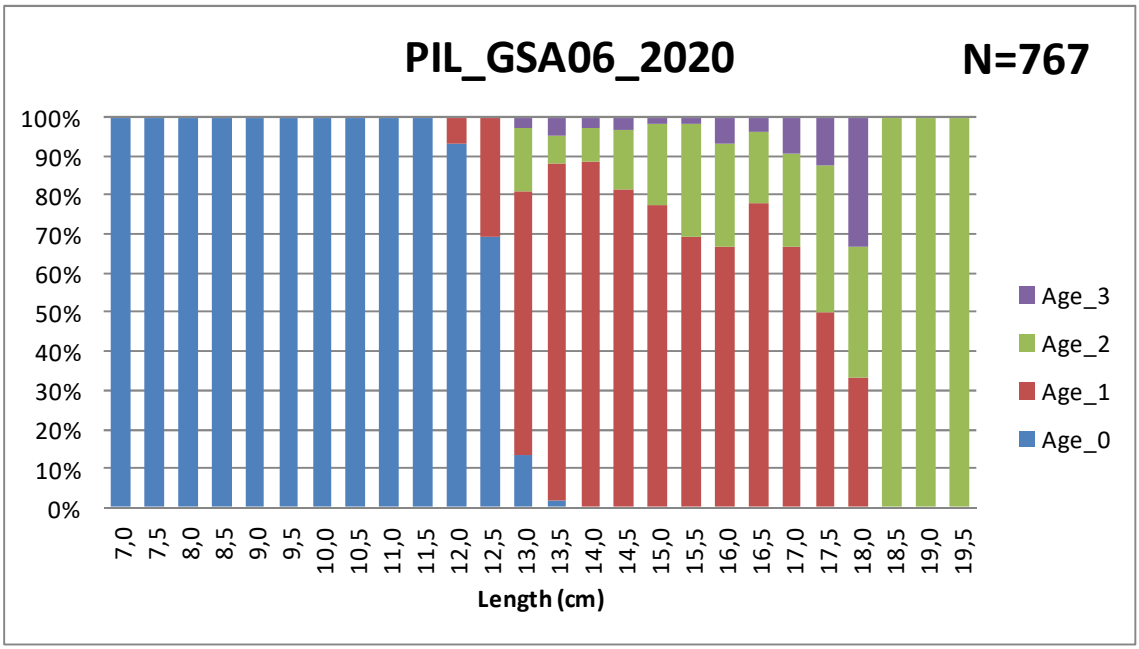


Figure 2.2.6a Sardine AKL in GSA06, MEDIAS 2020.

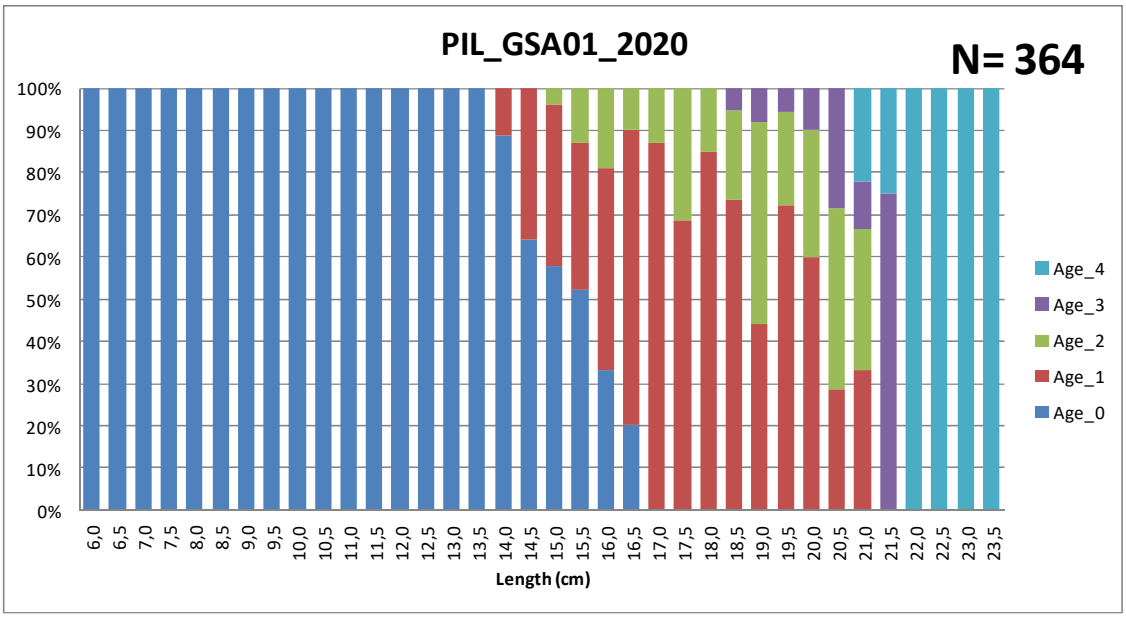


Figure 2.2.6b Sardine AKL in GSA01, MEDIAS 2020.

Anchovy ALK in GSA06, MEDIAS 2020, was represented by 3 year classes (0, 1, 2), both in GSA06 and GSA01. 633 pair of otoliths readings (Fig. 2.2.7a) were used in GSA06, and 106 in GSA01 (Fig 7b).

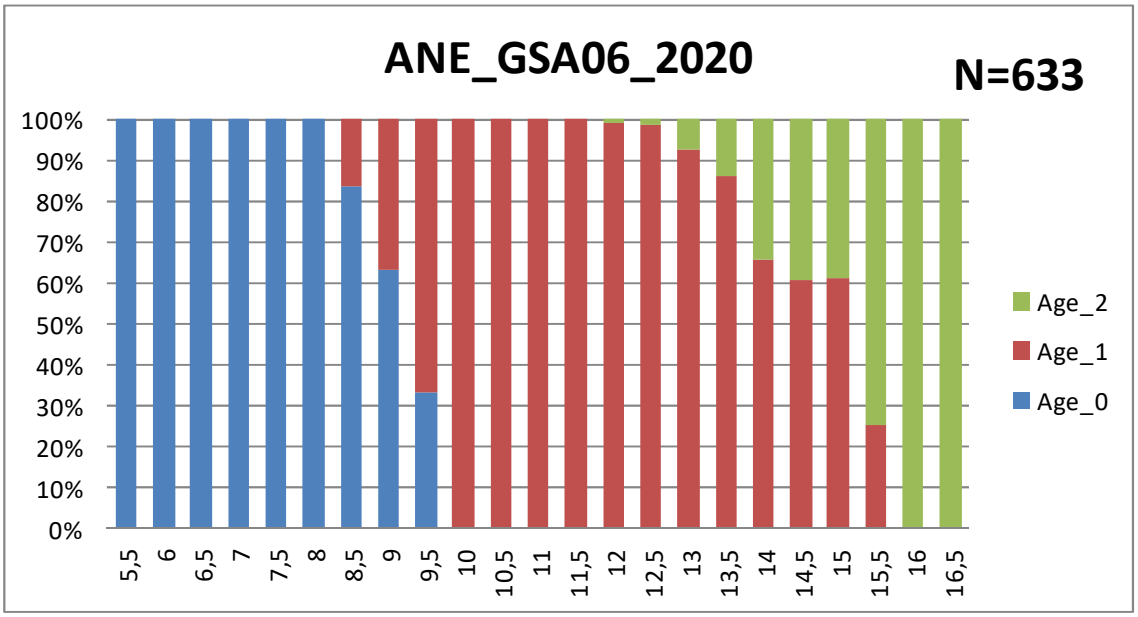


Figure 2.2.7a Anchovy AKL in GSA06, MEDIAS 2020.

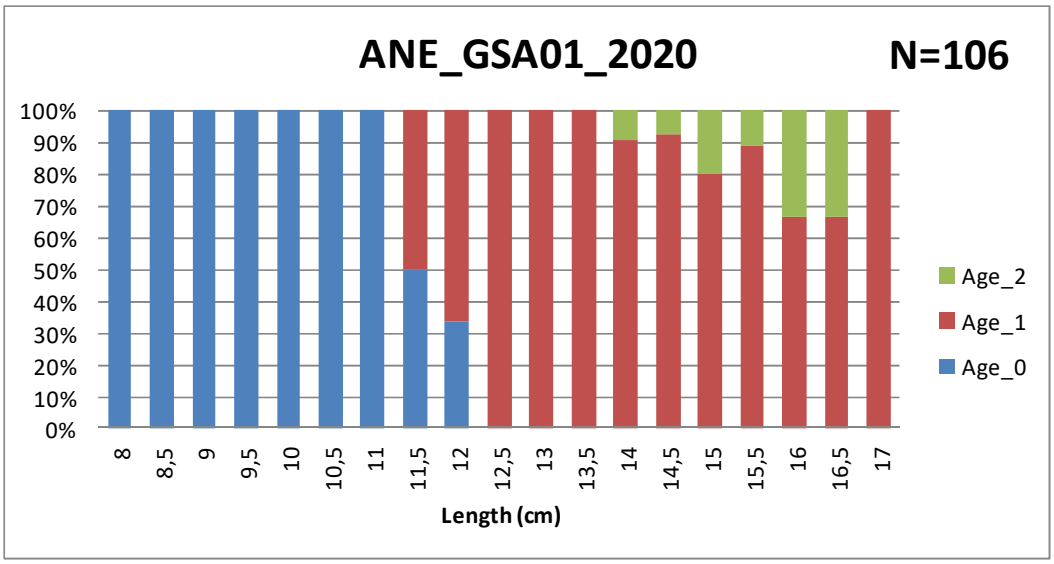


Figure 2.2.7b Anchovy AKL in GSA01, MEDIAS 2020.

h) Abundance indices of target species

Spatial distribution of sardine and anchovy in GSA 06 and 01 in 2019 (Figure 2.2.8a, b & 2.2.9 a, b) was mainly coastal for sardine, and covering all the continental shelf depth for anchovy in both areas, as in 2019, although a high recruitment was detected for sardine in GSA06 in the coastal area near Castellon (Fig. 2.2.8a).

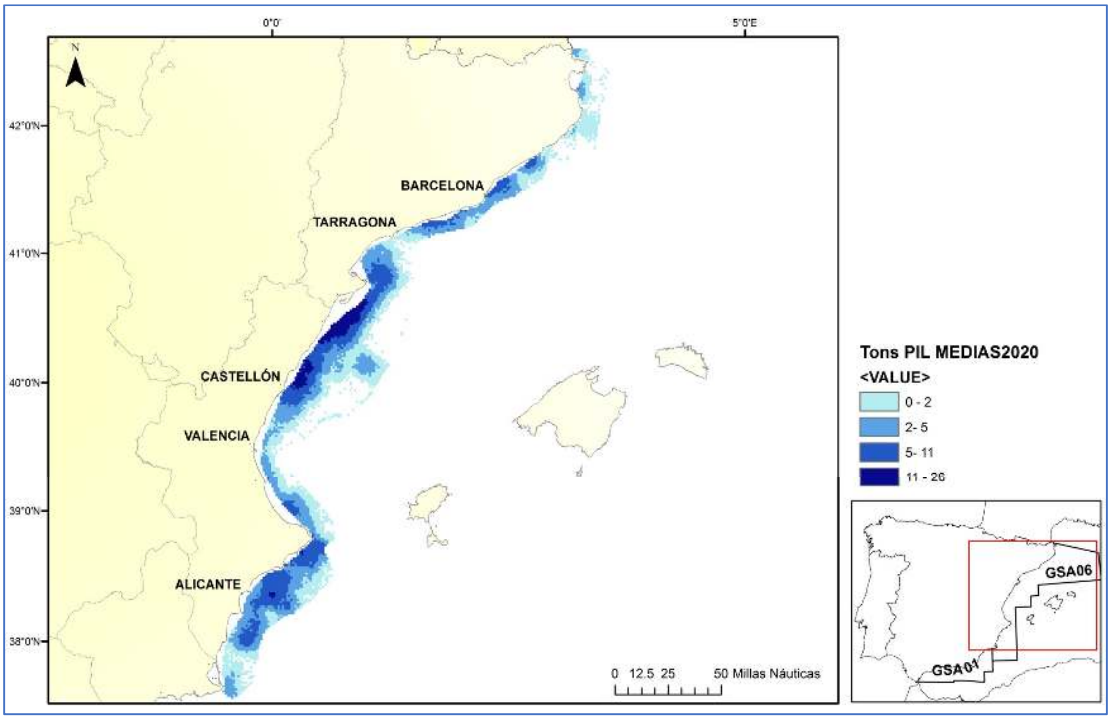


Figure 2.2.8a Sardine (PIL) spatial distribution in GSA06 in MEDIAS 2020.

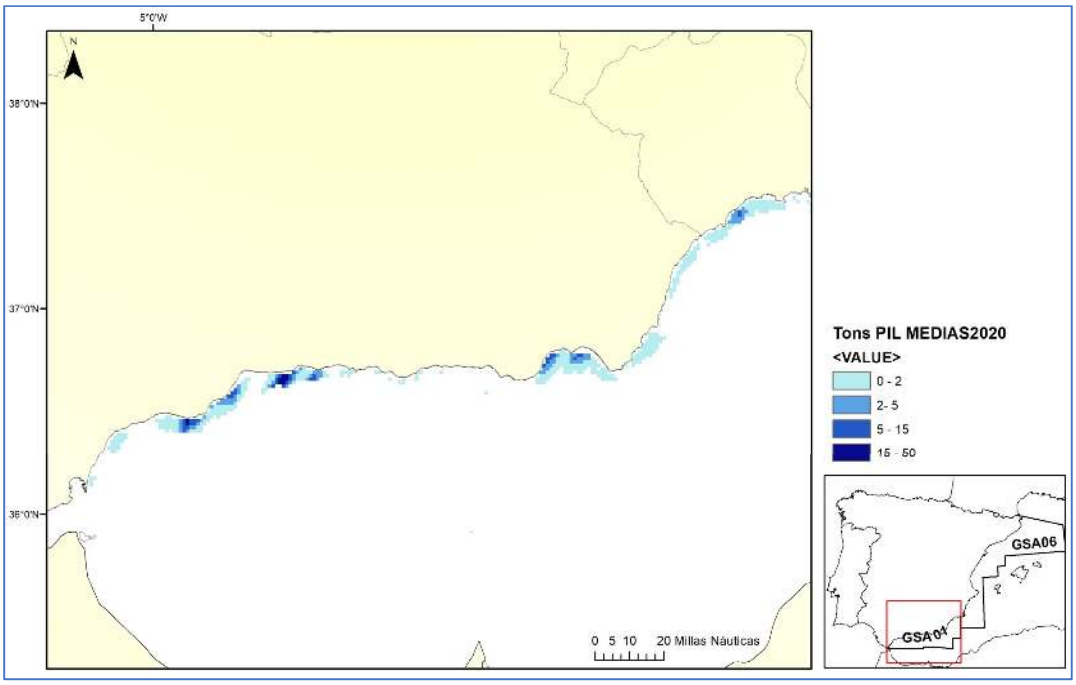


Figure 2.2.8b Sardine (PIL) spatial distribution in GSA01 in MEDIAS 2020.

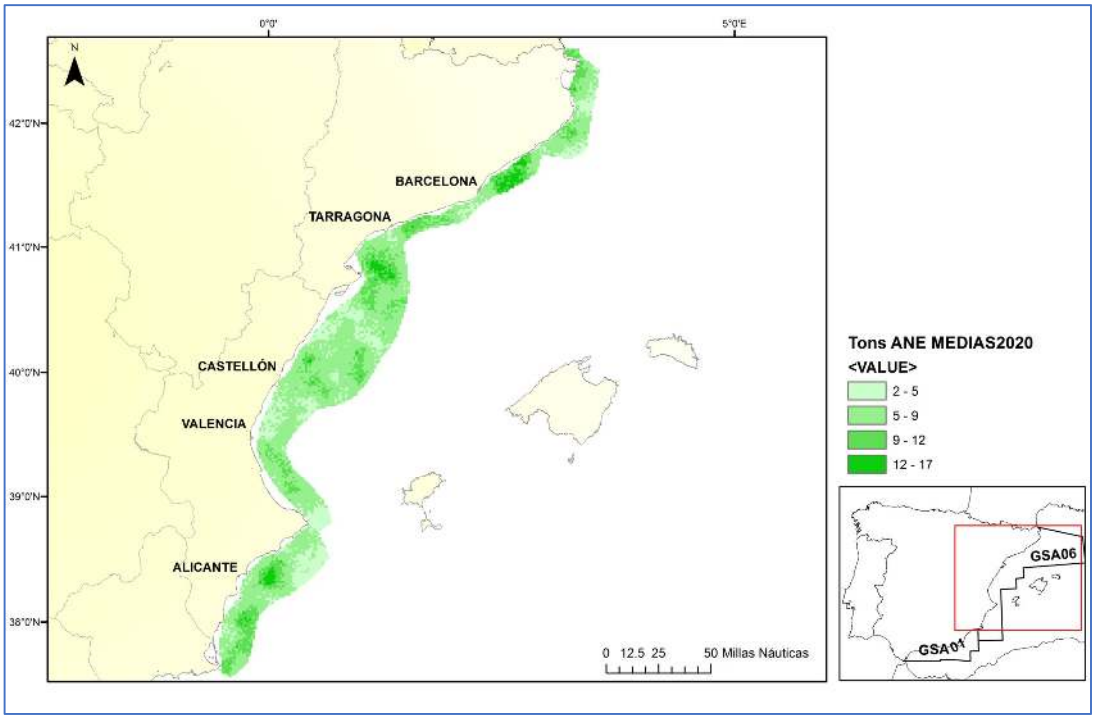


Figure 2.2.9a Anchovy (ANE) spatial distribution in GSA06 in MEDIAS 2020.

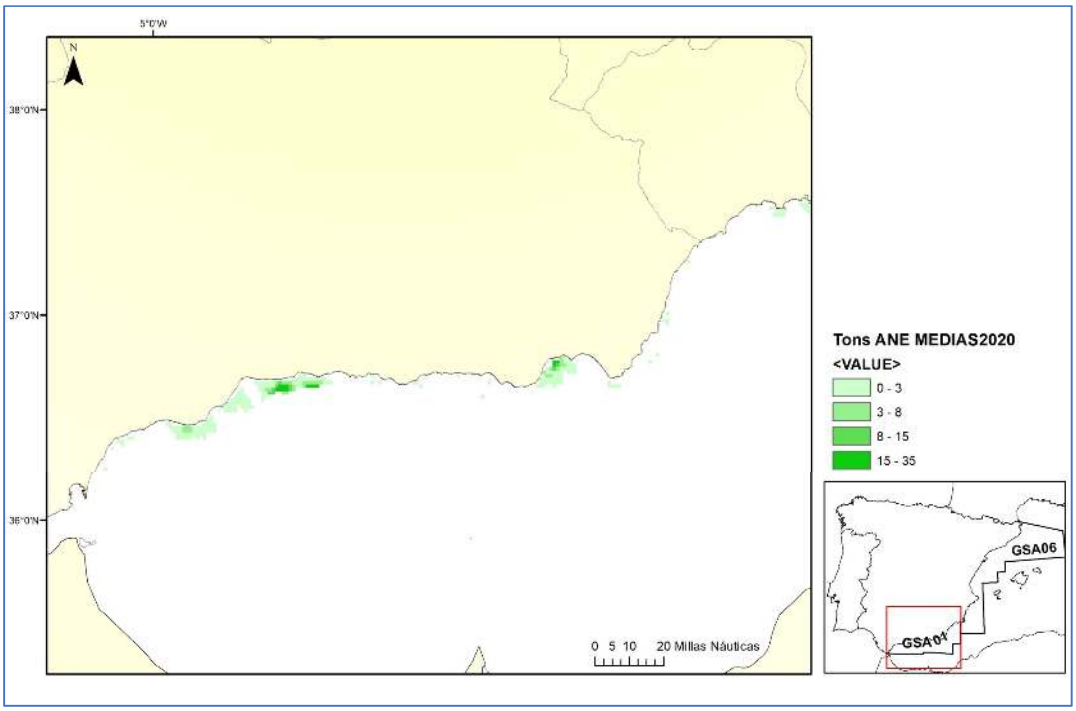


Figure 2.2.9b Anchovy (ANE) spatial distribution in GSA01 in MEDIAS 2020.

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*). In GSA01 were detected and captured schools of *Scomber scombrus* (MAC) near the Strait of Gibraltar, with lengths smaller than 19 cm corresponding a recruit's individuals.

2.3 MEDIAS 2019 in GSA 07 (Gulf of Lions, FRA) - (Tarek Hattab & Jean Hervé Bourdeix, IFREMER)

a) General information on the survey

The survey in 2019 took place in the period from June 26 to July 29, lasted 33 days at sea and covered study area in the Gulf of Lions (3300 NM^2) with the fishery R/V L'Europe (29.60 m length, 2 x 469 HP).

b) Type of echosounders and frequencies in use

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 1.024 ms. The surveying acoustic vessel speed is 8 knots. Additionally, the multi-beam echo sounder SIMRAD ME70 was used in order to visualize 3D echos and improve species allocation. The MOVIES 3D software was used to visualize and analyze acoustic data.

c) Calibration results

Calibration results related to MEDIAS in 2019 are shown in Table 2.3.1.

Table 2.3.1 Calibration results in MEDIAS 2019.

Frequency (kHz)	38kHz	70kHz	120kHz	200kHz	333kHz
Echo-sounder type	ES38B	ES70_7C	ES120_7	ES200_7C	ES333_7C
Transducer serial no.	31288	127	29497	288	159
Research vessel	l'Europe	l'Europe	l'Europe	l'Europe	l'Europe
Date	27/06/19	27/06/19	27/06/19	27/06/19	27/06/19
Place	Séte	Séte	Séte	Séte	Séte
Bottom depth (m)	13	13	13	13	13
Temperature (°C) at	19	19	19	19	19
Salinity (psu) at sphere	38.1	38.1	38.1	38.1	38.1
TS of sphere (dB)	-42.4	-41.5	-39.6	-39	-44
Pulse duration (ms)	1.024	1.024	1.024	1.024	1.024
Ping rate	0.35	0.35	0.35	0.35	0.35
Rms beam	0.12	0.11	0.14	0.23	0.24
Resulting gain (dB)	26.69	27.14	25.36	26.05	27.08
Sa correction (dB)	0.01	0.08	-0.04	0	-0.08
Beam width atwarth	6.67	6.72	7.42	6.66	6.84
Beam width along	6.81	6.71	7.47	6.81	7.1
Atwarth offset	0.01	0.01	-0.02	-0.1	-0.2
Along offset	-0.03	-0.01	-0.06	-0.12	-0.09

d) Survey design

The survey design is made of 9 parallel transects (min and max lengths are 13 and 42 nautical miles) perpendicular to the coastline and 12 nm apart, from the 15 m isobath to the 200 m one. In 2019 total nautical miles effectively used for acoustic analysis (minus pelagic trawls tracks and linking transects) were 278 (Fig. 2.3.1).

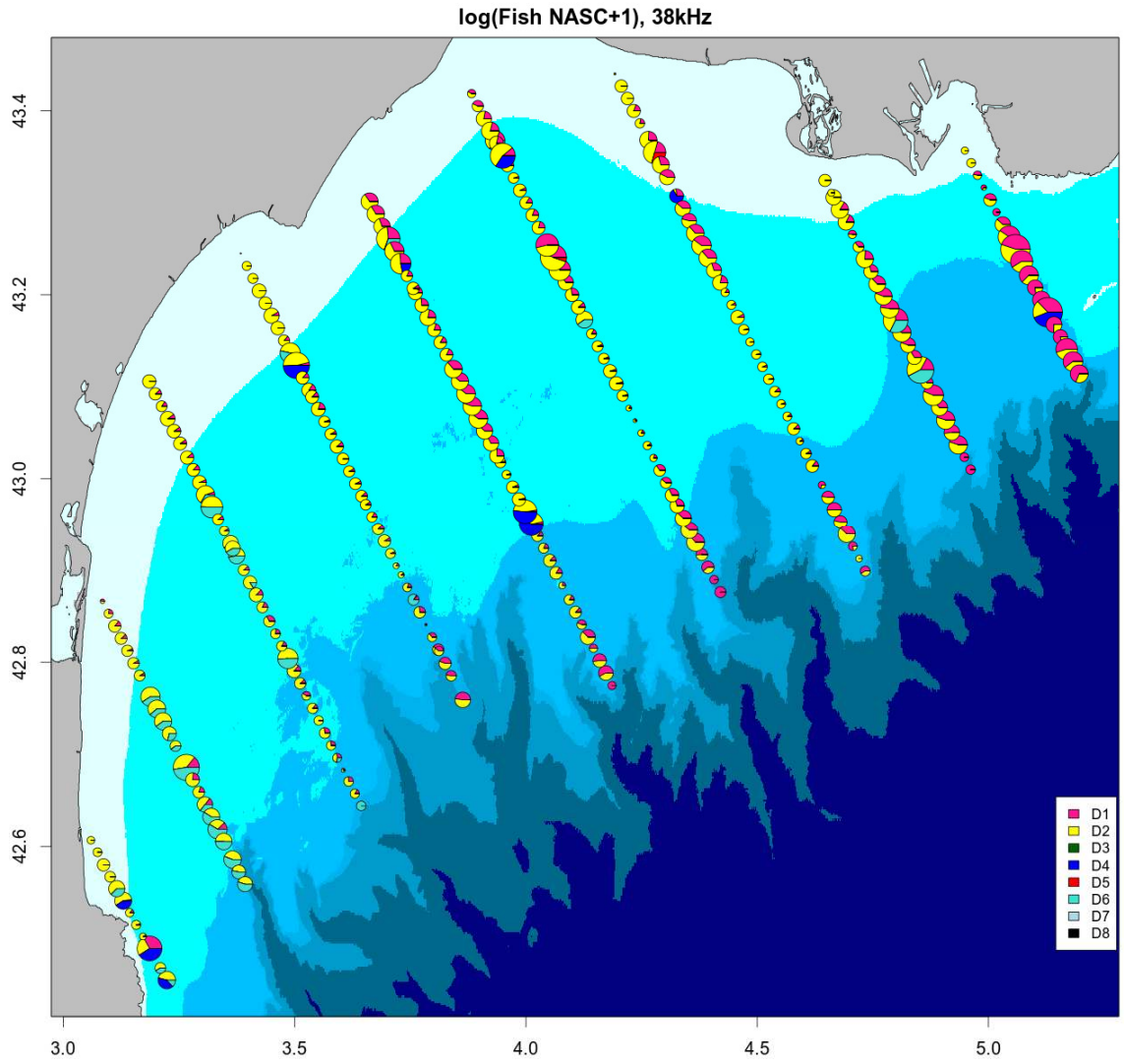


Figure 2.3.1. The survey design in GSA 7 (MEDIAS, 2019)

e) Fish sampling

Echotraces are identified with a pelagic haul. Forty-four (44) pelagic hauls were carried out in GSA07 (Fig. 2.3.2) to be used for the scrutinizing of the echograms. 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 speed 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. The pelagic net used has headline length of 83.2m, a sideline dimension of 65.20 m and a codend mesh size of 18mm.

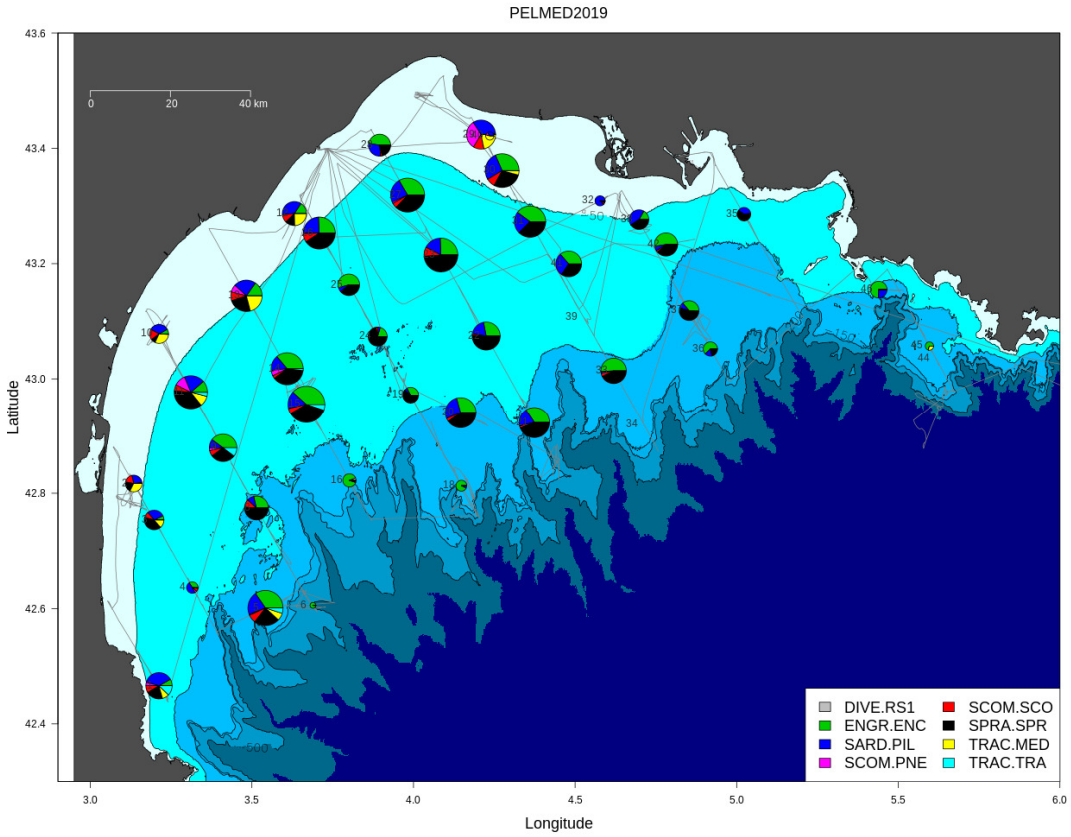


Figure 2.3.2 Catch compositions of pelagic hauls carried out in GSA07 in 2019.

f) <u>Oceanographic parameters</u>

In total 53 hydrological stations have been conducted using a SBE 19plus V2 CTD which measures conductivity, temperature, pressure, fluorescence, PAR (Photosynthetically active radiation), pH, oxygen and turbidity. Zooplankton was sampled through WP2 vertical nets, while phytoplankton was sampled through Niskin bottles in subsurface and at the maximum of chlorophyll depth.

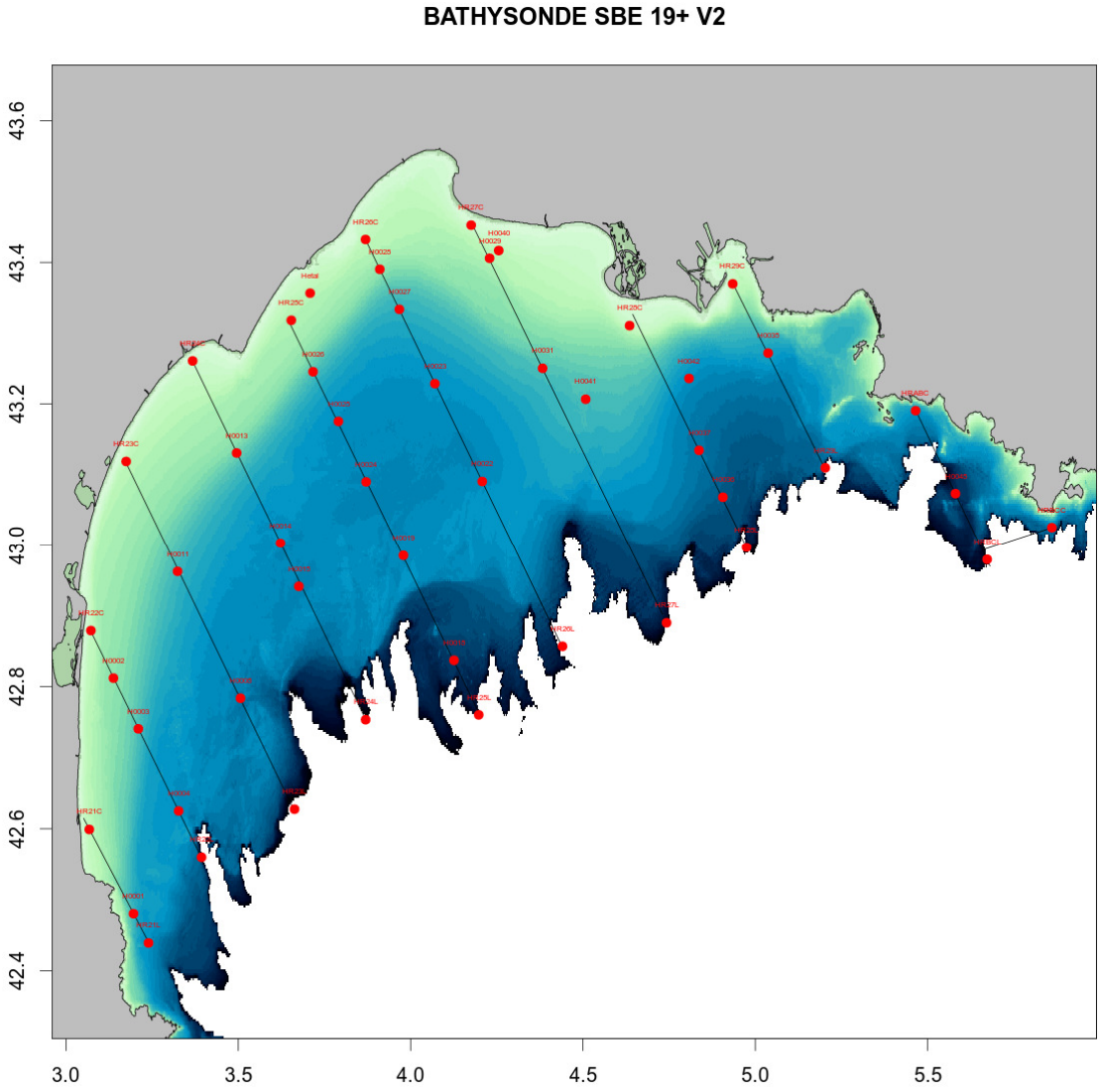


Figure 2.3.3 CTD stations conducted in GSA 7 during MEDIAS 2019.

g) Biomass estimations of target species

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 63311 t and 36168 t in 2019. The CVs of geostatistical simulations were 18% and 12% while the CV associated to Hauls / ESDUs associations were 9.2% and 5.5% for respectively for sardine and anchovy. Abundance at length estimates for sardines and anchovy are shown in Figure 2.3.4. Long-term biomass estimates are shown in Figure 2.3.5.

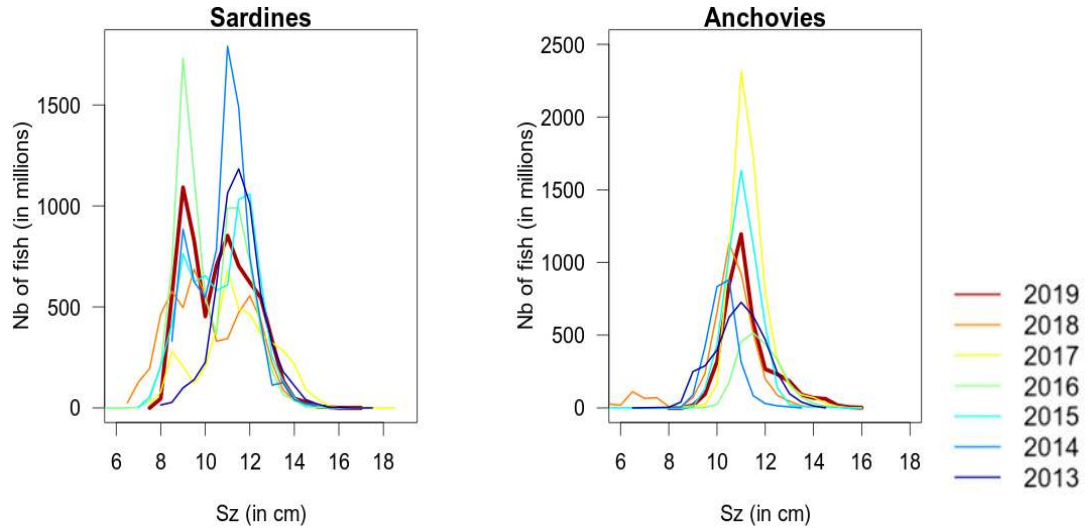


Figure 2.3.4. Abundance at length estimates for sardines and anchovy in GSA 7.

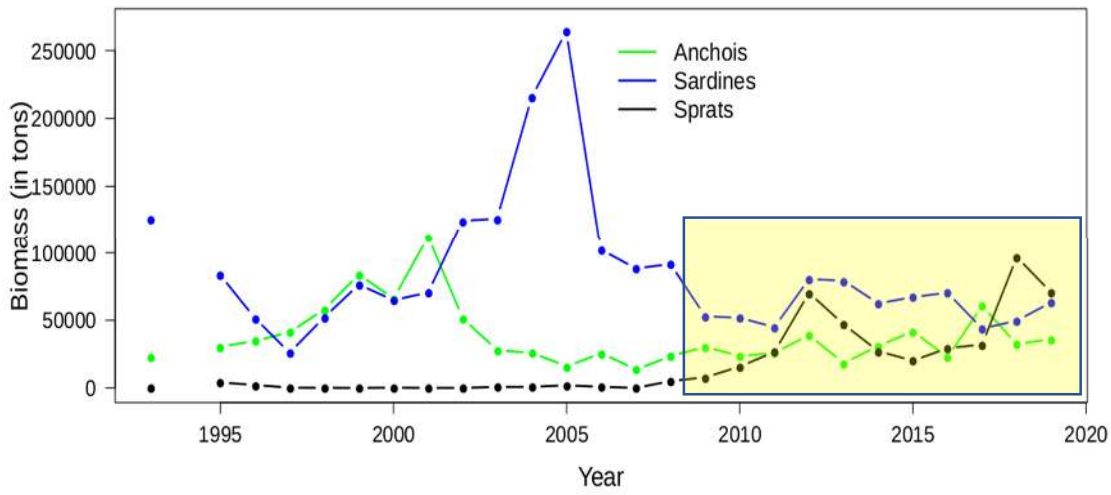


Figure 2.3.5. Long-term biomass estimates in GSA 7 for anchovy, sardine and sprat (DCF-MEDIAS estimates since 2009 are in yellow frame).

Biomass per age was estimated for sardine and anchovy using otoliths reading and survey specific age-length keys (Fig. 2.3.6 and Fig. 2.3.7).

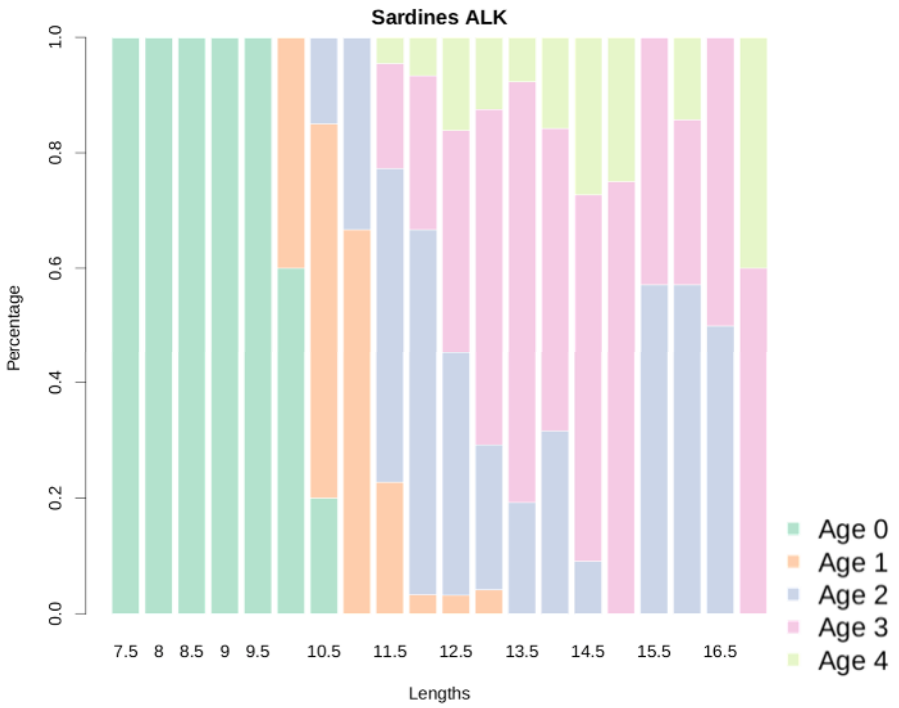


Figure 2.3.6 Age-length key for sardine in GSA 7 (MEDIAS 2019).

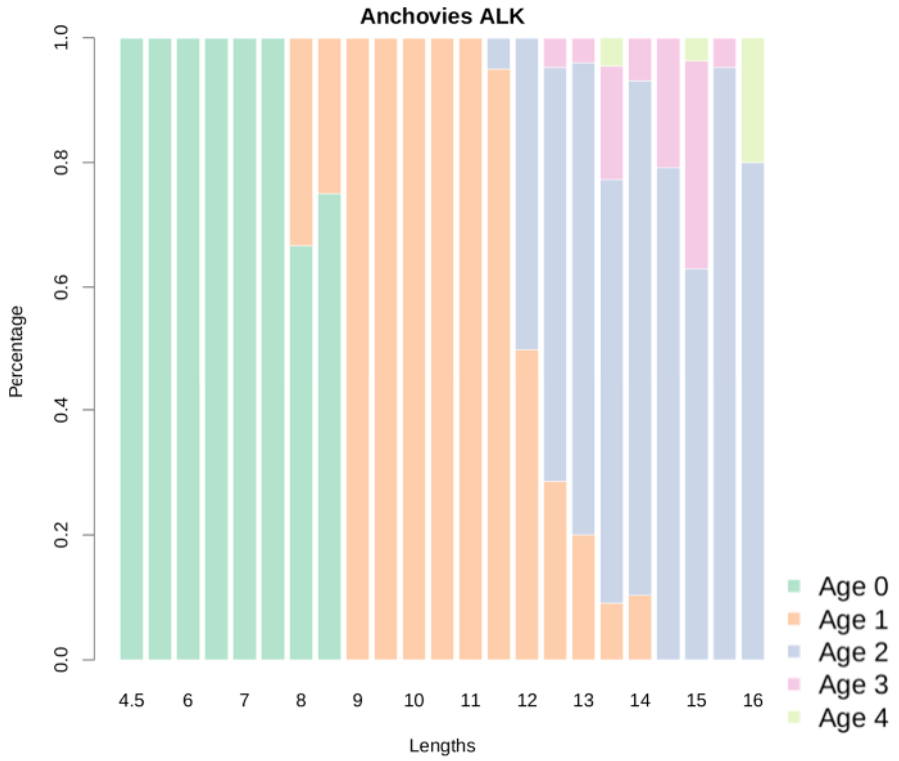


Figure 2.3.7 Age-length key for anchovy in GSA 7 (MEDIAS 2019).

Sardine and anchovy population's age structures, estimated as abundance at age, are shown in Figure 2.3.8.

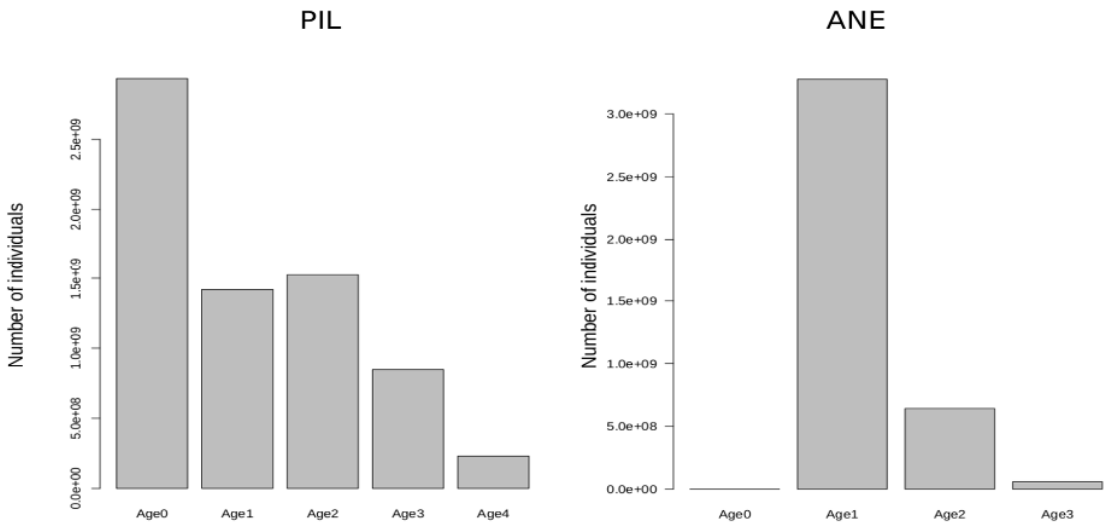


Figure 2.3.8. Sardine (PIL) and anchovy (ANE) population's age structures in GSA 7 (MEDIAS, 2019).

h) Abundance indices of target species

Spatial distributions of abundance indices of sardine and anchovy in GSA 7 during MEDIAS 2019 are shown in Figure 2.3.9. Age-structured estimates from acoustic surveys, related to sardine and anchovy populations, are shown in figures 2.3.10 and 2.3.11.

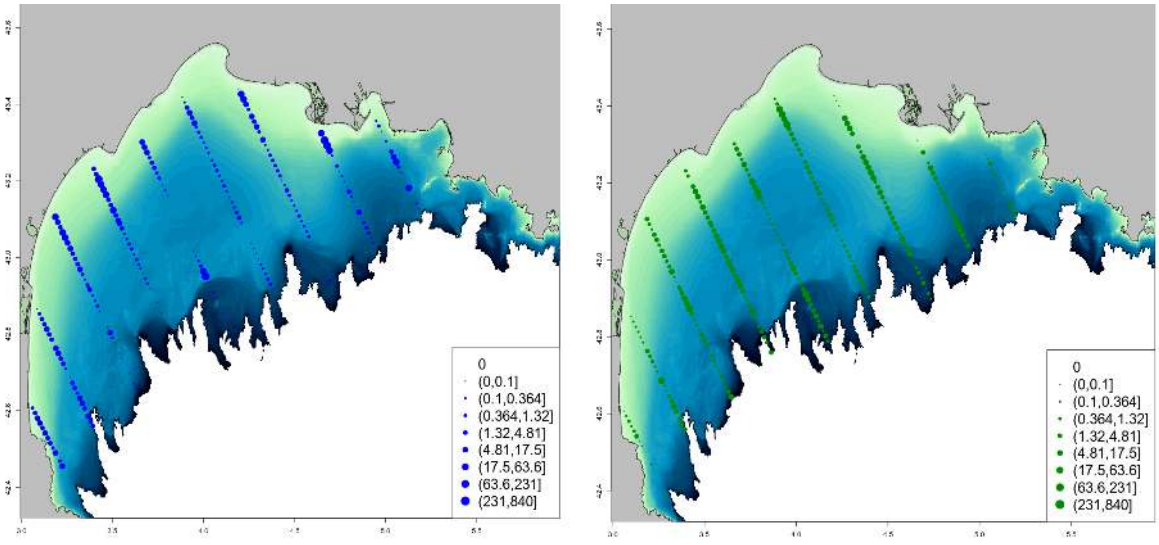


Figure 2.3.9. Spatial distributions of abundance indices of sardine (left) and anchovy (right) in GSA 7 during MEDIAS 2019.

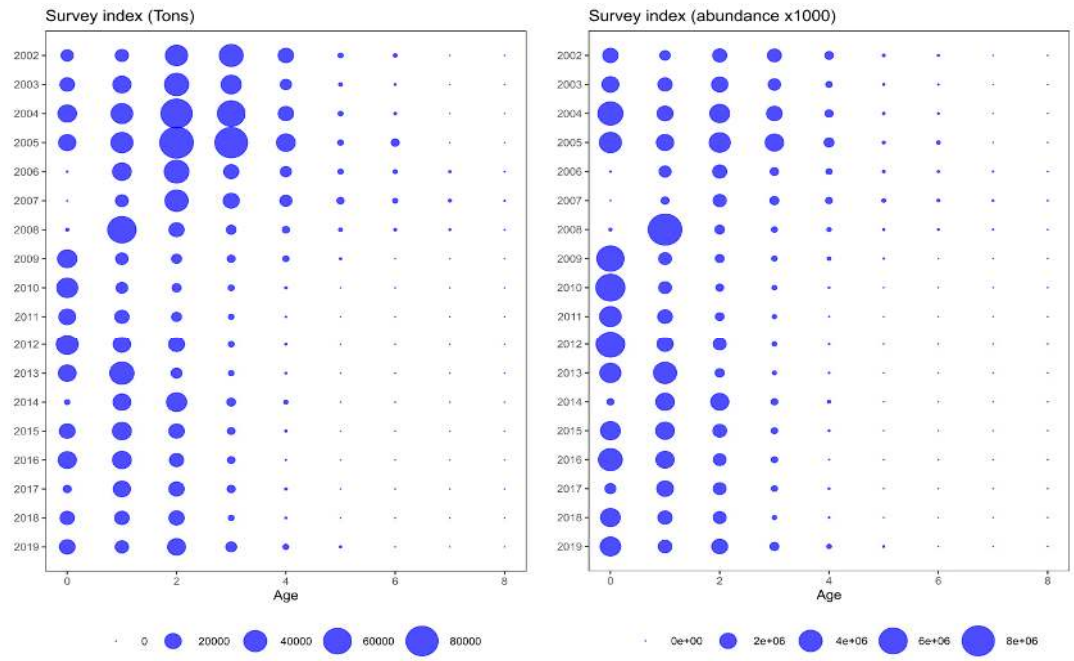


Figure 2.3.10 Age-structured estimates from acoustic surveys for sardine's population in GSA 7.

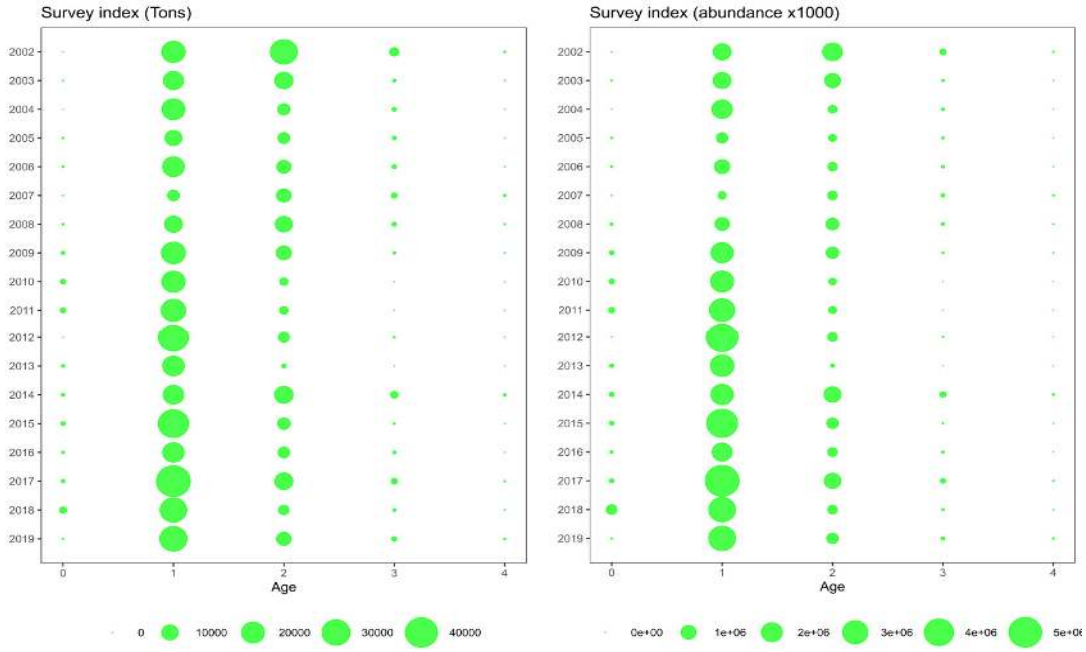


Figure 2.3.11 Age-structured estimates from acoustic surveys for anchovy's population in GSA 7.

2.4 MEDIAS 2020 in GSA 07 (Gulf of Lions, FRA) - (Tarek Hattab & Jean Hervé Bourdeix, IFREMER)

a) General information on the survey

The survey in 2020 took place from September 08 to October 02, lasted 24 days at sea and covered study area in the Gulf of Lions (3300 nm2) with the fishery R/V L'Europe (29.60 m length, 2 x 469 HP).

b) Type of echosounders and frequencies in use

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. The surveying acoustic vessel speed is 8 knots. Additionally, the multi-beam echo sounder SIMRAD ME70 was used in order to visualize 3D echos and improve species allocation. The MOVIES 3D software was used to visualize and analyze acoustic data.

c) Calibration results

Table 2.4.1 Calibration results in MEDIAS 2020.

Frequency (kHz)	38kHz	70kHz	120kHz	200kHz	333kHz
Echo-sounder type	ES38B	ES70_7C	ES120_7	ES200_7C	ES333_7C
Transducer serial no.	31288	127	29497	288	159
Research vessel	l'Europe	l'Europe	l'Europe	l'Europe	l'Europe
Date	04/09/20	04/09/20	04/09/20	04/09/20	04/09/20
Place	Rade de Toulon	Rade de Toulon	Rade de Toulon	Rade de Toulon	Rade de Toulon
Bottom depth (m)	17	17	17	17	17
Temperature (°C) at	19.6	19.6	19.6	19.6	19.6
Salinity (psu) at sphere	38	38	38	38	38
TS of sphere (dB)	-42	-41.7	-39.8	-38.8	-36.9
Pulse duration (ms)	1.024	1.024	1.024	1.024	1.024
Ping rate	0.5	0.5	0.5	0.5	0.5
Rms beam	0.1	0.14	0.08	0.1	0.22
Resulting gain (dB)	26.7	26.78	25.37	26.02	27.26
Sa correction (dB)	0.01	-0.36	0.01	-0.03	0.18
Beam width atwarth	6.64	6.38	7.23	6.57	6.72
Beam width along	6.67	6.51	7.39	-0.03	6.81
Atwarth offset	-0.02	-0.05	0.03	0	0.3
Along offset	0.05	0.03	0.08	6.56	0.05

d) Survey design

The survey design (Fig. 2.4.1) is made of 9 parallel transects (min and max lengths are 13 and 42 nautical miles) perpendicular to the coastline and 12 nm apart, from the 15 m isobath to the 200 m one. In 2020 total nautical miles effectively used for acoustic analysis (minus pelagic trawls tracks and linking transects) were 272.

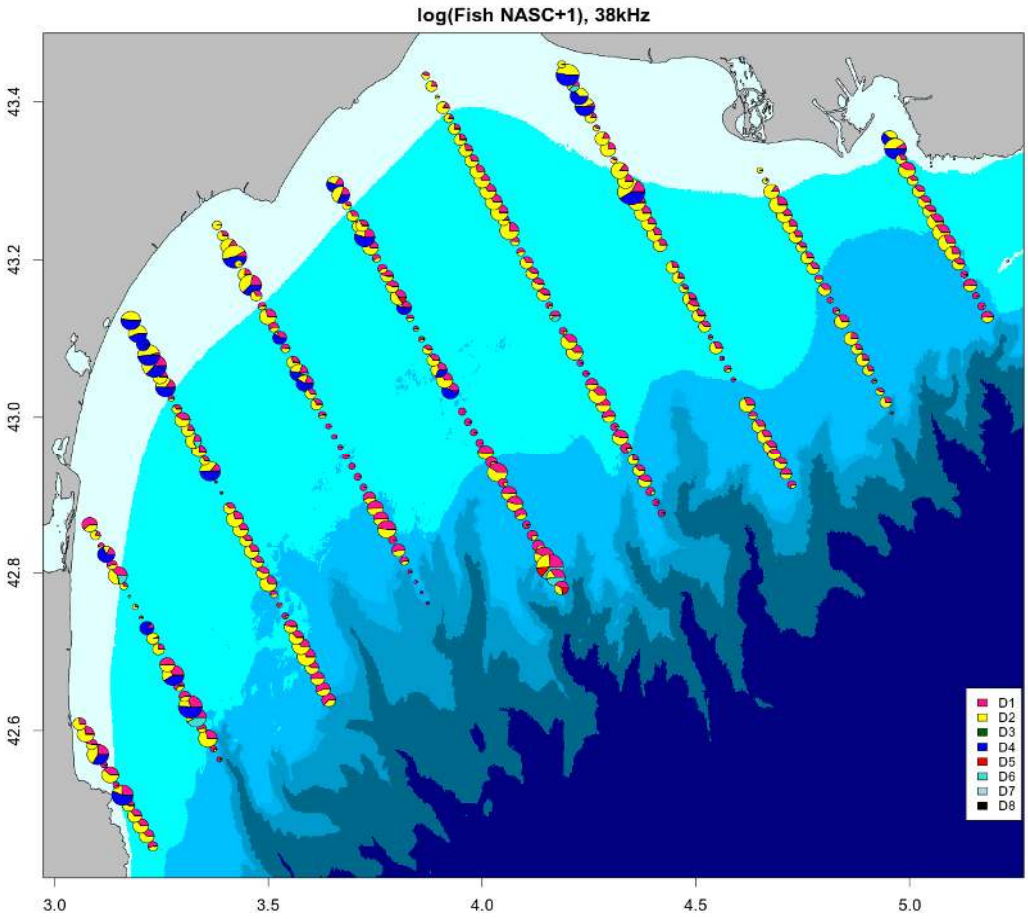


Figure 2.4.1 Survey design in GSA 7 (MEDIAS 2020)

e) Fish sampling

Echotraces are identified with a pelagic haul. Twenty-four (24) pelagic hauls (Fig. 2.4.2) were then carried out in GSA07 to be used for the scrutinizing of the echograms. 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 speed, 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. The pelagic net used has headline length of 83.2m, a sideline dimension of 65.20 m and a codend mesh size of 18mm.

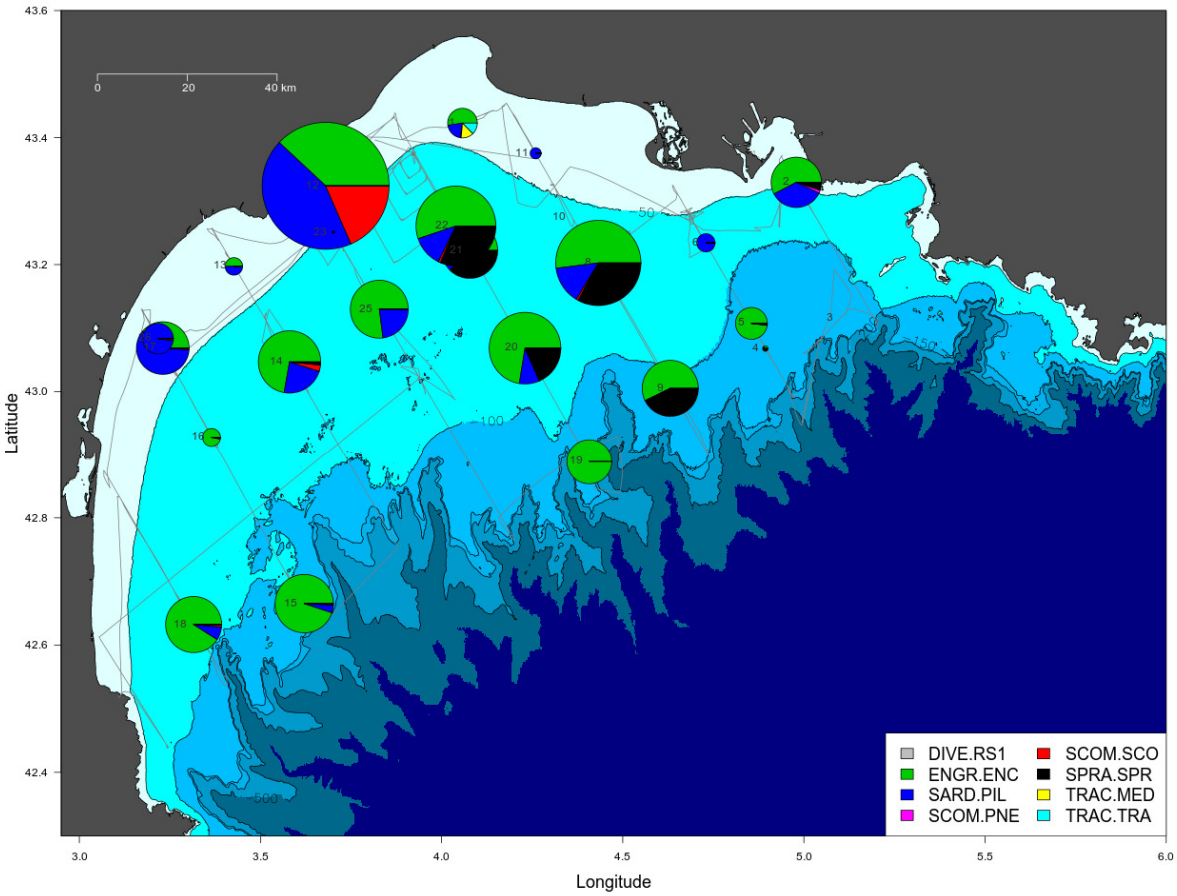


Figure 2.4.2 Catch compositions of pelagic hauls carried out in GSA07 during MEDIAS 2020.

f) Oceanographic parameters

In total 32 hydrological stations have been conducted (Fig. 2.4.3) using a SBE 19plus V2 CTD which measures conductivity, temperature, pressure, fluorescence, PAR (Photosynthetically active radiation), pH, oxygen and turbidity. Zooplankton was sampled through WP2 vertical nets, while phytoplankton was sampled through Niskin bottles in subsurface and at the maximum of chlorophyll depth.

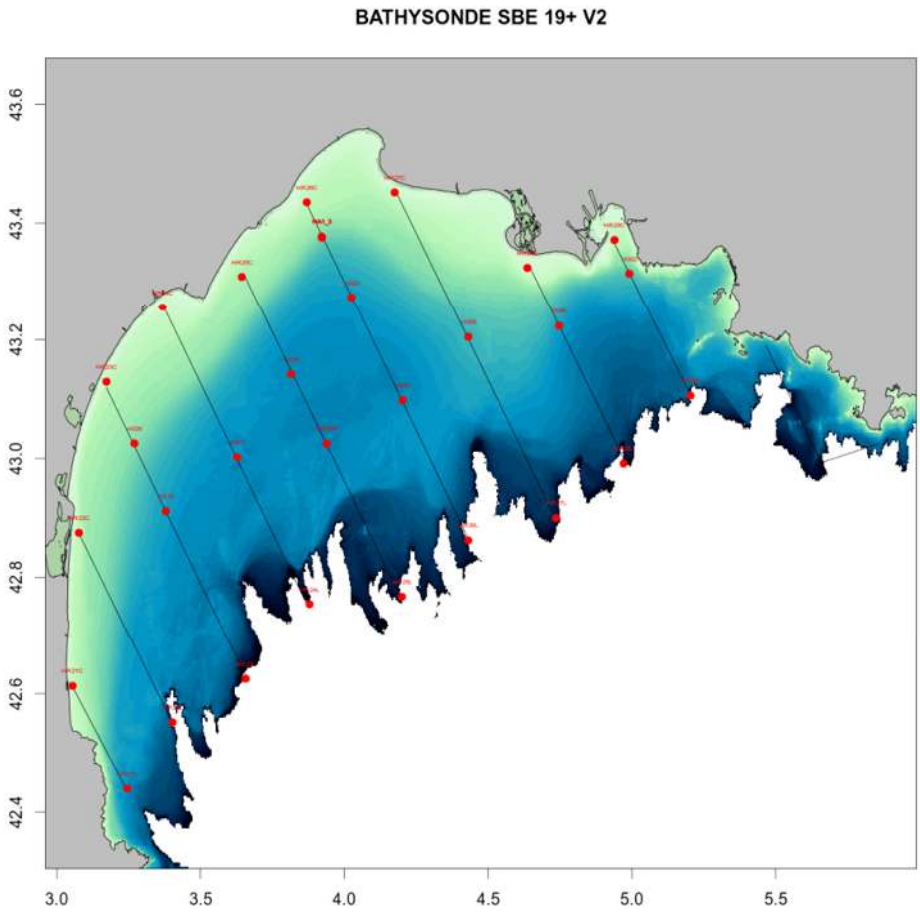


Figure 2.4.3 CTD stations conducted in GSA 7 during MEDIAS 2020.

g) Biomass estimations of target species

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 62849 t and 59073 t in 2020. The CVs of geostatistical simulations were 16 and 13 % while the CV associated to Hauls / ESDUs associations were 5.0 % and 2.9 % for respectively for sardine and anchovy. Abundance at length estimates for sardines and anchovy are shown in Figure 2.4.4. Long-term biomass estimates are shown in Figure 2.4.5.

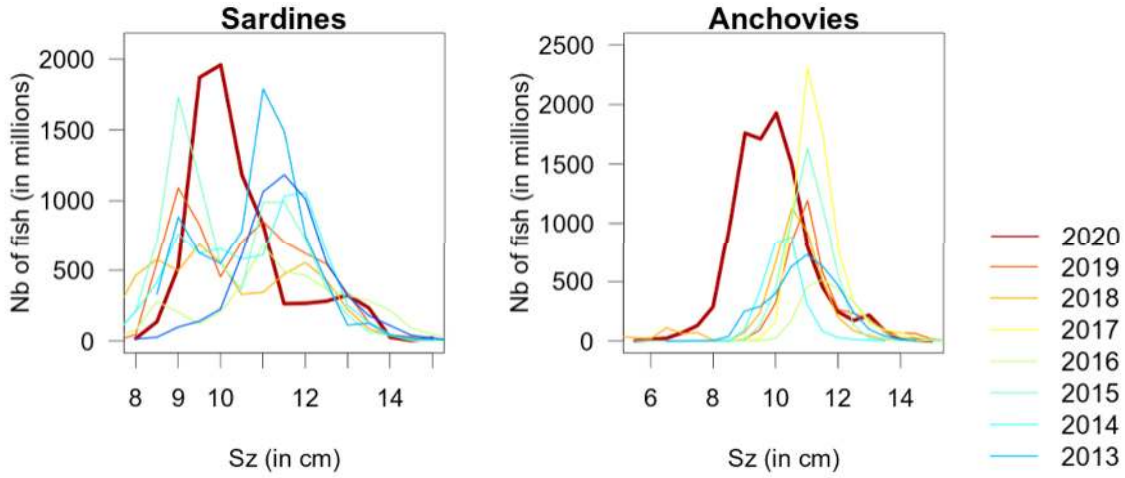


Figure 2.4.4. Abundance at length estimates for sardines and anchovy in GSA 7.

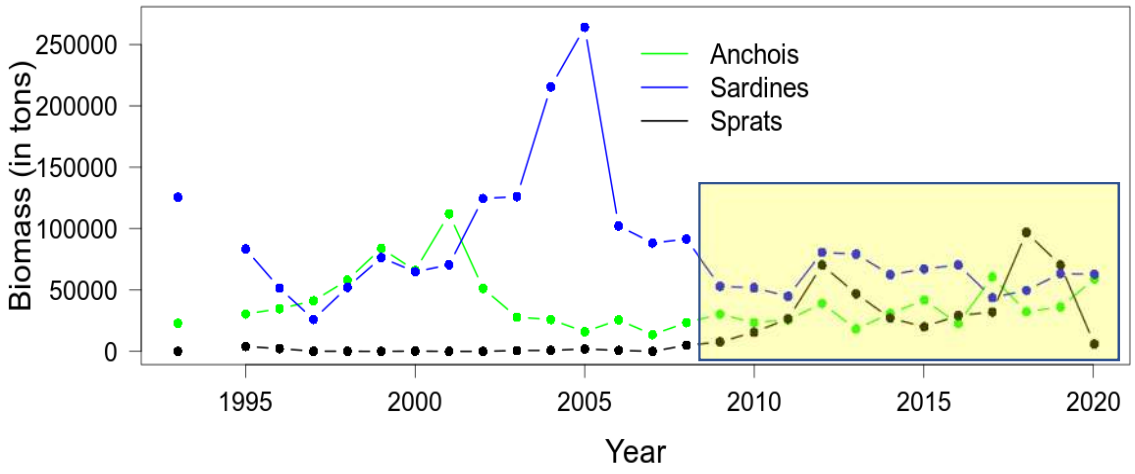


Figure 2.4.5. Long-term biomass estimates in GSA 7 for anchovy, sardine and sprat (DCF-MEDIAS estimates since 2009 are in yellow frame).

Biomass per age was estimated for sardine and anchovy using otoliths reading and survey specific age-length keys (Figure 2.4.6) obtained in MEDIAS 2020.

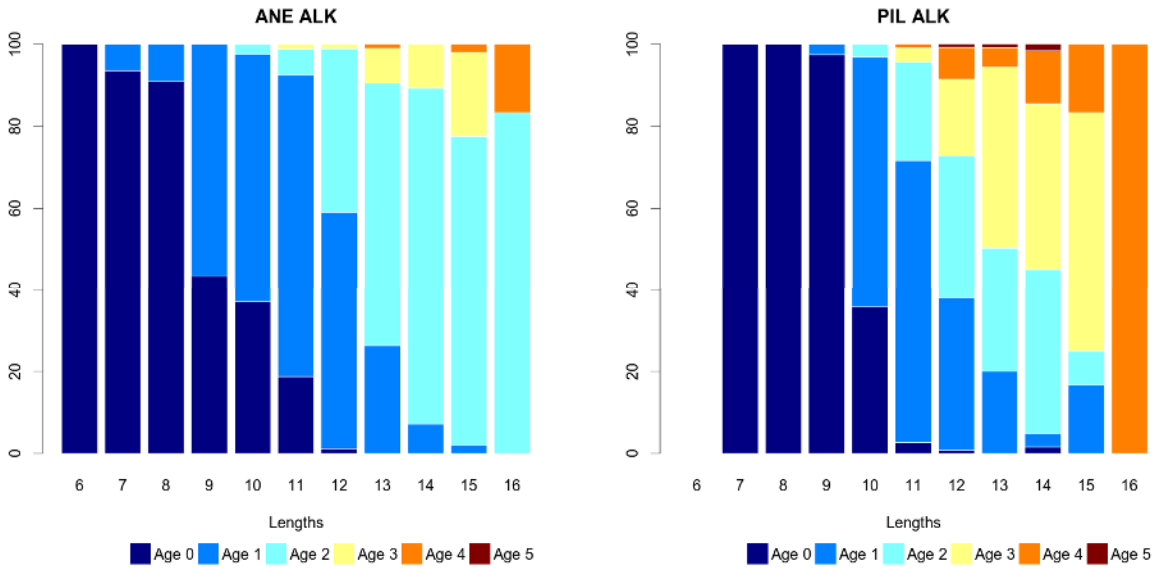


Figure 2.4.6 Survey specific age-length keys for sardine and anchovy obtained (MEDIAS, 2020).

Sardine and anchovy population's age structures, estimated as abundance at age, are shown in Figure 2.4.8.

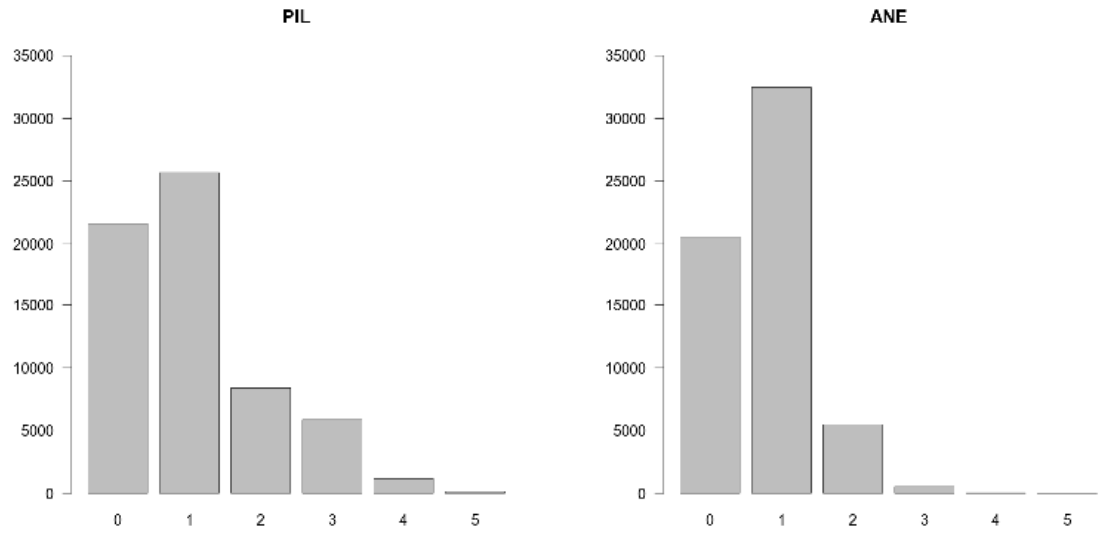


Figure 2.4.8. Sardine (PIL) and anchovy (ANE) population's age structures in GSA 7 (MEDIAS, 2020).

h) Abundance indices of target species

Spatial distributions of abundance indices of sardine and anchovy in GSA 7 during MEDIAS 2020 are shown in Figure 2.4.9. Age-structured estimates from acoustic surveys, related to sardine and anchovy populations, are shown in figures 2.4.10 and 2.4.11.

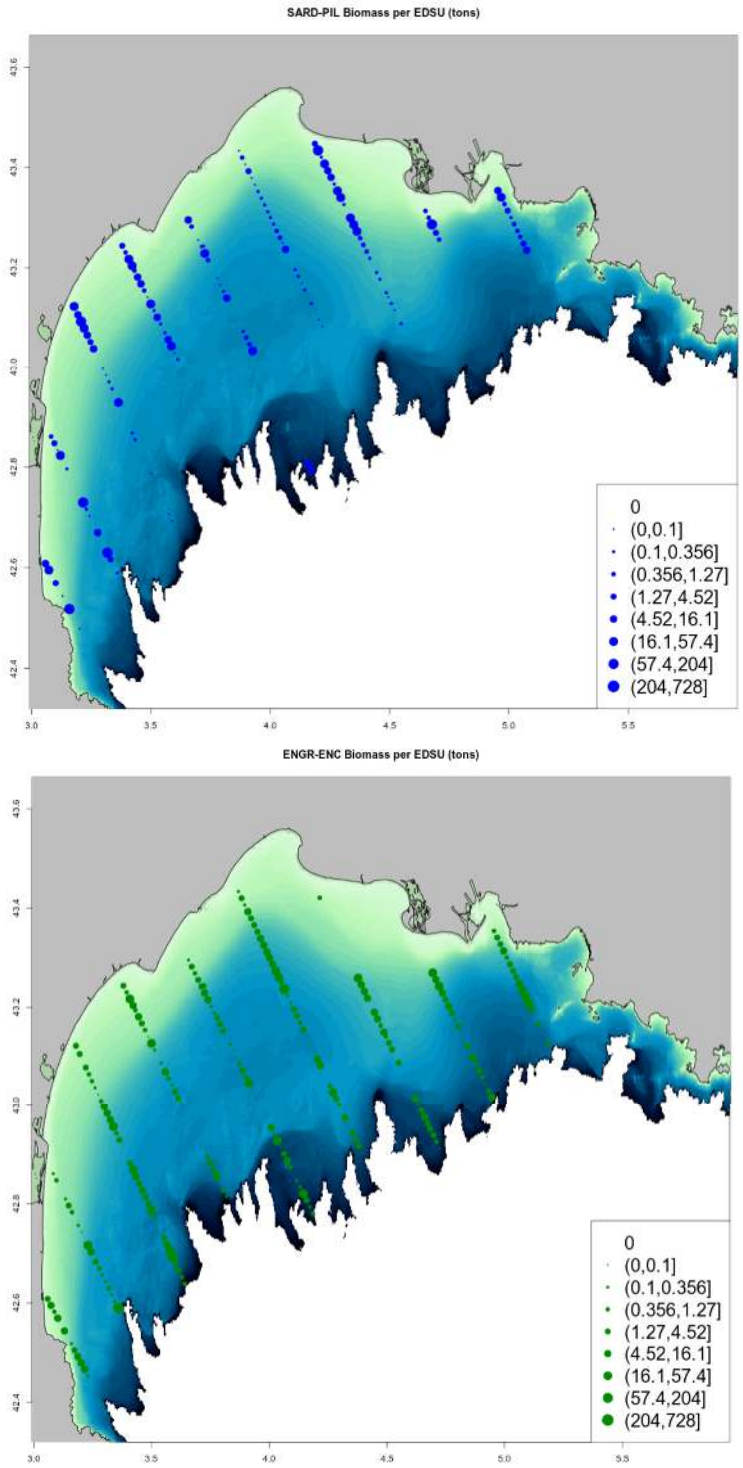


Figure 2.4.9 Spatial distributions of sardine(above) and anchovy (bellow) in GSA 7 during MEDIAS 2020.

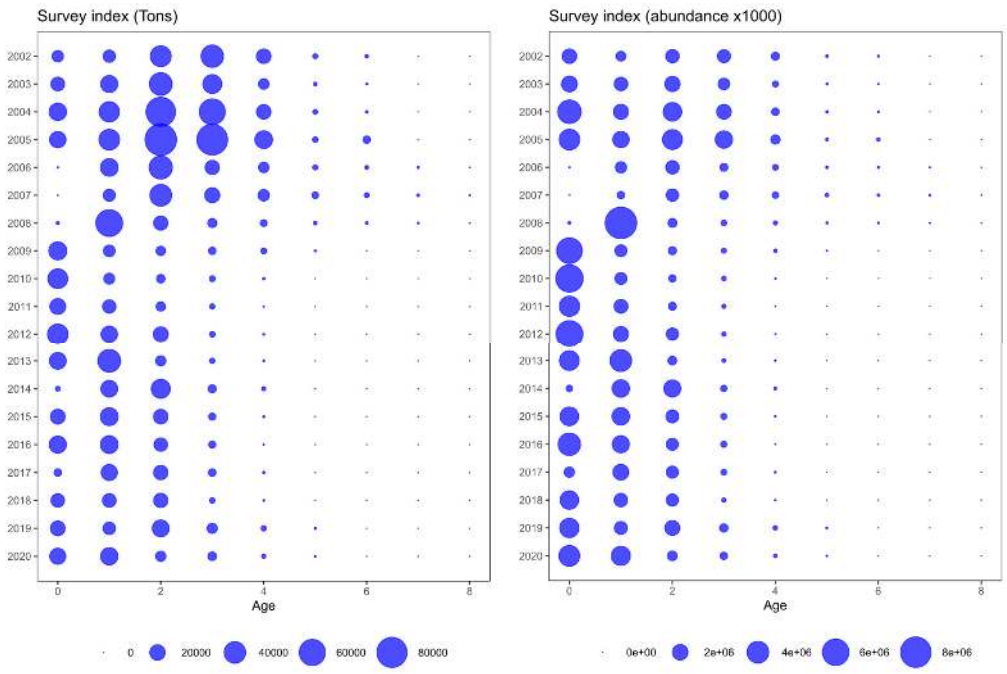


Figure 2.4.10 Age-structured estimates from acoustic surveys for sardine's population in GSA 7.

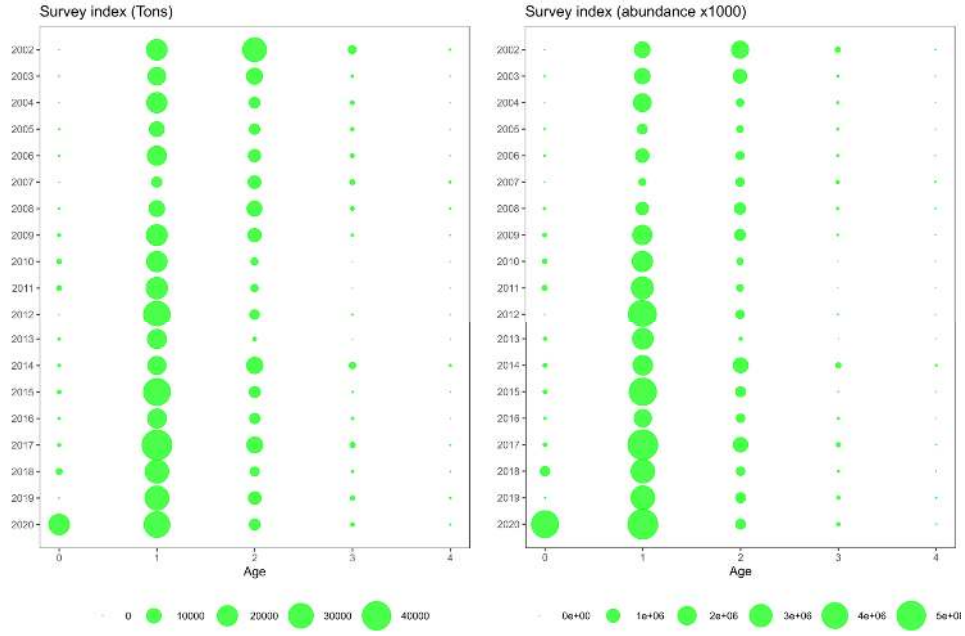


Figure 2.4.11 Age-structured estimates from acoustic surveys for anchovy's population in GSA 7.

2.5 Results of the 2019 acoustic survey in GSA 9 and GSA 10 (ITA) – Tyrrhenian Sea and Ligurian Sea (Angelo Bonanno, Gualtiero Basilone, Marco Barra, Simona Genovese & Rosalia Ferreri, CNR)

a) General information on the survey

In 2019, the survey took place from August 12 to September 02 (lasts 22 days at sea) and covered the continental shelf in the Ligurian and Tyrrhenian seas (6941 nm^2) with the fishery Research Vessel "G. Dallaporta" (35.7 m length, 1086 HP).

b) Type of echosounders and frequencies in use

The split beam echo sounder used is SIMRAD EK60, with the 38, 70, 120 and 200 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. The mean surveying acoustic vessel speed is 9 knots. The Echoview software was used to visualize and analyze acoustic data.

c) Calibration results

Calibration results for MEDIAS 2019 are presented in Table 2.5.1.

Table 2.5.1 Calibration results – MEDIAS 2019

Transducer Frequency	38 kHz	120 kHz
Transducer model	ES38B	ES120_7C
Transducer serial no.	30789	480
Vessel	"G. Dallaporta"	"G. Dallaporta"
Date	26/07/2019	26/07/2019
Place	Bay of Syracuse	Bay of Syracuse
Bottom depth (m)	15	15
Temperature at sphere depth	26.7°C	26.7°C
Salinity (PSU) at sphere depth	38.9	38.9
TS of sphere (dB)	-33.6	-40.4
Pulse duration (ms)	1.024	1.024
Ping interval (s)	1.0	1.0
RMS	0.15	0.29
Transducer gain (dB)	24.68	22.26
Sa corr. (dB)	-0.63	-0.40
Athw. Beam angle (deg)	6.96	6.21
Along Beam angle (deg)	6.92	6.33
Athw. Offset Beam angle (deg)	0.09	-0.04
Along Offset Beam angles (deg)	0.01	-0.31

d) Survey design

Most of the survey design is made of parallel transects perpendicular to the coastline (Fig. 2.5.1), from the 10-20 m isobath to the 200 m one. Due to the narrow continental shelf along the northern coast of Sicily and the western coast of Calabria, a zig-zag transects design was adopted. The total nautical miles effectively used for acoustic analysis (minus pelagic trawls tracks and linking transects) were 1819 in 2019.

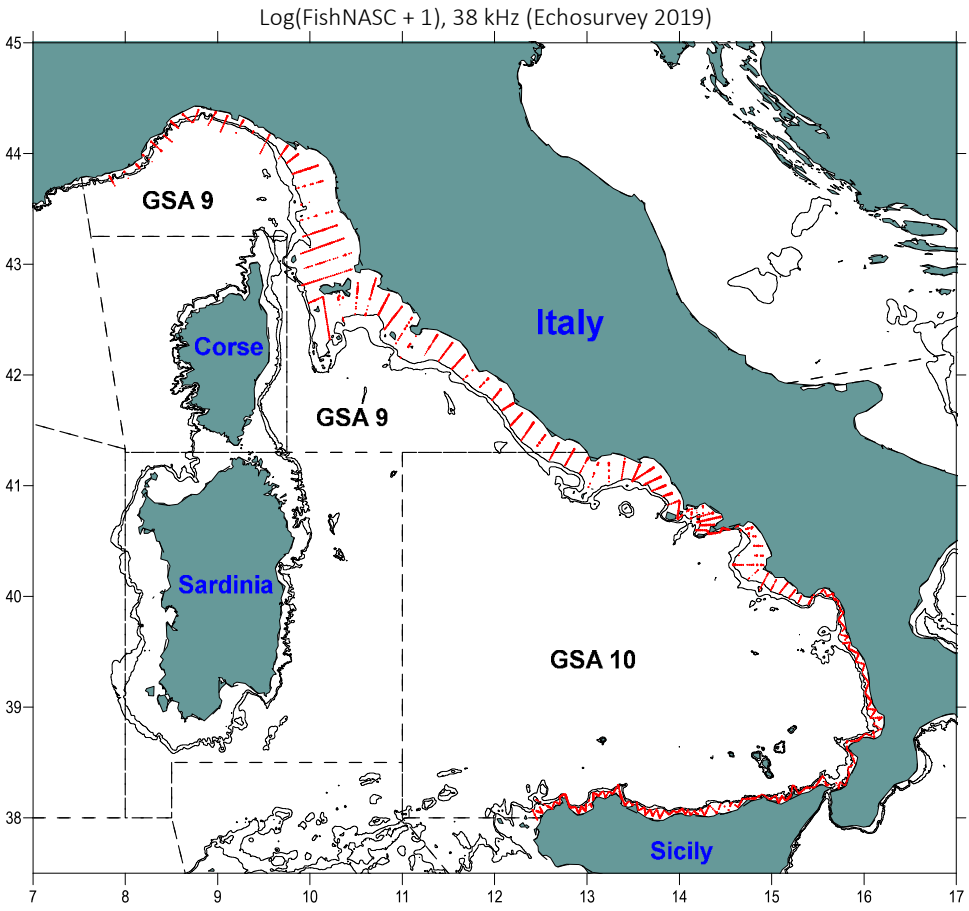


Figure 2.5.1 Survey design in GSA 9 and GSA 10 (MEDIAS 2019).

e) Fish sampling

Pelagic fishes are identified with a pelagic haul. In summer 2019, twenty-six (26) and twenty-four (24) pelagic hauls were carried out respectively in GSA 9 and GSA 10 to be used for the scrutinizing of the echograms (Fig. 2.5.2 and Fig. 2.5.3). Trawl hauls were performed during day time.

The pelagic net used has a total length of 78 m (Cod end length 22 m), Cod end mesh size of 18 mm, Vertical opening of 7 m, Horizontal opening 13 m, Initial mesh size 182x800 mm and Lateral mesh size 400 mm.

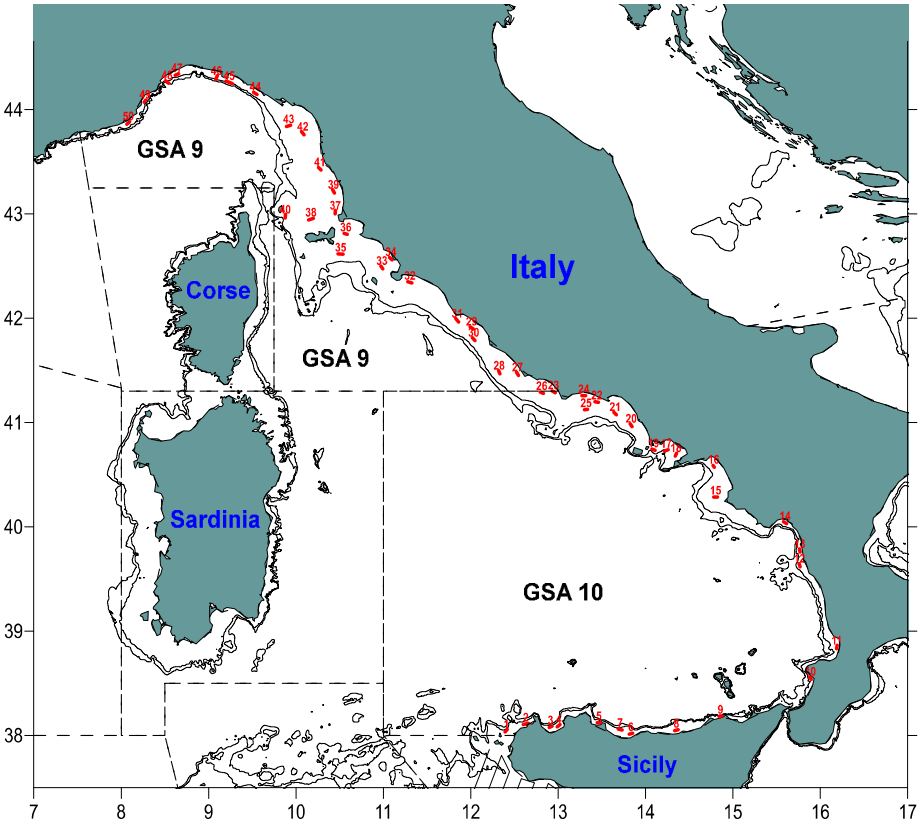


Figure 2.5.2 Trawl hauls performed during the Echosurvey in summer 2019.

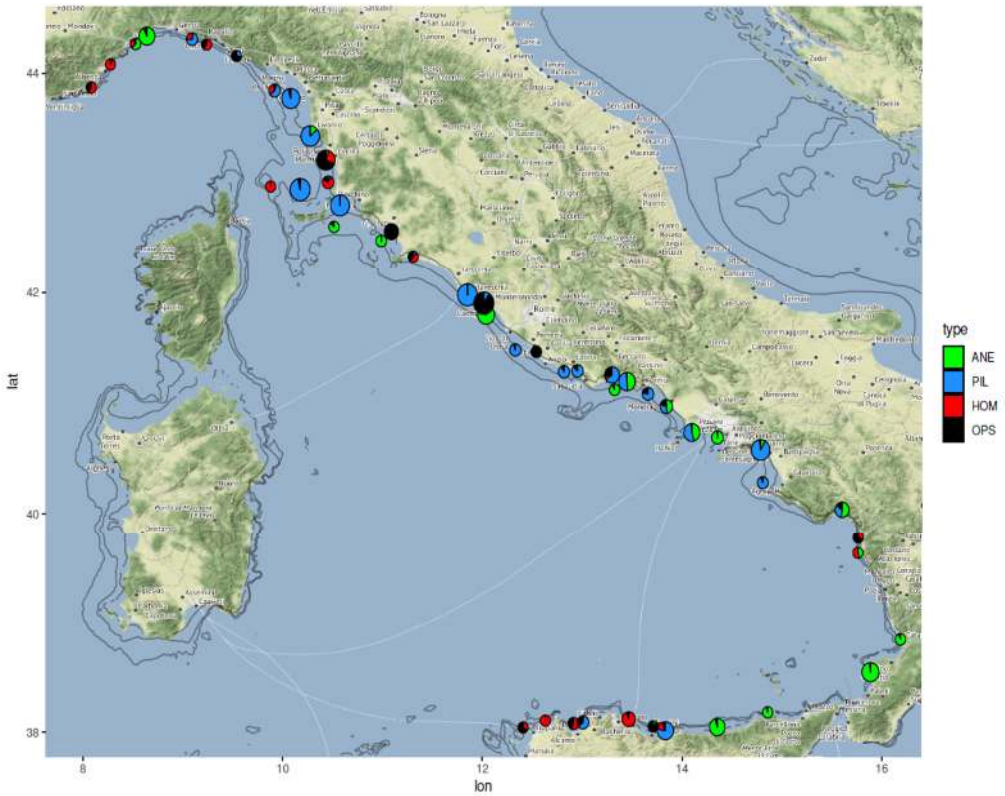


Figure 2.5.3 Map with pie charts reporting percentages in weight of anchovy, sardine and other species. MEDIAS 2019.

f) Oceanographic parameters

During the survey in summer 2019, 134 and 158 hydrological stations have been conducted in GSAs 9 and 10 respectively (Fig. 2.5.4) using a SBE 9/11plus CTD which measures conductivity, temperature, pressure, fluorescence, PAR (Photosynthetically active radiation), pH, oxygen and turbidity.

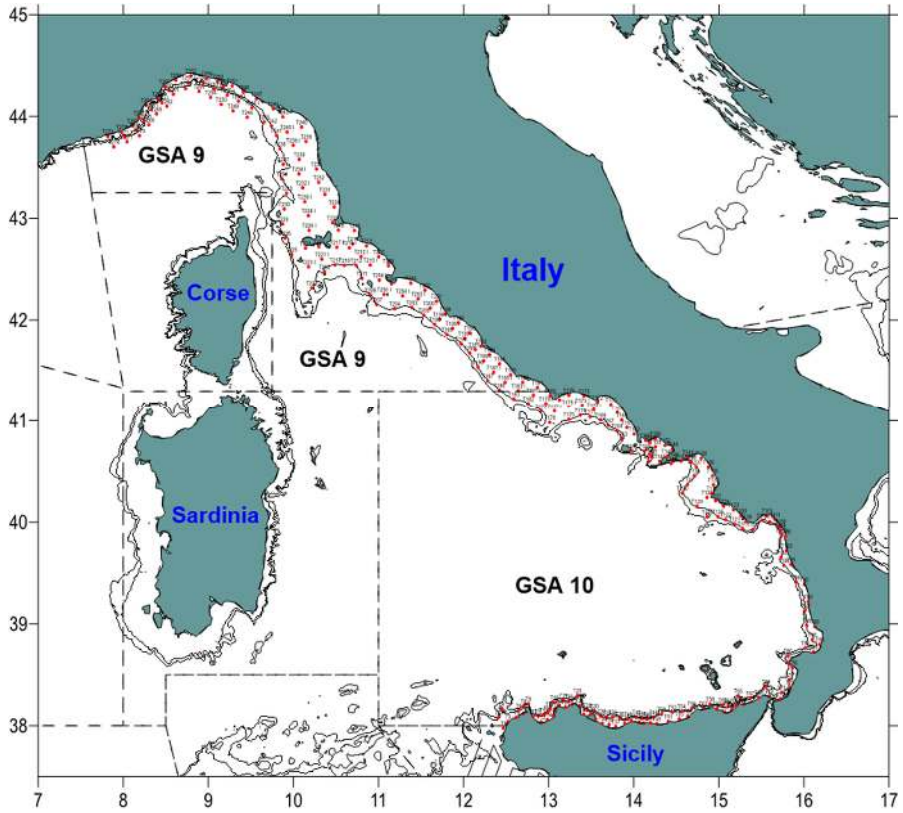


Figure 2.5.4 CTD stations performed during the echosurvey in summer 2019.

g) Biomass estimations of target species

The biomass estimation of sardine and anchovy in GSAs 9 and 10 during 2019, and the associated CVs of geostatistical simulations, are reported in the Table 2.5.2. Estimations of biomass densities are shown in Figure 2.5.5. Length structured biomass estimates are shown in Figure 2.5.6.

Table 2.5.2 The biomass estimation of sardine and anchovy in GSAs 9 and 10.

	GSA 9		GSA 10	
	2019		2019	
	Biomass (t)	CV	Biomass (t)	CV
Anchovy	21393.7	16.6	30483.4	14.7
Sardine	28969.8	12.5	15360.4	14.1

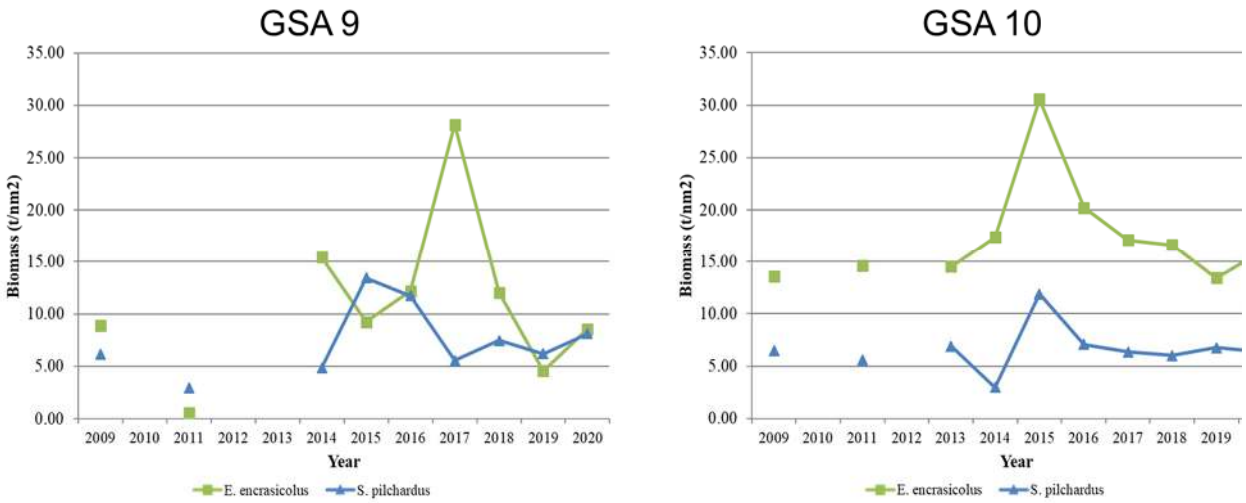


Figure 2.5.5 Biomass dentity (t/NM^2) in the period 2009-2019.

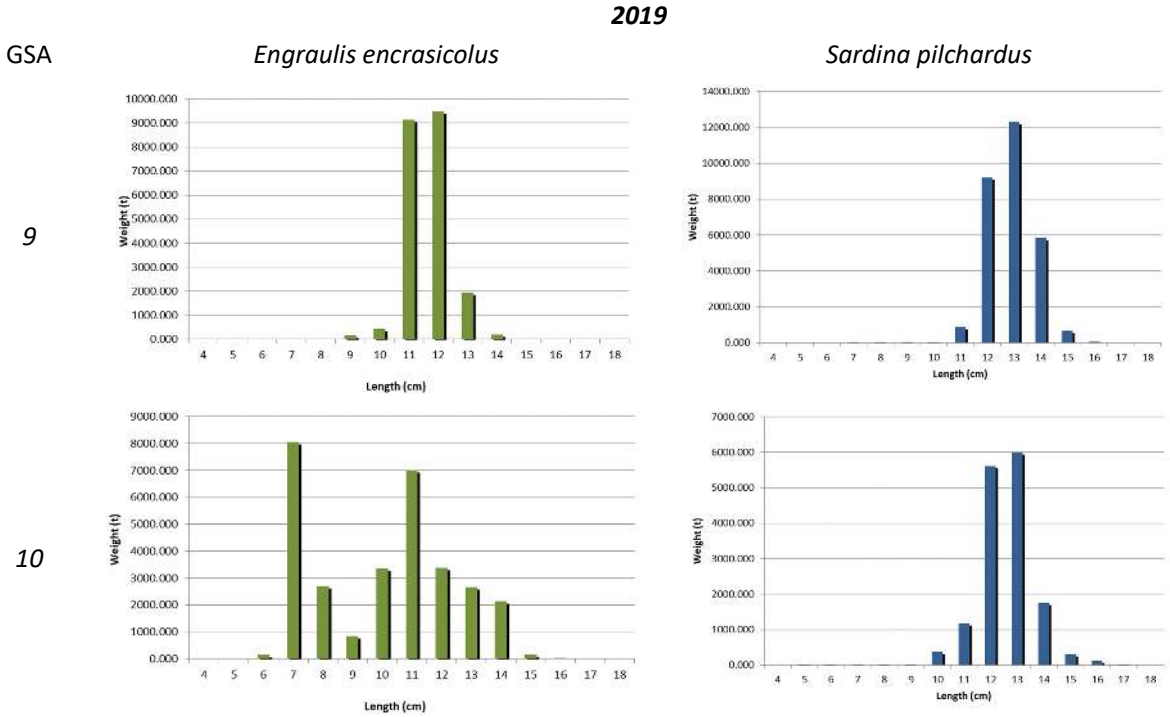


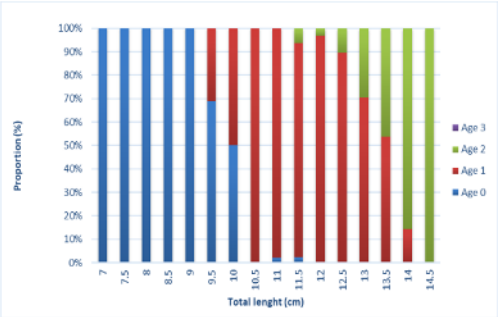
Figure 2.5.6 Length structured biomass estimates of target species in GSA 9 (above) and GSA 10 (bellow). MEDIAS 2019.

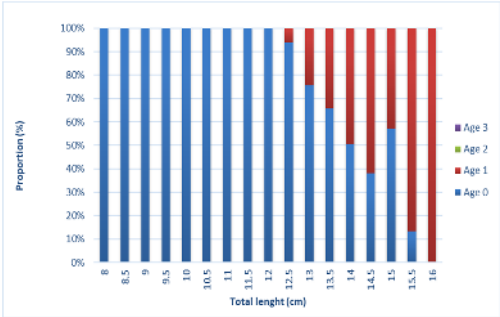
Biomass per age estimates for sardine and anchovy using otoliths readings and the related age-length keys for MEDIAS 2019 are shown in Figure 2.5.7 and Figure 2.5.8.

2019

GSA | *Engraulis encrasicolus* | *Sardina pilchardus*

9





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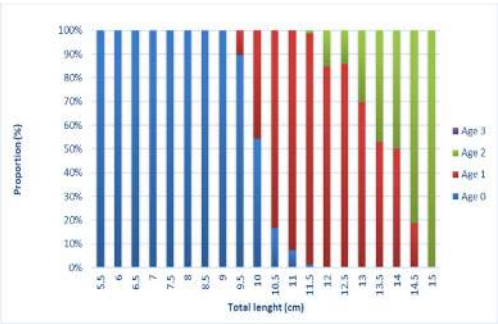


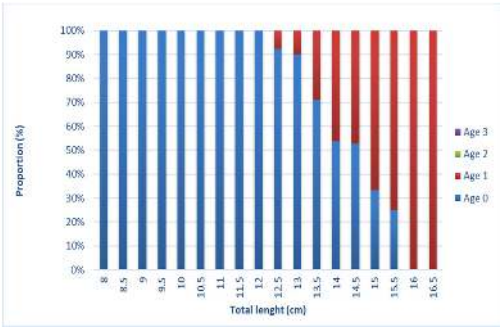
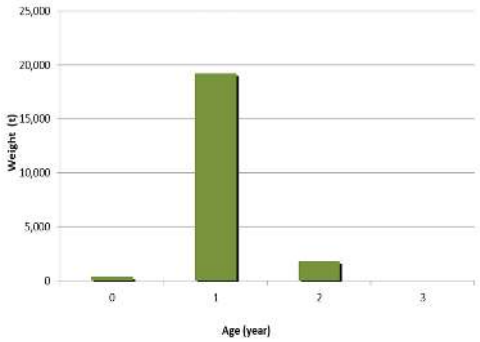


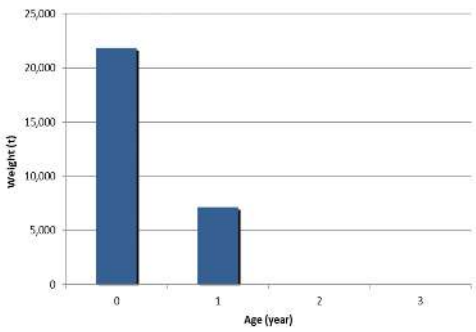
Figure 2.5.7 Age-length keys for MEDIAS 2019.

2019

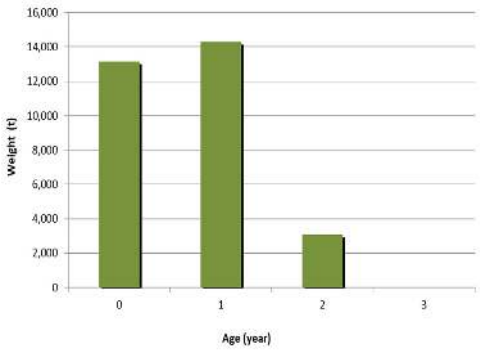
GSA | *Engraulis encrasicolus* | *Sardina pilchardus*

9





10



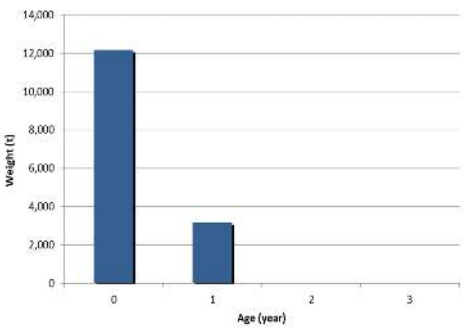


Figure 2.5.8 Biomass at age (in tons) estimates in MEDIAS 2019.

h) Abundance indices of target species in 2019

Spatial distributions of anchovy and sardine abundance indices are shown in Figure 2.5.9.

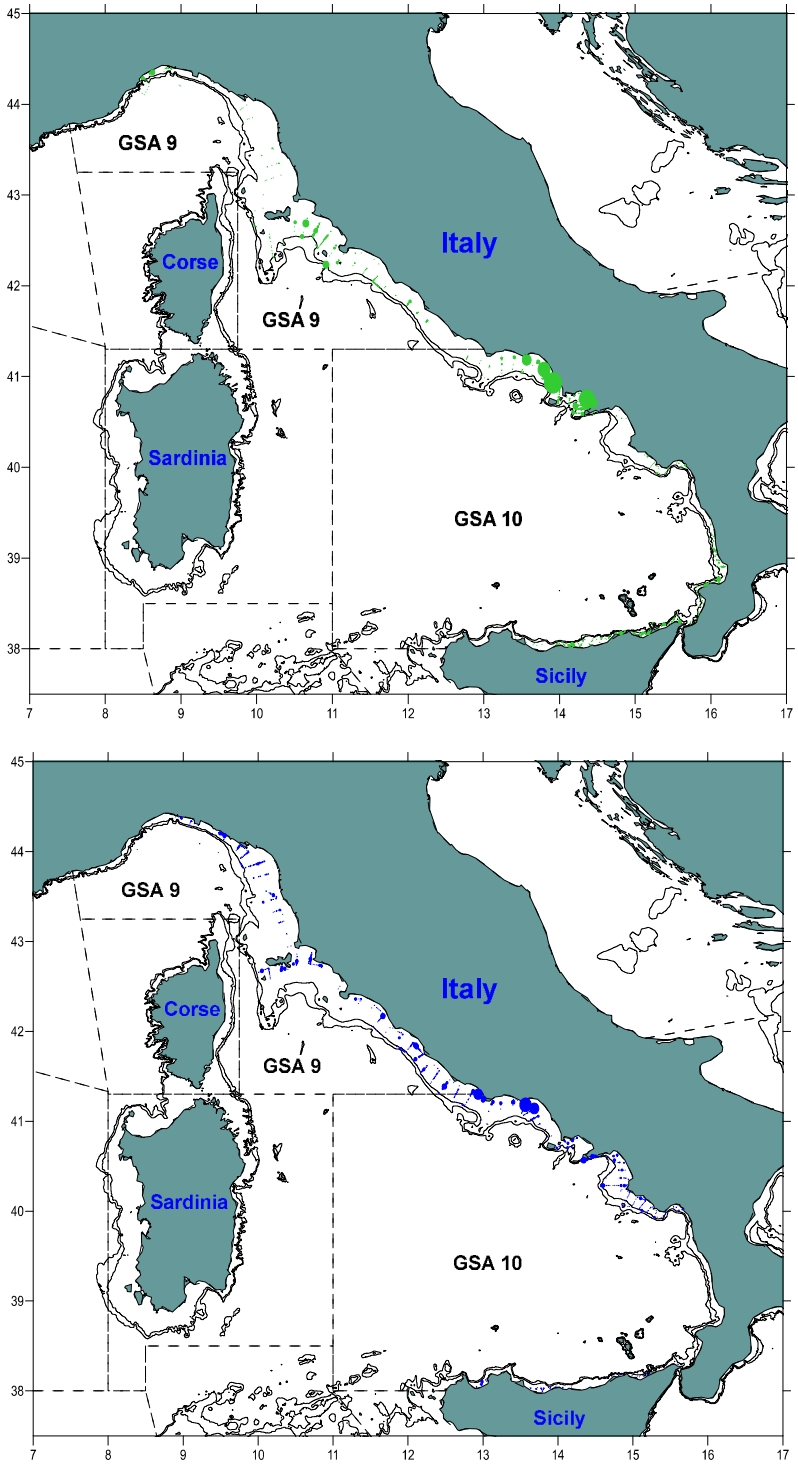


Figure 2.5.9 Anchovy (above) and sardine (bellow) NASC per EDSU in GSAs 9 and 10 in summer 2019.

2.6 Results of the 2020 acoustic survey in GSA 9 and GSA 10 (ITA) – Tyrrhenian Sea and Ligurian Sea (Angelo Bonanno, Gualtiero Basilone, Marco Barra, Simona Genovese & Rosalia Ferreri, CNR)

a) General information on the survey

In summer 2020, the survey was carried out on board the same vessel from August 25 to September 12 (lasts 19 days at sea) and covered an area of 6647 nm^2.

b) Type of echosounders and frequencies in use

The split beam echo sounder used is SIMRAD EK60, with the 38, 70, 120 and 200 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. The mean surveying acoustic vessel speed is 9 knots. The Echoview software was used to visualize and analyze acoustic data.

c) Calibration results

Calibration results for MEDIAS 2020 are presented in Table 2.5.1.

Table 2.6.1 Calibration results – MEDIAS 2020

Transducer Frequency	38 kHz	120 kHz
Transducer model	ES38B	ES120_7C
Transducer serial no.	30789	480
Vessel	"G. Dallaporta"	"G. Dallaporta"
Date	04/09/2020	04/09/2020
Place	Ponza island	Ponza island
Bottom depth (m)	25	25
Temperature at sphere depth	26.4°C	26.4°C
Salinity (PSU) at sphere depth	38.3	38.3
TS of sphere (dB)	-33.6	-40.4
Pulse duration (ms)	1.024	1.024
Ping interval (s)	1.0	1.0
RMS	0.17	0.31
Transducer gain (dB)	24.93	23.81
Sa corr. (dB)	-0.61	-0.37
Athw. Beam angle (deg)	7.04	6.83
Along Beam angle (deg)	6.87	6.80
Athw. Offset Beam angle (deg)	0.06	0.02
Along Offset Beam angles (deg)	-0.07	-0.12

d) Survey design

Most of the survey design is made of parallel transects perpendicular to the coastline (Fig. 2.6.1), from the 10-20 m isobath to the 200 m one. Due to the narrow continental shelf along the northern coast of Sicily and the western coast of Calabria, a zig-zag transects design was adopted. The total nautical miles effectively used for acoustic analysis (minus pelagic trawls tracks and linking transects) were 1405 in 2020.

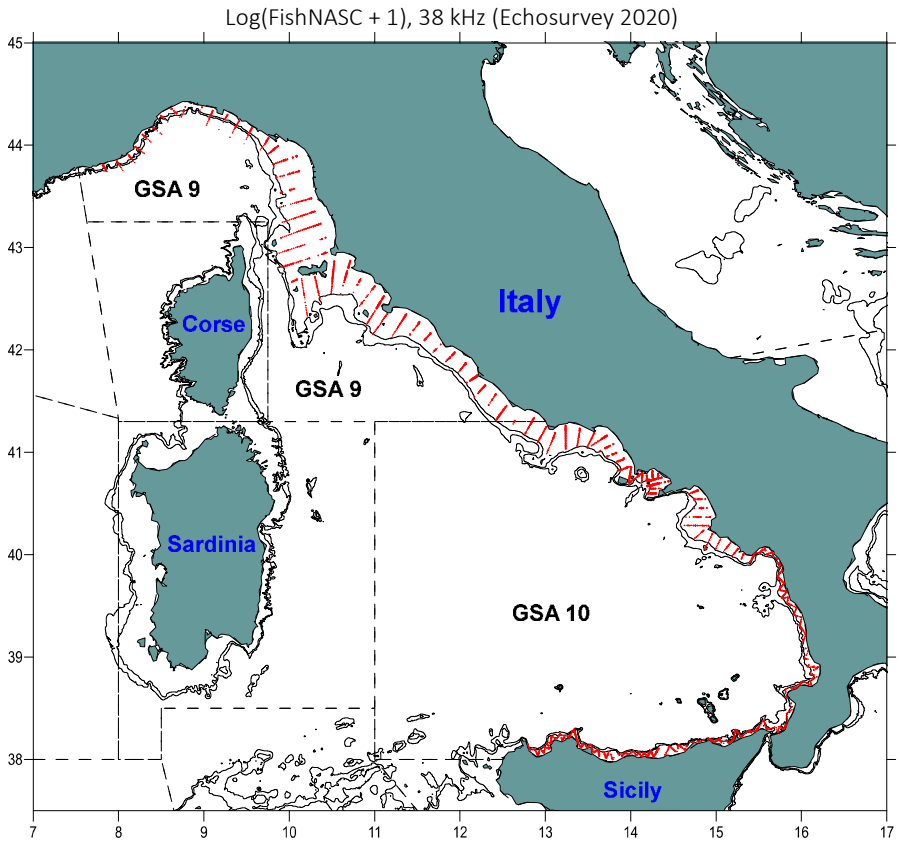


Figure 2.6.1 Survey design in GSA 9 and GSA 10 (MEDIAS 2020).

e) Fish sampling

Pelagic fishes are identified with a pelagic haul. In summer 2020, nineteen (19) and twenty (20) pelagic hauls were carried out in GSA 9 and GSA 10 respectively, to be used for the scrutinizing of the echograms (Fig. 2.6.2 and Fig. 2.6.3). Trawl hauls were performed during day time.
The pelagic net used has a total length of 78 m (Cod end length 22 m), Cod end mesh size of 18 mm, Vertical opening of 7 m, Horizontal opening 13 m, Initial mesh size 182x800 mm and Lateral mesh size 400 mm.

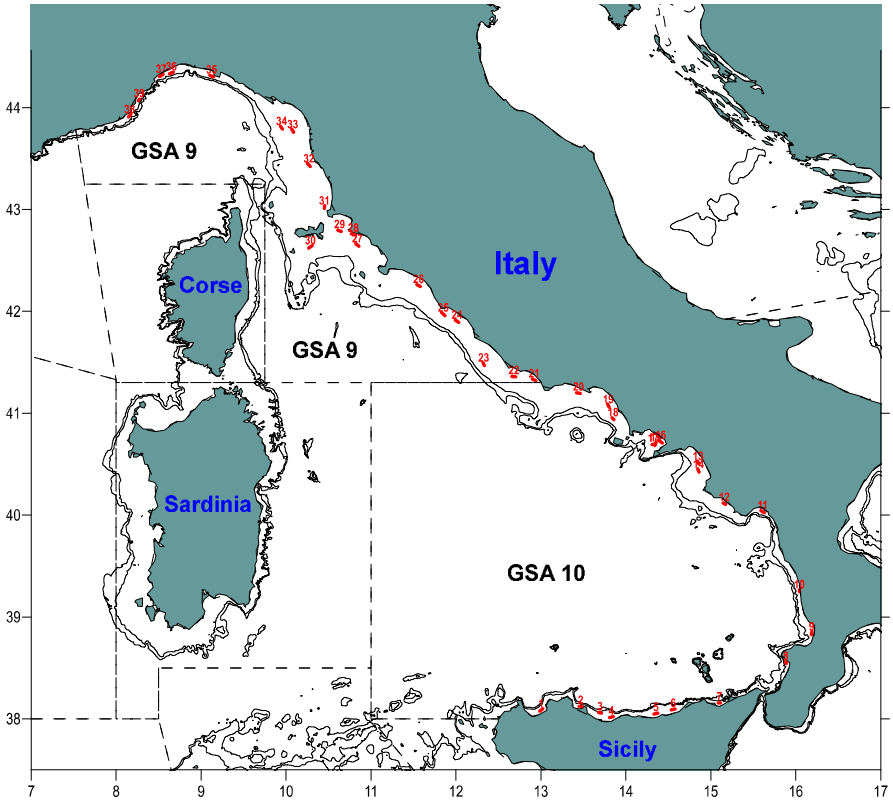


Figure 2.6.2 Trawl hauls performed during the Echosurvey in summer 2020.

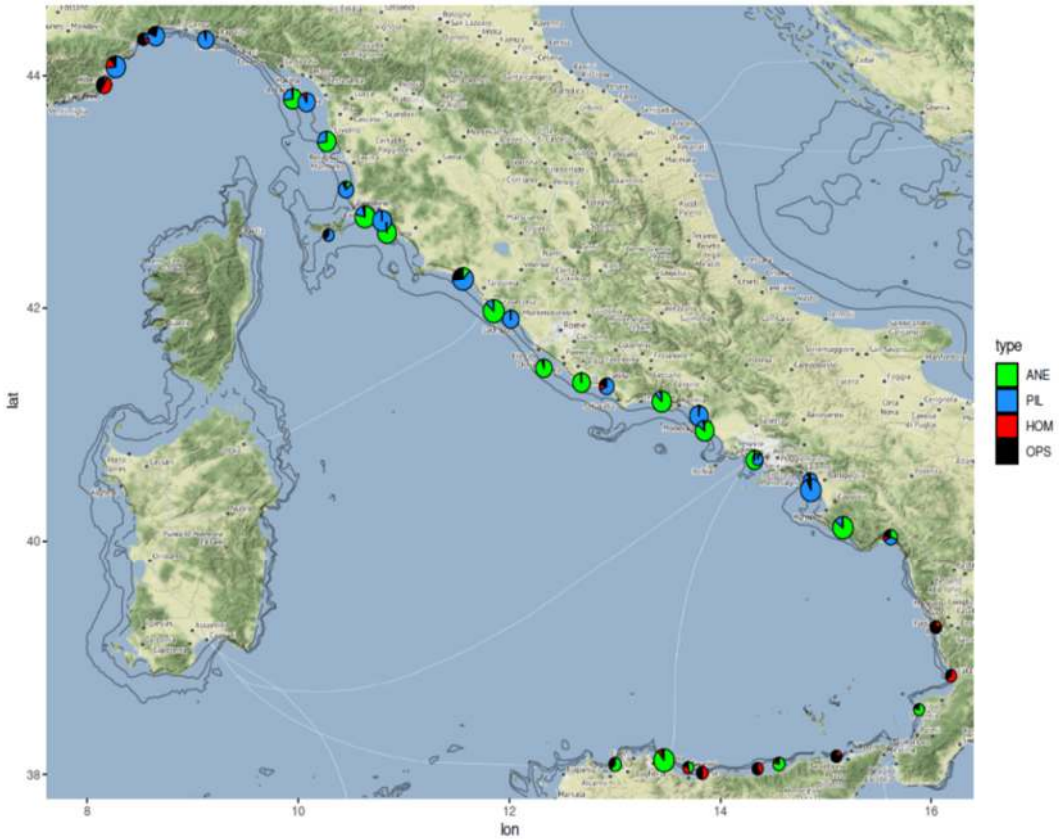


Figure 2.6.3 Map with pie charts reporting percentages in weight of anchovy, sardine and other species. MEDIAS 2020.

f) Oceanographic parameters

During the survey in summer 2020, 63 and 120 hydrological stations have been conducted in GSAs 9 and 10 respectively (Fig. 2.6.4) using a SBE 9/11plus CTD which measures conductivity, temperature, pressure, fluorescence, PAR (Photosynthetically active radiation), pH, oxygen and turbidity.

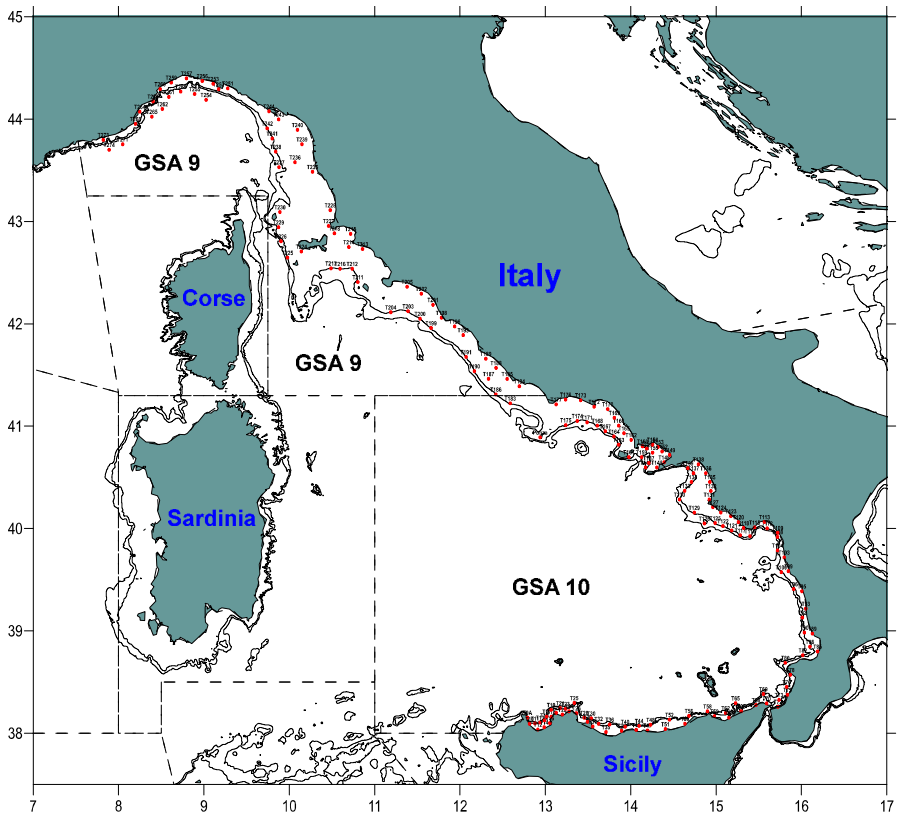


Figure 2.6.4 CTD stations performed during the echosurvey in summer 2020.

g) Biomass estimations of target species

The biomass estimation of sardine and anchovy in GSAs 9 and 10 during 2020, and the associated CVs of geostatistical simulations, are reported in the Table 2.6.2. Estimations of biomass densities are shown in Figure 2.6.5. Length structured biomass estimates are shown in Figure 2.6.6.

Table 2.6.2 The biomass estimation of sardine and anchovy in GSAs 9 and 10.

	GSA 9		GSA 10	
	2020		2020	
	Biomass (t)	CV	Biomass (t)	CV
Anchovy	37713.4	11	35726.8	9
Sardine	35667.1	13	14364.1	15

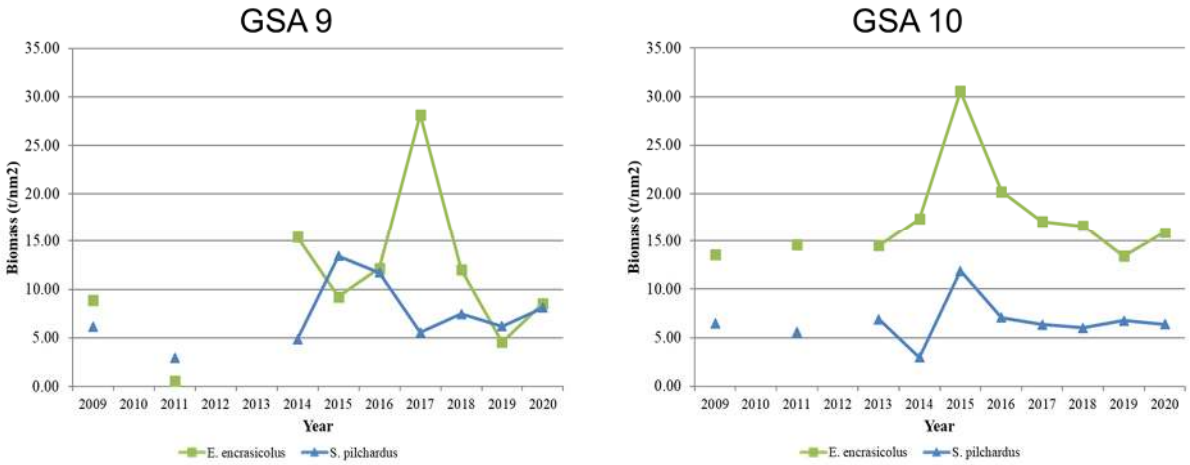


Figure 2.6.5 Biomass dentity (t/NM^2) in the period 2009-2020.

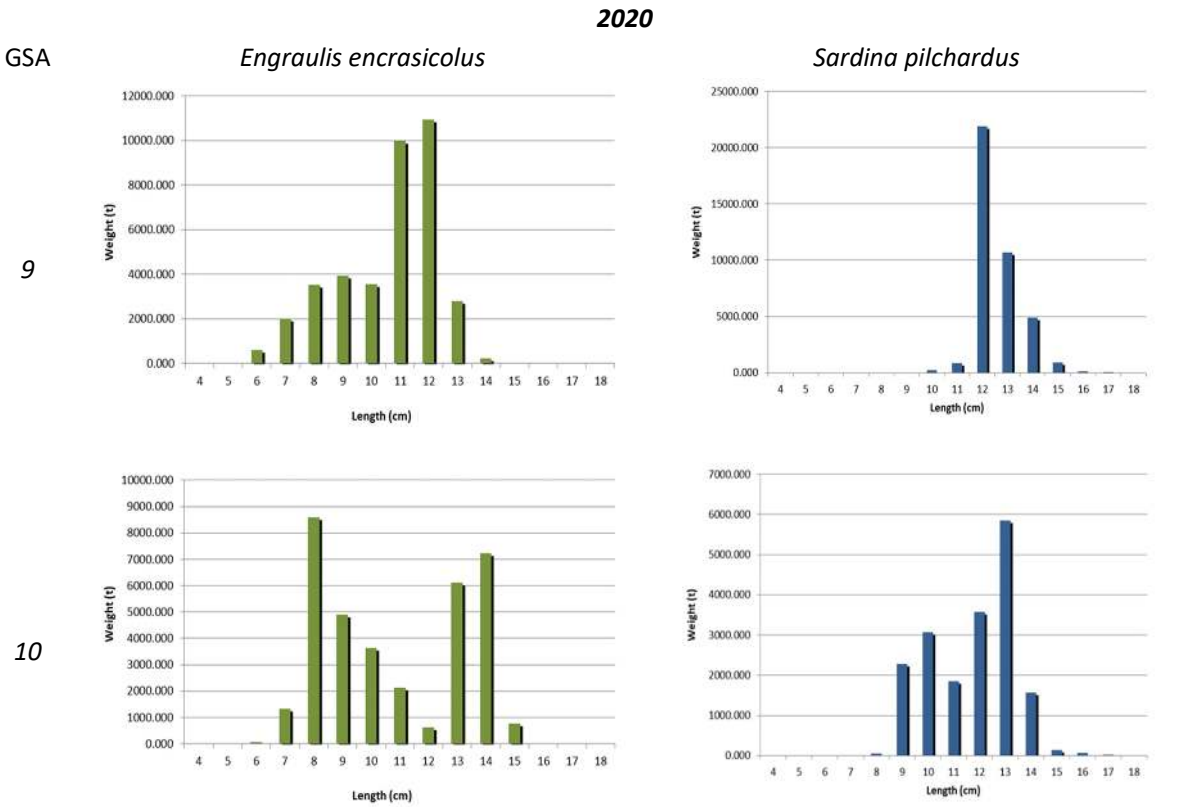


Figure 2.6.6 Length structured biomass estimates of target species in GSA 9 (above) and GSA 10 (bellow). MEDIAS 2020.

Biomass per age was estimated for sardine and anchovy using otoliths readings and the related age-length keys for MEDIAS 2020 are shown in Figure 2.6.7 and Figure 2.6.8.

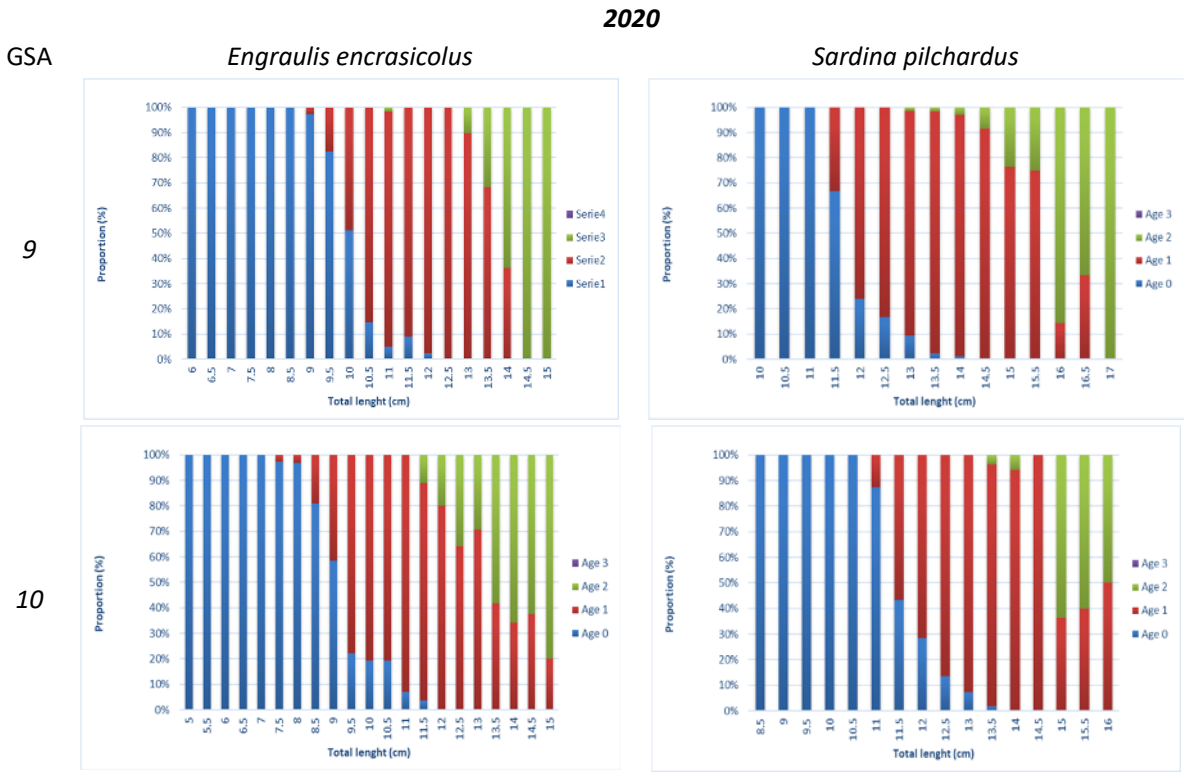


Figure 2.6.7 Age-length keys for MEDIAS 2020.

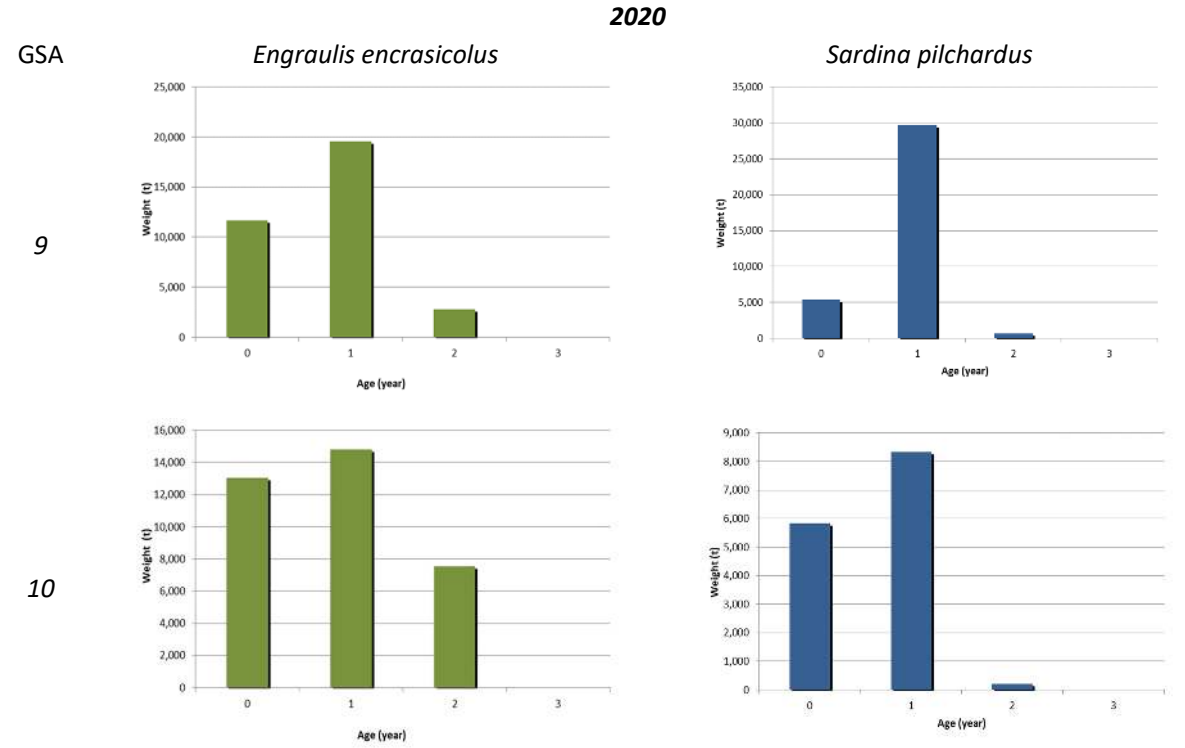


Figure 2.6.8 Biomass at age (in tons) estimates in MEDIAS 2020.

h) Abundance indices of target species in 2020

Spatial distributions of anchovy and sardine abundance indices are shown in Figure 2.6.9.

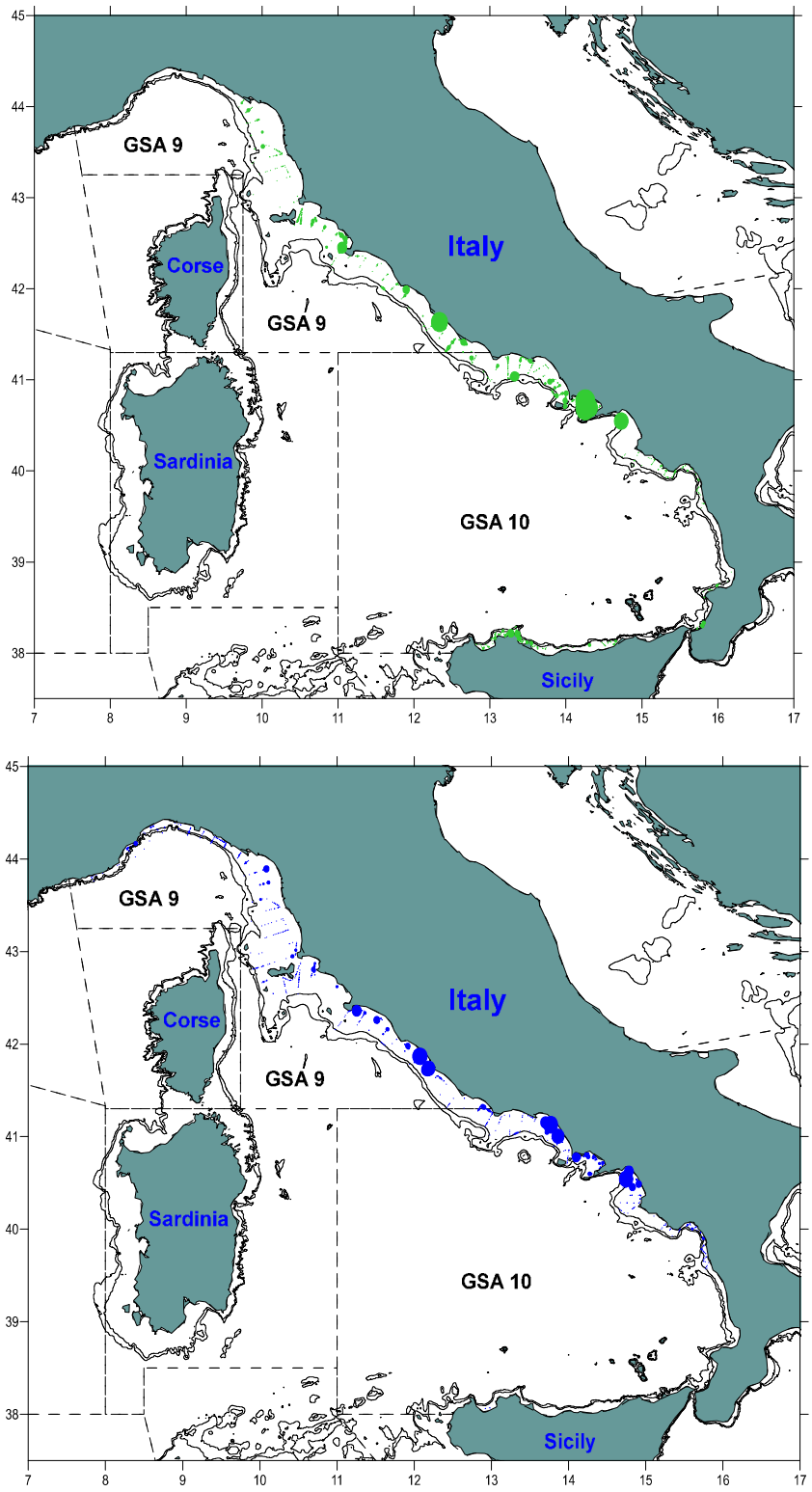


Figure 2.6.9 Anchovy (above) and sardine (bellow) NASC per EDSU in GSAs 9 and 10 in summer 2020.

2.7 Results of the 2019 acoustic survey in GSA 11 (ITA) - Sardinia (Angelo Bonanno, Gualtiero Basilone, Marco Barra, Simona Genovese & Rosalia Ferreri, CNR)

a) General information on the survey

The survey carried out in summer 2019 was the first echosurvey in GSA 11 and took place in the period 06 – 18 September (lasts 13 days at sea). The survey covered the continental shelf in the Sardinia Sea (3207 nm^2) with the fishery Research Vessel "G. Dallaporta" (35.7 m length, 1086 HP).

b) Type of echosounders and frequencies in use

The split beam echo sounder used is SIMRAD EK60, with the 38, 70, 120 and 200 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 1.024 ms. The mean surveying acoustic vessel speed is 9 knots. The Echoview software was used to visualize and analyze acoustic data.

c) Calibration results

During 2019, acoustic survey in GSA 11 used the same, previously calibrated research vessel (R/V G. Dallaporta) as survey in GSAs 9 and 10. Calibration results used for this survey are the same ones as in survey in GSAs 9 and GSA 10 (see Table 2.5.1).

d) Survey design

Most of the survey design is made of parallel transects perpendicular to the coastline (Fig. 2.7.1), from the 10-20 m isobath to the 200 m one. Due to the narrow continental shelf along part of the study area, a zig-zag transects design was adopted. The total nautical miles effectively used for acoustic analysis (minus pelagic trawls tracks and linking transects) were 666 in 2019.

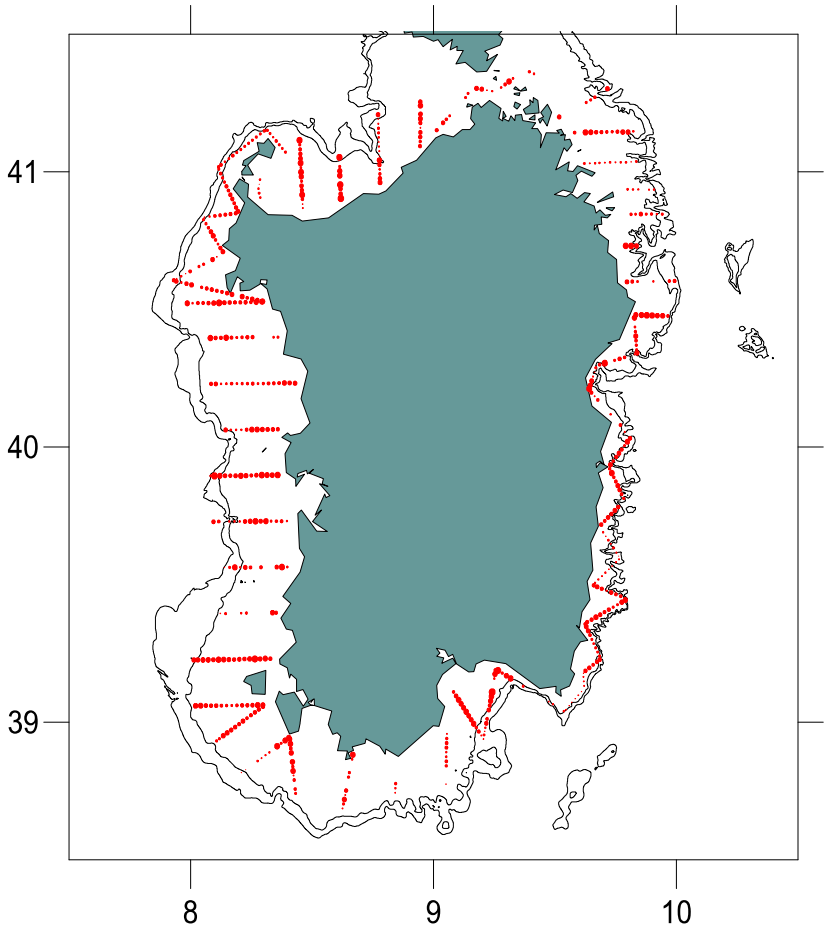


Figure 2.7.1 Survey desing in MEDIAS 2019.

e) Fish sampling

Seventeen (17) pelagic hauls were carried out in in GSA 11 in summer 2019 (Fig. 2.7.2 and Fig. 2.7.3). Trawl hauls were performed during day time. The pelagic net used has a total length of 78 m (Cod end length 22 m), Cod end mesh size of 18 mm, Vertical opening of 7 m, Horizontal opening 13 m, Initial mesh size 182x800 mm and Lateral mesh size 400 mm.

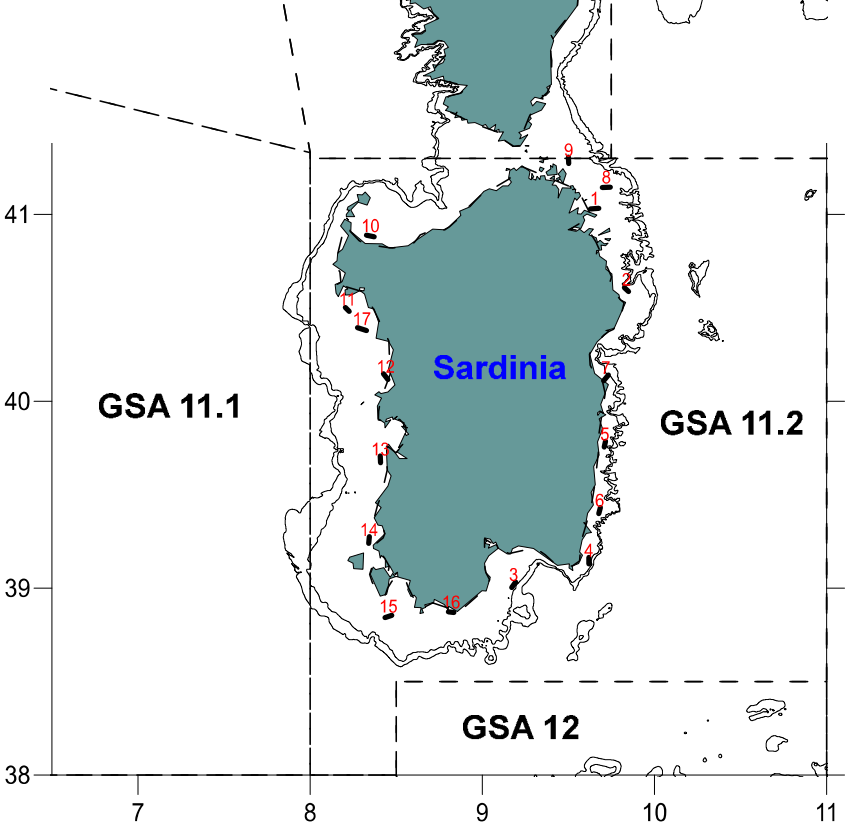


Figure 2.7.2 Trawl hauls performed during the Echosurvey in summer 2019

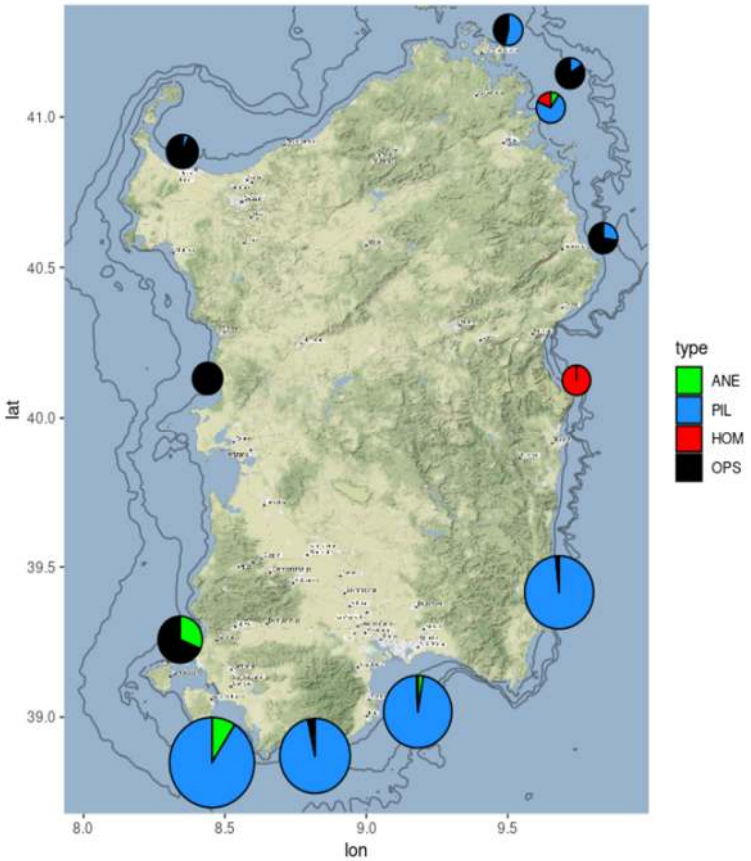


Figure 2.7.3 Map with pie charts reporting percentages in weight of anchovy, sardine and other species. MEDIAS 2019.

f) Oceanographic parameters

During the survey MEDIAS in summer 2019 in GSA 11, 79 hydrological stations have been performed (Fig. 2.7.4). A Seabird 9/11plus CTD, equipped with sensor for measuring conductivity, temperature, pressure, fluorescence, PAR (Photosynthetically active radiation), pH, oxygen and turbidity, was used.

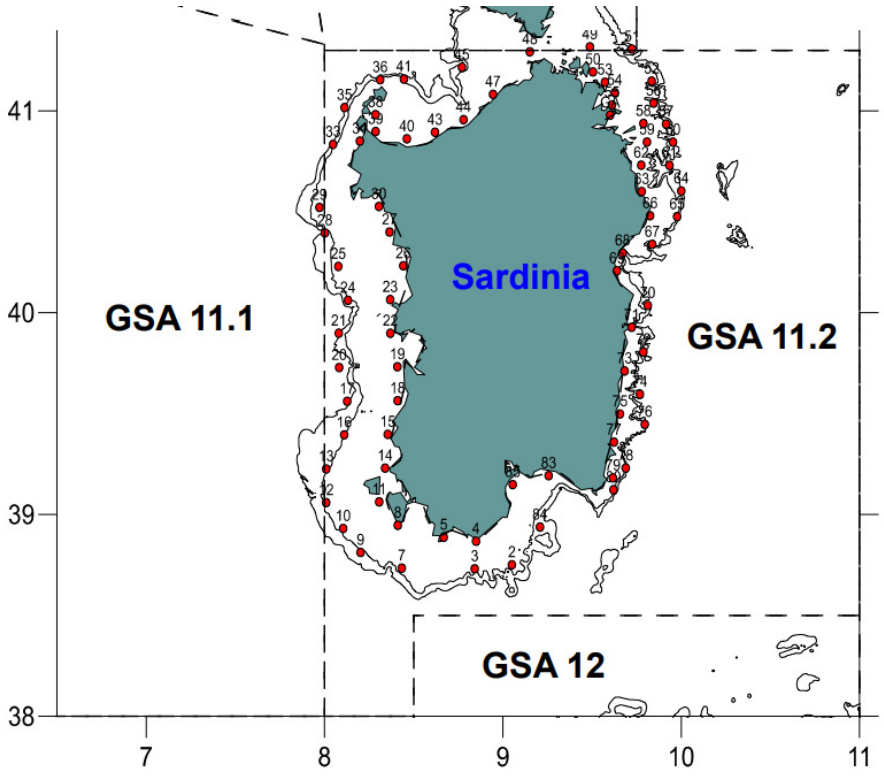


Figure 2.7.4 CTD stations performed during the MEDIAS in summer 2019.

g) Biomass estimations of target species

The biomass estimation of sardine and anchovy in GSA 11, and the associated CVs of geostatistical simulations during MEDIAS 2019, are reported in the Table 2.7.2. Length structured biomass estimates are shown in Figure 2.7.5.

Table 2.7.2 Biomass estimation of sardine and anchovy in GSA 11 in MEDIAS 2019.

	2019	
	Biomass (t)	**CV**
Anchovy	2155.9	13
Sardine	13309.6	11

Engraulis encrasicolus *Sardina pilchardus*

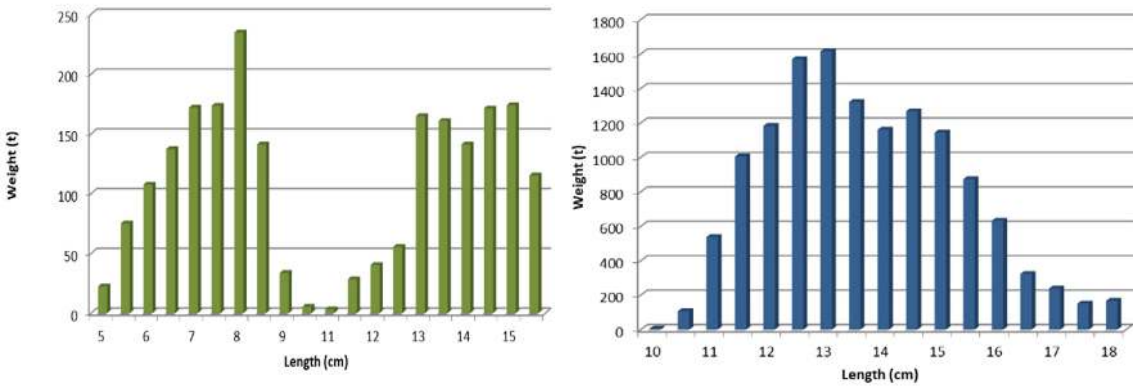
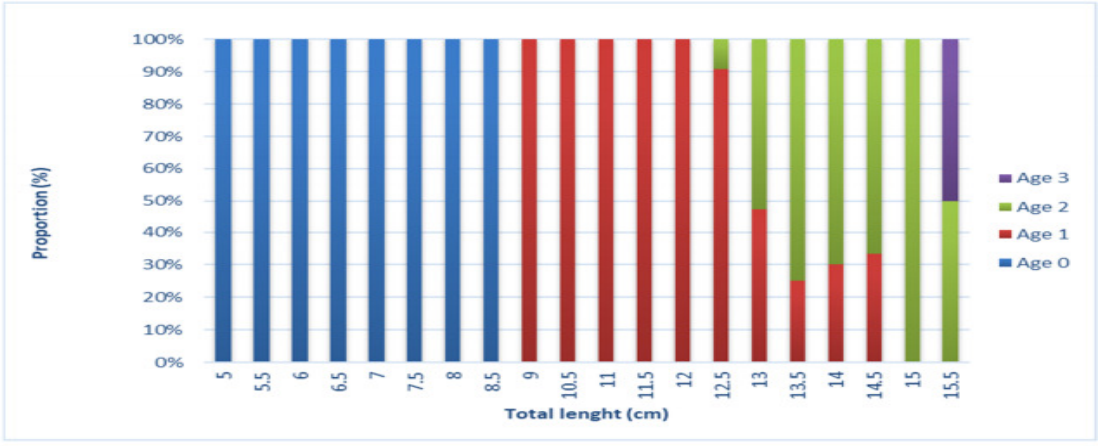
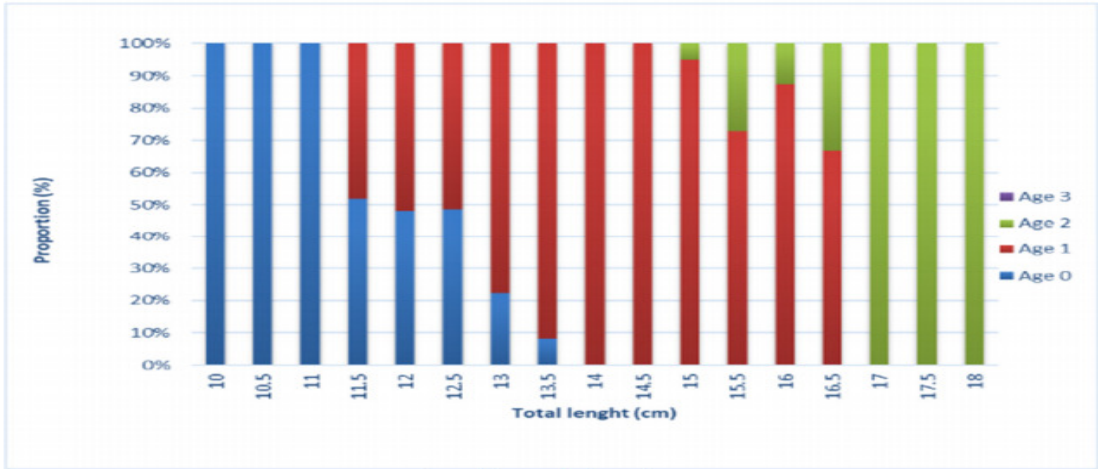


Figure 2.7.5 Length structured biomass estimates from MEDIAS 2019.

Biomass per age in GSA 11 in summer 2019 was estimated for sardine and anchovy using otoliths readings and the related MEDIAS 2019 age-length keys (Figure 2.7.6 and Figure 2.7.7).



Engraulis encrasicolus



Sardina pilchardus

Figure 2.7.6 Age-length keys for anchovy (above) and sardine (bellow) (MEDIAS, 2019).

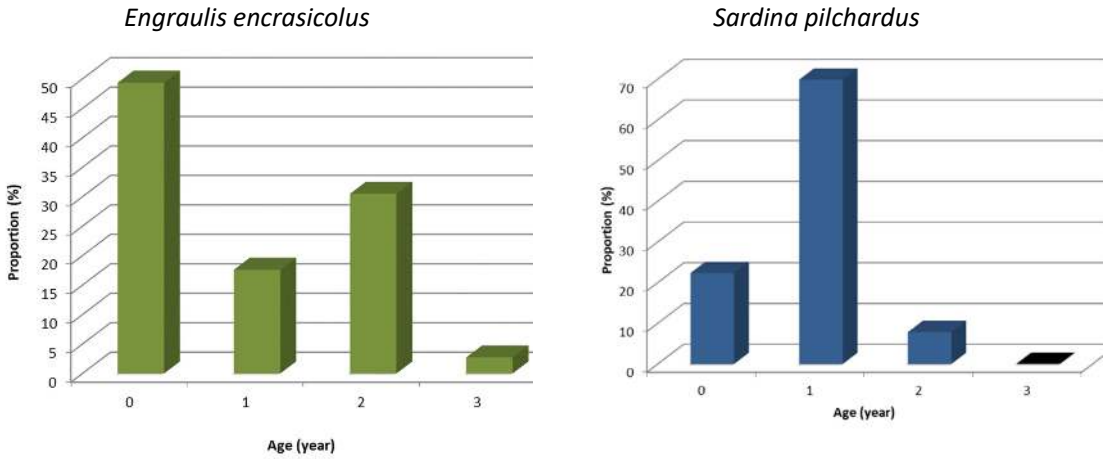


Figure 2.7.7 Biomass at age estimates (in tons) for target species in GSA 11 (MEDIAS, 2019).

h) Abundance indices of target species

Spatial distributions of anchovy and sardine abundance indices are shown in Figure 2.7.8.

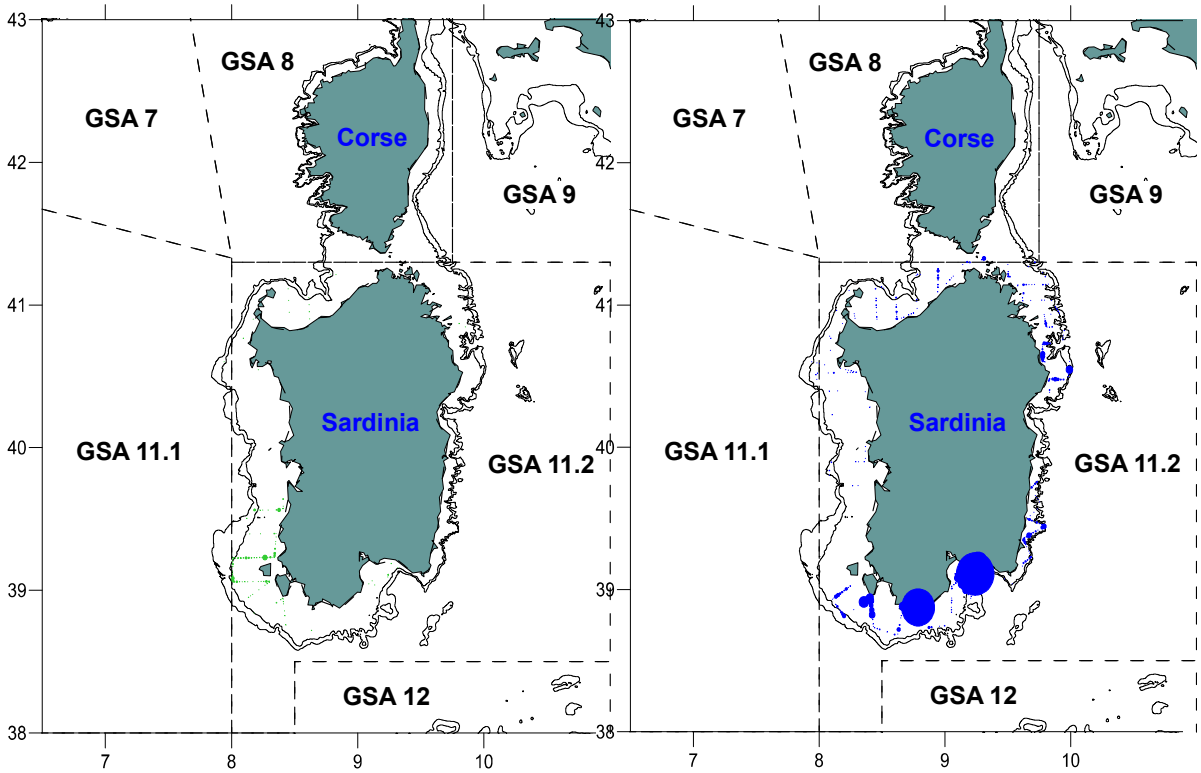


Figure 2.7.8 Anchovy (left) and sardine (right) NASC per EDSU in GSA 11 in summer (MEDIAS, 2019).

2.8 Results of the 2020 acoustic survey in GSA 11 (ITA) - Sardinia (Angelo Bonanno, Gualtiero Basilone, Marco Barra, Simona Genovese & Rosalia Ferreri, CNR)

a) General information on the survey

In summer 2020, due to very bad weather conditions, the survey was carried out only in the western and southern parts of the continental shelf of Sardinia; the survey took place on board R/V "G. Dallaporta" (35.7 m length, 1086 HP) from September 26 to October 8 2020 (lasts 19 days at sea) and covered an area of 1479 nm^2.

b) Type of echosounders and frequencies in use

The split beam echo sounder used is SIMRAD EK60, with the 38, 70, 120 and 200 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. The mean surveying acoustic vessel speed is 9 knots. The Echoview software was used to visualize and analyze acoustic data.

c) Calibration results

During 2020, acoustic survey in GSA 11 used the same, previously calibrated research vessel (R/V G. Dallaporta) as survey in GSAs 9 and 10. Calibration results used for this survey are the same ones as in survey in GSAs 9 and GSA 10 (see Table 2.6.1).

d) Survey design

Most of the survey design is made of parallel transects perpendicular to the coastline, from the 10-20 m isobath to the 200 m one. Due to the narrow continental shelf along part of the study area, a zig-zag transects design was adopted. The total nautical miles effectively used for acoustic analysis (minus pelagic trawls tracks and linking transects) were 307 in 2020.

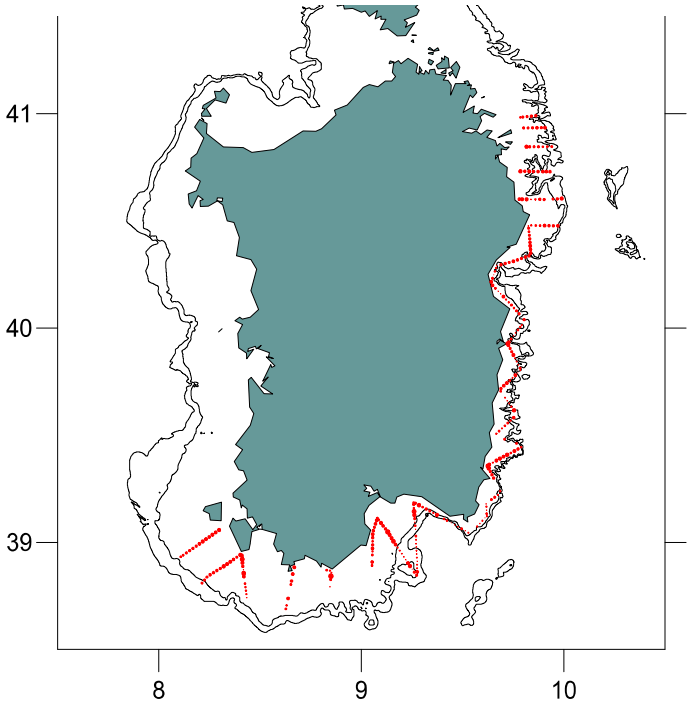


Figure 2.8.1 Survey desing in MEDIAS 2020.

e) Fish sampling

Seven (7) pelagic hauls were carried out in in GSA 11 in summer 2020 (Fig. 2.8.2 and Fig. 2.8.3). Trawl hauls were performed during day time. The pelagic net used has a total length of 78 m (Cod end length 22 m), Cod end mesh size of 18 mm, Vertical opening of 7 m, Horizontal opening 13 m, Initial mesh size 182x800 mm and Lateral mesh size 400 mm.

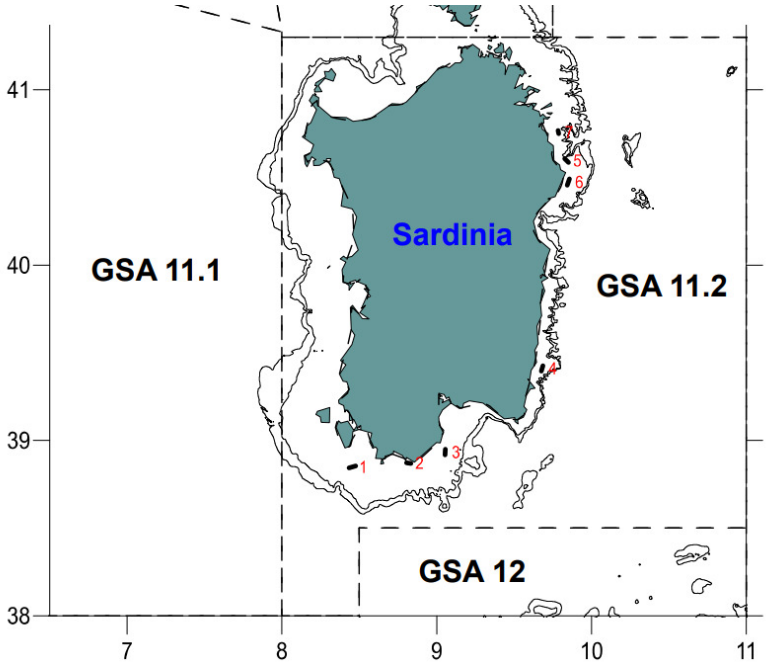


Figure 2.8.2 Trawl hauls performed during the Echosurvey in summer 2020.

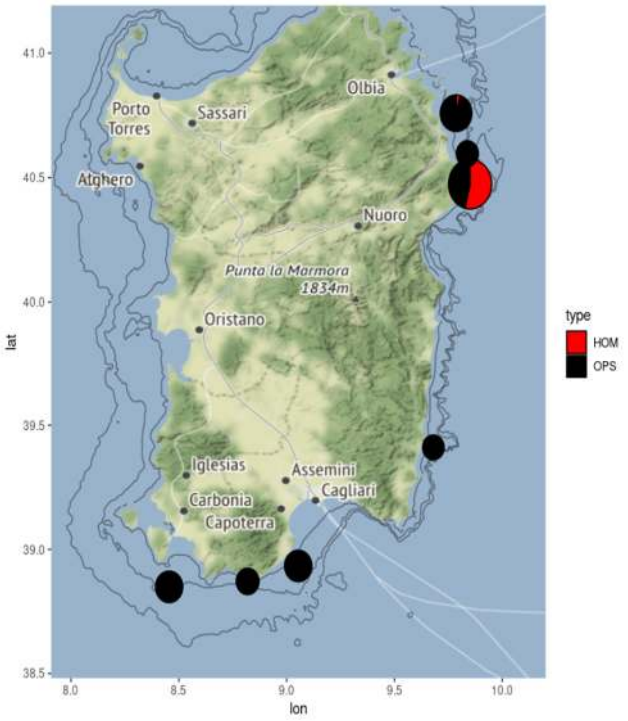


Figure 2.8.3 Map with pie charts reporting percentages in weight of anchovy, sardine and other species. MEDIAS 2020.

f) Oceanographic parameters

During the survey MEDIAS in summer 2020 in GSA 11, 33 hydrological stations have been performed (Fig. 2.8.4). A Seabird 9/11plus CTD, equipped with sensor for measuring conductivity, temperature, pressure, fluorescence, PAR (Photosynthetically active radiation), pH, oxygen and turbidity, was used.

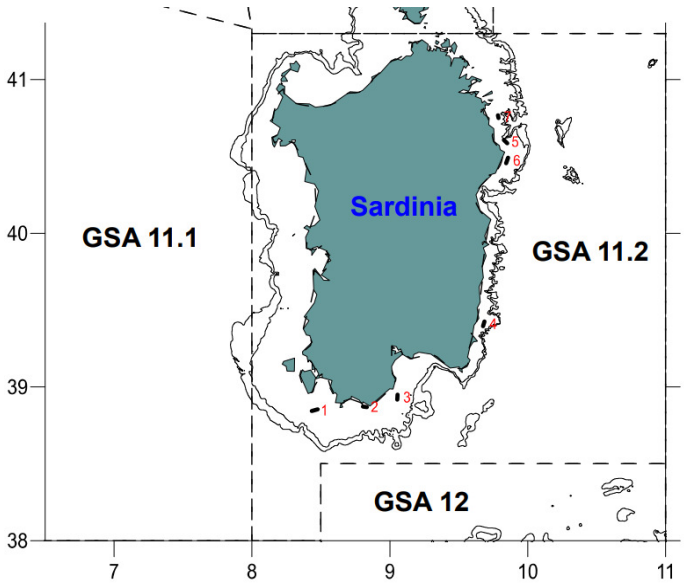


Figure 2.8.4 CTD stations performed during the echosurvey in summer 2020.

g) Biomass estimations of target species

The biomass estimation of sardine and anchovy in GSA 11, and the associated CVs of geostatistical simulations. In fact, no target species were recorded during MEDIAS 2020 within area surveyed (Table 2.8.2).

Table 2.8.2 Biomass estimation of sardine and anchovy in GSA 11 in MEDIAS 2020.

	Biomass (t)	CV
Anchovy	0.0	
Sardine	0.0	

h) Abundance indices of target species

No target species were recorded during MEDIAS 2020 within area surveyed.

i) Other information

The analysis of acoustic data collected in summer 2020 evidenced a lower biomass level of pelagic fish species. Due to very bad weather conditions, very few trawl hauls have been carried out. In such trawl hauls no anchovy and sardine specimen was caught. The survey in GSA 11 was not completed and it is not possible to be sure that the pelagic target fish species (anchovy and sardine) were not present in thi geographical subarea.

2.9 Results of the 2019 acoustic survey in GSA 16 - South Sicily (Angelo Bonanno, Gualtiero Basilone, Marco Barra, Simona Genovese & Rosalia Ferreri, CNR)

a) General information on the survey

The surveys in summer 2019 took place from July 26 to August 05 2019, (lasts 11 days at sea) and covered the continental shelf south of Sicily (3659 nm^2) with the fishery Research Vessel "G. Dallaporta" (35.7 m length, 1086 HP).

b) Type of echosounders and frequencies in use

The split beam echo sounder used is SIMRAD EK60, with the 38, 70, 120 and 200 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 1.024 ms. The mean surveying acoustic vessel speed is 9 knots. The Echoview software was used to visualize and analyze acoustic data.

c) Calibration results

During 2019, acoustic survey in GSA 16 used the same, previously calibrated research vessel (R/V G. Dallaporta) as survey in GSAs 9 and 10. Calibration results used for this survey are the same ones as in surveys in GSAs 9-10 and GSA 11(see Table 2.5.1).

d) Survey design

The survey design is made of 29 parallel transects (min and max lengths are 7 and 43 nautical miles) perpendicular to the coastline (Fig. 2.9.1), from the 10-20 m isobath to the 200 m one; a small part of the survey, located in the easternmost area, adopted a zig-zag design due to the very narrow extension of the continental shelf. In summer 2019, total nautical miles (EDSU) effectively used for acoustic analysis (minus pelagic trawls tracks and linking transects) were 578.

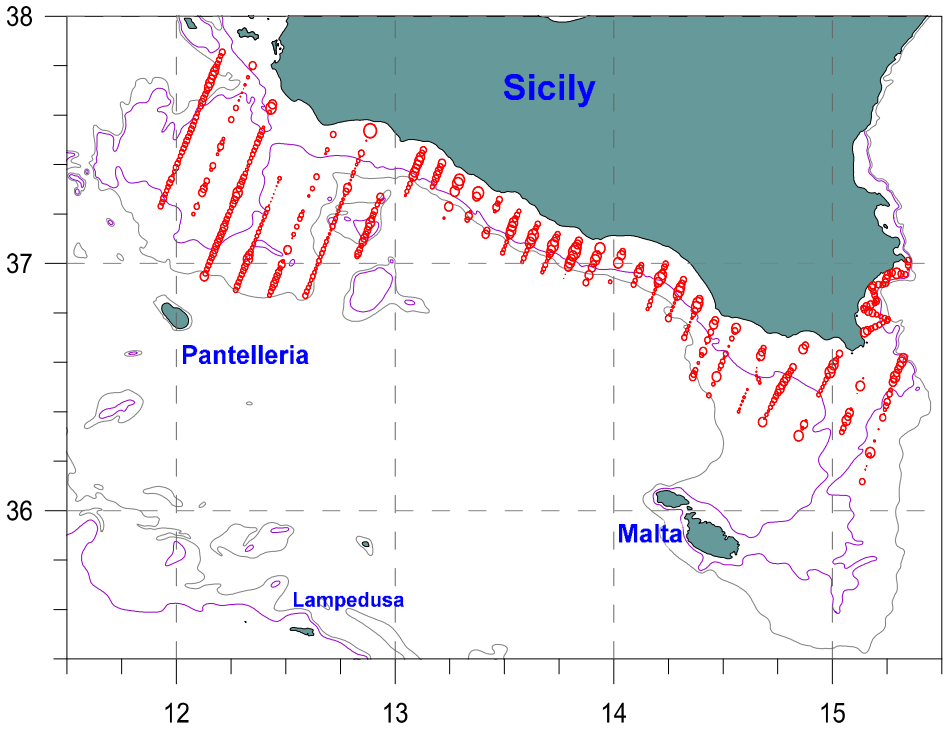


Figure 2.9.1 Survey design in GSA 16 (MEDIAS 2019).

e) Fish sampling

Twenty-three (23) pelagic hauls were carried out in in GSA 16 in summer 2019 (Fig. 2.9.2 and Fig. 2.9.3). Trawl hauls were performed during day time. The pelagic net used has a total length of 78 m (Cod end length 22 m), Cod end mesh size of 18 mm, Vertical opening of 7 m, Horizontal opening 13 m, Initial mesh size 182x800 mm and Lateral mesh size 400 mm.

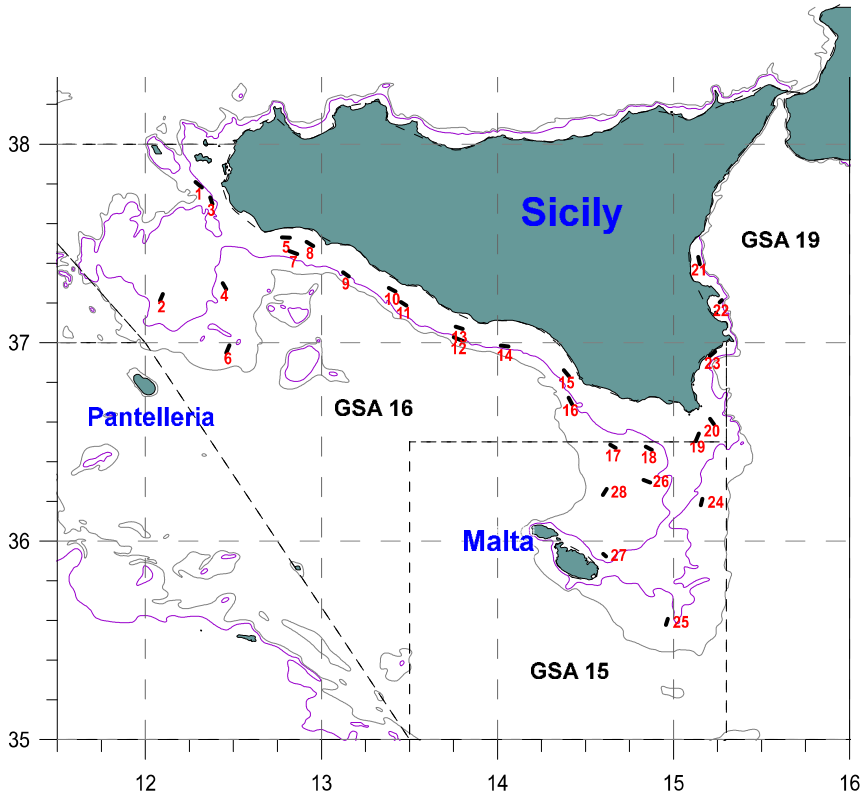


Figure 2.9.2 Trawl hauls performed during the MEDIAS in summer 2019.

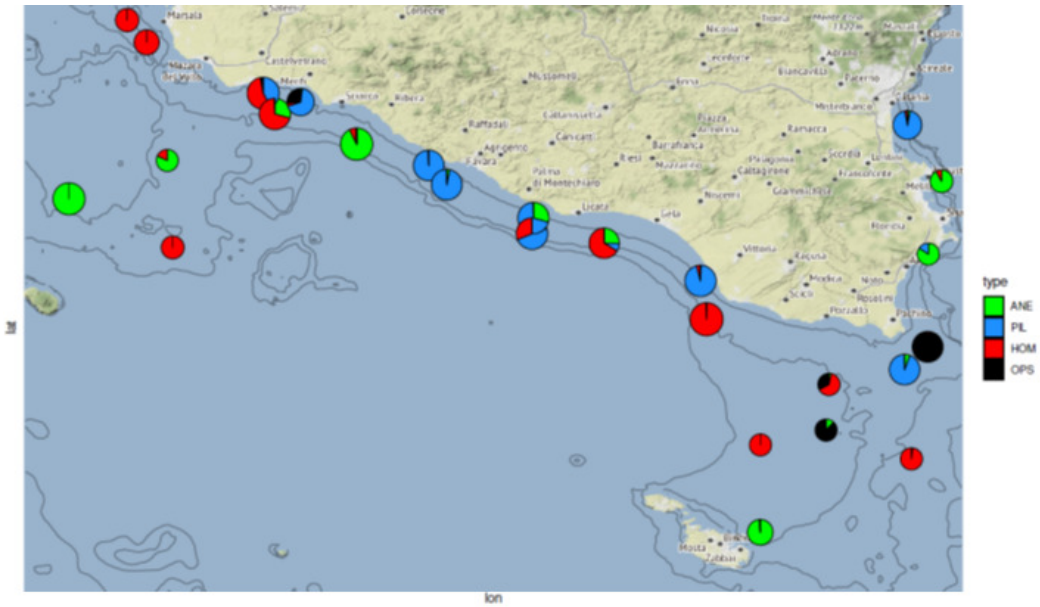


Figure 2.9.3 Map with pie charts reporting percentages in weight of anchovy, sardine and other species. MEDIAS 2019.

f) <u>Oceanographic parameters</u>

During the survey in summer 2019 in GSA 16, 114 hydrological stations have been performed (Fig. 2.9.4). A Seabird 9/11plus CTD, equipped with sensor for measuring conductivity, temperature, pressure, fluorescence, PAR (Photosynthetically active radiation), pH, oxygen and turbidity, was used.

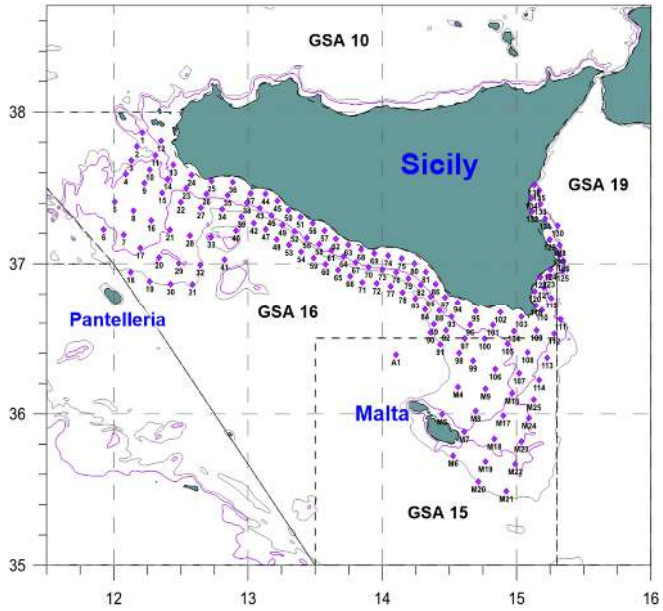


Figure 2.9.4 CTD stations performed during the MEDIAS in summer 2019.

g) Biomass estimations of target

The biomass estimation of sardine and anchovy in GSA 16, and the associated CVs of geostatistical simulations, are reported in the Table 2.9.2. Biomass density indices are shown in Figure 2.9.5.

Table 2.9.2 The biomass estimation of sardine and anchovy in GSA 16 in MEDIAS 2019.

	Biomass (t)	CV
Anchovy	14301.3	12
Sardine	14410.1	20

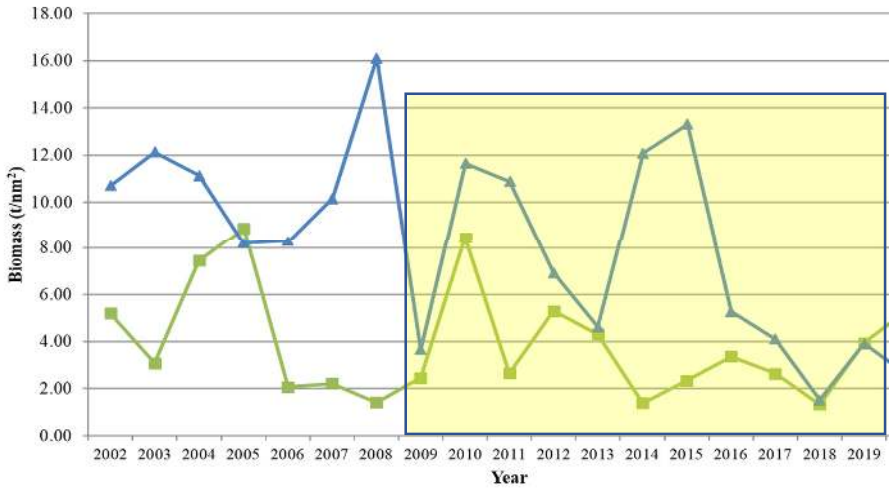


Figure 2.9.5 Biomass density (t/NM^2) in the period 2009-2019 (in yellow frame) in GSA 16 (anchovy - green line; sardine - blue line).

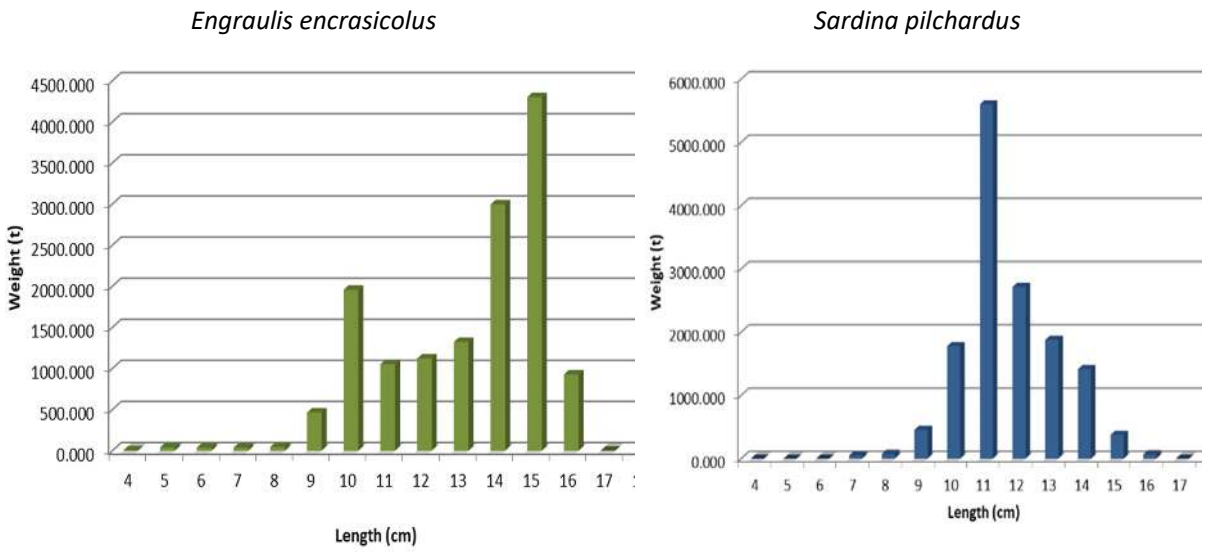


Figure 2.9.6 Biomass per length classes (in tons) of target species in GSA 16 (MEDIAS, 2019).

Biomass per age in GSA 16 in summer 2019 was estimated for sardine and anchovy using otoliths readings and the related MEDIAS 2019 age-length keys (Figure 2.9.7 and Figure 2.9.8).

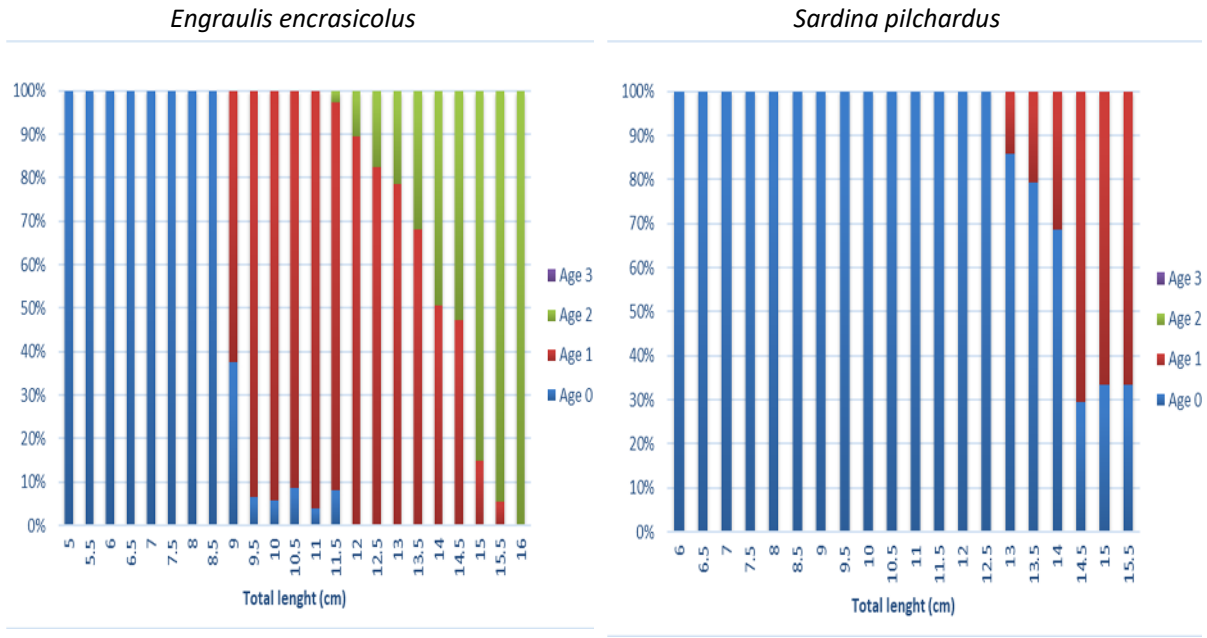


Figure 2.9.7 Age-length keys for anchovy (left) and sardine (right) (MEDIAS, 2019).

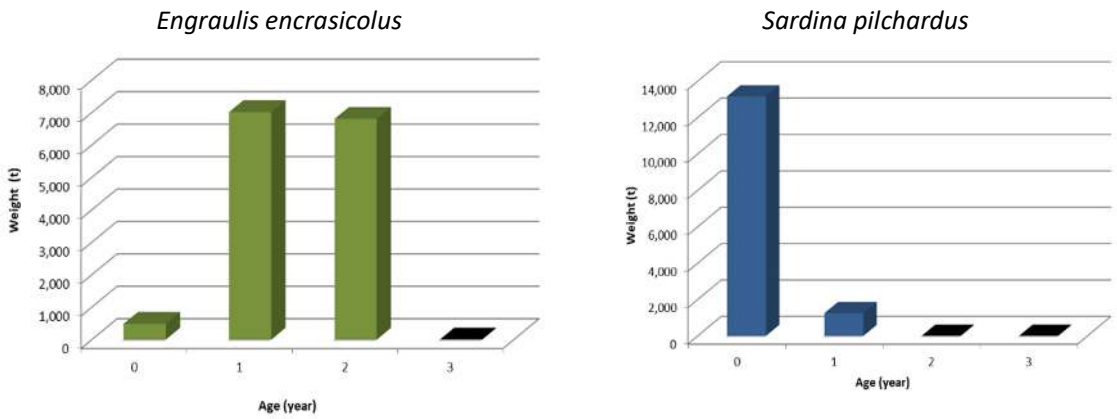


Figure 2.9.8 Biomass at age (in tons) of target species in GSA 16 (MEDIAS, 2019).

h) Abundance indices of target species

Spatial distributions of target species recorded NASC values in MEDIAS 2019 are shown in Figure 2.9.9.

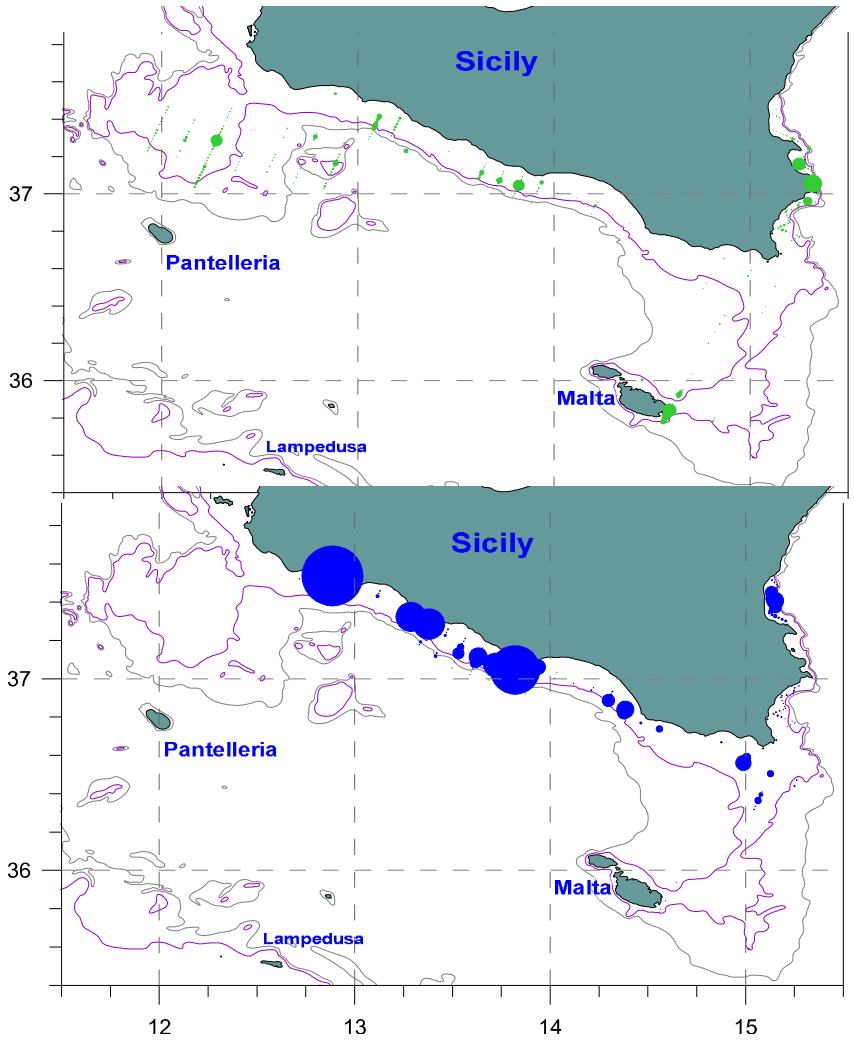


Figure 2.9.9 Spatial distributions of anchovy (above) and sardine (bellow) recorded NASC values in MEDIAS 2019.

2.10 Results of the 2020 acoustic survey in GSA 16 - South Sicily (Angelo Bonanno, Gualtiero Basilone, Marco Barra, Simona Genovese & Rosalia Ferreri, CNR)

a) General information on the survey

The survey in summer 2020 took place in the period 13 – 23 August, (lasts 11 days at sea) and covered the continental shelf south of Sicily (3659 nm^2) with the fishery Research Vessel "G. Dallaporta" (35.7 m length, 1086 HP).

b) Type of echosounders and frequencies in use

The split beam echo sounder used is SIMRAD EK60, with the 38, 70, 120 and 200 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 1.024 ms. The mean surveying acoustic vessel speed is 9 knots. The Echoview software was used to visualize and analyze acoustic data.

c) Calibration results

During 2020, acoustic survey in GSA 16 used the same, previously calibrated research vessel (R/V G. Dallaporta) as survey in GSAs 9 and 10. Calibration results used for this survey are the same ones as in survey in GSAs 9 -10 and GSA 11 (see Table 2.6.1).

d) Survey design

The survey design is made of 29 parallel transects (min and max lengths are 7 and 43 nautical miles) perpendicular to the coastline (Fig. 2.10.1), from the 10-20 m isobath to the 200 m one; a small part of the survey, located in the easternmost area, adopted a zig-zag design due to the very narrow extension of the continental shelf. Total nautical miles (EDSU) effectively used for acoustic analysis (minus pelagic trawls tracks and linking transects) in MEDIAS 2020 were 646.

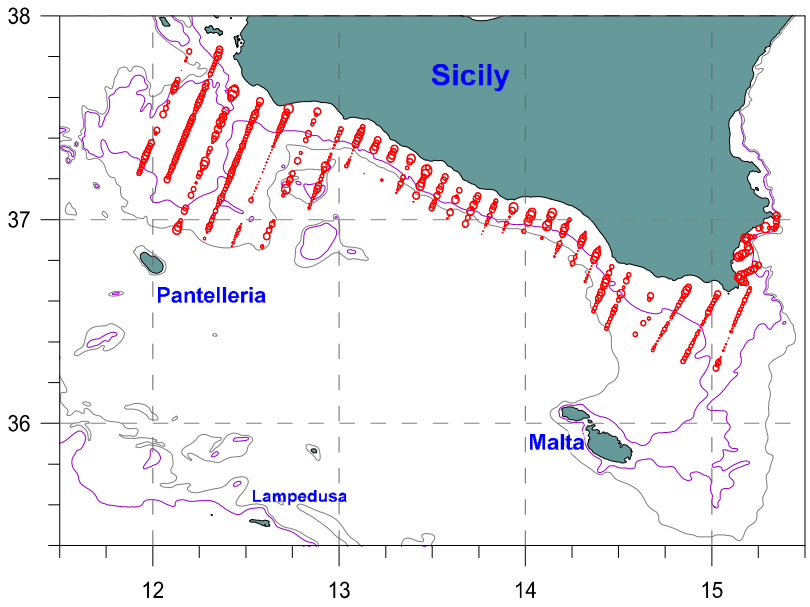


Figure 2.10.1 Survey design in GSA 16 (MEDIAS 2020).

e) Fish sampling

Twenty-two (22) pelagic hauls were carried out in in GSA 16 in summer 2020 (Fig. 2.10.2 and 2.10.3). Trawl hauls were performed during day time. The pelagic net used has a total length of 78 m (Cod end length 22 m), Cod end mesh size of 18 mm, Vertical opening of 7 m, Horizontal opening 13 m, Initial mesh size 182x800 mm and Lateral mesh size 400 mm.

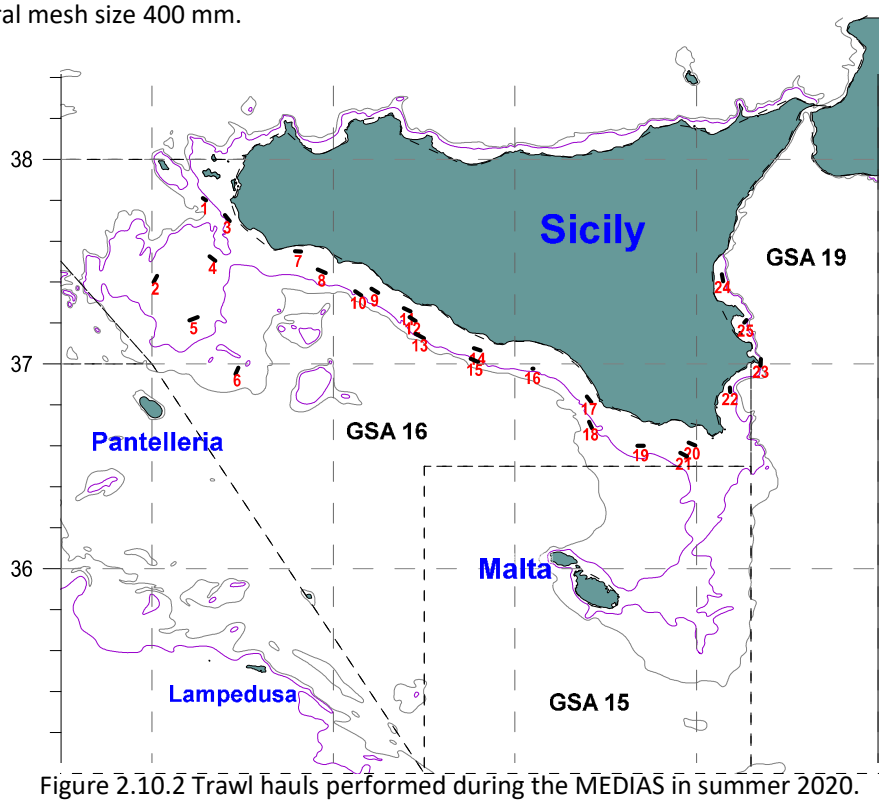


Figure 2.10.2 Trawl hauls performed during the MEDIAS in summer 2020.

Figure 2.10.3 Map with pie charts reporting percentages in weight of anchovy, sardine and other species. MEDIAS 2020.

f) Oceanographic parameters

During the survey in summer 2020 in GSA 16, 53 hydrological stations have been performed (Fig. 2.10.4). A Seabird 9/11plus CTD, equipped with sensor for measuring conductivity, temperature, pressure, fluorescence, PAR (Photosynthetically active radiation), pH, oxygen and turbidity, was used.

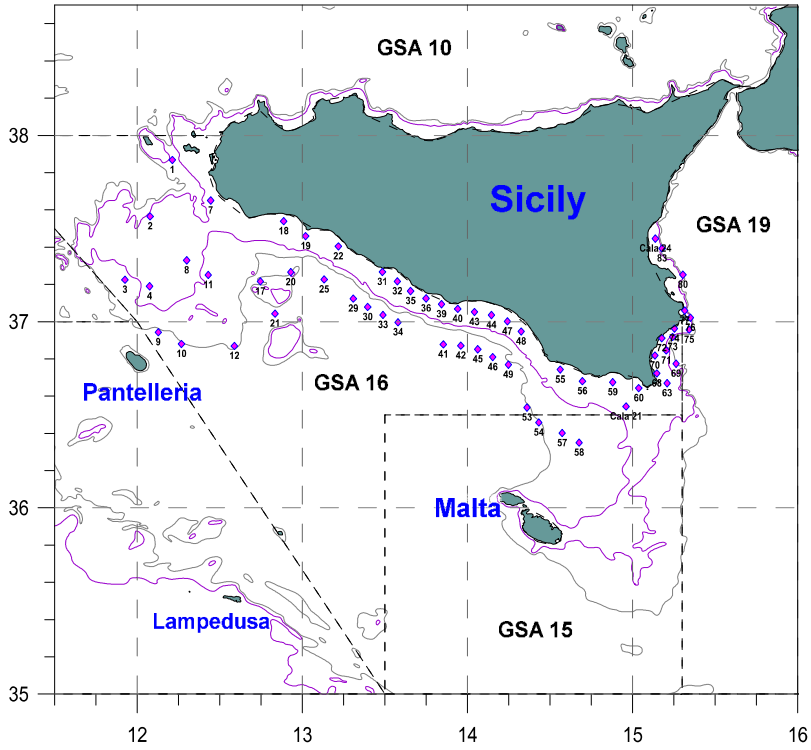


Figure 2.10.4 CTD stations performed during the MEDIAS in summer 2020.

g) Biomass estimations of target

The biomass estimation of sardine and anchovy in GSA 16, and the associated CVs of geostatistical simulations, are reported in the Table 2.10.2. Biomass density indices are shown in Figure 2.10.5.

Table 2.10.2 The biomass estimation of sardine and anchovy in GSA 16 in MEDIAS 2020.

	Biomass (t)	CV
Anchovy	20530.2	18
Sardine	9744.4	17

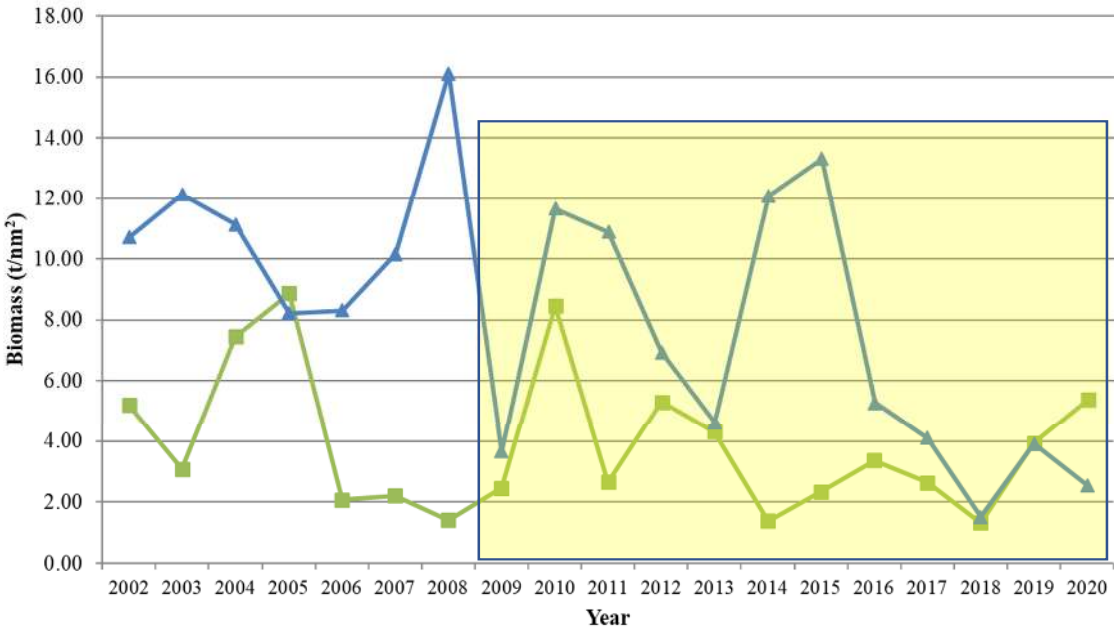


Figure 2.10.5 Biomass density (t/NM^2) in the period 2009-2020 (in yellow frame) in GSA 16 (anchovy - green line; sardine - blue line).

Engraulis encrasicolus *Sardina pilchardus*

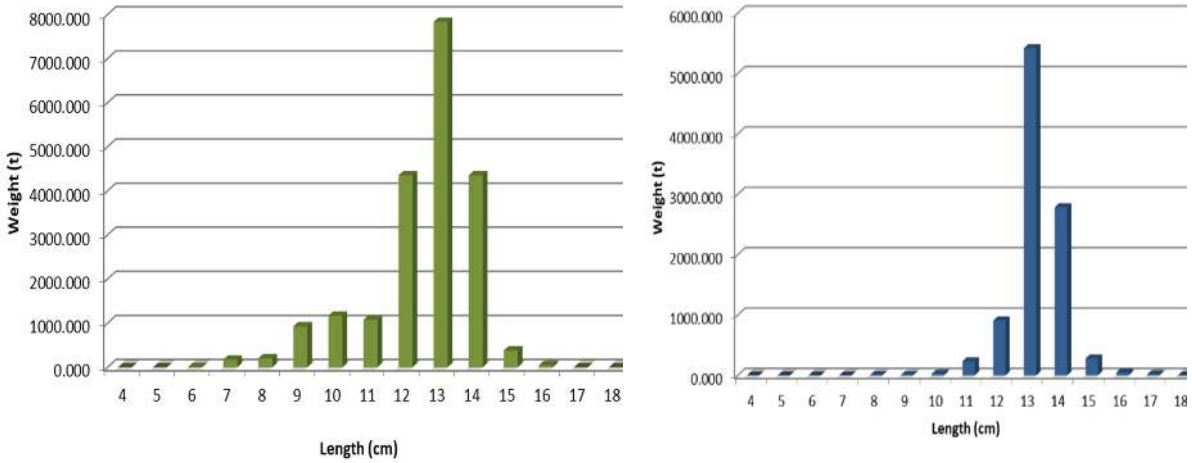


Figure 2.10.6 Biomass per length classes (in tons) of target species in GSA 16 (MEDIAS, 2020).

Biomass per age in GSA 16 in summer 2020 was estimated for sardine and anchovy using otoliths readings and the related MEDIAS 2020 age-length keys (Figure 2.10.7 and Figure 2.10.8).

Engraulis encrasicolus *Sardina pilchardus*

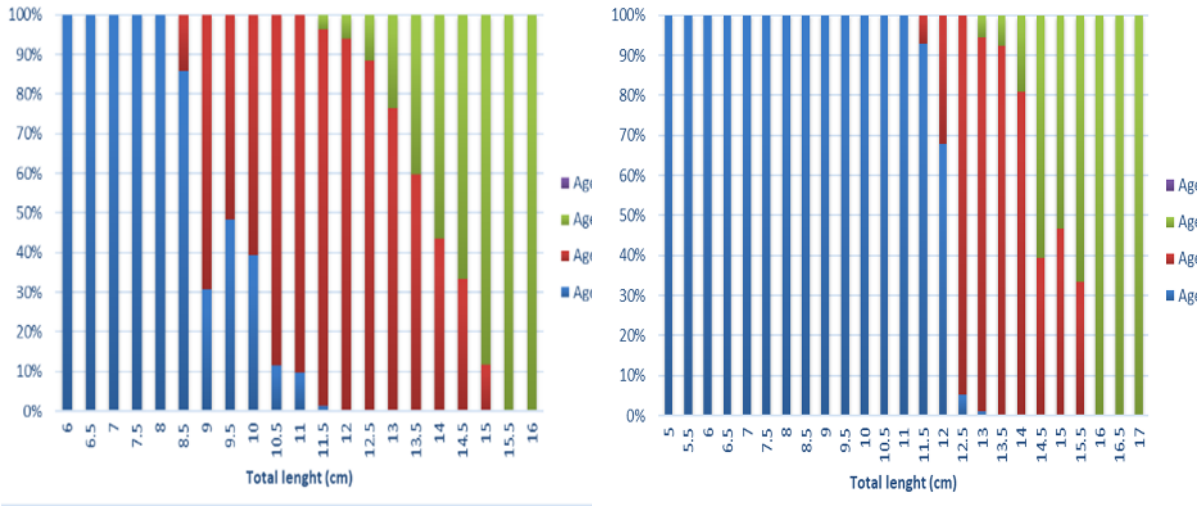


Figure 2.10.7 Age-length keys for target species (MEDIAS, 2020).

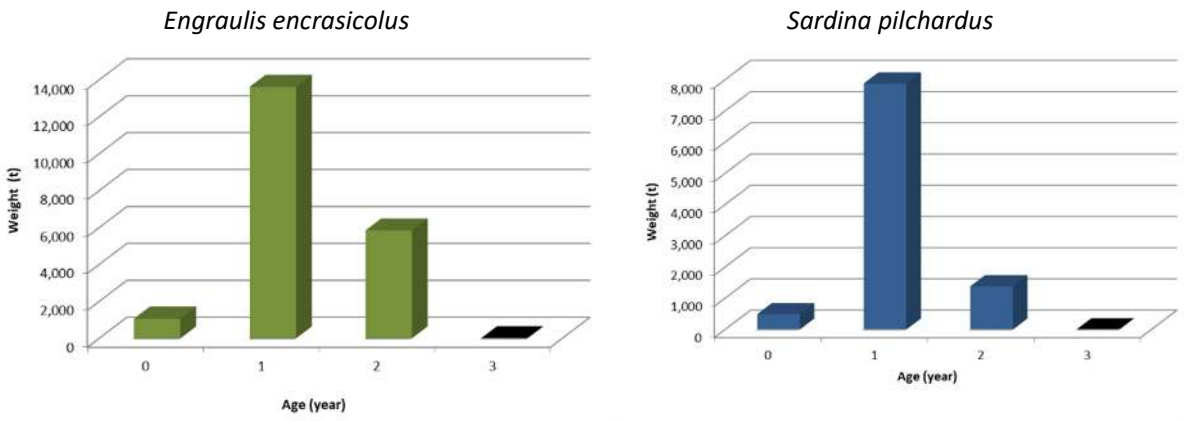


Figure 2.10.8 Biomass at age (in tons) of target species in GSA 16 (MEDIAS, 2020).

h) Abundance indices of target species

Spatial distributions of target species recorded NASC values in MEDIAS 2020 are shown in Figures 2.10.9 and 2.10.10.

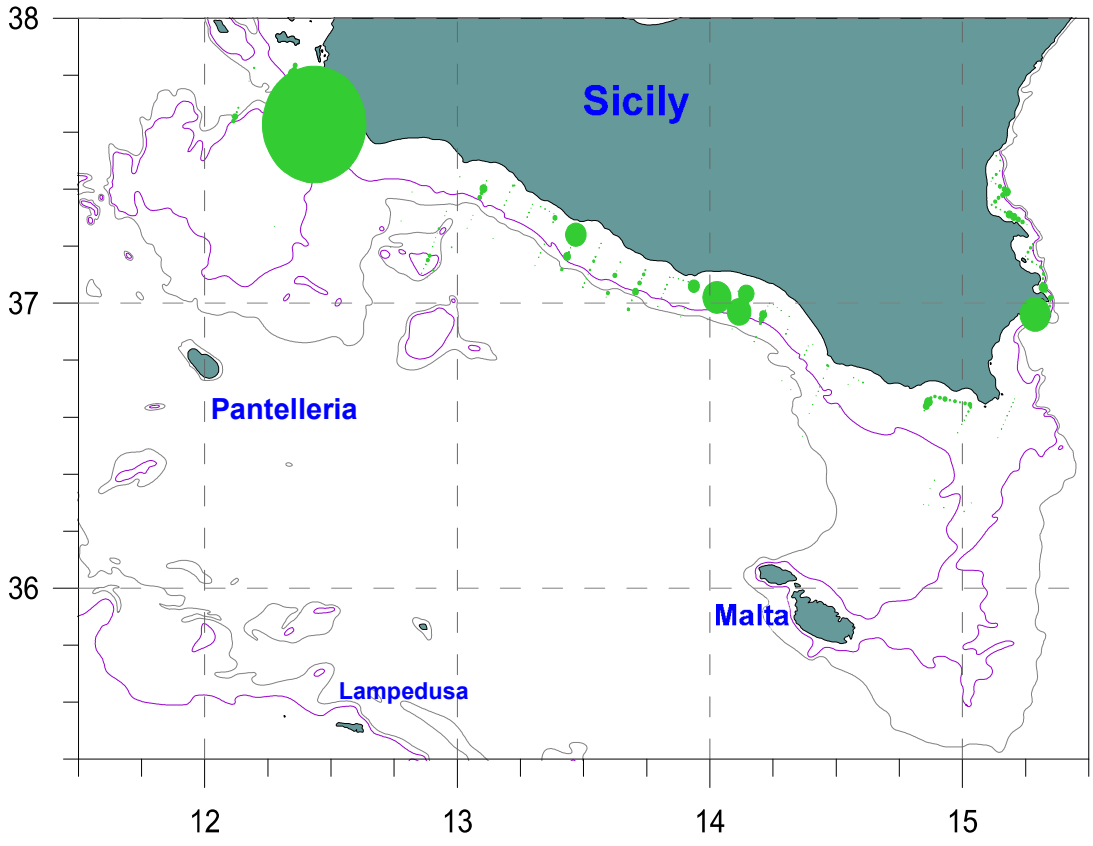


Figure 2.10.9 Spatial distributions of anchovy NASC values recorded in MEDIAS 2020.

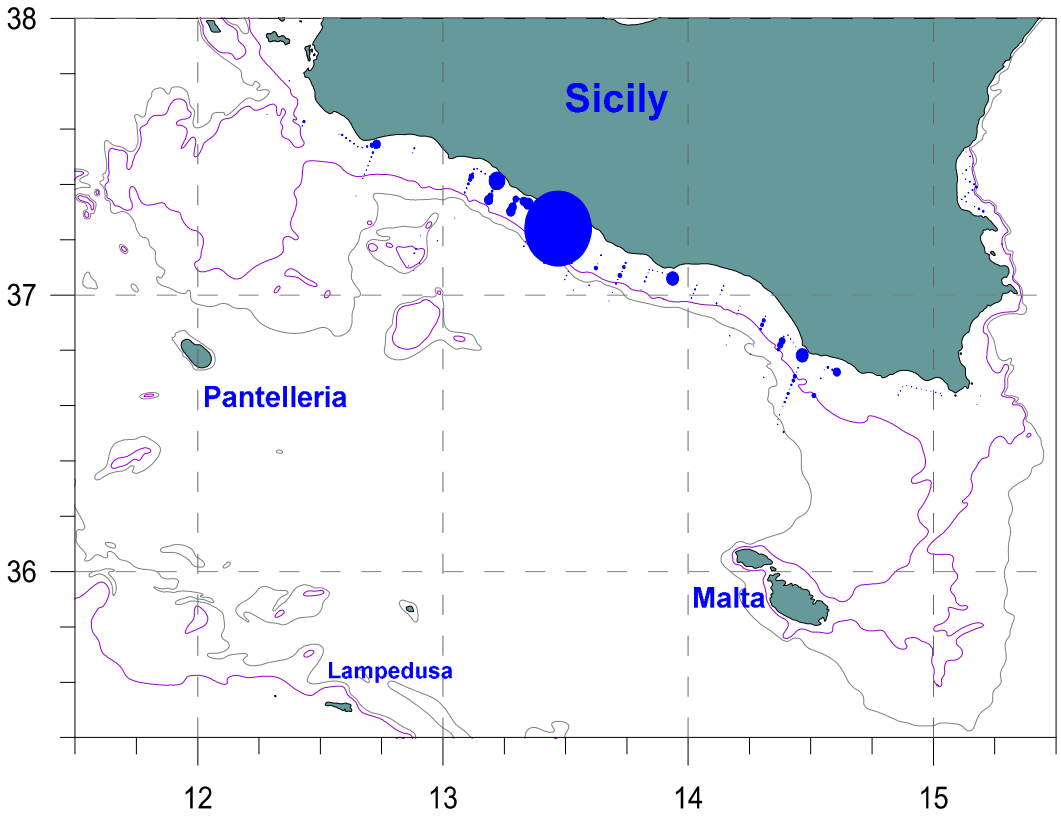


Figure 2.10.10 Spatial distributions of sardine NASC values recorded in MEDIAS 2020.

i) Other information

In summer 2020 no MEDIAS was carried out in GSA 15 due to limited available vessel time.

2.11 Results of the 2019 acoustic survey in the eastern part of GSA 17 (HRV) - Northern Adriatic Sea (V. Tičina, T. Juretić, D. Gašparević, et al.)

a) General information on the survey

Acoustic survey on the eastern part of GSA 17 was performed in the period from 29.8.2019. to 28.9.2019. For this purpose, R/V BIOS DVA (length: 36m, engine power: 1200HP) was used for 31 day, in order to survey the area of 13.578 NM^2.

b) Type of echosounders and frequencies in use

R/V BIOS DVA is equipped with SIMRAD scientific echosounder system (EK80), including GPT (38kHz) and WBT (120kHz) transceivers connected to hull-mounted transducers (ES38B and ES120-7). In line with MEDIAS Handbook, the principal frequency for the survey was 38 kHz, while 120 kHz acoustic equipment was used as

complementary with aim to improve categorization of different acoustic targets. The system was operating with SIMRAD EK80 software. In order to improve the quality of acoustic data collected in the rough sea conditions, echosounder system is connected to the vessel's motion reference unit (MRU3).

c) Calibration results

The acoustic system on R/V BIOS DVA was calibrated at the 1st day of the survey using the standard Cu-sphere (60 mm) and EK80 software. Calibration results are shown in Table 2.11.1.

Table 2.11.1 Calibration of 38 kHz scientific sounder system at R/V BIOS DVA (MEDIAS, 2019).

Calibration report	
Frequency (kHz)	38
Echosounder type	SIMRAD, EK80
Transducer serial no.	ES38B (30825)
Vessel	BIOS DVA
Date	29.08.2019.
Place	Kašjuni
Latitude	43°30.36' N
Longitude	16°23.46' E
Bottom depth (m)	36
Temperature (oC) at sphere depth	19.4
Salinity (psu) at sphere depth	38.4
Speed of sound (ms-1)	1524.25
TS of sphere (dB)	-33.6
Pulse duration (ms)	1.024
Equivalent 2-way beam angle (dB)	-20.7
Default TS transducer gain	22.74 dB
Iteration no.	522
Time	10:52 – 12:56
Range to sphere (m)	14-15
Ping rate	1 s
Calibrated TS transducer gain	22.81 dB
Time (GMT)	8:52-10:56
RMS	0.055
sA correction	0.06

Acoustic data calibration and processing has been done with EchoView softvare (Ver. 10), considering Elementary Sampling Distance Unit (EDSU) of 1 NM and data integration depth range from 7 to 200 m.

d) Survey design

Survey design in eastern part of GSA 17 (Fig. 2.11.1) is made of two long transects adapted to geomorphology of inner sea area (channel areas between small islands), and 30 parallel transects (direction: 43°-223°) in the open Adriatic (i.e. within Croatian territorial waters and EEZ). Inter-transect distance between parallel

transects is 10 NM. Parallel transect lengths are in the range from 6 to 55 NM. Number of nautical miles effectively processed for biomass estimation was 1411.

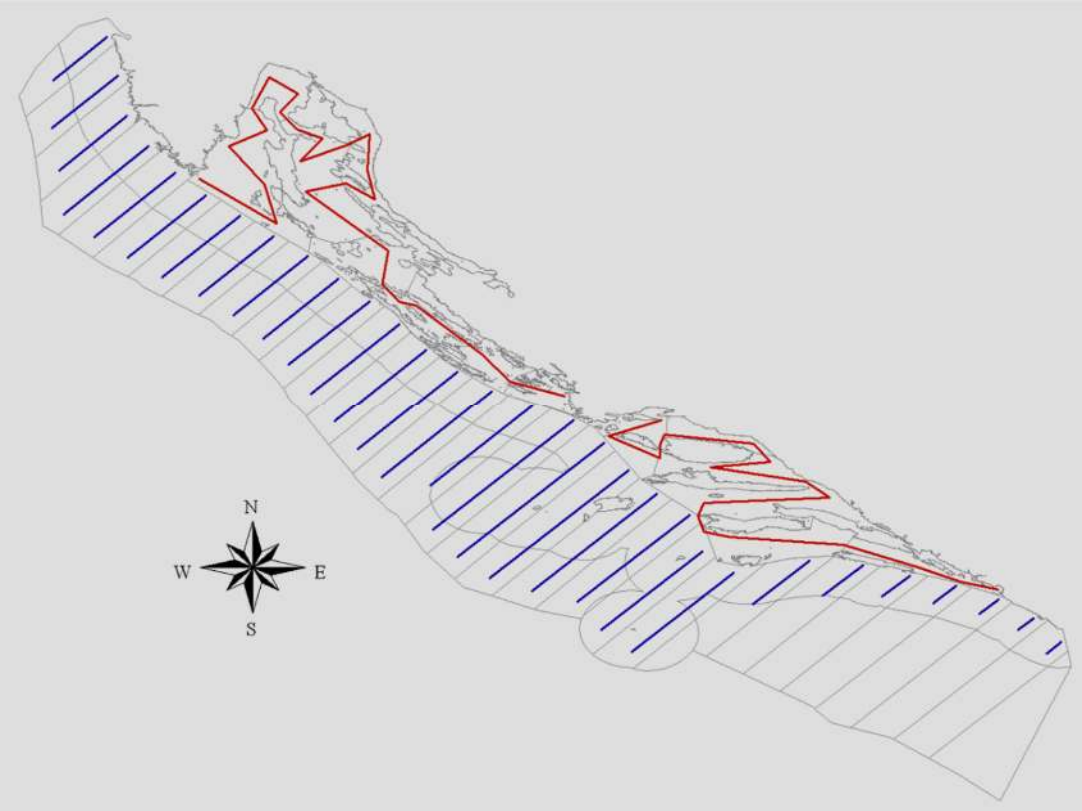


Figure 2.11.1 Acoustic survey design in the eastern part of GSA 17 (red transects in inner sea, and blue transects in open sea).

e) Fish sampling

In order to identify echo traces recorded by echosounder, 56 sampling has been made by pelagic trawl with otter boards. Pelagic trawl sampling net has headline length 29.40m and side-line lengths 24.80m, with 18 mm mesh size in the cod-end. In addition, fine mesh cod-end cover has been used in order to identify small acoustic targets (not used in fish LFDs). Trawling speed was around 4 knots (i.e. 3.5 – 4.5 knots), and haul's duration was about 30 min. During sampling operations, trawl was monitored by Simrad ITI System, indicating vertical opening about 10 m in most cases. Locations and species composition of samples obtained are shown in Figure 2.11.2.

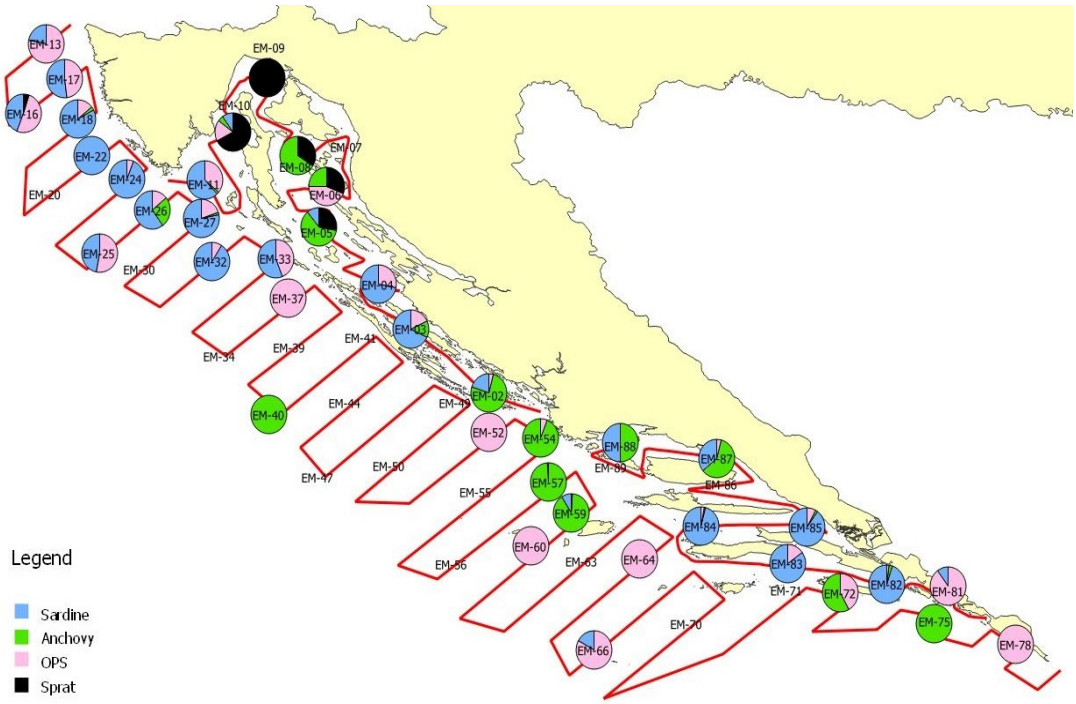


Figure 2.11.2 Locations and species composition of samples obtained (MEDIAS, 2019).

f) Oceanographic parameters

Oceanographic parameters were measured by CTD probe (temperature and salinity) at 89 different locations (Fig. 2.11.3). Based on measurements made, sound speeds were calculated and used to update echosounder during survey, as well as for surveyed area oceanographic description.

Figure 2.11.3 Locations of oceanographic measurement (CTD) made during survey (MEDIAS, 2019).

g) Biomass estimations of target species

The anchovy and sardine biomasses present in the eastern part of GAS 17, during survey period, were estimated to be 18232 tons (CV=10) and 109064 tons (CV=11) respectively in 2019. Time series of biomass densities for anchovy and sardine is shown in the Figure 2.11.4, and biomass estimates per length classes are shown in Figure 2.11.5.

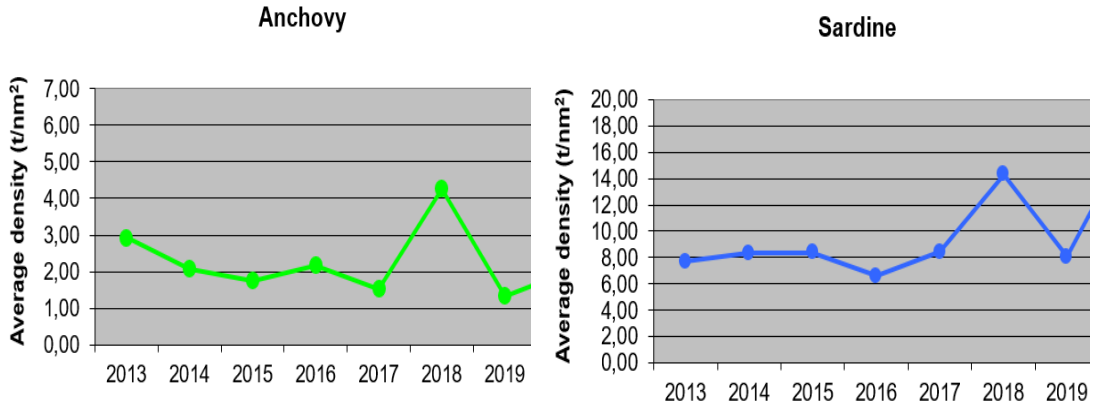


Figure 2.11.4 Biomass densities for anchovy and sardine in September in eastern part of GSA 17.

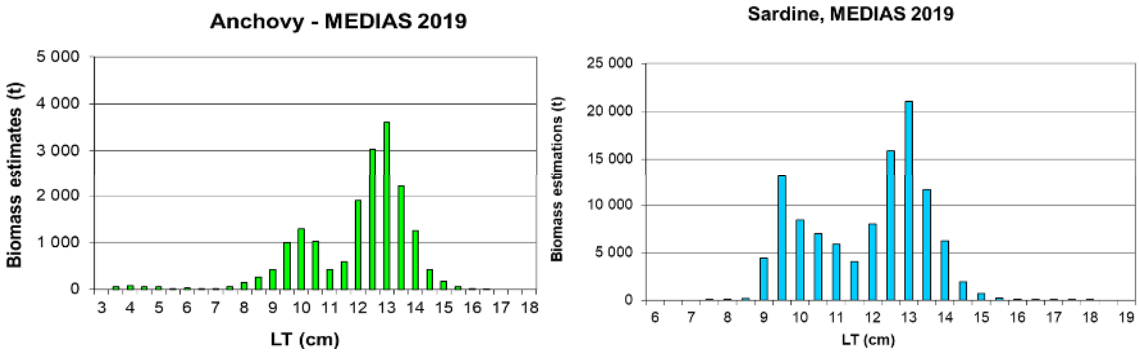


Figure 2.11.5 Biomass estimates per length classes (MEDIAS, 2019).

Age analyses, made in line with ICES WKARA2 report (2017) recommendations, resulted in survey specific ALKs for anchovy and sardine (Figure 2.11.6). Results of analyses indicated that anchovy and sardine populations consist of three age groups: 0, 1 and 2. During 2019, in terms of biomass, fish from age group 1 were dominant in anchovy's population, while in sardine's population dominant were fish from age group 0 (Fig. 2.11.7).

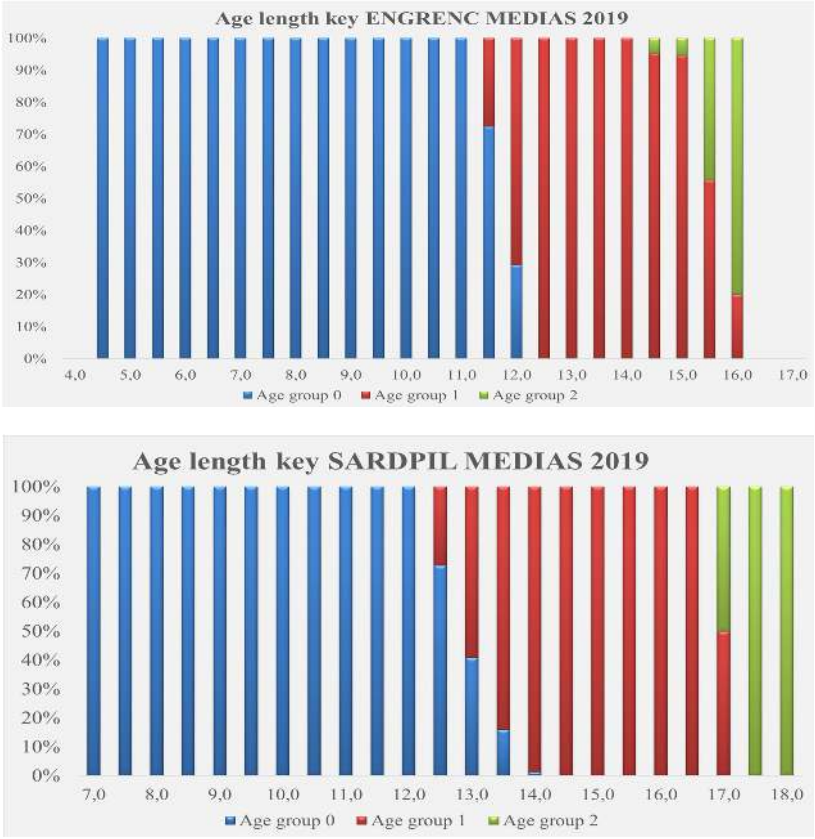


Figure 2.11.6 ALKs for anchovy (N=480) and sardine (N=520) for MEDIAS 2019 (GSA17-East).

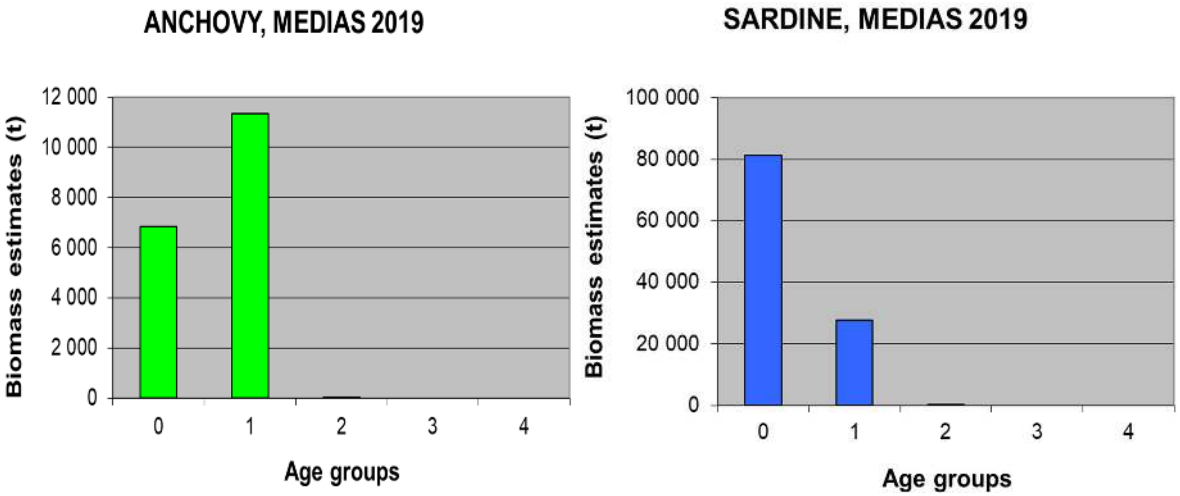


Figure 2.11.7 Biomass estimates per age groups (GSA 17-East).

h) Abundance indices of target species

Time series of sardine and anchovy abundance indices by age groups during September in the eastern part of GSA 17 is shown in Figure 2.11.8.

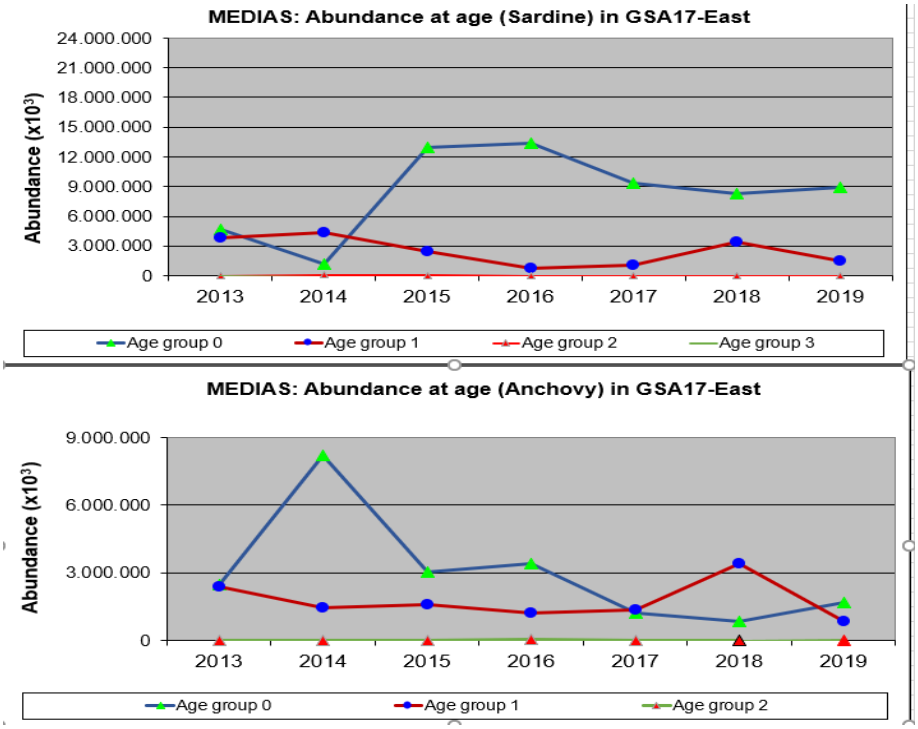


Figure 2.11.8. Abundance indices by age groups during September in the eastern part of GSA 17.

Abundance of sardine and anchovy, for all age groups combined, is shown in Figure 2.11.9. Abundances of small specimens (LT up to 10 cm), as a proxy to recruitment, are shown in Figure 2.11.10.

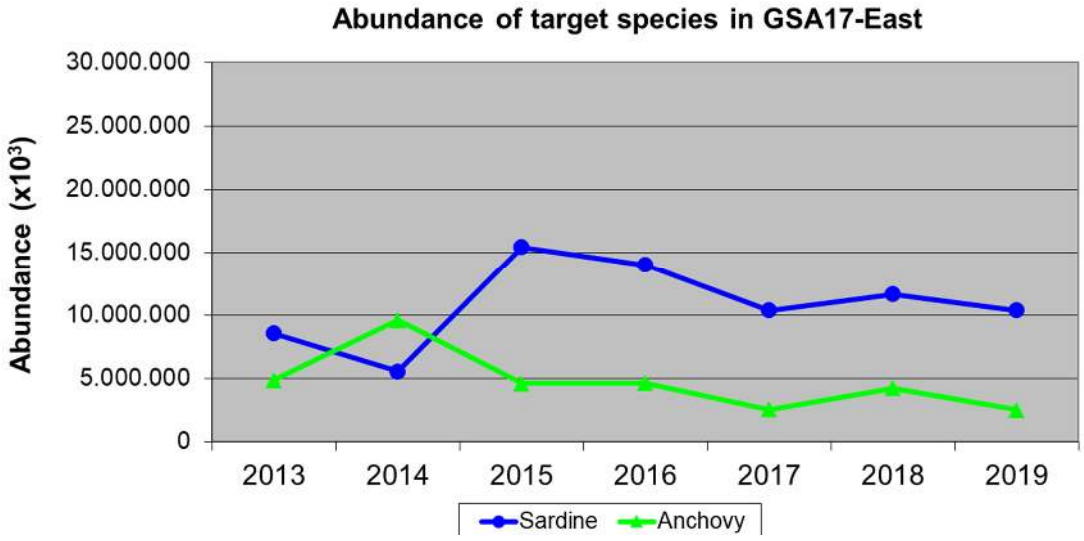


Figure 2.11.9 Abundance of sardine and anchovy, for all age groups combined (GSA 17-East).

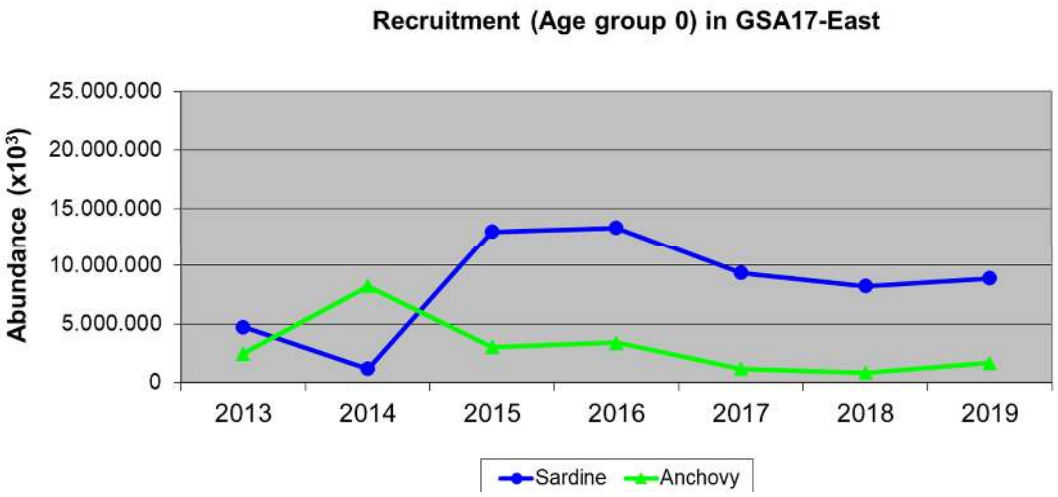


Figure 2.11.10 Abundances of small specimens (LT up to 10 cm), as a proxy to recruitment.

Spatial distributions of anchovy and sardine assemblages in September 2019 are shown in Figure 2.11.11.

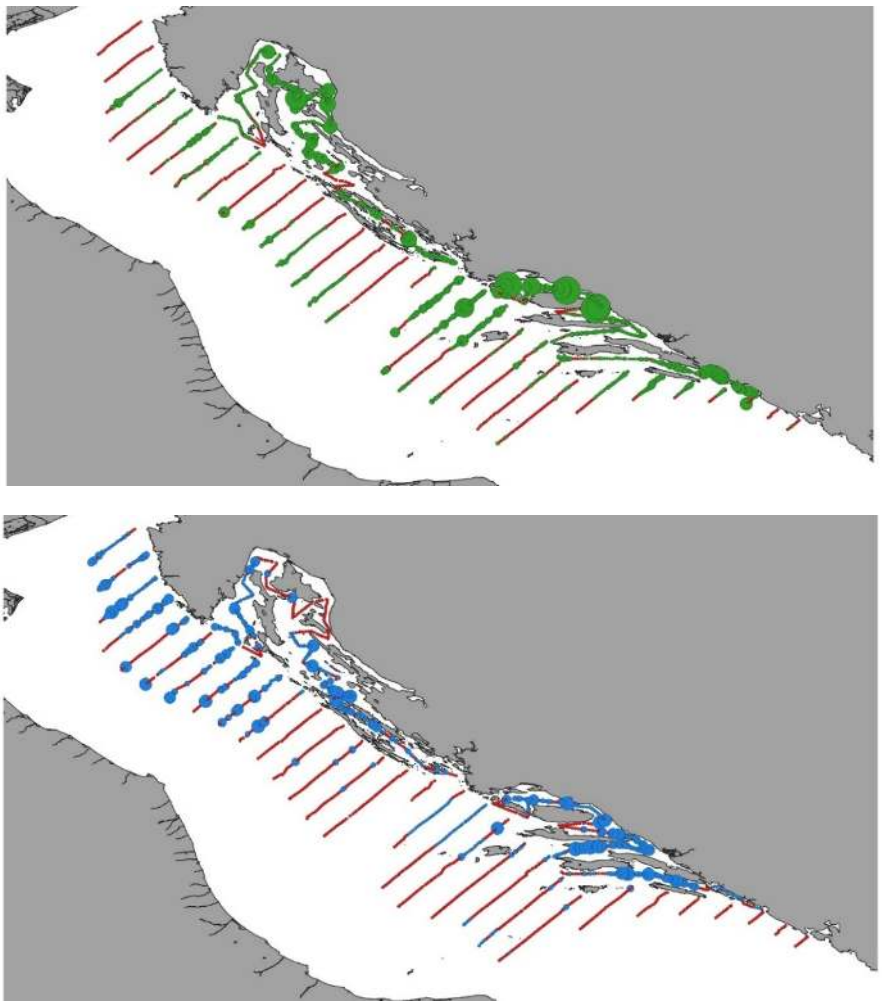


Figure 2.11.11 Spatial distributions of anchovy (above) and sardine (bellow) assemblages during September 2019 in the eastern part of GSA 17.

2.12 Results of the 2020 acoustic survey in the eastern part of GSA 17 (HRV) - Northern Adriatic Sea (V. Tičina, T. Juretić, D. Gašparević, et al.)

a) General information on the survey

Acoustic survey on the eastern part of GSA 17 was performed in the period from 28.8.2019. to 05.10.2019. For this purpose, R/V BIOS DVA (length: 36m, engine power: 1200HP) was used for 39 day, in order to survey the area of 13.578 NM^2.

b) Type of echosounders and frequencies in use

R/V BIOS DVA is equipped with SIMRAD scientific echosounder system (EK80), including GPT (38kHz) and WBT (120kHz) transceivers connected to hull-mounted transducers (ES38B and ES120-7). In line with MEDIAS Handbook, the principal frequency for the survey was 38 kHz, while 120 kHz acoustic equipment was used as complementary with aim to improve categorization of different acoustic targets. The system was operating with SIMRAD EK80 software. In order to improve the quality of acoustic data collected in the rough sea conditions, echosounder system is connected to the vessel's motion reference unit (MRU3).

c) Calibration results

The acoustic system on R/V BIOS DVA was calibrated at the 1st day of the survey using the standard Cu-sphere (60 mm) and EK80 software. Calibration results are shown in Table 2.12.1.

Table 2.12.1 Calibration of 38 kHz scientific sounder system at R/V BIOS DVA (MEDIAS, 2020).

Calibration report	
Frequency (kHz)	38
Echosounder type	SIMRAD, EK80
Transducer serial no.	ES38B (30825)
Vessel	BIOS DVA
Date	28.08.2020.
Place	Kašjuni
Latitude	43°30.37' N
Longitude	16°23.49' E
Bottom depth (m)	35
Temperature (oC) at sphere depth	20.4
Salinity (psu) at sphere depth	39.0
Speed of sound (ms-1)	1527.21
TS of sphere (dB)	-33.6
Pulse duration (ms)	1.024
Equivalent 2-way beam angle (dB)	-20.7
Default TS transducer gain	22.81 dB
Iteration no.	1293
Time	11:15 – 11:30
Range to sphere (m)	13-14
Ping rate	Max

Calibrated TS transducer gain	22.33 dB
Time (GMT)	09:15-09:30
RMS	0.068
sA correction	-0.48

Acoustic data calibration and processing has been done with EchoView softvare (Ver. 11), considering Elementary Sampling Distance Unit (EDSU) of 1 NM and data integration depth range from 7 to 200 m.

d) Survey design

Survey design in eastern part of GSA 17 (Fig. 2.12.1) is made of two long transects adapted to geomorphology of inner sea area (channel areas between small islands), and 30 parallel transects (direction: 43°-223°) in the open Adriatic (i.e. within Croatian territorial waters and EEZ). Inter-transect distance between parallel transects is 10 NM. Parallel transect lengths are in the range from 6 to 55 NM. Number of nautical miles effectively processed for biomass estimation was 1421.

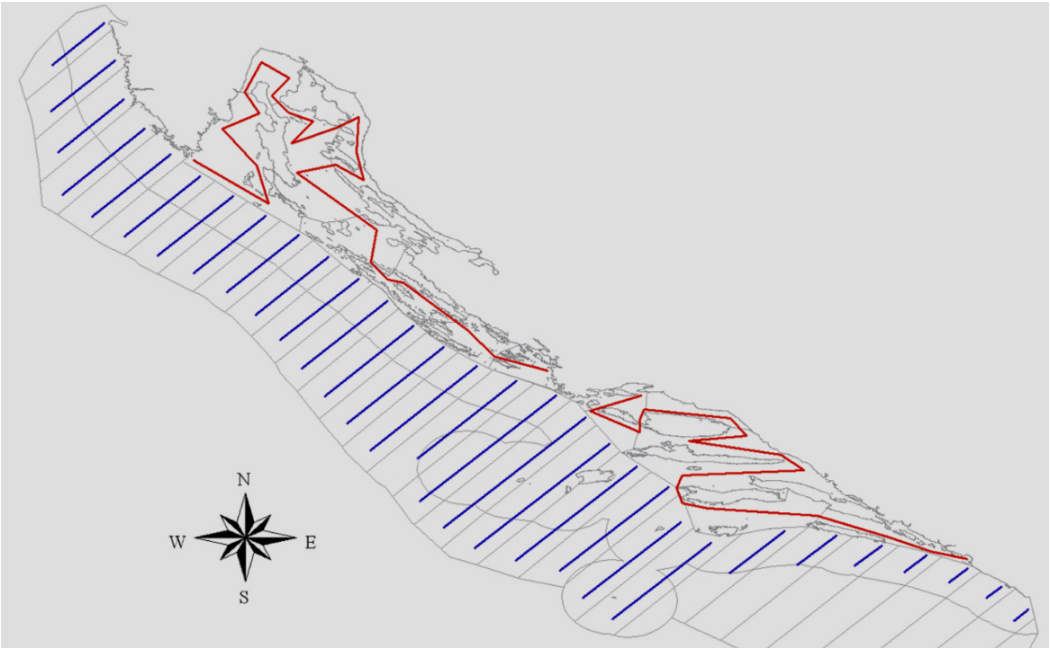


Figure 2.12.1 Acoustic survey design in the eastern part of GSA 17 (red transects in inner sea, and blue transects in open sea).

e) Fish sampling

In order to identify echo traces recorded by echosounder, 56 sampling has been made by pelagic trawl with otter boards. Pelagic trawl sampling net has headline length 29.40m and side-line lengths 24.80m, with 18 mm mesh size in the cod-end. In addition, fine mesh cod-end cover has been used in order to identify small acoustic targets (not used in fish LFDs). Trawling speed was around 4 knots (i.e. 3.5 – 4.5 knots), and haul's duration was about 30 min. During sampling operations, trawl was monitored by Simrad ITI System, indicating vertical opening about 10 m in most cases. Locations and species composition of samples obtained are shown in Figure 2.12.2.

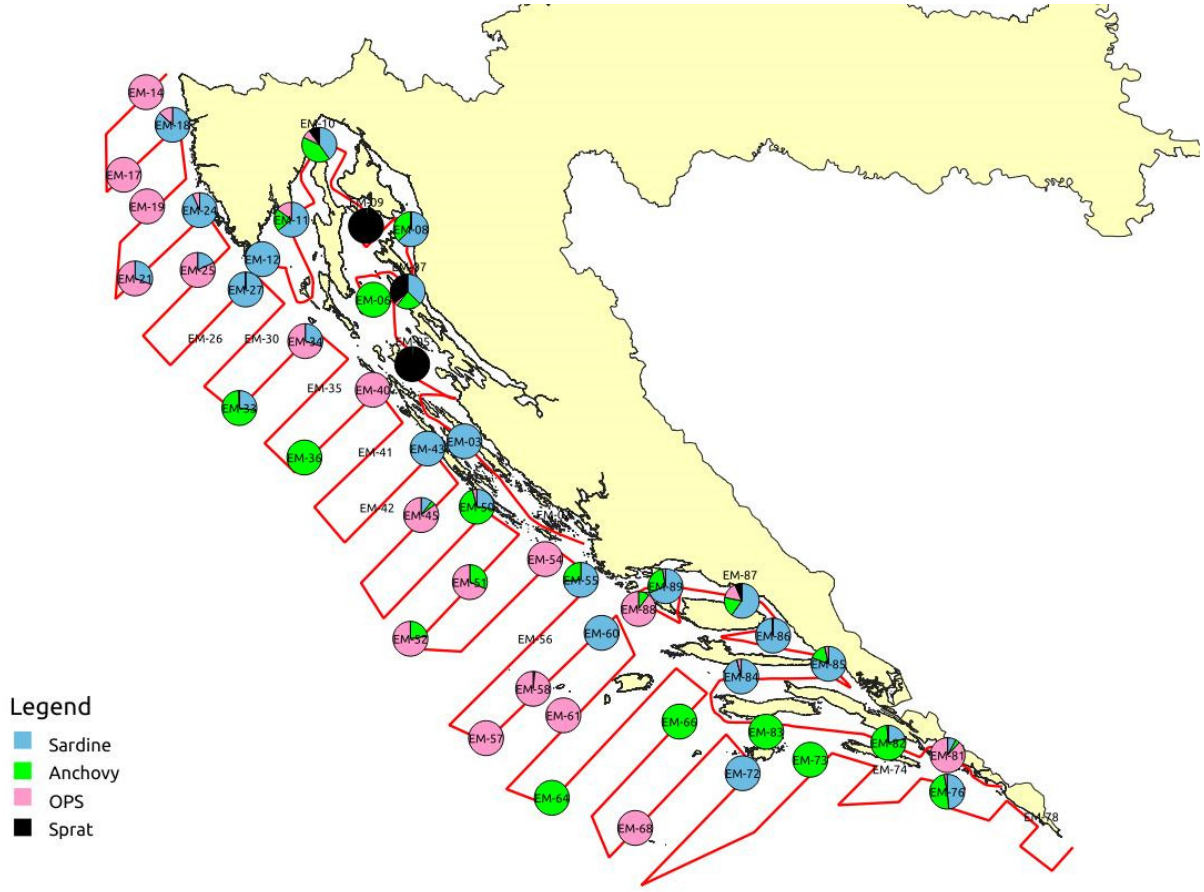


Figure 2.12.2 Locations and species composition of samples obtained by trawl (MEDIAS, 2020).

f) Oceanographic parameters

Oceanographic parameters were measured by CTD probe (temperature and salinity) at 89 different locations (Fig. 2.12.3). Based on measurements made, sound speeds were calculated and used to update echosounder during survey, as well as for surveyed area oceanographic description.

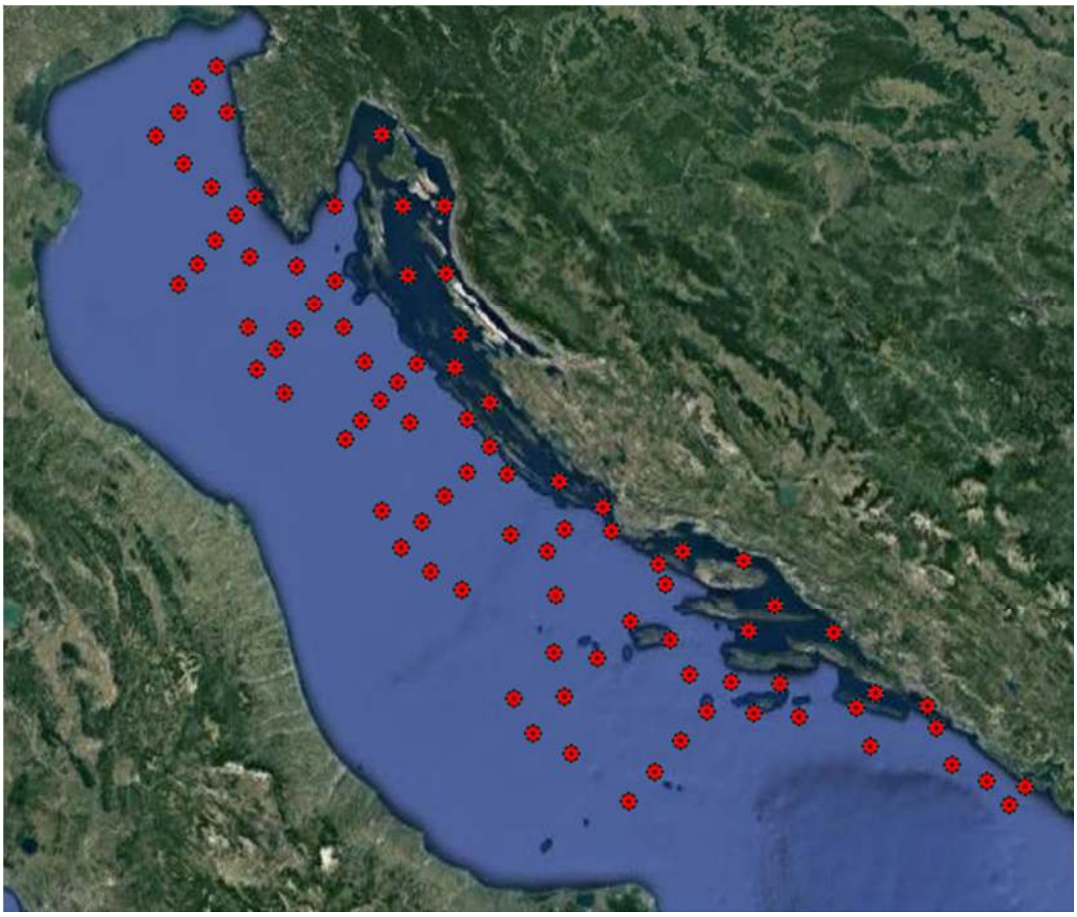


Figure 2.12.3 Locations of oceanographic measurement (CTD) made during survey (MEDIAS, 2020).

g) Biomass estimations of target species

The anchovy and sardine biomasses present in the eastern part of GAS 17, during survey period, were estimated to be 27326 tons (CV=10) and 232656 tons (CV=11) respectively in 2020. Time series of biomass densities for anchovy and sardine is shown in the Figure 2.12.4, and biomass estimates per length classes are shown in Figure 2.12.5.

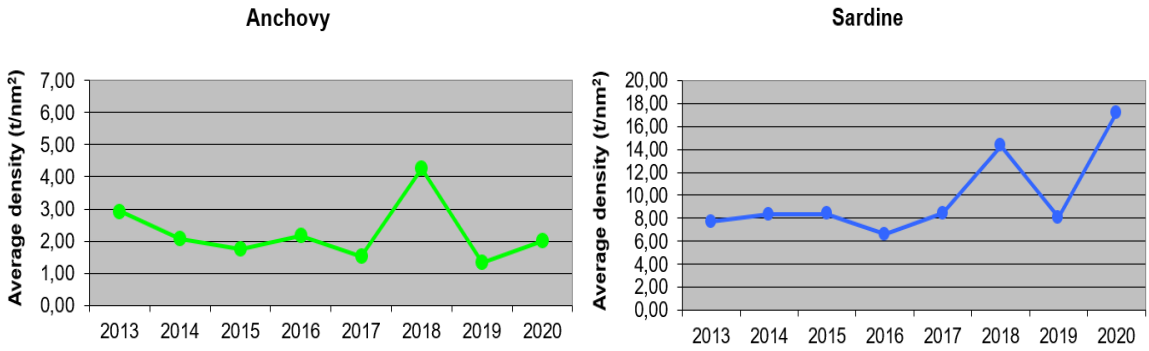


Figure 2.12.4 Biomass densities for anchovy and sardine in September in eastern part of GSA 17.

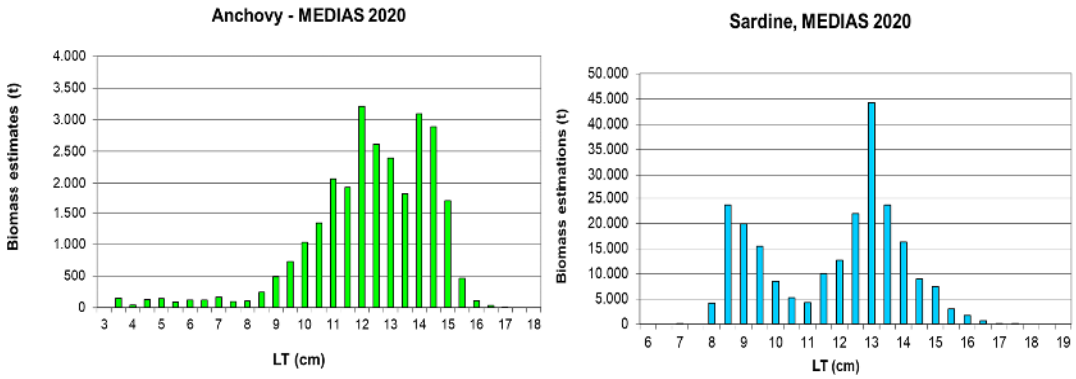


Figure 2.12.5. Biomass estimates per length classes (MEDIAS, 2020).

Age analyses, made in line with ICES WKARA2 report (2017) recommendations, resulted in survey specific ALKs for anchovy and sardine (Figure 2.12.6). Results of analyses indicated that anchovy and sardine populations consist of three age groups: 0, 1 and 2. During 2019, in terms of biomass, fish from age group 0 were dominant in anchovy's and in sardine's populations (Fig. 2.12.7).

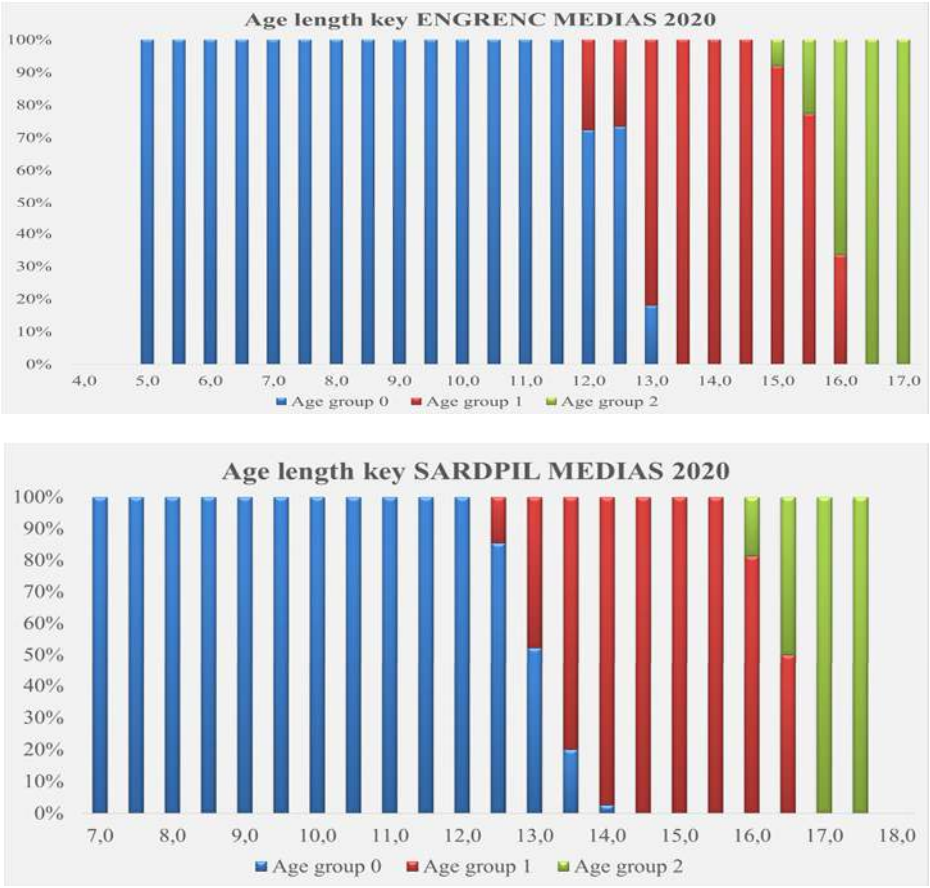


Figure 2.12.6 ALKs for anchovy (N=513) and sardine (N=622) for MEDIAS 2020 (GSA17-East).

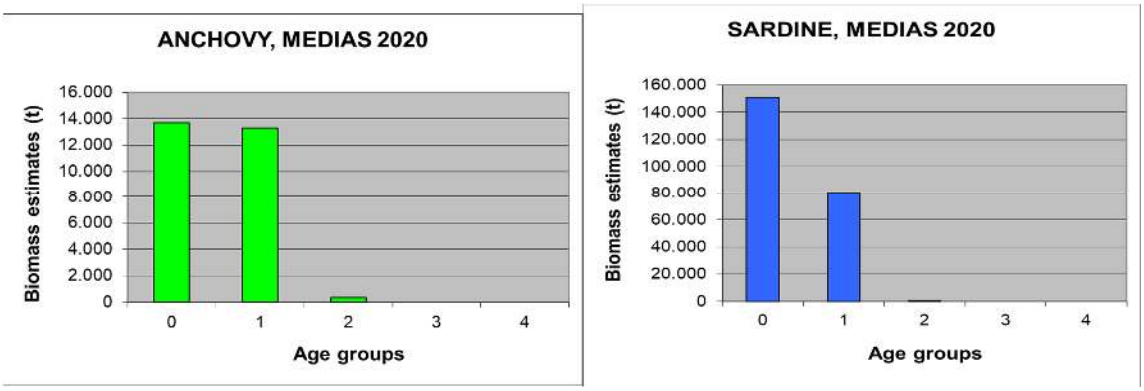


Figure 2.12.7 Biomass estimates per age groups (GSA 17-East).

h) Abundance indices of target species

Time series of sardine and anchovy abundance indices by age groups during September in the eastern part of GSA 17 is shown in Figure 2.12.8.

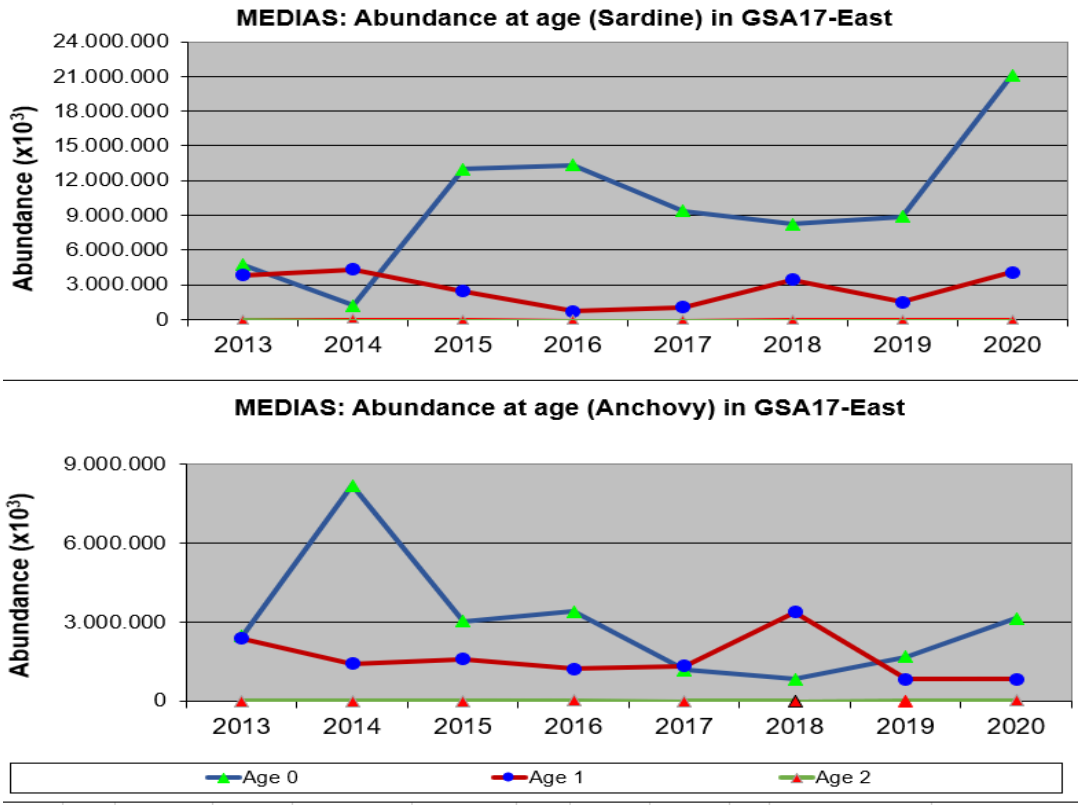


Figure 2.12.8. Abundance indices by age groups during September in the eastern part of GSA 17.

Abundance of sardine and anchovy, for all age groups combined, is shown in Figure 2.12.9. Abundances of small specimens (LT up to 10 cm), as a proxy to recruitment, are shown in Figure 2.12.10.

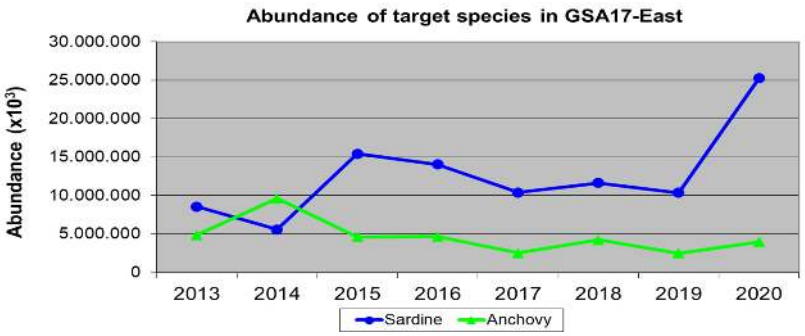


Figure 2.12.9 Abundance of sardine and anchovy, for all age groups combined (GSA 17-East).

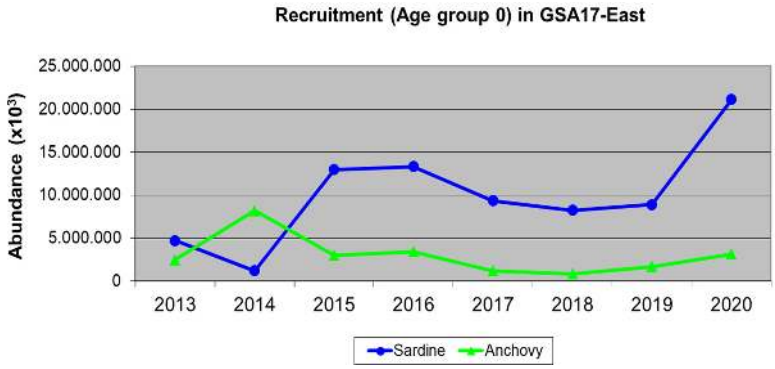


Figure 2.12.10 Abundances of small specimens (LT up to 10 cm), as a proxy to recruitment.

Spatial distributions of anchovy and sardine in September 2020 are shown in Figures 2.12.11. and 2.12.12.

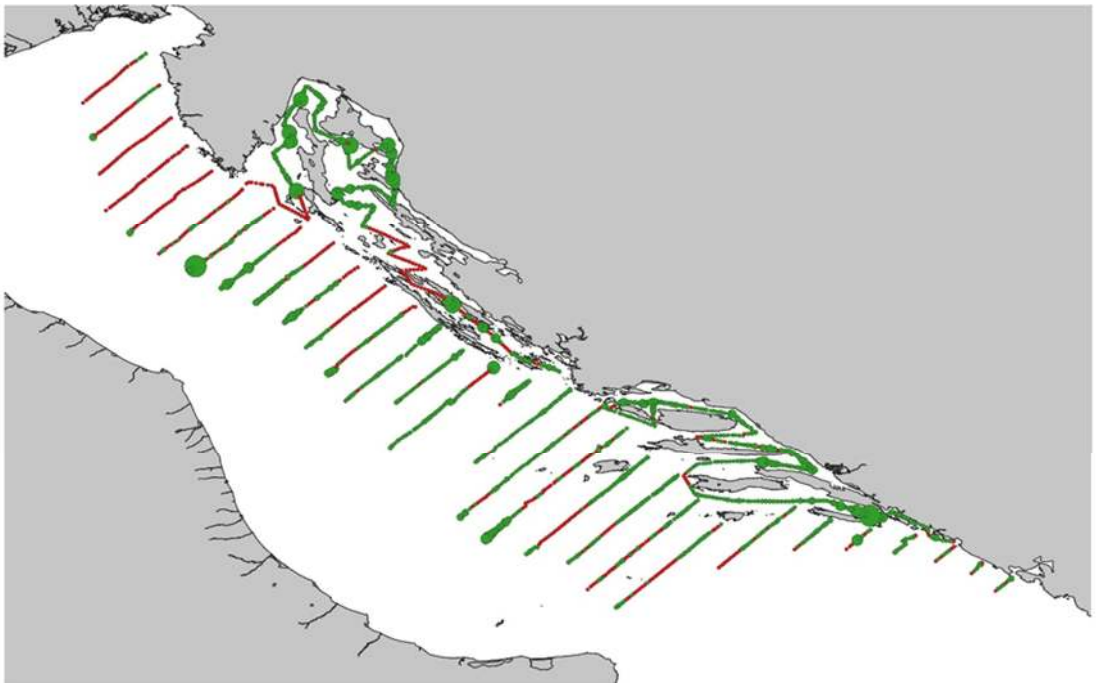


Figure 2.12.11 Spatial distributions of anchovy during September 2020 in the eastern part of GSA 17.

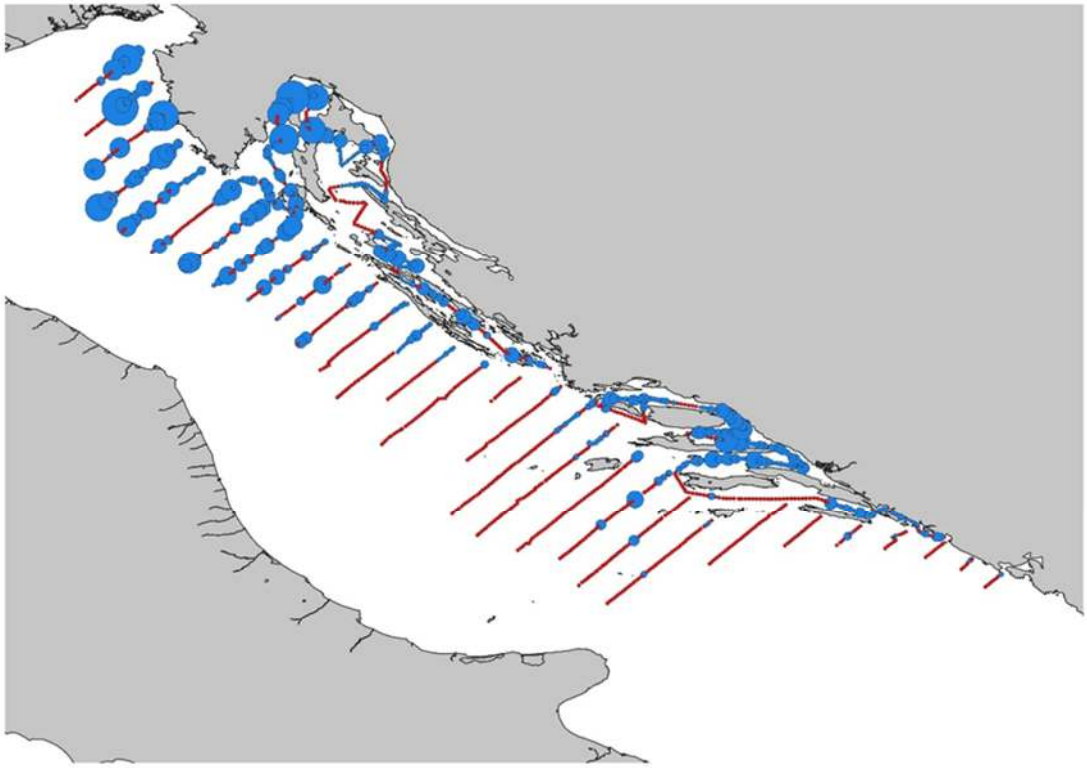


Figure 2.12.12 Spatial distributions of sardine during September 2020 in the eastern part of GSA 17.

i) Other information

In addition to COVID-19 related issues, the same problems as reported to RCG Med&BS (Malta, 2019) still persist in Croatia. Acoustic survey in the eastern part of GSA 17 has the largest area (>13,500 nm2) need to be covered with very limited vessel's days available (in Handbook: 30 days only), in average >450 nm2 /day need to be surveyed. Considering that, in order to be completed, surveys in 2019 and 2020 used research vessel for more than 30 days, it is obvious that an increase in number of vessel days for survey in the eastern part of GSA 17 is needed.

Furthermore, "recent expansion" of MEDITS survey area (due to declaration of Exclusive Economic Zones in the Adriatic; January, 2021) and new mandatory survey (SOLEMON) are strongly competing with MEDIAS for the same limited resources, resulting in heavy workload and bad maintenance of research vessel.

Lack of robustness in Croatian survey's capacities has been noted also. Due to very low financial resources available for MEDIAS in Croatia, it is not possible to rent research vessel with crew & equipment from other EU Member States if necessary.

2.13 Acoustic survey in western GSA 17 and GSA 18 (western Adriatic Sea). (Iole Leonori, Andrea De Felice, Ilaria Biagiotti, Giovanni Canduci, Ilaria Costantini, Sara Malavolti, Michele Centurelli, Antonio Palermino. CNR IRBIM Ancona, ITALY)

a) General information on the survey

The 2019 acoustic surveys were carried out from 10/06/2019 to 19/07/2019. They were conducted in the western GSA 17, including territorial waters of Slovenia, and western GSA 18, following MEDIAS protocol (MEDIAS Handbook, 2019) and identifying an area of ~ 13,300 nmi^2 in western Adriatic Sea. The cruises were conducted on board the research vessel "G. Dallaporta" (built in 2001, 35.30 m, 285 GT, 1100 CV). Dr Modic took part in the cruise in Slovenia waters.

b) Type of echosounders and frequencies in use

Acoustic System was SIMRAD EK60 scientific echosounder operating at 38 and 200 kHz and SIMRAD EK80 operating at 70 and 120 kHz connected with hull-mounted split beam transducers. No TS and Sv thresholds set for data logging. The threshold for data processing is -70 dB or -60 dB in case of strong scattering from plankton. The pulse duration is 1.024 ms for all frequencies. The surveying acoustic vessel speed is generally 9.5 knots. Echoview software was used to analyse acoustic data.

c) Calibration results

Calibration results, used during MEDIAS 2019 are shown in Table 2.13.1.

Table 2.13.1 Calibration results in 2019

Frequency	Beam Angles (deg)	Athw. Beam Angles (deg)	Athw. Offset Beam Angles (deg)	Along. Beam Angles (deg)	Along. Offset Beam Angles (deg)	Transducer Gain (dB)	Sa Correction (dB)	RMS (dB)
38 kHz	7	6.93	-0.07	6.94	0.01	25.39	-0.6219	0.0696
70 kHz	7	6.62	0.04	6.69	-0.07	27.27	-0.0112	0.0714
120 kHz	7	6.89	-0.16	6.66	0.21	26.86	-0.2101	0.0761
200 kHz	7	6.08	-0.10	5.92	0.5	26.51	-0.0183	0.2345

d) Survey design

Acoustic data were logged over a grid of systematic parallel transects (Fig. 2.13.1) perpendicular to coastline/bathymetry (inter-transect distance 8-10 nmi, minimum transect length: 5 nmi, maximum transect length: 40 nmi). Number of transects is 39 in GSA 17 and 11 in GSA 18 for a total of ~ 2,000 nmi in western Adriatic Sea.

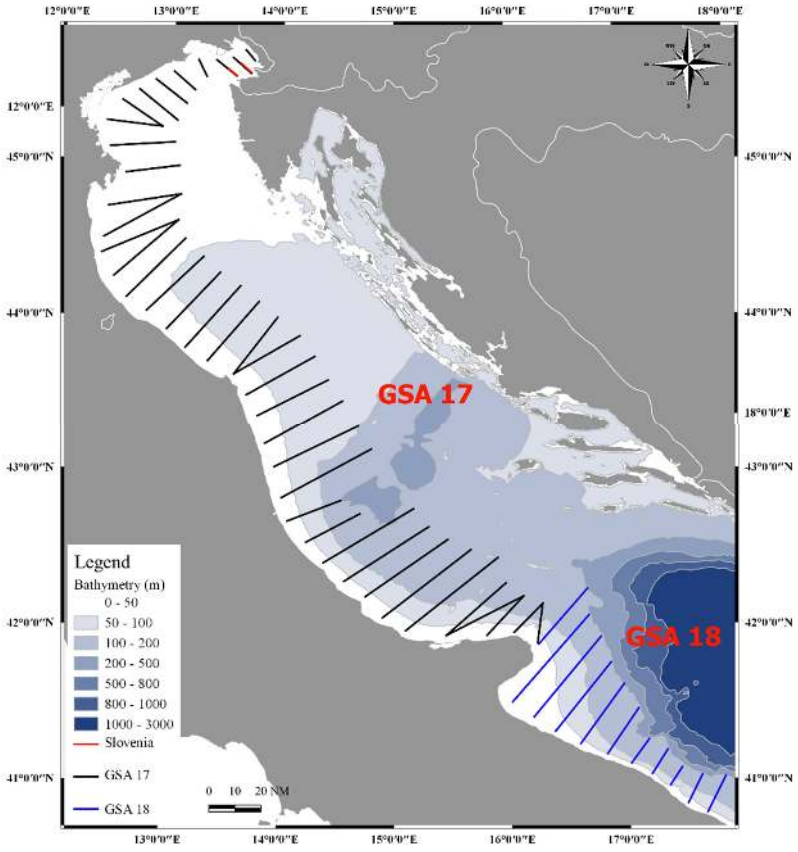


Figure 2.13.1 Acoustic survey route plan in western part of GSA 17 and GSA 18, in 2019

Survey period of the 2019 acoustic survey in western GSA 17 was 10/06/2019 – 07/07/2019; area coverage was 100% over a total area of 10,636 nmi² and 39 transects. The number of nautical miles effectively processed for biomass estimation was 1046.

2019 acoustic survey in western GSA 18 was done in the period of the 07/07/2019 – 19/07/2019; area coverage was 100% over a total area of 2,510 nmi² and 11 transects. The number of nautical miles effectively processed for biomass estimation was 253.

e) Fish sampling

A midwater sampling trawl "Volante" with the following characteristics was used during the surveys: 18 mm codend, about 10 m vertical opening and 12 m horizontal opening, headline/ft rope = 35 m; sidelines length = 27 m. Vessel speed was 3.5 – 4.5 knots during fishing. Haul's duration was about 30 min. Trawls were monitored by means of Simrad ITI System. Fishing operations were performed at different light conditions and bathymetry. Biological samplings were conducted along the survey routes for biomass allocation into species and to know mean lengths and weights of the pelagic fish (Species, Size Composition, length-weight). The entire catch is considered to determine the proportion in species by weight; in case the catch is huge (more than 50 kg) an adequate subsample is considered for this operation. Length frequency distributions on board are calculated measuring a subsample of 100 individuals per species when available. Subsamples of target species specimens of up to 5 individuals per 0.5 cm length class are collected to determine age, by

means of otoliths readings, following DCR standards, and maturity stages and frozen for successive measurements in the laboratory.

In western GSAs 17 and 18, in 2019, 32 pelagic hauls were done in GSA 17 and 7 pelagic hauls in GSA 18. Catch composition, desumed from pelagic hauls (Fig. 2.13.2), showed among the most abundant species *Engraulis encrasicolus*, *Sardina pilchardus*, *Sprattus sprattus.* Other pelagic species minor for occurrence were: *Trachurus mediterraneus, Trachurus trachurus, Spicara maena, Scomber scombrus, Scomber colias, Sardinella aurita, Boops boops, Aphia minuta, Alosa fallax, Spicara smaris.* Other Species found in some catches were: *Loligo volgaris, Illex coindetii and Alloteuthis media.*

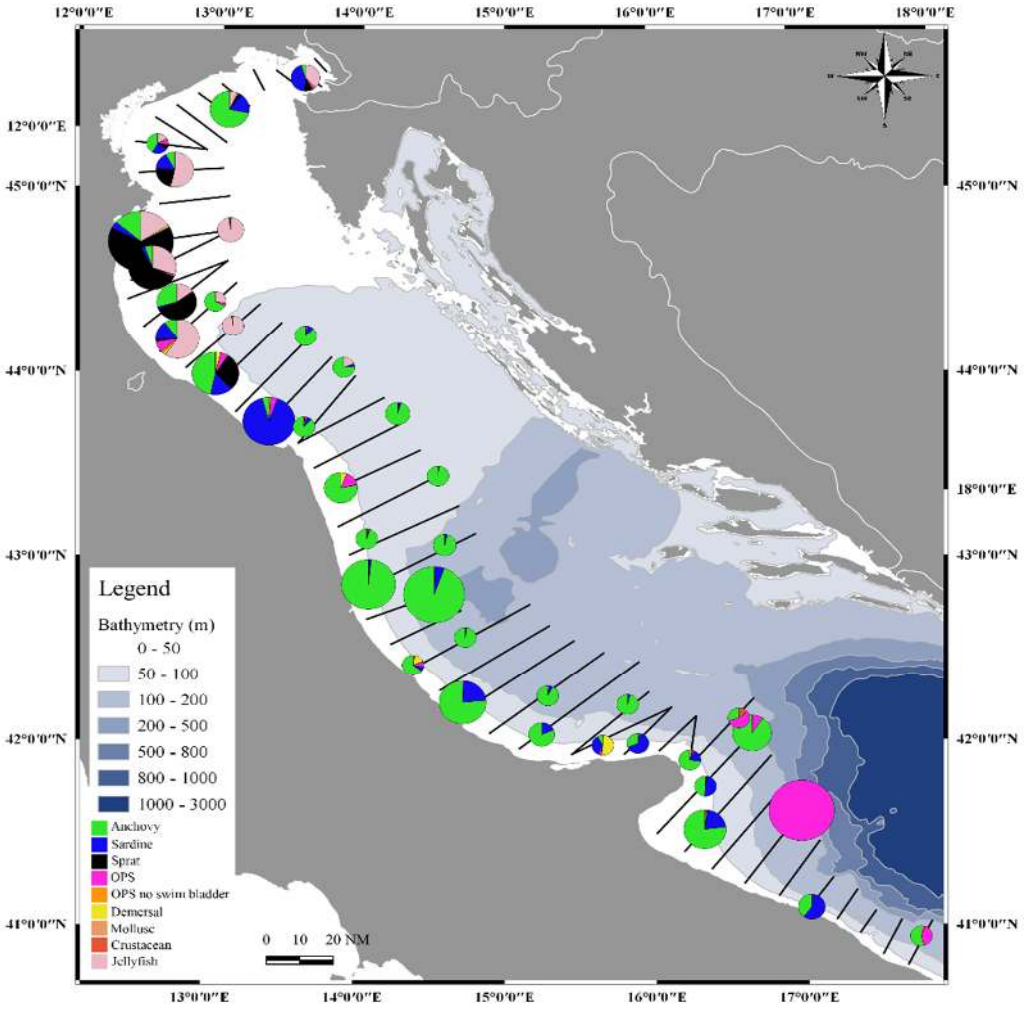


Figure 2.13.2 Catch composition from pelagic hauls in 2019.

f) <u>Oceanographic parameters</u>

In western GSAs 17 and 18, in 2019, 71 CTD stations were carried out in GSA 17 (Fig. 2.13.3) - in 46 of 71 stations there was also mesozooplancton and ichthyoplankton sampling (WP2 net: 200 µm) - and 32 CTD stations in GSA 18 (Fig. 2.13.4); each CTD station in GSA 18 had also mesozooplancton and ichthyoplankton sampling (WP2 net: 200 µm).

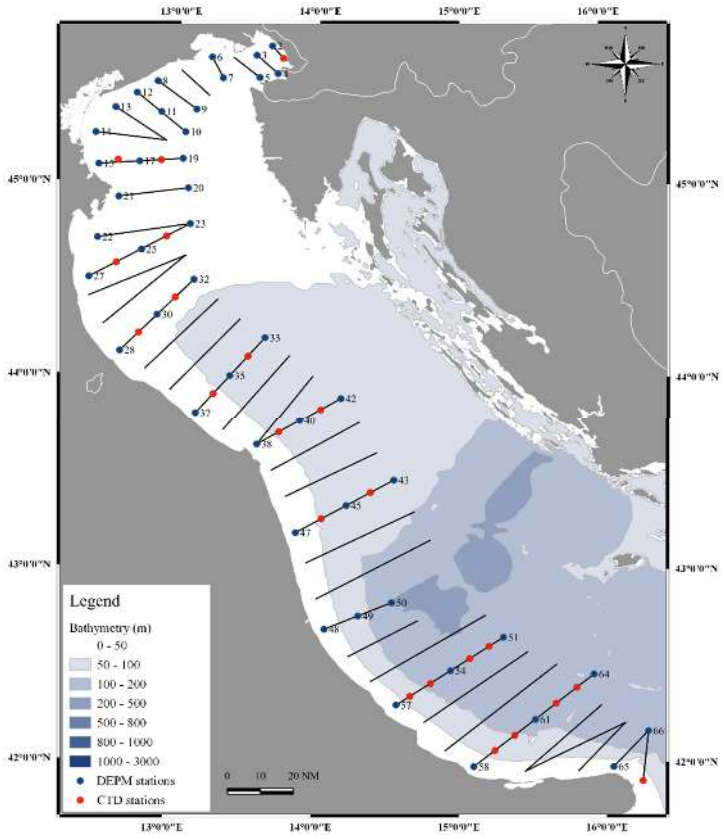


Figure 2.13.3 Acoustic survey route plan in western part of GSA 17 with grid of planned CTD stations in 2019.

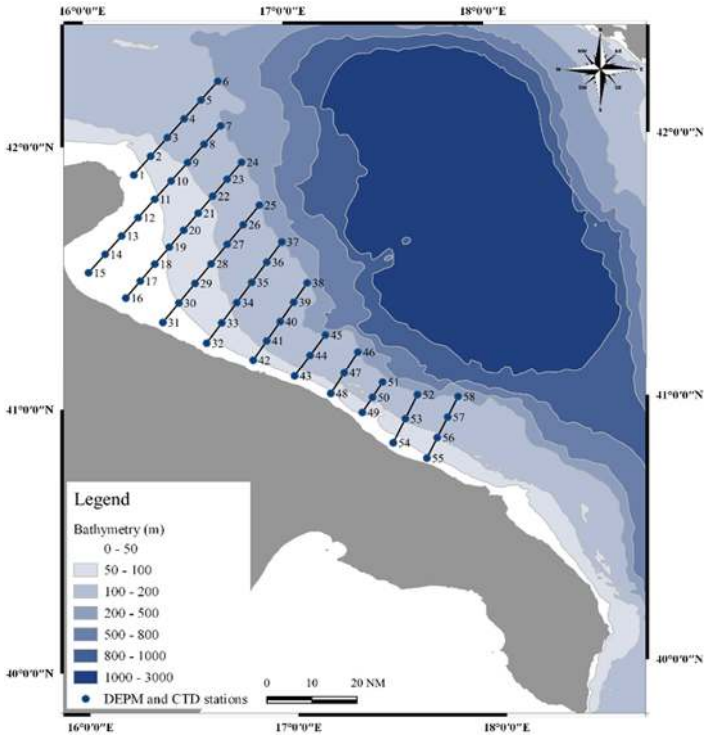


Figure 2.13.4 Acoustic survey route plan in western part of GSA 18 with grid of planned CTD stations in 2019.

g) Biomass estimations of target species

Anchovy and sardine biomass and related CV in 2019 in western GSA 17 are shown in Table 2.13.2.

Table 2.13.2 Anchovy and sardine biomass and related CV in MEDIAS 2019.

Year	Anchovy	CV	Sardine	CV	Sampled Area
2019	229,856 t	9%	82,666 t	11%	10,636 nmi^2

Historical trends for anchovy and sardine biomass density indices in GSA 17 are shown in Figure 2.13.5, while length-structured biomass estimates and age-length keys are shown in figures 2.13.6 and 2.13.7. Age-structured biomass estimates of target species are shown in Figure 2.13.8.

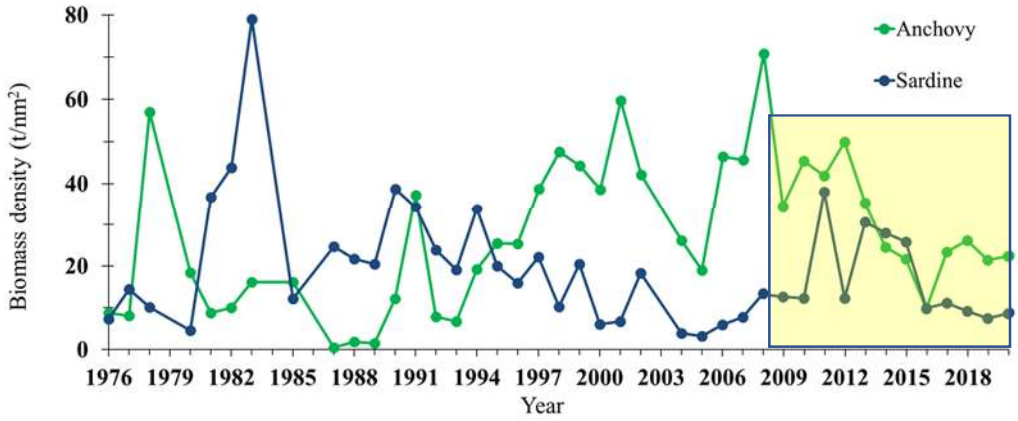


Figure 2.13.5 Historical trends in North-Western Adriatic Sea 1976-2019 in summer-early autumn. MEDIAS estimates are indicated in yellow area.

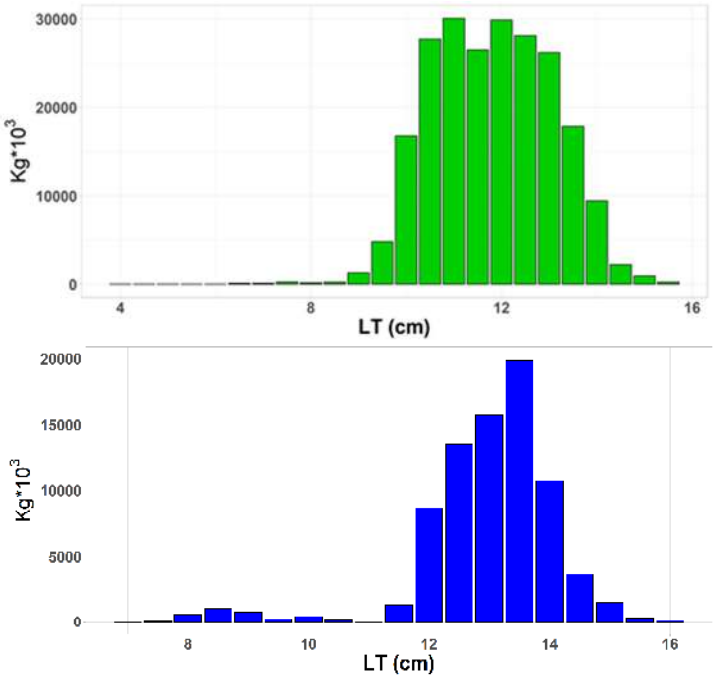


Figure 2.13.6 Anchovy (above) and sardine (bellow) biomass at length in western GSA 17 in MEDIAS 2019.

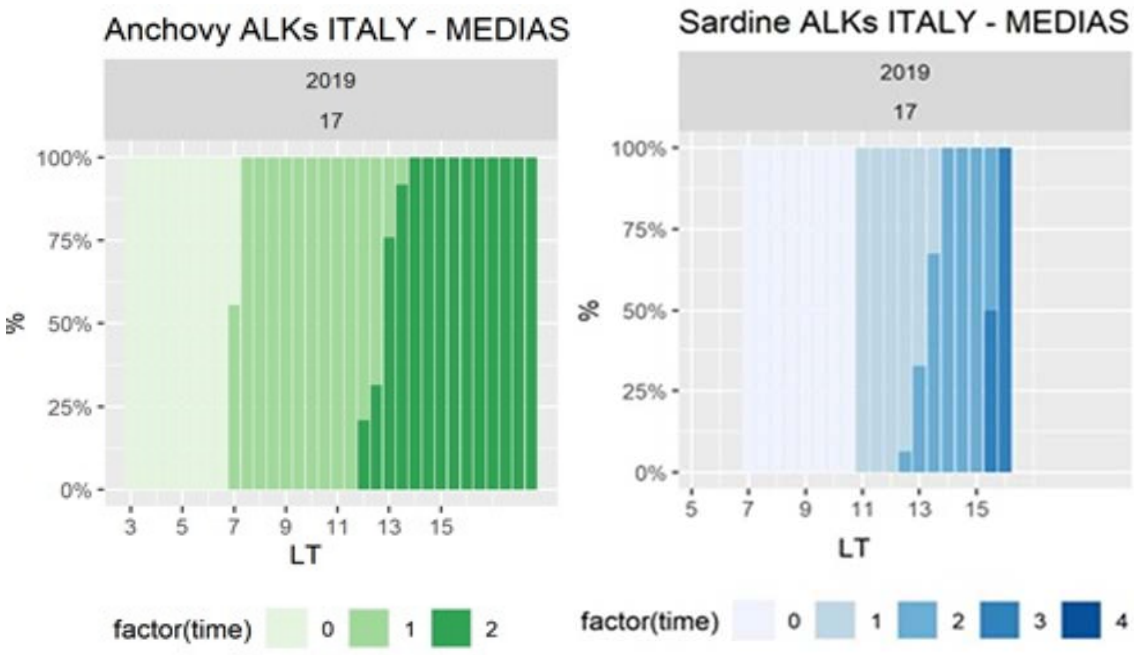


Figure 2.13.7 Anchovy and sardine ALK in 2019 in western GSA 17

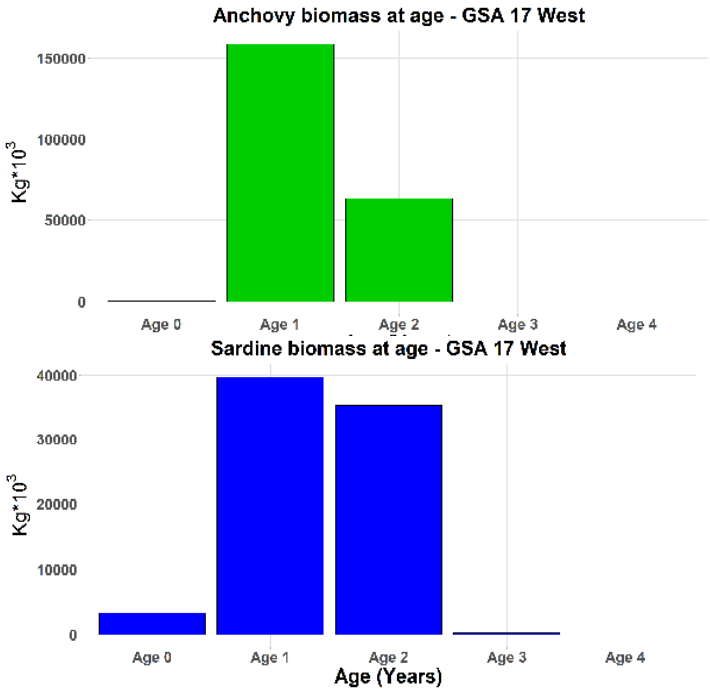


Figure 2.13.8 Anchovy (above) and sardine (bellow) biomass at age in western GSA 17 in 2019.

Anchovy and sardine biomass and related CV estimates obtained in MEDIAS 2019 in Western GSA 18 are shown in Table 2.13.3. Historical trends for anchovy and sardine biomass density indices in GSA 18 are shown in Figure 2.13.9, while length-structured biomass estimates and age-length keys are shown in figures 2.13.10 and 2.13.11. Age-structured biomass estimates of target species are shown in Figure 2.13.12.

Table 2.13.3 Anchovy and sardine biomass and related CV estimates obtained in MEDIAS 2019.

Year	Anchovy	CV	Sardine	CV	Sampled Area
2019	20,495 t	15%	10,503 t	17%	2,510 nmi^2

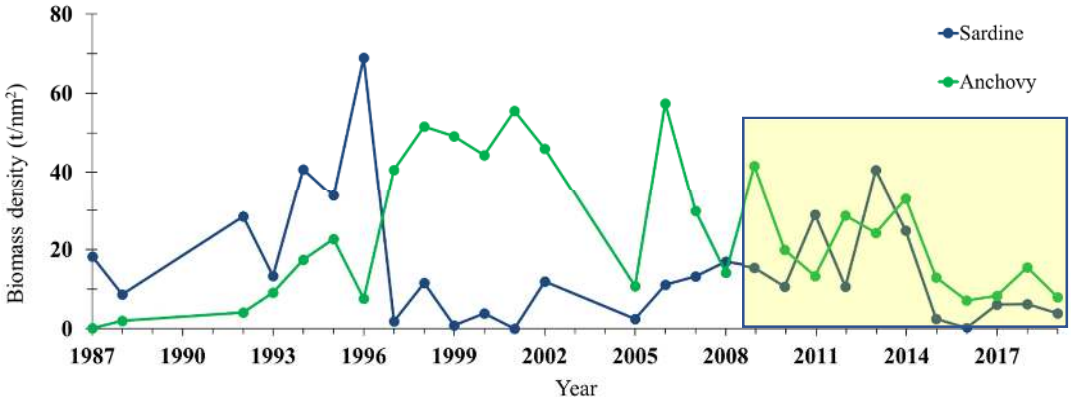


Figure 2.13.9 Historical trends in South-Western Adriatic Sea 1987-2019 in summer. MEDIAS estimates are indicated in yellow area.

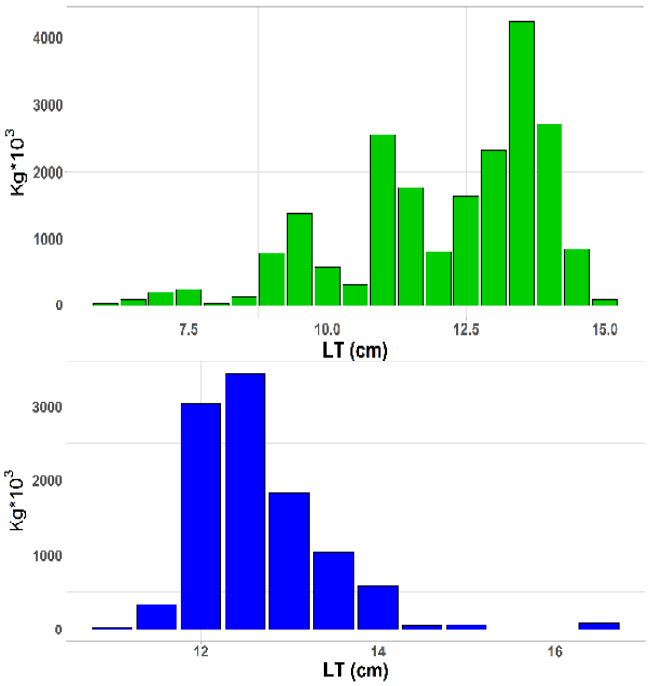


Figure 2.13.10 Anchovy (above) and sardine (bellow) biomass at length in GSA 18 West in MEDIAS 2019.

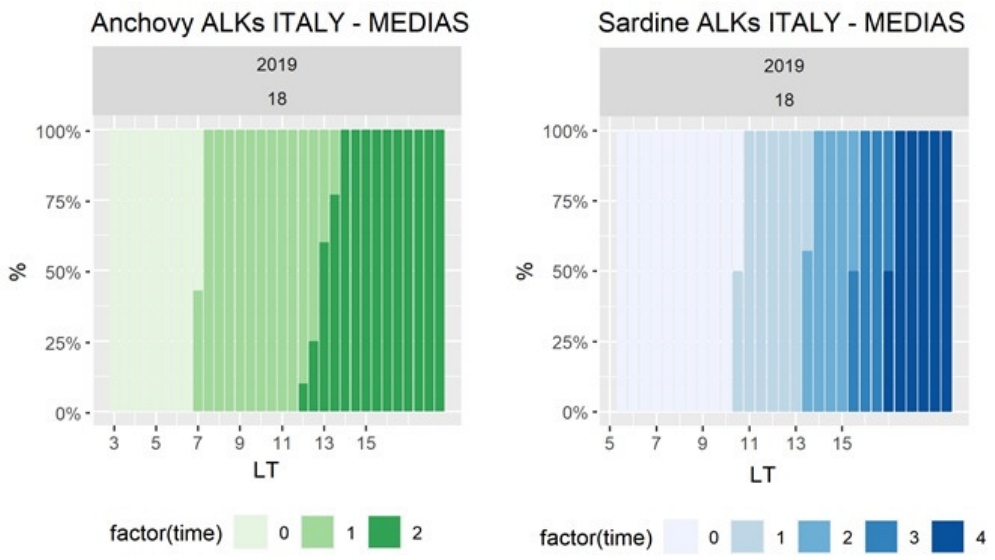


Figure 2.13.11 Anchovy and sardine ALKs in western GSA 18 as obtained in MEDIAS 2019.

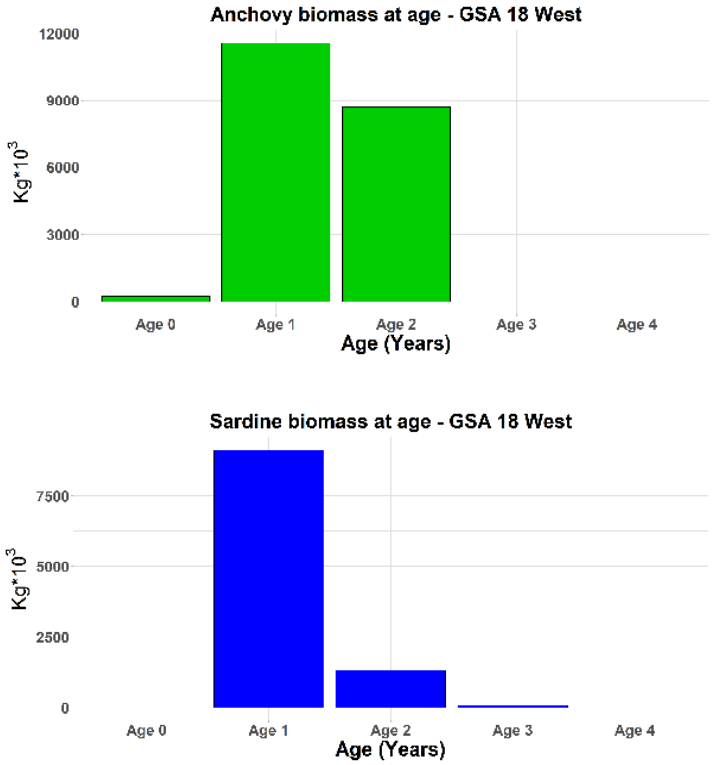


Figure 2.13.12 Anchovy and sardine biomass at age in GSA 18 in MEDIAS 2019.

h) Abundance indices of target species

Spatial distribution of anchovy and sardine in western part of GSA 17 and GSA 18 relative to MEDIAS 2019, are shown in figure 2.13.13. Estimated abundances at length and abundances at age are shown in figures 2.13.14 and 2.13.15.

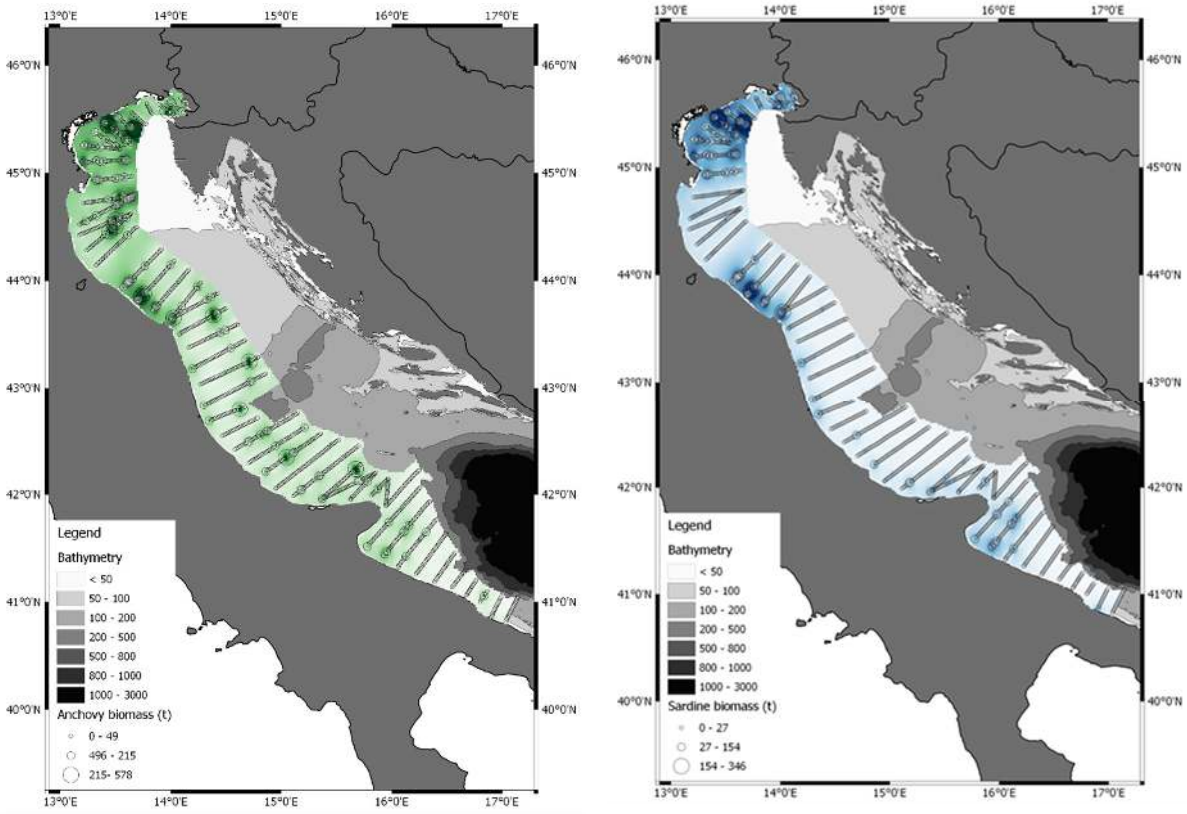


Figure 2.13.13 Anchovy and sardine spatial distribution in western GSA 17 and 18 in 2019

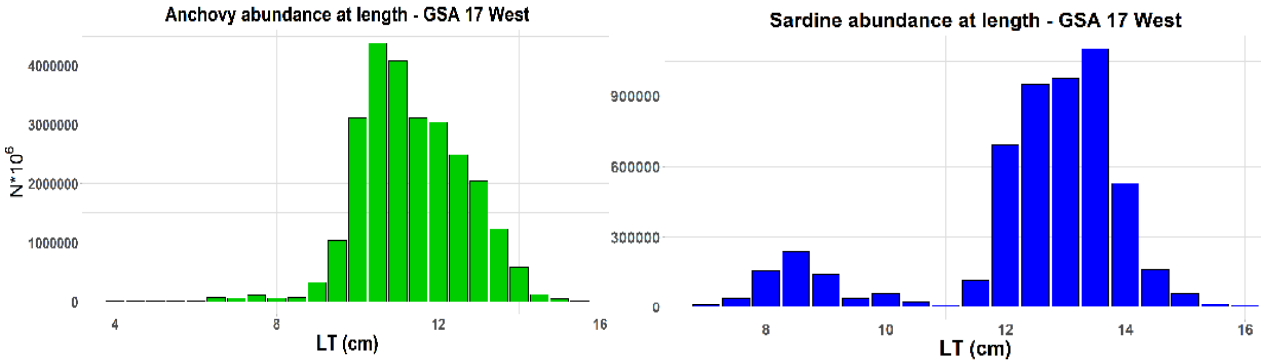
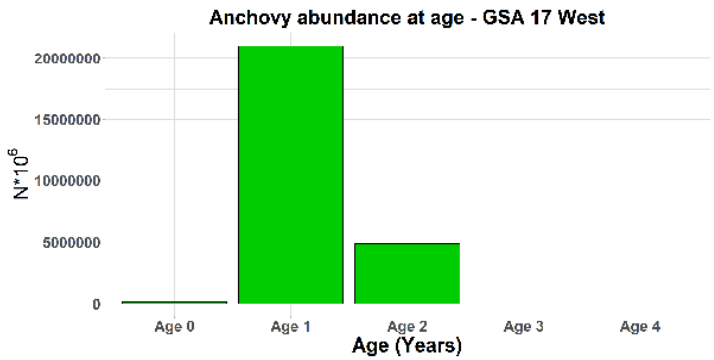


Figure 2.13.14 Anchovy and sardine number per length class in western GSA 17 in 2019.



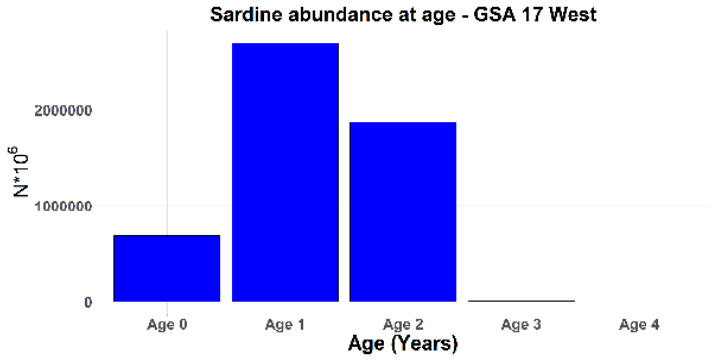


Figure 2.13.15 Anchovy and sardine number at age in western GSA 17 in 2019.

Length and age structured abundance estimates for target species in GSA 18 as obtained in MEDIAS 2019 are shown in figures 2.13.16 and 2.13.17.

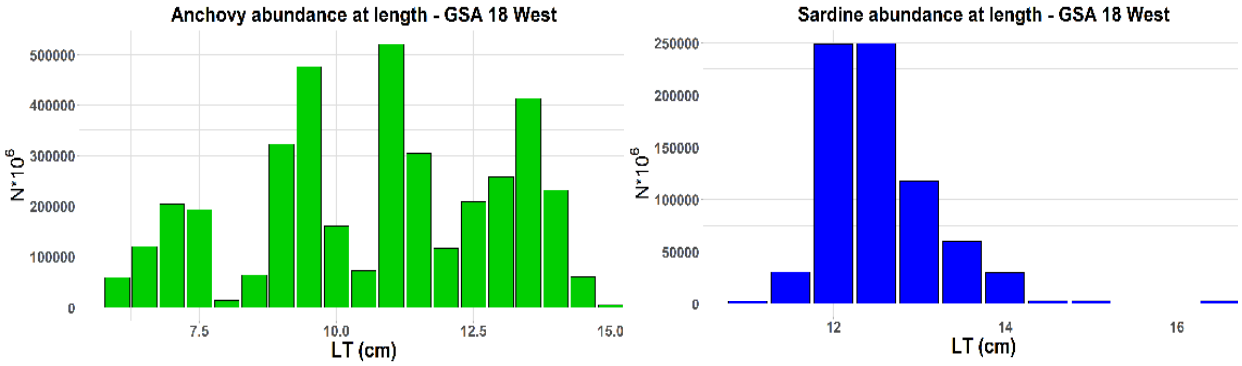


Figure 2.13.16 Anchovy and sardine number at length in GSA 18 in 2019.

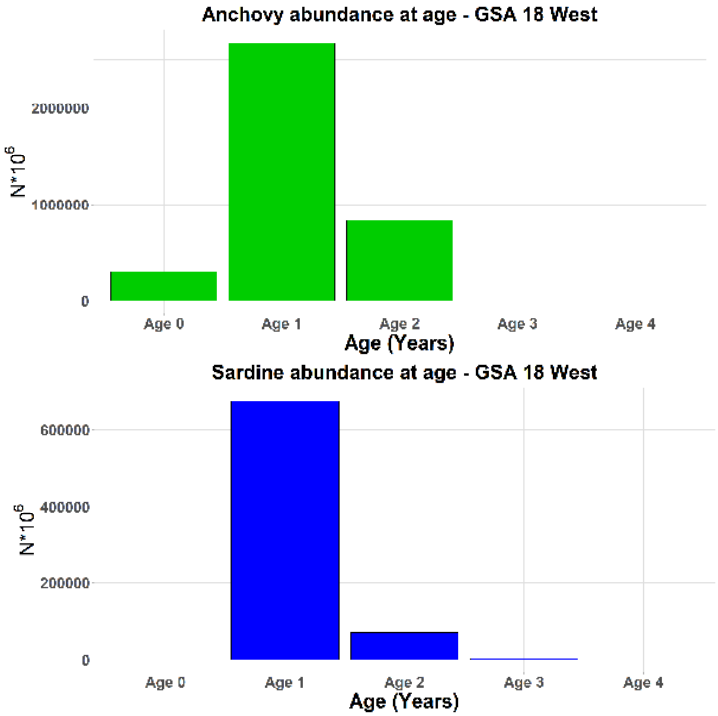


Figure 2.13.17 Anchovy (above) and sardine (bellow) number at age in GSA 18 West in 2019

2.14 Acoustic survey MEDIAS 2020 in western GSA 17 and GSA 18 (western Adriatic Sea).

(Iole Leonori, Andrea De Felice, Ilaria Biagiotti, Giovanni Canduci, Ilaria Costantini, Sara Malavolti, Michele Centurelli, Antonio Palermino. CNR IRBIM Ancona, ITALY)

a) General information on the survey

The 2020 acoustic surveys were carried out from 01/07/2020 to 28/07/2020. They were conducted in the western GSA 17, including territorial waters of Slovenia, and western GSA 18, following MEDIAS protocol (MEDIAS Handbook, 2019), in the planned area of ~ 13,300 nmi^2 in western Adriatic Sea. The cruises were conducted on board the research vessel "G. Dallaporta" (built in 2001, 35.30 m, 285 GT, 1100 CV). Dr Modic didn't take part in the cruise in Slovenia waters in 2020, it was not possible due to restrictions on board for COVID-19 pandemic: maximum 5 scientists (instead of 11) could be present on board R/V "G. Dallaporta".

b) Type of echosounders and frequencies in use

Acoustic System was SIMRAD EK60 scientific echosounder operating at 38 and 200 kHz and SIMRAD EK80 operating at 70 and 120 kHz connected with hull-mounted split beam transducers. No TS and Sv thresholds set for data logging. The threshold for data processing is -70 dB or -60 dB in case of strong scattering from plankton. The pulse duration is 1.024 ms for all frequencies. The surveying acoustic vessel speed is generally 9.5 knots. Echoview software was used to analyse acoustic data.

c) Calibration results

Calibration results, used during MEDIAS 2020 are shown in Table 2.14.1.

Table 2.14.1 Calibration results in 2020.

Frequency	Beam Angles (deg)	Athw. Beam Angles (deg)	Athw. Offset Beam Angles (deg)	Along. Beam Angles (deg)	Along. Offset Beam Angles (deg)	Transducer Gain (dB)	Sa Correction (dB)	RMS (dB)
38 kHz	7	6.98	0.00	6.94	-0.02	25.27	-0.5729	0.0516
70 kHz	7	6.63	0.03	6.59	0.02	27.19	-0.0010	0.1006
120 kHz	7	6.61	0.09	6.52	-0.14	26.87	-0.0761	0.2714
200 kHz	7	5.41	0.00	5.91	0.02	26.06	-0.3659	0.5596

d) Survey design

Acoustic data were logged over a grid of systematic parallel transects perpendicular to coastline/bathymetry (inter-transect distance 8-10 nmi, minimum transect length: 5 nmi, maximum transect length: 40 nmi). Number of transects is 39 in GSA 17 and 11 in GSA 18 for a total of ~ 2,000 nmi in western Adriatic Sea (Fig. 2.14.1).

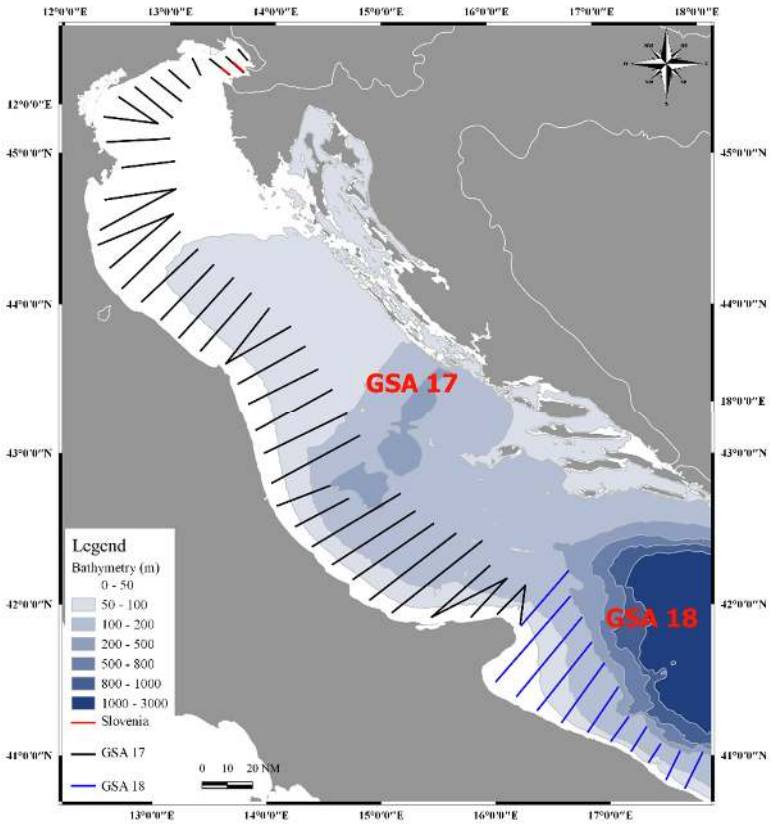


Figure 2.14.1 Acoustic survey route plan in western part of GSA 17 and GSA 18, in 2020.

Survey period of the 2020 acoustic survey in western GSA 17 was 01/07/2020 – 28/07/2020; area coverage was 100% over a total area of 10,636 nmi² and 39 transects. The number of nautical miles effectively processed for biomass estimation was 1056.

Due to COVID-19 restrictions affecting heavily ship availability in 2020, GSA 18 was only partially covered by the acoustic survey. Survey coverage in western GSA 18 was about 30% (24-26/07/2020) over a total area of 2,510 nmi²; 3 transects were monitored acoustically (88 nmi).

e) Fish sampling

A midwater sampling trawl "Volante" with the following characteristics was used during the surveys: 18 mm codend, about 10 m vertical opening and 12 m horizontal opening, headline/ft rope = 35 m; sidelines length = 27 m. Vessel speed was 3.5 – 4.5 knots during fishing. Haul's duration was about 30 min. Trawls were monitored by means of Simrad FX80 Trawl sonar in 2020. Fishing operations were performed at different light conditions and bathymetry. Biological samplings were conducted along the survey routes for biomass allocation into species and to know mean lengths and weights of the pelagic fish (Species, Size Composition, length-weight). The entire catch is considered to determine the proportion in species by weight; in case the catch is huge (more than 50 kg) an adequate subsample is considered for this operation. Length frequency distributions on board are calculated measuring a subsample of 100 individuals per species when available. Subsamples of target species specimens of up to 5 individuals per 0.5 cm length class are collected to determine age, by means of otoliths readings, following DCR standards, and maturity stages and frozen for successive measurements in the laboratory.

In western Adriatic Sea in 2020, 30 pelagic hauls were done in GSA 17 and 1 pelagic haul in GSA 18. Catch composition, desumed from pelagic hauls (Fig. 2.14.2), showed among the most abundant species *Engraulis encrasicolus*, *Sardina pilchardus*, *Sprattus sprattus.* Other pelagic species minor for occurrence were: *Trachurus mediterraneus, Trachurus trachurus, Spicara maena, Scomber scombrus, Scomber colias, Sardinella aurita, Boops boops, Aphia minuta, Alosa fallax, Spicara smaris.* Other Species found in some catches were: *Loligo volgaris, Illex coindetii and Alloteuthis media.*

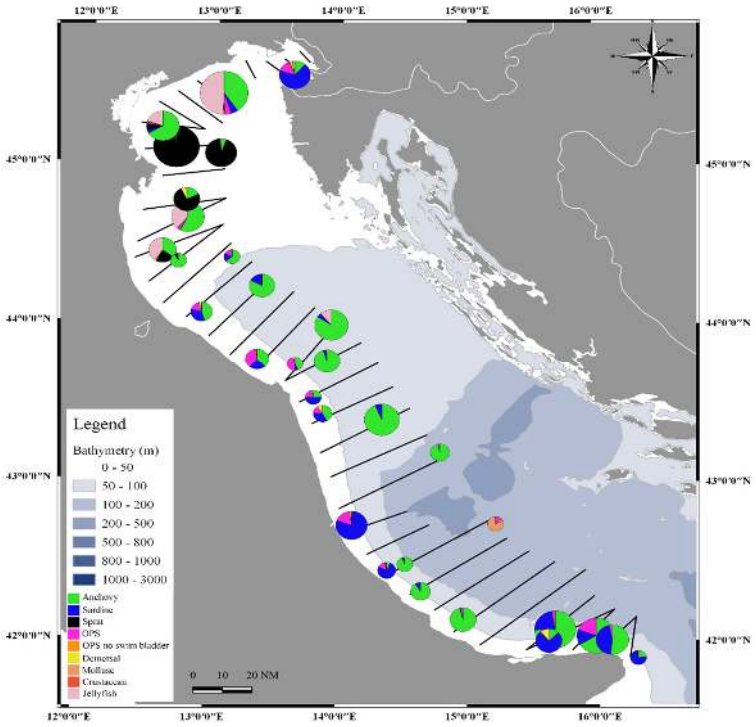


Figure 2.14.2 Catch composition from pelagic hauls in 2020.

f) Oceanographic parameters

In western Adriatic Sea in 2020, 59 CTD stations were performed in GSA 17 and 2 CTD stations in GSA 18; mesozooplancton and ichthyoplankton sampling was not possible due to COVID-19 restrictions.

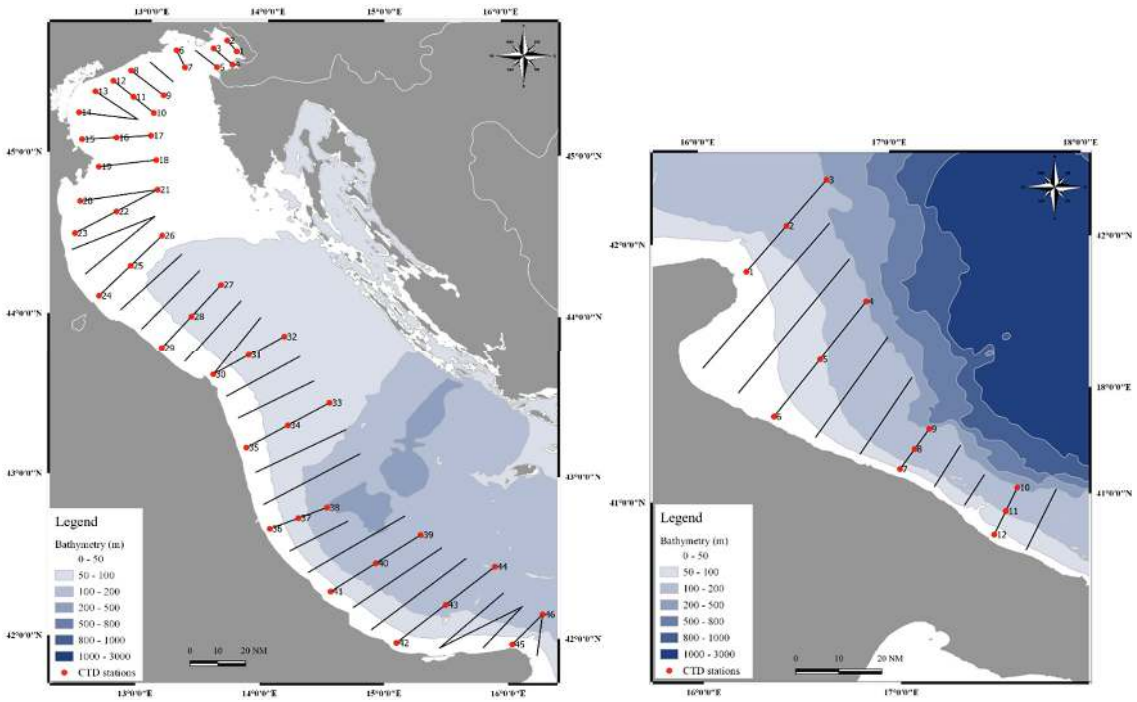


Figure 2.14.3 Acoustic survey route plan in western part of GSA 17 (left) and western GSA 18 (right) with grid of planned CTD stations in 2020.

g) Biomass estimations of target species

Anchovy and sardine biomass and related CV in 2020 in western GSA 17 are shown in Table 2.14.2.

Table 2.14.2 Anchovy and sardine biomass and related CV as estimated in MEDIAS 2020.

Year	Anchovy	CV	Sardine	CV	Sampled Area
2020	239,630 t	10%	94,950 t	13%	10,636 nmi^2

Historical trends for anchovy and sardine biomass density indices in GSA 17 are shown in Figure 2.14.4, while length-structured biomass estimates and age-length keys are shown in figures 2.14.5 and 2.14.6. Age-structured biomass estimates of target species are shown in Figure 2.14.7.

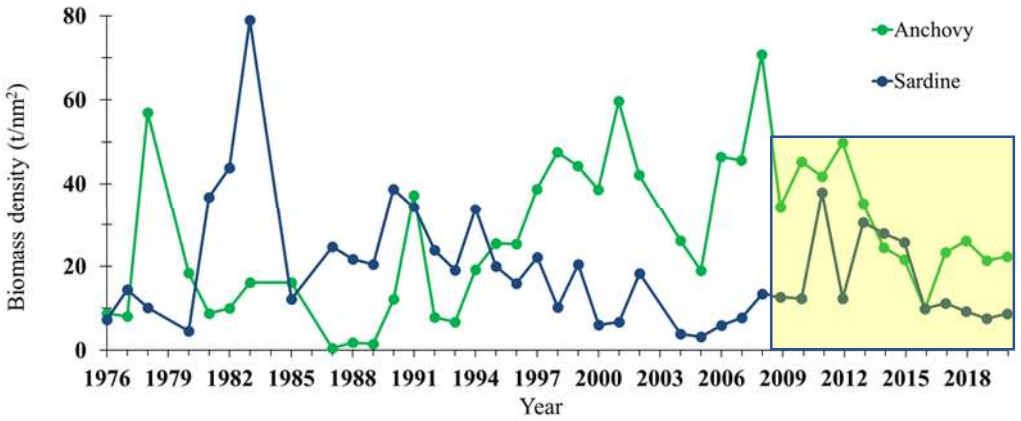


Figure 2.14.4 Historical trends in North-Western Adriatic Sea 1976-2020 in summer-early autumn. MEDIAS estimates are indicated in yellow area.

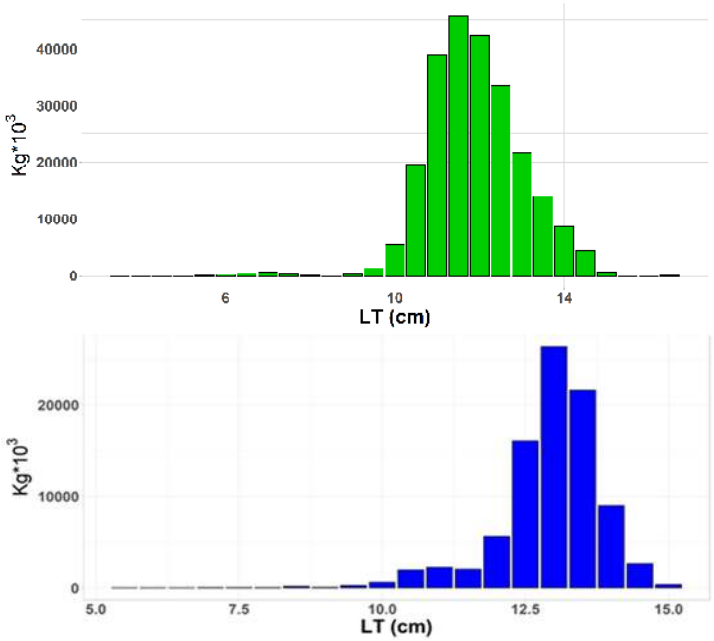


Figure 2.14.5 Anchovy (above) and sardine (bellow) biomass at length estimates in West GSA 17 in MEDIAS 2020.

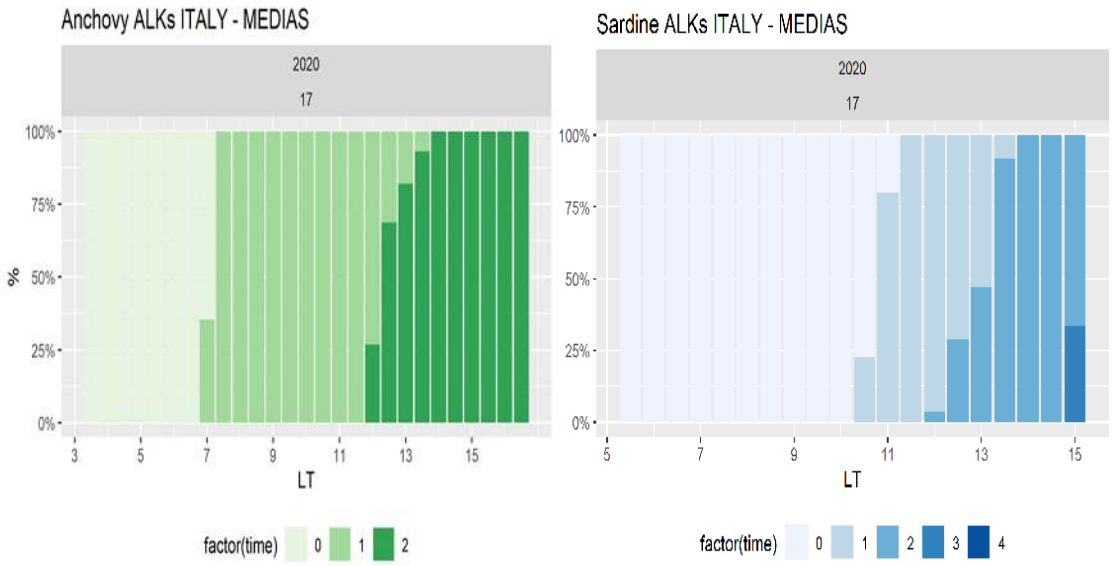


Figure 2.14.6 Anchovy and sardine ALK in 2020 in western GSA 17 (MEDIAS 2020).

Figure 12.14.7 Anchovy and sardine biomass at age in western GSA 17 in MEDIAS 2020.

h) Abundance indices of target species

Spatial distribution of anchovy and sardine in western part of GSA 17 and GSA 18 relative to MEDIAS 2020, are shown in figure 2.14.8. Estimated abundances at length and abundances at age are shown in figures 2.14.9 and 2.14.10.

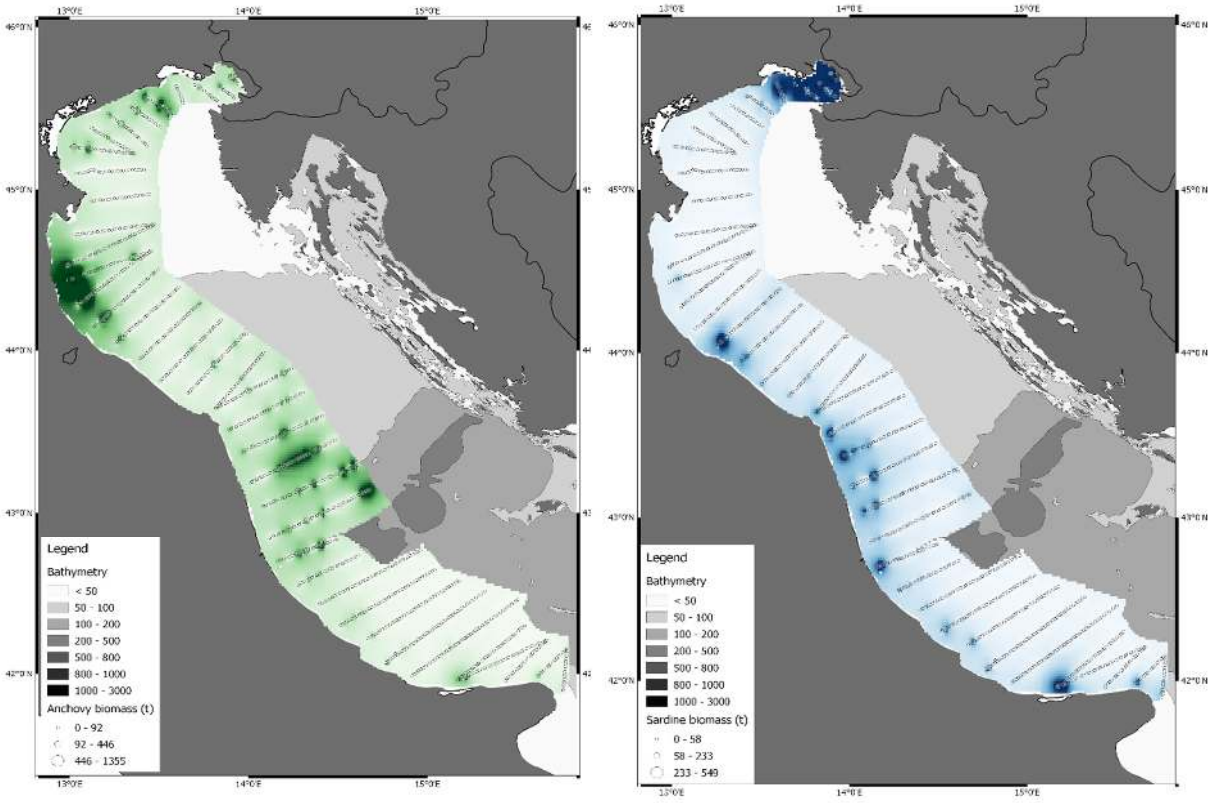


Figure 2.14.8. Anchovy (left) and sardine (right) spatial distribution in western GSA 17 as estimated in MEDIAS 2020.

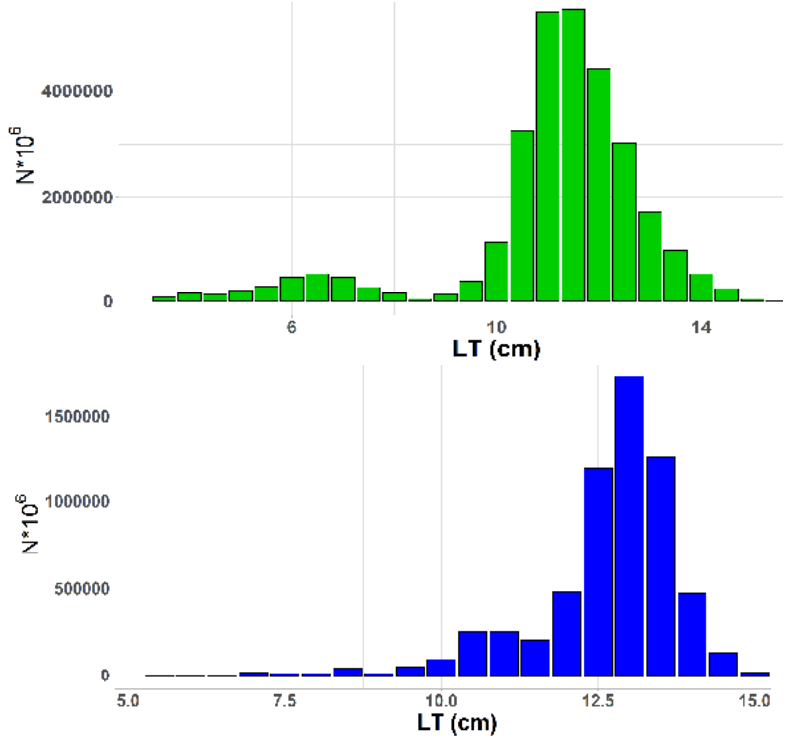


Figure 2.14.9 Anchovy (above) and sardine (bellow) number per length class in western GSA 17 in MEDIAS 2020.

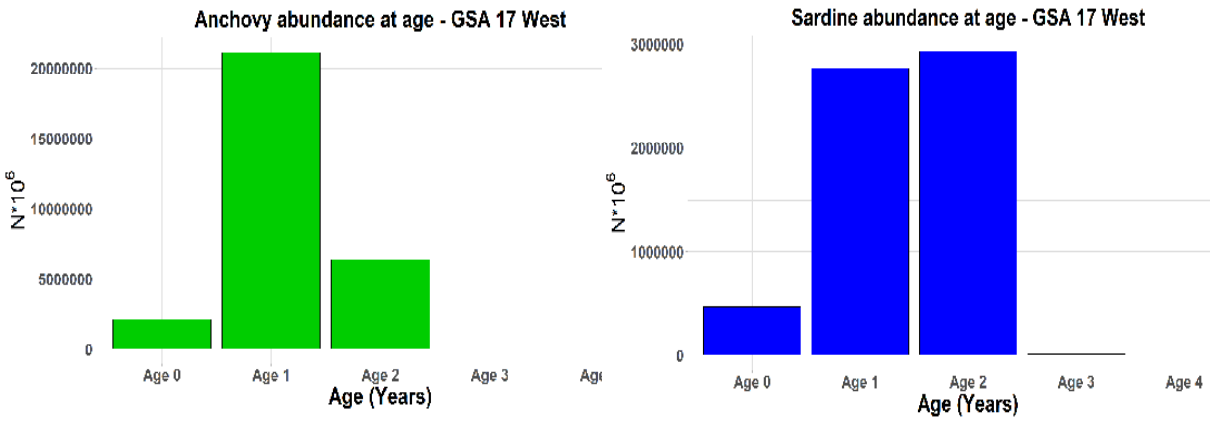


Figure 2.14.10 Anchovy and sardine number at age in western GSA 17 in 2010.

2.15 Acoustic survey in GSA 20 (Eastern Ionian Sea, GRC) - (A. Machias, K. Tsagarakis, Z. Kapelonis, M.M. Pyrounaki, S. Tsoukali, S. Somarakis, E. Schismenou, K. Markakis & M. Giannoulaki, HCMR)

a) General information on the survey

The survey took place in October 2019, and covered the eastern Ionian Sea (3069 nm2) with the fishery Research Vessel PHILIA (26.10 m length, 2× 340 HP).

b) Type of echosounders and frequencies in use

The split beam echo sounder used is SIMRAD EK80, with the 38, 120, 200 and 333 kHz frequencies. There is no threshold limit applied in the raw data and the threshold for processing for the assessment (38 KHz) is –70 dB. The pulse duration is 1024 ms. The surveying acoustic vessel speed is 8 knots. The Echoview software was used to visualize and analyze acoustic data.

c) Calibration results

Table 2.15.1 Calibration settings used for the MEDIAS of eastern Ionian Sea (GSA 20) in 2019.

	38 kHZ (ES38-7)	**120 kHz (ES120-7c)**	**200 kHz (ES200-7c)**	**333 kHz (ES333-7c)**
Target	**Copper (Cu) 60 mm**	**Copper (Cu) 23 mm**	**Copper (Cu) 13.7 mm**	**Tungsten (Wc-Co) 22 mm**
Beam Angle	7 deg	7 deg	7 deg	7 deg
Gain (adj. ,final)	(0.8, 26.3) dB	(0.28, 27.28) dB	(0.34, 27.34) dB	(-0.03, 27.31) dB
Sa correction	-0.1 dB	-0.13 dB	-0.24 dB	-0.04 dB
Offset Alongship	-0.04 deg	-0.1 deg	-0.32 deg	0.01 deg

Offset Athwart ship	-0.06 deg	0.02 deg	0.25 deg	-0.02 deg
Beamwidth along ship	8.31 deg	7.00 deg	6.52 deg	5.61 deg
Beamwidth Athwart ship	8.31 deg	7.00 deg	6.59 deg	6.05 deg
Depth	9 m	9 m	8 m	9 m
RMS TS error	0.06 dB	0.14 dB	0.23 dB	0.40 B

d) Survey design

The survey design is made of 27 parallel transects perpendicular to the coastline and 10 nm apart and 21 zigzag transects inside gulfs, from the 10m isobath to 200m isobaths (reaching the 900m isobath in certain areas like the Corinthiakos gulf) (Fig. 2.11.1). In 2019 total nautical miles effectively used for acoustic analysis were 493.

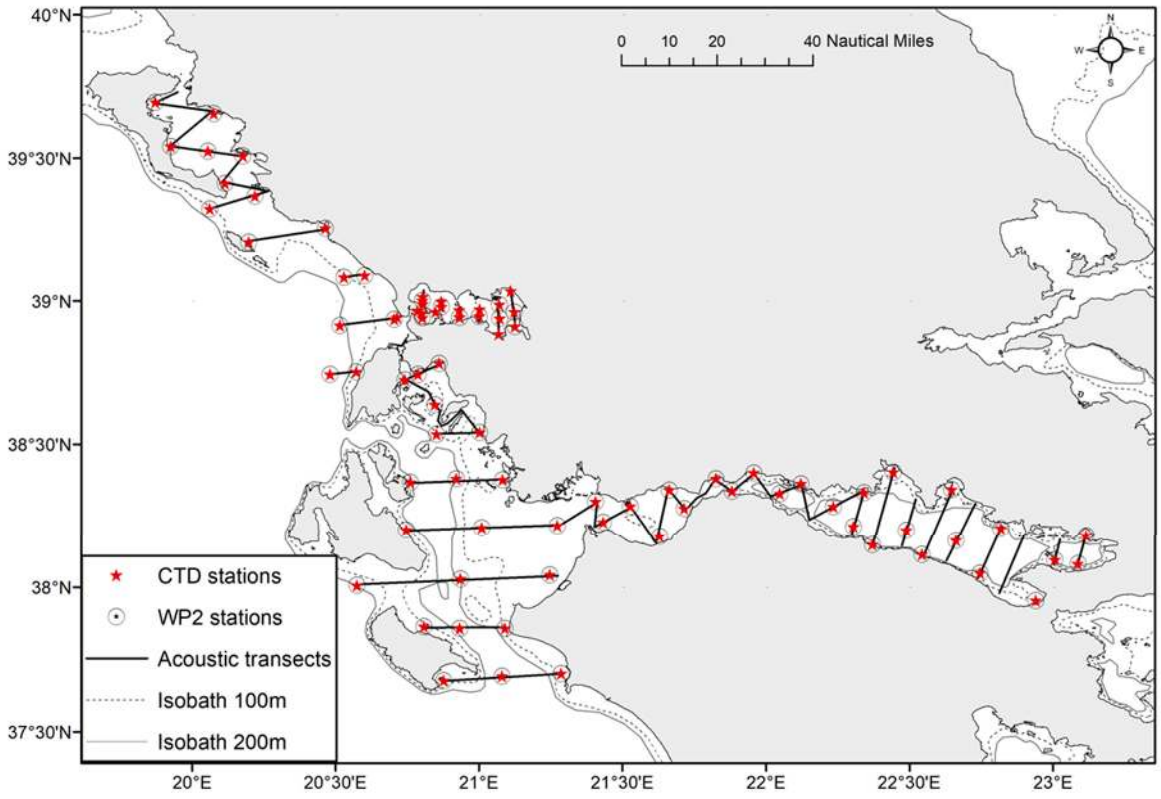


Figure 2.15.1 Acoustic transects sampled in the MEDIAS of the Hellenic part of eastern Ionian Sea (GSA 20) in October 2019. The position of CTD stations and WP2 stations sampled are also shown.

e) Fish sampling

Echotraces are identified with pelagic hauls. Eleven (11) pelagic hauls were carried out in GSA20 to be used for the scrutinizing of the echograms (Fig. 2.15.2). Acoustic recording was conducted during daytime and

trawl hauls during daytime/ night time. The pelagic net used has headline length of 28m, a sideline dimension of 55m and codend mesh size of 8mm.

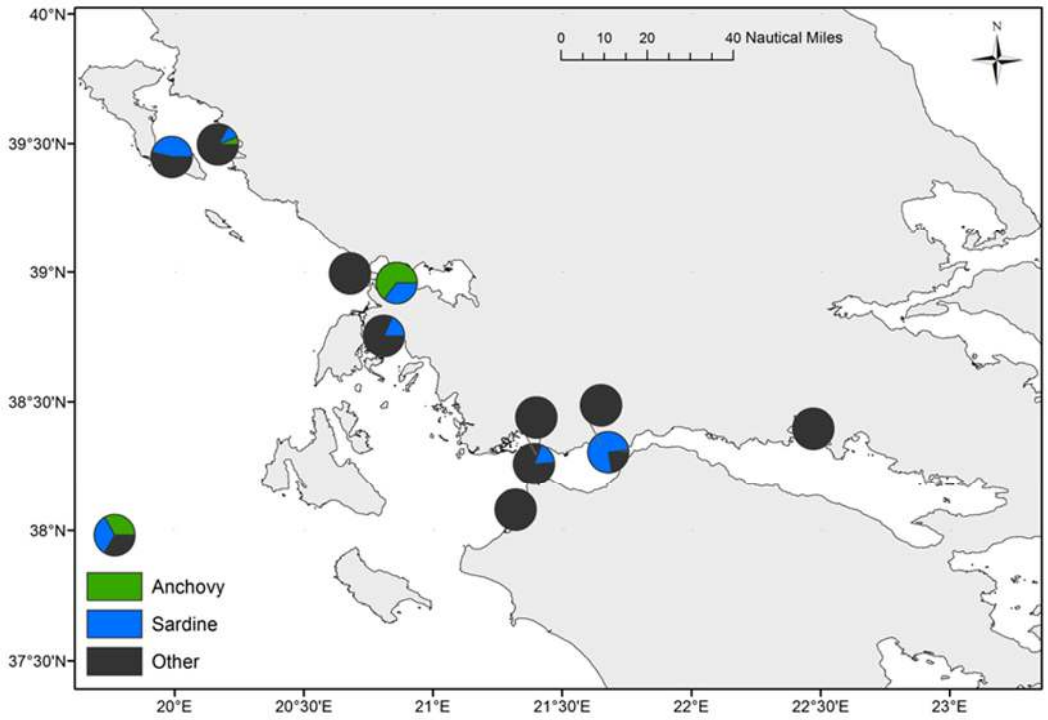


Figure 2.15.2 The catch compositions of the hauls (species kg/haul) weighted per hauling hour in eastern Ionian Sea (GSA 20) during October 2019.

f) Oceanographic parameters

Eighty-four (84) hydrological stations have been conducted using a SBE 19plus CTD, which measures conductivity, temperature, pressure, fluorescence, PAR (Photosynthetically active radiation), oxygen and turbidity. Zooplankton was sampled through WP2 vertical nets (Fig. 2.15.1).

g) Biomass estimations of target species

The anchovy and sardine biomasses were estimated to be respectively 20066 t and 6938 t in 2019. The CVs of geostatistical simulations were 8% and 19% respectively for anchovy and sardine. Biomass per length class for the two species is shown in figure 2.15.3. Biomass per age class was estimated for anchovy and sardine using otoliths reading and age-length key was assessed (Fig. 2.15.4). Subsequently, biomass per age class is shown in figure 2.15.5.

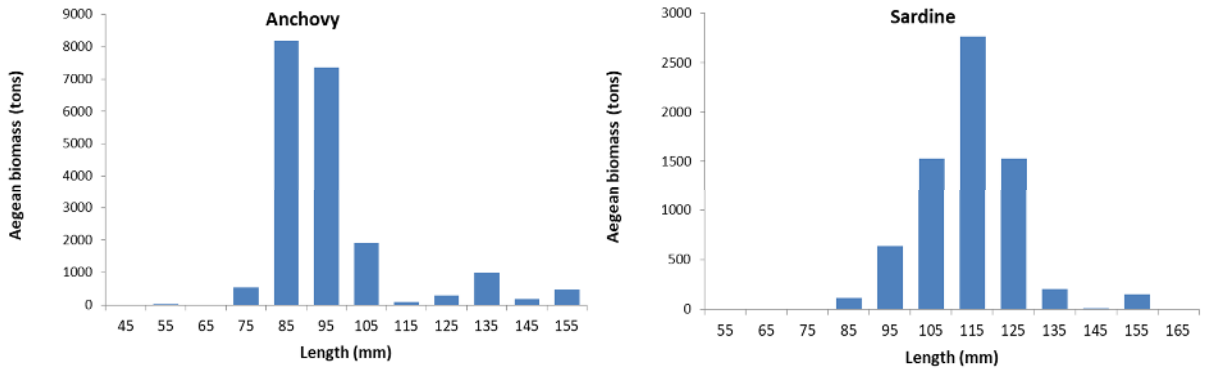


Figure 2.15.3 The anchovy and sardine biomasses (in tons) per length class in eastern Ionian Sea (GSA 20) during October 2019.

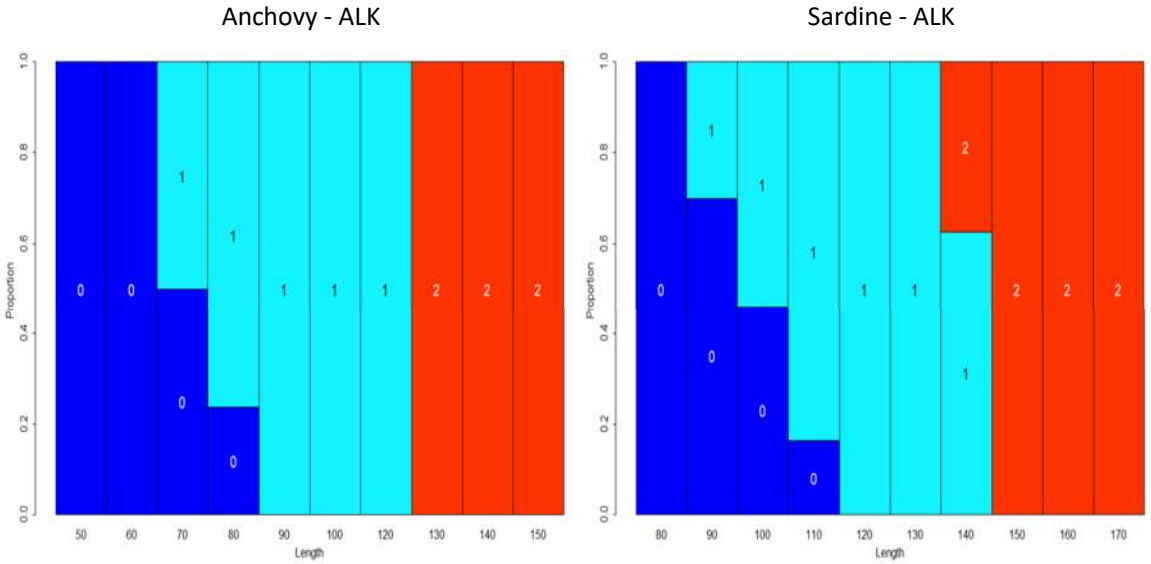


Figure 2.15.4 Age-length key assessed for anchovy and sardine.

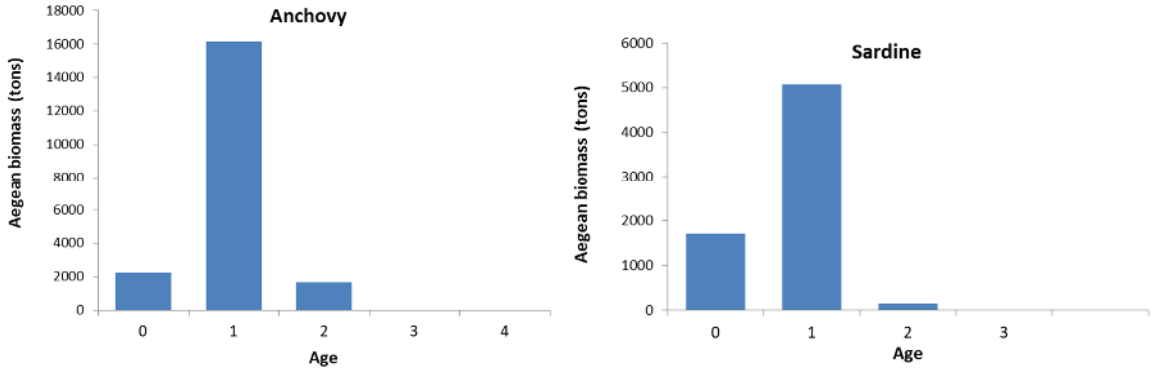


Figure 2.15.5 Anchovy and sardine biomasses (in tons) per age class in eastern Ionian Sea (GSA 20) during October 2019.

h) Abundance indices of target species

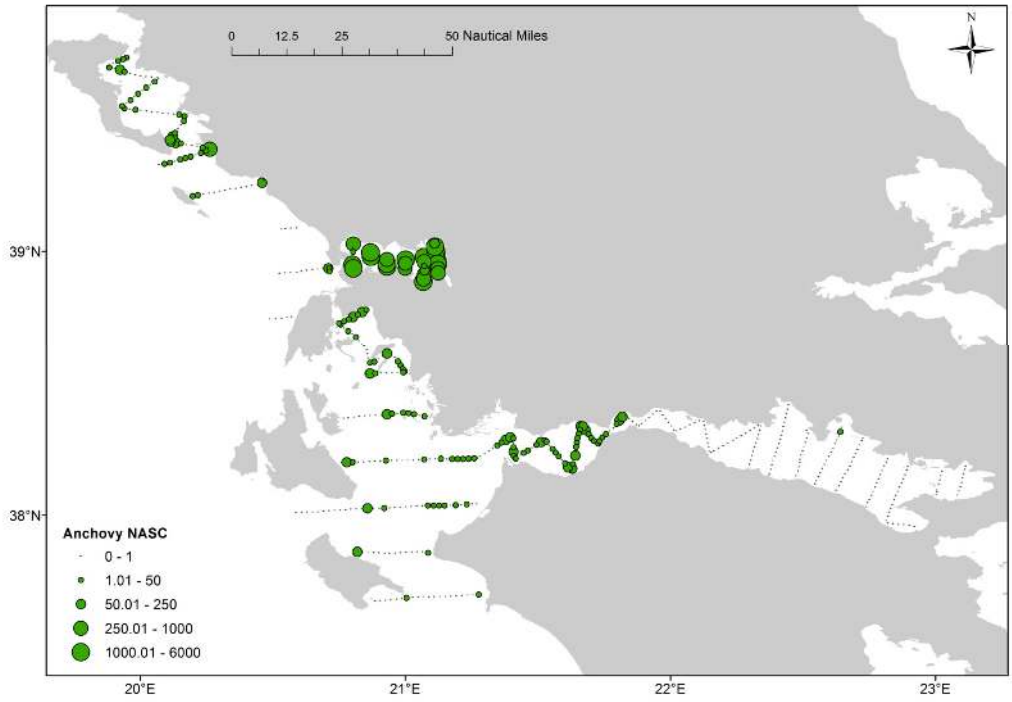


Figure 2.15.6 The distribution of the anchovy NASC (m2/nm2) per EDSU in eastern Ionian Sea (GSA 20) during October 2019.

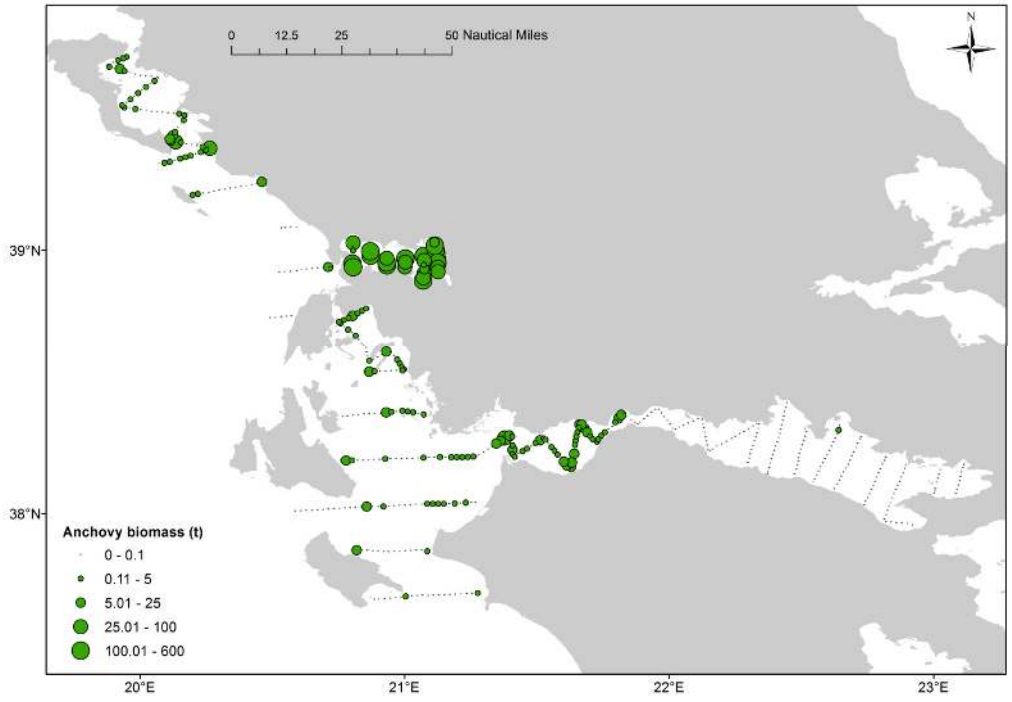


Figure 2.15.7 The distribution of the anchovy biomass (t) per EDSU in eastern Ionian Sea (GSA 20) during October 2019.

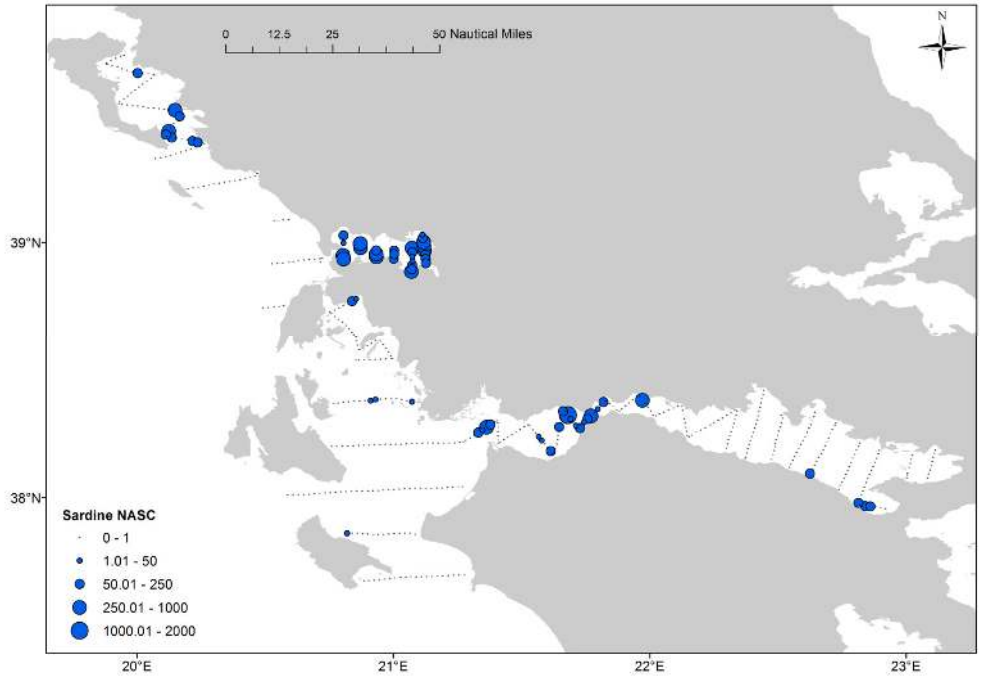


Figure 2.15.8 The distribution of the sardine NASC (m2/nm2) per EDSU in eastern Ionian Sea (GSA 20) during October 2019.

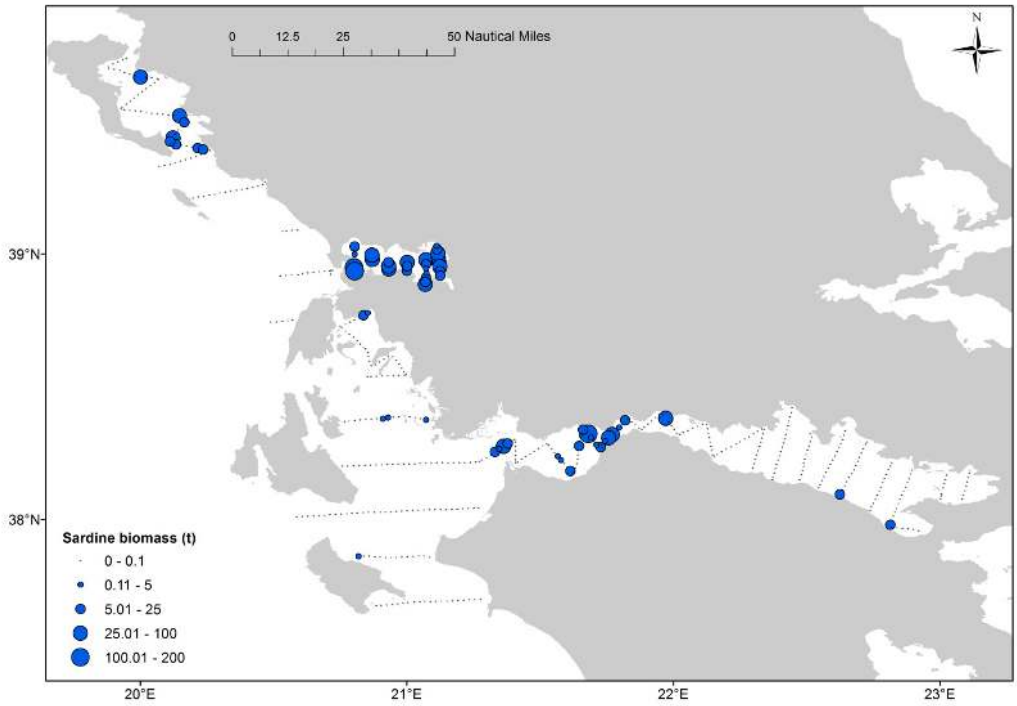


Figure 2.15.9 The distribution of the sardine biomass (t) per EDSU in eastern Ionian Sea (GSA 20) during October 2019.

2.16 Acoustic survey in GSA 22 during 2019 (northern Aegean Sea, GRC) - (A. Machias, K. Tsagarakis, Z. Kapelonis, M.M. Pyrounaki, S. Tsoukali, S. Somarakis, E. Schismenou, K. Markakis & M. Giannoulaki, HCMR)

a) General information on the survey

The survey took place in June - July, 2019, and covered the Northern Aegean Sea (9066 nm2) with the fishery Research Vessel PHILIA (26.10 m length, 2× 340 HP).

b) Type of echosounders and frequencies in use

The split beam echo sounder used is SIMRAD EK80, with the 38, 120, 200 and 333 kHz frequencies. There is no threshold limit applied in the raw data. The threshold for processing for the assessment (38 KHz) is –70 dB. The pulse duration is 1.024 ms. The surveying acoustic vessel speed is 8 knots. The Echoview software was used to visualize and analyze acoustic data.

c) Calibration results

Table 2.16.1 Calibration settings used for the MEDIAS of northern Aegean Sea (GSA 22) in 2019.

	38 kHZ (ES38-7)	**120 kHz (ES120-7c)**	**200 kHz (ES200-7c)**	**333 kHz (ES333-7c)**
Target	**Copper (Cu) 60 mm**	**Copper (Cu) 23 mm**	**Copper (Cu) 13.7 mm**	**Tungsten (Wc-Co) 22 mm**
Beam Angle	7 deg	7 deg	7 deg	7 deg
Gain (adj. ,final)	(0.8, 26.3) dB	(0.28, 27.28) dB	(0.34, 27.34) dB	(-0.03, 27.31) dB
Sa correction	-0.1 dB	-0.13 dB	-0.24 dB	-0.04 dB
Offset Alongship	-0.04 deg	-0.1 deg	-0.32 deg	0.01 deg
Offset Athwart ship	-0.06 deg	0.02 deg	0.25 deg	-0.02 deg
Beamwidth along ship	8.31 deg	7.00 deg	6.52 deg	5.61 deg
Beamwidth Athwart ship	8.31 deg	7.00 deg	6.59 deg	6.05 deg
Depth	9 m	9 m	8 m	9 m
RMS TS error	0.06 dB	0.14 dB	0.23 dB	0.40 B

d) Survey design

The survey design is made of 39 parallel transects perpendicular to the coastline and 10 nm apart and 31 zigzag transects inside gulfs, from the 10m isobath to 200m isobaths (reaching the 1500m isobath in certain

areas like the Thracian Sea plateau) (Fig. 2.16.1). In 2019 total nautical miles effectively used for acoustic analysis were 1259.

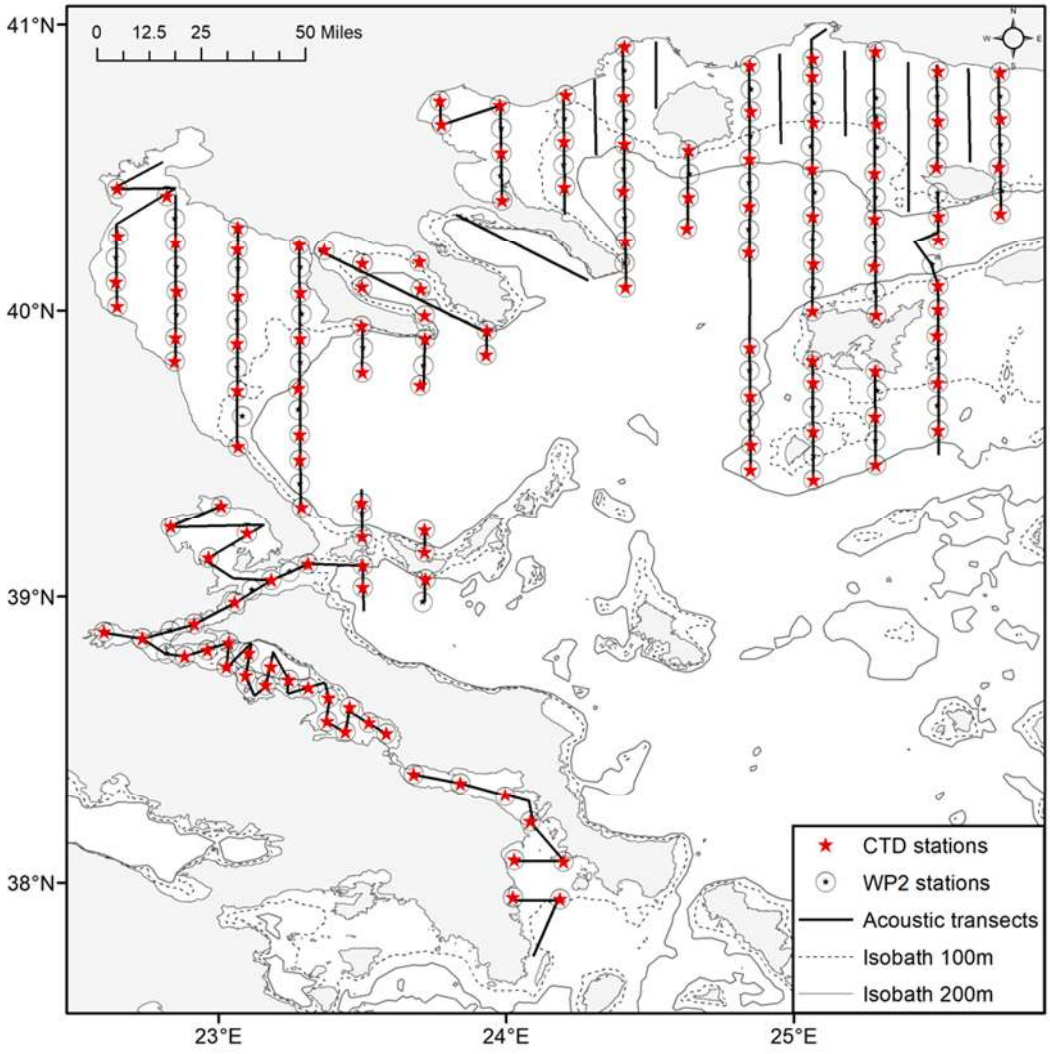


Figure 2.16.1 Acoustic transects sampled in the MEDIAS of the Hellenic part of northern Aegean Sea (GSA 22) in June-July 2019. The position of CTD stations and WP2 stations sampled are also shown.

e) Fish sampling

Echotraces are identified with pelagic hauls. Seventeen (17) pelagic hauls were carried out in GSA22 to be used for the scrutinizing of the echograms (Fig. 2.16.2). Acoustic recording was conducted during daytime and trawl hauls during daytime/ night time. The pelagic net used has headline length of 28m, a sideline dimension of 55m and codend mesh size of 8mm.

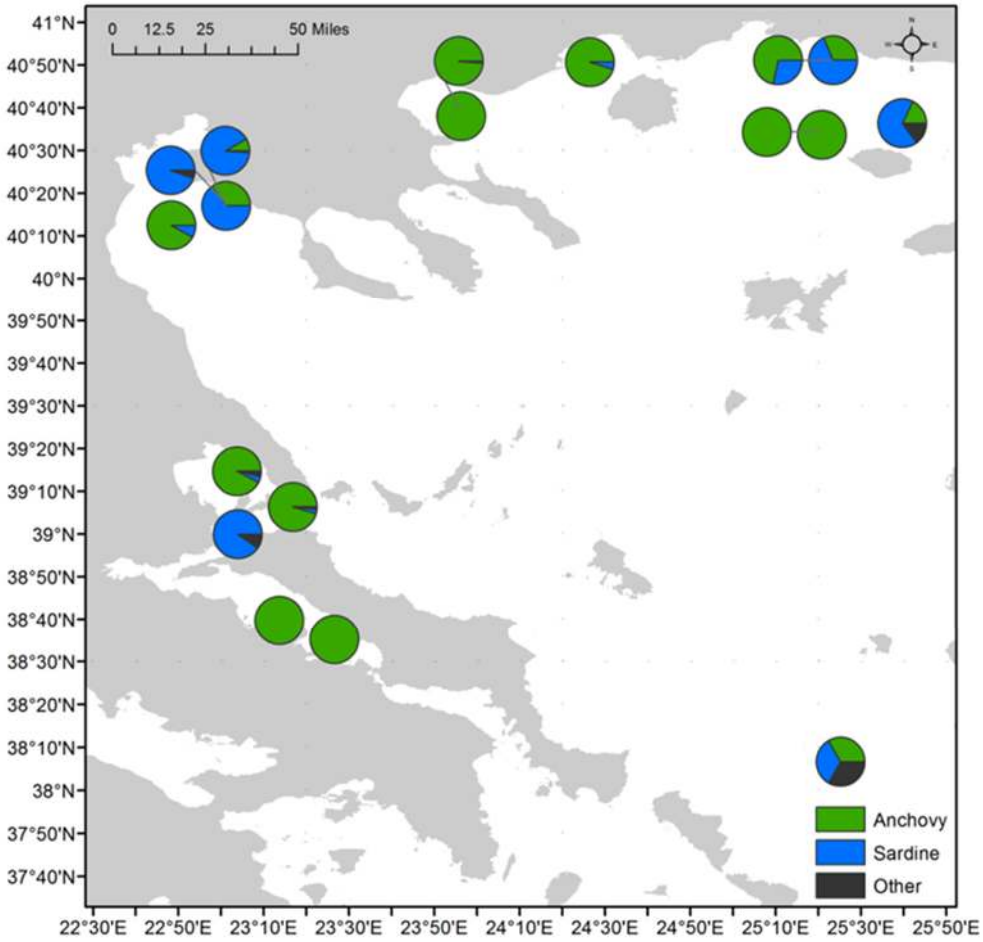


Figure 2.16.2 The catch compositions of the hauls (species kg/haul) weighted per hauling hour in northern Aegean Sea (GSA 22) during June-July 2019.

f) Oceanographic parameters

136 hydrological stations have been conducted using a SBE 19plus CTD, which measures conductivity, temperature, pressure, fluorescence, PAR (Photosynthetically active radiation), oxygen and turbidity. Auxilliary information on zooplankton was sampled through WP2 vertical nets in 205 stations (Fig. 2.16.1).

g) Biomass estimations of target species

The anchovy and sardine biomasses were estimated to be respectively 20150 t and 30235 t in 2019. The CVs of geostatistical simulations were 9% and 16% respectively for anchovy and sardine. Biomass per length class for the two species is shown in figure 2.16.3. Biomass per age class was estimated for anchovy and sardine using otoliths reading and assessing age-length key (Fig. 2.16.4). Subsequently, biomass estimates per age class are shown in figure 2.16.5.

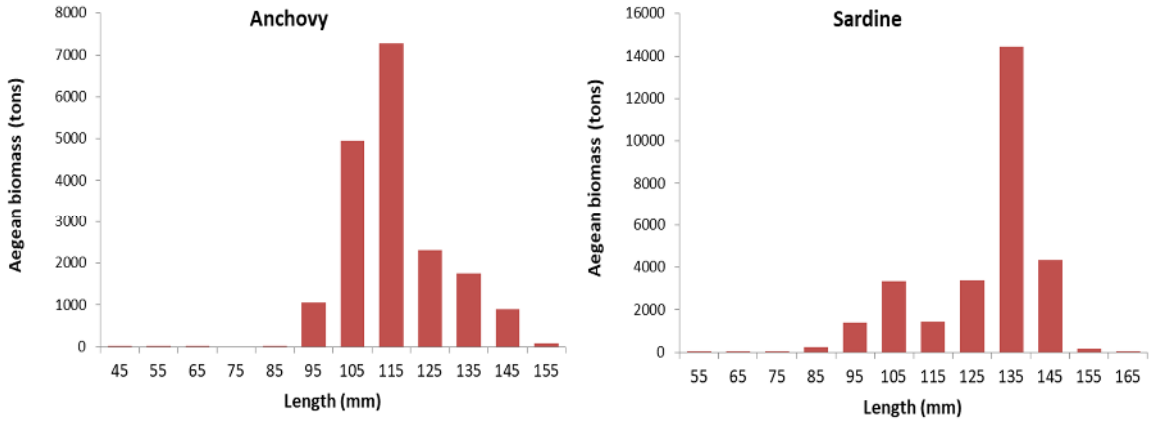


Figure 2.16.3 The anchovy and sardine biomasses (in tons) per length class in northern Aegean Sea (GSA 22) during June-July 2019.

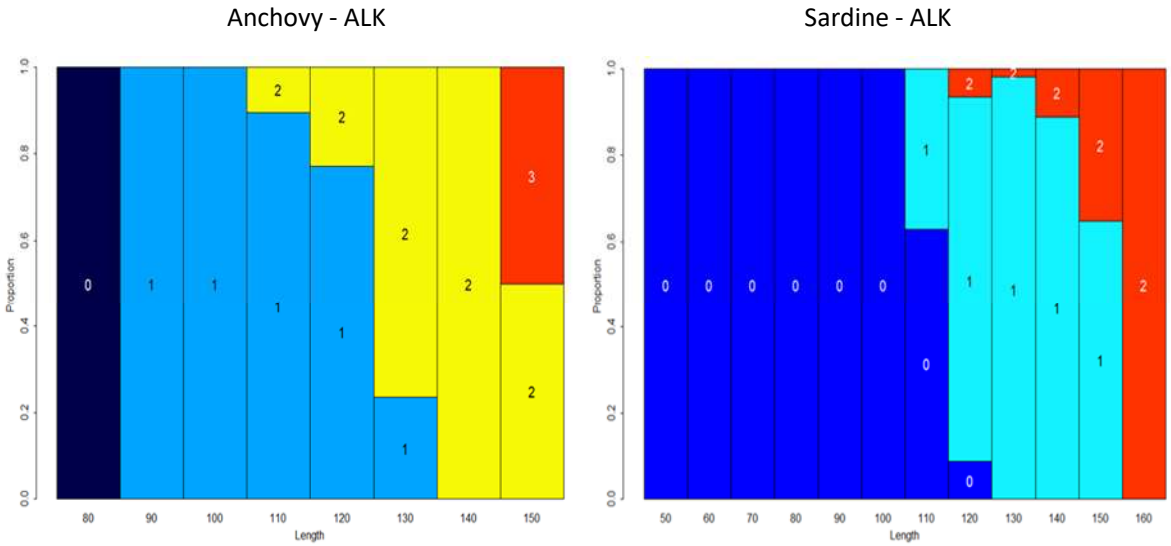


Figure 2.16.4 Age-length key assessed for anchovy (left) and sardine (right).

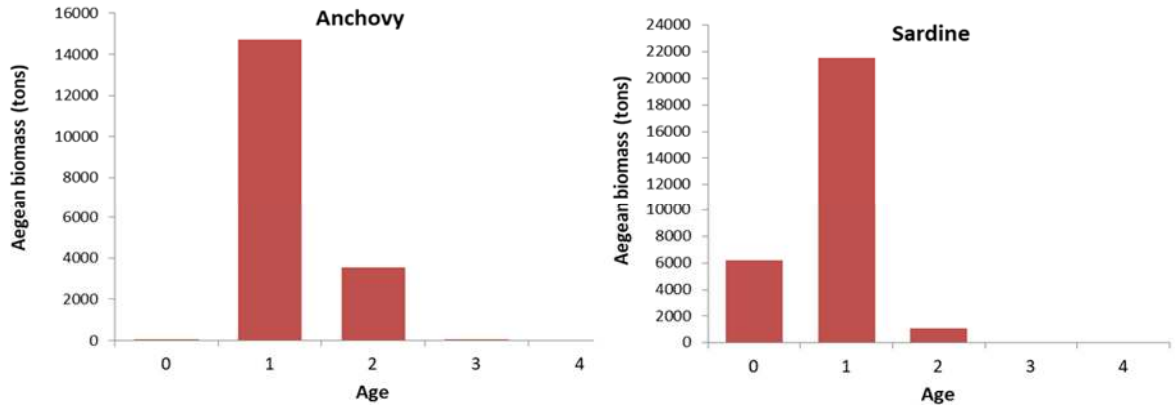


Figure 2.16.5 Anchovy and sardine biomasses (in tons) per age class in northern Aegean Sea (GSA 22) during June-July 2019.

h) Abundance indices of target species

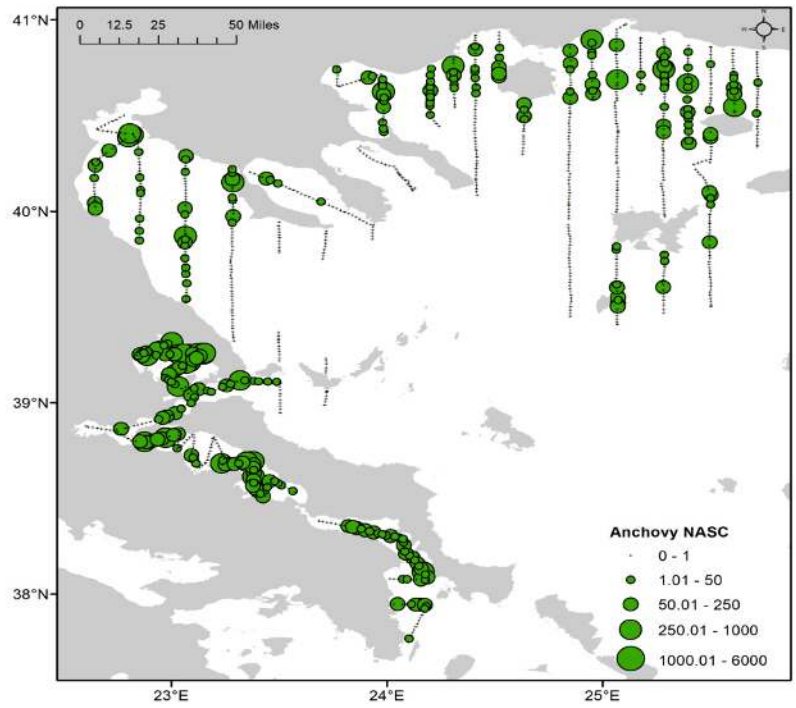


Figure 2.16.6 The distribution of the anchovy NASC (m2/nm2) per EDSU in northern Aegean Sea (GSA 22) during June-July 2019.

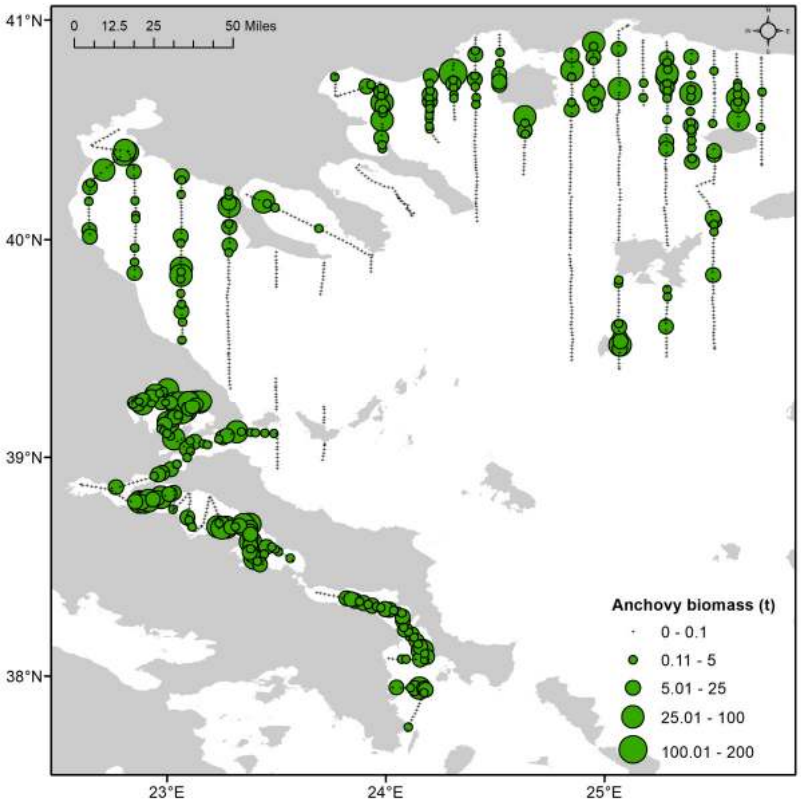


Figure 2.16.7 The distribution of the anchovy biomass (t) per EDSU in northern Aegean Sea (GSA 22) during June-July 2019.

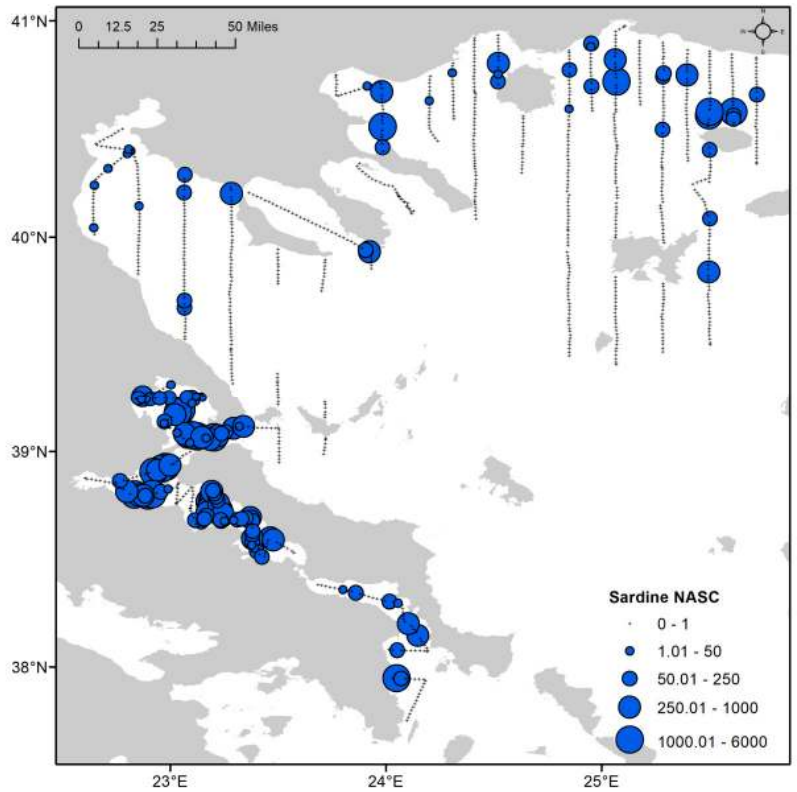


Figure 2.16.8. The distribution of the sardine NASC (m2/nm2) per EDSU in northern Aegean Sea (GSA 22) during June-July 2019.

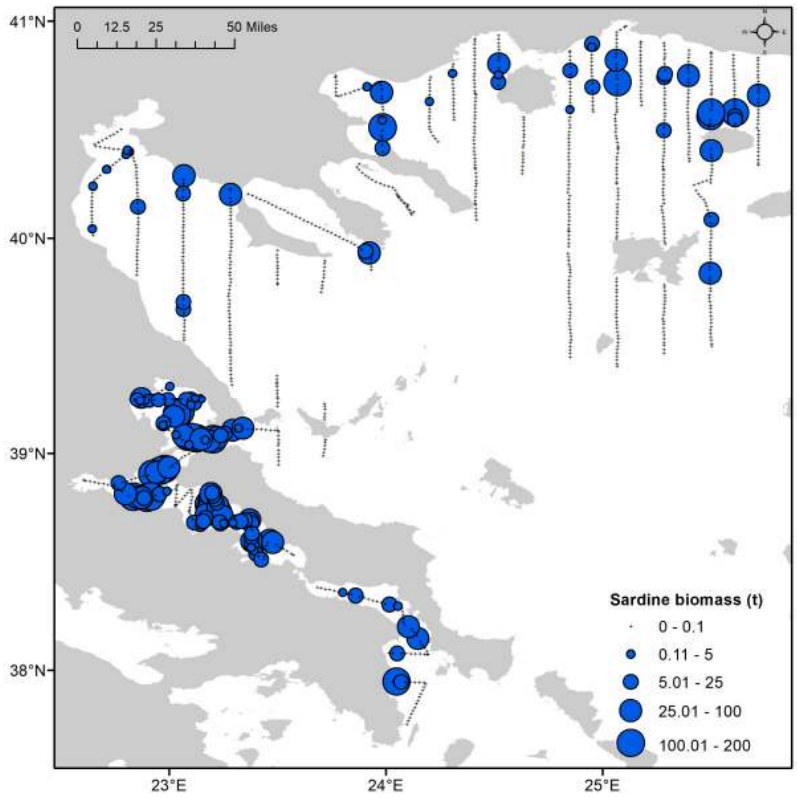


Figure 2.16.9 The distribution of the sardine biomass (t) per EDSU in northern Aegean Sea (GSA 22) during June-July 2019.

2.17 Acoustic survey in GSA 22 during 2020 (northern Aegean Sea, GRC) - (A. Machias, K. Tsagarakis, Z. Kapelonis, M.M. Pyrounaki, S. Tsoukali, S. Somarakis, E. Schismenou, K. Markakis & M. Giannoulaki, HCMR)

a) General information on the survey

The survey took place in June - July, 2020, and covered the Northern Aegean Sea (8502 nm^2) with the fishery Research Vessel PHILIA (26.10 m length, 2× 340 HP).

b) Type of echosounders and frequencies in use

The split beam echo sounder used is SIMRAD EK80, with the 38 kHz frequency. The rest of the transducers (120, 200 and 333 kHz) have not been used, because they exhibited high acoustic measurement and sector impedance value offsets during the calibration. There is no threshold limit applied in the raw data. The threshold for processing for the assessment (38 KHz) is –70 dB. The pulse duration is 1.024 ms. The surveying acoustic vessel speed is 8 knots. The Echoview software was used to visualize and analyze acoustic data.

c) Calibration results

Table 2.17.1 Calibration settings used for the MEDIAS of northern Aegean Sea (GSA 22) in 2020.

	38 kHZ **(ES38-7)**
Target	**Copper (Cu) 60 mm**
Beam Angle	7 deg
Gain (adj. ,final)	(0.62, 26.12) dB
Sa correction	-0.04 dB
Offset Alongship	-0.05 deg
Offset Athwart ship	-0.03 deg
Beamwidth along ship	7.50 deg
Beamwidth Athwart ship	7.53 deg
Depth	9 m
RMS TS error	0.07 B

d) Survey design

The survey design is made of 38 parallel transects perpendicular to the coastline and 10 nm apart and 21 zigzag transects inside gulfs, from the 10m isobath to 200m isobaths (reaching the 1500m isobath in certain areas like the Thracian Sea plateau) (Fig. 2.17.1). In 2020 total nautical miles effectively used for acoustic analysis were 1127.

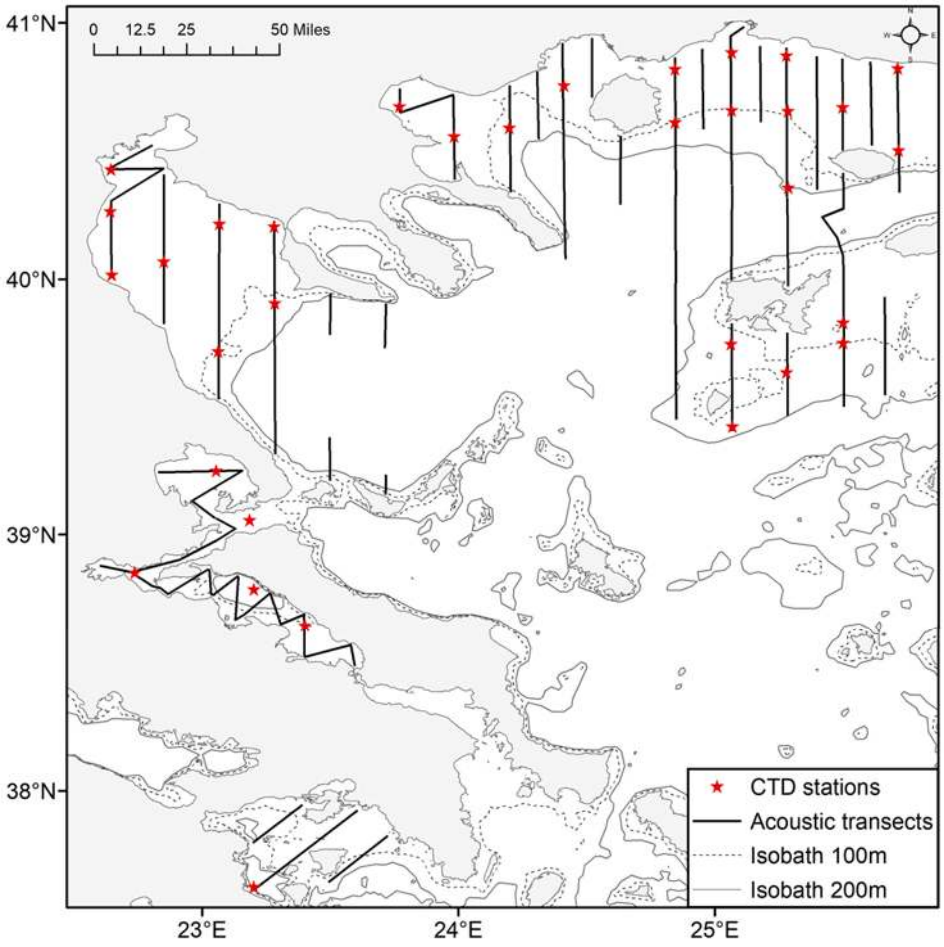


Figure 2.17.1. Acoustic transects sampled in the MEDIAS of the Hellenic part of northern Aegean Sea (GSA 22) in June-July 2020. The position of CTD stations sampled are also shown.

e) Fish sampling

Echotraces are identified with pelagic hauls. Fifteen (15) pelagic hauls were carried out in GSA22 to be used for the scrutinizing of the echograms (Fig. 2.17.2). Acoustic recording was conducted during daytime and trawl hauls during daytime/ night time. The pelagic net used has headline length of 28m, a sideline dimension of 55m and cod-end mesh size of 8mm.

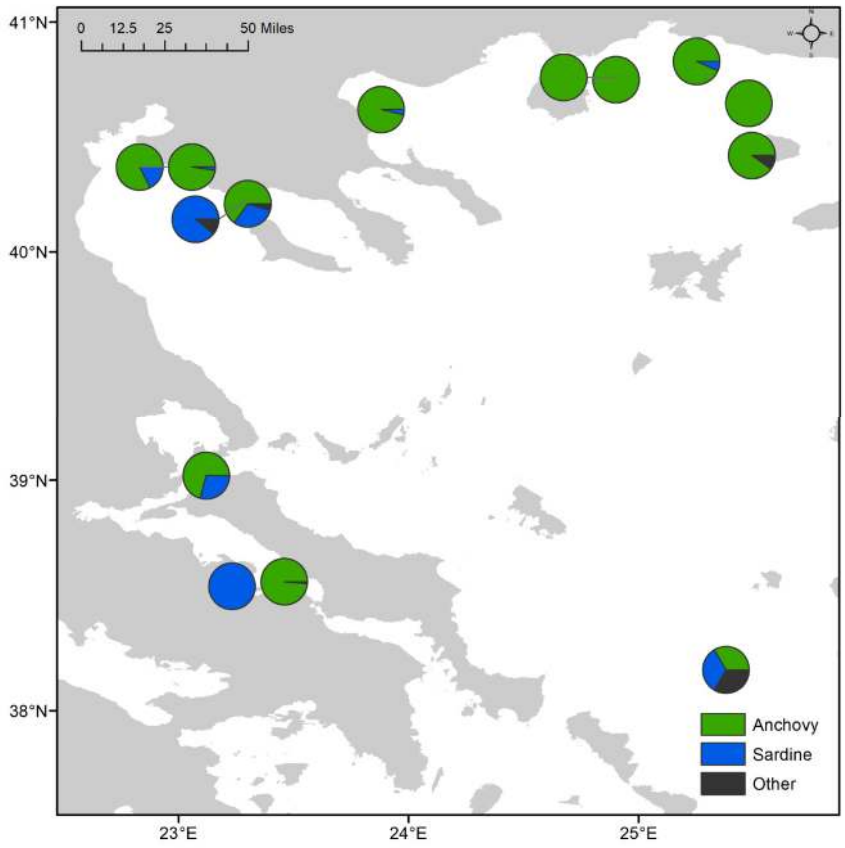


Figure 2.17.2. The catch compositions of the hauls (species kg/haul) weighted per hauling hour in northern Aegean Sea (GSA 22) during June-July 2020.

f) Oceanographic parameters

33 hydrological stations have been conducted using a SBE 19plus CTD, which measures conductivity, temperature, pressure, fluorescence, PAR (Photosynthetically active radiation), oxygen and turbidity (Fig.2.17.1).

g) Biomass estimations of target species

The anchovy and sardine biomasses were estimated to be respectively 20036 t and 34476 t in 2020. The CVs of geostatistical simulations were 8% and 16% respectively for anchovy and sardine. Biomass per length class for the two species is shown in figure 2.17.3. Biomass per age class was estimated for anchovy and sardine using otoliths reading and age-length key was assessed (Fig. 2.17.4). Subsequently, biomass per age class is shown in figure 2.17.5.

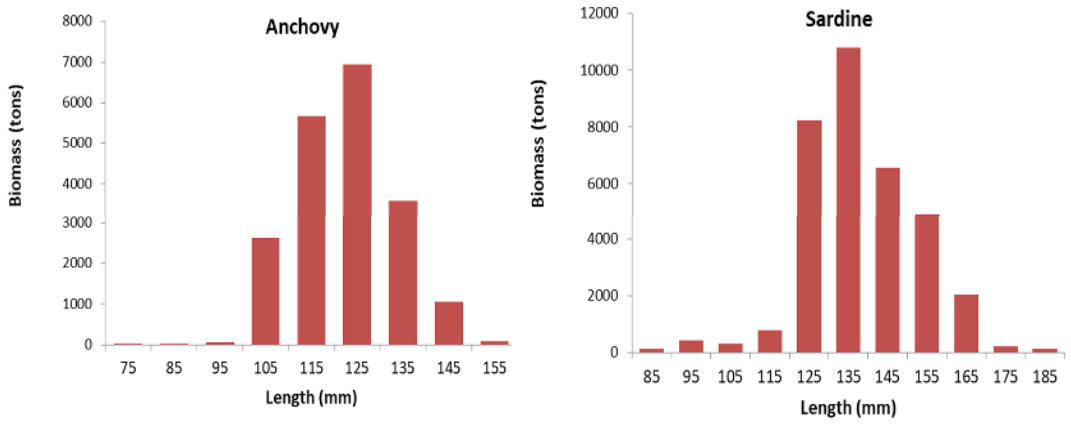


Figure 2.17.3 The anchovy and sardine biomasses (in tons) per length class in northern Aegean Sea (GSA 22) during June-July 2020.

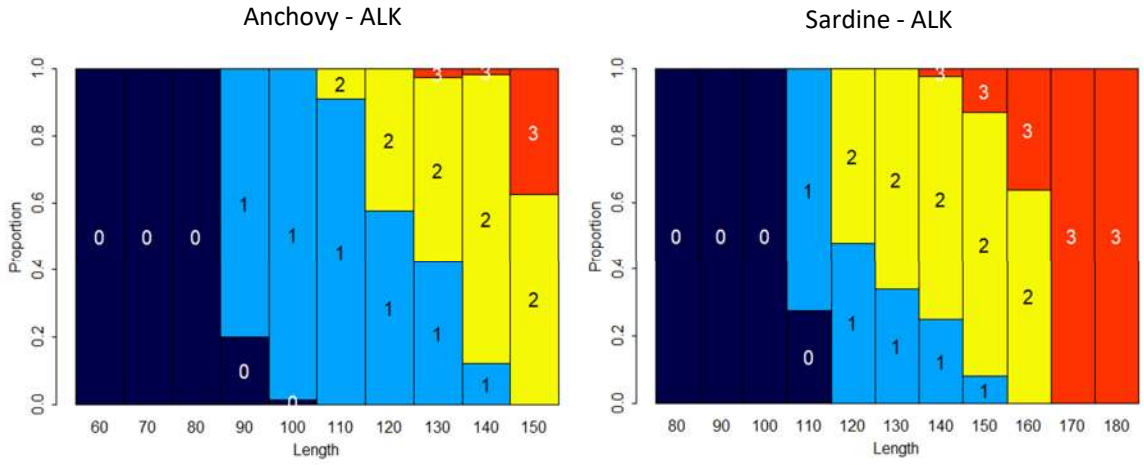


Figure 2.17.4 Age-length key assessed for anchovy (left) and sardine (right).

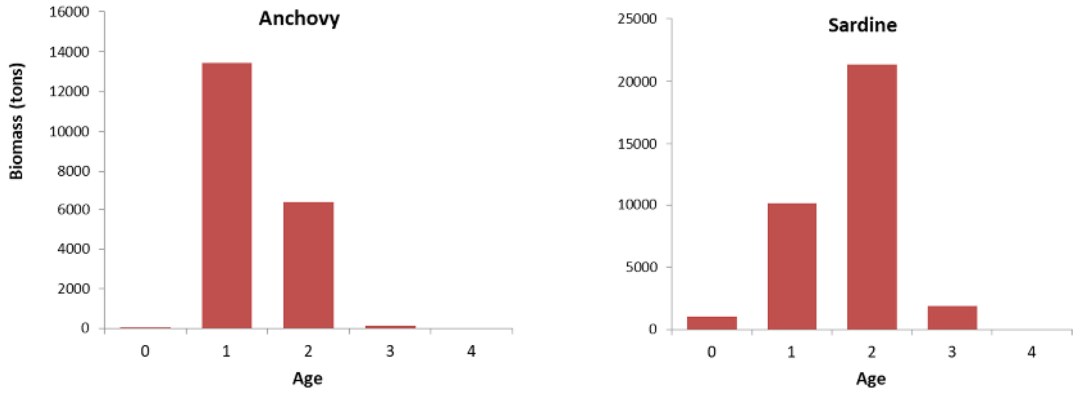


Figure 2.17.5 Anchovy and sardine biomasses (in tons) per age class in northern Aegean Sea (GSA 22) during June-July 2020.

h) Abundance indices of target species

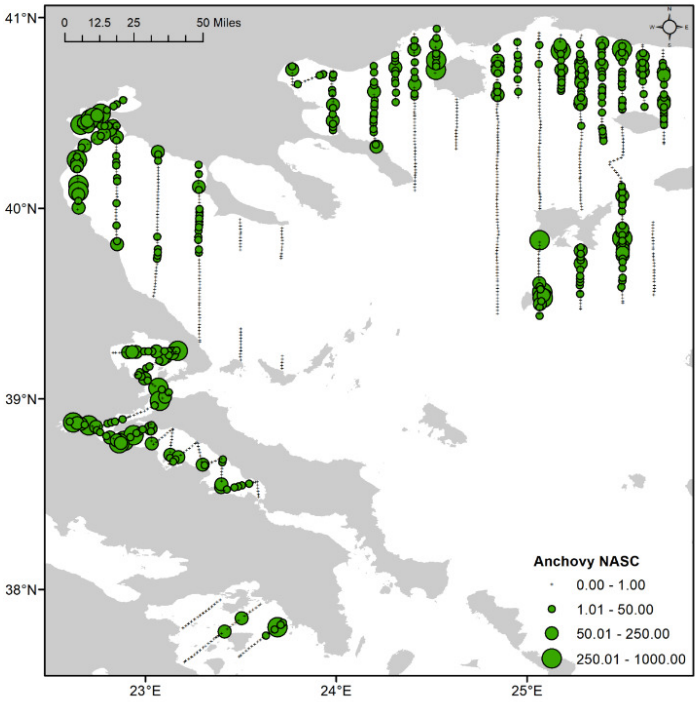


Figure 2.17.6 The distribution of the anchovy NASC (m2/nm2) per EDSU in northern Aegean Sea (GSA 22) during June-July 2020.

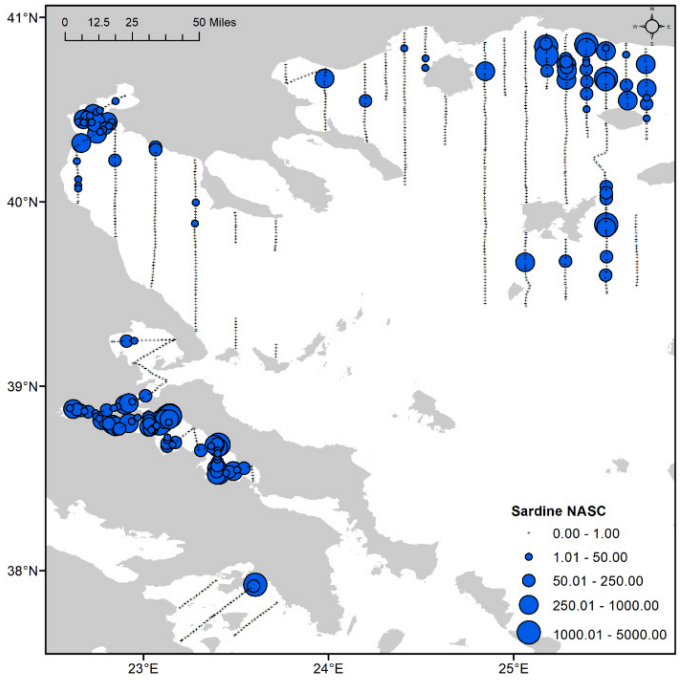


Figure 2.17.7 The distribution of the sardine NASC (m2/nm2) per EDSU in northern Aegean Sea (GSA 22) during June-July 2020.

3. Results of pelagic trawl surveys in the Black Sea (GSA 29) in 2019-2020

3.1 Results of the 2019-2020 surveys in the GSA 29 - Black Sea: Bulgarian survey (Raykov and Dimitrov)

Results of pelagic trawl surveys (2019 and 2020) in the Bulgarian waters of GSA 29 (Black Sea) were presented in the meeting. Detailed information on these surveys are available in the presentation uploaded in the MEDIAS web page http://www.medias-project.eu/medias/website/meetingrep/meet_pres_/2021-meeting-presentations/VRaykov-DDimitrov-MEDIAS-2021.pdf/.

3.2 Pelagic Surveys at the Romanian Black Sea Coast (GSA 29), in 2019 and 2020 (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 2019:

- period: 19 – 26 June and 05 - 12 November 2019;
- 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 100 – 2,500 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 20): 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.); common shrimp (*Cragon crangon L.*); other species.

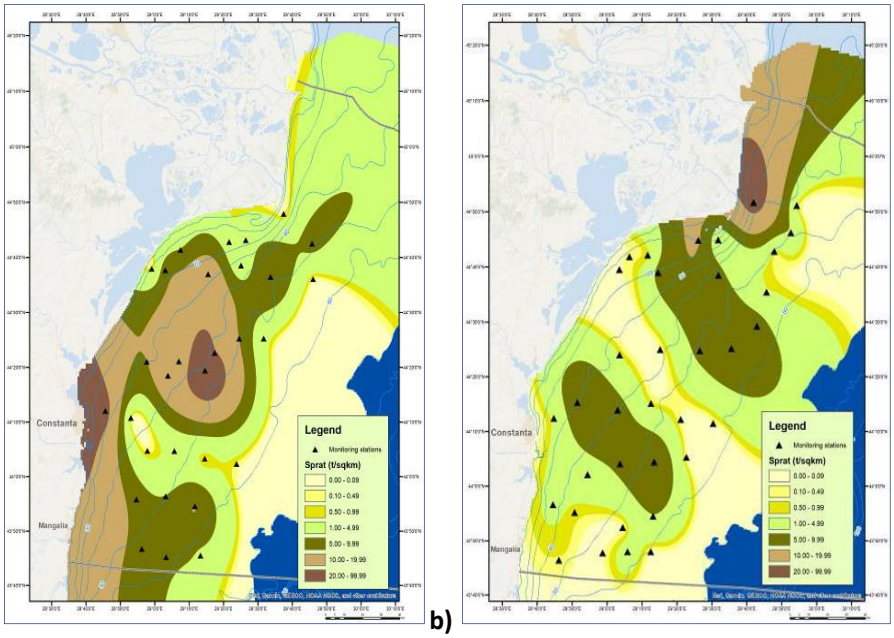
Estimated total biomass:

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

Spring - in the **30** sample trawlings made with the pelagic trawl, on an area of **15,670** Km², the average values of the catches were of about **7.687–9.386** t/Km². 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 **123,350.65 tons** (Fig. 3.2.1a).

Assessment of sprat agglomerations (tons), in June 2019

Depth range (m)	***0 – 30 m***	***30 – 50 m***	***50 - 70 m***	***Total***
Investigated area (Km²)	3,300	5,800	6,570	15,670
Variation of the catches (t/ Km²)	0.039-23.982	0.199-15.988	0.399-9.992	0.039-15.988
Average catch (t/ Km²)	7.687	9.386	3.283	6.785
Biomass of the fishing agglomerations (t)	18858.22	46301.75	24329.69	89489.67
Biomass extrapolated the Romanian shelf (t)				**123,350**



a) **b)**

Figure 3.2.1 The distribution of the sprat agglomerations in spring (a) and autumn period (b), pelagic trawl survey, in Romanian area

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

Spring survey 2019

Structure of biomass and abundance by length distribution (Fig. 3.2.2)

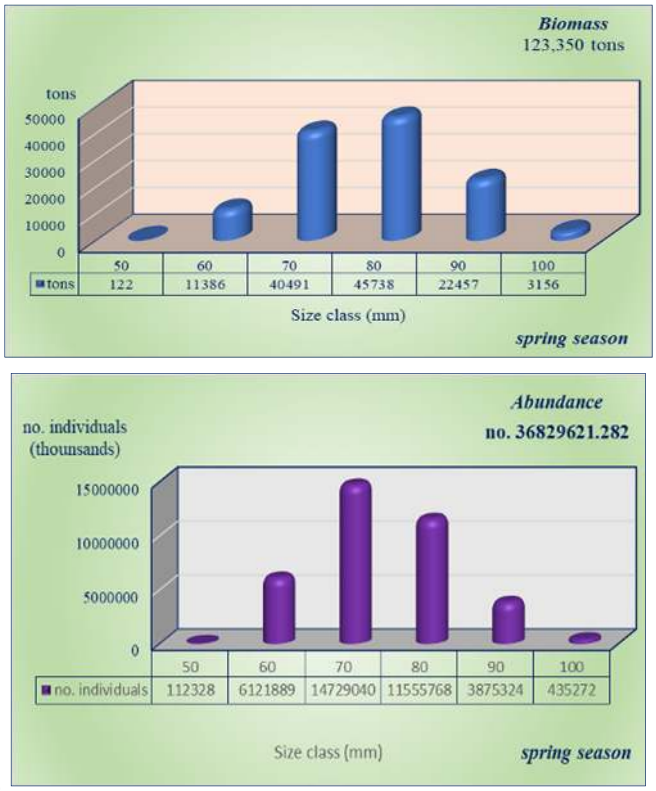


Figure 3.2.2 Structure by lengths of biomass (a) and abundance (b) of sprat during spring survey

Structure of biomass (a) and abundance (b) by age distribution (Fig. 3.2.3)

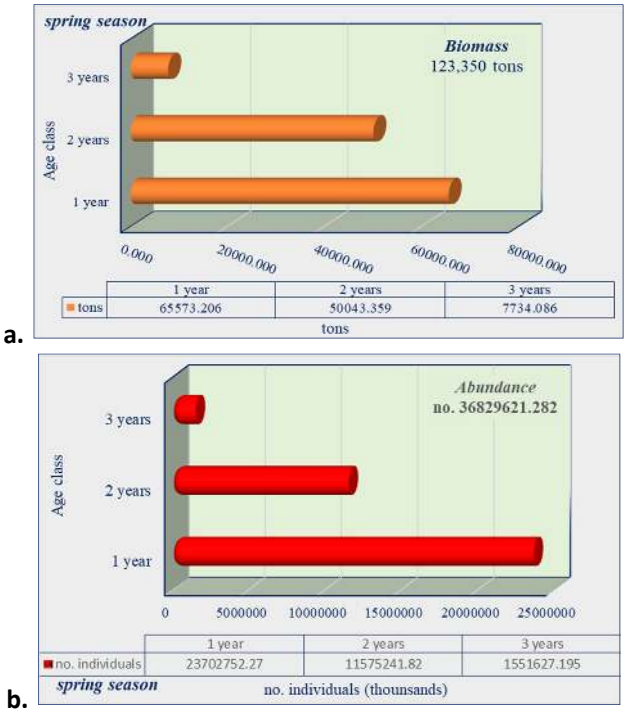


Figure 3.2.3 Structure by age of biomass (a) and abundance (b) of sprat sprat during spring survey.

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 55.0-110.0 mm / 1.085-8.163 g. The dominant classes are those of 65.0-90.0 mm / 1.95-4.98 g (Fig. 3.2.4a). The dominant females 60.26%, males (39.74%). The average body length was 79.916 mm and the average mass of 3.30 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 (64.42% of all specimens analyzed), followed by those of 2 years (31.37%) and 3 years (4.21%) (Fig. 3.2.4b).

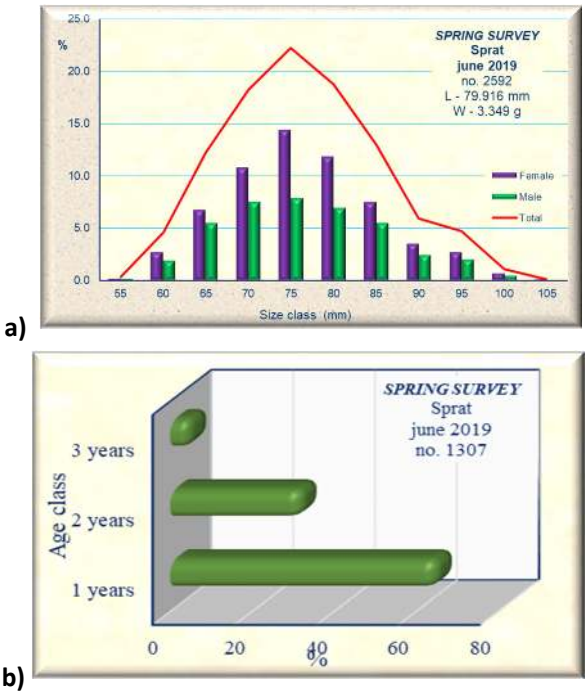


Figure 3.2.4 Structure by lengths (a) and age (b) of sprat during spring survey.

Autumn - in the **35** sample trawlings made with the pelagic trawl, on an area of **16,100** Km², the average values of the catches were of about 2.856-5.824 t/Km². The maximum value was recorded in the Sf. Gheorghe - Mangalia (30-70 m) sectors. The estimated biomass of sprat was about **71,312.58 tons**. (Fig. 3.2.1b).

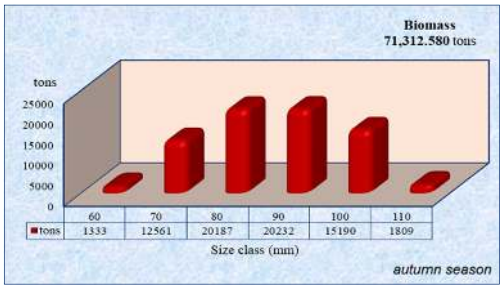
Assessment of sprat agglomerations (tons) in November 2019.

Depth range (m)	***0 – 30 m***	***30 – 50 m***	***50 - 70 m***	***Total***
Investigated area (Km²)	3,500	6,600	6,000	16,100
Variation of the catches (t/ Km²)	0.307-25.531	0.00-8.354	0.00-9.593	0.0-25.531
Average catch (t/ Km²)	5.824	3.246	2.856	3.976
Biomass of the fishing agglomerations (t)	14288.04	16016.45	21167.60	51472.10
Biomass extrapolated the Romanian shelf (t)				**71,312**

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

Autumn survey 2019

Structure of biomass and abundance by length distribution (Fig. 3.2.5)

a) 

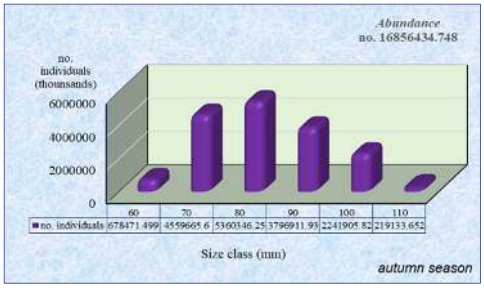
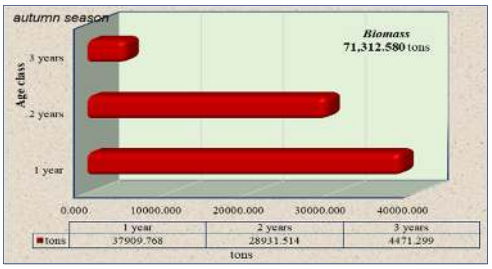
b) 

Figure 3.2.5 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. 3.2.6).

a) 

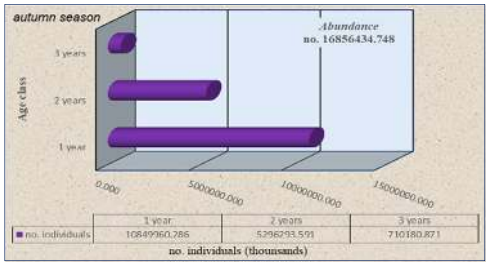
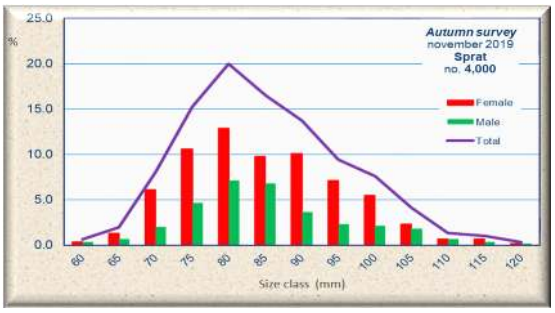
b) 

Figure 3.2.6 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 60.0-125.0 mm / 1.69-10.845 g. The dominant classes are those of 75-95 mm / 2.81-5.46 g (Fig. 3.2.7a). The dominant females 67.44%, males (32.56%). The average body length was 87.54 mm and the average mass of 4.118g. Age composition of sprat catches indicates the presence of individuals from 1 to 3 years. Most of the individuals caught are 1 years old (55.8 % of all specimens analyzed), followed by those of 2 years (35.4 %) and 3 years (8.8 %)(Fig. 3.2.7b).

a) 

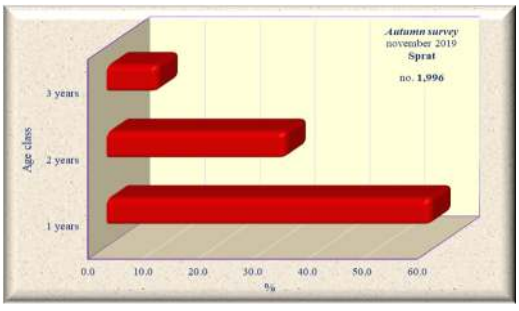
b) 

Figure 3.2.7 Structure by lengths (a) and age composition (b) of sprat during autumn survey.

b. *Aurelia aurita* (jellyfish)

Spring - sweeping area procedures were conducted on an surface of 15,670 Km^2. The average values of jellyfish catches were situated in the limits between 0,685-41.164 t/Km^2. They revealed that jellyfish had a flat distribution in large area between Sulina-Gura Portița sectors (0-50 m) and Cape Midia-Mangalia sectors (3.436-20.582 t/Km^2 (depth 30-50 m/Fig. 3.2.8a). The estimated biomass for the Romanian shelf was about **43,736** tons.

Assessment of jellyfish agglomerations (tons), in June 2019, Romanian area

Depth range (m)	***0 – 30 m***	***30 – 50 m***	***50 - 70 m***	***Total***
Investigated area (Nm^2)	3,300	5,800	6,570	15,670
Variation of the catches (t/ Nm^2)	0.685-41.164	3.436-20.582	0.686-13.721	0.685-41.164
Average catch (t/ Nm^2)	11.510	9.85	4.268	8.747
Biomass of the fishing agglomerations (t)	6,618	9,850	5229	24,492
Biomass extrapolated the Romanian shelf (t)				**43,736**

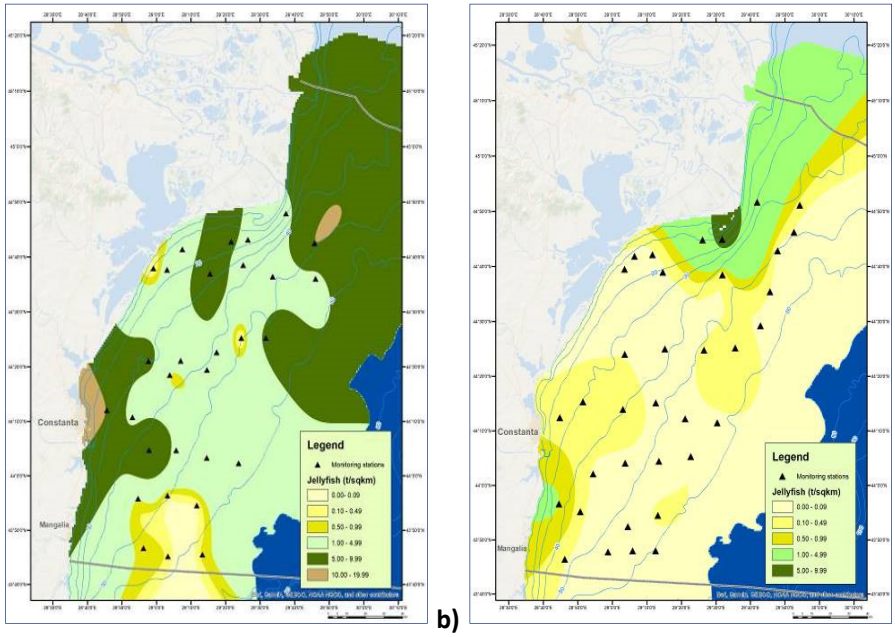
Autumn - in the **35** sample trawlings made with the pelagic trawl, on a surface of **16.100** Km^2, the average values of the catches were of about **0 - 14.888** t/Km^2. The maximum value was recorded in the Sf. Gheorghe-Mangalia sectors (50-70 m/Fig. 3.2.8b). The estimated biomass for the jellyfish crowds, in the research area, was of about **10,999 tons**.

Assessment of jellyfish agglomerations (tons), in November 2019, Romanian area

Depth range (m)	***0 – 30 m***	***30 – 50 m***	***50 - 70 m***	***Total***
Investigated area (Nm^2)	3,500	6,600	6,000	16,100
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)				**1,040.0**

Pelagic Survey 2020:

- period: 22 – 30 June and 22 - 31 October 2020
- type of fishing vessel: B-410 (***STEAUA DE MARE 1***);
- for estimating the fishable sprat crowds biomass, the holistic method of survey trawling was used and the pelagic trawl was used for sampling.



a) **b)**

Figure 3.2.8 The distribution of the jellyfish agglomerations in the spring (a) and autumn (b) period, pelagic trawl survey, in Romanian area.

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 25): sprat; European anchovy; Mediterranean horse mackerel; whiting; picked dogfish; red mullet; Caspian shad; bluefish; flathead grey mullet; jellyfish; knout goby; common shrimp; other species.

Estimated total biomass:

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

Spring - in the **30** sample trawlings made with the pelagic trawl, on an area of **14,796** Km², the average values of the catches were of about **0.099-8.713** t/Km². The maximum value was recorded in the Cap Midia-Sf. Gheorghe sectors (0-50 m) and Constanta–Cape Tuzla sectors (30–70 m). The estimated biomass for sprat crowds, in the research a area, was of abotut **58,559.64 tons** (Fig. 3.2.9a)**.**

Assessment of sprat agglomerations (tons), in June 2019

Depth range (m)	***0 – 30 m***	***30 – 50 m***	***50 - 70 m***	***Total***
Investigated area (Km^2)	2,453	4,933	7,410	14,796
Variation of the catches (t/ Km^2)	0.839-6.395	0.239-8.713	0.099-6.235	0.099-8.713
Average catch (t/ Km^2)	3.515	4.256	1.764	3.178
Biomass of the fishing agglomerations (t)	8622.92	20999.52	13074.57	42697.01
Biomass extrapolated the Romanian shelf (t)				**58,559.64**

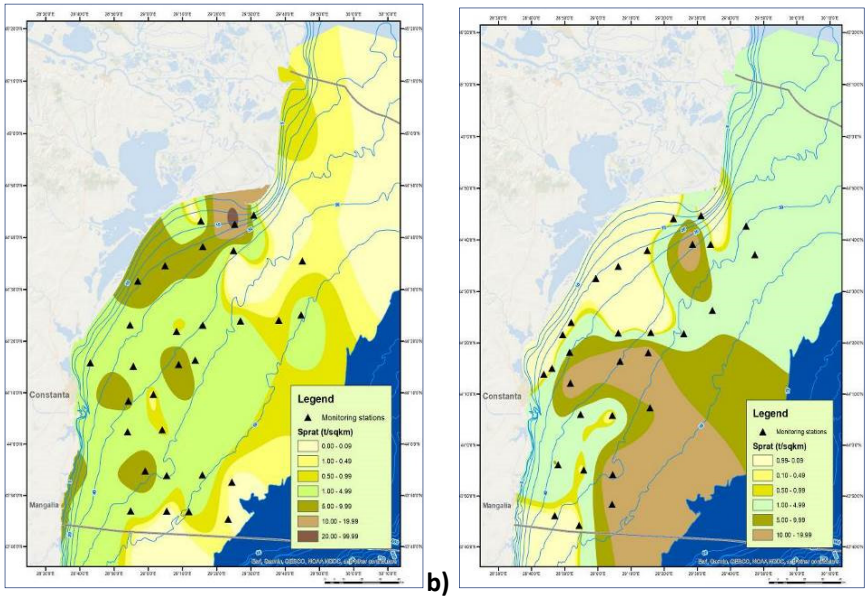


Figure 3.2.9 The distribution of the sprat agglomerations in spring (a) and autumn period (b), pelagic trawl survey, in Romanian area.

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

Spring survey 2020

Structure of biomass and abundance by length distribution (Fig. 3.2.10)

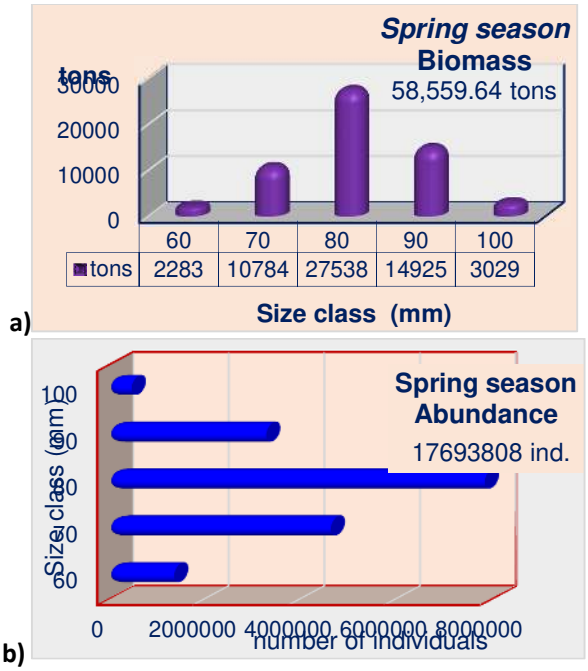


Figure 3.2.10 Structure by lengths of biomass (a) and abundance (b) of sprat during spring survey

Structure of biomass (a) and abundance (b) by age distribution (Fig. 3.2.11)

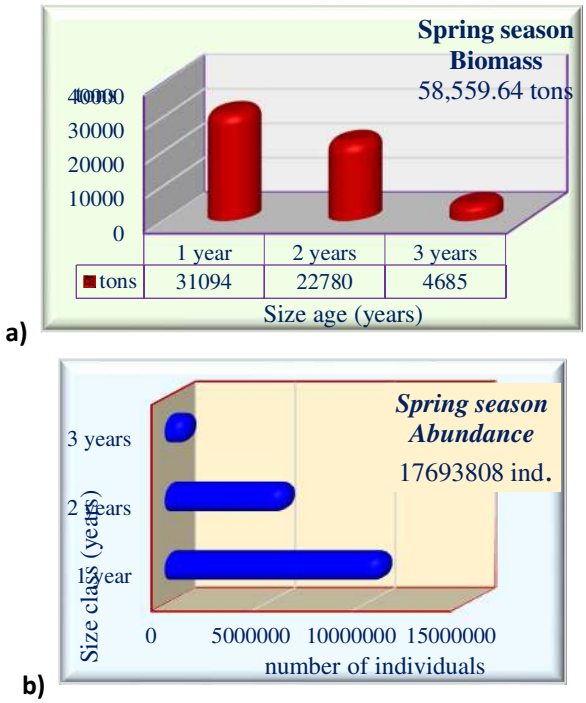


Figure 3.2.11 Structure by age of biomass (a) and abundance (b) of sprat sprat during spring survey.

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 60.0-105.0 mm /1.40-7.40 g. The dominant classes are those of 70.0 -95.0 mm / 2.10-5.02 g (Fig. 3.2.12a). The dominant females 60.05%, males (39.95%). The average body length was 82.29 mm and the average mass of 3.30 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 (61.21 % of all specimens analyzed), followed by those of 2 years (33.41 %) and 3 years (5.37%)(Fig. 3.2.12b).

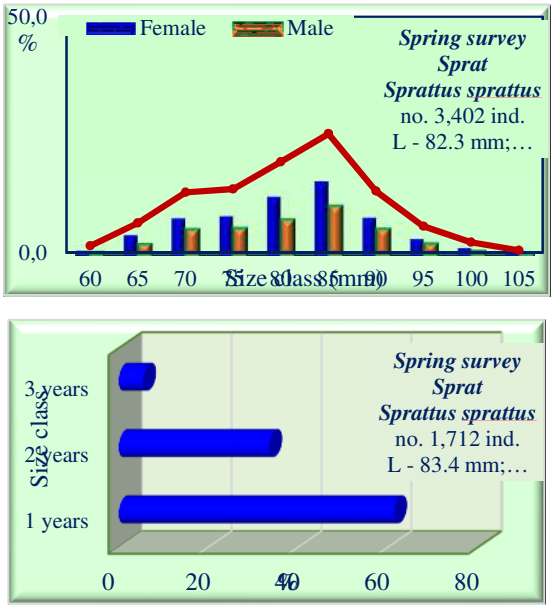


Figure 3.2.12 Structure by lengths (a) and age (b) of sprat during spring survey.

Autumn - in the **35** sample trawlings made with the pelagic trawl, on an area of **16,100** Km², the average values of the catches were of about 2.856-5.824 t/Km². The maximum value was recorded in the Sf. Gheorghe - Mangalia (30-70 m) sectors. The estimated biomass of sprat was about **71,312.58 tons**. (Fig. 3.2.9b).

Assessment of sprat agglomerations (tons) in November 2019

Depth range (m)	***0 – 30 m***	***30 – 50 m***	***50 - 70 m***	***Total***
Investigated area (Km²)	3,500	6,600	6,000	16,100
Variation of the catches (t/ Km²)	0.307-25.531	0.00-8.354	0.00-9.593	0.0-25.531
Average catch (t/ Km²)	5.824	3.246	2.856	3.976
Biomass of the fishing agglomerations (t)	14288.04	16016.45	21167.60	51472.10
Biomass extrapolated the Romanian shelf (t)				**71,312**

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

Autumn survey 2020

a) Sprat

Structure of biomass and abundance by length distribution (Fig. 3.2.13)

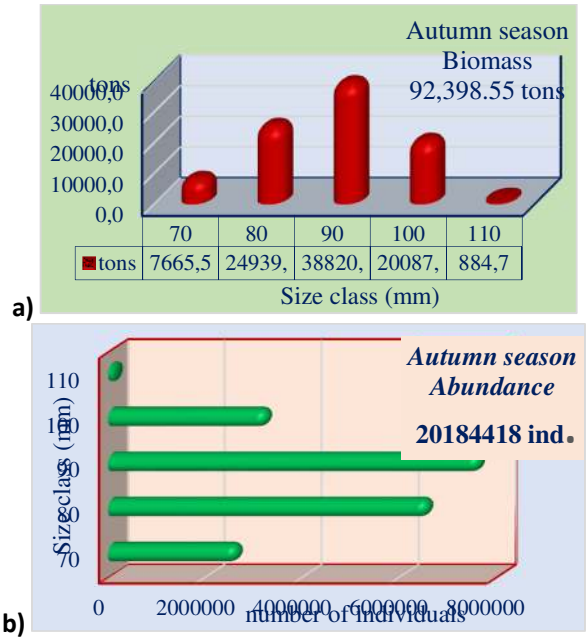


Figure 3.2.13 Structure by lengths of biomass (a) and abundance (b) of sprat during autumn survey.

Structure of biomass (a) and abundance (b) by age distribution (Fig. 3.2.14)

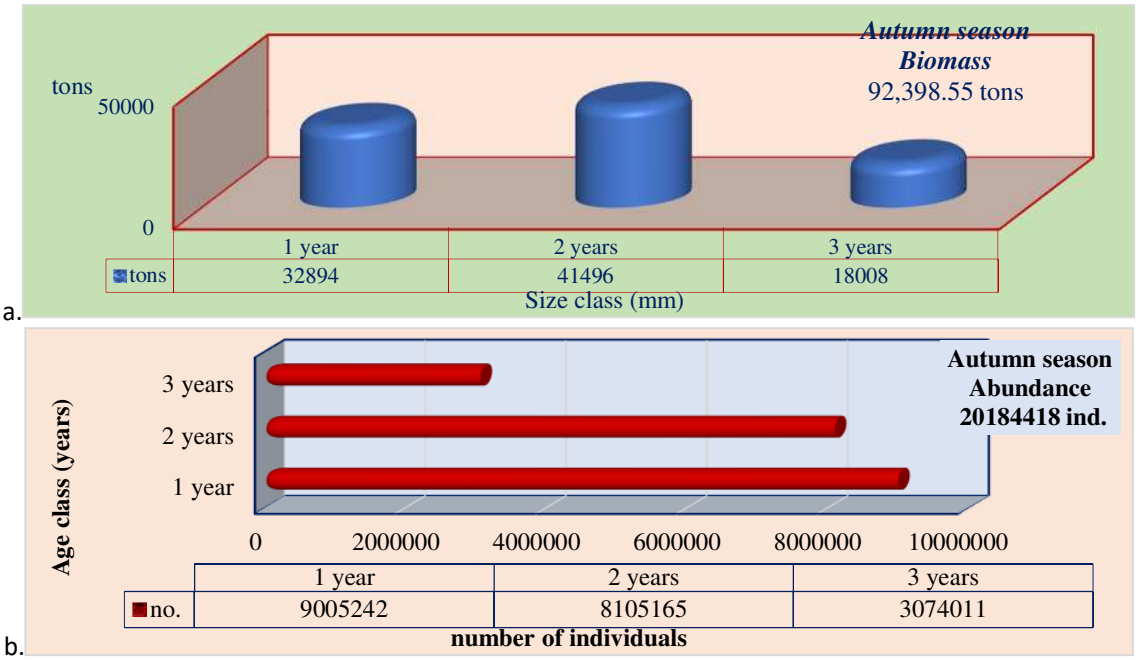


Figure 3.2.14 Structure by age of biomass (a) and abundance (b) of sprat during autumn survey

The length of sprat individuals are within the limits of classes of length 70-110 mm / 2.51-7.53 g. The dominant classes are those of 75-100 mm / 3.06–6.01 g (Fig. 3.2.15a). The dominant females 57.23 %, males (42.77 %). The average body length was 90.86 mm and the average mass of 4.57 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 (44.65 % of all specimens analyzed), followed closely by those of 2 years (40.12 %) and 3 years (15.23 %)(Fig. 3.2.15b).

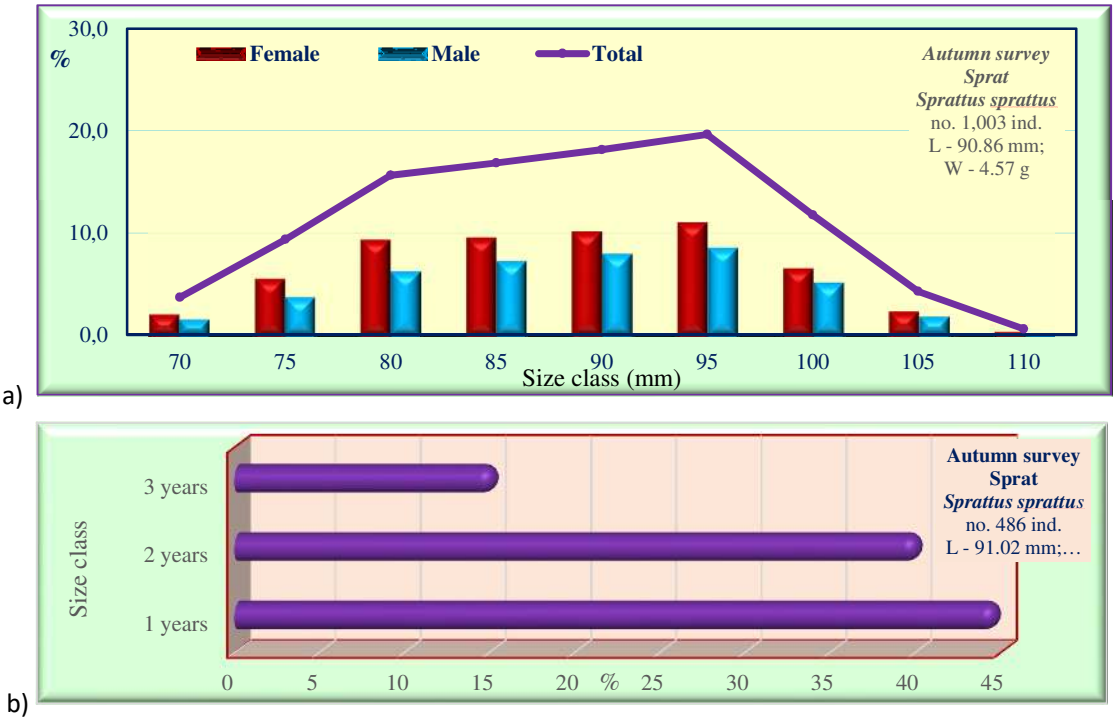


Figure 3.2.15 Structure by lengths (a) and age composition (b) of sprat during autumn survey.

b. *Aurelia aurita* (jellyfish)

Spring - sweeping area procedures were conducted on an surface of **14,796** Km^2. The average values of jellyfish catches were situated in the limits between 0.556 t/Km^2. They revealed that jellyfish had a flat distribution in large area between Sf. Gheorghe –Periboina 3.997 t/Km^2, depth 10-50 m and Cape Midia-Eforie sectors (0.099-3,997 t/Km^2/depth 30-50 m (Fig. 3.2.16a). The estimated biomass for the Romanian shelf was about **10,199.87** tons.

Assessment of jellyfish agglomerations (tons), in June 2020, Romanian area

Depth range (m)	***0 – 30 m***	***30 – 50 m***	***50 - 70 m***	***Total***
Investigated area (Nm^2)	2,453	4,933	7,410	14,796
Variation of the catches (t/ Nm^2)	0.139-1.998	0.199-3.997	0.099-0.599	0.099-3.997
Average catch (t/ Nm^2)	0.541	0.913	0.214	0.556
Biomass of the fishing agglomerations (t)	1329.12	4506.93	1586.71	7422.76
Biomass extrapolated the Romanian shelf (t)				**10,199.87**

Autumn - in the **30** sample trawlings made with the pelagic trawl, on a surface of **14,796** Km^2, the average values of the catches were of about 4,270 t/Km^2. The maximum value was recorded in the Gura Portita-Sf. Gheorghe sectors (0-50 m) Fig. 3.2.16b). The estimated biomass for the jellyfish crowds, in the research area, was of about **54,838.30** tons.

Assessment of jellyfish agglomerations (tons), in Octomber 2020, Romanian area

Depth range (m)	***0 – 30 m***	***30 – 50 m***	***50 - 70 m***	***Total***
Investigated area (Nm^2)	2030	3350	5900	11280
Variation of the catches (t/ Nm^2)	0.300-99.928	0.199-1.398	0.099-0.999	0.099-99.928
Average catch (t/ Nm^2)	12.235	0.311	0.266	4.270
Biomass of the fishing agglomerations (t)	30014.10	1536.35	1974.58	33525.04
Biomass extrapolated the Romanian shelf (t)				**54,838.30**

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, and jellyfish 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 (23,269 tons and 123,350 tons) and jellyfish (26,754 t and 54,838 t) (Fig. 3.2.17).

a. b.

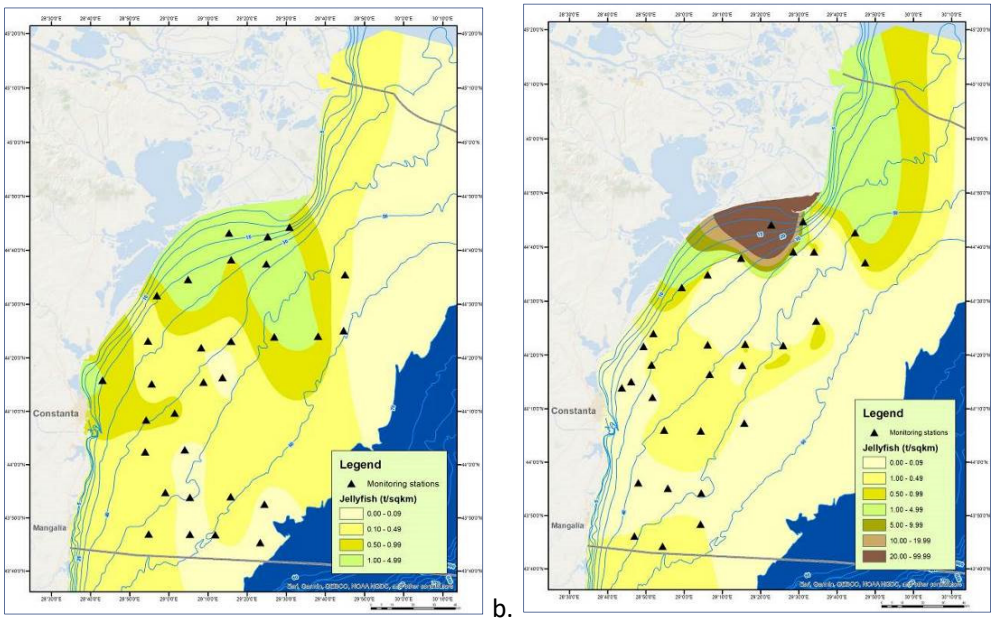


Figure 3.2.16 The distribution of the jellyfish agglomerations in the spring (a) and autumn (b) period, pelagic trawl survey, in Romanian area.

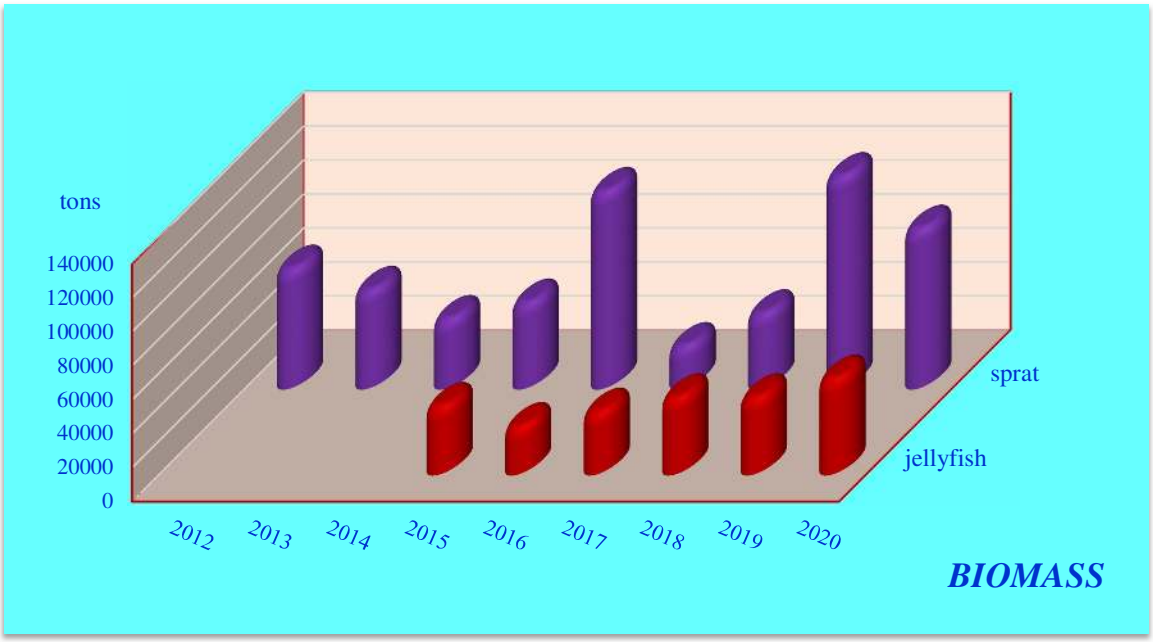


Figure 3.2.17 The agglomeration biomass of the main pelagic species from Romanian littoral.

4. Results of other acoustic surveys in GFCM area (outside EU waters)

4.1 Acoustic survey in the Albanian part of GSA 18 – Southern Adriatic Sea in 2019 (Andrea De Felice, Iole Leonori, Ilaria Biagiotti, Giovanni Canduci, Ilaria Costantini, Sara Malavolti)

a) General information on the survey

Continental shelf in front of Albania was monitored through acoustic survey since 2008 together with the area in front of Montenegro since 2008 until 2016 thanks to financing from FAO AdriaMed Projects and CNR. In 2017 and 2018 due to prolonged bad weather conditions and ship availability limitations it was not possible to investigate this area.

In 2019 in the framework of the new project "Institutional assistance for the development of Albanian maritime economy", acronym MarE, an acoustic survey following MEDIAS protocol as for the previous years and covering the Albanian area was carried out. MarE project is financed by "Cooperazione Italiana allo sviluppo"/AICS Tirana and executed by CIHEAM of Bari. This project was thought to give a help to Albania for Fishery and Tourism thematics and particularly for Fishery to help with the management of fish stocks through local technician instructions on stock assessment topics and through data on small pelagic fish collected on the field.

In 2020 another acoustic survey was scheduled, but due to Covid 19 restrictions it was canceled.

In 2021 acoustic survey in Albania is scheduled for the second half of May and it will be the last one for the project, that will end in December 2021.

The 2019 acoustic survey was carried out in June in eastern GSA 18 (Albania) following MEDIAS protocol (MEDIAS Handbook, 2019). Staff from CNR IRBIM of Ancona plus 3 Albanian scientists took part to the survey. The cruise was conducted on board the research vessel "G. Dallaporta" (built in 2001, 35.30 m, 285 GT, 1100 CV).

b) Type of echosounders and frequencies in use

Acoustic System was SIMRAD EK60 scientific echosounder operating at 38 and 200 kHz and SIMRAD EK80 operating at 70 and 120 kHz connected with hull-mounted split beam transducers. No TS and Sv thresholds set for data logging. The threshold for data processing is -70 dB or -60 dB in case of strong scattering from plankton. The pulse duration is 1024 ms for all frequencies. The surveying acoustic vessel speed is generally 9.5 knots. Echoview software was used to analyse acoustic data.

c) Calibration results

Table 4.1.1 Calibration results in 2019.

Frequency	Beam Angles (deg)	Athw. Beam Angles (deg)	Athw. Offset Beam Angles (deg)	Along. Beam Angles (deg)	Along. Offset Beam Angles (deg)	Transducer Gain (dB)	Sa Correction (dB)	RMS (dB)
38 kHz	7	6.93	-0.07	6.94	0.01	25.39	-0.6219	0.0696
70 kHz	7	6.62	0.04	6.69	-0.07	27.27	-0.0112	0.0714
120 kHz	7	6.89	-0.16	6.66	0.21	26.86	-0.2101	0.0761
200 kHz	7	6.08	-0.10	5.92	0.5	26.51	-0.0183	0.2345

d) Survey design

Acoustic data were logged over a grid of systematic parallel transects perpendicular to coastline/bathymetry (inter-transect distance 8-10 nmi) for a total of ~ 240 nmi - identifying an area of ~ 1569 nmi^2 in Albanian continental shelf (Fig. 4.1.2). Area coverage for acoustic survey in Albania was 100% of the total area estimated in 1569 nmi^2. Transect plan consisted of 8 transects; the number of nautical miles effectively processed for biomass estimation was 154.

e) Fish sampling

A midwater sampling trawl "Volante" with the following characteristics was used during the surveys: 18 mm codend, about 10 m vertical opening and 12 m horizontal opening, headline/ft rope = 35 m; sidelines length = 27 m. Vessel speed was 3.5 – 4.5 knots during fishing. Haul's duration was about 30 min. Trawls were monitored by means of Simrad ITI System. Fishing operations were performed at different light conditions and bathymetry. Biological samplings were conducted along the survey routes for biomass allocation into species and to know mean lengths and weights of the pelagic fish (Species, Size Composition, length-weight). The entire catch was considered to determine the proportion in species by weight; in case the catch was huge (more than 50 kg) an adequate subsample was considered for this operation. Length frequency distributions on board were calculated measuring a subsample of 100 individuals per species when available. Seven pelagic hauls were performed in the study area in 2019.

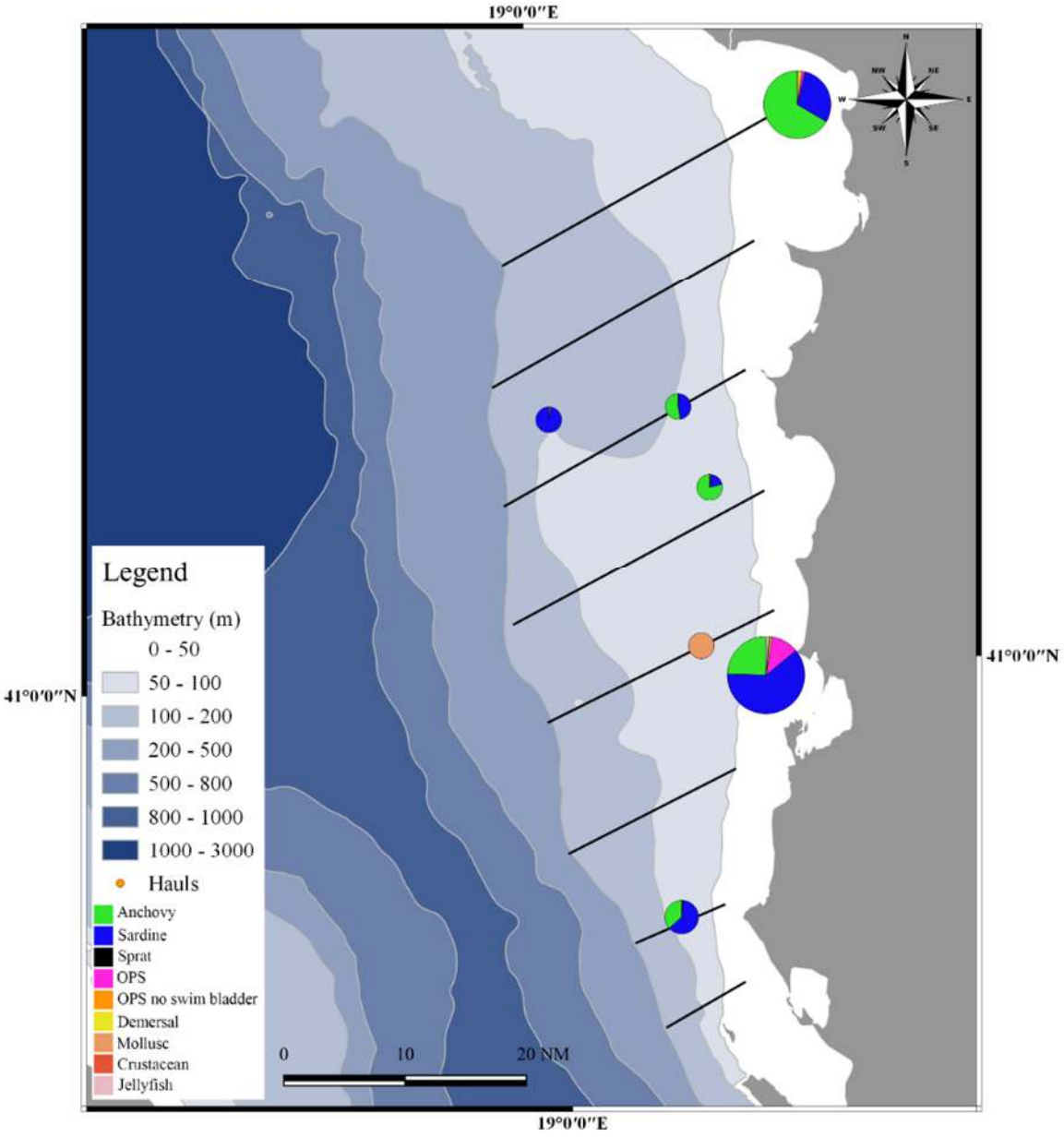


Figure 4.1.1 Catch composition of net samplings carried out in 2019 in eastern GSA 18 are reported. Size of pie charts is proportional to total catch.

f) Oceanographic parameters

In eastern GSA 18, in 2019, 37 CTD stations were carried out.

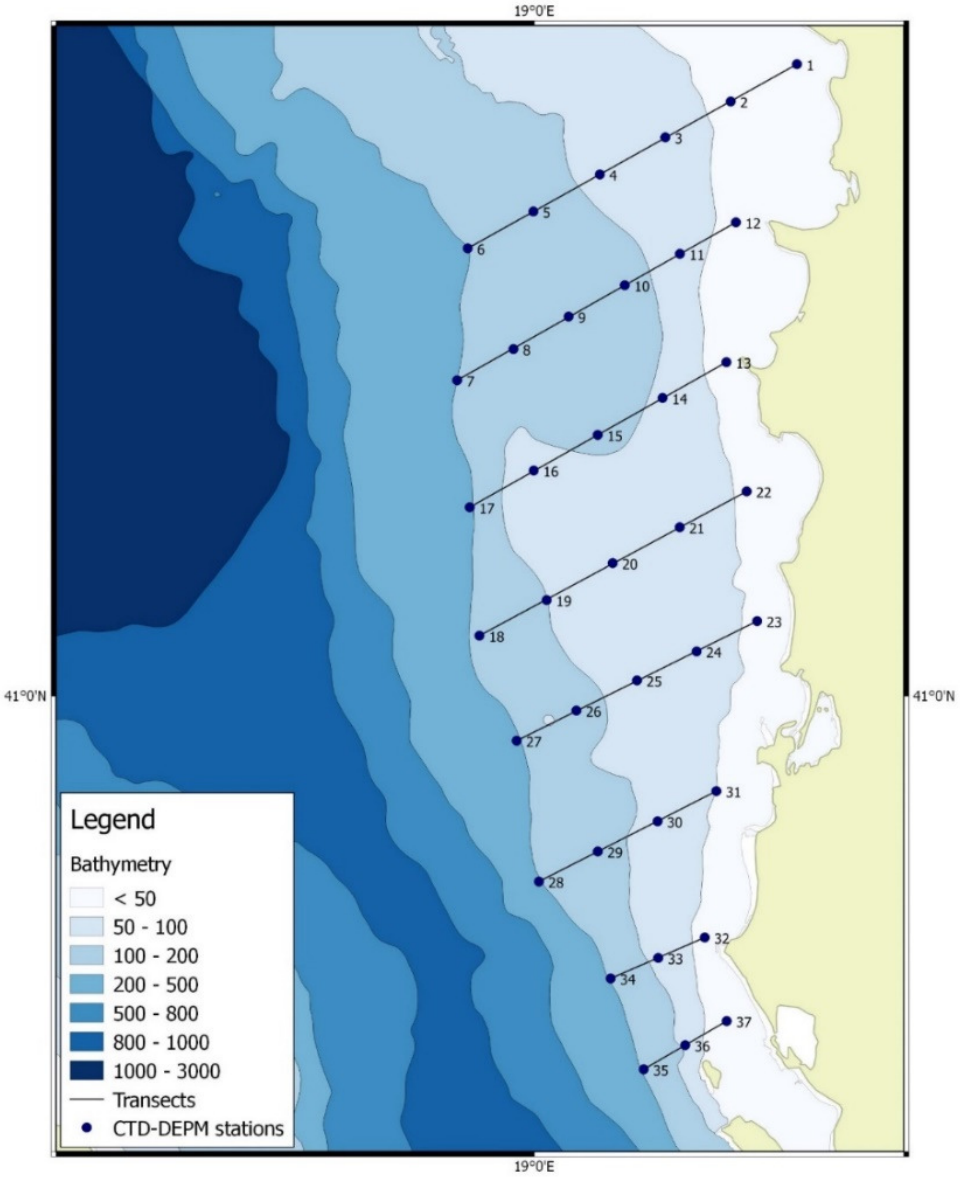


Figure 4.1.2 Acoustic survey route plan in eastern part of GSA 18 with grid of planned CTD stations

g) Biomass estimations of target species

Biomass of anchovy and sardine in tons in Albanian continental shelf (study area of 1569 nm^2) in 2019 resulted composed as the following:

- Anchovy (*Engraulis encrasicolus)* 6,067.7 t (3.9 t/nm^2),
- Sardine (*Sardina pilchardus)* 7,215.2 t (4.6 t/nm^2).

Length and age structured biomass estimates are shown in figures 4.1.3 and 4.1.4. Age structured estimates were based on age-length key obtained in MEDIAS survey in the western part of GSA 18 (Fig. 4.1.5). No specific age-length keys for anchovy and sardine were produces in this survey.

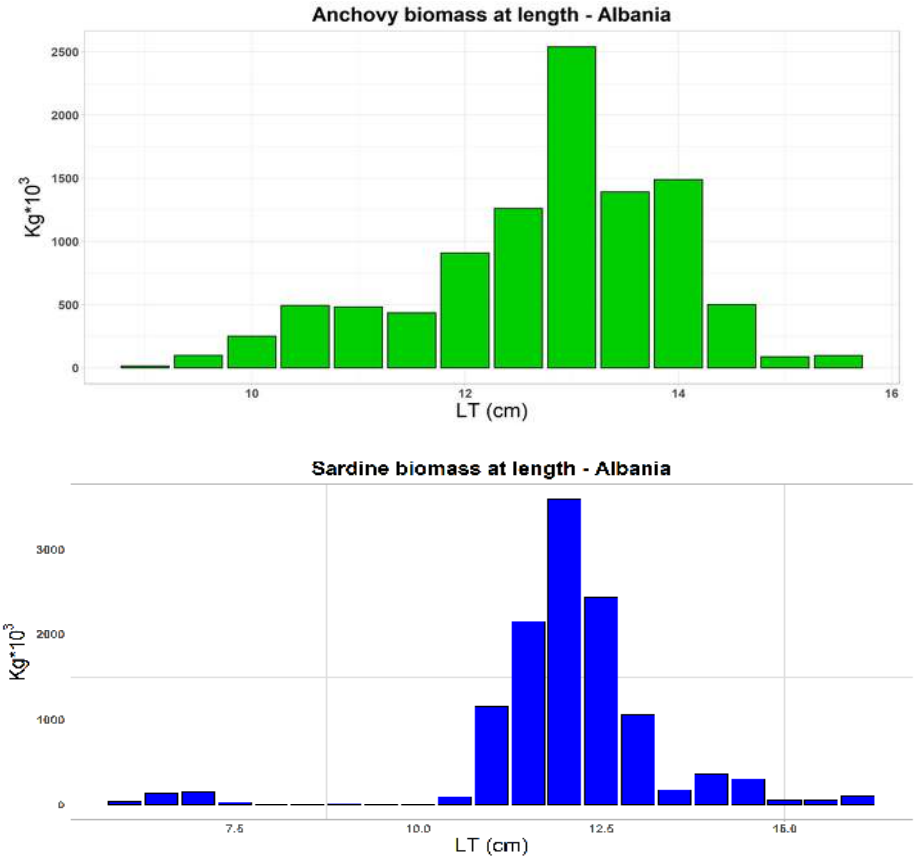


Figure 4.1.3 Anchovy and sardine biomass per length class in eastern part of GSA 18 in June 2019.

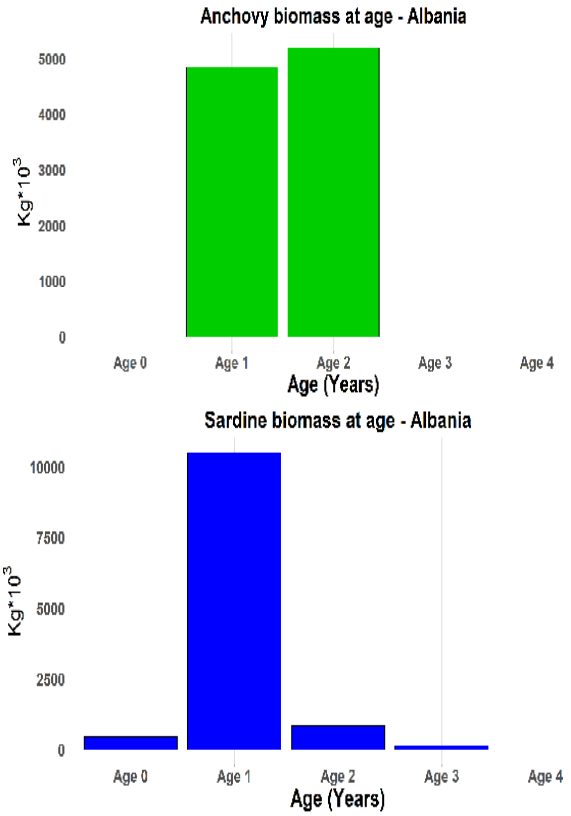


Figure 4.1.4 Anchovy and sardine biomass per age group in eastern part of GSA 18 in June 2019.

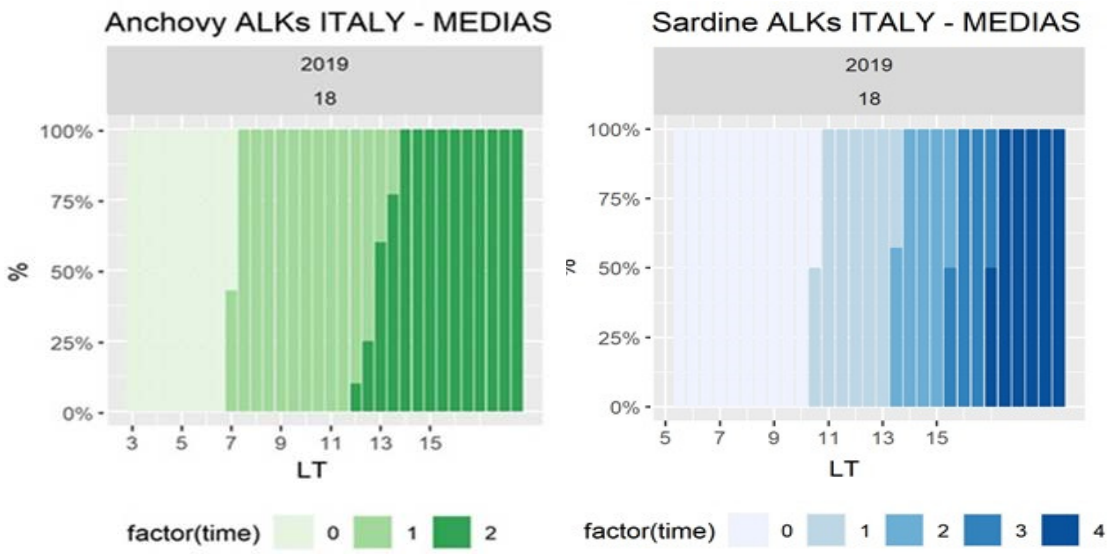


Figure 4.1.5 Anchovy and sardine ALKs estimated in western GSA 18 and applied to eastern GSA 18 data.

h) Abundance indices of target species

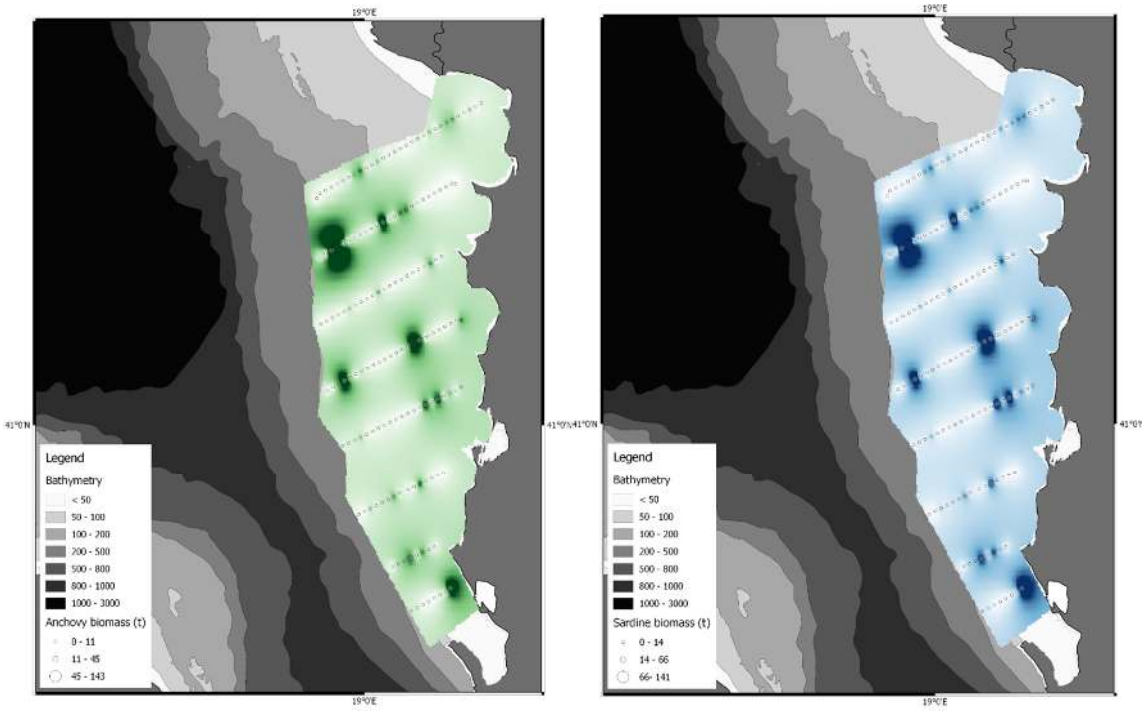


Figure 4.1.6 Anchovy (left) and sardine (right) spatial distribution in eastern GSA 18 in 2019.

Spatial distribution of anchovy and sardine in south-eastern Adriatic Sea in 2019 was quite similar between the two species and relatively sparse with sporadic clusters of high density both near the coast and offshore.

Anchovy and sardine number per length class in Albanian waters in eastern part of GSA 18 during June 2019 are presented in Figure 4.1.7.

Anchovy and sardine number per age group in Albanian waters in eastern part of GSA 18 during June 2019 are presented in Figure 4.1.8, indicating dominance of age group 1 in both, anchovy and sardine stocks.

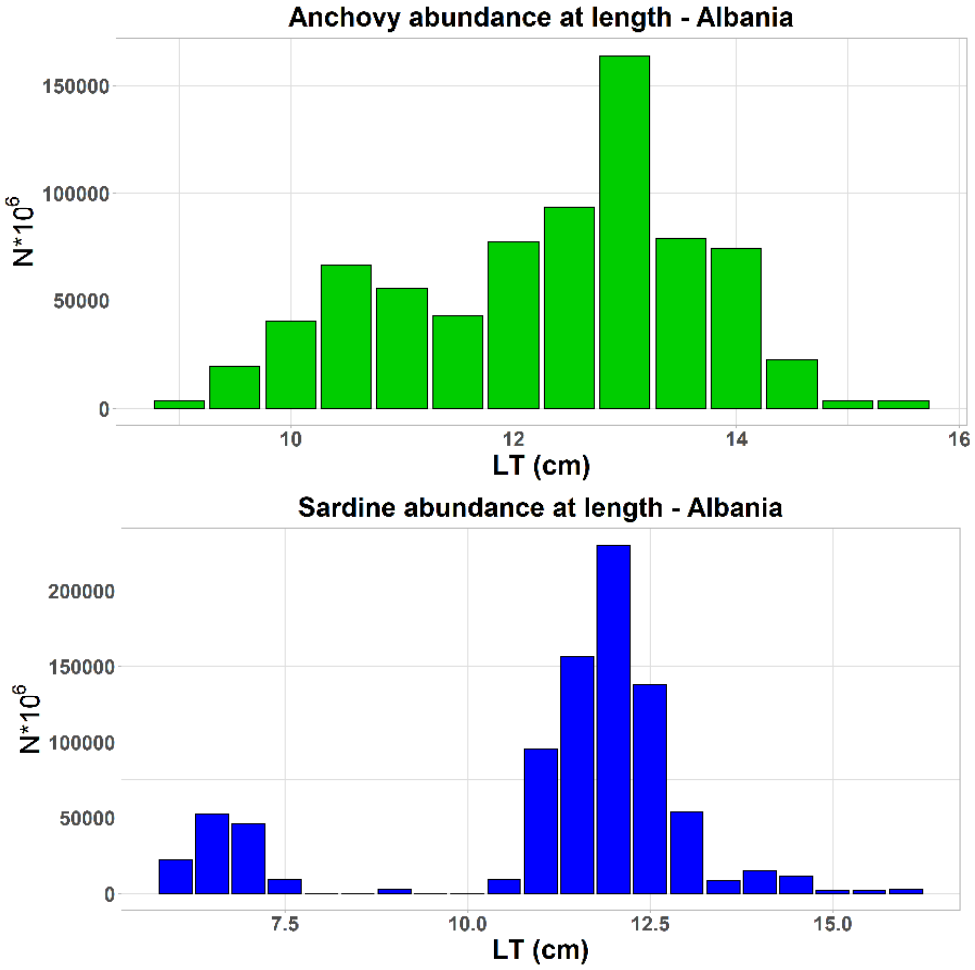


Figure 4.1.7 Anchovy and sardine number per length class in eastern part of GSA 18 in June 2019.

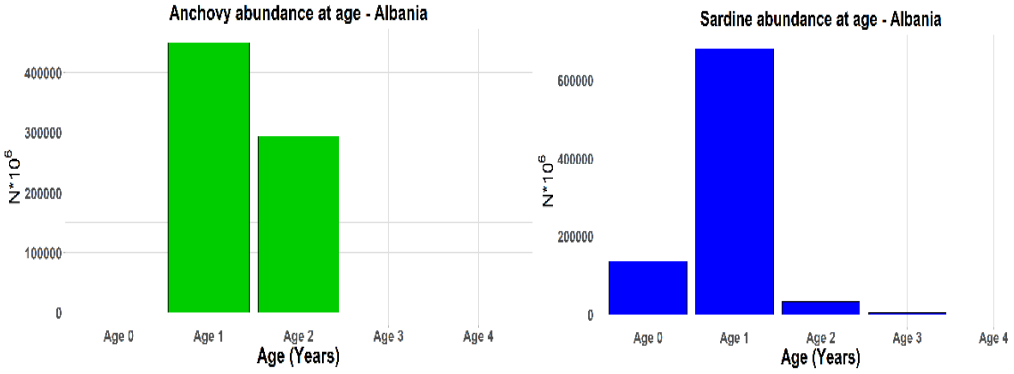


Figure 4.1.8 Anchovy and sardine number per age group in eastern part of GSA 18 in June 2019.

5. Views and suggestions from DG-MARE

MEDIAS Steering Committee 14th Coordination Meeting was attended by EC representative, Venetia Kostopoulou from DG –MARE Unit C3, during the 2nd day of the meeting. As previously suggested, she commented on MEDIAS issues highlighted during the RCG Med & BS 2019 meeting in Malta, as well as pending MEDIAS group proposals related to intercalibration of research vessels and the common database.

RCG Med& BS was identified as the right forum to discuss proposals related to bureaucracy issues in different member states.

European Maritime, Fisheries and Aquaculture Fund (EMFAF, 2021-2027) was mentioned as a potential way to address the problem of limited availability of resources (e.g. research vessels).

It was suggested that the proposed and pending MEDIAS intercalibration exercise could be linked to the EU Quality Assurance Framework, while the pending proposal for a common MEDIAS database could be linked to the MARE/2020/08 regional grant for the development of the Mediterranean and Black Seas regional database (RDB Med & BS). As indicated on the related Med& BS RDBFIS website (https://medbsrdb.eu/), the relevant Regional Coordination Groups (RCGs), the Commission, Member States and end-users (STECF, GFCM, ICCAT) will cooperate in the creation of the Med& BS RDBFIS. The role of the existing dedicated Steering Committee of the Member States in the RDB will be crucial. Therefore, it was proposed to discuss the issue of the MEDIAS common database at the Steering Committee Med & BS RDB meeting.

In addition, the EU STREAMLINE project (MARE/2020/08) aiming at the establishment of regional work plans in the Mediterranean & BS was mentioned as potentially useful for the MEDIAS Coordination Group.

Finally, the DG -MARE representative reminded the MEDIAS group of the obligation for MS to provide data to end-users of scientific data or other interested parties upon their request, in accordance with Regulation 2017/1004. The procedure for DCF data requests (e.g. MEDIAS data) was explained and a dedicated template for data requests was developed and is available on the DCF website (Guidelines - European Commission (europa.eu)).

6. Review of issues harmonized within MEDIAS Steering Committee framework and possibilities for future harmonization

MEDIAS Steering Committee reviewed the harmonization of various topics undertaken between the acoustics teams of the different institutes since the launch of EU-MEDIAS (Table 6.1). Considering the different national survey protocols used in different national acoustic surveys until 2009 (e.g. from

ancestors to MEDIAS), the importance of these achievements in harmonizing survey protocols was highlighted by MEDIAS Steering Committee.

Table 6.1 Review of harmonized topics in MEDIAS in the period 2009 - 2020.

Harmonized issues in the EU-MEDIAS	**Comments:**
Survey designs based on common geostatistical analysis	made in the ambit of AcousMed project
Common target species in all acoustic surveys	Anchovy and Sardine
Common sampling time for acoustic data	Only day-time acoustic sampling
Common agreement on oceanographic data collection	CTD – temperature and salinity in entire water column at each station
Common survey season agreed	June-September
Common biological analyses	LFD (0.5cm class), sex, maturity, otholits, Length-Weight relationships
Common otolith reading criteria for age estimation of target species*	based on ICES WKARA2 2016 outcomes, survey/year specific ALKs produced(1)
Common maturity stage determination criteria*	based on the ICES WKSPMAT (2009) (1)
Common Database structure agreed	Adopted in the 5th MEDIAS SC meeting
Common fish sampling gear type, fishing speed, min. haul duration and max. codend mesh size	Pelagic trawl with otterboards; 3.5-4.5 knots; 30 minutes; 24mm (mesh size)
Common calibration procedure and calibration report structure (Table) used	For acoustic sampling equipment only
Common workflow for acoustic data processing	As described in MEDIAS Handbook
Common Elementary Distance Sampling Unit	EDSU = 1 nautical mile
Common principle for echo partitioning	Based on echogram visual scrutinization
Common maximum echo sounding depth	200 m
Common frequency for assessment	38 kHz
Common scientific echo-sounder characteristics: transducer type and parameters used for acoustic sampling	Split-beam, pulse duration 1ms, threshold range -70 to -60dB, ping rate - maximum
Common format for survey's presentations	As described in MEDIAS Handbook
Common TS equation for sardine	TS=20log(TL)-72.6dB (2)

Notes: 1 – no intercalibration on age reading nor maturity estimations
2 - except in the GSA 7

Despite the fact that common age and maturity estimation protocols have been agreed upon, the lack of validation studies for age and maturity estimates in Mediterranean Sea has been pointed out. It was therefore suggested that small subgroups (for ageing and maturity estimations) be organized at MEDIAS level to try to further harmonize these estimates between different MEDIAS teams. Formally, these actions will be proposed in the RCG Med& BS meeting.

During the meeting, experts from GSA 7 also agreed to use a common TS equation for sardine to obtain estimates comparable to those of the other acoustic teams. However, to avoid affecting existing long-

term series, the GSA 7 experts will continue to use their TS equation for sardine from the past in parallel.

In the discussion that followed, MEDIAS Steering Committee mentioned some items that were not harmonized (Table 6.2) and suggested that these might be considered for further harmonization. Harmonization of some of these points (e.g. anchovies TS, format of survey reports) was initiated and some possible solutions were suggested. However, MEDIAS Steering Committee is aware of its limitations and some harmonization processes (e.g. intercalibration of research vessels, workload/vessel day, complementary frequencies) might require the involvement and synergy of the administrations of the respective EU Member States, RCG Med& BS and/or EC.

Table 6.2 Possibilities for future harmonization within EU-MEDIAS.

Non-harmonized issues in the EU-MEDIAS	**Comments:**
Different research vessels used in surveys	Vessels intercalibration is proposed
TS equation for anchovy	Common TS study submitted to MMS SI
Format for survey's reporting	Harmonization in progress…
Different workload per vessels and per vessel/day	Related to availability of resources
Fish sampling equipment	Technical details on trawl nets used*
Complementary frequencies available	Related to availability of resources
Echograms scrutinization	Agreement on some technical details
Survey design in shallow waters	To improve survey catchability (small fish)*
Other (e.g. plankton sampling etc.)	in line with evolution of MEDIAS activities*

*Note: * - further clarifications are needed in the Handbook.*

7. Information for management decisions

Regarding information used to make management decisions, MEDIAS Steering Committee noted that in GSA 7 only MEDIAS estimates were used directly to make advices for fishery management decisions. In other GSAs, advices for fishery management decisions are based on the results of fisheries-based single stock assessments, and estimates from MEDIAS are used as the principal tuning information to support analytical stock assessments of small pelagic fish stocks (e.g., anchovy and sardine) in EU Mediterranean waters. At the meeting, MEDIAS Steering Committee was informed that the practice of using MEDIAS results for fishery management advice in GSA 7 was recently changed in favor of fishery-based analytical stock assessments. MEDIAS SC was informed that a benchmark assessment for small pelagic fish in GSA 6 and GSA 7 combined was recently conducted within GFCM framework, using MEDIAS data for tuning.

7.1 Input for stock assessment purposes concerning stocks which are managed internationally

MEDIAS Steering Committee pointed out that stocks of small pelagic fish, anchovies and sardines within the Mediterranean Sea (i.e. MEDIAS target species) are managed internationally by the General Fisheries Commission for the Mediterranean (GFCM). To support fisheries management, EU-MEDIAS provides annual fishery-independent abundance and biomass estimates of anchovy and sardine stocks and their spatial distribution relative to the survey period.

MEDIAS Steering Committee was informed that 19 small pelagic stocks were assessed in the GFCM framework (GFCM WGSASP) this year using acoustic surveys as a tuning index, namely in GSAs 1, 3, 4, 9, 16, 20, and 22. Five of these stock assessments for small pelagic fish in the Mediterranean Sea were conducted using surplus production models (SPiCT) that used total biomass estimated acoustically as tuning index. In addition, 13 stock assessments were based on age-structured analytical models, and in these cases age- structure was based on acoustic surveys.

The survey-based evaluations of anchovy and sardine stocks are provided (by the respective EU Member States) to the end-user expert working groups (STECF and GFCM) as input for analytical stock assessments in the form of length-, age- and sex-structured abundance and biomass estimates (e.g. Number/age and per length class; Biomass/age and per length class). The EU-MEDIAS estimates are uploaded annually to the JRC database, within three specific templates (Abundance, Biomass and Abundance biomass) available at https://datacollection.jrc.ec.europa.eu/dc/medbs/templates.

7.2 Information for Good Environmental Status in the MSFD

The European Commission produced a set of detailed criteria and methodological standards aimed to help Member States implement the Marine Strategy Framework Directive (MSFD). These were revised in 2017 leading to the new Commission Decision on Good Environmental Status. Descriptors potentially related to MEDIAS are:

• D3: “Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock”

• D4: All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.

Important criteria related to Descriptor 3 (D3 (Commission Decision (EU) 2017/848 of 17 May 2017)) are:

D3C1 – Primary: The Fishing mortality rate of populations of commercially exploited species is at or below levels which can produce the maximum sustainable yield (MSY).

D3C2 – Primary: The Spawning Stock Biomass of populations of commercially exploited species are above biomass levels capable of producing maximum sustainable yield.

D3C3 – Primary: The age and size distribution of individuals in the populations of commercially-exploited species is indicative of a healthy population. This shall include a high proportion of old/large individuals and limited adverse effects of exploitation on genetic diversity. Member States shall establish threshold values through regional or sub-regional cooperation for each population of species in accordance with scientific advice obtained pursuant to Article 26 of Regulation (EU) No 1380/2013.

MEDIAS Steering Committee has been recalled on similarity of MSFD and Common Fishery Policy (CFP). Both, MSFD and CFP, requires estimations of fishing mortality (F) and spawning stock biomass (SSB), but in different periods: MSFD requires estimates within 6-year period, while CFP requires annual estimates.

Steering Committee noted that MEDIAS teams, if requested by their respective MS, might be able to contribute in description of Biodiversity indices (i.e. Population size per species: Total biomass and abundance estimates for target species (+CV estimation)) and in description of Population condition of target species (i.e. Biomass/abundance estimate per size/age) in particular GSAs. Potentially, MEDIAS can also provide Recruitment indexes (for sardine and summer surveys), as well as information on fish community synthesis (i.e. species composition and total fish NASC).

In following discussion, the potential usefulness of EU-MEDIAS carried out in DCF for other projects related to EMFAF (2021-2027) has been highlighted.

8. Review on status of MEDIAS papers in Special Issues of MMS journal and discussion on issues related to publication cost / invoices (Guest Editors)

The chairman of MEDIAS informed SC of his contacts with the guest editors of Mediterranean Marine Science, dedicated to Special Issue, and invited them to participate in this virtual meeting. However, two out of four guest editors were unable to attend the virtual meeting of MEDIAS. The remaining two guest editors (Marianna Giannoulaki and Andrea De Felice) were present at the meeting. Guest editors informed MEDIAS SC that about 11-12 papers were submitted for publication in MMS SI, including one rejected paper. One of the papers has been accepted and is now going through the editorial process, another has already been reviewed and comments have been sent to the authors, and the remaining papers are still in the revision process. In their opinion, everything is going well so far and MMS intends to publish these papers by the end of 2021.

The issue of payment of publication costs was also discussed, as there are problems with issuing too many small invoices for all the participating institutes. The guest editors informed MEDIAS SC that a maximum of two separate invoices can be issued for the total publication costs. To solve this problem, MEDIAS SC members Tarek Hattab and Angelo Bonanno kindly offered to share and cover the total publication cost by their institutes. On behalf of MEDIAS SC, the Chair thanks them.

8.1 Review of the paper on possible acoustic evidences of the anchovy recruitment (Ana Ventero)

Following the discussion on the scientific papers in the MMS SI, Ana Ventero from the IEO took the floor and presented SC an interesting research related to possible acoustic evidence of anchovy recruitment in the northern Alboran Sea.

During the MEDiterranean International Acoustic Survey (MEDIAS) carried out in 2016 and 2017 in the Northern Alboran Sea in July, a benthic scattering layer located mainly in the Malaga Bay was acoustically detected at multiple frequencies and biologically identified using different sampling devices (plankton net and pelagic trawl). This layer corresponded mainly to anchovy larvae aggregation in the range of 2 and 40 mm standard length. Our results pointed out that anchovy larvae massively migrate from the surface to the bottom near the coast, until the 70 m isobath, forming large aggregations that are acoustically detected as a scattering benthic layer in which small schools form and emerge.

This work has highlighted the potential of acoustic surveys such as MEDIAS to generate anchovy recruitment success indices complementary and simultaneously to traditional ones (biomass of the reproductive stock), and their great utility as a fisheries management tool in areas such as Alboran Sea where the fisheries resource is scarce.

9. Work on geostatistical scripts to produce standardized NASC maps at the Mediterranean scale

Ongoing work on geostatistical scripts to produce standardized NASC maps at the Mediterranean scale was presented by Marco Barra. During the presentation, various possibilities for producing anchovy and sardine distribution maps in the R environment were explored.

In particular, a possible procedure to generate average spatial distribution maps by taking advantage of the geostatistical simulations obtained during the CV calculation for acoustic biomass estimates was discussed. In order to export the obtained map into a georeferenced raster format and to allow easy visualization of the map, the "raster" package was used.

Regarding IDW, the effect of setting different IDP (inverse distance weighting power) values was discussed, highlighting the typical "bull's eye" effect obtained by increasing its value.

In the subsequent discussion, the need to define the scope of these maps was highlighted as a first step. In order to produce Mediterranean scale maps, the data from the different survey areas should be comparable. Large differences in NASC values between different survey areas and years, as well as differences in TS were mentioned as possible difficulties. To overcome the differences in absolute NASC values between and within survey areas, the use of NASC data at logarithmic scale was suggested as a possible option, using a common range of values from 0 to 4.

Finally, MEDIAS SC recognized that producing standardized NASC maps at the Mediterranean scale in the past could be a rather complicated task, especially for years in the past.

10. Update of the EchoR: Adaptation and application by MEDIAS groups interested

Tarek Hattab informed MEDIAS SC about the recent updates of EchoR that includes some new functions for mapping spatio-temporal series of fish biomass and hydrological indices. These new functions perform a spatial interpolation using the block-averaging methodology described in Petitgas et al. (2009, 2014) and Doray et al (2018a, 2018b). Block averaging can be used to quickly produce series of smoothed standard maps based on, e.g., integrated sea survey data collected using heterogeneous sampling schemes. It therefore allows for the comparison of fish biomass and hydrological indices at different spatial locations.

Following the presentation of the new algorithm of EchoR, the MEDIAS group encourages EchoR users to continue using this script for mapping and biomass estimation. MEDIAS SC acknowledged the work of M. Doray and the progress in script development.

Literature sources:

Petitgas, P., Doray, M., Huret, M., Massé, J., Woillez, M., 2014. Modelling the variability in fish spatial distributions over time with empirical orthogonal functions: anchovy in the Bay of Biscay. ICES J. Mar. Sci. 71, 2379–2389. http://dx.doi.org/10.1093/icesjms/fsu111.

Petitgas, P., Goarant, A., Massé, J., Bourriau, P., 2009. Combining acoustic and CUFES data for the quality control of fish-stock survey estimates. ICES J. Mar. Sci. 66,1384–1390.

Doray, M., Petitgas, P., Huret, M., Duhamel, E., Romagnan, J. B., Authier, M., ... & Spitz, J. (2018a). Monitoring small pelagic fish in the Bay of Biscay ecosystem, using indicators from an integrated survey. Progress in Oceanography, 166, 168-188.

11. Review, discussion and update of MEDIAS Website: http://www.medias-project.eu/medias/website/

The present structure of the website, as well as its contents, were revised. Some changes were proposed to provide more information about:

- the Research Vessel used during the survey by each institute
- the fishing equipment
- the upcoming Special Issue

It was also proposed to update the section linking other projects related to the activities carried out by the MEDIAS group and the adoption of an "HTTPS" domain was also suggested to improve the website search rankings.

Finally, considering that the registration is mainly meant to allow meeting participants to access the shared folder used during the meeting, it was proposed to use a private link allowing only the meeting participants to register to the website.

12. Review and updates of MEDIAS Handbook

Meeting participants went through the most recent version of MEDIAS Handbook (April, 2019), discussing some topics and proposing appropriate changes and updates.

Namely, in Table 1 of MEDIAS Handbook, that describes the size of the geographical area that is covered by each Institute, experts from Croatia (IOF) pointed out that in column "Standard number of days" 30 days only is foreseen for Croatia that covers the largest survey area. As presented during the 1st meeting day, it was not sufficient for surveys carried out in 2019 and 2020. Handbook will be updated by inserting a Note about this issue bellow the table 1. Similar issues are related to the recent and planned extensions of MEDIAS activities in some new areas. These issues will be communicated in the next RCG meeting, following with an appropriate recommendation at RCG level. Considering extensions of MEDIAS activities in some new areas (e.g. GSA 11), Figure 1 in the Handbook needs to be updated also, and if possible improve visibility of survey transects.

At this point, the Chair reminded SC members on RCG Med&BS 2017 Recommendation No. 10 (Larnaca, Cyprus 2017, in Annex IV) made on introduction of new surveys, highlighting that: "*Proposed surveys should not affect in any way the implementation of the existing surveys in terms of available resources for surveys at sea*". Therefore, appropriate additional resources (e.g. vessel availability, financial resources, personnel) need to be available in practice, and adopted by EC, RCG Med&BS and MS (included in MAP) for new surveys or survey's extensions.

SC members discussed different points on survey design and other sections, and appropriate changes as agreed were made in the text.

Updated version of MEDIAS Handbook (April, 2021) is available in Annex VI of this Report.

13. Terms of reference, venue and date for the next MEDIAS Steering Committee coordination meeting (2022)

MEDIAS SC discussed and accepted Terms of References (ToR) for the next, 15th MEDIAS coordination meeting in 2022 (Annex V).

Considering uncertain future situation related to the COVID-19 pandemic, SC considered two possible options. As suggested by Tomaž Modic from FRIS, if the organisation of a physical meeting will be possible, the venue for the 15th MEDIAS Steering Committee coordination meeting will be Ljubljana, Slovenia. If it will not be possible to organise a physical meeting, virtual meeting would be organised by the FRIS, Slovenia.

The tentative date proposed for the meeting is 5-7 April 2022.

14. Other issues

Experts from Spain informed SC about their intention to initiate an acoustic survey within GSA 5 (Balearic Islands). In line with RCG Med&BS 2017 Recommendation No.10 (Annex IV) the Chair expressed his hope that new/additional resources will be available to IEO for this purpose, and that this new survey in GSA 5 will not compete for resources with ongoing surveys in GSA 1 and GSA 6.

15. Conclusions and decisions of the MEDIAS Steering Committee (SC)

1. At the 14th MEDIAS meeting, the results of the acoustic surveys carried out in 2019 and 2020 were presented by participants from all countries working in MEDIAS: Spain, Greece, Italy, France, Slovenia and Croatia. In addition, the results of the pelagic trawl surveys conducted in Black Sea (GSA 29) by Romania and Bulgaria were also presented. The presentations were uploaded on MEDIAS web page.

2. MEDIAS SC noted that the previously adopted Common format for presentations has helped to harmonise the presentations of the surveys. However, in order to achieve further harmonisation, the need for some additional clarifications was also identified and it was decided to include examples of different graphs in this Common format for presentations.

3. Regarding the harmonisation of spatial distribution maps, MEDIAS SC concluded that these maps should present proportional NASC/target species values along transects without interpolation.

4. In order to standardise the age-length keys (ALKs), MEDIAS SC decided that the ALKs should be presented as proportions (%) with information on the total number of otoliths analysed.

5. Following the discussion on a possible interaction of EU-MEDIAS with other EU projects, SC decided that the Chair, on behalf of MEDIAS SC, will initially contact experts responsible for regional database related to the RCG (i.e. Stefanos Kavadas, coordinator of MARE /2020/08 regional grant), and the coordinator of the STREAMLINE project (Alessandro Ligas) to explore a possible future relationship with MEDIAS;

6. MEDIAS SC also decided to explore the possible usefulness of European Maritime Fisheries and Aquaculture Fund (EMFAF) in relation to research vessel concerns.

7. Following the discussion on biological data, MEDIAS SC decided to organise a subgroup of MEDIAS experts in biological analyses (e.g. age and maturity estimations) to conduct an exchange of images (and put them in a repository) to compare and discuss their estimates in the next meeting in 2022, with the aim of trying to standardise biological estimates (age and maturity), initially in the framework of MEDIAS. In addition, it was decided that MEDIAS SC will also request the organisation of thematic workshops on biological analyses in Mediterranean stocks within the RCG.

8. Following the presentation of the new algorithm of EchoR, the MEDIAS group encourages EchoR users to continue using this script for mapping and biomass estimation. MEDIAS SC acknowledged the work of M. Doray and the progress in script development.

9. The script developed by Marco Barra for estimating CV was successfully used by all groups and MEDIAS SC decided to make it mandatory for future surveys and in presentations.

10. MEDIAS SC agrees to continue with interest in previous proposals and decided to remind RCG Med&BS meetings of this and other upcoming issues (e.g. harmonisation of ageing), but also to explore the possibility of looking for other ways to proceed with proposals, as suggested by the EC representative.

11. MEDIAS SC decided to recommend the Spanish survey in GSA 5 to RCG Med&BS, but recalling on RCG Med&BS recommendation related to Introduction of new research surveys at sea (Larnaca, Cyprus, 2017).

12. Quick information on submitted items and their status was provided SC by MMS SI Guest Editors. The MEDIAS SC noted the kind offer of the experts from CNR-IAS (Dr. Angelo Bonanno) and from IFREMER (Dr. Tarek Hattab) to share the total publication costs between their two institutes and SC decided to accept it.

13. MEDIAS SC decided to proceed with efforts to update the website with new information and agreed that the members of SC would provide appropriate useful links to be included in the website.

14. Some aspects of the MEDIAS manual were discussed and updated in the latest version annexed to this report (Annex IV) based on the discussion held during the meeting. Discussing about Table 1 in the Handbook MEDIAS SC concluded that there is need to inform RCG Med&BS and get appropriate feedback before changes in Table 1 can be made. Therefore, updates of Table 1 (e.g. number of days for Croatia, info on Italian survey in GSA 11) in the Handbook are pending.

15. The MEDIAS Steering Committee approved the Terms of Reference for "MEDIAS 2022".

16. Finally, the MEDIAS SC decided that if the situation related to the COVID pandemic allows the organisation of a physical meeting, the venue for the 15th MEDIAS Steering Committee coordination meeting will be Ljubljana, Slovenia. If it is not possible to organise a physical meeting, it would be organised by the host country as an online meeting. The tentative date proposed for the meeting is 5-7 April 2022.

16. Closure of the meeting

The Chair thanked all participants for attending the meeting, as well as to Tomaž Modic (FRIS, Slovenia) for the effective organization and technical support of this virtual meeting.

The 14th MEDIAS Steering Committee was closed at 16:00 on 22 April 2021.

ANNEXES:

Annex I: List of participants

Name	e-mail	Country	Institution
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Vjekoslav Tičina	ticina@izor.hr	Croatia	IOF
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. 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

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

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

MEDIAS Coordination Meeting

(Mediterranean International Acoustic Surveys)

Zoom – virtual meeting, 20 - 22 April 2021

Meeting Agenda

Tuesday 20/04/2021

09:00 - 09:10 Opening of the meeting & welcome. Adoption of the agenda

09:10 - 09:40 Presentation of the 2019-2020 acoustic surveys in GSA 1 - Northern Alboran Sea and GSA 6 - Northern Spain (Magdalena Iglesias et al.)

09:40 - 10:10 Presentation of the 2019-2020 acoustic surveys in the GSA 7 - Gulf of Lion (Tarek Hattab et al.)

10:10 - 10:40 Presentation of the 2019-2020 acoustic survey in the eastern part of GSA 17 - Northern Adriatic Sea (Vjekoslav Tičina et al.)

10:40 - 11:10 Presentation of the 2019-2020 acoustic surveys in the western part of GSA 17 - Northern Adriatic and GSA 18 - Southern Adriatic (Iole Leonori et al.)

11:10 - 11:30 *Coffe break*

11:30 - 12:00 Presentation of the 2019-2020 acoustic surveys in GSA 20 - Eastern Ionian Sea and GSA 22 - Aegean Sea (Marianna Giannoulaki et. al)

12:00 - 12:30 Presentation of the 2019-2020 surveys in the GSA 29 - Black Sea: Bulgarian survey (Raykov and Dimitrov)

12:30 - 13:00 Presentation of the 2019-2020 surveys in the GSA 29 - Black Sea: Romanian survey (George Tiganov et al.)

13:00 - 14:00 *Lunch break*

14:00 - 14:30 Presentation of the 2019-2020 acoustic survey in GSA 9 and GSA 10 - Ligurian Sea (Angelo Bonanno et al.)

14:30 - 15:00 Presentation of the 2019-2020 acoustic survey in GSA 11 - Sardinia (Angelo Bonanno et al.)

15:30 - 16:00 Presentation of the 2019-2020 acoustic surveys in GSA 15 - Malta Island and GSA 16 - South Sicily (Angelo Bonanno et al.)

16:00 - 16:30 Presentation of other acoustic surveys from GFCM area (outside EU waters) [Presentation of the 2019-2020 acoustic surveys in the eastern part of GSA 18 - Southern Adriatic (Andrea De Felice et al.)]

Wednesday 21/04/2021

09:00 - 09:30 Presentation of other acoustic surveys from GFCM area (cont. – if needed)

09:30 - 10:00 General Discussion (on surveys presented)

10:00 - 10:30 Commission's views and suggestions (Venetia Kostopoulou, DG-MARE)

ToR 2020&2021. – Discussion on General issues

10:30 - 11:10 - Review of issues harmonized within MEDIAS Steering Committee framework and discussion on possibilities for future harmonization issues (Vjekoslav Tičina)

11:10 - 11:30 *Coffe break*

11:30 – 12:00 Information for management decisions

12:00 – 12:30 Input for stock assessment purposes concerning stocks which are managed internationally

12:30 – 13:00 Information for Good Environmental Status in the MSFD

13:00 – 14:00 *Lunch break*

ToR 2020&2021. – Discussion on Specific issues

14:00 – 14:20 Review on status of MEDIAS papers in Special Issues of MMS journal and discussion on issues related to publication cost / invoices and language editing (Guest Editors)

14:20 – 14:40 Acoustic evidences of the juvenile anchovy aggregation and schooling in northern Alboran Sea (Ana Ventero)

14:40 – 15:00 Work on geostatistical scripts to produce standardized NASC maps at the Mediterranean scale (Marco Barra)

15:00 – 15.30 Update of the EchoR: Adaptation and application by MEDIAS groups interested (Tarek)

15:30 – 16:00 Review of MEDIAS Handbook

Thursday 22/04/2021

09:00 – 09:30 Review on MEDIAS Website: http://www.medias-project.eu/medias/website/ (Marco Barra)

09.30 – 10:00 General discussion and revision of the common MEDIAS protocol and Website

10:00 – 10:30 Updating of MEDIAS Handbook

10:30 – 11:00 Drafting the meeting conclusions

11:00 – 11:15 *Coffee break*

11:15 – 11.30 Adoption of meeting conclusioins

11:30 – 12:30 Terms of reference for the next meeting (2022); dates and venue of next meeting

12:30 – 13:00 Other issues

13:00 – 14:00 *Lunch*

14:00 - 16.00 Drafting report

16:00 - Closure of the meeting

Annex IV – RCG Med&BS Recommendation on new surveys

Introduction of new research surveys at sea in the Mediterranean and Black Sea area	
RCM MED&BS 2017 Recommendation 10	RCG MED&BS recommend to introduce new surveys at sea in EU MAP Table 10 Research surveys at sea. Proposed new surveys are: - SOLEMON survey for the GSA 17 and - extension of the MEDIAS survey in GSA 11 and 19 Proposed surveys should not affect in any way the implementation of the existing surveys in terms of available resources for surveys at sea (MEDITS and MEDIAS). STECF EWG 17-14 should take in the consideration this recommendation.
Justification	SOLEMON research survey is filling the gap left behind other surveys. Beam trawl used as sampling gear enable appropriate sampling of benthic fish, crustaceans and cephalopods. SOLEMON research survey is the only fishery independent data source for stock assessment of Solea solea and other benthic species in Adriatic Sea. The SOLEMON data are used for stock assessment purposes. Acustic survey for the evaluation of the biomass and spatial distribution of small pelagic fish in the Mediterranean Sea started since the '70s and several research projects of this kind were undertaken at national level. Since 2009 the acoustic surveys of the UE area in the Mediterranean are coordinated by means of a common protocol under the umbrella of pan-Mediterranean Acoustic Surveys (MEDIAS). Recently, GFCM has approved and started the Mid Term Strategy aimed at improving already existent surveys in non EU countries or develop new ones where they does not yet exist, possibly with the support of MEDIAS group for what concerns acoustic surveys. The general aim is to expand research surveys at sea in the Mediterranean as much as possible in order to gather the most complete picture that is possible. Anyway, even at UE countries level some gaps in GSAs coverage exist by now. With the aim to try to strengthen coverage in UE area, scientists of CNR-ISMAR of Ancona and scientists from CNR-IAMC of Capo Granitola decided to give their availability to cover by acoustic survey respectively GSA 19 (western Ionian Sea) and GSA 11 (Sardinia), given an adequate financial support, possibly to be added to DCRF in the MEDIAS framework in the future.
Follow-up actions needed	Amendment of the Commission Implementing Decision (EU) 2016/1251, of 12 July 2016, adopting a multiannual Union programme for the collection, management and use of data in the fisheries and aquaculture sectors for the period 2017-2019, (notified under document C(2016) 4329).
Responsible persons for follow-up actions	COM, MS, LM, STECF EWG 17-14
Time frame (Deadline)	Report of the STECF EWG 17-14 (1st trimester of the 2018)

Annex V - Terms of Reference for the "MEDIAS 2022"

General:

- to present and harmonize the ongoing acoustic surveys in the Mediterranean Sea and Black Sea;
- to provide information for management decisions if requested;
- 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 if needed;
- Update the MEDIAS Website if needed;
- Agree on the method to produce standardized NASC maps at the Mediterranean scale;
- Work/Update on common maps template to be used by all MEDIAS groups;
- Work on standardization of age reading and maturity estimates.

MEDIAS HANDBOOK

(Version: April 2021)

Common protocol for the MEDIterranean International Acoustic Survey (MEDIAS)

The geographical areas that are 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 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 and Ligurian 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	Black Sea	4300 NM^2	20

Note: * This area includes both GSA 16 (South of Sicily) and part of GSA 15 (Malta Island)
** - not sufficient, as proved in surveys in 2019 and 2020; should be increased.

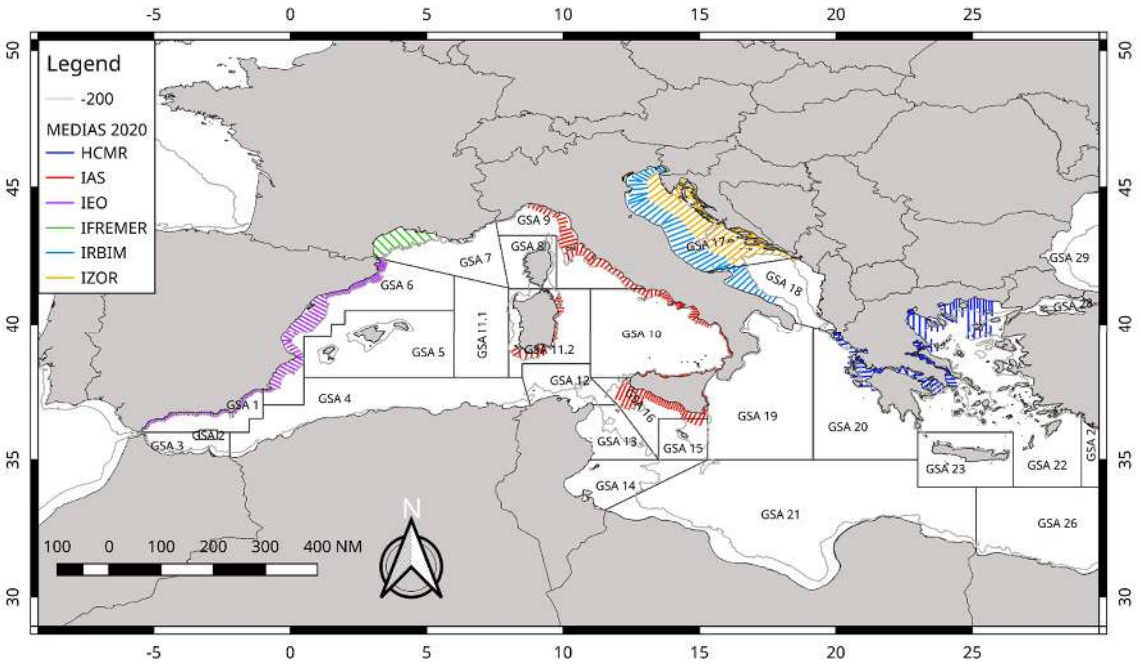

Figure 1: Surveys design in the MEDIAS 2020.

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.

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 2. In principle, one calibration per survey is suggested.

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	
Range to sphere (m)	
Ping rate	
Calibrated TS transducer gain	
Time (GMT)	
RMS	
sA correction	

Survey Design

The survey design for the acoustic sampling should consider 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, considering 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 evaluate the survey performances in each area, a dedicated session with this specific Terms of Reference should be held when needed 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 cavitation.

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 from recent study (in press) indicated that night estimates can be higher or lower compared to daytime estimates largely depending on the area peculiarities 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 whenever this is possible reach the 10 m isobath. 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". In the case of parallel transect designs, the acoustic energy in the inter-transect tracks will not be considered 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 scrutinization. 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 TS equations are currently applied depending on the area. The application of common TS equations should ideally derive from *in situ* estimations of TS, preferably based on acoustic data from the Mediterranean Sea. For this purpose, specific workshops were held in the framework of AcousMed project as well as DCF and MEDIAS coordination meetings but largely based on the analysis of available historical data. Based on these results, the 5th MEDIAS coordination meeting agreed to apply for sardine the following TS-TL equation this point forward:

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

where TS=Target Strength, TL=Total Length. The Steering Committee at its 14th annual meeting also agreed that in addition to use previous TS equation for sardine (with b20= -72.6 dB), IFREMER also will continue to use a b20=-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 procedure is considered mandatory to calculate geostatistical CV to be provided along with acoustic estimates.

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

b) 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.

c) Calibrate

d) 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.

e) Remove background noise

f) Before analyzing the acoustic data any ambient noise present in the underwater environment has to be removed.

g) 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:

1. Intermittent noise removal;
2. Evaluate possible interferences that may produce artefacts in the echograms, and adopt a procedure for removing them;
3. Surface and seafloor exclusions;
4. Use lines for correctly separating the backscattering signals from surface and bottom;
5. Single targets estimation;
6. 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;
7. Schools estimation;
8. Use regions and/or mathematical operators for estimating backscattering signal due to fish aggregations.

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 and/or group of species should be available also.

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 analyzed 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.

Considering that, 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. If codend cover is used it should be reported and not to be used for LFD of target species.
- 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.

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 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 (2017) 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. Mean TL at age should be reported.

- It is strongly recommended the use of ICES WKSPMAT report (2008) 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.

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: MEDIAS proposals in Annex VII). The 5th 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.

Ecosystem indices 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 3 the ecosystem indices that can derive from acoustic surveys (based on data regularly collected and analyzed) are reported.

Table 3. Ecosystem indices that could be derived from acoustic surveys.

Good Environmental Status indices	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)			
	Indices	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)			

Tables for DCF Data Call

The common templates (e. g. https://datacollection.jrc.ec.europa.eu/dc/medbs/templates), currently used for submission of MEDIAS results to Data Calls by MS, provided by JRC, are the following:

Abundance (in numbers per species per sex and length class)	xxx_Abundance
Biomass (biomass per species per sex and length class)	xxx_Biomass
Abundance biomass (abundance and biomass per species per sex and age class)	xxx_Abund_Biom

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 (time series of average t/nm^2)
- Headline, footrope length of the pelagic net, sidelines dimensions, mesh size
- CTD stations map
- Biomass per length classes (0.5 cm) and per age classes in tons
- Graphs of Age Length Keys (in %, with total No. otoliths, by length clases)
- Maps of anchovy and sardine spatial distribution (proportional maps of NASC values - bubble plots)
- 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.

Data accessibility

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

-MEDIAS results per survey are presented in the Annual MEDIAS report which is freely available in the MEDIAS website
-Overall biomass and abundance estimates are available through the DCF 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.

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Summary table 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 kHz depending on availability.
Pulse duration (ms)	0.5 or 1 ms, should be reported
Beam Angles (degrees) Athw. Beam Angle, Alog. Beam Angle	Should be reported
Ping rate	Maximum depending on depth
Calibration (No per survey)	A calibration report should be given One calibration per survey
Threshold for acquisition (dB)	-80
Threshold for assessment (dB)	-70 to -60 (reported)
Survey design	
Transects design	Perpendicular to the coastline/bathymetry, otherwise depending on topography The survey design according to the MEDIAS conclusion for each area and should be reported.
Inter-transect distance (NM)	Max <=12 NM. The inter-transect distance should be according to the MEDIAS conclusion for each area and should be reported
Time of day for acoustic sampling	Day time. Otherwise, in cases of time limitation and if echo allocation into species does not depend on school shape identification (in this case justification of the accuracy of results will be presented)

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

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

Annex VII - MEDIAS group proposals:

1) MEDIAS database

MEDIAS group is planning 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 is 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. General outline of a database for acoustic surveys is shown in Figure A1.

The major fields agreed are associated to:

a) input information related to export data from acoustic software (Figs. A2 & A3);

b) input information related to biological sampling and environmental data sampling (Figs. A4 & A5);

c) queries-calculations to fulfill DCF requirements (Fig. A6);

d) queries-calculations to facilitate abundance/biomass estimates (Fig. A6);

e) echosounder calibration report (Fig. A7);

f) data input validation and control checks;

g) up to date demands related to surveys and the Ecosystem Approach to Fisheries (Figs. A5 & A6).

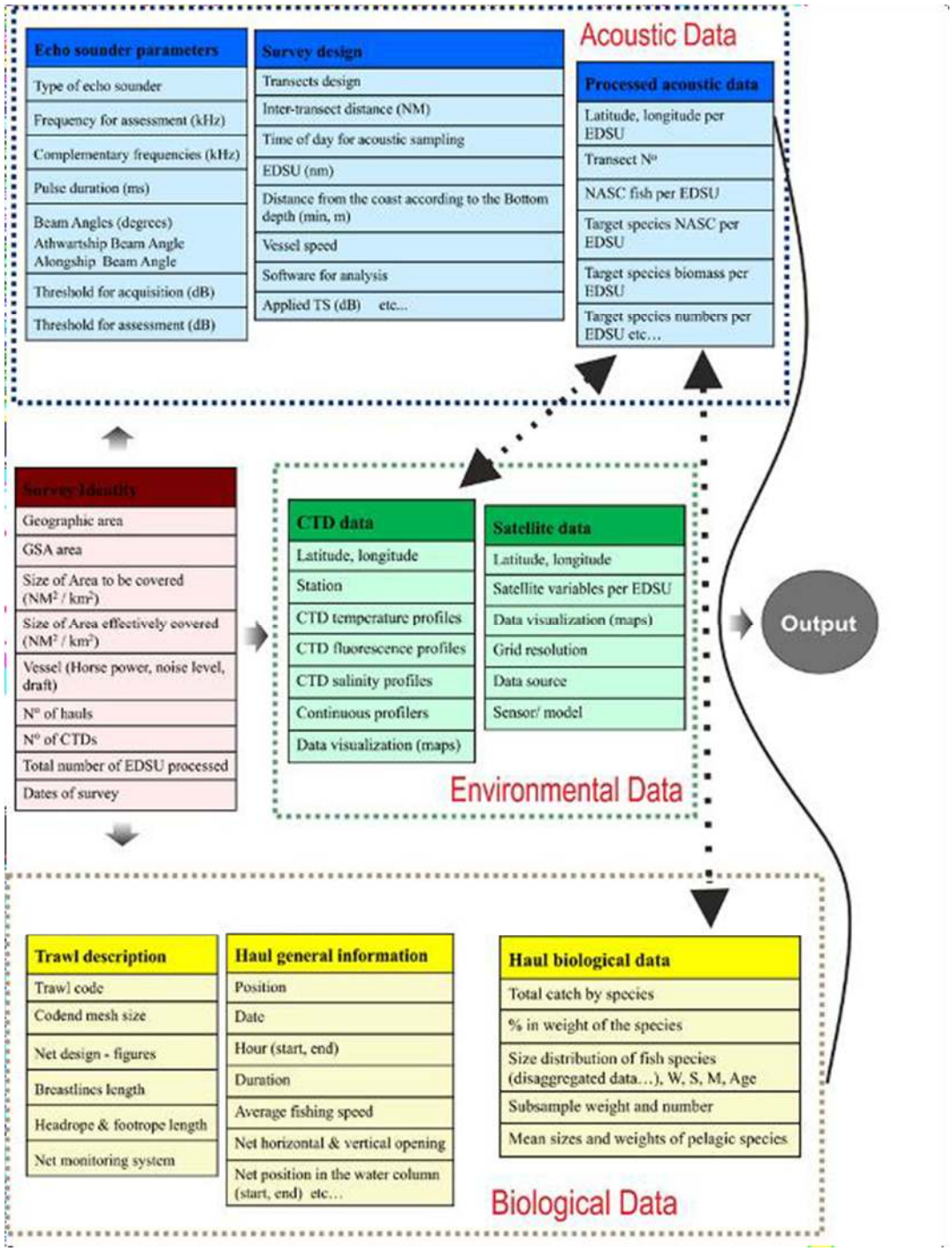

Figure A1. General outline of a database for acoustic surveys.

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 A2. 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 A3. 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.

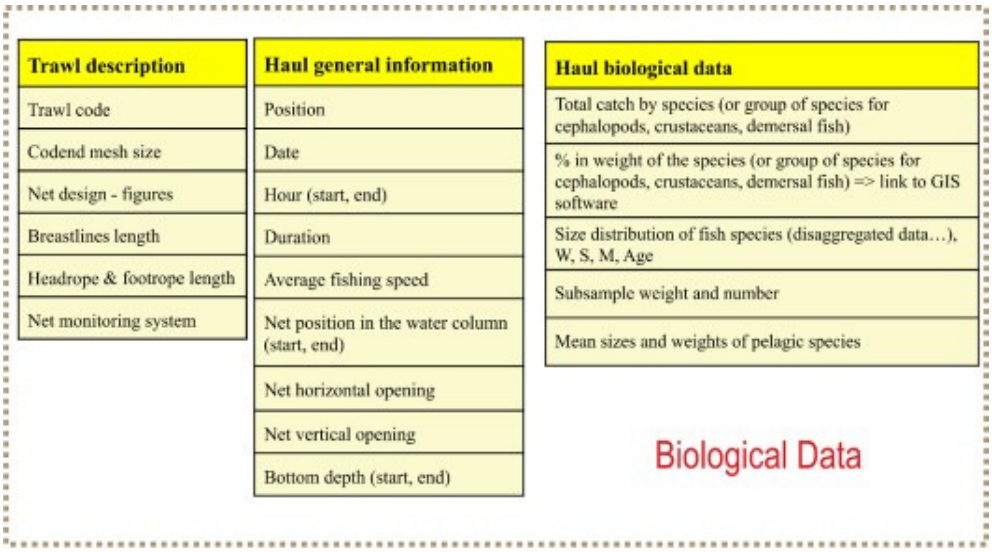

Figure A4. Fields associated with input info on Biological Data related to acoustic surveys

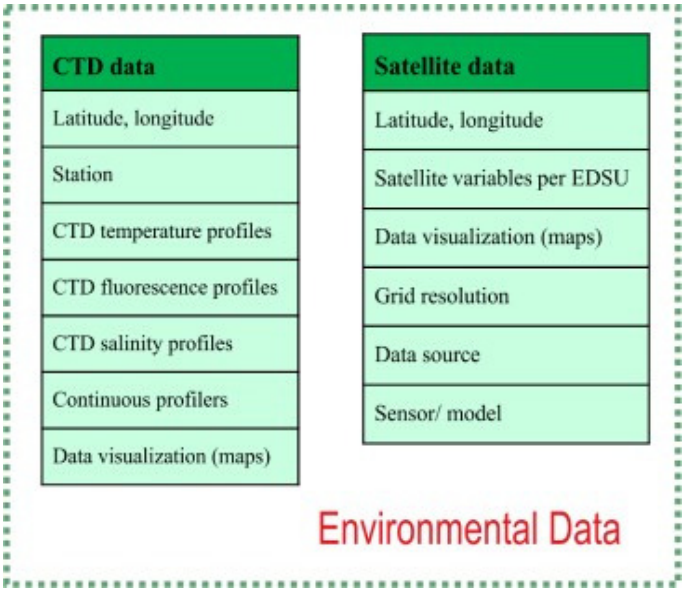

Figure A5. Fields associated with input info on Environmental Data related to acoustic surveys

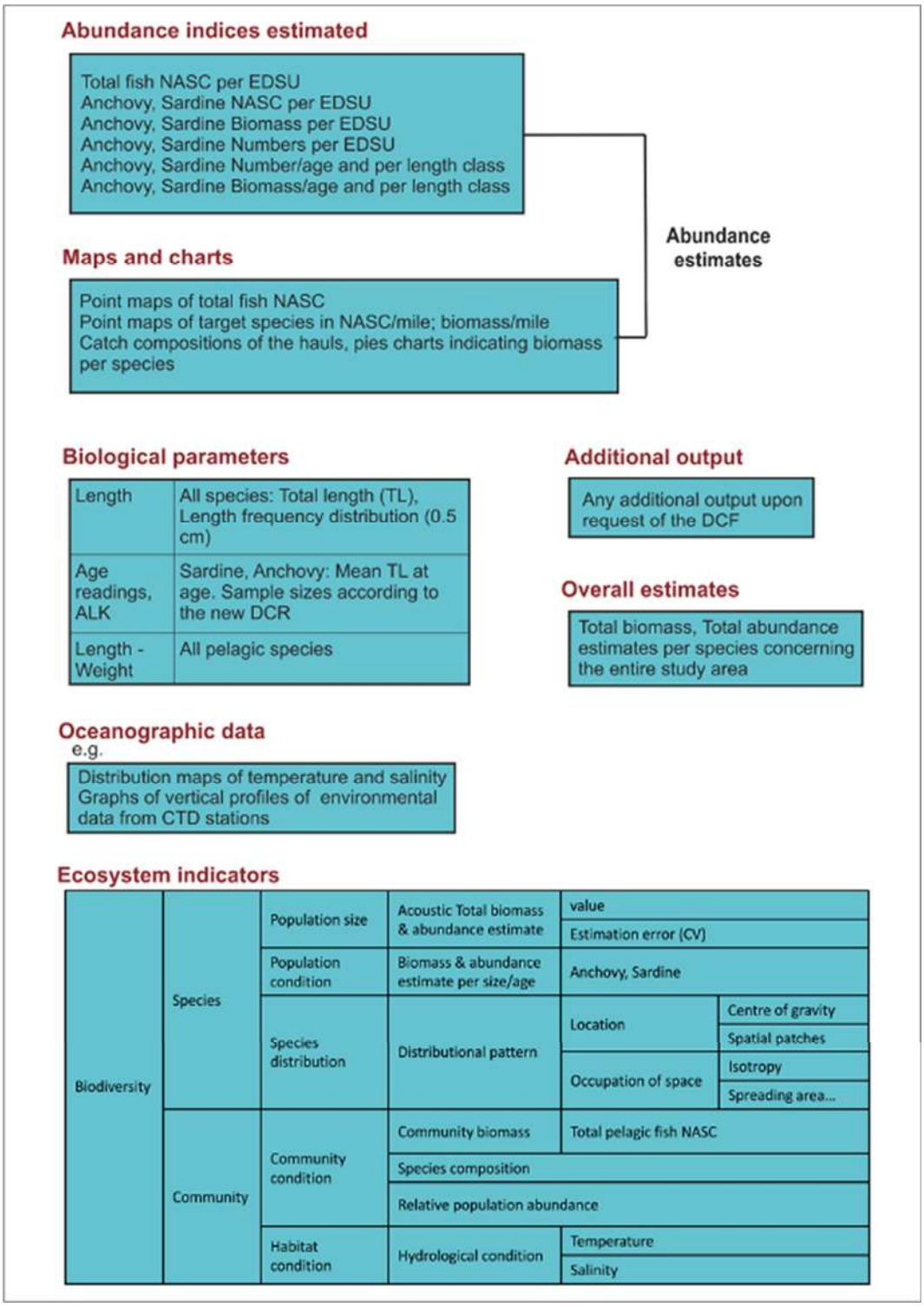

Figure A6. Fields associated with potential acoustic database output.

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 A7. Database Fields related to electro-acoustic calibration report.

2) 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) by CNR-IAS (Italy), western Adriatic Sea (GSA 17 and 18) by CNR-IRBIM (Italy), eastern Adriatic Sea (GSA 17) by IOF (Croatia) and eastern Ionian Sea and Aegean Sea (GSA 20 and 22) by HCMR (Greece). The proposal also concerns the acoustic survey carried out by CNR-IAS (Italy) in the Tyrrhenian and Ligurian seas (GSAs 9 and 10), that are part of the MEDIAS since 2017. 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.

A proper financial support is needed in order to plan and perform this kind of activity, both in the field and in the laboratory. Moreover, there is the need to buy specific staff such as plankton nets, bottles, laboratory staff for the preservation and the analysis of the samples, etc.

3) 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.