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Acoustic assessment and distribution of anchovy and sardine in ICES Subdivision 9a South during the *ECOCADIZ 2017-07* Spanish survey (July-August 2017) with notes on the distribution of other pelagic species.

By

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ABSTRACT

The present working document summarises a part of the main results obtained from the Spanish (pelagic ecosystem-) acoustic survey conducted by IEO between 31st July and 13rd August 2017 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cadiz onboard the R/V *Miguel Oliver*. The 21 foreseen acoustic transects were sampled. A total of 22 valid fishing hauls were carried out for echo-trace ground-truthing purposes. This working document only provides abundance and biomass estimates for anchovy and sardine which are presented without age structure. The distribution of all the mid-sized and small pelagic fish species susceptible of being acoustically assessed is also shown from the mapping of their back-scattering energies. Chub mackerel was the most frequent species in the fishing hauls, followed by anchovy, mackerel, sardine and bogue. *Trachurus* spp. showed a medium relative frequency of occurrence. Chub mackerel was also the most abundant species in these hauls, followed at quite a distance by anchovy, sardine and blue jack mackerel, with the remaining species showing negligible relative contributions. The bulk of the anchovy population was almost exclusively restricted to the central part of the surveyed area, with the smallest anchovies mainly occurring in the surroundings of the Guadalquivir river mouth and Bay of Cadiz, and larger/older anchovies occurring in the westernmost waters. The total biomass estimated for anchovy, 12.2 kt (1 504 million fish), was well below its historical average (ca, 23 kt) and such a level represent a strong and abrupt decreasing trend in relation to the most recent levels. This decreased biomass level is corroborated by its *PELAGO* spring survey counterpart (13.8 kt) and by the preliminary *BOCADEVA* DEPM survey estimate (12.4 kt). Sardine recorded weak acoustic echo-integration in summer 2017, with somewhat higher detections being recorded in the western and central zones in the Gulf. This pattern is quite similar to the one provided by *PELAGO* survey in spring. *ECOCADIZ* survey sardine estimates suggest in relative terms similar strong decreasing trends in abundance and biomass levels than the exhibited ones by its spring counterpart *PELAGO*. However, in absolute terms, *ECOCADIZ* provides a worst scenario, with a biomass estimate of only 11 kt (against the 39 kt estimated by *PELAGO* in spring). Although *ECOCADIZ* age structured estimates are not still available, the length frequency distribution of the whole population denotes a not very age-structured population, which is still maintained by relatively small sardines.

INTRODUCTION

ECOCADIZ surveys constitute a series of yearly acoustic surveys conducted by IEO in the Subdivision IXa South (Algarve and Gulf of Cadiz, between 20 – 200 m depth) under the "pelagic ecosystem survey" approach onboard R/V *Cornide de Saavedra* (until 2013, since 2014 on onboard R/V *Miguel Oliver*). This series started in 2004 with the *BOCADEVA 0604* pilot acoustic - anchovy DEPM survey. The following surveys within this new series (named *ECOCADIZ* since 2006 onwards) are planned to be routinely performed on a yearly basis, although the series, because of the available ship time, has shown some gaps in those years coinciding with the conduction of the triennial anchovy DEPM survey (the true *BOCADEVA* series, which first survey started in 2005).

Results from the *ECOCADIZ* series are routinely reported to ICES Expert Groups on both stock assessment (formerly in WGMHSA, WGANC, WGANSA, at present in WGHANSA) and acoustic and egg surveys on anchovy and sardine (WGACEGG).

The present Working Document advances some results from the *ECOCADIZ 2017-07* survey. These results will only refer to the acoustic estimates (not age-structured) and spatial distribution of anchovy and sardine and to inferences on the spatial distribution of other pelagic species from the distribution of the acoustic energy attributed to each of these species.

MATERIAL AND METHODS

The *ECOCADIZ 2017-07* survey was carried out between 31st July and 13rd August 2017 onboard the Spanish R/V *Miguel Oliver* covering a survey area comprising the waters of the Gulf of Cadiz, both Spanish and Portuguese, between the 20 m and 200 m isobaths. The survey design consisted in a systematic parallel grid with tracks equally spaced by 8 nm, normal to the shoreline (**Figure 1**).

Echo-integration was carried out with a *Simrad™ EK60* echo sounder working in the multi-frequency fashion (18, 38, 70, 120, 200 kHz). Average survey speed was about 10 knots and the acoustic signals were integrated over 1-nm intervals (ESDU). Raw acoustic data were stored for further post-processing using *Echoview™* software package. Acoustic equipment was previously calibrated during the *MEDIAS 2017* acoustic survey, a survey conducted in the Spanish Mediterranean waters just before the *ECOCADIZ* one, following the standard procedures (Demer *et al*., 2015).

Survey execution and abundance estimation followed the methodologies firstly adopted by the ICES *Planning Group for Acoustic Surveys in ICES Sub-Areas VIII and IX* (ICES, 1998) and the recommendations given more recently by the *Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES areas VIII and IX* (WGACEGG; ICES, 2006a,b).

Fishing stations for echo-trace ground-truthing were opportunistic, according to the echogram information, and they were carried out using a ca. 20 m-mean vertical opening pelagic trawl (*Gran Hermano* gear) at an average speed of 4 knots. Gear performance and geometry during the effective fishing was monitored with *Simrad™ Mesotech FS20/25* trawl sonar. Trawl sonar data from each haul were recorded and stored for further analyses.

Ground-truthing haul samples provided biological data on species and they were also used to identify fish species and to allocate the back-scattering values into fish species according to the proportions found at the fishing stations (Nakken and Dommasnes, 1975). Additional fishing hauls were conducted by night aimed at the collection of anchovy females with hydrated eggs (for DEPM adults parameters' sampling).

Length frequency distributions (LFD) by 0.5-cm class were obtained for all the fish species in trawl samples (either from the total catch or from a representative random sample of 100-200 fish). Only those LFDs based on a minimum of 30 individuals and showing a normal distribution were considered for the purpose of the acoustic assessment.

Individual biological sampling (length, weight, sex, maturity stage, stomach fullness, and mesenteric fat content) was performed in each haul for anchovy, sardine (in both species with otolith extraction and with additional preservation of gonads in anchovy mature females), mackerel and horse-mackerel species, and bogue. Specific DEPM adult parameters' biological sampling protocols, involving an extra sampling, were applied to all the anchovy positive samples (see Jiménez *et al*., WD 2017)..

The following TS/length relationship table was used for acoustic estimation of assessed species (recent IEO standards after ICES, 1998; and recommendations by ICES, 2006a,b):

Species	b_{20}
Sardine (*Sardina pilchardus*)	-72.6
Round sardinella (*Sardinella aurita*)	-72.6
Anchovy (*Engraulis encrasicolus*)	-72.6
Chub mackerel (*Scomber japonicus*)	-68.7
Mackerel (*S. scombrus*)	-84.9
Horse mackerel (*Trachurus trachurus*)	-68.7
Mediterranean horse-mackerel (*T. mediterraneus*)	-68.7
Blue jack mackerel (*T. picturatus*)	-68.7
Bogue (*Boops boops*)	-67.0
Blue whiting (*Micromesistius poutassou*)	-67.5
Boarfish (*Capros aper*)	-66.2* (-72.6)

*Boarfish b_{20} estimate following to Fässler *et al*. (2013). Between parentheses the usual IEO value considered in previous surveys.

The *PESMA 2010* software (J. Miquel, unpublished) has got implemented the needed procedures and routines for the acoustic assessment following the above approach.

The survey did not make use of *CUFES* sampler, as usual, since such sampling was carried out during the *BOCADEVA* DEPM survey, conducted almost at the same time. A *Sea-bird Electronics™ SBE 21 SEACAT* thermosalinograph and a *Turner™ 10 AU 005 CE Field* fluorometer were used during the acoustic tracking to continuously monitor some hydrographical variables (sub-surface sea temperature, salinity, and *in vivo* fluorescence. Vertical profiles of hydrographical variables were also recorded by night from 178 CTD casts by using *Sea-bird Electronics™ SBE 911+ SEACAT* (with coupled *Datasonics* altimeter, *SBE 43* oximeter, *WetLabs ECO-FL-NTU* fluorimeter and *WetLabs C-Star 25 cm* transmissometer sensors) and *LADCP T-RDI WHS* 300 kHz profilers (**Figure 2**). *VMADCP RDI 150 kHz* records were also continuously recorded by night between CTD stations.

Twenty five (25) *Manta trawl* hauls were also carried out to characterize the distribution pattern of micro-plastics over the shelf (**Figure 3**). These hauls did not follow a pre-established sampling scheme although the main goal was to have samples well distributed both in the coastal and oceanic areas of the shelf. Consequently, the hauls were opportunistically carried out taking the advantage of the conduction of fishing hauls, the start or end of an acoustic transect or whatever discrete station devoted to the sampling of either hydrographical or biological variables which were close to the preferred depths.

Information on presence and abundance of sea birds, turtles and mammals was also recorded during the acoustic sampling by one onboard observer.

RESULTS

Acoustic sampling

The acoustic sampling started on 01st August in the coastal end of the transect RA01 and finalized on 11th August in the oceanic end of the transect RA21 (**Table 1, Figure 1**). Transects were acoustically sampled in the E-W direction. The whole 21-transect sampling grid was sampled. The acoustic sampling usually started at 06:00 UTC although this time might vary depending on the duration of the works related with the hydrographic sampling. The foreseen start of transects RA14 and RA15 by the coastal end had to be displaced to deeper waters in order to avoid the occurrence of open-sea fish farming/fattening cages.

Groundtruthing hauls

Twenty two (22) fishing operations, all of them being considered as valid ones according to a correct gear performance and resulting catches, were carried out (**Table 2**, **Figure 4**). Three (3) additional fishing hauls were conducted by night aimed at the collection of anchovy females with hydrated eggs (for DEPM adults parameters' sampling).

As usual in previous surveys, some fishing hauls were attempted by fishing over an isobath crossing the acoustic transect as close as possible to the depths where the fishing situation of interest was detected over that transect. In this way the mixing of different size compositions (*i.e.*, bi-, multi-modality of length frequency distributions) was avoided as well as a direct interaction with fixed gears. The mixing of sizes is more probable close to nursery-recruitment areas and in regions with a very narrow continental shelf. Given that all of these situations were not very uncommon in the sampled area, 36% of valid hauls (8 hauls) were conducted over isobath.

Because of many echo-traces usually occurred close to the bottom, all the pelagic hauls were carried out like a bottom-trawl haul, with the ground rope working over or very close to the bottom. According to the above, the sampled depth range in the valid hauls oscillated between 43-170 m.

During the survey were captured 1 Chondrichthyan, 27 Osteichthyes, 3 Cephalopod and 2 Echinoderm species. The percentage of occurrence of the more frequent species in the trawl hauls is shown in the enclosed text table below (see also **Figure 5**). The pelagic ichthyofauna was the most frequently captured species set and the one composing the bulk of the overall yields of the catches. Within this pelagic fish species set, chub mackerel was the most frequent captured species in the valid hauls (21 hauls, 95% presence index) followed by anchovy, mackerel, sardine and bogue (with relative occurrences between 59-86%). *Trachurus* spp. showed a medium relative frequency of occurrence (ca. 30-40%), whereas round sardinella showed a low occurrence in the whole surveyed area (9%).

For the purposes of the acoustic assessment, anchovy, sardine, round sardinella, mackerel species, horse & jack mackerel species, and bogue were initially considered as the survey target species. All of the invertebrates, and both bentho-pelagic (*e.g.*, manta rays) and benthic fish species (*e.g.*, flatfish, gurnards, etc.) were excluded from the computation of the total catches in weight and in number from those fishing stations where they occurred. Catches of the remaining non-target species were included in an operational category termed as "*Others*".

According to the above premises, during the survey were captured a total of 15.2 tonnes and 367 thousand fish (**Table 3**). 84% of this fished biomass corresponded to chub mackerel, 7% to anchovy, sardine and Mediterranean horse mackerel 2% each, 3% to Mediterranean horse mackerel, and contributions

lower than 2% by the remaining species. The most abundant species in ground-truthing trawl hauls was also chub mackerel (66%) followed by a long distance by anchovy (27%), sardine (4%) and blue jack mackerel (2%), with the remaining species showing lower contributions than 0.5%.

Species	# of fishing stations	Occurrence (%)	Total weight (kg)	Total number
Scomber colias	21	95	12769,62	242415
Engraulis encrasicolus	19	86	1084,63	98912
Merluccius merluccius	18	82	13,537	153
Scomber scombrus	17	77	72,627	674
Sardina pilchardus	15	68	285,119	12714
Boops boops	13	59	72,191	586
Spondyliosoma cantharus	9	41	55,085	589
Trachurus trachurus	9	41	63,862	764
Pagellus erythrinus	8	36	95,934	604
Diplodus annularis	6	27	1,433	26
Trachurus picturatus	6	27	207,895	6896
Trachurus mediterraneus	6	27	288,781	1497
Diplodus vulgaris	6	27	137,684	910
Loligo media	5	23	1,322	297
Pagellus bellottii	4	18	18,72	123
Pomatomus saltatrix	3	14	5,43	16
Diplodus bellottii	3	14	3,251	56
Spicara flexuosa	3	14	8,404	162
Sardinella aurita	2	9	8,396	27

The species composition, in terms of percentages in number, in each valid fish station is shown in **Figure 5**. A first impression of the distribution pattern of the main species may be derived from the above figure. Thus, anchovy showed a relatively wide distribution over the surveyed area, although the highest yields were recorded in the Spanish waters. The size composition of anchovy catches confirms the usual pattern exhibited by the species in the area during the spawning season, with the largest fish being distributed in the westernmost waters and the smallest ones concentrated in the surroundings of the Guadalquivir river mouth and adjacent shallow waters, including those ones in front of the Bay of Cadiz (**Figure 6**). Although it was widely distributed, sardine was less frequent than anchovy and showed relatively low yields in the surveyed area. Juvenile sardines were almost exclusively captured in the shallowest hauls conducted in the coastal fringe between Tinto-Odiel river mouth and the Bay of Cadiz (**Figure 7**). Chub mackerel, horse mackerel, blue jack mackerel and bogue, although they occurred in a great part of the study area, only showed relatively high yields in the Portuguese waters. Mediterranean horse mackerel was restricted to the easternmost Spanish waters.

Back-scattering energy attributed to the "pelagic assemblage" and individual species

A total of 322 nmi (ESDU) from 21 transects has been acoustically sampled by echo-integration for assessment purposes. From this total, 210 nmi (11 transects) were sampled in Spanish waters, and 112 nmi (10 transects) in the Portuguese waters. The enclosed text table below provides the nautical area-scattering coefficients attributed to each of the selected target species and for the whole "pelagic fish assemblage".

S_A (m^2 nmi^{-2})	Total spp.	PIL	ANE	MAC	MAS	HOM	HMM	JAA	BOG	SAA
Total Area (%)	83284 (100.0)	9369 (11.2)	19044 (22.9)	34 (0.04)	32262 (38.7)	3078 (3.7)	15086 (18.1)	149 (0.2)	4189 (5.0)	73 (0.1)
Portugal (%)	35511 (42.6)	5121 (54.7)	2782 (14.6)	5 (14.7)	24022 (74.5)	3018 (98.1)	0 (0.0)	149 (100.0)	414 (9.9)	0 (0.0)
Spain (%)	47773 (57.4)	4248 (45.3)	16262 (85.4)	30 (88.2)	8240 (25.5)	61 (2.0)	15086 (100.0)	0 (0.0)	3775 (90.1)	73 (100.0)

For this "pelagic fish assemblage" has been estimated a total of 83 284 m^2 nmi^{-2}. Portuguese waters accounted for 43% of this total back-scattering energy and the Spanish waters the remaining 57%. However, given that the Portuguese sampled ESDUs were almost the half of the Spanish ones, the (weighted-) relative importance of the Portuguese area (*i.e.*, its density of "pelagic fish") is actually much higher. The mapping of the total back-scattering energy is shown in **Figure 8**. By species, chub mackerel (39%), anchovy (23%), Mediterranean horse mackerel (18%) and sardine (11%) were the most important species in terms of their contributions to the total back-scattering energy. Bogue (5%) and horse mackerel (4%) were the following species in importance. The remaining species contributed with less than 0.5% only.

Some inferences on the species' distribution may be carried out from regional contributions to the total energy attributed to each species: Mediterranean horse mackerel, round sardinella, mackerel and anchovy seemed to show greater densities in the Spanish waters, whereas chub mackerel, blue jack mackerel, horse mackerel, could be considered as typically "Portuguese species" in this survey. Regional acoustic contributions attributed to sardine were relatively balanced.

According to the resulting values of integrated acoustic energy, the species acoustically assessed in the present survey finally were anchovy, sardine, round sardinella, mackerel, chub mackerel, blue jack mackerel, horse mackerel, Mediterranean horse mackerel and bogue. For the time being the only available acoustic estimates of abundance and biomass are the ones for anchovy and sardine. Furthermore, these estimates are not still presented with age-structure. For the remaining species only the spatial distribution of NASCs will be shown in the present WD.

Spatial distribution and abundance/biomass estimates

Anchovy

Parameters of the survey's length-weight relationship for anchovy are given in **Table 4**. The back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are shown in **Figure 9**. The estimated abundance and biomass by size class are given in **Table 5** and **Figure 10**.

Anchovy concentrated almost exclusively between Eastern Cape Santa Maria and Bay of Cadiz, as previously reported by the *PELAGO* survey in spring (**Figure 9**).

The size class range of the assessed population varied between the 7.5 and 18.5 cm size classes, with two modal classes at 9.5 and 11.5 cm. The size composition of anchovy by coherent post-strata confirms the usual pattern exhibited by the species in the area during the spawning season, with the largest fish being distributed in the westernmost waters and the smallest ones concentrated in the surroundings of the Guadalquivir river mouth and adjacent shallow waters, including those ones in front of the Bay of Cadiz (**Table 5**, **Figures 9** and **10**, see also **Figure 6**). As it has been happening in the last years, during the 2017 survey some recruitment has also been recorded, probably as a consequence of the delayed survey dates.

This fact seems to have been as evident this summer as in 2015, when it was recorded the historical lowest estimates in mean length and weight for the whole estimated population (106 mm, 8.0 g). This year such variables (109 mm, 8.1 g) are very close to the abovementioned ones.

Ten coherent post-strata have been differentiated according to the S_A value distribution and the size composition in the fishing stations. The acoustic estimates by homogeneous post-stratum and total area are shown in **Table 5** and **Figure 10**. Overall acoustic estimates in summer 2017 were of 1504 million fish and 12229 tonnes. By geographical strata, the Spanish waters yielded 90% (1354 million) and 78% (9563 t) of the total estimated abundance and biomass in the Gulf confirming the importance of these waters in the species' distribution. The estimates for the Portuguese waters were 151 million and 2666 t.

The Gulf of Cadiz anchovy egg distribution from CUFES sampling is shown in **Figure 11**. Anchovy egg distribution in summer 2017 is quite coincident with the adults' distribution, although the high egg densities recorded west Cape Santa Maria do not correspond with the acoustic records. Nevertheless, such acoustic records correspond to the largest fish, supposedly with higher reproductive potential

Sardine

Parameters of the survey's size-weight relationship for sardine are shown in **Table 4**. The back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are shown in **Figure 12**. Estimated abundance and biomass by size class are given in **Table 6** and **Figure 13**.

Sardine recorded weak acoustic echo-integration in summer 2017, with somewhat higher detections being recorded in the western and central zones in the Gulf. This pattern is quite similar to the one provided by *PELAGO* survey in spring (**Figure 12**).

Sizes of the assessed population ranged between 9.5 and 18.0 cm size classes. The length frequency distribution of the population was clearly bimodal, with one main mode at 15.5 cm size class and a secondary one at 11.5 cm (**Table 6**; **Figure 13**). The 2017 summer estimate of mean size (142 mm) is among the lowest estimates within the series. This fact might be explained by the relative importance of the juvenile fraction in the estimated population (mode at 11.5 cm), which was mainly located in relatively shallow waters in front of the Guadiana and Guadalquivir river mouths and the Bay of Cadiz (**Table 6**, **Figure 13,** see also **Figure 7**). However, such a decrease in mean size is not coupled with a similar decreasing trend in the mean weight (23.4 g), which was close to the historical average. The contribution in biomass of the adult fraction in the assessed population (around at a main modal size class at 15.5 cm) may be enough to compensate the greater relative contribution of juveniles.

Eight size-based homogeneous sectors were delimited for the acoustic assessment. The estimates of Gulf of Cadiz sardine abundance and biomass in summer 2017 were 472 million fish and 11053 t. Portuguese waters accounted for 49.1% of abundance (232 million fish) and 65.6% of the total estimated biomass (7251 t), values from which could be inferred a large body size on average. In contrast, the estimates from the Spanish area (240 million fish – 50.9% of abundance –; 3802 t – 34.4% of biomass –), denote a dominance of the smallest sardines.

Mackerel

Parameters of the survey's length-weight relationship are shown in **Table 4**. The distribution of the back-scattering energy attributed to this species is shown in **Figure 14**.

Atlantic mackerel mainly occurred in the western and central zones of the study area (**Figure 14**).

Chub mackerel

Parameters of the survey's length-weight relationship are shown in **Table 4**. The distribution of the back-scattering energy attributed to this species is shown in **Figure 15**.

Although widely distributed, it was a typically Western Algarve species in summer 2017 (**Figure 15**).

Blue jack-mackerel

The survey's length-weight relationship for this species is given in **Table 4**. The distribution of the back-scattering energy attributed to this species is illustrated in **Figure 16**.

The species showed during the survey very weak acoustic detections. It was restricted almost exclusively to the Algarve outer shelf waters. In some extent its distribution resembles to the ones of chub mackerel and horse mackerel (**Figure 16**; see also **Figure 15** and **17** for comparison).

Horse mackerel

The survey's length-weight relationship for horse mackerel is shown in **Table 4**. The back-scattering energy attributed to this species is shown in **Figure 17**.

Horse mackerel was a typically Algarve species in summer 2017, almost absent in the Spanish waters (**Figure 17**).

Mediterranean horse-mackerel

The survey's length-weight relationship for this species is shown in **Table 4**. Back-scattering energy attributed to the species is represented in **Figure 18**.

Mediterranean horse-mackerel was only present all over the Spanish inner-mid shelf waters, extending this year its distribution a little further west in relation to its usual distribution, reaching to the Guadiana river mouth coastal waters (**Figure 18**).

Bogue

Parameters of the survey's length-weight relationship for bogue are shown in **Table 4**. Back-scattering energy attributed to bogue is shown in **Figure 19**.

Although widely distributed, the species showed relatively low acoustic detections, somewhat higher in the Spanish waters (**Figure 19**).

Round Sardinella

Parameters of the survey's length-weight relationship for bogue are shown in **Table 4**. Back-scattering energy attributed to bogue is shown in **Figure 20**.

The species showed weak detections restricted to the easternmost waters in the Gulf (**Figure 20**).

(SHORT) DISCUSSION

The historical series of anchovy biomass estimates is shown in **Figure 21**. The summer 2017 abundance estimate (1504 million)denotes a sudden and strong decreasing trend leading to the population levels well below to those ones corresponding to the historical average (ca. 2000 million fish). This decreasing trend in abundance is completely coupled to the trend exhibited by the biomass, which also showed a strong decrease in relation to the previous year estimate. The 2017 biomass estimate (12.2 kt) also situates well below its historical average (ca. 23 kt). The above decreasing trend is also corroborated by the *BOCADEVA* DEPM provisional estimate (12.4 kt; Jiménez *et al*., WD 2017).

For this same surveyed area, the Portuguese spring survey *PELAGO 17* estimated two months before 1855 million fish and 13797 t (137 million and 1208 t in Portuguese waters, 1718 million and 12589 t in Spanish ones; see Marques *et al*., 2017, WD). Both overall and regional estimates are very close to those provided by the *ECOCADIZ* summer survey. It should be recalled that *PELAGO 16* estimated the last year 65 345 t and 9 811 million (all the anchovy in Spanish waters), its historical maximum, suggesting an even more abrupt fall that the one showed by its summer counterpart.

Regarding sardine, *ECOCADIZ* survey estimates suggest in relative terms similar strong decreasing trends in abundance and biomass levels than the exhibited ones by its spring counterpart *PELAGO*. However, in absolute terms, *ECOCADIZ* provides a worst scenario, with a biomass estimate of only 11 kt (against the 39 kt estimated by *PELAGO* in spring). Although *ECOCADIZ* age structured estimates are not still available, the length frequency distribution of the whole population denotes a not very age-structured population, which is still maintained by relatively small sardines.

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Table 1. *ECOCADIZ 2017-07 s*urvey. Descriptive characteristics of the acoustic tracks.

Acoustic Track	Location	Date	Start				End			
			Latitude	Longitude	UTC time	Mean depth (m)	Latitude	Longitude	UTC time	Mean depth (m)
R01	Trafalgar	01/08/17	36º 13,100 N	6º 08,716 W	06:09	20	36º 02,154 N	6º 28,756 W	08:04	243
R02	Sancti-Petri	01/08/17	36º 08,995N	6º 34,016W	08:58	30	36º 19,390N	6º 14,469W	16:23	30
R03	Cádiz	02/08/17	36º 27,250N	6º 19,180W	06:03	28	36º 16,621N	6º 37,809W	10:59	246
R04	Rota	02/08/17	36º 24,500N	6º 40,750W	11:58	182	36º 34,46N	6º 23,128W	17:33	22
R05	Chipiona	03/08/17	36º 40,237N	6º 29,799 W	06:00	24	36º 31,150N	6º 46,250W	09:07	214
R06	Doñana	03/08/17	36º 37,927N	6º 51,406 W	10:08	182	36º 46,500N	6º 35,946 W	15:30	23
R07	Matalascañas	04/08/17	36º 53,681N	6º 40,848W	06:04	22	36º 43,933N	6º 58,323W	07:50	236
R08	Mazagón	05/08/17	37º 09,710 N	6º 44,530W	08:09	22	36º 49,449N	7º 06,172W	10:19	196
R09	Punta Umbría	05/08/17	36º 49,639N	7º 06,304 W	10:23	184	37º 03,927N	6º 56,374W	16:50	30
R10	El Rompido	06/08/17	37º 07,076N	7º 06,952W	06:02	23	36º 49,809N	7º 06,802W	07:47	224
R11	Isla Cristina	06/08/17	36º 53,546N	7º 16,804W	08:47	147	37º 07,414N	7º 16,940W	10:11	24
R12	V.R. do Sto. Antonio	07/08/17	37º 06,250N	7º 26,570W	08:04	26	36º 56,190N	7º 26,500W	09:49	249
R13	Tavira	07/08/17	36º 57,063N	7º 36,110W	10:41	144	37º 05,095N	7º 33,066W	13:27	23
R14	Fuzeta	07/08/17	36º 59,123N	7º 45,919W	16:19	76	36º 55,825N	7º 45,999W	16:39	200
R15	Cabo Sta. María	08/08/17	36º 55,255N	7º 55,955W	05:56	73	36º 52,077N	7º 55,999W	06:15	200
R16	Cuarteira	08/08/17	36º 50,165N	8º 05,968W	07:23	136	37º 00,554N	8º 05,828W	10:05	27
R17	Albufeira	09/08/17	37º 02,246N	8º 13,375W	07:57	30	36º 49,257N	8º 15,499W	11:01	219
R18	Alfanzinha	09/08/17	36º 50,414N	8º 25, 282W	11:55	134	37º 04,146N	8º 25,276W	15:11	30
R19	Portimao	10/08/17	37º 05,641N	8º 35,419W	06:11	35	36º 51,378N	8º 35,398W	09:18	209
R20	Burgau	10/08/17	36º 52,515N	8º 45,002W	10:12	105	37º 04,063N	8º 44,976W	11:22	29
R21	Punta de Sagres	11/08/17	37º 00,454N	8º 55,041N	06:03	38	36º 50,767N	8º 55,000W	07:01	156

Table 2. *ECOCADIZ 2017-07* survey. Descriptive characteristics of the fishing stations. Fishing hauls aimed at the capture of anchovy females with hydrated ovaries in light grey.

FISHING STATION	DATE	POSITION						TIMING				TRAWLED DISTANCE (nmi)	ACOUSTIC TRANSECT	ZONE/LANDMARK
		START			END			START	END	EFFECTIVE TRAWLING	TOTAL MANEOUVRE			
		LAT.	LON.	PROF.	LAT.	LON.	PROF.	UTC	UTC					
PE01	01-08-2017	36º 10.3669 N	6º 31.2384 W	119,6	36º 09.0152 N	6º 34.1601 W	195,12	11:15	11:55	00:39	1:16	2,724	R02	Sancti-Petri
PE02	01-08-2017	36º 16.3730 N	6º 19.7194 W	43,92	36º 14.5677 N	6º 23.2865 W	52,59	14:16	15:05	00:49	1:09	3,402	R02	Sancti-Petri
PE03	02-08-2017	36º 23.1710 N	6º 26.2867 W	58,18	36º 24.3241 N	6º 23.8825 W	50,75	07:09	07:41	00:32	0:58	2,257	R03	Cádiz
PE04	02-08-2017	36º 19.8503 N	6º 32.2985 W	104,68	36º 21.1833 N	6º 29.7711 W	80,89	09:08	09:45	00:36	1:00	2,437	R03	Cádiz
PE05	02-08-2017	36º 23.3908 N	6º 38.9507 W	168,27	36º 24.6127 N	6º 39.6182 W	170,81	13:29	13:50	00:20	0:48	1,334	R04	Rota
PE06	02-08-2017	36º 32.0561 N	6º 27.2176 W	42,86	36º 30.1972 N	6º 30.6510 W	58,18	15:41	16:28	00:46	1:06	3,333	R04	Rota
PE07	03-08-2017	36º 35.3611 N	6º 38.8370 W	73,53	36º 36.6198 N	6º 36.2689 W	56,03	07:09	07:45	00:35	0:58	2,42	R05	Chipiona
PE08	03-08-2017	36º 42.1664 N	6º 43.6876 W	67,64	36º 40.4116 N	6º 46.3035 W	96,21	11:10	11:50	0:40	1:02	2,738	R06	Doñana
PE09	03-08-2017	36º 40.1447 N	6º 38.8498 W	49,52	36º 42.3910 N	6º 41.2103 W	49,42	13:34	14:18	0:44	1:05	2,939	R06	Doñana
PE10	04-08-2017	36º 44.4201 N	6º 57.4351 W	143,36	36º 45.6747 N	6º 55.1296 W	113,67	08:11	08:45	00:33	1:05	2,237	R07	Matalascañas
PE11	04-08-2017	36º 48.5670 N	6º 53.3578 W	92,1	36º 47.0828 N	6º 51.5927 W	90,14	19:24	19:55	00:31	0:54	2,051	R07	Matalascañas
PE12	05-08-2017	36º 51.9792 N	7º 06.5428 W	128,78	36º 50.4769 N	7º 03.7150 W	127,2	12:00	12:42	00:41	1:07	2,721	R09	Punta Umbría
PE13	05-08-2017	36º 57.9699 N	6º 55.8524 W	50,62	36º 59.9630 N	6º 58.4898 W	46,96	15:20	16:04	00:44	1:03	2,903	R09	Punta Umbría
PE14	06-08-2017	36º 57.4392 N	7º 16.7068 W	102,39	36º 54.2563 N	7º 16.7733 W	142,89	11:35	12:23	00:48	1:14	3,179	R10	El Rompido
PE15	06-08-2017	36º 50.1417 N	7º 02.8766 W	123,23	36º 52.2860 N	7º 06.9959 W	125,74	20:09	21:09	01:00	1:28	3,939	R09	Punta Umbría
PE16	07-08-2017	37º 00.4756 N	7º 35.9474 W	96,85	36º 57.5050 N	7º 36.0468 W	150,19	11:31	12:17	00:46	1:15	2,968	R13	Tavira
PE17	07-08-2017	37º 03.1962 N	7º 35.6677 W	44,89	37º 02.2413 N	7º 38.1066 W	57,81	14:36	15:09	00:33	1:00	2,173	R13	Tavira
PE18	08-08-2017	36º 52.9192 N	8º 06.0394 W	99,14	36º 51.3055 N	8º 05.9827 W	109,84	07:58	08:20	00:22	0:50	1,612	R16	Cuarteira
PE19	08-08-2017	36º 57.3261 N	8º 03.9639 W	44,11	36º 57.4865 N	8º 05.8284 W	44,77	11:14	11:36	00:21	0:45	1,503	R16	Cuarteira
PE20	08-08-2017	37º 00.0629 N	7º 36.6649 W	97,65	36º 57.4813 N	7º 35.7400 W	149,26	19:43	20:23	00:39	1:07	2,683	R13	Tavira
PE21	09-08-2017	36º 53.0852 N	8º 15.3606 W	104,73	36º 55.1995 N	8º 15.4387 W	86,89	09:11	09:41	00:30	0:55	2,112	R17	Albufeira
PE22	09-08-2017	36º 55.1362 N	8º 25.1307 W	105,57	36º 52.6055 N	8º 25.1294 W	127,16	12:52	13:28	00:36	1:05	2,527	R18	Alfanzina
PE23	10-08-2017	36º 55.1111 N	8º 36.1719 W	97,68	36º 54.9748 N	8º 34.1472 W	95,27	07:54	08:18	00:23	0:47	1,629	R19	Portimao
PE24	10-08-2017	36º 52.8391 N	8º 42.1778 W	109,06	36º 53.5526 N	8º 45.4317 W	107,83	13:17	13:56	00:38	1:03	2,706	R20	Burgau
PE25	11-08-2017	36º 56.9753 N	7º 10.4668 W	99,82	36º 56.7254 N	7º 06.5153 W	92,33	19:08	19:54	00:45	1:09	3,177	R10	El Rompido

Table 3. *ECOCADIZ 2017-07* survey. Catches by species in number (upper panel) and weight (in kg, lower panel) from valid fishing stations.

ABUNDANCE (nº)													
Fishing station	**ANE**	**PIL**	**MAS**	**MAC**	**HOM**	**JAA**	**HMM**	**BOG**	**WHB**	**BOC**	**SAA**	**OTHERS SPP**	**TOTAL**
01	4	688	3894	1	0	3	1	0	0	0	0	0	**4591**
02	0	2127	212	0	0	0	479	0	0	0	26	772	**3616**
03	8	601	4	0	7	0	301	229	0	0	1	119	**1270**
04	6237	21	179	12	0	0	0	1	0	0	0	9	**6459**
05	20	932	6648	32	16	0	0	0	0	0	0	1	**7649**
06	4626	434	4	1	0	0	401	12	0	0	0	124	**5602**
07	12549	3548	0	151	0	0	0	0	0	0	0	8	**16256**
08	4618	756	44	81	0	0	0	0	0	0	0	1	**5500**
09	8582	79	1	0	0	0	175	5	0	0	0	29	**8871**
10	12995	0	23139	22	1	0	0	0	0	0	0	15	**36172**
11	13630	16	17	139	0	0	0	0	0	0	0	1	**13803**
12	3021	0	55	34	0	0	0	0	0	0	0	13	**3123**
13	1645	848	93	6	0	0	140	11	0	0	0	53	**2796**
14	9152	0	4180	61	0	0	0	0	0	0	0	8	**13401**
16	17739	0	4373	103	0	3	0	1	0	0	0	18	**22237**
17	659	753	13	1	272	0	0	13	0	0	0	325	**2036**
18	1314	0	114399	0	34	4812	0	4	0	0	0	4	**120567**
19	0	1635	1153	6	118	0	0	7	0	0	0	1173	**4092**
21	1079	0	17688	14	12	20	0	11	0	0	0	23	**18847**
22	461	273	40266	9	303	2035	0	288	0	0	0	33	**43668**
23	573	3	21052	1	0	0	0	3	0	0	0	13	**21645**
24	0	0	5001	0	1	23	0	1	0	0	0	1	**5027**
TOTAL	**98912**	**12714**	**242415**	**674**	**764**	**6896**	**1497**	**586**	**0**	**0**	**27**	**2743**	**367228**

Table 3. *ECOCADIZ 2017-07* survey. Cont'd.

BIOMASS (kg)													
Fishing station	**ANE**	**PIL**	**MAS**	**MAC**	**HOM**	**JAA**	**HMM**	**BOG**	**WHB**	**BOC**	**SAA**	**OTHERS SPP**	**TOTAL**
01	0,108	7,620	238,750	0,105	0	0,074	0,381	0	0	0	0	0	**247,038**
02	0	49,000	50,100	0	0	0	88,350	0	0	0	8,150	107,209	**302,809**
03	0,084	8,450	0,912	0	0,505	0	51,750	26,850	0	0	0,246	19,161	**107,958**
04	71,000	0,348	9,100	1,161	0	0	0	0,073	0	0	0	5,157	**86,839**
05	0,335	31,45	351,050	2,922	1,229	0	0	0	0	0	0	0,047	**387,033**
06	33,195	5,042	0,850	0,105	0	0	83,450	2,868	0	0	0	15,275	**140,785**
07	74,250	60,850	0	15,750	0	0	0	0	0	0	0	1,101	**151,951**
08	28,200	17,100	2,634	8,500	0	0	0	0	0	0	0	0,098	**56,532**
09	36,700	0,954	0,298	0	0	0	38,200	1,160	0	0	0	6,753	**84,065**
10	137,103	0	1226,350	2,215	0,149	0	0	0	0	0	0	1,556	**1367,373**
11	105,300	0,246	1,079	13,150	0	0	0	0	0	0	0	0,086	**119,861**
12	37,600	0	2,315	3,125	0	0	0	0	0	0	0	0,742	**43,782**
13	15,800	11,250	18,100	1,633	0	0	26,650	2,325	0	0	0	4,729	**80,487**
14	114,575	0	185,850	6,730	0	0	0	0	0	0	0	0,583	**307,738**
16	302,39	0	179,200	10,984	0	0,167	0	0,130	0	0	0	2,157	**495,028**
17	10,050	24,750	0,625	0,286	11,900	0	0	1,652	0	0	0	33,934	**83,197**
18	43,399	0	6144,227	0	3,579	155,476	0	0,442	0	0	0	0,168	**6347,291**
19	0	56,950	54,400	1,479	6,850	0	0	0,624	0	0	0	156,470	**276,773**
21	34,320	0	875,250	1,456	1,156	0,539	0	1,245	0	0	0	1,644	**915,610**
22	20,271	10,997	2009,530	2,931	38,342	50,231	0	34,478	0	0	0	3,356	**2170,136**
23	19,950	0,112	1094,400	0,095	0	0	0	0,250	0	0	0	11,178	**1125,985**
24	0	0	324,600	0	0,152	1,408	0	0,094	0	0	0	0,360	**326,614**
TOTAL	**1084,630**	**285,119**	**12769,620**	**72,627**	**63,862**	**207,895**	**288,781**	**72,191**	**0**	**0**	**8,396**	**371,764**	**15224,885**

Table 4. *ECOCADIZ 2017-07* survey. Parameters of the size-weight relationships for survey's target species. FAO codes for the species: PIL: *Sardina pilchardus*; ANE: *Engraulis encrasicolus*; MAS: *Scomber colias*; MAC: *Scomber scombrus*; JAA: *Trachurus picturatus;* HOM: *Trachurus trachurus*; HMM: *Trachurus mediterraneus*; BOG: *Boops boops*; WHB: *Micromesistius poutassou*; BOC: *Capros aper*.

PARAMETER	PIL	HOM	JAA	HMM	BOG	MAS	MAC	ANE	SAA
Size range (mm)	97-223	136-282	136-242	203-393	182-308	159-349	221-359	76-185	312-372
n	667	188	149	244	165	830	383	1122	27
a	0,003658	0,012523	0,006008	0,030710	0,003606	0,002041	0,000905	0,001963	0,352569
b	3,276988	2,846218	3,092380	2,582981	3,285272	3,422904	3,606129	3,447472	1,910583
r^2	0,94	0,99	0,98	0,95	0,95	0,98	0,95	0,99	0,86

Table 5. *ECOCADIZ 2017-07* survey. Anchovy (*E. encrasicolus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 9**.

***ECOCADIZ 2017-07*. *Engraulis encrasicolus*. ABUNDANCE (in numbers and million fish)**																
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**POL 10**	***n***			**Millions**		
											PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0		0	0	0	**0**	**0**	**0**
6,5	0	0	0	0	0	0	0	0	0		0	0	0	**0**	**0**	**0**
7	0	0	0	0	0	0	0	0	0		0	0	0	**0**	**0**	**0**
7,5	0	0	0	0	625897	14901807	642705	0	0	0	0	16170409	16170409	**0**	**16**	**16**
8	0	0	0	0	3778354	42199809	3879819	0	0	0	0	49857982	49857982	**0**	**50**	**50**
8,5	0	0	0	0	6256906	99257466	6424930	0	828904	0	0	112768206	112768206	**0**	**113**	**113**
9	0	0	0	0	27229680	106730349	27960910	0	3315618	0	0	165236557	165236557	**0**	**165**	**165**
9,5	0	0	0	0	56165925	59563271	57674213	0	13290101	0	0	186693510	186693510	**0**	**187**	**187**
10	0	0	0	0	57125540	39694195	58659598	0	27381477	0	0	182860810	182860810	**0**	**183**	**183**
10,5	0	0	19306695	0	44083912	4967269	45267748	60541	23236955	0	0	136923120	136923120	**0**	**137**	**137**
11	0	0	68496797	0	20152779	4967269	20693965	424340	32382534	0	0	147117684	147117684	**0**	**147**	**147**
11,5	0	0	109124798	1956123	9482408	2461655	9737050	1757903	16605719	2994318	0	154119974	154119974	**0**	**154**	**154**
12	0	6593424	47175490	12880057	1226758	2461655	1259701	2484951	8289045	6394842	6593424	82172499	88765923	**7**	**82**	**89**
12,5	0	15208331	21489191	23650401	2551596	0	2620117	1939528	828904	6122103	15208331	59201840	74410171	**15**	**59**	**74**
13	0	34009722	10744596	20490312	2551596	0	2620117	424340	0	1769897	34009722	38600858	72610580	**34**	**39**	**73**
13,5	0	33434313	0	13569385	0	0	0	60541	1657809	678944	33434313	15966679	49400992	**33**	**16**	**49**
14	0	24362787	0	3706885	0	0	0	0	0	136369	24362787	3843254	28206041	**24**	**4**	**28**
14,5	29957	14239055	0	1076397	0	0	0	0	0	0	14269012	1076397	15345409	**14**	**1**	**15**
15	117110	10478527	0	752157	0	0	0	0	0	0	10595637	752157	11347794	**11**	**1**	**11**
15,5	415873	7596631	0	246396	0	0	0	0	0	0	8012504	246396	8258900	**8**	**0,2**	**8**
16	783953	762735	0	0	0	0	0	0	0	0	1546688	0	1546688	**2**	**0**	**2**
16,5	1014514	381367	0	0	0	0	0	0	0	0	1395881	0	1395881	**1**	**0**	**1**
17	945907	0	0	0	0	0	0	0	0	0	945907	0	945907	**1**	**0**	**1**
17,5	304980	0	0	0	0	0	0	0	0	0	304980	0	304980	**0,3**	**0**	**0,3**
18	57102	0	0	0	0	0	0	0	0	0	57102	0	57102	**0,1**	**0**	**0,1**
18,5	5966	0	0	0	0	0	0	0	0	0	5966	0	5966	**0,01**	**0**	**0,01**
TOTAL *n*	3675362	147066892	276337567	78328113	231231351	377204745	237440873	7152144	127817066	18096473	150742254	1353608332	1504350586	**151**	**1354**	**1504**
Millions	**4**	**147**	**276**	**78**	**231**	**377**	**237**	**7**	**128**	**18**						

Table 5. *ECOCADIZ 2015-07* survey. Anchovy (*E. encrasicolus*). Cont'd.

ECOCADIZ 2017-07. *Engraulis encrasicolus*. BIOMASS (t)													
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**POL10**	**PT**	**ES**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	0	0	0
6,5	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0
7,5	0	0	0	0	1,43	34,04	1,468	0	0	0	0	36,938	36,938
8	0	0	0	0	10,707	119,581	10,994	0	0	0	0	141,282	141,282
8,5	0	0	0	0	21,717	344,518	22,301	0	2,877	0	0	391,413	391,413
9	0	0	0	0	114,47	448,68	117,544	0	13,938	0	0	694,632	694,632
9,5	0	0	0	0	283,101	300,225	290,703	0	66,988	0	0	941,017	941,017
10	0	0	0	0	342,117	237,723	351,304	0	163,984	0	0	1095,128	1095,128
10,5	0	0	136,258	0	311,125	35,057	319,479	0,427	163,996	0	0	966,342	966,342
11	0	0	565,446	0	166,363	41,005	170,83	3,503	267,32	0	0	1214,467	1214,467
11,5	0	0	1046,529	18,76	90,938	23,608	93,38	16,859	159,252	28,716	0	1478,042	1478,042
12	0	73,002	522,321	142,606	13,583	27,255	13,947	27,513	91,775	70,803	73,002	909,803	982,805
12,5	0	193,285	273,11	300,577	32,429	0	33,3	24,65	10,535	77,807	193,285	752,408	945,693
13	0	493,53	155,919	297,344	37,027	0	38,022	6,158	0	25,684	493,53	560,154	1053,684
13,5	0	551,266	0	223,733	0	0	0	0,998	27,334	11,194	551,266	263,259	814,525
14	0	454,332	0	69,128	0	0	0	0	0	2,543	454,332	71,671	526,003
14,5	0,629	299,062	0	22,607	0	0	0	0	0	0	299,691	22,607	322,298
15	2,759	246,884	0	17,721	0	0	0	0	0	0	249,643	17,721	267,364
15,5	10,951	200,039	0	6,488	0	0	0	0	0	0	210,99	6,488	217,478
16	22,992	22,37	0	0	0	0	0	0	0	0	45,362	0	45,362
16,5	33,031	12,417	0	0	0	0	0	0	0	0	45,448	0	45,448
17	34,084	0	0	0	0	0	0	0	0	0	34,084	0	34,084
17,5	12,127	0	0	0	0	0	0	0	0	0	12,127	0	12,127
18	2,499	0	0	0	0	0	0	0	0	0	2,499	0	2,499
18,5	0,287	0	0	0	0	0	0	0	0	0	0,287	0	0,287
TOTAL	**119,359**	**2546,187**	**2699,583**	**1098,964**	**1425,007**	**1611,692**	**1463,272**	**80,108**	**967,999**	**216,747**	**2665,546**	**9563,372**	**12228,918**

Table 6. *ECOCADIZ 2015-07* survey. Sardine (*S. pilchardus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 12**.

***ECOCADIZ 2017-07*. *Sardina pilchardus*. ABUNDANCE (in numbers and million fish)**														
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	***n***			**Millions**		
									PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
6,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
8	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
8,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
9	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
9,5	0	0	691060	0	0	0	0	0	0	691060	691060	**0**	**1**	**1**
10	0	0	1390714	0	0	0	0	0	0	1390714	1390714	**0**	**1**	**1**
10,5	0	0	7861485	0	0	0	0	0	0	7861485	7861485	**0**	**8**	**8**
11	0	0	20728046	0	129942	0	0	0	0	20857988	20857988	**0**	**21**	**21**
11,5	0	0	59408342	82649	2138172	351638	0	744356	0	62725157	62725157	**0**	**63**	**63**
12	0	0	47183836	297681	6976176	1266521	0	2680999	0	58405213	58405213	**0**	**58**	**58**
12,5	0	0	15938314	377980	2966086	1608163	0	3404193	0	24294736	24294736	**0**	**24**	**24**
13	0	0	4794377	424361	854137	1805494	0	3821909	0	11700278	11700278	**0**	**12**	**12**
13,5	2477108	0	1525099	256528	699220	1091430	0	2310363	2477108	5882640	8359748	**2**	**6**	**8**
14	1696393	0	1712991	458764	531393	1951865	0	4131751	1696393	8786764	10483157	**2**	**9**	**10**
14,5	5962764	0	699653	594044	266790	2527431	0	5350121	5962764	9438039	15400803	**6**	**9**	**15**
15	59962127	5313	966832	830081	743513	3531681	0	7475938	59967440	13548045	73515485	**60**	**14**	**74**
15,5	81663765	45455	0	384723	159637	1636851	1423874	3464922	81709220	7070007	88779227	**82**	**7**	**89**
16	59816592	68477	880545	144697	52483	615631	2092334	1303180	59885069	5088870	64973939	**60**	**5**	**65**
16,5	9149612	36600	0	28582	0	121604	1086927	257414	9186212	1494527	10680739	**9**	**1**	**11**
17	8018369	5313	0	32257	0	137242	336947	290518	8023682	796964	8820646	**8**	**1**	**9**
17,5	3196475	0	0	8295	0	35291	81519	74705	3196475	199810	3396285	**3**	**0,2**	**3**
18	0	0	0	0	0	0	43477	0	0	43477	43477	**0**	**0,04**	**0,04**
18,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	231943205	161158	163781294	3920642	15517549	16680842	5065078	35310369	232104363	240275774	472380137	**232**	**240**	**472**
Millions	**232**	**0**	**164**	**4**	**16**	**17**	**5**	**35**						

Table 6. *ECOCADIZ 2017-07* survey. Sardine (*S. pilchardus*). Cont'd

ECOCADIZ 2017-07. *Sardina pilchardus*. BIOMASS (t)											
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**PT**	**ES**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	0
6,5	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
7,5	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
8,5	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
9,5	0	0	4,403	0	0	0	0	0	0	4,403	4,403
10	0	0	10,438	0	0	0	0	0	0	10,438	10,438
10,5	0	0	68,971	0	0	0	0	0	0	68,971	68,971
11	0	0	211,069	0	1,323	0	0	0	0	212,392	212,392
11,5	0	0	697,589	0,970	25,107	4,129	0	8,740	0	736,535	736,535
12	0	0	635,116	4,007	93,903	17,048	0	36,087	0	786,161	786,161
12,5	0	0	244,589	5,800	45,518	24,679	0	52,241	0	372,827	372,827
13	0	0	83,459	7,387	14,868	31,429	0	66,53	0	203,673	203,673
13,5	48,686	0	29,975	5,042	13,743	21,451	0	45,408	48,686	115,619	164,305
14	37,481	0	37,848	10,136	11,741	43,126	0	91,290	37,481	194,141	231,622
14,5	147,508	0	17,308	14,696	6,600	62,524	0	132,353	147,508	233,481	380,989
15	1654,586	0,147	26,679	22,905	20,516	97,453	0	206,290	1654,733	373,843	2028,576
15,5	2504,694	1,394	0	11,800	4,896	50,204	43,671	106,272	2506,088	216,843	2722,931
16	2032,473	2,327	29,920	4,917	1,783	20,918	71,094	44,280	2034,800	172,912	2207,712
16,5	343,349	1,373	0	1,073	0	4,563	40,788	9,660	344,722	56,084	400,806
17	331,345	0,220	0	1,333	0	5,671	13,924	12,005	331,565	32,933	364,498
17,5	145,054	0	0	0,376	0	1,601	3,699	3,390	145,054	9,066	154,12
18	0	0	0	0	0	0	2,161	0	0	2,161	2,161
18,5	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**7245,176**	**5,461**	**2097,364**	**90,442**	**239,998**	**384,796**	**175,337**	**814,546**	**7250,637**	**3802,483**	**11053,120**

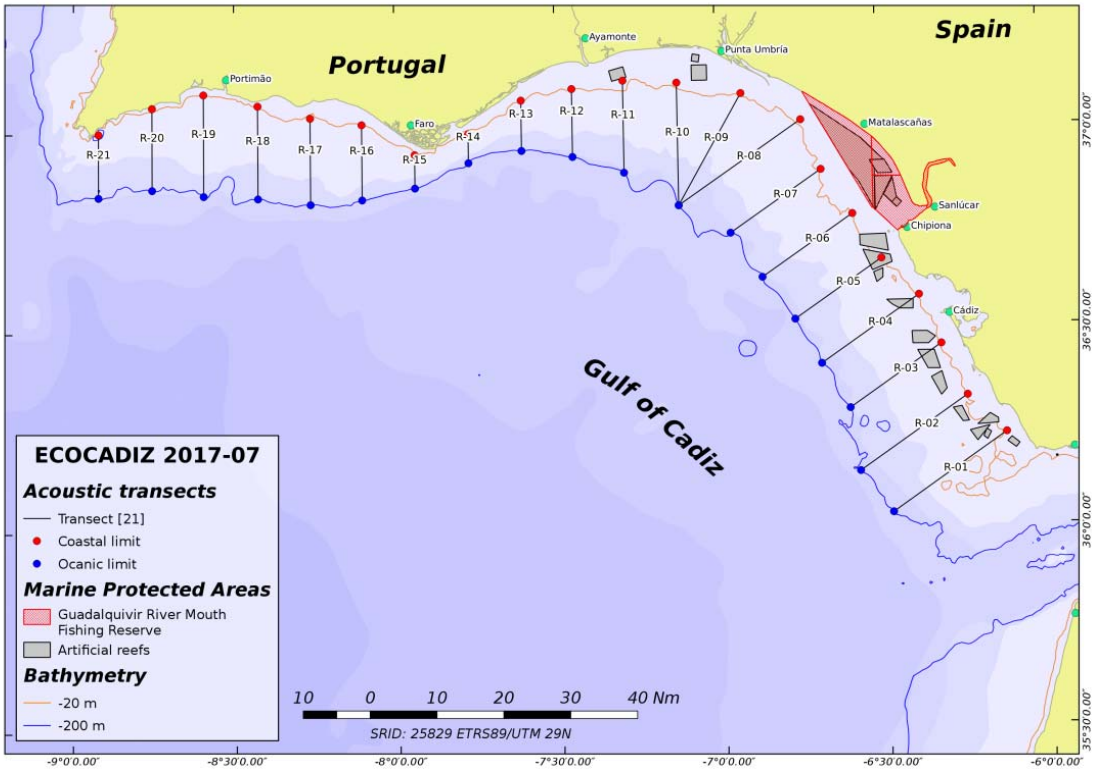


Figure 1. *ECOCADIZ 2017-07* survey. Location of the acoustic transects sampled during the survey. The different protected areas inside the Guadalquivir river mouth Fishing Reserve and artificial reef polygons are also shown.

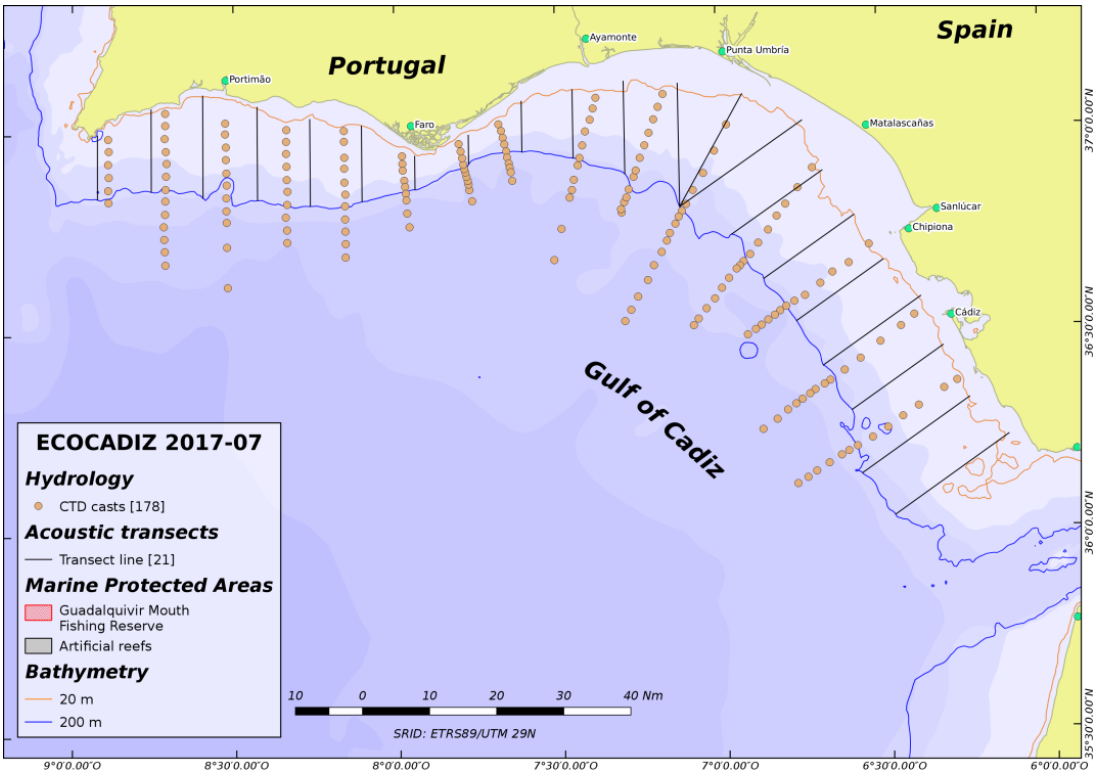


Figure 2. *ECOCADIZ 2017-07* survey. Location of CTD-LADCP stations.

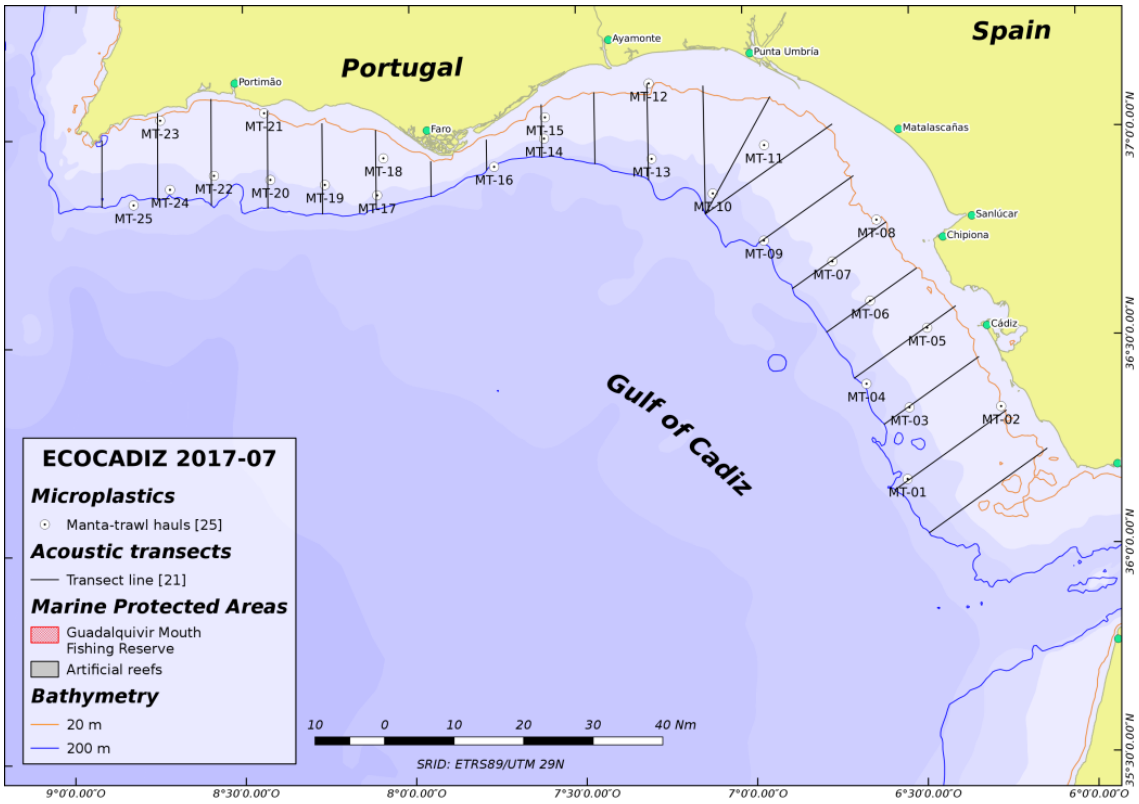


Figure 3. *ECOCADIZ 2017-07* survey. Location of Manta trawl hauls (micro-plastics).

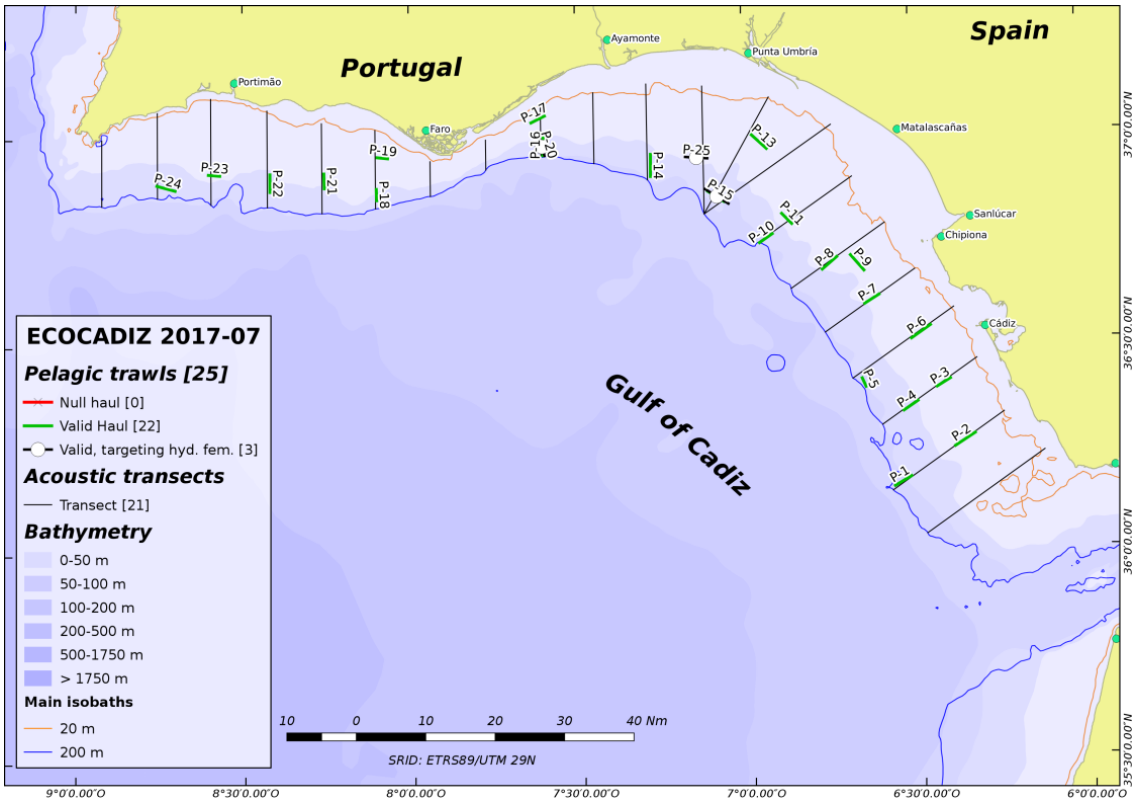


Figure 4. *ECOCADIZ 2017-07* survey. Location of ground-truthing fishing hauls. Night directed hauls aimed at the capture of anchovy with hydrated ovaries are also illustrated (Anchovy DEPM).

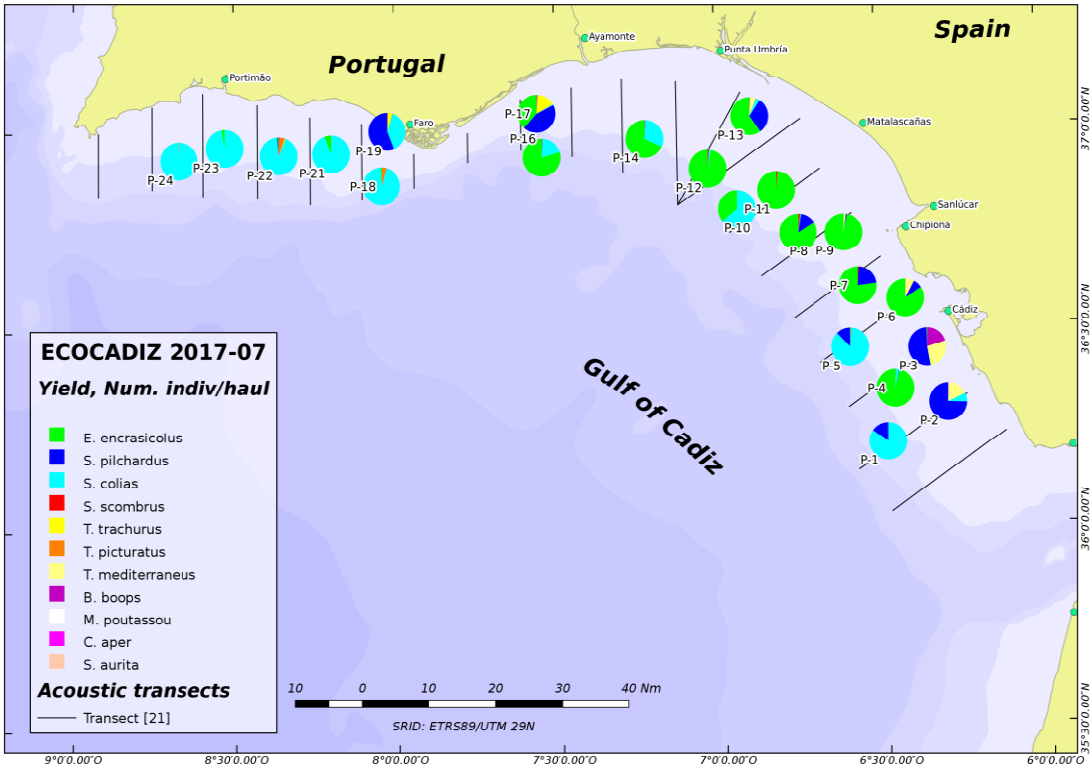


Figure 5. *ECOCADIZ 2017-07* survey. Species composition (percentages in number) in fishing hauls.

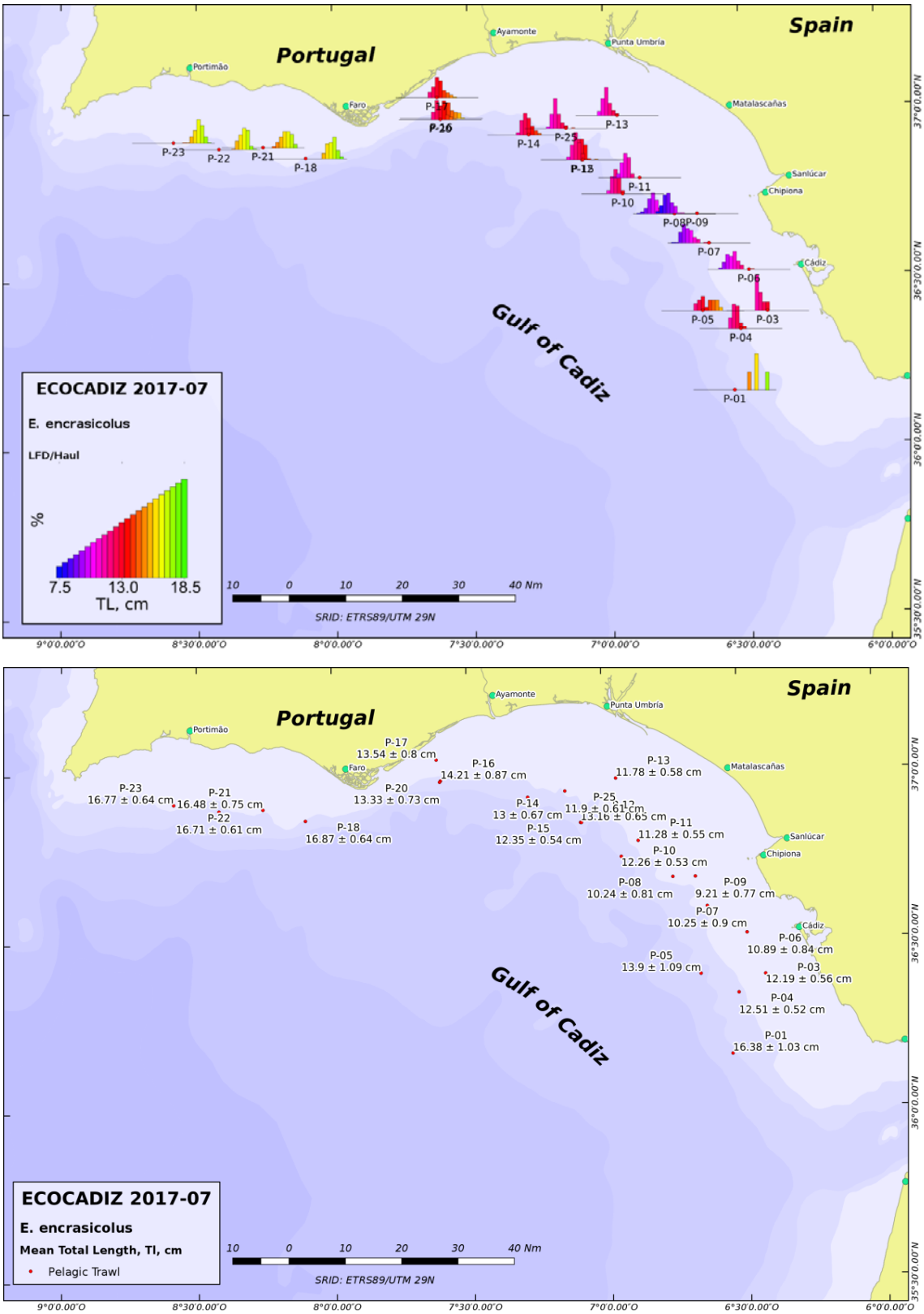


Figure 6. *ECOCADIZ 2017-07* survey. *Engraulis encrasicolus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

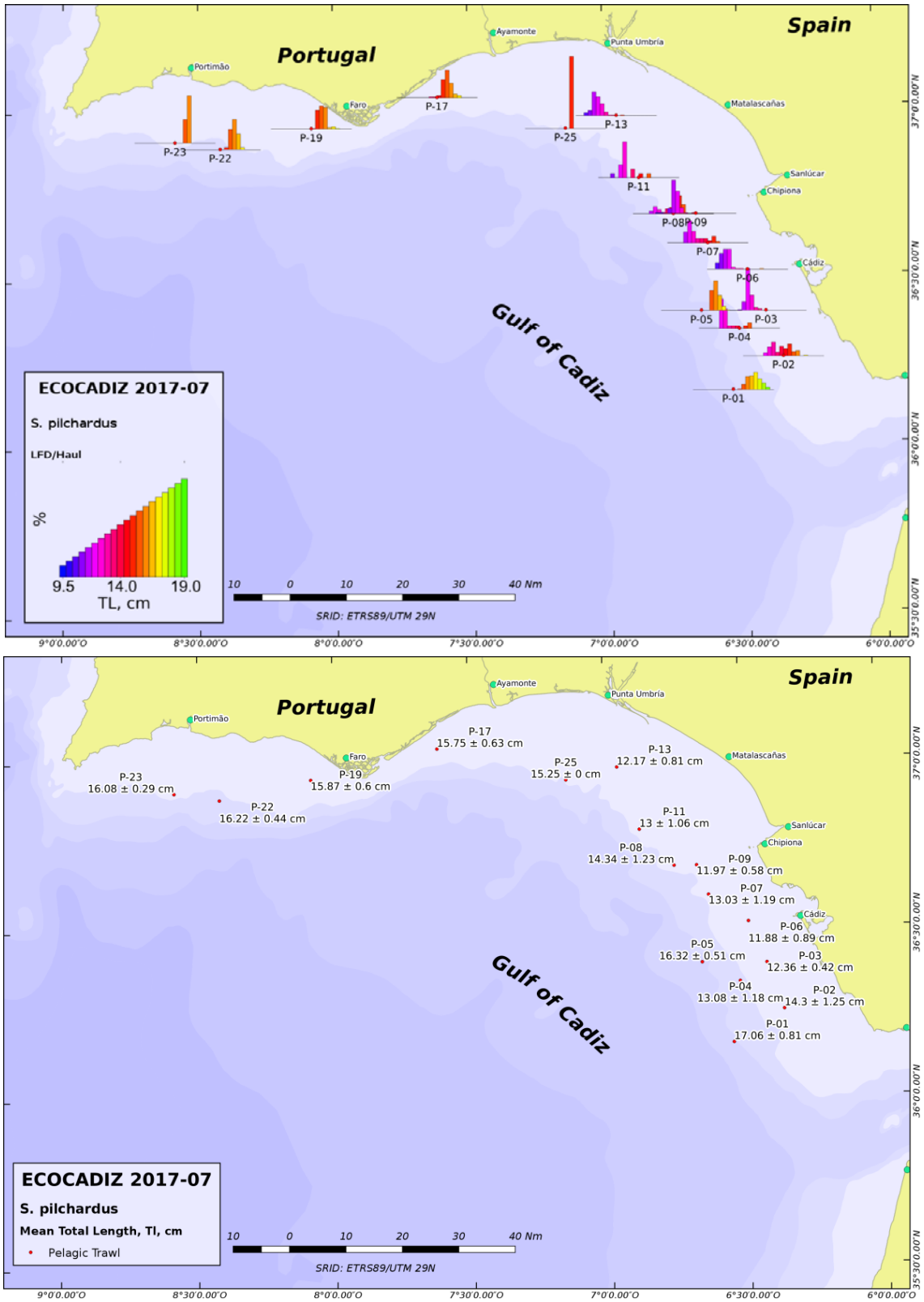


Figure 7. *ECOCADIZ 2017-07* survey. *Sardina pilchardus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

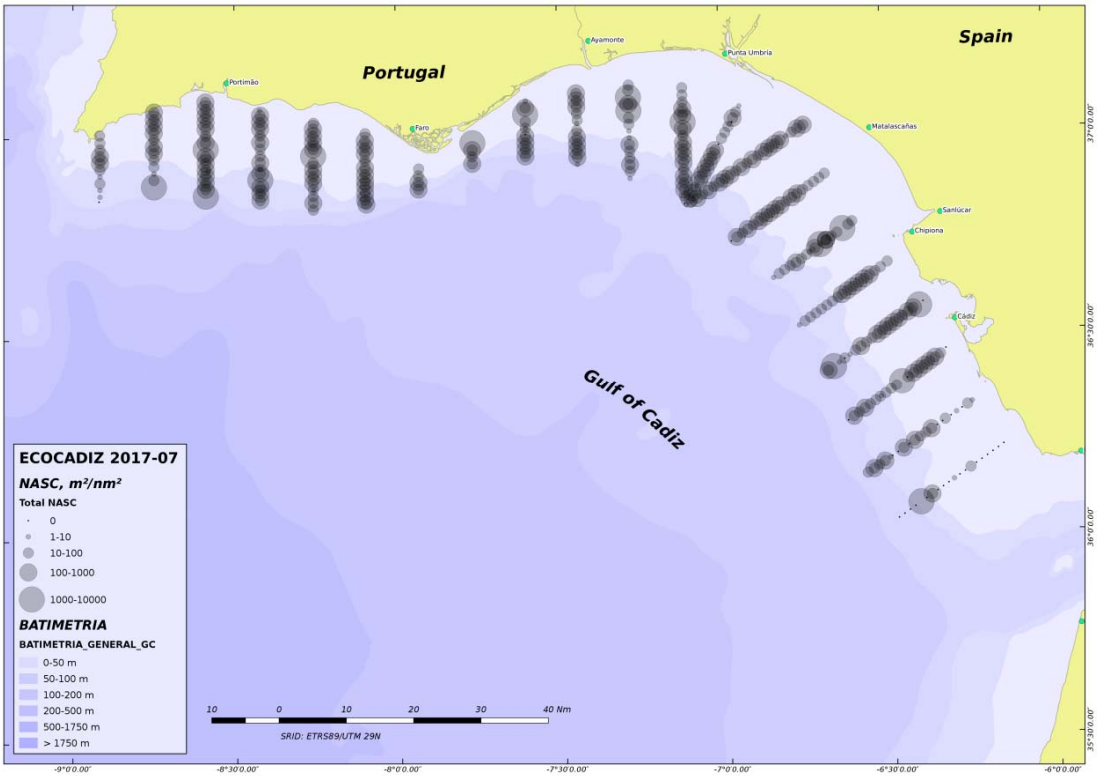


Figure 8. *ECOCADIZ 2017-07* survey. Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the pelagic fish species assemblage.

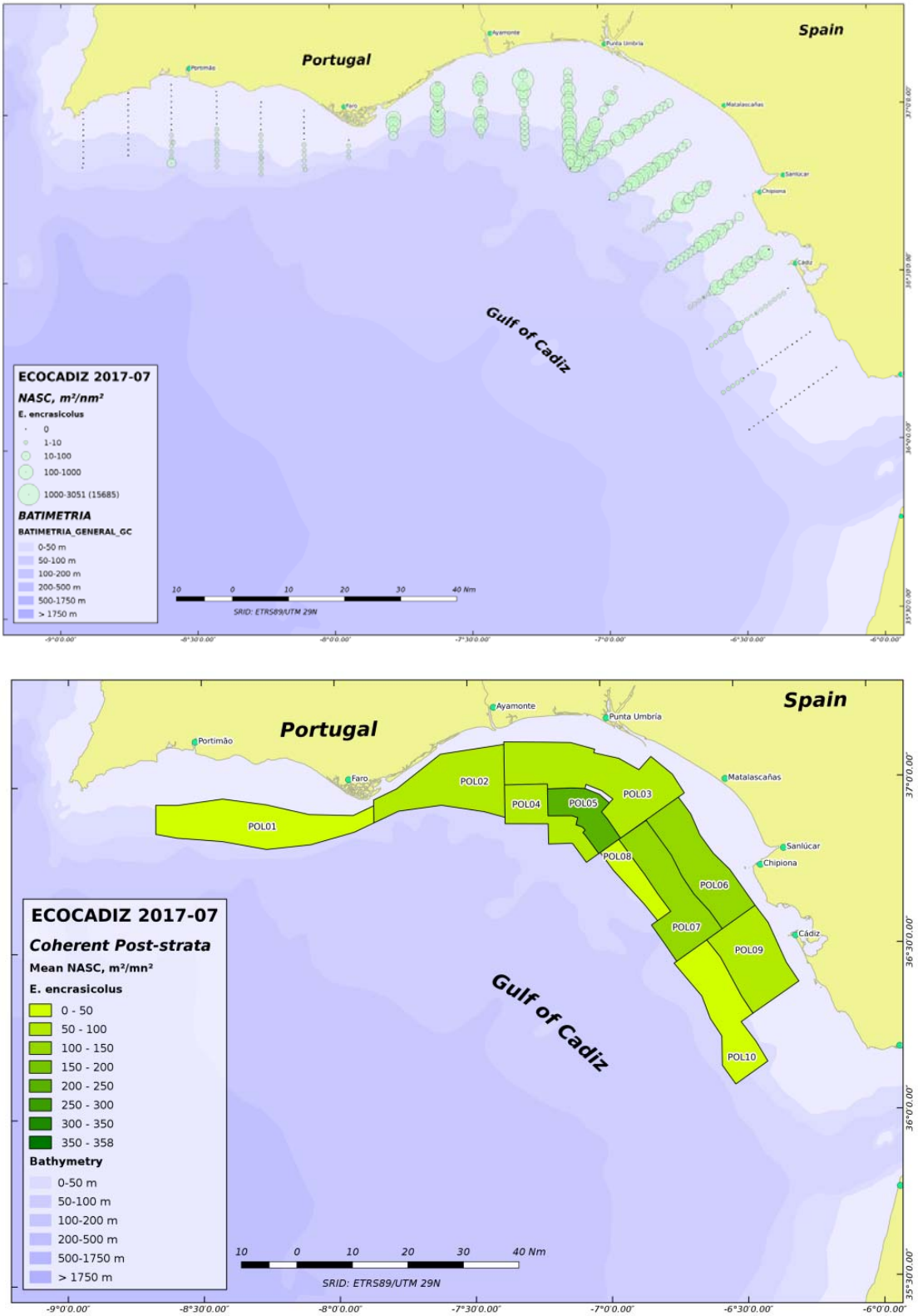


Figure 9. *ECOCADIZ 2017-07* survey. Anchovy (*Engraulis encrasicolus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

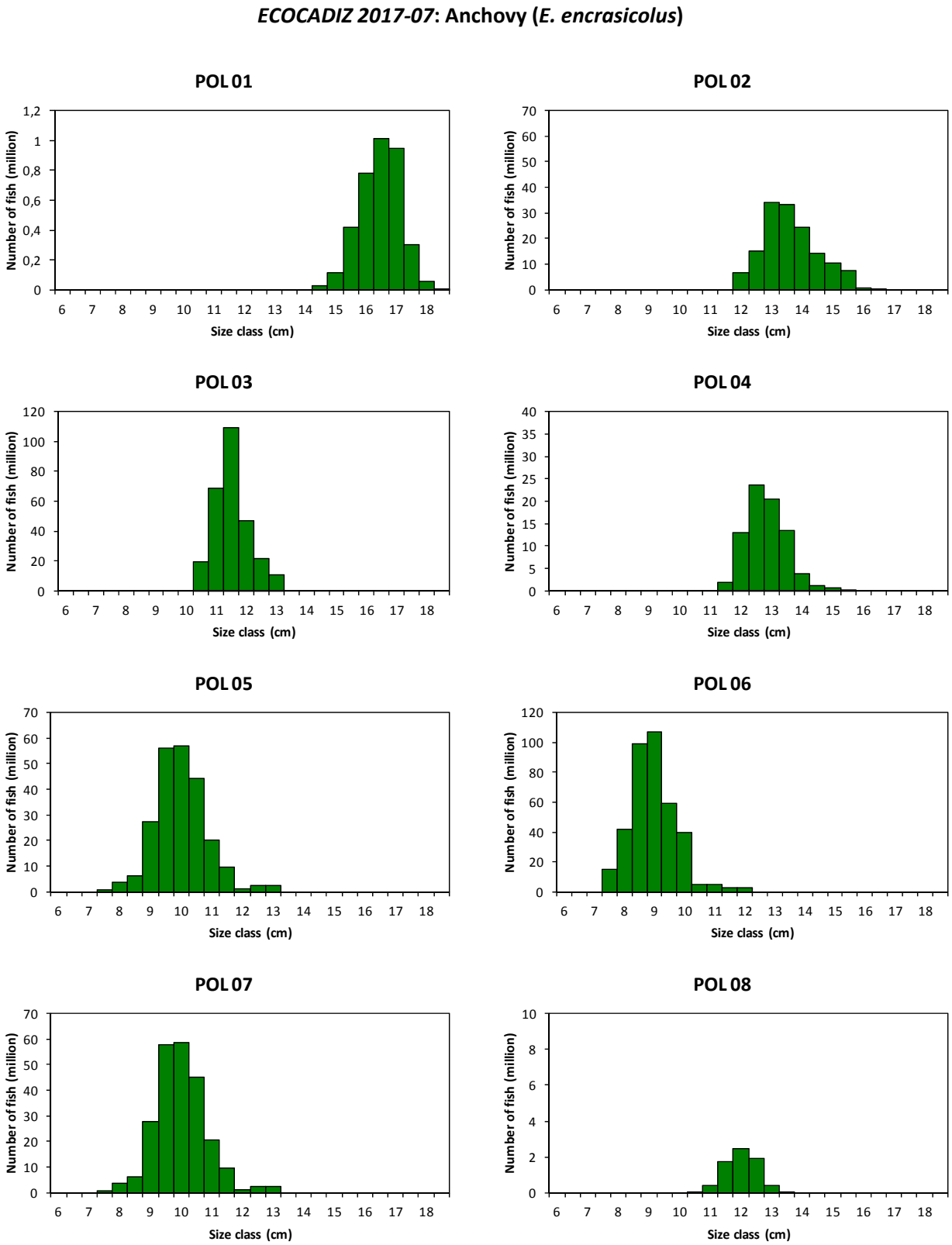


Figure 10. *ECOCADIZ 2017-07* survey. Anchovy (*E. encrasicolus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 9**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

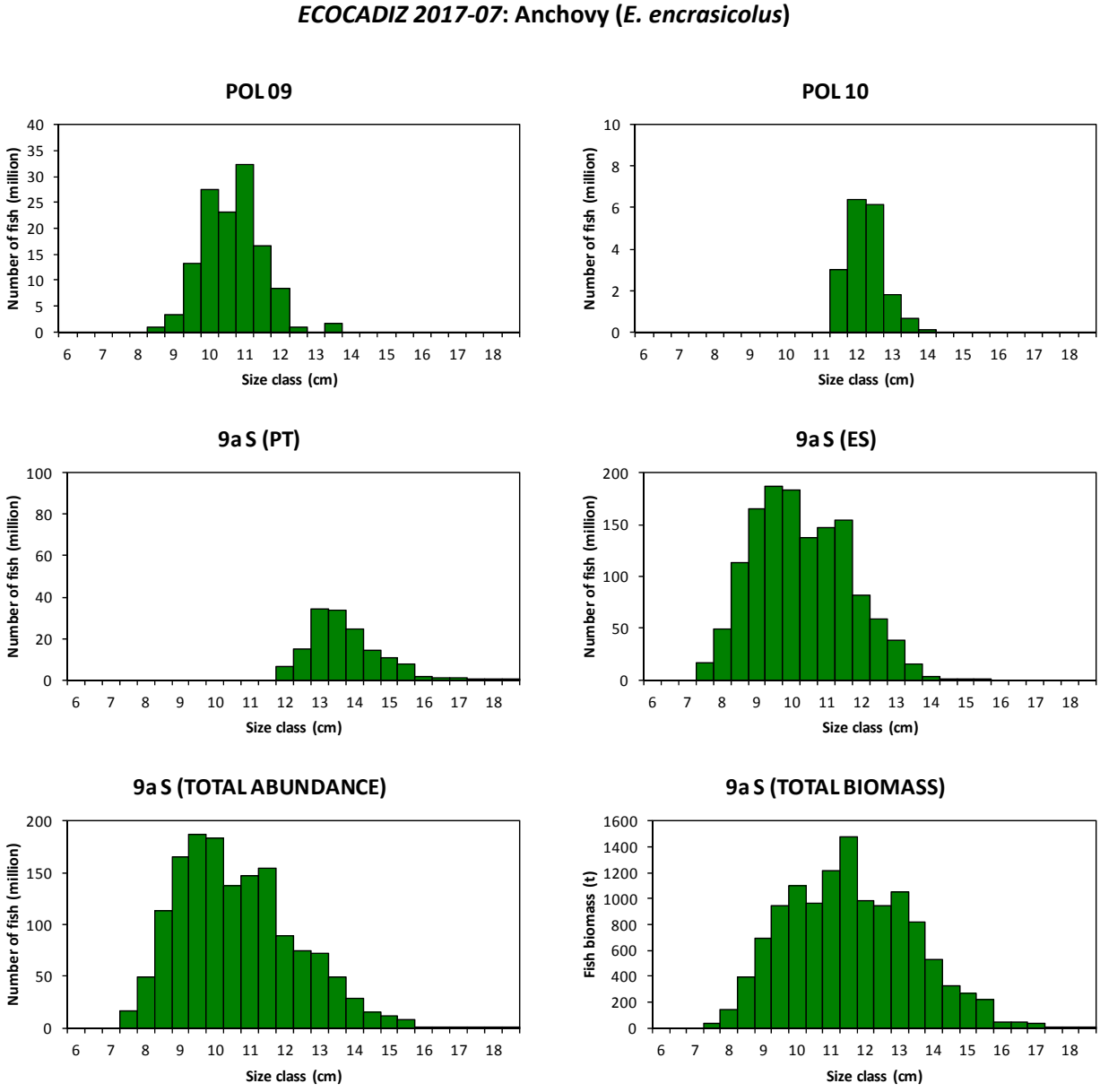
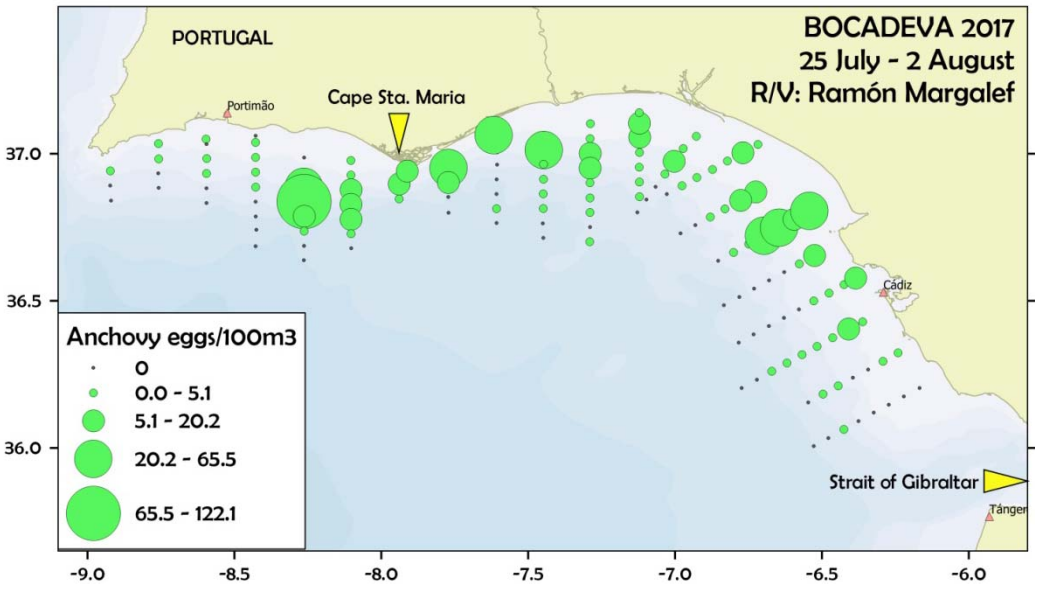


Figure 10. *ECOCADIZ 2017-07* survey. Anchovy (*E. encrasicolus*). Cont'd.



BOCADEVA 2017-07	
CUFES st	142
Positive anchovy st	88 (62 %)
Max number eggs by st	1453
Total anchovy eggs (in number)	7630
Max density by st (eggs/100 m^3)	122
Total density (eggs/100 m^3)	656

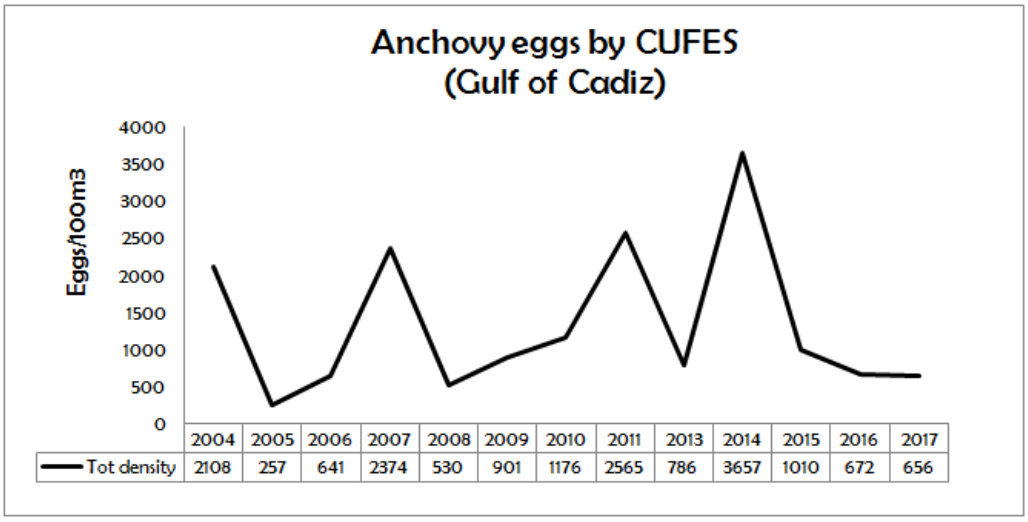


Figure 11. *ECOCADIZ 2017-07* survey. Anchovy (*E. encrasicolus*). Top: distribution of anchovy egg densities as sampled by CUFES (eggs m^{-3}) during the *BOCADEVA* anchovy DEPM survey. Centre: main descriptors of the CUFES sampling. Bottom: historical series of GoC anchovy egg densities as sampled by CUFES.

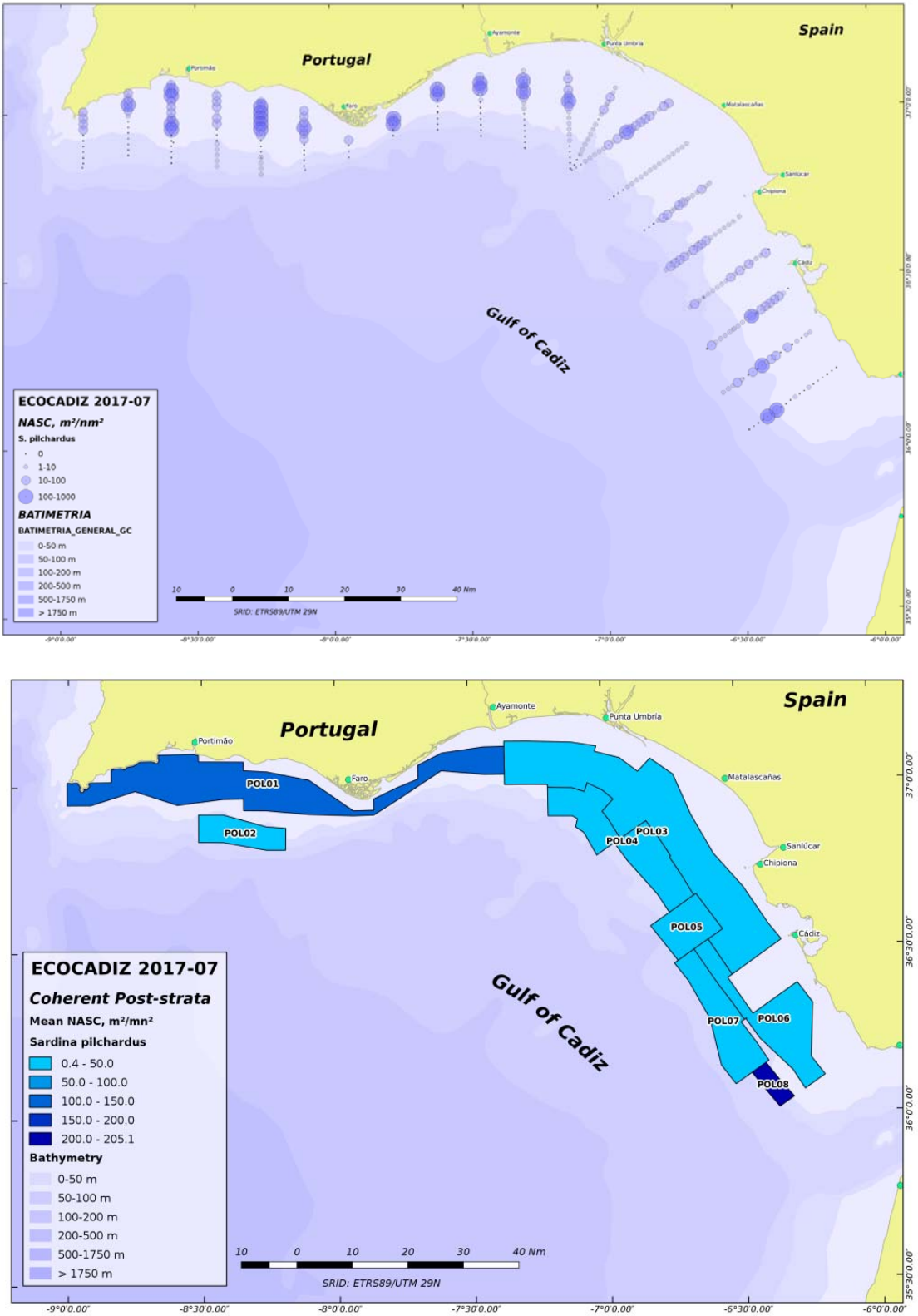


Figure 12. *ECOCADIZ 2017-07* survey. Sardine (*Sardina pilchardus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ 2017-07: Sardine (*S. pilchardus*)

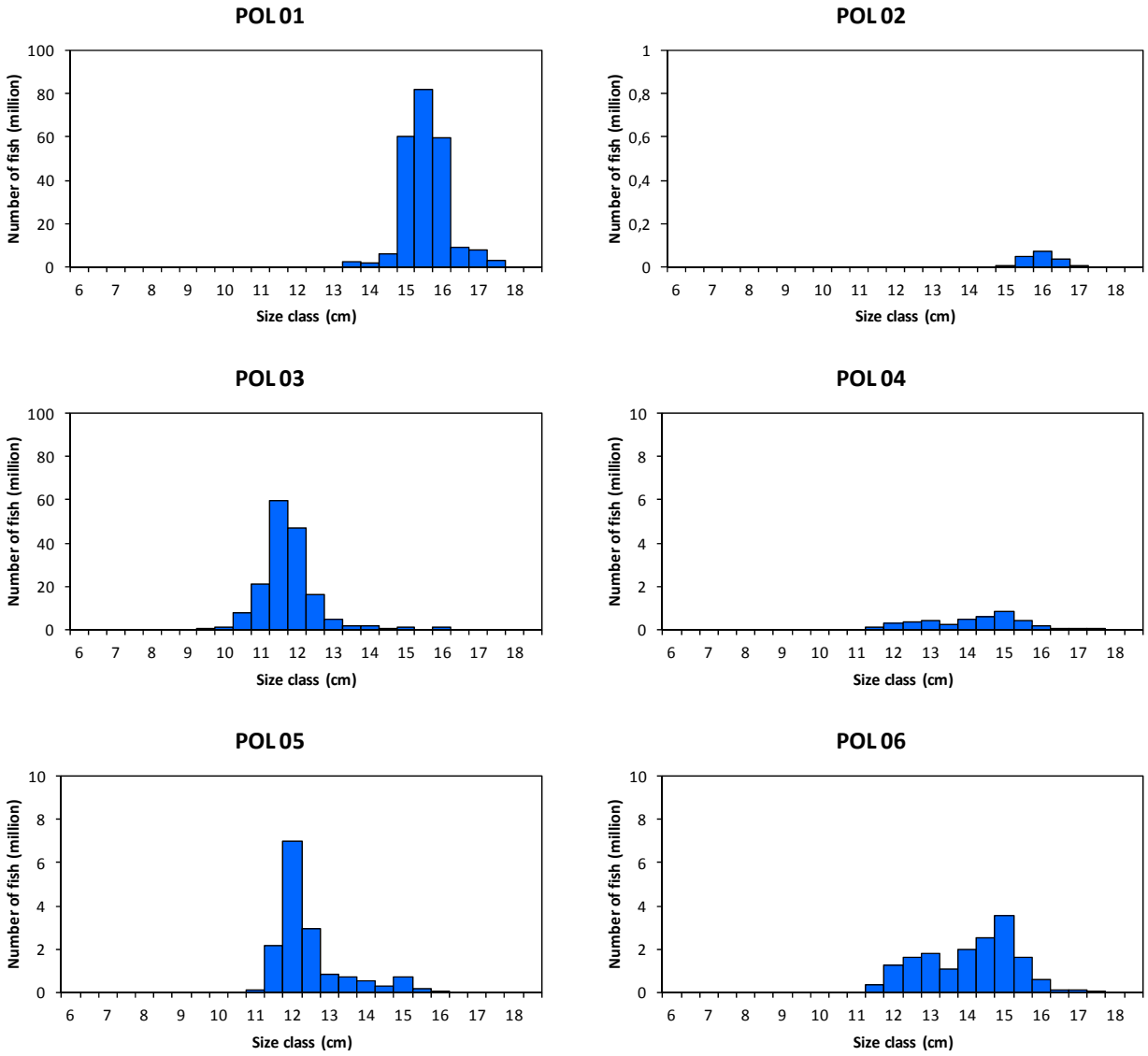


Figure 13. *ECOCADIZ 2017-07* survey. Sardine (*S. pilchardus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 12**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

ECOCADIZ 2017-07: Sardine (*S. pilchardus*)

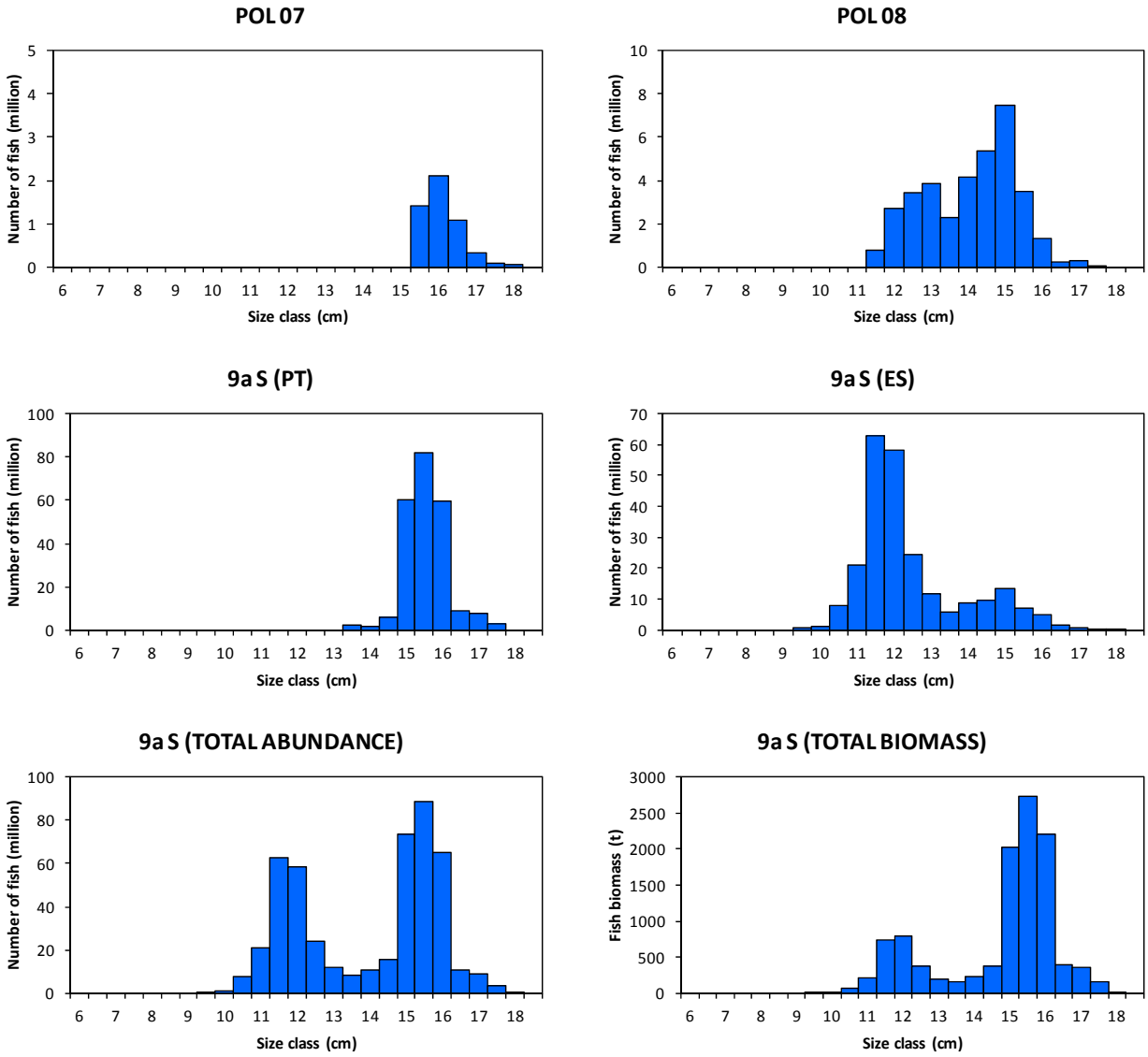


Figure 13. *ECOCADIZ 2017-07* survey. Sardine (*S. pilchardus*). Cont'd.

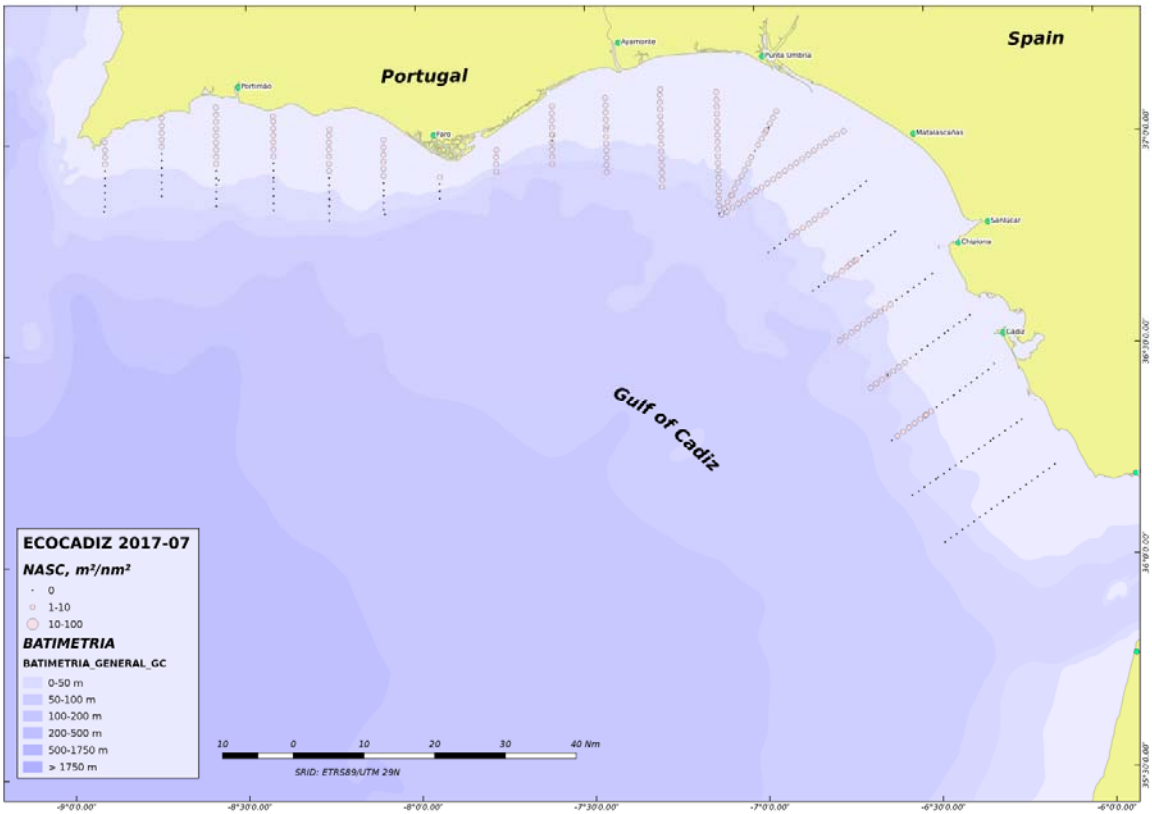


Figure 14. *ECOCADIZ 2017-07* survey. Mackerel (*Scomber scombrus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

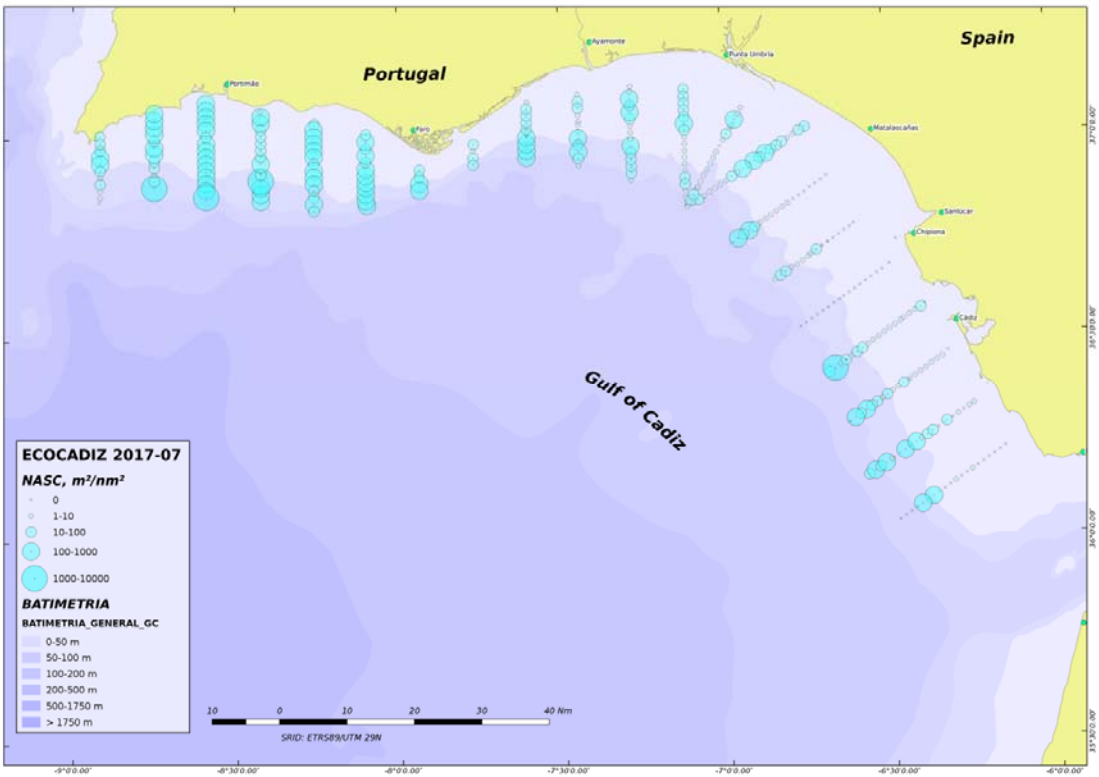


Figure 15. *ECOCADIZ 2017-07* survey. Chub mackerel (*Scomber colias*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

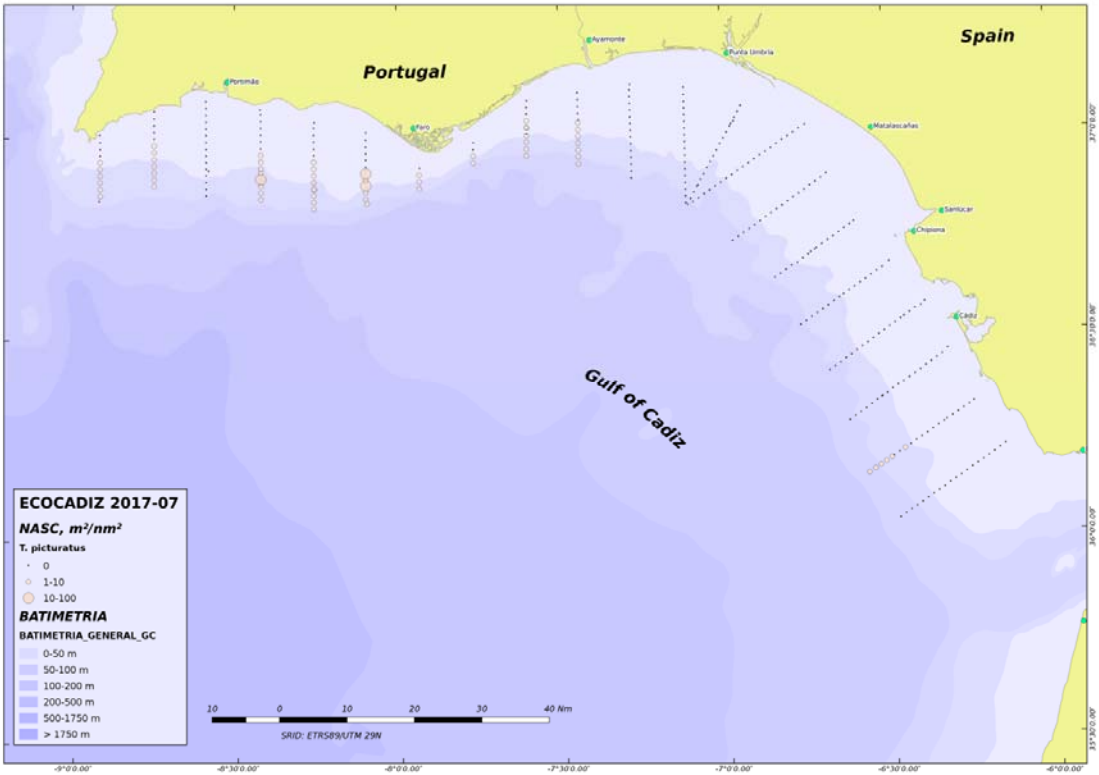


Figure 16. *ECOCADIZ 2017-07* survey. Blue jack mackerel (*Trachurus picturatus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

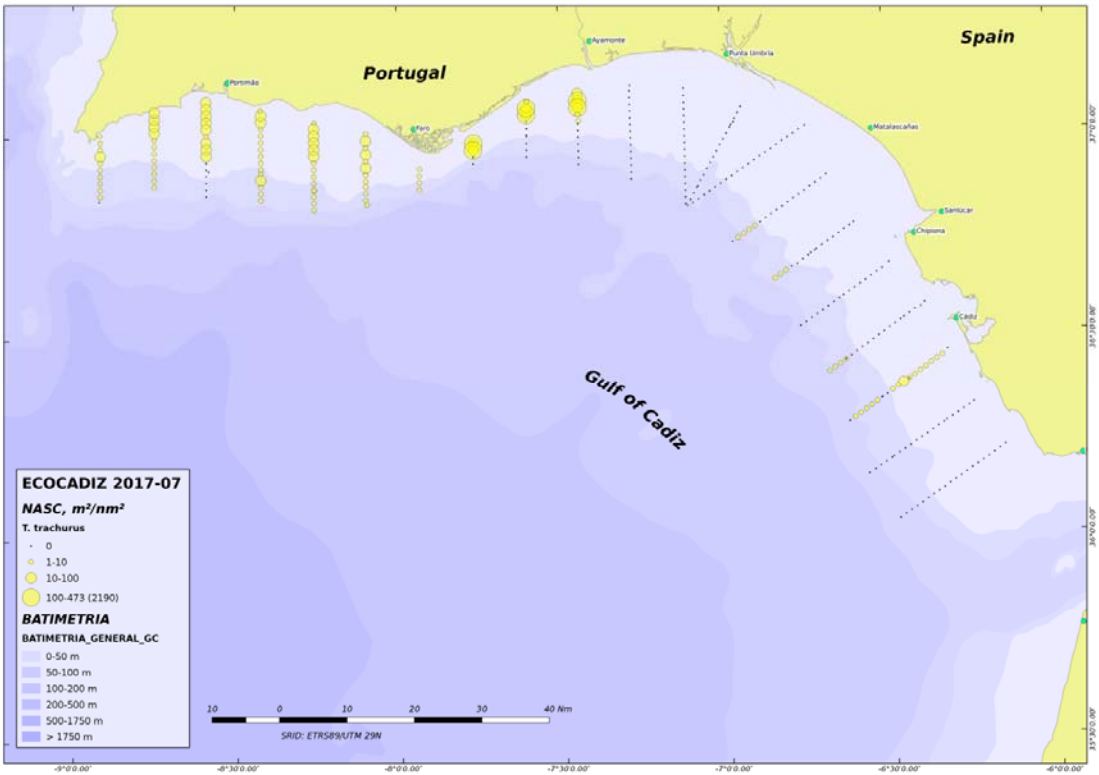


Figure 17. *ECOCADIZ 2017-07* survey. Horse mackerel (*Trachurus trachurus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

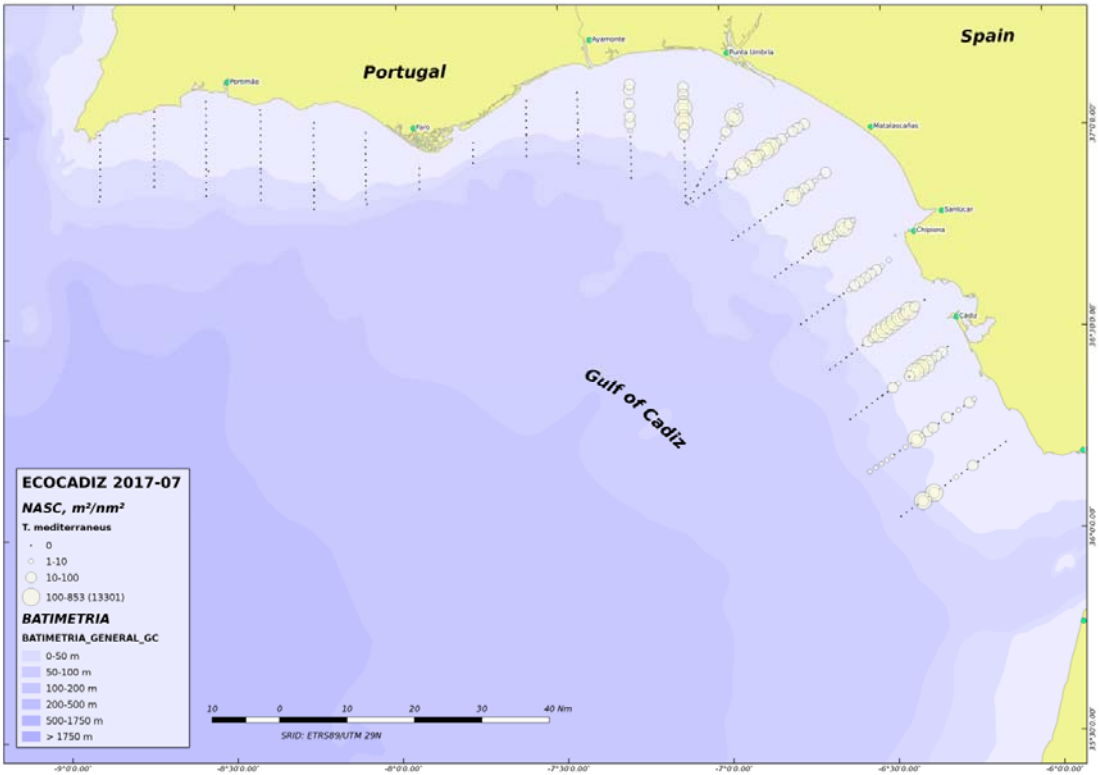


Figure 18. *ECOCADIZ 2017-07* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

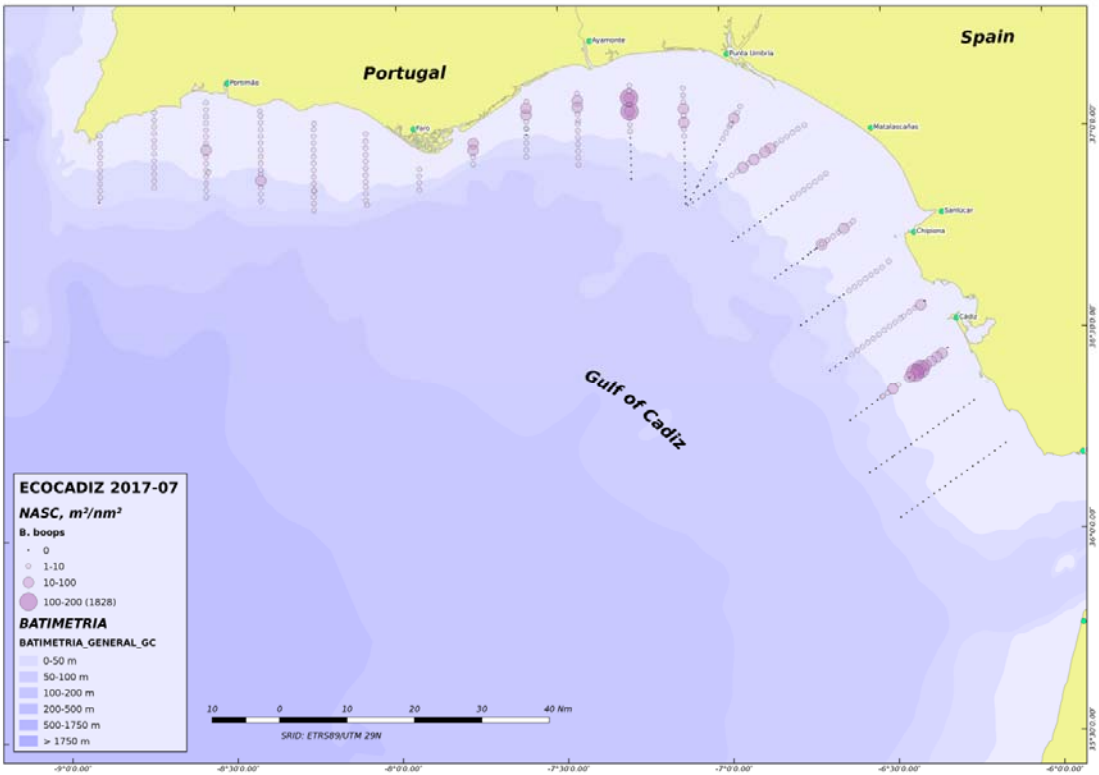


Figure 19. *ECOCADIZ 2017-07* survey. Bogue (*Boops boops*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

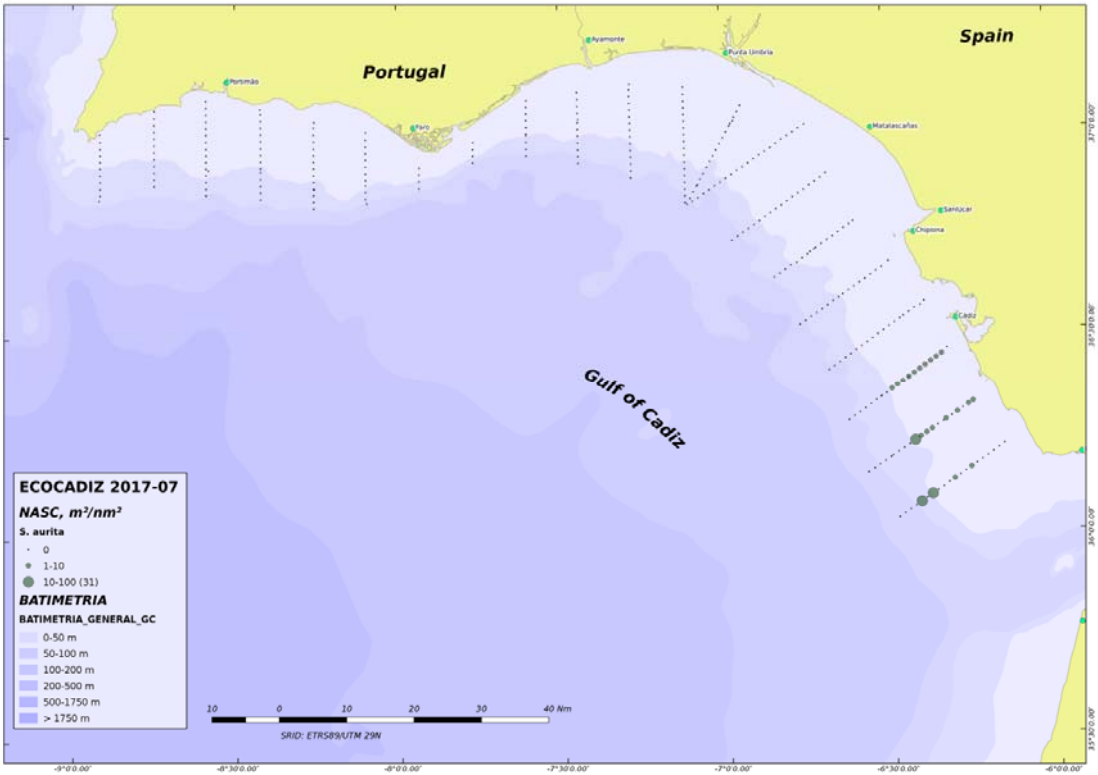


Figure 20. *ECOCADIZ 2017-07* survey. Round sardinella (*Sardinella aurita*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

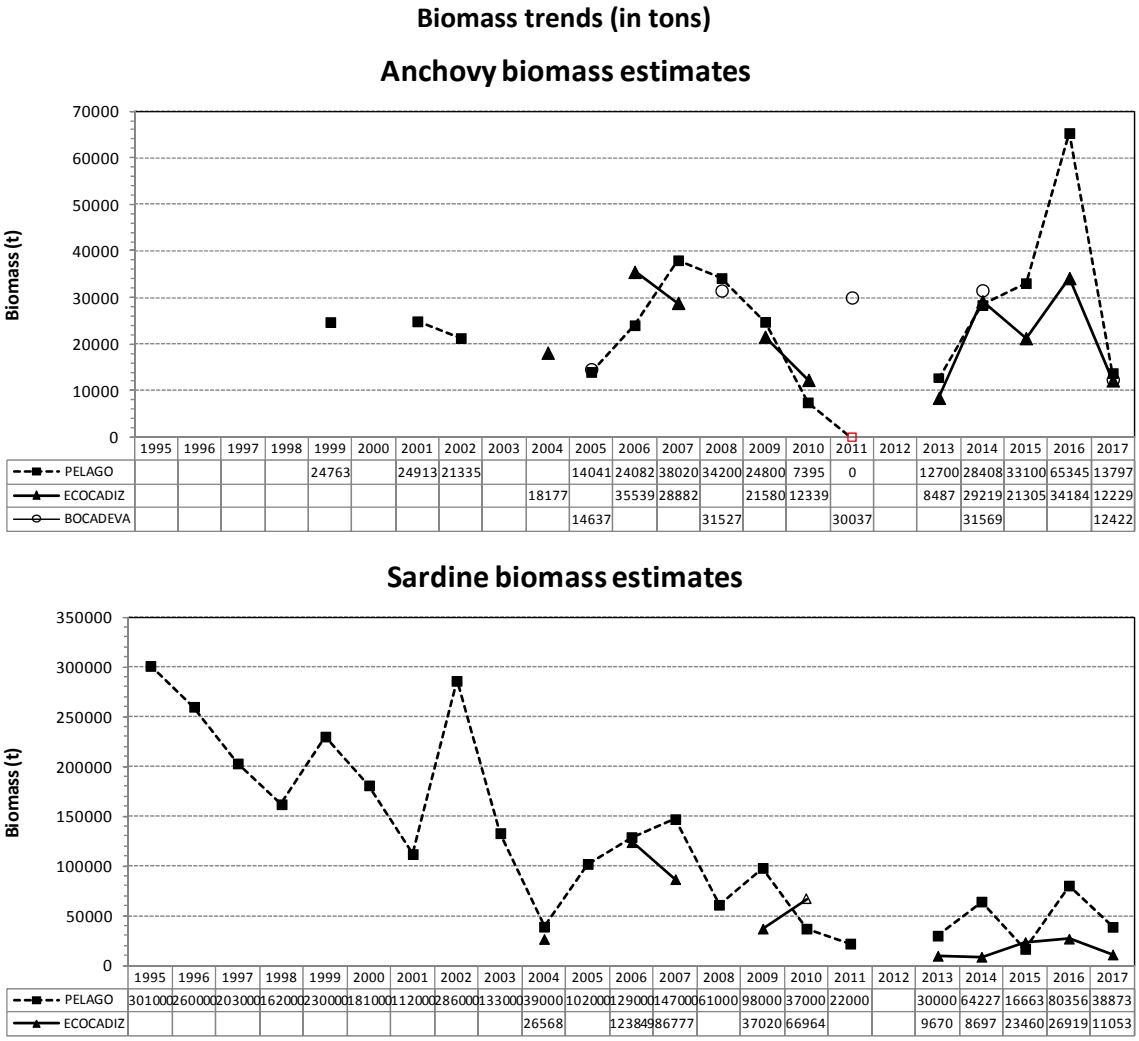


Figure 21. Trends in biomass estimates (in tons) for the main assessed species in Portuguese (*PELAGO*) and Spanish (*ECOCADIZ* and *BOCADEVA*) survey series. Note that the *ECOCADIZ* survey in 2010 partially covered the whole study area. The anchovy null estimate in 2011 from the *PELAGO* survey should be considered with caution.