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Acoustic assessment and distribution of anchovy, sardine and chub mackerel in ICES Subdivision 9a South during the *ECOCADIZ 2019-07* Spanish survey (July-August 2019) 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 2019 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 27 valid fishing hauls were carried out for echo-trace ground-truthing purposes. This working document only provides abundance and biomass estimates for anchovy, sardine and chub mackerel, 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 horse mackerel, anchovy, sardine, mackerel, blue jack mackerel, Atlantic pomfret (*Brama brama*) and bogue. Longspine snipefish, boarfish and transparent goby (*Aphia minuta*) showed a medium relative frequency of occurrence. Mediterranean horse-mackerel and pearlside showed a low occurrence. Pearlside was the most abundant species in these hauls, followed by sardine, chub mackerel, anchovy and longspine snipefish, with the remaining species showing negligible relative contributions. The estimate of total NASC allocated to the "pelagic fish species assemblage" has been the highest one ever recorded within the time series, denoting a high fish density during the survey. Such an increase is the result of the relatively high acoustic contributions of anchovy, sardine, chub mackerel, and the unexpected high contributions of the transparent goby and the Atlantic pomfret, species which usually have showed an accidental occurrence or very low abundance through the time-series. Anchovy was mainly distributed between Cape Santa Maria and Bay of Cadiz, although showing the highest densities in the Spanish central-western shelf waters. Anchovy eggs distribution resembled the adults' and, although overall egg density was higher than previous years, the spawning area showed a reduction as compared with those observed in previous years. Largest anchovies were mainly distributed in the westernmost waters and the smallest ones were concentrated between Doñana and Bay of Cadiz. Anchovy acoustic estimates in summer 2019 were of 5 485 million fish and 57 700 t (i.e. the historical biomass maximum in the time-series), well above the historical average (ca. 24 kt), showing a recent increasing trend. Sardine, widely distributed over the surveyed area, also recorded a high acoustic echo-integration in summer 2019 as a consequence of the occurrence of dense mid-water schools in the coastal fringe (20-60 m depth) comprised between Guadiana river mouth and Doñana. Acoustic estimates were of 2 917 million fish and 62 682 t, a biomass well above the historical average (ca. 47 kt). Spanish waters concentrated the bulk of the population. Chub mackerel was distributed all over the surveyed area but showing the highest densities in the Portuguese shelf waters. Acoustic estimates were of 465 million fish and 32 696 t, with the bulk of the population concentrated in the Portuguese waters, where the smallest fish were also recorded. Estimates showed a relative stable recent trend, with the recent biomasses very close to the historical average (ca. 35 kt).

INTRODUCTION

The *ECOCADIZ* surveys constitute a series of yearly acoustic surveys conducted by IEO in the Subdivision 9a 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 2019-07* survey. These results will only refer to the size-based acoustic estimates 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 2019-07* survey was carried out between 31st July and 13rd August 2019 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 2019* 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 by the *Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES areas 7, 8 and 9* (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. 15 m-mean vertical opening pelagic trawl (*Tuneado* 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 and a *Marport^{TM} combi TE/TS* (Trawl Eye/Trawl Speed) sensor. Trawl sonar and sensors 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).

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, mackerel and horse-mackerel species, and bogue. Otoliths were dissected from anchovy, sardine and chub mackerel sampled specimens.

The following TS/length relationship table was used for acoustic estimation of assessed species (following recent IEO standards after ICES, 1998 and recommendations by ICES, 2006a,b. b_{20} values for transparent goby and Atlantic pomfret following to Foote, 1987 for physoclists):

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
Transparent goby (*Aphia minuta*)	-67.5
Atlantic pomfret (*Brama brama*)	-67.5
Blue whiting (*Micromesistius poutassou*)	-67.5
Silvery lightfish/pearlside (*Maurolicus muelleri*)	-72.2
Longspine snipefish (*Macroramphosus scolopax*)	-80.0
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.

A *Continuous Underway Fish Egg Sampler* (CUFES, 121 stations), 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 biological (ichthyoplankton and *in vivo* fluorescence) and hydrographical variables (sub-surface sea temperature and salinity). Vertical profiles of hydrographical variables were also recorded by night from 150 CTD casts distributed in 15 transects 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 six (26) *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 into deeper waters in order to avoid the occurrence of open-sea fish farming/fattening cages.

Groundtruthing hauls

Twenty seven (27) 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**).

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. This type of hauls is also conducted in depths showing hard and/or very irregular bottoms or when the echotraces to be identified either are very scarce or very located in the bathymetric gradient. Given that all of these situations were not very uncommon in the sampled area, 41% of valid hauls (11 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 42-183 m.

During the survey were captured 2 Chondrichthyan, 37 Osteichthyes, 6 Cephalopod, 3 Crustacean and 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 table includes all the species under study and also those species with a higher occurrence than the former ones. 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 (24 hauls, 89% presence index) followed by horse mackerel and anchovy (with relative occurrences of 74 and 63%, respectively), sardine, mackerel, jack mackerel, Atlantic pomfret (*Brama brama*) and bogue (between 37 and 48%), snipefish, boarfish and transparent goby (*Aphia minuta*) (19-22%), Mediterranean horse-mackerel and pearlside (7% each one). Round sardinella was absent in the catches and the occurrence of blue whiting (4%) was incidental.

For the purposes of the acoustic assessment, anchovy, sardine, mackerel species, horse & jack mackerel species, bogue, goby, pomfret, snipefish and pearlside 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 25.9 tonnes and 841 thousand fish (**Table 3**). 49% of this fished biomass corresponded to chub mackerel, 33% to sardine, 8% to anchovy, and contributions lower than 3% to the remaining species. The most abundant species in ground-truthing trawl hauls was pearlside (27%), followed by sardine (27%), chub mackerel (24%), anchovy (17%) and snipefish (3%), with the remaining species showing lower contributions than 1.5%.

Species	# of fishing stations	Occurrence (%)	Total weight (kg)	Total number
Merluccius merluccius	25	93	118,878	1054
Scomber colias	24	89	12658,800	199954
Trachurus trachurus	20	74	654,182	5566
Loligo subulata	19	70	6,465	1041
Engraulis encrasicolus	17	63	2036,631	144812
Sardina pilchardus	13	48	8498,372	216529
Loligo media	12	44	3,131	1124
Scomber scombrus	12	44	35,398	375
Trachurus picturatus	12	44	184,676	3560
Brama brama	11	41	666,044	945
Boops boops	10	37	24,650	216
Spondyliosoma cantharus	9	33	12,683	61
Trachinus draco	9	33	3,671	35
Diplodus annularis	8	30	4,804	77
Pagellus erythrinus	8	30	56,959	327
Alosa fallax	7	26	2,684	10
Macroramphosus scolopax	6	22	204,464	28328
Capros aper	5	19	7,486	1221
Aphia minuta	5	19	4,593	11844
Pagellus acarne	5	19	35,573	108
Illex coindetii	5	19	1,100	29
Polybius henslowi	4	15	5,520	311
Diplodus bellottii	4	15	13,982	234
Lepidopus caudatus	4	15	0,138	5
Spicara flexuosa	3	11	15,226	243
Diplodus vulgaris	3	11	62,924	362
Chelidonichthys obscurus	2	7	0,214	2
Zeus faber	2	7	4,286	3
Trachurus mediterraneus	2	7	320,380	661
Maurolicus muelleri	2	7	167,214	226431
Loligo vulgaris	2	7	0,134	2
Lepidotrigla cavillone	1	4	0,088	3
Arnoglossus laterna	1	4	0,004	1
Mola mola	1	4	54,000	1
Microchirus boscanion	1	4	0,022	2
Raja clavata	1	4	0,368	1
Goneplax rhomboides	1	4	0,003	1
Micromesistius poutassou	1	4	0,022	1

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 was captured between Cape Santa María and Cape Trafalgar, although the highest yields were recorded in the Spanish central waters. The size composition of anchovy catches confirms the usual

pattern exhibited by the species in the area during the survey season, with the largest fish inhabiting the westernmost waters and the smallest ones concentrated in the surroundings of the Guadalquivir river mouth and adjacent shallow waters (**Figure 6**). Sardine catches showed a quite similar distribution to the above described for anchovy, but showing the highest yields in the surroundings of the Cadiz Bay and between Cape Santa María and the Guadiana river mouth. Juvenile sardines were mainly captured in the shallowest hauls conducted in the coastal fringe between Matalascañas 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, pomfret and transparent goby were restricted to the central and easternmost Spanish waters. The size composition of these last species in fishing hauls is shown in **Figures 8** to **18**.

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

A total of 328 nmi (ESDU) from 21 transects has been acoustically sampled by echo-integration for assessment purposes. From this total, 214 nmi (11 transects) were sampled in Spanish waters, and 114 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	FIM	POA	SNS	MAV
Total Area	259503	50456	74313	44	45335	6474	4904	2744	1265	12772	45617	6273	9307
(%)	(100,0)	(19,4)	(28,6)	(0,02)	(17,5)	(2,5)	(1,9)	(1,1)	(0,5)	(4,9)	(17,6)	(2,4)	(3,6)
Portugal	71465	10780	1402	2	43856	4889	0	2717	1206	0	0	6272	341
(%)	(27,5)	(21,4)	(1,9)	(4,5)	(96,7)	(75,5)	(0,0)	(99,0)	(95,3)	(0,0)	(0,0)	(99,9)	(3,7)
Spain	188038	39675	72910	41	1479	1585	4904	27	60	12772	45617	1	8967
(%)	(72,5)	(78,6)	(98,1)	(93,2)	(3,3)	(24,5)	(100,0)	(1,0)	(4,7)	(100,0)	(100,0)	(0,1)	(96,3)

For this "pelagic fish assemblage" has been estimated a total of 259 503 m^2 nmi^{-2}, the highest estimate ever recorded within the time-series (**Figure 19**). Portuguese waters accounted for 28% of this total back-scattering energy and the Spanish waters the remaining 72%. 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 19**. By species, anchovy (29%), sardine (19%), pomfret and chub mackerel (18% each) were the most important species in terms of their contributions to the total back-scattering energy. Transparent goby (5%), pearlside (4%), Atlantic and Mediterranean horse mackerel and snipe fish (2-3%) were the following species in importance. The remaining species contributed with less than 1%.

Some inferences on the species' distribution may be carried out from regional contributions to the total energy attributed to each species: Mediterranean horse mackerel, pomfret, transparent goby, sardine, pearlside, mackerel and anchovy seemed to show greater densities in the Spanish waters, whereas chub mackerel, blue jack mackerel, horse mackerel, bogue and snipefish could be considered as typically "Portuguese species" in this survey.

According to the resulting values of integrated acoustic energy, the species acoustically assessed in the present survey finally were anchovy, sardine, mackerel, chub mackerel, blue jack mackerel, horse mackerel, Mediterranean horse mackerel, bogue, transparent goby, Atlantic pomfret, longspine snipefish and pearlside.

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 20**. The estimated abundance and biomass by size class are given in **Table 5**, and **Figure 21**.

Anchovy was mainly distributed between Cape Santa Maria and Bay of Cadiz, although showing the highest densities in the Spanish shelf waters between El Rompido (RA10) and Bay of Cadiz (RA03) (**Figure 20**).

Five (5) coherent post-strata have been differentiated according to the S_A value distribution and the size composition in the fishing stations (**Figure 20**). The acoustic estimates by homogeneous post-stratum and total area are shown in **Table 5** and **Figure 21**. Overall acoustic estimates in summer 2019 were of 5 485 million fish and 57 700 tonnes. By geographical strata, the Spanish waters yielded 99% (5 405 million) and 97% (56 139 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 80 million and 1 560 t. The current biomass estimate (57 700 t) becomes in the historical maximum within the time-series (2006: 35 539 t; 2016: 34 184 t; 2018: 34 908 t; see **Figure 36**). The *PELAGO 19* spring Portuguese survey previously estimated for this same area 29 876 t (3 398 million), with all the anchovy located in the Spanish waters.

The size class range of the assessed population varied between the 8.5 and 17.5 cm size classes, with one main modal class at 12.0 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 (and oldest) fish being distributed both in the westernmost waters and the smallest (and youngest) ones concentrated in the surroundings of the Guadalquivir river mouth and adjacent shallow waters (**Table 5; Figure 21;** see also **Figure 6**).

The Gulf of Cadiz anchovy egg distribution from CUFES sampling is shown in **Figure 22**. Anchovy egg distribution and densities in summer 2019 are quite coincident with that of adults. The estimated total egg density is higher than the observed in the most recent years but the spawning area showed a reduction as compared with those observed ones in previous years.

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 23**. Estimated abundance and biomass by size class are given in **Table 6** and **Figure 24**.

Sardine also recorded a high acoustic echo-integration in summer 2019 as a consequence of the occurrence of dense mid-water schools in the coastal fringe (20-60 m depth) comprised between Ayamonte (RA11) and Doñana (RA06), (**Figure 23**).

Seven (7) size-based homogeneous sectors were delimited for the acoustic assessment (**Figure 23**). The estimates of Gulf of Cadiz sardine abundance and biomass in summer 2019 were 2 917 million fish and 62 682 t, a biomass well above the historical average (ca. 47 kt), but lower than the biomass estimated in 2018 (114 631 t; see **Figure 36**). Spanish waters concentrated the bulk of the population (2 495 million and 44 899 t). The estimates for the Portuguese waters were 422 million and 17 783 t.

Sizes of the assessed population ranged between 10.5 and 20.0 cm size classes. The length frequency distribution of the population was clearly bimodal, with one main mode at 11.5 cm size class and a secondary one at 15.0 cm (**Table 6**; **Figure 24**). The relatively important juvenile fraction in the estimated population (≤11.5 cm), was mainly located in relatively shallow waters along the coastal fringe comprised between Matalascañas and the Bay of Cadiz (**Table 6**; **Figure 24**; see also **Figure 7**).

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 25**.

Atlantic mackerel showed very scattered and low acoustic records during the 2019 survey, which were mainly observed over the shelf located in the central part of the Gulf of Cadiz (**Figure 25**). Juveniles were mainly recorded in the Spanish outer shelf central waters, whereas larger fish occurred in shallower waters.

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 and the coherent strata considered for the acoustic estimation are shown in **Figure 26**. Estimated abundance and biomass by size class are given in **Table 7** and **Figure 27**.

Chub mackerel was widely distributed in the surveyed area, although the highest densities occurred all over the Portuguese shelf waters. In the Spanish waters the species occurred in the middle-outer shelf waters, where the smallest fish were also found (**Figure 26**).

Five (5) size-based homogeneous sectors were delimited for the acoustic assessment (**Figure 26**). The estimates of Gulf of Cadiz chub mackerel abundance and biomass in summer 2019 were 465 million fish and 32 696 t. These estimates and the most recent ones showed a relative stable recent trend, with biomasses very close to the historical average (ca. 35 kt; see **Figure 36**). Portuguese waters concentrated the bulk of the population (454 million and 31 536 t). The estimates for the Spanish waters were 11 million and 1 159 t.

Sizes of the assessed population ranged between 16.5 and 27.5 cm size classes. The length frequency distribution of the population was clearly mixed, with one main mode at 19.5 cm size class and a secondary one at 23.5 cm (**Table 7**; **Figure 27**).

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 28**.

The species was mainly distributed all over the Portuguese outer shelf waters. An incidental occurrence was also recorded in the Spanish easternmost waters. The surveyed population was composed by juveniles and subadults (**Figure 28**).

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 29**.

Horse mackerel showed a quite similar distribution pattern to the abovementioned one for blue jack mackerel, with the species being almost absent in the easternmost shelf and showing relatively higher densities in the shelf area comprised between Cape San Vicente and Cape Santa Maria. Juveniles were scarce and occurred incidentally in the Spanish outer shelf central waters (**Figure 29**).

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 30**.

Mediterranean horse mackerel was restricted, as usual, to the Spanish waters, more specifically between Doñana and Sancti-Petri, with the population being composed by adult fish (**Figure 30**).

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 31**.

Bogue showed a distribution pattern quite similar to the described ones for blue jack mackerel and horse-mackerel, with a very incidental occurrence in Spanish waters (just in front of the Bay of Cadiz) and the highest densities being recorded in the westernmost waters of the Gulf (**Figure 31**).

Transparent goby

Parameters of the survey's length-weight relationship for transparent goby are shown in **Table 4**. Back-scattering energy attributed to the species is shown in **Figure 32**.

This gobiid species showed this year unusually high acoustic integration and densities, which were exclusively recorded over the inner-middle shelf waters of the Spanish part of the Gulf, between Mazagon and Bay of Cadiz. Its occurrence was associated to the typical (plankton-) scattering layer recorded close to the bottom in the Guadalquivir river mouth's influence area (**Figure 32**).

Atlantic pomfret

Parameters of the survey's length-weight relationship for *Brama brama* are shown in **Table 4**. Back-scattering energy attributed to the species is shown in **Figure 33**.

The Atlantic pomfret showed an unexpected high frequency of occurrence and abundance in the fishing hauls not recorded in previous surveys. The species acoustically contributed with 17% of the total NASC recorded in the survey, although it was restricted to the Spanish middle-outer shelf waters (**Figure 33**).

Longspine snipefish

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 34**.

M. scolopax showed an incidental occurrence mainly restricted to the westernmost outer shelf waters just to the west of Portimão (**Figure 34**).

Pearlside

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 35**.

Pearlside was located close to the deepest limit of the surveyed area (200 m), just in the transition between outer shelf and upper slope waters. The highest densities were recorded in the Spanish outer shelf (**Figure 35**).

(SHORT) DISCUSSION

The total NASC estimated in this survey for "pelagic fish assemblage", 259 503 m^2 nmi^{-2}, is the highest estimate ever recorded within the time-series (**Figure 19**), a situation which was repeated in the last year's survey. In the current survey such an increase in acoustic energy is the result of the relatively high partial contributions of anchovy, sardine, chub mackerel (as was also the case the last year), and the unexpected high contributions of the transparent goby and the Atlantic pomfret, species which usually have showed an accidental occurrence or very low abundance through the time-series. Anchovy has shown an increased contribution in relation to the one recorded last year, but almost exclusively restricted to the Spanish waters. In many of the anchovy positive hauls, this species was the dominant in terms of numbers and weight. Sardine also showed during the 2009 survey the occurrence of dense schools in the coastal (20-60 m) waters in the central part of the Gulf (between the Guadiana river mouth and Doñana), although not so numerous as in the 2018 survey.

The current anchovy biomass estimate (57 700 t) becomes in the historical maximum within the time-series (2006: 35 539 t; 2018: 34 908 t; see **Figure 36**) and denotes a strong increase in relation to the previous years, up to levels well above the historical average (ca. 24 kt), showing a recent increasing trend. Although the spring *PELAGO 19* survey also estimated increased population levels (29 876 t), such increase was not so pronounced as the estimated by its summer counterpart.

The estimates of Gulf of Cadiz sardine abundance and biomass in summer 2019 were 2 917 million fish and 62 682 t, a biomass well above the historical average (ca. 47 kt), but lower than the biomass estimated the previous year (114 631 t, **Figure 36**).

Chub mackerel acoustic estimates were of 465 million fish and 32 696 t, with the bulk of the population concentrated in the Portuguese waters, where the smallest fish were also recorded. Estimates showed a relative stable recent trend, with the recent biomasses very close to the historical average (ca. 35 kt; **Figure 36**).

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Unión Europea

Fondo Europeo Marítimo y de Pesca (FEMP)

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Table 1. *ECOCADIZ 2019-07 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	01/08/19	36º 12,975' N	6º 08,870' W	06:06	23	36º 02,200' N	6º 28,800' W	10:02	241
R02	Sancti-Petri	01/08/19	36º 08,890' N	6º 34,190' W	11:04	149	36º 19,350' N	6º 14,860' W	14:48	28
R03	Cádiz	02/08/19	36º 26,712' N	6º 19,122' W	06:00	25	36º 17,150' N	6º 36,730' W	09:42	201
R04	Rota	02/08/19	36º 24,510' N	6º 40,720' W	10:39	200	36º 34,881' N	6º 21,885' W	00:00	20
R05	Chipiona	03/08/19	36º 31,220' N	6º 46,330' W	06:06	201	36º 40,347' N	6º 29,483' W	09:30	20
R06	Doñana	03/08/19	36º 46,610' N	6º 35,780' W	10:23	20	36º 38,050' N	6º 51,520' W	13:50	241
R07	Matalascañas	04/08/19	36º 54,300' N	6º 39,340' W	05:59	20	36º 44,006' N	6º 58,304' W	10:05	208
R08	Mazagón	04/08/19	36º 49,450' N	7º 06,060' W	13:58	192	37º 01,060' N	6º 44,720' W	17:36	23
R09	Punta Umbría	05/08/19	37º 03,902' N	6º 56,385' W	06:01	27	36º 49,663' N	7º 06,613' W	09:38	200
R10	El Rompido	05/08/19	36º 50,110' N	7º 07,200' W	13:20	156	37º 07,950' N	7º 07,190' W	16:38	21
R11	Isla Cristina	06/08/19	37º 06,762' N	7º 17,190' W	06:02	25	36º 53,379' N	7º 17,156' W	08:27	200
R12	V.R. do Sto. Antonio	06/08/19	36º 51,310' N	7º 27,130' W	10:52	129	37º 06,420' N	7º 27,140' W	13:25	21
R13	Tavira	07/08/19	37º 04,780' N	7º 37,140' W	06:00	20	36º 56,950' N	7º 37,090' W	06:44	214
R14	Fuzeta	07/08/19	36º 59,122' N	7º 47,076' W	15:44	44	36º 55,480' N	7º 47,040' W	16:06	65
R15	Cabo Sta. María	08/08/19	36º 55,590' N	7º 57,010' W	06:00	65	36º 52,070' N	7º 56,960' W	6:20	214
R16	Quarteira	08/08/19	36º 49,750' N	8º 06,880' W	10:26	111	37º 01,760' N	8º 07,040' W	11:38	20
R17	Albufeira	09/08/19	37º 01,452' N	8º 16,979' W	06:10	31	36º 49,376' N	8º 16,788' W	07:21	198
R18	Alfanzina	09/08/19	36º 50,290' N	8º 26,770' W	11:56	193	37º 04,550' N	8º 27,030' W	15:29	21
R19	Portimao	10/08/19	37º 05,990' N	8º 37,050' W	06:02	24	36º 51,270' N	8º 36,740' W	08:00	203
R20	Burgau	10/08/19	36º 51,960' N	8º 46,690' W	13:15	200	37º 02,644' N	8º 46,985' W	15:40	44
R21	Ponta de Sagres	11/08/19	36º 59,160' N	8º 56,800' W	05:59	26	36º 50,610' N	8º 56,610' W	06:49	208

Table 2. *ECOCADIZ 2019-07* survey. Descriptive characteristics of the fishing stations.

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	01-08-2019	36º 02.8258 N	6º 27.5187 W	118.26	36º 04.6665 N	6º 24.2185 W	92.6	08:17	09:02	0:45	1:10	3.246	R01	Cape Trafalgar
PE02	01-08-2019	36º 12.2035 N	6º 28.0417 W	100.28	36º 10.4644 N	6º 31.2328 W	120.76	12:07	12:50	0:43	1:12	3.113	R02	Sancti-Petri
PE03	02-08-2019	36º 22.2477 N	6º 27.1795 W	62.66	36º 24.1798 N	6º 23.7697 W	49.62	07:17	08:08	0:51	1:17	3.362	R03	Cádiz
PE04	02-08-2019	36º 23.9902 N	6º 39.4744 W	175.4	36º 25.6666 N	6º 40.9363 W	183.04	11:37	12:05	0:27	1:02	2.048	R04	Rota
PE05	02-08-2019	36º 29.0500 N	6º 32.7102 W	73.03	36º 27.2992 N	6º 35.7808 W	96.73	13:34	14:16	0:42	1:07	3.032	R04	Rota
PE06	03-08-2019	36º 37.4764 N	6º 35.0545 W	46.66	36º 35.7088 N	6º 38.0509 W	68.01	07:41	08:23	0:41	1:02	2.989	R05	Chipiona
PE07	03-08-2019	36º 39.8023 N	6º 48.2119 W	108.63	36º 41.6428 N	6º 44.9131 W	79.21	12:03	12:49	0:45	1:11	3.228	R06	Doñana
PE08	04-08-2019	36º 48.2986 N	6º 47.7196 W	57.98	36º 51.2457 N	6º 50.2405 W	57.49	07:47	8:37	0:50	1:10	3.572	R07	Matalascañas
PE09	04-08-2019	36º 47.1990 N	6º 52.5756 W	94.96	36º 45.3591 N	6º 55.7908 W	118.79	11:50	12:35	0:45	1:11	3.17	R07	Matalascañas
PE10	04-08-2019	36º 53.5684 N	6º 55.1256 W	72.92	36º 55.4394 N	6º 56.9512 W	69.32	15:26	15:59	0:33	0:59	2.374	R08	Mazagón
PE11	05-08-2019	36º 58.8694 N	6º 59.2051 W	54.47	37º 00.7732 N	7º 01.8807 W	48.83	07:21	08:03	0:41	1:16	2.865	R09	Punta Umbría
PE12	05-08-2019	36º 52.7992 N	7º 03.8962 W	109.65	36º 50.4193 N	7º 05.2735 W	141.78	12:09	12:46	0:37	1:05	2.621	R09	Punta Umbría
PE13	05-08-2019	36º 58.1839 N	7º 07.1824 W	81.75	36º 55.8414 N	7º 07.1809 W	99.68	14:34	15:07	0:32	0:57	2.34	R10	El Rompido
PE14	06-08-2019	36º 58.9606 N	7º 27.0352 W	105.34	36º 56.8828 N	7º 27.0894 W	135.35	11:36	12:05	0:28	0:56	2.076	R12	Vila Real do Santo Antonio
PE15	06-08-2019	37º 04.6033 N	7º 25.0948 W	43.02	37º 04.6153 N	7º 28.6036 W	44.79	14:31	15:10	0:39	0:59	2.808	R12	Vila Real do Santo Antonio
PE16	07-08-2019	36º 57.8844 N	7º 35.8137 W	126.63	36º 58.3597 N	7º 39.6316 W	124.62	07:51	08:34	0:42	1:20	3.096	R13	Tavira
PE17	07-08-2019	36º 59.7265 N	7º 35.1627 W	103.56	36º 59.1631 N	7º 37.8753 W	103.27	12:09	12:41	0:31	1:02	2.245	R13	Tavira
PE18	07-08-2019	37º 03.4497 N	7º 34.8718 W	45.56	37º 02.8950 N	7º 37.0614 W	42.44	14:09	14:35	0:25	0:47	1.838	R13	Tavira
PE19	08-08-2019	36º 54.6022 N	7º 56.9863 W	77.54	36º 52.6036 N	7º 56.9668 W	108.33	07:03	07:31	0:28	1:01	1.996	R15	Cape Santa María
PE20	08-08-2019	36º 57.7930 N	8º 06.8919 W	44.07	36º 56.3266 N	8º 06.8956 W	48.78	12:14	12:34	0:20	0:51	1.464	R16	Quarteira
PE21	08-08-2019	36º 51.8557 N	8º 05.6689 W	111.81	36º 50.7514 N	8º 07.9687 W	107.01	14:18	14:48	0:29	1:07	2.15	R16	Quarteira
PE22	09-08-2019	36º 50.5998 N	8º 15.6259 W	118.65	36º 51.9970 N	8º 18.5947 W	116.37	08:50	09:29	0:39	1:06	2.761	R17	Albufeira
PE23	09-08-2019	36º 57.2746 N	8º 26.9154 W	85.23	36º 53.8497 N	8º 26.8420 W	123.63	13:13	14:01	0:48	1:14	3.421	R18	Alfanzina
PE24	10-08-2019	36º 52.8750 N	8º 36.7405 W	115.4	36º 55.0627 N	8º 36.7875 W	101.16	08:34	09:04	0:30	0:58	2.185	R19	Portimao
PE25	10-08-2019	36º 52.3045 N	8º 35.9494 W	114.11	36º 52.8616 N	8º 38.8939 W	117.34	11:35	12:09	0:34	1:04	2.427	R19	Portimao
PE26	10/08/2019	36º 56.9764 N	8º 46.7872 W	109.7	36º 55.4947 N	8º 46.7656 W	113.93	14:16	14:36	0:20	0:46	1.48	R20	Burgau
PE27	11/08/2019	36º 51.7239 N	8º 56.6149 W	145.45	36º 54.4681 N	8º 56.6929 W	116.09	7:22	8:01	0:38	1:09	2.741	R21	Ponta de Sagres

Table 3. *ECOCADIZ 2019-07* survey. Catches by species in number (upper panel) and weight (in kg, lower panel) from valid fishing stations.

CATCH IN NUMBERS																
Fishing station	**ANE**	**PIL**	**MAS**	**MAC**	**HOM**	**JAA**	**HMM**	**BOG**	**FIM**	**POA**	**WHB**	**BOC**	**SNS**	**MAV**	**OTHERS SPP**	**TOTAL**
01	0	0	6	0	3	0	0	0	0	0	0	334	4	0	16	**363**
02	1	0	27	1	658	6	646	0	0	76	0	8	0	0	80	**1503**
03	152	4431	0	4	2	0	0	1	0	14	0	0	0	0	269	**4873**
04	0	0	0	0	0	0	0	0	0	106	0	0	0	226417	2	**226525**
05	3695	12	6	13	2	0	0	0	7343	274	0	0	0	0	132	**11477**
06	6517	3229	0	0	1	0	15	0	1603	9	0	0	0	0	51	**11425**
07	6364	0	28	0	2	0	0	0	452	20	0	0	0	0	34	**6900**
08	551	3	1	105	0	0	0	0	2430	395	0	0	0	0	67	**3552**
09	5778	0	61	116	0	0	0	0	0	4	0	0	0	0	39	**5998**
10	6147	0	1	37	1	0	0	0	16	4	0	0	0	0	68	**6274**
11	2182	16	17	13	2	0	0	0	0	41	0	0	0	0	217	**2488**
12	34223	0	15	2	0	1	0	0	0	0	0	0	0	0	45	**34286**
13	53810	621	22	39	1	0	0	0	0	2	0	0	0	0	42	**54537**
14	16713	88584	2095	0	0	0	0	0	0	0	0	0	0	0	5	**107397**
15	188	109	1	21	5	0	0	14	0	0	0	0	0	0	138	**476**
16	1	59	7228	0	0	487	0	0	0	0	0	0	10	0	0	**7785**
17	8134	86254	34326	0	0	0	0	0	0	0	0	0	0	0	6	**128720**
18	0	29945	32	23	634	40	0	34	0	0	0	0	0	0	401	**31109**
19	353	12	3146	1	448	14	0	18	0	0	0	0	0	0	436	**4428**
20	0	3254	147256	0	49	0	0	0	0	0	0	0	0	0	0	**150559**
21	3	0	344	0	3194	88	0	20	0	0	0	0	0	0	97	**3746**
22	0	0	1839	0	30	810	0	0	0	0	0	824	22	0	62	**3587**
23	0	0	852	0	297	7	0	67	0	0	1	15	3	14	225	**1481**
24	0	0	1347	0	12	18	0	18	0	0	0	0	1	0	12	**1408**
25	0	0	101	0	14	211	0	13	0	0	0	40	28288	0	2	**28669**
26	0	0	1180	0	177	7	0	22	0	0	0	0	0	0	36	**1422**
27	0	0	23	0	34	36	0	9	0	0	0	0	0	0	22	**124**
TOTAL	**144812**	**216529**	**199954**	**375**	**5566**	**1725**	**661**	**216**	**11844**	**945**	**1**	**1221**	**28328**	**226431**	**2504**	**841112**

Table 3. *ECOCADIZ 2019-07* survey. Cont'd.

CATCH IN WEIGHT (kg)																
Fishing station	**ANE**	**PIL**	**MAS**	**MAC**	**HOM**	**JAA**	**HMM**	**BOG**	**FIM**	**POA**	**WHB**	**BOC**	**SNS**	**MAV**	**OTHERS SPP**	**TOTAL**
01	0	0	0,780	0	0,148	0	0	0	0	0	0	1,866	0,024	0	2,662	**5,480**
02	0,008	0	3,080	0,166	94,050	2,340	316,800	0	0	52,367	0	0,044	0	0	7,869	**476,724**
03	1,678	102,700	0	1,632	0,142	0	0	0,278	0	9,550	0	0	0	0	38,754	**154,734**
04	0	0	0	0	0	0	0	0	0	81,647	0	0	0	167,200	0,074	**248,921**
05	43,550	0,225	0,520	1,030	0,007	0	0	0	3,130	189,050	0	0	0	0	13,908	**251,420**
06	50,480	38,784	0	0	0,003	0	3,580	0	0,774	6,900	0	0	0	0	4,218	**104,739**
07	79,550	0	1,664	0	0,006	0	0	0	0,232	13,950	0	0	0	0	3,490	**98,892**
08	5,730	0,074	0,182	5,754	0	0	0	0	0,450	274,650	0	0	0	0	6,655	**293,495**
09	78,240	0	6,250	4,902	0	0	0	0	0	3,200	0	0	0	0	4,966	**97,558**
10	75,550	0	0,140	1,587	0,005	0	0	0	0,007	3,372	0	0	0	0	6,072	**86,733**
11	25,550	0,326	2,213	3,474	0,032	0	0	0	0	29,450	0	0	0	0	13,662	**74,707**
12	444,700	0	1,192	0,070	0	0,013	0	0	0	0	0	0	0	0	4,379	**450,354**
13	712,850	11,350	0,738	2,572	0,014	0	0	0	0	1,908	0	0	0	0	4,734	**734,166**
14	334,672	3218,545	137,601	0	0	0	0	0	0	0	0	0	0	0	1,720	**3692,538**
15	2,234	2,080	0,193	6,660	0,420	0	0	1,970	0	0	0	0	0	0	15,665	**29,222**
16	0,019	2,780	521,050	0	0	70,837	0	0	0	0	0	0	0,121	0	0	**594,807**
17	174,312	3739,108	2191,580	0	0	0	0	0	0	0	0	0	0	0	2,222	**6107,222**
18	0	1216,776	2,446	7,225	50,486	1,702	0	4,188	0	0	0	0	0	0	48,193	**1331,016**
19	7,410	0,462	315,480	0,326	55,150	0,834	0	2,728	0	0	0	0	0	0	97,366	**479,756**
20	0	165,162	8908,991	0	1,595	0	0	0	0	0	0	0	0	0	0	**9075,748**
21	0,098	0	37,300	0	390,500	6,654	0	2,640	0	0	0	0	0	0	5,570	**442,762**
22	0	0	201,850	0	3,696	80,950	0	0	0	0	0	4,830	0,227	0	8,728	**300,281**
23	0	0	74,750	0	31,300	0,300	0	7,285	0	0	0,022	0,084	0,032	0,014	31,472	**145,259**
24	0	0	120,600	0	1,316	1,690	0	1,028	0	0	0	0	0,010	0	1,072	**125,716**
25	0	0	10,470	0	0,761	15,350	0	1,355	0	0	0	0,662	204,050	0	54,096	**286,744**
26	0	0	117,250	0	20,200	0,454	0	2,137	0	0	0	0	0	0	6,884	**146,925**
27	0	0	2,480	0	4,351	3,552	0	1,041	0	0	0	0	0	0	6,270	**17,694**
TOTAL	**2036,631**	**8498,372**	**12658,800**	**35,398**	**654,182**	**184,676**	**320,380**	**24,650**	**4,593**	**666,044**	**0,022**	**7,486**	**204,464**	**167,214**	**390,701**	**25853,613**

Table 4. *ECOCADIZ 2019-07* survey. Parameters of the size-weight relationships for survey's target species. FAO codes for the species: ANE: *Engraulis encrasicolus*; PIL: *Sardina pilchardus*; MAS: *Scomber colias*; MAC: *Scomber scombrus*; HOM: *Trachurus trachurus*; JAA: *Trachurus picturatus;* HMM: *Trachurus mediterraneus*; BOG: *Boops boops*; FIM: *Aphia minuta*; POA: *Brama brama*: BOC: *Capros aper*; SNS: *Macrorhamphosus scolopax*; MAV: *Maurolicus muelleri*. (*) FIM's LW relationship parameters following Iglesias *et al*. (1997).

PARAMETER	ANE	PIL	MAS	MAC	HOM	JAA	HMM	BOG	FIM(*)	POA
Size range (mm)	92-173	108-202	132-343	158-381	66-336	121-384	282-463	193-297		358-517
n	723	469	766	229	408	320	65	167		388
a	0,002644	0,002409	0,003183	0,002395	0,008879	0,007130	0,029374	0,005556	0,004000	0,027261
b	3,356048	3,460818	3,286908	3,351769	2,974619	3,048874	2,630445	3,157324	3,690000	2,722180
r^2	0,95	0,95	0,96	0,99	0,94	0,99	0,97	0,84		0,71

PARAMETER	BOC	SNS	MAV
Size range (mm)	53-104	94-164	36-64
n	181	96	98
a	0,034164	0,003662	0,010578
b	2,743768	3,158905	2,869503
r^2	0,99	0,80	0,96

Table 5. *ECOCADIZ 2019-07* 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 20**.

***ECOCADIZ 2019-07* . *Engraulis encrasicolus* . ABUNDANCE (in numbers and million fish)**											
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	***n***			**Millions**		
						PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**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	75490733	0	75490733	75490733	0	75	75
9	0	0	0	0	320755985	0	320755985	320755985	0	321	321
9,5	0	0	0	0	339549037	0	339549037	339549037	0	340	340
10	0	30229	0	28787841	396246718	30229	425034559	425064788	0,03	425	425
10,5	0	88331	0	84121160	396246718	88331	480367878	480456209	0,1	480	480
11	0	296251	0	282131250	301962933	296251	584094183	584390434	0,3	584	584
11,5	0	684742	0	652106300	75490733	684742	727597033	728281775	1	728	728
12	526172	1027334	85251	978369750	94283785	1553506	1072738786	1074292292	2	1073	1074
12,5	4276461	727989	692874	693292319	56697682	5004450	750682875	755687325	5	751	756
13	12520921	423300	2028645	403124967	18793052	12944221	423946664	436890885	13	424	437
13,5	17191270	122965	2785336	117104394	0	17314235	119889730	137203965	17	120	137
14	18025661	57916	2920525	55155988	0	18083577	58076513	76160090	18	58	76
14,5	10746620	14341	1741172	13657314	0	10760961	15398486	26159447	11	15	26
15	5221908	5029	846056	4789252	0	5226937	5635308	10862245	5	6	11
15,5	3803656	2933	616270	2793205	0	3806589	3409475	7216064	4	3	7
16	1918459	2096	310830	1996047	0	1920555	2306877	4227432	2	2	4
16,5	1266905	0	205264	0	0	1266905	205264	1472169	1	0,2	1
17	633641	0	102663	0	0	633641	102663	736304	1	0,1	1
17,5	128131	0	20760	0	0	128131	20760	148891	0,1	0,02	0,1
18	0	0	0	0	0	0	0	0	0	0	0
18,5	0	0	0	0	0	0	0	0	0	0	0
TOTAL *n*	76259805	3483456	12355646	3317429787	2075517376	79743261	5405302809	5485046070	**80**	**5405**	**5485**
Millions	**76**	**3**	**12**	**3317**	**2076**						

Table 5. *ECOCADIZ 2019-07* survey. Anchovy (*E. encrasicolus*). Cont'd.

ECOCADIZ 2019-07 . *Engraulis encrasicolus* . BIOMASS (t)								
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	**0**	**0**	**0**
6,5	0	0	0	0	0	**0**	**0**	**0**
7	0	0	0	0	0	**0**	**0**	**0**
7,5	0	0	0	0	0	**0**	**0**	**0**
8	0	0	0	0	0	**0**	**0**	**0**
8,5	0	0	0	0	288,531	**0**	**288,531**	**288,531**
9	0	0	0	0	1478,103	**0**	**1478,103**	**1478,103**
9,5	0	0	0	0	1868,042	**0**	**1868,042**	**1868,042**
10	0	0,197	0	187,412	2579,613	**0,197**	**2767,026**	**2767,222**
10,5	0	0,675	0	642,860	3028,146	**0,675**	**3671,007**	**3671,682**
11	0	2,638	0	2512,574	2689,189	**2,638**	**5201,763**	**5204,402**
11,5	0	7,059	0	6722,832	778,265	**7,059**	**7501,097**	**7508,156**
12	6,241	12,186	1,011	11605,228	1118,376	**18,427**	**12724,614**	**12743,042**
12,5	58,038	9,880	9,403	9409,065	769,477	**67,918**	**10187,945**	**10255,864**
13	193,418	6,539	31,338	6227,295	290,307	**199,957**	**6548,940**	**6748,896**
13,5	300,825	2,152	48,740	2049,178	0	**302,977**	**2097,917**	**2400,894**
14	355,721	1,143	57,634	1088,457	0	**356,864**	**1146,092**	**1502,956**
14,5	238,178	0,318	38,590	302,688	0	**238,496**	**341,278**	**579,774**
15	129,476	0,125	20,978	118,749	0	**129,601**	**139,727**	**269,328**
15,5	105,129	0,081	17,033	77,201	0	**105,210**	**94,234**	**199,444**
16	58,906	0,064	9,544	61,288	0	**58,970**	**70,832**	**129,802**
16,5	43,077	0	6,979	0	0	**43,077**	**6,979**	**50,057**
17	23,787	0	3,854	0	0	**23,787**	**3,854**	**27,641**
17,5	5,296	0	0,858	0	0	**5,296**	**0,858**	**6,154**
18	0	0	0	0	0	**0**	**0**	**0**
18,5	0	0	0	0	0	**0**	**0**	**0**
TOTAL	**1518,093**	**43,057**	**245,962**	**41004,828**	**14888,048**	**1561,150**	**56138,839**	**57699,989**

Table 6. *ECOCADIZ 2019-07* 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 23**.

***ECOCADIZ 2019-07* . *Sardina pilchardus* . ABUNDANCE (in numbers and million fish)**														
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	***n***			**Millions**			
								PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**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	0	0	0	0	0	0	0	0	0
8	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
9	0	0	0	0	0	0	0	0	0	0	0	0	0
9,5	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0
10,5	0	0	0	0	0	46134625	0	0	46134625	46134625	0	46	46
11	0	0	0	0	0	401738683	0	0	401738683	401738683	0	402	402
11,5	0	0	5287	344650	0	434808636	6533734	5287	441687020	441692307	0,01	442	442
12	0	0	123877	8075256	0	230673126	51803176	123877	290551558	290675435	0,1	291	291
12,5	0	0	477036	31096837	0	158000885	174544036	477036	363641758	364118794	0,5	364	364
13	0	0	623775	40662444	0	39602289	103373005	623775	183637738	184261513	1	184	184
13,5	0	689625	435540	28391856	12	0	103373005	1125165	131764873	132890038	1	132	133
14	0	0	263791	17195950	0	0	90538885	263791	107734835	107998626	0,3	108	108
14,5	0	5858790	173399	11303478	101	0	168010302	6032189	179313881	185346070	6	179	185
15	0	18549645	50371	3283575	320	0	168010302	18600016	171294197	189894213	19	171	190
15,5	0	55071293	15861	1033950	951	6532336	90538885	55087154	98106122	153193276	55	98	153
16	421819	77868987	0	0	1344	0	58103563	78290806	58104907	136395713	78	58	136
16,5	1068476	95100475	19899	1297138	1642	0	19367854	96188850	20666634	116855484	96	21	117
17	1522131	80488671	0	0	1390	0	0	82010802	1390	82012192	82	0,001	82
17,5	1619626	49191791	0	0	849	0	0	50811417	849	50812266	51	0,001	51
18	907309	20445846	0	0	353	408271	0	21353155	408624	21761779	21	0,4	22
18,5	712317	4423230	0	0	76	0	0	5135547	76	5135623	5	0,0001	5
19	161167	5773899	0	0	100	0	0	5935066	100	5935166	6	0,0001	6
19,5	31835	0	0	0	0	0	0	31835	0	31835	0,03	0	0,03
20	31835	0	0	0	0	0	0	31835	0	31835	0,03	0	0,03
20,5	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0
21,5	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL *n*	6476515	413462252	2188836	142685134	7138	1317898851	1034196747	422127603	2494787870	2916915473	**422**	**2495**	**2917**
Millions	**6**	**413**	**2**	**143**	**0,01**	**1318**	**1034**	**422**	**2495**	**2917**			

Table 6. *ECOCADIZ 2019-07* survey. Sardine (*S. pilchardus*). Cont'd.

ECOCADIZ 2019-07 . Sardina pilchardus . BIOMASS (t)										
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0
6,5	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
7,5	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
8,5	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
9,5	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
10,5	0	0	0	0	0	412,386	0	0	412,386	412,385673
11	0	0	0	0	0	4202,917	0	0	4202,917	4202,91701
11,5	0	0	0,064	4,191	0	5287,667	79,456	0,064	5371,314	5371,37823
12	0	0	1,740	113,438	0	3240,392	727,708	1,740	4081,537	4083,27737
12,5	0	0	7,696	501,701	0	2549,110	2816,010	7,696	5866,822	5874,51786
13	0	0	11,497	749,442	0	729,902	1905,249	11,497	3384,593	3396,08951
13,5	0	14,449	9,125	594,856	0,0003	0	2165,834	23,574	2760,690	2784,2644
14	0	0	6,254	407,689	0	0	2146,535	6,254	2554,224	2560,47808
14,5	0	156,511	4,632	301,959	0,003	0	4488,197	161,143	4790,159	4951,30207
15	0	556,131	1,510	98,444	0,010	0	5037,059	557,641	5135,513	5693,15333
15,5	0	1846,099	0,532	34,660	0,032	218,977	3035,043	1846,631	3288,712	5135,34216
16	15,755	2908,488	0	0	0,050	0	2170,228	2924,243	2170,279	5094,52169
16,5	44,322	3944,889	0,825	53,807	0,068	0	803,403	3990,036	857,278	4847,31409
17	69,906	3696,548	0	0	0,064	0	0	3766,453	0,064	3766,51731
17,5	82,115	2494,022	0	0	0,043	0	0	2576,137	0,043	2576,18052
18	50,643	1141,211	0	0	0,020	22,788	0	1191,853	22,808	1214,66132
18,5	43,657	271,097	0	0	0,005	0	0	314,755	0,005	314,759189
19	10,820	387,623	0	0	0,007	0	0	398,443	0,007	398,449639
19,5	2,336	0	0	0	0	0	0	2,336	0	2,335535
20	2,547	0	0	0	0	0	0	2,547	0	2,546617
20,5	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0
21,5	0	0	0	0	0	0	0	0	0	0
TOTAL	**322,100**	**17417,066**	**43,876**	**2860,187**	**0,301**	**16664,139**	**25374,722**	**17783,042**	**44899,349**	**62682,392**

Table 6. *ECOCADIZ 2019-07* survey. Chub mackerel (*S. colias*). 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 26**.

***ECOCADIZ 2019-07* . *Scomber colias* . ABUNDANCE (in numbers and million fish)**											
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	***n***			**Millions**		
						PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
14	0	0	0	0	0	0	0	0	0	0	0
14,5	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
15,5	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0
16,5	0	0	77681	59963	0	137644	0	137644	0,1	0	0,1
17	0	0	0	246882	0	246882	0	246882	0,2	0	0,2
17,5	1300	3129413	392794	609828	0	4133335	0	4133335	4	0	4
18	14944	35976560	1290155	1344685	0	38626344	0	38626344	39	0	39
18,5	12345	29719859	605556	1229431	0	31567191	0	31567191	32	0	32
19	17544	42235385	372795	2174674	0	44800398	0	44800398	45	0	45
19,5	25341	61005487	638051	3094861	0	64763740	0	64763740	65	0	65
20	23392	56312430	532860	4631120	0	61499802	0	61499802	61	0	61
20,5	19493	46926317	2146888	8474131	0	57566829	0	57566829	58	0	58
21	8447	20335870	4786827	5736797	0	30867941	0	30867941	31	0	31
21,5	5848	14079170	8587093	3710154	564893	26382265	564893	26947158	26	1	27
22	1300	3129413	10340636	1568805	1506382	15040154	1506382	16546536	15	2	17
22,5	0	0	13177806	893268	753191	14071074	753191	14824265	14	1	15
23	0	0	14085391	773343	2824466	14858734	2824466	17683200	15	3	18
23,5	0	0	15833475	623566	2071275	16457041	2071275	18528316	16	2	19
24	0	0	10953874	79489	2447871	11033363	2447871	13481234	11	2	13
24,5	0	0	8232993	39744	753191	8272737	753191	9025928	8	1	9
25	0	0	5789958	0	188298	5789958	188298	5978256	6	0,2	6
25,5	0	0	3752320	583821	188298	4336141	188298	4524439	4	0,2	5
26	0	0	1602233	0	0	1602233	0	1602233	2	0	2
26,5	0	0	678786	0	0	678786	0	678786	1	0	1
27	0	0	765255	34523	0	799778	0	799778	1	0	1
27,5	0	0	70230	0	0	70230	0	70230	0,1	0	0,1
28	0	0	0	0	0	0	0	0	0	0	0
28,5	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0
TOTAL *n*	129954	312849904	104713657	35909085	11297865	453602600	11297865	464900465	**454**	**11**	**465**
Millions	**0,1**	**313**	**105**	**36**	**11**						

Table 6. *ECOCADIZ 2019-07* survey. Chub mackerel (*S. colias*). Cont'd.

ECOCADIZ 2019-07 . *Scomber colias* . BIOMASS (t)								
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**PORTUGAL**	**SPAIN**	**TOTAL**
14	0	0	0	0	0	0	0	0
14,5	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
15,5	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0
16,5	0	0	2,608	2,013	0	4,621	0	4,621
17	0	0	0	9,131	0	9,131	0	9,131
17,5	0,053	127,133	15,957	24,774	0	167,917	0	167,917
18	0,665	1601,288	57,424	59,851	0	1719,228	0	1719,228
18,5	0,601	1445,705	29,457	59,805	0	1535,568	0	1535,568
19	0,931	2240,150	19,773	115,344	0	2376,197	0	2376,197
19,5	1,462	3520,251	36,818	178,585	0	3737,117	0	3737,117
20	1,465	3527,752	33,382	290,121	0	3852,721	0	3852,721
20,5	1,323	3185,141	145,721	575,185	0	3907,370	0	3907,370
21	0,620	1492,672	351,358	421,086	0	2265,736	0	2265,736
21,5	0,463	1115,520	680,372	293,963	44,758	2090,319	44,758	2135,076
22	0,111	267,182	882,860	133,941	128,612	1284,095	128,612	1412,706
22,5	0	0	1210,350	82,045	69,179	1292,395	69,179	1361,573
23	0	0	1389,538	76,291	278,636	1465,829	278,636	1744,465
23,5	0	0	1675,139	65,972	219,135	1741,111	219,135	1960,246
24	0	0	1241,031	9,006	277,334	1250,037	277,334	1527,371
24,5	0	0	997,484	4,815	91,254	1002,300	91,254	1093,554
25	0	0	749,160	0	24,364	749,160	24,364	773,524
25,5	0	0	517,833	80,569	25,986	598,402	25,986	624,388
26	0	0	235,542	0	0	235,542	0	235,542
26,5	0	0	106,172	0	0	106,172	0	106,172
27	0	0	127,209	5,739	0	132,948	0	132,948
27,5	0	0	12,393	0	0	12,393	0	12,393
28	0	0	0	0	0	0	0	0
28,5	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0
TOTAL	**7,694**	**18522,796**	**10517,581**	**2488,236**	**1159,258**	**31536,307**	**1159,258**	**32695,565**

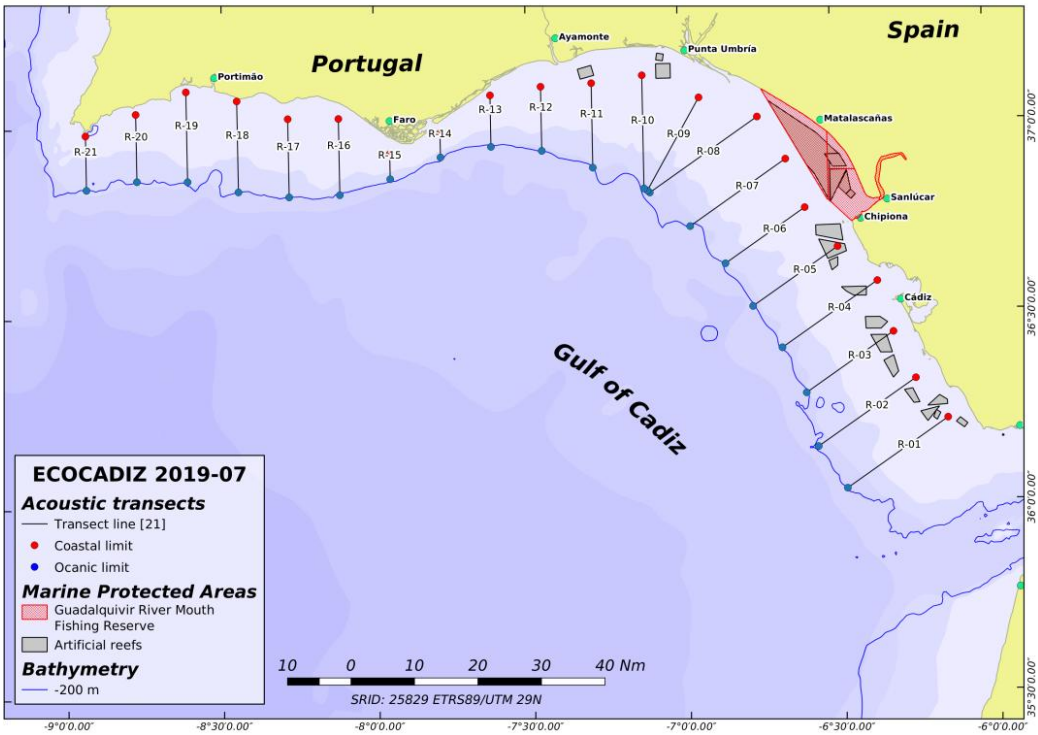


Figure 1. *ECOCADIZ 2019-07* survey. Location of the acoustic transects sampled during the survey. The different protected areas inside the Guadalquivir river mouth Fishing Reserve and artificial reef polygons are also shown.

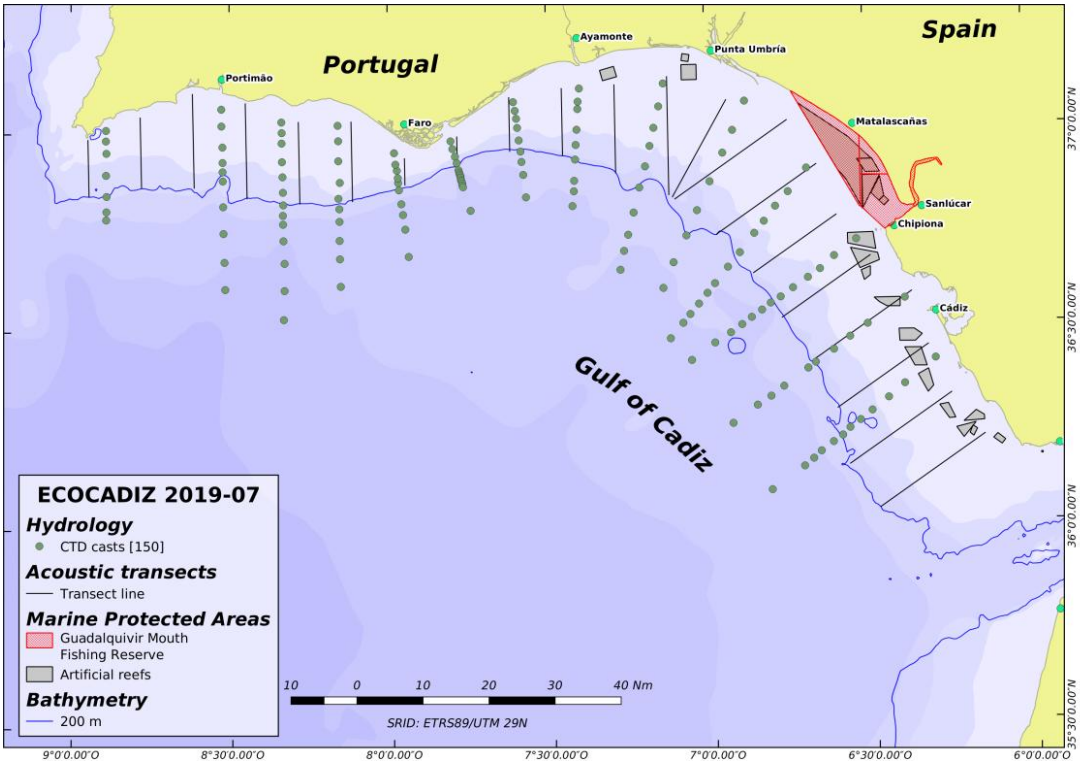


Figure 2. *ECOCADIZ 2019-07* survey. Location of CTD-LADCP stations.

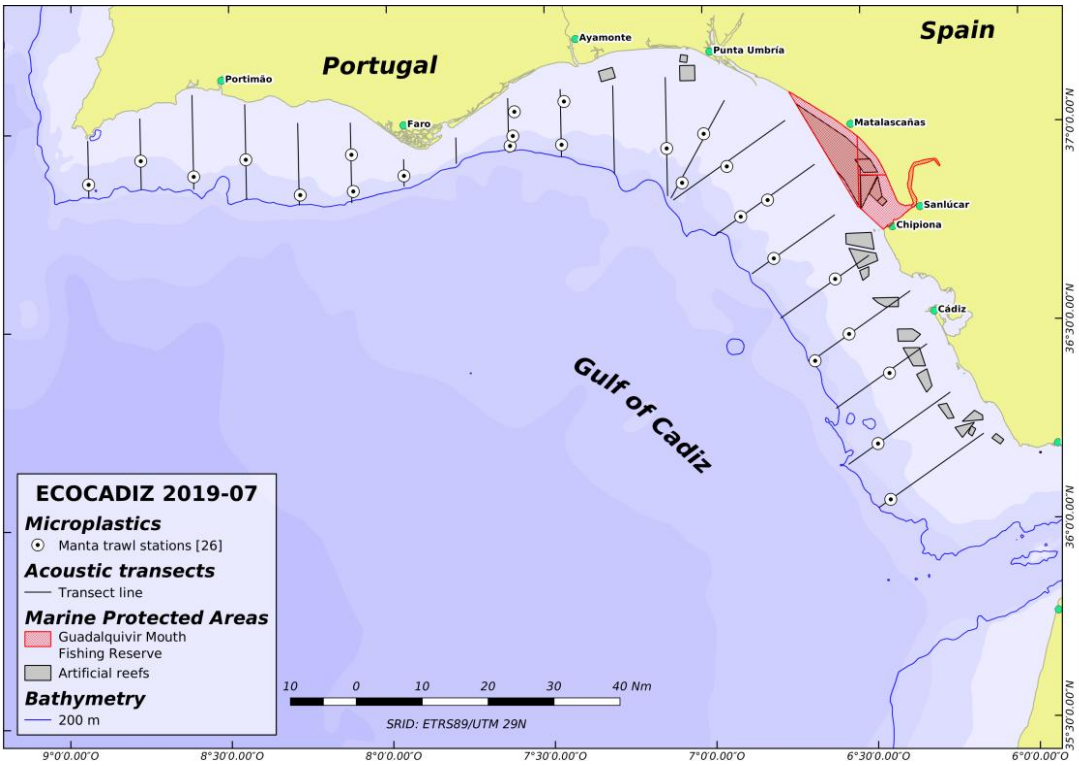


Figure 3. *ECOCADIZ 2019-07* survey. Location of Manta trawl hauls (micro-plastics).

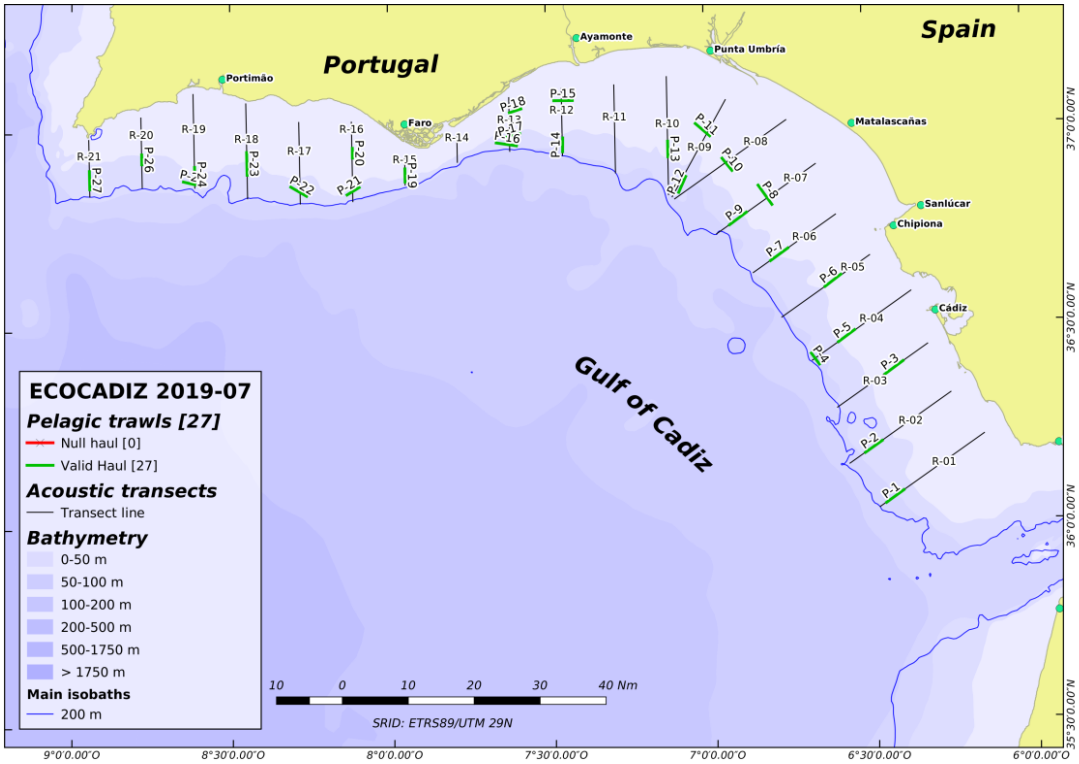


Figure 4. *ECOCADIZ 2019-07* survey. Location of ground-truthing fishing hauls.

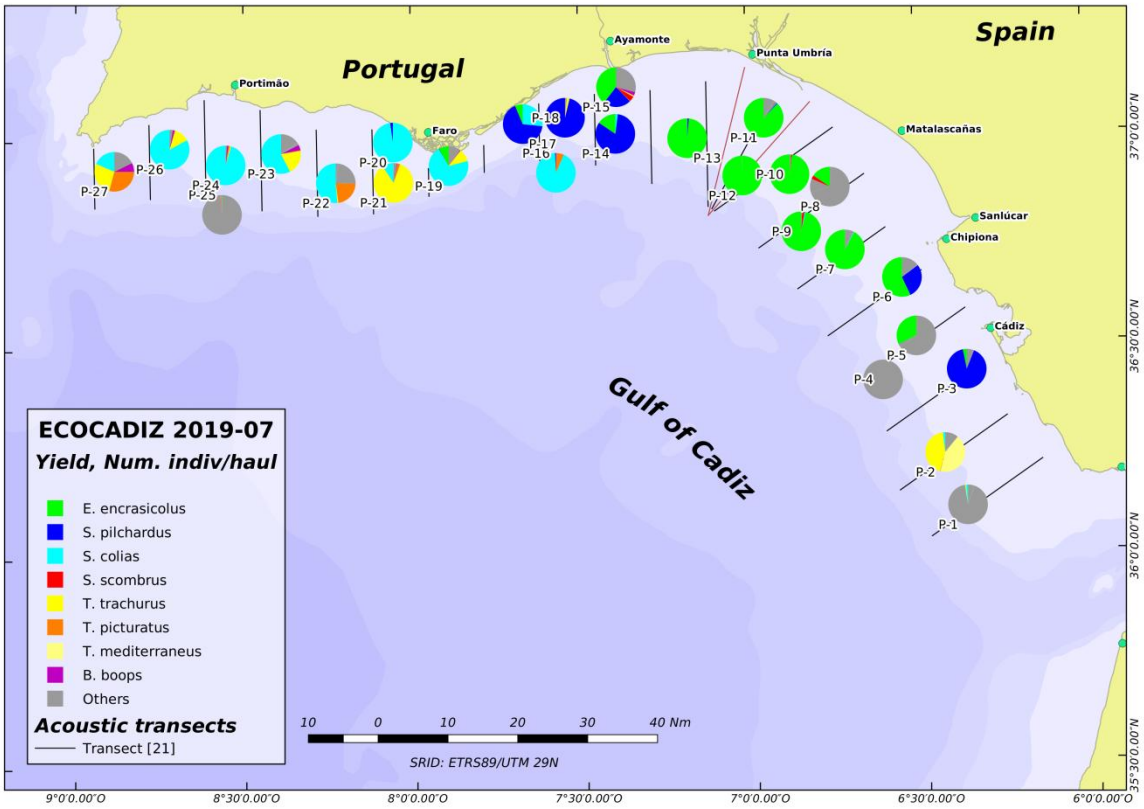


Figure 5. *ECOCADIZ 2019-07* survey. Species composition (percentages in number) in fishing hauls.

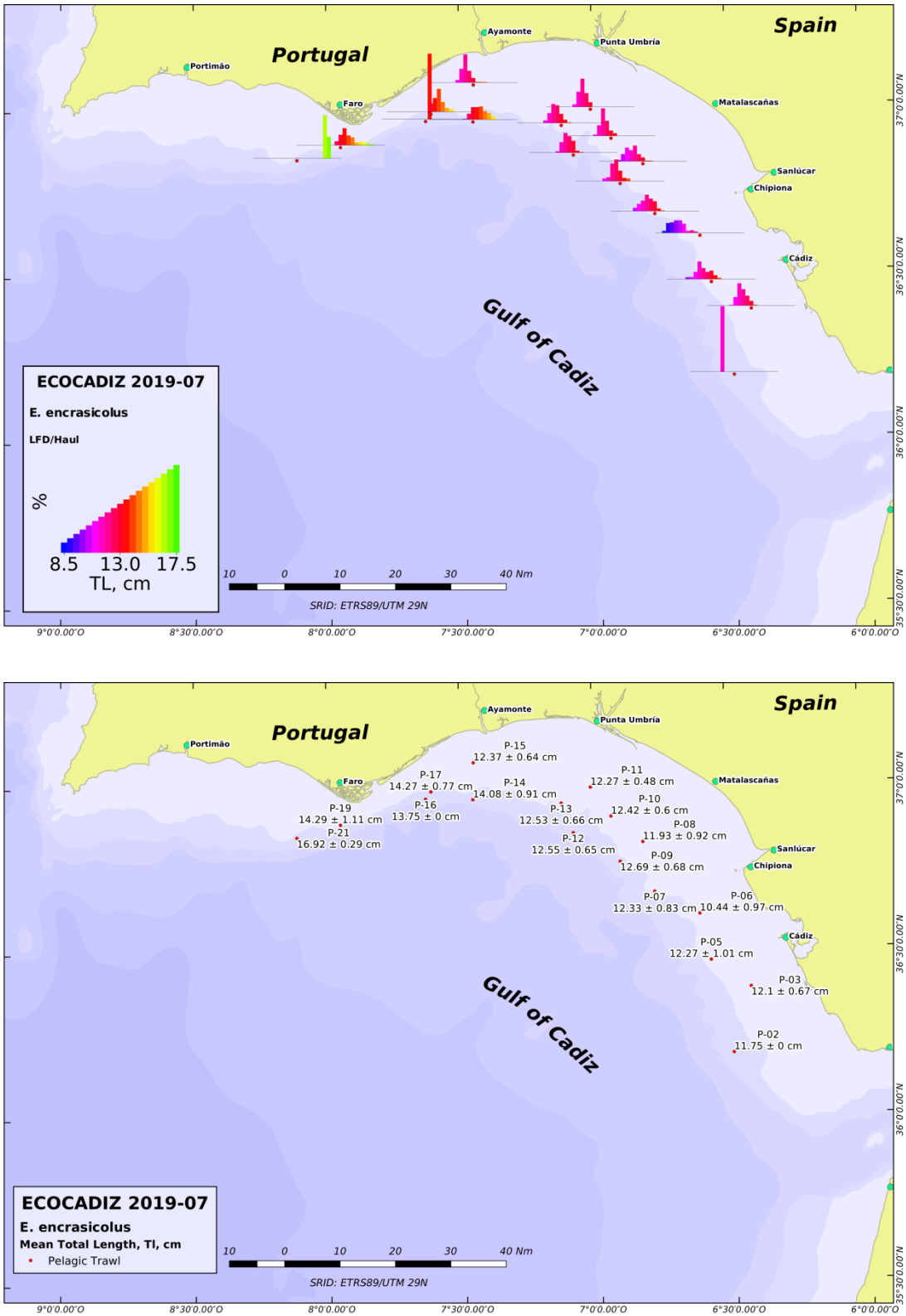


Figure 6. *ECOCADIZ 2019-07* survey. *Engraulis encrasicolus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

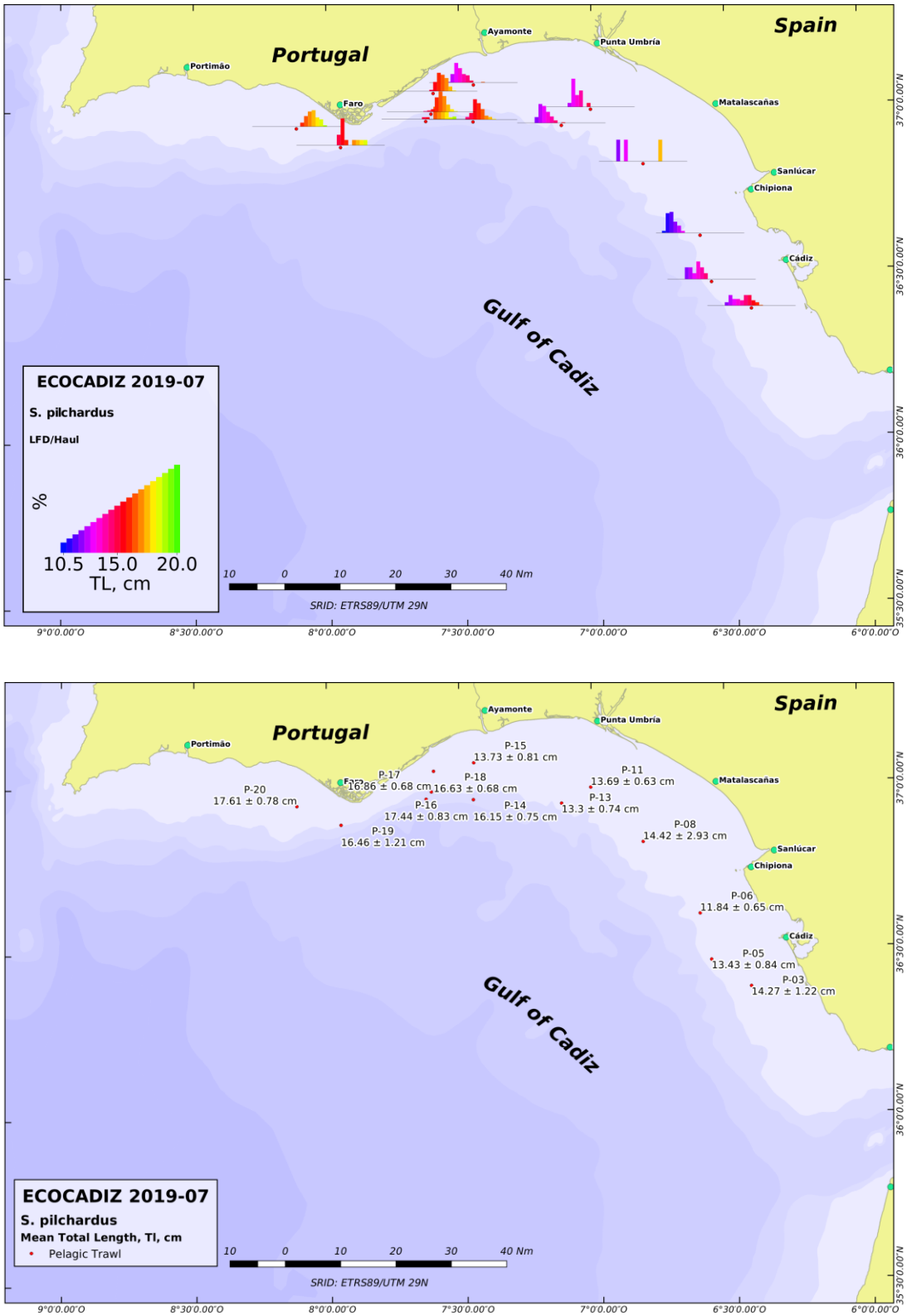


Figure 7. *ECOCADIZ 2019-07* survey. *Sardina pilchardus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

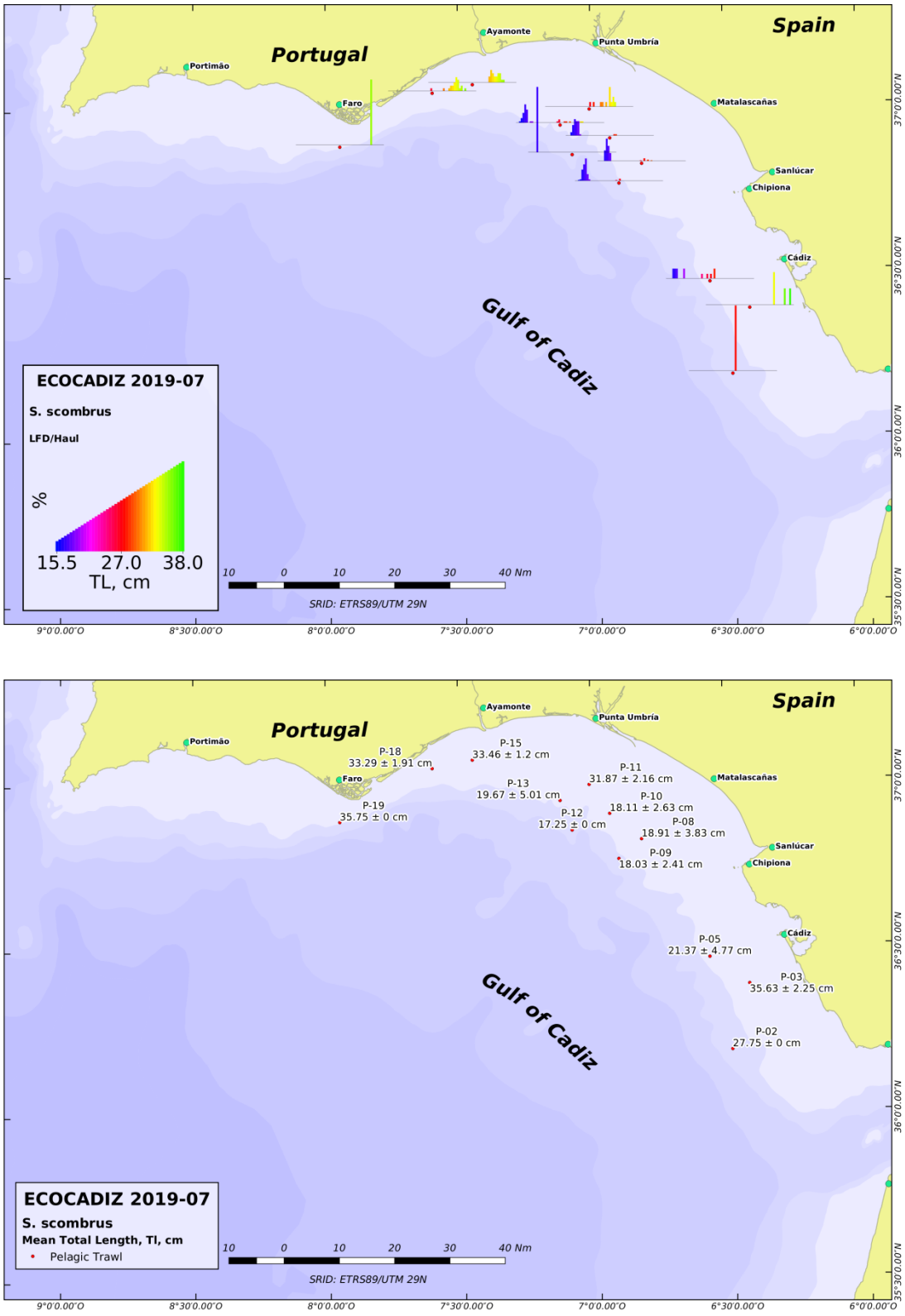


Figure 8. *ECOCADIZ 2019-07* survey. *Scomber scombrus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

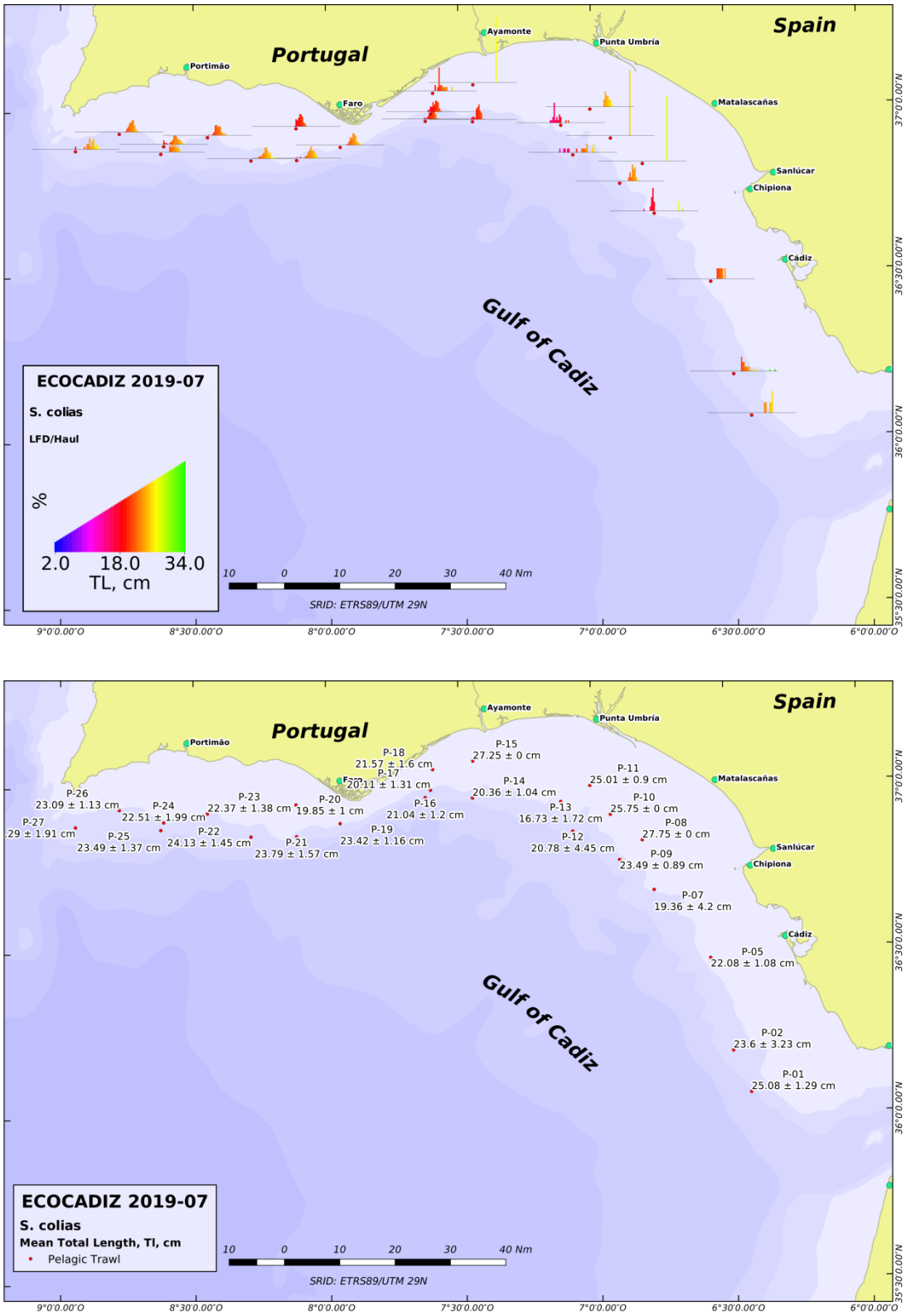


Figure 9. *ECOCADIZ 2019-07* survey. *Scomber colias*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

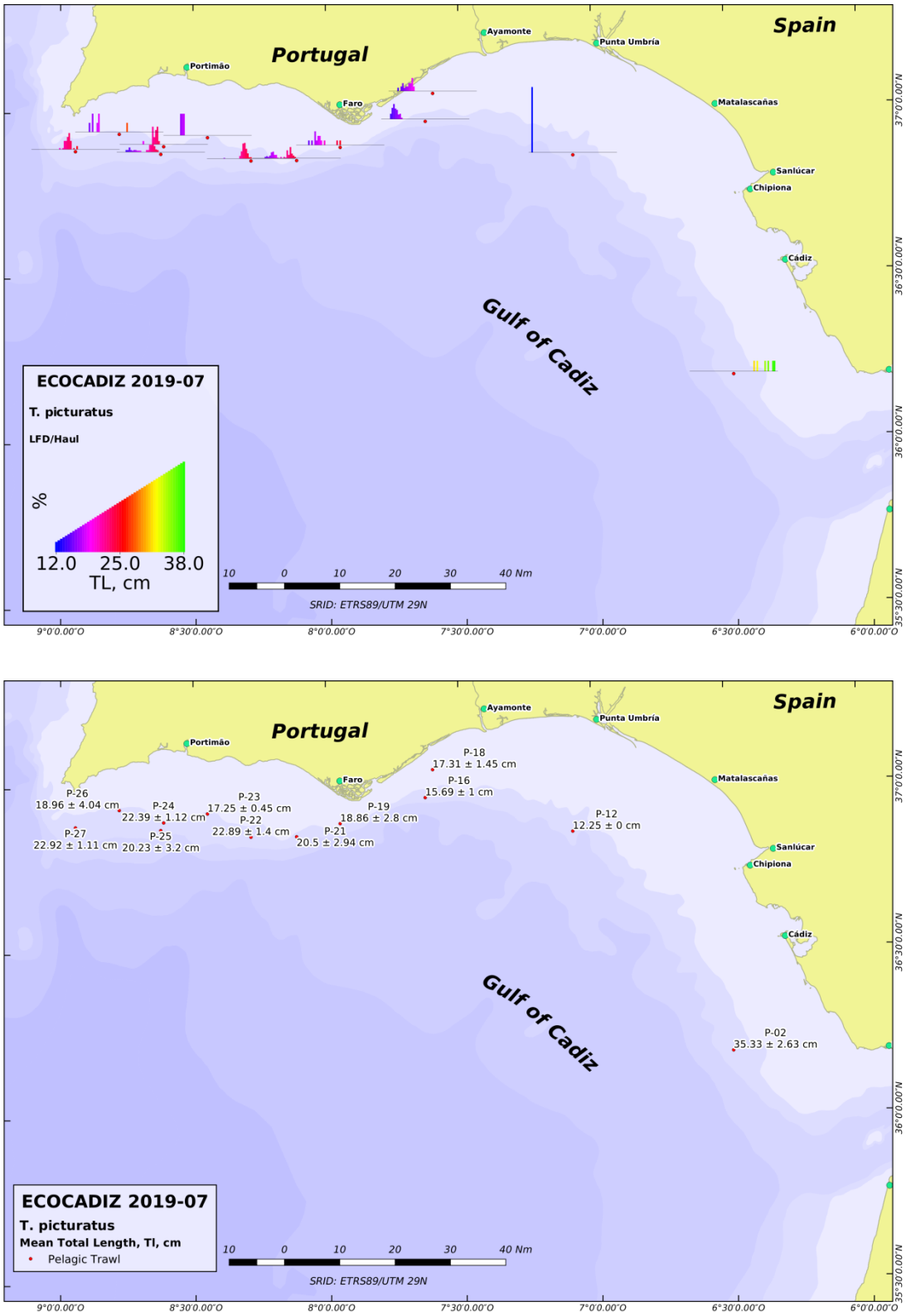


Figure 10. *ECOCADIZ 2019-07* survey. *Trachurus picturatus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

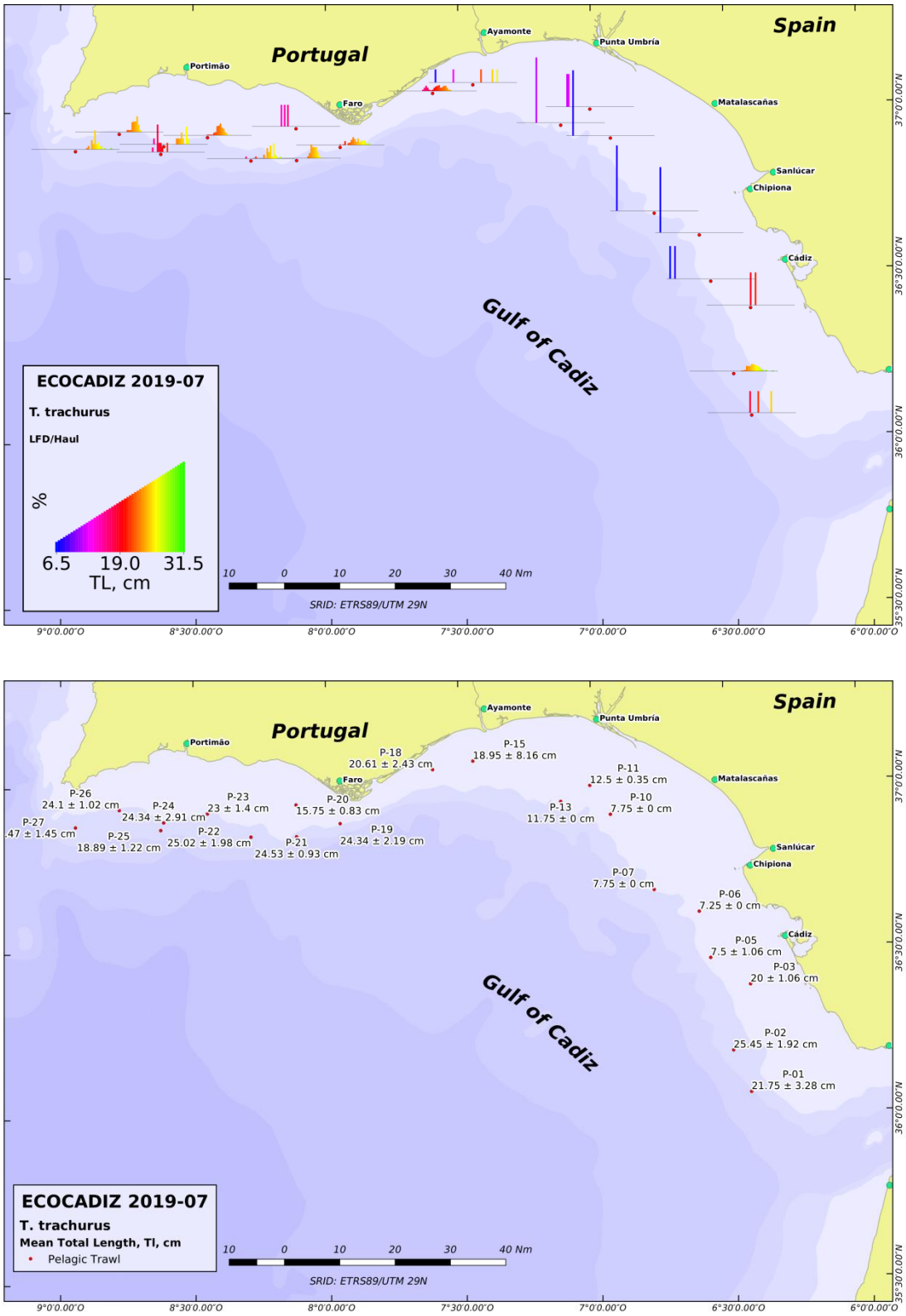


Figure 11. *ECOCADIZ 2019-07* survey. *Trachurus trachurus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

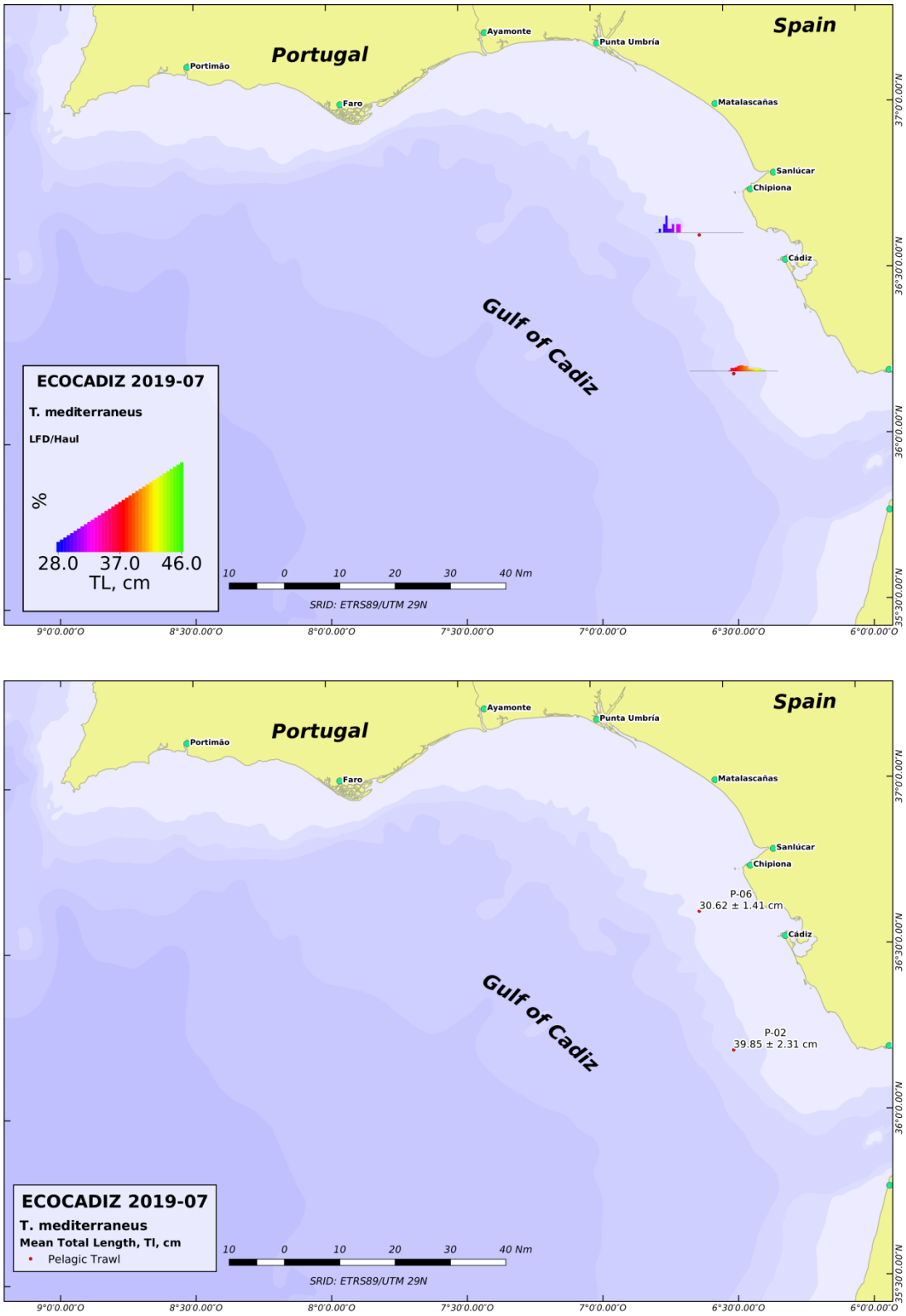


Figure 12. *ECOCADIZ 2019-07* survey. *Trachurus mediterraneus*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

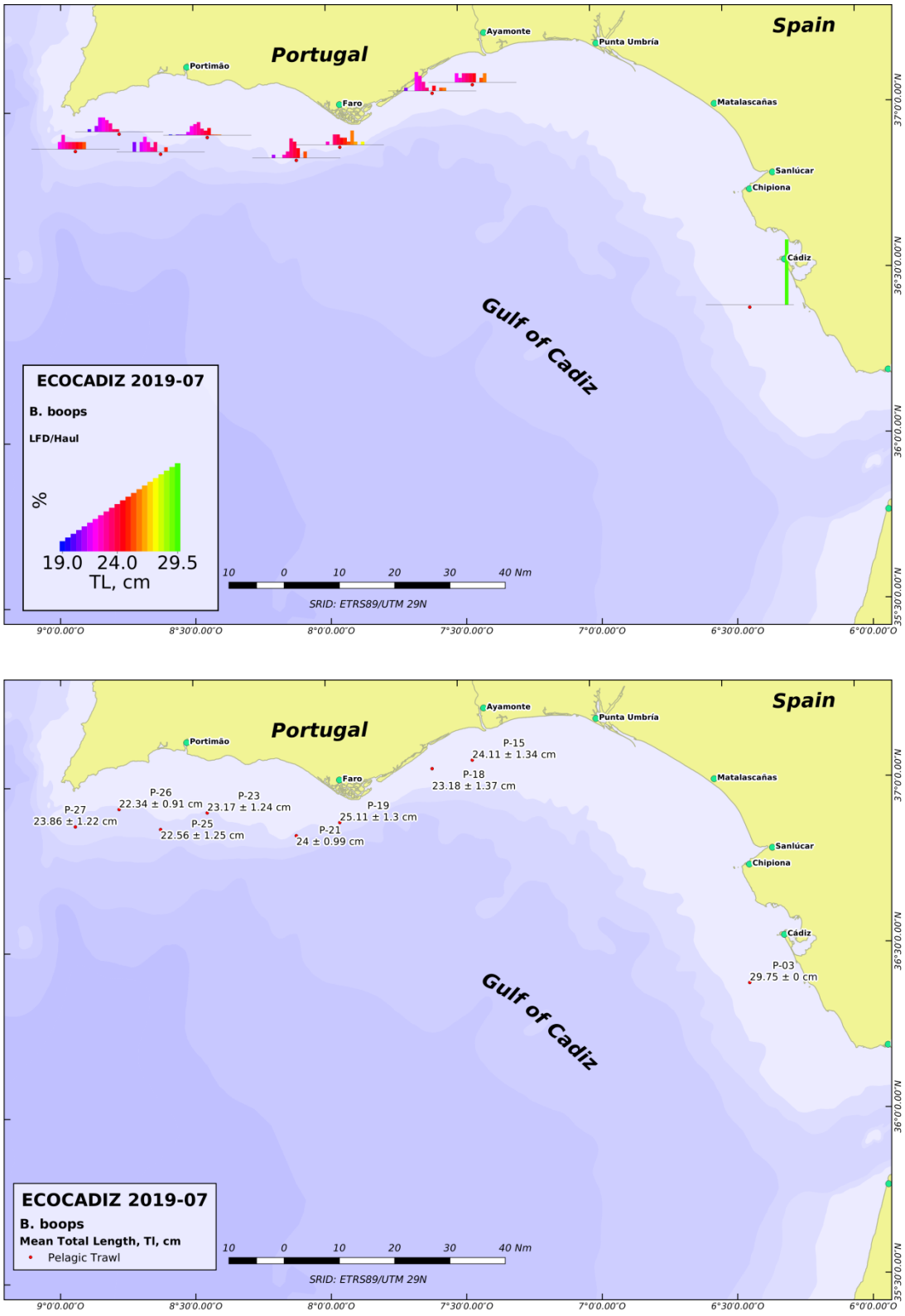


Figure 13. *ECOCADIZ 2019-07* survey. *Boops boops*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

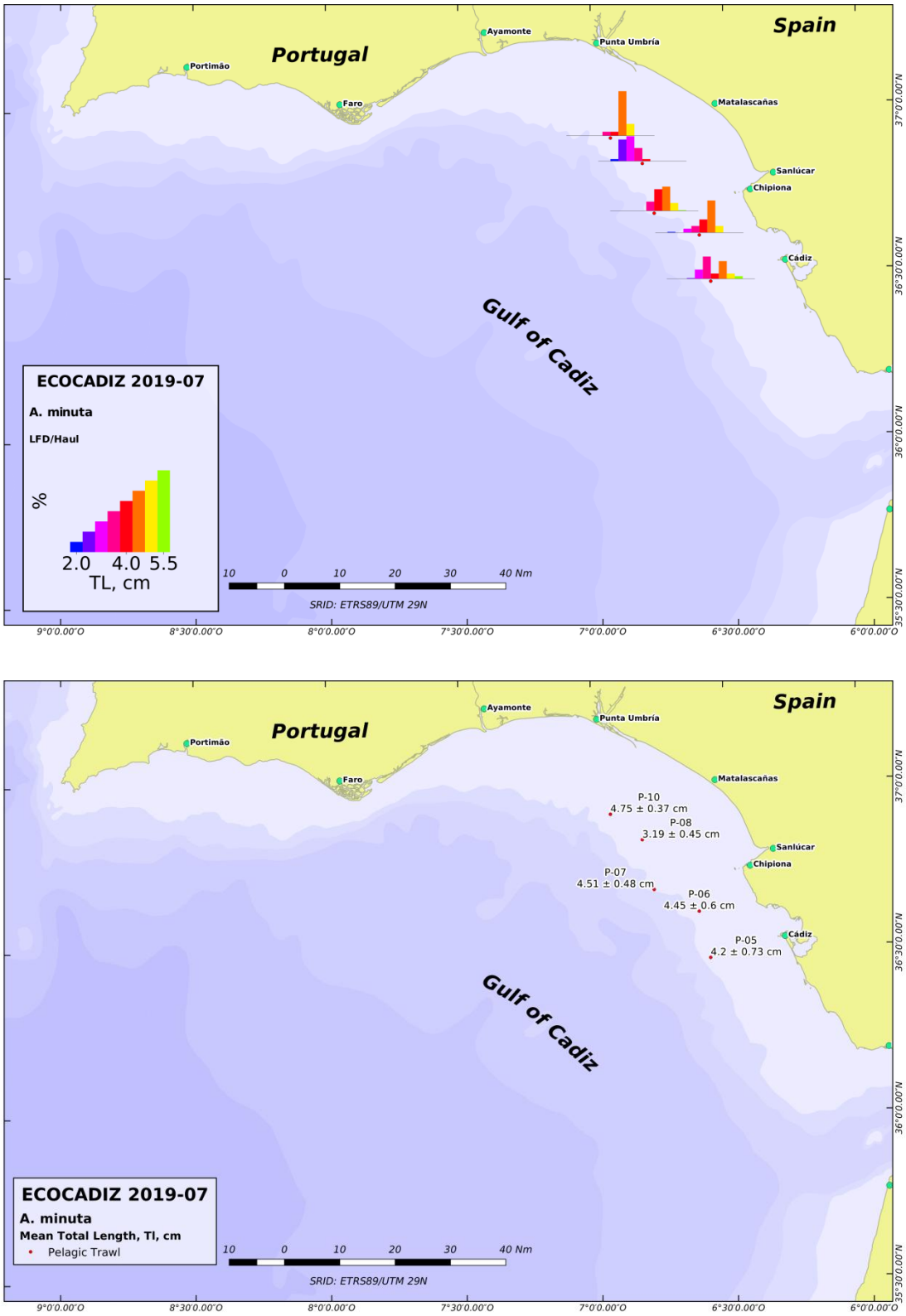


Figure 14. *ECOCADIZ 2019-07* survey. *Aphia minuta*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

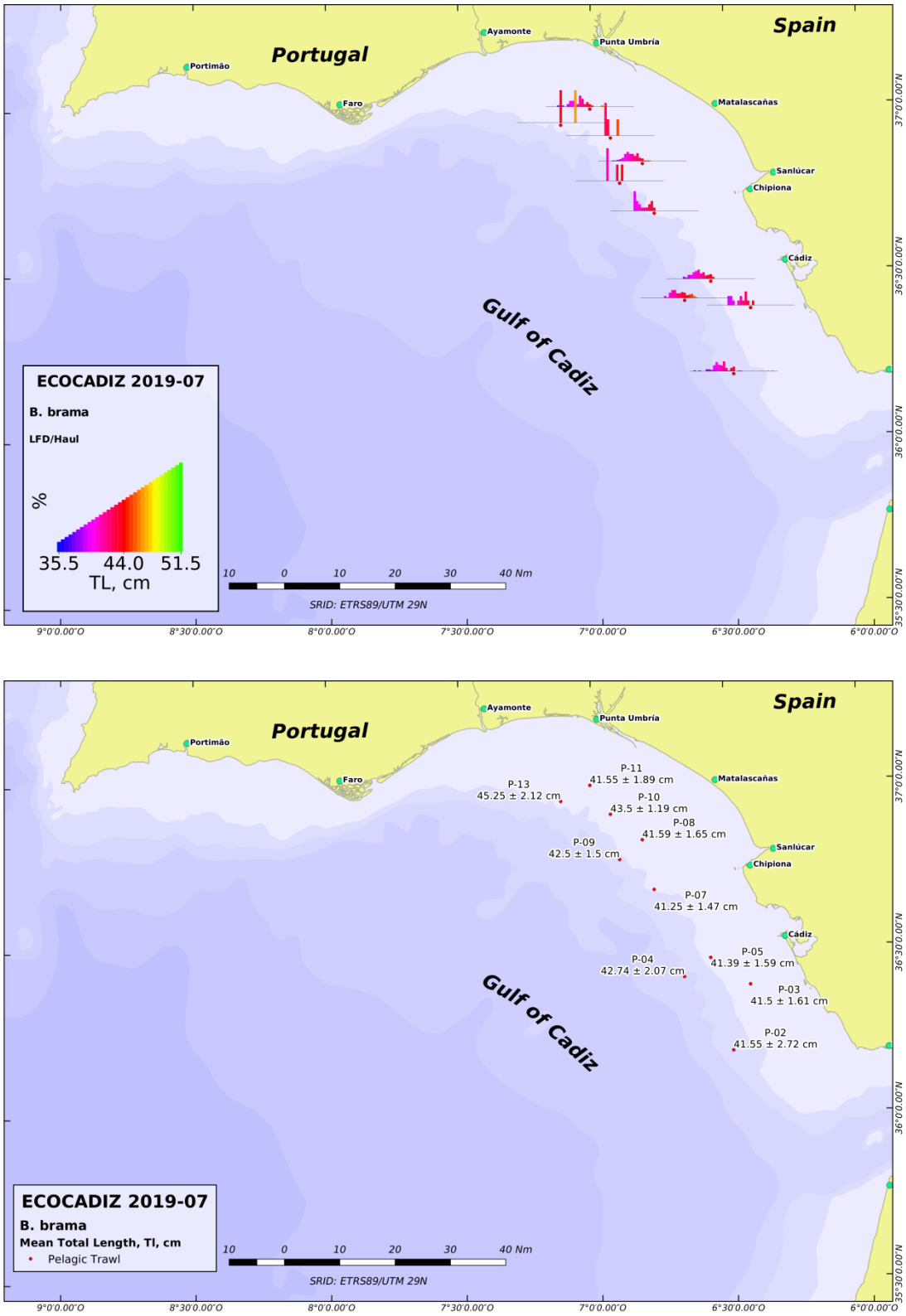


Figure 15. *ECOCADIZ 2019-07* survey. *Brama brama*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

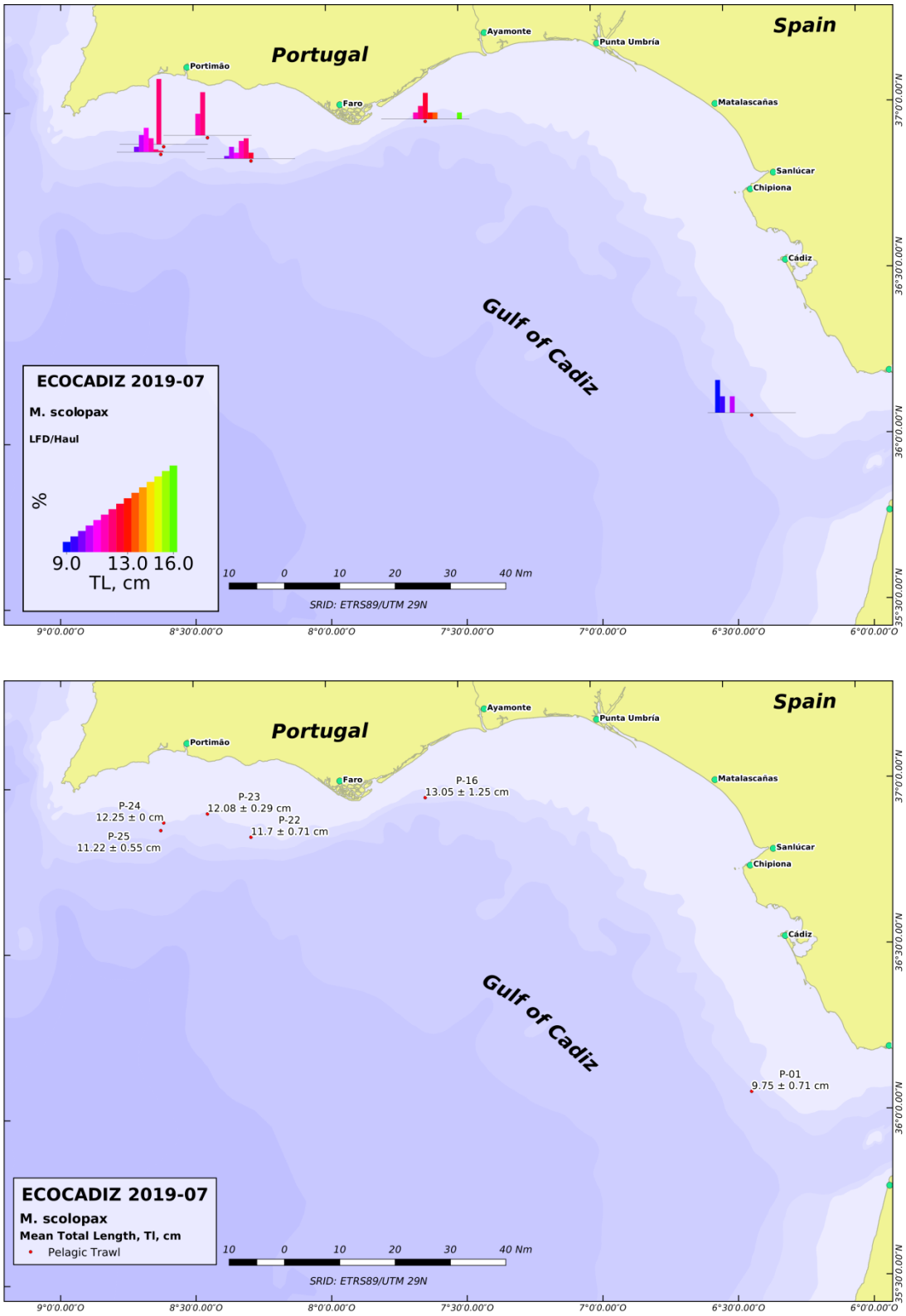


Figure 16. *ECOCADIZ 2019-07* survey. *Macrorhamphosus scolopax*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

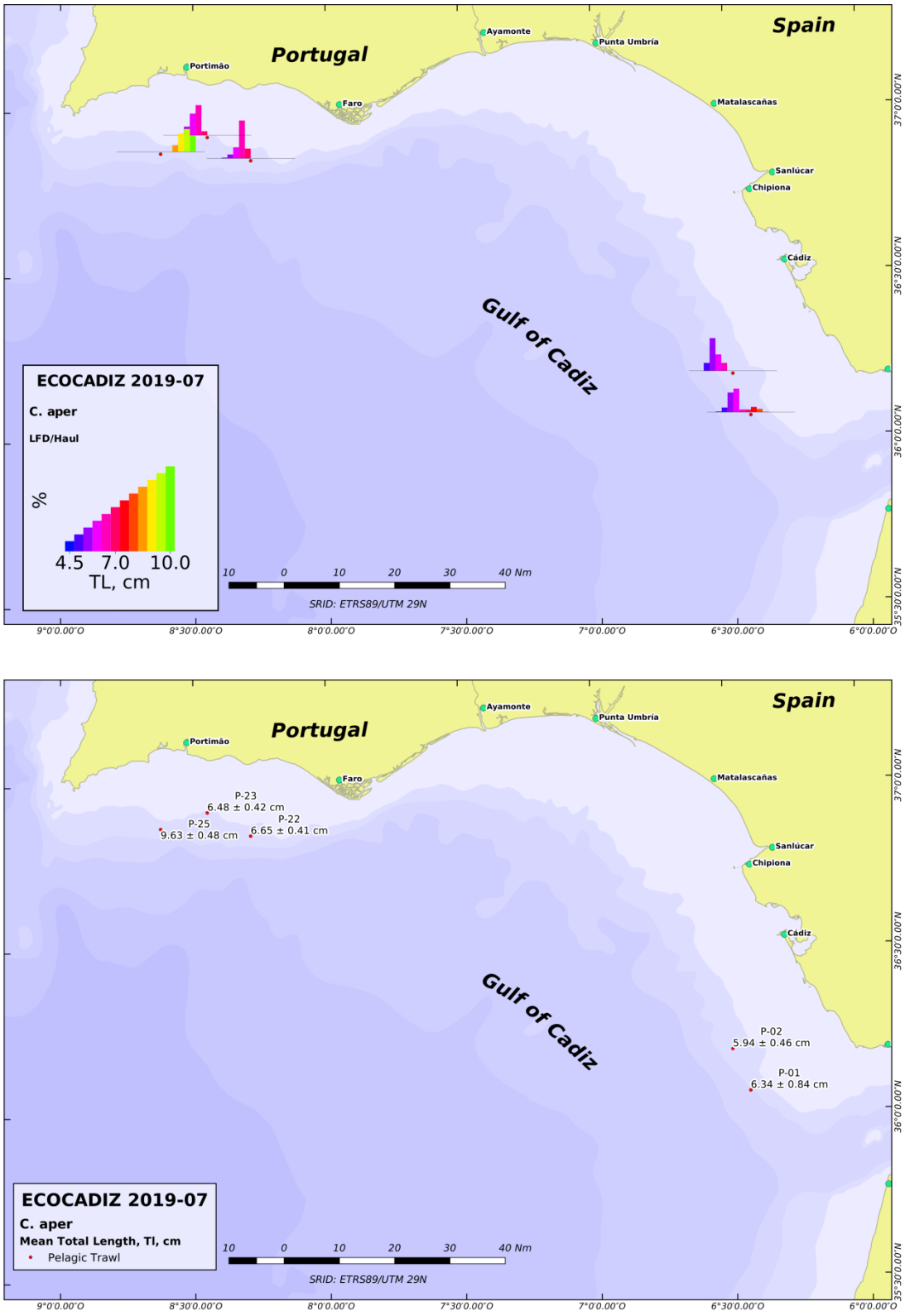


Figure 17. *ECOCADIZ 2019-07* survey. *Capros aper*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

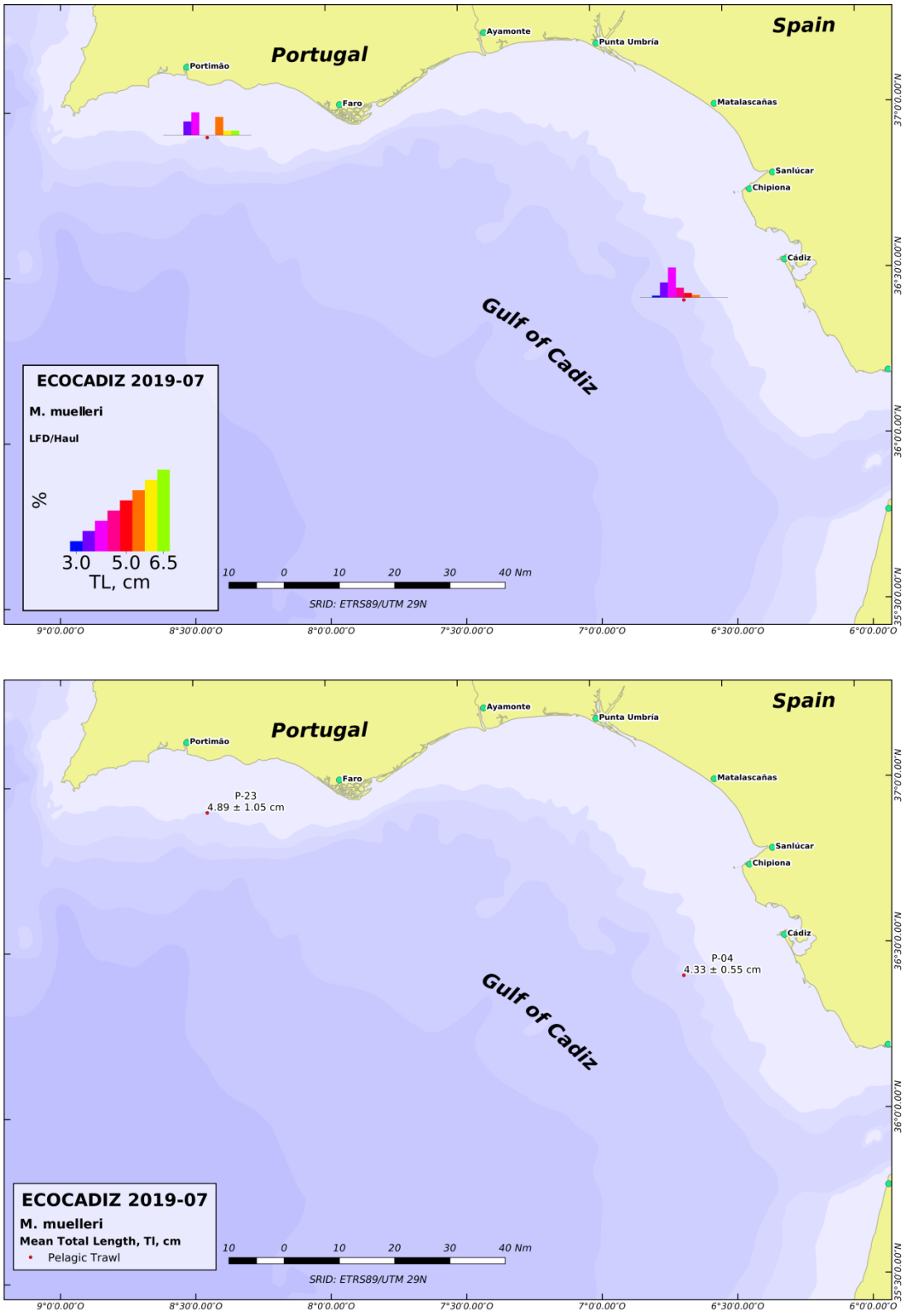


Figure 18. *ECOCADIZ 2019-07* survey. *Maurolicus muelleri*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

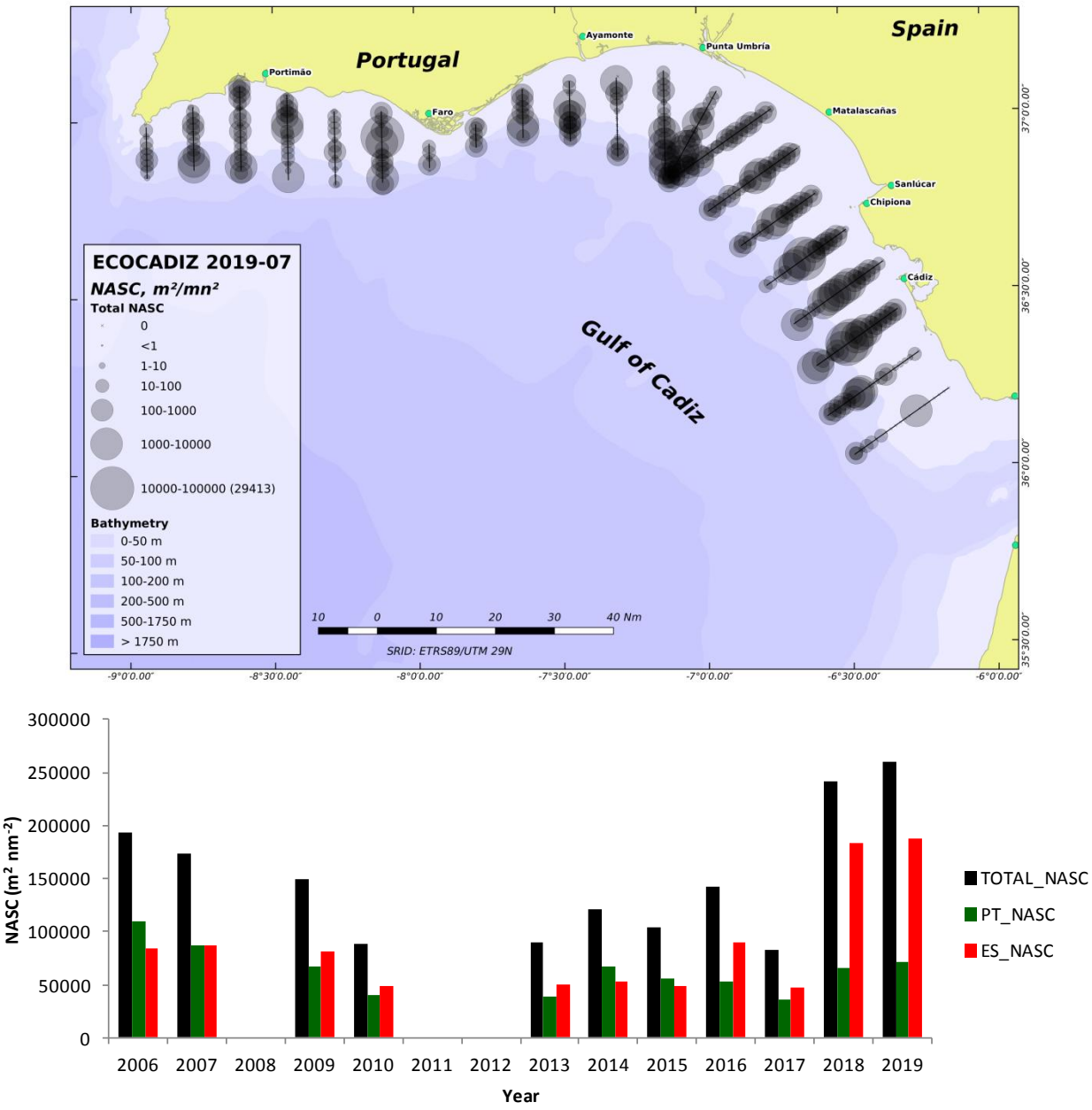


Figure 19. *ECOCADIZ 2019-07* survey. Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the pelagic fish species assemblage. Bottom: time-series of total NASC estimates per survey.

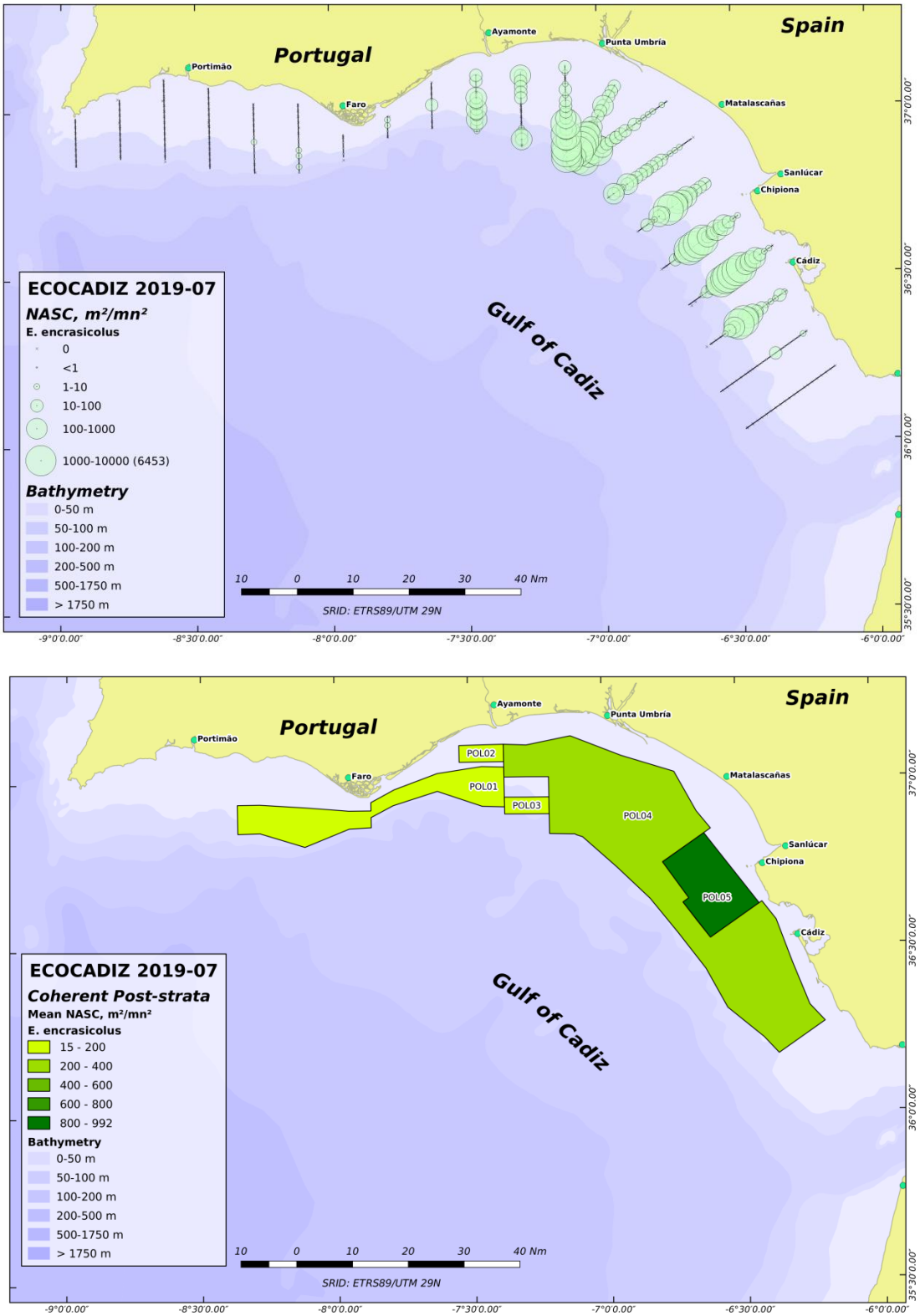


Figure 20. *ECOCADIZ 2019-07* survey. Anchovy (*Engraulis encrasicolus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

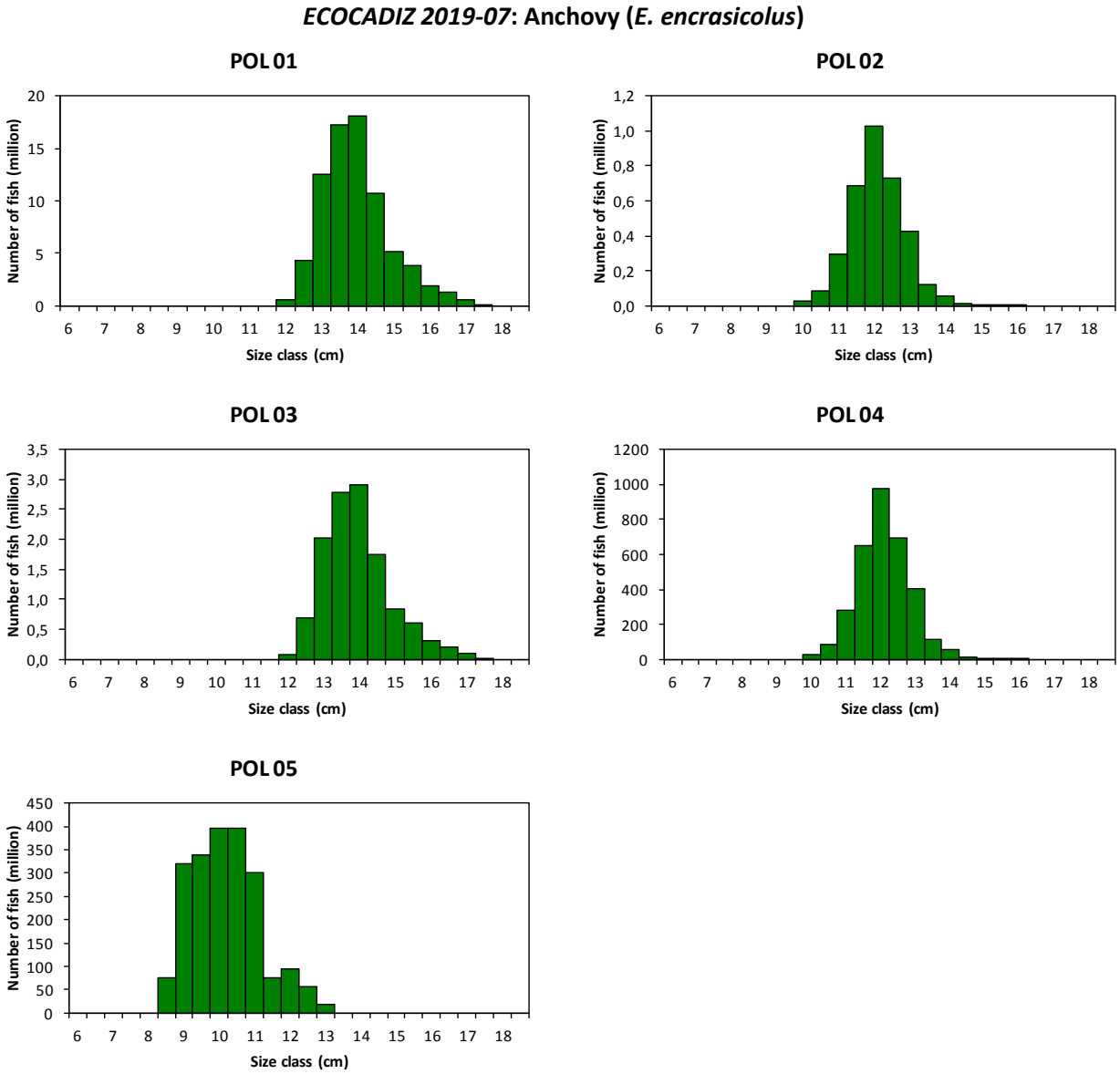


Figure 21. *ECOCADIZ 2019-07* survey. Anchovy (*E. encrasicolus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 20**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

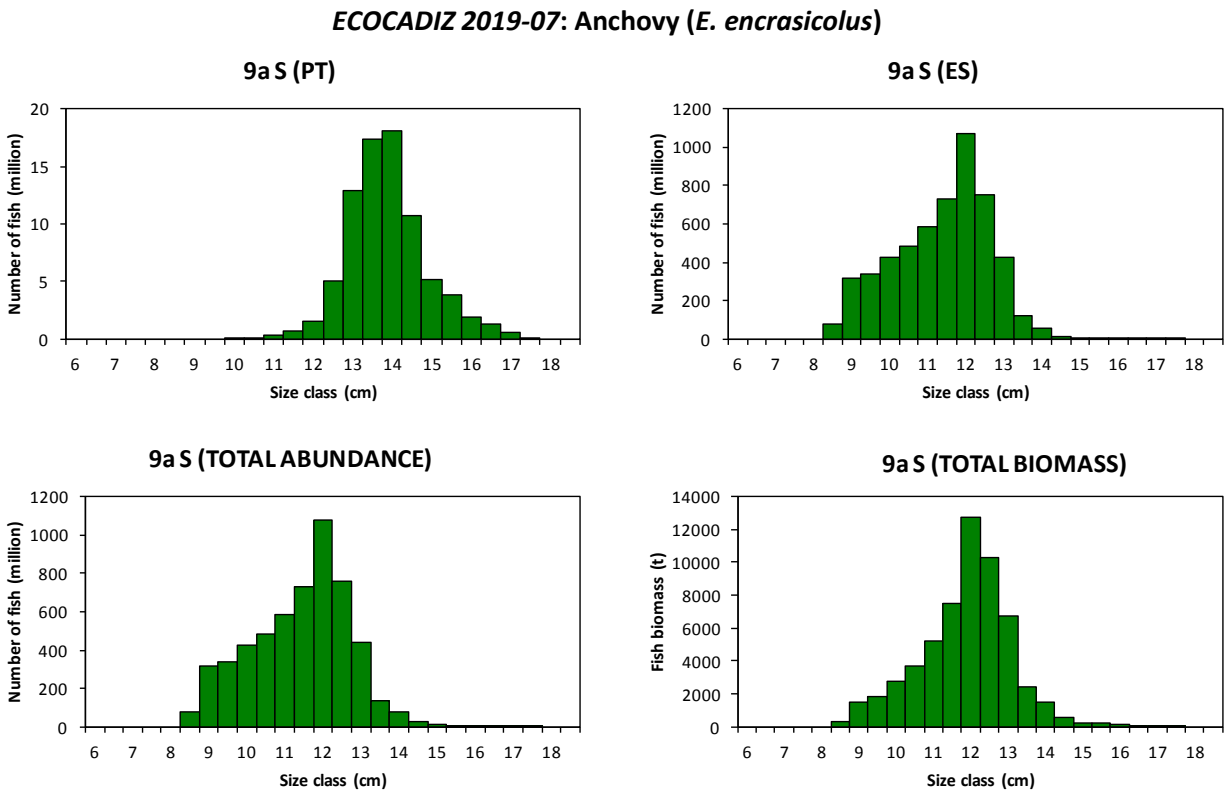
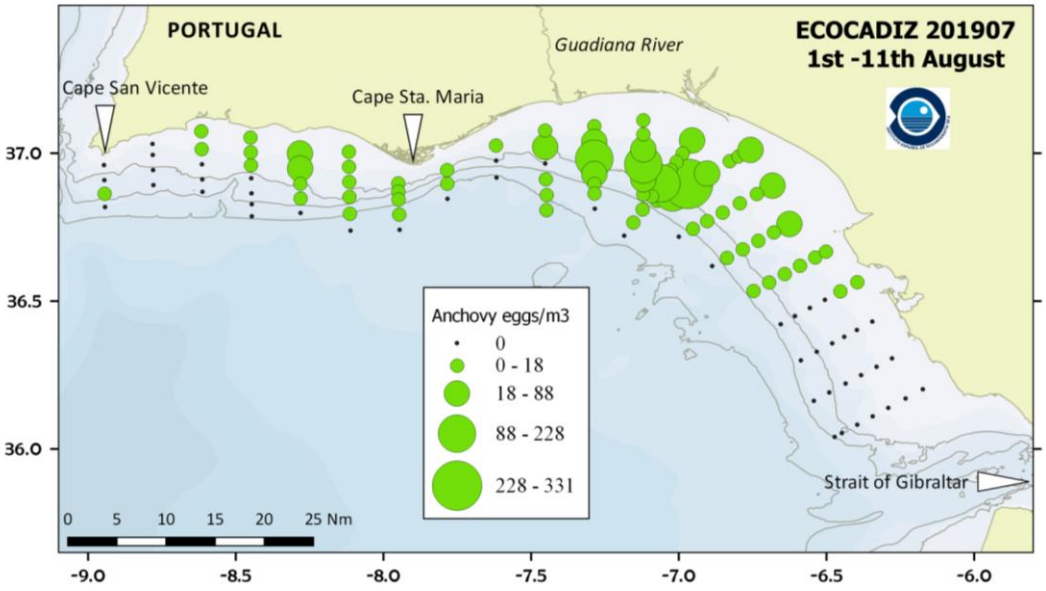
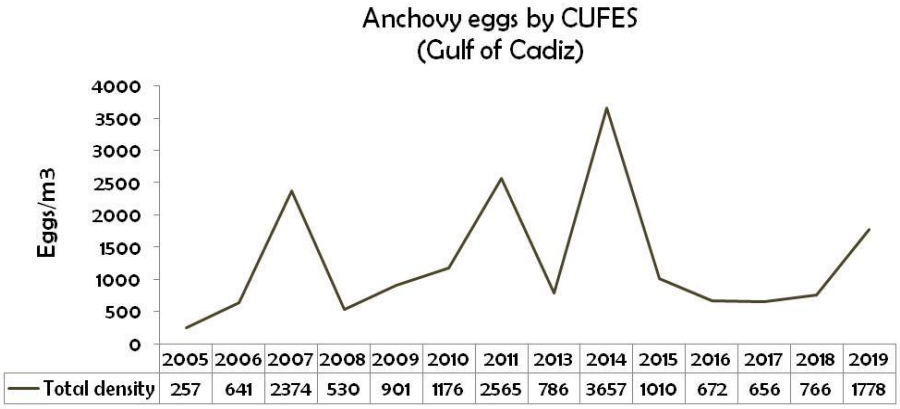


Figure 21. *ECOCADIZ 2019-07* survey. Anchovy (*E. encrasicolus*). Cont'd.



ECOCADIZ 2019-07	
CUFES st	121
Positive anchovy st8	73 (60.3 %)
Max number eggs by st	3599
Total anchovy eggs (in number)	19031
Max density by st (eggs/m^3)	331.4
Total density (eggs/m^3)	1778

Figure 22. *ECOCADIZ 2019-07* survey. Anchovy (*E. encrasicolus*). Top: distribution of anchovy egg densities sampled by CUFES (eggs m^{-3}). Bottom: main descriptors of the CUFES sampling.



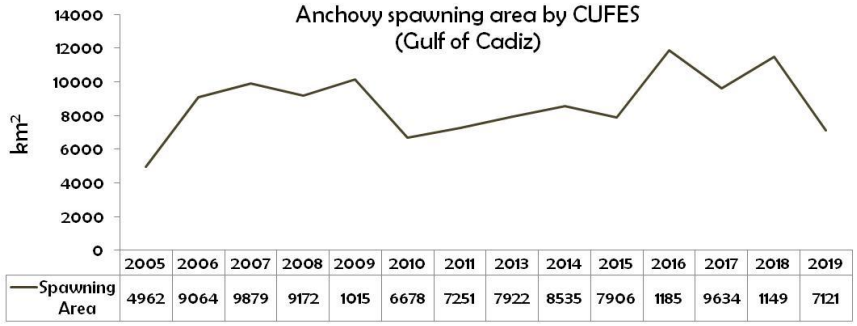


Figure 22. *ECOCADIZ 2019-07* survey. Anchovy (*E. encrasicolus*). Cont'd. Top: historical series of GoC anchovy egg total densities (eggs * m^{-3}) sampled by CUFES. Bottom: historical series of estimates of the extension of the GoC anchovy spawning area (in km^2).

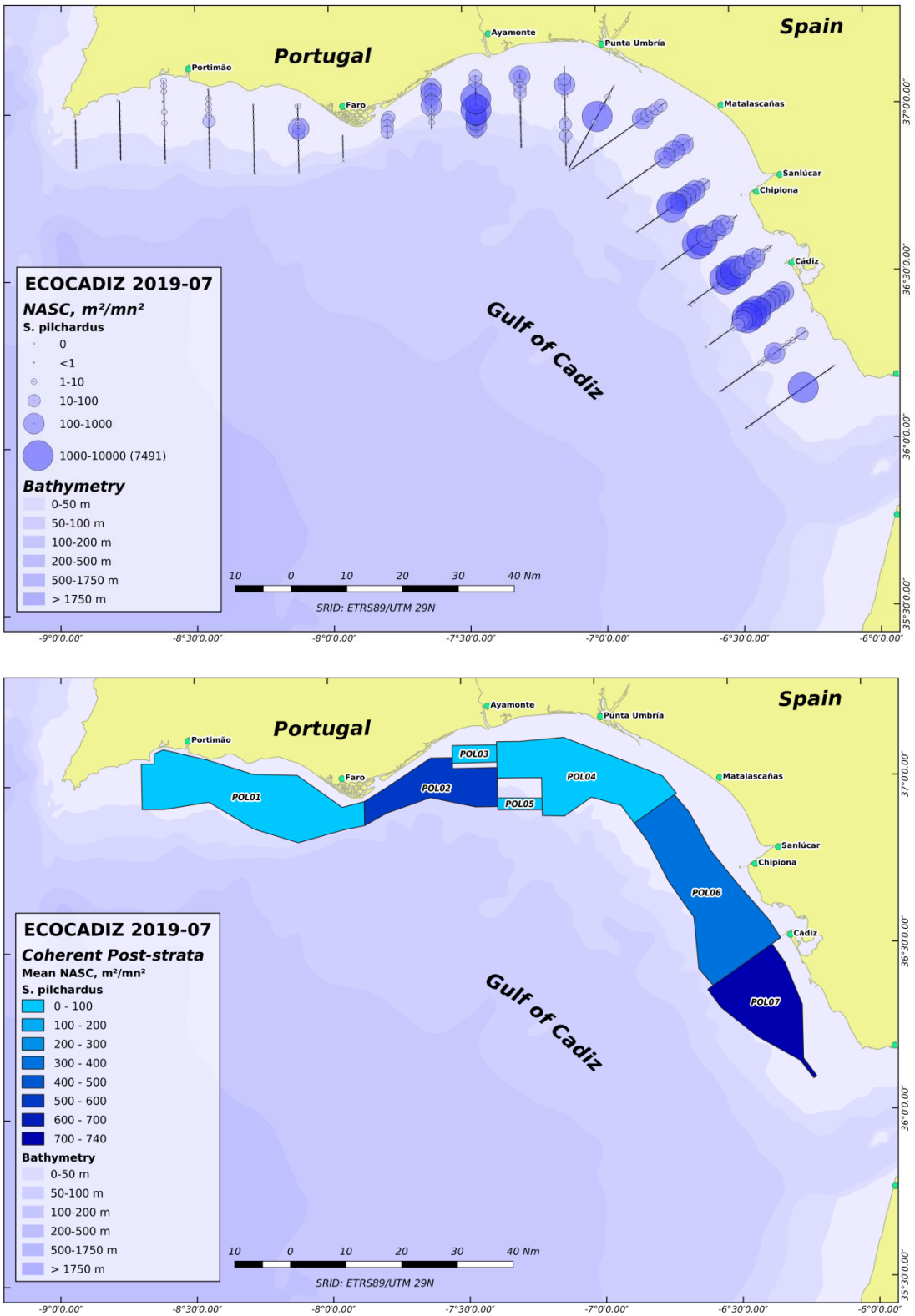


Figure 23. *ECOCADIZ 2019-07* survey. Sardine (*Sardina pilchardus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

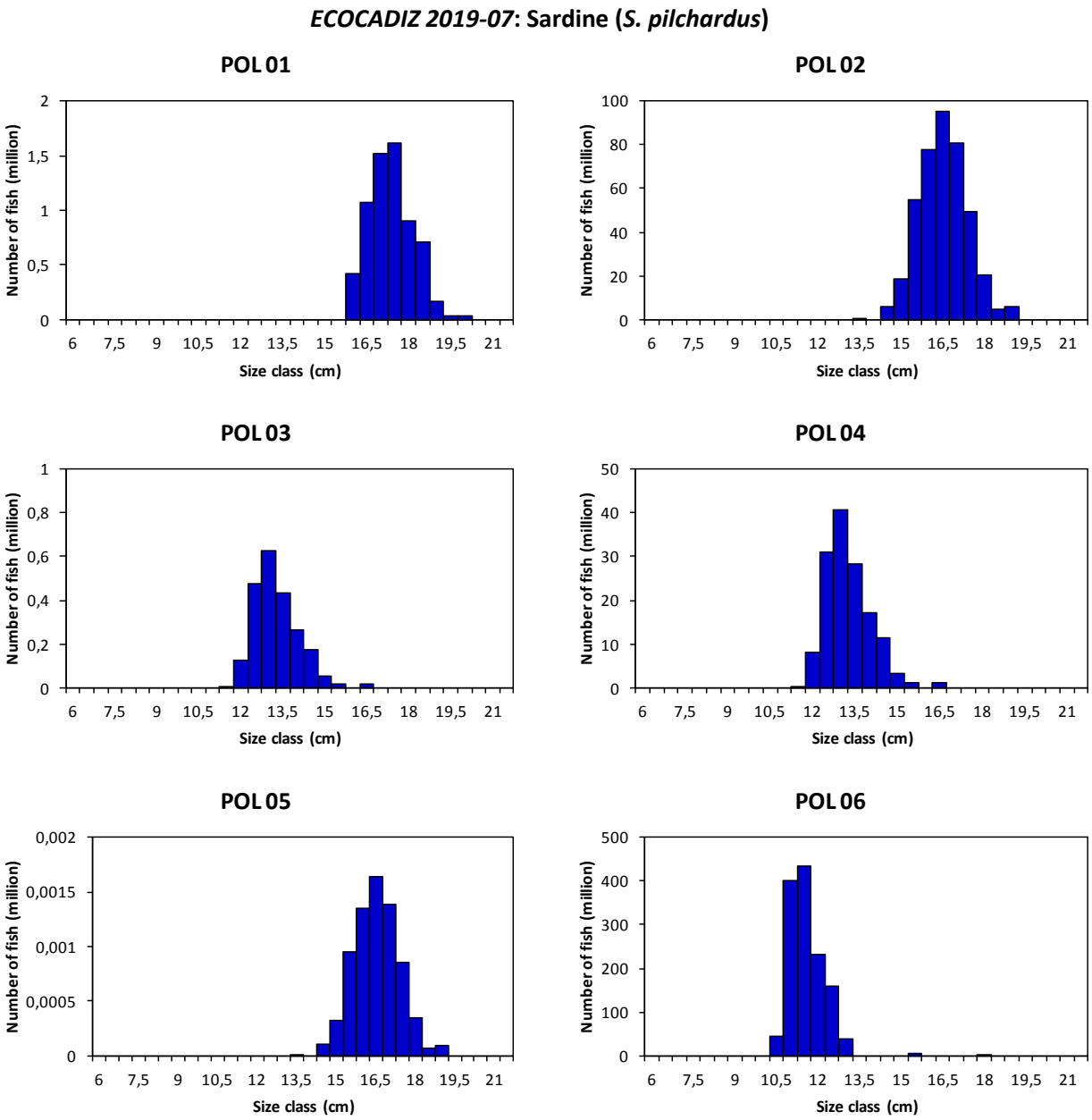


Figure 24. *ECOCADIZ 2019-07* survey. Sardine (*S. pilchardus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 23**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

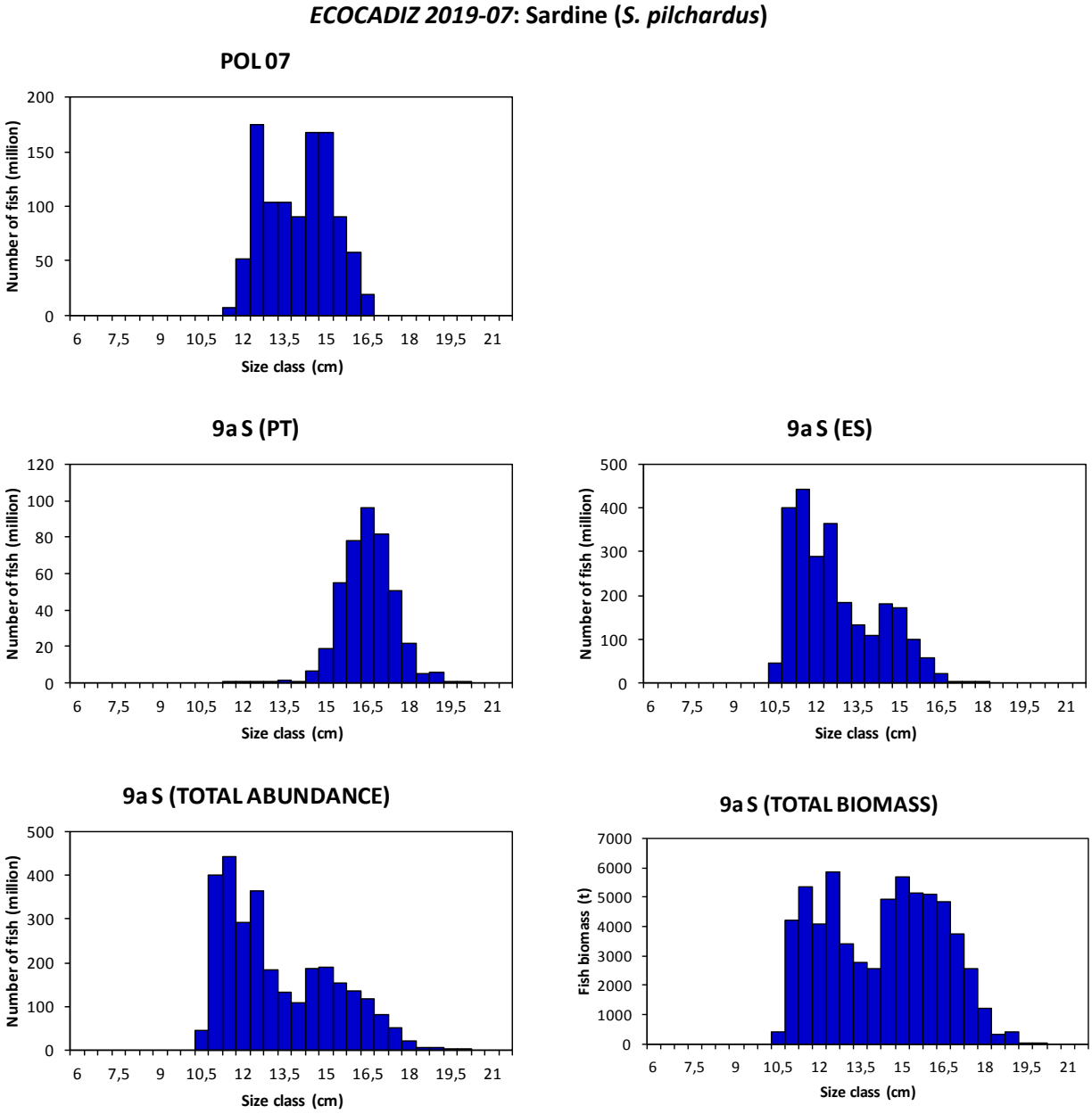


Figure 24. *ECOCADIZ 2019-07* survey. Sardine (*S. pilchardus*). Cont'd.

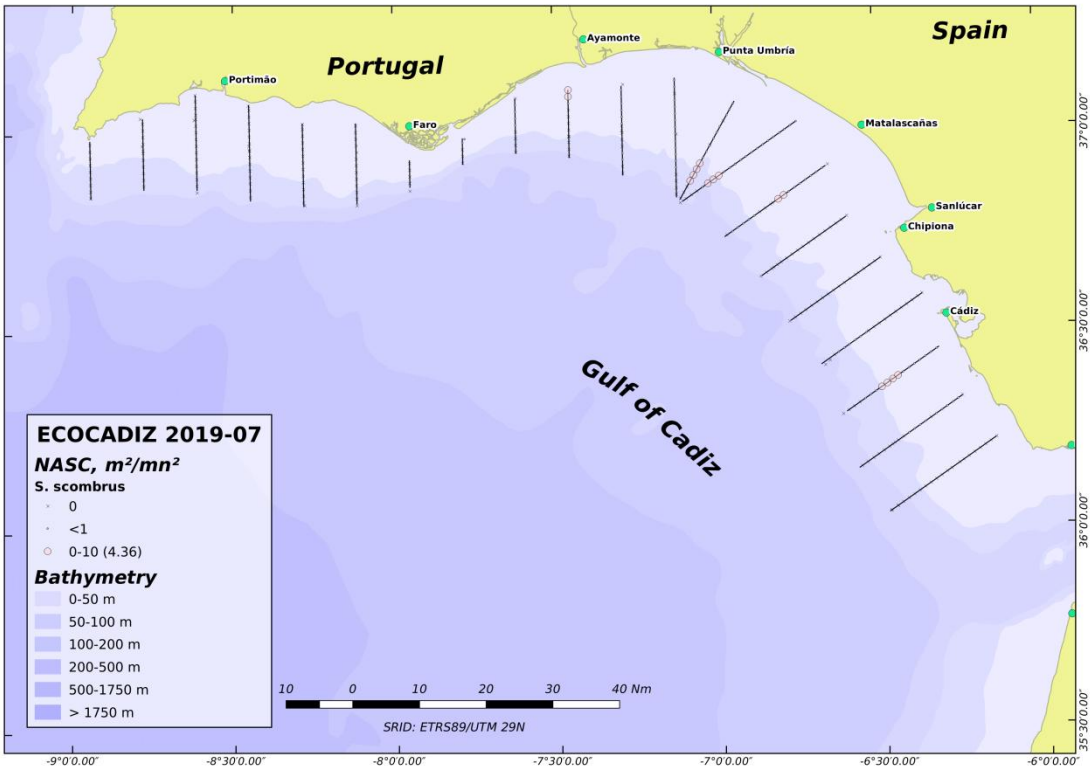


Figure 25. *ECOCADIZ 2019-07* survey. Mackerel (*Scomber scombrus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

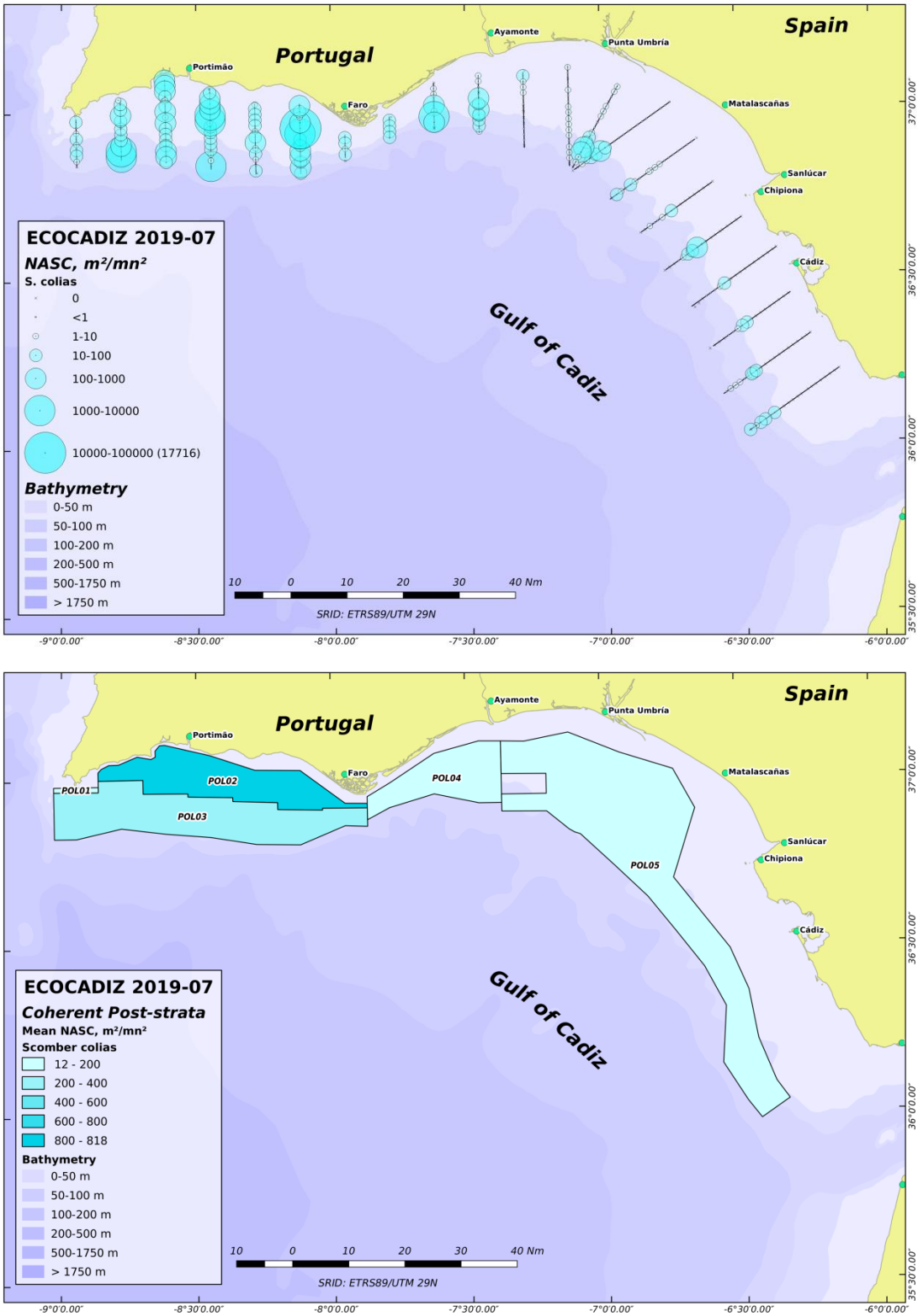


Figure 26. *ECOCADIZ 2019-07* survey. Chub mackerel (*Scomber colias*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

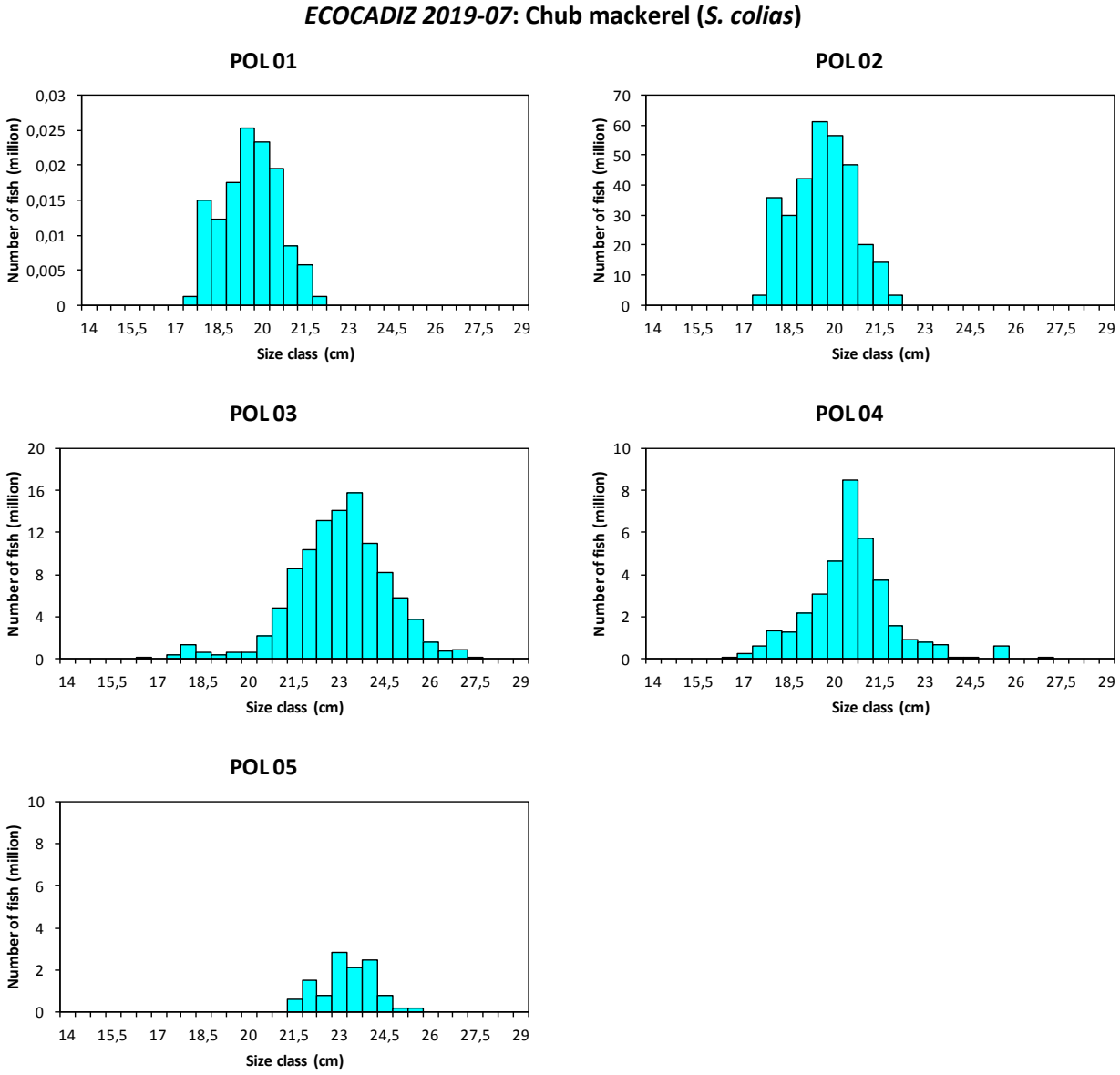


Figure 27. *ECOCADIZ 2019-07* survey. Chub mackerel (*Scomber colias*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 26**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

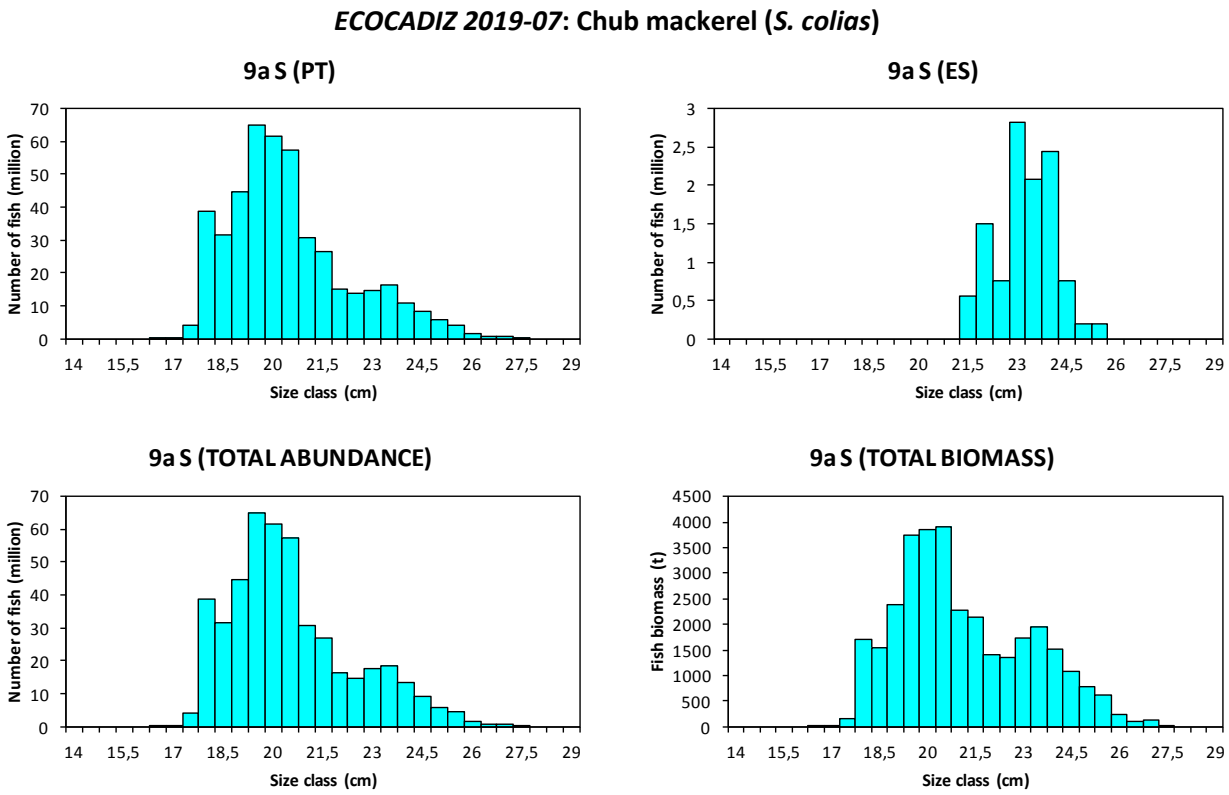


Figure 27. *ECOCADIZ 2019-07* survey. Chub mackerel (*Scomber colias*). Cont'd.

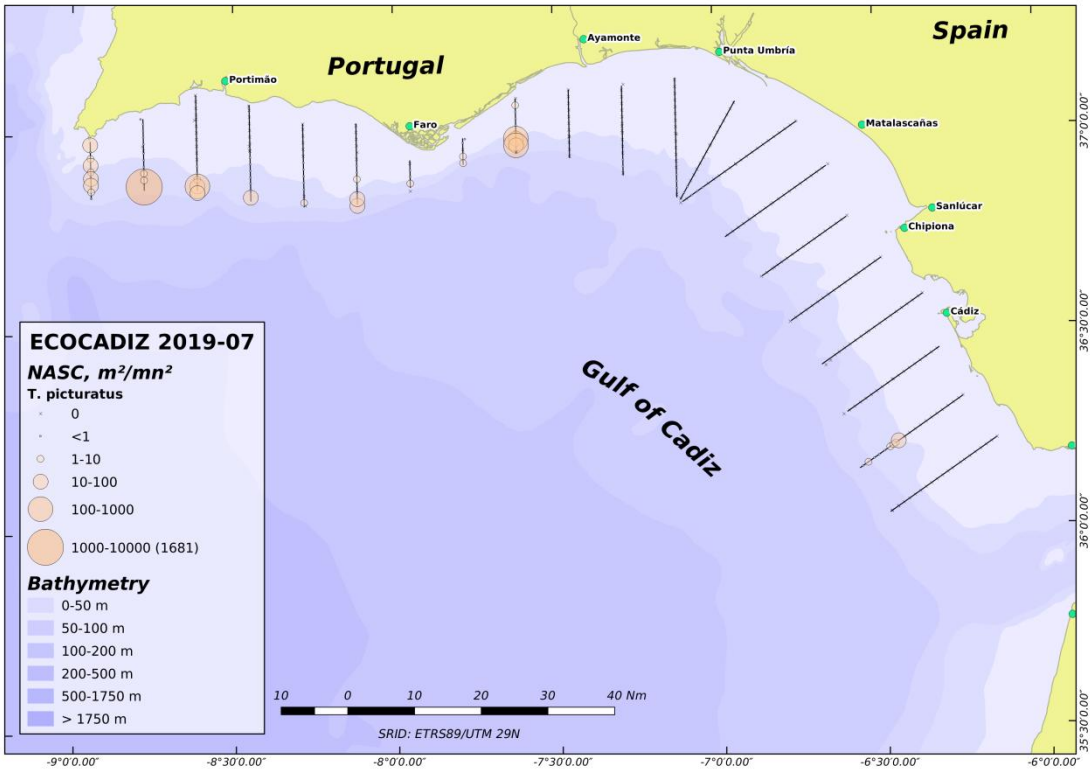


Figure 28. *ECOCADIZ 2019-07* survey. Blue jack mackerel (*Trachurus picturatus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

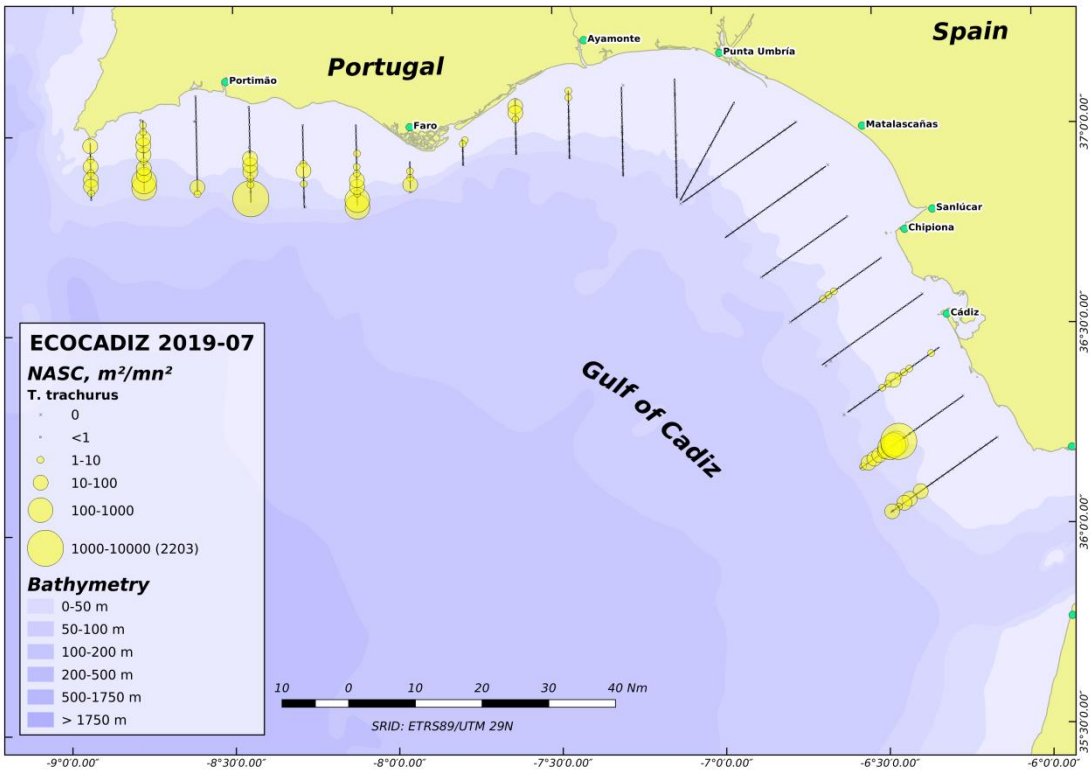


Figure 29. *ECOCADIZ 2019-07* survey. Horse mackerel (*Trachurus trachurus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

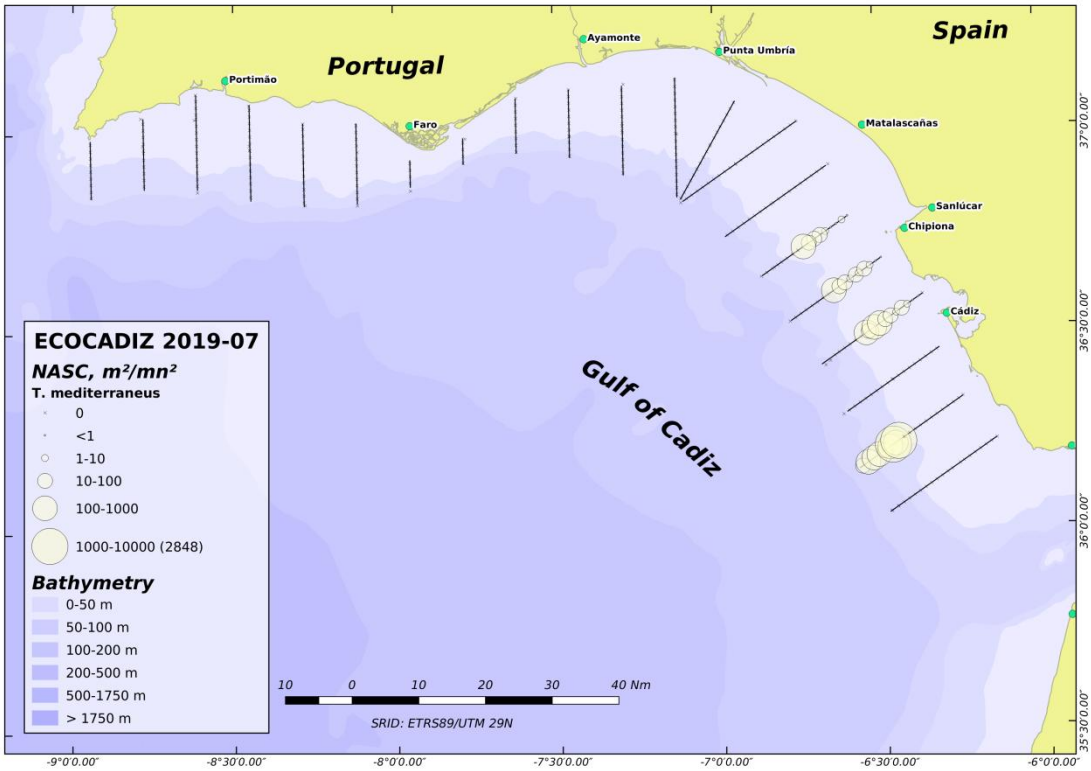


Figure 30. *ECOCADIZ 2019-07* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

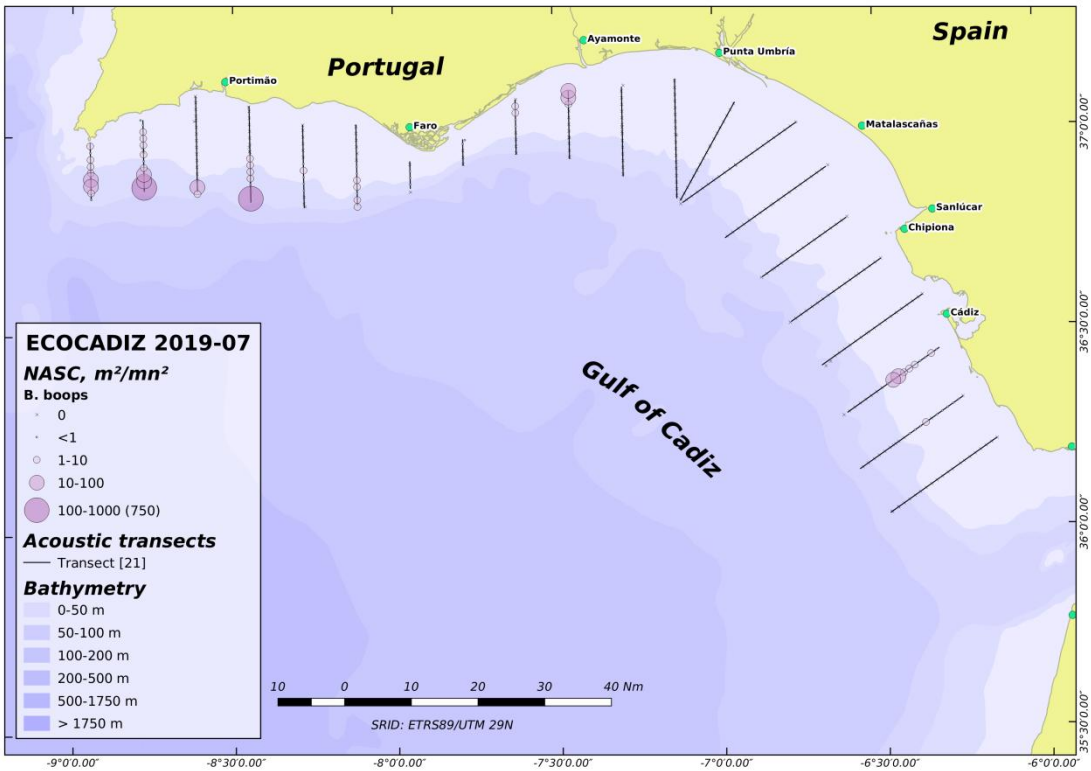


Figure 31. *ECOCADIZ 2019-07* survey. Bogue (*Boops boops*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

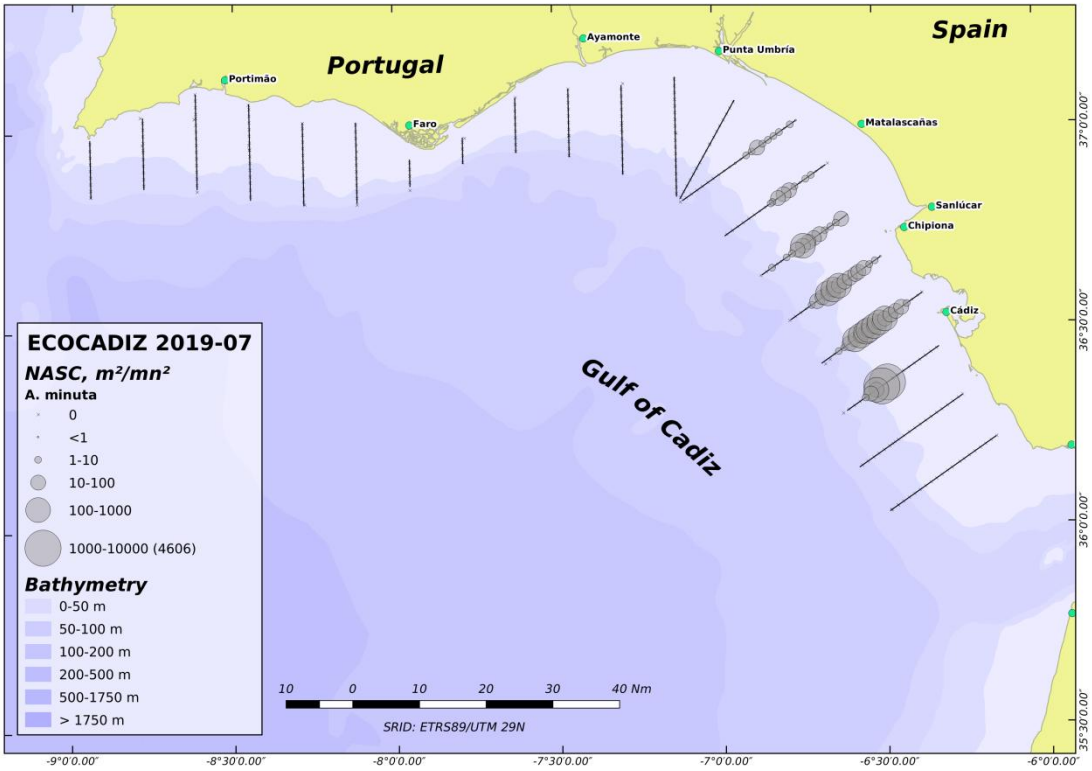


Figure 32. *ECOCADIZ 2019-07* survey. Transparent goby (*Aphia minuta*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

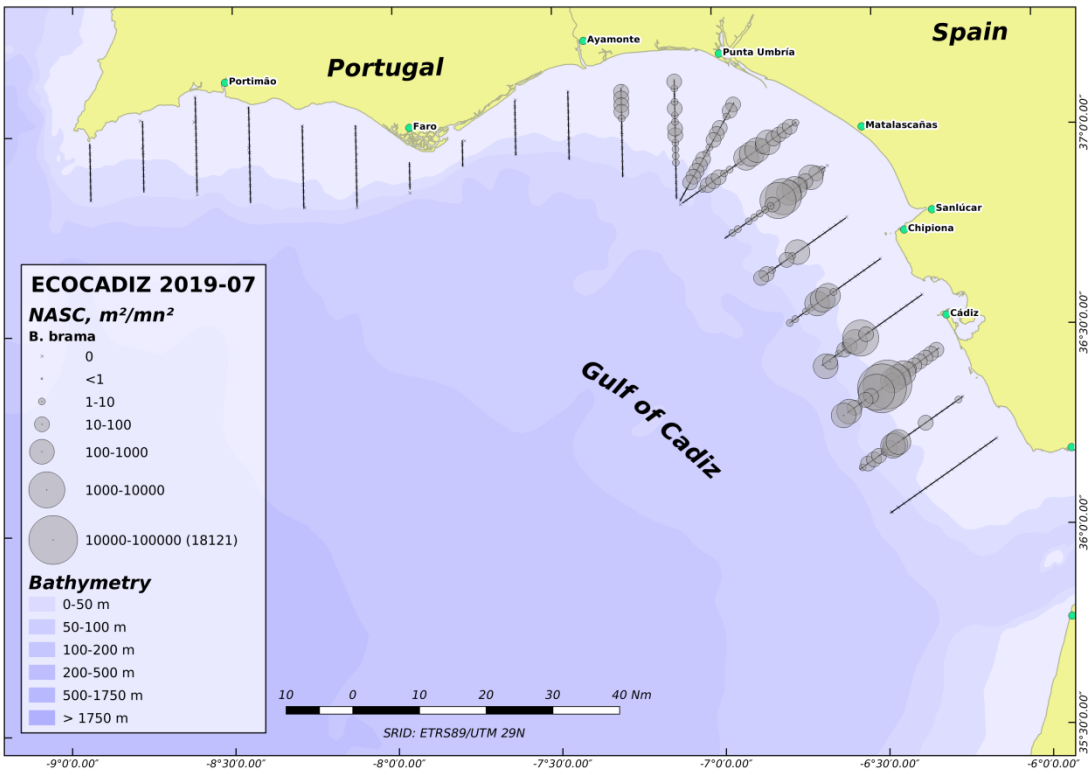


Figure 33. *ECOCADIZ 2019-07* survey. Atlantic pomfret (*Brama brama*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

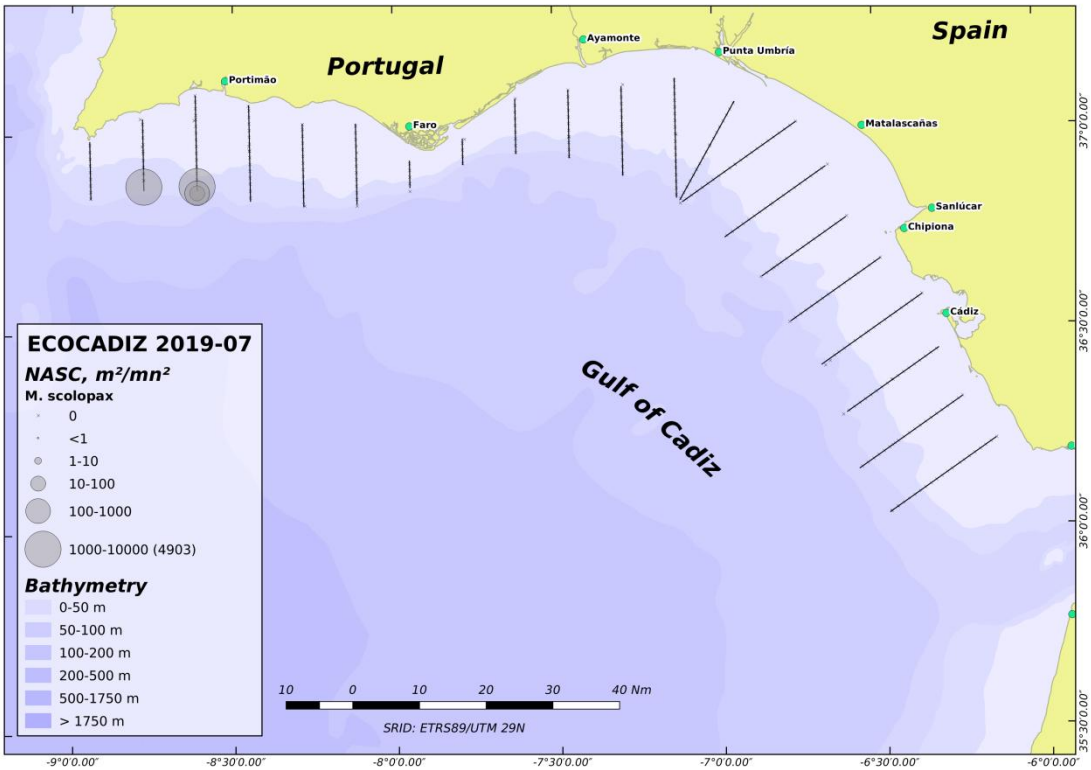


Figure 34. *ECOCADIZ 2019-07* survey. Longspine snipefish (*Macroramphosus scolopax*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

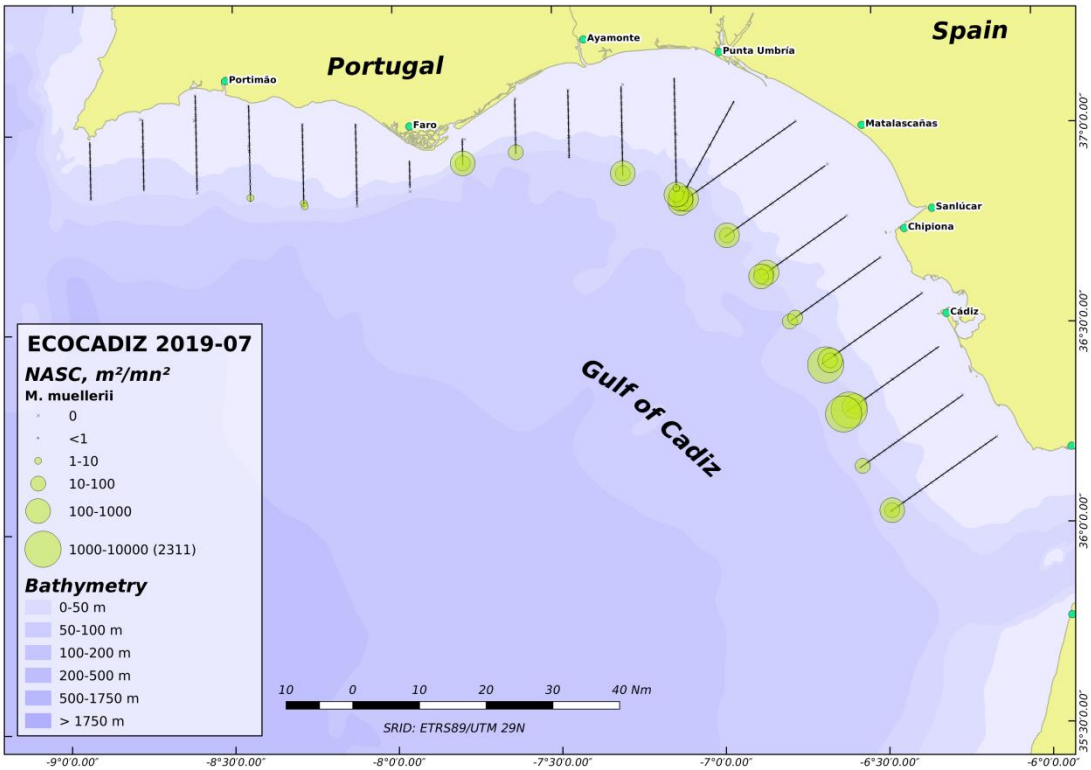


Figure 35. *ECOCADIZ 2019-07* survey. Pearlside (*Maurolicus muelleri*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

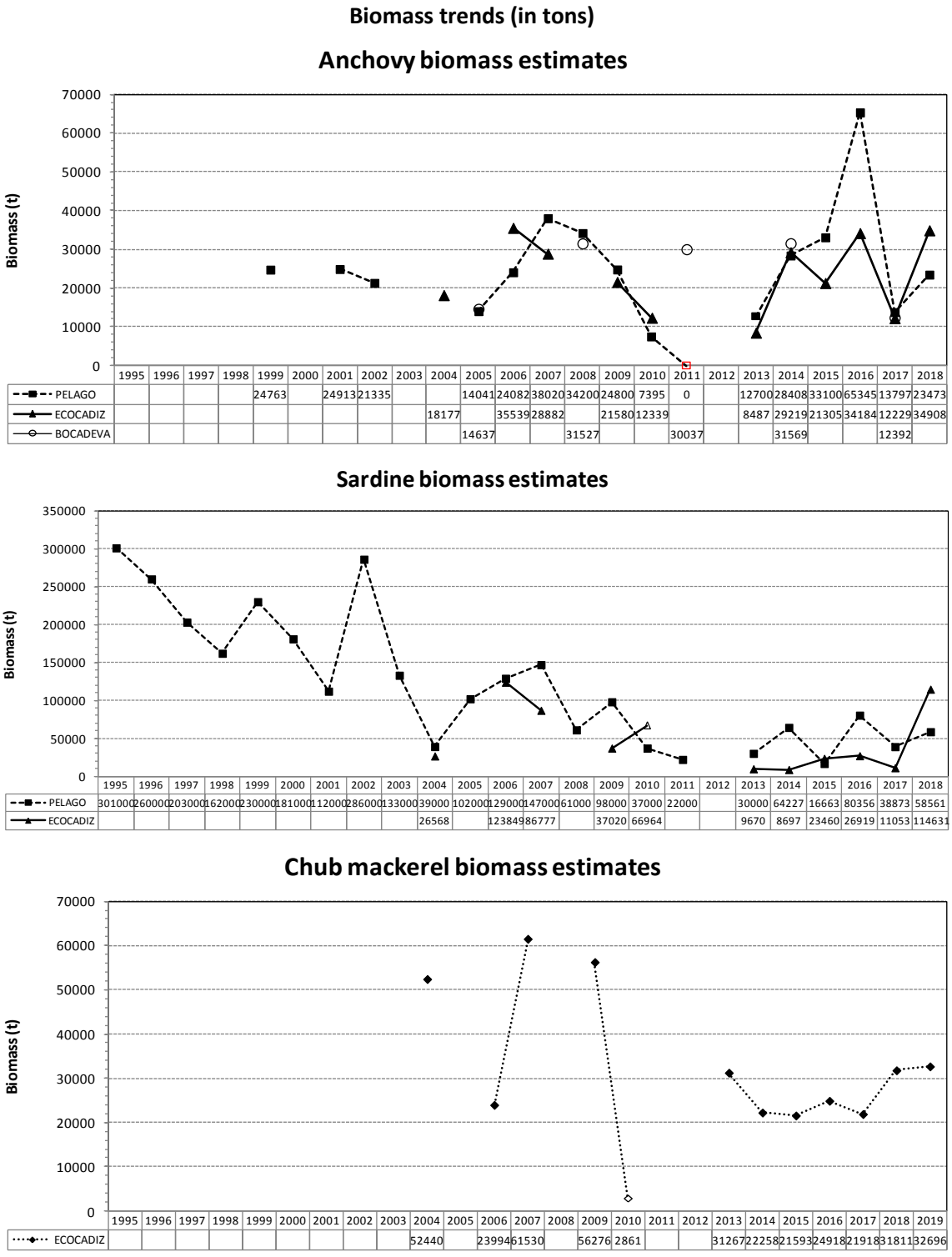


Figure 36. Trends in biomass estimates (in tons) for the main assessed species in Portuguese (*PELAGO*) and Spanish (*ECOCADIZ* and *BOCADEVA*) survey series. Note that the *ECOCADIZ* survey in 2010 partially covered the whole study area. The anchovy null estimate in 2011 from the *PELAGO* survey should be considered with caution.