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Acoustic assessment and distribution of the main pelagic fish species in the ICES Subdivision IXa South during the *ECOCADIZ 0813* Spanish survey (August 2013).

By

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ABSTRACT

The present working document summarises the main results from the Spanish (pelagic ecosystem-) acoustic survey conducted by IEO between 2nd and 13th August 2013 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cadiz onboard the R/V "*Cornide de Saavedra*". The survey dates were somewhat delayed in relation to the usual ones and to the anchovy (*Engraulis encrasicolus*) peak spawning as well. Abundance and biomass estimates are given for all the mid-sized and small pelagic fish species susceptible of being acoustically assessed according to their occurrence and abundance levels in the study area. The distribution of these species is also shown from the mapping of their back-scattering energies. The bulk of the anchovy population was concentrated in the Spanish shelf, with a residual nucleus to the west of Cape Santa Maria. A delay of the usual survey dates may be the reason of a higher relative importance of smaller anchovies in the population as a probable consequence of the incorporation of the first waves of recently recruited juveniles to the adult population. The total biomass estimated for anchovy was 8.5 thousand tonnes (609 million fish), the lowest estimate in its series. Sardine showed a distribution pattern almost complementary to that described for anchovy, with higher densities occurring over the inner-middle shelf of both extremes of the surveyed area, mainly west to Cape Santa Maria, and in shallower waters than anchovy. Sardine yielded a total of 9.7 thousand tonnes (232 million fish). The 2013 sardine estimate was also the lowest one in its series and corroborates a clear recent decline in the population which has also been evidenced by the *PELAGO* surveys. Chub mackerel was present all over the surveyed area although showed a more "oceanic" distribution in the westernmost waters. The species was the most important in terms of assessed biomass, rendering estimates of 31.3 thousand tonnes (333 million fish). Acoustic estimates for jack and horse-mackerel species (*Trachurus spp*.), and bogue (*Boops boops*) are also given in the WD. No acoustic estimates either for mackerel *S. scombrus* or round sardinella (*Sardinella aurita*) were computed because their incidental occurrence in the study area during the survey.

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*. 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 (initially 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 (WGACEGG).

The present Working Document summarises the main results from the *ECOCADIZ 0813* survey. After conducting this survey the RV *Cornide de Saavedra* was definitively out of service.

MATERIAL AND METHODS

The *ECOCADIZ 0813* survey was carried out between 2nd and 13th August 2014 onboard the Spanish R/V *Cornide de Saavedra* 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 between 7.5 - 8 knots (see below) and the acoustic signals were integrated over 1-nm intervals (ESDU). Raw acoustic data were stored for further post-processing using *Myriax Software Echoview™* software package (by *Myriax Software Pty. Ltd.,* ex *SonarData Pty. Ltd.*). Acoustic equipment was previously calibrated during the *MEDIAS 07 2013* acoustic survey, a survey conducted in the Spanish Mediterranean waters just before the *ECOCADIZ* one, following the standard procedures (Foote *et al*., 1987).

Vessel self-noise tests and the revision/calibration of the *Scanmar* depth sensor were carried out on 2nd August after the finalization of the acoustic sampling and fishing hauls. Vessel self-noise tests were carried out with only one of the two R/V engines, since it was agreed to conduct the survey with only one engine in order to save fuel. With only one engine the maximum speed achievable by this R/V is of 8.6 knots (with good weather and sea conditions), or even decrease up to 7 knots with bad sea conditions.

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 were opportunistic, according to the echogram information, and they were carried out using a ca. 16 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. Trawl sonar data from each haul were recorded and stored for further analyses.

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, mesenteric fat content) was performed in each haul for anchovy, sardine (in both species with otolith extraction), mackerel and horse-mackerel species, and bogue.

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

Trawl 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). 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), a *Sea-bird Electronics™ SBE 21 SEACAT* thermo-salinometer and a *Turner™ 10 AU 005 CE Field* fluorometer were used during the acoustic tracking to continuously monitor the anchovy egg abundance and to collect some hydrographical variables (sub-surface sea temperature, salinity, and *in vivo* fluorescence). Vertical profiles of hydrographical variables were also recorded by night from 146 CTD stations by using a *Sea-bird Electronics™ SBE 911+ SEACAT* profiler (**Figure 2**). Information on presence and abundance of sea birds, turtles and mammals was also recorded during the acoustic sampling by one onboard observer.

ECOCADIZ 0813 was also utilized this year as observational platform for the IFAPA (Instituto de Investigación y Formación Agraria y Pesquera)/IEO research project entitled *Ecology of the early stages of the anchovy life-cycle: the role of the coupled Guadalquivir estuary-coastal zone of influence in the species' recruitment process (ECOBOGUE)*. Thus, an *ad hoc* sampling grid of 4 stations including Carousel-CTD-LDCP, Bongo 40 and suprabenthic sledge samplings and 4 opportunistic Bongo 90 hauls were carried out in order to characterize the ichthyoplankton, mesozooplankton and suprabenthos species assemblages in the eastern sector of the study area (coastal area surrounding the Guadalquivir river mouth) and their relationships with environmental conditions (**Figure 3**).

RESULTS

Vessel self-noise tests

Results of the vessel self-noise tests (expressed in dB) are shown in the following enclosed table and revealed that the use of a single engine generated greater amount of self-noise than if the two vessel's engines were used. In any case, the tests' results advised to perform the acoustic sampling with a 40° blade pitch, equivalent to a speed of 8.6 knots.

Tests/Working freq.	18 kHz	38 kHz	70 kHz	120 kHz	200 kHz	Speed
Propeller: disengaged	-152	-158	-161	-163	-167	-
Propeller: engaged	-122	-144	-159	-165	-165	0.8
Blade pitch: 10°	-124	-144	-157	-163	-166	1.2
Blade pitch: 20°	-106	-119	-135	-146	-156	5.0
Blade pitch 30°	-110	-124	-140	-155	-163	7.0
Blade pitch: 40°	-115	**-130**	-143	-158	-164	8.6
Tacking to port	-115	-128	-145	-157	-165	-
Tacking to starboard	-116	-128	-145	-153	-164	-

Acoustic sampling

The acoustic sampling was carried out during the periods of 02 – 05 and 07 – 11 August (**Table 1**). The acoustic sampling started in the coastal end of the transect RA01 on 02 August towards the RA21. The acoustic sampling stopped on 06 August in order to dedicate that day to the sampling tasks of the *ECOBOGUE* project. Until 09 August the acoustic sampling started every day at 05:30 UTC. From then on (in the westernmost Algarve waters) the acoustic sampling started half an hour later. The whole 21-transect sampling grid was sampled. The foreseen start of transect RA09 by the coastal end had to be slightly displaced in order to avoid some tugs maneuvering in such shallow waters. As commented above, in order to save fuel, the acoustic sampling was carried out with only one of the two R/V engines. Such a limitation entailed navigation and acoustic sampling speeds of about 7,5 – 8 knots as an average, speeds quite lower than those ones considered as standard (10 knots). Lower speeds than the standard one negatively impacted in the progress of both the acoustic sampling and mainly in the number of fishing hauls per day (see below).

Groundtruthing hauls

Seventeen (17) fishing operations, 16 of them valid according to a correct gear performance and resulting catches, were carried out (**Table 1**, **Figure 4**). Such a number of fishing hauls was nearly the half of hauls that are usually carried out during a standard survey.

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, 31% of valid hauls (5 hauls) were conducted over isobath.

Because of the 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 very close to the bottom. According to the above, the sampled depth range in the valid hauls oscillated between 36-146 m.

During the survey were captured 1 species of Chondrichthyans, 38 species of Osteichthyes and 5 species of Cephalopods. 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**). Chub mackerel and blue jack mackerel (13 hauls), and

anchovy and horse-mackerel (12 hauls) stood especially out from the set of small and mid-sized pelagic fish species. They were followed by mackerel (11 hauls), bogue (10), sardine (9), and Mediterranean horse mackerel (6 hauls).

Species	# of positive fishing stations	Occurrence (%)	Total weight (kg)	Total number
Merluccius merluccius	14	88	150	1364
Scomber colias	13	81	2862	28981
Trachurus picturatus	13	81	279	5258
Engraulis encrasicolus	12	75	1324	65335
Trachurus trachurus	12	75	496	10360
Scomber scombrus	11	69	82	471
Boops boops	10	63	93	941
Spondyliosoma cantharus	10	63	10	87
Loligo media	10	63	6	1325
Sardina pilchardus	9	56	362	10122
Loligo vulgaris	7	44	1	28
Trachurus mediterraneus	6	38	340	1921

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 6 092 kg and 158 thousand fish (**Table 2**). 47% of the total fished biomass corresponded to chub mackerel, 22% to anchovy, 8% to horse mackerel, 6% to sardine and Mediterranean horse mackerel, and 5% to blue jack-mackerel. The most abundant species in groundtruthing trawl hauls was anchovy (42%) followed by a long distance by chub mackerel (19%), horse-mackerel and sardine (7% each). Total catches and yields of Mediterranean horse-mackerel and blue jack mackerel were very low, with those of bogue, mackerel and round sardinella being almost incidental. The species composition, in terms of percentages in number, in each valid fish station is shown in **Figure 5**.

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

A total of 320 nmi (ESDU) from 21 transects has been acoustically sampled by echo-integration for assessment purposes. From this total, 206 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.	Sardine	Round sardinella	Anchovy	Mackerel	Chub mack.	Horse-mack.	Medit. h-mack.	Blue jack-mack.	Bogue
Total Area	89375	6062	6	10168	16	38545	16084	4832	5689	7973
(%)	(100.0)	(6.8)	(0.0)	(11.4)	(0.0)	(43.1)	(18.0)	(5.4)	(6.4)	(8.9)
Portugal	38858	3752	0	1194	5	3502	13950	0	3546	7149
(%)	(43.5)	(61.9)	(0.0)	(11.7)	(34.1)	(24.0)	(86.7)	(0.0)	(62.3)	(89.7)
Spain	50517	2310	6	8974	10	29284	2133	4832	2143	824
(%)	(56.5)	(38.1)	(100.0)	(88.3)	(65.9)	(76.0)	(13.3)	(100.0)	(37.7)	(10.3)

For this "pelagic fish assemblage" has been estimated a total of 89375 m^2 nmi^{-2}. Portuguese waters accounted for 43.5% of this total back-scattering energy and the Spanish waters the remaining 56.5%.

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 6**. By species, chub mackerel accounted for 43.1% of this total back-scattering energy, a relative importance corroborated by its high frequency of occurrence in hauls. Horse mackerel is the following species in importance with 18.0%. Anchovy only contributed with 11.4%, followed by bogue with 8.9%, sardine with 6.8%, blue jack mackerel with 6.4%, Mediterranean horse mackerel with 5.4%, and negligible energetic contributions by mackerel and round sardinella.

Some inferences on the species' distribution may be carried out from regional contributions to the total energy attributed to each species: round sardinella, Mediterranean horse mackerel, anchovy, mackerel and chub mackerel seem to show greater densities in the Spanish waters, whereas bogue, horse mackerel, blue jack mackerel and sardine may 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, chub mackerel, blue jack mackerel, horse mackerel, Mediterranean horse mackerel and bogue.

Spatial distribution and abundance/biomass estimates

Anchovy

Parameters of the survey's length-weight relationship for anchovy are given in **Table 11**. The back-scattering energy attributed to this species, positive valid fishing stations with anchovy and the coherent strata considered for the acoustic estimation are shown in **Figure 6**. The estimated abundance and biomass by size and age class are given in **Tables 3** and **4** and **Figures 8** and **9**.

The bulk of the anchovy population was concentrated in the central part of the surveyed area which corresponds to the Spanish shelf. In this area the species distributed all over the shelf showing spots of high density at different depths. A residual nucleus was also recorded to the west of Cape Santa Maria, in waters with a bathymetry between 75 and 108 m depth (**Figure 6**).

The size class range of the assessed population varied between the 7.5 and 18 cm size classes, with two modal classes at 11 and 14.5 cm. As usual, largest anchovies occurred in the westernmost waters whereas the smallest ones were observed in the central coastal part of the sampled area, coinciding with the location of the main recruitment area close to the Guadalquivir river mouth. The delay of the survey dates in relation to the rest of surveys in the series may be the reason of a higher relative importance of the first modal component in the population, as also happened in the previous survey (in 2010). This fact is a probable consequence of the incorporation of the first waves of recently recruited juveniles to the adult population that usually occur in mid-late summer (**Tables 3** and **4**, **Figures 7** and **8**).

Six sectors have been differentiated according to the S_A value distribution and the size composition in the fishing stations. The acoustic estimates by homogeneous stratum and total area are shown in **Tables 3** and **4**, and **Figures 7** and **8**. A total of 8 487 t and 609 millions of fish have been estimated for this species for the whole surveyed area.

A total of 107 stations were sampled by CUFES from which 68 stations (64%) were positive with anchovy eggs. These positive stations were distributed all over the acoustic transects but the easternmost one and rendered a total of 10 005 anchovy eggs. The spatial distribution of anchovy eggs resembled to the above described for the adult population. Total, maximum and mean anchovy egg densities were estimated at 769, 130 and 7 eggs m^{-3} respectively. Greater anchovy egg densities were mainly observed in the inner-middle shelf waters located between Cadiz Bay and Tinto-Odiel rivers mouths. However, the highest egg

density (130 eggs m^{-3}) was recorded in a station with a bathymetry of 87.6 m depth located in the closest transect to the Portuguese-Spanish border (**Figure 9**). In that station were collected a total of 2014 eggs, accounting for 20% of the total of the collected anchovy eggs during the survey, with practically all of them belonging to the *no embryo* stage.

Sardine

Parameters of the survey's size-weight relationship for sardine are shown in **Table 11**. The back-scattering energy attributed to this species, positive valid fishing stations with sardine and the coherent strata considered for the acoustic estimation are shown in **Figure 10**. Estimated abundance and biomass by size class are given in **Table 5** and **Figure 11**.

Sardine preferably occurred over the inner-middle shelf of both extremes of the surveyed area, in shallower waters than anchovy, and curiously in those waters where anchovy was absent, resulting in a distribution pattern almost complementary to the one deployed by this last species (**Figure 10**). In any case, higher sardine densities were more constantly recorded in the waters west to Cape Santa Maria.

The size range of the assessed population ranged between 11 and 21.5 cm size classes, with two modal classes, a secondary one at 13 and the most important at 17 cm. As also evidenced in previous surveys, the size composition of the surveyed population evidences that the central coastal area might correspond with a recruitment area for the species (**Table 5**, **Figure 11**).

Five size-based homogeneous sectors were delimited for the acoustic assessment. The acoustic estimates by homogeneous stratum and total area are shown in **Table 5** and **Figure 11**. Sardine was the third most important species in terms of both biomass and abundance: 9 670 t and 232 millions of fish have been estimated for this species for the whole surveyed area.

Round sardinella and Mackerel

The occurrence of round sardinella during the survey was incidental and restricted to a very small coastal area between Rota and Chipiona, in the eastern waters of the Gulf (**Figure 12**). Acoustic integration for the species was considered negligible and therefore the species was not acoustically assessed. The same also applies to mackerel, although in this case the species showed a wider distribution, occurring in all transects but the two easternmost ones, with the species distributing over the middle and outer shelf waters of the Gulf (**Figure 12**).

Chub mackerel

Parameters of the survey's length-weight relationship are shown in **Table 11**. The back-scattering energy attributed to this species, positive valid fishing stations with chub mackerel and the coherent strata considered for the acoustic estimation are shown in **Figure 13**. Estimated abundance and biomass by size class are given in **Table 6** and **Figure 14**.

Chub mackerel was present all over the surveyed area although in the westernmost waters showed a more "oceanic" distribution than in the rest of the surveyed area, where the highest densities were mainly recorded in different locations over the inner shelf (**Figure 13**). The size class range for the assessed population oscillated between 19 and 32 cm size classes. Two mixed size cohorts may be differentiated in the sampled population, both corresponding to juvenile/sub-adult fish (with modes at 20 and 22 cm; **Table 6** and **Figure 14**). Larger fish were more frequent in the central area.

Seven sectors were differentiated for the purposes of acoustic assessment. The acoustic estimates by homogeneous stratum and total area are shown in **Table 6** and **Figure 14**. Chub mackerel in the sampled

area was the most important species in terms of assessed biomass, rendering estimates of 31 267 t and 333 million fish.

Blue jack-mackerel

The survey's length-weight relationship for this species is given in **Table 11**. The back-scattering energy attributed to this species, the species' positive fishing stations and the coherent strata considered for the acoustic estimation are illustrated in **Figure 15**. Estimated abundance and biomass by size class are given in **Table 7** and **Figure 16**.

Blue jack mackerel occurred in 3 main locations: the area between Cape San Vicente and Cape Santa Maria, the area close to the Guadiana river mouth (where the highest densities were recorded), and the easternmost extreme of the surveyed area. Spots of high density were indistinctly recorded both in the inner and middle shelf (**Figure 15**). The sampled population showed a well bell-shaped length frequency distribution, with size classes ranging between 14.5 and 21.5 cm, and a modal class at 17.5 cm, all of them probably corresponding to juvenile/sub-adult fish. Larger fish were mainly recorded in the easternmost waters of the sampled area (**Table 7**, **Figure 16**).

The estimates for the four post-strata considered in the assessment are shown in **Table 7** and **Figure 16**. A total of 3 889 t and 76 millions of fish were estimated for the whole surveyed area.

Horse mackerel

The survey's length-weight relationship for horse mackerel is shown in **Table 11**. The back-scattering energy attributed to this species, the distribution of fishing stations and their coherent strata are shown in **Figure 17**. Estimated abundance and biomass by size class are given in **Table 8** and **Figure 18**.

The spatial distribution of acoustic energy attributable to horse mackerel resembled in a great extent to that previously described for sardine and blue jack mackerel, with highest densities occurring in both extremes of the surveyed area and a relatively scarce presence in the central part. Again, westernmost Portuguese shelf waters were those where the species recorded the highest values (**Figure 17**). The sampled population, which ranged between 10.5 and 22.5 cm size classes, was basically distributed amongst two cohorts with one main mode at 17 cm (sub-adults), and a secondary one at 12.5 cm (juveniles, which were located in the central part of the middle-inner shelf of the surveyed area) (**Table 8**, **Figure 18**).

The estimates for the four coherent strata considered in the assessment and for the whole surveyed area are given in **Table 8** and illustrated in **Figure 18**. During this survey were estimated 10 398 t and 228 million fish of horse mackerel in the surveyed area, the species ranking as the second most important one in terms of biomass.

Mediterranean horse-mackerel

The survey's length-weight relationship for this species is shown in **Table 11**. Positive fishing stations, back-scattering energy attributed to the species and coherent strata are represented in **Figure 19**. Estimated abundance and biomass by size class are given in **Table 9** and **Figure 20**.

Mediterranean horse-mackerel was only present over the Spanish inner shelf waters, with the densest concentrations being recorded in the easternmost waters **(Figure 19**). Size range of the sampled population oscillated between 17 and 38 cm size classes, showing 3 modal classes at 19, 28.5 and 35 cm, although the bulk of the sampled specimens occurred around the second mode, between 22.5 and 32 cm. Again, the smallest fish occurred in the central part of the surveyed area, in front of the Coto de Doñana National Park (**Table 9**, **Figures 19**, **20**).

The acoustic estimates, given in **Table 9** and **Figure 20**, were: 4 853 t and 26 millions of fish.

Bogue

Parameters of the survey's length-weight relationship for bogue are shown in **Table 11**. Positive fishing hauls, back-scattering energy attributed to bogue and coherent strata delimited for acoustic estimations are shown in **Figure 21**. Estimated abundance and biomass by size class are given in **Table 10** and **Figure 22**.

Bogue was mainly located in the westernmost Portuguese waters, where the species also recorded the highest densities. In the rest of the area the species showed a very scattered distribution with very low densities (**Figure 21**). The sampled population was composed by fish belonging to size classes comprised between 10.5 and 24 cm, although mainly distributed between the 19 and 24.5 cm size classes. Three modes were identified at 13.5, 17 and, the most important, at 21 cm. Large fish were mainly located in the western coherent strata, whereas juveniles were only observed in front of the Coto de Doñana and in the easternmost waters (**Table 10**, **Figure 22**).

The bogue acoustic estimates for the whole surveyed area, shown in **Table 10** and **Figure 22**, were: 4 783 t and 52 million fish.

(SHORT) DISCUSSION

No standard acoustic survey (neither *PELAGO* nor *ECOCADIZ*) was carried out in 2012 in the Gulf of Cadiz for different reasons. Spain could finally conduct between 10 and 27 November of that year the *ECOCADIZ-RECLUTAS 1112* survey, a survey aimed at obtaining acoustic estimates of Gulf of Cadiz anchovy and sardine juveniles in their main recruitment areas off the Gulf (Ramos *et al*., 2013). Although a probable underestimation should be assumed, since the surveyed area was restricted to the Spanish waters only, 2012 autumn acoustic estimates for anchovy (2 649 million fish, 13 680 t) and sardine (603 million fish, 22 119 t) were close to those ones estimated by IPMA five months after (5 April – 15 May 2013) during the *PELAGO 13* survey (Marques *et al*., 2013; **Table 12**). A further within-year comparison between *PELAGO 13* and *ECOCADIZ 0813* estimates reveals however marked decreases in the population levels of both species in mid-summer 2013, with the decrease exhibited by sardine being much more evident. During the *ECOCADIZ 0813* survey the greatest decreases in abundance and biomass were recorded in the Portuguese waters for anchovy and, more dramatically, in the Spanish ones for sardine. The above values are also illustrated in the context of their respective historical series in **Figure 23**. Anchovy and sardine biomass estimates in 2013 are amongst the lowest ones within their respective survey series. For both species, the 2013 *ECOCADIZ* survey estimates even were the lowest ones in the whole series. In their Portuguese counterparts, the anchovy estimate was about the half of the historical average (about 24 kt). In any case, Gulf of Cadiz anchovy has experienced a very fluctuating trend in the recent years. Since 2007 on the sardine biomass, as estimated by the *PELAGO* surveys, is experiencing a clear decreasing trend, which culminated in 2011 and it is still maintaining in the latest years. This decline is also corroborated, although based on less data points, by the Spanish summer surveys.

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Table 1. *ECOCADIZ 0813 s*urvey. Descriptive characteristics of the acoustic tracks.

Acoustic track	Location	Date	Start				End			
			Latitude	Longitude	UCT time	Mean depth (m)	Latitude	Longitude	UCT time	Mean depth (m)
R01	Trafalgar	02/08/2013	36º 13,670 N	6º 7,620 W	10:17	25	36º 2,070 N	6º 28,560 W	14:44	190
R02	Sancti-Petri	03/08/2013	36º 19,320 N	6º 14,630 W	5:38	31	36º 8,980 N	6º 34,070 W	9:38	208
R03	Cádiz	03/08/2013	36º 17,250 N	6º 36,600 W	11:00	172	36º 27,180 N	6º 19,110 W	17:18	24
R04	Rota	04/08/2013	36º 34,460 N	6º 23,260 W	5:35	23	36º 24,510 N	6º 40,740 W	9:50	214
R05	Chipiona	04/08/2013	36º 30,990 N	6º 46,430 W	10:49	189	36º 40,160 N	6º 29,810 W	14:35	25
R06	Doñana	05/08/2013	36º 37,920 N	6º 51,430 W	6:01	149	36º 46,410	6º 41,050 W	10:28	23
R07	Matalascañas	05/08/2013	36º 53,510 N	6º 41,050 W	10:28	23	36º 43,980 N	6º 58,190 W	14:11	211
R08	Mazagón	07/08/2013	36º 49,120 N	7º 6,730 W	5:37	191	37º 1,070 N	6º 44,520 W	8:25	21
R09	Punta Umbría	07/08/2013	37 º4,530 N	6º 55,870 W	9:47	28	36º 49,040 N	7º 6,860 W	11:54	200
R10	El Rompido	07/08/2013	36º 49.170 N	7º 6.810 W	14:44	195	37º 6.860 N	7º 6.910 W	16:41	24
R11	Isla Cristina	08/08/2013	36º 52,370 N	7º 16,710 W	5:36	200	37º 7,150 N	7º 16,950 W	9:13	20
R12	V. R. de Sto. Antonio	08/08/2013	37º 6,190 N	7º 26,510 W	10:11	30	36º 56,190 N	7º 26,500 W	12:56	241
R13	Tavira	08/08/2013	36º 57,070 N	7º 36,100 W	14:29	125	37º 4,940 N	7º 36,050 W	16:55	21
R14	Fuzeta	08/08/2013	36º 59,280	7º 45,930 W	18:19	78	36º 55,7 N	7º 45,850 W	18:34	160
R15	Cabo de Sta. María	09/08/2013	36º 56,000 N	7º 55,080 W	5:33	67	36º 51,870 N	7º 55,990 W	6:02	217
R16	Cuarteira	09/08/2013	36º 50,170 N	8º 5,900 W	7:52	122	37º 1,340N	8º 5,960 W	11:12	21
R17	Albufeira	09/08/2013	37º 2,450 N	8º 15,430 W	12:12	31	36º 49,380 N	8º 15,490 W	15:26	175
R18	Alfanzina	10/08/2013	37º 4,170 N	8º 25,300 W	6:04	32	36º 50,360 N	8º 25,240 W	10:18	213
R19	Portimao	10/08/2013	36º 51,480 N	8º 35,360 W	11:42	115	37º 6,020 N	8º 35,390 W	14:43	25
R20	Burgau	11/08/2013	37º 1,400 N	8º 45,040 W	10:04	60	36º 52,380 N	8º 45,030 W	11:10	229
R21	Ponta de Sagres	11/08/2013	36º 50,820 N	8º 54,970 W	12:10	161	37º 0,490 N	8º 55,010 W	13:23	25

Table 2. *ECOCADIZ 0813* survey. Descriptive characteristics of the fishing stations. Null hauls shadowed.

Fishing station	Date	Start		End		UTC Time		Depth (m)		Duration (min.)		Trawled Distance (nm)	Acoustic transect	Zone (landmark)
		Latitude	Longitude	Latitude	Longitude	Start	End	Start	End	Effective trawling	Total manoeuvre			
01	02/08/2013	36° 07.5001 N	6° 19.9345 W	36° 08.5708 N	6° 16.9120 W	12:13	12:41	42,81	35,86	00:28	00:58	2,672	R01	Trafalgar
02	03/08/2013	36° 15.4470 N	6° 21.8920 W	36° 16.4845 N	6° 19.9524 W	07:01	07:28	50,52	45,12	00:27	00:55	1,88	R02	Sancti-Petri
03	03/08/2013	36° 21.1015 N	6° 31.9429 W	36° 18.7477 N	6° 30.6034 W	13:09	13:47	97,68	95,96	00:38	01:08	2,588	R03	Cádiz
04	03/08/2013	36° 24.6126 N	6° 23.6392 W	36° 23.4348 N	6° 25.7391 W	15:36	16:08	50,52	56,67	00:32	10:22	2,063	R03	Cádiz
05	04/08/2013	36° 31.6408 N	6° 28.1515 W	36° 30.6189 N	6° 29.9770 W	07:24	02:50	46,66	54,38	00:26	00:59	1,791	R04	Rota
06	04/08/2013	36° 33.9931 N	6° 41.0815 W	36° 32.4217 N	6° 43.9122 W	11:54	12:35	95,03	119,96	00:41	01:13	2,768	R05	Chipiona
07	05/08/2013	36° 43.7650 N	6° 40.7755 W	36° 42.5242 N	6° 43.0849 W	07:35	08:07	39,53	59,51	00:32	00:56	2,232	R06	Coto Doñana
08	05/08/2013	36° 47.6104 N	6° 51.5898 W	36° 48.9349 N	6° 49.2508 W	12:11	12:43	87,58	64,8	00:32	01:06	2,297	R07	Matalascañas
09	05/08/2013	36° 44.4166 N	6° 57.3940 W	36° 45.5032 N	6° 55.4485 W	14:45	15:15	140,95	115,33	00:30	01:10	1,903	R07	Matalascañas
10	07/08/2013	36° 50.6850 N	7° 06.0118 W	36° 52.2754 N	7° 04.7218 W	12:19	12:48	145,93	115,87	00:29	01:09	1,896	R09	Punta Umbría
11	08/08/2013	36° 57.6747 N	7° 16.7926 W	36° 55.4401 N	7° 16.7557 W	06:45	07:17	99,08	119,77	00:32	01:07	2,232	R11	Isla Cristina
12	08/08/2013	37° 04.9612 N	7° 27.5697 W	37° 04.9858 N	7° 25.2487 W	10:47	11:13	39,66	37,73	00:26	00:51	1,857	R12	V. R. Sto. Antonio
13	08/08/2013	37° 01.0086 N	7° 36.0274 W	36° 59.0446 N	7° 36.0439 W	15:12	15:41	93,71	108,98	00:29	01:12	1,962	R13	Tavira
14	09/08/2013	36° 51.5641 N	8° 06.3967 W	36° 52.5043 N	8° 04.3080 W	08:56	09:26	104,07	103,62	00:30	00:01	1,921	R16	Quarteira
15	09/08/2013	36° 57.8074 N	8° 12.8953 W	36° 58.5202 N	8° 15.4957 W	13:30	14:01	52,57	50,04	00:31	01:00	2,202	R17	Albufeira
16	10/08/2013	36° 55.3374 N	8° 27.8494 W	36° 55.1391 N	8° 25.3438 W	08:09	08:39	106,72	103,76	00:30	01:03	2,019	R18	Alfanzina
17	11/08/2013	37° 01.9326 N	8° 44.5479 W	37° 02.0304 N	8° 45.1161 W	06:41	06:50	51,07	50,97	00:09	01:05	0,465	R20	Burgau

Table 2. *ECOCADIZ 0813* survey. Catches by species in number (upper panel) and weight (in kg, lower panel) from valid fishing stations.

Fishing station	ABUNDANCE (nº)										
	Anchovy	*Sardine*	*Chub mack.*	*Mackerel*	*Horse-mack.*	*Blue Jack-mack.*	*Medit. Horse-mack.*	*Bogue*	*Silvery lightfish*	Other spp.	TOTAL
01						29	17	30		10	**86**
02		441	264		367	300	302	27		65	**1766**
03	2628		1	8	18		2			290	**2947**
04	694	8469	6706		543	28	182	32		232	**16886**
05	4070	185	4519		231	12	1378	66		116	**10577**
06	6339			2	2	1			9	251	**6604**
07	8596	107	438	1	95	2	40	76		640	**9995**
08	350			5				1		100	**456**
09	7750		37	90						155	**8032**
10	5224		142	139		2			31835	174	**37516**
11	20663	2	81	19	2	4				69	**20840**
12		271	8717	44	852	1342		164		176	**11566**
13	12	234	7	31	30	1449		2		30	**1795**
14	8898		10	72	405	7				59	**9451**
15		404	3		484	16		186		66	**1159**
16	111	9	8056	60	7331	2066		357		95	**18085**
TOTAL	**65335**	**10122**	**28981**	**471**	**10360**	**5258**	**1921**	**941**	**31844**	**2528**	**157761**

Fishing station	BIOMASS (kg)										
	Anchovy	*Sardine*	*Chub mack*	*Mackerel*	*Horse-mack.*	*Blue Jack-mack.*	*Medit. Horse-mack.*	*Bogue*	*Silvery lightfish*	Other spp.	TOTAL
01						1,556	2,734	2,103		0,79	**7,183**
02		25,74	23,1		13,767	16,22	50,875	2,039		7,468	**139,209**
03	54,44		0,122	1,285	0,854		0,219			28,515	**85,435**
04	12,701	269,107	640,059		21,842	1,979	31,793	3,78		26,998	**1008,259**
05	56,034	6,862	476,077		8,804	0,794	247,517	8,361		12,221	**816,67**
06	108,547			0,268	0,015	0,023			0,004	19,955	**128,812**
07	93,6	4,496	72,7	0,256	3,546	0,161	7,15	12,4		26,188	**220,497**
08	6			1,078				0,119		8,251	**15,448**
09	172,16		5,222	10,7						20,88	**208,962**
10	117,24		18,2	22,08		0,136			22,34	15,672	**195,668**
11	461,477	0,127	10,352	3,236	0,033	0,196				6,297	**481,718**
12		16,884	719,557	16,613	34,13	65,851		16,003		18,219	**887,257**
13	0,331	13,61	0,546	5,446	1,553	74,94		0,171		5,51	**102,107**
14	237,798		1,358	10,683	19,167	0,446				6,219	**275,671**
15		24,78	0,358		21,226	0,976		12,425		14,724	**74,489**
16	3,248	0,434	894,281	10,075	371,554	115,802		35,812		13,085	**1444,291**
TOTAL	**1323,576**	**362,04**	**2861,932**	**81,72**	**496,491**	**279,08**	**340,288**	**93,213**	**22,344**	**230,992**	**6091,676**

Table 3. *ECOCADIZ 0813* survey. Anchovy (*E. encrasicolus*). Estimated abundance and biomass by size class. Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 6**.

***ECOCADIZ 0813* . *Engraulis encrasicolus* . ABUNDANCE (in number of fish).**								
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**TOTAL *n***	**Millions**
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	2108395	0	0	0	2108395	**2**
8	0	0	10541977	0	0	0	10541977	**11**
8,5	0	0	10541977	0	0	0	10541977	**11**
9	0	0	19015339	0	0	0	19015339	**19**
9,5	0	0	33774106	0	0	0	33774106	**34**
10	0	0	50641280	0	0	0	50641280	**51**
10,5	0	0	54897852	0	0	0	54897852	**55**
11	0	249819	59114625	0	0	0	59364444	**59**
11,5	0	499639	35882489	0	0	0	36382128	**36**
12	0	5959978	37990893	424102	0	0	44374973	**44**
12,5	1061277	9186217	14758767	2653834	0	0	27660095	**28**
13	3079196	8443898	8433580	6893501	1386595	0	28236770	**28**
13,5	6940750	2234100	4216790	12548190	7545128	0	33484958	**33**
14	8787371	1734461	0	13219247	12905746	2165248	38812073	**39**
14,5	7554796	499639	0	11312930	22877712	4759035	47004112	**47**
15	5626037	249819	0	6183753	18348680	11677680	42085969	**42**
15,5	3163653	0	0	3282773	11189921	13408748	31045095	**31**
16	452536	0	0	2388186	10320276	11243501	24404499	**24**
16,5	266812	0	0	791844	2967353	4324858	8350867	**8**
17	0	0	0	447198	1781239	2165248	4393685	**4**
17,5	0	0	0	148199	791469	434177	1373845	**1**
18	0	0	0	148199	0	0	148199	**0**
TOTAL *n*	36932428	29057570	341918070	60441956	90114119	50178495	608642638	**609**
Millions	**37**	**29**	**342**	**60**	**90**	**50**	**609**	

***ECOCADIZ 0813* . *Engraulis encrasicolus* . BIOMASS (t).**							
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**TOTAL**
6	0	0	0	0	0	0	**0**
6,5	0	0	0	0	0	0	**0**
7	0	0	0	0	0	0	**0**
7,5	0	0	5,404	0	0	0	**5,404**
8	0	0	33,139	0	0	0	**33,139**
8,5	0	0	40,162	0	0	0	**40,162**
9	0	0	86,862	0	0	0	**86,862**
9,5	0	0	183,227	0	0	0	**183,227**
10	0	0	323,487	0	0	0	**323,487**
10,5	0	0	409,706	0	0	0	**409,706**
11	0	2,163	511,807	0	0	0	**513,97**
11,5	0	4,986	358,082	0	0	0	**363,068**
12	0	68,149	434,407	4,849	0	0	**507,405**
12,5	13,829	119,703	192,318	34,581	0	0	**360,431**
13	45,496	124,762	124,609	101,854	20,487	0	**417,208**
13,5	115,742	37,255	70,318	209,251	125,821	0	**558,387**
14	164,67	32,503	0	247,721	241,846	40,575	**727,315**
14,5	158,453	10,479	0	237,276	479,834	99,815	**985,857**
15	131,575	5,842	0	144,618	429,116	273,103	**984,254**
15,5	82,21	0	0	85,305	290,779	348,437	**806,731**
16	13,023	0	0	68,729	297,004	323,573	**702,329**
16,5	8,478	0	0	25,16	94,283	137,415	**265,336**
17	0	0	0	15,642	62,303	75,735	**153,68**
17,5	0	0	0	5,691	30,392	16,672	**52,755**
18	0	0	0	6,231	0	0	**6,231**
TOTAL	**733,476**	**405,842**	**2773,528**	**1186,908**	**2071,865**	**1315,325**	**8486,944**

Table 4. *ECOCADIZ 0813* survey. Anchovy (*E. encrasicolus*). Estimated abundance (thousands of individuals) and biomass (tonnes) by age group. Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 6** and ordered from west to east.

Age class	POL06	POL05	POL03	POL04	POL02	POL01	TOTAL
	Number	Number	Number	Number	Number	Number	Number
0	0	140	167444	403	958	186	169131
I	35607	76721	161824	56519	28081	35140	393891
II	14572	13253	0	3520	19	1606	32970
III	0	0	0	0	0	0	0
TOTAL	50178	90114	329268	60442	29058	36932	595992

Age class	POL06	POL05	POL03	POL04	POL02	POL01	TOTAL
	Weight	Weight	Weight	Weight	Weight	Weight	Weight
0	0	2	1105	6	12	3	1128
I	889	1684	1630	1079	394	688	6364
II	426	386	0	102	0	42	957
III	0	0	0	0	0	0	0
TOTAL	1315	2072	2735	1187	406	733	8448

Table 5. *ECOCADIZ 0813* survey. Sardine (*S. pilchardus*). Estimated abundance and biomass by size class. Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 10**.

***ECOCADIZ 0813* . *Sardina pilchardus* . ABUNDANCE (in number of fish).**							
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**TOTAL *n***	**Millions**
8	0	0	0	0	0	0	**0**
8,5	0	0	0	0	0	0	**0**
9	0	0	0	0	0	0	**0**
9,5	0	0	0	0	0	0	**0**
10	0	0	0	0	0	0	**0**
10,5	0	0	0	0	0	0	**0**
11	0	0	36825	0	0	36825	**0**
11,5	0	0	184124	0	0	184124	**0**
12	0	3195967	405072	0	0	3601039	**4**
12,5	0	14275531	441897	0	0	14717428	**15**
13	294457	15866996	36825	0	0	16198278	**16**
13,5	147228	7274144	36825	0	0	7458197	**7**
14	147228	2811152	36825	0	0	2995205	**3**
14,5	147228	4960128	36825	0	0	5144181	**5**
15	1361863	4960128	36825	0	0	6358816	**6**
15,5	1509091	1651838	110474	0	1505941	4777344	**5**
16	2134811	4847806	110474	0	5722577	12815668	**13**
16,5	1509091	4078177	184124	0	15661787	21433179	**21**
17	1509091	4847806	405072	76766	37046166	43884901	**44**
17,5	1656320	3031445	184124	643122	21384367	26899378	**27**
18	1509091	4847806	368248	2203682	14155847	23084674	**23**
18,5	1361863	2918864	257773	2114660	18673667	25326827	**25**
19	1509091	1651838	331423	1552191	4216636	9261179	**9**
19,5	1214635	1267024	478722	809833	2710695	6480909	**6**
20	147228	0	184124	522010	0	853362	**1**
20,5	0	0	36825	76766	0	113591	**0**
21	0	0	36825	230298	0	267123	**0**
21,5	0	0	0	153532	0	153532	**0**
22	0	0	0	0	0	0	**0**
22,5	0	0	0	0	0	0	**0**
23	0	0	0	0	0	0	**0**
TOTAL *n*	16158316	82486650	3940251	8382860	121077683	232045760	**232**
Millions	**16**	**82**	**4**	**8**	**121**	**232**	

Table 5 (cont'd).

ECOCADIZ 0813 . *Sardina pilchardus* . BIOMASS (t).						
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**TOTAL**
8	0	0	0	0	0	**0**
8,5	0	0	0	0	0	**0**
9	0	0	0	0	0	**0**
9,5	0	0	0	0	0	**0**
10	0	0	0	0	0	**0**
10,5	0	0	0	0	0	**0**
11	0	0	0,414	0	0	**0,414**
11,5	0	0	2,376	0	0	**2,376**
12	0	47,122	5,972	0	0	**53,094**
12,5	0	239,166	7,403	0	0	**246,569**
13	5,578	300,575	0,698	0	0	**306,851**
13,5	3,139	155,101	0,785	0	0	**159,025**
14	3,519	67,183	0,88	0	0	**71,582**
14,5	3,928	132,342	0,983	0	0	**137,253**
15	40,418	147,209	1,093	0	0	**188,72**
15,5	49,648	54,344	3,635	0	49,544	**157,171**
16	77,606	176,229	4,016	0	208,03	**465,881**
16,5	60,434	163,317	7,374	0	627,202	**858,327**
17	66,386	213,259	17,819	3,377	1629,692	**1930,533**
17,5	79,825	146,097	8,874	30,995	1030,598	**1296,389**
18	79,476	255,31	19,394	116,057	745,518	**1215,755**
18,5	78,189	167,581	14,8	121,409	1072,112	**1454,091**
19	94,238	103,152	20,696	96,93	263,317	**578,333**
19,5	82,323	85,874	32,446	54,887	183,721	**439,251**
20	10,808	0	13,516	38,321	0	**62,645**
20,5	0	0	2,922	6,092	0	**9,014**
21	0	0	3,153	19,72	0	**22,873**
21,5	0	0	0	14,16	0	**14,16**
22	0	0	0	0	0	**0**
22,5	0	0	0	0	0	**0**
23	0	0	0	0	0	**0**
TOTAL	**735,515**	**2453,861**	**169,249**	**501,948**	**5809,734**	**9670,307**

Table 6. *ECOCADIZ 0813* survey. Chub mackerel (*S. colias*). Estimated abundance and biomass by size class. Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 13**.

***ECOCADIZ 0813* . *Scomber colias* . ABUNDANCE (in number of fish).**									
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**TOTAL *n***	**Millions**
13	0	0	0	0	0	0	0	0	**0**
13,5	0	0	0	0	0	0	0	0	**0**
14	0	0	0	0	0	0	0	0	**0**
14,5	0	0	0	0	0	0	0	0	**0**
15	0	0	0	0	0	0	0	0	**0**
15,5	0	0	0	0	0	0	0	0	**0**
16	0	0	0	0	0	0	0	0	**0**
16,5	0	0	0	0	0	0	0	0	**0**
17	0	0	0	0	0	0	0	0	**0**
17,5	0	0	0	0	0	0	0	0	**0**
18	0	0	0	0	0	0	0	0	**0**
18,5	0	0	0	0	0	0	0	0	**0**
19	0	0	0	0	0	7808826	0	7808826	**8**
19,5	0	0	0	0	0	19522061	874020	20396081	**20**
20	0	0	0	0	0	27312978	3053165	30366143	**30**
20,5	0	291024	0	0	0	14310211	5238217	19839452	**20**
21	3688690	589707	646142	0	0	9098356	13529596	27552491	**28**
21,5	15961106	2052485	161535	0	0	3904412	6549247	28628785	**29**
22	18412628	3224240	161535	0	0	13002768	7417359	42218530	**42**
22,5	17175463	2933216	323071	0	51422	13002768	3927185	37413125	**37**
23	10541533	6456139	484606	0	77133	14310211	4364195	36233817	**36**
23,5	4086622	3813948	928829	0	192858	6501385	874020	16397662	**16**
24	1968065	6157455	1251900	3274	204664	5211855	1311030	16108243	**16**
24,5	1354612	3224240	1574971	13096	216520	5211855	437010	12032304	**12**
25	1933855	2343510	1574971	11459	120603	5211855	0	11196253	**11**
25,5	1047885	880731	928829	13096	88989	3904412	0	6863942	**7**
26	0	880731	807677	14733	75133	2596971	0	4375245	**4**
26,5	0	1171755	928829	1637	45519	2596971	0	4744711	**5**
27	0	291024	2059578	1637	17807	1307441	0	3677487	**4**
27,5	0	291024	928829	1637	17807	1307441	0	2546738	**3**
28	0	0	928829	0	13856	0	0	942685	**1**
28,5	0	0	646142	0	0	0	0	646142	**1**
29	0	0	1090364	0	0	0	0	1090364	**1**
29,5	0	0	646142	0	0	0	0	646142	**1**
30	0	0	484606	0	0	0	0	484606	**0**
30,5	0	0	161535	0	0	0	0	161535	**0**
31	0	0	484606	0	0	0	0	484606	**0**
31,5	0	0	161535	0	0	0	0	161535	**0**
32	0	0	323071	0	0	0	0	323071	**0**
32,5	0	0	0	0	0	0	0	0	**0**
33	0	0	0	0	0	0	0	0	**0**
TOTAL *n*	76170459	34601229	17688132	60569	1122311	156122777	47575044	333340521	**333**
Millions	**76**	**35**	**18**	**0**	**1**	**156**	**48**	**333**	

Table 6 (cont'd)**.**

ECOCADIZ 0813 . *Scomber colias* . BIOMASS (t).								
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**TOTAL**
13	0	0	0	0	0	0	0	**0**
13,5	0	0	0	0	0	0	0	**0**
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	0	0	0	0	0	**0**
17	0	0	0	0	0	0	0	**0**
17,5	0	0	0	0	0	0	0	**0**
18	0	0	0	0	0	0	0	**0**
18,5	0	0	0	0	0	0	0	**0**
19	0	0	0	0	0	430,085	0	**430,085**
19,5	0	0	0	0	0	1166,571	52,228	**1218,799**
20	0	0	0	0	0	1767,2	197,545	**1964,745**
20,5	0	20,349	0	0	0	1000,579	366,26	**1387,188**
21	278,205	44,476	48,733	0	0	686,207	1020,416	**2078,037**
21,5	1296,215	166,684	13,118	0	0	317,081	531,87	**2324,968**
22	1607,392	281,471	14,102	0	0	1135,12	647,523	**3685,608**
22,5	1609,194	274,817	30,269	0	4,818	1218,248	367,944	**3505,29**
23	1058,353	648,186	48,654	0	7,744	1436,722	438,158	**3637,817**
23,5	439,015	409,722	99,782	0	20,718	698,426	93,894	**1761,557**
24	225,907	706,792	143,701	0,376	23,493	598,25	150,488	**1849,007**
24,5	165,918	394,917	192,908	1,604	26,52	638,368	53,527	**1473,762**
25	252,422	305,893	205,577	1,496	15,742	680,292	0	**1461,422**
25,5	145,579	122,357	129,039	1,819	12,363	542,427	0	**953,584**
26	0	130,074	119,285	2,176	11,096	383,544	0	**646,175**
26,5	0	183,758	145,661	0,257	7,138	407,264	0	**744,078**
27	0	48,408	342,582	0,272	2,962	217,475	0	**611,699**
27,5	0	51,29	163,695	0,289	3,138	230,421	0	**448,833**
28	0	0	173,261	0	2,585	0	0	**175,846**
28,5	0	0	127,445	0	0	0	0	**127,445**
29	0	0	227,186	0	0	0	0	**227,186**
29,5	0	0	142,085	0	0	0	0	**142,085**
30	0	0	112,365	0	0	0	0	**112,365**
30,5	0	0	39,459	0	0	0	0	**39,459**
31	0	0	124,609	0	0	0	0	**124,609**
31,5	0	0	43,687	0	0	0	0	**43,687**
32	0	0	91,826	0	0	0	0	**91,826**
32,5	0	0	0	0	0	0	0	**0**
33	0	0	0	0	0	0	0	**0**
TOTAL	**7078,2**	**3789,194**	**2779,029**	**8,289**	**138,317**	**13554,28**	**3919,853**	**31267,162**

Table 7. *ECOCADIZ 0813* survey. Blue jack-mackerel (*T. picturatus*). Estimated abundance and biomass by size class. Estimated abundance and biomass by size class. Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 15**.

***ECOCADIZ 0813* . *Trachurus picturatus* . ABUNDANCE (in number of fish).**						
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**TOTAL *n***	**Millions**
10	0	0	0	0	0	**0**
10,5	0	0	0	0	0	**0**
11	0	0	0	0	0	**0**
11,5	0	0	0	0	0	**0**
12	0	0	0	0	0	**0**
12,5	0	0	0	0	0	**0**
13	0	0	0	0	0	**0**
13,5	0	0	0	0	0	**0**
14	0	0	0	0	0	**0**
14,5	236152	0	0	0	236152	**0**
15	314869	0	0	0	314869	**0**
15,5	118076	574977	0	0	693053	**1**
16	551021	275989	0	0	827010	**1**
16,5	787172	5427785	0	167142	6382099	**6**
17	1456269	10280592	0	1177957	12914818	**13**
17,5	2322158	9153634	1022971	2515096	15013859	**15**
18	1456269	4852808	3568773	3693053	13570903	**14**
18,5	1653062	275989	6637684	3016524	11583259	**12**
19	1456269	0	4254628	3183667	8894564	**9**
19,5	669096	0	848601	2515096	4032793	**4**
20	551021	0	511485	167142	1229648	**1**
20,5	118076	0	0	0	118076	**0**
21	118076	0	0	0	118076	**0**
21,5	118076	0	0	0	118076	**0**
22	0	0	0	0	0	**0**
22,5	0	0	0	0	0	**0**
23	0	0	0	0	0	**0**
23,5	0	0	0	0	0	**0**
24	0	0	0	0	0	**0**
24,5	0	0	0	0	0	**0**
25	0	0	0	0	0	**0**
25,5	0	0	0	0	0	**0**
26	0	0	0	0	0	**0**
26,5	0	0	0	0	0	**0**
27	0	0	0	0	0	**0**
27,5	0	0	0	0	0	**0**
28	0	0	0	0	0	**0**
TOTAL *n*	11925662	30841774	16844142	16435677	76047255	**76**
Millions	**12**	**31**	**17**	**16**	**76**	

Table 7 (cont'd)**.**

ECOCADIZ 0813 . *Trachurus picturatus* . BIOMASS (t).					
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**TOTAL**
10	0	0	0	0	**0**
10,5	0	0	0	0	**0**
11	0	0	0	0	**0**
11,5	0	0	0	0	**0**
12	0	0	0	0	**0**
12,5	0	0	0	0	**0**
13	0	0	0	0	**0**
13,5	0	0	0	0	**0**
14	0	0	0	0	**0**
14,5	6,546	0	0	0	**6,546**
15	9,629	0	0	0	**9,629**
15,5	3,971	19,337	0	0	**23,308**
16	20,318	10,177	0	0	**30,495**
16,5	31,737	218,837	0	6,739	**257,313**
17	64,029	452,014	0	51,792	**567,835**
17,5	111,067	437,813	48,928	120,296	**718,104**
18	75,593	251,903	185,25	191,702	**704,448**
18,5	92,921	15,514	373,114	169,563	**651,112**
19	88,459	0	258,44	193,387	**540,286**
19,5	43,833	0	55,592	164,765	**264,19**
20	38,857	0	36,069	11,787	**86,713**
20,5	8,947	0	0	0	**8,947**
21	9,597	0	0	0	**9,597**
21,5	10,278	0	0	0	**10,278**
22	0	0	0	0	**0**
22,5	0	0	0	0	**0**
23	0	0	0	0	**0**
23,5	0	0	0	0	**0**
24	0	0	0	0	**0**
24,5	0	0	0	0	**0**
25	0	0	0	0	**0**
25,5	0	0	0	0	**0**
26	0	0	0	0	**0**
26,5	0	0	0	0	**0**
27	0	0	0	0	**0**
27,5	0	0	0	0	**0**
28	0	0	0	0	**0**
TOTAL	**615,782**	**1405,595**	**957,393**	**910,031**	**3888,801**

Table 8. *ECOCADIZ 0813* survey. Horse mackerel (*T. trachurus*). Estimated abundance and biomass by size class. Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 17**.

***ECOCADIZ 0813* . *Trachurus trachurus* . ABUNDANCE (in number of fish).**						
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**TOTAL *n***	**Millions**
10	0	0	0	0	0	**0**
10,5	0	36363	0	0	36363	**0**
11	0	36363	0	0	36363	**0**
11,5	0	327267	0	0	327267	**0**
12	0	363630	0	0	363630	**0**
12,5	0	1418157	0	0	1418157	**1**
13	0	690897	0	0	690897	**1**
13,5	0	290904	0	0	290904	**0**
14	0	145452	0	0	145452	**0**
14,5	50650	109089	0	0	159739	**0**
15	1002859	36363	207396	0	1246618	**1**
15,5	3245639	0	1055836	0	4301475	**4**
16	5978250	0	3808552	5588103	15374905	**15**
16,5	5255795	0	6335017	32632875	44223687	**44**
17	2518284	0	2545319	55828023	60891626	**61**
17,5	1142183	0	1055836	43941502	46139521	**46**
18	530503	0	641043	22613200	23784746	**24**
18,5	320713	0	414793	12189257	12924763	**13**
19	151951	0	0	4457895	4609846	**5**
19,5	50650	0	0	5619913	5670563	**6**
20	50650	0	0	3160522	3211172	**3**
20,5	50650	0	0	1828186	1878836	**2**
21	50650	0	0	0	50650	**0**
21,5	50650	0	0	0	50650	**0**
22	50650	0	0	0	50650	**0**
22,5	50650	0	0	0	50650	**0**
23	0	0	0	0	0	**0**
23,5	0	0	0	0	0	**0**
24	0	0	0	0	0	**0**
24,5	0	0	0	0	0	**0**
25	0	0	0	0	0	**0**
25,5	0	0	0	0	0	**0**
26	0	0	0	0	0	**0**
26,5	0	0	0	0	0	**0**
27	0	0	0	0	0	**0**
27,5	0	0	0	0	0	**0**
28	0	0	0	0	0	**0**
TOTAL *n*	20551377	3454485	16063792	187859476	227929130	**228**
Millions	**21**	**3**	**16**	**188**	**228**	

Table 8 (cont'd)**.**

ECOCADIZ 0813 . *Trachurus trachurus* . BIOMASS (t).					
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**TOTAL**
10	0	0	0	0	**0**
10,5	0	0,374	0	0	**0,374**
11	0	0,43	0	0	**0,43**
11,5	0	4,416	0	0	**4,416**
12	0	5,572	0	0	**5,572**
12,5	0	24,551	0	0	**24,551**
13	0	13,449	0	0	**13,449**
13,5	0	6,34	0	0	**6,34**
14	0	3,535	0	0	**3,535**
14,5	1,367	2,945	0	0	**4,312**
15	29,973	1,087	6,198	0	**37,258**
15,5	107,032	0	34,818	0	**141,85**
16	216,86	0	138,155	202,708	**557,723**
16,5	209,114	0	252,053	1298,374	**1759,541**
17	109,599	0	110,776	2429,711	**2650,086**
17,5	54,235	0	50,135	2086,518	**2190,888**
18	27,418	0	33,131	1168,699	**1229,248**
18,5	17,999	0	23,279	684,095	**725,373**
19	9,241	0	0	271,098	**280,339**
19,5	3,331	0	0	369,563	**372,894**
20	3,595	0	0	224,301	**227,896**
20,5	3,872	0	0	139,765	**143,637**
21	4,164	0	0	0	**4,164**
21,5	4,47	0	0	0	**4,47**
22	4,791	0	0	0	**4,791**
22,5	5,127	0	0	0	**5,127**
23	0	0	0	0	**0**
23,5	0	0	0	0	**0**
24	0	0	0	0	**0**
24,5	0	0	0	0	**0**
25	0	0	0	0	**0**
25,5	0	0	0	0	**0**
26	0	0	0	0	**0**
26,5	0	0	0	0	**0**
27	0	0	0	0	**0**
27,5	0	0	0	0	**0**
28	0	0	0	0	**0**
TOTAL	**812,188**	**62,699**	**648,545**	**8874,832**	**10398,264**

Table 9. *ECOCADIZ 0813* survey. Mediterranean horse-mackerel (*T. mediterraneus*). Estimated abundance and biomass by size class. Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 19**.

***ECOCADIZ 0813* . *Trachurus mediterraneus* . ABUNDANCE (in number of fish).**					
Size class	**POL01**	**POL02**	**POL03**	**TOTAL *n***	**Millions**
10	0	0	0	0	**0**
10,5	0	0	0	0	**0**
11	0	0	0	0	**0**
11,5	0	0	0	0	**0**
12	0	0	0	0	**0**
12,5	0	0	0	0	**0**
13	0	0	0	0	**0**
13,5	0	0	0	0	**0**
14	0	0	0	0	**0**
14,5	0	0	0	0	**0**
15	0	0	0	0	**0**
15,5	0	0	0	0	**0**
16	0	0	0	0	**0**
16,5	0	0	0	0	**0**
17	0	0	35982	35982	**0**
17,5	0	0	71963	71963	**0**
18	0	0	107945	107945	**0**
18,5	0	0	215890	215890	**0**
19	0	0	179908	179908	**0**
19,5	0	0	215890	215890	**0**
20	0	0	143926	143926	**0**
20,5	0	0	179908	179908	**0**
21	0	0	71963	71963	**0**
21,5	0	0	71963	71963	**0**
22	0	0	35982	35982	**0**
22,5	0	148192	35982	184174	**0**
23	0	148192	35982	184174	**0**
23,5	0	148192	35982	184174	**0**
24	0	296384	0	296384	**0**
24,5	0	444575	0	444575	**0**
25	0	740959	0	740959	**1**
25,5	77257	862791	0	940048	**1**
26	154515	503055	0	657570	**1**
26,5	347658	1699278	0	2046936	**2**
27	849830	1307367	0	2157197	**2**
27,5	849830	1229179	0	2079009	**2**
28	1506517	1298293	0	2804810	**3**
28,5	1738290	1420126	0	3158416	**3**
29	927088	1239814	0	2166902	**2**
29,5	270400	906436	0	1176836	**1**
30	270400	302145	0	572545	**1**
30,5	231772	180313	0	412085	**0**
31	154515	180313	0	334828	**0**
31,5	231772	121833	0	353605	**0**
32	154515	58480	0	212995	**0**
32,5	0	58480	0	58480	**0**
33	77257	58480	0	135737	**0**
33,5	77257	58480	0	135737	**0**
34	115886	0	0	115886	**0**
34,5	695316	0	0	695316	**1**
35	1004345	0	0	1004345	**1**
35,5	965716	0	0	965716	**1**
36	424915	0	0	424915	**0**
36,5	309029	0	0	309029	**0**
37	77257	0	0	77257	**0**
37,5	77257	0	0	77257	**0**
38	38629	0	0	38629	**0**
38,5	0	0	0	0	**0**
39	0	0	0	0	**0**
TOTAL *n*	11627223	13411357	1439266	26477846	**26**
Millions	**12**	**13**	**1**	**26**	

Table 9 (cont'd).

ECOCADIZ 0813 . *Trachurus mediterraneus* . BIOMASS (t).				
Size class	**POL01**	**POL02**	**POL03**	**TOTAL**
10	0	0	0	**0**
10,5	0	0	0	**0**
11	0	0	0	**0**
11,5	0	0	0	**0**
12	0	0	0	**0**
12,5	0	0	0	**0**
13	0	0	0	**0**
13,5	0	0	0	**0**
14	0	0	0	**0**
14,5	0	0	0	**0**
15	0	0	0	**0**
15,5	0	0	0	**0**
16	0	0	0	**0**
16,5	0	0	0	**0**
17	0	0	1,522	**1,522**
17,5	0	0	3,298	**3,298**
18	0	0	5,348	**5,348**
18,5	0	0	11,539	**11,539**
19	0	0	10,353	**10,353**
19,5	0	0	13,349	**13,349**
20	0	0	9,546	**9,546**
20,5	0	0	12,777	**12,777**
21	0	0	5,464	**5,464**
21,5	0	0	5,832	**5,832**
22	0	0	3,108	**3,108**
22,5	0	13,623	3,308	**16,931**
23	0	14,48	3,516	**17,996**
23,5	0	15,37	3,732	**19,102**
24	0	32,589	0	**32,589**
24,5	0	51,764	0	**51,764**
25	0	91,25	0	**91,25**
25,5	10,052	112,26	0	**122,312**
26	21,218	69,081	0	**90,299**
26,5	50,336	246,03	0	**296,366**
27	129,602	199,378	0	**328,98**
27,5	136,382	197,26	0	**333,642**
28	254,183	219,051	0	**473,234**
28,5	308,08	251,691	0	**559,771**
29	172,449	230,62	0	**403,069**
29,5	52,746	176,816	0	**229,562**
30	55,27	61,759	0	**117,029**
30,5	49,603	38,59	0	**88,193**
31	34,599	40,376	0	**74,975**
31,5	54,261	28,523	0	**82,784**
32	37,794	14,304	0	**52,098**
32,5	0	14,935	0	**14,935**
33	20,587	15,583	0	**36,17**
33,5	21,467	16,249	0	**37,716**
34	33,556	0	0	**33,556**
34,5	209,687	0	0	**209,687**
35	315,262	0	0	**315,262**
35,5	315,35	0	0	**315,35**
36	144,265	0	0	**144,265**
36,5	109,029	0	0	**109,029**
37	28,31	0	0	**28,31**
37,5	29,389	0	0	**29,389**
38	15,247	0	0	**15,247**
38,5	0	0	0	**0**
39	0	0	0	**0**
TOTAL	**2608,724**	**2151,582**	**92,692**	**4852,998**

Table 10. *ECOCADIZ 0813* survey. Bogue (*B. boops*). Estimated abundance and biomass by size class. Estimated abundance and biomass by size class. Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 21**.

***ECOCADIZ 0813* . *Boops boops* . ABUNDANCE (in number of fish).**							
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**TOTAL *n***	**Millions**
10	0	0	0	0	0	0	**0**
10,5	0	0	38941	0	0	38941	**0**
11	0	0	38941	0	0	38941	**0**
11,5	0	0	38941	0	0	38941	**0**
12	0	0	155764	0	0	155764	**0**
12,5	46357	0	155764	0	0	202121	**0**
13	92714	0	389411	0	0	482125	**0**
13,5	139071	0	389411	0	0	528482	**1**
14	92714	0	311528	0	0	404242	**0**
14,5	46357	0	233646	0	0	280003	**0**
15	185428	0	194705	0	0	380133	**0**
15,5	231785	0	194705	0	0	426490	**0**
16	231785	0	116823	0	0	348608	**0**
16,5	139071	0	194705	0	0	333776	**0**
17	185428	0	350469	0	0	535897	**1**
17,5	0	0	116823	91682	0	208505	**0**
18	0	0	38941	183363	0	222304	**0**
18,5	0	0	0	91682	0	91682	**0**
19	0	0	0	275045	0	275045	**0**
19,5	0	0	0	275045	3139387	3414432	**3**
20	0	50136	0	531753	2052676	2634565	**3**
20,5	0	74082	0	183363	2052676	2310121	**2**
21	0	98027	0	348390	12316057	12762474	**13**
21,5	0	148163	0	183363	7244742	7576268	**8**
22	0	139932	0	275045	9297417	9712394	**10**
22,5	0	121973	0	183363	2052676	2358012	**2**
23	0	98027	0	275045	1086711	1459783	**1**
23,5	0	71837	0	91682	2052676	2216195	**2**
24	0	0	0	91682	1086711	1178393	**1**
24,5	0	0	0	0	1086711	1086711	**1**
25	0	0	0	0	0	0	**0**
25,5	0	0	0	0	0	0	**0**
26	0	0	0	0	0	0	**0**
26,5	0	0	0	0	0	0	**0**
27	0	0	0	0	0	0	**0**
27,5	0	0	0	0	0	0	**0**
28	0	0	0	0	0	0	**0**
TOTAL *n*	1390710	802177	2959518	3080503	43468440	51701348	**52**
Millions	**1**	**1**	**3**	**3**	**43**	**52**	

Table 10 (cont'd)**.**

ECOCADIZ 0813 . *Boops boops* . BIOMASS (t).						
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**TOTAL**
10	0	0	0	0	0	**0**
10,5	0	0	0,467	0	0	**0,467**
11	0	0	0,535	0	0	**0,535**
11,5	0	0	0,609	0	0	**0,609**
12	0	0	2,757	0	0	**2,757**
12,5	0,924	0	3,105	0	0	**4,029**
13	2,072	0	8,703	0	0	**10,775**
13,5	3,47	0	9,716	0	0	**13,186**
14	2,572	0	8,644	0	0	**11,216**
14,5	1,425	0	7,183	0	0	**8,608**
15	6,294	0	6,609	0	0	**12,903**
15,5	8,659	0	7,274	0	0	**15,933**
16	9,502	0	4,789	0	0	**14,291**
16,5	6,239	0	8,735	0	0	**14,974**
17	9,078	0	17,159	0	0	**26,237**
17,5	0	0	6,227	4,887	0	**11,114**
18	0	0	2,254	10,614	0	**12,868**
18,5	0	0	0	5,751	0	**5,751**
19	0	0	0	18,657	0	**18,657**
19,5	0	0	0	20,135	229,821	**249,956**
20	0	3,953	0	41,93	161,86	**207,743**
20,5	0	6,281	0	15,546	174,031	**195,858**
21	0	8,92	0	31,704	1120,763	**1161,387**
21,5	0	14,448	0	17,88	706,459	**738,787**
22	0	14,599	0	28,695	969,986	**1013,28**
22,5	0	13,594	0	20,436	228,776	**262,806**
23	0	11,655	0	32,701	129,202	**173,558**
23,5	0	9,098	0	11,612	259,981	**280,691**
24	0	0	0	12,354	146,43	**158,784**
24,5	0	0	0	0	155,588	**155,588**
25	0	0	0	0	0	**0**
25,5	0	0	0	0	0	**0**
26	0	0	0	0	0	**0**
26,5	0	0	0	0	0	**0**
27	0	0	0	0	0	**0**
27,5	0	0	0	0	0	**0**
28	0	0	0	0	0	**0**
TOTAL	**50,235**	**82,548**	**94,766**	**272,902**	**4282,897**	**4783,348**

Table 11. *ECOCADIZ 0813* survey. Parameters of the size-weight relationships for survey's target species. Mackerel was not acoustically assessed because of the negligible backscattering energy attributed to the species. FAO codes for the species: PIL: *Sardina pilchardus*; ANE: *Engraulis encrasicolus*; MAS: *Scomber colias*; MAC: *Scomber scombrus*; JAA: *Trachurus picturatus;* HOM: *Trachurus trachurus*; BOG: *Boops boops*; HMM: *Trachurus mediterraneus*.

Parameter	PIL	ANE	MAS	MAC	JAA	HOM	HMM	BOG
n	347	555	443	213	266	439	228	260
a	0,0049376	0,0031904	0,0045302	0,0019810	0,0099823	0,0073594	0,0143861	0,0103193
b	3,1936283	3,2664826	3,1802800	3,3993235	2,9462604	3,0497220	2,8043959	2,9723640
r^2	0,98	0,95	0,97	0,95	0,95	0,91	0,99	0,97

Table 12. *ECOCADIZ 0813* survey. Comparison of anchovy (ANE) and sardine (PIL) acoustic estimates from the present survey with those ones derived from the same area during the *ECOCADIZ-RECLUTAS 1112* (10 -27 November 2012) *PELAGO13* (5 April – 15 May 2013) surveys. ALG: Portuguese (Algarve) waters; CAD: Spanish waters. Sardine estimates from the post-stratum 4 in the *ECOCADIZ 0813* survey (shared between Portuguese and Spanish waters) have been equally allocated between both countries for the purposes of this table.

ESTIMATE	SURVEY	ANE			PIL		
		ALG	CAD	TOTAL	ALG	CAD	TOTAL
ABUNDANCE (Millions)	*ECOCADIZ-R 1112*	?	2649	?	?	603	?
	PELAGO 13	262	634	897	197	493	690
	ECOCADIZ 0813	50	558	609	125	107	232
BIOMASS (t)	*ECOCADIZ-R 1112*	?	13680	?	?	22119	?
	PELAGO 13	5044	7656	12700	9492	21049	30541
	ECOCADIZ 0813	1315	7172	8487	6061	3609	9670

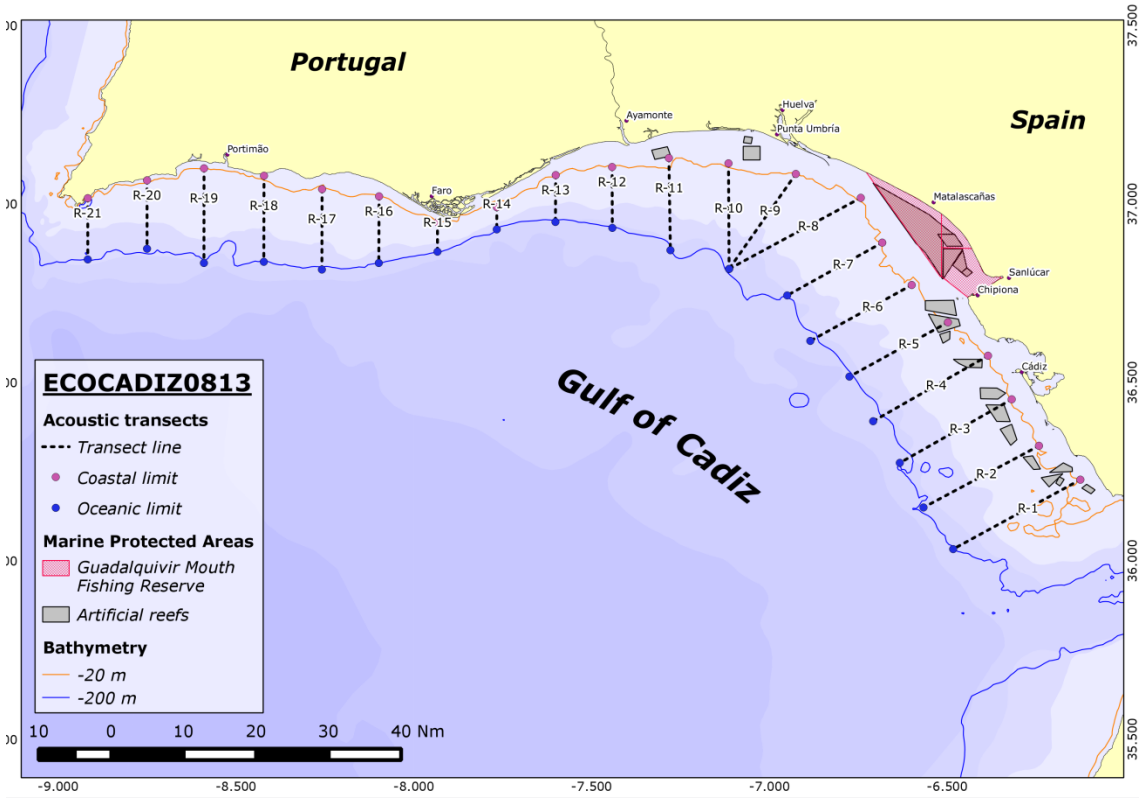

Figure 1. *ECOCADIZ 0813* survey. Location of the acoustic transects sampled during the survey. The different protected areas inside the Guadalquivir river mouth Fishing Reserve and artificial reef polygons are also shown.

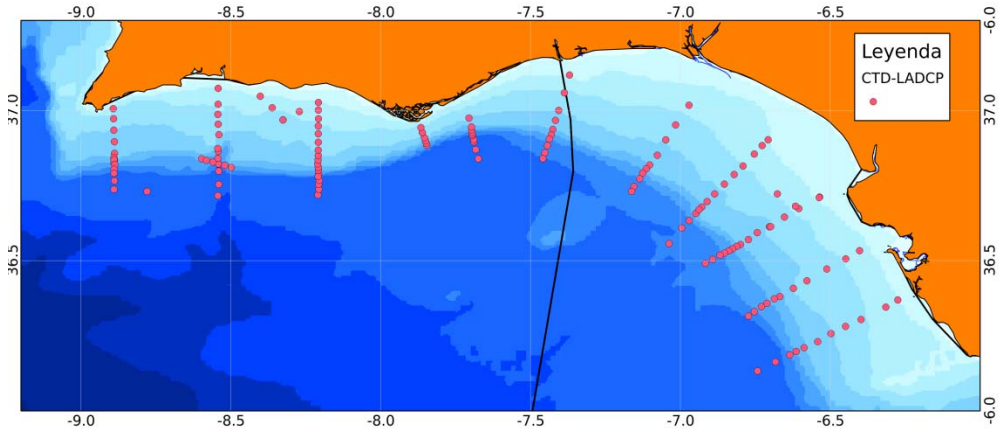

Figure 2. *ECOCADIZ 0813* survey. Sampling grid of CTD stations.

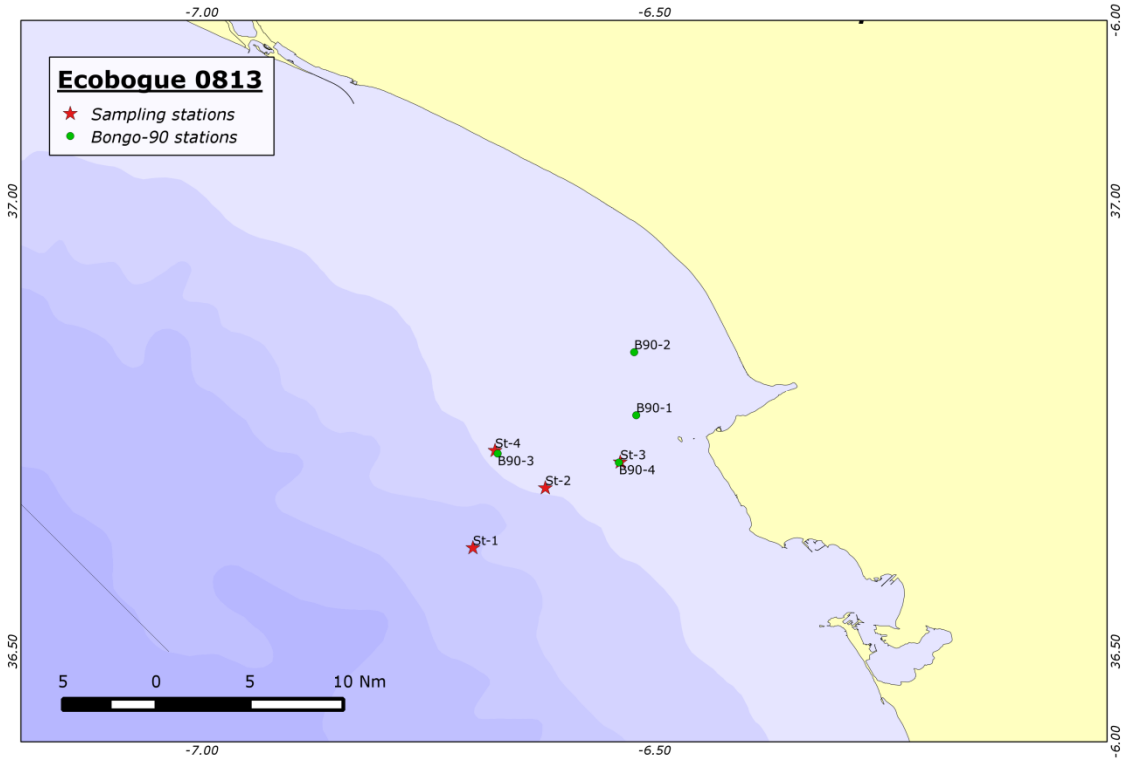

Figure 3. ***ECOCADIZ 0813.*** Location of the *ECOBOGUE* research project sampling stations.

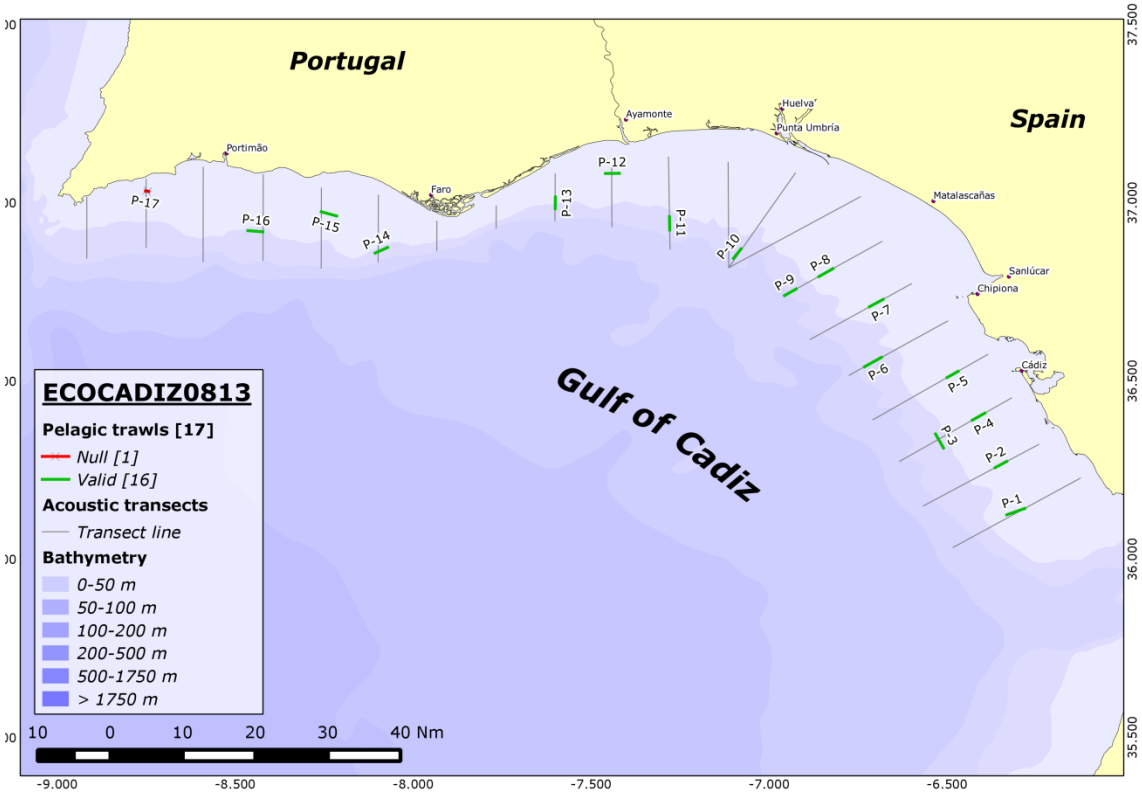

Figure 4. ***ECOCADIZ 0813.*** Location of groundtruthing fishing hauls. Null hauls in red.

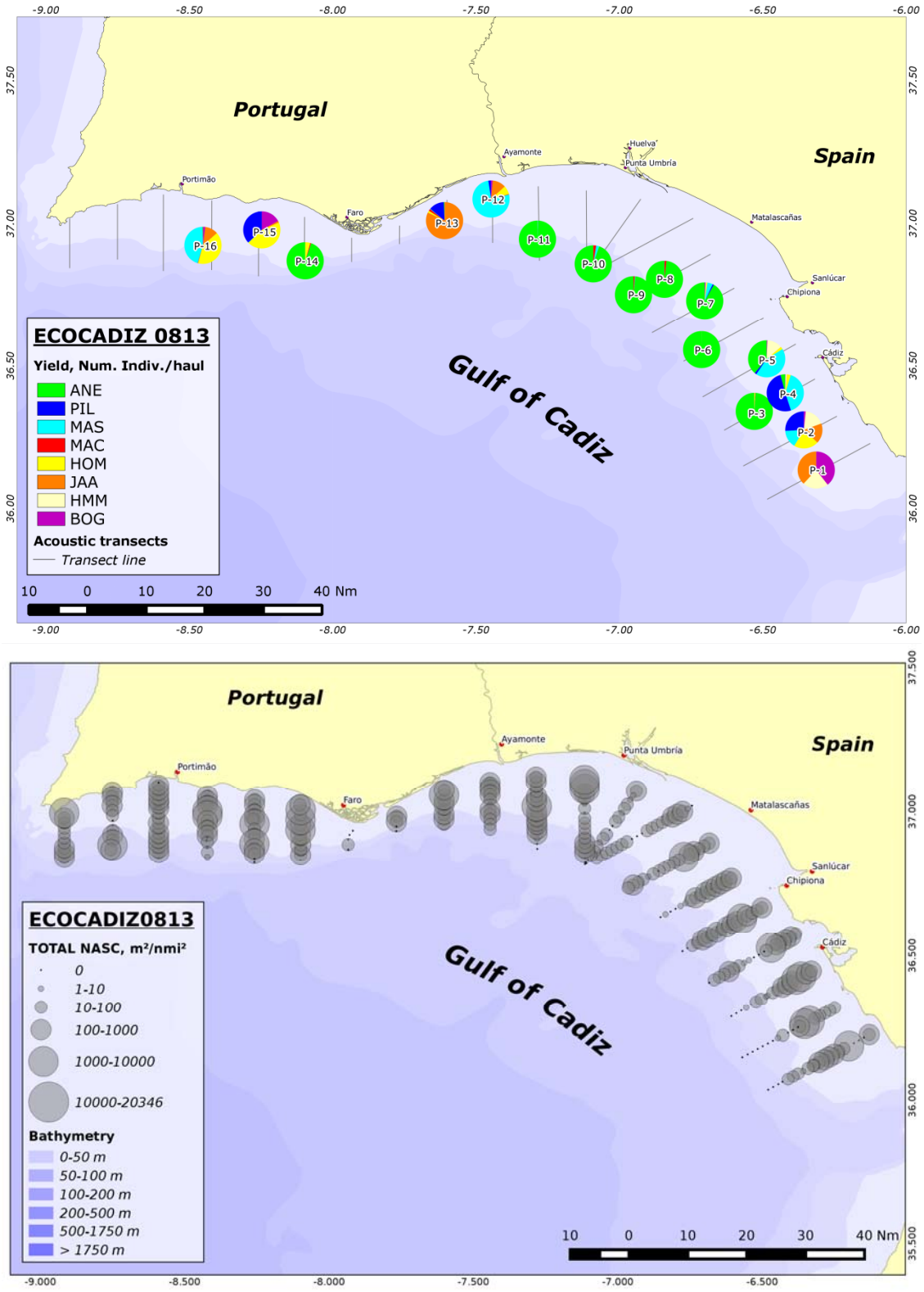

Figure 5. *ECOCADIZ 0813* survey. Top: species composition (percentages in number) in fishing hauls. Bottom: Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the pelagic fish species assemblage.

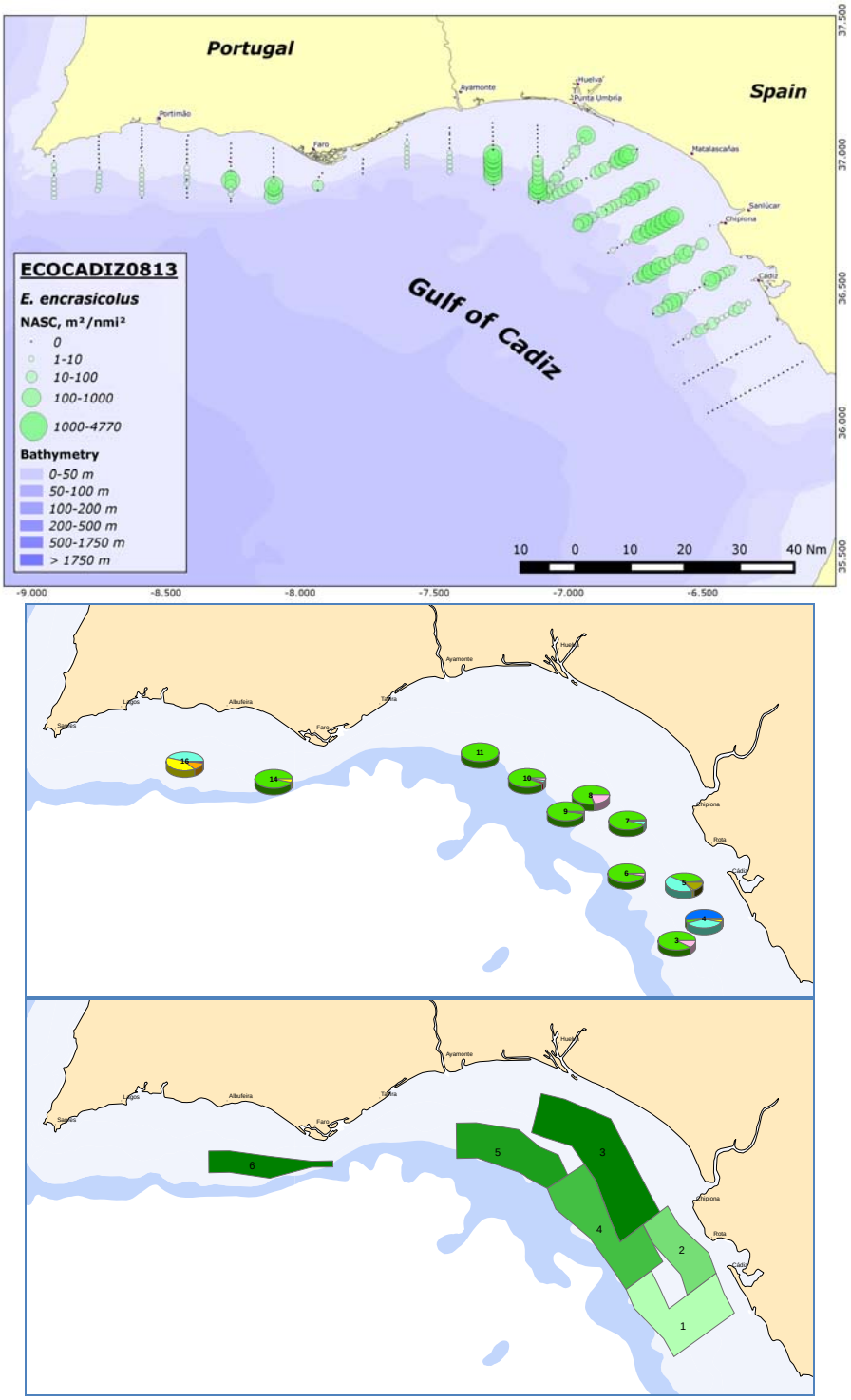

Figure 6. *ECOCADIZ 0813* survey. Anchovy (*Engraulis encrasicolus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Middle: valid fishing hauls for the species (more than 30 individuals showing a normal distribution). 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. Bottom right: distribution of anchovy egg densities (eggs 100 m^{-3}) as sampled by CUFES.

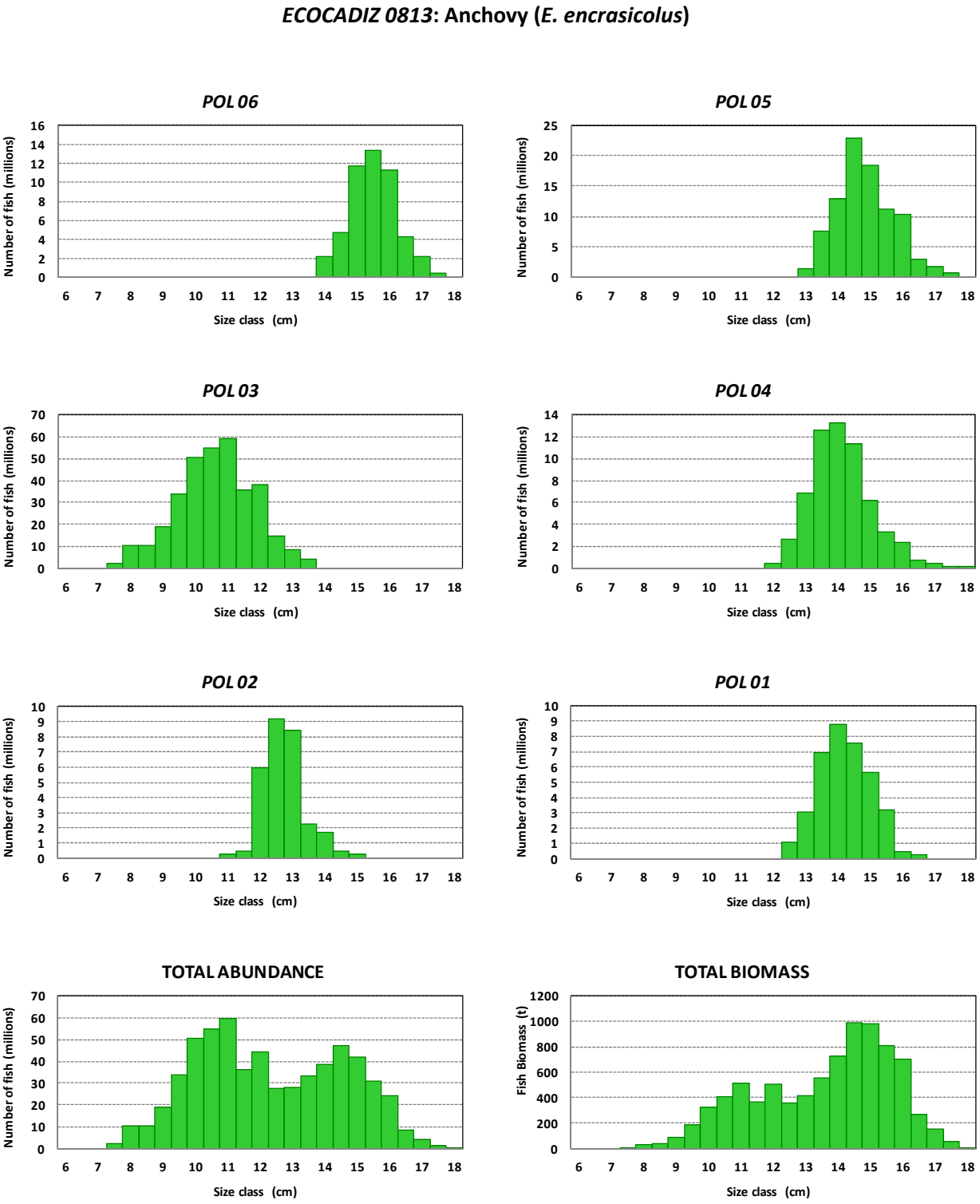

Figure 7. *ECOCADIZ 0813* survey. Anchovy (*E. encrasicolus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 6**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

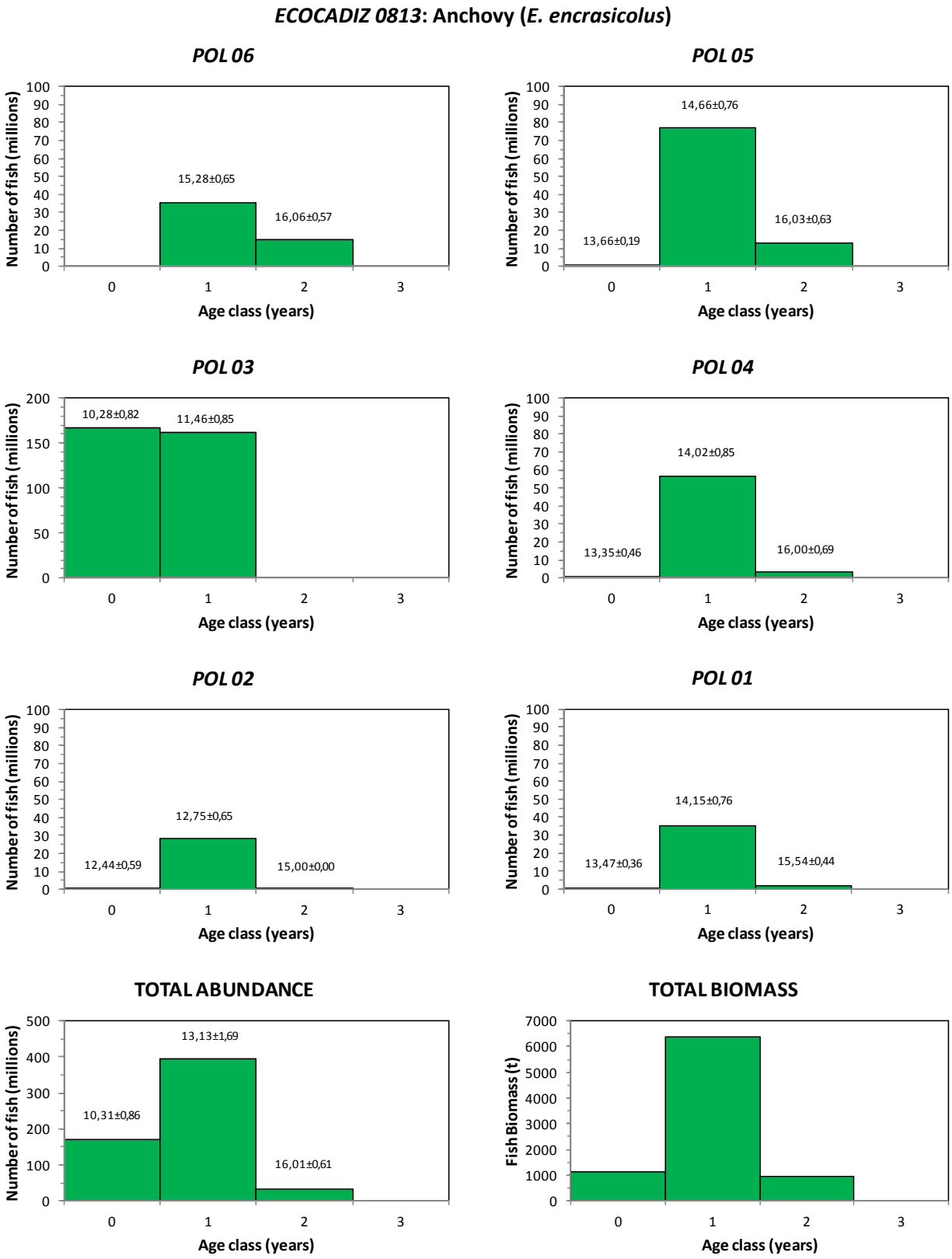

Figure 8. *ECOCADIZ 0813* survey. Anchovy (*E. encrasicolus*). Estimated abundances (number of fish in millions) by age class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 6**) and total sampled area. Post-strata ordered in the W-E direction. Mean length (±SD) by age group is also shown.The estimated biomass (t) by age class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

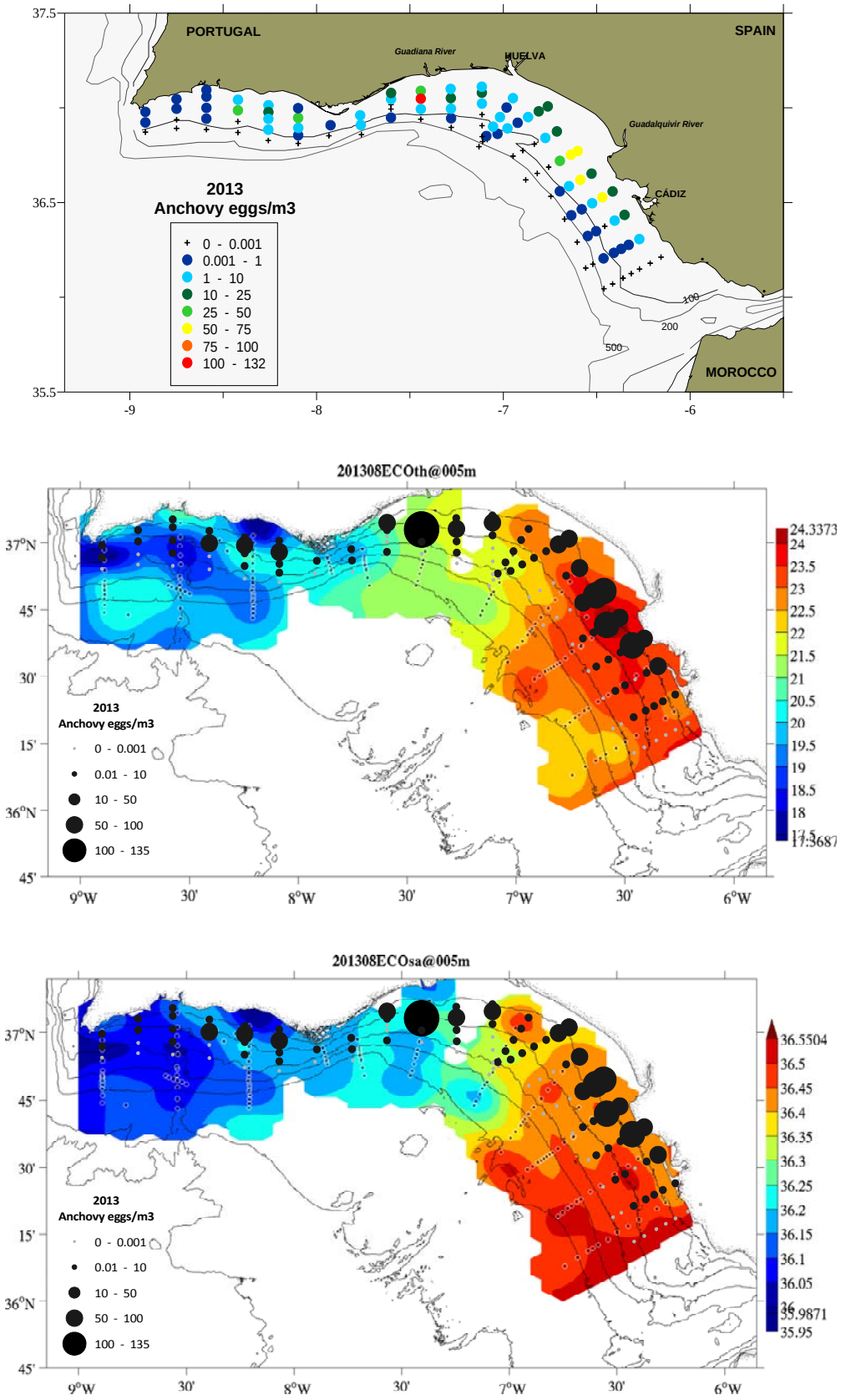

Figure 9. *ECOCADIZ 0813* survey. Anchovy (*Engraulis encrasicolus*). Distribution of anchovy egg densities (eggs m^{-3}) as sampled by CUFES. Middle and bottom panels show the same egg distribution superimposed to the distribution of sea temperature and salinity at 5 m depth respectively.

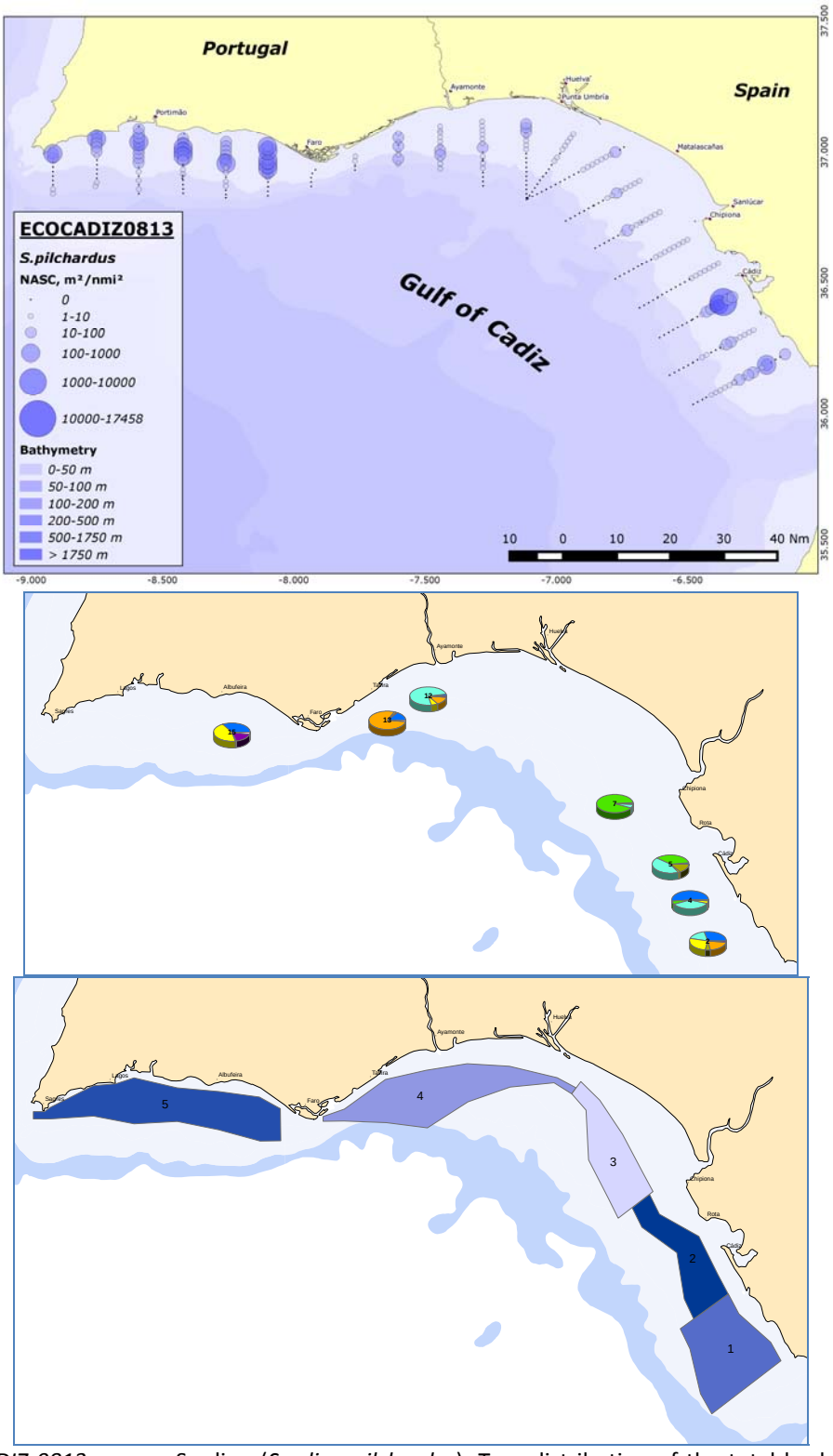

Figure 10. *ECOCADIZ 0813* survey. Sardine (*Sardina pilchardus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Middle: valid fishing hauls for the species (more than 30 individuals showing a normal distribution). 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.

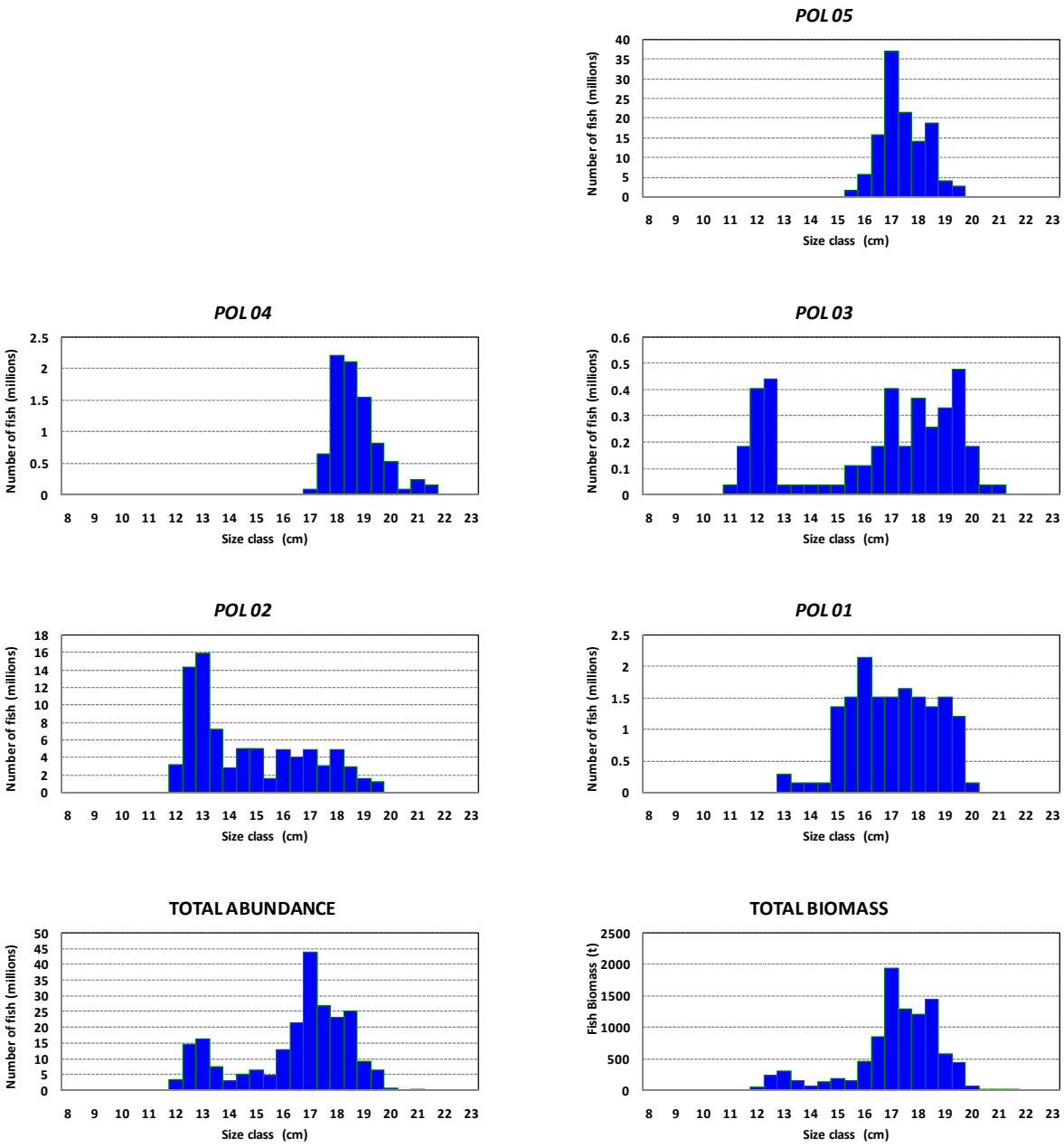

Figure 11. *ECOCADIZ 0813* survey. Sardine (*S. pilchardus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 10**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

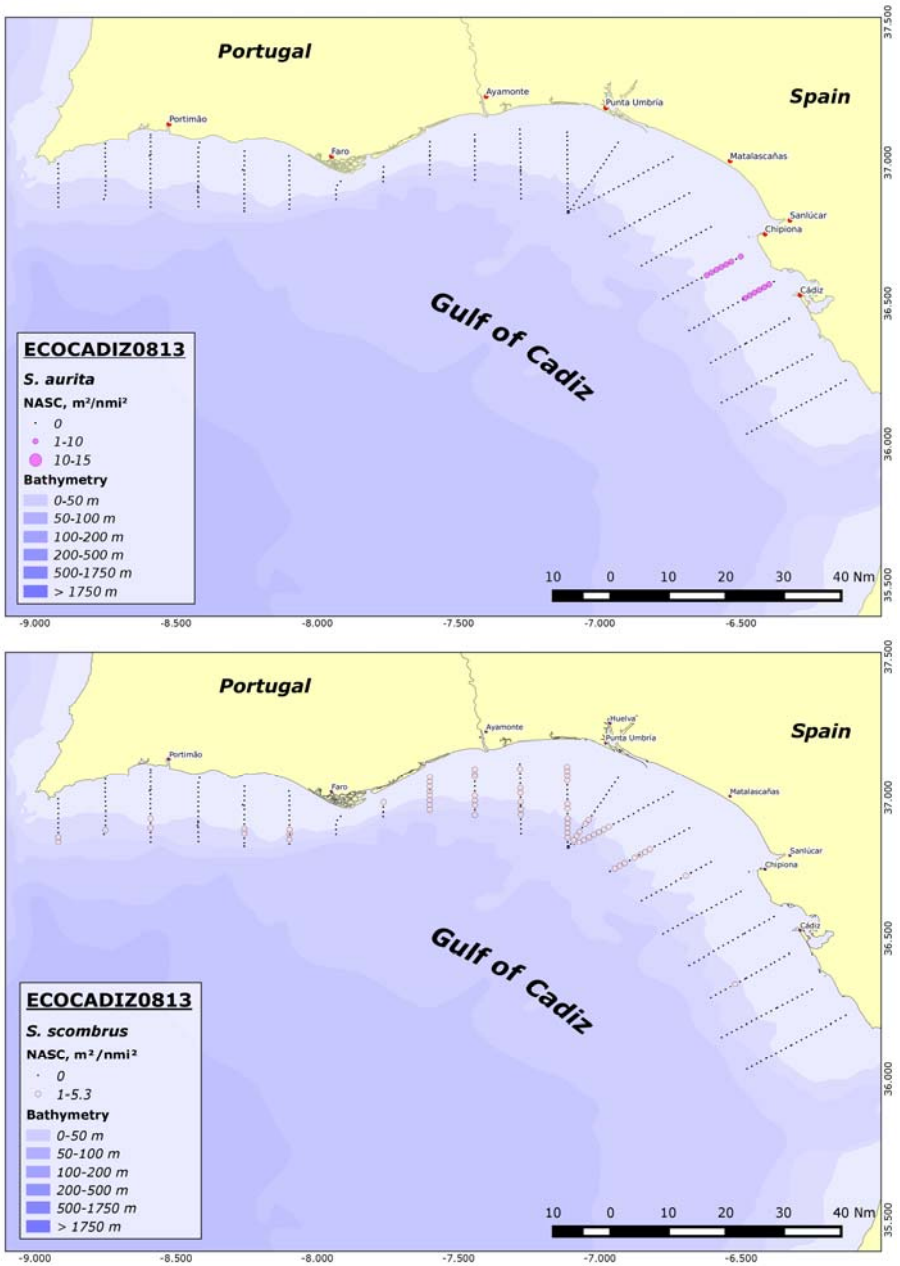

Figure 12. *ECOCADIZ 0813* survey. Round sardinella (*Sardinella aurita*) and Mackerel (*Scomber scombrus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

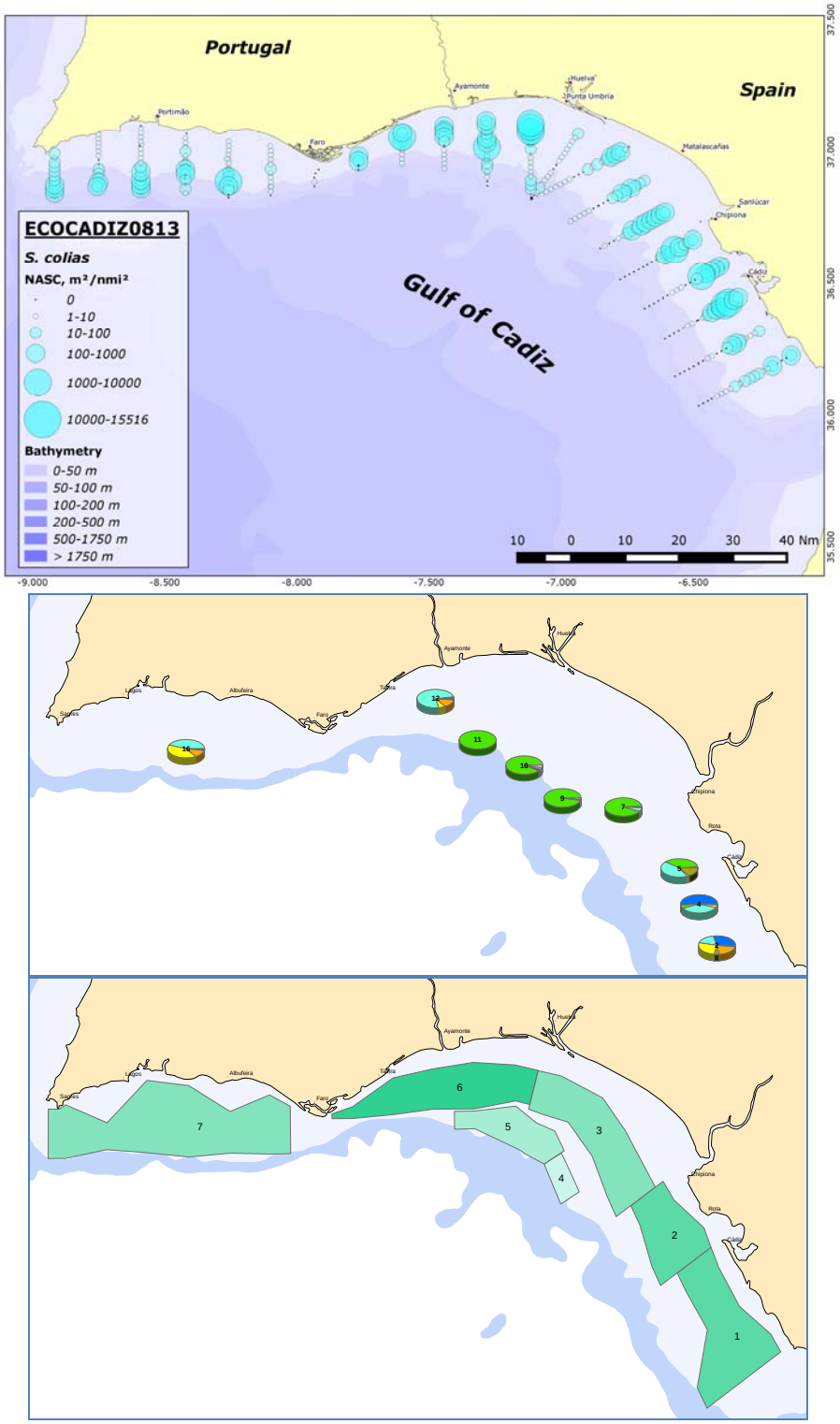

Figure 13. *ECOCADIZ 0813* survey. Chub mackerel (*Scomber colias*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Middle: valid fishing hauls for the species (more than 30 individuals showing a normal distribution). 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.

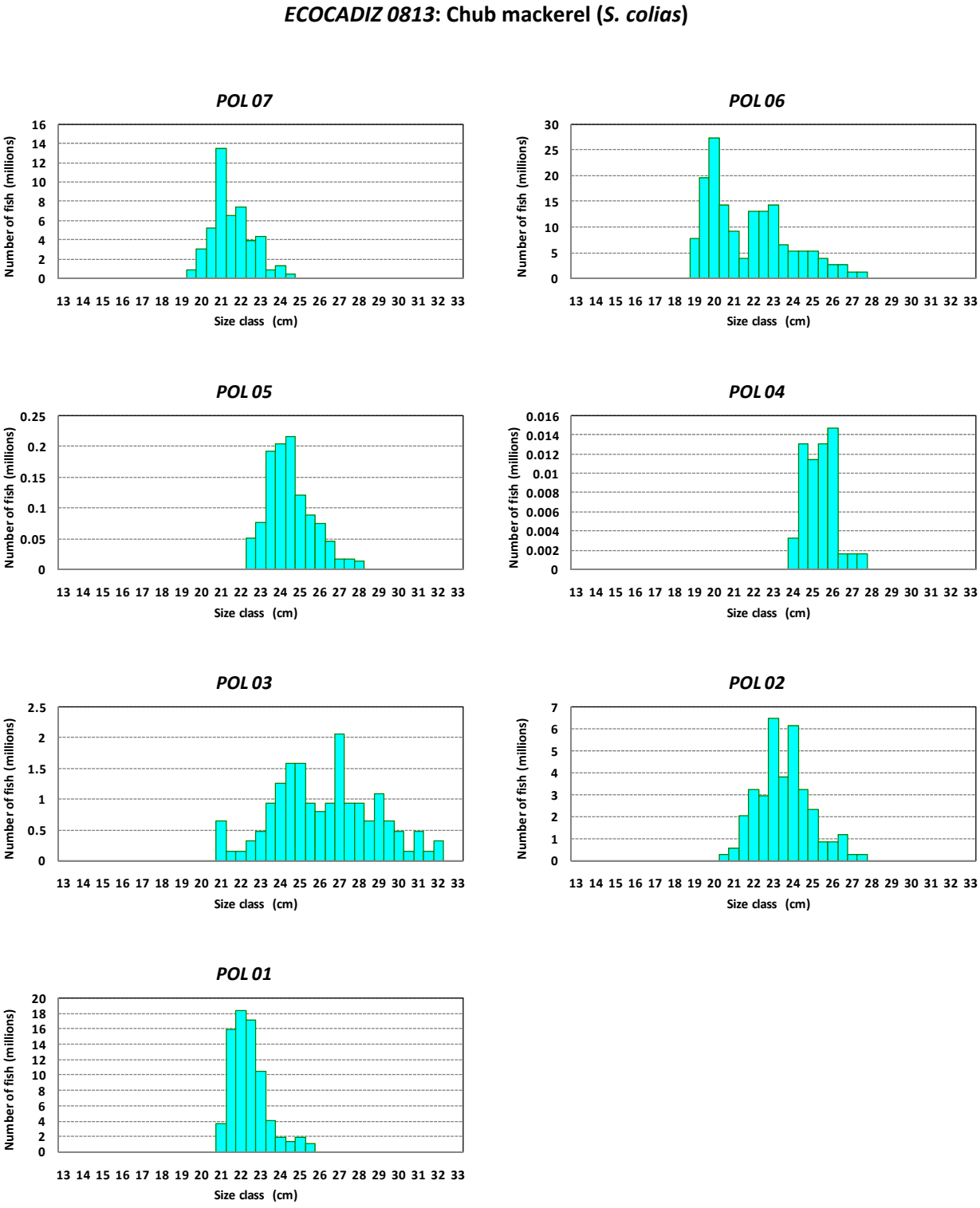

Figure 14. *ECOCADIZ 0813* survey. Chub mackerel (*S. colias*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 13**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

***ECOCADIZ 0813*: Chub mackerel (*S. colias*)**

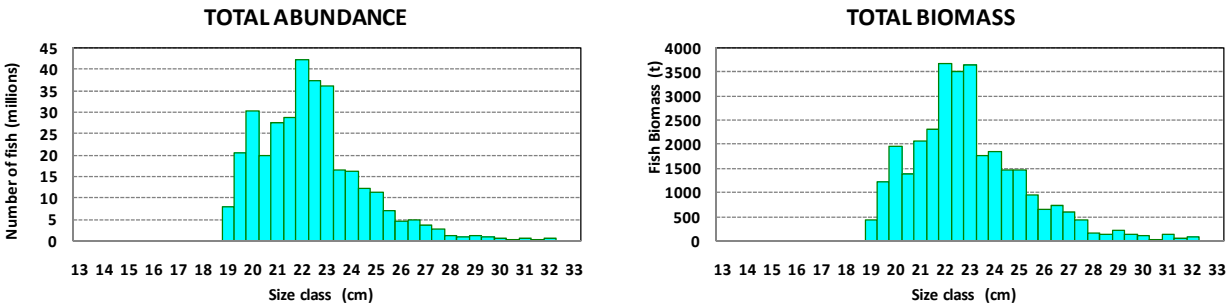

Figure 14. *ECOCADIZ 0813* survey. Chub mackerel (*S. colias*). Cont'd.

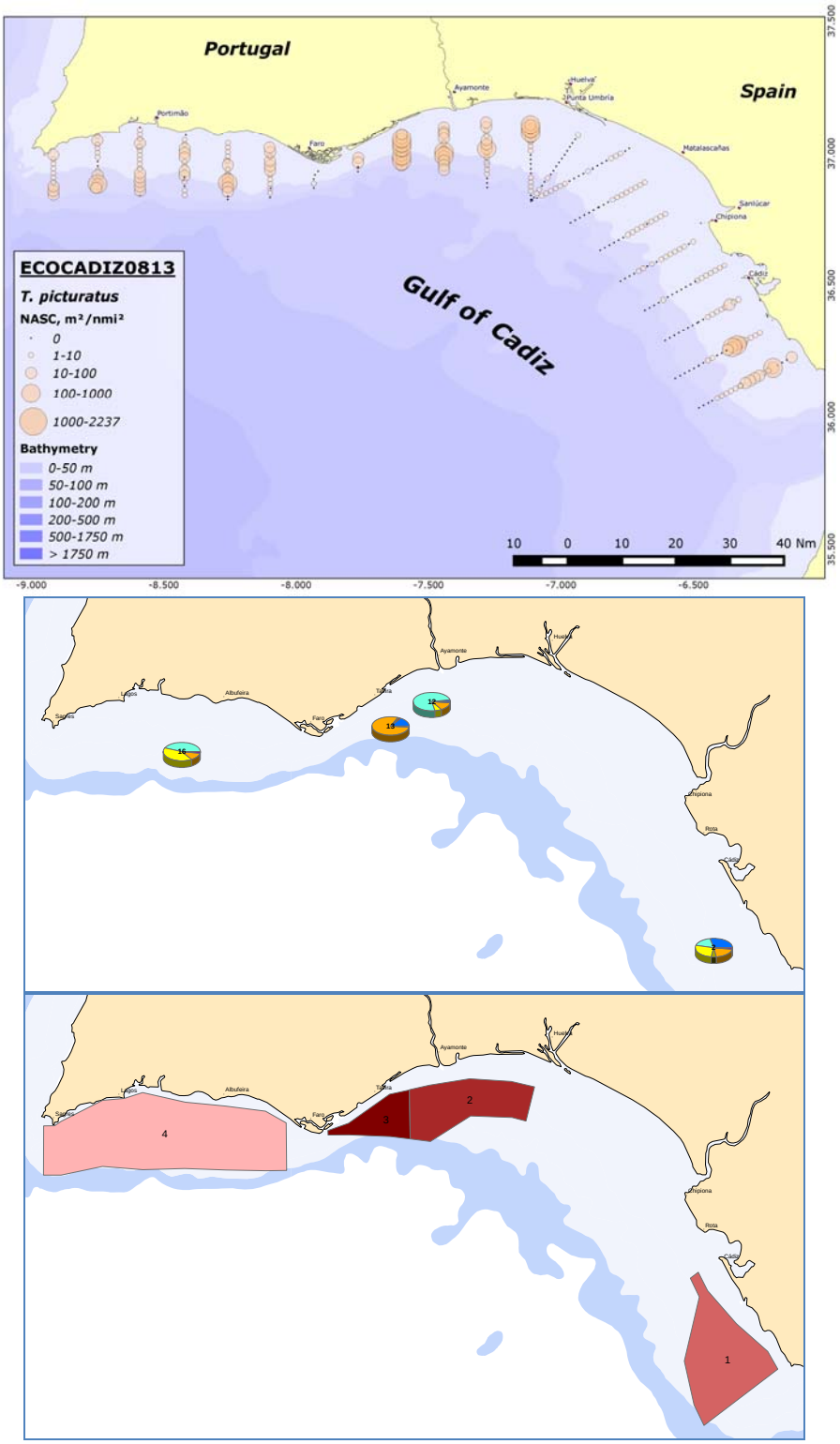

Figure 15. *ECOCADIZ 0813* survey. Blue jack mackerel (*Trachurus picturatus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Middle: valid fishing hauls for the species (more than 30 individuals showing a normal distribution). 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.

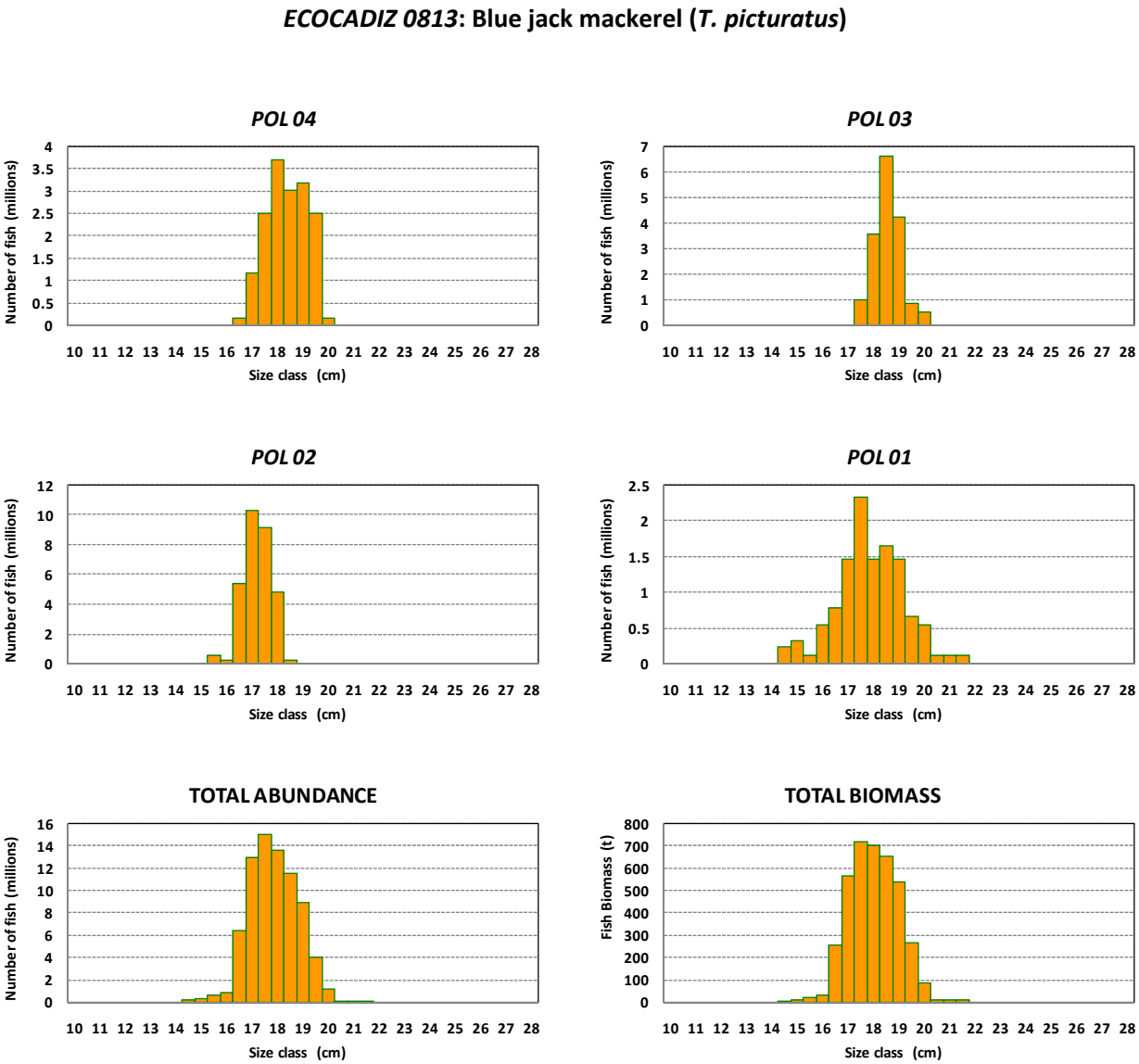

Figure 16. *ECOCADIZ 0813* survey. Blue jack mackerel (*T. picturatus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 15**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

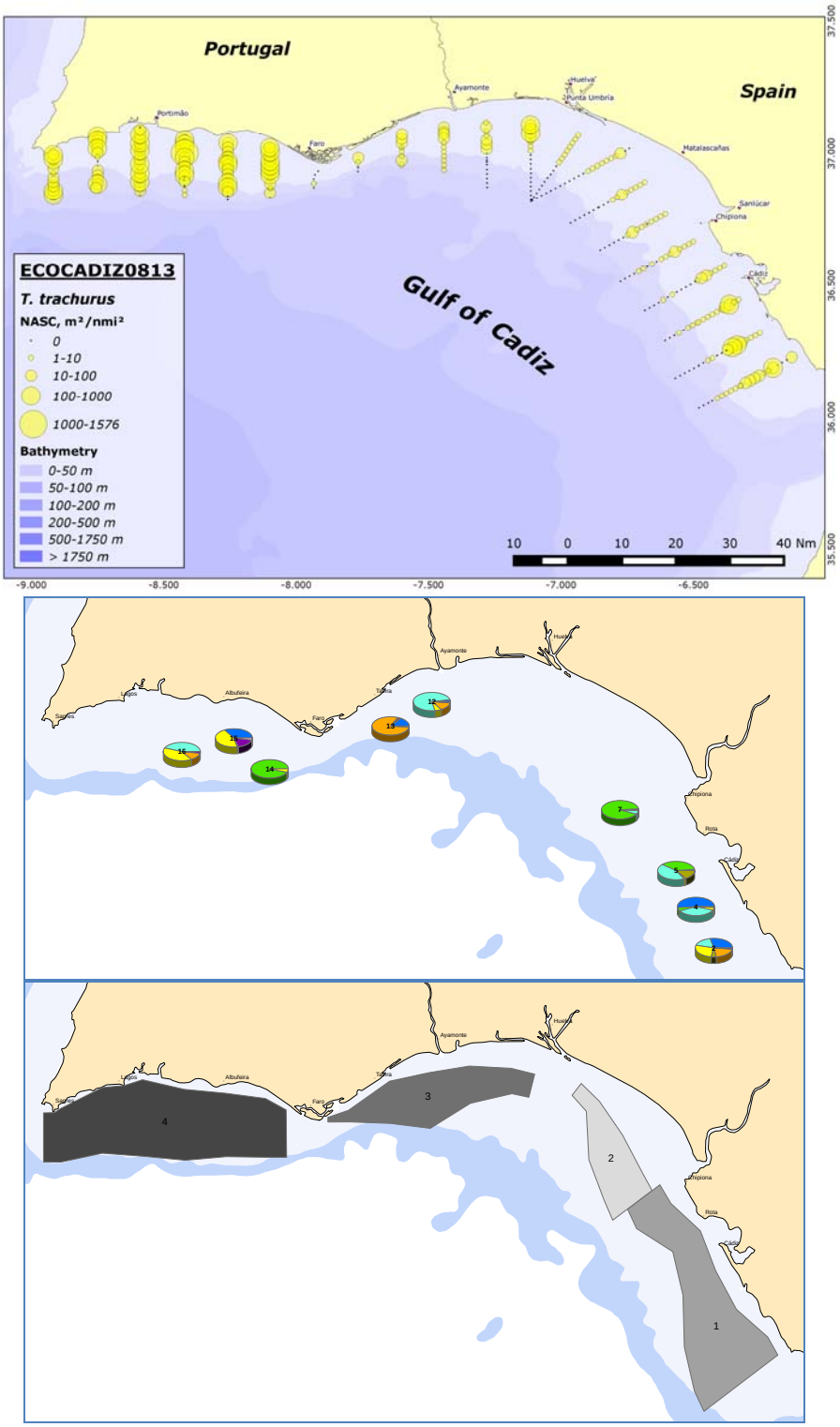

Figure 17. *ECOCADIZ 0813* survey. Horse mackerel (*Trachurus trachurus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Middle: valid fishing hauls for the species (more than 30 individuals showing a normal distribution). 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.

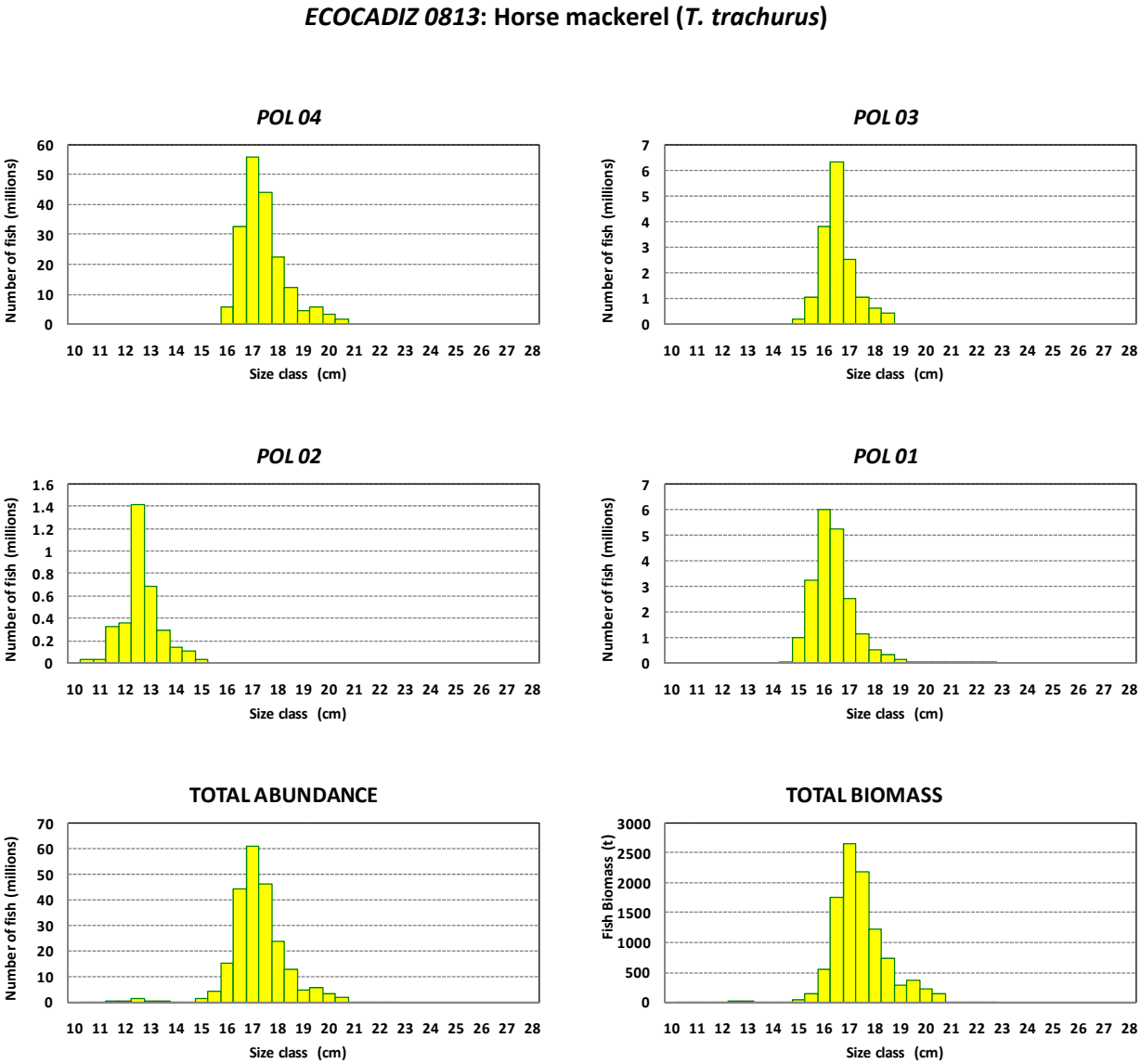

Figure 18. *ECOCADIZ 0813* survey. Horse mackerel (*T. trachurus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 17**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

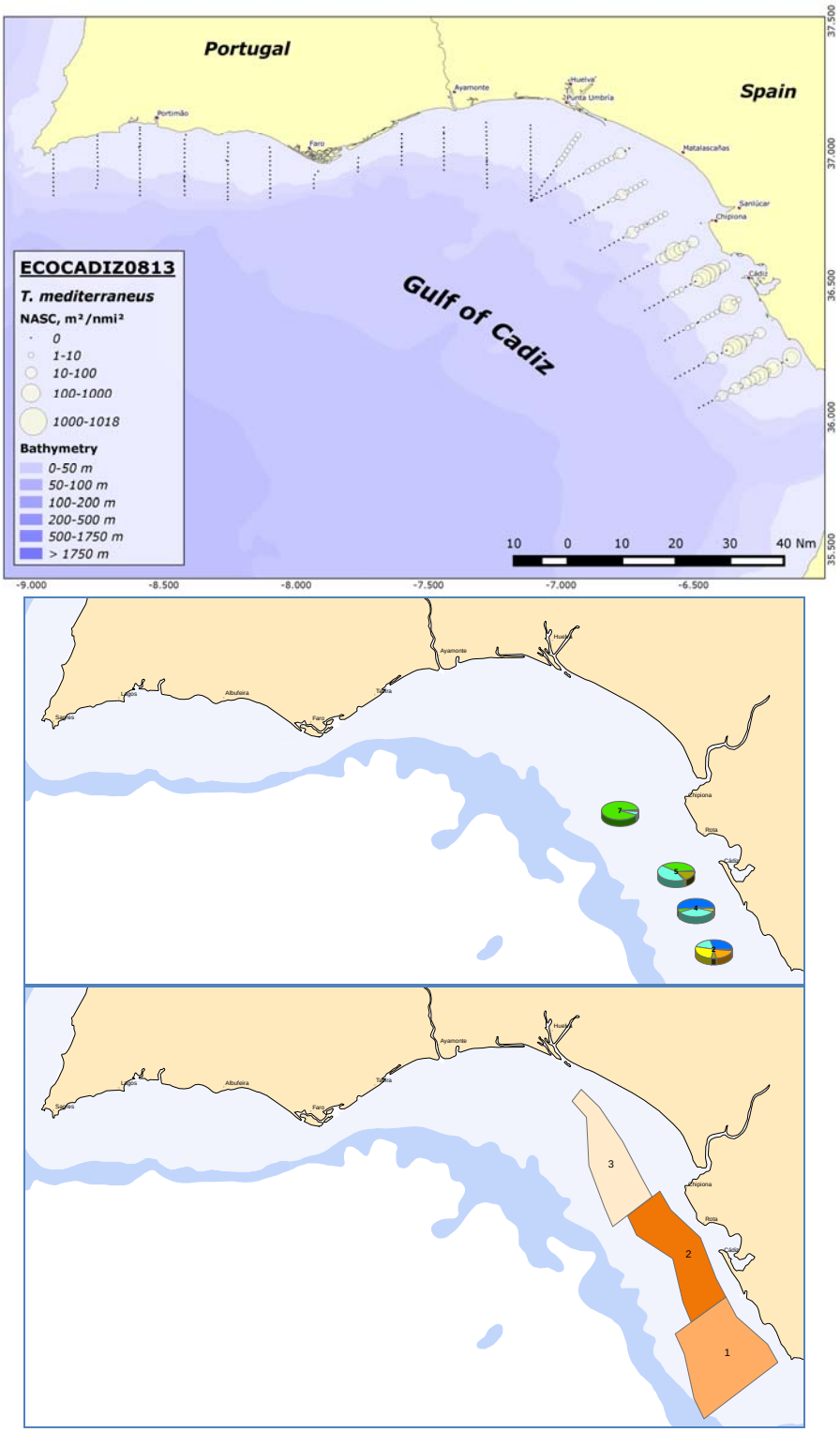

Figure 19. *ECOCADIZ 0813* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Middle: valid fishing hauls for the species (more than 30 individuals showing a normal distribution). 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.

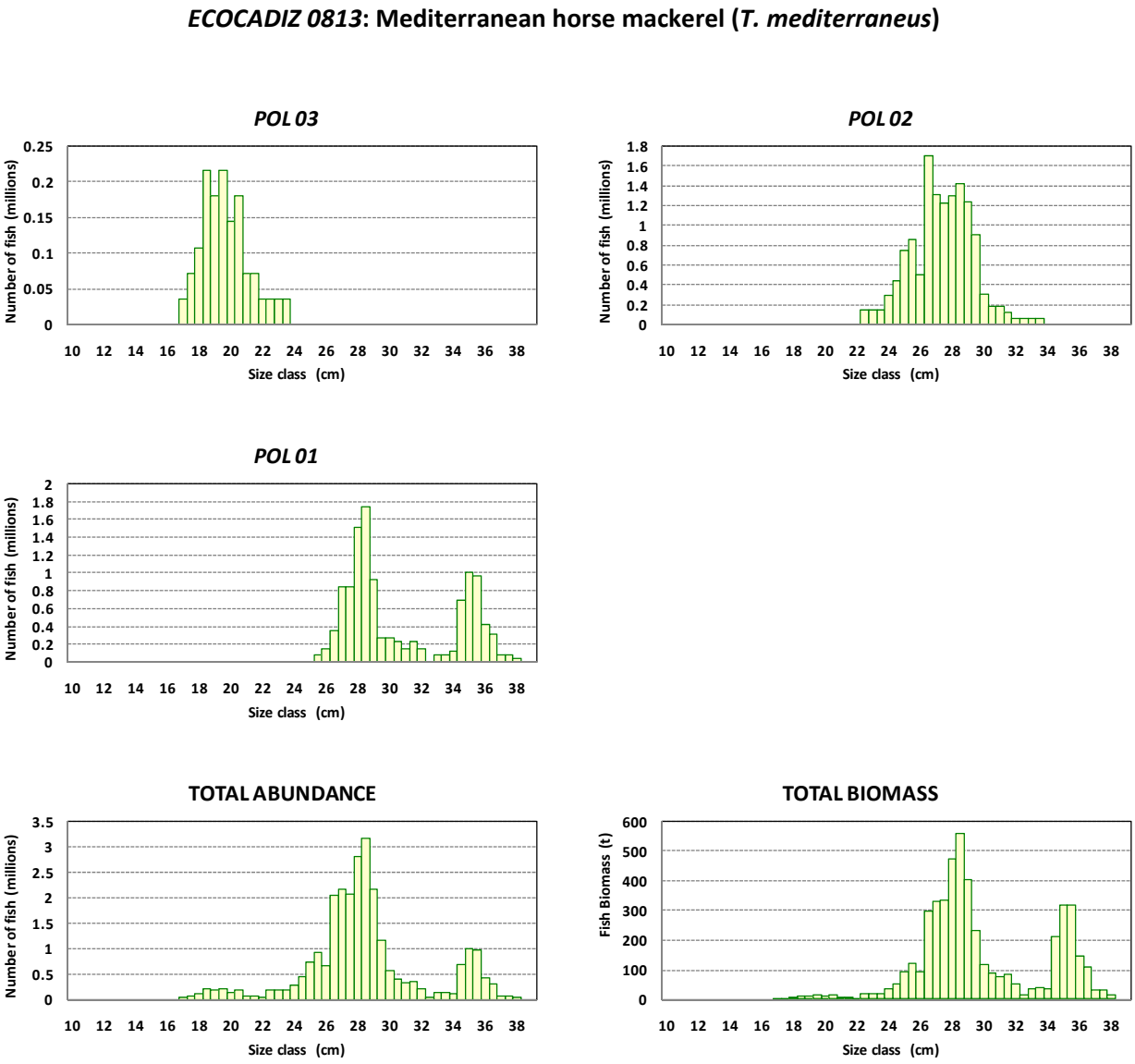

Figure 20. *ECOCADIZ 0813* survey. Mediterranean horse mackerel (*T. mediterraneus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 19**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

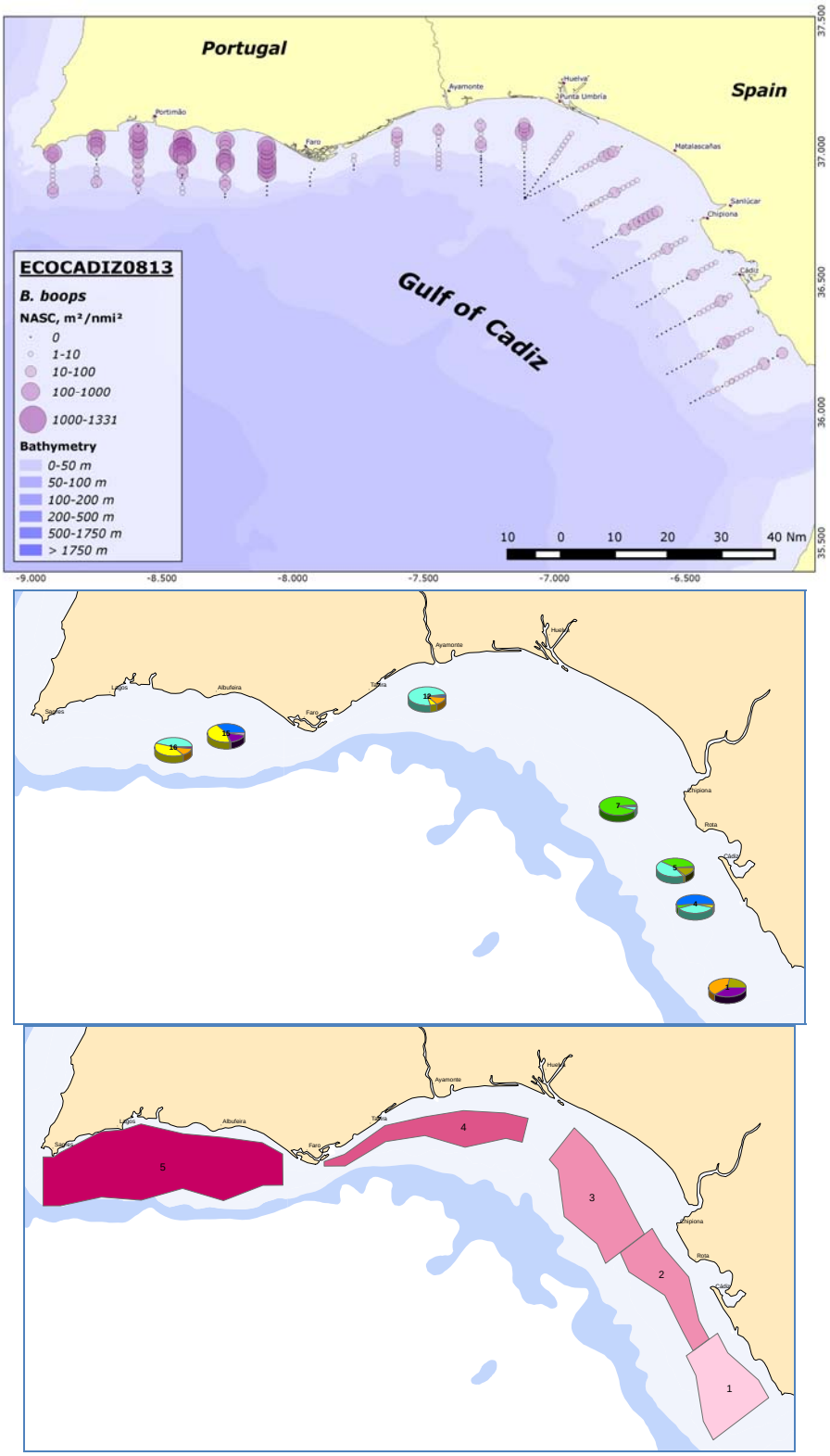

Figure 21. *ECOCADIZ 0813* survey. Bogue (*Boops boops*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Middle: valid fishing hauls for the species (more than 30 individuals showing a normal distribution). 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.

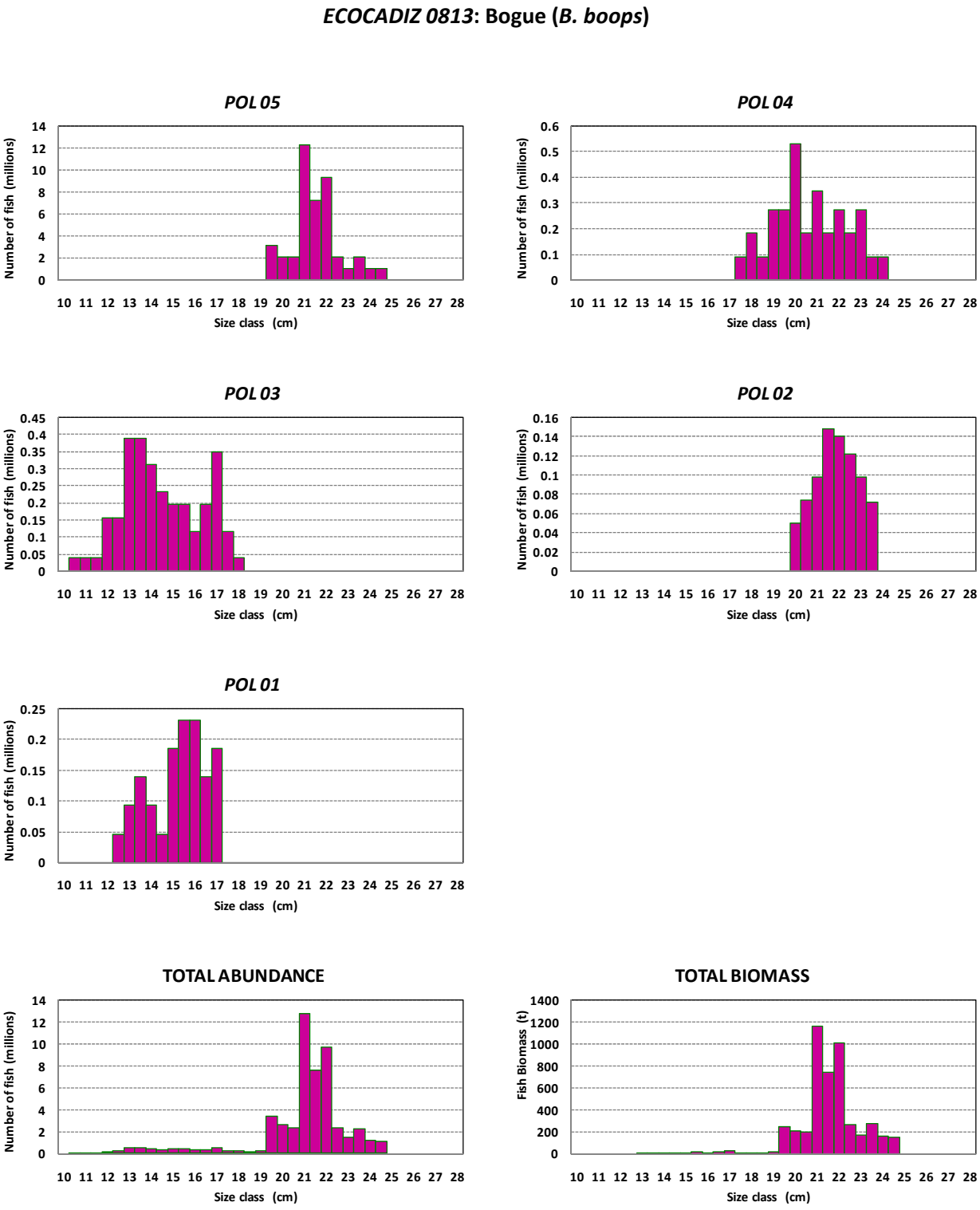

Figure 22. *ECOCADIZ 0813* survey. Bogue (*B. boops*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 21**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

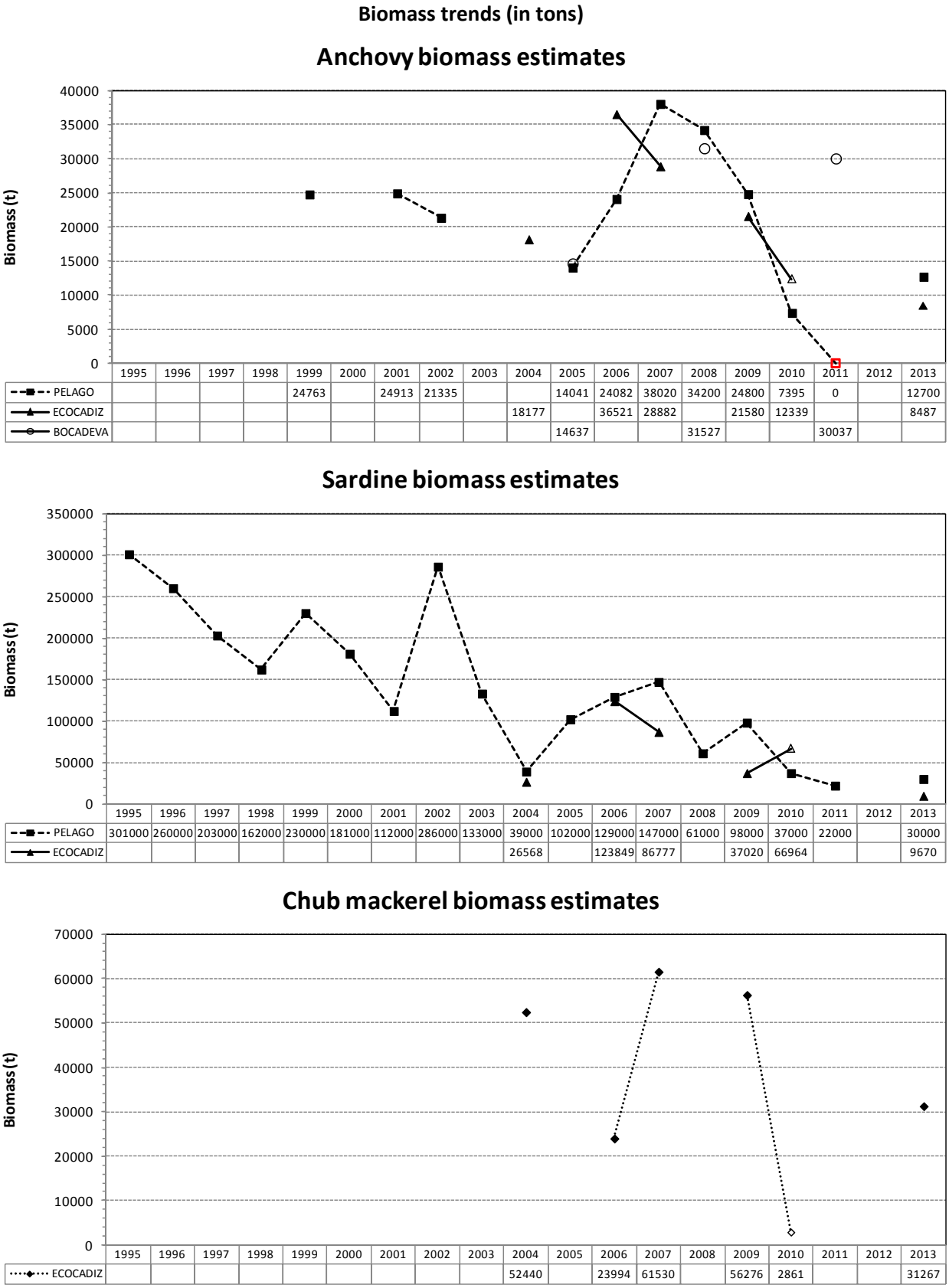

Figure 23. Trends in biomass estimates (in tons) for the main assessed species in Portuguese (*PELAGO*) and Spanish (*ECOCADIZ*) survey series. Gaps for the 2005, 2008 and 2011 anchovy acoustic estimates in the *ECOCADIZ* series are filled with the *BOCADEVA* Spanish egg survey estimates. Note that the *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.