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## PRELIMINAR RESULTS OF THE PELACUS0313 SURVEY: ESTIMATES OF SARDINE ABUNDANCE AND BIOMASS IN GALICIA AND CANTABRIAN WATERS

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**Abstract**

The PELACUS 0313 survey was undertook this year on board R/V Miguel Oliver, an oceanographic stern trawler ship similar to Thalassa. The survey was characterised by a very bad weather conditions during the first two weeks which did not allow working properly. Moreover, the weather conditions during the rest of survey were almost similar. As a consequence, most of the coastal pelagic fish community remained very close to the coast, thus not accessible to the pelagic gear samplers. (33% of the total acoustic energy –NASC- was unable to be properly allocated into fish species).

Outside the coastal area (>90 m depth) sardine distribution was scarce, and occurred in small schools (probably as a consequence of the bad weather condition). It was only found in a small area in VIIIc-West and in the eastern part of the VIIIc-East. The total biomass estimated in this area was 2.530 tonnes corresponding to 38,4 million fish.

Together with this assessment, made on account the fish proportion found at the ground truth fishing station, a direct assignation was achieved by echogram scrutinization. Although the experience, only few schools could be properly allocated to sardine, all of them located inside the Rias Baixas, giving an estimation of 813 tonnes (16 million fish). Overall, total biomass estimation is 3.343 tonnes, corresponding to 54 million fish.

On the contrary, the number of sardine eggs found at the CUFES stations showed an increase compared to those found in 2012 (from 1665 to 5936). Nevertheless, the distribution area was rather similar, with a significant gap between the southern area (IXaN) and the inner part of the Bay of Biscay (VIIIc-East-east).

Given the amount of unallocated schools in shallower waters, the acoustic sardine assessment is considered unreliable since only the inner part of the distribution (waters deeper than 90 m) was properly surveyed. The egg distribution, similar to that found the last year could indicate that the stock estimation would be similar. On the other hand, the significant increase in egg number would be either related with the shift in the survey time (two weeks earlier than the

previous year), thus arriving at the peak spawning, or with an increase in the sardine abundance.

## Introduction

PELACUS 0313 is the latest of the long-time series (started in 1984) of spring acoustic surveys carried out by the Instituto Español de Oceanografía to monitor pelagic fishery resources in the north and northwest shelf of the Iberian Peninsula (ICES divisions IXa – South Galicia and VIIIc – Cantabrian Sea).

This year the survey was carried out on board R/V Miguel Oliver. This ship, made in 2007, is similar to the Thalassa, vessel traditionally used for the survey since 1997 (i.e. a 70 m length stern trawler with diesel-electric power and fixed pitch propeller, within the standard ship underwater radiated noise recommended in ICES CRR 209). Before the cruise, the ship was tested, including acoustic calibration (Foote *et al.*, 1987), during a small survey performed in February in Galician waters.

We present the results on the distribution of sardine egg and adult fish together with the estimated values of adult fish abundance and biomass obtained in the survey. We also compare the new values with those obtained in previous years.

## Material and methods

The methodology was similar to that of the previous surveys (see Iglesias et al. (2010) for further details). Survey design consisted in a grid with systematic parallel transects equally separated by 8 nm and perpendicular to the coastline (Figure 1) with random start, covering the continental shelf from 30 to 1000 m depth and from Portuguese-Spanish border to the Spanish -French one. Acoustic records were obtained during day time together with egg samples from a Continuous Underwater Fish Egg Sampler (CUFES), with an internal water intake located at 5 m depth. CTD casts and plankton and water samples were taken during night time over the same grid in alternating transects. Besides, pelagic trawl hauls were performed in an opportunistic way to provide ground-truthing for acoustic data.

Acoustic equipment consisted in a Simrad EK-60 scientific echosounder (18, 38, 120 and 200 KHz). The elementary distance sampling unit (EDSU) was fixed at 1 nm. Acoustic data were obtained only during daytime at a survey speed of 10 knots. Data were stored in raw format and post-processed using SonarData Echoview software (Myriax Ltd.). The integration values are expressed as nautical area scattering coefficient (NASC) units or $s_A$ values ($m^2$ $nm^{-2}$) (MacLennan *et al.*, 2002).

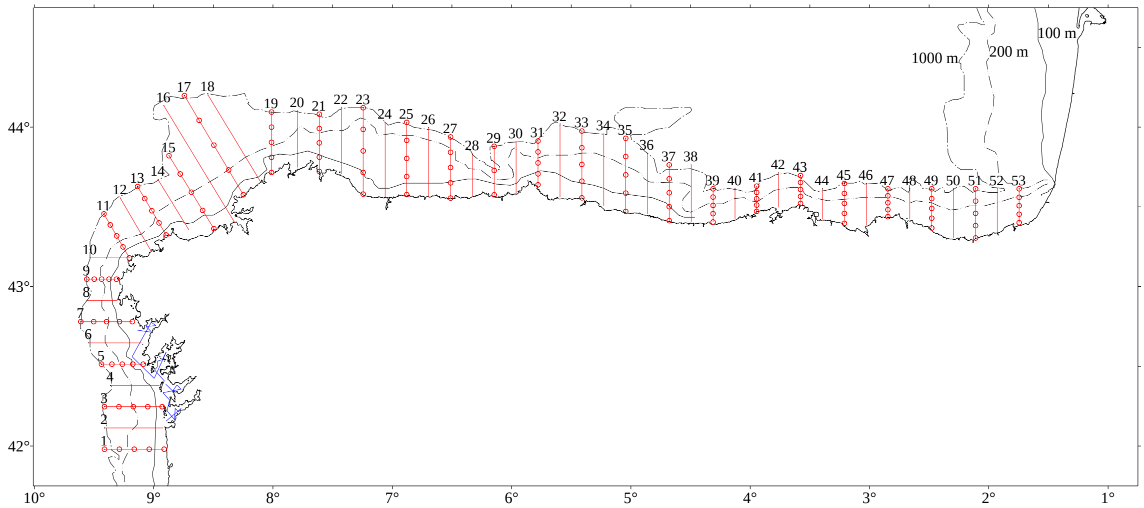


*Figure 1 Survey track*

Two different pelagic gears were used. Nevertheless, due to the bad weather condition and the specific characteristics of those trawls, hauls were mainly performed in depths higher than 90 m (coastal areas with hard, rough bottoms were inaccessible when fish schools occurred close to the seabed). Hauls had a minimum duration of 20 minutes. A two steps method was used to assess the pelagic fish community. First, hauls were classified on account the following criteria: weather condition, gear performance and fish behaviour in front of the trawl derived from the analysis of the net sonar (Simrad FS20/25), catch composition in number and length distribution. Each haul was categorised and ranked as follows:

| | **0** | **1** | **2** | **3** |
|---|---|---|---|---|
| **Gear performance Fish behaviour** | Crash | Bad geometry<br>Fish escaping | Bad geometry<br>No escaping | God geometry<br>No escaping |
| **Weather conditions** | Swell >4 m height<br>Wind >30 knots | Swell: 2 -4 m<br>Wind: 30-20 knots | Swell: 1-2m<br>Wind 20-10 knots | Swell <1 m<br>Wind < 10 knots |
| **Fish number** | total fish caught <100 | Main species >100<br>Second species <25 | Main species > 100<br>Second species< 50 | Main species > 100<br>Second species > 50 |
| **Fish length distribution** | No bell shape | Main species bell shape | Main species bell shape<br>Seconds: almost bell shape | Main species bell shape<br>Seconds: bell shape |

These criteria were used as a proxy for ground-truthing. Hauls considered as the best representation of the fish community (i.e. those with higher overall rank on account the four criteria) were used to allocate the backscattering energy got on similar echotraces located in the same area.

Once backscattering energy was allocated, spatial distribution for each species was analysed on account both the NASC values and the length frequency distributions (LFD). These were obtained for all the fish species in the trawl (either from the total catch or from a representative random sample of 100-200 fish). For the purpose of acoustic assessment, only those size distributions which were based on a minimum of 30 individuals and which presented a bell shape (normal) distribution were considered. Random subsamples were taken when the total fish caught was higher than 100 specimens. Differences in probability density functions (PDF) were tested using Kolmogorov-Smirnoff (K-S) test. PDF distributions without significant differences were joined, giving a homogenous PDF stratum. Spatial structure and surface (square nautical miles) for each stratum were calculated using EVA and SURFER packages. Fish abundance was calculated with the 38 kHz frequency as recommended at the PGAAM (ICES 2002). Nevertheless, echograms from 18 and 120 kHz frequencies were used to visually discriminate between fish and other scatter-producing objects such as plankton or bubbles, and to distinguish different fish according to the strength of their echo. Also these frequencies have been used to create a mask allowing a better discrimination among fish species and plankton. The threshold used to scrutinize the echograms was –70 dB. Backscattered energy ($s_A$) was allocated to fish species according to the proportions found at the fishing stations (Nakken and Dommasnes, 1975). For this purpose, the following TS values were used: sardine and anchovy, -72.6 dB ($b_{20}$); horse mackerels (*Trachurus trachurus, T. picturatus* and *T. mediterraneus*), –68.7 dB, bogue (*Boops boops*), –67 dB, chub mackerel (*Scomber colias*), -68.7, mackerel (*Scomber scombrus*), –84.9 dB and blue whiting (*Micromesistius poutassou*), -67.5 dB. When possible, direct allocation was also used. Biomass estimation was done on each strata (polygon) using the arithmetic mean of the backscattering energy (NASC, $s_A$) attributed to each fish species and the surface expressed in square nautical miles.

Besides each fish was measured and weighed to obtain a length-weight relationship. Otoliths were also extracted from anchovy, sardine, horse mackerel, blue whiting and mackerel in order to estimate age and to obtain the age-length key (ALK) for each species for each area.

**Results**

A total of 3642 nautical miles were steamed, 1080 corresponding to the survey track. In IXa-N, due to the bad weather conditions, half of the transects were not surveyed and the rest, together with those located in the VIIIc-W Sub-Division, have had to be sternway steamed to avoid bubbles sweep down. This can cause attenuation of sound transmission and reception of backscattering energy, thus an underestimation of the fish population. This phenomenon still persisted and, therefore, acoustic records gathered in the western areas were filtered to remove those pings with a large amount of attenuation. For each ping of the 38 kHz frequency, Sv were tested for deviations (a total of 500 samples-Sv values- in the echogram for each ping). If the maximum value of Sv achieved in the water column was lower than -70dB, we assumed that an important attenuation occurred and therefore the ping was removed. This was applied until the 22$^{nd}$ March when main swell and wind directions were either stern or bow way. The number of pings removed is shown in the following table

| Day | Total ping number | Pings removed | % |
|---|---|---|---|
| 08/03/13 | 35388 | 783 | 2.21 |
| 09/03/13 | 64659 | 1175 | 1.82 |
| 10/03/13 | 22408 | 356 | 1.59 |
| 11/03/13 | 27790 | 1274 | 4.58 |
| 12/03/13 | 44615 | 935 | 2.10 |
| 13/03/13 | 47876 | 955 | 1.99 |
| 14/03/13 | 26872 | 123 | 0.46 |
| 15/03/13 | 32980 | 217 | 0.66 |
| 16/03/13 | 55257 | 451 | 0.82 |
| 17/03/13 | 49619 | 501 | 1.01 |

| | | | |
|---|---|---|---|
| 18/03/13 | 33884 | 1516 | 4.47 |
| 19/03/13 | 40805 | 505 | 1.24 |
| 21/03/13 | 93009 | 2140 | 2.30 |
| 22/03/13 | 61923 | 394 | 0.64 |

Sternway steaming has considerable reduced the number of ping removed. However, the coverage in the continental shelf was reduced by a 50%.

A total of 45 fishing station were performed, one of them was removed. Figure 2a-d shows the location and the value for each ground truthing criteria (from 0 to 3).

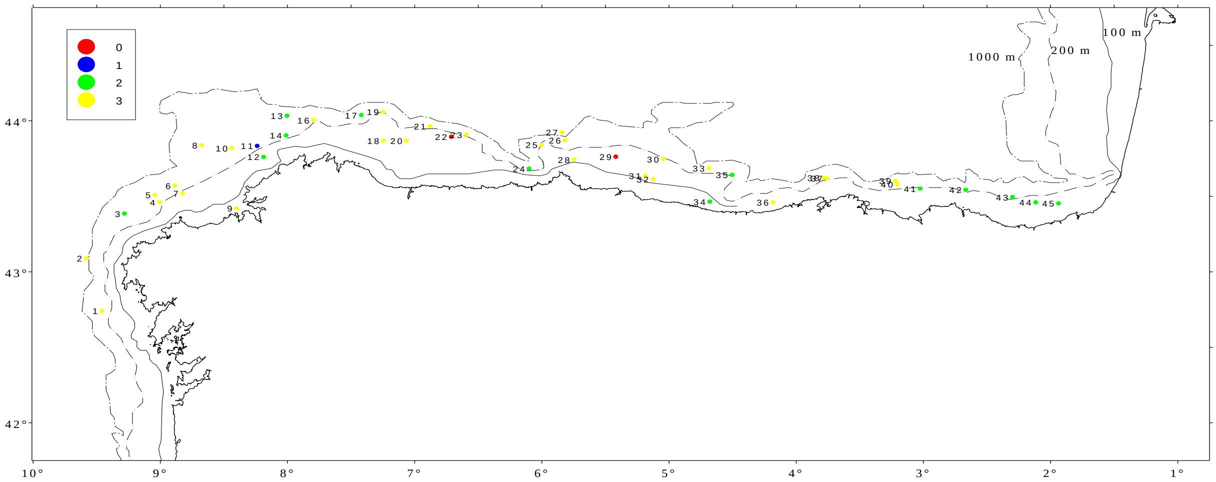


*Figure 2a: Fishing station and colour system according with the Gear performance and fish behaviour criteria*

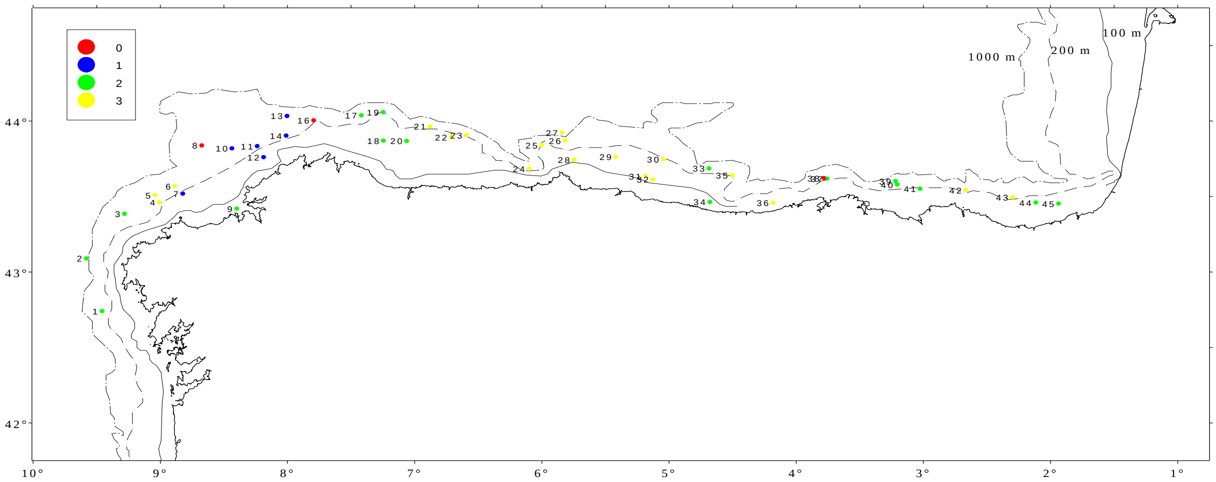


*Figure 2b: Id according with the Weather condition criteria*

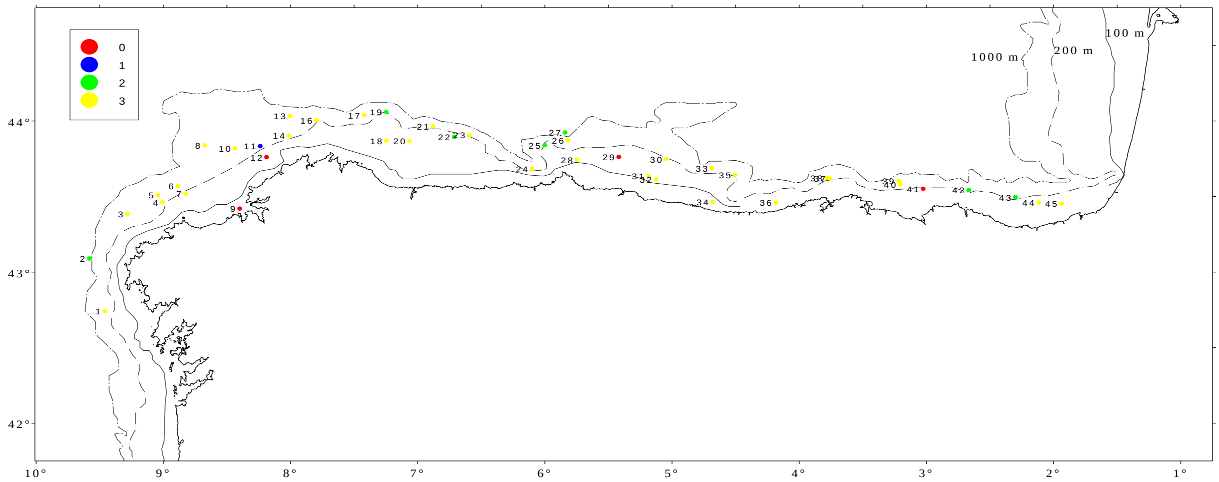


*Figure 2c: Id according with the Fish number criteria*

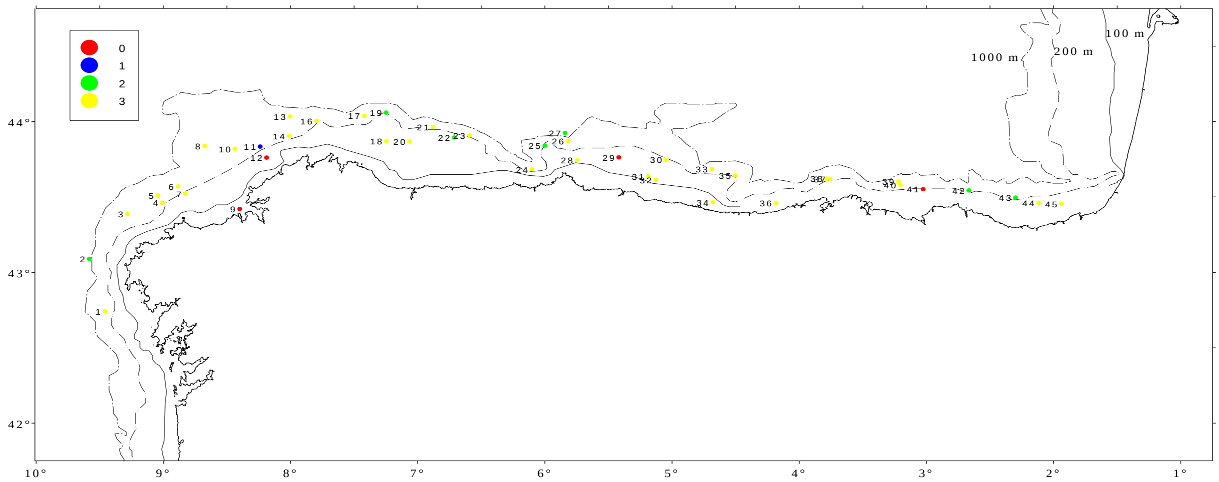


*Figure 2d: Id according with the Fish length distribution criteria*

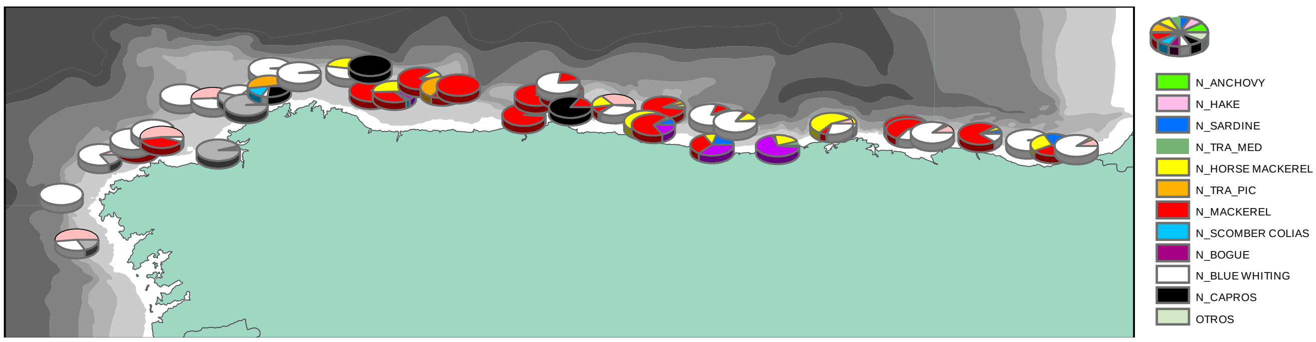


*Figure 2e: Fish proportion at each fishing station*

On the other hand, 381 CUFES stations, comprising 3 nautical miles each were taken, as shown in figure 3.

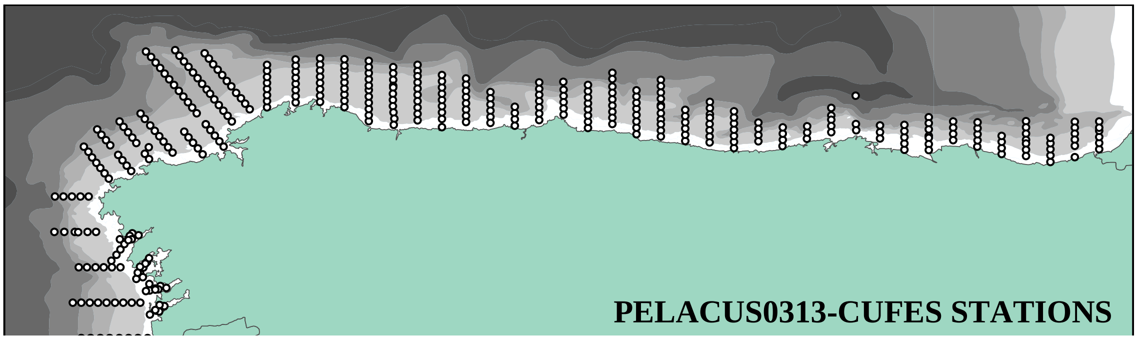

*Figure 3. PELACUS0313 CUFES stations.*

## Results

***Acoustic***

A total of 105.384,67 $s_A$ were attributed to fish species. Table 1 shows the fishing station used to allocate backscattering energy when echotraces were similar to those found around these fishing station.

*Table 1: Fishing station used for backscattering energy allocation and transects*

| Fishing station | Transects |
|---|---|
| PE02 | RA01, RA03, RA05, RA07, RA09 |
| PE03 | RA11 |
| PE04 | RA12, RA13, RA14, RA15, RA16, RA17 |
| PE05 | RA12, RA13 |
| PE06 | RA14 |
| PE08 | RA16, RA17, RA18 |
| PE13 | RA19 |
| PE14 | RA19, RA20 |
| PE16 | RA21 |
| PE17 | RA22, RA25 |
| PE18 | RA21, RA22, RA23, RA24 |
| PE19 | RA23 |
| PE20 | RA24 |
| PE21 | RA25 |
| PE22 | RA26 |
| PE23 | RA26, RA27 |
| PE24 | RA29 |
| PE25 | RA30 |
| PE26 | RA31 |
| PE27 | RA31 |
| PE28 | RA30, RA31 |
| PE30 | RA34, RA35, RA37 |
| PE31 | RA33, RA34 |
| PE31 | RA35 |
| PE32 | RA33, RA34, RA35, RA36, RA37 |
| PE33 | RA36, RA37 |
| PE34 | RA36, RA37, RA38, RA39, RA40 |
| PE35 | RA38, RA39 |
| PE36 | RA39, RA40 |
| PE37 | RA42, RA43 |
| PE38 | RA40, RA41, RA42, RA43 |
| PE39 | RA44, RA45, RA46, RA47 |
| PE40 | RA44, RA45, RA46, RA47 |
| PE42 | RA48 |
| PE43 | RA48, RA48, RA49, RA50 |
| PE44 | RA49, RA50, RA51, RA52, RA53 |

Due to the bad weather conditions and gear performance limitations to properly work close to the coast with hard and rough sea bed, a 33% of the total backscattering energy (34.720,97 $s_A$) was no possible to allocate and therefore remained as unallocated. Table 2 shows the backscattering energy distributed by species and ICES subdivision, either by direct allocation (DA) or through the proportion found at de fishing stations (Fst). Direct assignation was feasible accounting for its special acoustic properties, morphology and geographical characteristics for some sardine schools, board fish, horse mackerel and sardine. In IXa-N the 55% of the energy was unallocated (4% of the total energy); in VIIIc-W, the 37 % (5% of the total); in VIIIc-Ew, the 28% (18 % of the total energy); and in VIIIc-Ee, the 41% (6% of the total energy).

*Table 2: Backscattering energy ($s_A$) allocated by species, both by direct allocation (DA) and by the fish proportion found at the ground-truth fishing stations, and by ICES Sub-Division*

| | | WHB | MAC | HOM | PIL | JAA | BOG | MAS | BOC | SBR | HMM | NEI | total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **IXa** | **DA** | | | 382.8 | 1897.3 | | | | | | | 4188.0 | 6468.1 |
| | **Fst** | 1214.3 | | 0.7 | | | | | | | | | 1215.0 |
| **VIIIc-W** | **DA** | | 28.6 | | | | | | 737.1 | | | 5536.4 | 6302.1 |
| | **Fst** | 6768.5 | 1419.1 | 122.9 | 4.8 | 120.6 | | 65.4 | 5.6 | 0.4 | | | 8507.4 |
| **VIIIc-Ew** | **DA** | | 3424.1 | | 749.0 | | | | 2315.2 | | | 18975.9 | 25464.1 |
| | **Fst** | 16207.1 | 2631.8 | 8213.8 | 598.6 | 2131.4 | 9647.3 | 921.9 | 2182.3 | 64.6 | 29.3 | | 42628.1 |
| **VIIIc-Ee** | **DA** | | 577.2 | | | | | | | | | 6020.6 | 6597.9 |
| | **Fst** | 3270.9 | 579.2 | 3203.3 | 839.2 | 45.1 | 202.5 | 61.5 | 0.3 | | | | 8202.0 |
| **Total** | **DA** | | 4029.9 | 382.8 | 2646.2 | 0.0 | 0.0 | 0.0 | 3052.3 | | | 34721.0 | 44832.2 |
| | **Fst** | 27460.9 | 4630.0 | 11540.8 | 1442.6 | 2297.0 | 9849.8 | 1048.8 | 2188.2 | 65.0 | 29.3 | | 60552.5 |
| **Total** | | 27460.9 | 8659.9 | 11923.6 | 4088.8 | 2297.0 | 9849.8 | 1048.8 | 5240.4 | 65.0 | 29.3 | 34721.0 | 105384.7 |

## ***Sardine distribution and assessment***

Sardine was detected mainly in south Galicia (ICES sub-areas IXa-N), and in a very low density in VIIIc-W, and was almost absent in the central area, with only scarce detections found in the eastern part of Asturias (ICES sub-area VIIIcE-w) and in the Basque country (ICES sub-area VIIIcE-e) (Figure 5). Contrary to the normal behaviour, sardine seemed to occur in small pelagic schools, mixed with similar echotraces belonging to other species, mainly bogue, as shown in figure 4:

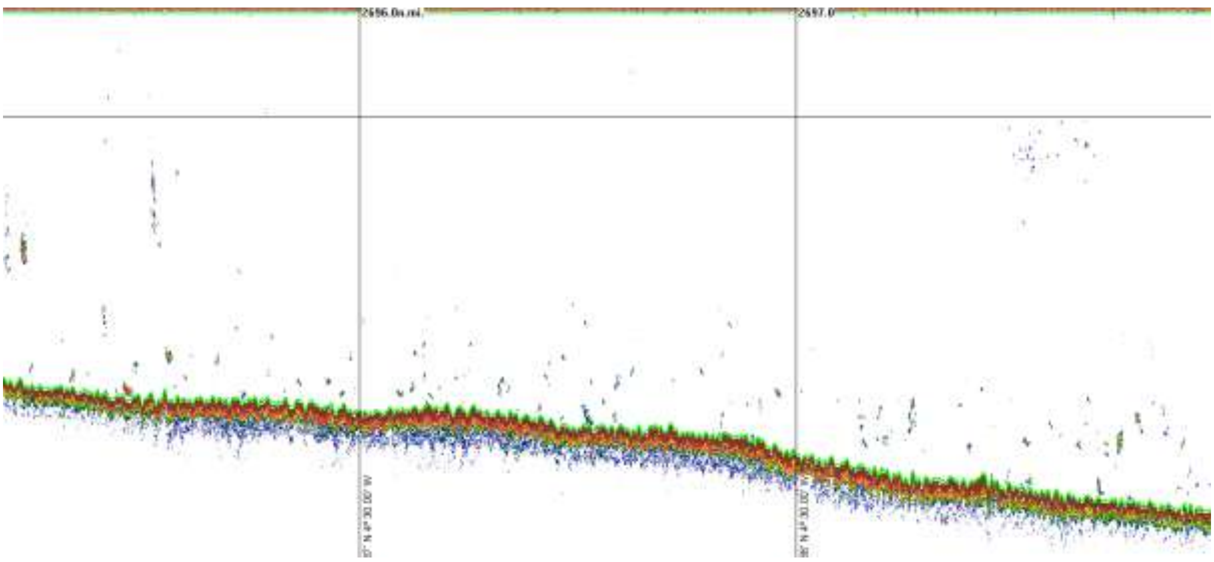

*Figure 4: Sardine occurrence in Cantabrian Sea*

Adult sardine were found in sufficient numbers to present a representative length distribution in only 6 of the 57 trawl hauls completed during the survey (see Figure 3). The total sardine abundance for the whole area surveyed was estimated as $54.35 \times 10^6$ individuals corresponding to 3,342.77 tons.

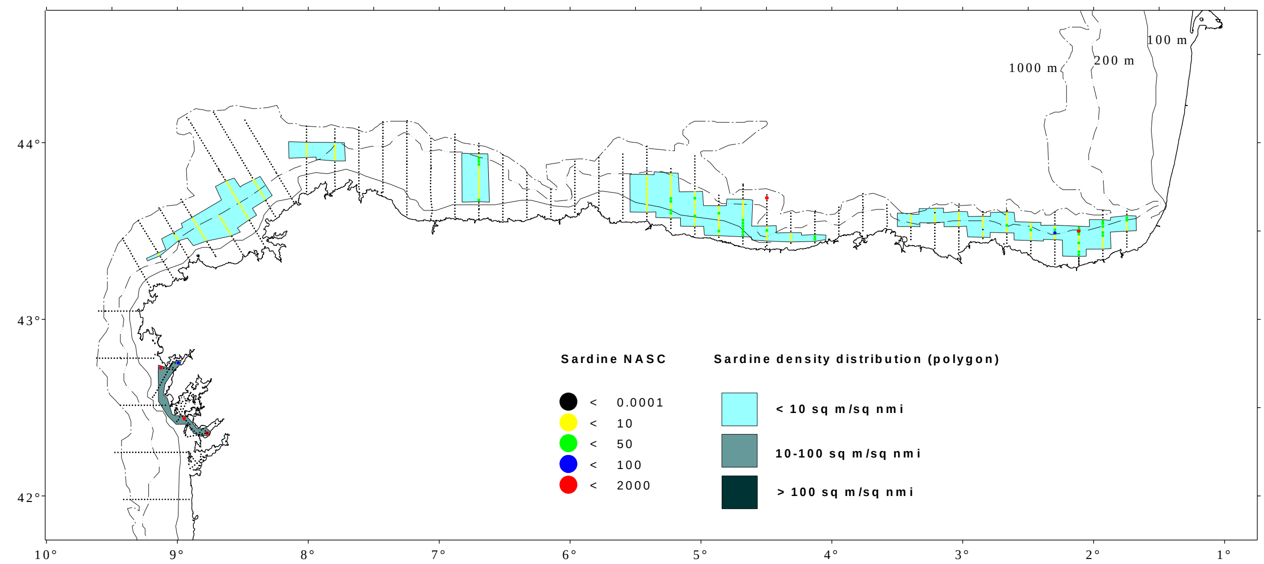


*Figure 4. Sardine: spatial distribution of energy allocated to sardine during the PELACUS0313cruise. Polygons are drawn to encompass the observed echoes, and polygon colour indicates integrated energy in m² within each polygon.*

*Table 3 Sardine acoustic assessment*

| Zone | Area | No | Mean | σ̃² | Model | v* | nugget/model | Area | Fishing st. | PDF | No (million fish) | Biomass (tonnes) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **IXa** | Rias Baixas | 42 | 45.18 | 31014.79 | 5000+Sph(34000,4) | 1362.358 | 8.7 | 89 | M01-M02 | S04 | 16 | 813 |
| | ***Total*** | **42** | **45** | | | | | **89** | | | **16** | **813** |
| **VIIIc-W** | Artabro | 45 | 0.06 | 0.008 | na | na | Na | 380 | P12-P14 | S01 | 0.07 | 5.71 |
| | Estaca | 11 | 1.62 | 6.83 | na | na | Na | 107 | P12-P14 | S01 | 0.47 | 40.22 |
| | ***Total*** | ***56*** | ***0.37*** | | | | | ***486*** | | | ***1*** | ***46*** |
| **VIIIc-Ew** | Masma | 16 | 6.40 | 5.33E+01 | 5+Sph (48, 4.5) | 5.38 | 6% | 147 | P12-P14 | S01 | 3 | 220 |
| | Asturias | 75 | 6.40 | 57.41 | na | na | Na | 589 | P31-P32-P34 | S02 | 13 | 820 |
| | ***Total*** | ***91*** | ***6.40*** | | | | | ***737*** | | | ***15*** | ***1040*** |
| **VIIIc-Ee** | Euskadi | 64 | 13.11 | 2275.65 | na | na | Na | 516 | P42-P44 | S03 | 23 | 1444 |
| | ***Total*** | **64** | **13** | | | | | **516** | | | **23** | **1444** |
| | ***Total IXa*** | ***42*** | ***45*** | | | | | ***89*** | | | ***16*** | ***813*** |
| | ***Total VIIIc*** | ***211*** | ***7*** | | | | | ***1739*** | | | ***38*** | ***2530*** |
| | ***Total Spain*** | ***253*** | ***13.20*** | | | | | ***1829*** | | | ***54*** | ***3343*** |

Sardine ranged in length from 14 to 24.5 cm, with a mode at 21.5 cm (Figure 5) which corresponds to quite large fish. Most fish (24% of the abundance and 19% of the biomass) in the entire surveyed area were assigned as belonging to the age class 5 (Table 4, Figure 6).
By sub-area, in subdivision IXaN (South of Galicia) the population was dominated by age 1 fish whilst in the eastern part of the Cantabrian area the population was mainly composed by older individuals (age 5). The age composition of the subdivision VIIIcW is not very reliable, since is based in few individuals.

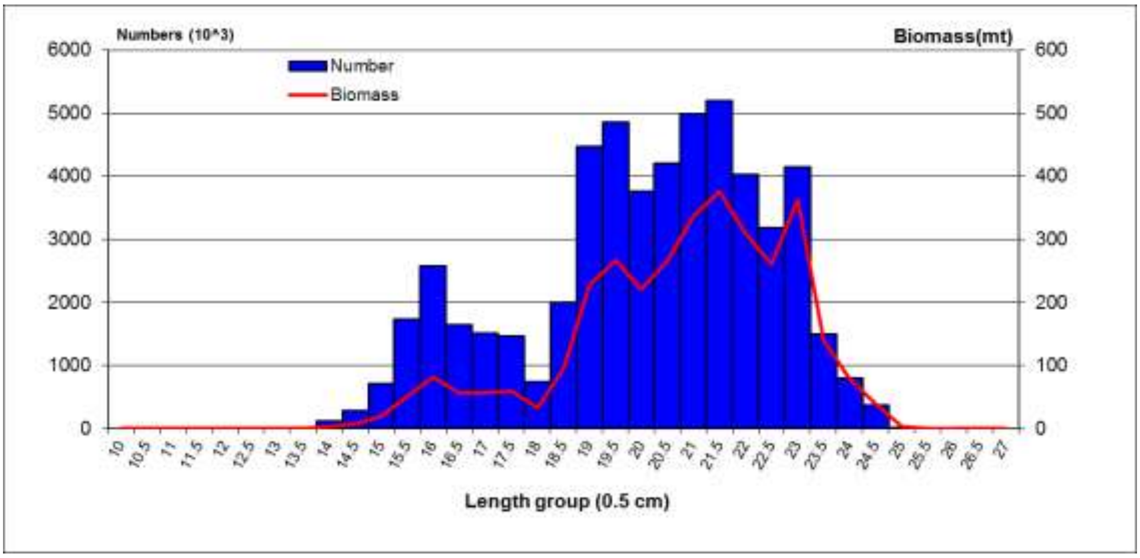


*Figure 5. Sardine: fish length distribution in biomass and abundance during the PELACUS0313 survey.*

*Table 4. Sardine abundance in number (thousand fish) and biomass (tons) by age group and ICES sub-area in PELACUS0313.*

| AREA VIIIcE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **AGE** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **TOTAL** |
| **Biomass (Tonnes)** | 91 | 498 | 524 | 359 | 626 | 283 | 58 | 37 | 8 | | 2484 |
| **% Biomass** | 3.7 | 20.0 | 21.1 | 14.5 | 25.2 | 11.4 | 2.4 | 1.5 | 0.3 | | 100 |
| **Abundance (N in '000)** | 2851 | 9035 | 8638 | 4846 | 8095 | 3303 | 661 | 386 | 74 | | 37888 |
| **% Abundance** | 7.5 | 23.8 | 22.8 | 12.8 | 21.4 | 8.7 | 1.7 | 1.0 | 0.2 | | 100 |
| **Medium Weight (gr)** | 31.95 | 55.11 | 60.62 | 74.13 | 77.32 | 85.82 | 88.35 | 94.98 | 104.91 | | 74.8 |
| **Medium Length (cm)** | 16.28 | 19.73 | 20.41 | 21.92 | 22.23 | 23.09 | 23.32 | 23.94 | 24.80 | | 21.7 |
| | | | | | | | | | | | |
| **AREA VIIIcW** | | | | | | | | | | | |
| **AGE** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **TOTAL** |
| **Biomass (Tonnes)** | 0 | 1 | 3 | 9 | 17 | 11 | 3 | 2 | 1 | | 46 |
| **% Biomass** | 0.0 | 1.8 | 5.6 | 18.9 | 36.1 | 24.6 | 6.2 | 5.0 | 1.8 | | 100 |
| **Abundance (N in '000)** | 0 | 12 | 33 | 106 | 195 | 125 | 31 | 24 | 8 | | 534 |
| **% Abundance** | 0.0 | 2.2 | 6.1 | 19.9 | 36.5 | 23.5 | 5.8 | 4.5 | 1.5 | | 100 |
| **Medium Weight (gr)** | 0.0 | 69.2 | 78.2 | 81.7 | 85.1 | 90.2 | 92.3 | 97.1 | 104.3 | | 74.2 |
| **Medium Length (cm)** | 0.0 | 21.4 | 22.3 | 22.7 | 23.0 | 23.5 | 23.7 | 24.1 | 24.8 | | 20.1 |
| | | | | | | | | | | | |
| **AREA IXaN** | | | | | | | | | | | |
| **AGE** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **TOTAL** |
| **Biomass (Tonnes)** | 216 | 168 | 143 | 101 | 143 | 37 | 5 | 0 | | | 813 |
| **% Biomass** | 26.5 | 20.6 | 17.5 | 12.5 | 17.6 | 4.6 | 0.6 | 0.0 | | | 100 |
| **Abundance (N in '000)** | 6612 | 3004 | 2336 | 1432 | 1989 | 486 | 65 | 5 | | | 15929 |
| **% Abundance** | 41.5 | 18.9 | 14.7 | 9.0 | 12.5 | 3.1 | 0.4 | 0.0 | | | 100 |
| **Medium Weight (gr)** | 32.6 | 55.8 | 61.0 | 70.8 | 71.8 | 76.4 | 79.1 | 87.3 | | | 61.4 |
| **Medium Length (cm)** | 16.4 | 19.8 | 20.5 | 21.6 | 21.7 | 22.2 | 22.5 | 23.3 | | | 20.4 |
| | | | | | | | | | | | |
| **TOTAL SPAIN** | | | | | | | | | | | |
| **AGE** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **TOTAL** |
| **Biomass (Tonnes)** | 307 | 666 | 669 | 469 | 785 | 332 | 66 | 39 | 9 | | 3343 |
| **% Biomass** | 9.2 | 19.9 | 20.0 | 14.0 | 23.5 | 9.9 | 2.0 | 1.2 | 0.3 | | 100 |
| **Abundance (N in '000)** | 9463 | 12050 | 11007 | 6384 | 10279 | 3914 | 757 | 415 | 82.5 | | 54351 |
| **% Abundance** | 17.4 | 22.2 | 20.3 | 11.7 | 18.9 | 7.2 | 1.4 | 0.8 | 0.2 | | 100 |
| **Medium Weight (gr)** | 32.4 | 55.3 | 60.8 | 73.5 | 76.4 | 84.8 | 87.7 | 95.0 | 104.8 | | 74.5 |
| **Medium Length (cm)** | 16.4 | 19.8 | 20.4 | 21.9 | 22.1 | 23.0 | 23.3 | 23.9 | 24.8 | | 21.7 |

The distribution of sardine eggs (obtained from the analysis of 380 CUFES stations) indicates a very coastal distribution with whole areas, e.g. Asturias (ICES sub-area VIIcE-w) and northern Galicia devoid of eggs. Total number of sardine eggs detected in Spanish waters was 5939, which represents an important increase from the 2012 values. (Figure 7)

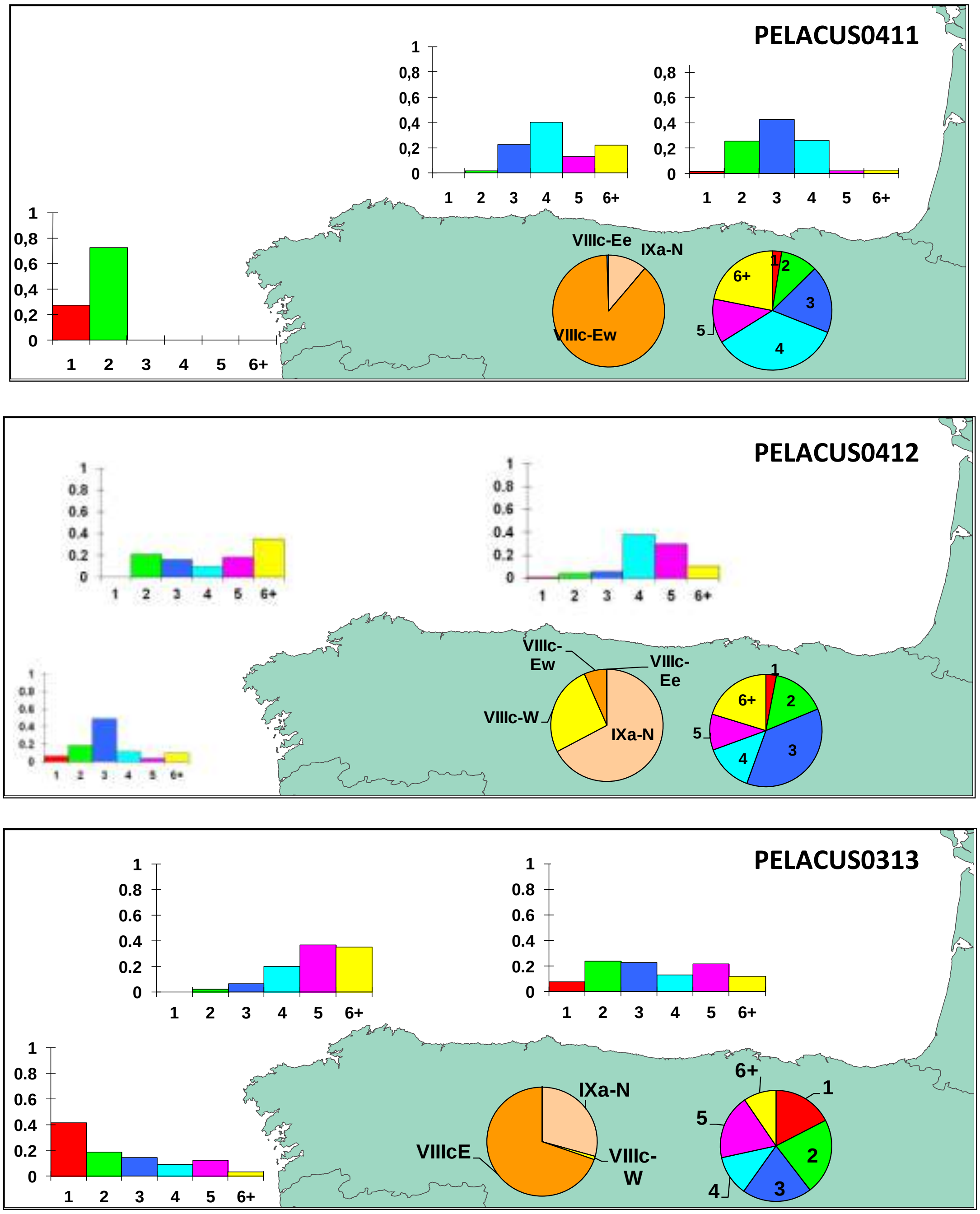


*Figure 6. Sardine: relative abundance at age in each sub-area (i.e. the proportion of all age classes within sub-area sum to 1) estimated in the PELACUS spring surveys (2011-2013). The pie chart shows the contribution of each sub-area to the total stock numbers.*

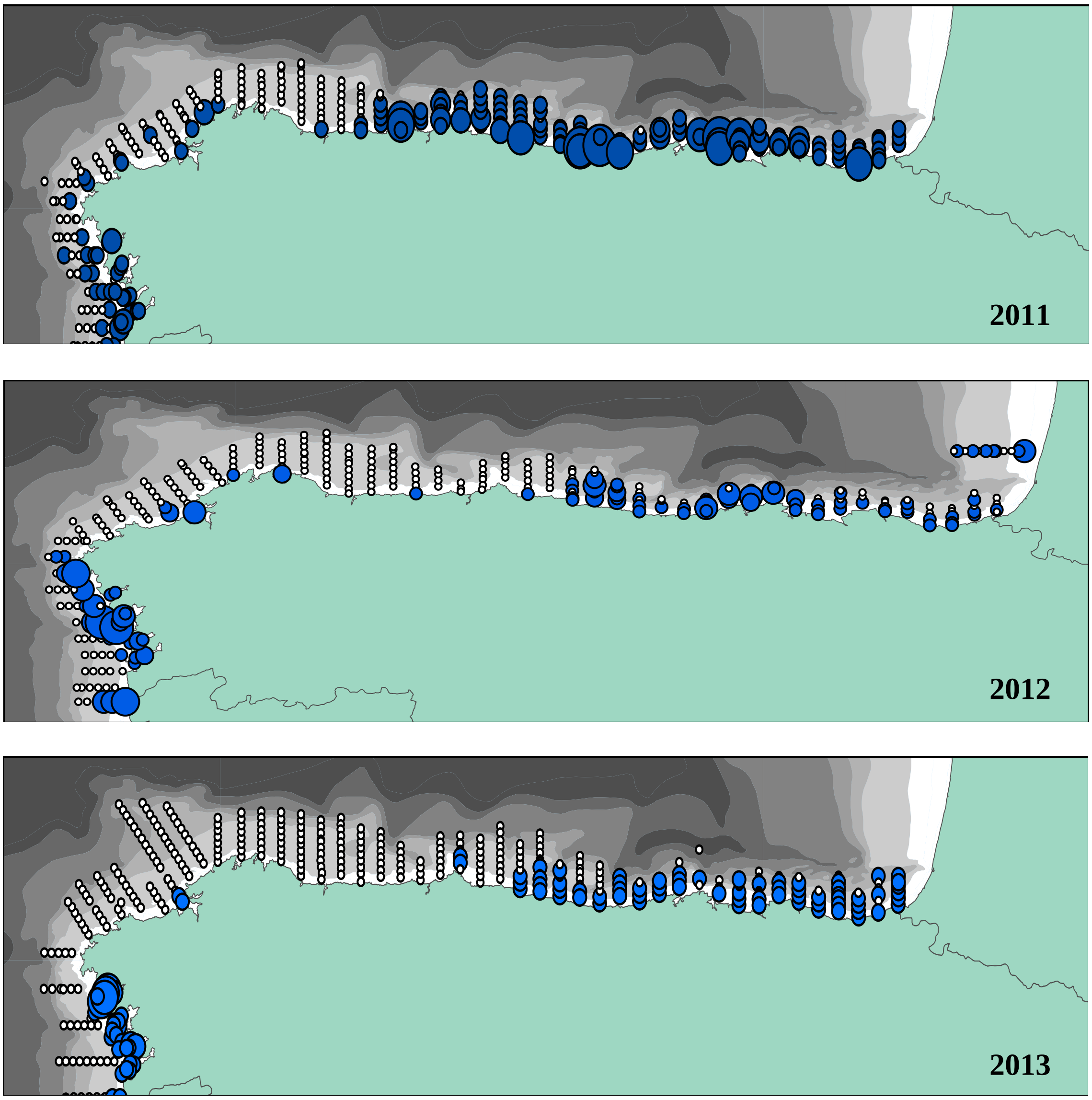


*Figure 7. Sardine: distribution of eggs (CUFES samples) in 2011-2013 PELACUS surveys. Blue circles indicate positive stations with diameter proportional to egg abundance.*

***Discussion***

PELACUS 0313 is characterised by both the bad weather conditions and the change of the R/V Thalassa by the R/V Miguel Oliver. In spite, no intercalibration was made. This exercise would be done next year. Vessel effect on acoustic assessment is very difficult to achieve when both vessels have similar characteristics (i.e. low noise radiated level). We believe vessel effect on the total NASC recorded would be negligible since no differences in fish behaviour should be expected due to the similar vessel characteristics. Another source of random error is the fishing stations which could change the species composition and/or proportion of the pelagic community. Again, the pelagic trawl with a vertical opening of about 16-18 m (20-25 in horizontal one) would have had the same performance as the Thalassa one. We had not seen any particular escaping behaviour in front of the gear and we assumed the fishing stations were ground-truthing. Unfortunately, schools close to the coast were inaccessible to the fishing gear, nor it was possible to allocate directly into fish species on account their morphological, acoustic and geographical characteristics.

On account this last feature, we were only able to properly assess the inner part of the sardine distribution (i.e. between 90 m and the self-break), and therefore a very low biomass was estimated, (3343 metric tonnes).

Nevertheless, an important amount of schools were detected close to the coast, in shallower waters in a very hard and rough sea bed, thus no accessible to the pelagic year, and these represented 33% of the total backscattering energy. Between 1992 and 2002, in coastal waters (depth <90m) sardine achieved up to 67% of the total backscattering energy (12% in deeper waters than 90 m), ranging from 40% up to 75%. If we assume that such proportion of backscattering energy for sardine in coastal waters is stable and independent of the total energy and also assuming that the sardine eggs collected in the CUFES is a good estimator of the sardine spawning biomass distribution, then the biomass estimation including an estimated proportion ranging between 30% to 60 % of the unallocated backscattering energy in coastal waters will increase the estimation in around 7 to 13 thousand tonnes (10-16 thousand tonnes in total), which is still too low.

In spite the lack of fishing stations in coastal waters allowing distributing the backscattering energy into fish species, we can conclude that the sardine biomass would remain in the lowest level of the time series, with no signal of recovery, nor of a good incoming year class in the surveyed area (IXa-North and VIIIc).

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