Working document for the WGHANSA 24-29/06/2015, IPMA Lisboa, Portugal

PRELIMINARY RESULTS OF THE PELACUS0315 SURVEY: ESTIMATES OF SARDINE ABUNDANCE AND BIOMASS IN GALICIA AND CANTABRIAN WATERS

Isabel Riveiro & Pablo Carrera

[1] **Instituto Español de Oceanografía. Centro Oceanográfico de Vigo. PO Box 1552, Vigo, Spain.**

Abstract

A total of 10 384 tons of sardine (191 million fish) was estimated to be present in northwest and northern Spanish waters by the Spanish spring acoustic survey PELACUS0315, carried out from 13th March to 16th April 2015. These values are virtually identical to those recorded in 2014, which shows a stable trend at the lower level of the time series.

Sardine distribution was wider than previous years, but the energy allocated to this species was in general very low. Sardine was presented throughout the whole sampled area, but the energy attributed to this species was in general very low. Higher sardine concentrations were detected in Galicia and in the Vasque Country area. Most fish in the entire surveyed area were assigned as belonging to the age 1 (29% of the abundance and 20% of the biomass), age 2 (28% of the abundance and 26% of the biomass) and age 3 (27% of the abundance and 29% of the biomass) years classes.

By sub-area, IXa subdivision represents 21.1%, VIIIc West 0.3%, VIIIcEast-West 25.4% and VIIIcEast- East 53.1% of the total abundance. Galicia populations (IXaN and VIIIcW subdivisions) were dominated by age 1 fish whilst the Cantabrian area was mainly composed by older individuals.

The distribution of sardine eggs indicates a coastal distribution, agreeing with that observed in previous years. Sardine eggs showed a widespread distribution in the surveyed area, with higher percentage of positive stations than in earlier years.

Introduction

PELACUS 0315 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). Since 2013, the survey is carried out in the R/V Miguel Oliver.

We present the results on the distribution of egg and adult fish together with the estimated values of adult fish abundance and biomass obtained in the survey, for sardine and anchovy. 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.

Survey was carried out from 13th March to 15th April in the R/V Miguel Oliver and sampling 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).

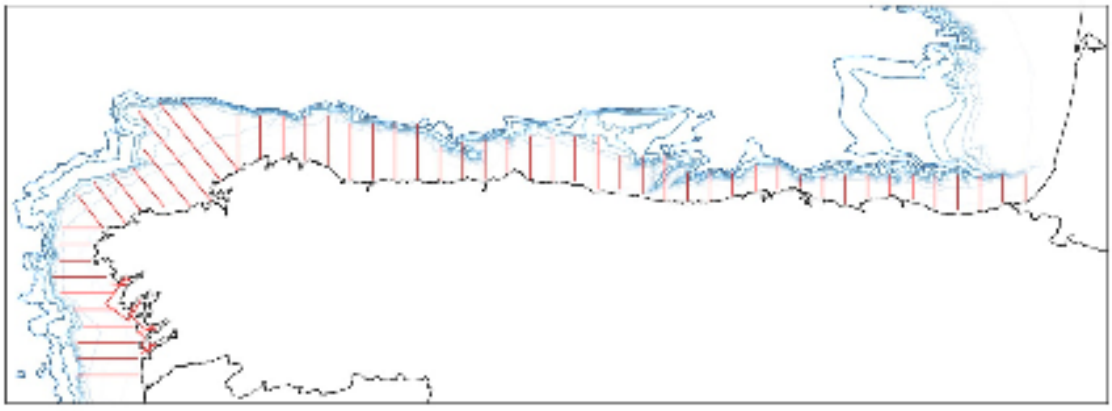

Figure 1. 2015 Survey track

Two different pelagic gears were used, depending of the depth of the area. Hauls were mainly performed in depths between 47 m and 800 m, with an average duration of 27 minutes (and usually with 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 Fish escaping	Bad geometry No escaping	God geometry No escaping
Weather conditions	Swell >4 m height Wind >30 knots	Swell: 2 -4 m Wind: 30-20 knots	Swell: 1-2m Wind 20-10 knots	Swell <1 m Wind < 10 knots
Fish number	total fish caught <100	Main species >100 Second species <25	Main species > 100 Second species< 50	Main species > 100 Second species > 50
Fish length distribution	No bell shape	Main species bell shape	Main species bell shape Seconds: almost bell shape	Main species bell shape 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, chub mackerel, Mediterranean horse mackerel 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 2315 nautical miles were steamed, 1190 corresponding to the survey track.
In the area surveyed, a total of 66 fishing stations were performed (Figure 2).

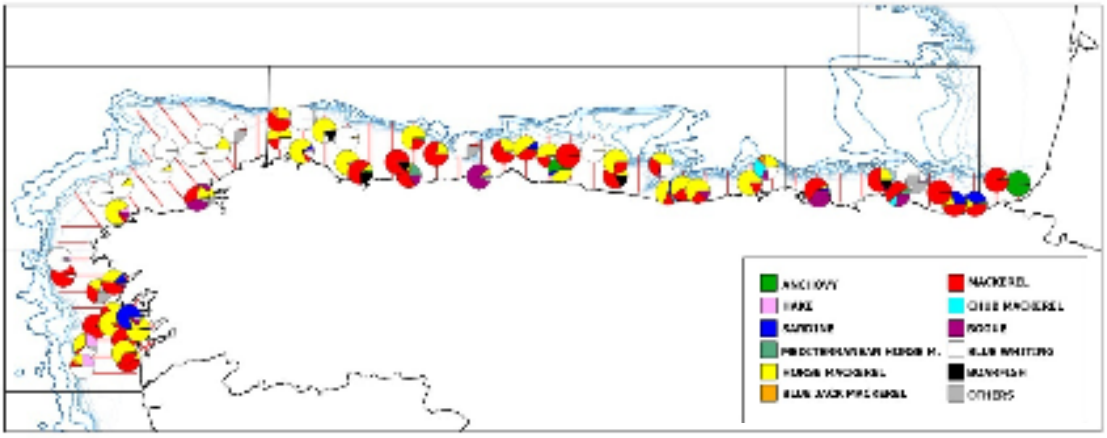

Figure 2: PELACUS0315 Fish proportion (abundance) at each fishing station

On the other hand, 355 CUFES stations, comprising 3 nautical miles each were taken, as shown in Figure 3. Due to problems during installation of CUFES, the first days of the survey, corresponding to the southern area of Galicia (IXaN, excluding Rias Baixas), were not sampled.

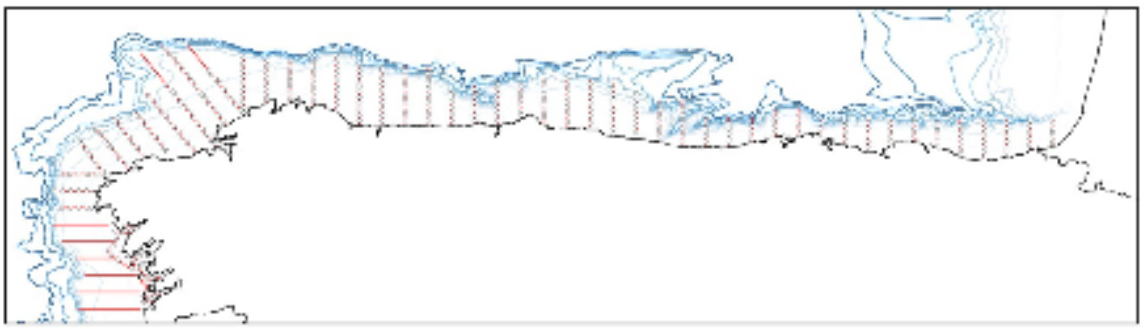

Figure 3. PELACUS0315 CUFES stations.

Results

Acoustic

Sardine distribution and assessment

Sardine was presented throughout the whole sampled area, but the energy attributed to this species was in general very low. Higher sardine concentrations were detected in Galicia (IXa North subdivision) and in the Vasque Country area (Figure 4).

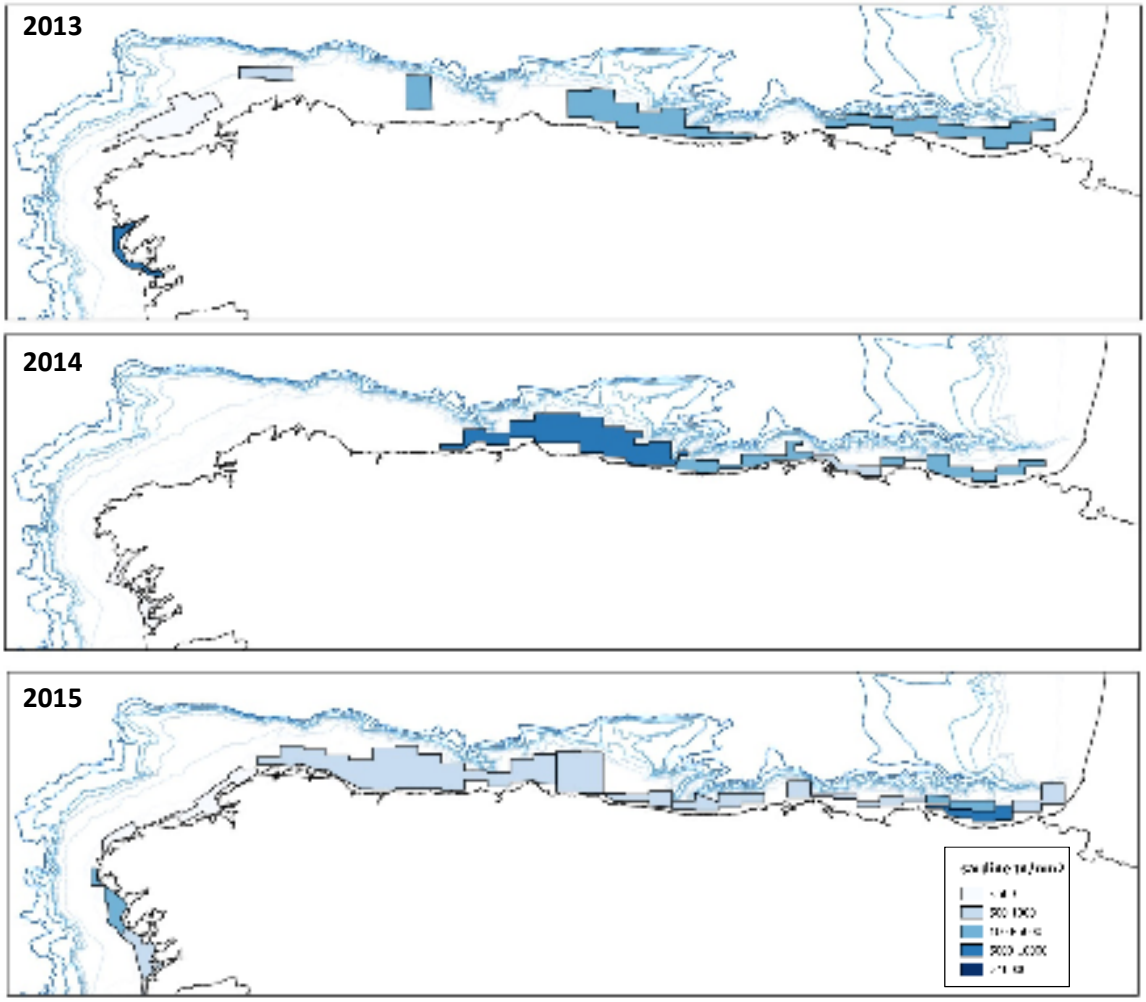

Figure 4. Sardine: spatial distribution of energy allocated to sardine during 2013-2015 PELACUS surveys. Polygons are drawn to encompass the observed echoes, and polygon colour indicates sardine density in nm^2 within each polygon.

According to the behaviour observed over the last years, sardine seemed to occur dispersed and not in dense schools, mixed with other species, mainly mackerel (which represented more than 70 percent of the biomass in the PELACUS catches) and horse mackerel.

The total sardine abundance in PELACUS0315 for the IXa and VIIIc subdivisions was estimated at 191×10^6 individuals corresponding to 10384 tons ($200x10^6$ individuals and 10815 tons for the whole area surveyed, including VIIIb ICES subdivision) (Table 1).

Table 1. Sardine acoustic assessment

Zone	Area	No	Mean	Area	Fishing st.	PDF	No (million fish)	Biomass (tonnes)	Density (Tn/nmi-2)
IXa	Rias Baixas	51	33.47	149	P08-P09-P11	S01	25	921	6
	Muros	29	43.96	122		S02	16	1283	10
	Total	***80***	***37.27***	***271***			***40***	***2204***	8
VIIIc-W	Costa da Morte	8	0.99	61	P32-P33-P34	S02	0	11	0
	Artabro	28	0.26	177	P37	S03	0	8	0
	Total	***36***	***0.42***	***239***			***1***	***19***	0
VIIIc-Ew	West	152	7.26	1174	P32-P33-P34	S02	27	1966	2
	Central	54	11.05	409			17	952	2
	East	23	6.23	172			4	219	1
	Total	**229**	***8.05***	**1754**			***48***	***3138***	2
VIIIc-Ee	Laredo	20	0.52	159	P43	S04	0	18	0
	Euskadi_off	14	17.57	102	P46-P49-P52	S05	5	443	4
	Euskadi_coast	17	186.82	123			96	4561	37
	Total	**51**	***67.30***	**383**			**101**	**5023**	13
VIIIb	Euskadi	16	16.93	128	P46-P49-P52	S05	9	431	3
	Total	***16***	***16.93***	***128***			***9***	***431***	3
	Total IXa	***80***	***37***	***271***			***40***	***2204***	8
	Total VIIIc	***316***	***17***	***2376***			***150***	***8161***	3
	Total VIIIb	***16***	***17***	***128***			***9***	***431***	3
	Total Spain	***412***	***20.74***	***2775***			***199***	***10795***	4

Sardine ranged in length from 13 to 26 cm, with a mode at 18 cm (Figure 5) which corresponds to quite large fish. Most fish in the entire surveyed area were assigned as belonging to the age 1 (29% of the abundance and 20% of the biomass), age 2 (28% of the abundance and 26% of the biomass) and age 3 (27% of the abundance and 29% of the biomass) years classes (Table 2, Figure 4).

By sub-area, IXa subdivision represents 21.1%, VIIIc West 0.3%, VIIIcEast-West 25.4% and VIIIcEast- East 53.1% of the total abundance. Galicia populations (IXaN and VIIIcW subdivisions) were dominated by age 1 fish whilst the Cantabrian area was mainly composed by older individuals (age 2 and 3) (Figure 5).

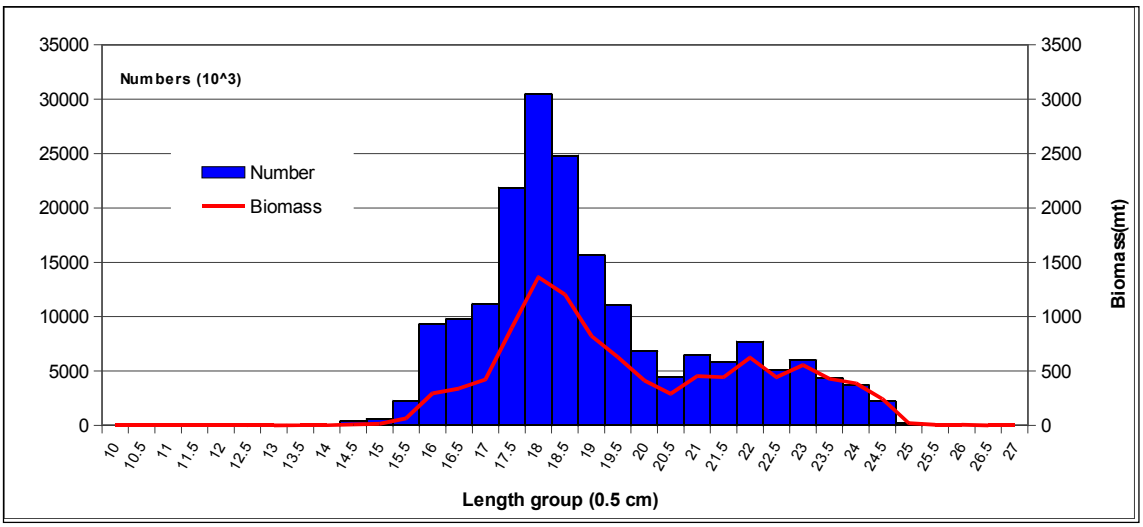

Figure 4. Sardine: fish length distribution in biomass and abundance during the PELACUS0315 survey (including VIIIb subdivision).

Table 2. Sardine abundance in number (thousand fish) and biomass (tons) by age group and ICES sub-area in PELACUS0315.

AREA VIIIcE											
AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	1384	2435	2602	597	376	291	344	106	25		8161
% Biomass	17.0	29.8	31.9	7.3	4.6	3.6	4.2	1.3	0.3		100
Abundance (N in '000)	34150	48892	46882	7856	4200	2966	3596	1022	219		149784
% Abundance	22.8	32.6	31.3	5.2	2.8	2.0	2.4	0.7	0.1		100
Medium Weight (gr)	40.5	49.8	55.5	76.0	89.6	98.2	95.7	103.7	113.2		80.2
Medium Length (cm)	17.6	18.9	19.5	21.7	23.0	23.7	23.5	24.2	24.9		21.9
AREA VIIIcW											
AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	15	3	1	0.1							19
% Biomass	78.7	13.9	6.9	0.4							100
Abundance (N in '000)	443	61	28	1							533
% Abundance	83.0	11.5	5.2	0.2							100
Medium Weight (gr)	34.6	44.1	48.5	61.4							23.6
Medium Length (cm)	16.7	18.1	18.7	20.3							9.2
AREA IXaN											
AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	721	225	366	297	238	145	150	51	12		2204
% Biomass	32.7	10.2	16.6	13.5	10.8	6.6	6.8	2.3	0.5		100
Abundance (N in '000)	21084	4150	5092	3523	2685	1546	1579	509	112		40279
% Abundance	52.3	10.3	12.6	8.7	6.7	3.8	3.9	1.3	0.3		100
Medium Weight (gr)	34.2	54.2	71.9	84.4	88.6	93.7	94.8	100.0	104.1		71.2
Medium Length (cm)	16.7	19.3	21.3	22.5	22.9	23.4	23.4	23.9	24.2		21.0
TOTAL SPAIN											
AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	2120	2663	2970	894	614	436	494	157	36		10384
% Biomass	20.4	25.6	28.6	8.6	5.9	4.2	4.8	1.5	0.4		100
Abundance (N in '000)	55677	53103	52002	11380	6885	4512	5176	1532	331		190596
% Abundance	29.2	27.9	27.3	6.0	3.6	2.4	2.7	0.8	0.2		100
Medium Weight (gr)	38.1	50.1	57.1	78.6	89.2	96.6	95.4	102.4	110.1		71.8
Medium Length (cm)	17.2	18.9	19.7	22.0	23.0	23.6	23.5	24.1	24.6		19.7

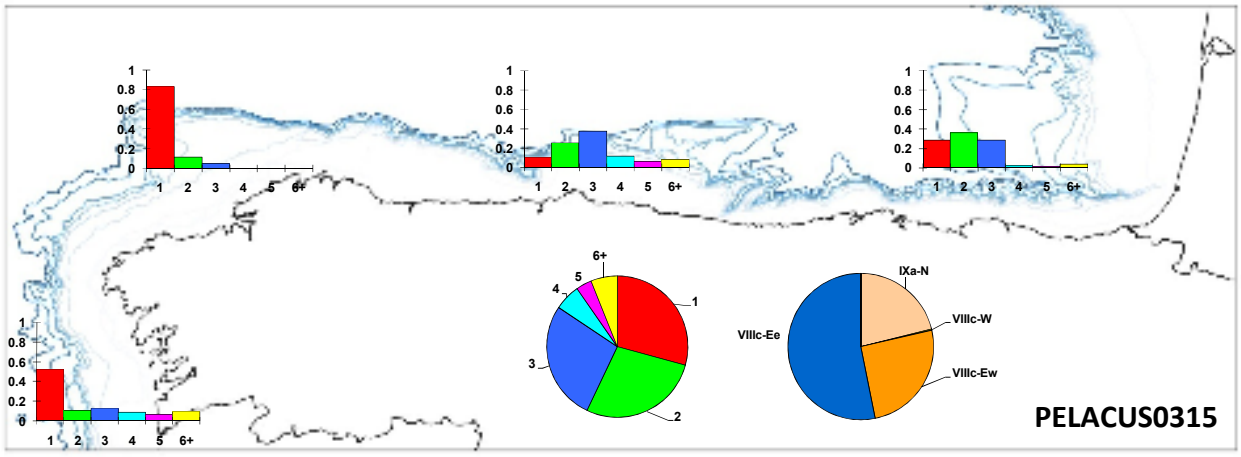

Figure 5. Sardine: relative abundance at age in each sub-area estimated in the PELACUS0315. The pie chart shows the contribution of each sub-area and each age group to the total stock numbers.

The distribution of sardine eggs (obtained from the analysis of 355 CUFES stations) indicates a coastal distribution, agreeing with that observed in previous years (Figure 6). Total number of sardine eggs detected in Spanish waters was 7588, which represents an important increase from the 2014 value (4214 in 358 CUFES stations). Sardine eggs showed a widespread distribution in the surveyed area, with higher percentage of positive stations than in previous years (45% in 2015, 33% in 2014, 28% in 2013).

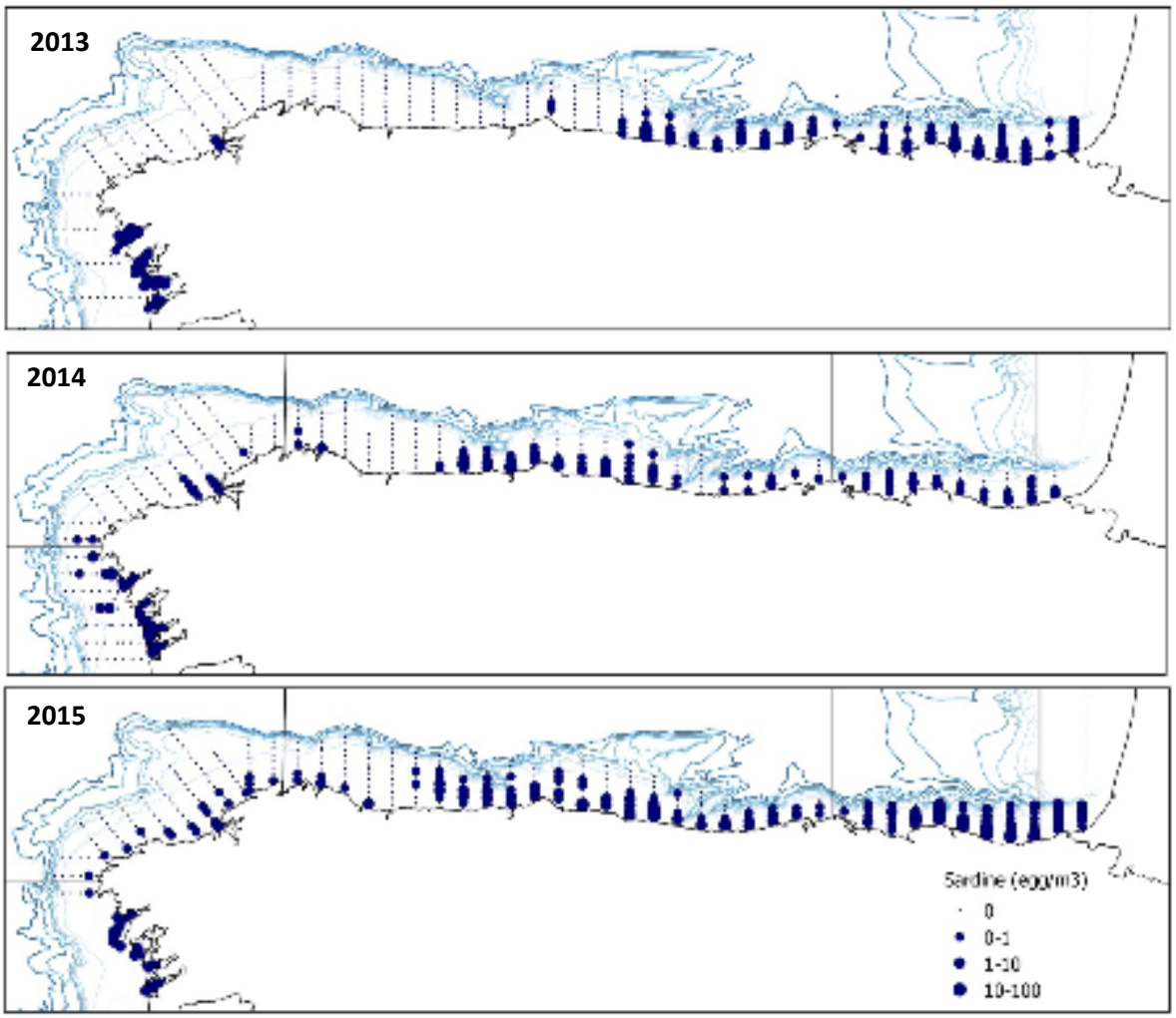

Figure 6. Sardine: distribution of sardine eggs (CUFES samples) in 2013-2015 PELACUS surveys. Blue circles indicate positive stations with diameter proportional to egg density.

Acknowledgements

We would like to thank all the participants and crew of the PELACUS surveys.

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