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PRELIMINARY RESULTS OF THE PELACUS0314 SURVEY: ESTIMATES OF SARDINE ABUNDANCE AND BIOMASS IN GALICIA AND CANTABRIAN WATERS

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Abstract

A total of 9,023 tons of sardine (147 million fish) was estimated to be present in northwest and northern Spanish waters by the Spanish spring acoustic survey PELACUS0314, carried out from 9th March to 8th April 2014. That represents an important increase in relation to 2013 abundance and biomass, but still at the lower levels of the time series.

Fish were mainly found in Cantabrian area (mainly in VIIIc East-West subdivision) and inside Rias Baixas (South Galicia, ICES sub-areas IXa-N) and was almost absent from the rest of the surveyed area. Most fish in the entire surveyed area were assigned as belonging to the age 2 (38% of the abundance and 43% of the biomass) and age 3 (24.5% of the abundance and 25.5 % of the biomass) years classes. By subdivisions, the IXaN (South of Galicia) population was dominated by age 1 fish whilst the Cantabrian area was mainly composed by a population of age 2 and age 3 individuals.

The distribution of sardine eggs (obtained from the analysis of 358 CUFES stations) indicates a very coastal distribution, agreeing with that observed in previous years The percentage of positive stations was very similar in both surveys, but total number of sardine eggs detected in Spanish waters was 4214, which represents an important decrease from the 2013 value.

Introduction

PELACUS 0314 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 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.

Survey was carried out from 9th March to 8th 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).

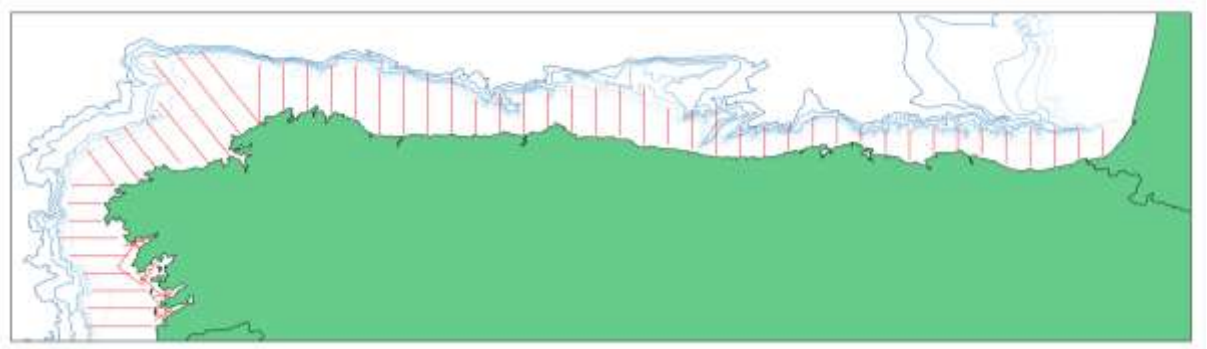

Figure 1. 2014 Survey track

Two different pelagic gears were used, depending of the depth of the area. Hauls were mainly performed in depths between 36 m and 554 m, with an average duration of 39 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 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 1903 nautical miles were steamed, 1075 corresponding to the survey track.
In the area surveyed, a total of 52 fishing stations were performed (Figure 2).

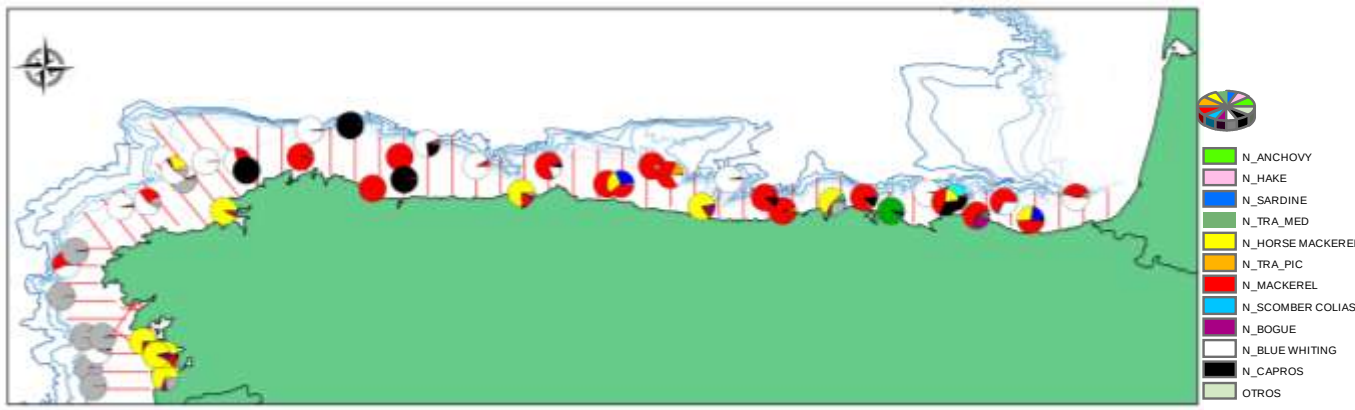

Figure 2: PELACUS0314 Fish proportion (abundance) at each fishing station

On the other hand, 358 CUFES stations, comprising 3 nautical miles each were taken, as shown in Figure 3.

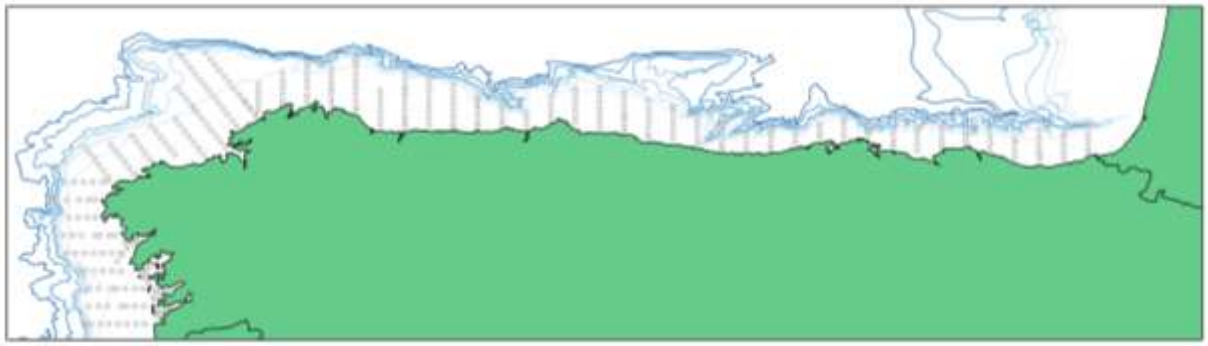

Figure 3. PELACUS0314 CUFES stations.

Results

Acoustic

Sardine distribution and assessment

Sardine was detected mainly in south Galicia, inside the Rias Baixas (ICES sub-areas IXa-N), showed a gap in the entire VIIIcWest subdivision and reappeared on the Asturias coast, covering all the VIIIcEast subdivision, but with lower densities in the Vasque Country area (Figure 4).

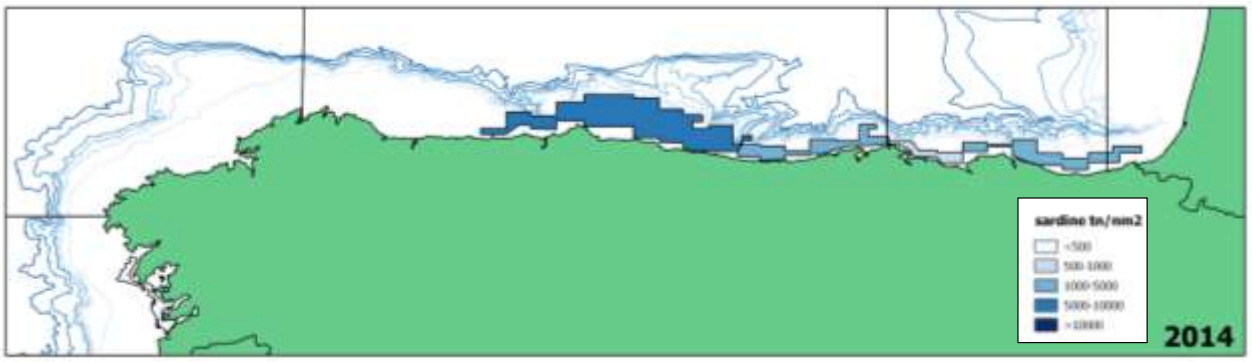

Figure 4. Sardine: spatial distribution of energy allocated to sardine during PELACUS0314 survey. Polygons are drawn to encompass the observed echoes, and polygon colour indicates sardine density in nm^2 within each polygon.

Contrary to the normal behaviour, and despite having detected more acoustic energy in the study area, 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 PELACUS0314 for the IXa and VIIIc subdivisions was estimated as 147×10^6 individuals corresponding to 9023 tons (149×10^6 individuals and 9130 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 (10^6 fish)	Biomass (tons)	Density (Kg/nmi-2)
IXa	Rias Baixas	52	2.63	103	P08-P09-P11	S01	1	50	488.63
	Total	**52**	**3**	**103**			**1**	**50**	
VIIIc-Ew	Asturias-W	111	41.20	856	P32-P33-P34	S02	121	7615	8898.08
	Asturias-E	28	17.64	218	P37	S03	15	782	3591.38
	Total	***139***	***36.45***	***1073***			***136***	***8397***	
VIIIc-Ee	Laredo	8	3.32	79	P43	S04	2	44	559.53
	Euskadi	30	11.24	216	P46-P49-P52	S05	8	532	2466.36
	Total	**38**	***9.57***	**295**			**10**	**576**	**1955.33**
VIIIb	Euskadi	2	11.24	43	P46-P49-P52	S05	2	107	2466.36
	Total	***2***	***11.24***	***43***			***2***	***107***	**2466.36**
	Total IXa	***52***	***3***	***103***			***1***	***50***	**488.63**
	Total VIIIc	***177***	***31***	***1368***			***146***	***8973***	**6558.55**
	Total VIIIb	***2***	***11***	***43***			***2***	***107***	
	Total Spain	***231***	***24.20***	***1514***			***149***	***9130***	**6029.75**

Sardine ranged in length from 14 to 25.5 cm, with a mode at 18.5 cm (Figure 5) which corresponds to quite large fish. Most fish in the entire surveyed area were assigned as belonging to the age 2 (38% of the abundance and 43% of the biomass) and age 3 (24.5% of the abundance and 25.5 % of the biomass) years classes (Table 2, Figure 4).

By sub-area, IXa subdivision represents 1%, VIIIcEast-East 6% and VIIIcEast-West 93% of the total abundance. The IXaN (South of Galicia) population was dominated by age 1 fish whilst the Cantabrian area was mainly composed by a population of age 2 and age 3 individuals (Figure 5).

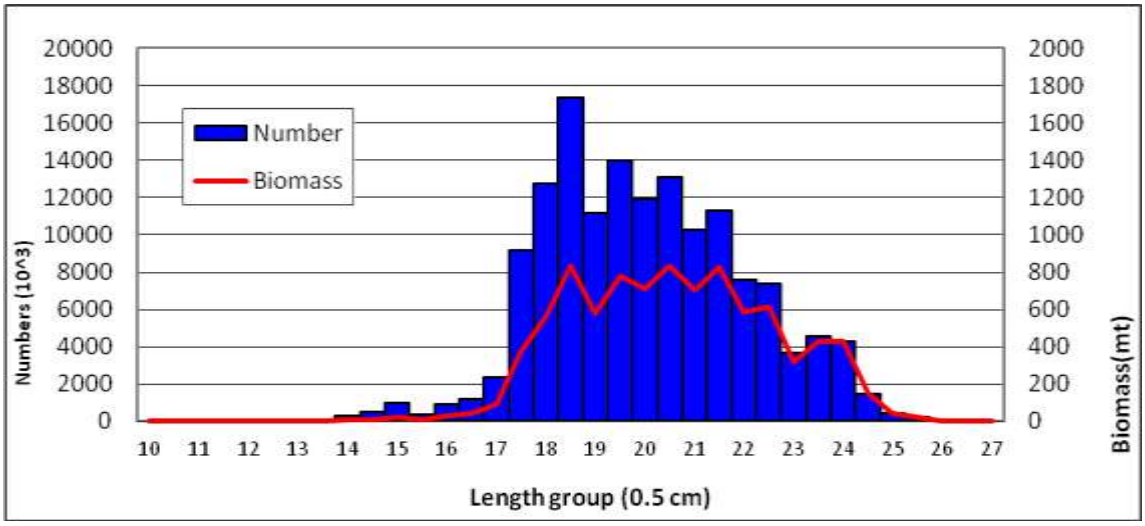

Figure 4. Sardine: fish length distribution in biomass and abundance during the PELACUS0314survey.

Table 2. Sardine abundance in number (thousand fish) and biomass (tons) by age group and ICES sub-area in PELACUS0314.

AREA VIIIcE											
AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	680	3409	2197	855	667	688	357	121			8973
% Biomass	7.6	38.0	24.5	9.5	7.4	7.7	4.0	1.3			100
Abundance (N in '000)	16147	63086	34238	11556	7892	7950	3762	1166			145796
% Abundance	11.1	43.3	23.5	7.9	5.4	5.5	2.6	0.8			100
Medium Weight (gr)	42.14	54.04	64.17	73.96	84.46	86.57	94.80	103.41			75.4
Medium Length (cm)	17.81	19.47	20.73	21.80	22.86	23.06	23.83	24.59			21.8
AREA IXaN											
AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	32	12	3	1	1	1	0	0			50
% Biomass	64.3	24.2	5.8	2.0	1.3	1.8	0.5	0.1			100
Abundance (N in '000)	980	275	45	14	8	10	3	0			1336
% Abundance	73.3	20.6	3.4	1.0	0.6	0.8	0.2	0.0			100
Medium Weight (gr)	32.9	44.1	63.8	72.4	82.3	85.4	88.2	93.5			63.5
Medium Length (cm)	16.4	18.1	20.7	21.6	22.7	23.0	23.2	23.8			20.4
TOTAL SPAIN											
AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	713	3421	2200	856	667	689	357	121			9023
% Biomass	7.9	37.9	24.4	9.5	7.4	7.6	4.0	1.3			100
Abundance (N in '000)	17229	63917	34731	11738	8029	8079	3824	1180			148728
% Abundance	11.6	43.0	23.4	7.9	5.4	5.4	2.6	0.8			100
Medium Weight (gr)	41.6	54.0	64.2	74.0	84.5	86.6	94.8	103.4			67.0
Medium Length (cm)	17.7	19.5	20.7	21.8	22.9	23.1	23.8	24.6			19.3

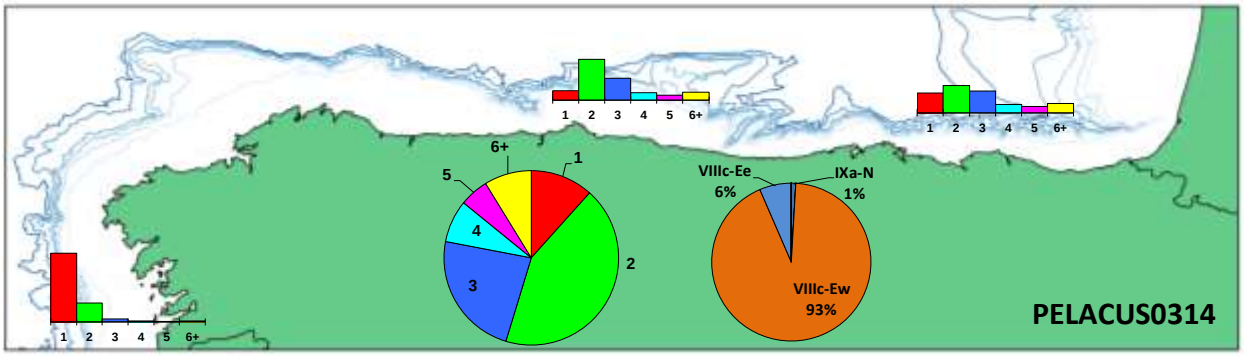

Figure 5. Sardine: relative abundance at age in each sub-area (i.e. the proportion of all age classes within sub-area sum to 1) estimated in the PELACUS0314. The pie chart shows the contribution of each sub-area and each age group to the total stock numbers.

The distribution of sardine eggs (obtained from the analysis of 358 CUFES stations) indicates a very coastal distribution, agreeing with that observed in previous years (Figure 6). Total number of sardine eggs detected in Spanish waters was 4214, which represents an important decrease from the 2013 value (5939 in 380 CUFES stations). The percentage of positive stations was very similar in both surveys (33% in 2014 *vs* 28% in 2013).

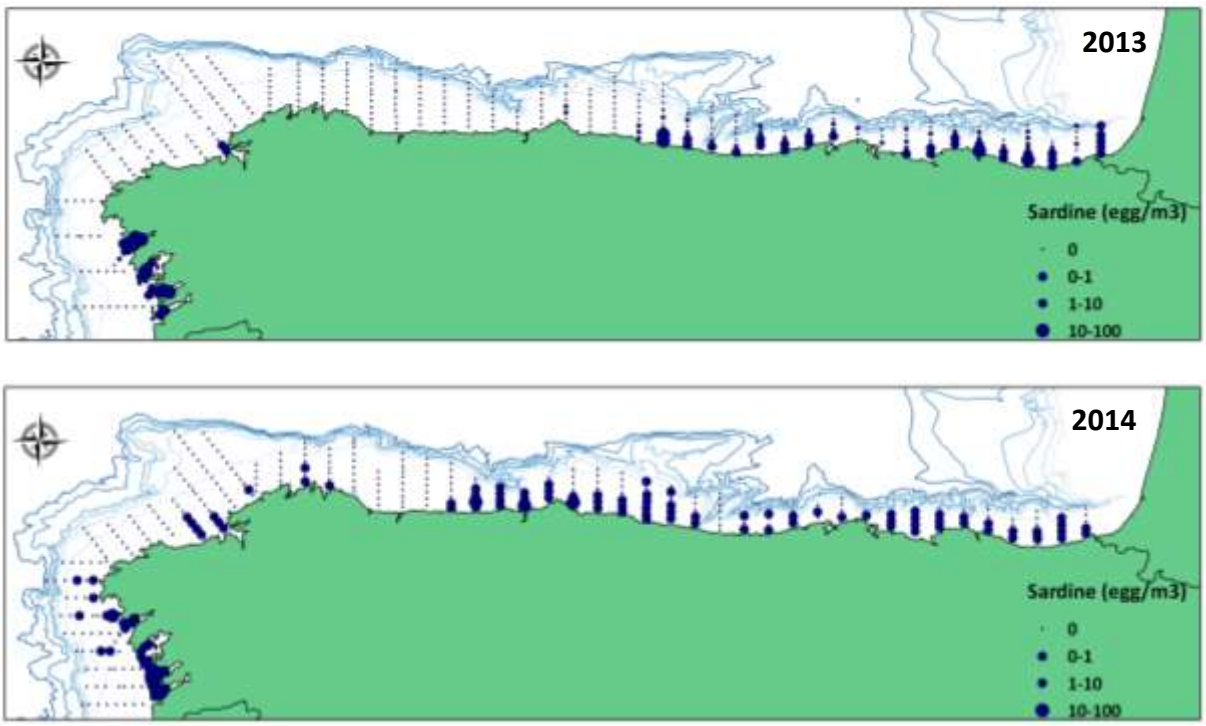

Figure 6. Sardine: distribution of sardine eggs (CUFES samples) in 2013-2014 PELACUS surveys. Blue circles indicate positive stations with diameter proportional to egg density.

Acknowledgements

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