

## Direct assessment of small pelagic fish by the PELGAS13 acoustic survey

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## 1. Material and method

### 1.1. PELGAS survey on board Thalassa

Acoustic surveys are carried out every year in the Bay of Biscay in spring onboard the French research vessel Thalassa. The objective of PELGAS surveys is to study the abundance and distribution of pelagic fish in the Bay of Biscay. The main target species are anchovy and sardine but they are considered in a multi-specific context and within an ecosystemic approach as they are located in the centre of pelagic ecosystem.

These surveys are connected with IFREMER programs on data collection for monitoring and management of fisheries and ecosystemic approach for fisheries. This task is formally included in the first priorities defined by the Commission regulation EU N° 199/2008 of 06 November 2008 establishing the minimum and extended Community programmes for the collection of data in the fisheries sector and laying down detailed rules for the application of Council Regulation (EC) No 1543/2000. These surveys must be considered in the frame of the Ifremer fisheries ecology action "resources variability" which is the French contribution to the international Globec programme. It is planned with Spain and Portugal in order to have most of the potential area covered from Gibraltar to Brest with the same protocol regarding sampling strategy. Data are available for the ICES working groups WGHANSA, WGWIDE and WGACEGG.

In the spirit of the ecosystemic approach, the pelagic ecosystem is characterised at each trophic level. To achieve this and to assess an optimum horizontal and vertical description of the area, two types of actions are combined :

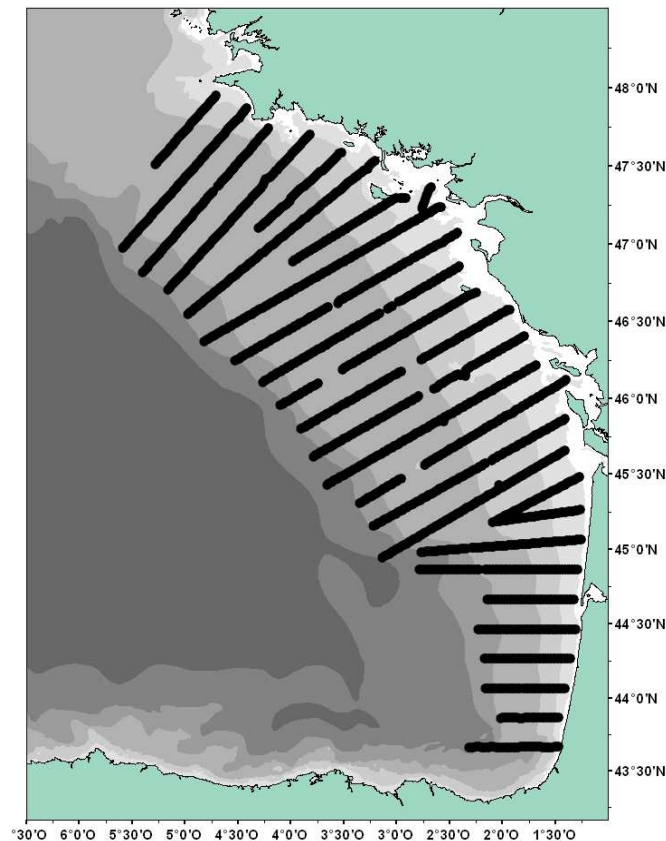
- 1) Continuous acquisition of acoustic data from six different frequencies and pumping sea-water under the surface in order to evaluate the number of fish eggs using a CUFES system (Continuous Under-water Fish Eggs Sampler)

2) discrete sampling at stations (by pelagic trawls, plankton nets, CTD). Satellite imagery (temperature and sea colour) and modeling have been also used before and during the survey to recognise the main physical and biological structures and to improve the sampling strategy. Concurrently, a visual counting and identification of cetaceans and birds (from board) carried out in order to characterise the higher level predators of the pelagic ecosystem.

The strategy this year was the identical to previous surveys (2000 to 2012). The protocol for acoustics has been described during WGACEGG in 2009 (*Doray et. Al,2009*):

- acoustic data were collected along systematic parallel transects perpendicular to the French coast (figure 1.1.1). The length of the ESDU (Elementary Sampling Distance Unit) was 1 mile and the transects were uniformly spaced by 12 nautical miles and cover the continental shelf from 20 m depth to the shelf break (or sometimes more offshore – see figure below).

- acoustic data were only collected during the day because of pelagic fishes behaviour in this area. These species are usually dispersed very close to the surface during the night and so "disappear" in the blind layer of the echo-sounders between the surface and 8 m depth.



**Fig. 1.1.1** - Transects prospected during PELGAS13 by Thalassa.

Three different echo-sounders were used during the survey :

In 2013, as in previous surveys (since 2009), three modes of acoustic observations were used :

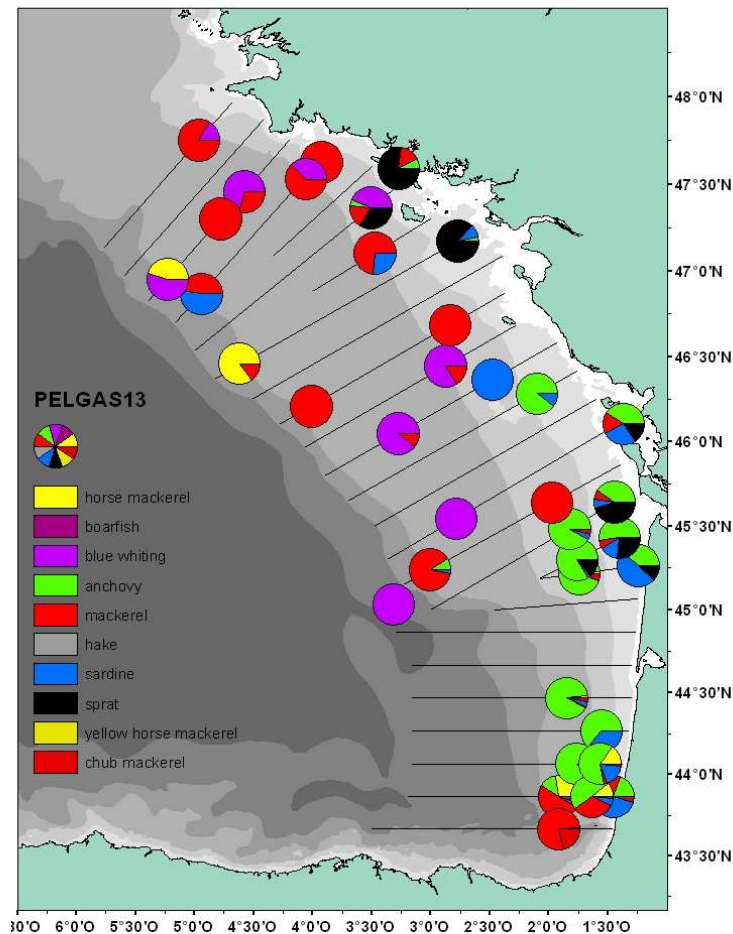
- 6 split beam vertical echo-sounders (EK60), 6 frequencies, 18, 38, 70, 120, 200 and 333 kHz

- 1 horizontal echo-sounder on the starboard side for surface echo-traces
- 1 SIMRAD ME70 multi-beam echo-sounder (32 x 2°beams, from 70 to 120 kHz) used essentially for visualisation to observe the behaviour and shapes of fish schools during the whole survey. Nevertheless, only echoes stored on the vertical echo-sounder were used for abundance index calculation.

Energies and samples provided by all sounders were simultaneously visualised and stored using the MOVIES+ and MOVIES3D software and stored at the same standard HAC format.

The calibration method was the same that the one described for the previous years (see WD 2001) and was performed at anchorage in the Douarnenez bay, in the West of Brittany, in medium meteorological conditions at the end of the survey.

Acoustic data were collected by R/V Thalassa along a total amount of 6500 nautical miles from which 1770 nautical miles on one way transect were used for assessment. A total of 24 432 fishes were measured (including 6260 anchovies and 5910 sardines) and 2633 otoliths were collected for age determination (1249 of anchovy and 1384 of sardine).



**Fig. 1.1.2:** Species distribution according to Thalassa identification hauls.

## 1.2. The consort survey

A consort survey is routinely organised since 2007 with French commercial vessels during 18 days. This approach, in the continuity of last year survey, and their trawl hauls were used for echoes identification and biological parameters at the same level than Thalassa ones.

Five commercial vessels (two pairs of pelagic trawlers during the two first weeks and a single pelagic trawler for the 4 last days) participated to PELGAS13 survey:

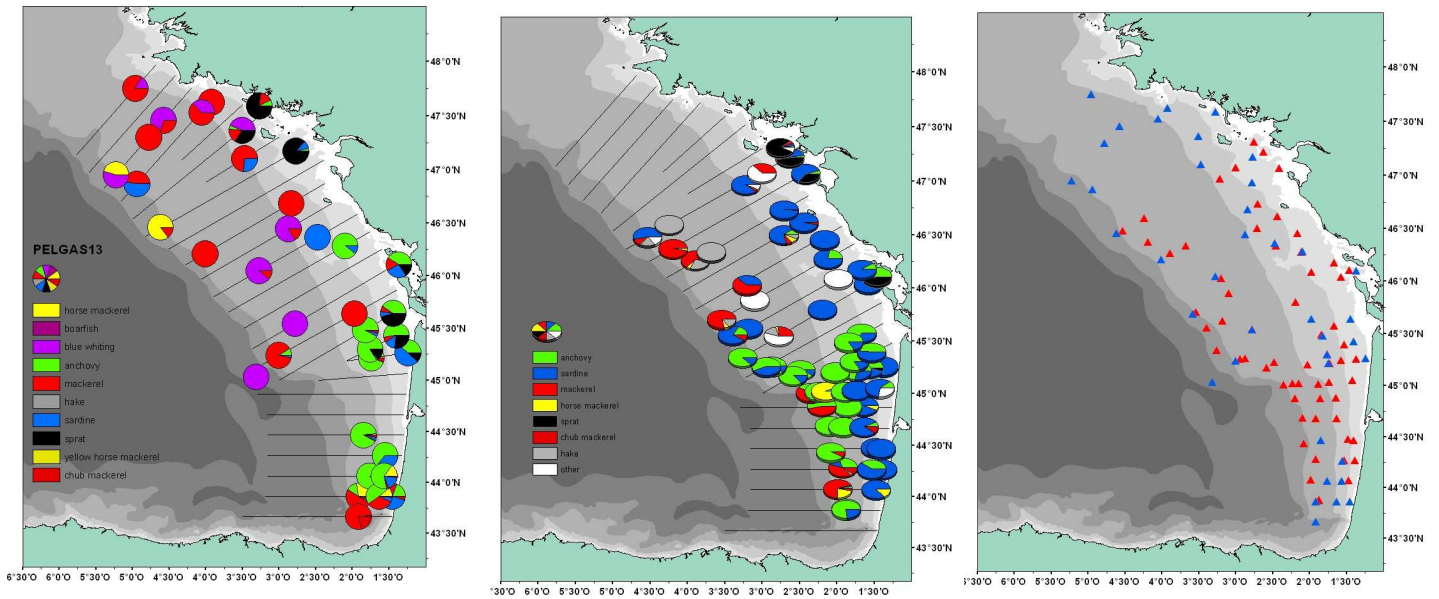
Vessel	gear	Period	Days at sea
Jérémi-Simon / Prométhée	Pelagic pair trawl	29/04 to 05/05/2013	7
Maïlys-Charlie / Pen Kiriak III	Pelagic pair trawl	06/05 to 12/05/2013	7
Bara Pemdez II	Pelagic single trawl	15/05 to 18/05/2011	4

The regular transects network agreed for several years for Thalassa is 12 miles separated parallel transects. Commercial vessels worked between standard transects and 2 NM northern. Sometimes, they carried out fishing operations on request (complementary to Thalassa, particularly for surface hauls or in very coastal areas) Their pelagic trawl was until 25 m vertical opening and the mesh of their codend was similar to Thalassa (12 mm).

A scientific observer was onboard to control every operation, and to collect biological data. The fishing operations were systematically agreed after a radio contact with Thalassa in order to confirm their usefulness. In some occasions, the use was to check the spatial extension of species already observed and identified by Thalassa (and therefore the spatial distribution), in others the objective was to enlarge the vertical distribution description by stratified catches. Globally, a great attention was given on a good distribution of samples to avoid over-sampling on some situations. Regularly a biological sample was provided by commercial vessels to Thalassa to improve otoliths collection and sexual maturity (18 samples of sardine, 15 of anchovy). A total of 10 600 fishes were measured onboard commercial vessels, including 4103 anchovies and 4067 sardines.

The catches and biological data have been directly used with the same consideration than Thalassa ones for identification and biological characterisation.

A total of 101 hauls were carried out during the assessment coverage including 39 hauls by Thalassa and 62 hauls by commercial vessels.



a) *Thalassa* (nb :39)

b) *Commercial vessels* (nb : 62)

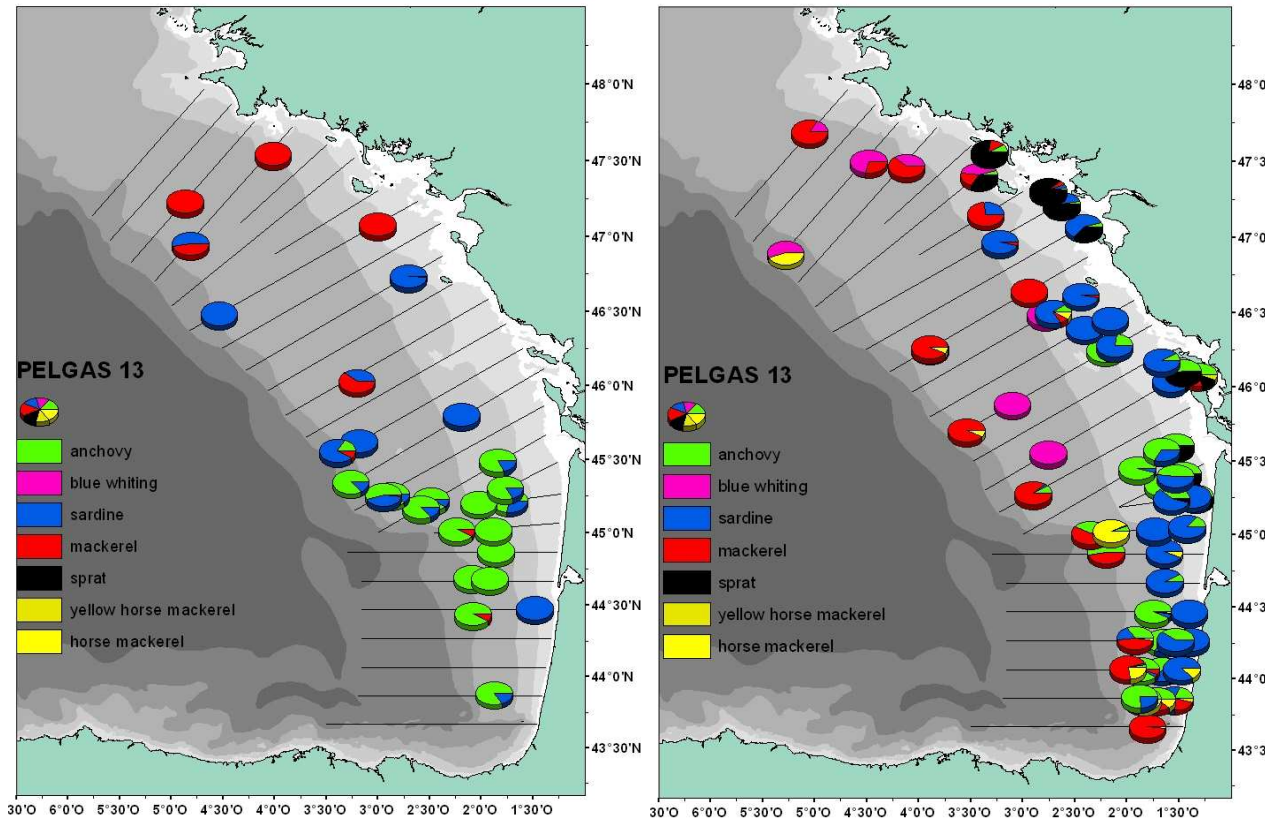
c) *all fishing hauls* (nb :101)

**Figure 1.2.2** : fishing operations carried out by *Thalassa* and commercial vessels during consort survey PELGAS13

The collaboration between *Thalassa* and commercial vessels was excellent. It was once more a very good opportunity to explain to fishermen our methodology and furthermore, to verify that both scientists and fishermen observe the same types of echo-traces and have similar interpretations. Some fishing operations were done in parallel by *Thalassa* and commercial vessel in order to check if the catches were well comparable (in proportion of species and, most of the time, in quantity as well). As last year, the fishing operations by commercial vessels were carried out only during day time (as for *Thalassa*) each time it was necessary and preferentially at the surface or in mid-water, since the pair trawlers are more efficient at surface than single back trawlers.

	<b>R/V <i>Thalassa</i></b>	<b>Commercial vessels</b>	<b>Total</b>
<b>Surface Hauls</b>	<b>3</b>	<b>35</b>	<b>38</b>
<b>Classic Hauls</b>	<b>29</b>	<b>23</b>	<b>52</b>
<b>Valid</b>	<b>32</b>	<b>58</b>	<b>90</b>
<b>Null</b>	<b>7</b>	<b>4</b>	<b>11</b>
<b>Total</b>	<b>39</b>	<b>62</b>	<b>101</b>

**Table 1.2.3.** : number of fishing operations carried out by *Thalassa* and commercial vessels during consort survey PELGAS13



a) Hauls carried out at surface or in mid-water levels (Thalassa & commercial vessels)

b) classic Hauls carried out near the bottom and 50m upper (Thalassa + commercial vessels)

**Figure 1.2.4 :** Vertical localisation of fishing operations carried out by Thalassa and commercial vessels during survey PELGAS13

## 2. Acoustics data processing

### 2.1. Echo-traces classification

All the acoustic data along the transects were processed and scrutinised by the date of the meeting (figure 2.2.1). Acoustic energies ( $S_a$ ) have been cleaned by sorting only fish energies (excluding bottom echoes, parasites, plankton, etc.) and classified into 4 categories of echo-traces this year :

D1 – energies attributed to mackerel, chub mackerel, horse mackerel, blue whiting, hake, whiting, corresponding to cloudy schools or layers (sometimes small dispersed points) close to the bottom or of small drops in a 10m height layer close to the bottom.

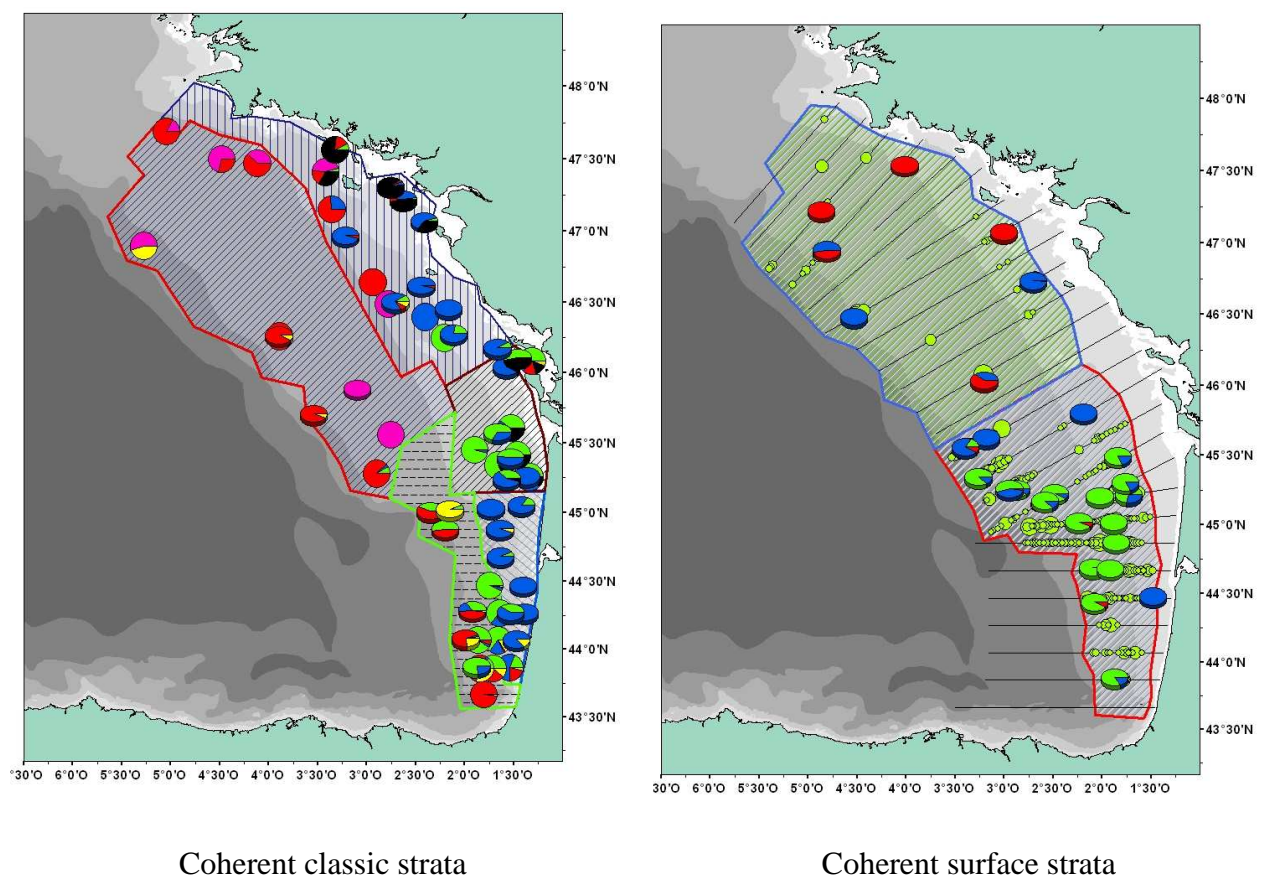
D2 –energies attributed to anchovy, sardine, and sprat corresponding to the usual echo-traces observed in this area since more than 15 years, constituted by schools well defined, mainly situated between the bottom and 50 meters above. These echoes are typical of clupeids in coastal areas and sometimes more offshore.

D4 – energies attributed to sardine, mackerel and anchovy corresponding to small and dense echoes, very close to the surface.

D8 – energies attributed exclusively to sardine (big and very dense schools).

## 2.2. Splitting of energies into species

As for previous years (except in 2003, see WD-2003), the global area has been split into several strata where coherent communities were observed (species associations) in order to minimise the variability due to the variable mixing of species. Figure 2.2. shows the strata considered to evaluate biomass of each species. For each strata, energies were converted into biomass by applying catch ratio, length distributions and weighted by abundance of fish in the haul surrounded area.



**Fig. 2.2.** – Coherent strata (classic and surface), in terms of echoes and species distribution, taken into consideration for multi-species biomass estimate from acoustic and catches data during PELGAS13 survey.

## 2.3. Biomass estimates

The fishing strategy has been followed all along the survey in order to profit of the best efficiency of each vessel and maximise the number of samples (in term of identification and biological parameters as well). Therefore, the commercial vessels carried out mostly surface hauls when *Thalassa* fish preferably in the bottom layer. According to previous strata,

using both Thalassa and consort fishing operations, biomass estimates have been calculated for each main pelagic species in the surveyed area.

Biomass indices are gathered in table 2.3.1. and 2.3.2. and figure 2.3.1. No estimate has been provided for mackerel according to the low level of TS and particular behaviour in the Bay of Biscay where it is scattered and mixed with soft plankton echoes.

Anchovy was present this year as an abundance index around the average on the serie, a bit more than 93 000 tonnes, including one fourth of this abundance in the surface layer.

Sardine was well present this year, mostly in coastal waters from the south until the North of the bay of Biscay. It was also spotted offshore (mainly in the Northern part), in lower quantities than anchovy, near the surface.

About other species, the main characteristic of this year is that mackerel was very present, along the shelfbreak in the South and all along the platform in the North part of the Bay of Biscay.

As previous years, horse mackerel was very rare, scattered along the shelf. Another particularity of this year is the presence of sprat in the river plumes, according to the fresh water discharges from the rivers.

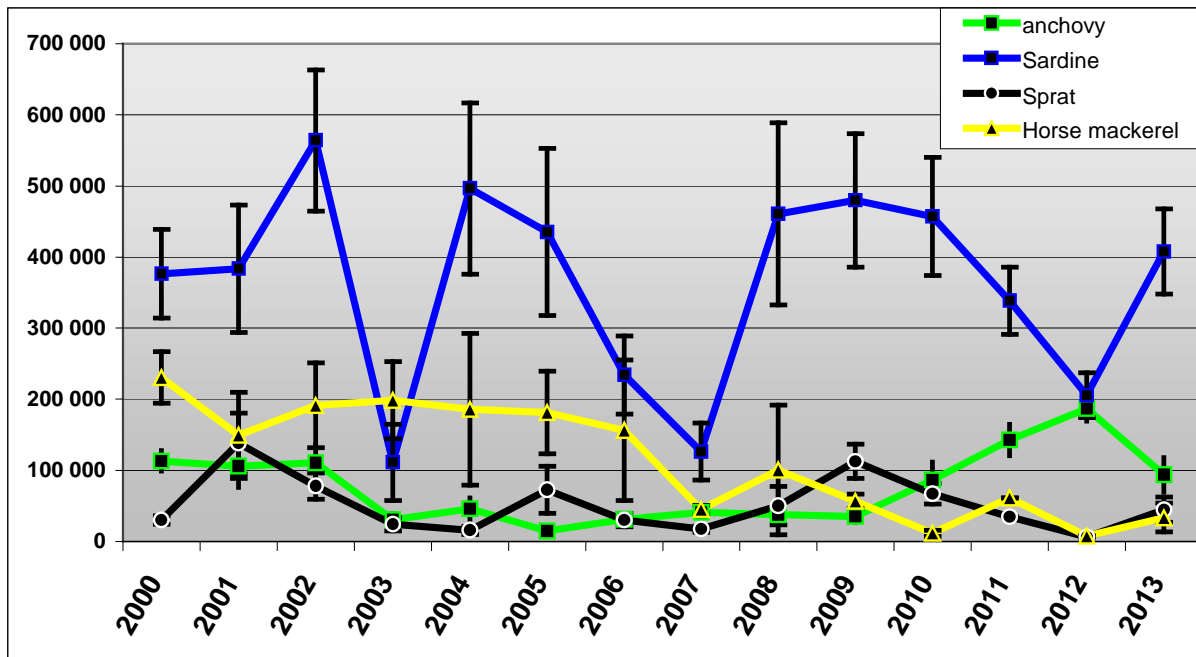
	<b>Classic</b>	<b>Surface</b>	<b>total</b>
<b>anchovy</b>	68 710	25 144	93 854
<b>sardine</b>	366 378	41 363	407 740
<b>sprat</b>	44 651		44 651
<b>mackerel</b>	627 418	105 320	732 739
<b>horse mackerel</b>	33 471		33 471
<b>blue whiting</b>	51 430		51 430

Table 2.3.1. Acoustic biomass index for sardine and anchovy by strata during PELGAS13

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>anchovy</b>	113 120	105 801	110 566	30 632	45 965	14 643	30 877	40 876	37 574	34 855	86 354	142 601	186 865	93 854
<i>CV anchovy</i>	0.064	0.141	0.113	0.132	0.167	0.171	0.136	0.100	0.162	0.112	0.147	0.0774	0.0466	0.1282
<b>Sardine</b>	376 442	383 515	563 880	111 234	496 371	435 287	234 128	126 237	460 727	479 684	457 081	338 468	205 627	407 740
<i>CV sardine</i>	0.083	0.117	0.088	0.241	0.121	0.135	0.117	0.159	0.139	0.098	0.091	0.0699	0.0767	0.0738
<b>Sprat</b>	30 034	137 908	77 812	23 994	15 807	72 684	30 009	17 312	50 092	112 497	67 046	34 726	6 417	44 651
<i>CV sprat</i>	0.098	0.155	0.120	0.198	0.178	0.228	0.162	0.132	0.268	0.108	0.108			0.1992
<b>Horse mackerel</b>	230 530	149 053	191 258	198 528	186 046	181 448	156 300	45 098	100 406	56 593	11 662	61 237	7 435	33 471
<i>CV HM</i>	0.079	0.204	0.156	0.137	0.287	0.160	0.316	0.065	0.455	0.09	0.188			0.3007
<b>Blue Whiting</b>	-	-	35 518	1 953	12 267	26 099	1 766	3 545	576	4 333	48 141	11 823	68 533	25 715
<i>CV BW</i>	-	-	0.386	0.131	0.202	0.593	0.210	0.147	0.253	0.219	0.074			0.1542

Table 2.3.2. Acoustic biomass index for the five main pelagic species since the beginning of PELGAS surveys (2000)





**figure 2.3.1.** – biomass estimate using *Thalassa* acoustic data along transects and all the consort identification fishing operations (*Thalassa* + pair trawlers) and coefficients of variation associated.

### 3. Anchovy data

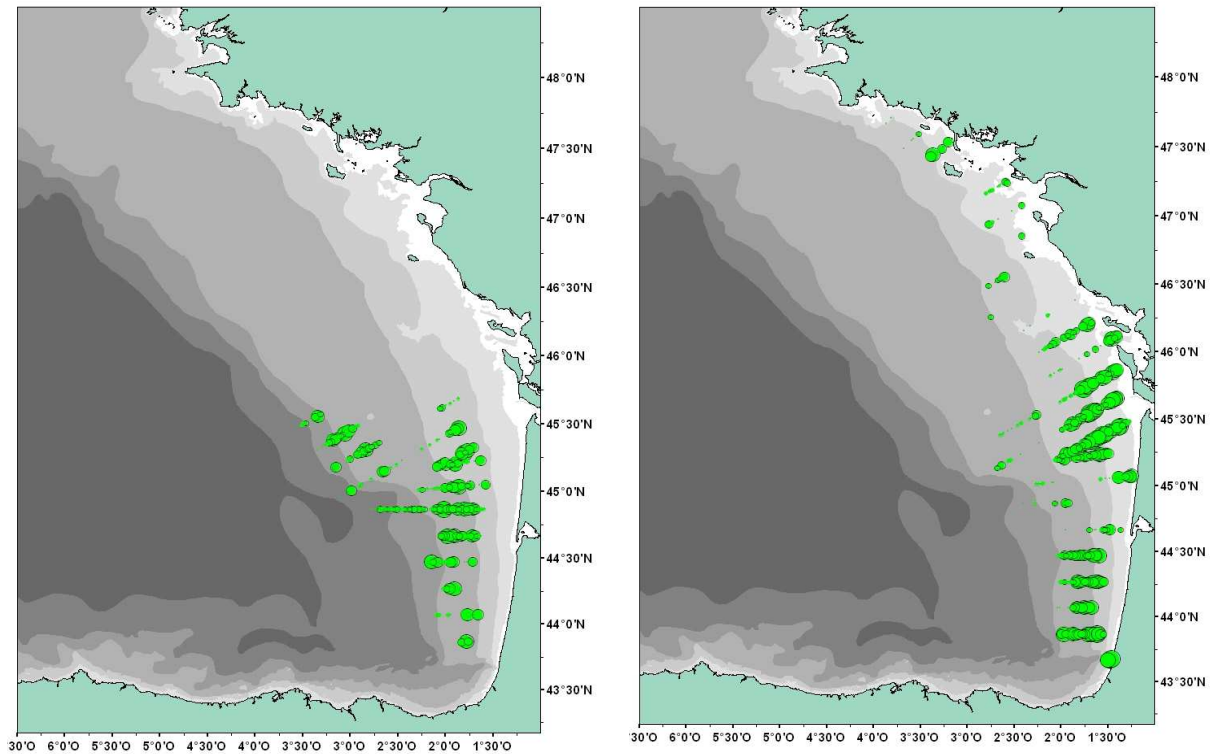
#### 3.1. anchovy biomass

The main observation in 2013 is that anchovy was present in important densities at the shelfbreak, near the surface, as abundance in this layer never observed before. These echoes were systematically identified on each transect and revealed most of the time pure anchovy (the biggest individual this year) or at least a large majority of anchovy.

In the Gironde area, we found a configuration more classic (in size and in  $S_a$ ), with an acoustic energy attributed to anchovy about the average, and far away from the very high energies from 2012. Nevertheless, anchovy was predominant in this area. The most part of the age 1 of anchovy was there, in size class comparable with a “normal” year (all, except 2012 where the fish was much smaller).

In the South part of the bay of Biscay, anchovy was also well present in the middle of the platform, in the whole water column (close to the bottom until the surface).

On the South coast of Brittany, little sightings of anchovy occurred around the Loire river.



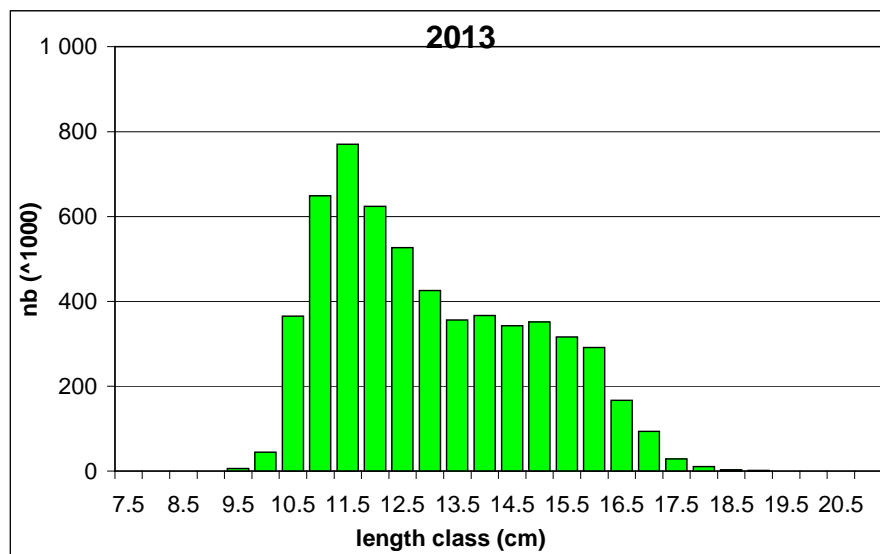
Surface distribution

Classic distribution, between the bottom and 40m above

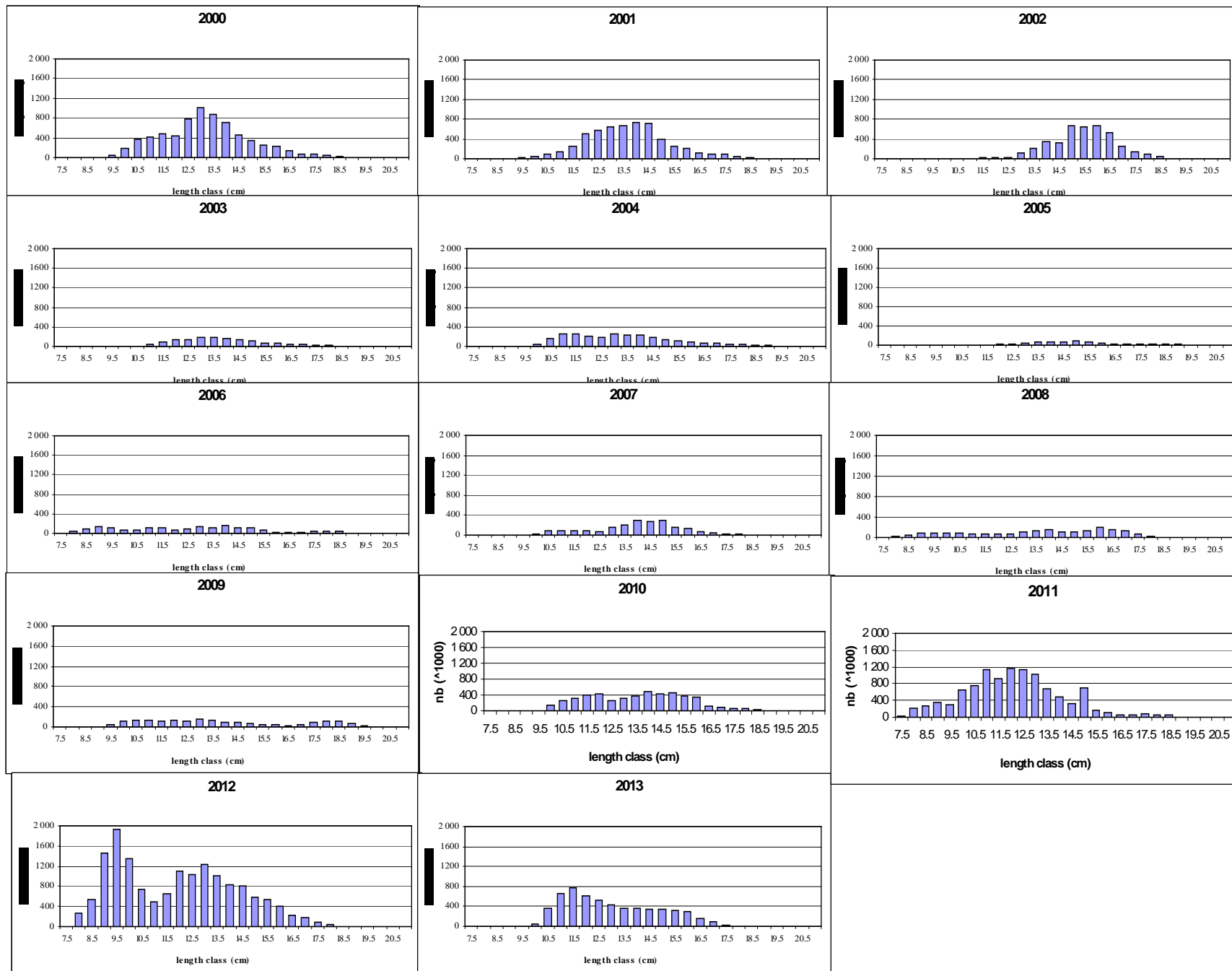
**Figure 3.1.** – Anchovy distribution according to PELGAS13 survey.

### 3.2. Anchovy length structure

Length distribution in the trawl haul were estimated from random samples. The population length distributions (figures 3.2.1 and 3.2.2) has been estimated by a weighted average of the length distribution in the hauls. Weights used are acoustic coefficients (Dev\* $X_e$  Moule in thousands of individuals per  $n.m.^2$ ) which correspond to the abundance in the area sampled by each trawl haul.



**Figure 3.2.1:** length distribution of global anchovy as observed during PELGAS13 survey



**Figure 3.2.2.** – length composition of anchovy as estimated by acoustics since 2000

### 3.3. Demographic structure

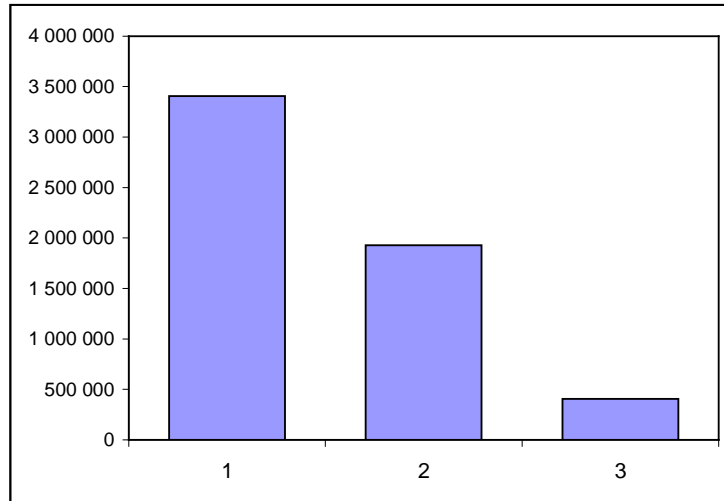
An age length key was built for anchovy from the trawl catches (Thalassa hauls) and samples from commercial vessels. We took the otoliths from a set number of fishes per length class (4 to 6 /half-cm), for a total amount of around 50 fish per haul. As there was a lot of fishing operations where anchovy was present, the number of otoliths we took during the survey was more or less the same as the 3 last years (1248 otoliths read on board), The population length distributions were estimated by a weighted use of length distributions in the hauls, weighted as described in section 3.2.

**Table 3.3.1.** PELGAS13 anchovy Age/Length key.

taille (mm)	1	2	3	4	Total
85	100%				100%
90	100%				100%
95	100%				100%
100	92%	8%			100%
105	83%	17%			100%
110	86%	14%			100%
115	88%	10%	2%		100%
120	80%	20%			100%
125	73%	22%	5%		100%
130	76%	20%	5%		100%
135	61%	34%	5%		100%
140	53%	43%	4%		100%
145	35%	59%	7%		100%
150	20%	62%	18%		100%
155	5%	78%	17%		100%
160		73%	27%		100%
165	2%	74%	24%		100%
170		68%	32%		100%
175		53%	47%		100%
180		47%	53%		100%
185			100%		100%
190		100%			100%

Applying the age distributions to the abundance in biomass and numbers, the distribution in age of the biomass has been calculated. The total biomass used here has been updated with the value obtained from the previous method based on strata.

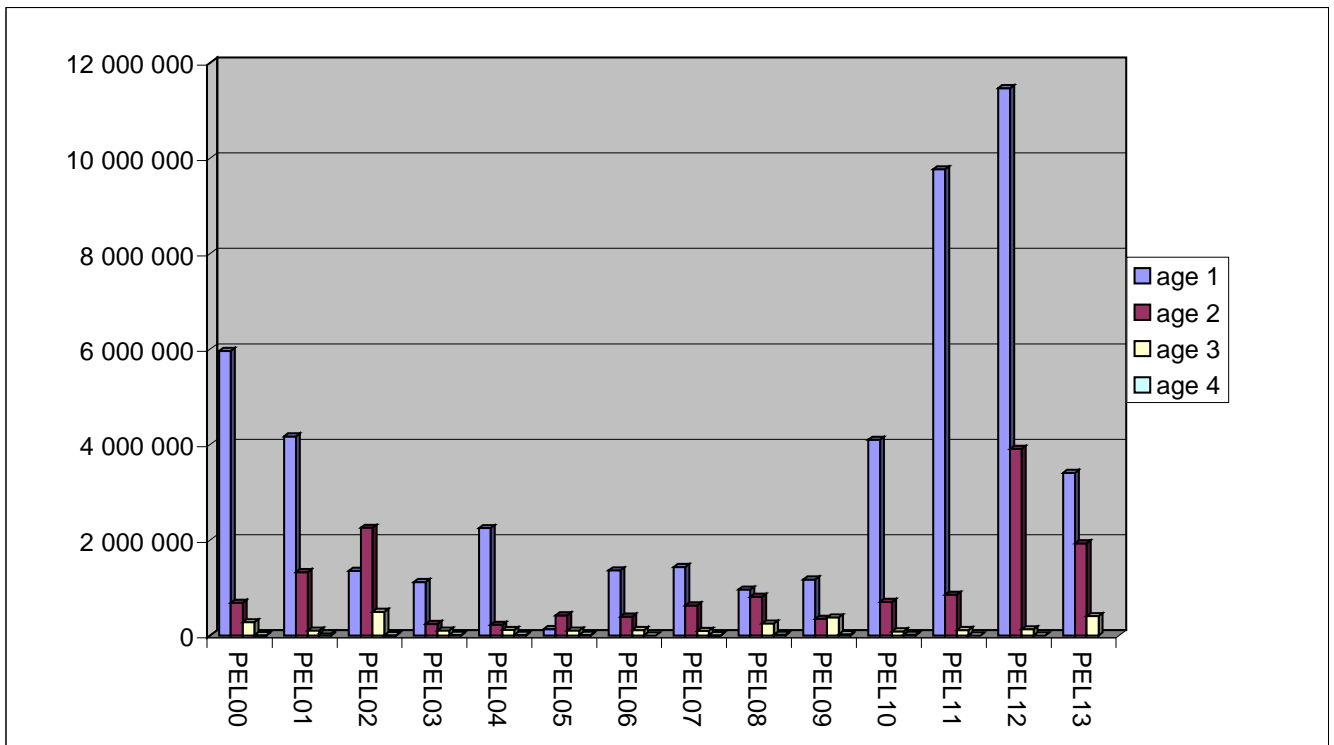
Age distribution is shown in figures 3.3.2. The age distributions compared from 2000 to 2012 are shown in figure 3.3.3.



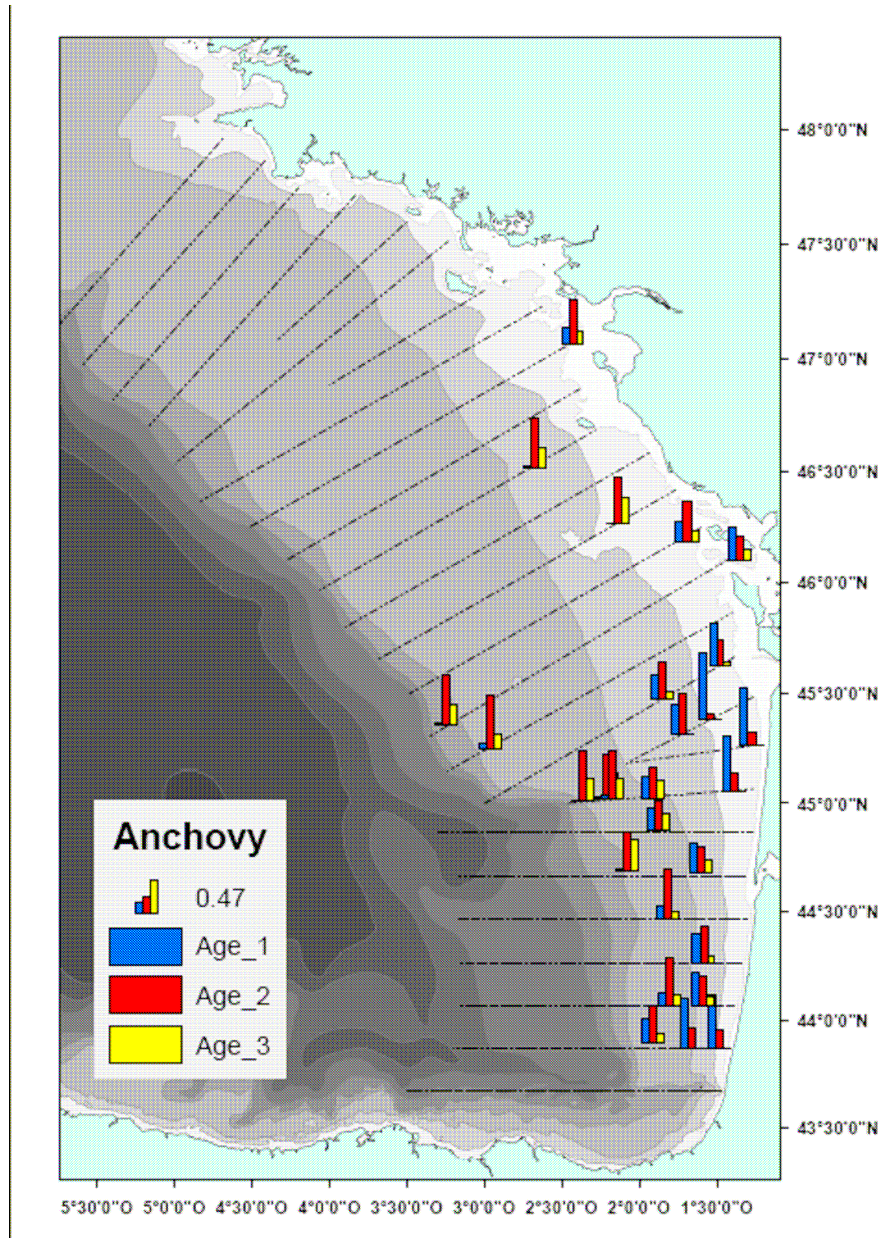
**Figure 3.3.2**— global age composition (numbers) of anchovy as observed during PELGAS13.

Looking at the numbers at age since 2000 (fig 3.3.3.), the number of 1 year old anchovies this year seems to be around the average of the serie, but far away from the two previous years level of recruitment.

The number of age 2 this year indicates maybe a light overestimate of the last year recruitment. But it must be noticed that the high densities and abundance of anchovy (mainly 2 years old) near the surface, thus in the blind layer of the Thalassa echo-sounders, lead probably to an underestimation of the age classes 2 and 3.



**Figure 3.3.3** Anchovy numbers at age as observed during PELGAS surveys since 2000



**Figure 3.3.4** Anchovy proportion at age in each haul as observed during PELGAS13 survey.

During previous surveys, anchovy was well geographically stratified depending on the age (see WD 2010, *Direct assessment of small pelagic fish by the PELGAS10 acoustic survey, Masse J and Duhamel E.*). It is less true this year as age1 were as usual predominant in the Gironde area, but also dispersed on the platform, mixed with age 2. The surface anchovy, present at the shelfbreak in the area called “fer à cheval” was almost exclusively constituted by age 2 and 3. At least, no age 4 was observed this year, on 1248 otoliths read.

age	PEL13 % - nk
1	59.3
2	33.6
3	7.1
4	0

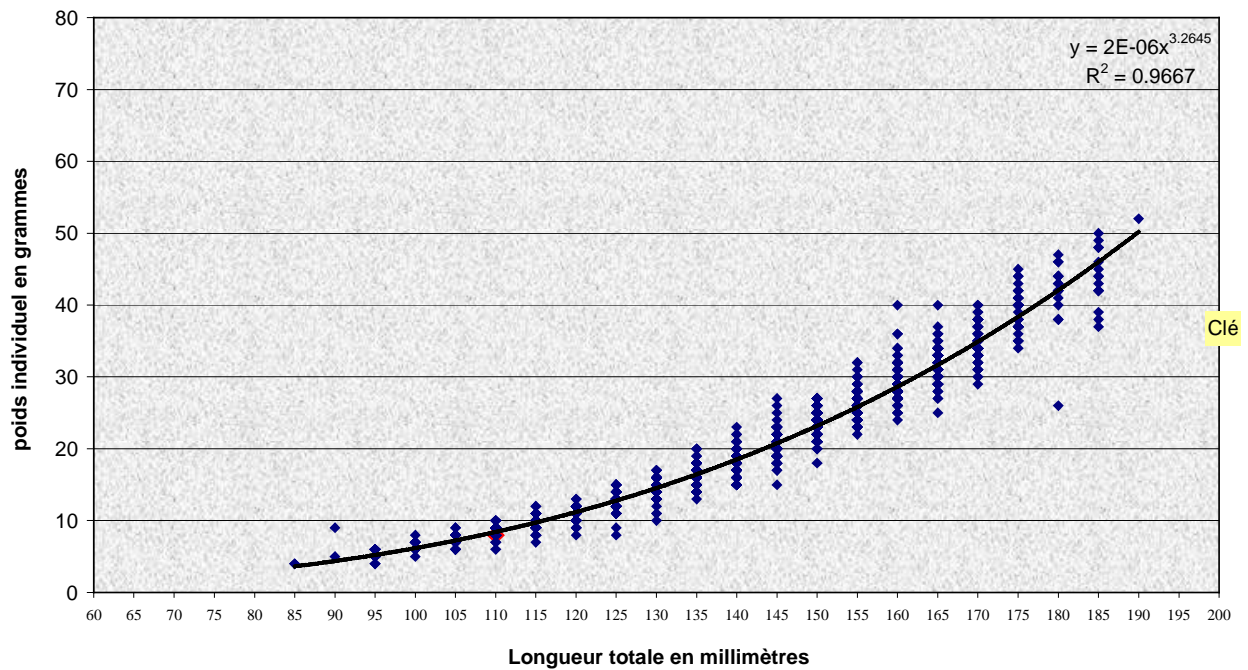
age	PEL13_%_W
1	45.29%
2	43.41%
3	11.30%
4	0.00%

**Figure 3.3.5** percentage by age of the Anchovy population observed during PELGAS13 in numbers (left) and biomass (right).

### 3.4. Weight/Length key

Based on 1248 weights of individual fishes, the following weight/length key was established (figure 4.5.) :

$$W = 2E-06L^{3.2645} \text{ with } R^2 = 0.9667 \text{ (with } W \text{ in grams and } L \text{ in mm)}$$



**Fig. 3.4.** – Weight/length key of anchovy established during PELGAS13

### 3.5. Mean Weigth at age

mean weigth at age (g)	AGE					
survey		1	2	3	4	5
PEL00		14.78	25.98	30.62	36.06	
PEL01		16.09	25.91	21.28	36.39	
PEL02		20.41	27.17	28.49	36.85	
PEL03		16.73	25.63	32.79	28.79	
PEL04		15.12	32.83	36.98	52.32	
PEL05		18.80	26.29	32.75	30.74	
PEL06		13.39	25.47	31.87	46.12	
PEL07		17.80	24.28	20.66		
PEL08		11.57	26.94	27.34	27.37	
PEL09		15.26	31.04	40.24	41.59	
PEL10		15.74	25.94	34.78	48.11	50.52
PEL11		11.33	27.13	26.02	60.54	
PEL12		7.72	19.70	20.85	35.36	
PEL13		12.61	21.34	26.46		

**Fig. 3.5.** – mean Weight at age (g) of anchovy for each PELGAS survey

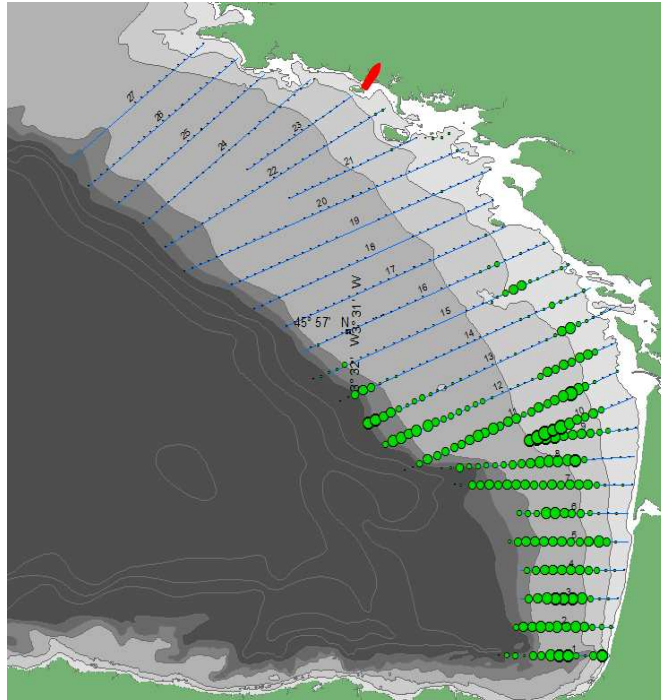
### 3.6. Eggs

During this survey, in addition of acoustic transects and pelagic trawl hauls, 650 CUFES samples were collected and counted, 70 vertical plankton hauls and 73 vertical profiles with CTD were carried out. Eggs were sorted and counted during the survey.

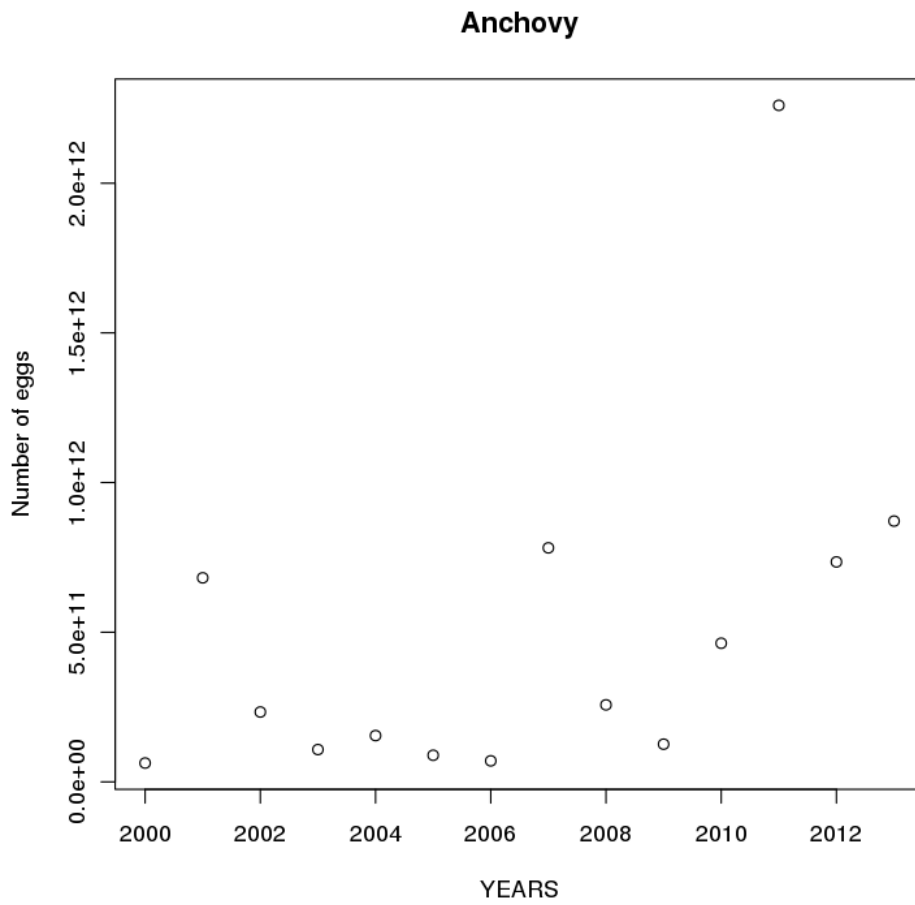
This year was classical in terms of egg spatial distribution, with maximum for anchovy over the southern shelf, a few along the coast North of the Gironde, and no egg north of 46°N (fig 3.6.1).

Looking at the time series from 2000 to 2013 (Figure 3.6.2. and 3.6.3.), anchovy eggs abundance is above the average of the time series since 2000, but far away from the 2011 strong peak.





**Figure 3.6.1** – Distribution of anchovy eggs observed with CUFES during PELGAS13.



**Figure 3.6.2** – Number of eggs observed during PELGAS surveys from 2000 to 2013

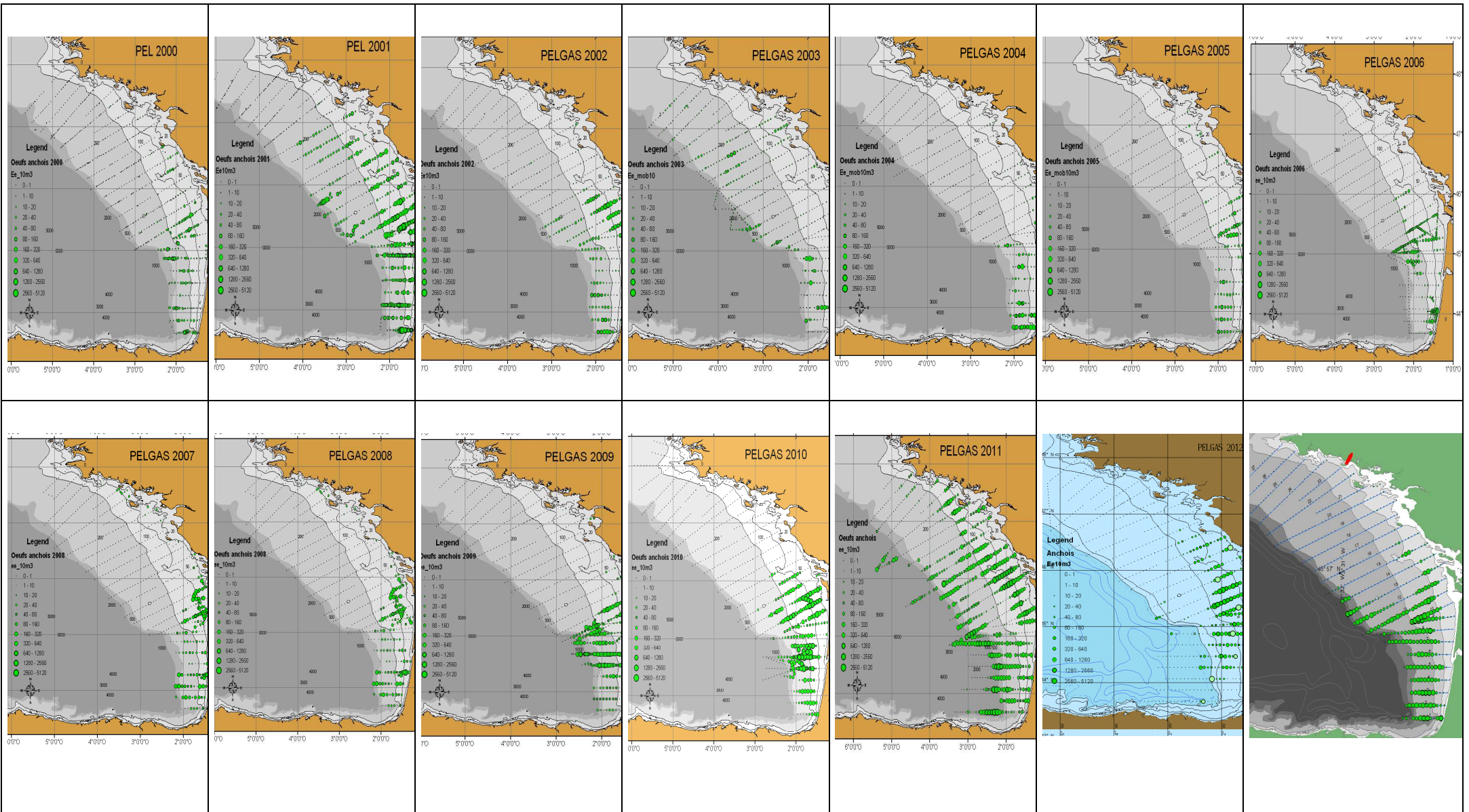


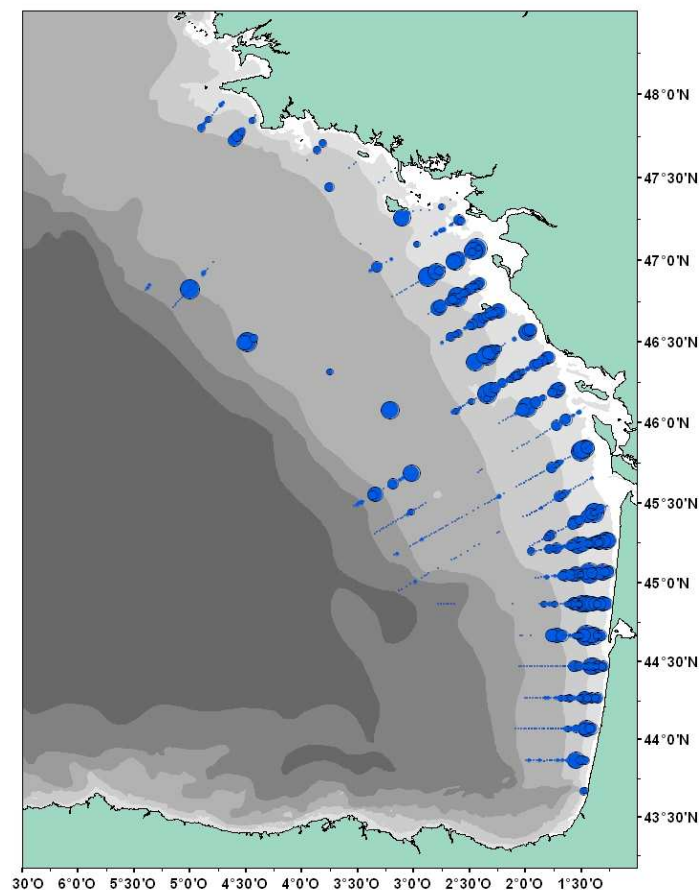
Figure 3.6.3 – distribution of anchovy eggs observed with CUFES during PELGAS from 2000 to 2013 (number for 10m<sup>3</sup>).

## 4. Sardine

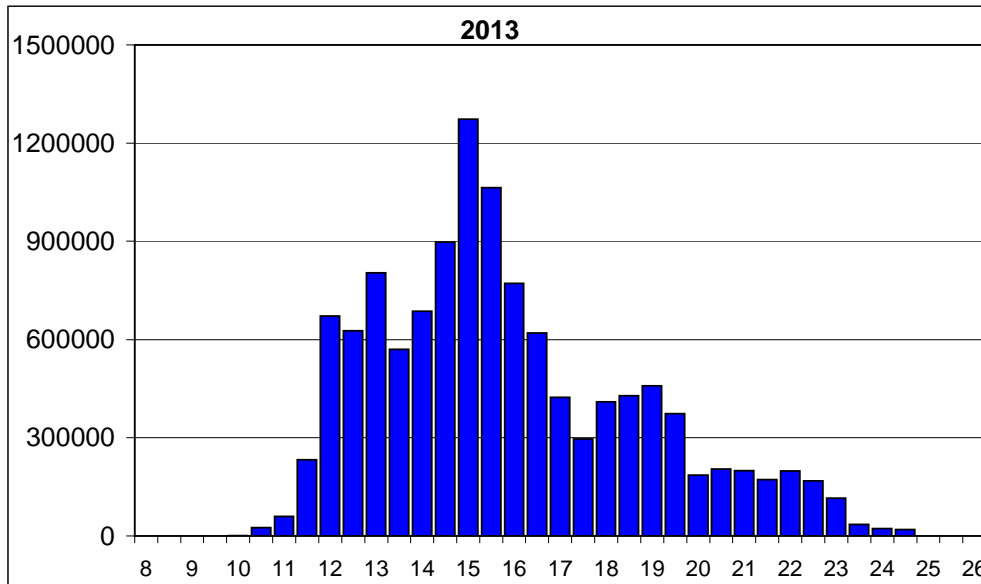
### 4.1. Adults

The biomass estimate of sardine observed during PELGAS13 is **407 740** tons (table 2.3.), which is a bit upper than the average level of the PELGAS series, and constituting a new increase of the biomass. It must be enhance that these survey don't cover the total area of potential presence of sardine. It is possible that some years, this specie could be present up to the North, in the Celtic sea, SW of Cornouailles or Western Channel where some fishery occurs, apparently more and more. It is also possible that sometimes, a small fraction of the population could be present in very coastal waters, when the R/V Thalassa is unable to operate in those waters. The estimate is representative of the sardine present in the survey area at the time of the survey and can be therefore considered as an estimate of the Bay of Biscay (VIIIab) sardine population.

Sardine was distributed mixed with anchovy front of the Gironde (small fishes for both species) and mixed with sprat in the Loire plume. Then, sardine appeared pure along the Landes's coast, where a upwelling occured, due to the regular Northern wind. Sardine was also present close to the surface in the Northern part of the bay of Biscay, along the shelfbreak, sometimes mixed with mackerel.



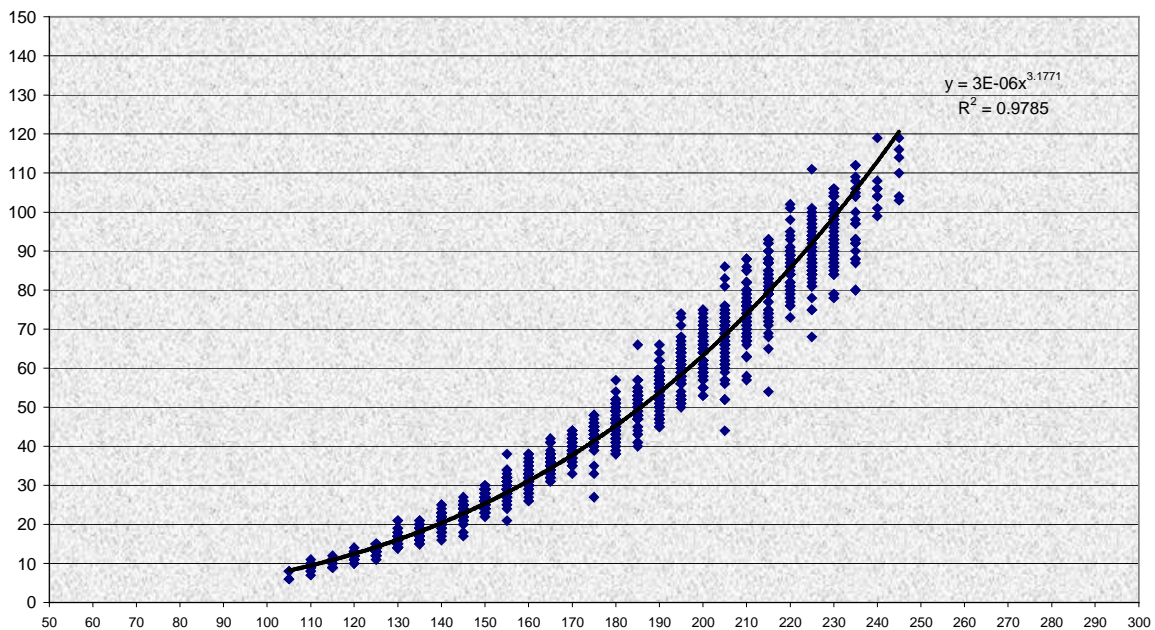
**Figure 4.1.1** – distribution of sardine observed by acoustics during PELGAS13



**Figure 4.1.2.** – length distribution of sardine as observed during PELGAS13

Length distributions in the trawl hauls were estimated from random samples. The population length distributions have been estimated by a weighted average of the length distribution in the hauls. Weights used are acoustic coefficients (Dev\* $X_e$  Moule in thousands of individuals per n.m.<sup>2</sup>) which correspond to the abundance in the area sampled by each trawl haul. The global length distribution of sardine is shown on figure 4.1.2.

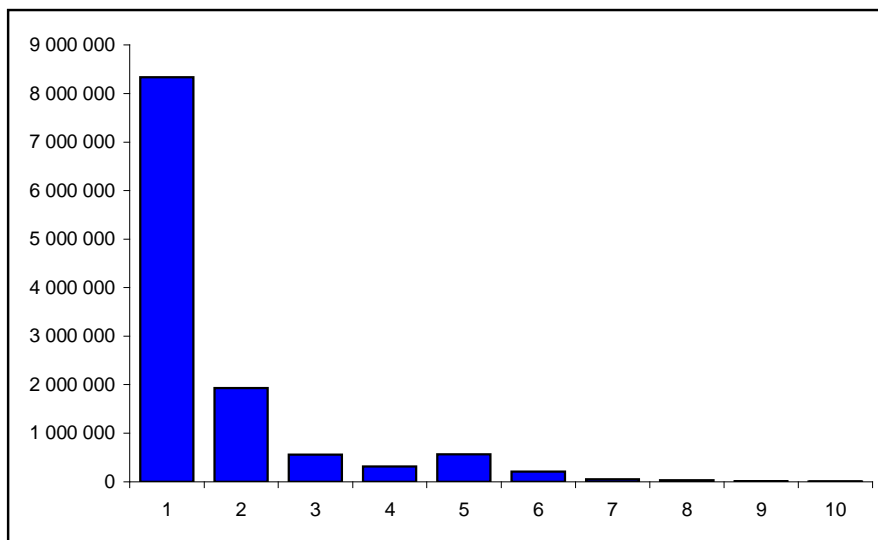
As usual, sardine shows a bimodal length distribution, the first one (about 15 cm, corresponding to the age 1, and very well present this year along the coast) and the second about 19 cm, which is mainly constituted by the 2 and 3 years old.



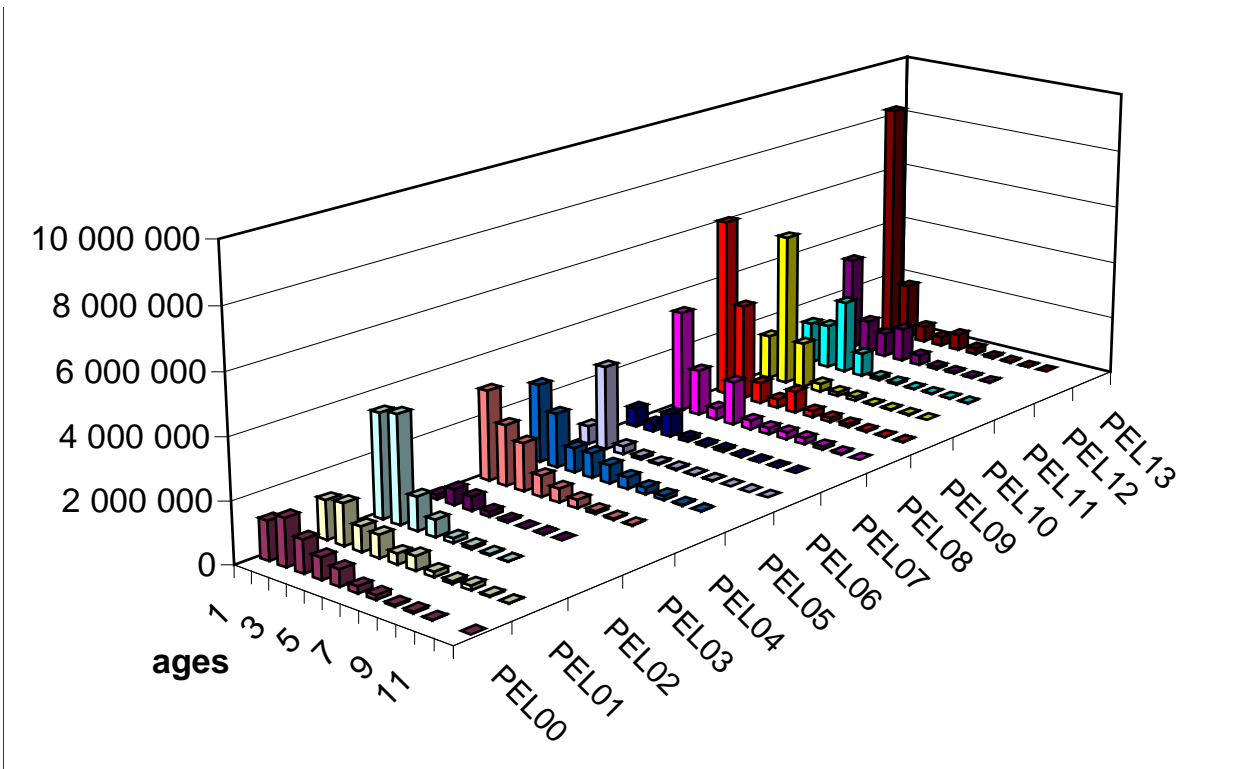
**Figure 4.1.3** – Weight/length key of sardine established during PELGAS13

longueur (mm)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
85																	0%
90																	0%
95																	0%
100																	0%
105		100%															100%
110		100%															100%
115		100%															100%
120		100%															100%
125		100%															100%
130		100%															100%
135		100%															100%
140		100%															100%
145		98%	2%														100%
150		100%															100%
155		98%	2%														100%
160		90%	10%														100%
165		81%	19%														100%
170		47%	53%														100%
175		15%	85%														100%
180		5%	84%	11%													100%
185			77%	20%	3%												100%
190			62%	31%	4%	3%											100%
195		1%	44%	32%	12%	11%											100%
200			27%	31%	21%	17%	3%										100%
205			16%	25%	25%	27%	6%	2%									100%
210			7%	20%	26%	34%	11%	2%									100%
215				8%	17%	57%	15%	2%	2%								100%
220				2%	16%	53%	19%	7%	2%								100%
225					15%	44%	35%	2%			4%						100%
230					5%	46%	29%	12%	7%								100%
235					9%	52%	22%	9%		9%							100%
240						29%	29%	14%	29%								100%
245								17%	33%	50%							100%
250																	0%
255																	0%
260																	0%
265																	0%
Total		39%	23%	10%	7%	14%	5%	1%	1%	0%	0%						100%

**Table 4.1.4 :** sardine age/length key from PELGAS13 samples (based on 1310 otoliths)



**Figure 4.1.5.-** Global age composition (nb) of sardine as observed during PELGAS 13



**Figure 4.1.6-** Age composition of sardine as estimated by acoustics since 2000

The series of age distribution in numbers since 2000 are shown in figure 4.1.6. We can observe that we can follow cohorts (i.e. the very low 2005 age class, or very high 2008 age class). 2003 and 2007 were atypical years in terms of environmental conditions and therefore fish (and particularly sardine) distributions.

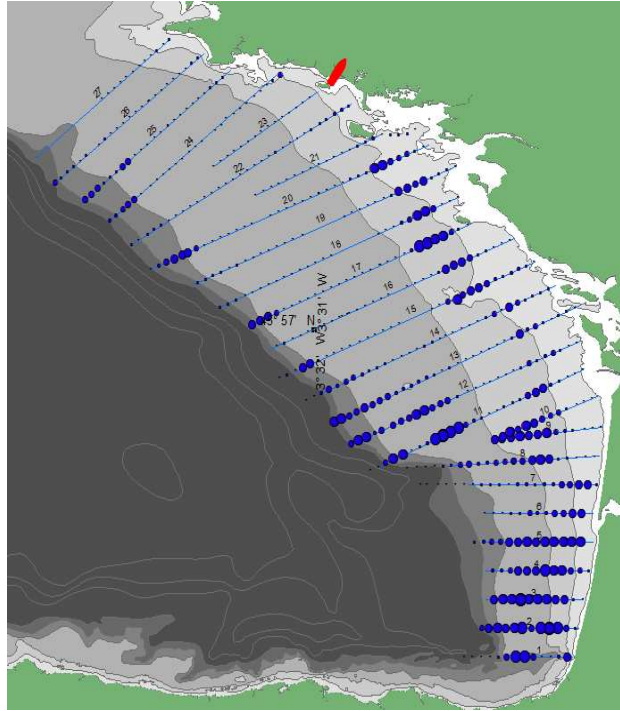
The high abundance of age 1 (69% and 8 billions fishes) gives the impression that a very good recruitment occurred this year, maybe the best of the whole PELGAS serie.

survey	age	1	2	3	4	5	6	7	8	9	10
PEL00		35.05	54.74	69.15	76.46	84.82	89.93	98.83	110.18	105.04	112.87
PEL01		41.28	58.85	76.83	83.84	93.68	96.92	103.41	105.35	112.71	120.97
PEL02		40.48	60.2	74.94	81.7	92.31	99.42	106.68	118.05		
PEL03		53.35	68.04	73.15	78.11	86.04	93.33	88.74	96.09		
PEL04		35.94	64.73	76.54	84.39	95.87	98.83	104.34	109.19	106.15	
PEL05		34.44	63.45	73.29	79.62	84.88	88.96	90.04	105.42	109.45	98.35
PEL06		39.17	58.37	70.78	81.18	86.37	82.48	91.25	97.22	107.02	112.02
PEL07		37.55	65.96	71.77	79.05	84.02	94.45	100.37	96.93	101.27	114.86
PEL08		33.44	60.33	71.1	75.18	83.82	92.84	90.45	95.67	99.48	101.41
PEL09		29.51	57.13	73.62	81.28	83.26	88.35	95.67	91.44	96.50	106.67
PEL10		30.33	50.55	64.04	73.05	78.43	87.58	93.16	105.88	106.96	116.01
PEL11		27.37	50.13	58.69	69.84	78.35	83.00	84.28	108.17	105.38	108.33
PEL12		22.88	44.66	57.40	65.45	78.42	87.83	95.26	92.27	99.83	
PEL13		21.16	44.33	55.82	68.30	77.42	84.27	89.28	99.10	113.27	89.17

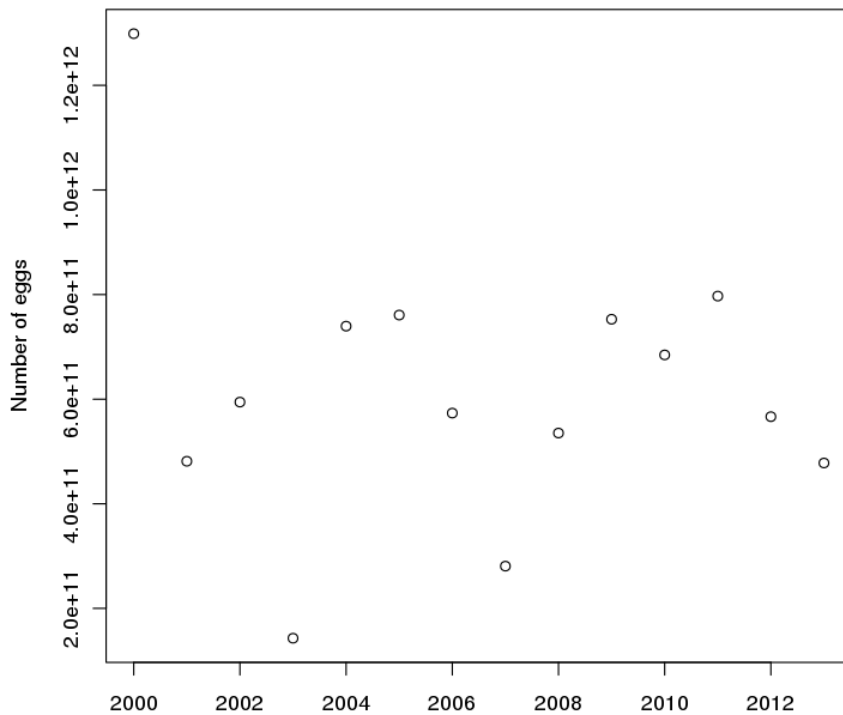
**Figure 4.1.7-** mean Weight at age (g) of anchovy for each PELGAS survey

## 4.2. Eggs

Sardine eggs were observed mainly along the coast between the 50 and the 100m isobaths, from the south of the bay of Biscay to the south of Brittany. Then, another lower concentration was visible along the end of the continental slope, northern than the “fer à cheval”, according to the presence of adults in surface.



**Figure 4.2.1.** Distribution of sardine eggs observed with CUFES during PELGAS13.



**Figure 4.2.2.** Number of eggs observed during PELGAS surveys from 2000 to 2013

The number of eggs collected by CUFES during the PELGAS13 survey was comparable to previous years but still far below the maximum observed in 2000.





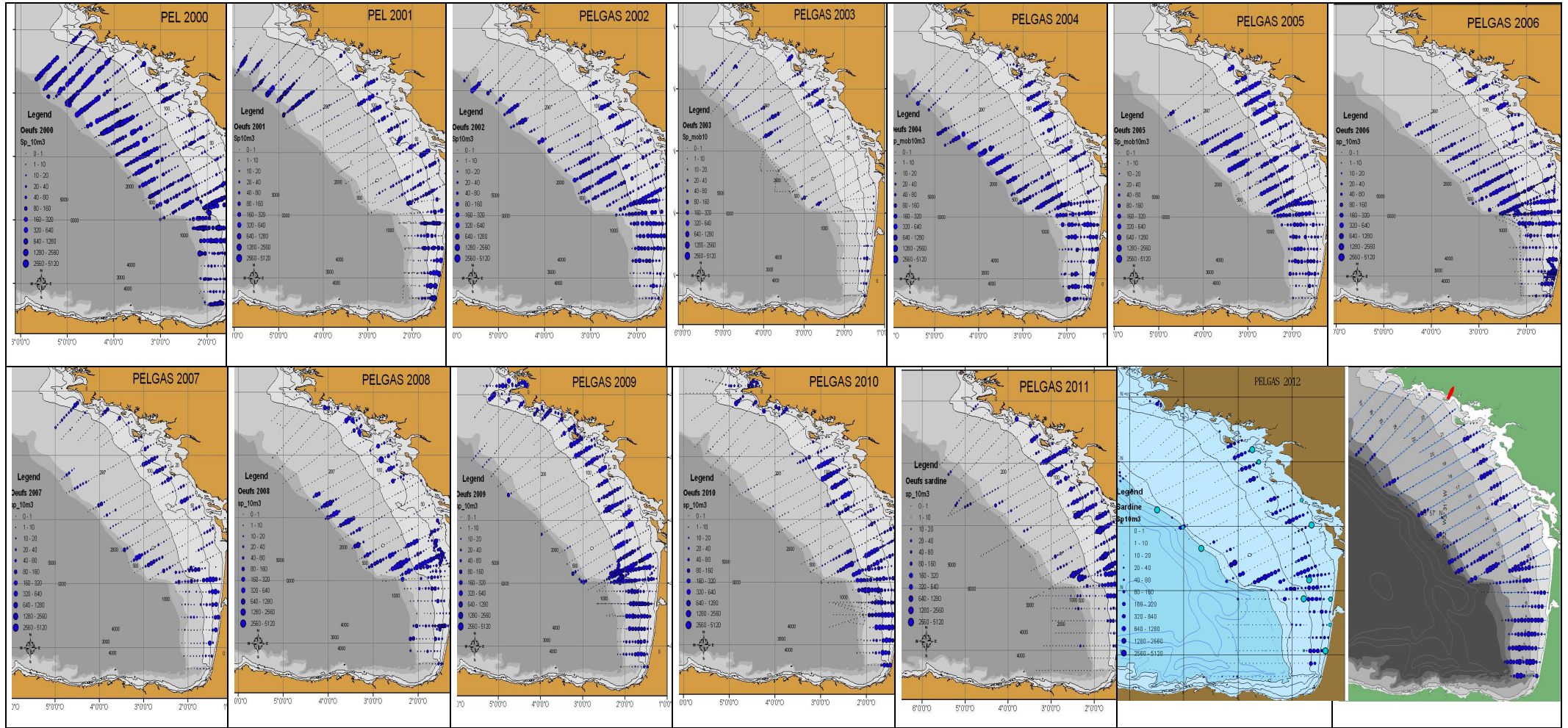
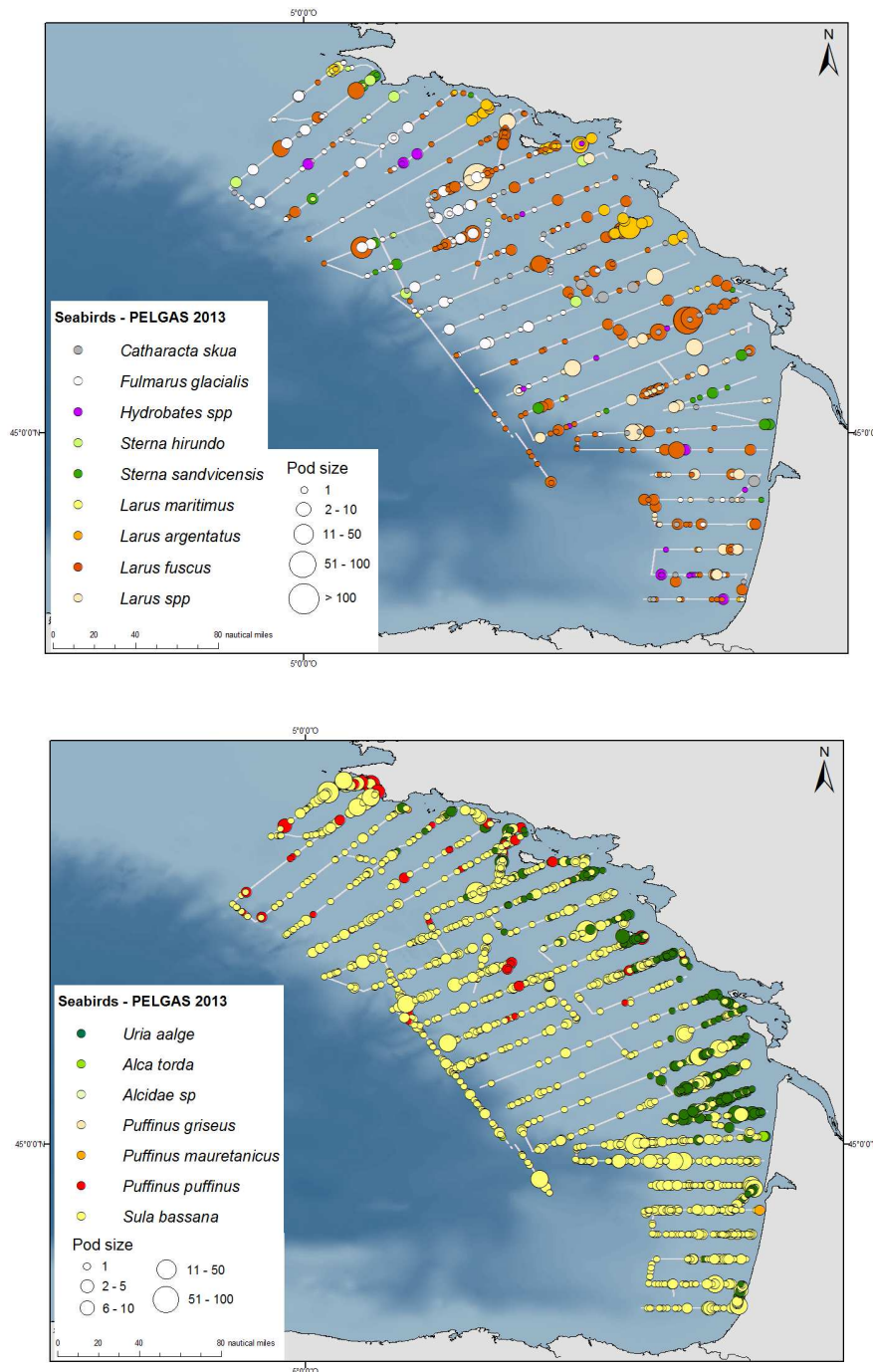


Figure 4.2.3 – distribution of sardine eggs observed with CUFES during PELGAS from 2000 to 2013 (number for 10m<sup>3</sup>).

## 5. Top predators

### 5.1 – Birds



**Figure 5.1.1** Distribution of surface (up) and diving (down) marine birds observed during the PELGAS13 survey

Birds constitute the main recorded sightings, however, should be separated marine species from other of shorebirds and passerines (3% of birds inventoried). 2982 sightings of seabirds were found all over the Bay of Biscay, divided into 24 species and 7664 individuals

Gannet sightings constitute 56% of seabirds recording. It's species that add the highest number of individuals. It presents a homogeneous distribution across the Bay of Biscay. Numerous individuals were seen close to Brittany and in front of Gironde estuary.

Second specie more observed is Guillemot. Alcids sightings represent 15% of seabirds and 797 individuals. Most of them are localized on the shelf in the Gironde estuary area.

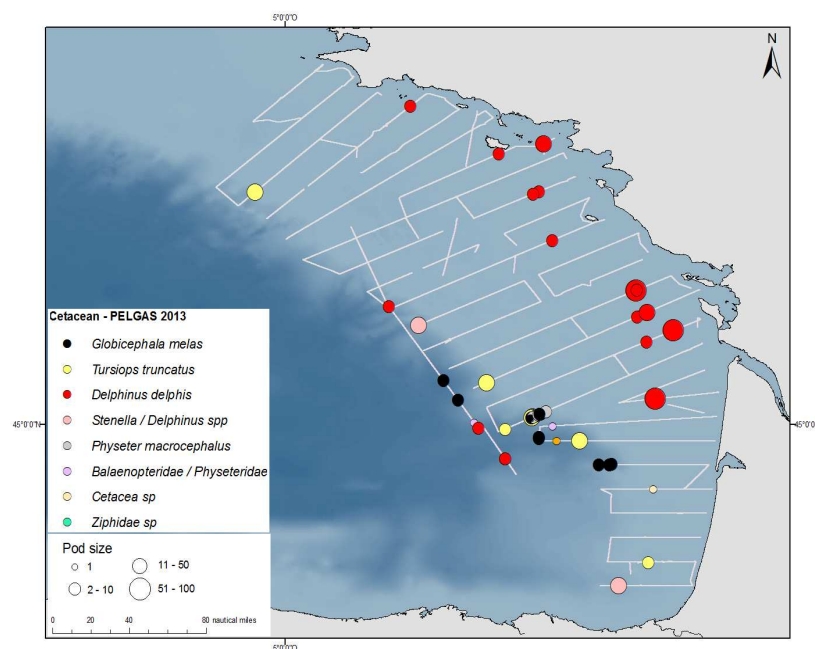
Lesser Black-backed gull (9%) and other large gulls show 14% of seabirds sightings. Large pods with several hundred individuals were seen on the east part of the shelf. A few of them were seen in the south whereas an important fishing activity were recorded.

Great skuas, fulmars and Manx shearwater are other species also appearing in the sampling area but in lower quantities.

Seabirds sightings are substantially increased with nearly 3 000 records and 7 600 individuals. Gannets abundance could be the main reason, number of sighting is twice more important than last year. They were seen throughout the bay of Biscay and half of them were adults. Guillemot appears as a new frequent specie than usually, and most of sightings were localized in front of the Gironde estuary. Abundant in quantities, Larids were recorded with adult and immature black-backed gulls distributed in the northern half of the studied area.

Numerous seabirds have been observed this year, it could indicate various conditions. Generally, adult Gannets and Guillemots stay in the Bay of Biscay for wintering. Early in springtime, they join their breeding colonies in the North, out of this area. This abundance of seabirds seems to indicate conditions more close of wintertime than the springtime, but it need to confirm with hydrological data collected during the survey.

## 5.2 – Mammals



**Figure 5.2.1** Distribution of mammals during the PELGAS13 survey.

A total of 50 sightings were recorded with 4 out of effort period (visual prospection) during trawling operations or hydrological stations. The total corresponds to an estimate of 610 individuals and 4 species of cetaceans clearly identified.

Common dolphin is the most recorded species (32% of cetacean sightings). Common dolphin shows a distribution on the inshore part of the continental shelf, this pattern is usual during springtime. Few sightings are localised in the slope to the southern bay of Biscay. Group size varies from 2 to 100 individuals.

Pilot whale appears very present (28%) with small pods recorded around the slope and canyons in the middle of the area. Bottlenose dolphins sightings are less regular (14%) and correspond to pods mainly located on the slope.

Pods of unidentified small dolphins relate mostly distant sightings, and it is highly probable that it is common or striped dolphin.

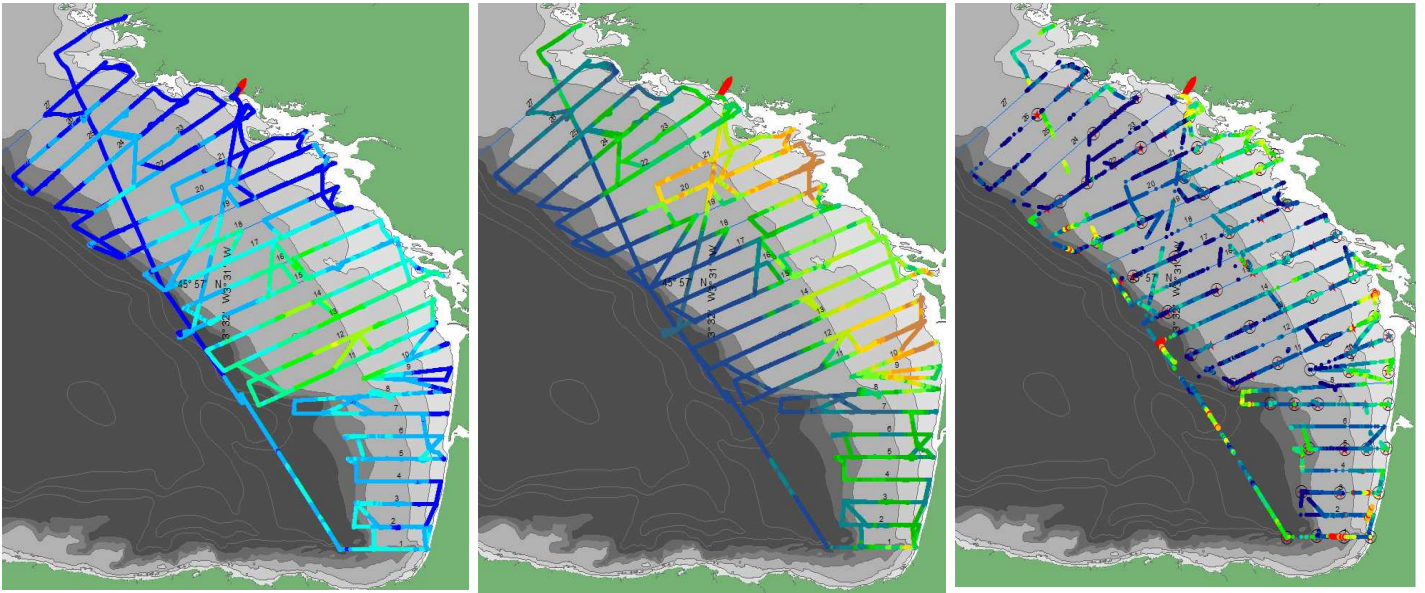
Large whales have been encountered this year only with sperm whales but no fin/minke whale. They were localised to the Cap Ferret canyon at the same place that a probable Cuvier's beaked whale.

Specific richness detected this year is relatively poor with four cetaceans identified. Very few marine mammals were seen in the northern part of the Bay of Biscay. General distribution shows a stronger presence of cetaceans in the slope middle-west notably Sperm whale and Pilot whale. Only Common dolphin was localised more on the inshore part of the continental shelf. Also absence of large whales (fin/minke) could be explained by less offshore observation effort. However, the general trend in the distribution pattern is similar than previous Pelgas surveys, only the northern part seems abnormally poor. Weather conditions in that area were not clearly limited, moreover sunfishes were observed. The presence of unusual military activities working with acoustics systems might be an explanation..

## **6. Hydrological conditions**

After a relatively cold and wet winter, conditions have changed from early April to bad weather. We started the survey with cold and bad weather, and these conditions were predominant until the survey break on 24<sup>th</sup> of May, except 2 or 3 days of good weather.

Temperature were about 2°C below the average temperature in May over the whole Bay of Biscay. Stratification was weak under low light availability and sustained wind, and actually more related to the cumulated freshwater discharged throughout winter. The latter also explained early blooms in late february, but no high chlorophyll biomass was observed during the survey. The sustained wind from the North explained the occurrence of an upwelling with low temperature along the Landes's coast, potentially separating sardine and anchovy, the latter being more offshore in that specific area.



**Figure 6.1.** – Surface temperature, salinity and fluorescence observed during PELGAS13.

The medium river discharges during the spring (after a very wet winter) could be explained by the fact that the snow was still in the mountains during the survey's period

## 8. Conclusion

The Pelgas13 acoustic survey has been carried out with medium weather conditions (wind, cold temperatures) for the whole area, from the south of the bay of Biscay to the west of Brittany. The help of commercial vessels (two pairs of pelagic trawlers and a single one) during 18 days provided about 100 identification hauls as a whole instead of about 50 before 2007 when *Thalassa* was alone to identify echo traces. Their participation increased the precision of identification of echoes and some double hauls permitted to confirm that results provided by the two types of vessels (R/V and Fishing boats) were comparable and usable for biomass estimate purposes. These commercial vessels participated to the PELGAS survey in a very good spirit of collaboration, with the financial help of "France Filière Pêche" which is a groupment of French fishing organisations.

Temperature and salinity recorded during PELGAS13 were affected by rather bad weather conditions before and during the survey. During the whole survey, water column showed a lack of stratification, with a very low surface temperature (often 2°C below the average SST).

The PELGAS13 survey observed a medium abundance of anchovy (93 854 tons), far away the highest level observed on the time series (186 865 tons, last year). In the South, anchovy was mostly concentrated in the middle of the platform, and the small individuals as usual were mostly present in the Gironde area. Nevertheless, this year was particular in terms of a very important presence of anchovy offshore in the surface layer (between this one and 20 meters

below). This configuration, never observed before in that quantity, lead probably to an underestimation of the age 2 and 3, predominant in this area.

The biomass estimate of sardine observed during PELGAS13 is 407 740 tons, which constitutes an increase of the last years level of biomass. It represents an high abundance, and the high abundance of age 1 (69% and 8 billions fishes) gives the impression that a very good recruitment occurred this year, maybe the best of the whole PELGAS serie. It must be noticed that the number of age 5 individuals this year is rather still important compared to ages 3, 4 and 6, and confirms (one more time) the very good recruitment of the 2008 year class and confirms also the age readings and the fact that we can follow sardine cohorts in the sardine population of the bay of Biscay. Geographical distribution looks as usual, with maximum again in the Centre of the bay, with extension to the North and the South both along the coast and, in less quantity, along the slope.

Concerning the other species, mackerel was well present this year, all along the shelfbreak and on the platform in the North part of the bay, while horse mackerel was still rather absent this year.