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Direct assessment of small pelagic fish by the PELGAS10 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 on board 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 in 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 to be covered from Gibraltar to Brest with the same protocol for sampling strategy. Data are available for the ICES working groups WGANSA, WGWIDE and WGACEGG.

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

1) Continuous acquisition by storing acoustic data from five 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)), and
2) discrete sampling at stations (by trawls, plankton nets, CTD). Satellite imagery (temperature and sea colour) and modelisation will be also used before and during the cruise to recognise the main physical and biological structures and to improve the sampling strategy. Concurrently, a visual counting and identification of cetaceans (from

board) and of birds (by plane) will be carried out in order to characterise the higher level predators of the pelagic ecosystem.

Satellite imagery (temperature and sea colour) and modelisation are also used before and during the cruise to recognise the main physical and biological structures and to improve the sampling strategy.

Concurrently, a visual counting and identification of cetaceans and of birds (from board) is carried out in order to characterise the top predators of the pelagic ecosystem.

The strategy this year was the identical to previous surveys (2000 to 2009) the protocols for acoustics has been described durin WGACEGG in 2009 (Doray et. Al 2009, Annex 6):

- 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 covering the continental shelf from 20 m depth to the shelf break.

-acoustic data were collected only 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 for the echo sounder between the surface and 8 m depth.

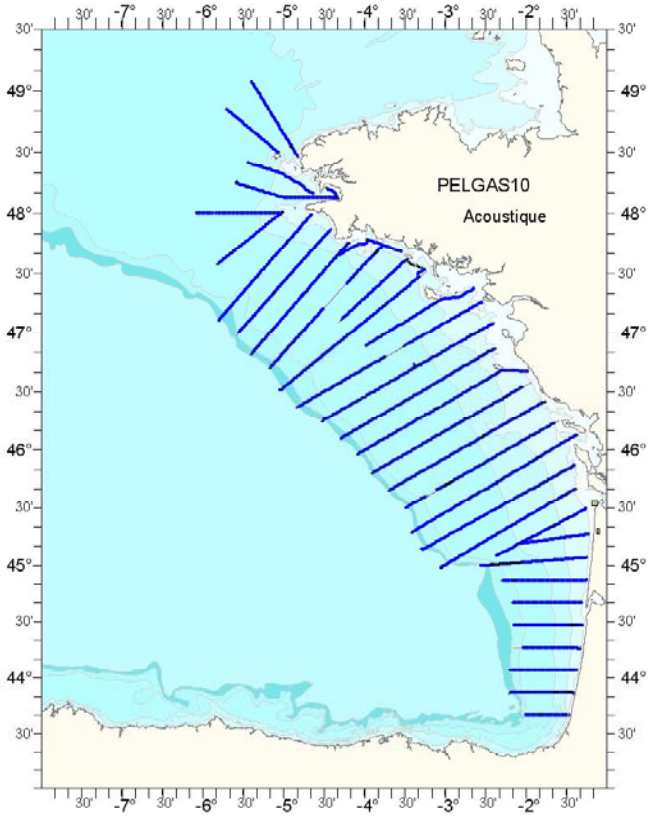


Fig. 1.1.1 - Transects prospected during PELGAS10 by Thalassa.

Two vertical echo-sounders were used during survey (SIMRAD EK60 for vertical echo-sounding and OSSIAN 500 as net-sonde). In 2010, as in 2009, the SIMRAD ME70 has been used for multi-beam visualisation and was helpful to determine behaviour and forms of fish schools for the whole survey. Energies and samples provided by split beam transducers (5 frequencies EK60, 18, 38, 70, 120 and 200 kHz), simple beam (OSSIAN 49 kHz) and multibeam echo-sounder (32 x 2°beams, from 70 to 120 kHz) were simultaneously visualised, stored using the MOVIES+ software and at the same standard HAC format.

The calibration method was the same that the one described for the previous years (see W.D. 2001) and was performed at anchorage in the Douarnenez bay, in the west side of Brittany, in optimum meteorological conditions at the end of the survey (another calibration was done during PELACUS one month before).

Acoustic data were therefore collected by Thalassa along a total amount of 6900 nautical miles from which 1972 nautical miles on one way transect were used for assessment. A total of 27 464 fish were measured on board Thalassa (including 7091 anchovy and 4702 sardine) and 1945 otoliths were collected for age determinations (928 anchovy and 1 017 sardine).

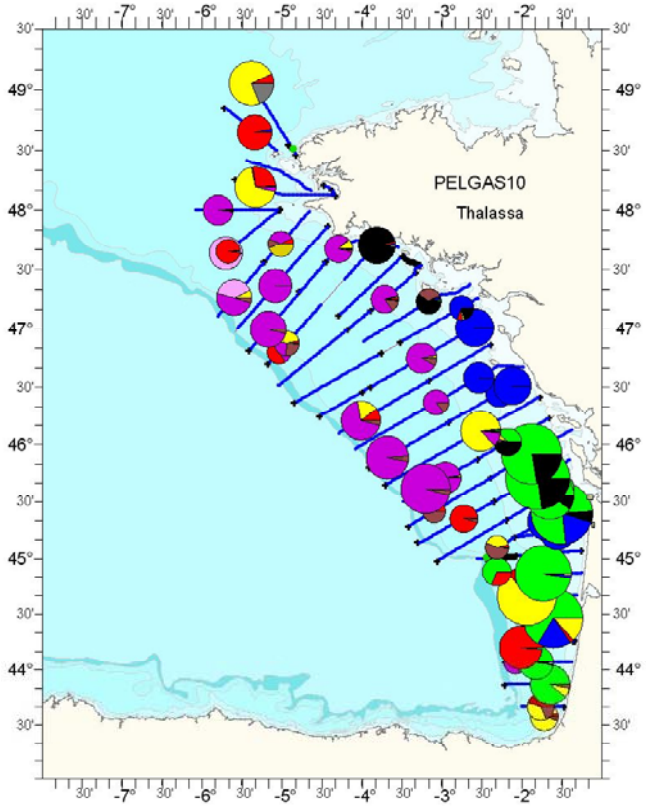


Fig. 1.1.2: Species distribution according to Thalassa identification hauls.

1.2 The consort survey

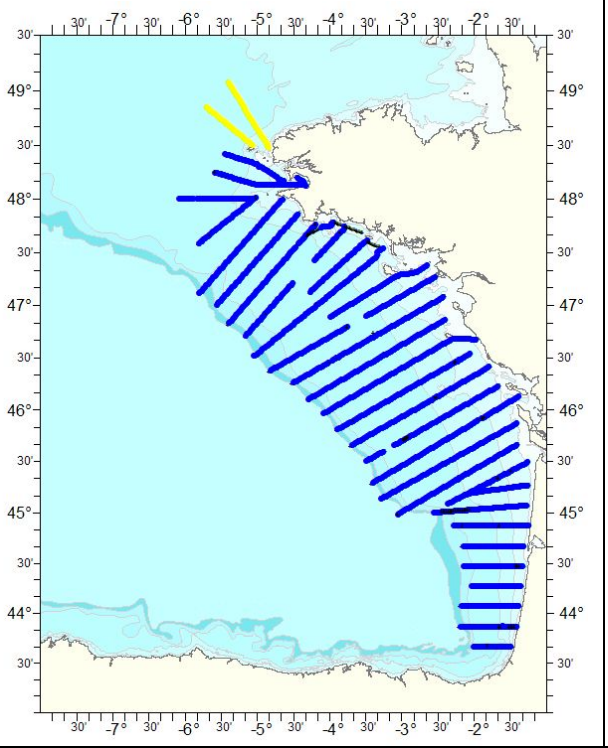
A consort survey was organized as since 2007 with French pair trawlers during the 22 first days and purse seiners during 3 days . This approach, in the continuity of last year survey, and the commercial vessels hauls were used for echo identification and biological parameters at the same level than Thalassa one.

Five commercial vessels (two pair of pair trawlers and two purse seiners) participated to PELGAS10 survey:

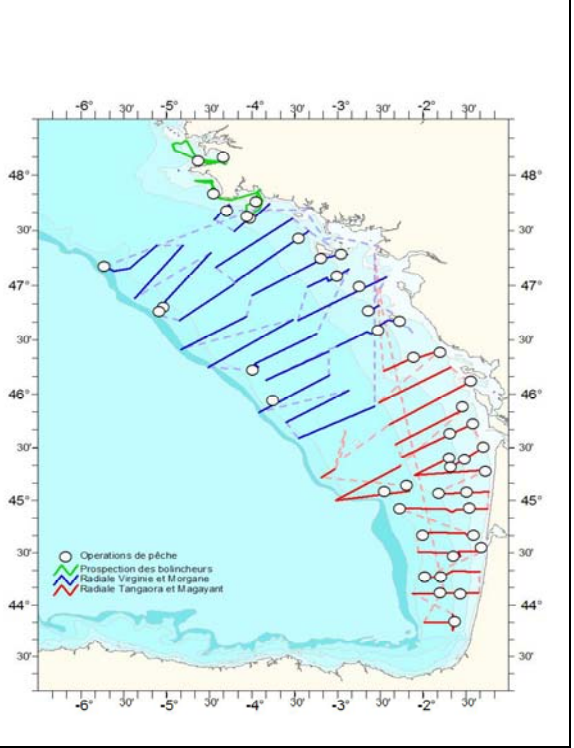
Vessel	gear	Period	Days at sea
Tangaroa/Magayant	Pelagic pair trawl	26/04 to 06/05/2010	11
Morgane/Virginie	Pelagic pair trawl	07/05 to 17/05/2010	11
Etoile Polaire	Purse seine	17-18/05/2010	2

Vag a Lamm	Purse seine	23/05/2010	3

The transects network agreed for several years for Thalassa is 12 miles separated parallel transects. Commercial vessels worked between standard transects and 4 NM northern. Sometimes, they carried out fishing operations on demand (complementary to Thalassa, particularly for surface hauls or in very coastal areas) or, sometimes, according to their surveying 4 NM northern than our transects. Their pelagic trawl was until 35 m vertical opening and the mesh of their codend was similar to Thalassa (12 mm).



Acoustic transects network (Thalassa)



Acoustic transects network and location of fishing operations (Commercial vessels)

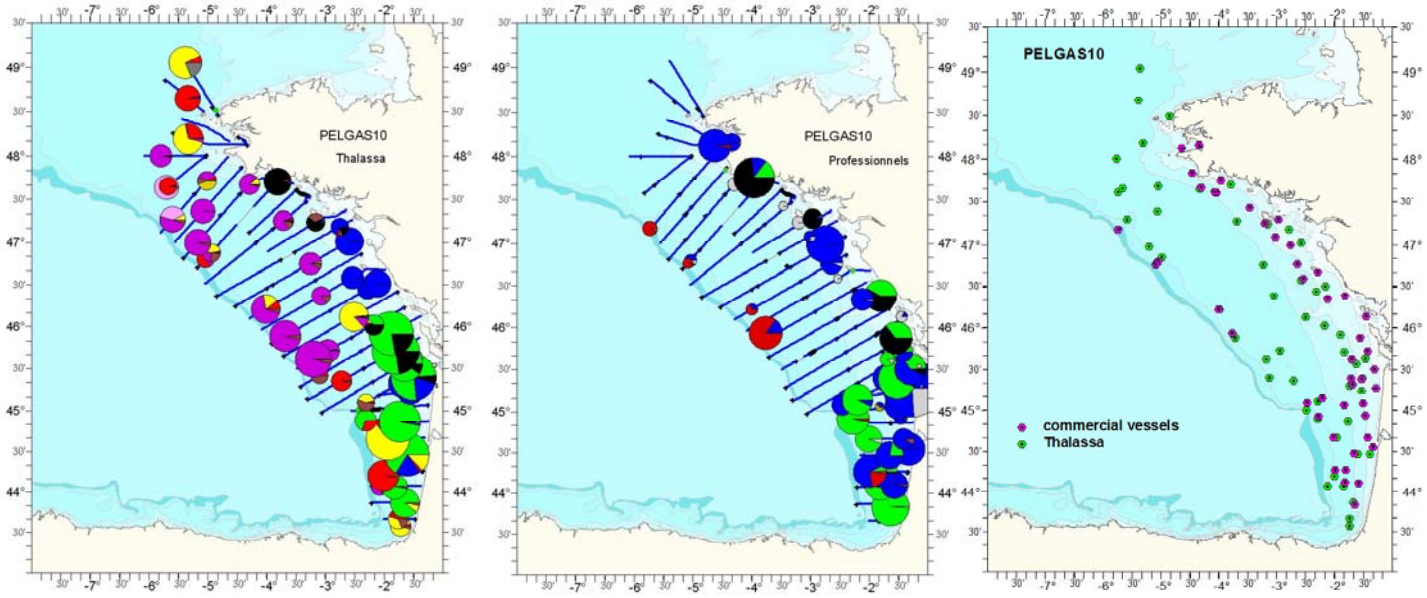
Fig. 1.2.1 – Transects network resulting of the combination of Thalassa and commercial vessels during PELGAS10 survey.

A scientific observer was onboard to control every operation, to collect acoustic data and biological data. Their fishing operations were systematically previously agreed after a radio contact with Thalassa in order to confirm its utility. In some occasions, the use was to check the spread of a 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 taken on a good distribution of samples to avoid over-sampling on some situations. Sometimes a biological sample was provided by commercial vessels to Thalassa to improve otoliths collecting and sexual maturity (twelve samples of sardine, seven of anchovy). A total of 6222 fishes were measured onboard commercial vessels, including 2657 sardines and 1751 anchovies.

The commercial vessels were still equipped with a precision weighting machine and a calibrated echo-sounders (Simrad ER60 – 70 kHz) able to store data at a standard format. Their consort surveying and fishing operations can be so considered as qualitative and could be used

as quantitative as well. The catches and biological data have been directly used at the same level than Thalassa one for identification and biological characterisation. The echo sounder was implemented on board the commercial vessel on a small towed body and because of a non sufficient stability of this kind of boat. the data was stored only during small sequences when notable echo-traces were observed and mainly after fishing. Commercial vessel acoustic data will be processed later in order to compare the echo types and energies to Thalassa one in identical place or similar conditions. They were not available for the present WG and will not be used for assessment.

A total of 103 hauls were carried out during the assessment coverage including 52 hauls by Thalassa and 51 hauls by commercial vessels (figures 1.2.2.a and 1.2.2.b). The fishing operations by commercial vessels were carried out as Thalassa only during day time each time it was necessary and preferentially at the surface or in mid-water, taking into account the fact that pair trawlers are more efficient at surface than single back trawlers.



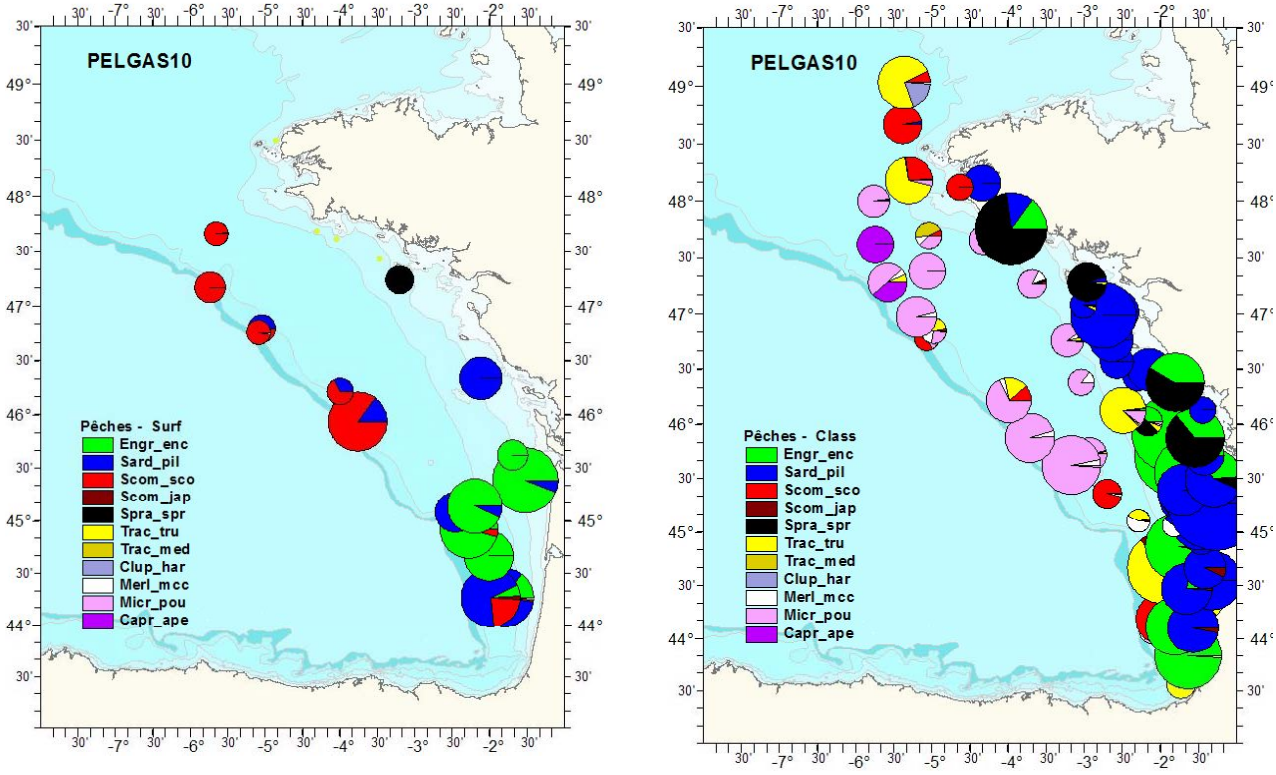
a) Thalassa (nb :52) *b) Commercial vessels (nb : 51)* *c) all fishing hauls (nb :103)*

Figure 1.2.2 : fishing operations carried out by Thalassa and commercial vessels during consort survey PELGAS10

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.

	R/V Thalassa	Commercial vessels	total
surface trawls	3	18	21
classic trawls	46	28	74
null	3	5	8
Total	52	51	103

Table 1.2.3. : number of fishing operations carried out by Thalassa and commercial vessels during consort survey PELGAS10



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

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

Figure 1.2.4 : Localisation of fishing operations carried out by Thalassa and commercial vessels during survey PELGAS10

2. Acoustics data processing

2.1. Echo-traces classification

All the acoustic data along the transects were processed and scrutinised at the date of the meeting (figure 2.2.1). Acoustic energies (Sa) have been cleaned by sorting only fish energies

(excluding bottom echoes, parasites, plankton, etc.) and classified into 7 categories of echo-traces :

D1 – energies attributed to mackerel, horse mackerel, blue whiting, various demersal fish, 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, sprat, sardine and herring corresponding to the usual echo-traces observed in this area since more than 15 years, constituted by schools well designed, mainly situated between the bottom and 50 meters above. These echoes are typical of clupeids in coastal areas and sometimes more offshore.

D3 – energies attributed to blue whiting, myctophids and capros aper offshore, just closed to the shelf-break.

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

D5 – energies attributed to blue whiting, hake and horse mackerel. Detection appeared as blue points (low energy) closed to the bottom.

D6 – energies attributed to a mix, usually between 50 and 100 m depth when D1 and D2 were not separable

D7 – energies attributed exclusively to anchovy (big schools).

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

2.2. Splitting of energies into species

As 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 2.2.1 shows the strata considered to evaluate biomass of each species. For each strata, energies where converted into biomass by applying catch ratio, length distributions and weighted by abundance of fish in the haul surrounded area.

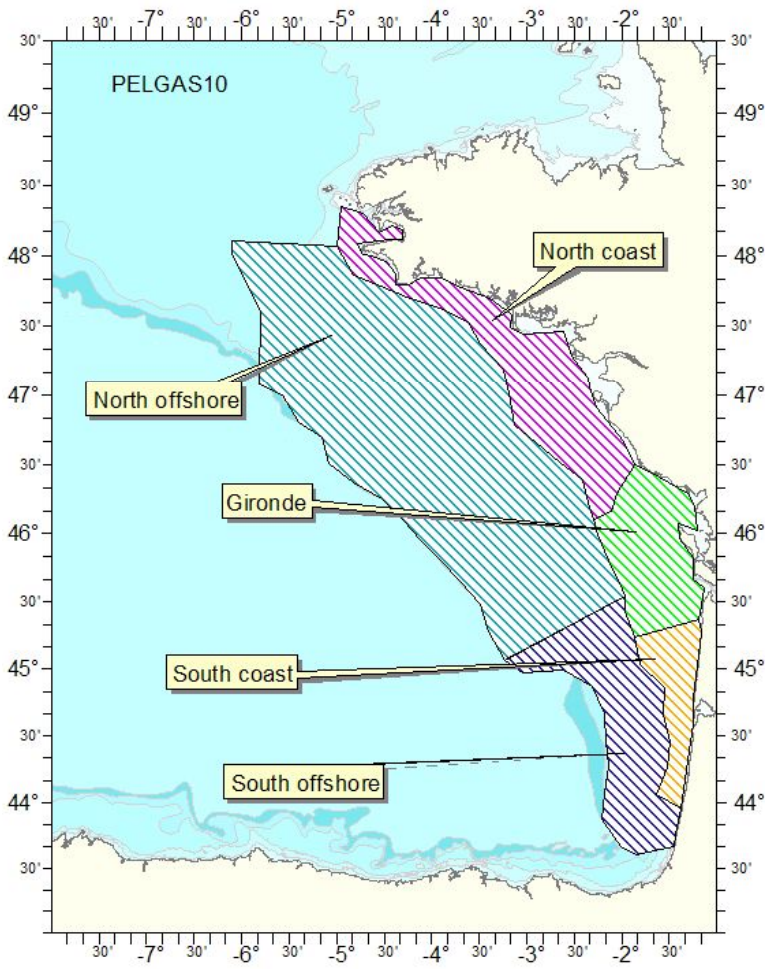


Fig. 2.2. – coherent strata, in terms of echoes and species distribution, taken into consideration for multi-species biomass estimate from acoustic and catches data during PELGAS10 survey

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 estimates and respective coefficient of variation are gathered below. 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 totally scattered and mixed with soft plankton echoes.

Globally, anchovy and sardine were well present this year from the south (sardine inshore and anchovy offshore) to the north (sardine quite exclusively offshore). About other species, the main characteristics of this survey is that horse mackerel and mackerel were very rare, unlike blue whiting was permanently present on the platform from 50m depth to the shelf

break north of 45° N, scattered in small dots echoes close to the bottom and where numerous hauls identified constantly a mix of blue whiting and hake. Blue whiting was historically present along the shelf break, but very occasionally on the platform

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
anchovy	**113 120**	**105 801**	**110 566**	**30 632**	**45 965**	**14 643**	**30 877**	**40 876**	**37 574**	**34 855**	**86 354**
CV anchovy	*0.064*	*0.141*	*0.113*	*0.132*	*0.167*	*0.171*	*0.136*	*0.100*	*0.162*	*0.112*	*0.147*
Sardine	**376 442**	**383 515**	**563 880**	**111 234**	**496 371**	**435 287**	**234 128**	**126 237**	**460 727**	**479 684**	**457 081**
CV sardine	*0.083*	*0.117*	*0.088*	*0.241*	*0.121*	*0.135*	*0.117*	*0.159*	*0.139*	*0.098*	*0.091*
Sprat	**30 034**	**137 908**	**77 812**	**23 994**	**15 807**	**72 684**	**30 009**	**17 312**	**50 092**	**112 497**	**67 046**
CV sprat	*0.098*	*0.155*	*0.120*	*0.198*	*0.178*	*0.228*	*0.162*	*0.132*	*0.268*	*0.108*	*0.108*
Horse mack	**230 530**	**149 053**	**191 258**	**198 528**	**186 046**	**181 448**	**156 300**	**45 098**	**100 406**	**56 593**	**11 662**
CV HM	*0.079*	*0.204*	*0.156*	*0.137*	*0.287*	*0.160*	*0.316*	*0.065*	*0.455*	*0.09*	*0.188*
Blue Whitin	-	-	**35 518**	**1 953**	**12 267**	**26 099**	**1 766**	**3 545**	**576**	**4 333**	**48 141**
CV BW	-	-	*0.386*	*0.131*	*0.202*	*0.593*	*0.210*	*0.147*	*0.253*	*0.219*	*0.074*

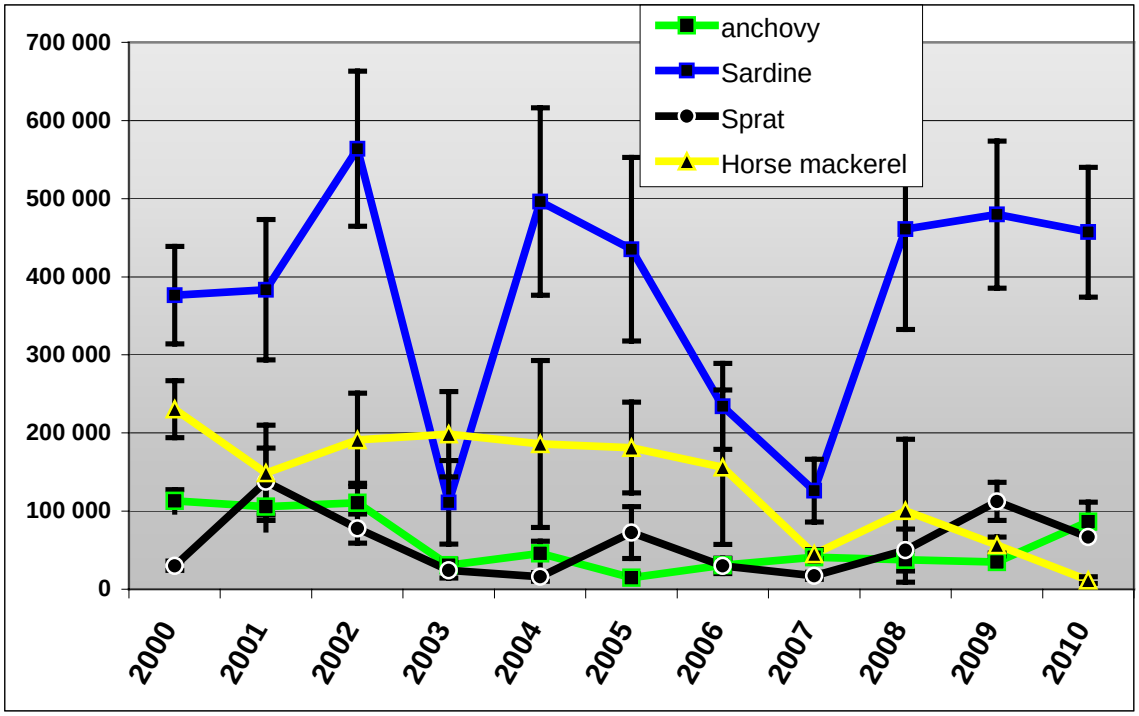


Table and figure 2.3. – biomass estimate using Thalassa acoustic data along transects and all the consort identification fishing operations (Thalassa + pair trawlers) and coefficients of variation associated.

4. Anchovy data

4.1. anchovy biomass

Two principal anchovy concentration areas (figure 2.4.2.2. & 2.4.2.3.) were observed :

Offshore on the southern platform, big anchovy was well present between 100m and 120m depth, often mixed with sardine at the surface, and with horse mackerel in the water column between the bottom and 50 to 70 m above. Echo-traces were most of the time traditionally vertically distributed, horse mackerel closed to the bottom and anchovy as soft and

small schools 15 to 25 meters above. Nevertheless, anchovy echo-traces this year appeared in a non traditional way. If they were sometimes distributed as soft and small schools in a layer between 20 and 40 m above the bottom, as it is usually the case, most of them appeared this year as very big and dense schools, which is very unusual. Their geographic distribution was therefore not on a continuous way as usual, but as patches of very dense schools.

Small anchovies were observed in front of the Gironde, from the coast between 45° N and 46° 30 N until 100 m depth. It was , mixed with sardine in the southern end and with sprat in the Northern end..

Some anchovies were observed in south Brittany, in an area limited between the coast and Glenans islands.

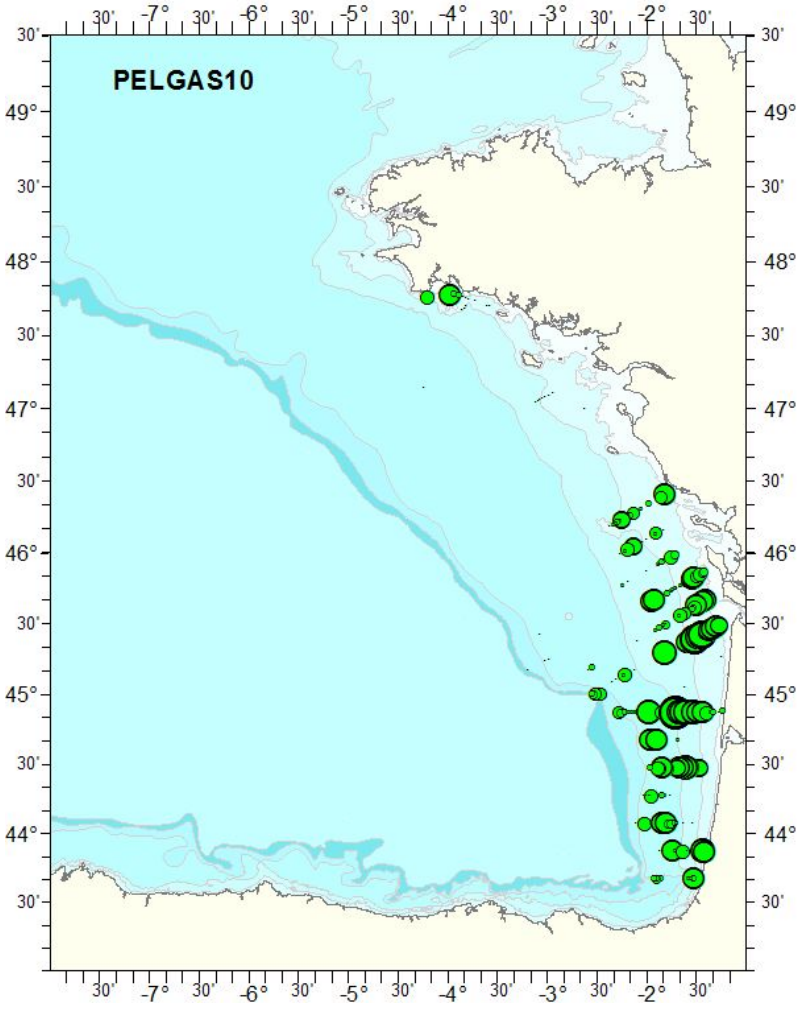


Figure 4.1. – Anchovy distribution according to PELGAS10 survey.

4.2. Anchovy length structure

Length distribution in the trawl haul were estimated from random samples. The population length distributions (figures 4.2.1 and 4.2.2) has been estimated by a weighted average of the length distribution in the hauls. Weights used are acoustic coefficients (Dev*Xe Moule in thousands of individuals per n.m.^{2}) which correspond to the abundance in the area sampled by each trawl haul.

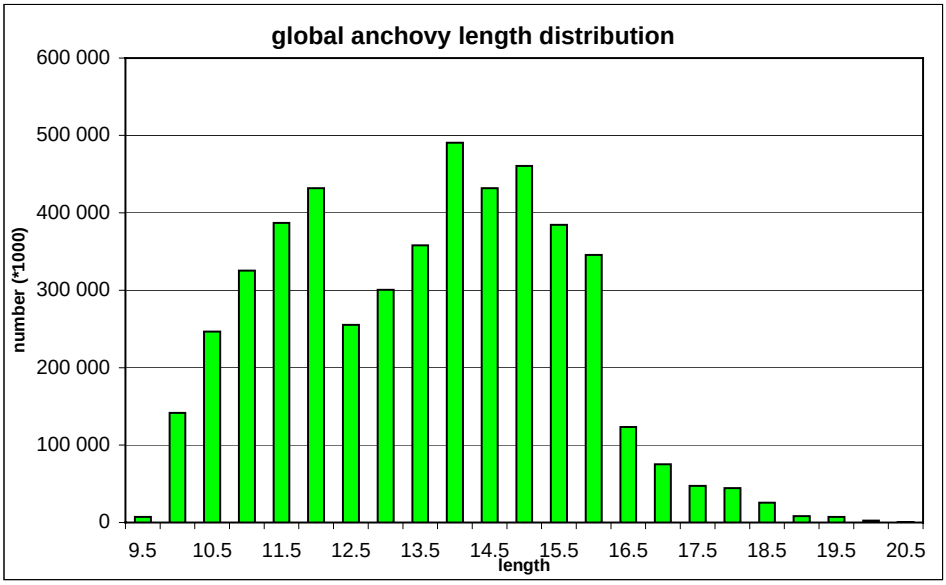


Figure 4.2.1: length distribution of global anchovy as observed during PELGAS10 survey

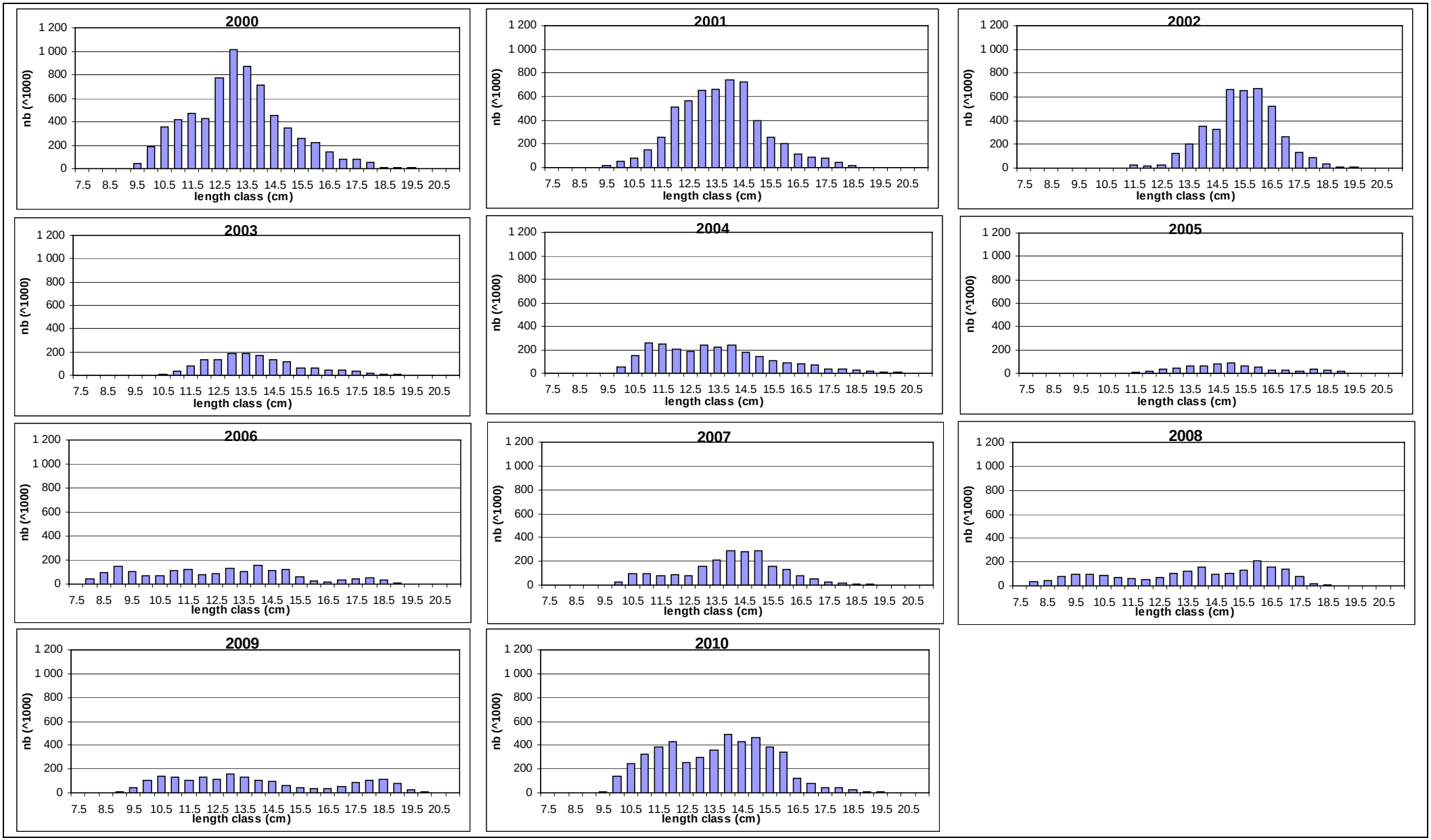


Figure 4.2.2. – length composition of anchovy as estimated by acoustics since 2000

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4.3. Demographic structure

Two age length keys were built for anchovy from the trawl catches (Thalassa hauls) and some samples from commercial vessels for each anchovy area (Gironde and southern offshore). Sub-samples (928 otoliths for the whole survey) were taken from the previous samples, according to a stratified scheme based on length classes. The population length distributions were estimated by a weighted use of length distributions in the hauls. Weights used are acoustic coefficients (Dev*Xe*Moule in thousands of individuals per n.m.^{2}) which correspond to the abundance in the area sampled by each trawl haul.

NB Age	Age					
Long.(1/2cm)	1	2	3	4	5	Total
10.5	100.00%	0.00%	0.00%	0.00%	0.00%	100.00%
12	50.00%	50.00%	0.00%	0.00%	0.00%	100.00%
12.5	83.33%	16.67%	0.00%	0.00%	0.00%	100.00%
13	83.33%	16.67%	0.00%	0.00%	0.00%	100.00%
13.5	94.44%	5.56%	0.00%	0.00%	0.00%	100.00%
14	87.50%	12.50%	0.00%	0.00%	0.00%	100.00%
14.5	87.80%	9.76%	2.44%	0.00%	0.00%	100.00%
15	76.60%	23.40%	0.00%	0.00%	0.00%	100.00%
15.5	84.00%	16.00%	0.00%	0.00%	0.00%	100.00%
16	69.39%	26.53%	4.08%	0.00%	0.00%	100.00%
16.5	48.89%	48.89%	2.22%	0.00%	0.00%	100.00%
17	15.38%	69.23%	15.38%	0.00%	0.00%	100.00%
17.5	3.45%	86.21%	10.34%	0.00%	0.00%	100.00%
18	0.00%	80.00%	13.33%	6.67%	0.00%	100.00%
18.5	0.00%	30.77%	50.00%	19.23%	0.00%	100.00%
19	0.00%	13.04%	60.87%	21.74%	4.35%	100.00%
19.5	0.00%	16.67%	50.00%	33.33%	0.00%	100.00%
20	0.00%	0.00%	50.00%	50.00%	0.00%	100.00%
Total	51.86%	33.06%	10.95%	3.93%	0.21%	100.00%

Table 4.3.1.a – anchovy age/Length key from PELGAS10 samples for Gironde/coastal area

NB Age	Age				
Long.(1/2cm)	1	2	3	4	Total
10.5	100.00%	0.00%	0.00%	0.00%	100.00%
11	100.00%	0.00%	0.00%	0.00%	100.00%
11.5	100.00%	0.00%	0.00%	0.00%	100.00%
12	97.22%	2.78%	0.00%	0.00%	100.00%
12.5	94.59%	5.41%	0.00%	0.00%	100.00%
13	94.74%	5.26%	0.00%	0.00%	100.00%
13.5	89.19%	8.11%	2.70%	0.00%	100.00%
14	76.32%	23.68%	0.00%	0.00%	100.00%
14.5	91.43%	8.57%	0.00%	0.00%	100.00%
15	60.00%	36.00%	4.00%	0.00%	100.00%
15.5	43.75%	50.00%	6.25%	0.00%	100.00%
16	0.00%	37.50%	37.50%	25.00%	100.00%
16.5	0.00%	50.00%	50.00%	0.00%	100.00%
17	0.00%	50.00%	50.00%	0.00%	100.00%
18	0.00%	100.00%	0.00%	0.00%	100.00%
18.5	0.00%	66.67%	33.33%	0.00%	100.00%
19.5	0.00%	0.00%	100.00%	0.00%	100.00%
Total	83.09%	13.35%	2.97%	0.59%	100.00%

Table 4.3.1.b – anchovy age/Length key from PELGAS10 samples for southern/offshore anchovy

Applying the age distributions to the abundance in biomass and numbers, the distribution in age of the biomass has been calculated and gathered in the table 8. The total biomass used here has been up-dated with the value obtained from the previous method based on strata.

Age distributions per area and global are shown in figures 4.3.2. & 4.3.3. The age distributions compared from 2000 to 2010 are shown in figure 4.3.4.

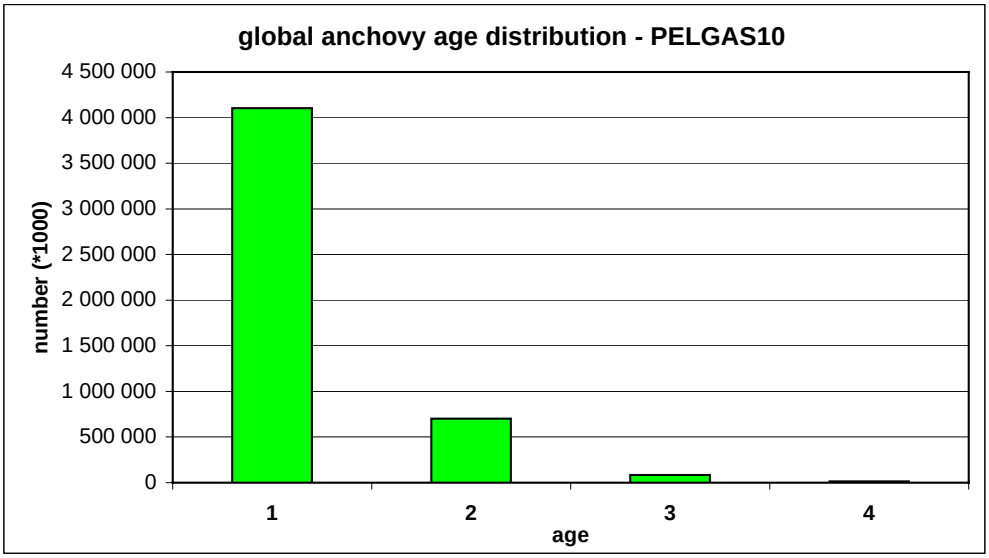

Figure 4.3.2– global age composition of anchovy as observed during PELGAS10 survey

Looking at the numbers at age since 2000 (fig 4.3.4.), The number of 1 year old anchovies this year seems to be medium (4 100 millions fish against 1174 in 2009 and 960 millions in 2008) compared to good years (about 10 000 millions fish). They represent 75% of the biomass (84% in numbers). The 1 year old class is the first good recruitment since 2001 and 2 years old are still well present considering the low level of 1 year old in 2009.

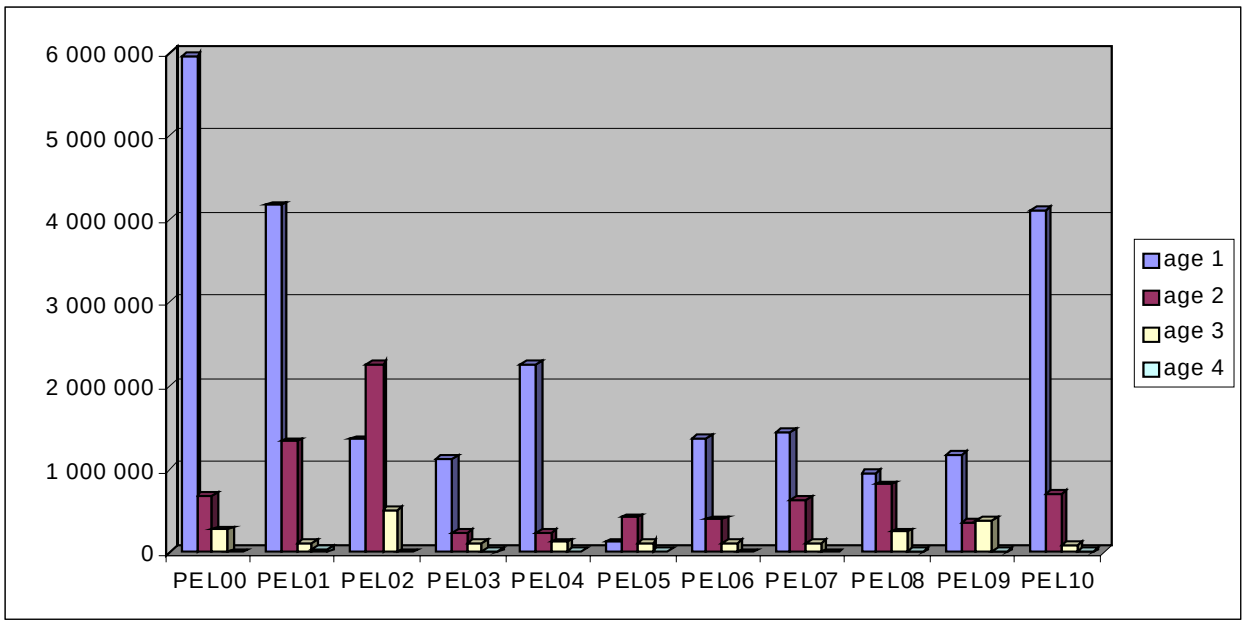

Figure 4.3.4 Anchovy numbers at age as observed during PELGAS surveys since 2000

4.4. Strata comparison

Because of the separate distribution of species as observed previously for assessment purposes, two distinctive strata are considered as significant anchovy biomass : the coastal area (Gironde and coastal areas northern) and the south offshore one. Length and age distributions have been splitted and show that the Gironde coastal zone shows a high predominance of age one, but this age class is also well present offshore.

NB Age	1	2	3	4	5	Total
Gironde and coastal	2 827 453	222 605	16 723	731	0	3 067 512
south offshore	1 275 200	479 137	66 431	13 411	351	1 834 531
total Bay of Biscay	**4 102 653**	**701 742**	**83 155**	**14 142**	**351**	**4 902 043**

NB Age	1	2	3	4	5	Total
Gironde and coastal	57.68%	4.54%	0.34%	0.01%	0.00%	62.58%
south offshore	26.01%	9.77%	1.36%	0.27%	0.01%	37.42%
total Bay of Biscay	**83.69%**	**14.32%**	**1.70%**	**0.29%**	**0.01%**	**100.00%**

Table 4.4.1. - age distribution of anchovy in numbers as estimated from PELGAS10 survey according to separate areas where anchovy was present

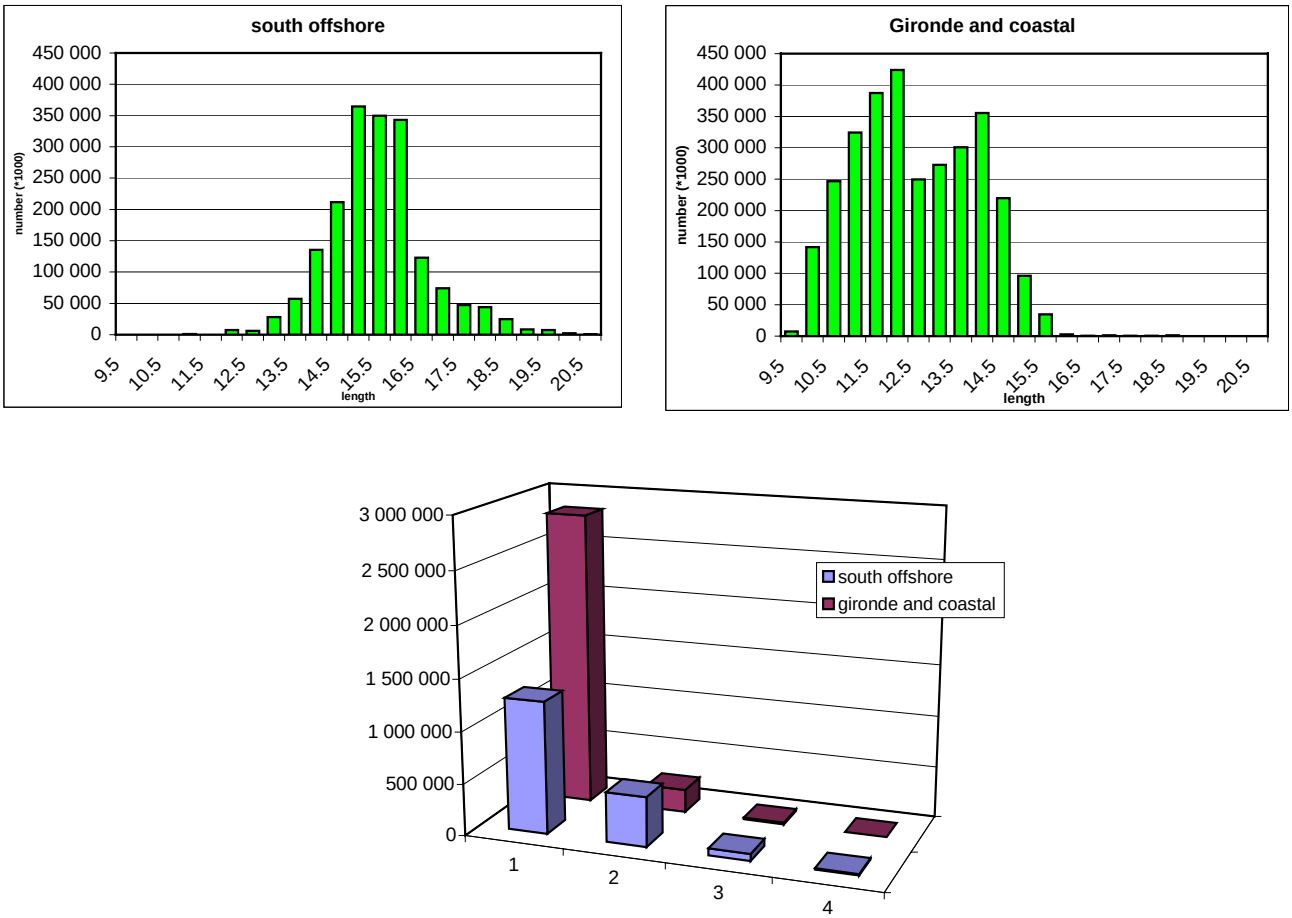

Fig 4.4.2. : length and age distribution during PELGAS10 according to the two main areas where anchovy occurred.

It must be noticed that last year, 95 % of the recruitment (age 1) was only visible in front of the Gironde. This year it is visible in the whole area with 69 % of age 1 (in number) in front of the Gironde and 31 % in the south.

In the Gironde area, 92 % of the fish was 1 year old (mean length 12.3 cm) and only 7% at age 2. In the south, 70 % of the fish was at age 1 (mean length 15.1 cm) and 26 % at age 2 (figure 4.4.3.).

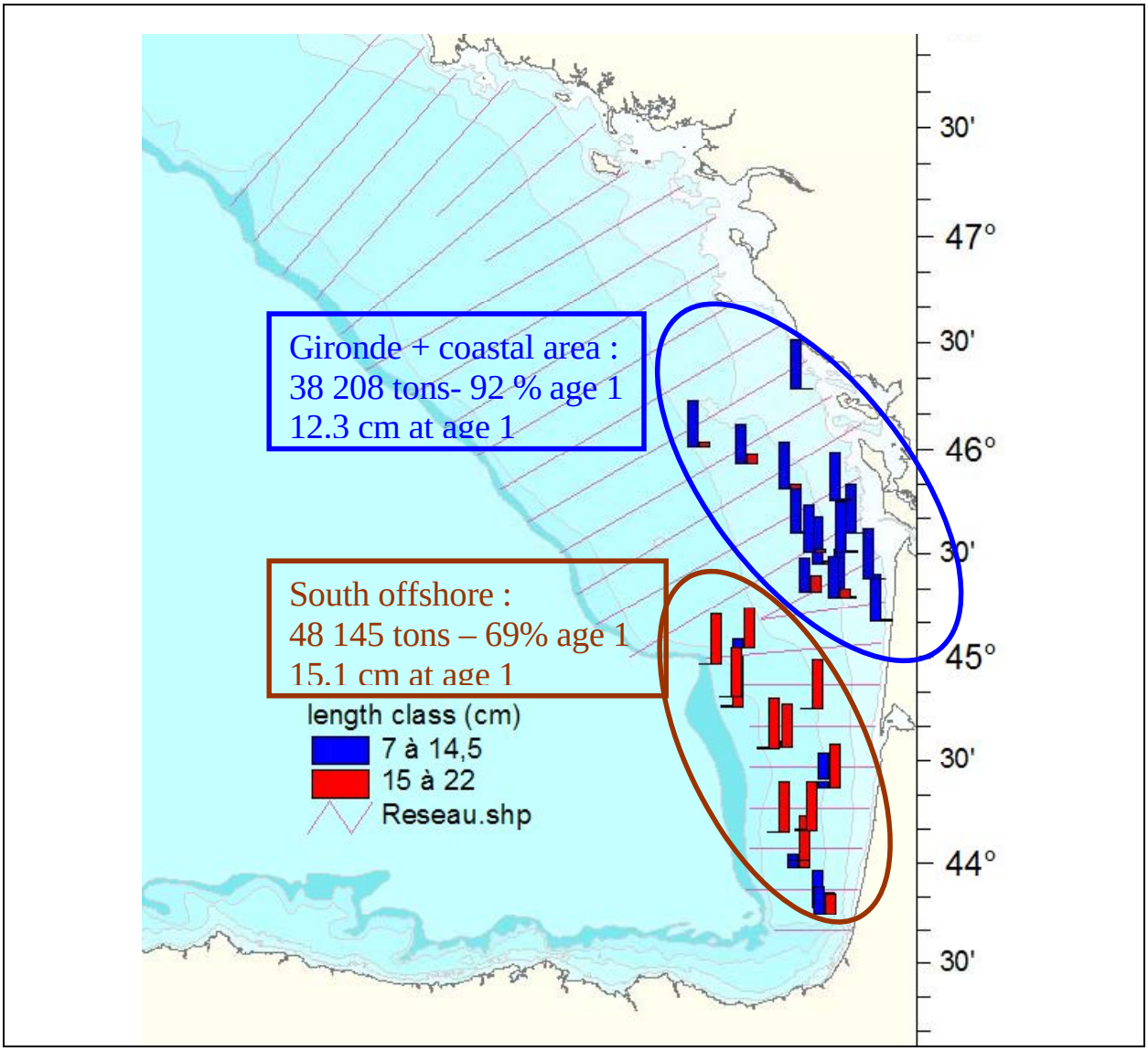

Fig 4.4.3. : geographical distribution of anchovy during PELGAS10. Two areas are considered : Gironde / Coastal area and South offshore area.

4.5. Weight/Length key

Based on 1240 weight of individual fishes, the following weight/length key was established (figure 4.5.) :

$W = 0.0026\ L^{3.3665}$ (with $R^2 = 0.9592$)

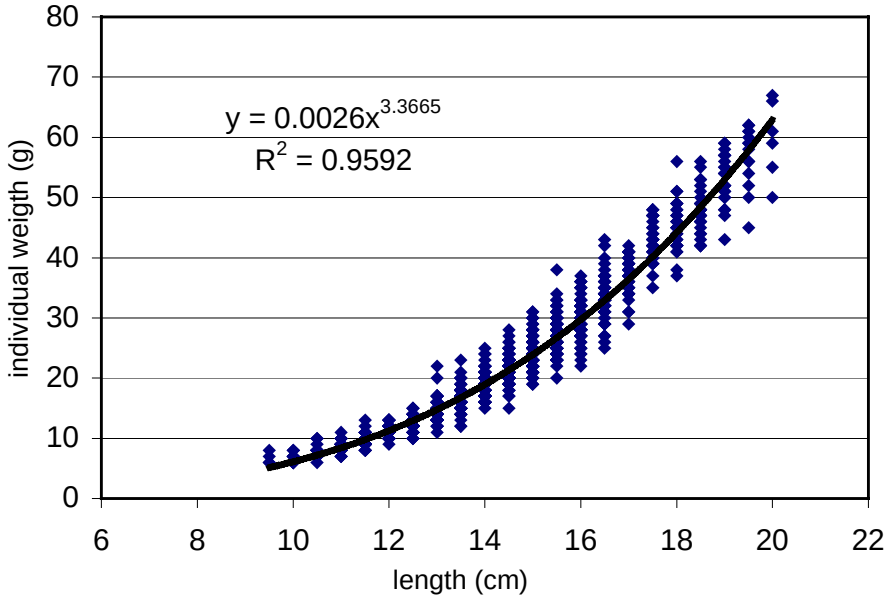

Fig. 4.5. – Weight/length key of anchovy established during PELGAS10

4.6. Eggs

During this survey, in addition of acoustic transects and pelagic trawl hauls, 875 CUFES samples were collected and counted, 107 vertical plankton hauls and 119 vertical profiles with CTD were carried out. Eggs were sorted and counted during the survey.

We observed an eggs distribution close to what is usually seen in May, with a centre of gravity over the shelf of the Landes, and an extension to the North limited to 46°N for anchovy eggs. 2010, like 2009, is particular in the absence of eggs over the slope north of the Gironde latitude (figure 4.6.1.).

Looking at the time series from 2000 to 2010 (Figure 4.6.2. and 4.2.4), anchovy eggs abundance was close to the strong maximum of the time series since 2000. Eggs were abundant on the shelf of the whole VIIIb subdivision. By the way, eggs were not present in very coastal waters, or in very low quantity. Spatial distribution display an average pattern. This year, some adults were found on the south coast of Brittany (even in a low quantity), closed to the coast, but no eggs were presents.

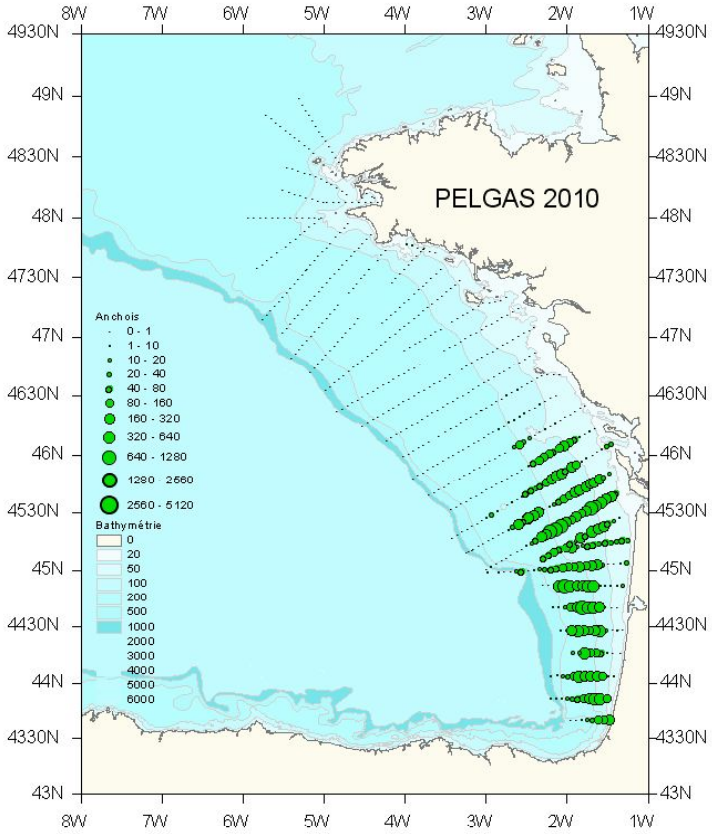

Figure 4.6.1 – Distribution of anchovy eggs observed with CUFES during PELGAS10.

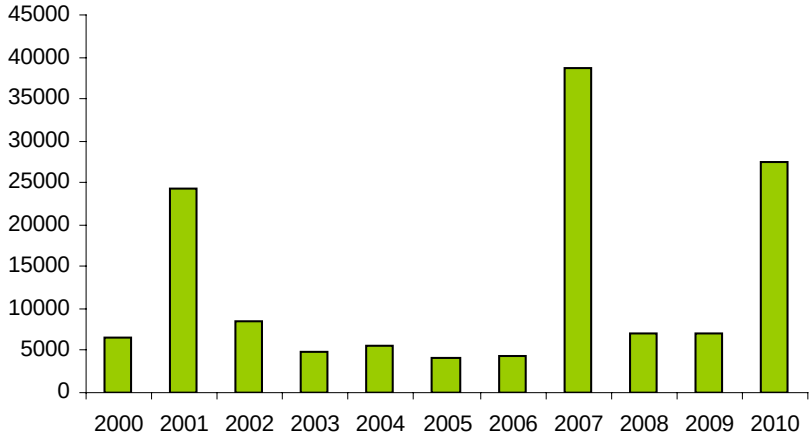

Figure 4.6.2 – Number of eggs observed during PELGAS surveys from 2000 to 2010

The last week was spent prospecting the southern area (where eggs where more abundant) between the Gironde plume, Arcachon, and in the zone called previously “south offshore” where anchovy was well present (figure 4.6.3). The main objective was to study the nyctemeral behaviour of anchovy, the coherence between the eggs and the adults distribution, and to collect data on eggs density and vertical distribution with the multinet (MINOF, 17 hauls). The last experiments were carried out in order to validate a vertical model of egg distribution, which could be used in the future to extrapolate the CUFES data over the whole water column for a quantitative use.

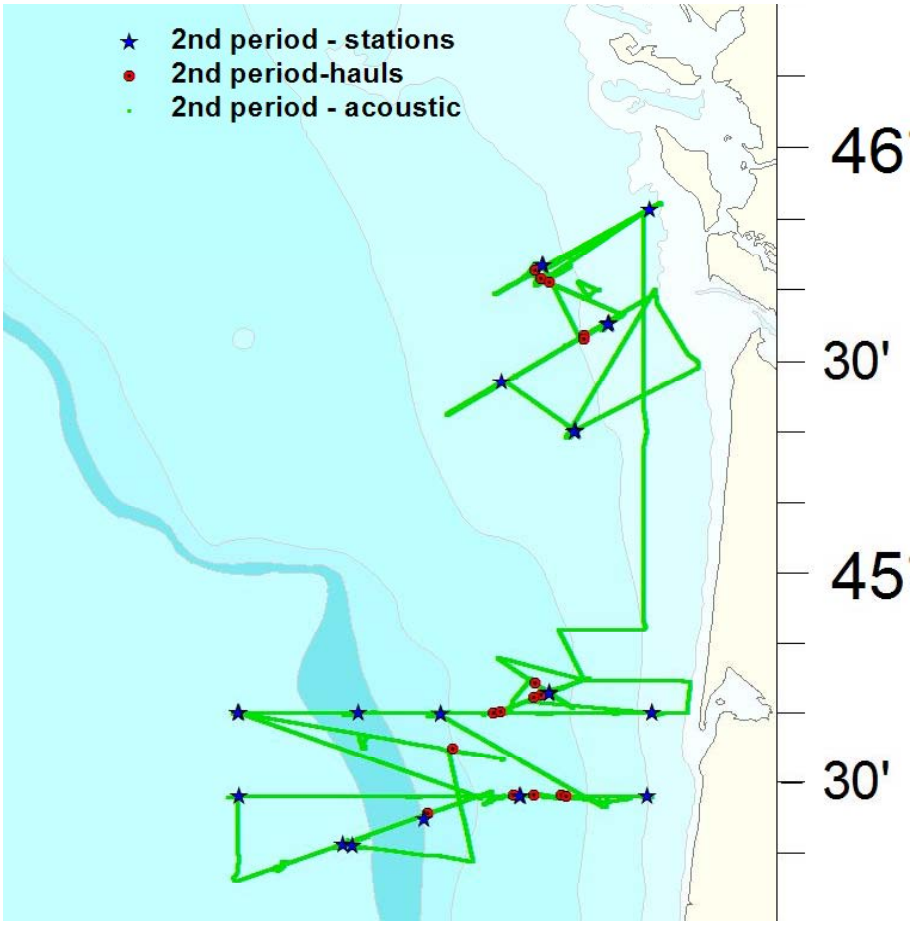

Figure 4.6.3 – Studied area prospected during the last week of the PELGAS10 with the acoustic and CUFES network, hydrology stations, and pelagic hauls.

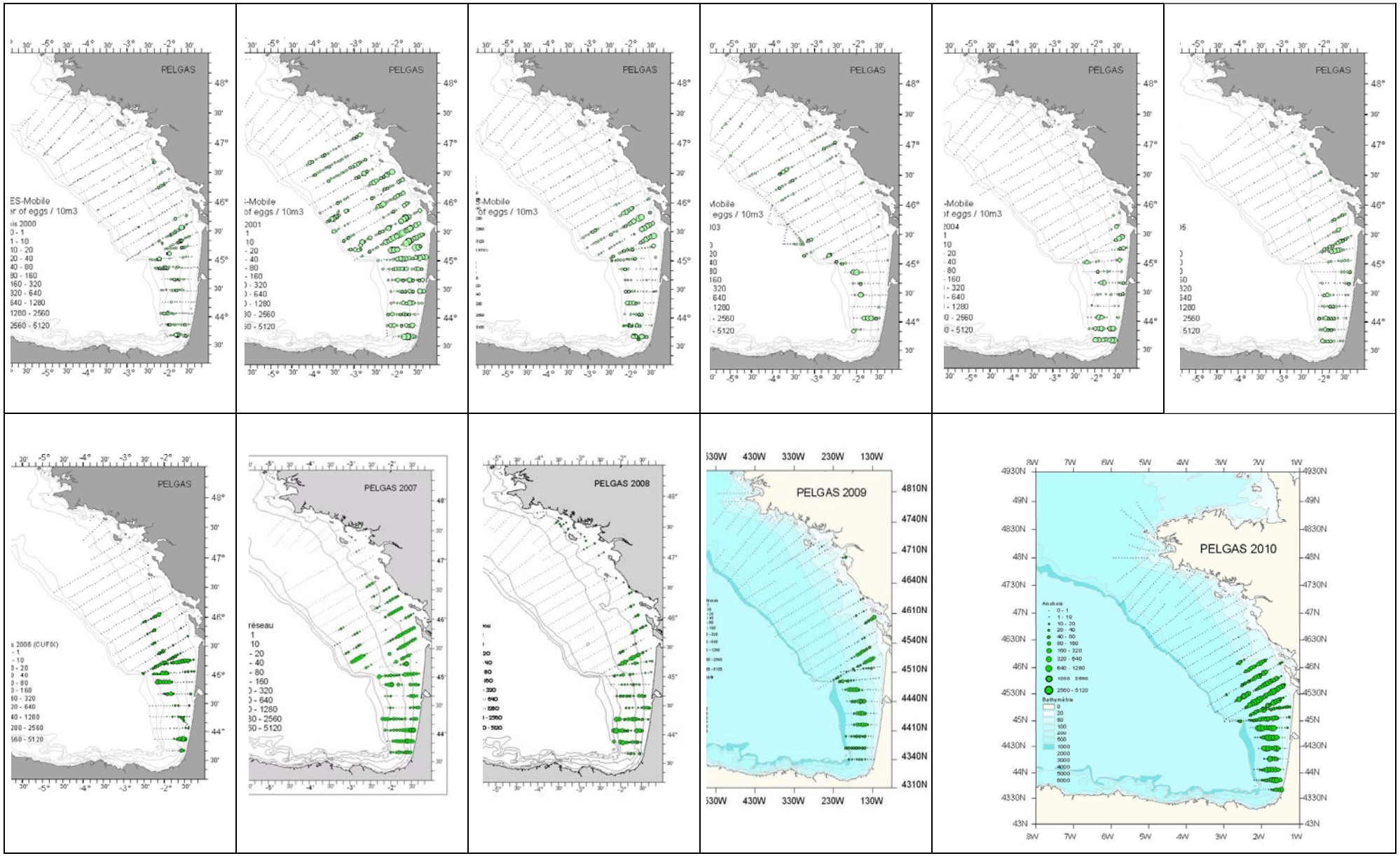

Figure 4.6.4 – distribution of anchovy eggs observed with CUFES during PELGAS from 2000 to 2010 (number for $10m^3$).

5. Sardine

5.1. Adults

The biomass estimate of sardine observed during PELGAS10 is 457 081 tons (table 2.3.), which is one of the highest level of the PELGAS series, but almost constant since 3 years. It must be enhance that these surveys 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. 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 mainly pure in three principal areas along to the French coast : In the southern part of the Bay of Biscay (close to the bottom and in surface), around the Loire plume, adn in the west and south-west of Brittany.

This year, in the offshore area, sardine was rather absent except in surface around the 46°N, northern than the area called “fer à cheval”.

It must be noticed that the number of age 2 this year is really important, and confirms a good recruitment of the 2008 year class. The relative high abundance of age 3 corresponds to the good recruitment of the 2007 year class that we observed previous years.

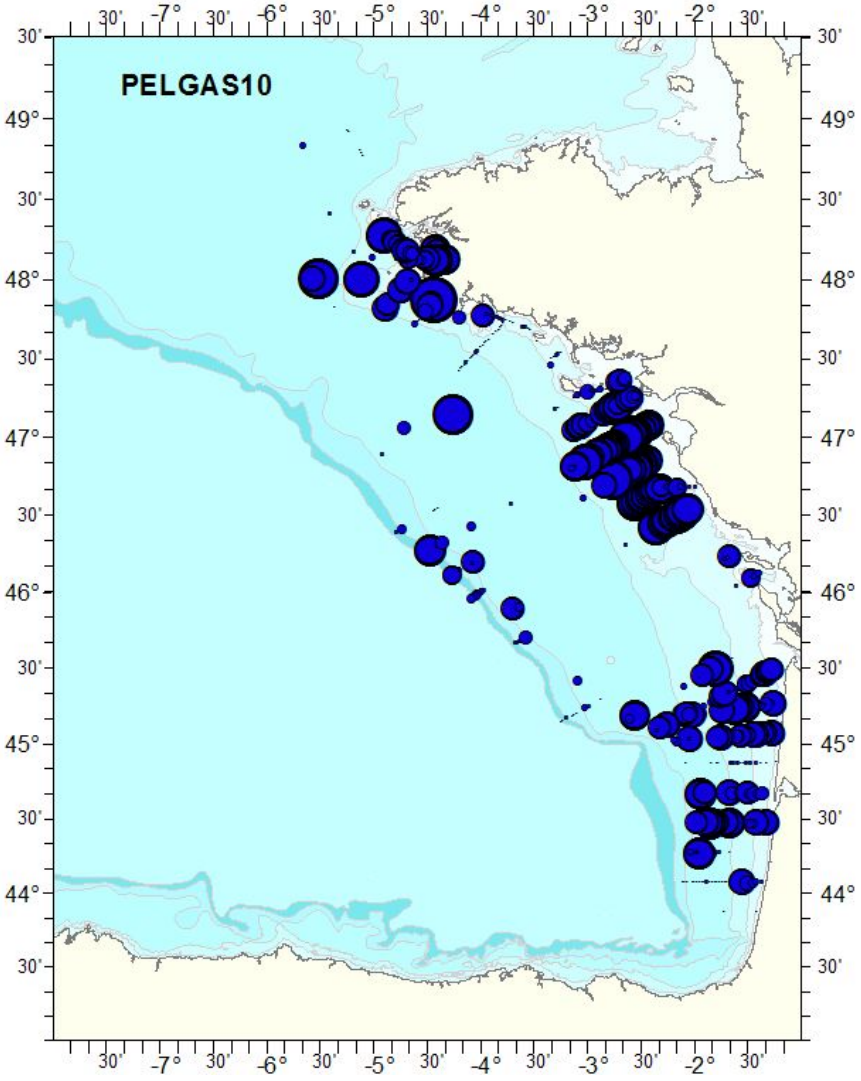

Figure 5.1.1 – distribution of sardine observed by acoustics during PELGAS10

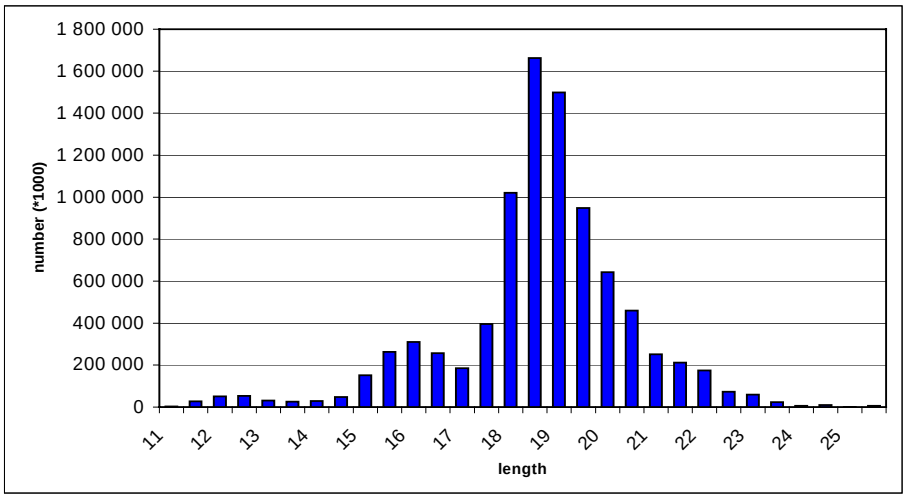

Figure 5.1.2. – length distribution of sardine as observed during PELGAS10.

Length distribution in the trawl haul 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*Xe Moule in thousands of individuals per n.m.^{2}) which correspond to the abundance in the area sampled by each trawl haul. The global length distribution of sardine is shown on figure 5.1.2.

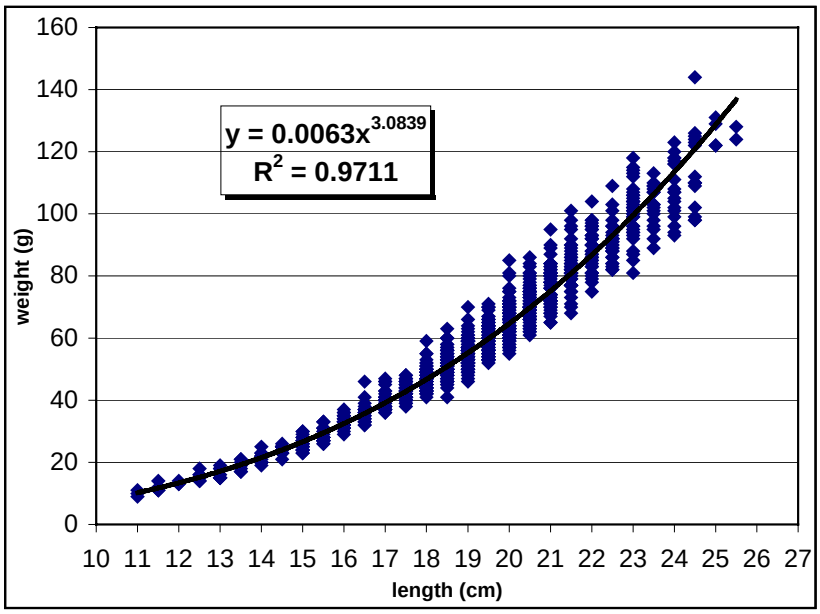

Figure 5.1.3 – Weight/length key of sardine established during PELGAS10

The series of length distributions in numbers as observed since 2000 are shown in figure 5.1.6. As usual, sardine shows a bimodal length distribution, the first one (about 16 cm, not well present this year) represent mainly age 1 (table 5.1.7).

The series of age distribution in numbers since 2000 are shown in figure 5.1.10. We can observe that we can follow cohorts (i.e. the very low 2005 age class, or high 2004 age class). 2003 was an atypical year in terms of environmental conditions and therefore fish distributions.

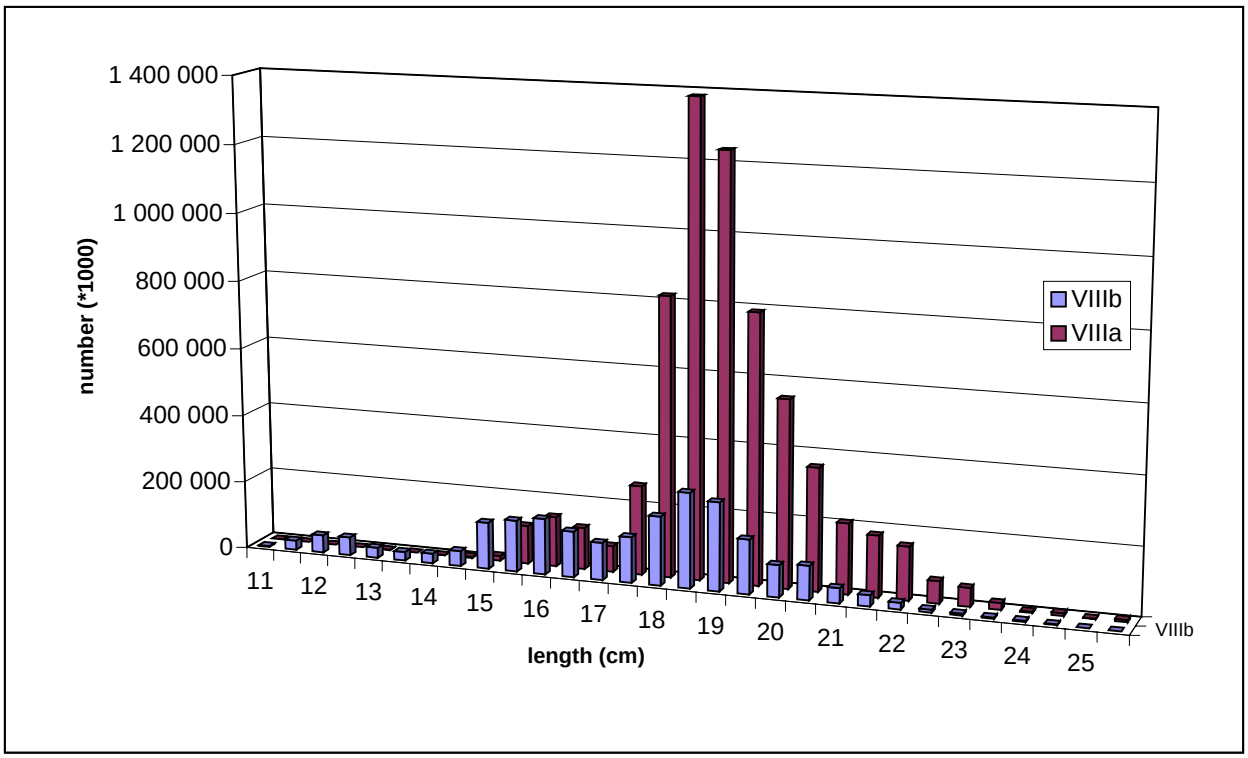

Figure 5.1.4: length distribution of sardine by subdivision (8a/8b) as observed during PELGAS10 survey

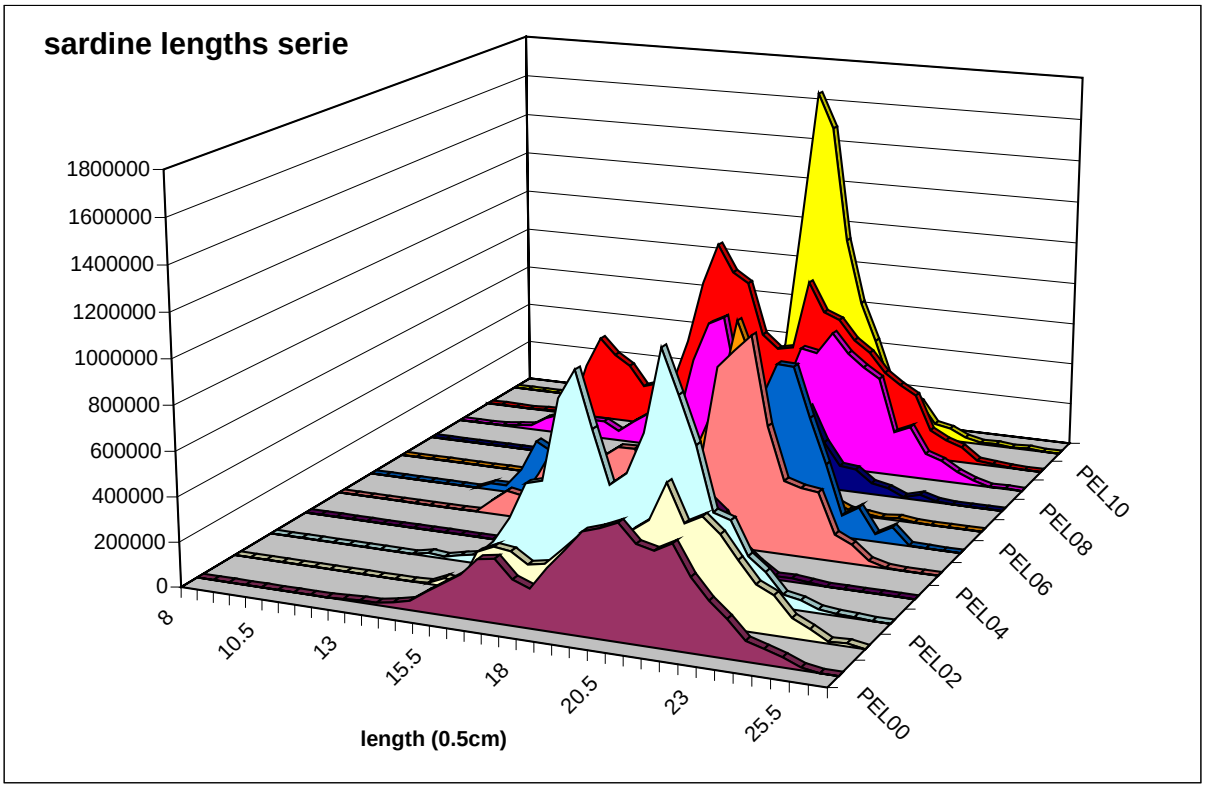

Figure 5.1.6. – length composition of sardine as estimated by acoustics from 2000 to 2010.

NB age	age										
longueur (cm)	1	2	3	4	5	6	7	8	9	10	Total
11	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
11.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
12	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
12.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
13	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
13.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
14	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
14.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
15	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
15.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
16	96.43%	3.57%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
16.5	90.48%	9.52%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
17	48.48%	51.52%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
17.5	13.46%	86.54%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
18	9.46%	90.54%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
18.5	2.38%	95.24%	2.38%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
19	1.09%	82.61%	15.22%	0.00%	1.09%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
19.5	0.00%	63.33%	35.56%	1.11%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
20	0.00%	43.37%	48.19%	8.43%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
20.5	0.00%	18.57%	67.14%	11.43%	2.86%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
21	0.00%	14.52%	50.00%	24.19%	8.06%	3.23%	0.00%	0.00%	0.00%	0.00%	100.00%
21.5	0.00%	4.17%	60.42%	10.42%	10.42%	12.50%	2.08%	0.00%	0.00%	0.00%	100.00%
22	0.00%	0.00%	38.46%	25.64%	10.26%	23.08%	2.56%	0.00%	0.00%	0.00%	100.00%
22.5	0.00%	0.00%	12.50%	21.88%	21.88%	21.88%	9.38%	6.25%	6.25%	0.00%	100.00%
23	0.00%	0.00%	8.82%	8.82%	32.35%	26.47%	8.82%	11.76%	2.94%	0.00%	100.00%
23.5	0.00%	0.00%	0.00%	5.88%	0.00%	47.06%	17.65%	11.76%	17.65%	0.00%	100.00%
24	0.00%	0.00%	0.00%	0.00%	10.53%	36.84%	10.53%	21.05%	5.26%	15.79%	100.00%
24.5	0.00%	0.00%	0.00%	0.00%	0.00%	13.33%	20.00%	40.00%	13.33%	13.33%	100.00%
25	0.00%	0.00%	0.00%	0.00%	0.00%	66.67%	0.00%	0.00%	33.33%	0.00%	100.00%
25.5	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%	100.00%
Total	19.15%	39.98%	21.42%	5.63%	3.65%	5.13%	1.58%	1.88%	1.09%	0.49%	100.00%

Table 5.1.7 : sardine age/length key from PELGAS10 samples (based on 1013 otoliths)

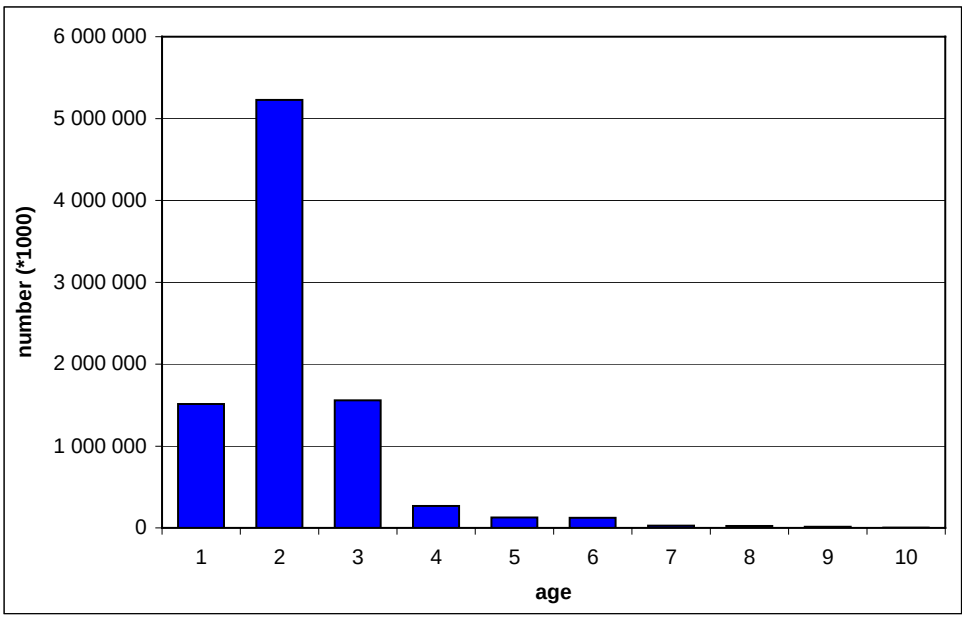

Figure 5.1.8.- Global age composition of sardine as observed during PELGAS 10

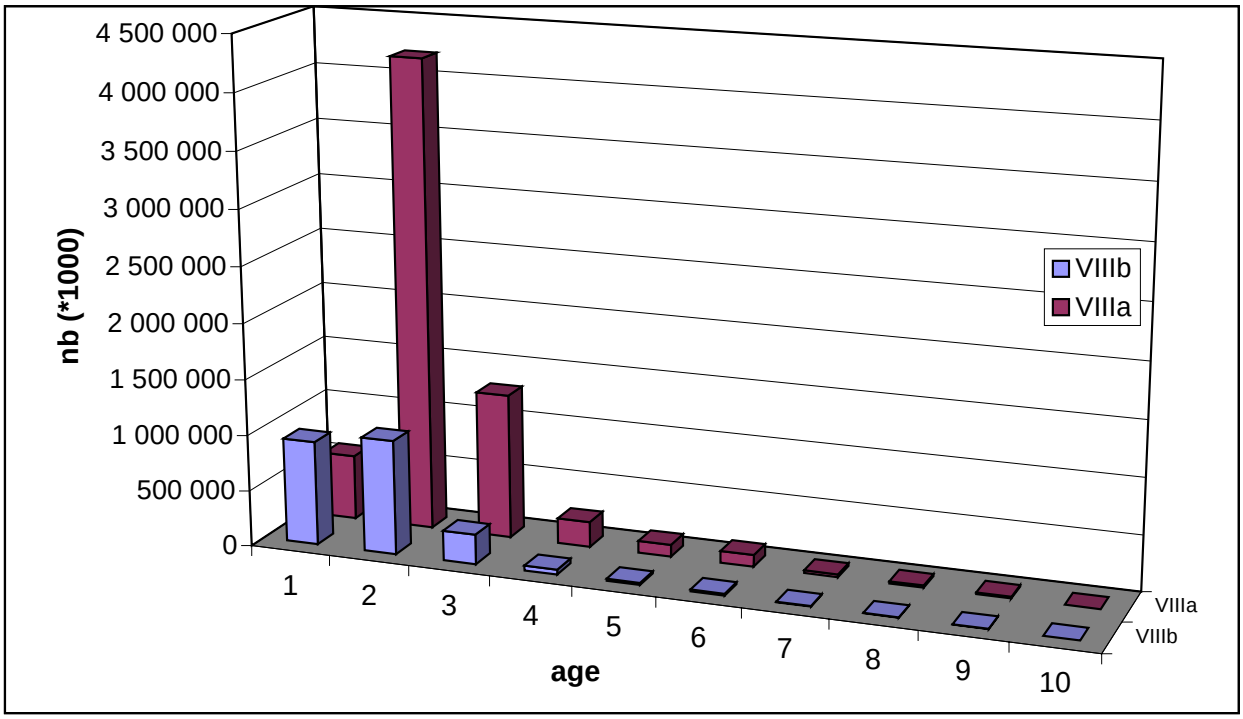

Figure 5.1.9: age distribution of sardine by geographical area (offshore/coastal waters) as observed during PELGAS10 survey

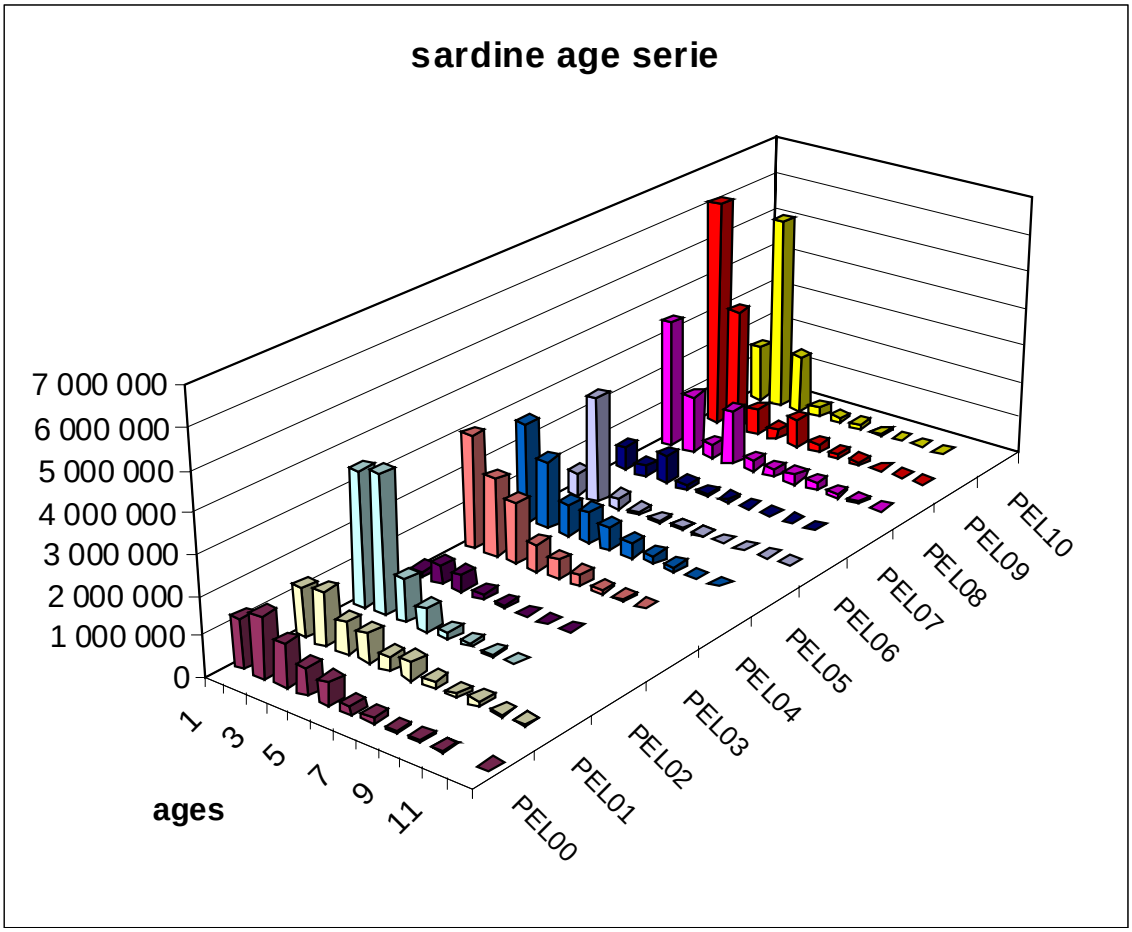

Figure 5.1.10- Age composition of sardine as estimated by acoustics since 2000

5.2. Eggs

Sardine eggs were observed in three distinct zones : first, almost the whole platform in the south part of the Bay of Biscay. Northern, eggs are present within the 100m isobath along the coast of Vendée, until the Loire river. Then, a new concentration was well visible along the south-west coast of Brittany, according to an important presence of adults

It must be noticed that adults appear also at the surface at the shelf break (near the 46°N), but a very low number of eggs was observed in this area.

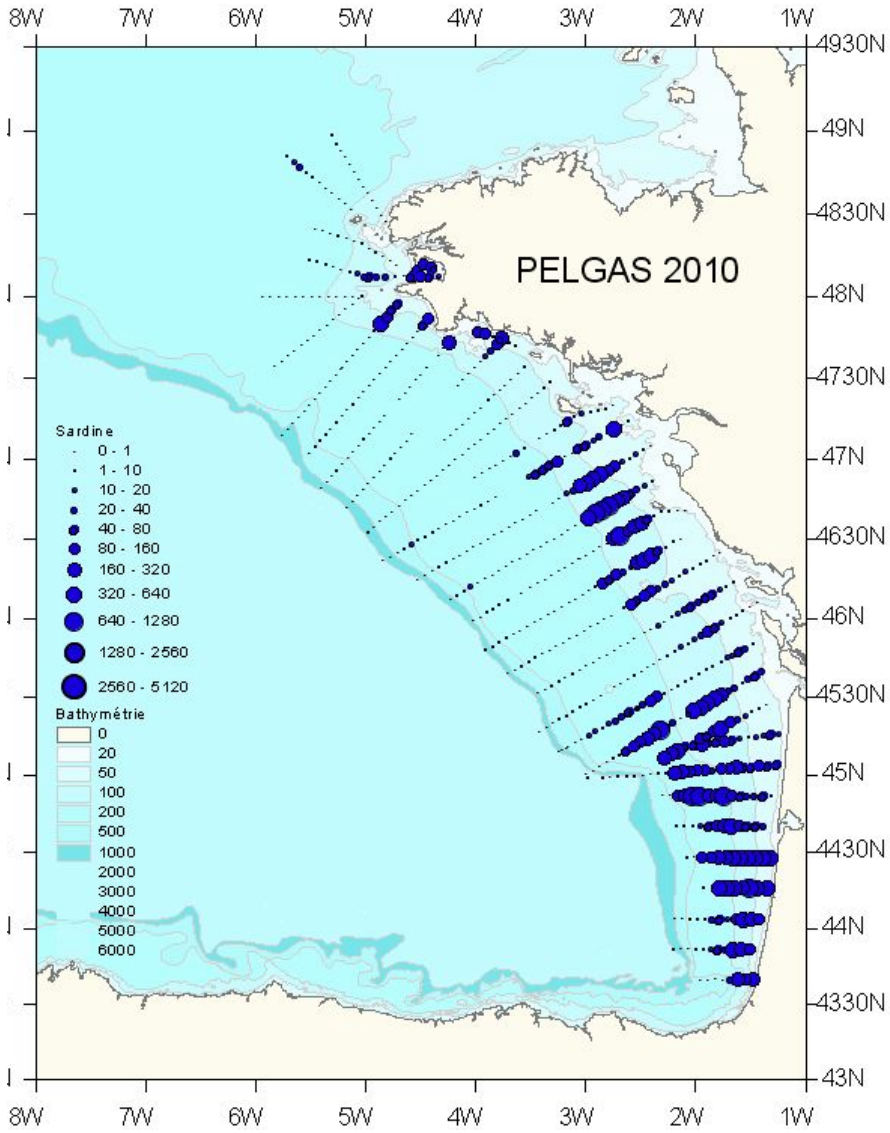

Figure 5.2.1. Distribution of sardine eggs observed with CUFES during PELGAS10.

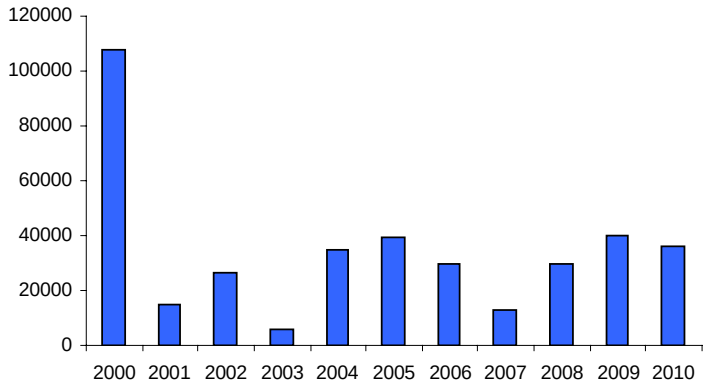

Figure 5.2.2. Number of eggs observed during PELGAS surveys from 2000 to 2010

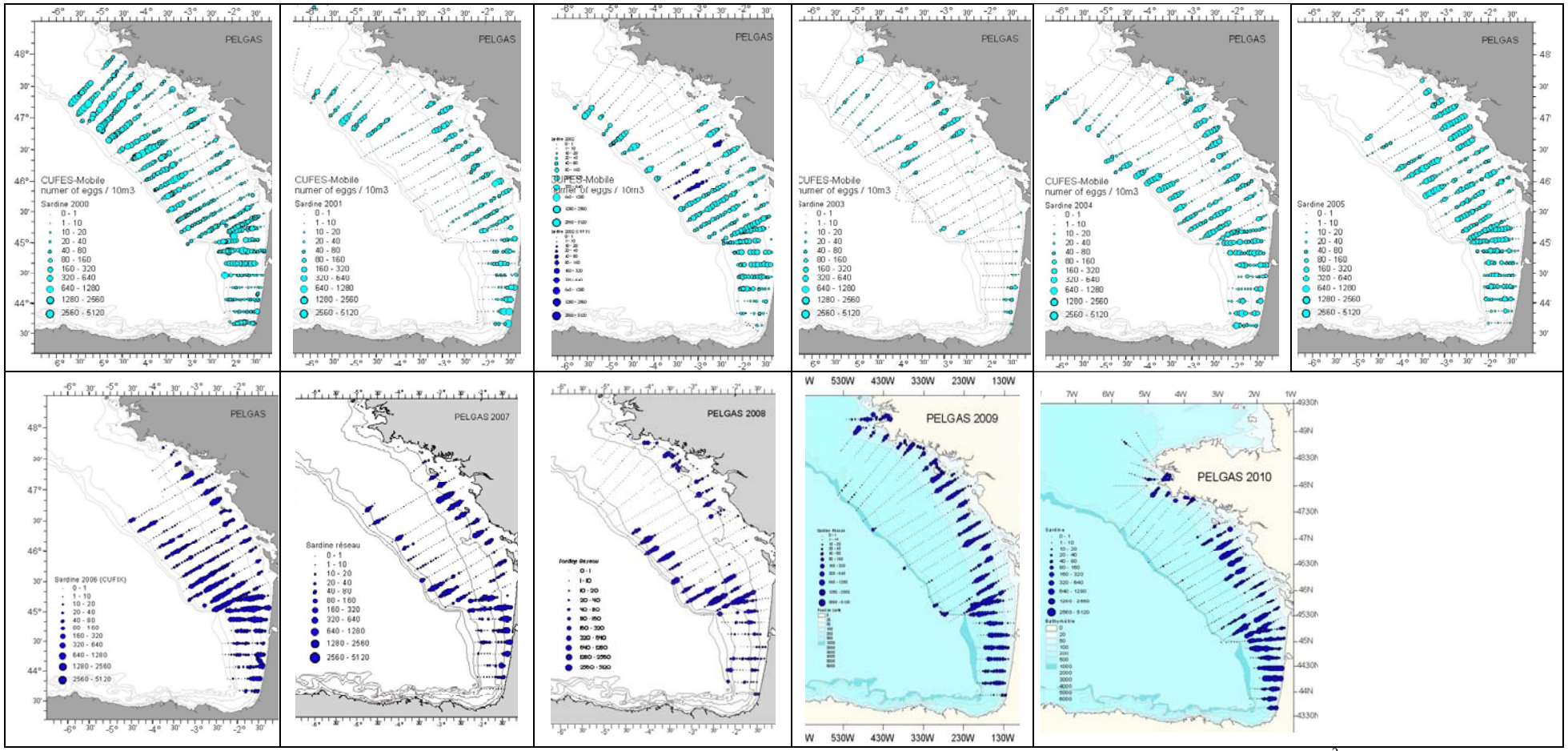

Figure 5.2.3 – distribution of sardine eggs observed with CUFES during PELGAS from 2000 to 2010 (number for $10m^3$).

The number of eggs collected by CUFES during the PELGAS10 survey was comparable to previous years but still far below the maximum observed in 2000.

6. Top predators

6.1 – Birds

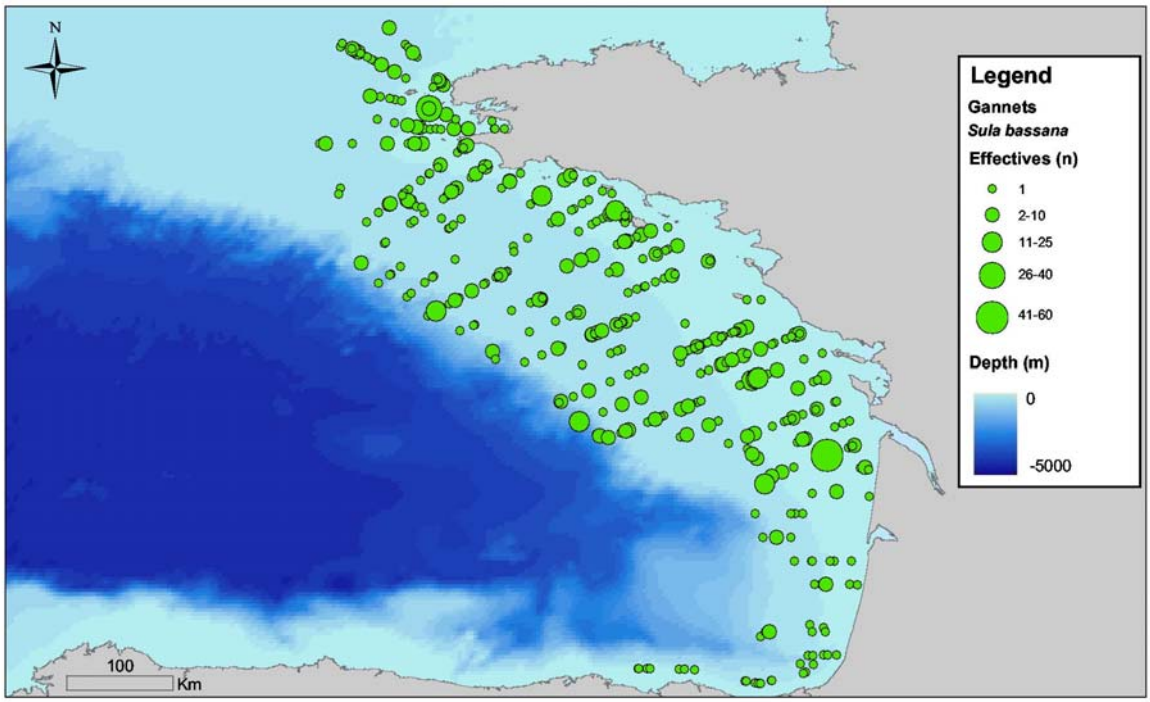

Figure 6.1.1 Distribution of gannets observed during the PELGAS10 survey

Globally, the gannets were present in medium quantity all over the area prospected. The most important concentration seems to be west of Brittany.

The guillemot habitat is, as usual, coastal and this species is rarely observed over the 50 meters bathymetric line.

Fulmar were mainly observed in the northern and offshore part of the bay of Biscay.

Gulls were not well present this year, compared to some previous surveys, and seem to be scattered in the whole area, without predominance inshore or offshore.

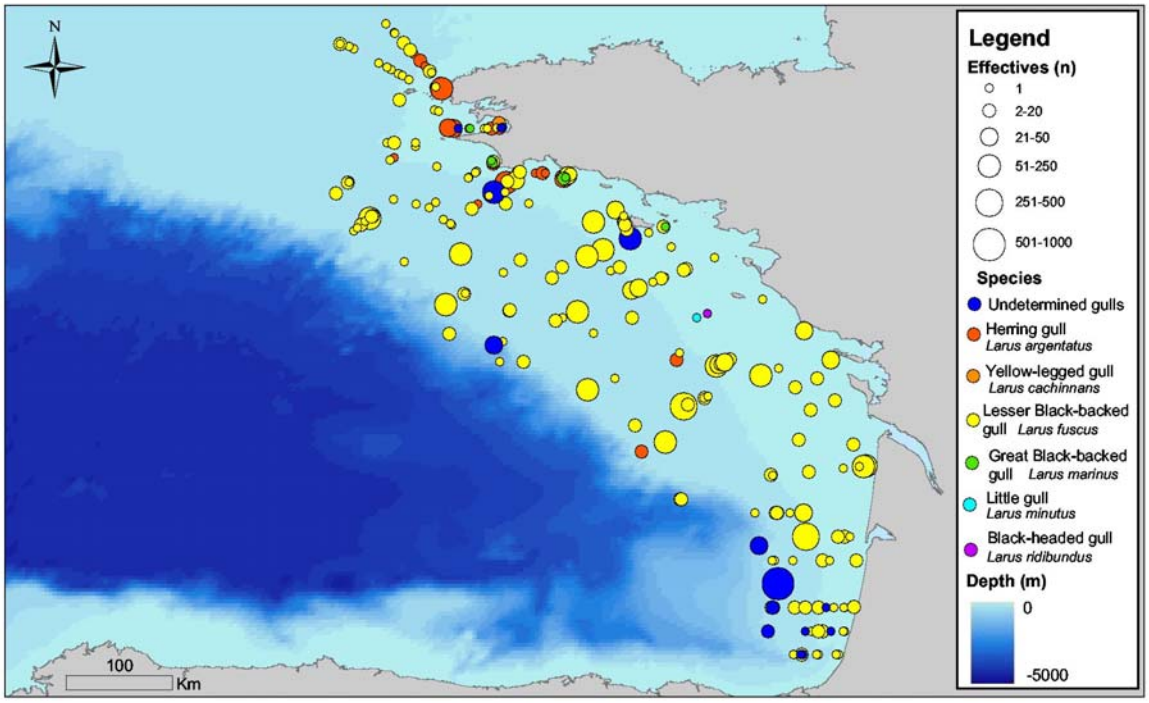

Figure 6.1.2 Distribution of sea gulls observed during the PELGAS10 survey

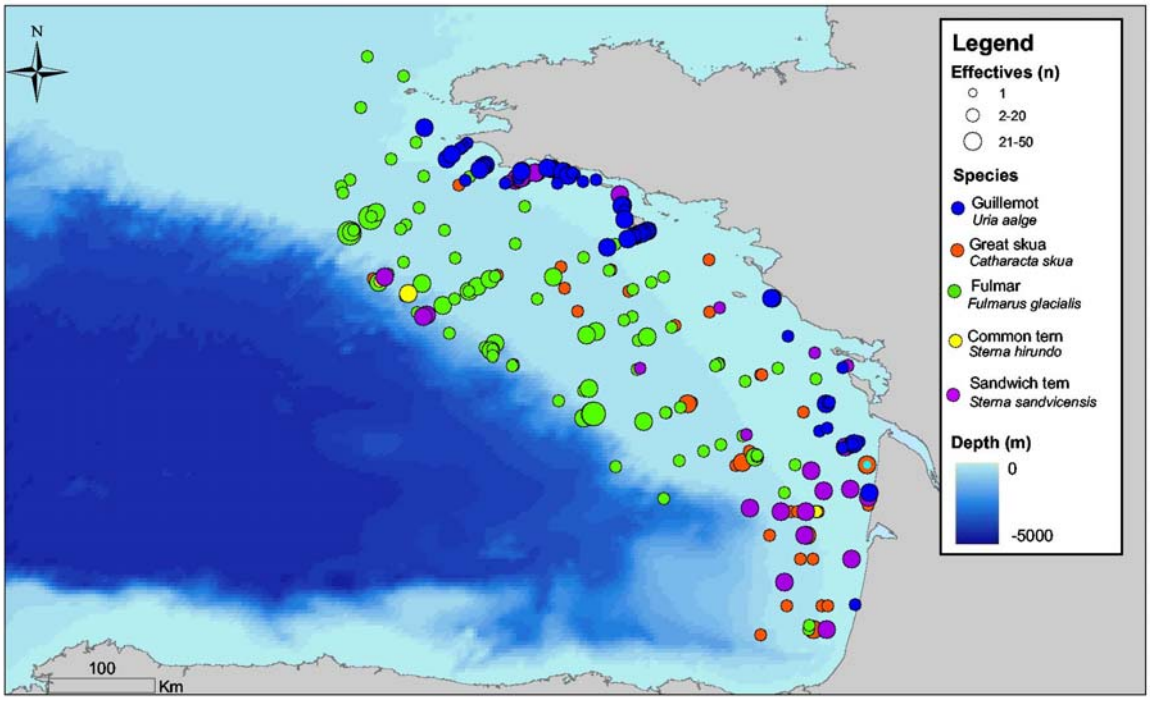

Figure 6.1.3 Distribution of other birds (guillemot, fulmar, terns) during the PELGAS10 survey.

6.2 – Mammals

The more frequent cetacean species is the common dolphin, *Delphinus delphis*, exclusively present this year in shallow waters, except in the “fer à cheval” area (2 obs). Then the bottlenose dolphin (*Tursiops truncatus*) and the striped dolphin were as usual distributed along the shelf edge in the Bay of Biscay and this distribution is similar to the previous years

Large cetacean (fig 6.2.2) where as usual observed along the shelfbreak : 3 sperm whales (*Physeter macrocephalus*) in the "fer à cheval" area (but in bad conditions of observation, see figure 3), and a lot of minke whale (*Baleanoptera acutorostrata*) in this zone.

It must be noticed that two exceptional species were observed this year : closed to the same area, 2 mesoplodon were detected. And northern, at the south-west of Brittany, a killer whale was noticed, for the first time on the Pelgas serie.

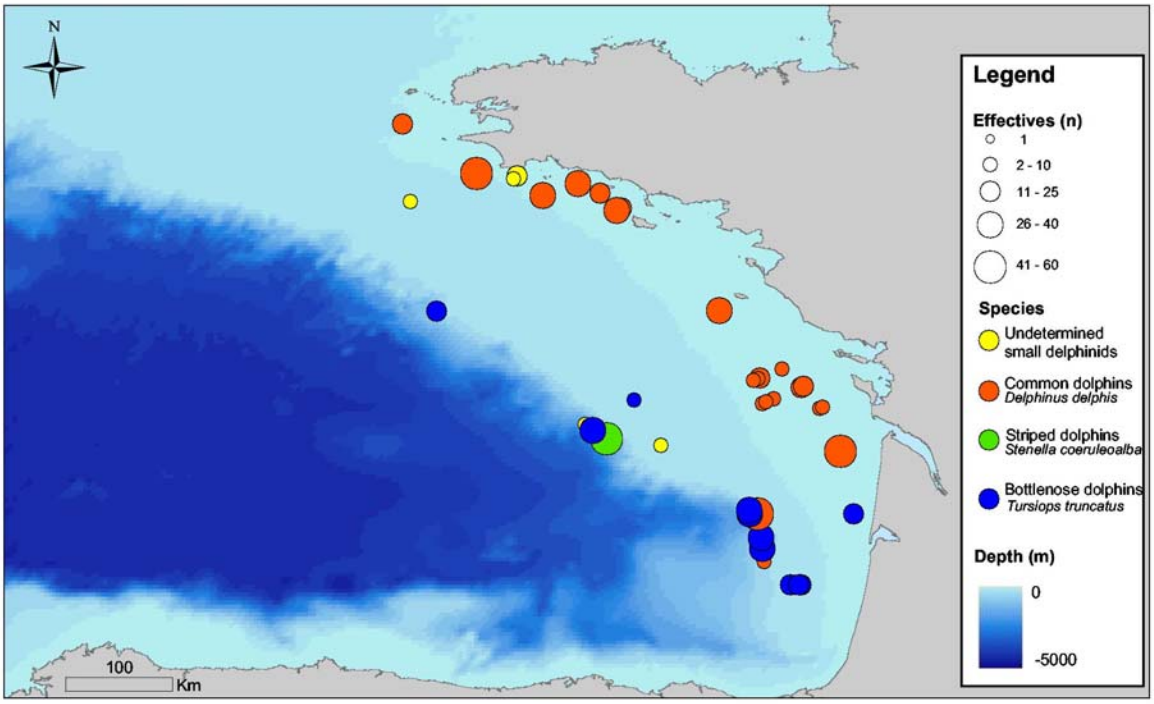

Figure 6.2.1 Distribution of delphinids during the PELGAS10 survey.

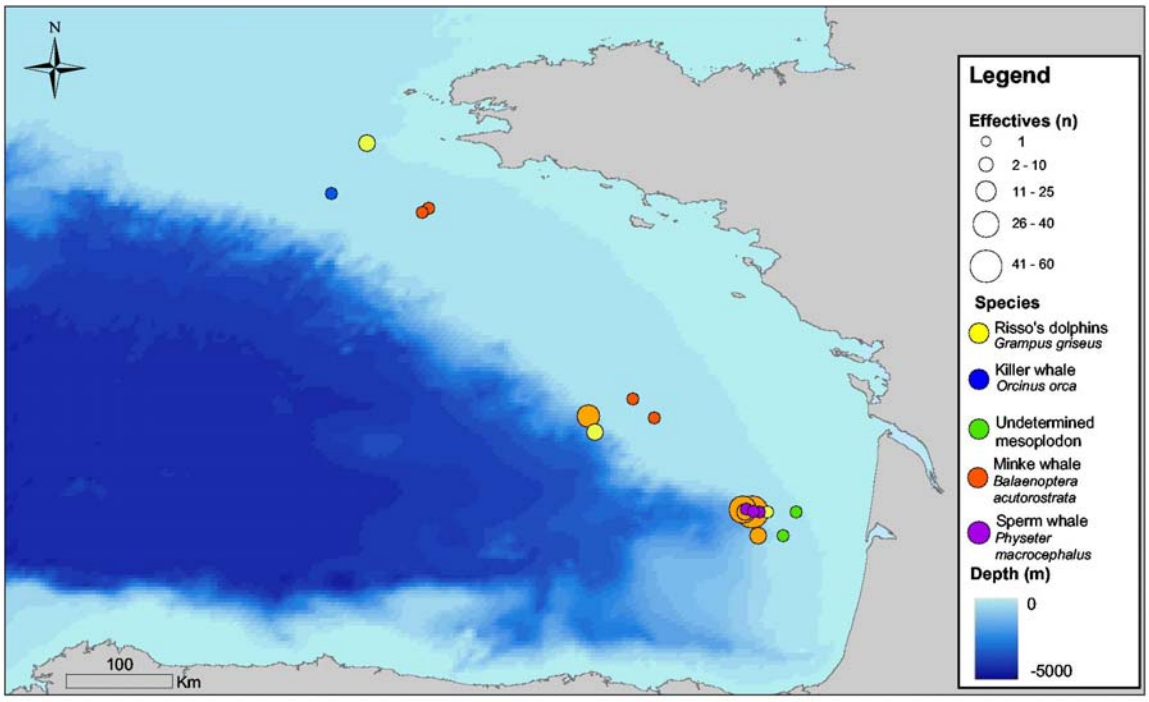

Figure 6.2.2 Distribution of large cetacean during the PELGAS10 survey.

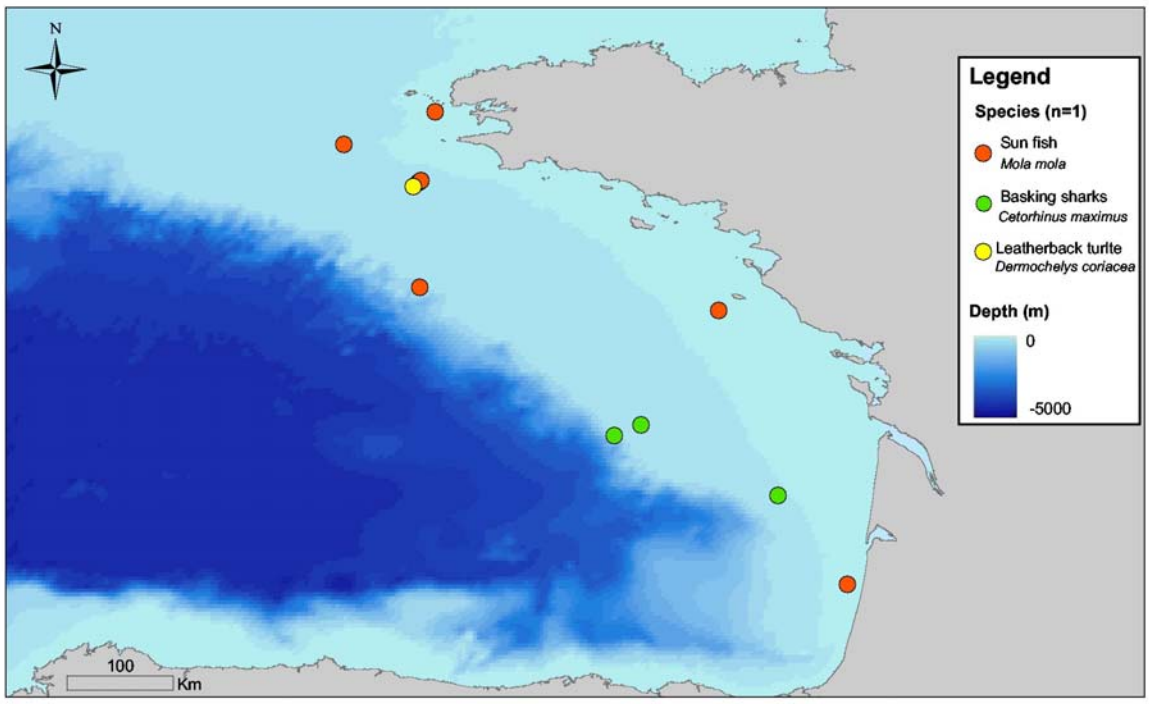

Figure 6.2.3 Distribution of other vertebrates during the PELGAS10 survey.

6.3 – Conditions of observation

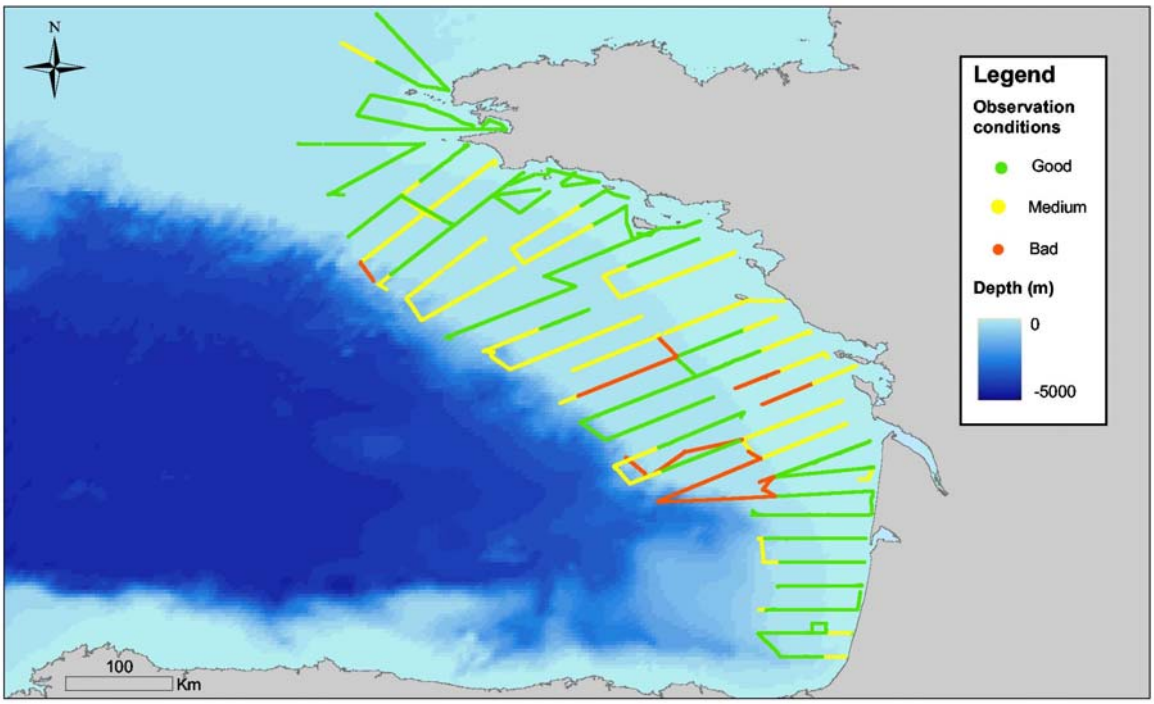

Figure 6.3. conditions of observation of top predators

For each observation of a top predator (bird, mammal), the condition of observation was noted. In red we can see the bad weather conditions (lot of wind, fog, etc). average conditions are in orange, and optimum ones are in green.

We can see that this year, we met a lot of good weather conditions of observation (except in the area called “fer à cheval” which is one of the most important zone for the presence of cetacean), which does not explain the relative low number of mammals and birds observed. Maybe this fact is also an effect of the fish global distribution (closed to the coast, low abundance of all pelagic species behind the 100 meters isobath).

7. Hydrological conditions

Stable anticyclonic conditions dominated the first leg of Pelgas 2010. However, a period of moderate winds from the NE occured and mixed the water column that were strongly stratified at the end of April. SST was cooled during that event. After the mid-survey break, nice weather dominated, and surface temperature warmed up and stratification strengthened.

River plumes are quite reduced under low river discharges. They extend to the north and offshore under low wind conditions, and low salinity were observed along the coast of Brittany until the Mer d'Iroise.

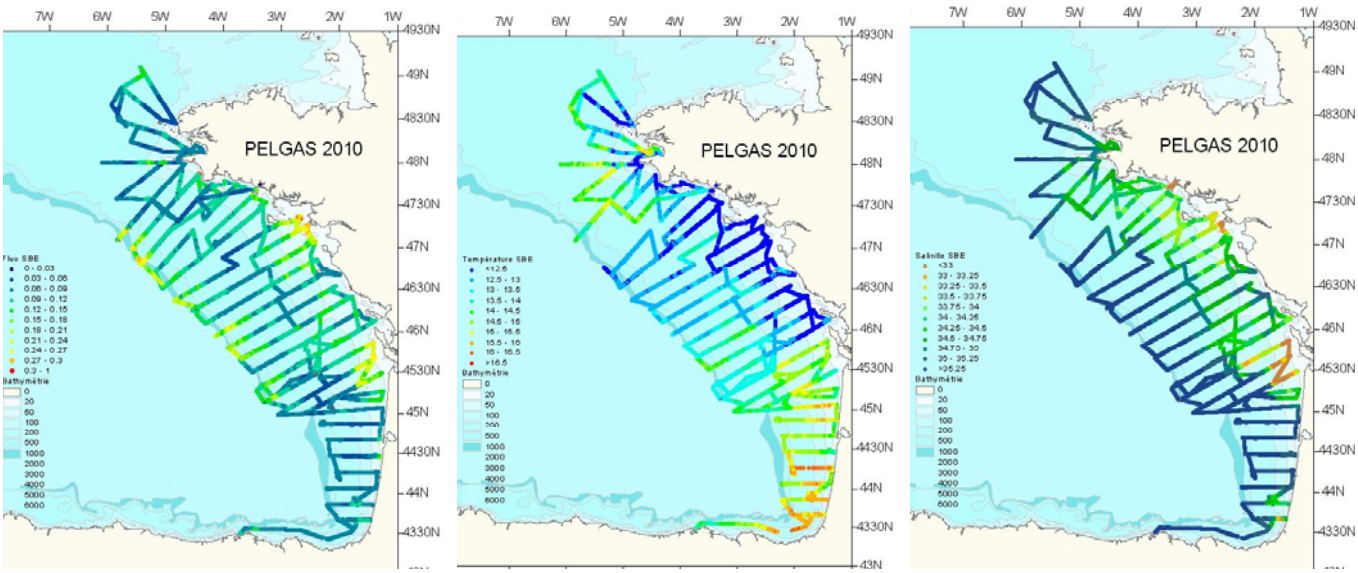

Figure 7.1. – Surface temperature, salinity and fluorescence observed during PELGAS10.

8. Conclusion

The Pelgas10 acoustic survey has been carried out with good weather conditions on average for the whole area, from the south of the bay of Biscay to the west of Brittany. The help of commercial vessels (two pair of trawlers and a purse seiner) during the whole coverage provided about 100 identification hauls as a whole instead of about 50 the years before, when Thalassa wa alone to identify echo traces. These commercial vessels participated to the PELGAS survey in a very good spirit of collaboration. This year, as the two before, they were equipped of scientific echo-sounder and acoustic data will be considered in the near future but for assessment processing, only catches were used. It increased the precision of identification of echoes and some double hauls permitted to confirm that results of both hauls were comparable and usable for biomass estimate purposes at the same time..

Temperature and salinity recorded during Pelgas were affected by weather conditions before and during the survey. When the survey started in the South, water column showed a strong stratification, with a low surface temperature due to the strong winter (-1°C compared to the average on the whole serie). After 10 days, a period of moderate winds from the NE occured and mixed the water column. SST was cooled during that event. After the mid-survey break, nice weather dominated, and surface temperature warmed up and stratification strengthened.

Sardine was predominant during this survey with a biomass of 457 081 tons. Most of it was 2 years old, with a strong mode at 18.5cm, which confirms the strong 2008 year class. The age one was observed, but in lower quantity than the two previous years.

Anchovy were present in two separate zones : the biggest abundance was in the south offshore, showing a biomass of 48 000 tons of medium and big sizes, with 70% of age 1. The second zone is localised in front of the Gironde and the coastal area northern, where 38 000 tonnes of small anchovy (92% of age 1) were present.

Nevertheless, anchovy echo-traces this year appeared in a non traditional way. If they were sometimes distributed as soft and small schools in a layer between 20 and 40 m above the bottom, as it is usually the case, most of them appeared this year as very big and dense schools, which is very unusual. This spatial distribution could explain the high index of abundance associated to a relatively high coefficient of variation indicating a patch distribution of fish.

Ref.

ICES, 2009 – WGACEGG report – Annex 6 : PELGAS sea survey protocol by Mathieu Doray, Jacques Massé and Pierre Petitgas