

ICES Working Group on the assessment of
Mackerel, Horse Mackerel, Sardine and Anchovy.
Vigo, 5-15 September 2005

Working Document

Direct assessment of anchovy by the PELGAS05 acoustic survey

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1. Material and method

An acoustic survey was carried out in the bay of Biscay from May 3rd to June 1st on board the French research vessel Thalassa. The objective of PELGAS05 survey was to study the abundance and distribution of pelagic fish in the Bay of Biscay. The target species were mainly anchovy and sardine and were considered in a multi-specific context. The results have to be used during ICES working groups in charge of the assessment of sardine, anchovy, mackerel and horse mackerel and in the frame of the Ifremer fisheries ecology program "resources variability".

To assess an optimum horizontal and vertical description of the area, two types of actions were combined :

- 1) Continuous acquisition by storing **acoustic** data from four different frequencies and pumping sea-water under the surface, in order to evaluate the number of fish eggs using **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 were 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) was carried out in order to characterise the higher level predators of the pelagic ecosystem.

This survey was considered in the frame of the national FOREVAR program which is the French contribution to the international Globec programme. Furthermore, this task is formally included in the first priorities defined by the Commission regulation (EC) No 1639/2001 of 25 July 2001 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.

The strategy was the identical to previous surveys (2000 to 2004) :

- acoustic data were collected along systematic parallel transects perpendicular to the French coast (**figure 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 25 m depth to the shelf break.

-acoustic data were collected only during the day because of anchovy behaviour in this area. This species is usually grouped very close to the surface during night and so "disappear" in the blind layer for the echo sounder between the surface and 10 m depth.

Two echo-sounders were used during the whole survey (SIMRAD EK60 and OSSIAN 500). Energies and samples provided by split beam transducer (5 frequencies EK60, 18, 38, 70, 120 and 200 kHz) and simple beam (OSSIAN 12 and 49 kHz) were simultaneously visualised, stored and sorted 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 at cap Machichaco on the north coast of Spain in good meteorological conditions.

A total of 2300 nautical miles were prospected during the survey and are usable for evaluation. A total of 41 pelagic hauls (**figure 2.1.**) were carried out for identification of echo-traces.

2. Acoustics data processing

2.1. Echo-traces classification

At the time of the meeting, all the data were totally scrutinised (**figure 2.2.**) biomass estimates available for main species. Acoustic energies (S_a) have been cleaned by sorting the only fish energies (excluding bottom echoes, parasites, plankton, etc.) and classified into 5 categories of echo-traces :

D1 – energies attributed to horse mackerel and gadoids corresponding to cloudy schools or layers 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 mackerel corresponding to the usual echo-traces observed in this area since more than 15 years, constituted by schools, mainly situated between the bottom and 50 meters above. These echoes are typical of coastal areas and sometime more offshore.

D3 – energies attributed to blue whiting and myctophids offshore.

D4 – energies attributed to sardine, mackerel or anchovy corresponding to small and dense echoes, very close to the surface. These echoes were very predominant in the southern part around the shelf break and catches showed a predominance of mackerel, sardine and some horse mackerel, but very few anchovy.

D5 – energies attributed to an horse mackerel and anchovy mix observed in a small area in the south of Bay of Biscay where it was impossible to separate echo-traces into previous categories (**fig.4.2.**).

2.2. Splitting of energies into species

As previous years (except in 2003, see WD-2003) The global area has been splitted 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 where converted into biomass by applying catch ratio, length distributions and weighted by abundance of fish in the haul surrounded area.

3. Eggs

During this survey, more than acoustic transects and pelagic trawl hauls, 955 CUFES samples were collected and counted, 53 vertical plankton hauls and 79 vertical profiles with CTD were carried out. Eggs were sorted and counted, 16 600 fish were measured and 1 340 otoliths were collected for age determinations.

The survey was interrupted before the end of the whole coverage according to the anchovy situation which was observed. One week was therefore devoted exclusively to anchovy in the southern area (**fig 3.1.**) with two objectives : i) to check the adults distribution in the southern area and have more samples in the Gironde coastal area and ii) to study the vertical distribution of eggs, validate a vertical model and therefore have a estimate of the validity of CUFES samples in a quantitative point of view.

The number of eggs collected by CUFES during the survey (**fig 3.2.**) was similar to the one observed the previous years (except 2001 where eggs numbers were extremely high). Only the area seems to change from one year to the other (fig 3.3.). Two main spawning areas were observed by CUFES, one in "Adour" area, the other one in front of the Gironde.

The spawning area localised in the south of the Bay of Biscay (Adour) seems to be linked with the adults distribution. On the other hand, the eggs presence in front of Gironde is broader than the adults one. Many plankton net hauls combined to dense CUFES samples (1 nm instead of 3 nm) were carried out in this area. A gradual distribution of eggs was observed according to the stage of eggs proving that the broad distribution was due to the drift of eggs from the coast to offshore and that these eggs were mainly produced very close to the coast. This area (depth < 25 m) is of course badly surveyed by acoustics for security reasons.

4. Biomass estimate

At the time of the meeting, all the data were totally scrutinised (**figure 2.2.**) and therefore, biomass estimates were available for main species. The specific biomass are gathered in **table 1**

Table 1 – Areas covered during the PELGAS05 survey for each geographic strata and biomass in tons and in number per species

	Adour	Gironde	offshore	North coastal	North offshore	Total
anchovy	10 660	4 787	156			15 603
sardine	41 358	88 520	154 052	12 573	133 018	429 521
sprat		56 596		32 330		88 926
horse mackerel	22 310		15 116	26 470	119 366	183 262

Main of the anchovy was observed in the southern area around 100 and 110 m depth, from 43° 40 N and 43° 50 N. They were mixed with horse mackerel in most of the cases. Some anchovy were seen in the Gironde area, but in low proportions, mixed with sardine and sprat.

According to CUFES samples, 2 sampling areas are observed, one linked with the adults distribution in "Adour" area, the other one in front of the Gironde.

5. Length structure

Length distribution in the trawl haul were estimated from random samples. The population length distributions (**figure 5.1**) 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. A global length distribution of anchovy is shown in **figure 5.2**.

6. Demographic structure

An age length key was constituted from the trawl catches. Sub-samples (918 otoliths for the whole survey) which were taken from the previous samples, according to a stratified scheme based on length classes (**Table 3**) . The population age-length key was estimated by a weighted average of the age length key 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.

Length	G 1	G 2	G 3	G 4
950	1.00	0.00	0.00	0.00
100	1.00	0.00	0.00	0.00
105	0.89	0.11	0.00	0.00
110	1.00	0.00	0.00	0.00
115	0.75	0.25	0.00	0.00
120	0.56	0.33	0.11	0.00
125	0.38	0.58	0.04	0.00
130	0.35	0.59	0.06	0.00
135	0.36	0.58	0.04	0.02
140	0.29	0.60	0.11	0.00
145	0.22	0.60	0.11	0.07
150	0.17	0.78	0.04	0.00
155	0.14	0.73	0.14	0.00
160	0.10	0.74	0.15	0.00
165	0.03	0.58	0.39	0.00
170	0.00	0.71	0.27	0.02

175	0.03	0.63	0.31	0.03
180	0.00	0.58	0.38	0.04
185	0.00	0.53	0.47	0.00
190	0.00	0.67	0.27	0.07
195	0.00	0.40	0.50	0.10
200	0.00	0.50	0.50	0.00
205	0.00	0.00	1.00	0.00

Applying the age distributions to respective areas, the abundance in biomass and numbers have been calculated and gathered in **table 4** below. Age distributions per area and global are shown in **figures 6.1. & 6.2.** The age distributions compared from 2000 to 2005 are shown in **figure 6.4.**

in numbers	area (nm ²)	G 1	G 2	G 3+	Total
Gironde	2226	78 080 361	151 622 696	25 219 051	254 922 108
offshore	4176	2 632 269	4 968 393	825 757	8 426 419
Adour	2456	46 920 080	244 806 289	75 631 252	367 357 622
total	8858	127 632 711	401 397 378	101 676 060	630 706 149
%		20.24	63.64	16.12	100

in tons	area (nm ²)	G 1	G 2	G 3+	Total
Gironde	2226	1 283	2 962	542	4 787
offshore	4176	45	94	16	156
Adour	2456	1 077	6 983	2 600	10 660
total	8858	2 405	10 039	3 158	15 603

7. Weight/Length key

Based on 2740 weight of individual fishes, the following weight/length key was established (**figure 7**) :

$$W = 0.0048 L^{3.149} \quad (\text{with } R^2 = 0.9557)$$

The mean weight at age are as following :

mean weight (g)	G1	G2	G3+
Gironde	16.43	19.54	21.48
Large	17.21	19.01	19.69
Landes	22.95	28.52	34.38

8. Environmental conditions

Hydrological observations showed surface temperatures rather similar to previous years but well visible up-wellings along the Landes coast. The river plumes are narrow and rather cold at the surface, showing a recent flow of fresh water and well correlated to the dry winter

which preceded. Nevertheless, temperatures at 40 m depth were very cold ($< 11^{\circ}$), even 2° below the colder one registered since 2000.

9. Conclusion

The distribution of anchovy observed during this survey was not totally atypical, as on the one hand the 2 main areas are traditional spawning areas and on the second hand small fish are closed to the coast, mainly in front of the Gironde and bigger fish in Adour area. Nevertheless, the abundance was very low and the predominance of big fish indicates a very low level of recruitment (1 group fish from 2004 year class).

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The number of 1 year old anchovy was estimated at a level of 127 millions of fish. When applying a usual M factor of 1.2 (only on the 5 first month of the year) this estimate would correspond to a number of about 200 millions of fish of G1 on the 1st of January. This level of recruitment is very low and even far below the lowest recruitment index observed since 1987 (1 000 millions of fish in 1989). Nevertheless, the combination of the two observations 1) of eggs (CUFES) and 2) acoustics and pelagic trawl hauls, shows that the Gironde spawners were certainly very close to the coast and might be under-estimated.

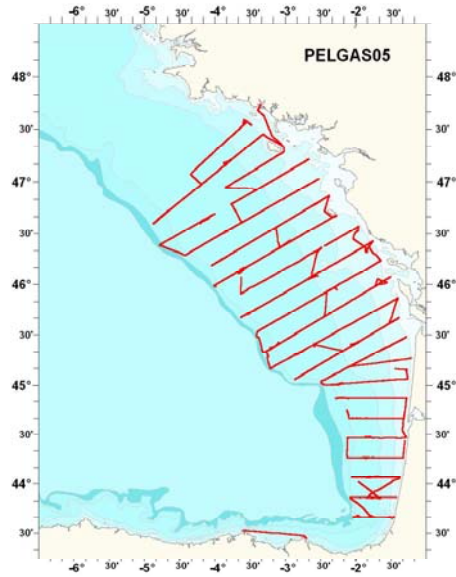


Fig. 1 - Transects prospected during PELGAS05 (in red). The 10 northern transects (in blue) were not processed at the date of the present STECF meeting.

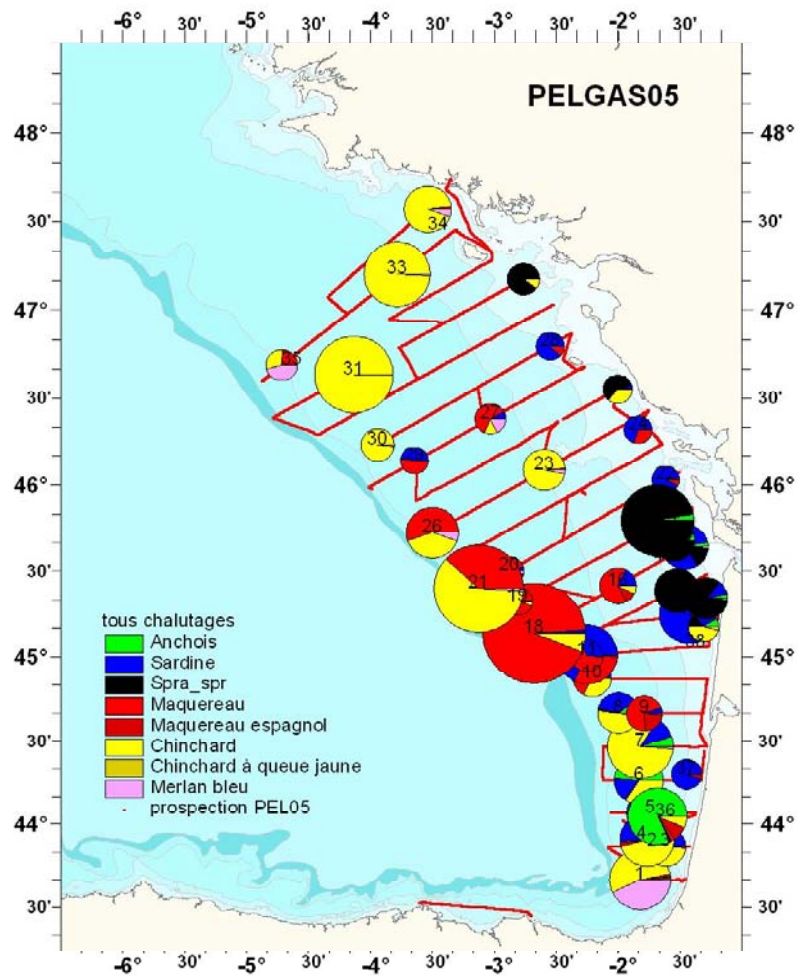


Fig. 2.1. Species distribution according to identification hauls

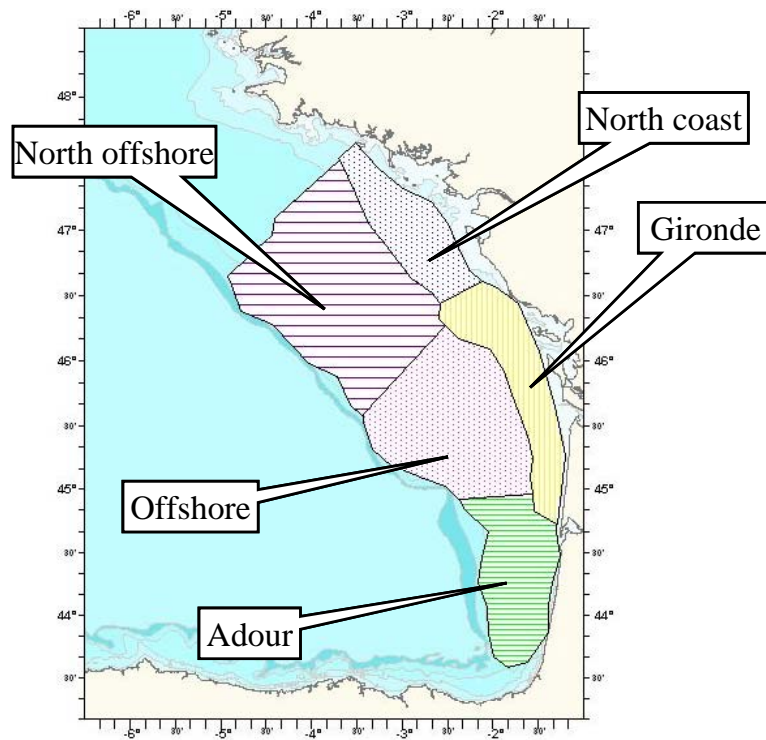


figure 2.2. – areas taken into account for assessment

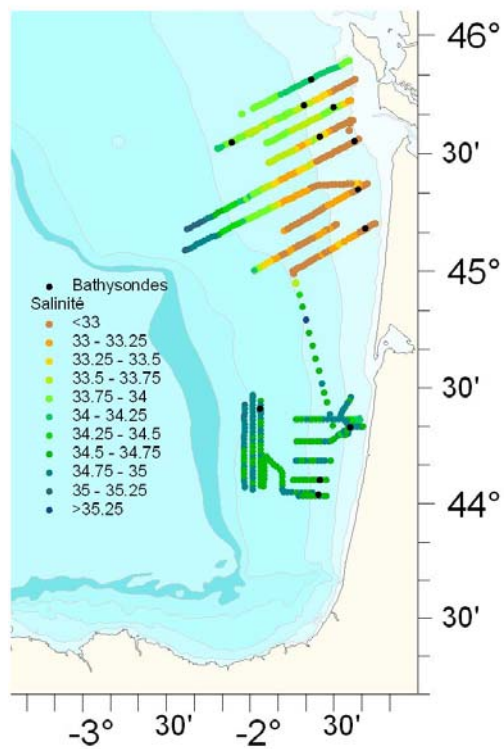


Figure 3.1. – Area prospected during the last week of the PELGAS05 survey

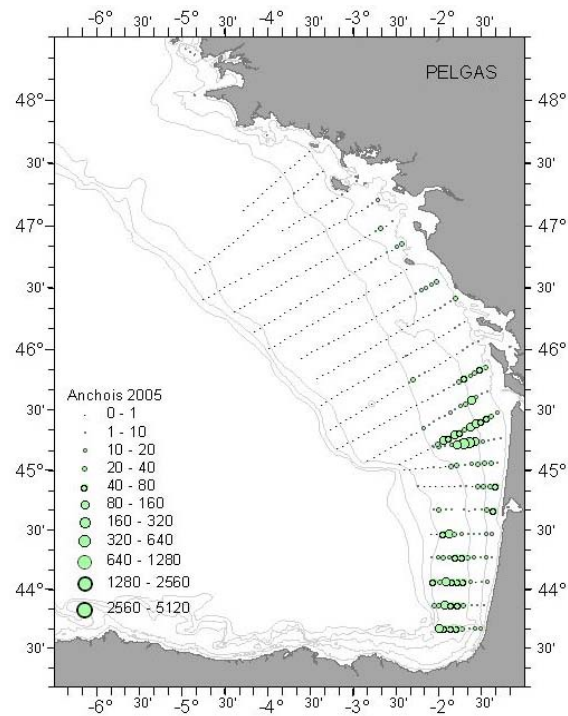


Figure 3.2. – distribution of anchovy eggs observed with CUFES during PELGAS05

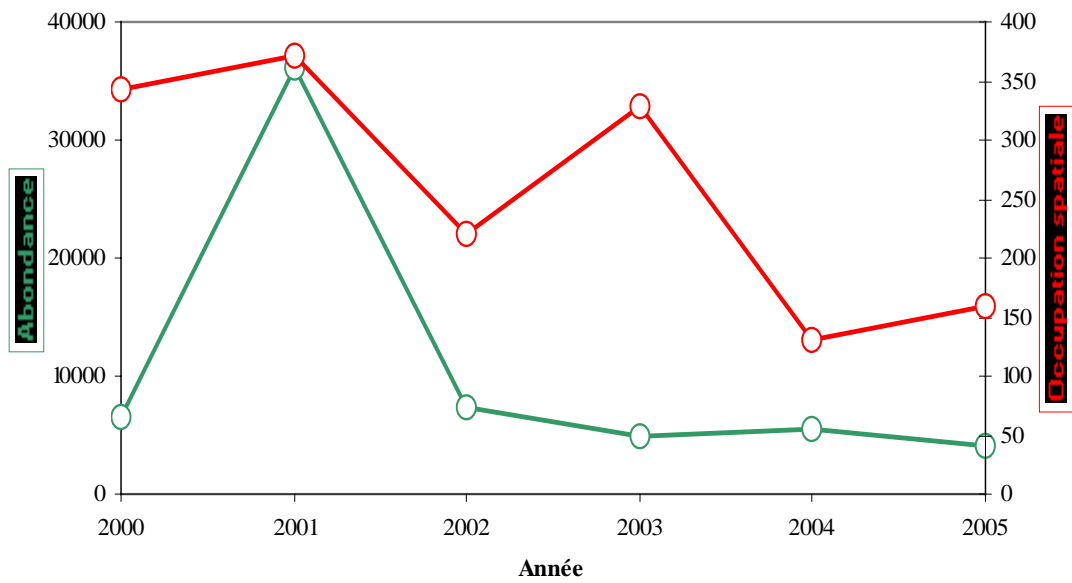


Figure 3.3. – Number of eggs and positive areas observed during PELGAS surveys from 2000 to 2005

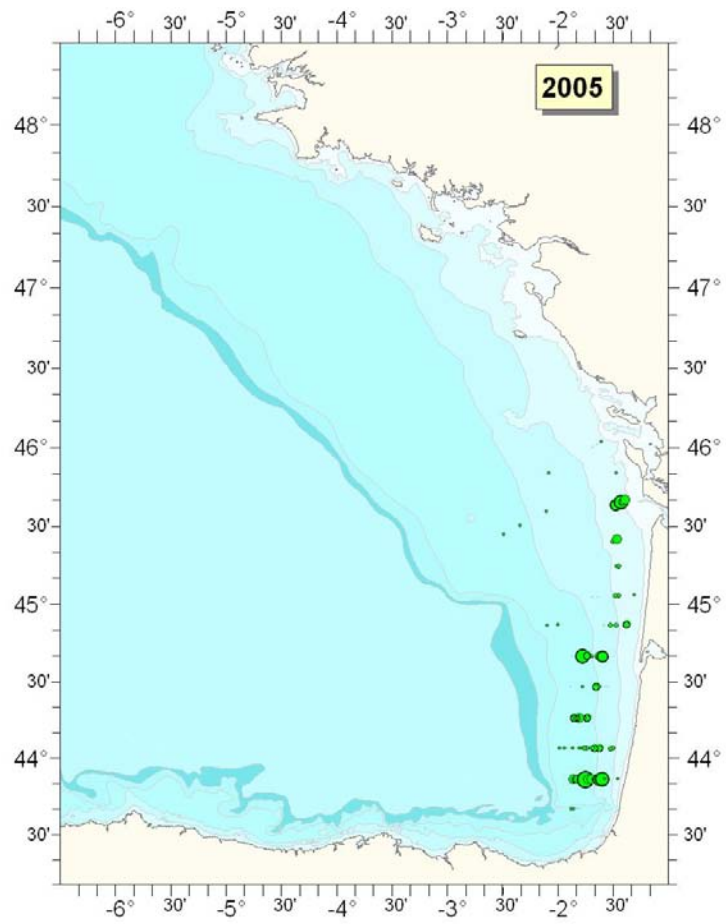


figure 4.1. – Distribution of anchovy in biomass per ESDU

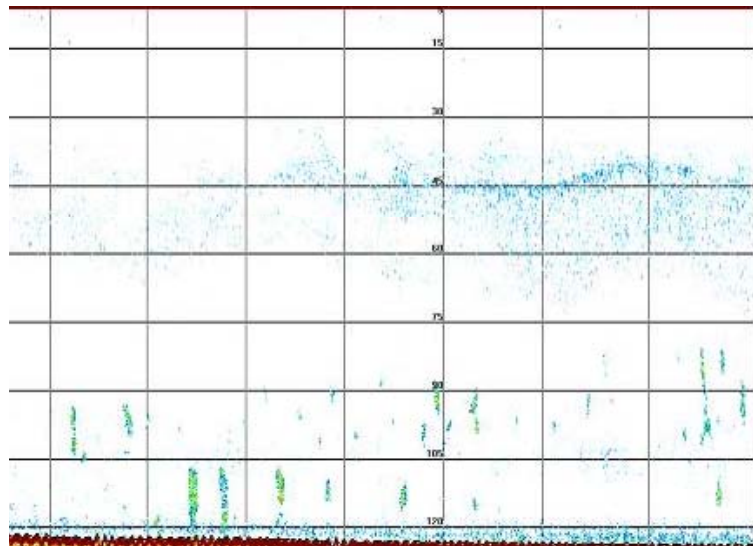


figure 4.2. – Anchovy and Horse mackerel mixed in southern area

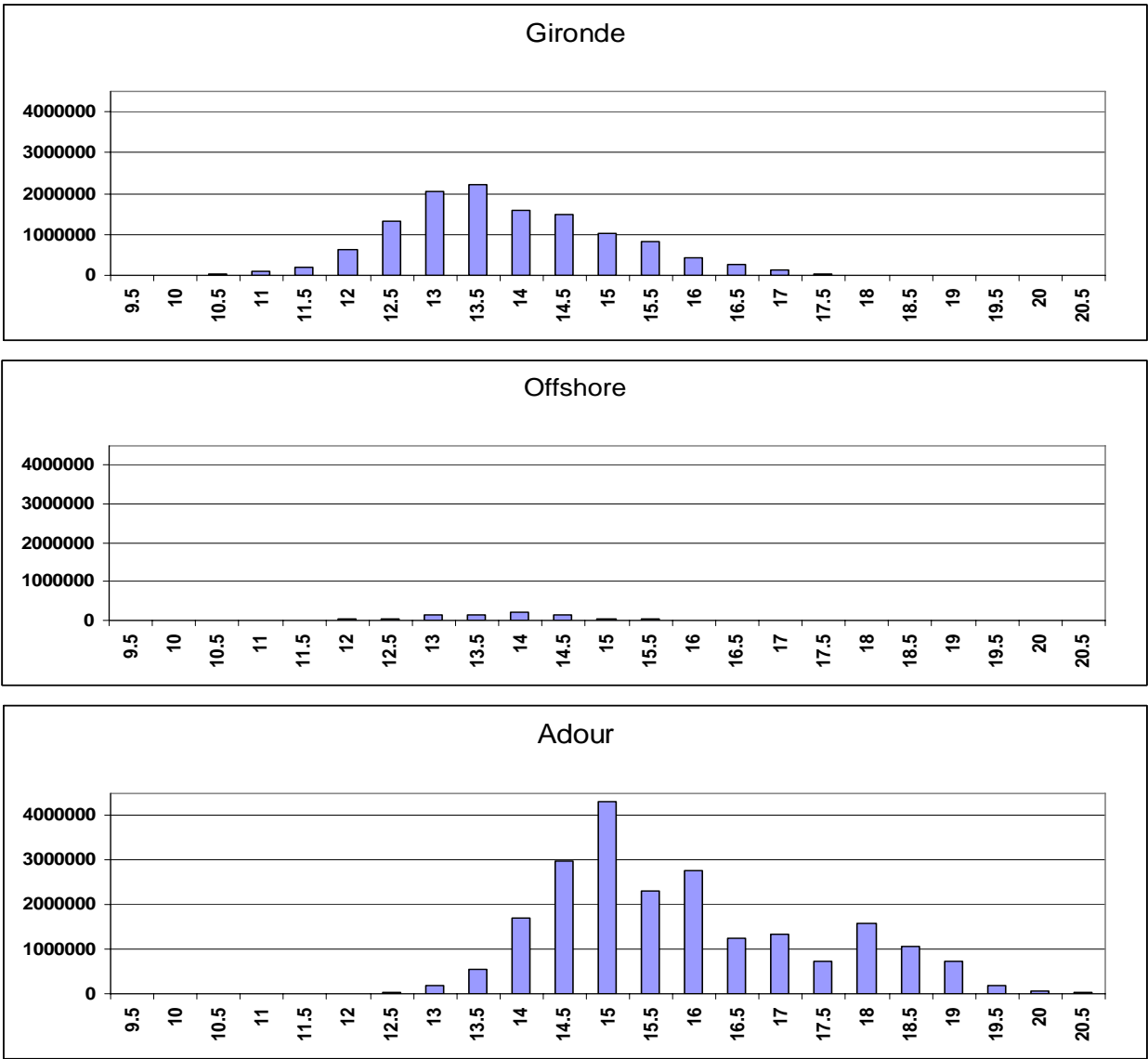


Figure 5.1 –length distribution of anchovy observed during PELGAS05 (sum of numbers/nm² of each ESDU) survey by areas

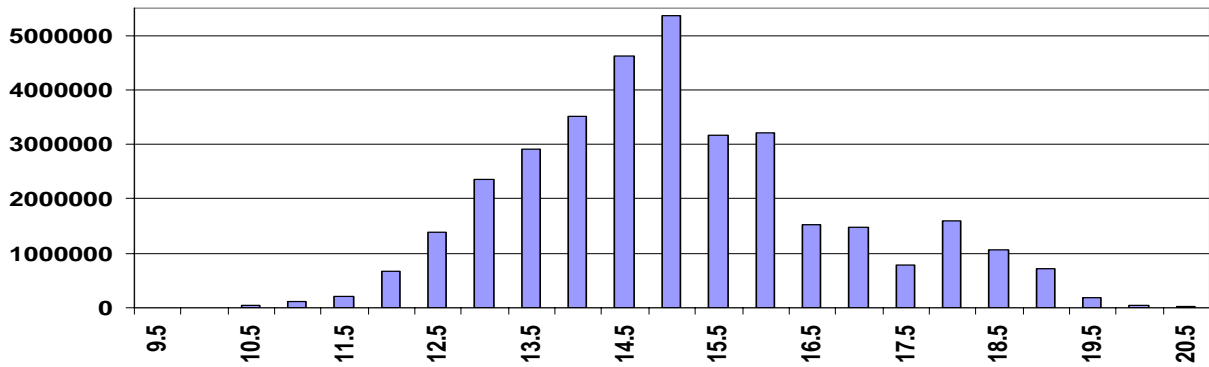


Figure 5.2–length distribution of global anchovy as observed during PELGAS05 survey

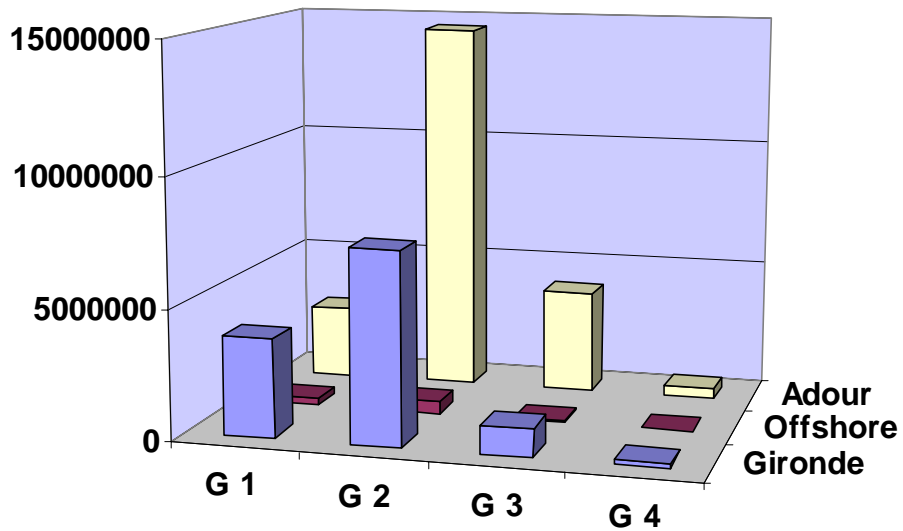


Figure 6.1– Number of anchovy per age group during PELGAS05 in numbers (sum of numbers/nm² per ESDU)

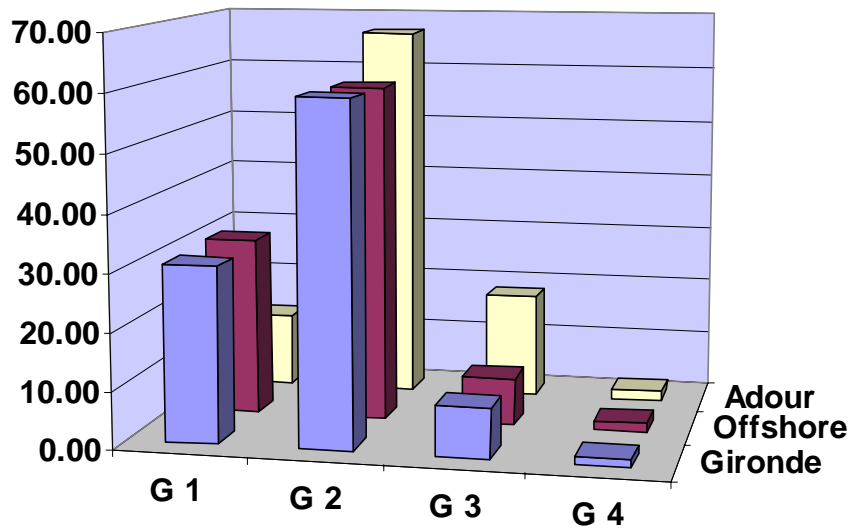


Figure 6.2– Age proportions for anchovy during PELGAS05 (in %)

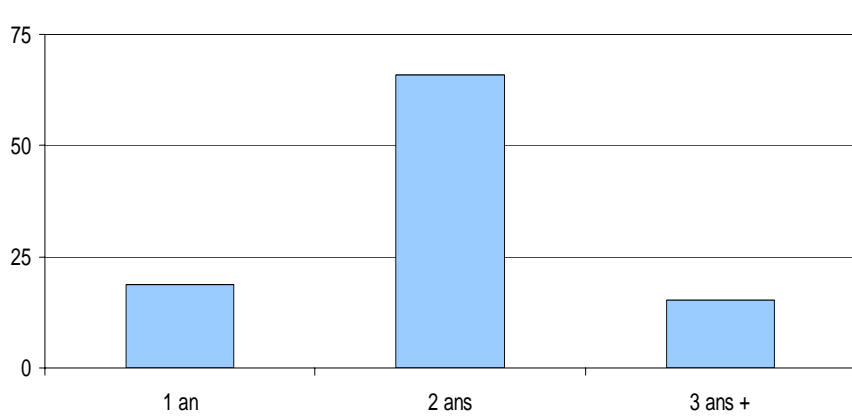


Figure 6.3 – Age proportions of global anchovy as observed during PELGAS05 survey

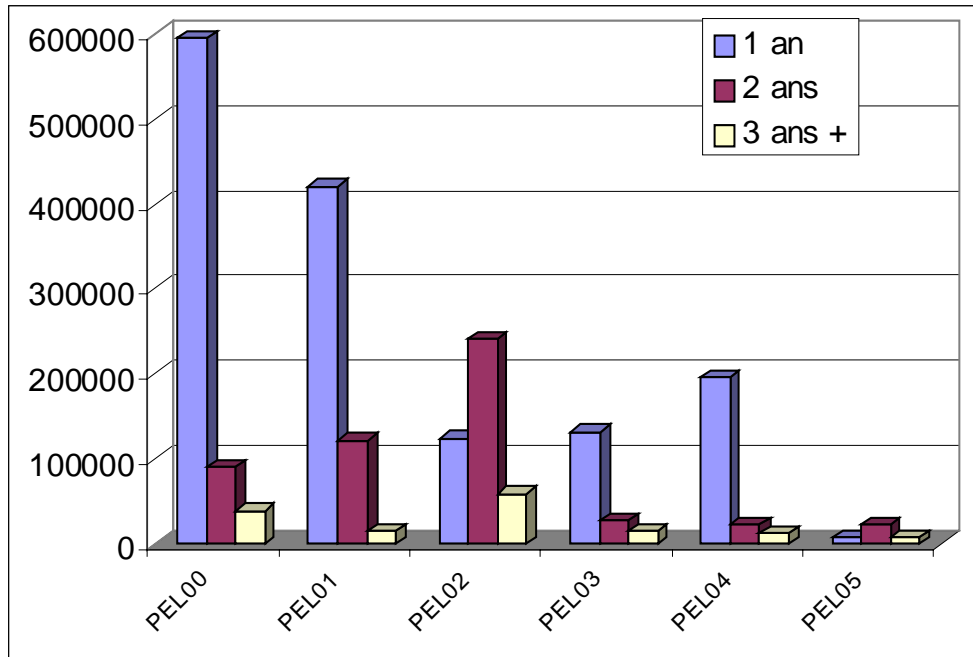


Figure 6.4 – Age proportions of anchovy as observed during PELGAS surveys since 2000

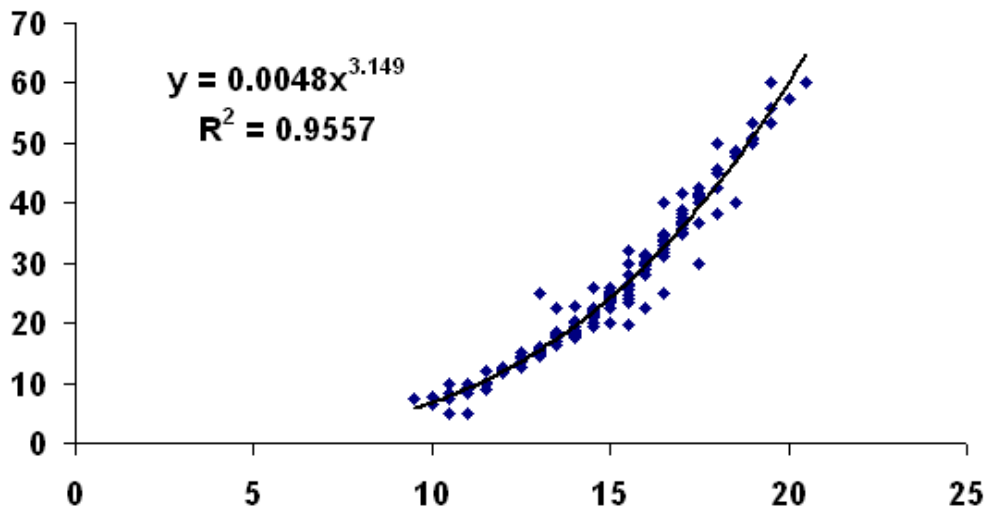


Figure 7 – Weight/length key of anchovy established during PELGAS05

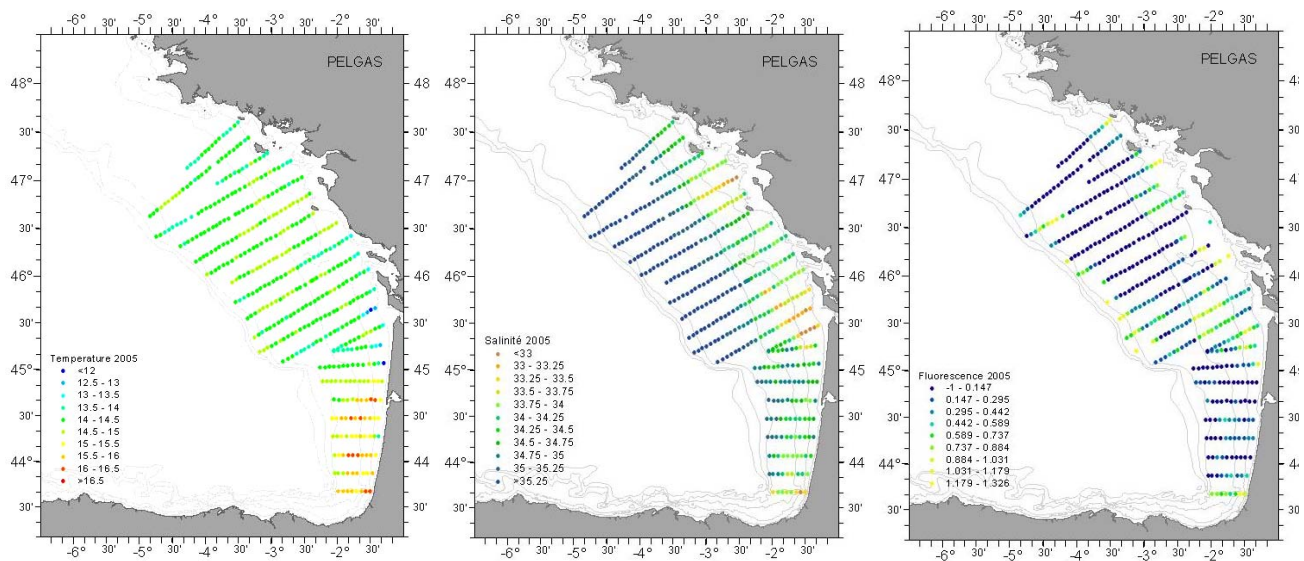


Figure 8.1. – Surface temperatures, salinity and fluorescence observed during PELGAS05

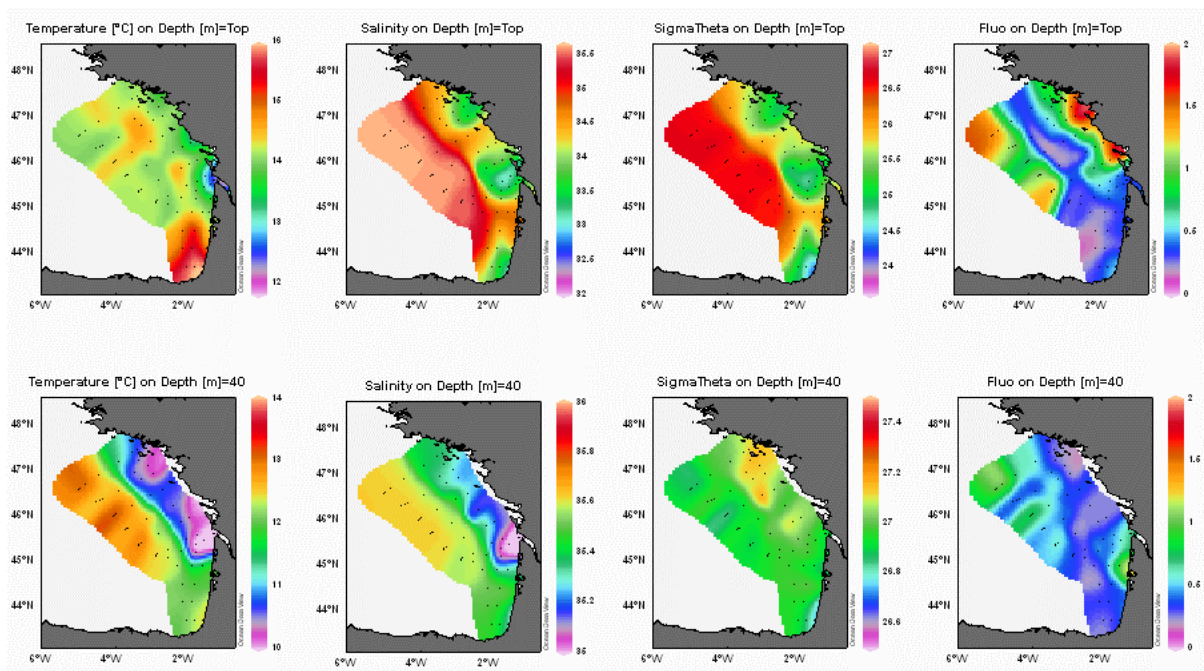


Figure 8.2. –temperatures, salinity, densities and fluorescence observed during PELGAS05 at the surface (top) and at 40 m depth (bottom)