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Working Document

Direct assessment of anchovy by the PELGAS04 acoustic survey

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1. Material and method

An acoustic survey was carried out in the bay of Biscay from April 27th to May 25th on board the French research vessel Thalassa. The objective of PELGAS04 survey was to study the abundance and distribution of pelagic fish in the Bay of Biscay. The target species were mainly sardine and anchovy but had to be 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 (from board) and of birds (by plane) 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 2003) :

- acoustic data were collected along systematic parallel transects perpendicular to the French coast (fig. 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.

Three echo-sounders were used during the whole survey (SIMRAD EK500, SIMRAD EK60 and OSSIAN 500). Energies and samples provided by split beam transducer (4 frequencies EK500, 38 and 120 kHz and EK60, 18 and 70 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).

A total of 4500 nautical miles were prospected during the survey and about 2500 nautical miles are usable for evaluation. A total of 52 pelagic hauls (fig. 2) were carried out for identification of echo-traces.

During this survey, more than acoustic transects and pelagic trawl hauls, 1200 Cufes samples were collected and counted, 48 vertical plankton hauls and 79 vertical profiles with CTD were carried out. Eggs were sorted and counted, 19 500 fish were measured and 1793 otoliths were collected for age determinations.

2. Acoustics data processing

2.1. Echo-traces classification

To be able to have a first estimate of the anchovy biomass at the date of this meeting, the 17st transects have been processed from the main frequency (38 kHz). At the time of the HMMAS WG, only the southern part of the transects (figure 1) have been scrutinised. This area match with the anchovy distribution. Therefore, it is possible to have the acoustic assessment for this species and at least for sardine in this southern zone. For this part of the survey, acoustic energies (Sa) have been cleaned by sorting the only fish energies (excluding bottom echoes, parasites, plankton, etc.) and classified into 6 categories of echo-traces :

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

D3 – energies attributed to mackerel in scattered layers.

D4 – energies attributed to sardine or anchovy corresponding to small and dense echoes, very close to the surface. Compare to previous years, these echoes were very few in the southern part and catches showed a predominance of sardine.

D5 – cloudy echo-traces observed after the shelf break, corresponding to blue whiting and myctophids.

D6 –energies attributed exclusively to horse mackerel and corresponding to very well recognisable echoes, since 2001, constituted by very dense and big schools, sometimes up in the water layer, sometimes down inside plankton layers

2.2. Splitting of energies into species

As previous years (except last year, 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 3 shows the strata considered to evaluate biomass of sardine, anchovy and sprat according to D2 echoes observed during PELGAS04 acoustic survey. D4 echoes were separated into 2 stata according to the bathymetric distribution. For each strata, energies attributed to these species where converted into biomass by applying catch ratio, length distributions and weighted by abundance of fish in the haul surrounded area.

3. Results

3.1. Biomass estimate

The global estimate for these species is as following

strata	**Total biomass (t)**	Rochebonne	Gironde-Landes	Adour	Offshore	surface (coastal)	surface (offshore)
anchovy	**46 018**	3 112	28 343	13 864	135	563	0
sardine	**323 021**	69 055	60 579	7 689	32 582	10 135	142 981
sprat	**16 266**	4 759	8 981	0	0	2 525	0

3.2. Biological parameters

3.2.1. Anchovy

Length and demographic structure

Length distribution in the trawl haul were estimated from random samples. The population length distributions (figure 5.1, 5.2, 5.3) 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.

Length distribution of anchovy were gathered for the coastal area on one hand (Gironde + Rochebonne –fig.5.1) and for the southern part and offshore on the other hand (Offshore and Adour – fig 5.2). A global length distribution is shown in figure 5.3. Main of the anchovy was observed in front of the Gironde or along the coast and constituted of small individuals. Sizes were bigger offshore and in Adour area.

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. 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
100	100.00%	0.00%	0.00%	0.00%
105	100.00%	0.00%	0.00%	0.00%
110	100.00%	0.00%	0.00%	0.00%
115	100.00%	0.00%	0.00%	0.00%
120	100.00%	0.00%	0.00%	0.00%
125	100.00%	0.00%	0.00%	0.00%
130	93.55%	6.45%	0.00%	0.00%
135	97.22%	2.78%	0.00%	0.00%
140	95.24%	2.38%	2.38%	0.00%
145	88.37%	2.33%	9.30%	0.00%
150	88.24%	7.84%	3.92%	0.00%
155	85.11%	14.89%	0.00%	0.00%
160	67.44%	25.58%	6.98%	0.00%
165	42.86%	41.07%	16.07%	0.00%
170	13.64%	65.91%	20.45%	0.00%
175	3.03%	81.82%	12.12%	3.03%
180	6.06%	57.58%	33.33%	3.03%
185	0.00%	62.50%	29.17%	8.33%
190	0.00%	19.05%	71.43%	9.52%
195	0.00%	11.76%	76.47%	11.76%
200	0.00%	0.00%	66.67%	33.33%
205	0.00%	25.00%	25.00%	50.00%
210	0.00%	0.00%	100.00%	0.00%

Applying the age distributions to respective areas, the abundance in biomass and numbers have been calculated and gathered in tables below.

	Total biomass (10^3 t.)	G1 (10^3 t.)	G2 (10^3 t.)	G3 (10^3 t.)	G4 (10^3 t.)
coastal area	**32 019**	**30 553**	**1 046**	**415**	**5**
offshore + Adour	**14 000**	**6 571**	**4 680**	**2 403**	**346**
Total	**46 018**	**37 124**	**5 726**	**2 818**	**351**
%		95.42	3.27	1.30	0.02

	Total number (10^6 ind.)	G1 (10^6 ind.)	G2 (10^6 ind.)	G3 (10^6 ind.)	G4 (10^6 ind.)
coastal area	**2303**	**2247**	**42**	**15**	**0**
offshore + Adour	**374**	**218**	**103**	**48**	**5**
Total	**2678**	**2465**	**145**	**63**	**5**
%		92.05	5.40	2.35	0.20

Weight/Length key

Based on 696 weight of individual fishes, the following weight/length key was established (figure 7) :

$W = 0.00396\ L3.22311$ (with $R^2 = 0.9483$)

The mean length and mean weight at age are as following :

Coastal area	Lm (cm)	**11.98**	**14.45**	**15.07**	**18.68**	**12.04**
	Wm (g)	**11.86**	**21.70**	**24.86**	**49.62**	**12.06**
Adour + offshore	Lm (cm)	**14.93**	**16.98**	**17.45**	**18.96**	**15.87**
	Wm (g)	**24.11**	**36.50**	**39.84**	**52.08**	**29.38**

3.2.2. Sardine

Length distributions for sardine are shown in figures 8.1, 8.2 and 8.3 following the same method than for anchovy, for the 2 areas and merged for a global distribution.

The sardine age length key has been established and is shown below.

length	G 1	G 2	G 3	G 4	G 5	G 6	G 7	G 8	G 9
12.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
13	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
13.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
14	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
14.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
15	95.24%	4.76%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
15.5	90.91%	9.09%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
16	93.94%	6.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
16.5	88.24%	11.76%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
17	89.36%	10.64%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
17.5	90.91%	9.09%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
18	85.07%	14.93%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
18.5	58.82%	37.25%	3.92%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
19	20.00%	74.29%	5.71%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
19.5	4.17%	70.83%	23.61%	0.00%	0.00%	1.39%	0.00%	0.00%	0.00%
20	2.78%	66.67%	29.17%	1.39%	0.00%	0.00%	0.00%	0.00%	0.00%
20.5	1.45%	40.58%	44.93%	10.14%	2.90%	0.00%	0.00%	0.00%	0.00%
21	0.00%	28.57%	51.43%	15.71%	2.86%	1.43%	0.00%	0.00%	0.00%
21.5	0.00%	6.45%	46.77%	33.87%	8.06%	4.84%	0.00%	0.00%	0.00%
22	2.04%	0.00%	22.45%	40.82%	20.41%	12.24%	2.04%	0.00%	0.00%
22.5	0.00%	2.56%	15.38%	20.51%	35.90%	20.51%	2.56%	2.56%	0.00%
23	0.00%	0.00%	3.57%	14.29%	53.57%	7.14%	14.29%	3.57%	3.57%
23.5	0.00%	0.00%	0.00%	11.76%	23.53%	35.29%	17.65%	5.88%	5.88%
24	0.00%	0.00%	0.00%	0.00%	27.27%	36.36%	18.18%	18.18%	0.00%
24.5	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	0.00%
25	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%
26.5	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%

The age distributions are shown in figures 9.1, 9.2 and 9.3.

3. Conclusion

The situation observed during this last acoustic survey was more closed to a classical situation, with small fish closed to the coast and mainly in front of the Gironde and bigger fish offshore or in Adour area..

1- Anchovy biomass is not very high, but age 1 is predominant.

2- Anchovy was most of the time visible as small schools between 10 and 30 m above the bottom as usual. It was mixed with horse mackerel and mackerel in the south, then with sardine and finally in front of the Gironde with sprat.

3- Group 1 is mainly represented until a size of 16 cm. This confirm the high growth of 0 group last year taking advantage from a sooner spawning season and a long and hot summer.

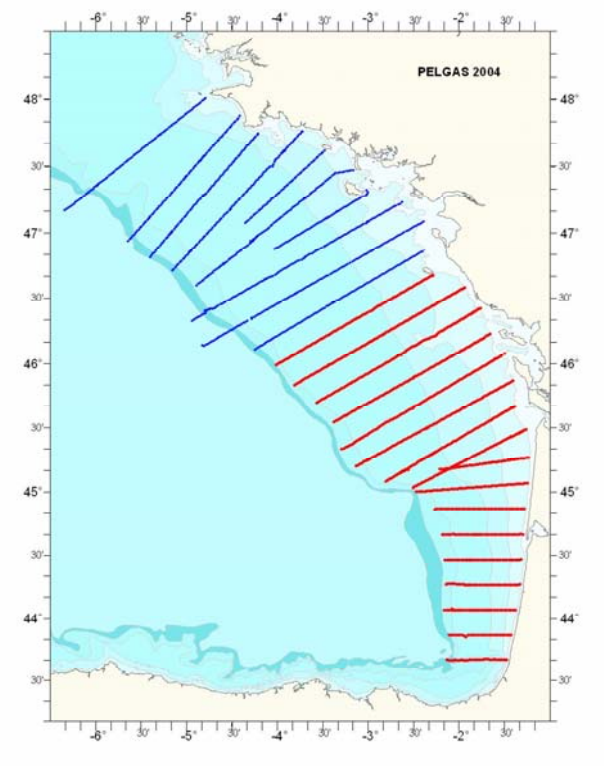

Fig. 1 - Transects prospected during PELGAS04 (in red). The 10 northern transects (in blue) were not processed at the date of the present STECF meeting.

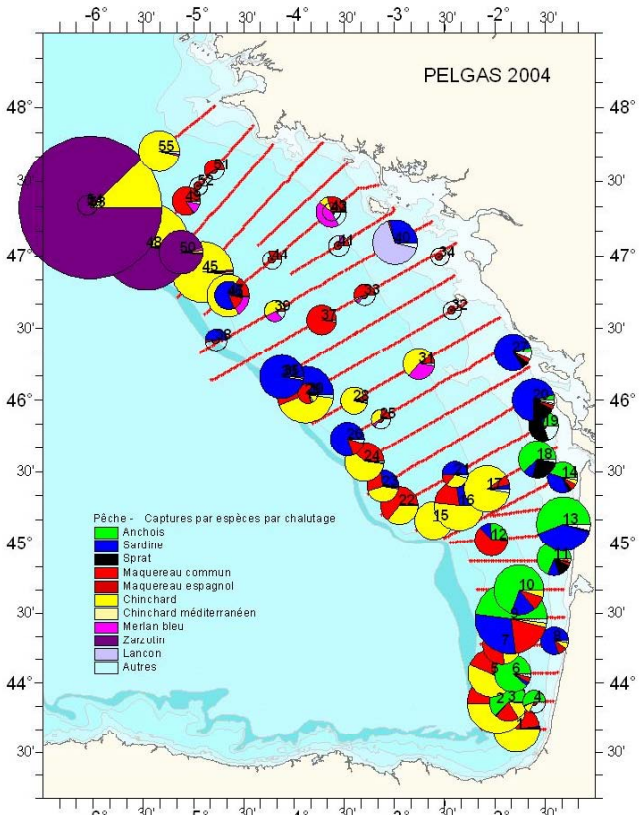

Fig. 2 Species distribution according to identification hauls

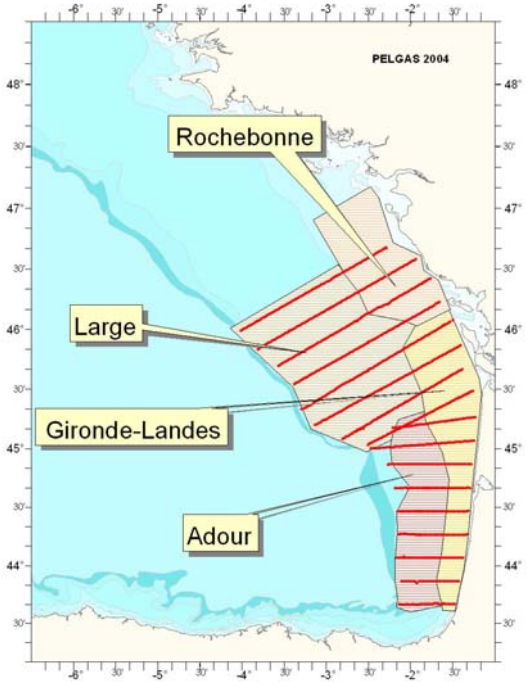

figure 3 – areas taken into account for assessment

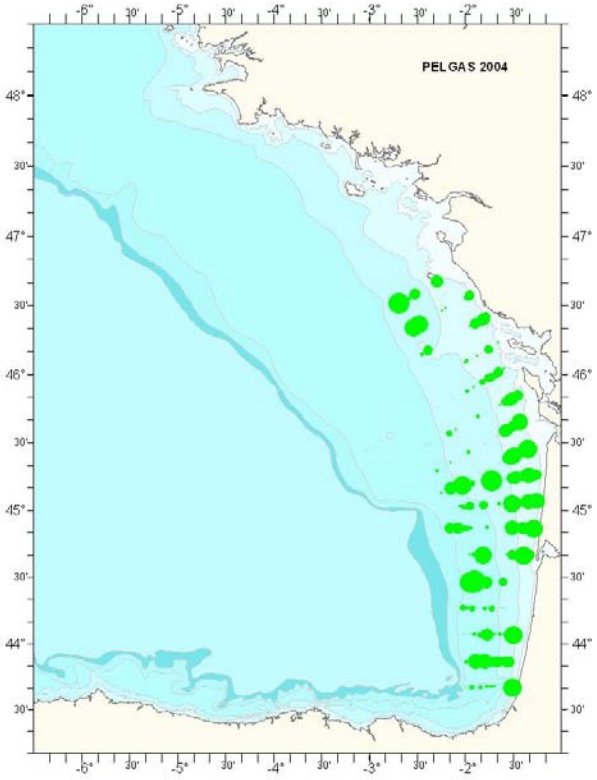

figure 4. – Distribution of anchovy in biomass per ESDU

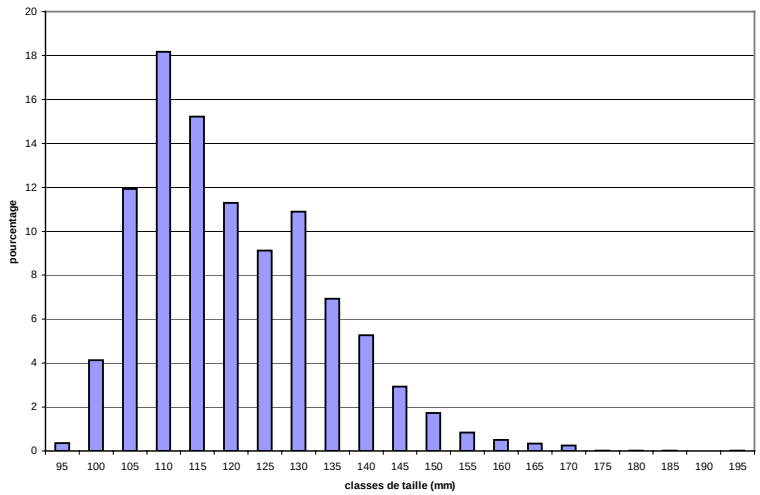

Figure 5.1 –length distribution of anchovy observed during PELGAS04 survey in coastal area (Gironde and Rochebonne)

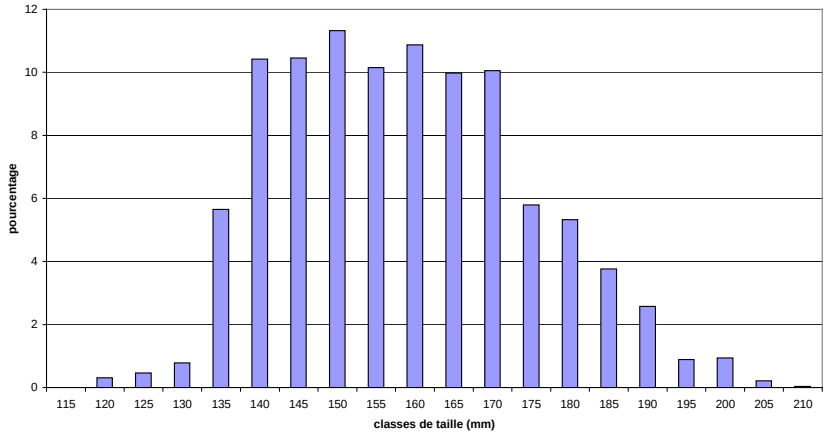

Figure 5.2–length distribution of anchovy observed during PELGAS04 survey in southern and offshore area (Adour and Offshore)

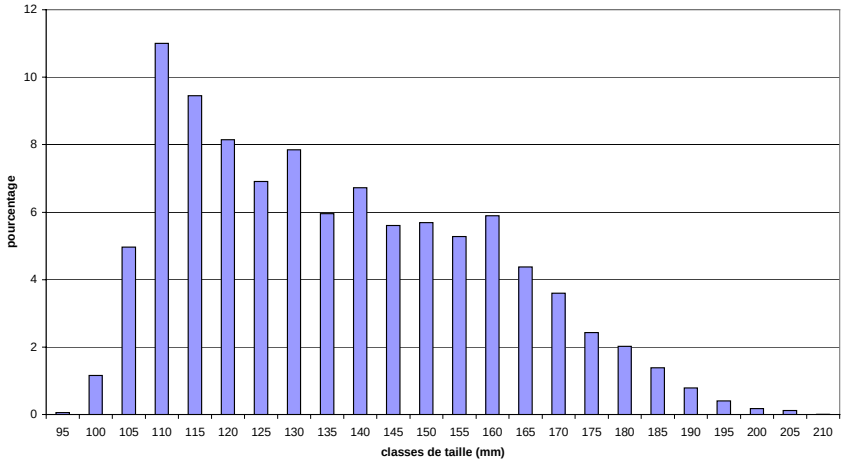

Figure 5.3–length distribution of global anchovy as observed during PELGAS04 survey

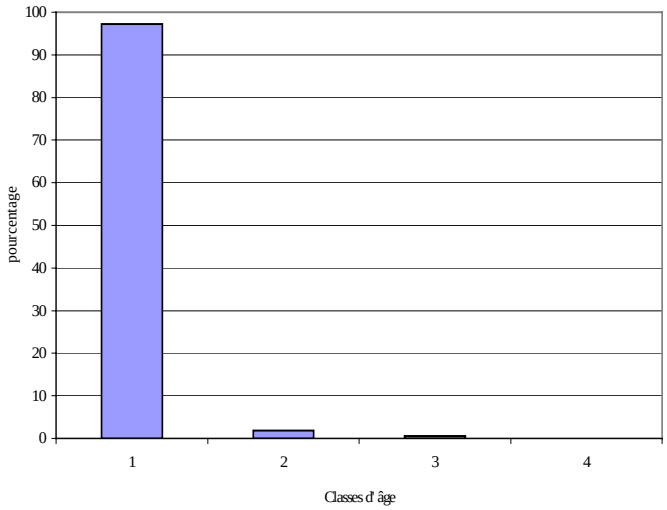

Figure 6.1– Age proportions for anchovy during PELGAS04 in coastal area(Gironde and Rochebonne)

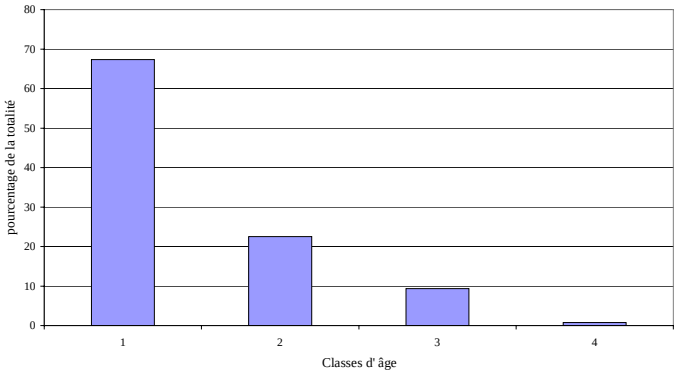

Figure 6.2– Age proportions for anchovy during PELGAS04 in southern and offshore area (Adour and Offshore)

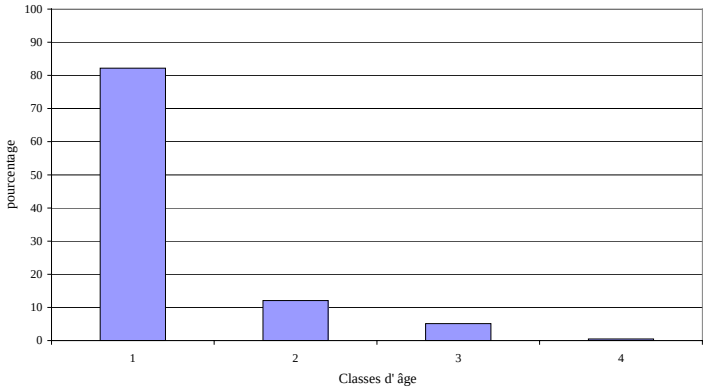

Figure 6.3 – Age proportions of global anchovy as observed during PELGAS04 survey

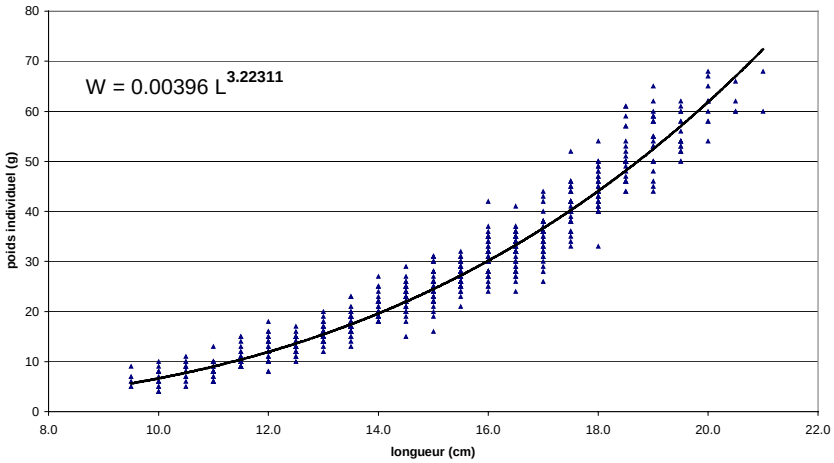

Figure 7 – Weight/length key of anchovy established during PELGAS04

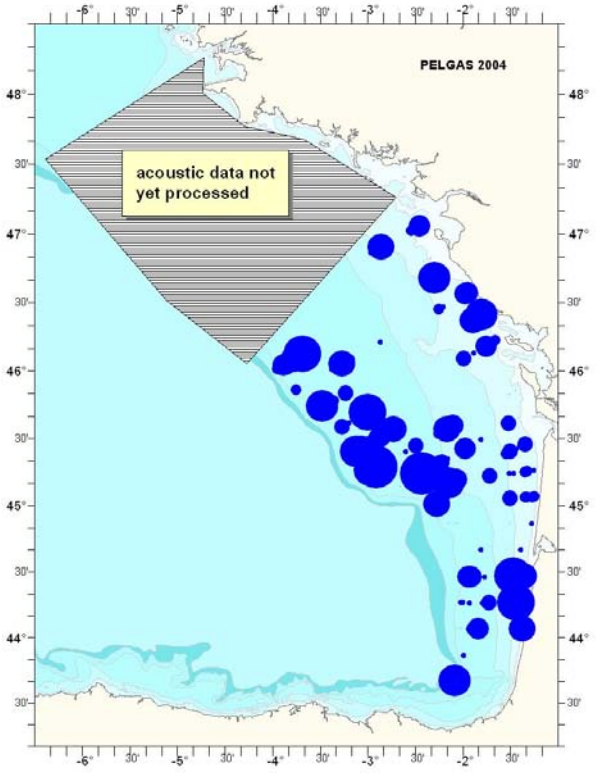

figure 8. – Distribution of sardine in biomass per ESDU

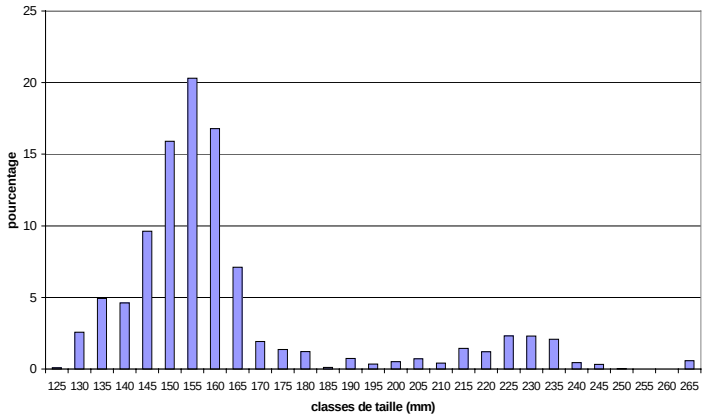

Figure 8.1 –length distribution of sardine observed during PELGAS04 survey in coastal area (Gironde and Rochebonne)

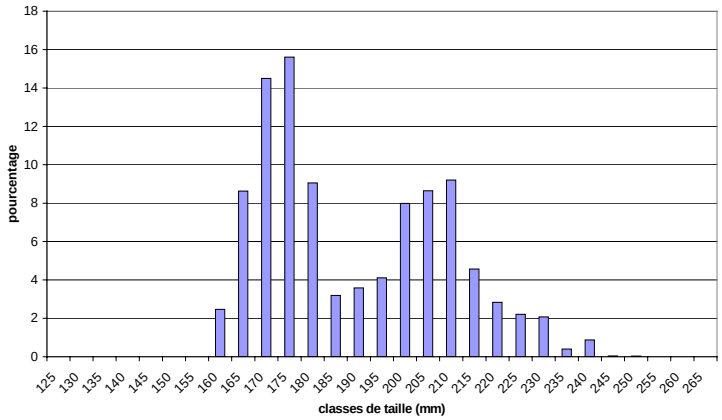

Figure 8.2–length distribution of sardine observed during PELGAS04 survey in southern and offshore area (Adour and Offshore)

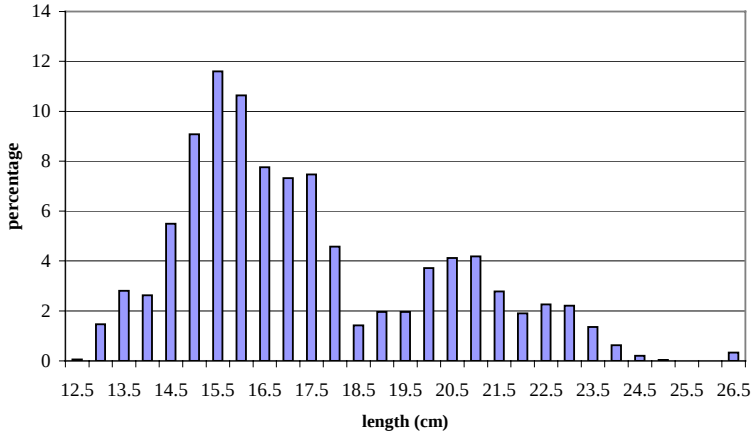

Figure 8.3–length distribution of global sardine as observed during PELGAS04 survey

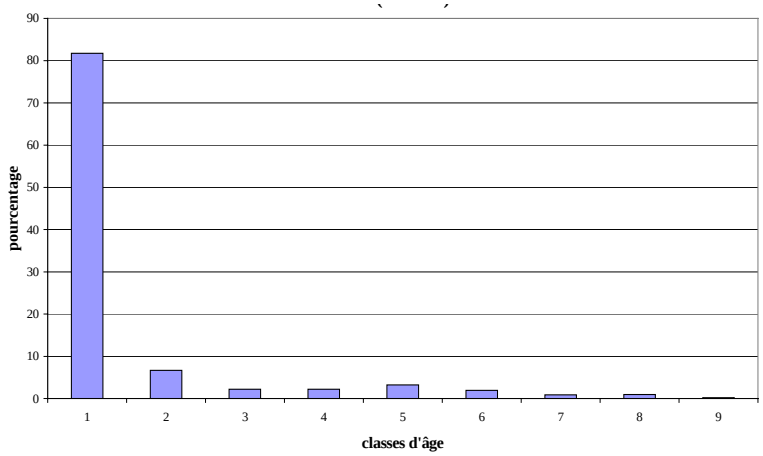

Figure 9.1– Age proportions for sardine during PELGAS04 in coastal area(Gironde and Rochebonne)

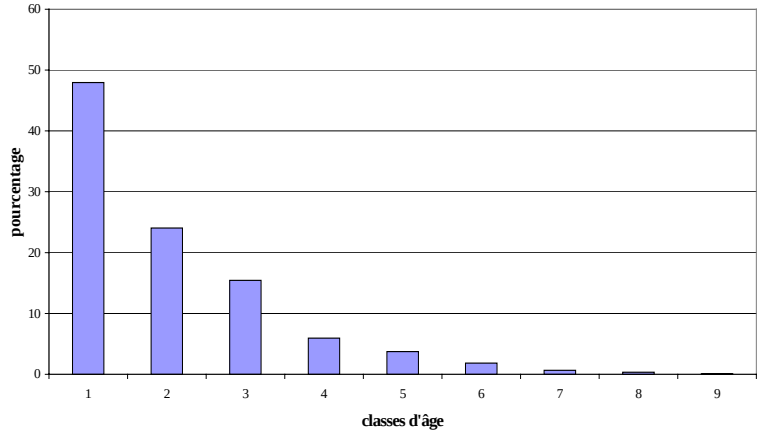

Figure 9.2– Age proportions for sardine during PELGAS04 in southern and offshore area (Adour and Offshore)

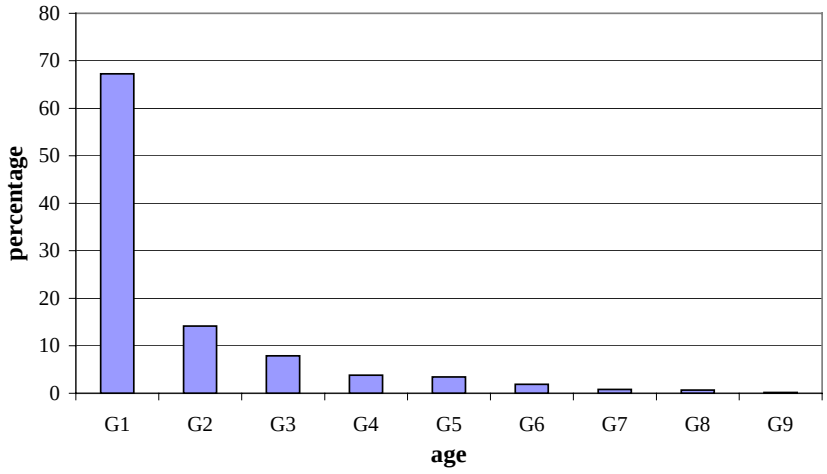

Figure 9.3 – Age proportions of global sardine as observed during PELGAS04 survey

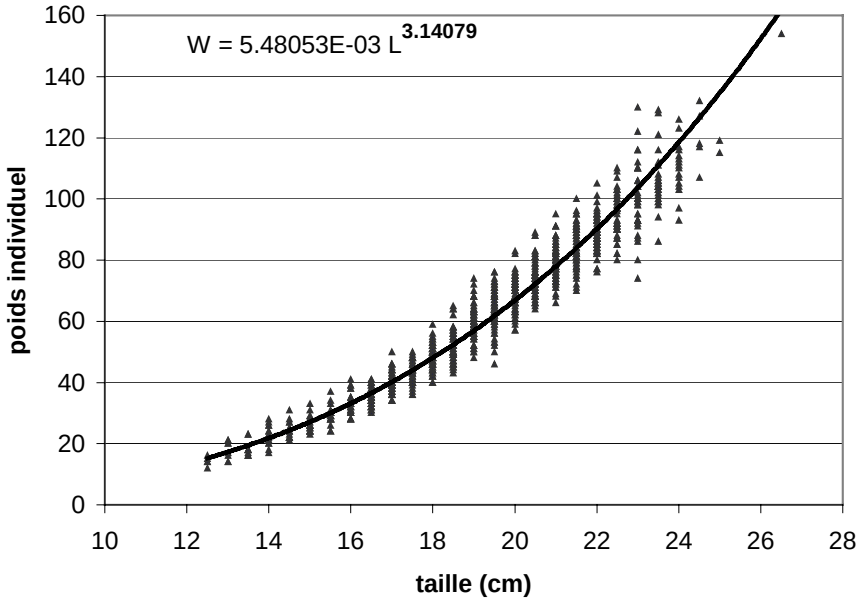

Figure 10 – Weight/length key of sardine established during PELGAS04