

COMPARISON OF THREE SOLEA SOLEA (L.) NURSERY GROUNDS
OF THE BAY OF BISCAY : DISTRIBUTION, DENSITY
AND ABUNDANCE OF O-GROUP AND I-GROUP

by

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ABSTRACT

The abundance of sole juveniles was estimated in October 1986 and 1987 for three nursery grounds which contribute to the stock of the Bay of Biscay (Bay of Vilaine : 332 km², Pertuis Breton : 264 km², Pertuis d'Antioche : 276 km²). Topography and sediments induce differences in sole distribution. The densities of juveniles are highest in both Pertuis, by x 6 to x 20 compared to the Vilaine. The interannual variation of the mean densities is opposite in the northern zone (x 0,66) and in both southern zones (x 2,13). The mean lengths of O-group are different between the three sites and between years. The contribution of a given nursery ground to the stock is not merely proportional to its surface and each of the nurseries may have its own dynamics. The final recruitment of the common stock would come from variable combinations of several contributing areas. Nevertheless, both Pertuis probably provide the main part of the recruitment.

RESUME

L'abondance des juvéniles de sole a été estimée sur trois nourriceries qui alimentent le stock du golfe de Gascogne : la baie de Vilaine (332 km²), le Pertuis Breton (264 km²) et le Pertuis d'Antioche (276 km²). La topographie et la nature des fonds entraînent des distributions différentes. Les densités de juvéniles sont 6 à 20 fois plus élevées dans les Pertuis qu'en Vilaine. La variation interannuelle des densités moyennes est opposée dans la zone nord (diminution de 53 %) et dans les deux zones sud (augmentation de 71 à 107 %). Les tailles moyennes des soles du groupe O diffèrent entre les trois sites et les deux années. La contribution d'une nourricerie au stock global n'est pas proportionnelle à sa surface et chaque nourricerie peut avoir sa propre dynamique. Le recrutement final du stock pourrait donc résulter de combinaisons variables de plusieurs nourriceries, mais les Pertuis fournissent sans doute la part essentielle du recrutement du golfe de Gascogne.

INTRODUCTION

Even if the stock of Dover sole in the Bay of Biscay is considered as a unique stock for managements (Anon., 1991), its recruitment relies on the dynamics of spawning units which are more or less continuous from the South (spawning occurs in January, off La Rochelle) to the North (spawning in March, off river Loire estuary) (ARBAULT et al., 1986). Above all, benthic juveniles concentrate, during their first years of life, in a series of several isolated nursery grounds (BEILLOIS et al., 1978). The main nurseries are located in the Bay of Vilaine, the Loire estuary, the Bay of Bourgneuf, the "Pertuis Charentais", near La Rochelle, the Gironde estuary and on the southern exit of it. Since 1981, the Vilaine nursery ground was surveyed in order to

provide an estimate of the fluctuation of the recruitment for O and I-Group (DOREL et al., 1991a) and to build up a first model of seasonal distribution (DOREL et al., 1991b). Some discrepancies between this series and that from VPA established for the whole exploited stock (ANON., 1991) lead to believe that different nurseries do not contribute in the same way to the stock. Accordingly, an attempt to compare the characteristics of three well defined nurseries was carried out.

MATERIAL AND METHODS

GEOGRAPHICAL FRAME (fig. 1a,b)

North of the Loire estuary, the Bay of Vilaine nursery grounds spreads on 332 km² of soft grounds which can be prospected by bottom trawling, from the estuary down to 35 m depth, in the neighbourhoods of Houat and Hoëdic Islands.

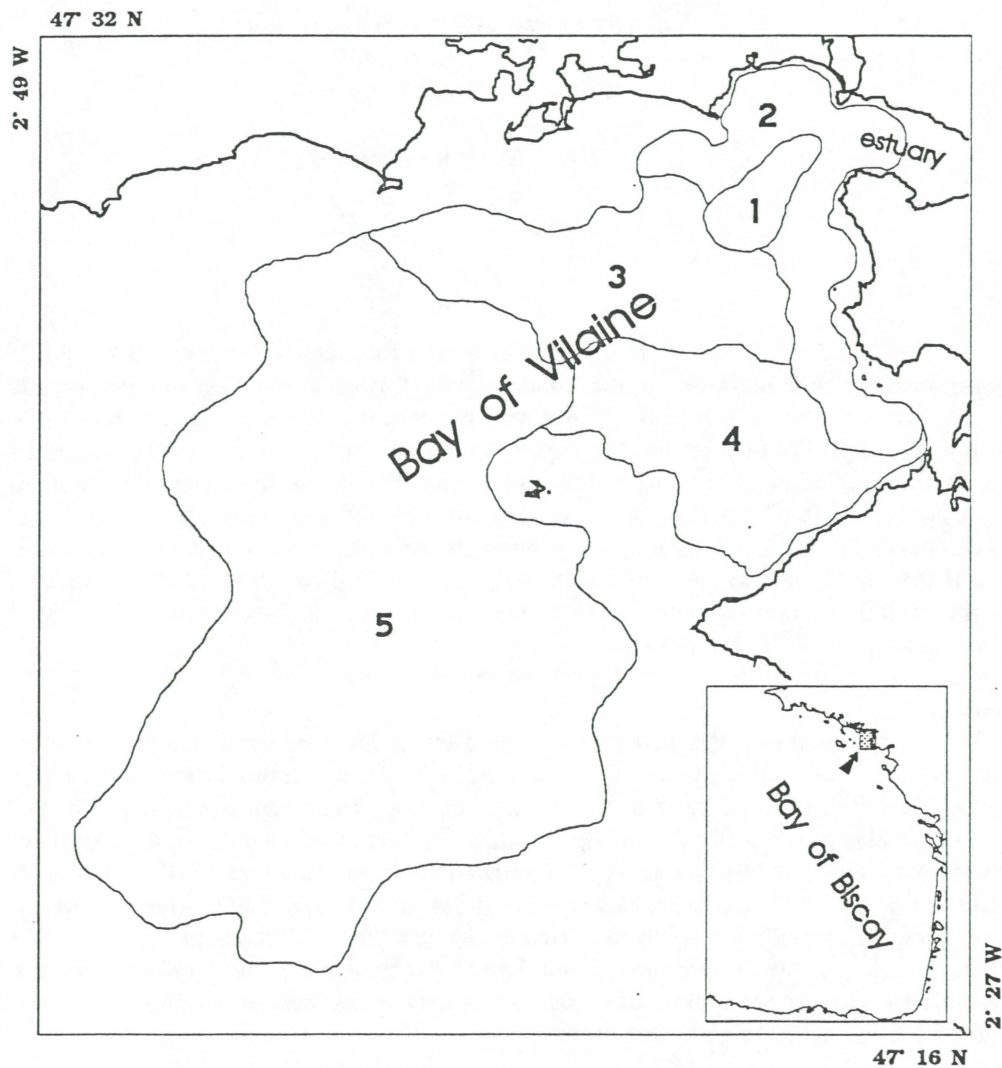


Fig. 1a - Bay of Vilaine nursery with the strata used for evaluation

On both sides offshore la Rochelle, the "Pertuis Charentais" constitute a "peri-estuarine zone", with regard to the muddy estuaries of small rivers (le Lay, la sèvre Niortaise, la Charente). Internal ditches reach 40 m depth (locally 50 m) : the "fosse de Chevarache" edges the Ré Island and the "fosse d'Antioche" edges the Oleron Island. The northern "Pertuis Breton" covers 264 km² whereas the "Pertuis d'Antioche" covers 276 km². Although the three sectors do not exhibit the same topography, the sequency of sediment types from the coast to the ocean are comparable : from the estuaries to the 30 m depth, one can find the estuarine mud (with

shellfish farming for oysters and mussels), then cleaner sandbanks (sub-marine deltas, according to LE BRIS, 1986) and again muddy bottoms between 15 m and the ditches.

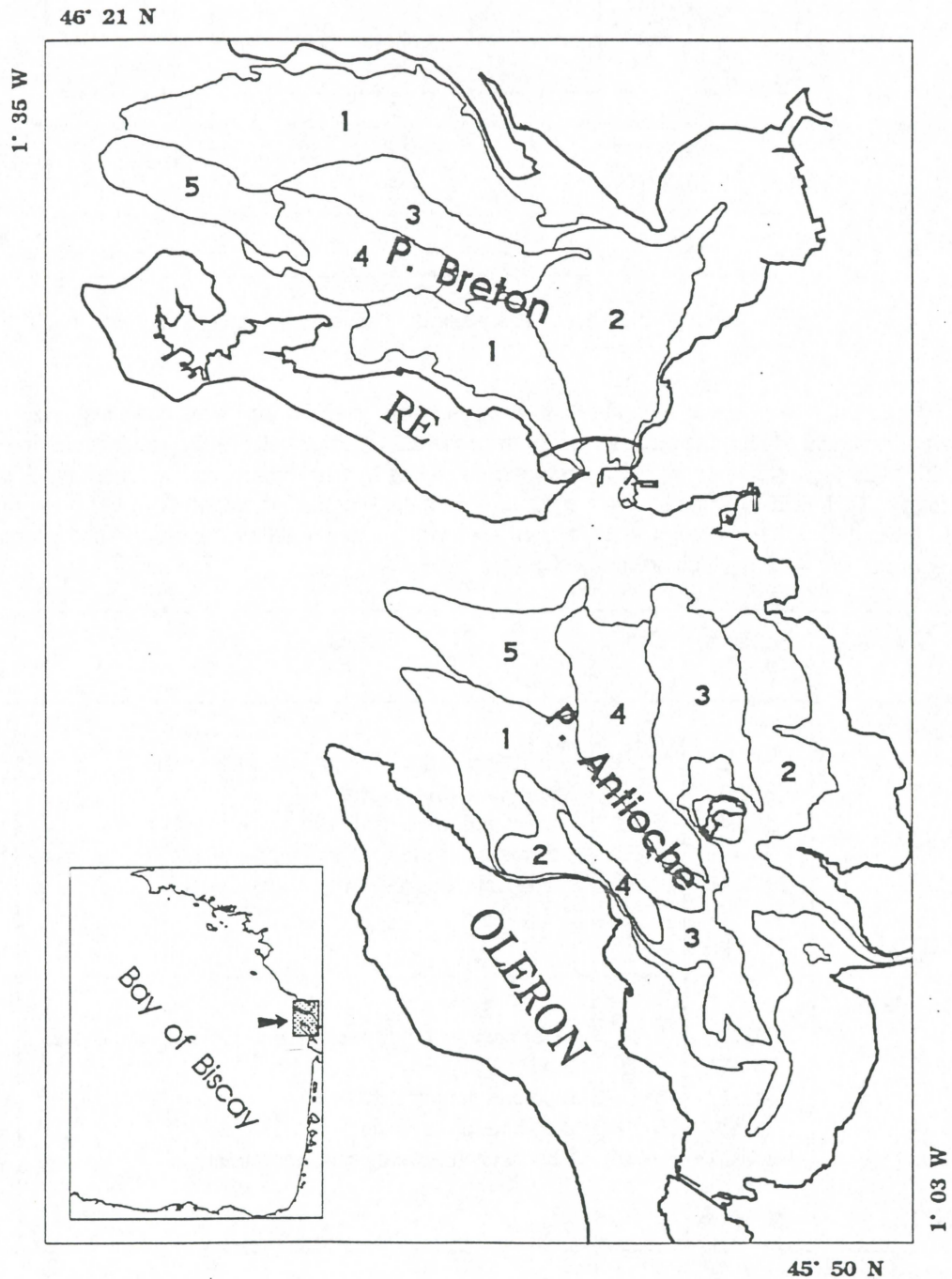


Fig 1b - Pertuis nurseries with the strata used for evaluation

The three sectors are limited on their offshore side by sand and gravels banks, at different depths, about 40 m out of the bay of Vilaine, and 20 m out of the Pertuis.

TRAWL SURVEYS

Results come from two series of cruises by the R/V GWEN DREZ (length 25 m, power 600 Hp., draft 3,4 m), carried out in September 1986 and 1987 in the Vilaine area and in October 1986 and 1987 in the Pertuis (table. 1).

Dates	B. of Vilaine	"P. Breton"	"P. Antioche"
18-27/IX/86 7-11/X/86 13-18/X/86	47	53	70
4-13/IX/87 2-5/X/87 9-13/X/87	77	42	46
TOTAL	124	95	116

Table 1 - Number of hauls annually made in the three nurseries.

Catches were made by using a 3 m beam trawl, with 20 mm stretched mesh size in the cod end, without additional tickler chain ahead the footrope (DESAUNAY et al., 1981). Hauls were operated according a stratified sampling scheme, the strata being defined by bathymetric limits and sediment types (table 2), out of the estuary. Technical constraints in some strata limited the number of samples (in very coastal zones and in muddy grounds). All the cruises were carried out with normal weather conditions and before the seasonal cooling of inshore waters which normally occurs in November.

Strata	Surfaces (km ²)	Depth	Facies	%
VILAINE				
1	6.03	2-3	muddy fine sand (Nephthys and Lanices)	1.82
2	30.334	0-5	sandy mud (Sternapsis)	9.15
3	39.942	5-10	sandy mud (Sternapsis and Ampelisca)	12.04
4	38.173	0-10	heterogenous muddy sand and "gravelle" (Lanices)	11.51
5	217.216	10-35	mud (Haploops and Ampelisca)	65.49
TOTAL	331.695			
P. BRETON				
1	121.022	0-20	heterogenous muddy sand (south), clean sand (north)	45.92
2	58.853	0-5	mud	22.33
3	31.517	5-10	mud and muddy sand	11.96
4	28.32	10-20	mud and muddy sand	10.75
5	23.827	+ 20	heterogenous muddy sand and mud	9.04
TOTAL	263.539			
P. ANTIOCHE				
1	49.711	0-20	clean coarse and medium sand	18.03
2	74.464	0-5	mud and sandy mud	27.00
3	68.834	5-10	mud and sandy mud	24.96
4	45.671	10-20	mud	16.56
5	37.091	+ 20	sandy mud	13.45
TOTAL	275.771			

Table 2 - Stratification criteria and sampled strata surfaces. Bio sedimentary facies from LE BRIS (1986) for the Bay of Vilaine and from HILY (1975) for the "Pertuis".

DATA PROCEEDING

The age determination of young soles was checked by an examination of the otoliths (5 individuals of each sex by cm size class). Catches were evaluated for the swept areas and the strata areas to estimate the population index or density (nb individuals/1000 m) and total numbers (table 3).

		B. of vilaine	"P. Breton"	"P. Antioche"
Mean densities (nb/1000 m)	1986	2.12	10.52	12.78
	1987	1.41	19.20	30.55
Estimated Abundances (n.10 ⁶)	1986	0.703	2.772	3.526
	1987	0.467	5.061	8.425

Table 3: Mean densities and estimated abundances of sole juveniles (0,1 and 2 groups) on the three nurseries.

A correction of the raw catches was made for selectivity of the gear. This correction takes in consideration the escapement of fishes through the anterior part of the beam trawl (40 mm and 30 mm mesh size). The O-Group is mainly concerned as the L50 value is 7,5 cm (DOREL et al., 1989).

RESULTS

AGE DISTRIBUTION

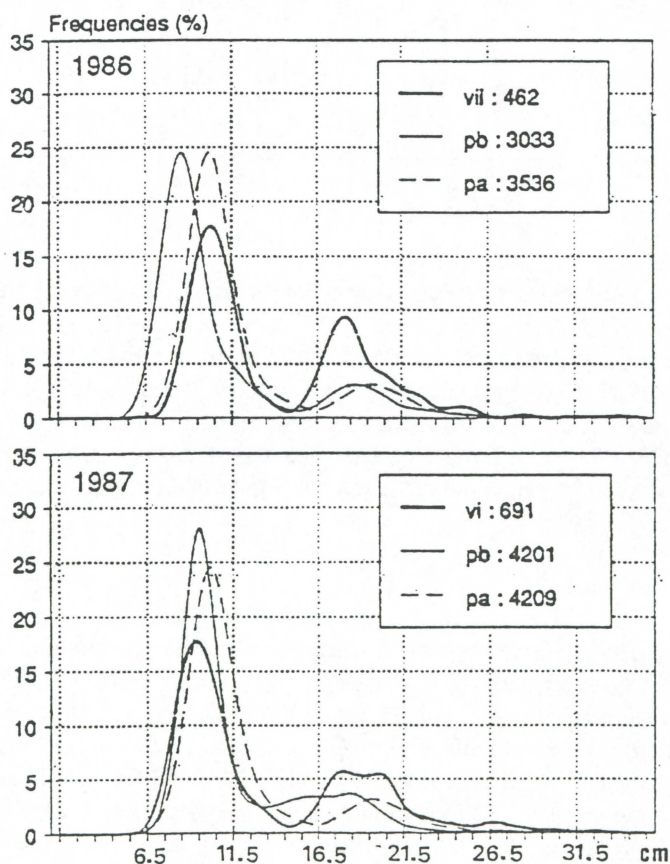


Fig 2 -Length frequencies distributions for thr three nurseries and the two years

The length frequency distributions (fig. 2) clearly show the two predominating groups for the all six examined cases. From the otolith readings, there are O-Group and I-Group of soles with the addition of a small

amount of older fish. We can state that the part of adult sole longer than 25 cm is quite neglectable, which is a characteristic figure of a nursery ground. Taking into consideration the spawning periods which are earlier in the south and the dates of sampling (later in the Pertuis). The mean age of O-Group is estimated to 6-7 months in the Vilaine area and 9 months in the Pertuis area. One could accordingly expect higher length of soles of the same age group in the southern region.

MEAN LENGTH AND GROWTH

The otolith readings lead to the separation of the total length distribution into age-group distribution from which the mean lengths are calculated. The comparison of the mean lengths, shows significant differences between cohorts and sectors (fig. 3).

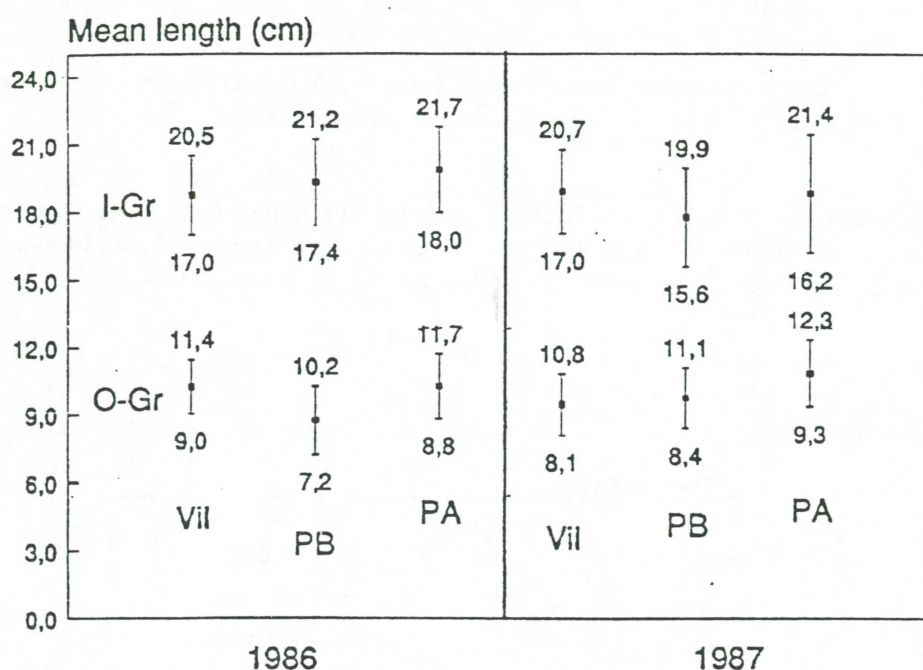


Fig. 3 -Mean lengths and standard deviations for the two first age-groups and the three nurseries

Indeed, the expected sequency of increasing sizes from the North (Vilaine) to the South (pertuis) is verified for the cohort 1987 (O-Group) and the cohort 1985 (I-Group, in 1986). It fails to agree with the cohort 1986 which could be checked as O-Group and as I-Group. In particular, the mean length in pertuis Breton is the weakest of the two cruises. These differences seem to be real (T test performed on the means) and demonstrate a trend for every nursery area to have its own dynamics and growth characteristics.

DISCUSSION

The whole stock of sole in the Bay of Biscay results from the contribution of inshore nursery grounds which have already been described (DESAUNAY et al., 1982 ; LAGARDERE, 1982). Their topography hydrology and sediments allow to gather these areas under the concept of "peri-estuarine" zone, proposed by LAGARDERE (1982) for more southern region (Gironde estuary and related marine sectors). In addition, the idea of "estuarine-dependence" (MILLER et al., 1984 ; KOUTSIKOPOULOS et al., 1989a) can be applied to the sole. One could have thought that the production of juveniles by a nursery area was directly proportional to its surface, thus estimating roughly the carrying capacity of the whole seashore region. On the contrary, this comparison of three sectors demonstrate that both Pertuis amounting for 62 % of the total studied area, give 90 % in 1986 and 96 % in 1987 of the young soles, thus contributing for a major part to the stock recruitment. This weak part of the Bay of Vilaine, nevertheless, must be related to the low abundance level noticed in this sector in 1981 and 1987 over the 80's (DOREL et al., 1991). This occasional low level has perhaps not occurred in the

Pertuis, which were lesser influenced by the very cold winters which occurred in 1986 and 1987. Moreover, a separate dynamic of each area, in term of abundance variation and growth could be illustrated by the following assumptions:

- A possible genetic heterogeneity, related to disconnected spawning grounds. The overall survey of spawning areas (ARBAULT et al., 1986 ; KOUTSIKOPOULOS et al., 1991) and a preliminary study of genetic characteristics of the juvenile soles from these sectors (AUTEM et al., 1986) indicate that a limited discontinuity may be found without any drastic separation between Northern and Southern spawning areas. But an average delay of two months for the spawning periods and the distance of 150 km between the spawning locations may be responsible for different issues of the eggs and larvae transports to the coastal waters. In addition, a shorter distance between spawning grounds and nursery grounds in the Southern region would be profitable for survival and abundance of O-Group soles.
- Differences in natural mortality in relation with the local climate. An example is given by the trend of the Vilaine ecosystem to anoxic events during summer, which revealed to have an impact on O-Group growth (KOUTSIKOPOULOS et al., 1989b).
- Differences in fishing mortality especially due to the by-catches of the brown shrimp fisheries, which are more developed in the Pertuis.

CONCLUSION

This heterogeneity in the pre-recruitment processes is one of the reasons why discrepancies are found between the direct estimates (survey of nursery grounds) and the VPA series. Not taking into account any correction for catchability, the total number of juveniles on the three sectors doubled from 7 to 14 millions individuals within the two years, whereas the VPA estimated give a constancy of the stock (respectively 55 and 57 millions) (FOREST, com. pers). Knowing that the recruitment is the result of the separate production of several nursery grounds, one can assume that a reasonable level of heterogeneity explains a fairly good stability of the recruitment at the Bay of Biscay stock level.

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