ELSEVIER

Fisheries Research 50 (2001) 173–187

FISHERIES RESEARCH

www.elsevier.com/locate/fishres

Distribution of hake (*Merluccius merluccius*, Linnaeus, 1758) in the Bay of Biscay and the Celtic sea from the analysis of French commercial data

Jean-Charles Poulard

IFREMER, Laboratoire d'Ecologie Halieutique, Rue de l'Ile d'Yeu, BP 21105, 44311 Nantes Cedex 03, France

Abstract

Hake landings and effort data provided by the French otter trawl fleets exploiting the Celtic sea and Bay of Biscay fishing grounds were used for years 1992–1994. Monthly catch rates of five hake weight market categories were calculated and used as input in a correspondence analysis and hierarchical ascending classification procedure to describe the spatio-temporal distribution of hake in the Celtic sea and the Bay of Biscay. Results show a great difference in hake catch composition between the two zones. The higher proportion of small hake in the Bay of Biscay can be explained by the use of a minimum mesh of size 65 mm instead of 80 mm in the Celtic sea and the existence of a hake nursery coinciding with the muddy bottom of *Nephrops* fishing grounds in the northern part of the Bay of Biscay. Adult hake were found relatively more abundant in the shallow water of the eastern Celtic shelf from April to November. Oldest fish seemed to move westwards at the end of the year. They congregate for spawning along the slope and on the shelf in the north-western part of the Celtic sea from February to April–May. There is no evidence that young adult hake follow the same migratory pattern but they were found in abundance along the slope in the north of the Bay of Biscay during autumn and winter months.

Keywords: Hake; Catch per unit of effort; Correspondence analysis; Distribution; Bay of Biscay; Celtic sea

1. Introduction

Hake of the Northern stock are mainly taken in mixed fisheries together with other demersal species (Casey and Pereiro, 1995). This is the case of the hake landed by French fleets which exploit fishing grounds in the Celtic sea and the Bay of Biscay. Longline, fixed netting and otter trawling are the main gears used by French fishing boats in these zones (Anon., 1991).

The target species for French longline fisheries are skates, dogfish, ling and pollack. Quantities of hake landed by corresponding fishing vessels were very low for the period 1992–1994. The majority of fixed net activity targets at hake, however, the spatial distribution of hake catches provided by this fishery appears very restricted to Bay of Biscay and no reliable effort data were available for years 1992–1994. Otter trawling is the gear the most used by French fishing vessels.

In this study, hake landings and effort data supplied by bottom trawl fisheries were used, although hake is most often a by-catch species; target species being mainly nephrops, anglerfish, sole, megrim and gadoids.

Undoubtedly, it may be difficult to achieve a good description of the spatio-temporal distribution of hake

E-mail address: jcpoular@ifremer.fr (J.-C. Poulard).

0165-7836/01/$ – see front matter
PII: S0165-7836(00)00250-2

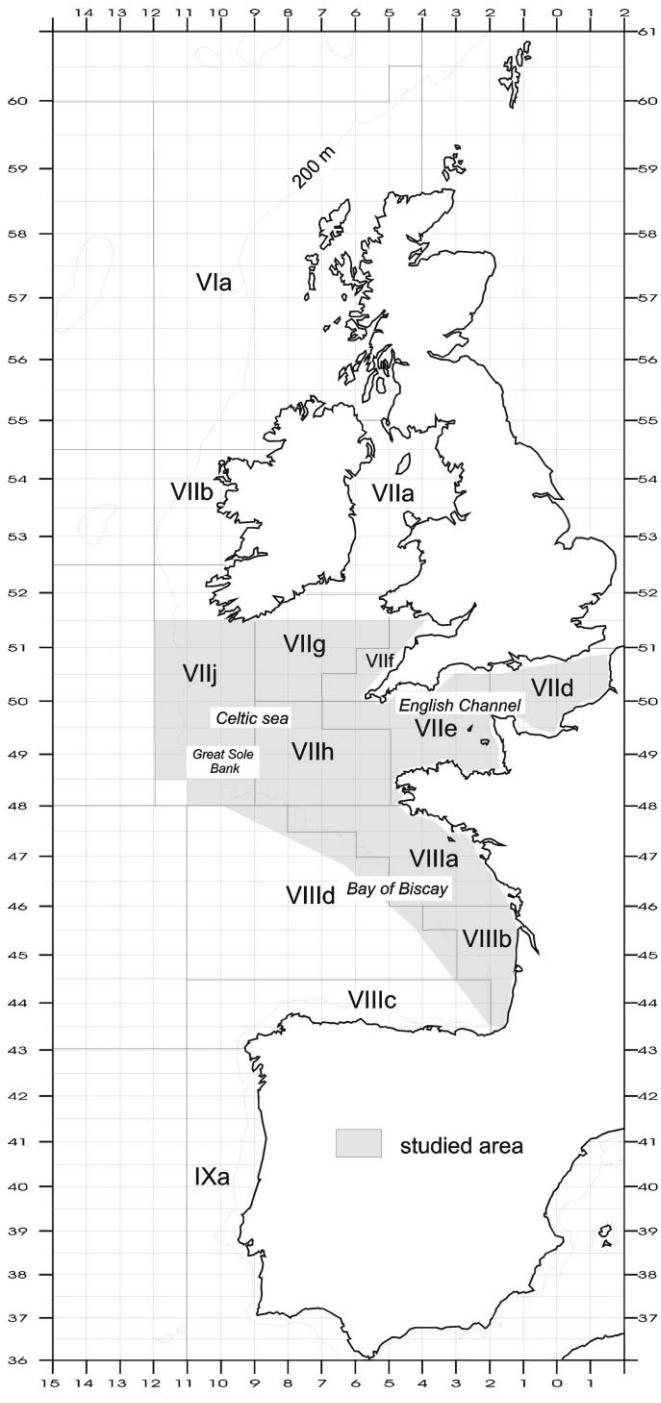

Fig. 1. ICES fisheries statistical areas and studied area.

from these data insofar as fishing vessels are not allocating fishing effort in order to catch hake throughout the year.

Landings are sorted by hake weight market categories. This information about catch composition was used with relevant bibliographic data to distinguish immature and mature hake. Multivariate analysis and classification procedure were used in a first-step to describe the general distribution pattern of hake over the Celtic sea and the Bay of Biscay areas. A more detailed analysis was then performed to exhibit some features of adult hake distribution.

2. Material and methods

The studied area (Fig. 1) includes the Bay of Biscay (ICES divisions VIIIab), the Celtic shelf (ICES divisions VIIfghj) and the English Channel (ICES divisions VIIed).

Landings of hake and fishing effort data were extracted from the French commercial database for the surveyed areas. Data were considered for years 1992–1994 and for the three main fishing gears, i.e. bottom trawl, pelagic trawl and gill net. Landings data are available by ICES statistical rectangle, generally sorted into market categories (Table 1). Table 2 gives the total catches and the proportion of catches sorted by market category for each year and gear.

Bottom trawl data are available over the whole studied area. Total catch distribution patterns from 1992 to 1994 were similar. Most fish was caught in the inshore Bay of Biscay shelf (Fig. 2) and catches in the other parts of the studied area were low compared to that of Bay of Biscay. Catches were higher from May to August both in 1994 and 1992. In 1993, the monthly catch distribution is different. The maximum occurred in May, then steadily decreased until September and increased again until November but did not reach the May peak. Catches were also high in March.

The distribution of the fishing effort in 1994 is mapped on Fig. 3. Two main areas are identified: the inner part of the Bay of Biscay shelf and the northern central part of the Celtic shelf. For the three years studied monthly fishing effort values do not vary much from March to November but decrease in December and January.

The difference between hake catch and fishing effort distributions in the north of the Celtic shelf (Figs. 2 and 3) can be noticed. Hake catches were bigger in the east of the area although higher values of effort spread westwards. Monthly catch per unit of effort (cpue) was calculated for each market category in each ICES statistical rectangle. The data matrix obtained has five variables corresponding to the five market categories and a spatio-temporal identifier (month/ICES statistical rectangle) is assigned to each row. In other words, each row represents the cpue profile for a given month/statistical rectangle.

Data were provided by several fleets having different fishing powers and exploiting different parts of the studied area. For these reasons we chose to restrict the study to the analysis of the distribution profiles, i.e. the distribution of the market category cpue within each month/statistical rectangle.

Table 1
Characteristics of the market categories used[a]

Market categories	Gutted weight range (kg)	Approximate mean length (cm)
C10	>2.4	>75
C20	[1.2–2.5[	66
C30	[0.6–1.2[	52
C40	[0.28–0.6[	41
C50	[0.2–0.28[	33

[a] The mean length approximate values are estimated using a total-weight–gutted-weight ratio of 1.17 and the following values for the weight–length relationship parameters: $a = 5.13 \times 10^{-3}$ and $b = 3.074$ (Anon., 1991).

Table 2
Total hake catches and proportion of catches sorted by market category for the three main gears used in the studied area

Year		Bottom trawl	Pelagic trawl	Gill net
1992	Total catch (t)	5474	4154	2886
	Sorted catch (t)	3491	1658	1399
	Sorted catch (%)	64	40	48
1993	Total catch (t)	5417	2503	2611
	Sorted catch (t)	3827	1080	1355
	Sorted catch (%)	71	43	52
1994	Total catch (t)	5453	3080	2255
	Sorted catch (t)	4061	1773	1184
	Sorted catch (%)	74	58	53

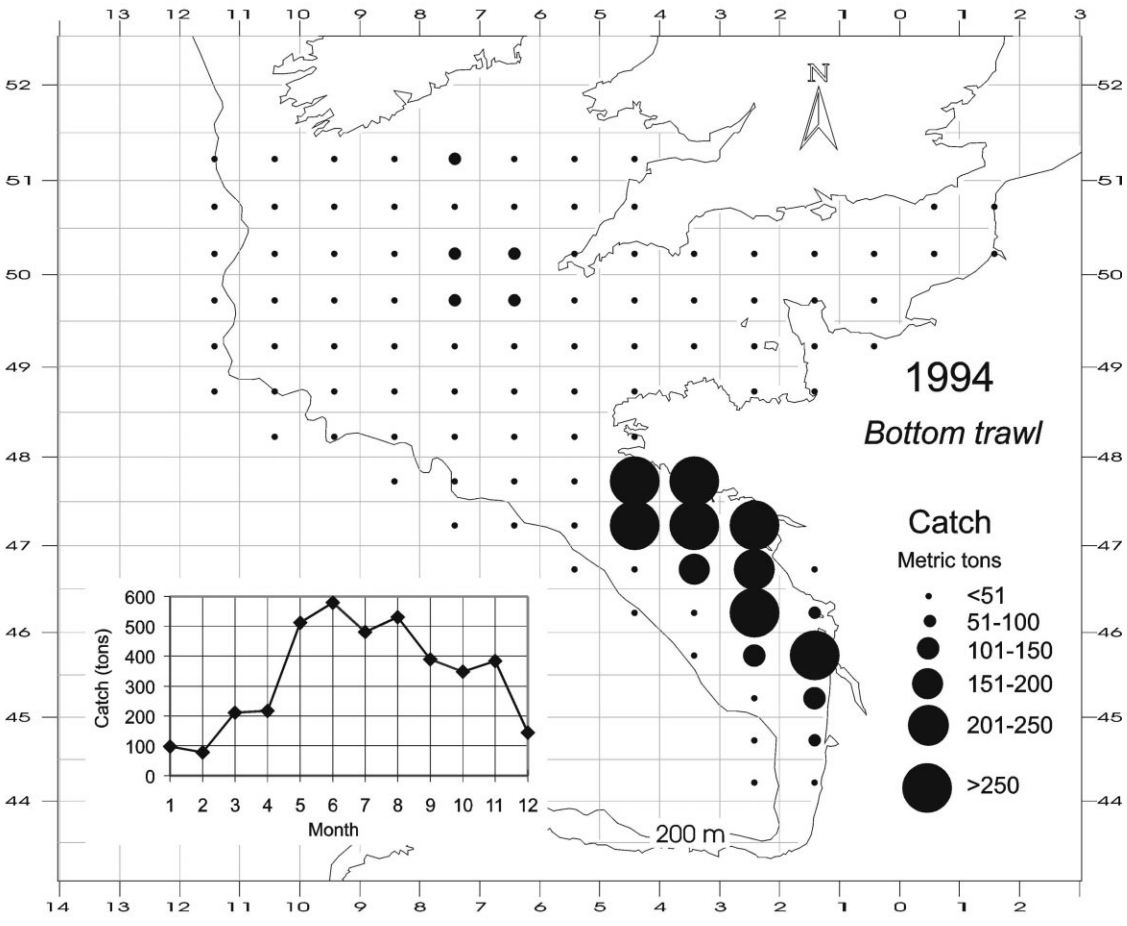

Fig. 2. Distribution of bottom trawl catches of hake in 1994.

The cpue data matrix was used as input in a multivariate analysis to study the spatio-temporal distribution of hake in 1992–1994. A correspondence analysis was chosen to examine similarities among profiles (Lebart et al., 1984). The five components of the cpue (i.e. the five market categories) are the active variables. The numbers of rows were 997, 941 and 909, respectively, for 1992, 1993 and 1994.

Then, the individuals were classified using their first coordinates obtained from correspondence analysis in a hierarchical ascending classification procedure. The groups obtained were then clustered using a moving centers procedure in order to improve the class homogeneity.

Pelagic trawl and gill net fishing grounds have a very limited spatial distribution. In addition, no reliable effort data are available for gill net. Results for these gears are not presented in this paper.

3. Results

3.1. Correspondence analysis

For the three studied years, the first three axes account for about 94% of the total variance (93.8% in 1992, 94.5% in 1993 and 93.8% in 1994).

The configurations of the variables in the projection planes 1–2 and 1–3 (Table 3) are very similar for the three years and are illustrated by year 1994 in Fig. 4. Two illustrative variables (latitude and month) were

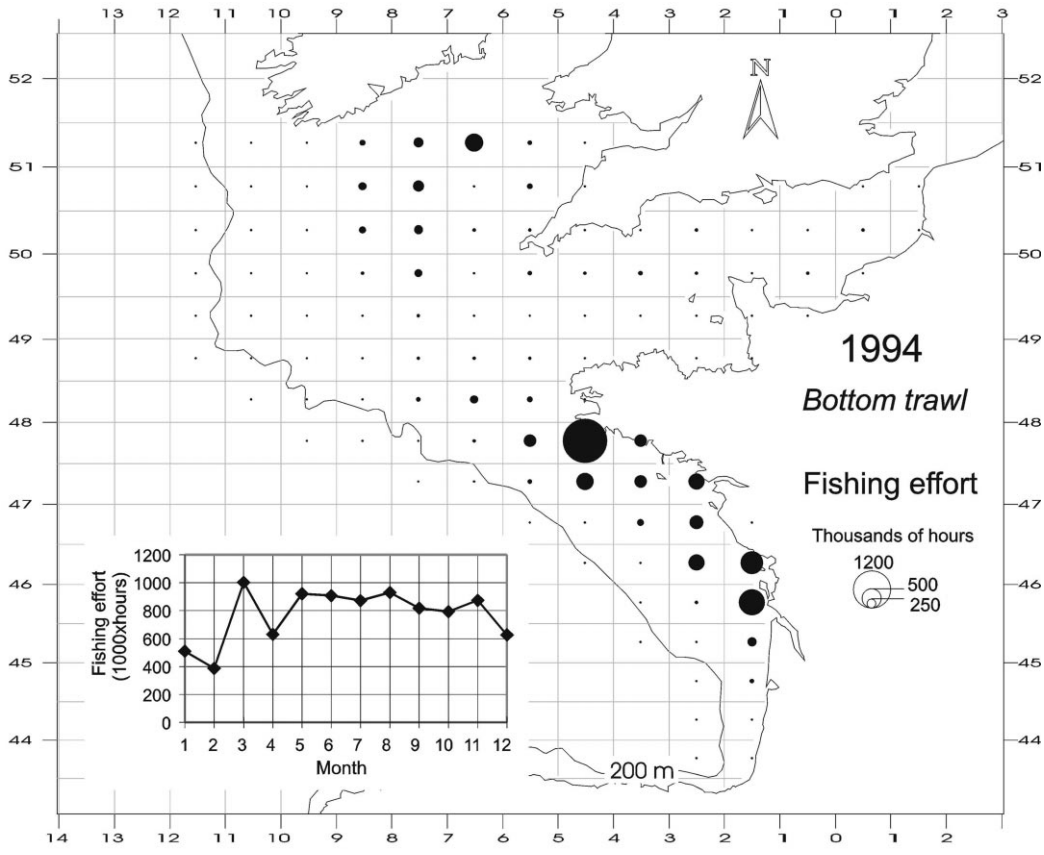

Fig. 3. Distribution of bottom trawl fishing effort in 1994.

Table 3
Correspondence analysis: coordinates and contributions of the variables

Year	Variable	Coordinates			Absolute contributions			Squared correlations		
		F1	F2	F3	F1	F2	F3	F1	F2	F3
1992	C10	−0.31	0.54	−0.37	3.7	17.4	15.4	0.14	0.41	0.19
	C20	−0.38	0.42	−0.08	13.9	26.3	2.0	0.38	0.46	0.02
	C30	−0.31	−0.18	0.33	13.0	7.2	46.5	0.38	0.14	0.46
	C40	0.12	−0.43	−0.28	1.8	39.2	30.6	0.05	0.67	0.28
	C50	0.90	0.28	0.15	67.6	9.9	5.5	0.89	0.08	0.02
1993	C10	−0.56	0.31	−0.51	5.0	4.1	20.6	0.30	0.09	0.25
	C20	−0.66	0.25	−0.18	27.6	11.0	10.2	0.76	0.11	0.06
	C30	−0.38	−0.16	0.36	11.8	5.3	51.2	0.48	0.08	0.43
	C40	0.35	−0.59	−0.24	7.4	55.2	16.5	0.24	0.65	0.11
	C50	0.80	0.34	0.06	48.2	24.4	1.5	0.84	0.16	0.01
1994	C10	−0.65	−0.48	−0.58	6.8	9.4	20.8	0.31	0.17	0.24
	C20	−0.67	−0.29	−0.24	22.1	11.0	11.5	0.66	0.13	0.09
	C30	−0.57	0.10	0.46	21.0	1.6	52.3	0.59	0.02	0.38
	C40	0.22	0.50	−0.19	4.0	55.0	12.0	0.14	0.75	0.11
	C50	0.75	−0.33	0.10	46.1	23.0	3.3	0.82	0.16	0.02

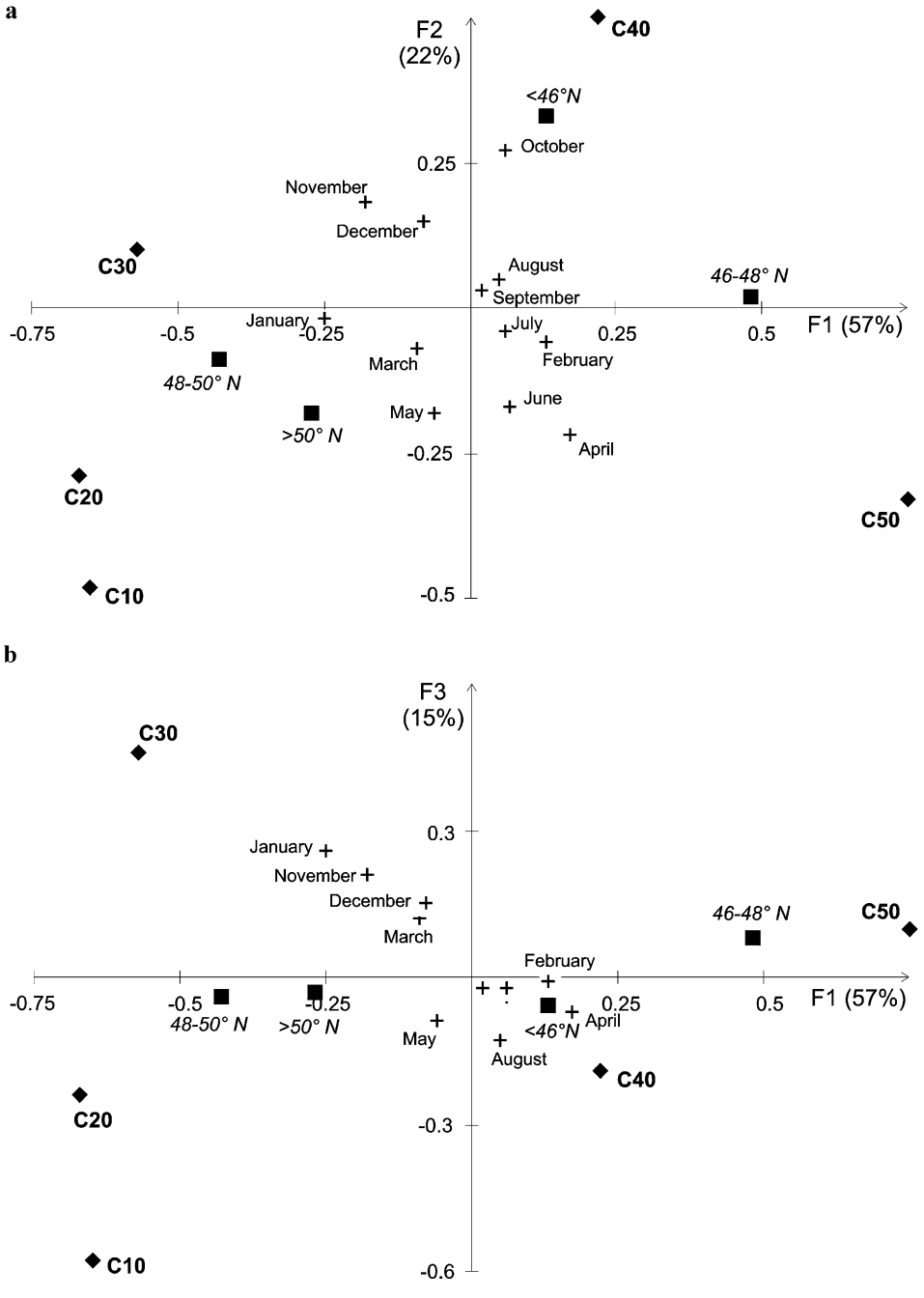

Fig. 4. Correspondence analysis, projection of the five active (C10–C50) and two illustrative (month and latitude) variables: (a) on axes 1 and 2. The proportions of the total variance explained by axes 1 and 2 are, respectively, 57 and 22%; (b) on axes 1 and 3. The proportion of the total variance explained by the third axis is 15%.

added to the five active variables (market categories C10–C50, Table 1).

Market category C50 contributes mainly to the first axis. The smallest fish (C50) is opposed to large ones (C20 and C30) on the first axis. This means small fish is not usually caught in the same place or time than the fish belonging to market categories C20 and C30. The first axis is highly related to the illustrative variable latitude and small fish is mostly caught in the southern part of the studied area.

Variable C40 strongly contributes to the second axis. Also, the second axis is related to the illustrative variable month and shows an opposition between the second and the fourth quarter. Fish belonging to market category C40 is mainly caught in the Bay of Biscay (latitude less than 46°N, and between 46 and 48°N) and during the fourth quarter of 1994. Variable C50 participates to a lesser extent to the building of the second axis and is opposed to market category C40 on this axis. This means that fish belonging to market categories C50 and C40 are mainly caught in the same area but not at the same time of the year.

Market category C30 strongly contributes to the third axis which is weakly related to the illustrative variable month. The hake belonging to this market category appear to be mainly caught in winter (November–January) in the northern part of the studied area.

The same overall comments can be made for the years 1992 and 1993, except that the temporal changes are less marked in 1992 and 1993. The variable month is poorly related to the second and third axes in 1993 and weakly in 1992.

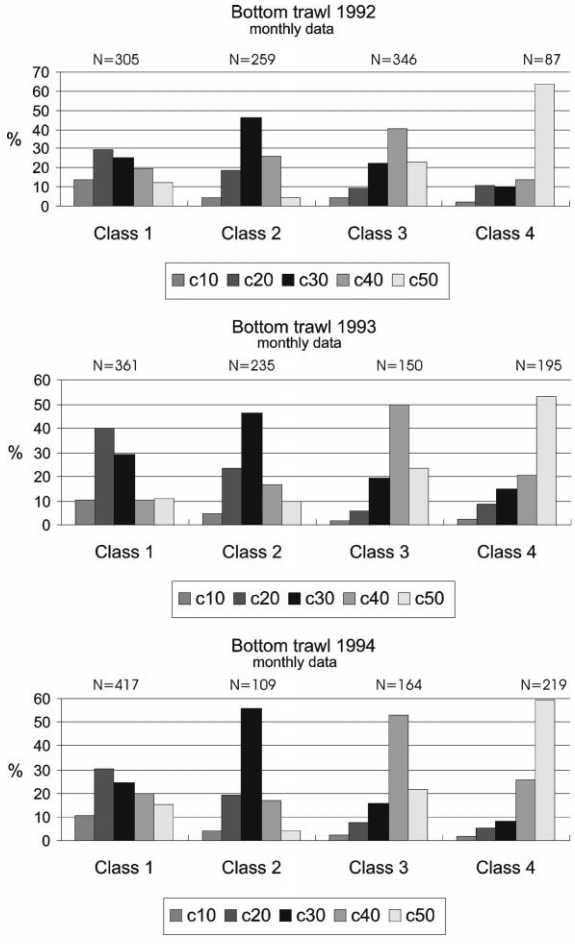

Fig. 5. Frequency distribution of the market categories (C10–C50) in the four classes identified after performing a hierarchical classification procedure on the first coordinates provided by the correspondence analysis of the bottom trawl data sets of 1992–1994 (*N* is class numbers).

3.2. Classification

Four clusters of ICES statistical rectangle/month were identified through each year. One of the market categories C50, C40 or C30 is prevailing in either of three of them (Fig. 5). The last one is rather a mixture of the five market categories more or less dominated by the C20 category.

The ratio of the between cluster inertia to the total inertia of the data is 0.7 in 1994, 0.68 in 1993 and 0.58 in 1992. It is necessary to divide into six groups the 1992 set of data to obtain the same ratio value as in 1994. In this case, the third class of our partition into four clusters is split into three groups. One is well characterized by the predominance of market category C40 and in the two others the C40 category is associated, in equal proportion, to either the C30 category or the C50 one. However, it was chosen to keep four clusters in 1992 to make easier comparison between years.

Figs. 6–8 show the spatial distributions of the four groups of cpue profiles while temporal distribution of the classes is presented in Fig. 9 for selected latitudes.

Through the three years, small hake (class 4) was mainly found in the Bay of Biscay from the coast to the edge of the shelf. In 1993 and 1994, it appeared

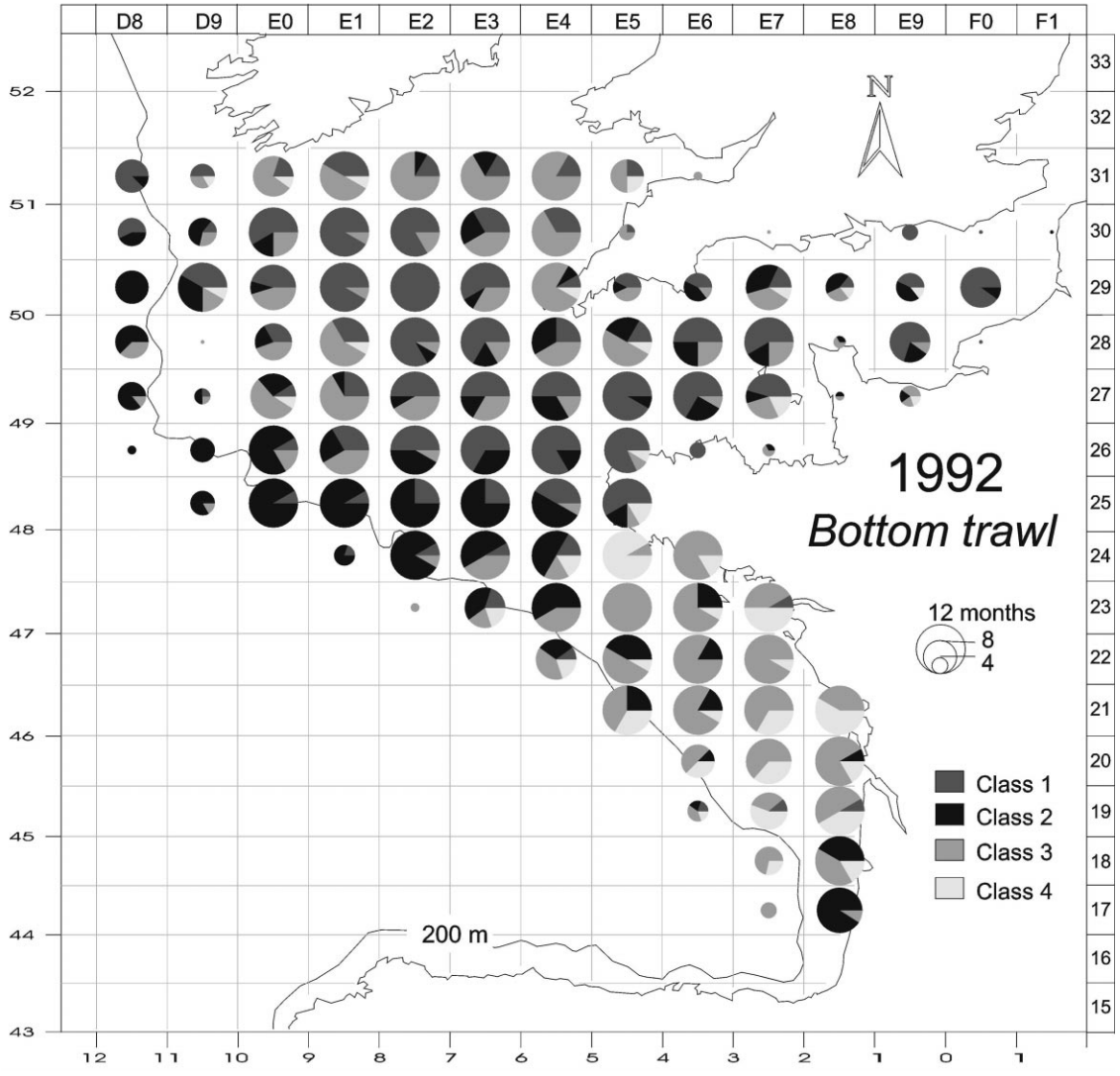

Fig. 6. Spatial distribution of the four classes of cpue profiles in 1992. In an ICES statistical rectangle, the diameter of the pie-chart is proportional to the number of months during which catches occurred. The pie-chart is built from the count of the number of months belonging to each class of cpue profile.

also in the northern part of the Celtic shelf and in the western part of the English Channel but to a smaller extent and often close to the coast. In 1992, class 4 showed a lower frequency than in 1993 and 1994 and was most often replaced by class 3.

Class 4 occurred during the first half-year in the Bay of Biscay and mostly during the fourth quarter in the Celtic sea and the English Channel.

Group 3 was widely distributed over all the studied area in 1992 and was present all year long. In 1993 and 1994, this group was mainly found in the Bay of Biscay and in the south of the Celtic shelf where it was mostly present during the second half-year in place of the class 4.

The main feature of class 2 distribution was its high frequency west of Brittany (generally between lati-

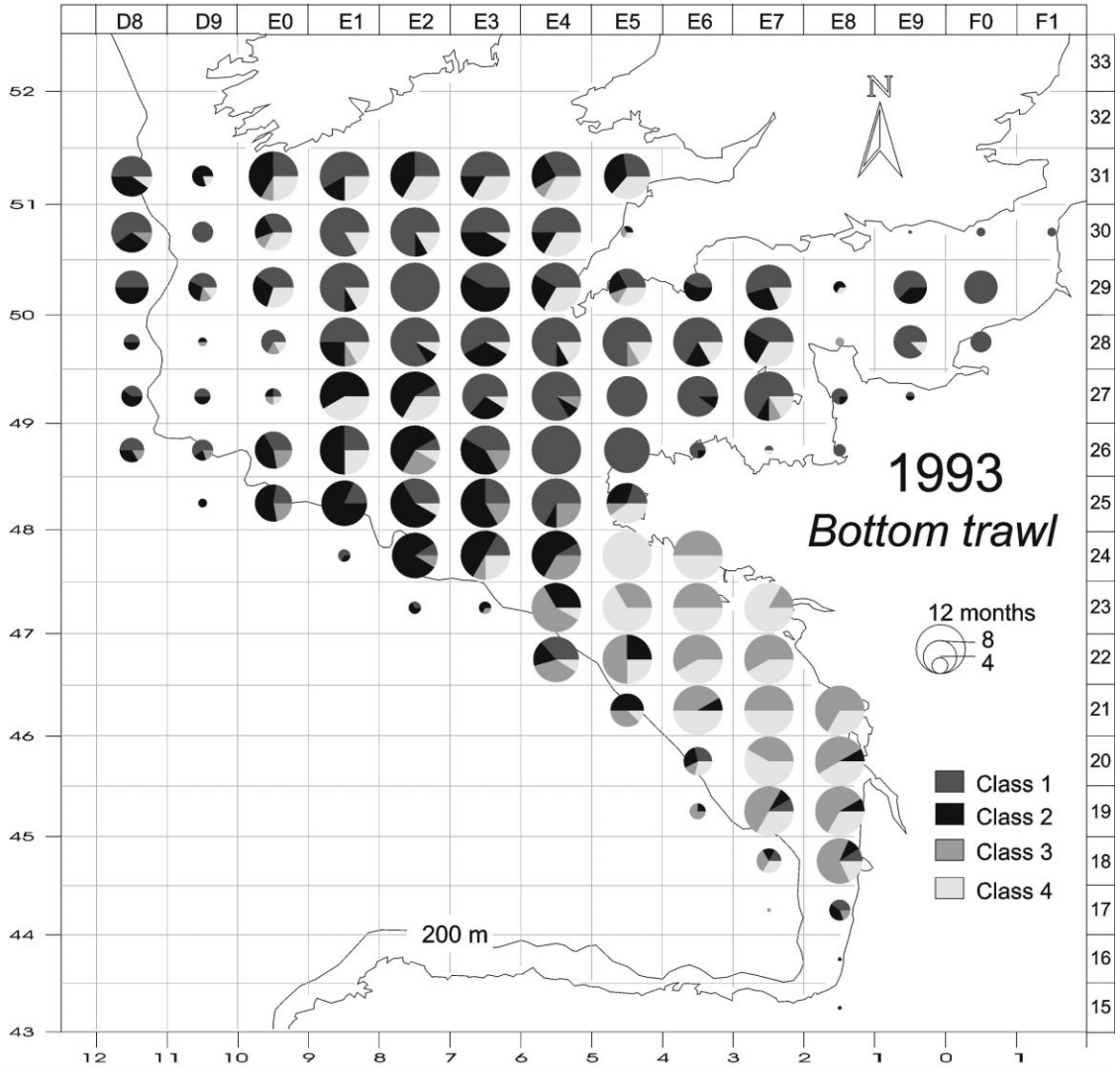

Fig. 7. Spatial distribution of the four classes of cpue profiles in 1993. In an ICES statistical rectangle, the diameter of the pie-chart is proportional to the number of months during which catches occurred. The pie-chart is built from the count of the number of months belonging to each class of cpue profile.

tudes 47°30′N and 49°N). It was a permanent characteristic observed throughout the years, although there was a decreasing trend in the frequency of that class from 1992 to 1994. Class 2 occurred almost all year long in this area. This class was also found along the slope in the Celtic sea and in the Bay of Biscay. The monthly observations were too sparse along the Celtic shelf edge to provide a good information about its occurrence period in this area. Group 2 seemed to appear in winter along the Bay of Biscay shelf edge and in the south of Bay of Biscay coastal area.

Group 2 distribution shows year-to-year changes on the Celtic shelf and in the English Channel. Class 2 strength was low (Fig. 5) in 1994 and this class was almost absent from this area. On the contrary in 1993, this group spread throughout the Celtic shelf and the English Channel where it was mainly found during spring and summer. The 1992 class 2 distribution was

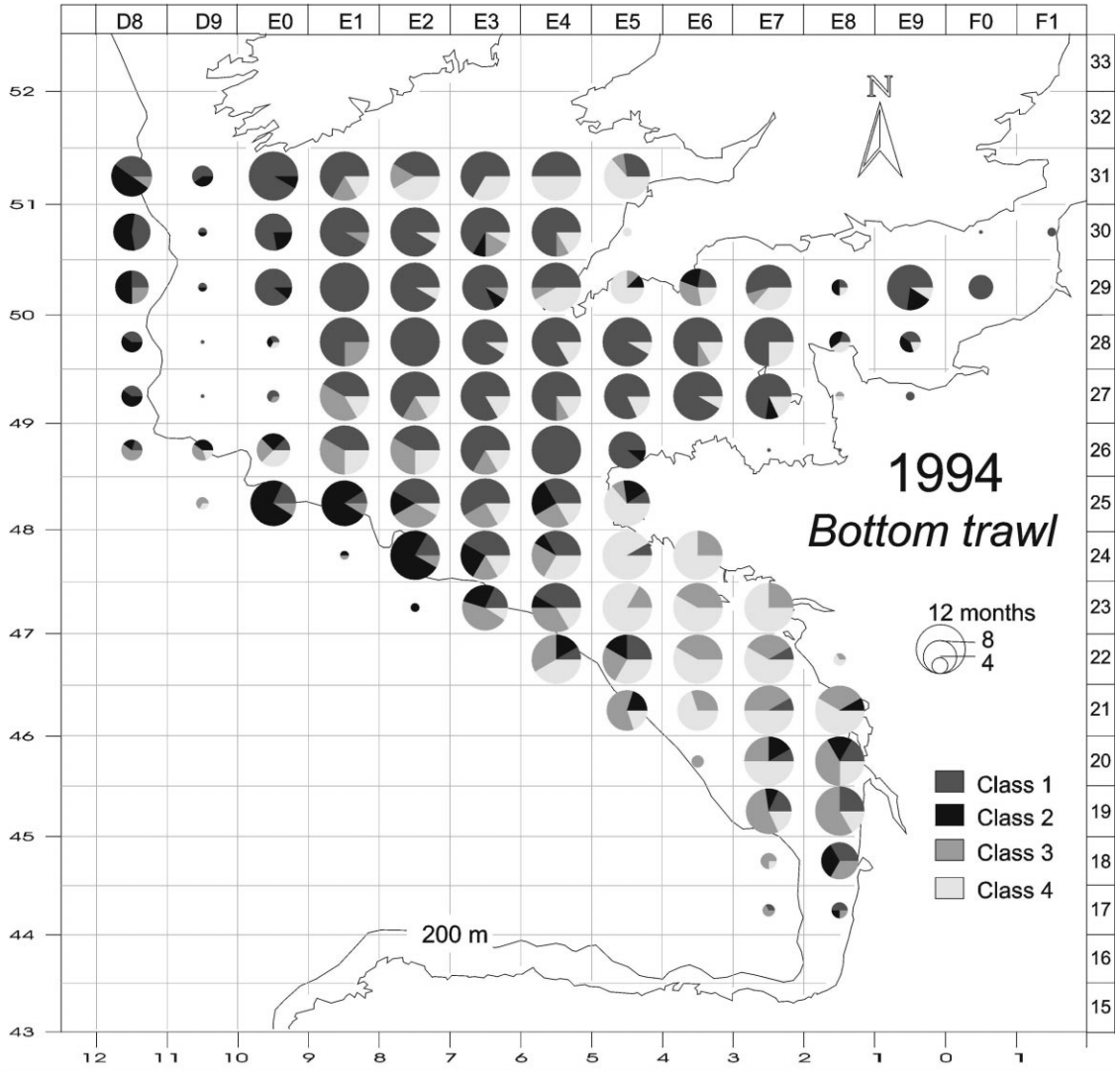

Fig. 8. Spatial distribution of the four classes of cpue profiles in 1994. In an ICES statistical rectangle, the diameter of the pie-chart is proportional to the number of months during which catches occurred. The pie-chart is built from the count of the number of months belonging to each class of cpue profile.

more restricted than the 1993 one to the eastern part of the Celtic shelf where it largely occurred during the second half-year.

Class 1 was scarce in the Bay of Biscay compared to its high frequency on the Celtic shelf. However, its distribution spread to the north of the Bay of Biscay in 1994. In this area, class 1 appeared during winter along the slope and in the coastal area, mainly in the south as in 1994. On the Celtic shelf and in the western part of the English Channel, class 1 occurred during a large part of the year especially in 1993 and 1994. In these years, it was replaced by class 4 during the fourth quarter.

4. Discussion

Both multivariate analysis and classification results reveal substantial differences in hake catch composi-

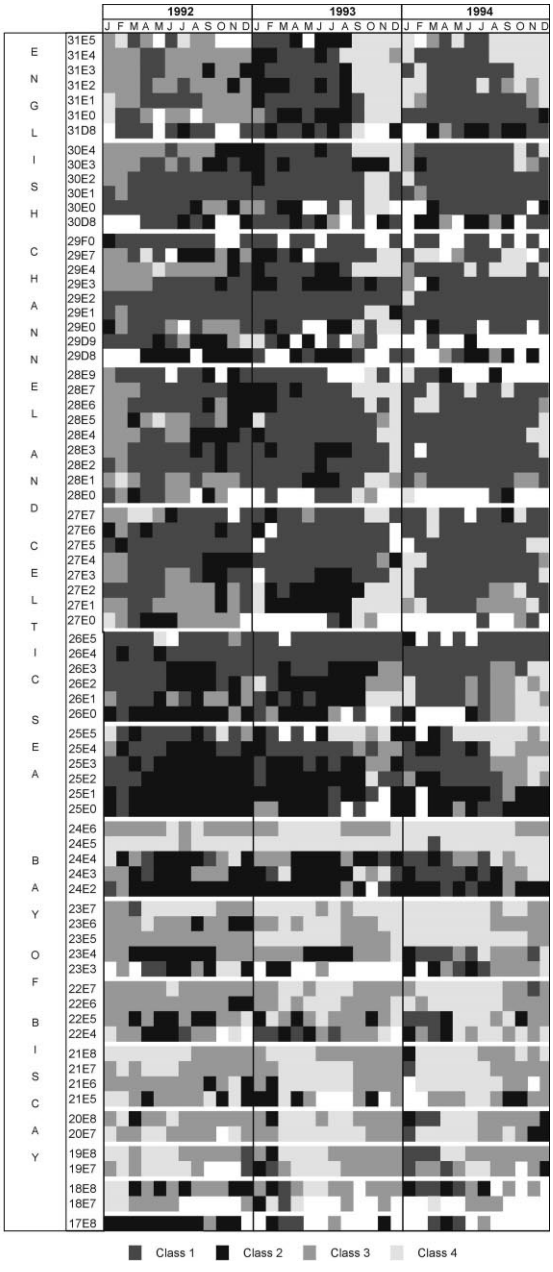

Fig. 9. Temporal distribution of the four groups of cpue profiles during the years 1992–1994. For a given latitude, ICES statistical rectangle are ordered according to ascending longitude.

tion between the Celtic sea and the Bay of Biscay. A first explanation for the higher proportion of small hake in the Bay of Biscay catches is that the minimum mesh size for hake fisheries is 65 mm in ICES sub-area VIII (south of 48°N) while it is 80 mm in ICES sub-area VII (north of 48°N).

The high frequency of class 4 in the Bay of Biscay may be also related to the existence of a hake nursery coinciding with the muddy bottom of *Nephrops* fishing grounds in the northern part of the Bay of Biscay (Anon., 1977; Petitgas, 1991).

The spatio-temporal distributions of class 3 and 4 showed some differences over the three years studied. Particularly in 1992, the group 3 strength was high while that of group 4 was low compared with the 1993 and 1994 strengths of these groups (Fig. 5). This seems to be linked to the low level of the C50 market category catch in 1992 (800 t against 1500 and 1600, respectively, in 1993 and 1994) while C40 catches were alike (1000, 1100 and 1200 t from 1992 to 1994). The C50 category weight range encompass the mean catch weights at age 3 used for the assessment of the hake Northern stock (Anon., 1997). It is therefore reasonable to assume that the majority of the fish contributing to the C50 market category catches belonged to the year-classes 1989 in 1992, 1990 in 1993 and 1991 in 1994. Now, the recruitment at age 0 for the hake of the Northern stock was low in 1989 and close to the 1978–1993 mean both in 1990 and 1991 (Anon., 1997).

Hake males mature at a smaller size than female (Casey and Pereiro, 1995) and the length at first maturity (mean length at which 50% of the fish observed are mature) varies according to the area of capture (Hickling, 1930).

Martin (1991) found length at first maturity values of 37.7 cm for males and 50.5 for females for hake sampled in the Bay of Biscay. This parameter was estimated at 33.2 cm for males and 59.2 cm for females from data collected during English groundfish surveys in the Celtic sea and northern Bay of Biscay (Anon., 1990).

The approximate values of the hake mean length have been calculated for each market category (Table 1) using their weight limits. From the mean length values of the C10, C20 and C30 market categories, one can state that all the fish contributing to the C10 catches, almost all those to the C20 and the most of those to the C30 were mature fish. As these market categories together account for 65–79% of the composition of classes 1 and 2, one can expect to get good information about the behaviour of the adult hake by

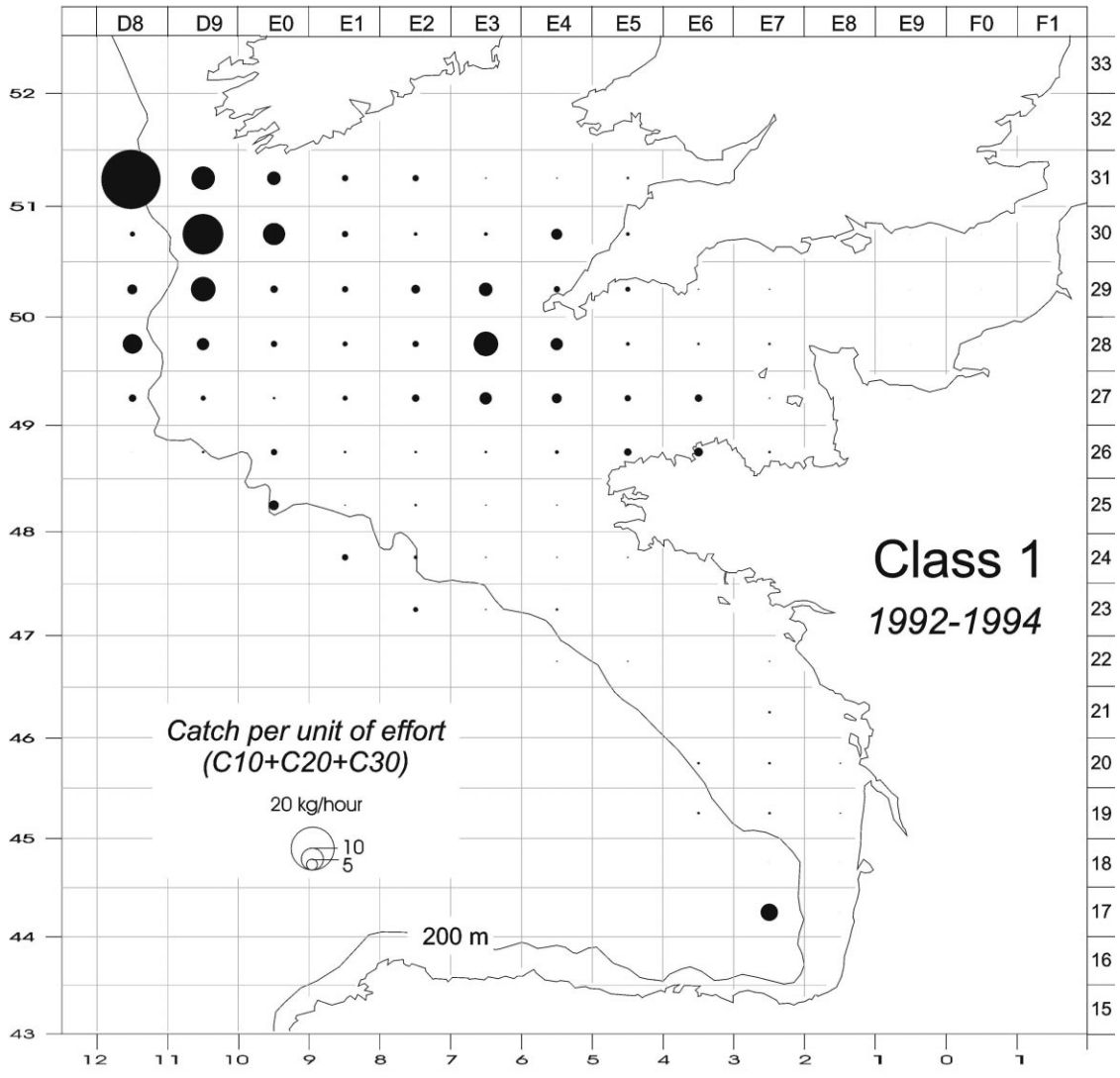

Fig. 10. Distribution map of the sum of the market category C10–C30 catches per unit of effort (cpue) for class 1, after pooling the three years studied.

studying the spatio-temporal distribution patterns of these two classes.

Class 1 was scarce in the Bay of Biscay. It occurred a large part of the year over the Celtic shelf, in the English Channel as well as along the slope in the Celtic sea and in the north of Bay of Biscay. The main change in its spatio-temporal distribution was its replacement by class 4 during the fourth quarter, mainly in the shallow water of the Celtic shelf (Figs. 7 and 9). As class 1 distribution was mainly restricted to the Celtic sea, the reserve with regard to the use of cpue values expressed in material and method part is no more justified. So, all the individuals (ICES statistical rectangle/month) identified as belonging to class 1 over years were pooled, and the sum of market category C10–C30 cpue values was used as an indicator of the abundance of class 1 to describe its distribution. From Fig. 10, two areas can be delimited in Celtic sea on either side of 8°W longitude: a north-western area enclosing medium

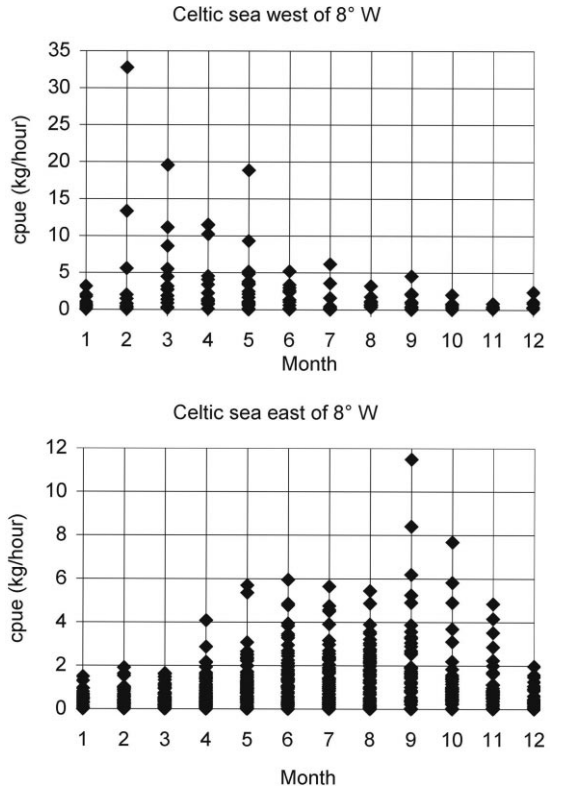

Fig. 11. Through year scatter diagram of the sum of the market category C10–C30 catches per unit of effort (cpue) for class 1, after pooling the three years studied.

and deep waters, an eastern and shallow water area. This distribution pattern was observed in 1992 and 1994. In 1993, the western area was not so well defined.

The throughout year catch rate scatter diagrams (Fig. 11) show opposite trends between the two areas. High cpue values were observed from February to May in western area while relatively high cpue occurred from May to November in eastern area. The same procedure was used for class 2. The two areas previously identified appear on the map of Fig. 12, one more area spread along the slope in the north of the Bay of Biscay where the largest yields were observed. The three areas were well represented both in 1992 and 1993. On the other hand, the 1994 data did not show eastern Celtic shelf area and they provided most of the large yields located along the shelf edge.

In the Celtic sea east of 8°W area (Fig. 13), the cpue values were low from January to May and in December while relatively high cpue were observed from June to October–November. Observations from the Celtic sea west of 8°W area did not show any trend over months except that catch rates were low in January and February. In the north of the Bay of Biscay, higher cpue seem to occur at the beginning and end of the year, cpue values being low in spring and summer except a lonely high value in June.

Results from this study have shown adult hake were relatively more abundant in the Celtic shelf east of 8°W area from April to November. The oldest ones, belonging to class 1, seem to move westwards at the end of the year. They seem to congregate along the slope and on the shelf in north-western part of the Celtic sea from February to April–May when the highest cpue values were observed. There is no evidence the young adult hake belonging to class 2 followed the same migratory pattern but they were found in abundance along the slope in the north of the Bay of Biscay during autumn and winter months.

Peak spawning occurs in February in the Bay of Biscay (Sarano, 1983), between March and July in the south and west of Ireland (Fariña and Fernandez, 1986). In addition, Coombs and Mitchell (1982) reported that the highest concentrations of hake eggs and larvae occurred from March to July, for the years 1973–1980, in the area of the Great Sole Bank. One can therefore conclude the north-western Celtic sea and the north of the Bay of Biscay areas are pre-spawning and spawning concentration areas.

Although these results must be considered with caution because they are based on scarce fishing effort data notably in the outer part of the continental shelf and slope areas (Fig. 3), they are corroborated by former observations. Belloc (1935) used logbook data for the year 1923 provided by La Rochelle trawlers. He noted that in surroundings of Great Sole Bank the best hake catches were made from January to March and from October to December, hake catches being very low in July.

Results of this study agree with the description of the seasonal variations in the south west Ireland hake fishery made by Hickling (1927). That is to say, in March, the best hake fishing is found in the deep water on western grounds; in June, the hake fishery is

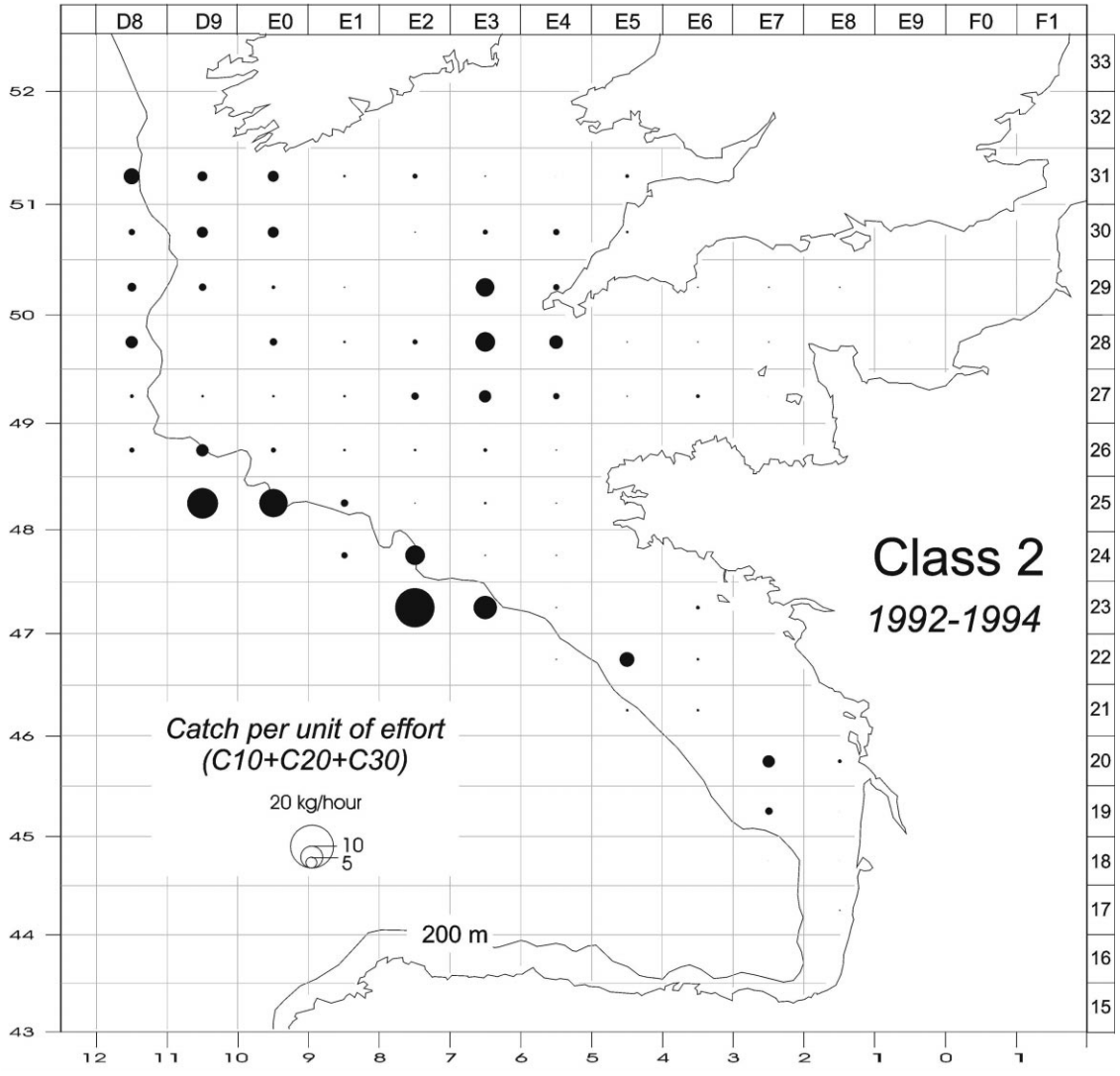

Fig. 12. Distribution map of the sum of the market category C10–C30 catches per unit of effort (cpue) for class 2, after pooling the three years studied.

extensively spread over the shoal water areas, whereas it is chiefly in deep water in September and December.

In addition, the cpue temporal variations described for the Celtic sea east of 8°W area are similar to those obtained by Hickling (1927) in a close area in the south east of Ireland. The monthly landings of big hake (mature hake) reach their maximum in June and then decrease to a minimum in winter, whereas small hake are taken in increasing numbers until a maximum is reached in September or October.

More recently, data provided by the English Celtic sea groundfish surveys carried out in March for the period 1985–1991, showed that hake longer than about 20 cm were distributed over the whole survey area but higher densities occurred in the deeper water at the shelf edge (Warnes and Jones, 1995).

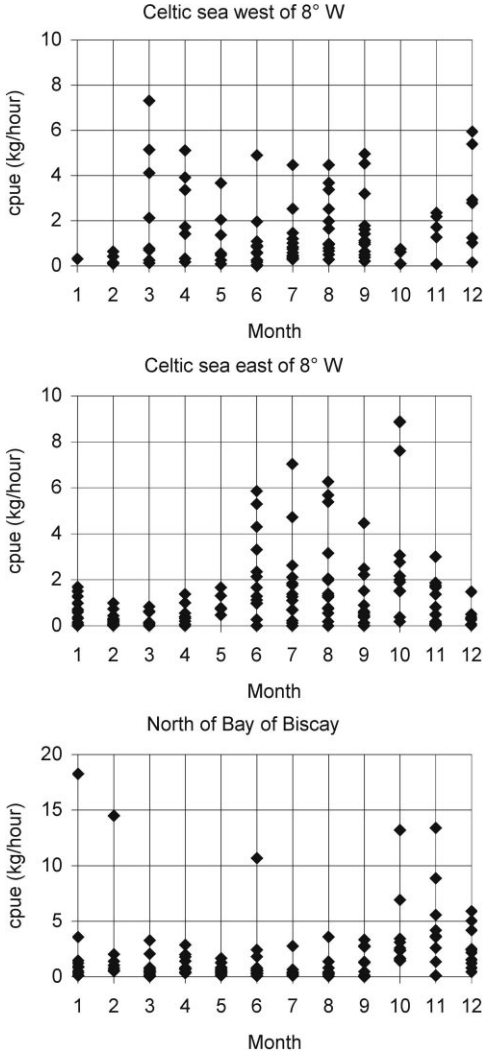

Fig. 13. Through year scatter diagram of the sum of the market category C10–C30 catches per unit of effort (cpue) for class 2, after pooling the three years studied.

Acknowledgements

I am thankful to Alain Biseau (IFREMER, Lorient) for making available the data sets.

References

Anon., 1977. Résumé des connaissances sur le merlu (*Merluccius merluccius* L.). Int. Council Explor. Sea C.M. 1977/G:3 — Appendix, 15 pp.

Anon., 1990. Report of the Working Group on Fisheries Units in Sub-areas VII and VIII. Int. Council Explor. Sea C.M. 1990/Asses:23, 129 pp.

Anon., 1991. Report of the Working Group on Fisheries Units in Sub-areas VII and VIII. Int. Council Explor. Sea C.M. 1991/Asses:24, 215 pp.

Anon., 1997. Report of the Working Group on the Assessment of Southern Shelf Demersal Stocks. Int. Council Explor. Sea C.M. 1997/Asses:5, 640 pp.

Belloc, G., 1935. Etude monographique du merlu (*Merluccius merluccius* L.) 3éme partie. Revue Trav. Off. (Scient. Tech.) Pêch. Marit. 8 (2), 145–202.

Casey, J., Pereiro, J., 1995. European hake (*M. Merluccius*) in the north-east Atlantic. In: Alheit, J., Pitcher, T.J. (Eds.), Hake: Fisheries, Ecology and Markets. Fish and Fisheries Series No. 15. Chapman & Hall, London, pp. 125–147.

Coombs, S.H., Mitchell, C.E., 1982. The development rate of eggs and larvae of the hake *Merluccius merluccius* (L.) and their distribution to the west of the British Isles. J. Cons. Int. Explor. Mer. 40, 119–126.

Fariña, A.C., Fernandez, A., 1986. Datos biologicos de la merluza del oeste de Irlanda. Inf. Tec. Inst. Esp. Oceanogr. No. 47/86, 13 pp.

Hickling, C.F., 1927. The natural history of the hake. Parts I and II. Fish. Invest. Ser. II, 10 (2), 112 pp.

Hickling, C.F., 1930. The natural history of the hake. Part III. Fish. Invest. Ser. II, 12 (1), 78 pp.

Lebart, L., Morineau, A., Warwick, K.M., 1984. Multivariate Descriptive Statistical Analysis. Wiley, New York, 2 31 pp.

Martin, I., 1991. A preliminary analysis of some biological aspects of hake (*Merluccius merluccius* L., 1758) in the Bay of Biscay. Int. Council Explor. Sea C.M. 1991/G:54, 31 pp.

Petitgas, P., 1991. Contributions géostatistiques à la biologie des pêches maritimes. Thèse de Docteur de 3e cycle. Ecole Nationale Supérieure des Mines de Paris, 213 pp.

Sarano, F., 1983. La reproduction du merlu (*Merluccius merluccius* L.): cycle ovarien et fécondité et cycle sexuel de la population du golfe de Gascogne. Thèse de Docteur de 3e cycle. Université de Poitiers — Institut Scientifique et Technique des Pêches Maritimes, La Rochelle, 148 pp.

Warnes, S., Jones, B.W., 1995. Species distributions from English Celtic sea groundfish surveys, 1984–1991. Fish. Res. Tech. Rep., MAFF Direct. Fish. Res. Lowestoft (98), 42 pp.