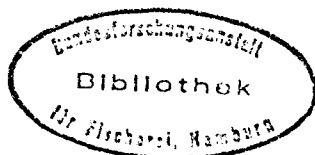


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(including results from EC-SEFOS)

OCCURENCE OF BLUE WHITING IN TRAWL CATCHES DURING
SURVEYS FROM PORTUGAL TO FAROE ISLANDS, 1979-1995.

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ABSTRACT

Historical data on blue whiting (*Micromesistius poutassou*) from survey trawl stations of 7 countries, have been congregated and prepared into special files, together with corresponding temperature and salinity observations. The majority of the data originate from bottom trawl stations and hence represent the on-shelf part of the stock, i.e. mainly younger age groups. The pelagic stations, mainly worked off the shelf over deeper water west of the British Isles, represent the more oceanic part of the stock, which are both young and older age groups. These biological data are presented on maps by quarter of year and age groups.

Special attention is paid to the data from the Norwegian surveys whose main target is blue whiting when this is congregated along the slope west of the British Isles to spawn. These data clearly show a south-bound tendency of the abundance with year in the 1980's. Age 1 is more frequent in the south and north than in the central area, i.e. around lat. 55° N, while older fish are more uniformly distributed.

The increase in temperature and salinity southwards from lat. 59° N off North Scotland, is roughly linear, while the values North of Scotland show a much greater dispersion.

INTRODUCTION

One of the commercially important fish species distributed along the shelf edge from Portugal to the Norwegian Sea, is the blue whiting (*Micromesistius poutassou*). It is found in most parts of the warmer side of the northeast Atlantic. The distribution ranges from the Mediterranean Sea in the south to the Barents Sea and Spitzbergen in the north, between Southeast Greenland and the Kola peninsula (Monstad, 1990).

The spawning period is from January/February to May/June, starting in the south and ending in the Faroe/Shetland area. The peak spawning of the main oceanic stock, however, will be in March and April, along the continental slope at 300-500m depth, west of Ireland and Scotland respectively.

In the 1970's the interest in commercial exploitation had a rapid increase, and an international fishery developed in the feeding areas in the Norwegian Sea during summer and autumn as well as in the main spawning area west of the British Isles during spring. In addition, blue whiting was caught throughout the year as by-catch in the mixed industrial fishery in the North Sea and on the shelf off Portugal and North-Spain. A total number of around 13 nations have used to exploit the blue whiting stock.

Every spring since the beginning of the 1970's the spawning stock west of the British Isles has been monitored acoustically by vessels from one or more countries, e.g. Norway, Russia, Scotland and The Faroes, but during the last 10 years by Norway and Russia only (Anon., 1996). However, during the 1980's and -90's, other countries have in addition carried out bottom trawl surveys on the shelf, and hence blue whiting has all in all been recorded over a rather wide area.

Blue whiting feeding in the Norwegian Sea migrate every spring southwards to the spawning grounds west of the British Isles, and likewise blue whiting from the south migrate northwards to the same area. In this context, the Porcupine bank area west of Ireland is considered an area where blue whiting from the north and south mix during the spawning period. However, the proportions originating from the north and south respectively are unknown, as well as how much of the spawning products drift north and south. In addition to oceanic parts of the stock, there is also a number of local stocks in inshore waters.

Preliminary results of genetical investigations in 1991-1993 indicate that several populations of blue whiting could appear in the spawning area. However, there were no indications of genetical substructure among the blue whiting from west of the British Isles to Gibraltar (Mork and Giæver, 1993)

Blue whiting, its structure and composition within certain areas and seasons, are familiar to various institutes. The total picture is incomplete, for the distribution as well as for the migrations of the various parts of the stock. This paper presents results of the trawl catch data collected from 7 countries, combined to describe distribution for various age groups of blue whiting, on and off the shelf from Portugal to Shetland and off the shelf west of the British Isles.

MATERIAL AND METHODS

Within the EU-project SEFOS (AIR-programme), survey data from 7 countries, i.e. France, Spain, The Netherlands, Portugal, Scotland, Norway and Germany, have been collected and prepared into special standard formatted files. The data consist of survey trawl catches of blue whiting, transformed into numbers of specimens of each age groups 0-5+ years caught per hour trawling, together with corresponding temperature and salinity for the catch. The text table below shows the various items for each single trawl station in the datafile:

Country, species, cruise, date, haul no., ICES-rectangle, position, hour, depth, temperature, salinity, 0 year, 1 year, 2 year, 3 year, 4 year, 5+year, total numbers
as given in the following example:
Sp,blw,N92,120992,01,13E1,4214,0859W,1215,98,13.1,3584, 60,579,226,24,0,0,889

Only Spain and Norway supplied the biological data as age distributions for each station. The other countries gave length distributions when available, or just "empty" stations. Appropriate age-length keys were created for various quarters of the years and areas, and used to convert the length data into age groups from 0-5+ years. For this, Spanish data were used for the length distributions from southern areas and Norwegian data for distributions from northern areas, i.e. south and north of approximately 50° N.

From this material a database for blue whiting with around 6000 survey trawl stations collected from 7 countries, with corresponding temperature and salinity observations, has been created in ASCII format. The data are also recorded in EXCEL format and as SAS dataset. Using a SURFER graphic programme the data are plotted on maps for various aspects and combinations, such as distributions for each year group or total, for separate surveys, seasons, quarter of year or total. These are stored in a picture library for all distributional maps on blue whiting.

The data are plotted on maps for each half year, as numbers of blue whiting caught per hour separately of the age groups 0, 1, 2 and 3+ years. However, due to the long time series and consequently a large data base, only the years from 1989 to 1995 are presented on maps in the present paper. The distributions from earlier years, 1979-1986 are described in the text only.

The Norwegian surveys to the west of the British Isles were all acoustic assessment surveys with blue whiting as the main target. The spawning stock size was assessed, with mapping of the stock distribution and investigations on its age, length, sex and maturity composition. These annual results are given in e.g. Monstad and Midttun (1980), Monstad (1990), Monstad and Belikov (1991), Monstad et al. (1992, 1994, 1995). Trawl stations were performed to identify the echo recordings as well as to collect biological samples. A pelagic blue whiting trawl with vertical opening of 20-25 m and an innernet in the cod end of 11mm mesh size, were used, and in some cases also a bottom trawl (Rockhopper), when sampling on the shelf, i.e. in the Porcupine bank area.

The hydrographic observations were made by a CTD-sonde, both along standard sections and at a web of stations mostly in connection with the trawl stations.

RESULTS

Table 1 shows the various countries', laboratories' or institutes' contributions of blue whiting trawl survey data to the special SEFOS-database, by year and quarters of the year.

Most of the data originate from bottom trawl stations on the continental shelf, and only Norway had data also from pelagic trawl stations off the shelf in the northern part. These surveys were, however, all conducted during the spawning season only, and hence the data are from the oceanic part of the stock when it congregated along the shelf edge to spawn. The other data were obtained during various seasons, and they rather represent the "shelf-part" of the stock, which might be young fish and fish from local stocks. The two types of samples to a large extent fill in for each other when describing the pattern of distribution.

Due to a more or less constant movement of the stock while migrating to and from the spawning grounds, the picture of distribution varies from year to year depending on the time period and the actual area surveyed. However, it is not possible to obtain complete pictures of the distribution, but the jointed survey data from the various countries, give valuable information of the stock in a more complete way than before.

The 0-group blue whiting, however, were generally not caught during the first half year, and are hence present here for the second half year. But for 2 years, i.e. 1986 in the southern area and 1995 in the northern area, 0-group blue whiting appeared in the trawl catches, both years in June.

Distribution

For 1979 and 1980, only Norway contributed with data, i.e. data from 2nd. quarter of the year when surveying the spawning stock. In 1979 the area of investigation was limited to west of the Hebrides, but in 1980 it was extended southwards to the Porcupine bank west of Ireland. For either of these two years the young fish, i.e. the 1-group blue whiting, were present in a scattered way throughout the area surveyed, best recorded west of the Hebrides. The 2- and 3+ groups, however, were fairly well represented at St. Kilda west of the Hebrides, and in 1980 also at the Porcupine bank and north of Shetland.

In 1981 also Scotland contributed with data, starting a series of 1st quarter data every year up to 1994, and 4th quarter data from 1985 to 1995. 1-gr. blue whiting were also present in 1981, but in a rather scattered manner among the trawl stations. They appeared, however, in some numbers at the Rockall bank, at the slope north of Faroe Isles, and in the area between Faroe Isles and Shetland. The 2- and 3+ groups were found from North-Ireland to southern part of the Norwegian Sea.

In 1982 Scotland and Portugal contributed with bottom trawl survey data from 1st and 4th quarter respectively. No information of the stock beyond the shelf were available. In the 1st quarter only low numbers of blue whiting appeared in the catches from North-Ireland to north of the Hebrides, of which 1 and 2 year olds were found north of Ireland, and 3+

year olds west of the Hebrides.

In the 4th quarter of 1982 rather good numbers of both 0-group and 1-group blue whiting were caught on the western and the southern Portuguese shelf. The 2 year and the 3+ year olds were found in slightly lower numbers, but also throughout the area surveyed.

In 1983 Scotland and Norway performed surveys in the northern area in 1 and 2 quarter respectively, and Spain off its western and northern coasts in 3rd and 4th quarters. In the 1st half of the year a few 1-group blue whiting were found on the shelf north of Ireland and along the shelf edge west of the Hebrides, and in higher numbers between The Faroes and Shetland. Blue whiting, 1 group as well as 2 and 3+ groups, were also caught far offshore this year, i.e. west and southwest of the Rockall bank. The oldest blue whiting, the 3+ group, were numerous on the shelf from west of the Hebrides to north of Shetland. During the 2nd half of the year in the south, both 0, 1, 2, and 3+ years old blue whiting were found in rather significant numbers on the shelf off the Spanish coast.

For 1984 data were available from Scotland, Norway and Spain in the 1st, 2nd and 3rd quarters respectively. In the north all the three groups of blue whiting, i.e. 1, 2 and 3+ year olds, were found off the shelf from south of the Porcupine bank to the Faroe-Shetland area, the 2-group, i.e. the 1982 yearclass, being the most numerous one in the trawl catches. In the south the picture was very much the same as in the 3rd quarter of 1983, with 0-, 1-, 2- and 3+ year olds found in the catches along the entire western and northern coasts of Spain.

In 1985 Scotland contributed with data from the 1st quarter from the northern area, i.e. the shelf from North-Ireland to the Orkneys, and the 4th quarter from the shelf from South-Ireland to the Orkneys. Portugal and Spain contributed with data in the 3rd and 4th quarters from the shelf off their northern, western and southern shelves. No data were available from the stock beyond the shelf area.

In the north during the 1st quarter only modest numbers of blue whiting were found in the catches in 1985, with 1-group found in highest number west of the Hebrides. During the 4th quarter some 0-group of blue whiting were found both west of the Hebrides and in the Minch. The other yearclasses were only poorly represented in the catches.

In the south during the 3rd and 4th quarter rather good numbers of all the age groups were represented, found on the entire shelf area surveyed.

In 1986 data from 1st, 2nd and 4th quarters were available in the north and from 2nd, 3rd and 4th in the south. 1-group blue whiting were caught in the 1st and 2nd quarters from the Porcupine bank area to Shetland, the highest numbers found in the trawl catches between The Faroes and Shetland. The 3+ group were, however, more frequent in the catches, found in almost all the off-shelf trawl stations. In the south during the 2nd quarter (in June) 0-group, as well as 1, 2 and 3+ group, were caught on most of the Portuguese shelf.

During the 4th quarter only very small numbers of blue whiting were found in the northern shelf area, while in the south during the 3rd and 4th quarters 0-group as well as the other

groups were found on the northern and western Spanish shelves.

In 1987 five countries contributed with trawl data to the data base. During 1st and 2nd quarters, Scotland and Norway in the north with data from the shelf and off the shelf respectively, as marked on Figure 1a. During the 4th quarter, Scotland in the north and France, The Netherlands and Portugal in the south as marked on Figure 2a.

During 1st and 2nd quarter 1-group blue whiting were found on the southern part of the Porcupine bank and off the Hebrides and NW of Shetland, mostly off the shelf, and also at one station off the western Norwegian coast (Figure 1b). During the 4th quarter 0-group blue whiting as well as 1-group were found in the north, from the English Channel to west of Shetland, mostly in the western part of the Channel, but also off the Hebrides. The highest numbers, however, were caught in the southern area in the 4th quarter, in Bay of Biscay off the French coast and on the Portuguese shelf (Figure 2a-b). Older fish were more abundant in north during the 1st half of the year, and more abundant in the south during the 2nd half of the year.

In 1988 six countries conducted surveys, i.e. 3 surveys in the 1st half of the year and 5 surveys in the 2nd half; Scotland and France conducting surveys in both periods (Figures 3a and 4a).

In the 1st half of the year in the northern area, the 2- and 3+ groups were found more or less evenly distributed from the Porcupine bank to The Faroes, while 1-group were more scattered, i.e. west of South-Ireland and off the shelf from west of the Hebrides to the Faroe-Shetland area, and at 2 stations near Rockall. All of the age groups 0-3+ were caught on the shelf off the French coast in bay of Biscay, with the youngest ones, the 1- and 2-groups mostly at the outermost stations at the edge, while 3+ group were caught both at the outer stations and at the inner stations near the coast (Figure 3).

During the 2nd half of the year 0-group blue whiting were caught both in north and south. It was found in the Celtic Sea, near the coast west of Ireland, off the Hebrides and off Shetland. In the south, the 0-group was still found in Bay of Biscay off the French coast, continuing further along the shelves of the Spanish and the Portuguese coasts. The 1-group had a very much similar distribution, but in a lesser degree in the north than the 0-group.

Older age groups were found scattered on the shelf in the northern area, with only small catches on 3 stations west of the Hebrides and 1 west of Shetland. In the south, the occurrence of older age groups were better, being caught on the shelf from the Channel to South-Portugal (Figure 4).

From 1989 to 1992 all the seven countries contributed with blue whiting trawl data, either for the 1st half of the years, the 2nd half or for both (Table 1). During the 1st half of the years in this period, the coverage of the entire shelf edge area from Shetland to South-Portugal, was not complete for any year (Figures 5,7,9 and 11). During the 2nd half of these years there were complete coverages of the shelf, except or 1991 (Figures 6,8,10 and 12). In addition Norway extended the area from 1989 onwards, by contributing with data from North Sea surveys in the 2nd half of these years. These were, however, from bottom trawl surveys. In 1989 the shelf area off the Norwegian coast northwards to 71°N was

also surveyed, both with bottom and pelagic trawls. (Figures 13-16).

During the 2nd half of the years, 0-group was caught every year over rather large areas in the south, i.e. mainly from southwest of Ireland to South-Portugal. In the area north of the Porcupine bank, 0-group was most of these years caught only at a few stations (Figures 6a, 8a, 10a and 12a).

In 1989, however, rather large numbers were also caught in the north during the second half of the year, i.e. in notable numbers off the Hebrides in November (Figure 6a), and further also in Norwegian waters, both in the North Sea and northwards along the shelf up to Lofoten at 69°N (Figure 13). For the years 1990-1992, 0-group blue whiting were also caught in the North Sea surveys during October, but at lower numbers (Figures 14-16). Unfortunately no blue whiting surveys were conducted northwards along the Norwegian shelf these years.

During the 1st half of 1989 the 1- and 2-groups were found in notable numbers off the shelf west of the British Isles northwards to the Hebrides, and to a lesser degree at some stations in the Bay of Biscay (Figures 5b and c). During the 2nd half of 1989 these 2 age groups, however, were found to be more abundant in the south, being found in the Celtic Sea and in the western part of the Channel, and further southwards on the shelf to the southern coast of Portugal (Figures 6b and c). The oldest age groups, 3+ year, were most abundant off the shelf from the Porcupine bank to the Hebrides in the 1st half of the year, and with lower numbers but more frequently at stations in the Bay of Biscay and further southwards to the Portuguese shelf (Figures 5d and 6d).

The 1- and 2-groups during the 1st half of the years 1990-1992, were mostly found off the southwestern coast of Ireland, and in 1991 when a lot more stations were worked, also in the Celtic Sea and further southwards along the French coast. (Figures 9b and c). The older blue whiting in 1st half of these years were found much in the same pattern as in 1989, but also north of Scotland. In 1991 they were also caught in the Celtic Sea and in the Bay of Biscay, as the younger age groups were, but in 1992 they were not obtained off the shelf, as would be usual, because no stations were worked there.

During the second half of the years 1990-1992, most blue whiting were found in the southern area. Except for 1991 the entire shelf area from North of Scotland to south of Portugal was surveyed (Figures 8-12).

In 1993 six countries contributed with blue whiting survey data, in 1994 all the seven countries and in 1995 five of the countries. Only modest numbers of 1-group were caught in the first half of these years, both in the north and in the south. (Figures 17b, 19b and 21b). The 2- and the 3+ groups were caught rather in low numbers in 1994, and in high numbers in 1993 and 1995, especially the 3+ group for both of these years (Figures 17cd, 19cd and 21cd).

0-group blue whiting, however, was in 1995 for the first time ever recorded, caught by trawl in the northern area during the first half of the year. It was caught with pelagic trawl along the continental slope in June, at one station south of Ireland, and in significant numbers at stations from NW of Ireland to NW of the Hebrides (Figure 21a). This was the

first indication of the 1995 yearclass as a very numerous one.

During the 2nd half of the years, the 0-group was rather numerous in the southern area from Ireland to South-Portugal in 1994 and 1995, and along the Spanish and Portuguese coasts in 1993. In the northern area it was found from south of Ireland to north of the Hebrides in 1993 and 1995, in the latter in significant numbers. In the north the other age groups were only found in relative modest numbers all the three years, while in the south they were as usual caught in notable numbers along the shelves of France, Spain and Portugal in 1994 and 1995, the latter year having the highest numbers, and off the Spanish and Portuguese coasts in 1993 (Figures 18,20 and 22).

Blue whiting were also caught, with bottom trawl, in the North Sea during the 2nd half of these years. In 1993 0-group was caught in the Norwegian Trench at a few stations only (Figure 23a), in 1994 in modest numbers at more stations (Figure 24a) and in 1995 in significant numbers at many stations from south of Bergen (at 60°N) to Kattegat (Figure 25a). Also the 1-group was best represented in this area in 1995. Except for 1993 the 1- and 2-groups were notably abundant in the Norwegian Trench these years. Blue whiting as a whole were, however, caught in significant numbers (Figures 23,24 and 25).

The general impression of the presented data is that most years the abundance of blue whiting is apparently higher in the southern area than in the northern. The number of stations worked is highest in the south, and hence blue whiting seem to be more frequent there. However, when blue whiting are caught in the north, especially in the 1st half of each year, the numbers are in most cases significantly higher than in the south.

The migratory behaviour causes the appearance of blue whiting in the northern area, i.e. west of the British Isles, during spring when the mature part congregates there to spawn. In the 2nd half of each year the stock has returned to the feeding grounds, either northwards or southwards, and the majority of the larvae and later the 0-groups have likewise drifted northwards or southwards.

The southern area, i.e. the shelf area from the Channel to Gibraltar, is to a larger extent a nursery area, where the majority of the southwards drifting larvae ends up, while the shelf area in the north remains an area with specimens mostly belonging to local populations. The northwards drifting larvae end up in areas where the survey frequency is much lower, i.e. mainly in Faroese waters, in the Norwegian Trench and further north along the Norwegian coast, and hence the catch frequency of blue whiting is much lower than in the south. In addition there are also local stocks on the shelves, both in the north and the south.

As mentioned earlier it is not possible to get a complete picture from the trawl station results alone, as the number of stations and their distribution are mostly in disaccordance with the blue whiting's abundance and availability.

The blue whiting data of the years 1989-95 were set up as numbers by age of fish caught per hour for each year in relation to the total number of stations worked (Figure 26), but no clear relation with the yearclass abundance level known from other sources, i.e. VPA-runs and catch statistics (Anon., 1996), could be established. For most of these years the

values of the 0-groups were higher than for other age groups, something which could be explained by the high number of trawl stations in the south where 0-group were frequent. Furthermore, the well known very abundant 1989 yearclass obtained lower values as 0-group than the much poorer 1991 and 1992 yearclasses did, and the very rich 1995 yearclass lower value than the 1994 yearclass.

The maps merely show the geographical distribution of blue whiting within the shelf edge area from Gibraltar to the Norwegian Sea, and its level of occurrence in the survey trawl catches, but to a certain degree could also reflect the yearclass strength.

Norwegian blue whiting surveys

As mentioned above, the Norwegian surveys to the west of the British Isles, were all acoustic assessment surveys with blue whiting as the main target. Trawling is performed for identification and sampling of blue whiting and actually much more often on high concentrations than on weak ones. The trawl stations therefore to a certain degree may represent an indication of abundance in the concentrations recorded, but will never give the precise picture. They rather supplement the picture obtained by acoustic recordings.

As an example of the acoustic blue whiting surveys the cruise track and stations in spring 1995 are shown on Figures 27, and the distribution with relative abundance on Figure 28. An example of blue whiting echo recordings is shown on Figure 29.

The majority of the trawl stations were worked in deep sea areas off the shelf, and hence represent the oceanic part of the blue whiting stock. In spring the mature part of it, migrating from south and from north, congregates along the continental slope to spawn, and then returns northwards to its feeding areas in the Norwegian Sea, and partly also southwards from the Porcupine bank area. This more or less constant movement of the spawning stock to and from the spawning area, where also younger and immature age groups partly follow, causes difficulties in timing the surveys to the optimal period for the spawning stock within the area to be surveyed. The variability in survey estimates therefore may be caused by this, in addition to weather conditions and progress of the gonad maturation and spawning, which again may be influenced by the hydrographic situation.

The Norwegian spring surveys, from 1979-1995 except for 1982 and 1985, were conducted in March to May. Due to short cruise time and very rough weather, only few stations were worked in 1979. The earliest survey was conducted 1981 and the latest one in 1979 (Figure 30).

A scatterplot of the stations' latitudinal positions versus year is shown on Figure 31. A south-bound tendency can be observed in the 1980's, with the location being more or less stabilized after 1988.

Plots for age groups 1, 2 and 3+ through years are presented in absolute numbers on Figures 34 and in proportion of the total on Figure 35. Age 1 is obviously more present (in absolute numbers as well as in proportion) in the northern and in the southern parts of the survey areas, and less present in the middle. This tendency also exists, but to a lesser extent for age 2. The adults, i.e. age 3 years and older, are more evenly distributed over

the whole area. There is, however, a shift to the South from the mid-80's onwards, as can be observed on Figure 34c, where the concentrations' center of gravity is marked.

The three years old and older are rather uniformly distributed, but with a decreasing tendency northwards. The rich 1989 yearclass is significantly visible, especially as 2 year olds in 1991. Also to be noted are the large numbers of 1 year olds in 1987 and 1995, indicating the strength of the yearclasses 1986 and 1995. The 3 year olds and older were also numerous in 1983, 1989 and 1992.

The representative temperatures and salinities for each trawl station at 200, 300, 400, 500m and at catch depth, were analysed for the years 1979-1985, except for 1982 and 1985 when data were not available. Scatter plots of the temperature and salinity at the catch depth versus year are shown on Figures 32 and 33 respectively.

For illustration of the blue whiting concentrations in relation to the hydrographical conditions, the echo recordings of blue whiting along a vertical section over the Porcupine bank (latitude 53°30'N) and the temperatures and salinities in spring 1995, are shown on Figures 36a and b.

The temperature generally increases with salinity, and increases to the south, and is lower and more variable north of 59°N (off northern Scotland), where the pattern changes: The temperature at catch depth is increasing from 8° to 11° C southwards and decreasing from 8° to 2° C northwards; the salinity at catch depth, being generally between 35.20 and 35.60‰, decreases to 34.80‰ north of 59°N.

Plots of T-S values at catch depth for the whole period 1980-95 are shown on Figure 37, indicating the type of water where the bulk of blue whiting appears. T-S diagrams for each year are shown on Figure 38. A fitted line for the points is drawn for the average of all the years.

The main features of this figure are the following: The T/S diagrams for 1980, -81 and -83 are quite unusual. In 1983 and 1980 the salinities are low while the temperatures are not so low; in 1981, when the survey period was early, the temperatures are low, but not the salinities. In addition, the year 1990 show particularly high salinities with relatively high temperatures, something which is in agreement with the maximal salinity in Atlantic water in the Faroe-Shetland Channel, as the annual mean at two standard sections between The Faroes and Shetland (With courtesy of the Marine Lab. Aberdeen, Bill Turrel, pers. comm.), and also with conclusions drawn by Hansen and Jakupsstovu (1992) that a strong influx of Atlantic water took place in 1990. However, no relation appears which could explain the good recruitment for the years 1983, -89 and -95.

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Table 1. Survey trawl data of blue whiting, 1979-95 by country and quarter of year.

Year	IFREMER Nantes, France			IEO Vigo, Spain			RIVO, IJmuiden Netherlands			IPIMAR Lisboa, Portugal			SOAFD, Aberdeen Scotland			IMR Bergen, Norway			IFS-BFF Hamburg, Germany		
	Q	Fish/h	St.N	Q	Fish/h	St.N	Q	Fish/h	St.N	Q	Fish/h	St.N	Q	Fish/h	St.N	Q	Fish/h	St.N	Q	Fish/h	St.N
1979																2	52573	8			
1980																2	236626	49			
1981													1	1242	38	1,2	36436	28			
1982										4	1183172	189	1	3424	30	n.a.					
1983				3,4	408056	111							1	7375	47	2	1203692	29			
1984				3	499889	95							1	20	12	1,2	147479	31			
1985				3	479503	97				4	318574	150	1,4	3434	103	n.a.					
1986				3,4	387567	92				2,3	104889	118	1,4	191	55	1,2	50540	13			
1987	4	1110262	131	n.a.			4	73204	41	4	532456	82	1,4	474	86	1,2	375682	23			
1988	2,4	799859	270	3,4	1026803	102	4	15299	40	4	453152	98	1,4	29366	93	1,2	189485	49			
1989	3,4	288545	142	3,4	368331	92	4	56061	55	3,4	565355	252	1,4	82340	96	1,2,4	747721	208	2	55123	46
1990	3,4	390980	193	3,4	432813	122	4	3386	51	3,4	737580	221	1,4	5166	90	1,2,4	105359	132	1	61278	21
1991	2	119981	199	3,4	852462	108	4	33680	42	3,4	559450	203	1,4	39109	105	1,2,4	248352	146	1	135474	34
1992	3,4	347961	171	3,4	254731	118	4	80206	36	3,4	361835	228	1,4	902	80	1,2,4	375879	138	2	201795	60
1993	n.a.				96901	110	4	13729	44	1,4	158763	207	1,4	20545	85	1,2,4	137988	167	1	9974	24
1994	3,4	1431049	156		364311	120	4	76064	48	4	338211	88	1,4	17015	79	1,2	49771	125	1	6	2
1995	4	513308	114		345373	122				3,4	438411	169	4	210309	105	1,2	2397302	191	n.a.		
Total		5001945	1376		5516740	1289		351629	357		5751848	2005		420912	1104		6354885	1337		463650	187

St.N: Number of stations

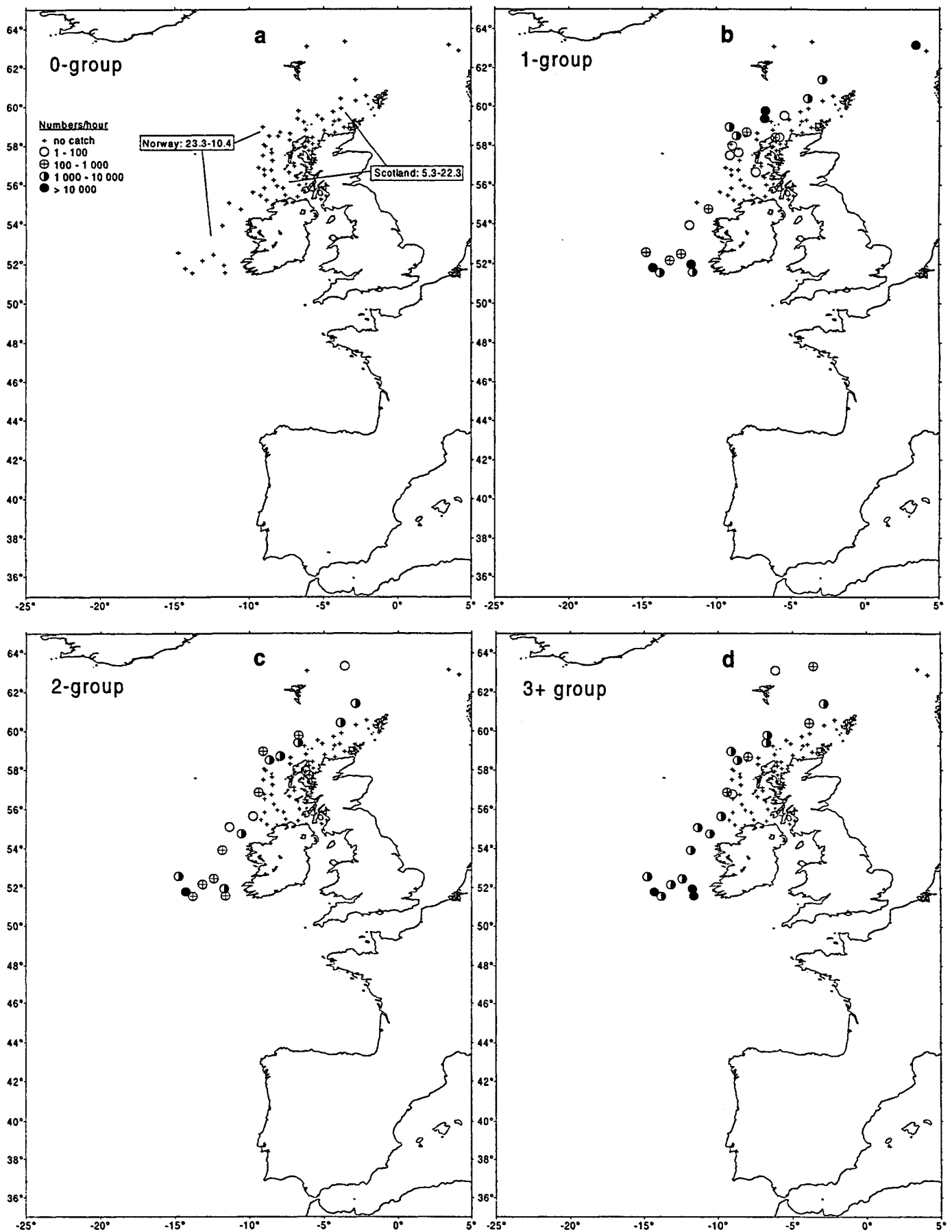


Figure 1. Survey trawl stations and catch of blue whiting (N/hour) in 1st half of 1987.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

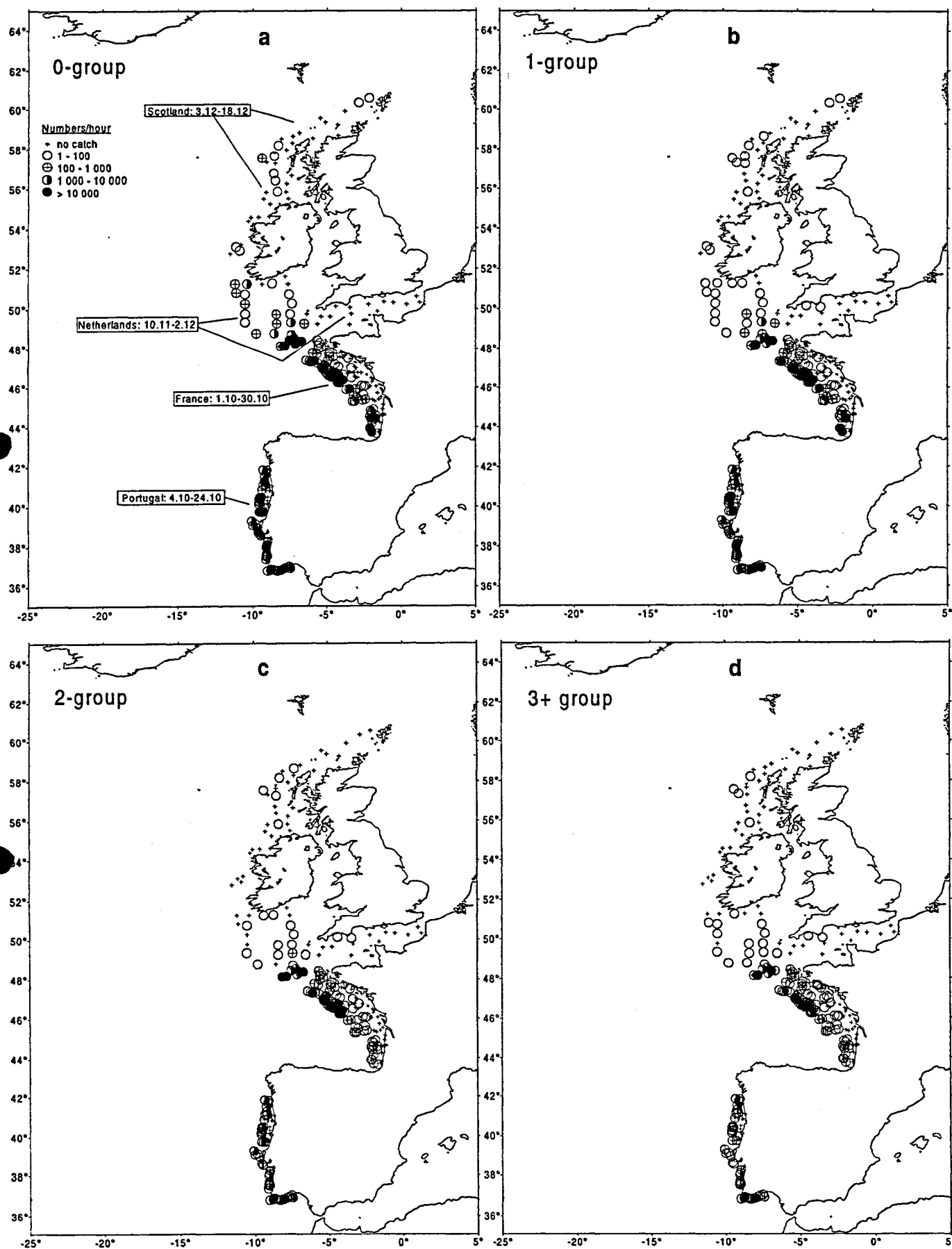


Figure 2. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1987.
 a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

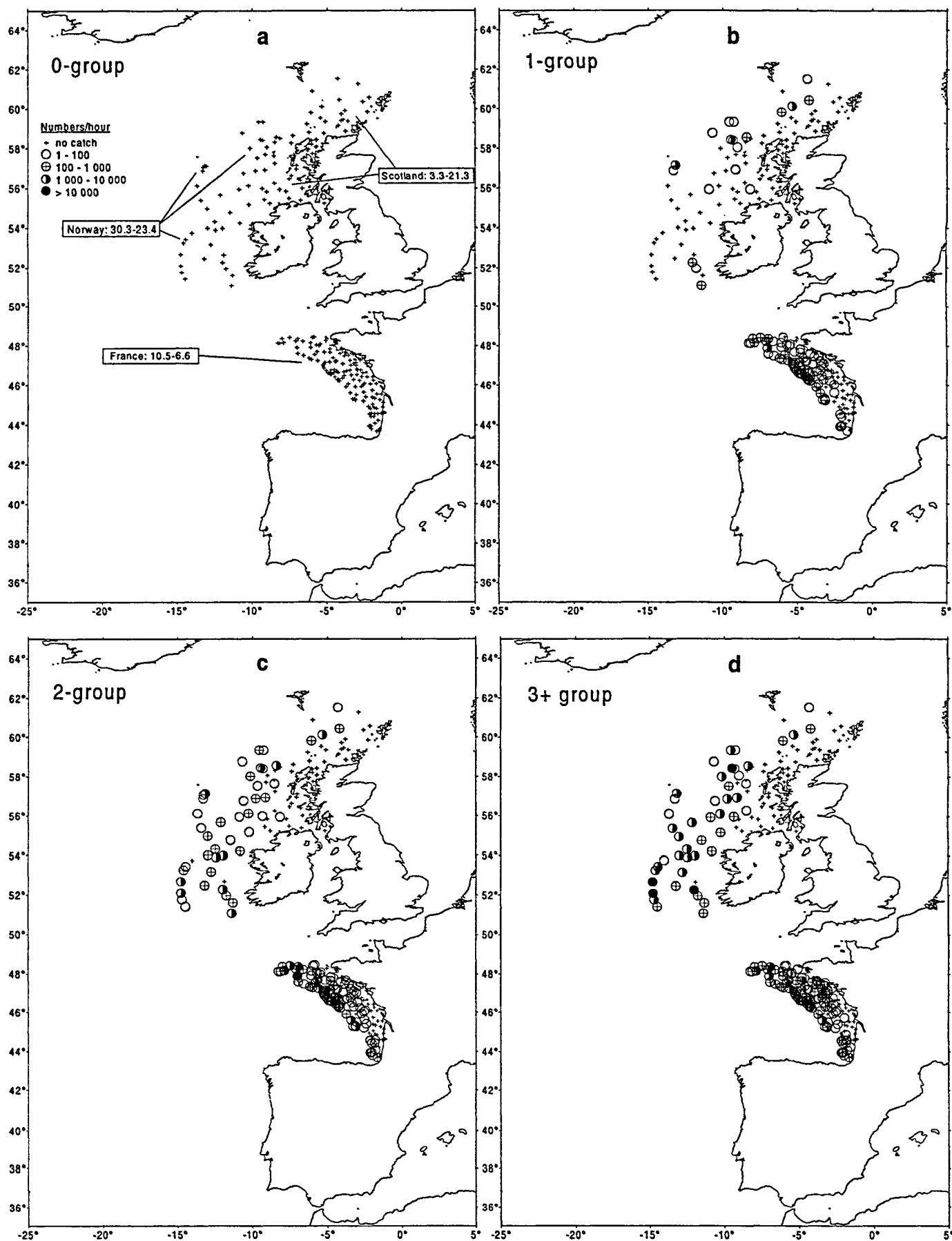


Figure 3. Survey trawl stations and catch of blue whiting (N/hour) in 1st half of 1988.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

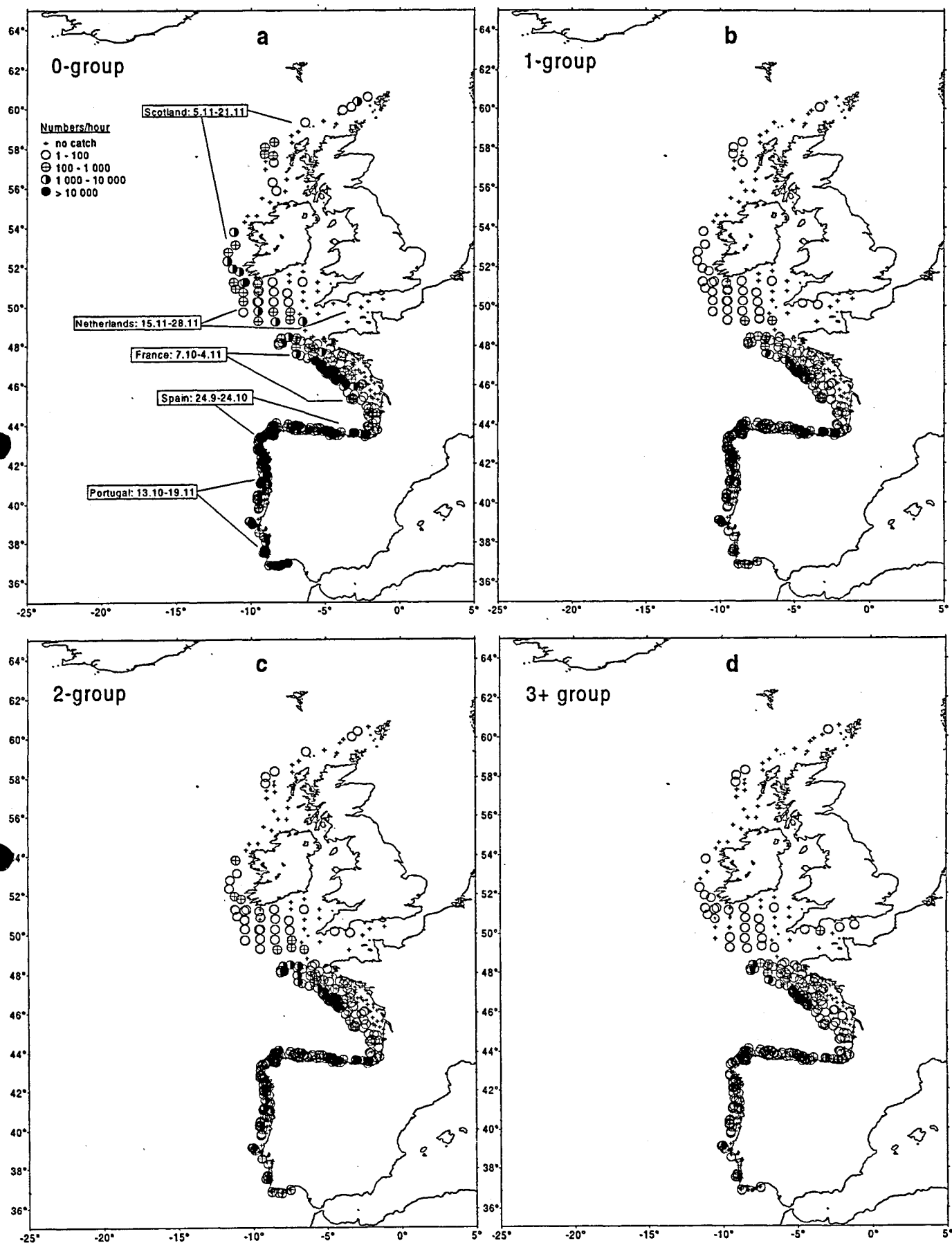


Figure 4. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1988.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

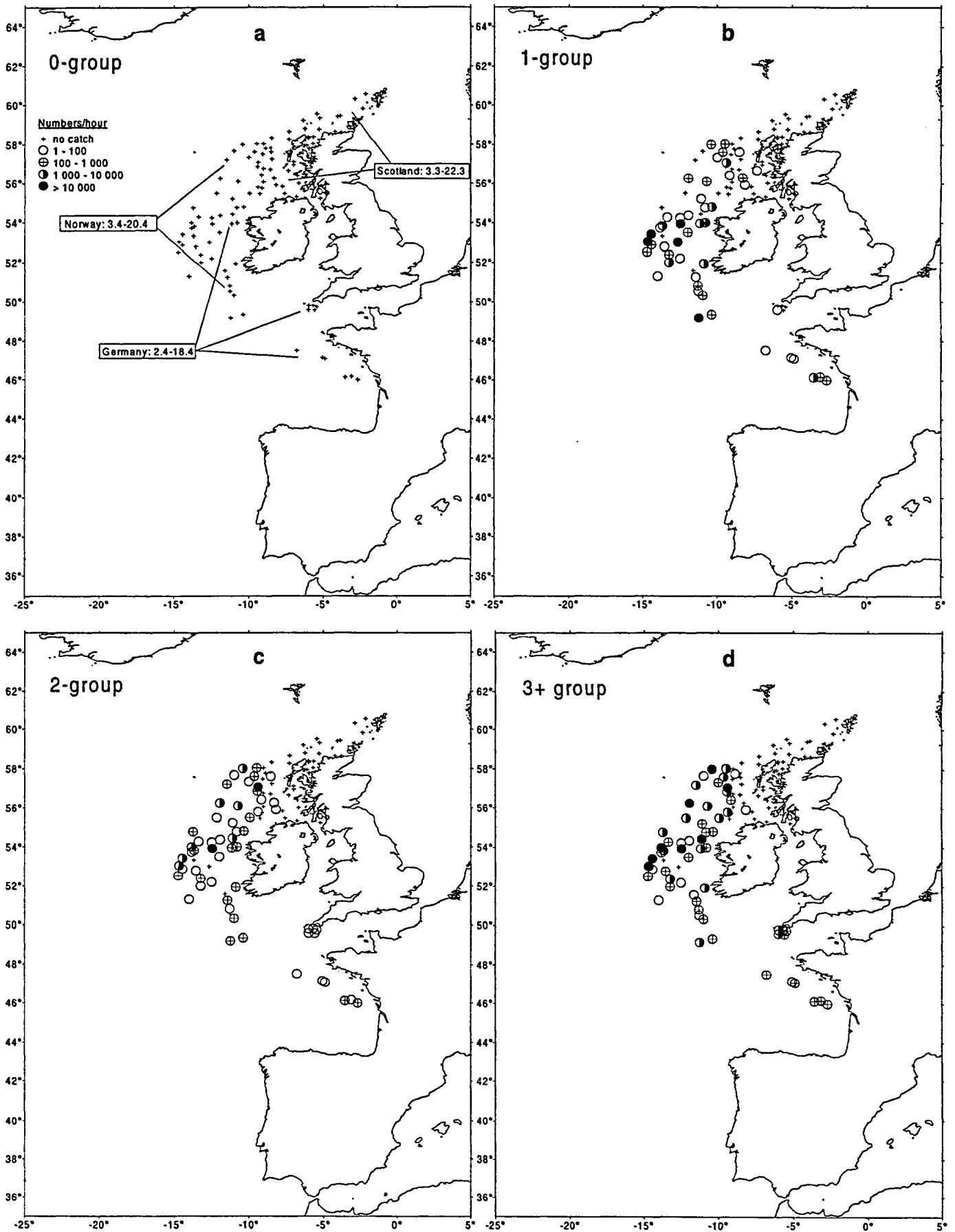


Figure 5. Survey trawl stations and catch of blue whiting (N/hour) in 1st half of 1989.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

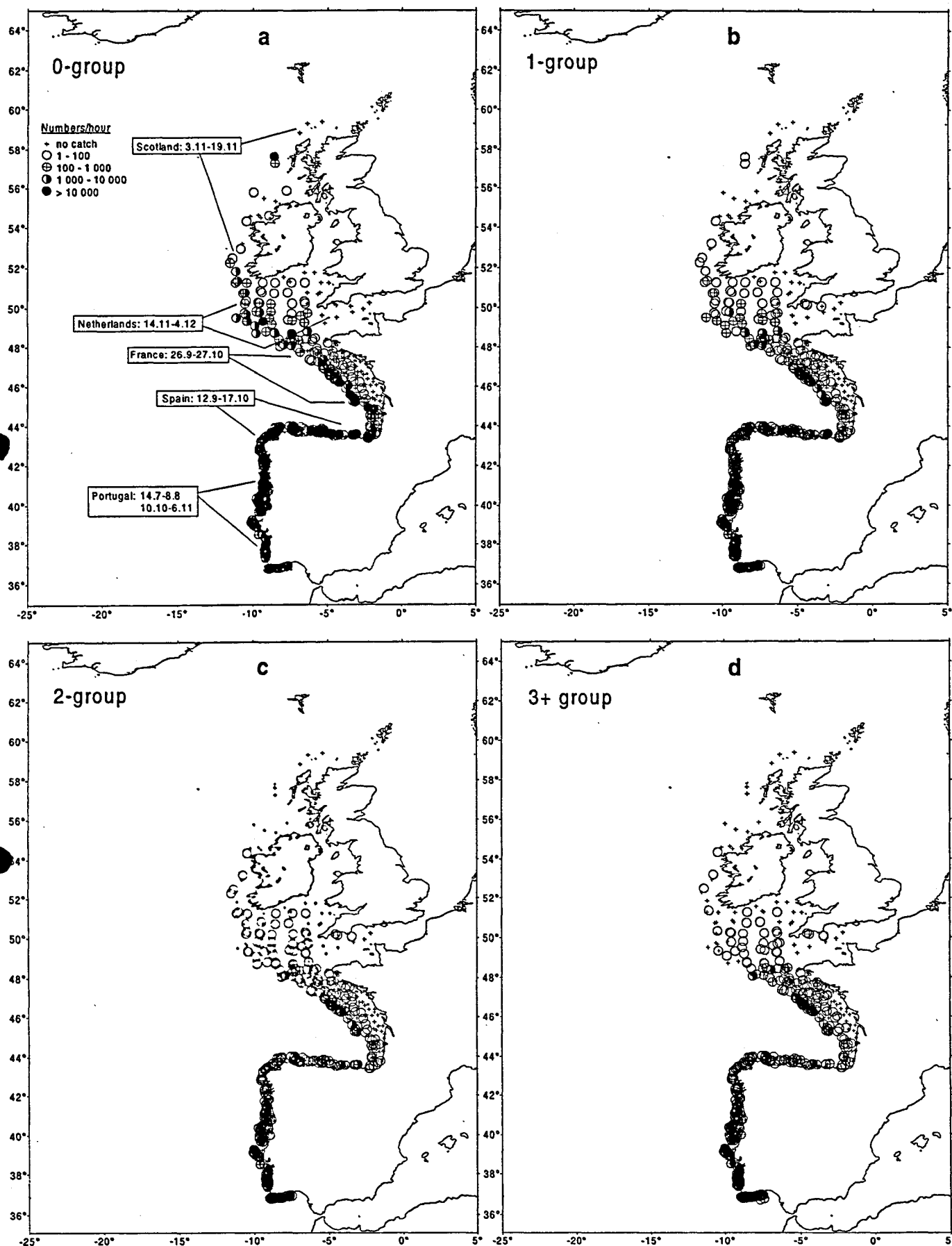


Figure 6. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1989.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

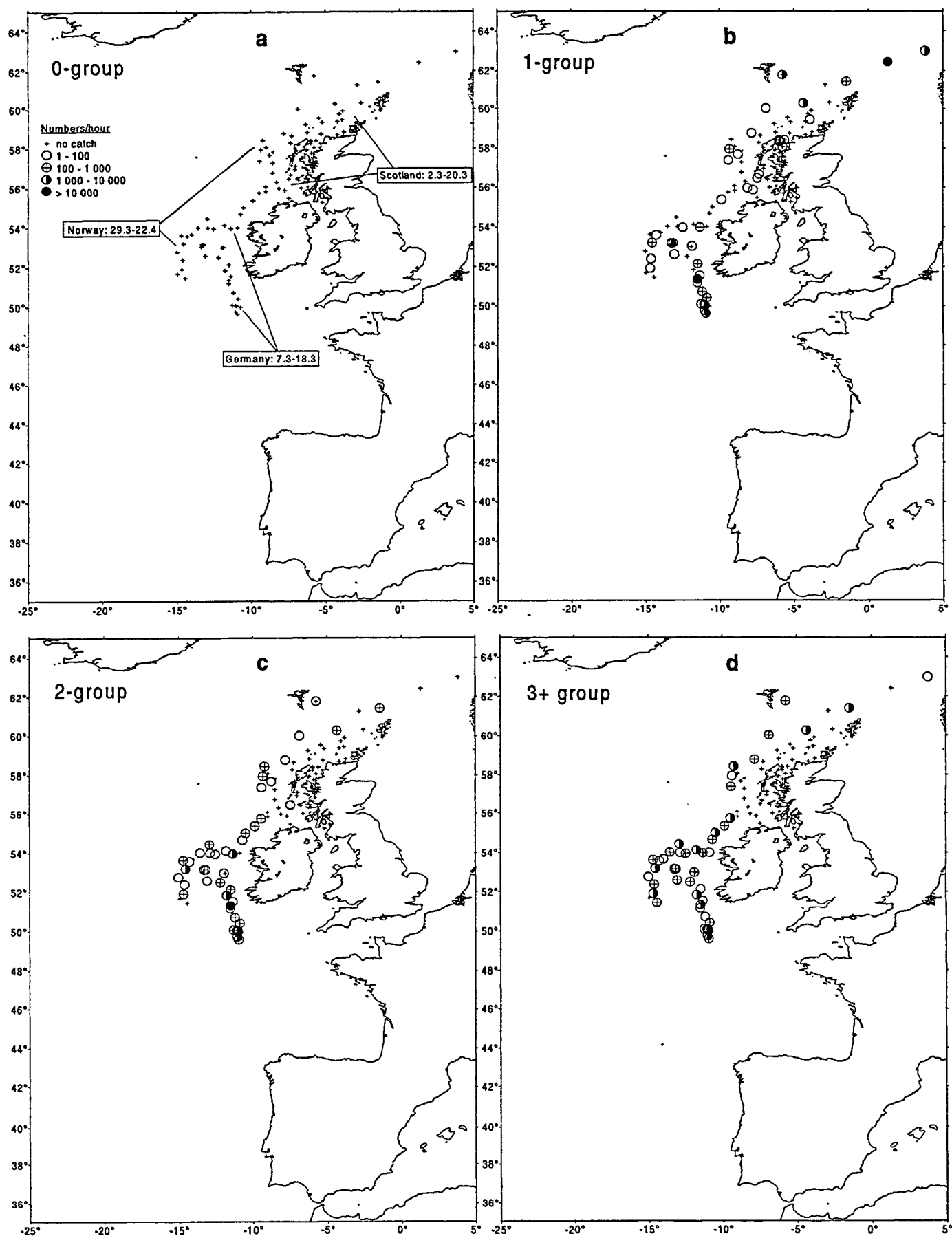
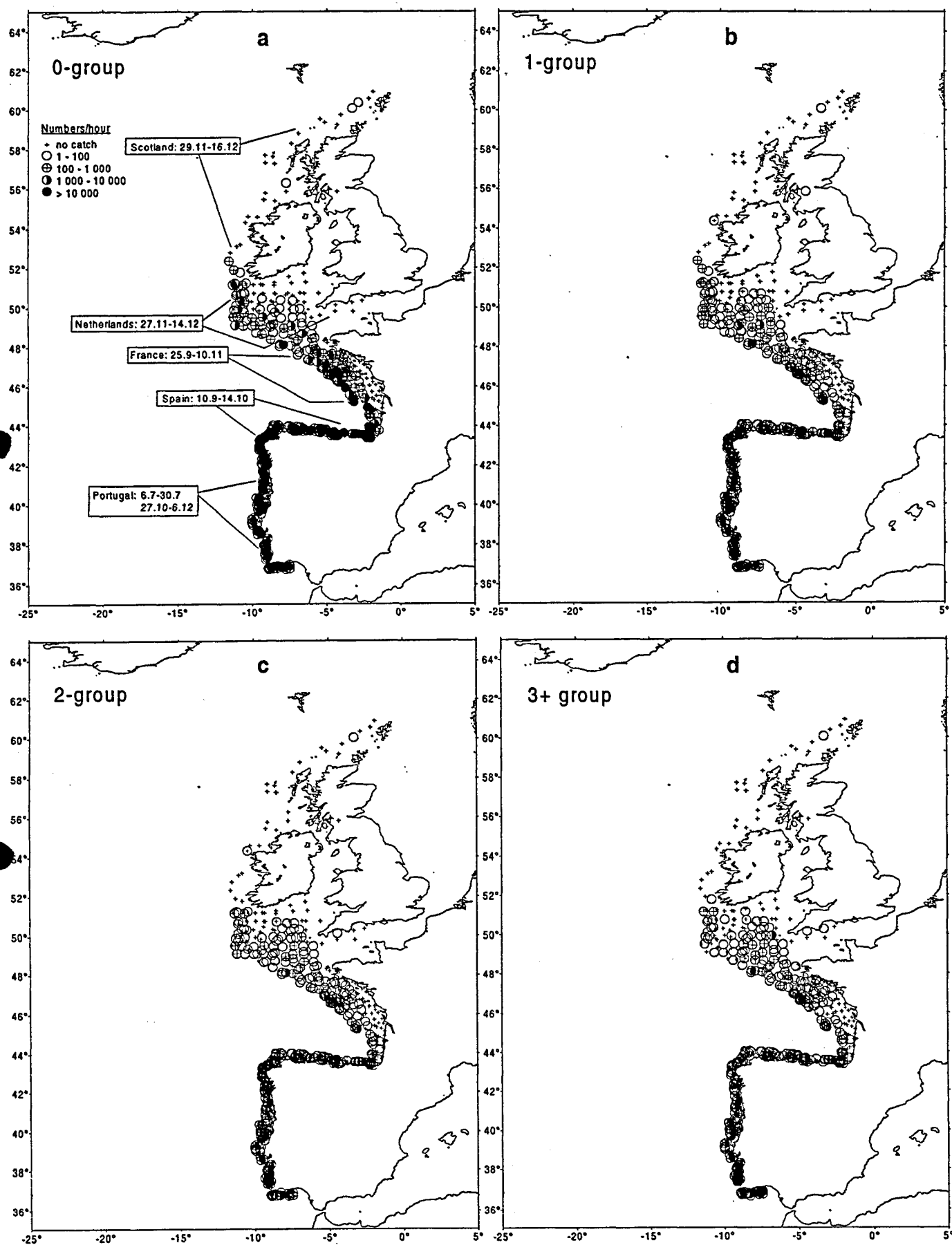


Figure 7. Survey trawl stations and catch of blue whiting (N/hour) in 1st half of 1990.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.



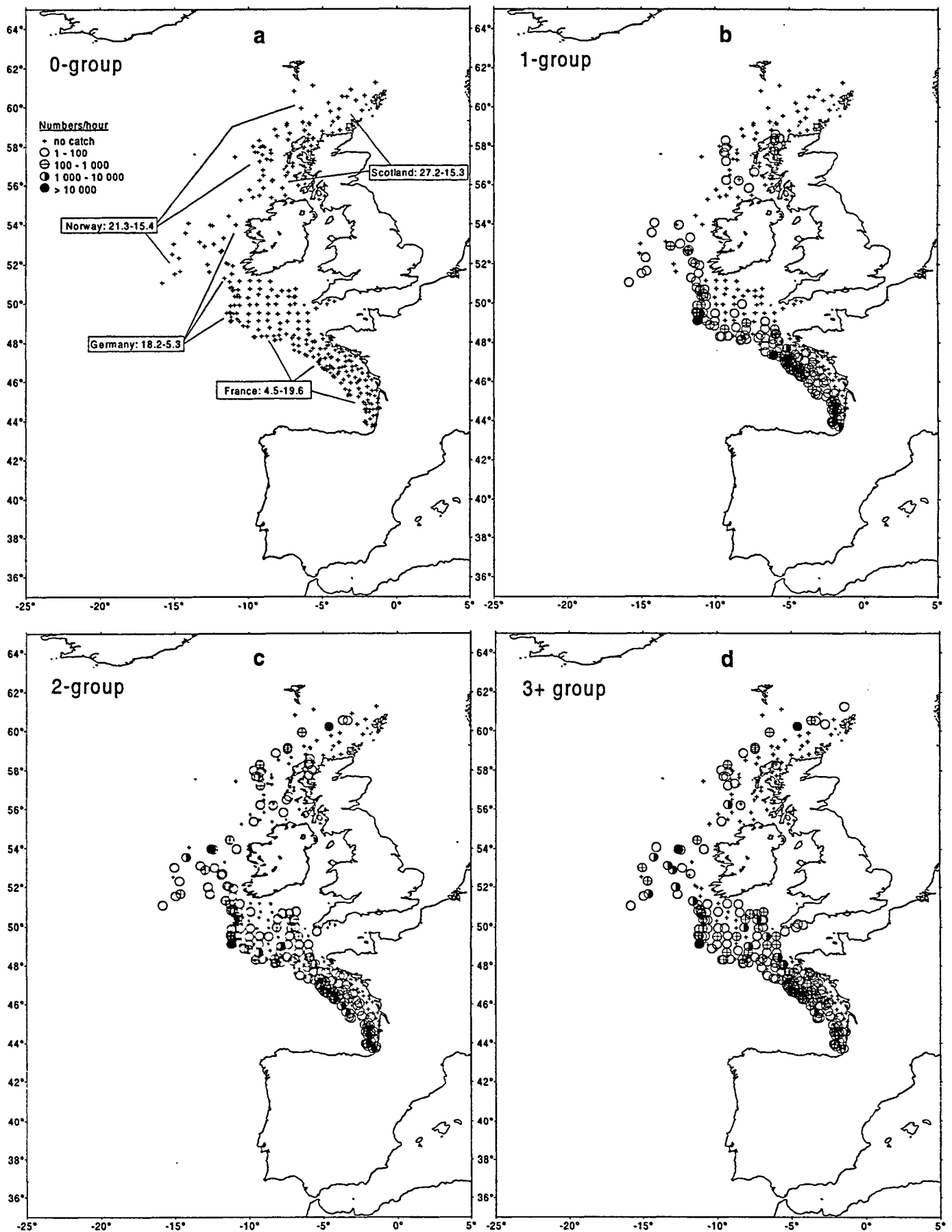


Figure 9. Survey trawl stations and catch of blue whiting (N/hour) in 1st half of 1991.

a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

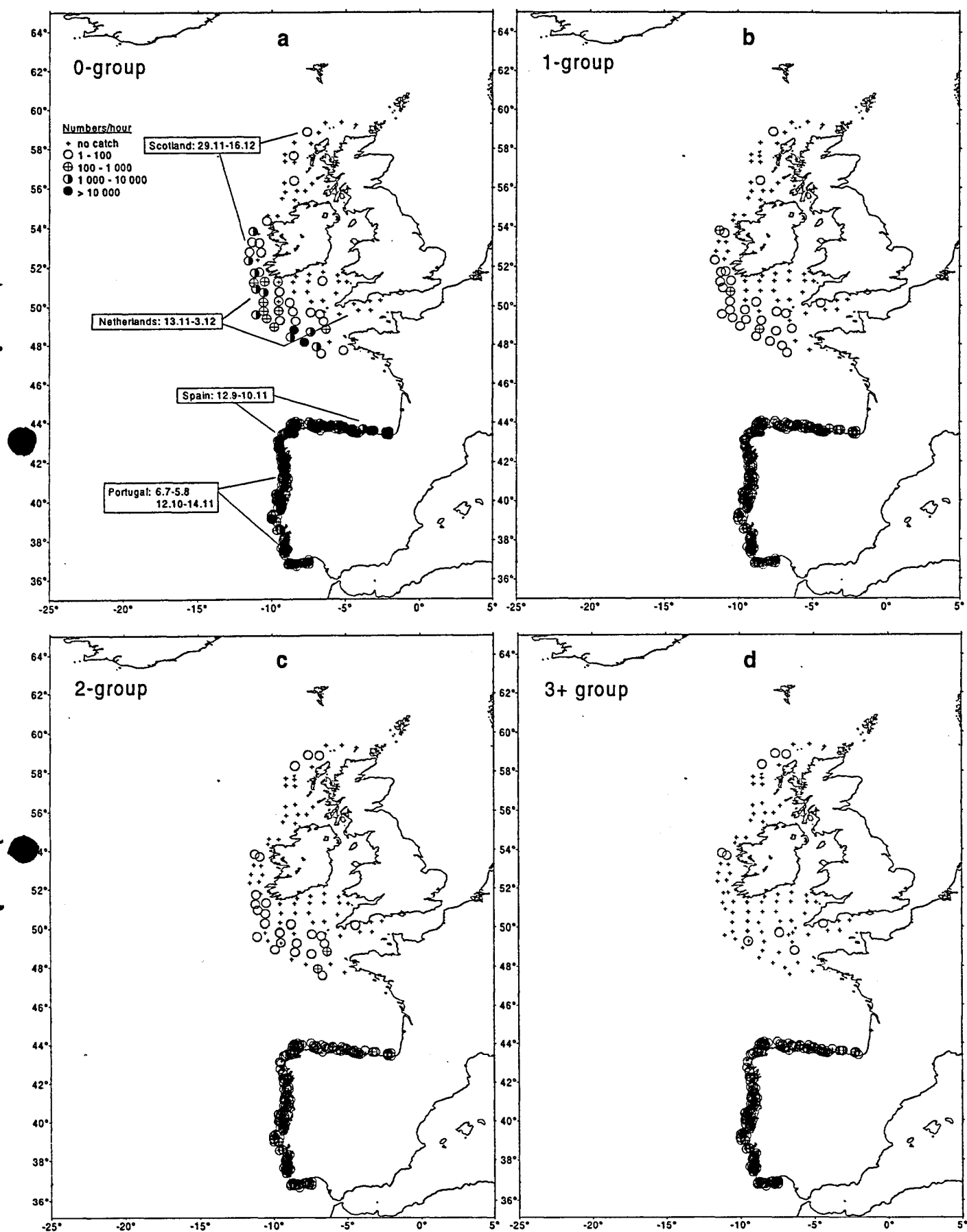


Figure 10. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1991.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

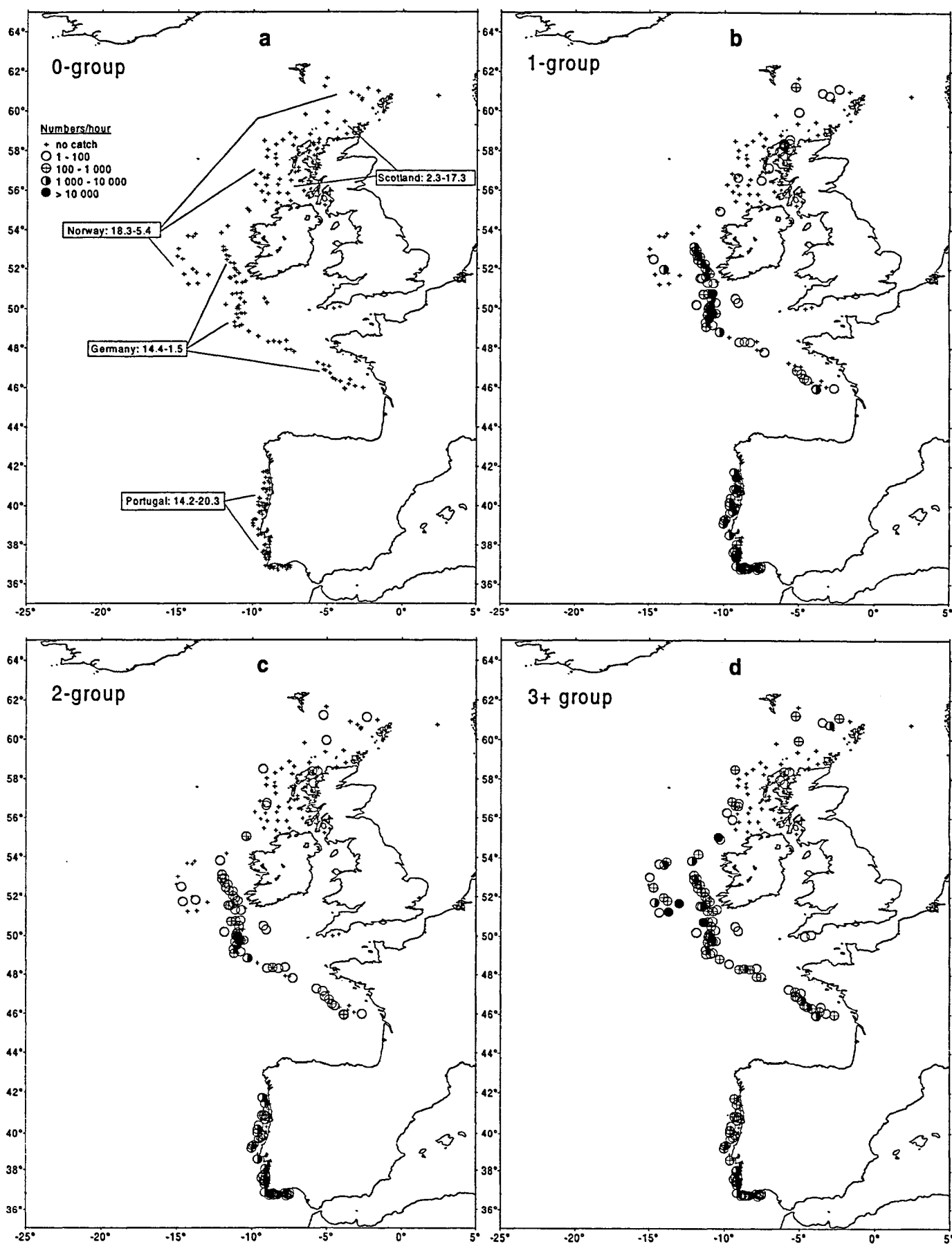


Figure 11. Survey trawl stations and catch of blue whiting (N/hour) in 1st half of 1992.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

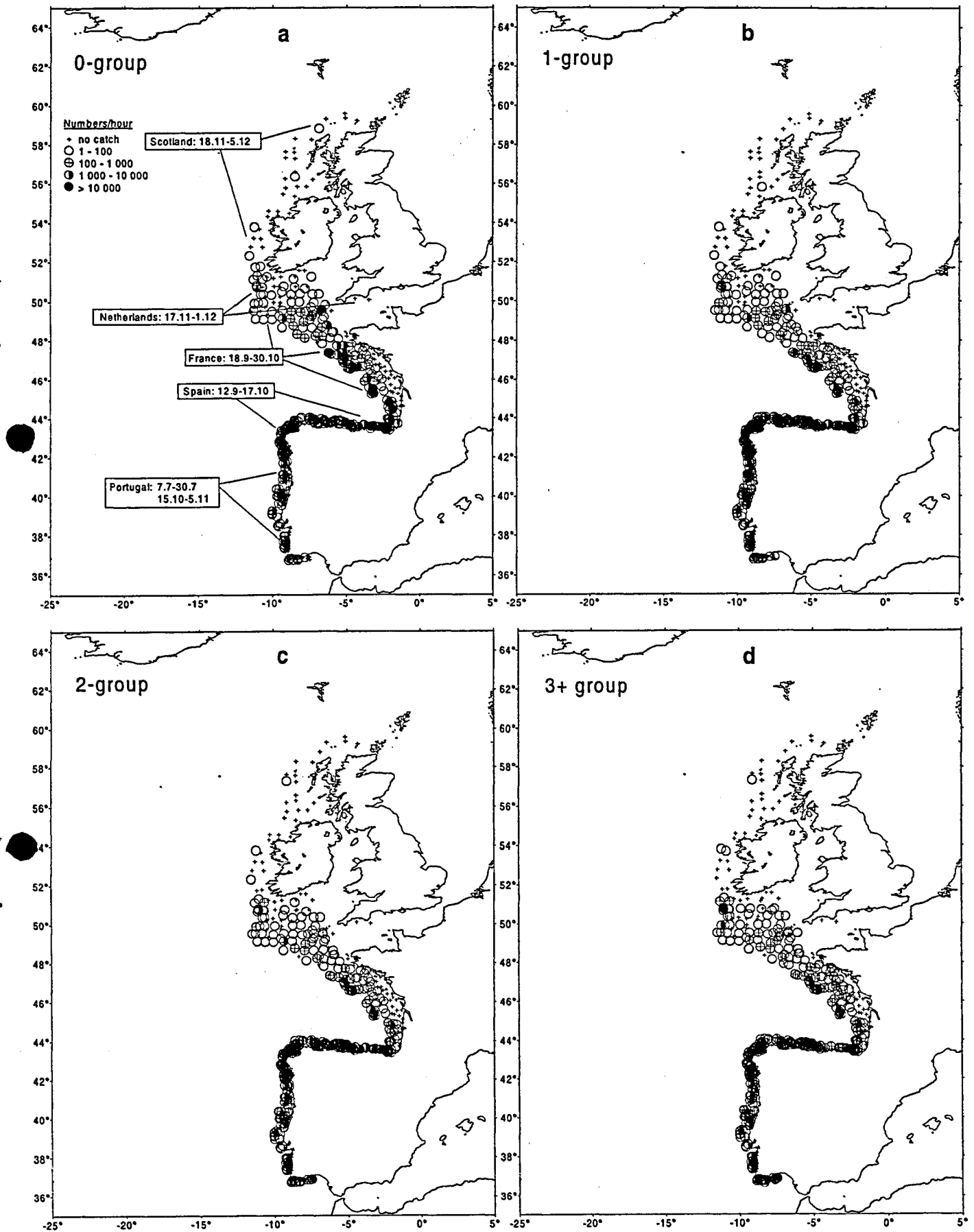


Figure 12. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1992.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

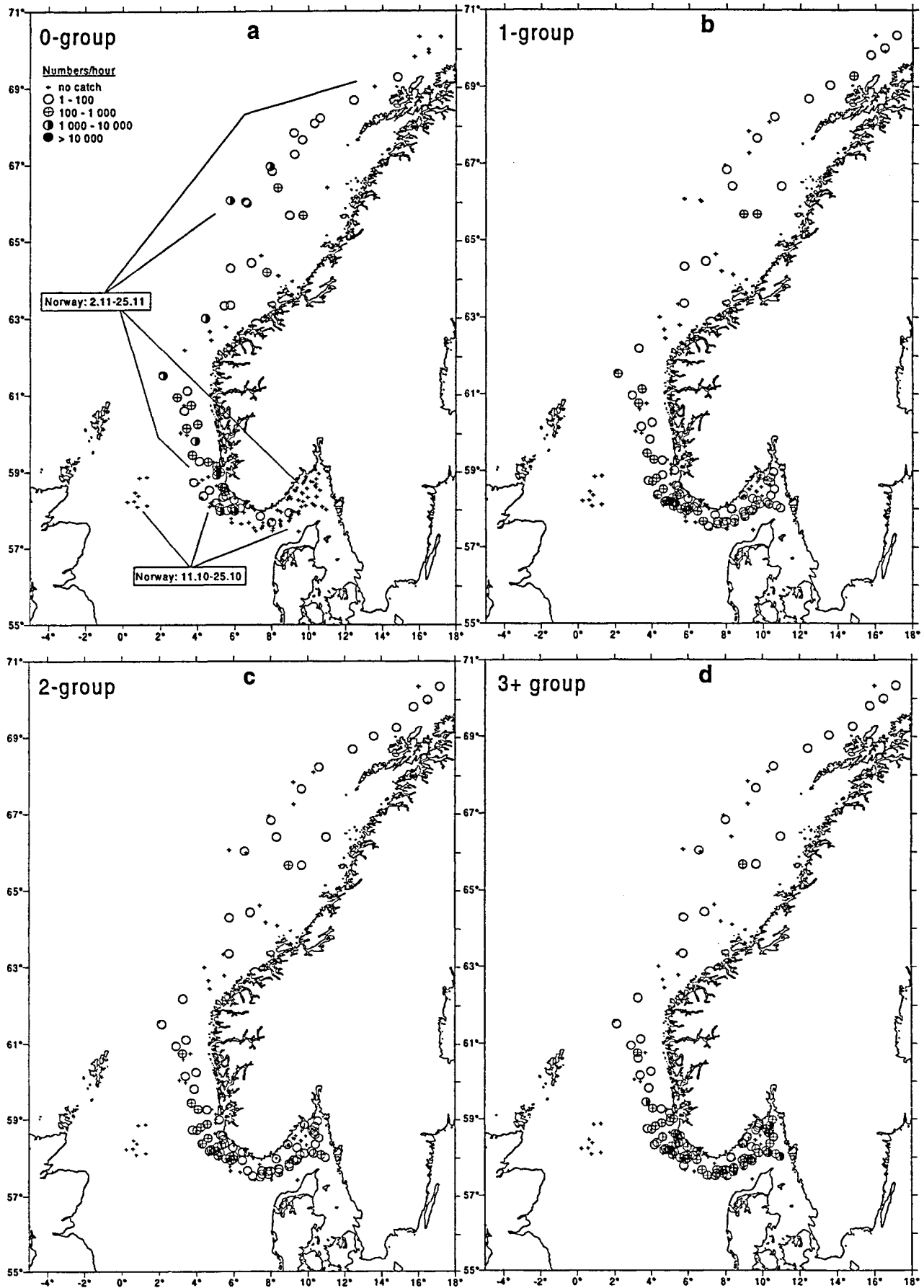


Figure 13. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1989.
 a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

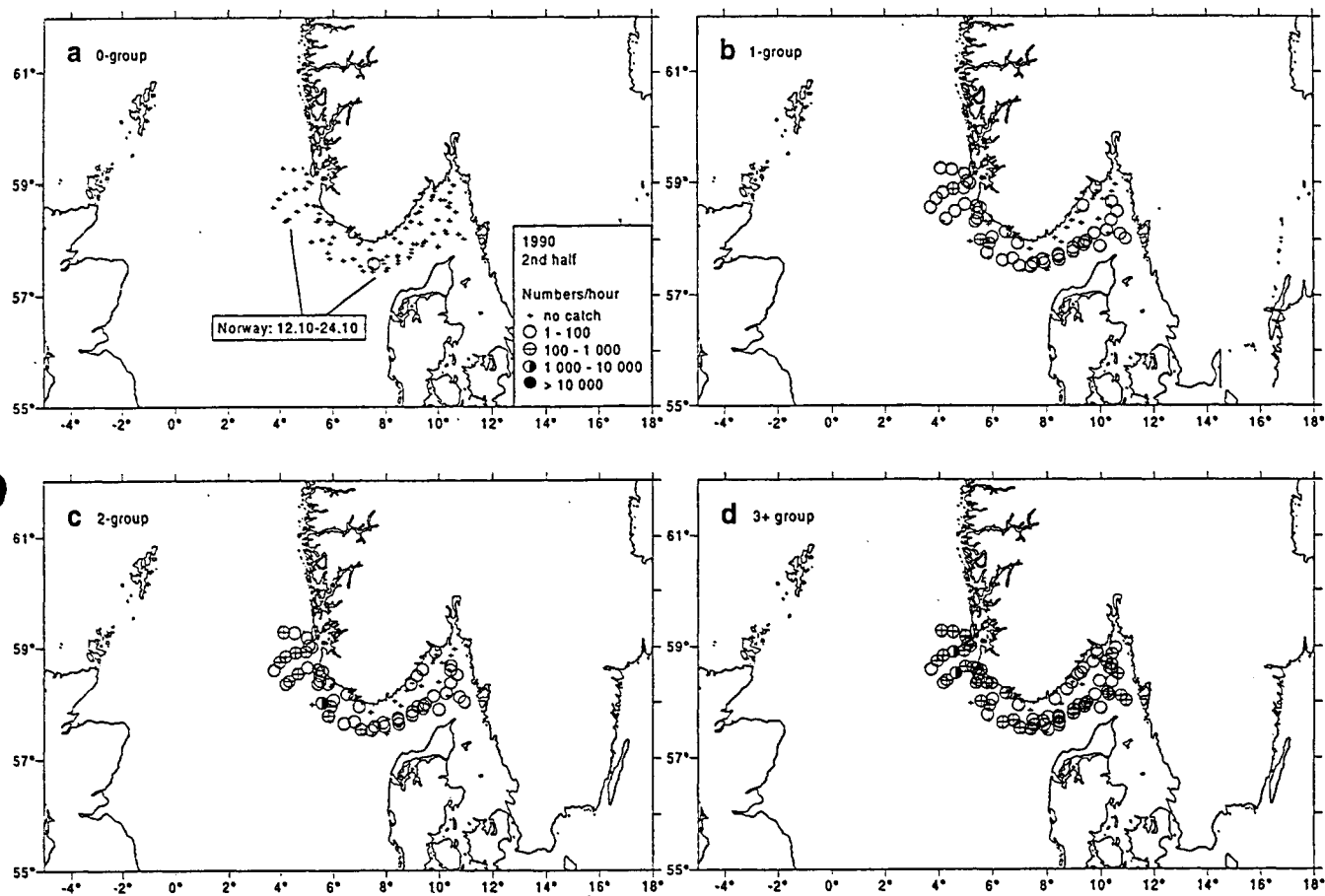


Figure 14. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1990.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

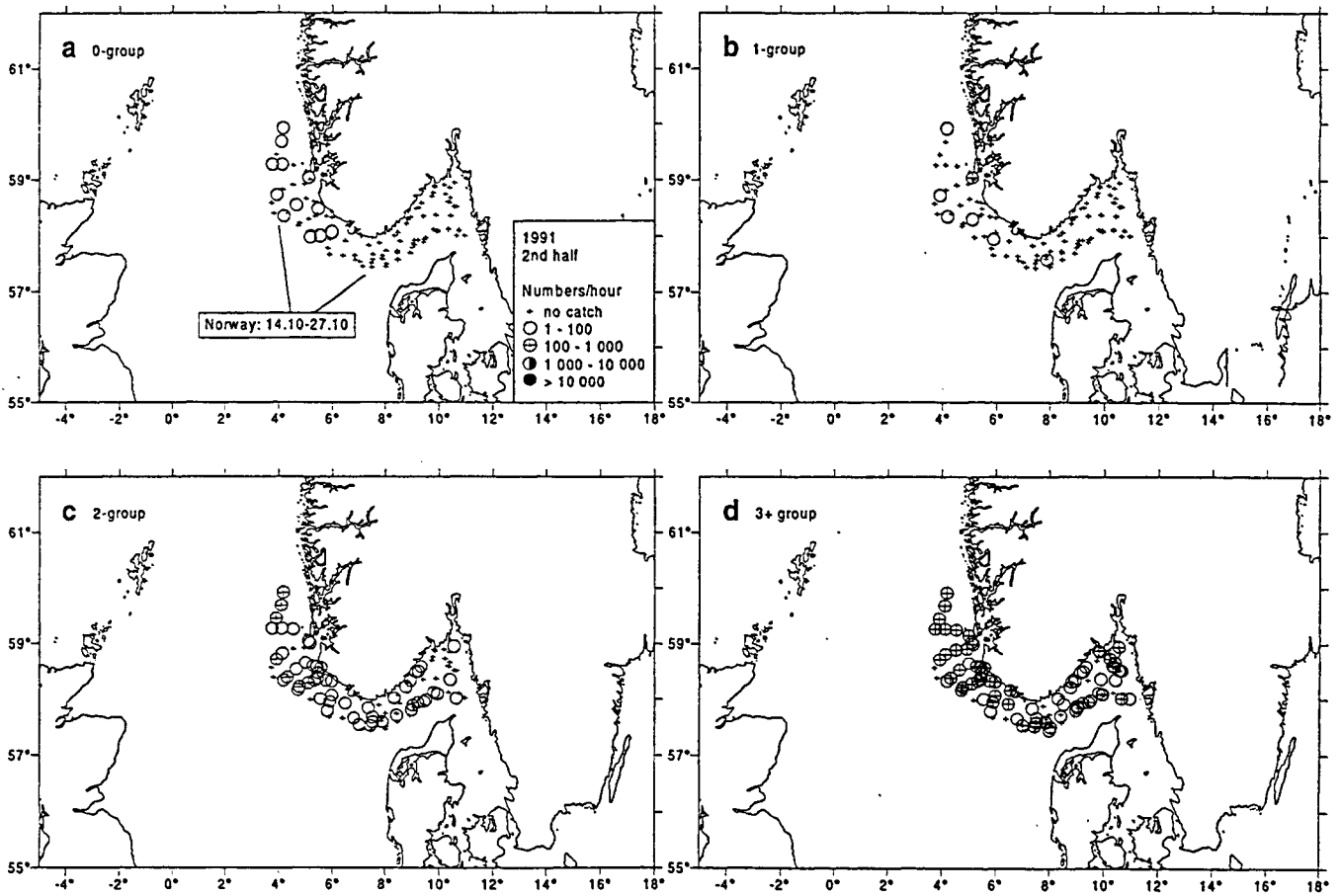


Figure 15. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1991.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

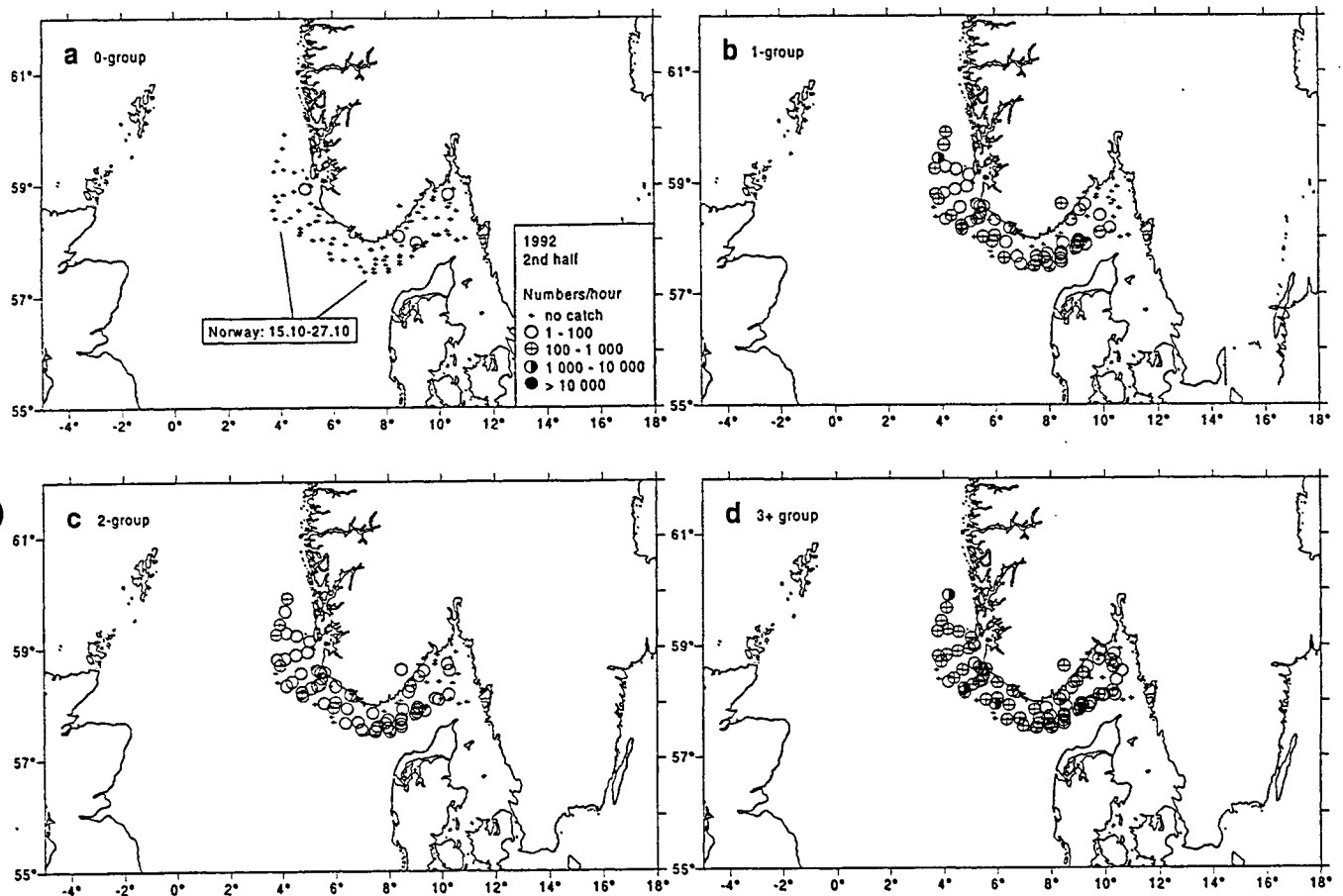


Figure 16. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1992.

a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

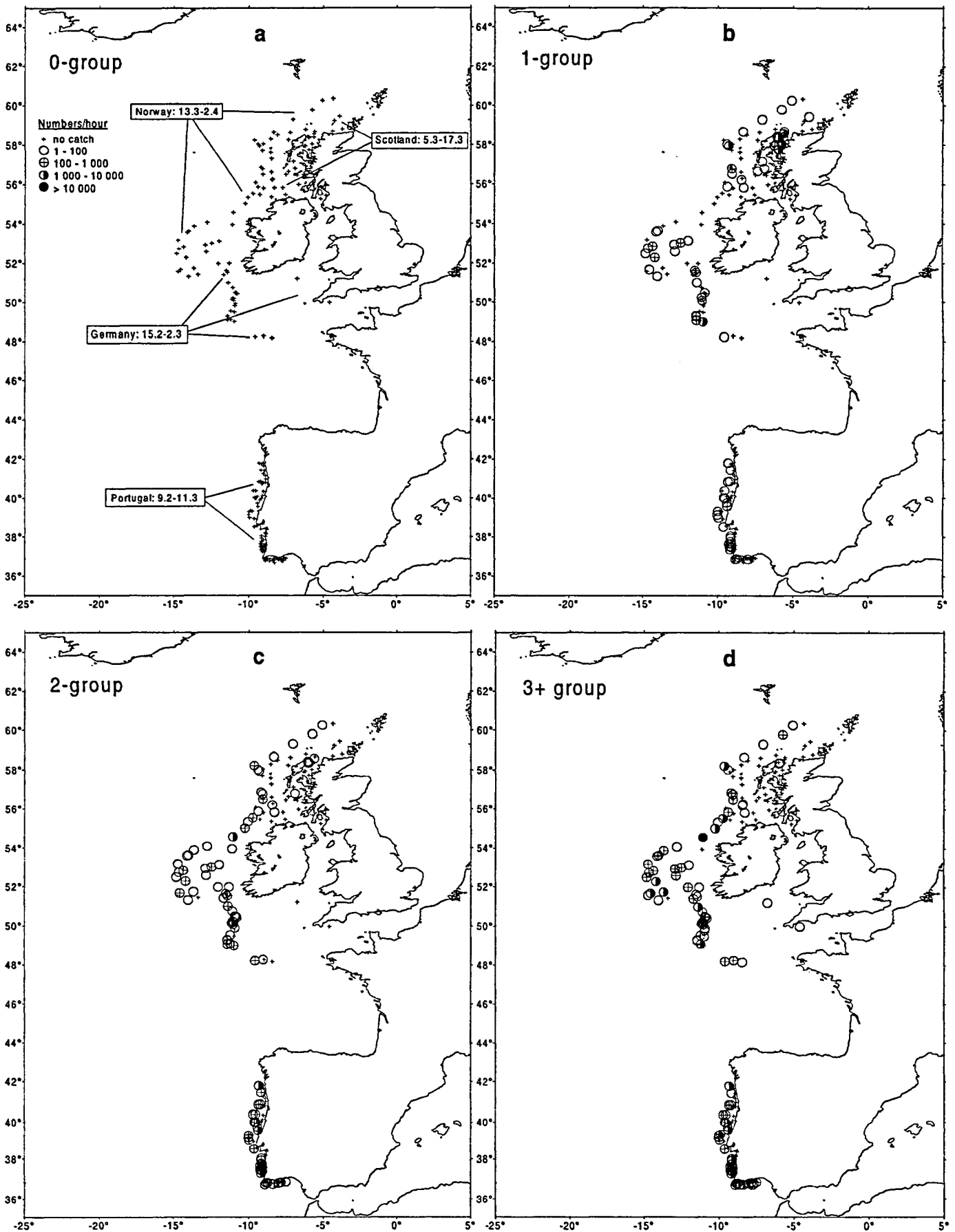


Figure 17. Survey trawl stations and catch of blue whiting (N/hour) in 1st half of 1993.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

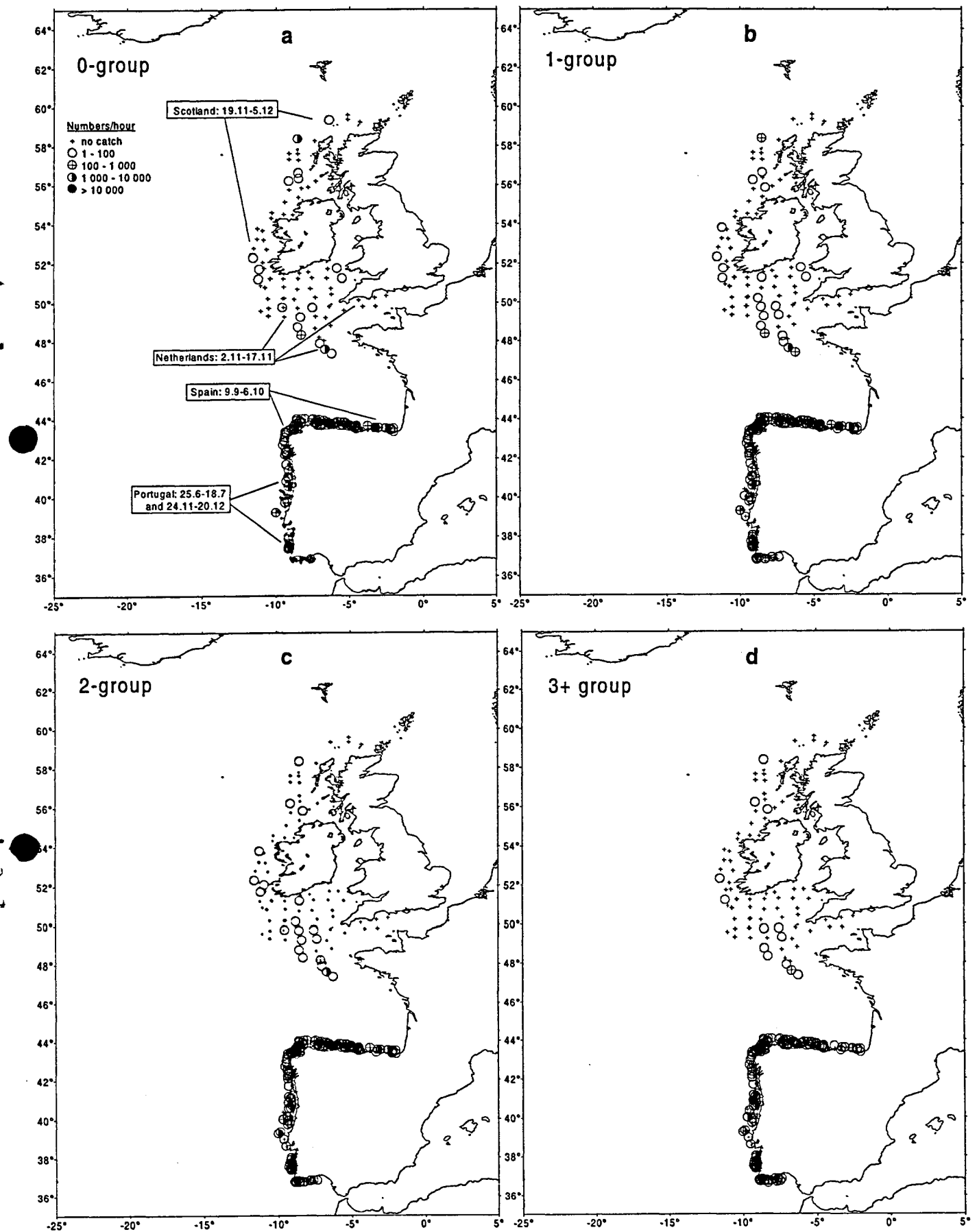


Figure 18. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1993.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

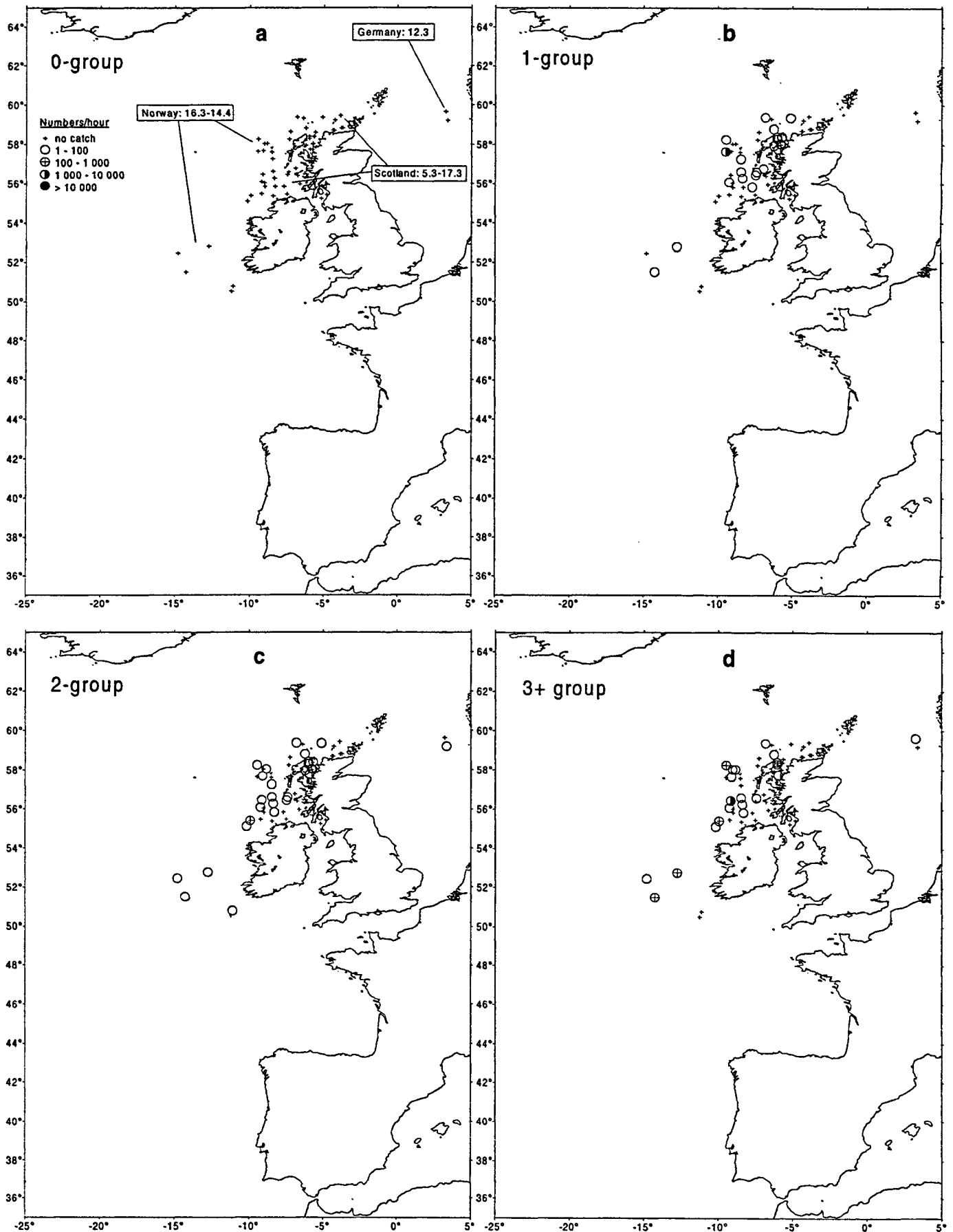


Figure 19. Survey trawl stations and catch of blue whiting (N/hour) in 1st half of 1994.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

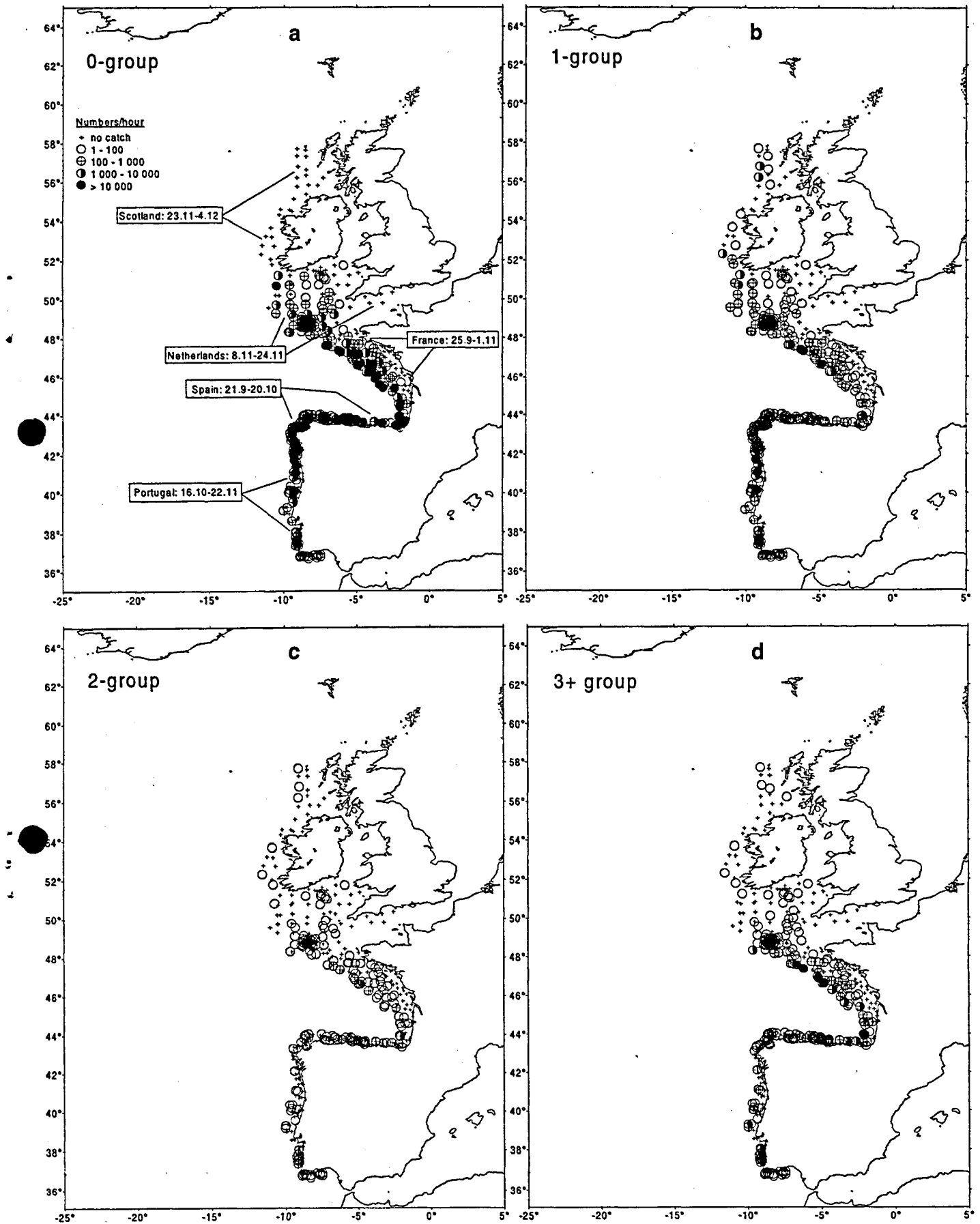


Figure 20. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1994.
 a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

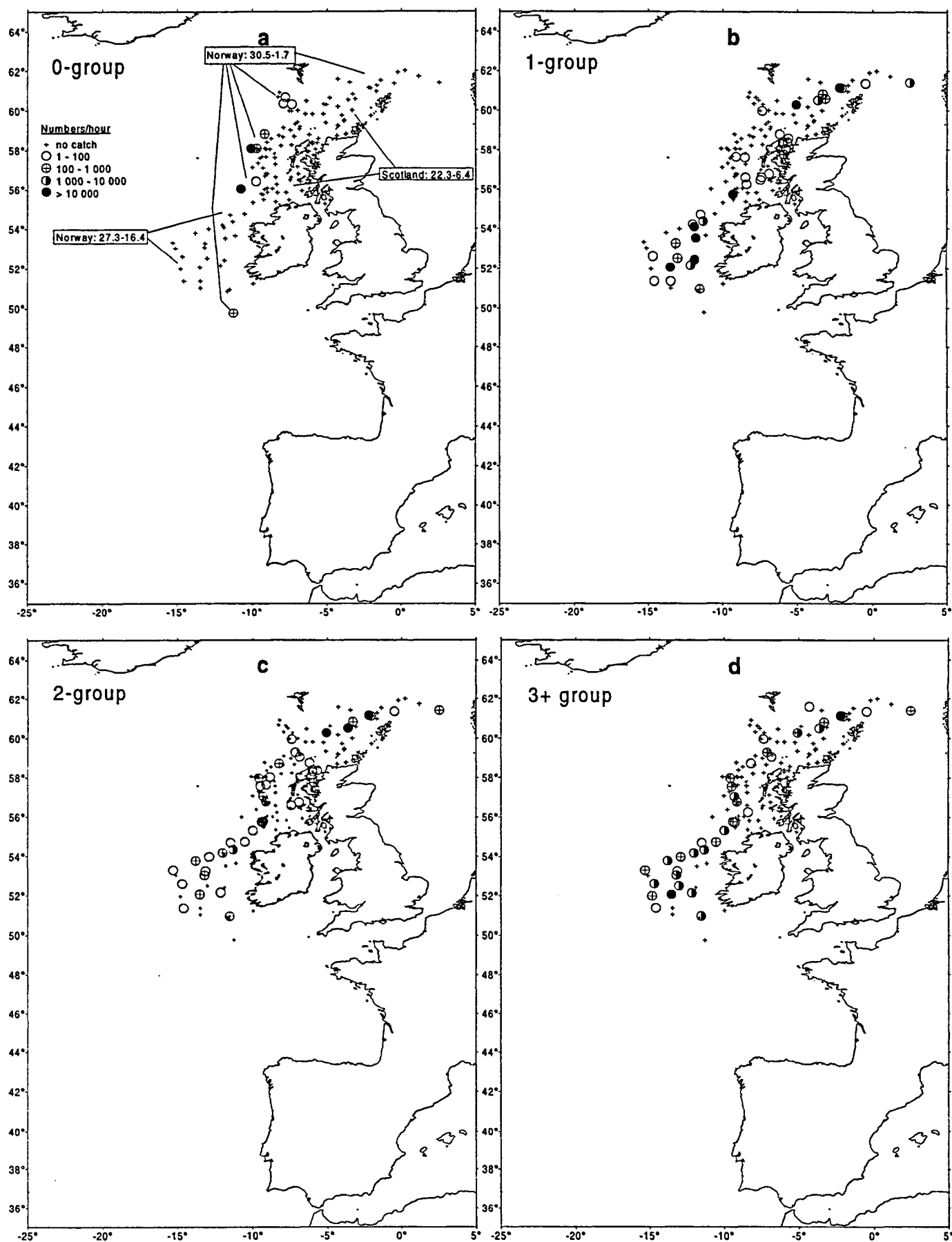


Figure 21. Survey trawl stations and catch of blue whiting (N/hour) in 1st half of 1995.
 a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

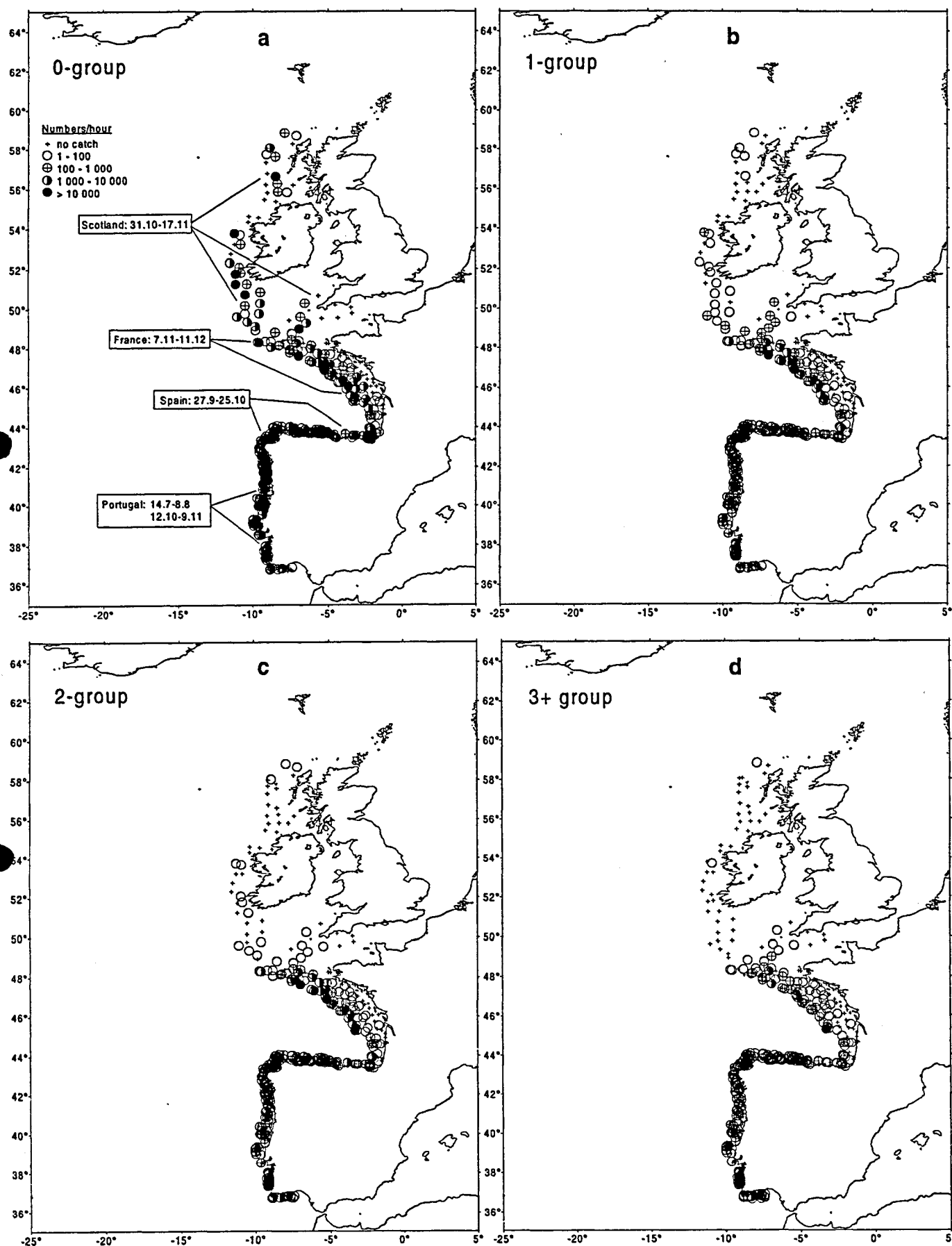


Figure 22. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1995.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

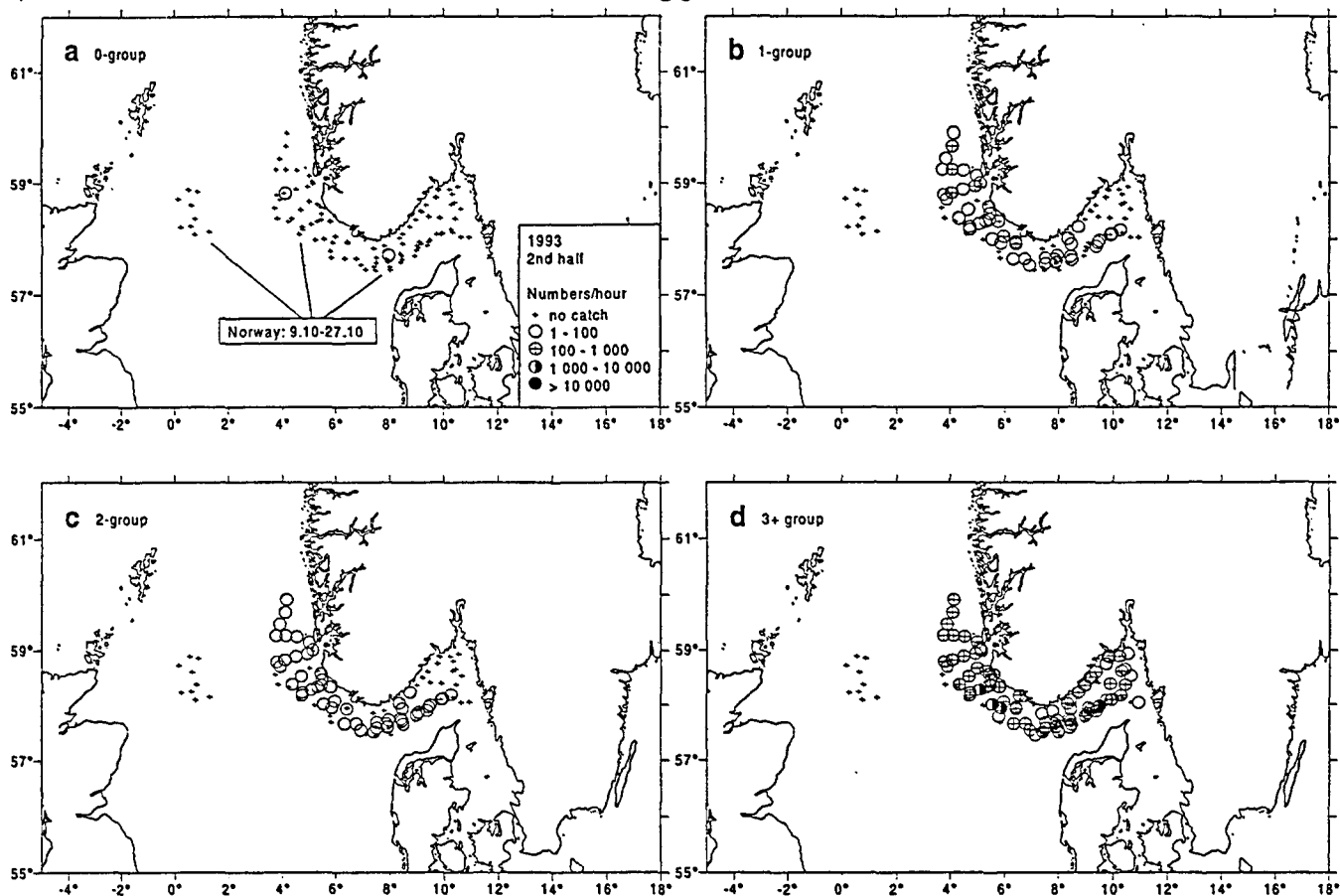


Figure 23. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1993.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

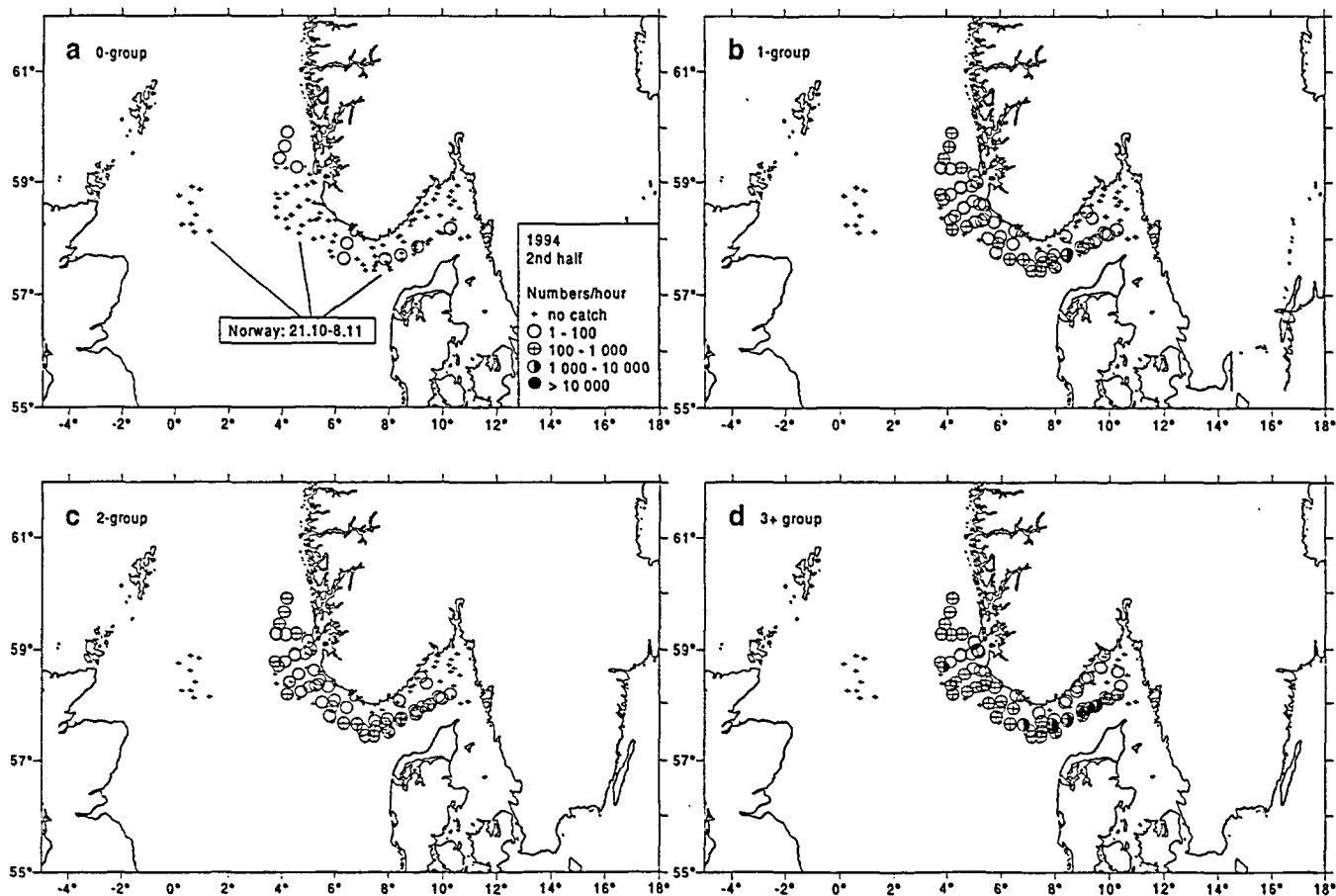


Figure 24. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1994.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

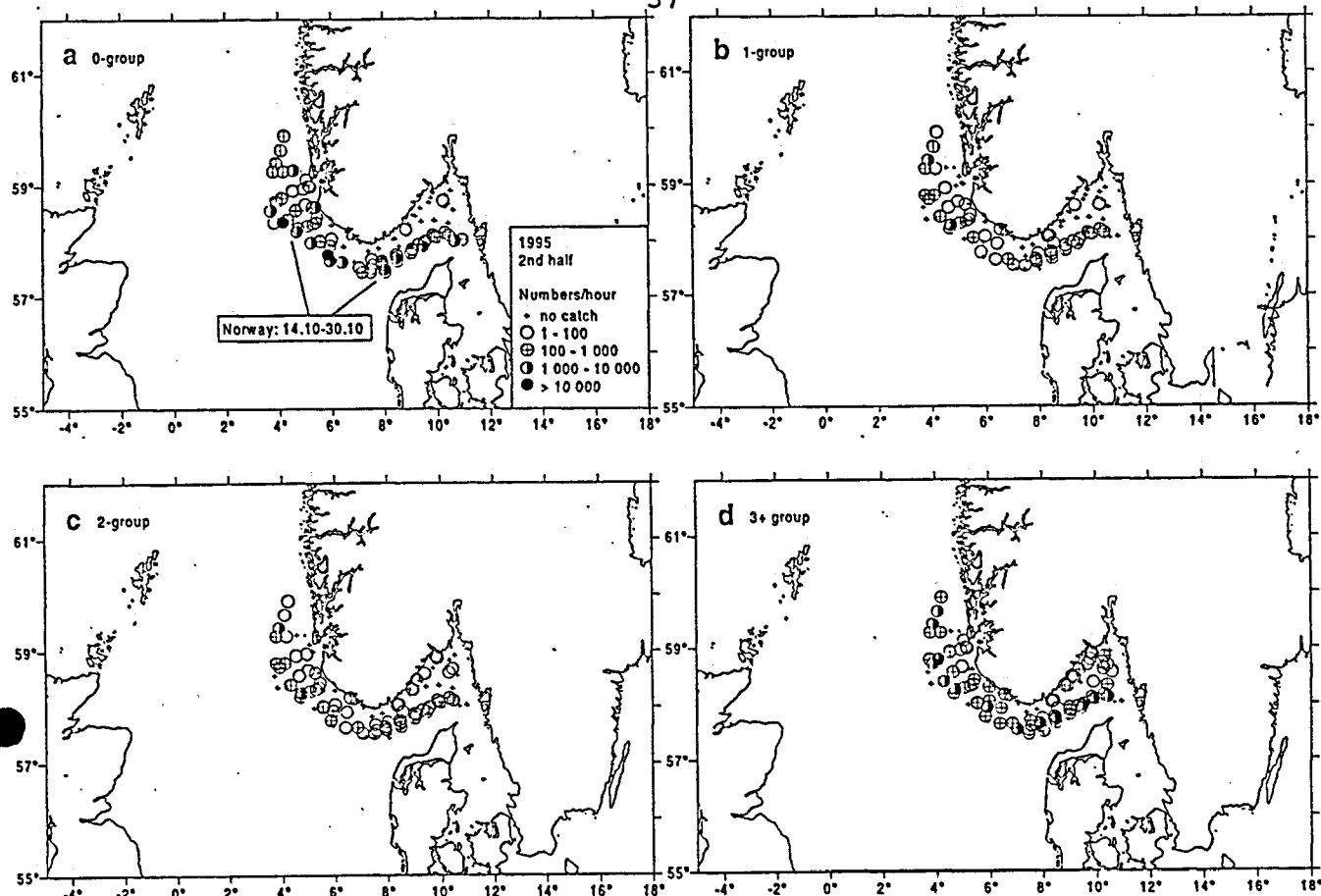


Figure 25. Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1995.
a) 0-group, survey nation and date, b) 1-group, c) 2-group, d) 3+ group.

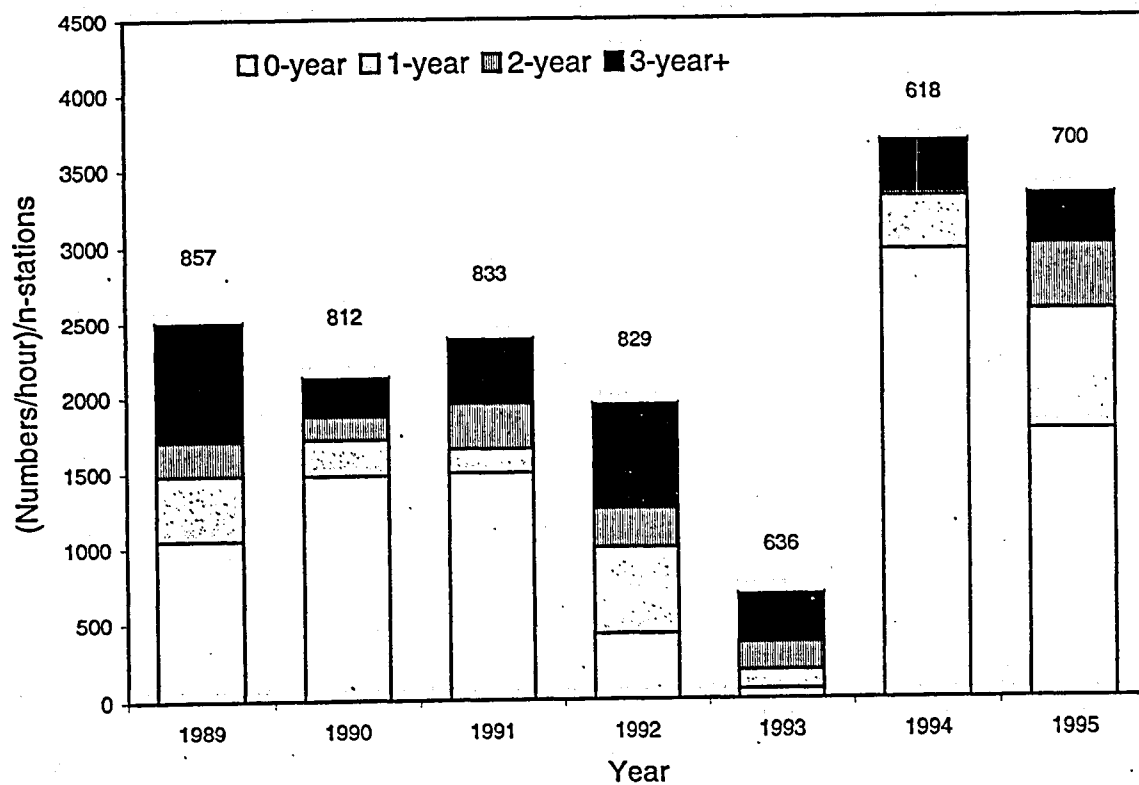


Figure 26. Total blue whiting survey data 1989-95. Number of fish by age caught per hour trawling in relation to the total number of stations in a year.

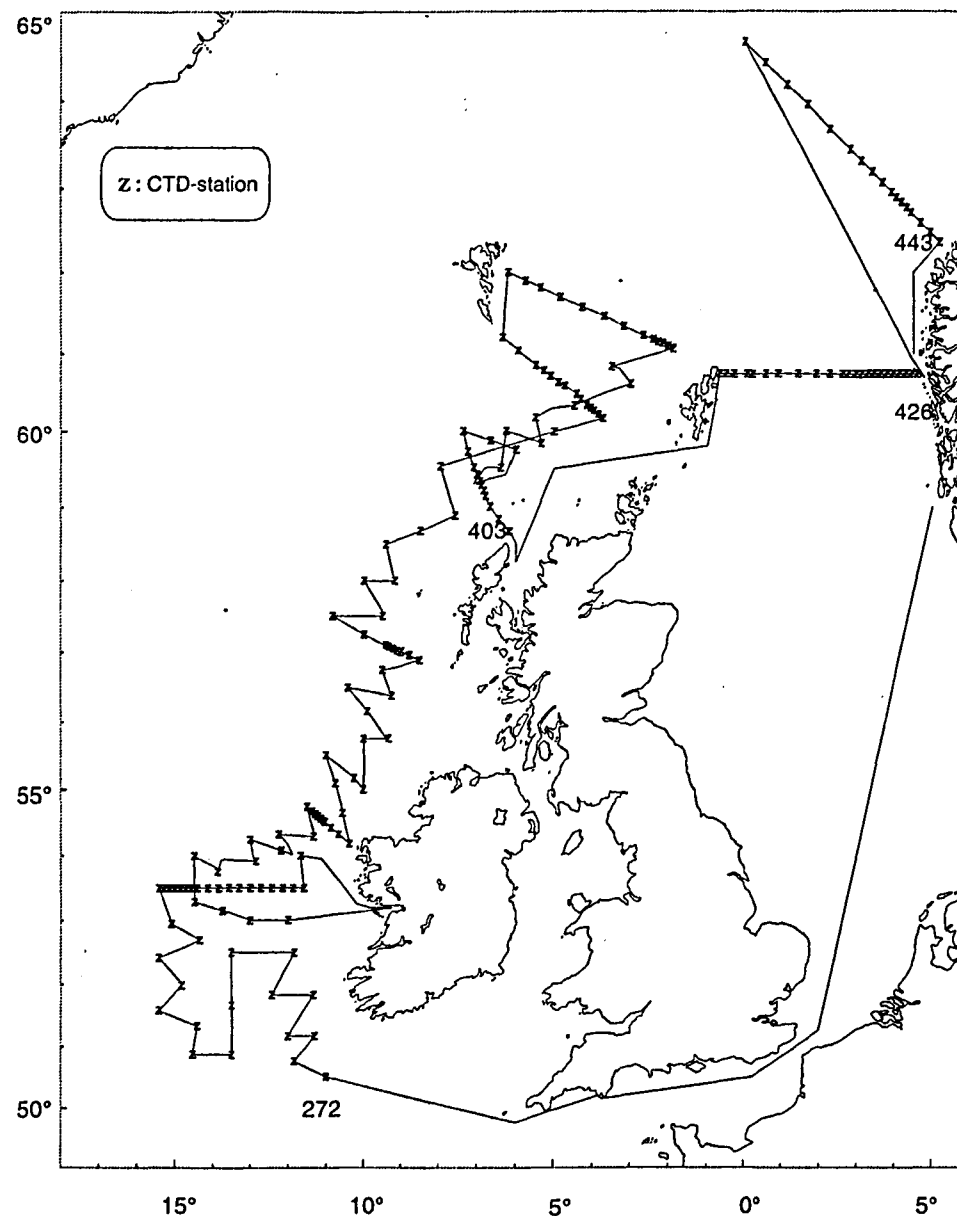
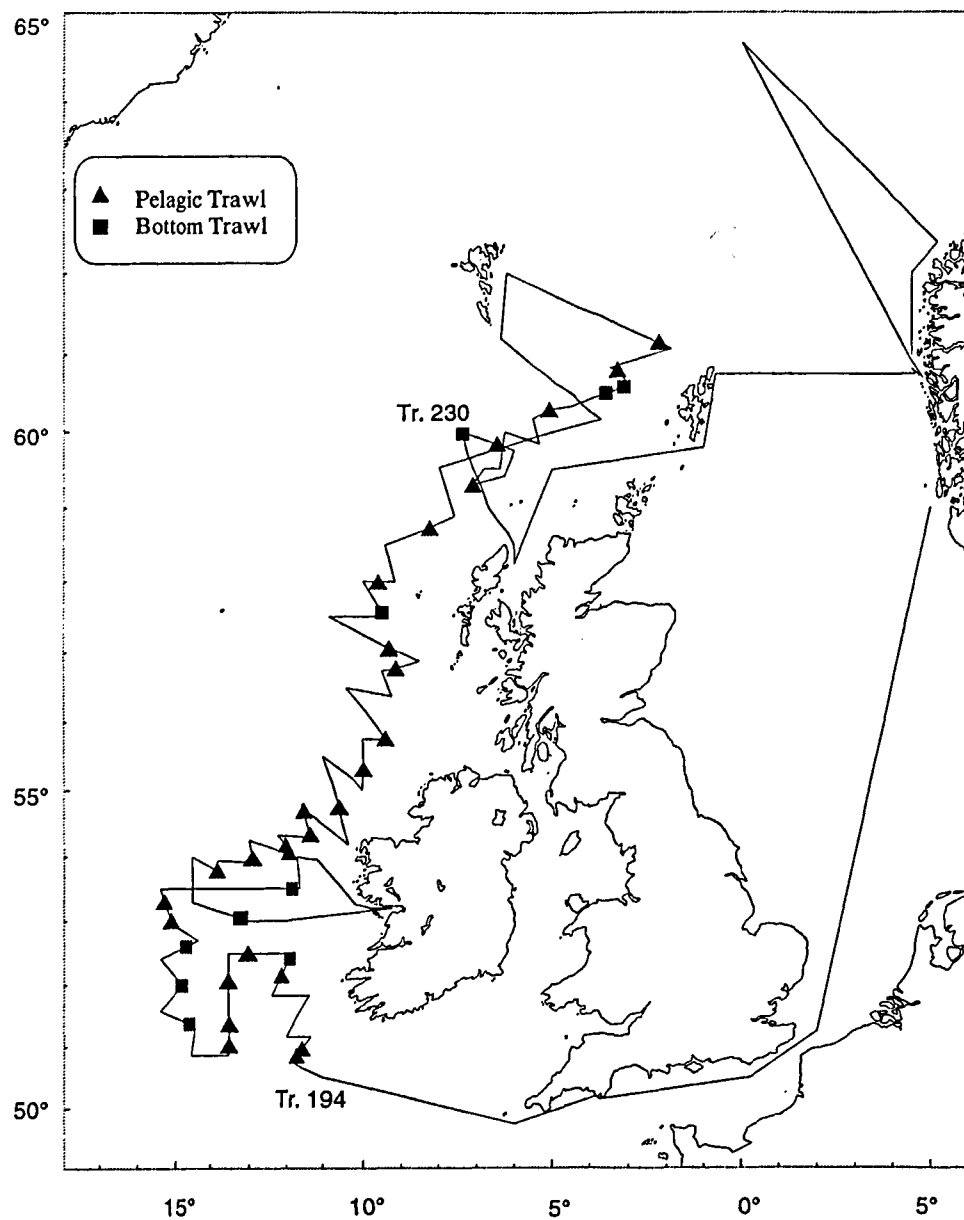


Figure 27. Cruise track and stations of R.V. "Johan Hjort", March/April 1995.

a) Trawl stations, b) hydrographic stations.

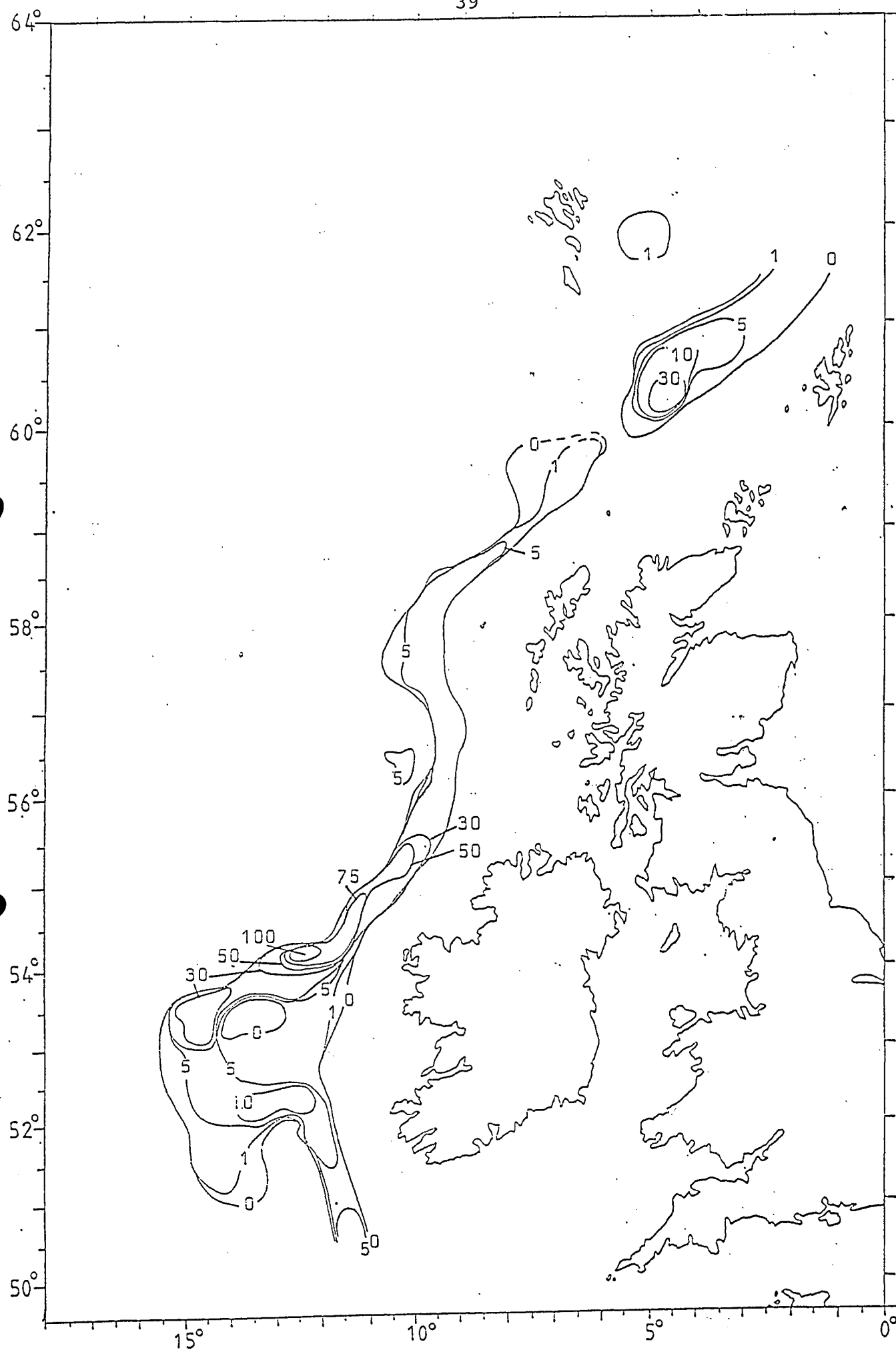


Figure 28. Distribution and relative density of blue whiting, March/April 1995. Echo intensity (Sa-values) in $\text{m}^2/\text{n.mile}^2 \times 1/100$.

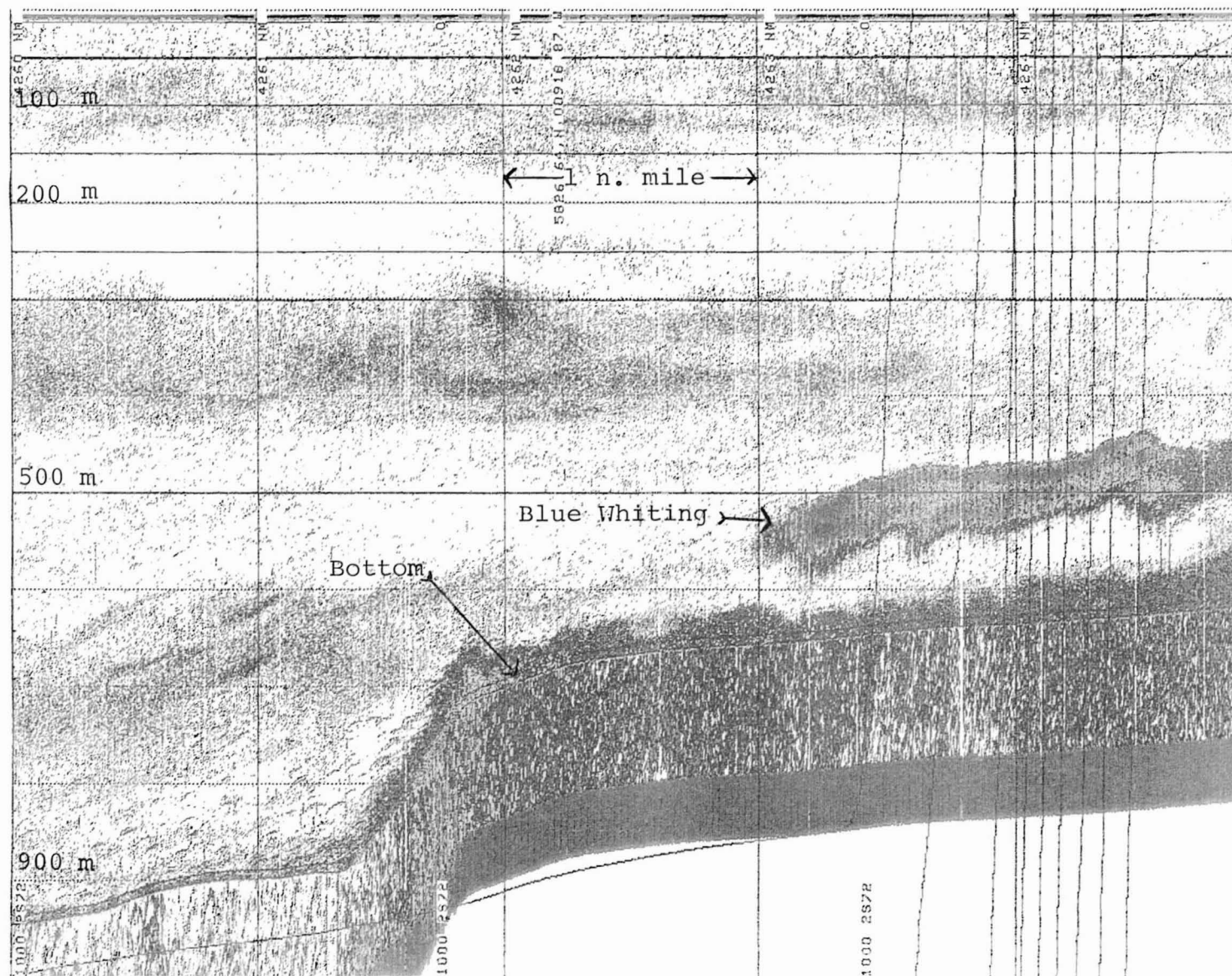


Figure 29. An example of blue whiting echo recordings from west of the British Isles.
Simrad EK-500 echo sounder, 38 kHz.

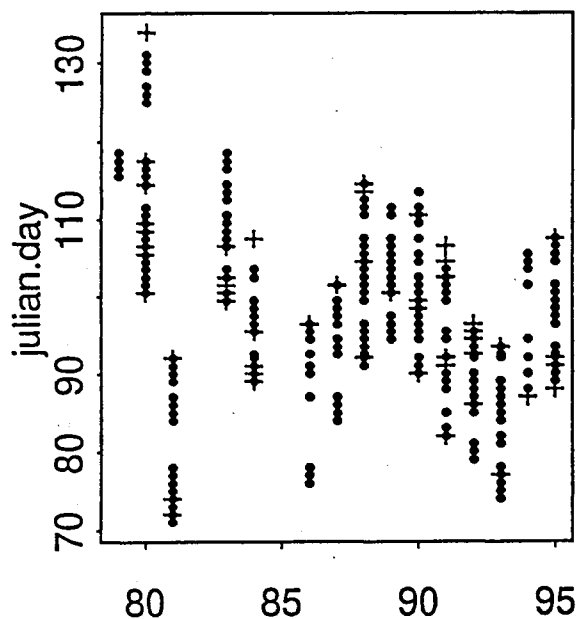


Figure 30. Julian days for the trawl stations of Norwegian surveys west of the British Isles 1979-95. Dots: catch of blue whiting, cross: no catch.

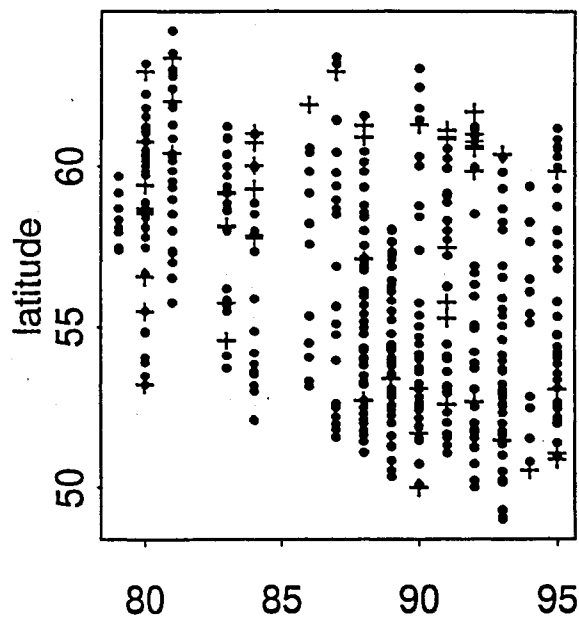


Figure 31. Latitudinal position of the trawl stations on Figure 30.

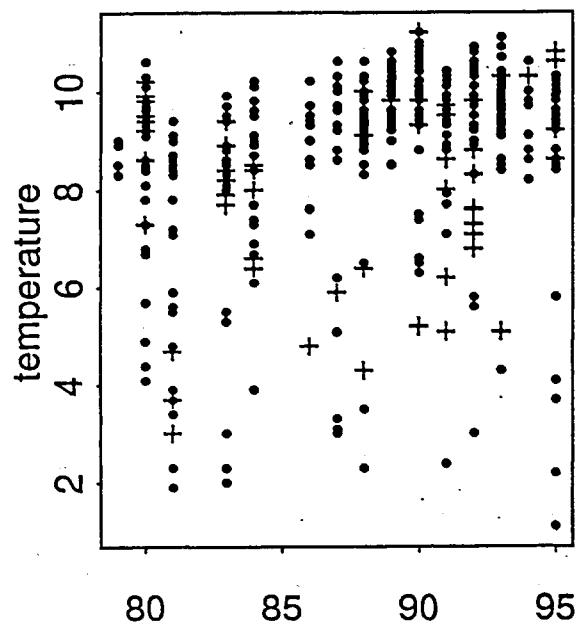


Figure 32. Temperature, $t^{\circ}\text{C}$, at catch depth for the trawl stations on Figure 30.

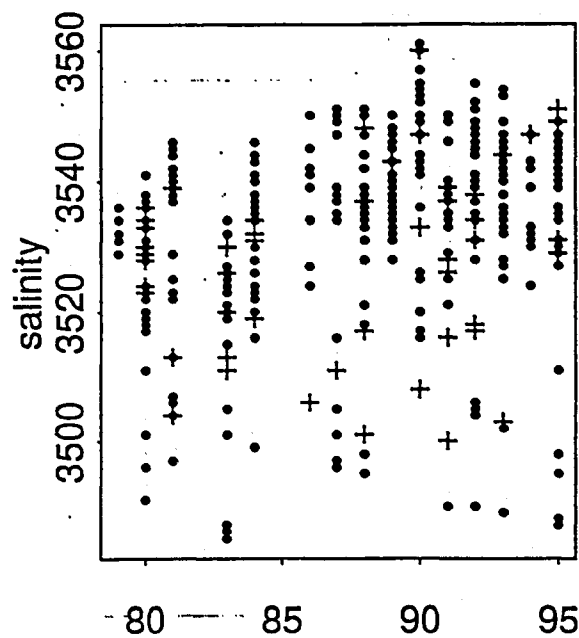


Figure 33. Salinity, $S_{\text{‰}}$, at catch depth for the trawl stations on Figure 30.

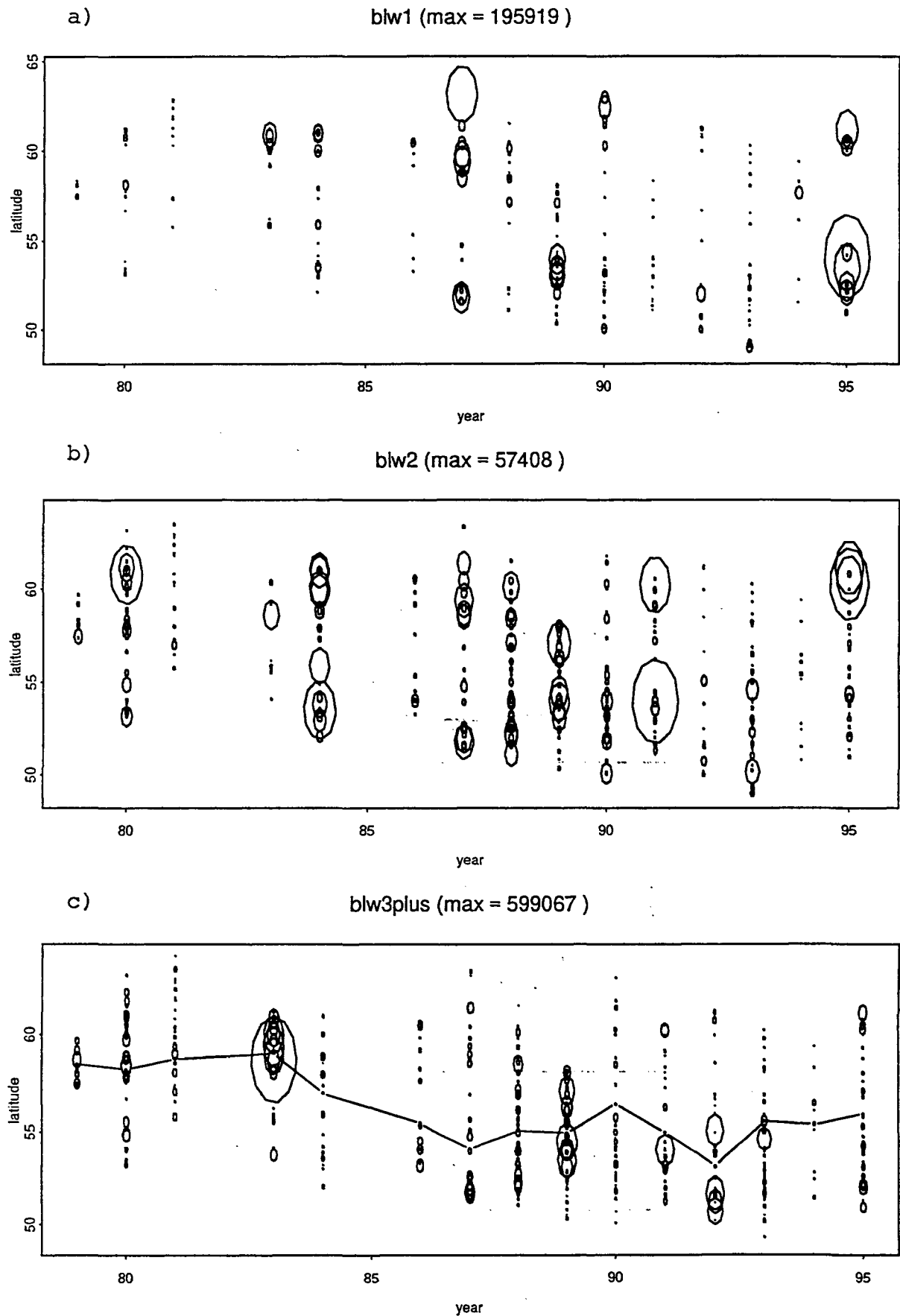


Figure 34. Catch of blue whiting by age group (in absolute numbers) and latitude, from the Norwegian surveys west of the British Isles 1979-95. a) 1-group, b) 2-group, c) 3+ group.

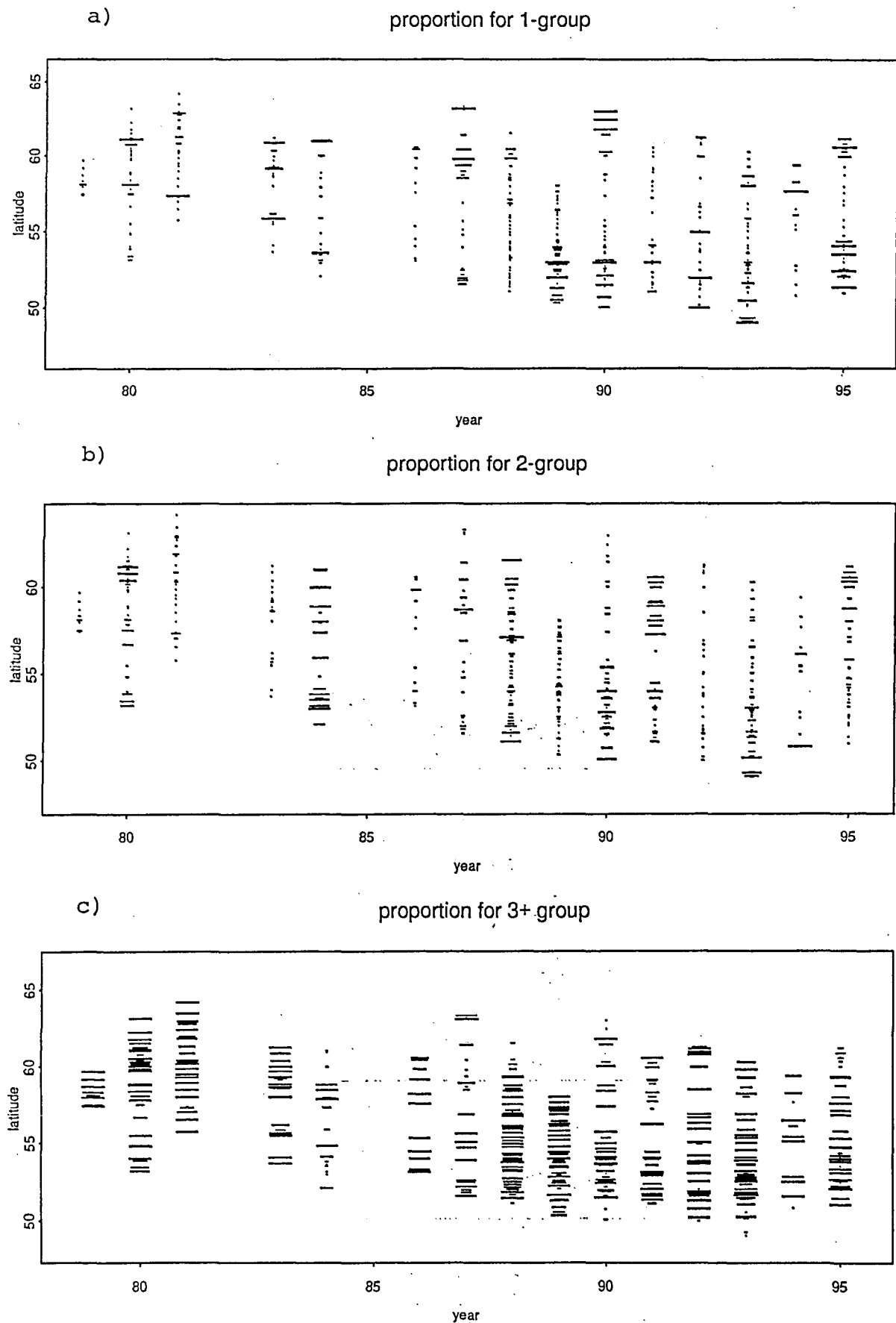


Figure 35. Catch of blue whiting by age group (in proportion of the total) and latitude, from the Norwegian surveys west of the British Isles 1979-95. a) 1-group, b) 2-group, c) 3+ group.

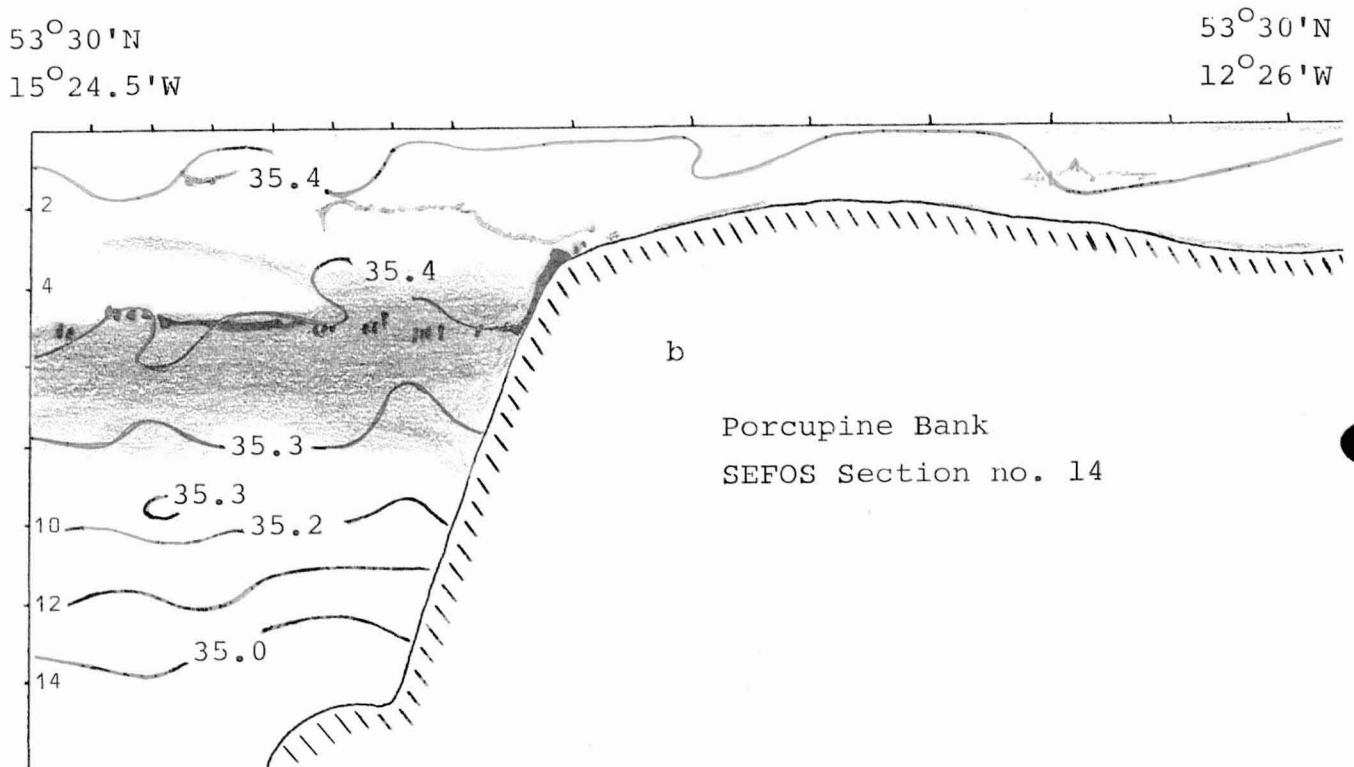
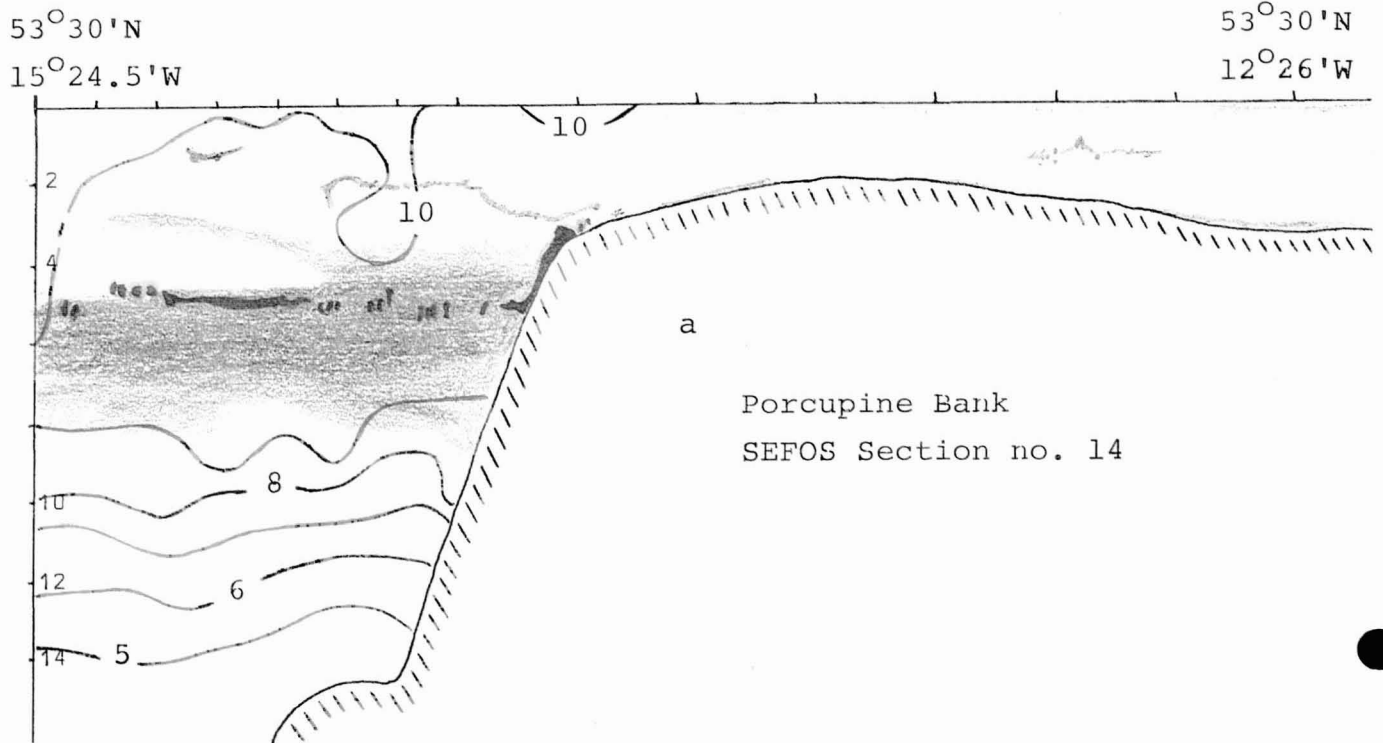


Figure 36. Echo recordings of blue whiting (red markings) and plankton and mesopelagic fish (blue markings) along a hydrographic section at the Porcupine Bank, down to 1500m depth, spring 1995. a) with temperature, t° C, b) with salinity, S‰. Depths in 100m's scale.

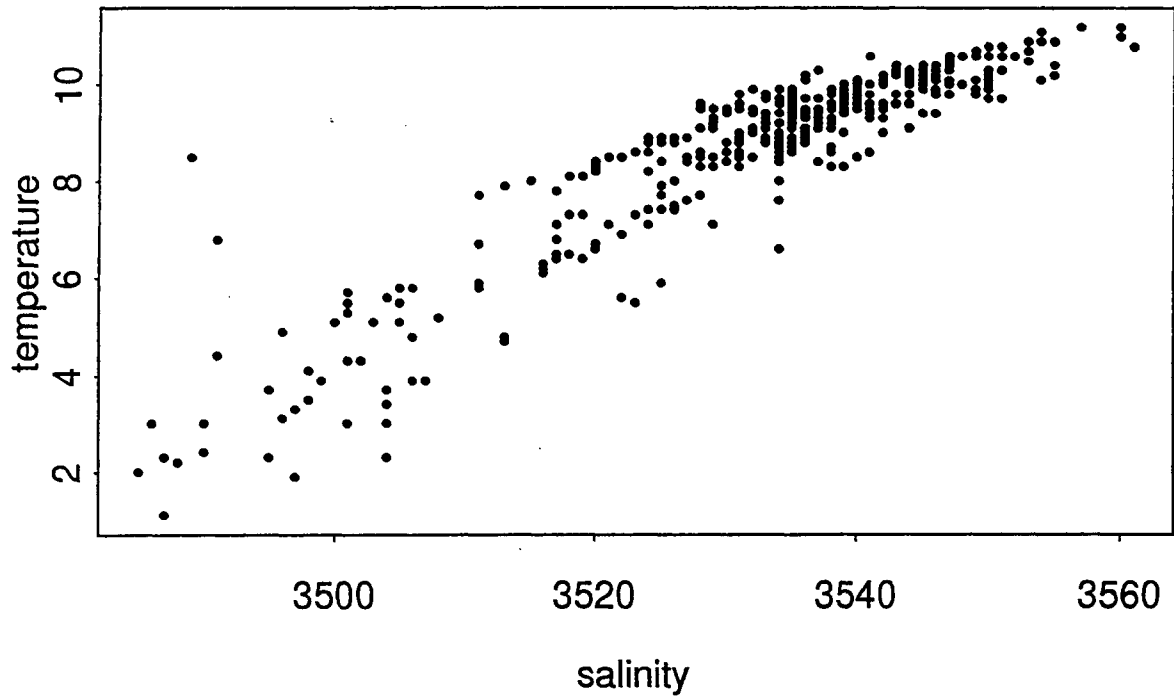


Figure 37. T-S plot of values from catch depth of all the Norwegian trawl stations west of the British Isles 1980-95.

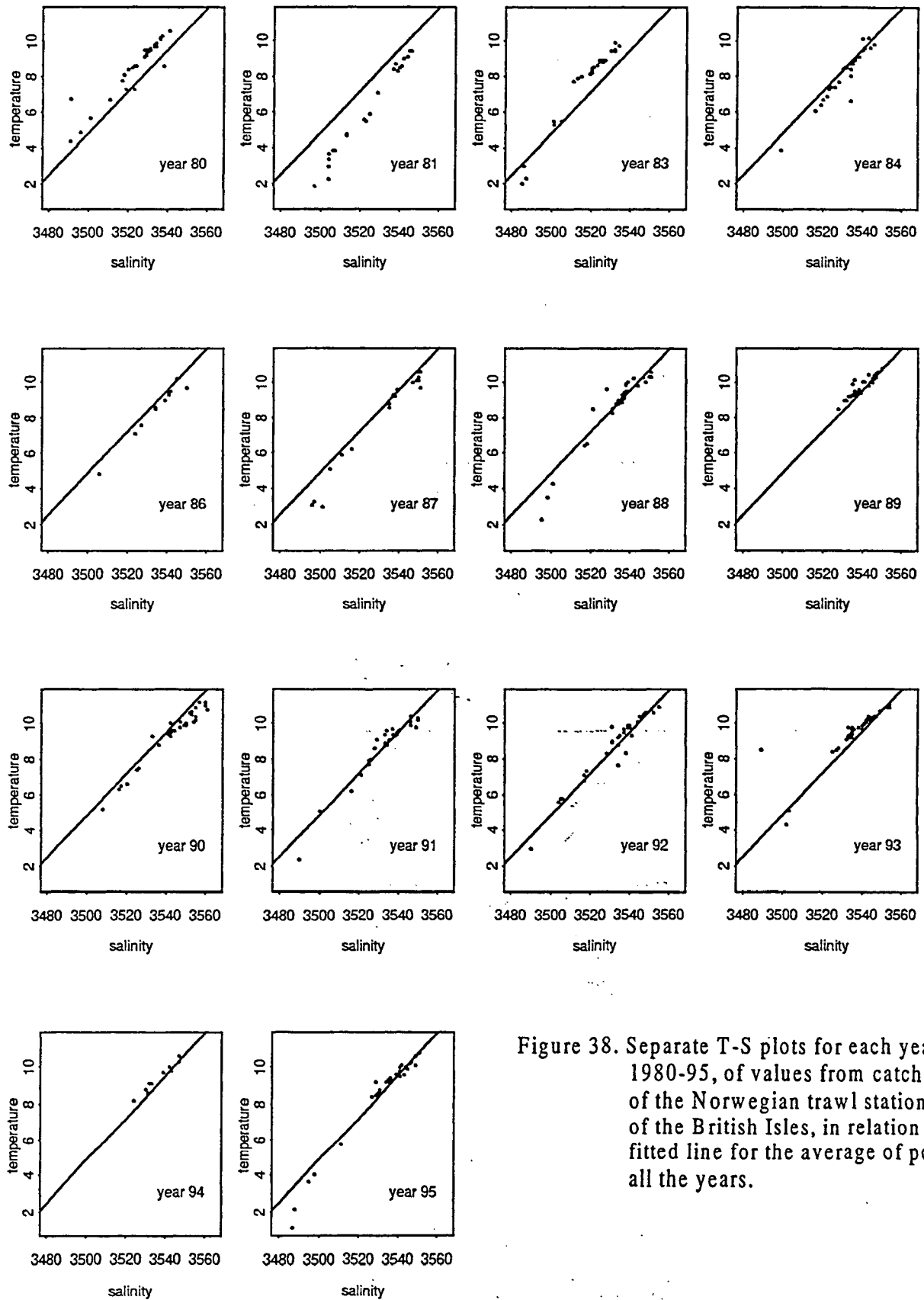


Figure 38. Separate T-S plots for each year 1980-95, of values from catch depth of the Norwegian trawl stations west of the British Isles, in relation to a fitted line for the average of points of all the years.