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**Species distributions from English Celtic Sea
groundfish surveys, 1984 to 1991**

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1. CELTIC SEA FISHERIES

The Celtic Sea area supports important and valuable fisheries. Total international landings are given in Table 1 for 1988, the most recent year for which international data have been published. At that time the main countries fishing there were Spain, France and the United Kingdom for demersal species, and Ireland, the Netherlands and Denmark for pelagic species. In addition a substantial quantity of blue whiting was taken by Norway, USSR and the Faroes. Vessels registered in England and Wales landed about 25 thousand tonnes valued at £29 million (excluding shellfish other than cephalopods and *Nephrops*). Total international landings were 324 thousand tonnes and, based on the unit prices of landings by vessels registered in England and Wales, had a value in 1988 equivalent to £171 million.

In terms of weight landed the most important species in 1988 in the international fishery were blue whiting, horse mackerel and mackerel. In terms of the value of

landings hake, anglerfish and megrim were the most important.

2. HISTORY OF THE SURVEYS

The original objectives of this series of surveys, which commenced in 1981, were to investigate the distribution and biology of mackerel of the Western stock (spring surveys) and the distribution and abundance of pre-recruit mackerel (winter surveys). At this time there had been a big expansion in the fishery for Western mackerel and there were concerns about overexploitation of the stock. Subsequently, with an increasing need for fishery independent data on the state of western demersal stocks for assessment purposes, the objectives were widened to include the biology, distribution and abundance of all species which could be sampled representatively by bottom trawl and, by 1982, catch numbers, catch weight, and length compositions were recorded routinely for all species caught.

Table 1. Landings in 1988 from ICES Divisions VII-f-k by vessels registered in England and Wales and for all countries combined (Excludes shellfish other than cephalopods and *Nephrops*)

	£ / Tonne	England and Wales		Total	International
		Tonnes	£ '000	Tonnes	£ '000
Brill	3,896	67	261	206	802
Dab	282	71	20	223	63
Flounder	200	5	1	23	5
Lemon Sole	1,898	275	522	1,883	3,574
Megrim	1,704	1,413	2,408	8,872	15,119
Plaice	723	1,064	769	3,132	2,264
Sole	4,961	482	2,391	1,605	7,962
Turbot	5,217	189	986	544	2,838
Witch	1,550	129	200	2,215	3,434
Cod	773	453	350	14,319	11,063
Haddock	793	275	218	2,888	2,289
Hake	3,111	3,127	9,728	13,534	42,104
Ling	702	1,726	1,211	6,837	4,797
Pollack	765	766	586	3,723	2,848
Blue Whiting ¹	35	3	0	108,890	3,811
Saithe	851	463	394	3,855	3,280
Whiting	815	433	353	12,149	9,904
Conger Eel	568	111	63	606	344
Gurnards	256	129	33	819	210
Anglerfish	1,651	2,498	4,124	11,524	19,025
Sea Breems	4,692	26	122	136	638
Spurdog	640	550	352	8,033	5,141
Spotted Dog	472	106	50	2,126	1,003
Skates and Rays	568	1,481	841	8,016	4,552
Horse Mackerel	147	3,206	471	62,209	9,139
Herring	400	5	2	8,741	3,496
Pilchard ²	102	0	0	2,119	216
Sprat ²	187	0	0	704	132
Mackerel	177	4,572	811	30,511	5,412
Others	1,445	1,522	2,199	3,688	5,328
		25,147	29,466	324,130	170,796

¹ Unit values from landings in Scotland

² Unit values from landings in England and Wales from all sea areas

Sources: Quantities from MAFF Statistics and ICES Fisheries Statistics

Unit values from MAFF Statistics: Averages for landings in England and Wales and abroad by British registered vessels fishing in Divisions VII-f-k

On the earliest cruises, when the main interest was the distribution of mackerel, the surveys covered the continental shelf of all, or part of, an area extending from the northern North Sea, around the west coast of Britain, and south through the Bay of Biscay to the northern coast of Spain. Later, as the objectives changed, the survey area was reduced to one extending from the west of Ireland at 52° N to the northern coast of Spain over the continental shelf to a maximum depth of 300 m. This area of coverage proved to be too ambitious and only exceptionally did cruise duration and weather conditions permit sufficient stations to be worked for the full area to be adequately sampled. From the winter cruise of 1987 it was decided to further reduce the survey area to concentrate on the area of prime interest. This extends from 47° 30' N to 52° 30' N and from 3° W to 12° W and includes International Council for the Exploration of the Sea (ICES) Divisions VII f,g,h,j and the north-western part of Division VII e but excludes the Irish Sea (VII a). Figure 1(a) shows the boundaries of the ICES Divisions in the survey area and Figure 1(b) shows the positions of standard survey stations as at March 1991. The elimination of the Bay of Biscay from the survey has involved some sacrifice of information as this is an important area for pre-recruit hake and horse mackerel.

In the earlier years two surveys were normally carried out each year, one in the spring (March/April) and one

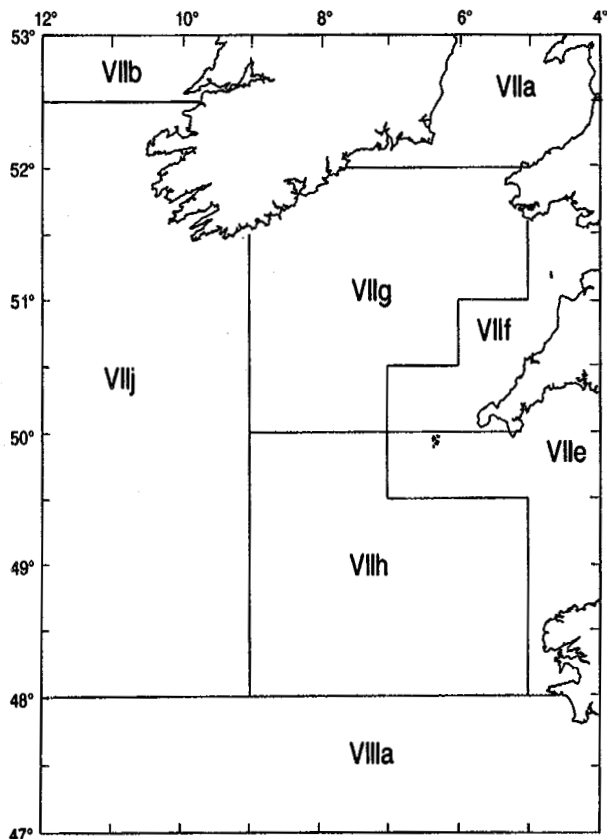


Figure 1(a). Boundaries of ICES Divisions in the survey area

in the winter (December). From 1989 onwards only the spring survey has been undertaken due to other demands for ship's time.

3. CURRENT SURVEY OBJECTIVES

The current objectives of the survey are as follows:

1. To determine the abundance and distribution of fish within the survey area.
2. To determine the abundance and distribution of the pre-recruits of the main commercial species with a view to deriving recruitment indices.
3. To monitor changes in the stocks of commercial fish species independently of commercial fisheries data, and to monitor stock changes for species not currently of commercial interest.
4. To collect data for the determination of biological parameters for the more important species.
5. To supplement the shore-based sampling programme.

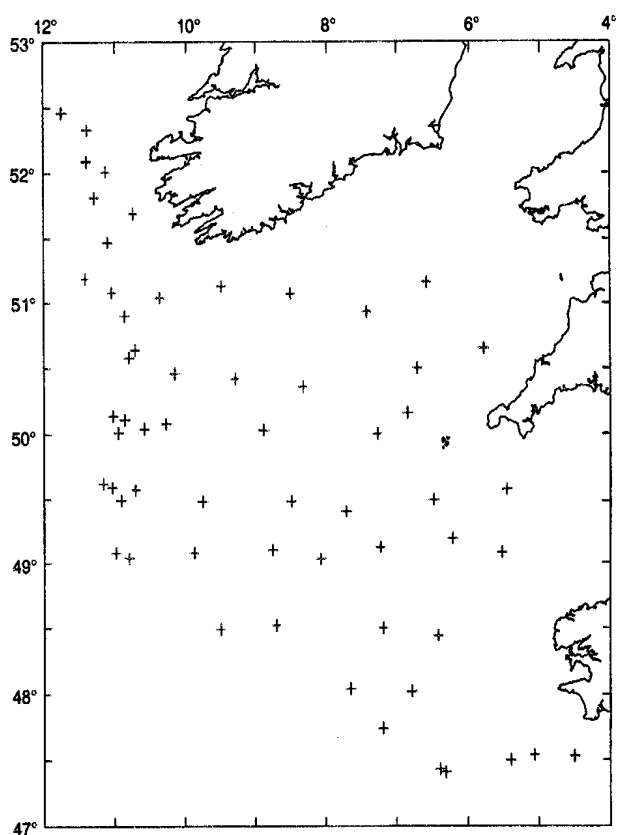


Figure 1(b). Positions of standard survey stations as at March 1991

4. SURVEY METHODS

The standard bottom trawl used on these surveys is a modified Portuguese High-headline Trawl which is fitted with 14 inch rubber bobbins on the groundrope and a bunt tickler chain. The codend is fitted with a small-meshed liner (nominal diagonal stretched mesh size 20 mm). Warp length to water depth ratio tends to be varied with depth with lower ratios at greater depths. For the spring 1992 survey, for example, the overall average ratio was 3.76. In recent years Scanmar equipment has been used to monitor trawl parameters, and headline height and door spread have been recorded at 1 min intervals during the tow. A Scanmar temperature sensor was also attached to the trawl to monitor bottom temperature. For the survey conducted in spring 1992 average headline height for the cruise was 4.4 m and average door-spread was 81.7 m. There is a tendency for door spread to decrease over the duration of a tow with an associated increase in headline height. The reduction in door spread can be as much as 10%.

The standard haul duration is 60 min and trawl hauls are restricted to the hours of daylight. Fixed station positions are used and for analysis purposes stations are allocated to depth strata as follows:

Depth stratum	Depth range (m)
1	<90
2	90-114
3	115-139
4	140-179
5	>180

Depth strata were further sub-divided by latitude at 48° 45' N and 50° 15' N.

The following data are recorded routinely:

- (i) Station log data.
- (ii) For each species caught the number and weight of fish in the catch, using sub-sampling techniques where appropriate.
- (iii) For each species caught the length composition of the total catch or of a sub-sample. Some species are sorted by sex before measuring.

- (iv) For selected species additional biological sampling is undertaken for age, sexual maturity etc.

These data are stored in a survey computer database.

5. PHYSICAL CHARACTERISTICS OF THE AREA

The survey is restricted to the continental shelf down to a depth of 300 m. Figure 2 shows isobaths contoured by hand from depths recorded at the standard stations.

Figures 3 and 4 show temperatures in degrees Celsius of the water at the surface and the bottom in the spring as illustrated by the March 1991 data. Bottom temperature was recorded by a Scanmar temperature sensor and surface temperature was measured from a sensor attached to the ship's hull.

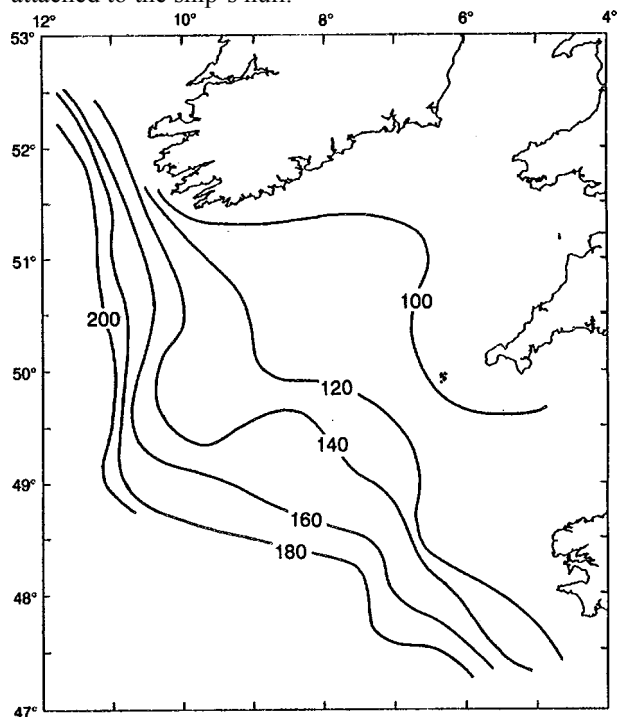


Figure 2. Bottom depths (metres) over the survey area. Contours drawn by eye from depths recorded at trawl stations

6. SPECIES RECORDED BY THE SURVEY

Table 2 gives a complete list of scientific and common names of all species caught on surveys from 1984 to 1991, together with an indication of presence or absence for each survey.

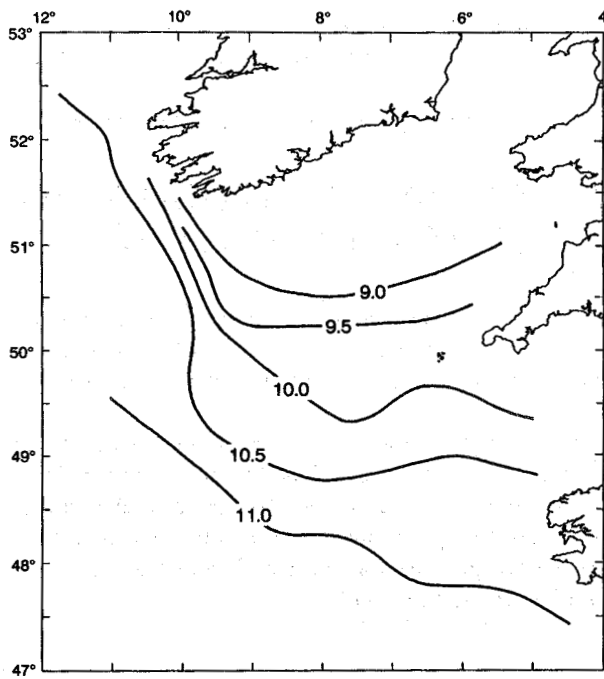


Figure 3. Surface water temperature (°C) recorded in March, 1991. Contours drawn by eye from temperatures recorded at trawl stations

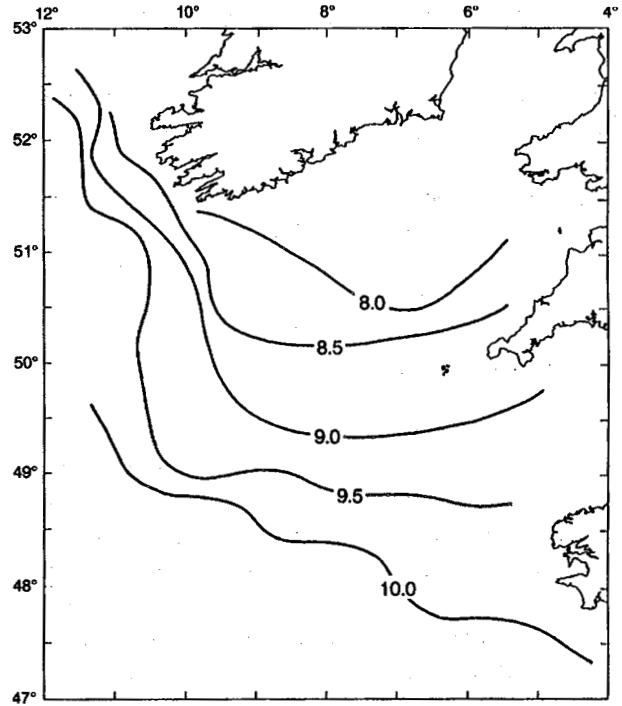


Figure 4. Temperature (°C) recorded on the bottom in March, 1991. Contours drawn by eye from temperatures recorded at trawl stations by a Scanmar temperature sensor attached to the trawl

Table 2. List of species taken on the surveys with an indication of presence on each survey

Latin name	Common name	1984	1985		1986		1987		1988		1989	1990	1991
		Dec	Mar	Dec	Mar	Dec	Mar	Dec	Mar	Dec	Mar	Mar	Mar
<i>Petromyzon marinus</i>	Sea lamprey										*		
<i>Hexanchus griseus</i>	Six-gilled shark		*		*								
<i>Galeus melastomus</i>	Black-mouthed dogfish										*		*
<i>Scyliorhinus canicula</i>	Lesser spotted dogfish	*	*	*	*	*	*	*	*	*	*	*	*
<i>Scyliorhinus stellaris</i>	Nursehound		*			*	*		*				*
<i>Galeorhinus galeus</i>	Tope shark	*		*	*	*	*	*	*	*	*	*	*
<i>Mustelus asterias</i>	Starry smooth hound		*		*	*		*	*		*	*	*
<i>Mustelus mustelus</i>	Smooth hound			*		*		*			*	*	*
<i>Squalus acanthias</i>	Spurdog	*	*	*	*	*	*	*	*	*	*	*	*
<i>Torpedo nobiliana</i>	Common electric ray			*		*	*						
<i>Torpedo torpedo</i>	Electric ray										*		
<i>Raja brachyura</i>	Blonde ray			*						*			*
<i>Raja microocellata</i>	Painted ray		*										
<i>Raja montagui</i>	Spotted ray		*	*	*	*	*	*	*	*	*	*	*
<i>Raja batis</i>	Common skate			*	*	*	*	*	*	*	*	*	*
<i>Raja nidarosiensis</i>	Black skate			*									
<i>Raja oxyrinchus</i>	Long-nose skate											*	
<i>Raja fullonica</i>	Shagreen ray	*	*	*	*	*	*	*	*	*	*	*	*
<i>Raja cicularis</i>	Sandy ray												*
<i>Raja naevus</i>	Cuckoo ray	*	*	*	*	*	*	*	*	*	*	*	*
<i>Raja undulata</i>	Undulate ray										*		
<i>Raja clavata</i>	Thornback ray	*	*	*	*	*	*	*	*	*	*	*	*
<i>Chimaera monstrosa</i>	Rabbit fish		*								*		
<i>Anguilla anguilla</i>	European eel					*				*			
<i>Conger conger</i>	European conger eel	*	*	*	*	*	*	*	*	*	*	*	*
<i>Alosa alosa</i>	Allis shad							*					
<i>Clupea harengus</i>	Herring	*	*	*	*	*	*	*	*	*	*	*	*
<i>Sprattus sprattus</i>	Sprat	*	*	*	*	*	*	*	*	*	*	*	*
<i>Sardina pilchardus</i>	Pilchard	*	*	*	*	*	*	*	*	*	*	*	*

Table 2. continued

Latin name	Common name	1984	1985		1986		1987		1988		1989	1990	1991
		Dec	Mar	Dec	Mar	Dec	Mar	Dec	Mar	Dec	Mar	Mar	
<i>Engraulis encrasicolus</i>	European anchovy	*	*	*	*		*	*	*	*	*	*	*
Argentinidae	Argentines	*	*	*	*	*	*	*	*	*	*	*	*
<i>Maurollicus muelleri</i>	Pearlside	*	*				*	*	*	*	*	*	*
Myctophidae	Lantern fishes			*									
<i>Lophius piscatorius</i>	Anglerfish (monk)	*	*	*	*	*	*	*	*	*	*	*	*
<i>Lophius budegassa</i>	White anglerfish	*	*	*	*	*	*	*	*	*	*	*	*
<i>Gadus morhua</i>	Cod	*	*	*	*	*	*	*	*	*	*	*	*
<i>Pollachius virens</i>	Saithe	*	*	*	*	*	*	*	*	*	*	*	*
<i>Pollachius pollachius</i>	Pollack	*	*	*	*	*	*		*	*	*	*	*
<i>Melanogrammus aeglefinus</i>	Haddock	*	*	*	*	*	*	*	*	*	*	*	*
<i>Rhinonemus cimbricus</i>	Four-bearded rockling		*	*		*							
<i>Phycis blennoides</i>	Greater forkbeard	*	*	*	*	*	*	*	*	*	*	*	*
<i>Trisopterus minutus</i>	Poor cod	*	*	*	*	*	*	*	*	*	*	*	*
<i>Trisopterus luscus</i>	Whiting-pout (bib)		*	*	*				*	*		*	*
<i>Trisopterus esmarkii</i>	Norway pout	*	*	*	*	*	*	*	*	*	*	*	*
<i>Merlangius merlangus</i>	Whiting	*	*	*	*	*	*	*	*	*	*	*	*
<i>Molva molva</i>	Common ling	*	*	*	*	*	*	*	*	*	*	*	*
<i>Molva macrophthalmalma</i>	Spanish ling			*									
<i>Gaidropsarus vulgaris</i>	Three-bearded rockling	*		*	*		*	*	*	*	*	*	*
<i>Gadiculus argenteus</i>	Silvery pout	*	*	*	*	*	*	*	*	*	*	*	*
<i>Micromesistius poutassou</i>	Blue whiting	*	*	*	*	*	*	*	*	*	*	*	*
<i>Merluccius merluccius</i>	European hake	*	*	*	*	*	*	*	*	*	*	*	*
<i>Echiodon drummondi</i>	Pearlfish			*	*			*		*			
<i>Coryphaenoides rupestris</i>	Roundnose grenadier						*						
<i>Malacocephalus laevis</i>	Soft-headed rattail			*				*		*			
<i>Belone belone</i>	Garfish	*						*					
<i>Zeus faber</i>	John Dory	*	*	*	*	*	*	*	*	*	*	*	*
<i>Capros aper</i>	Boar fish	*	*	*	*	*	*	*	*	*	*	*	*
<i>Macroramphosus scolopax</i>	Snipe-fish	*	*					*		*	*	*	*
<i>Heliocolenus dactylopterus</i>	Blue-mouth redfish	*	*	*	*	*	*	*	*	*	*	*	*
<i>Trigla lucerna</i>	Tub gurnard		*	*	*	*	*	*	*	*	*	*	*
<i>Eutrigla gurnardus</i>	Grey gurnard	*	*	*	*	*	*	*	*	*	*	*	*
<i>Aspitrigla cuculus</i>	Red gurnard	*	*	*	*	*	*	*	*	*	*	*	*
<i>Taurulus bubalis</i>	Sea scorpion												*
<i>Agonus cataphractus</i>	Pogge (armed bullhead)					*						*	*
<i>Trachurus trachurus</i>	Horse mackerel (scad)	*	*	*	*	*	*	*	*	*	*	*	*
<i>Trachurus mediterraneus</i>	Mediterranean scad			*			*						*
<i>Pagellus bogaraveo</i>	Red seabream	*	*	*		*		*				*	
<i>Spondyliosoma cantharus</i>	Black seabream				*				*				*
<i>Mullus surmuletus</i>	Red mullet	*	*	*	*	*	*		*	*	*	*	*
<i>Dicentrarchus labrax</i>	European seabass				*				*				*
Mugilidae	Mullet								*				
<i>Labrus mixtus</i>	Cuckoo wrasse					*							
<i>Trachinus vipera</i>	Lesser weever fish		*		*	*	*		*	*	*	*	*
<i>Blennius ocellaris</i>	Butterfly blenny						*					*	
Ammodytidae	Sandeels	*	*			*		*		*			
Callionymiidae	Dragonets	*	*	*	*	*	*	*	*	*	*	*	*
Gobiidae	Gobies	*	*	*		*	*	*	*	*	*	*	*
<i>Benthodesmus simonyi</i>	Silvery scabbard fish		*										
<i>Scomber scombrus</i>	Mackerel	*	*	*	*	*	*	*	*	*	*	*	*
<i>Scophthalmus maximus</i>	Turbot			*						*	*		*
<i>Scophthalmus rhombus</i>	Brill		*		*		*		*		*		*
<i>Arnoglossus laterna</i>	Scaldfish	*	*	*	*	*	*	*		*	*	*	*
<i>Arnoglossus imperialis</i>	Imperial scaldfish	*	*	*	*	*	*	*	*	*	*	*	*
<i>Lepidorhombus boscii</i>	Four-spot megrim	*	*	*	*	*	*	*	*	*	*	*	*
<i>Lepidorhombus whiffiagonis</i>	Megrim	*	*	*	*	*	*	*	*	*	*	*	*
<i>Glyptocephalus cynoglossus</i>	Witch	*	*	*	*	*	*	*	*	*	*	*	*
<i>Hippoglossoides platessoides</i>	Long rough dab	*	*	*	*	*	*	*	*	*	*	*	*
<i>Limanda limanda</i>	Dab	*	*	*	*	*	*	*	*	*	*	*	*
<i>Microstomus kitt</i>	Lemon sole	*	*	*	*	*	*	*	*	*	*	*	*
<i>Platichthys flesus</i>	Flounder		*										
<i>Pleuronectes platessa</i>	Plaice	*	*	*	*	*	*	*	*	*	*	*	*
<i>Solea solea</i>	Sole	*	*	*	*	*	*	*	*	*	*	*	*
<i>Microchirus variegatus</i>	Thickback sole	*	*	*	*	*	*	*	*	*	*	*	*

7. SPECIES DISTRIBUTIONS

Figures 5 to 18 show abundance distributions, as numbers of fish caught per 60 min tow, of the main species on each survey. The figures are arranged so that the winter (December) survey for one year is presented next to the spring (March/April) survey for the following year. This layout enables the winter distributions to be easily compared with those of the following spring. From 1989 onwards only spring surveys were undertaken. The species thus illustrated are as follows:

Hake, excluding juveniles
Hake, juveniles (0-group in December, 1-group in March)
Anglerfish
White anglerfish
Megrin
Four-spot megrim
Cod
Blue whiting
Poor cod
Norway pout
Mackerel, excluding 0- or 1-group
Mackerel, juveniles (0-group in December, 1-group in March)
Horse mackerel, excluding 0- or 1-group
Horse mackerel, (0-group in December, 1-group in March)

In addition Figures 19 and 20 show single survey (March 1991) examples of distributions for haddock, whiting, grey gurnard, red gurnard, lesser-spotted dogfish, John Dory, boarfish and lemon sole.

The distribution maps were plotted using the software package Surfer (Golden Software, Inc.). In the figures '+' represents a station position. At stations where the species was caught the abundances, in terms of numbers caught per 60 min tow, have been plotted as circles the diameter of which is proportional to the square root of the numbers caught. A square root relationship has been used to accommodate what is often a large range in abundance. The same scale has been used for all the charts for a 'species' and a key to the scale is given in the lower left-hand corner of each chart to aid comparison between species

7.1 Hake (*Merluccius merluccius*), 0- or 1-group excluded (Figure 5)

Hake from the surveys have not been aged due to difficulties in interpreting otoliths. 0-group fish (December surveys) or 1-group fish (March surveys) have therefore been separated from the older fish by identifying the mode of the youngest age group in the length composition of the catch and splitting the length composition at the trough between the youngest and the

older age groups. Normally this results in fish less than about 21 cm being classed as the youngest age group.

Hake (excluding 0- or 1-group) are distributed over the whole survey area at densities generally of less than 50 fish per hour. Higher densities occur in the deeper water at the shelf edge. There is, perhaps, an indication of a greater abundance along the shelf edge in the spring, possibly the result of a movement towards the shelf edge to spawn.

7.2 Hake (*Merluccius merluccius*), 0- or 1-group (Figure 6)

Hake of the youngest age group are distributed on the continental shelf to the south of Ireland and particularly in the Bay of Biscay as exemplified in the earlier surveys which extended further south beyond the current survey area. The latter area is a well known nursery ground for hake and the young are particularly associated with areas of muddy bottom. The survey results provide an indication of the strength of pre-recruit yearclasses, those of 1985 and 1990 being particularly abundant.

7.3 Anglerfish (*Lophius piscatorius*) (Figure 7)

Anglerfish are distributed over the whole survey area at relatively low densities.

7.4 White anglerfish (*Lophius budegassa*) (Figure 8)

White anglerfish have a similar distribution to anglerfish occurring at relatively low densities over the survey area. However, unlike anglerfish, white anglerfish show an increasing density towards the shelf edge.

7.5 Megrin (*Lepidorhombus whiffiagonis*) (Figure 9)

Megrin are widely distributed over the survey area with the highest abundances being recorded towards the shelf edge. Very little difference in distribution is apparent between the spring and winter surveys but, as spawning takes place in spring in the vicinity of the shelf edge, it is possible that adult fish migrate offshore from the shallower areas to spawn. During the spring females have a wider distribution into shallow water with the males being more restricted to the shelf edge.

7.6 Four-spot megrim (*Lepidorhombus boscii*) (Figure 10)

Four-spot megrim are recorded at lower densities than megrim. Their distribution is restricted to the deeper waters towards the edge of the shelf.

7.7 Cod (*Gadus morhua*) (Figure 11)

Cod abundance varies considerably from year to year according to the strength of yearclasses. In normal years only low numbers per haul are recorded and they are distributed mainly on the plateau, rather than in the deep water, with abundance tending to decrease from north to south.

7.8 Blue whiting (*Micromesistius poutassou*) (Figure 12)

Blue whiting are recorded at low densities over the continental shelf but the highest densities, in both winter and spring, are found in the deeper water at the shelf edge.

7.9 Poor cod (*Trisopterus minutus*) (Figure 13)

Poor cod occur over the whole of the survey area but the greatest densities are found in the south-east around Cornwall, in the western English Channel and west of Ushant. Their abundance is highly variable and high densities may be recorded. The distribution of poor cod is, to some extent complementary to that of Norway pout.

7.10 Norway pout (*Trisopterus esmarkii*) (Figure 14)

Norway pout is a more northern species than poor cod. In the survey area it is most abundant in the northern Celtic Sea and its distribution does not extend into the southern part of the area or into the deeper waters. Abundances in the winter surveys have tended to be greater than in the spring ones.

7.11 Mackerel (*Scomber scombrus*), 0- or 1-group excluded (Figure 15)

Samples of mackerel caught on the surveys are aged on a routine basis. However for the purposes of these distribution charts the separation into the youngest and older age groups is done on the basis of the length distributions as there is normally no overlap of the modes. The split is usually at about 23 cm.

Mackerel in the survey area belong to the Western stock. The adults of this stock have a regular annual pattern of migration. Spawning takes place along the shelf edge west of Ireland and south into the Bay of Biscay in the spring and early summer after which there is a movement northwards to the waters around Scotland and the northern North Sea. The survey area covers a large part of the mackerel spawning grounds and during the spring survey the adults are aggregating on

the spawning grounds with the highest densities being recorded along the shelf edge and in the western approaches to the English Channel. Catch rates in excess of 1 tonne per hour are not uncommon. In the winter surveys mackerel are much less abundant in the survey area as a large proportion of the stock are in the more northern areas. Catch-per-unit-effort data series from these surveys have recently been used in an ICES assessment Working Group to tune a Virtual Population Analysis of the Western stock of mackerel (Anon., 1993) giving a similar result to the assessment tuned to egg survey results. Should groundfish surveys prove to be a reliable source of data for tuning Western mackerel stock assessments then they should offer a much cheaper alternative to the international egg surveys.

7.12 Juvenile mackerel (*Scomber scombrus*), 0- or 1-group (Figure 16)

Juvenile mackerel occur throughout the survey area in both the spring and winter surveys. Their distribution tends to be very patchy with the young fish frequently occurring in dense shoals. Abundance indices from these surveys are combined with data from other surveys to give overall annual indices of abundance of pre-recruit mackerel as first and second winter fish which are used in catch predictions.

7.13 Horse mackerel (*Trachurus trachurus*), 0- or 1-group excluded (Figure 17)

Horse mackerel have not been aged and the youngest age group has been separated on the basis of the length compositions of the catches. Normally the split between the youngest and the older age groups is at about 15 cm.

In the spring surveys adult horse mackerel tend to have a distribution in the survey area similar to that of mackerel. The horse mackerel spawn in a similar area to mackerel and at a similar time of year. Unlike mackerel, horse mackerel are also abundant in the area during the winter survey with the highest densities in the western English Channel and at the shelf edge. Catch rates in excess of 1 tonne per hour are not uncommon.

7.14 Juvenile horse mackerel (*Trachurus trachurus*), 0- or 1-group (Figure 18)

As with juvenile mackerel the young horse mackerel tend to occur in dense shoals but their distribution tends to be less patchy with the highest densities occurring in the western approaches to the English Channel and in the northern part of the Bay of Biscay.

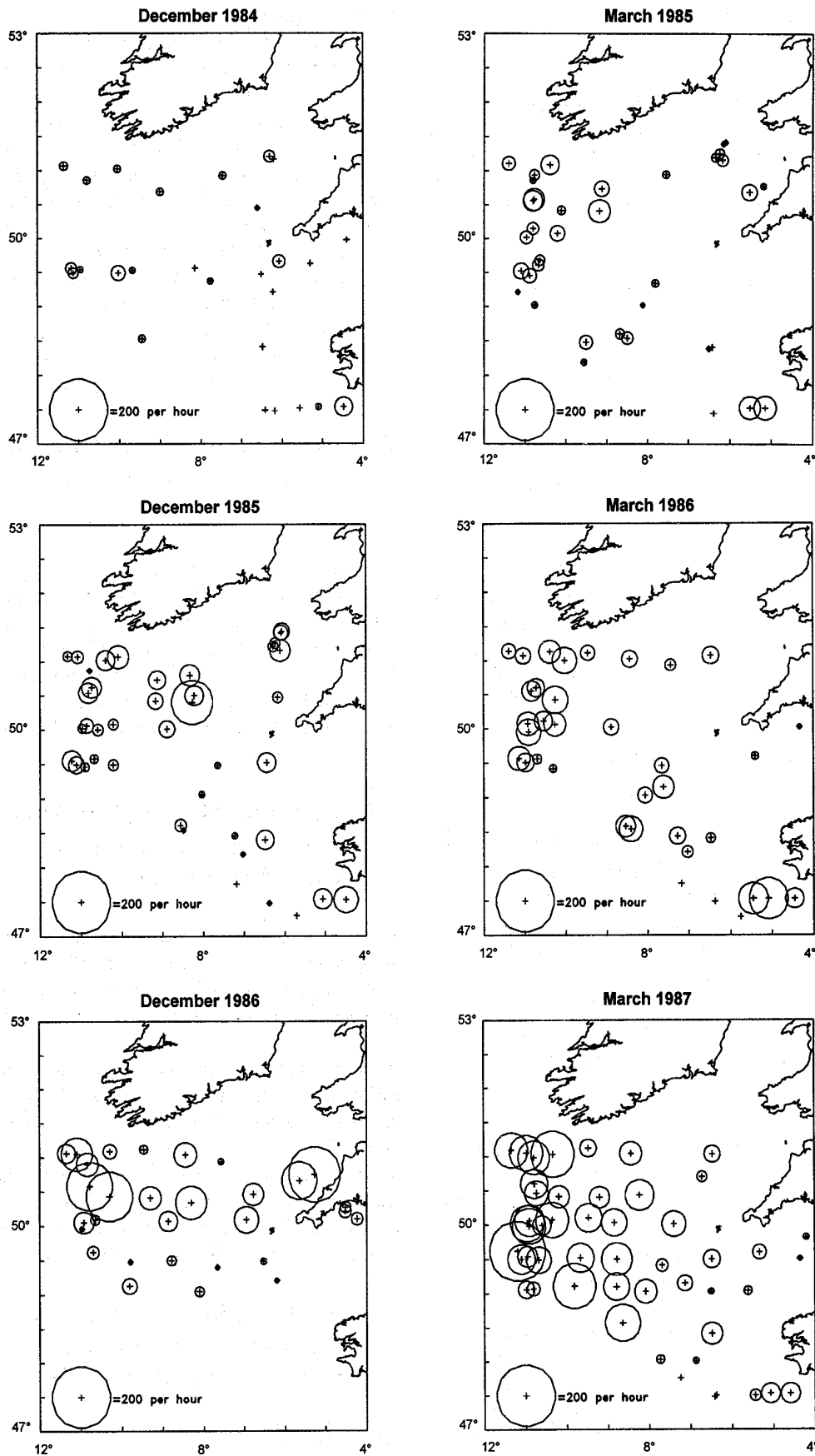


Figure 5. Hake (excluding 0- or 1-group). Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

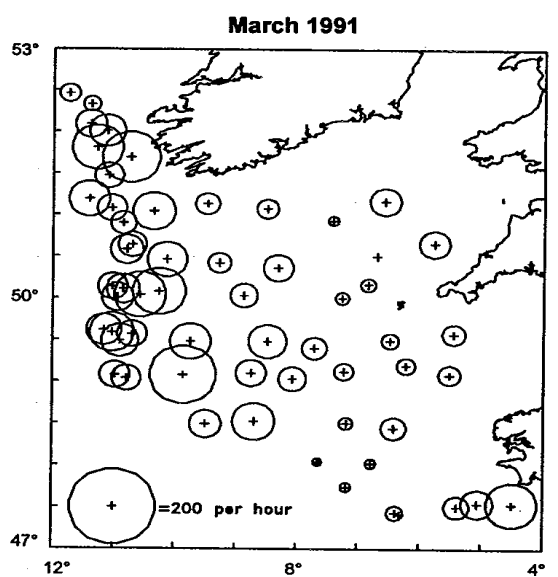
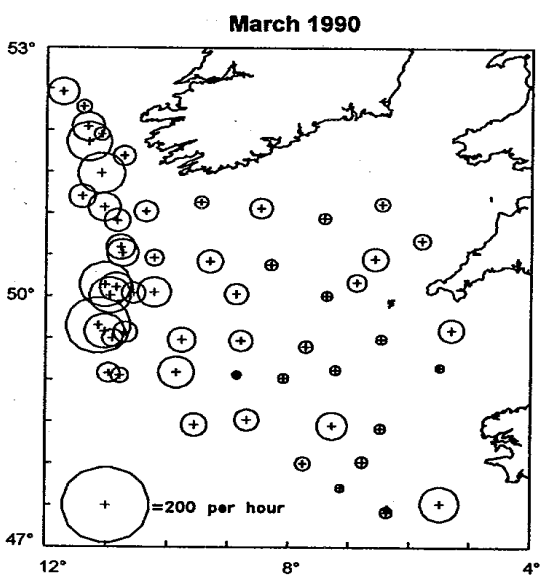
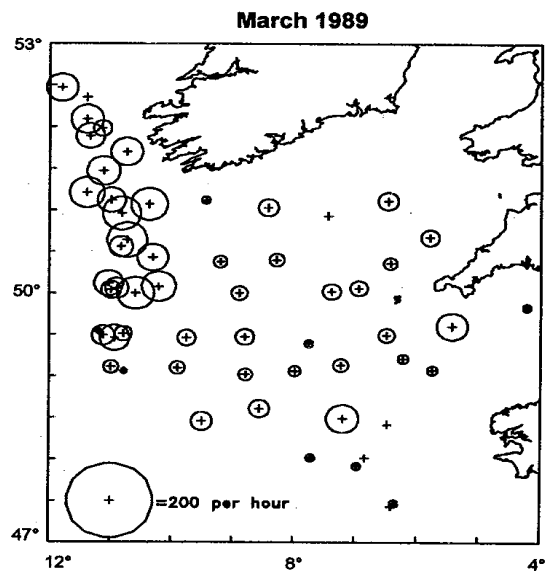
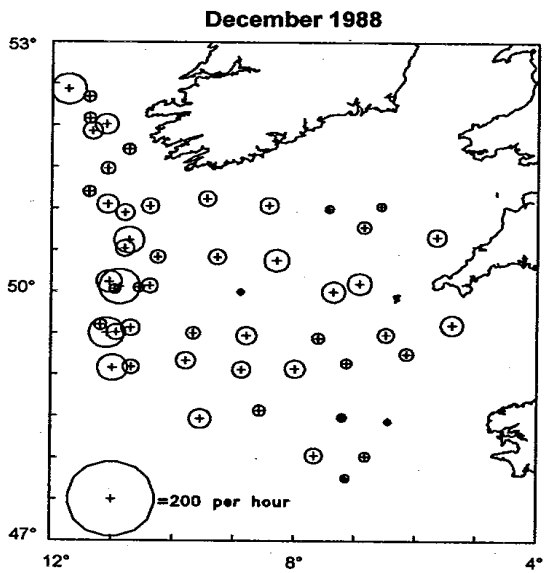
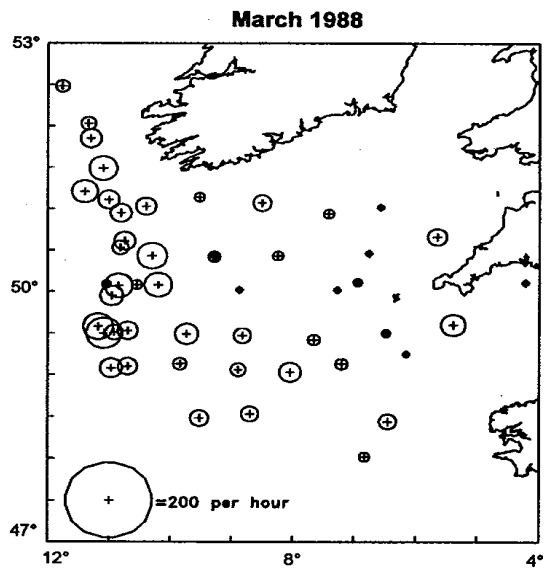
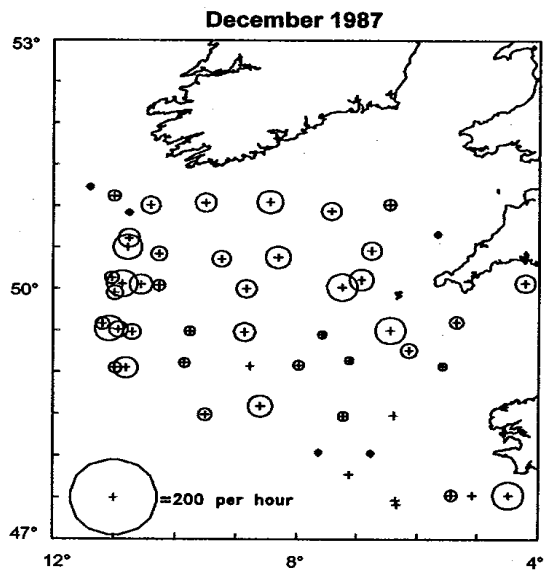


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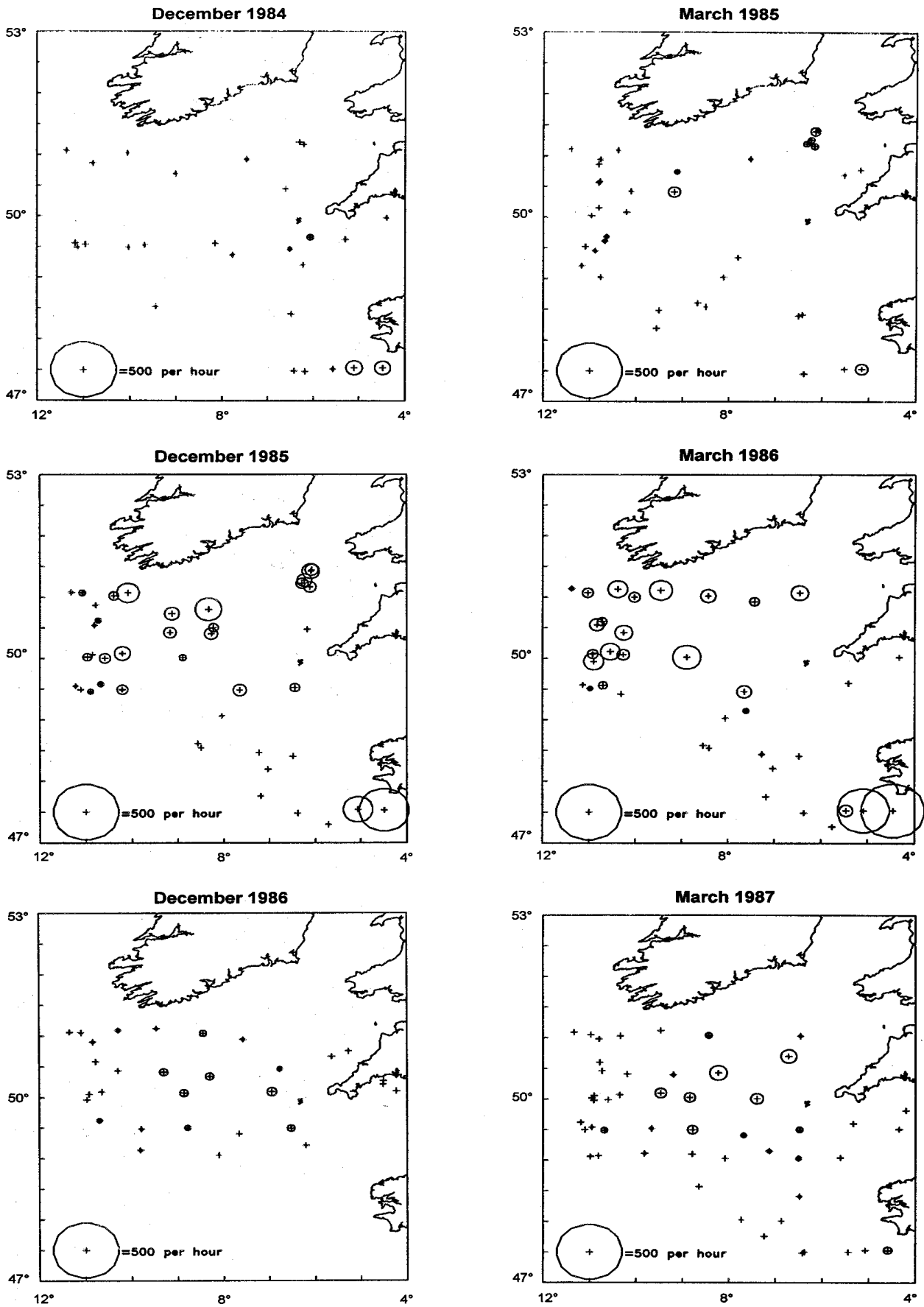


Figure 6. 0- or 1-group hake. Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

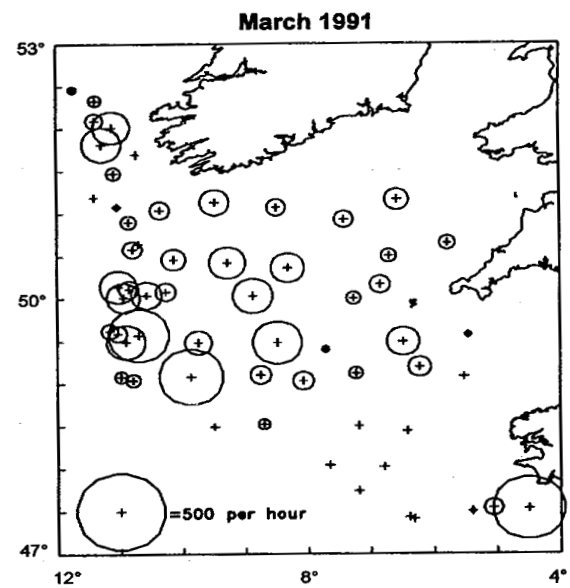
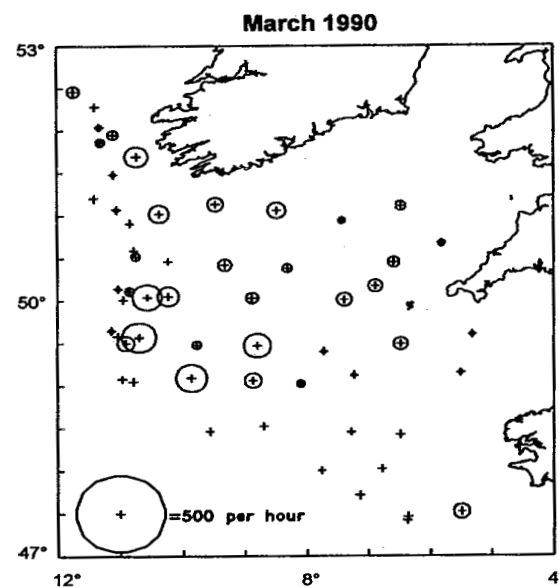
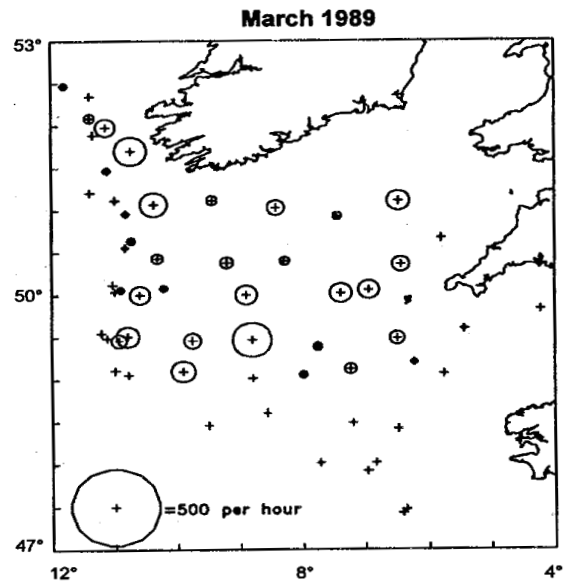
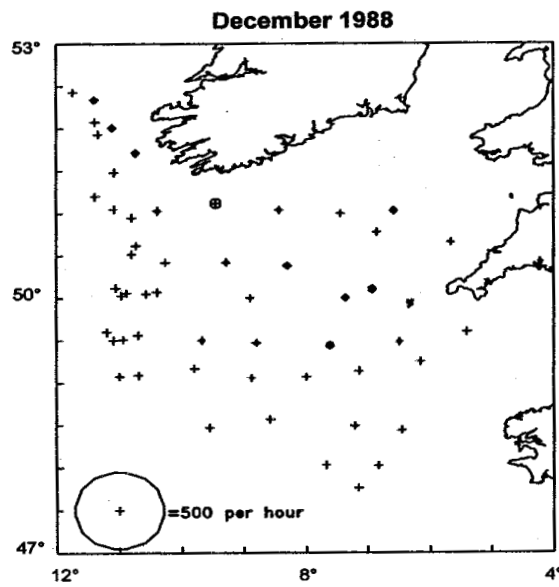
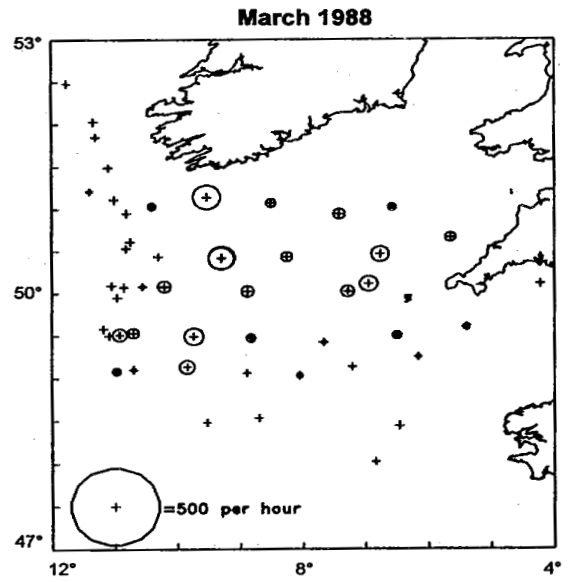
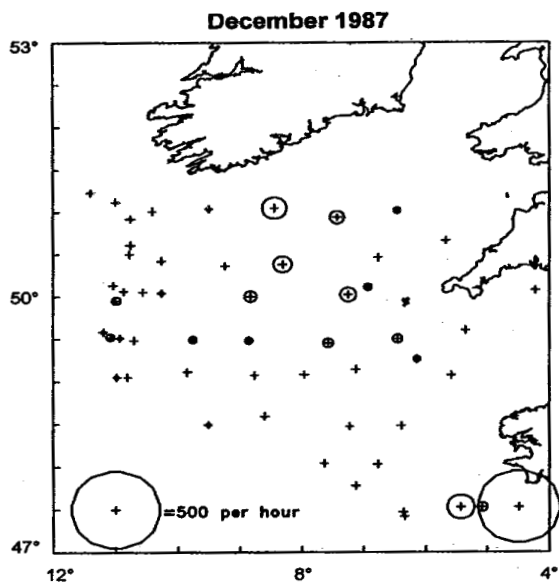


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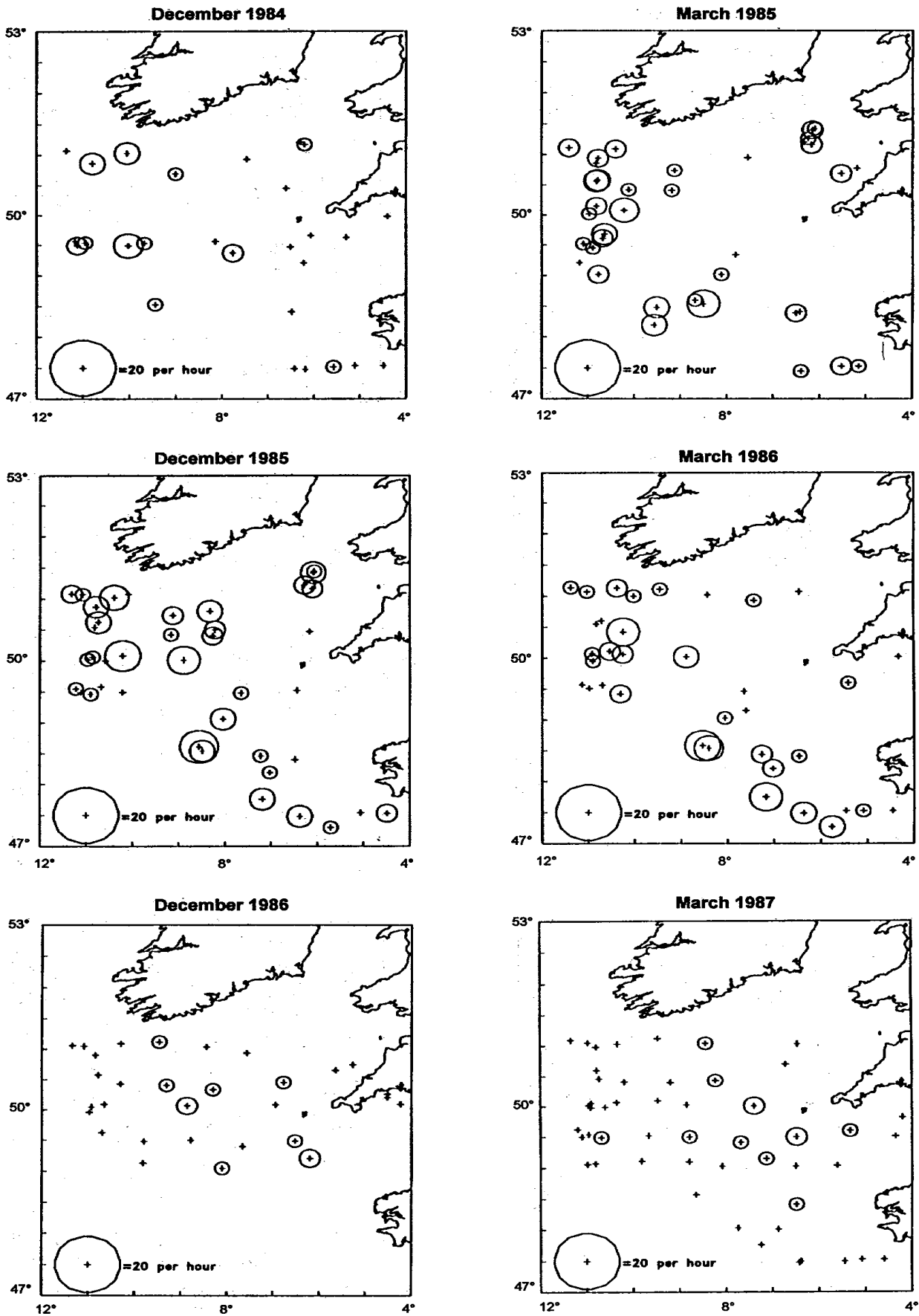


Figure 7. Anglerfish (*Lophius piscatorius*). Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

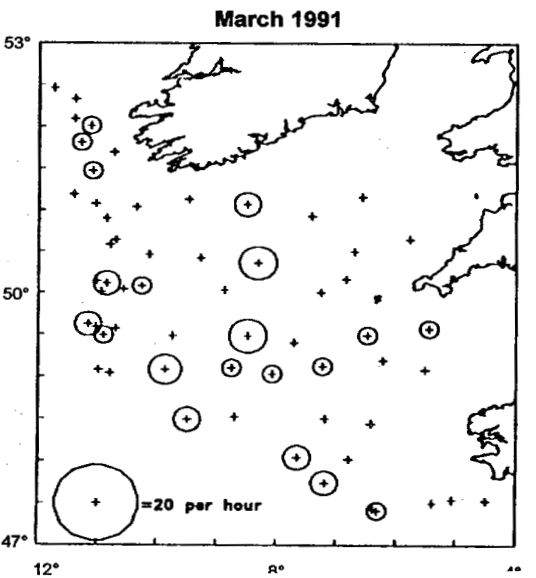
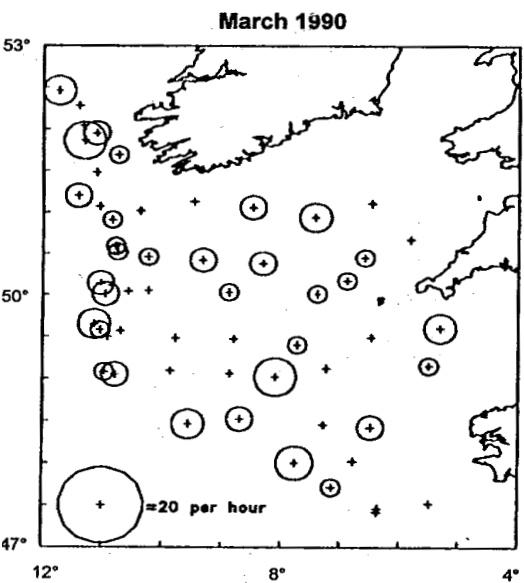
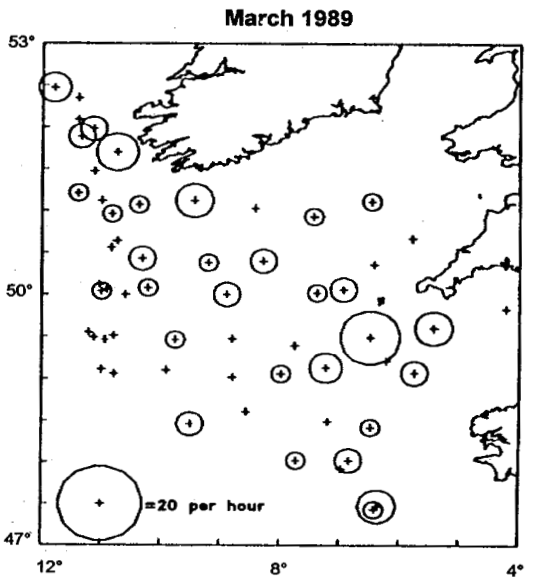
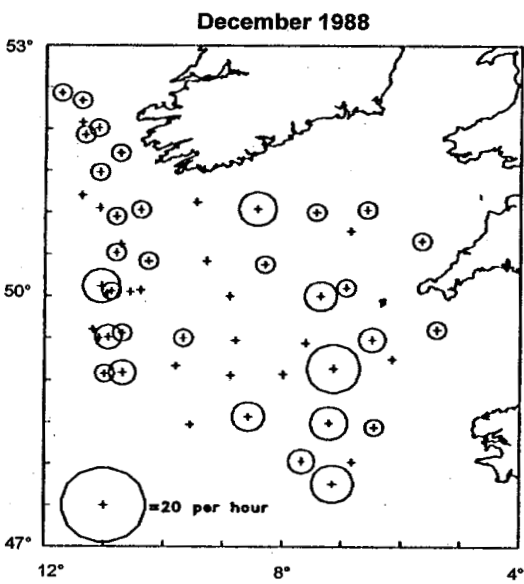
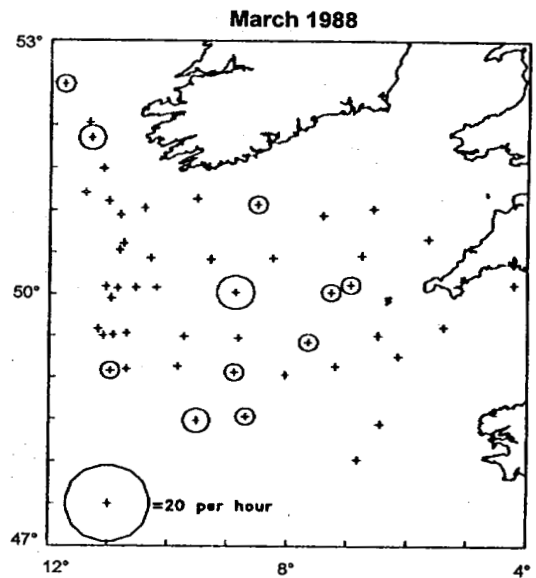
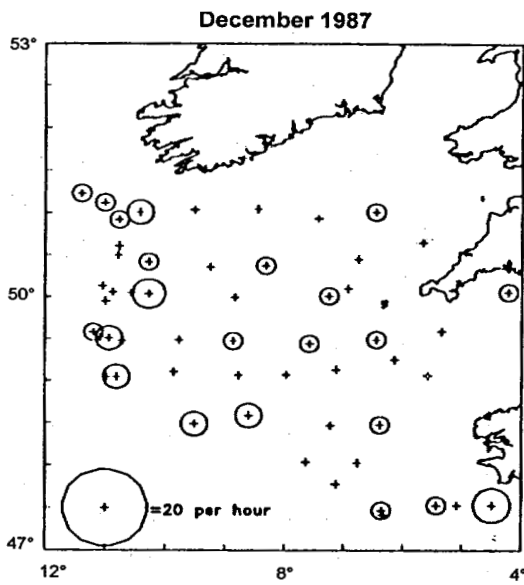


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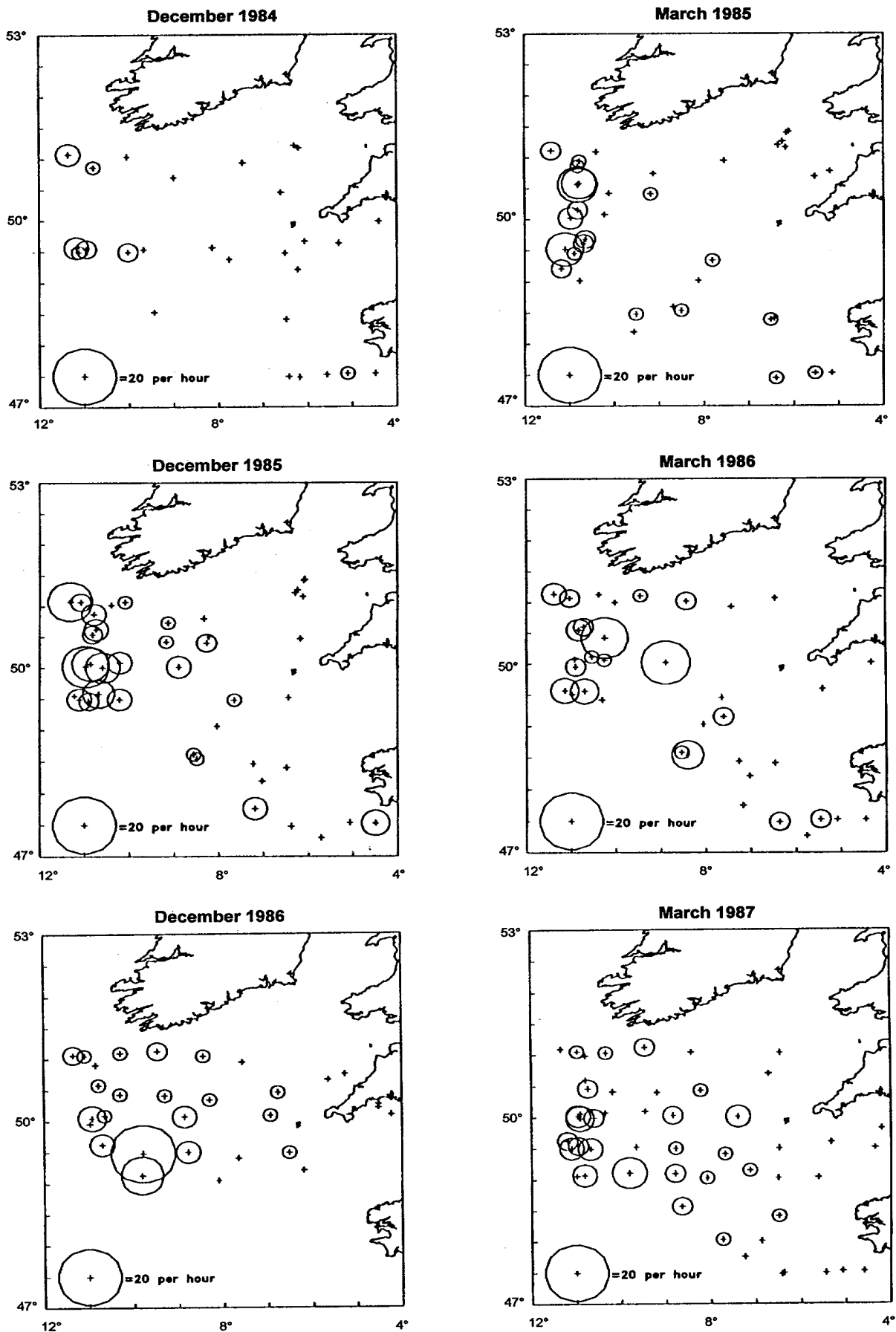


Figure 8. White anglerfish (*Lophius budegassa*). Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

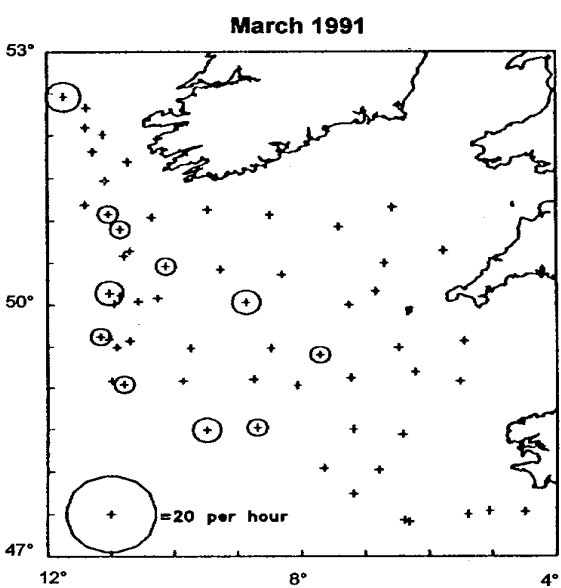
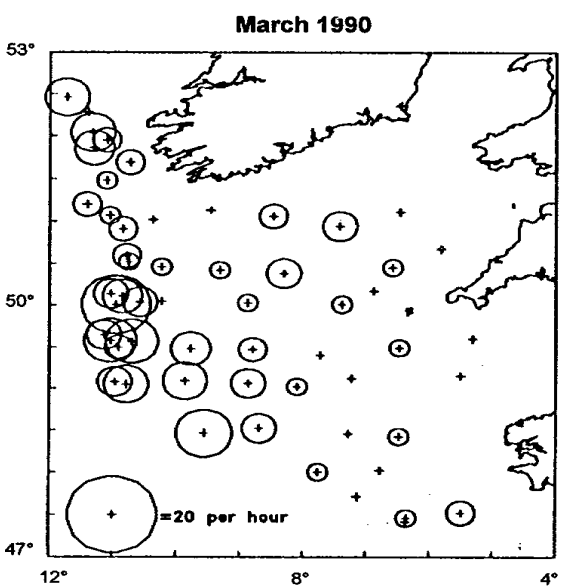
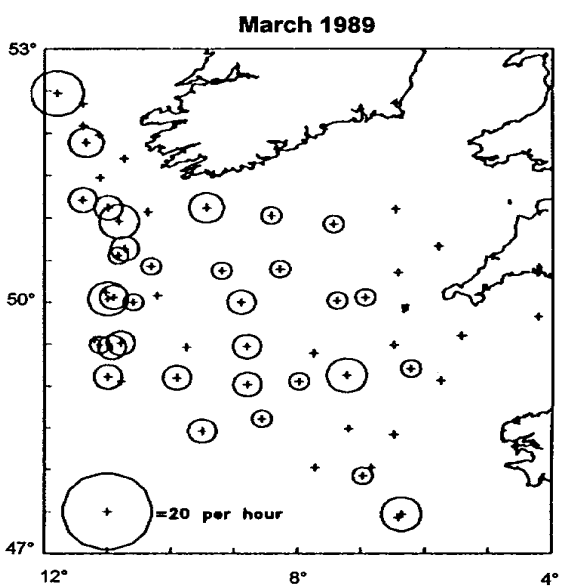
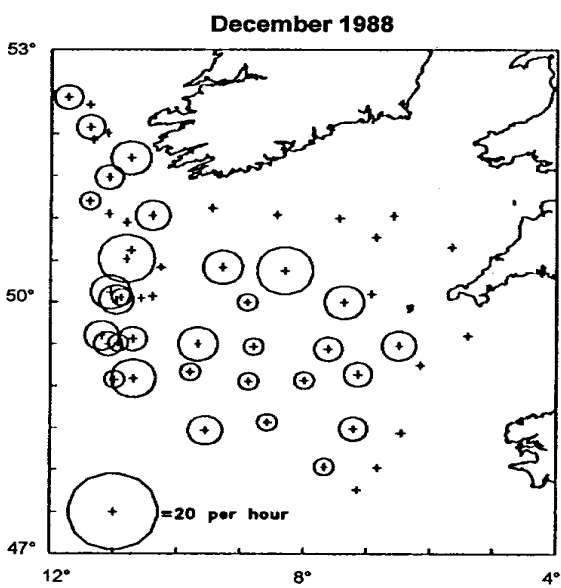
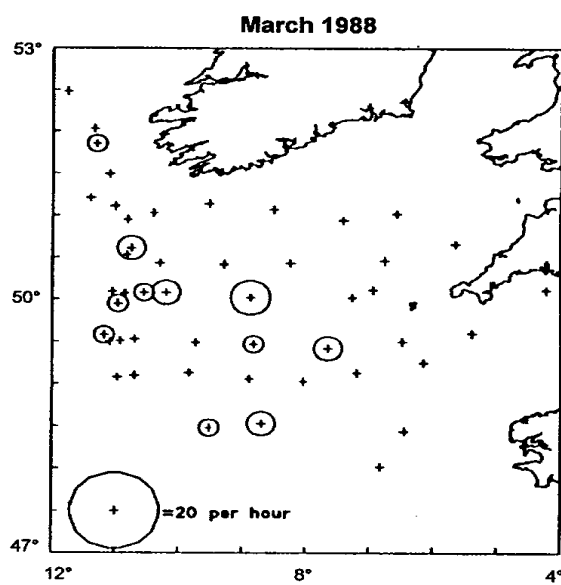
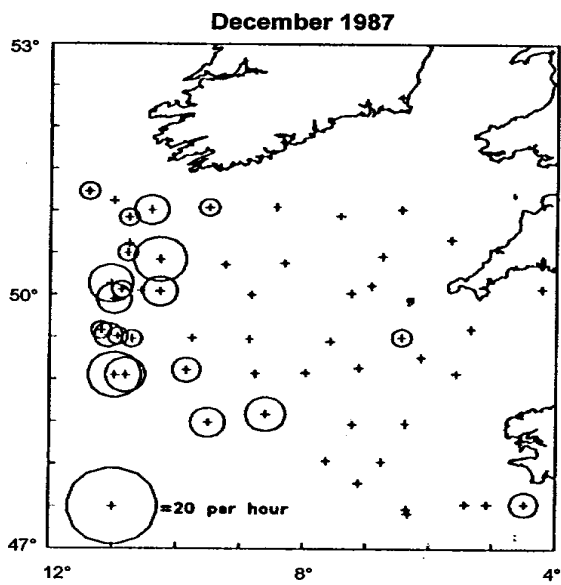


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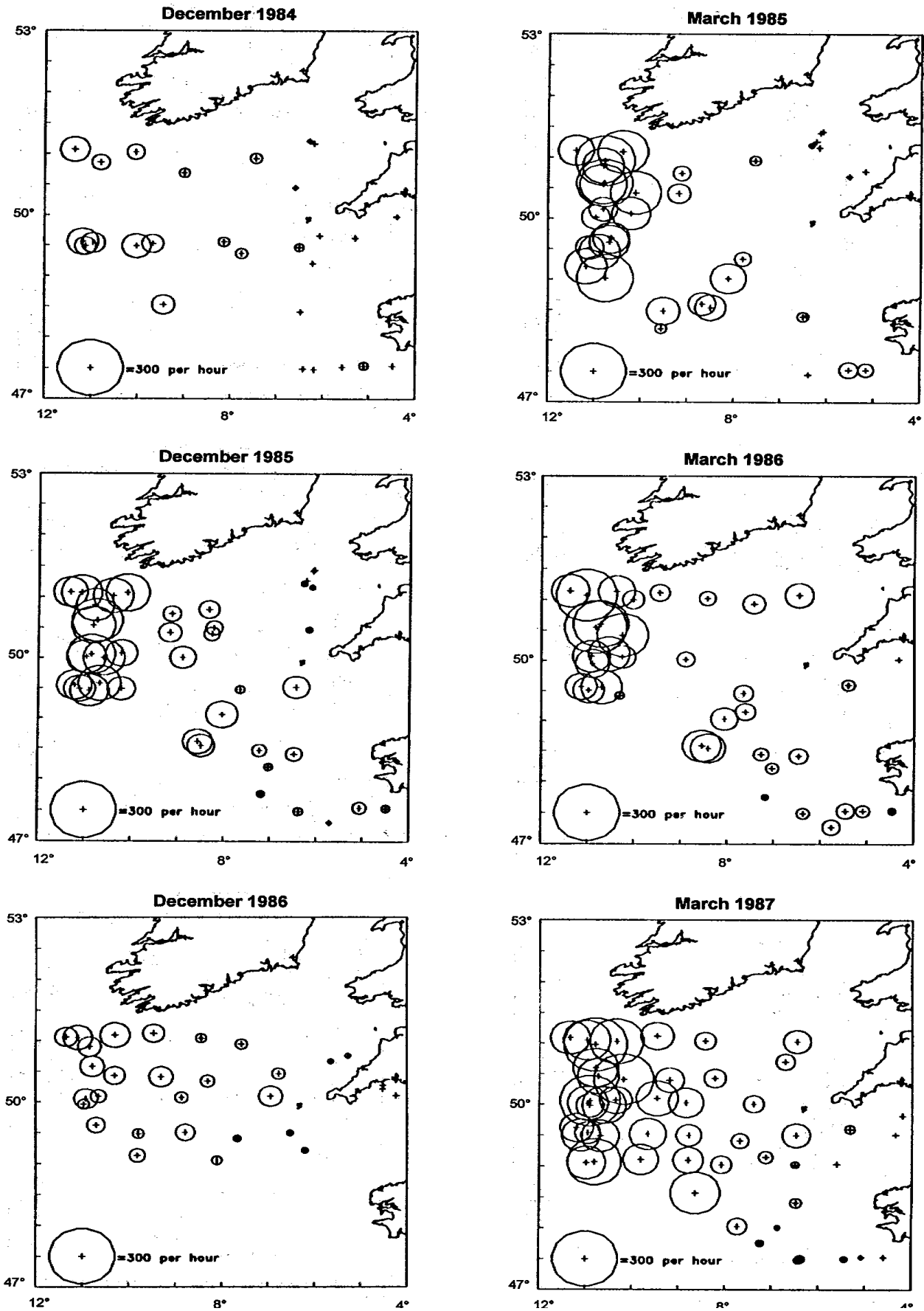


Figure 9. Megrim (*Lepidorhombus whiffiagonis*). Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

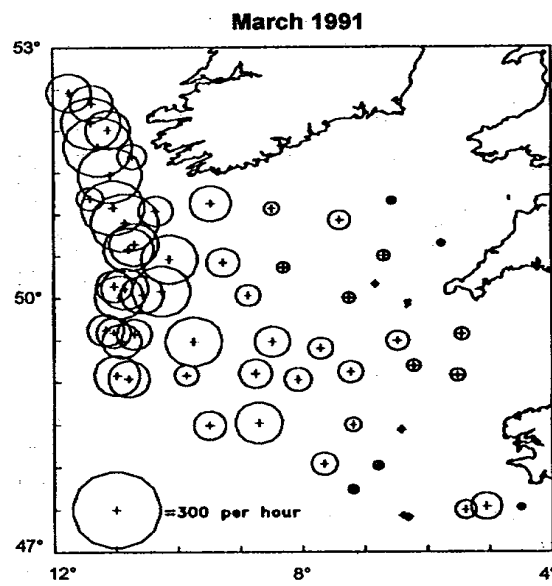
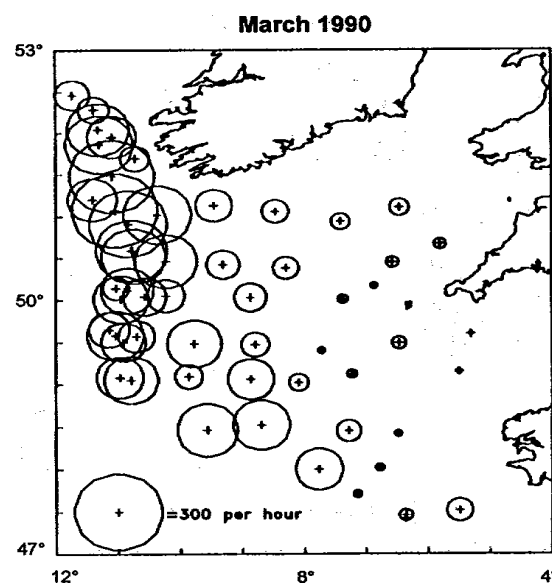
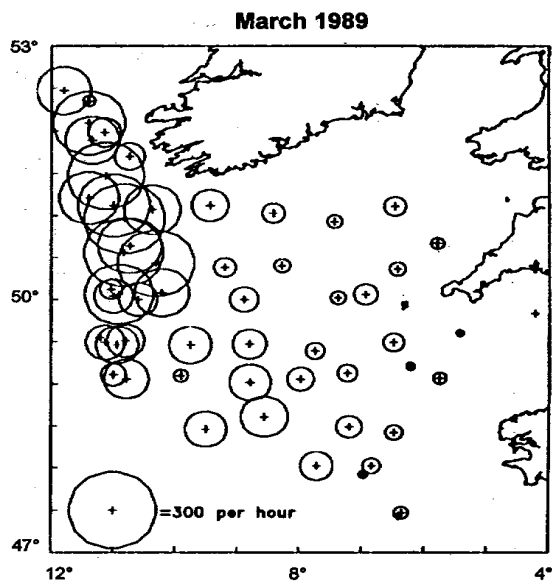
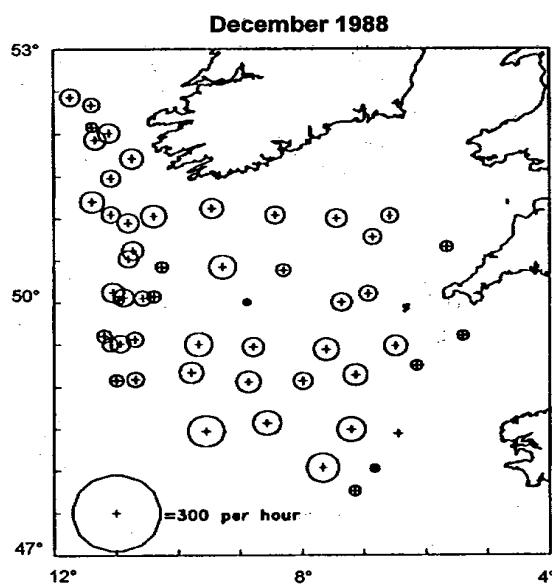
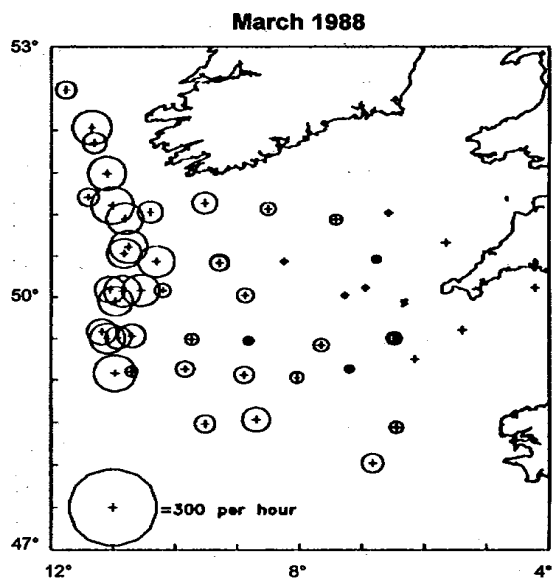
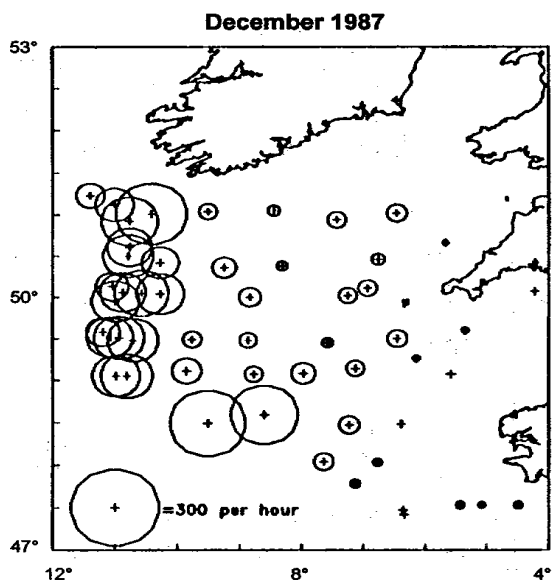


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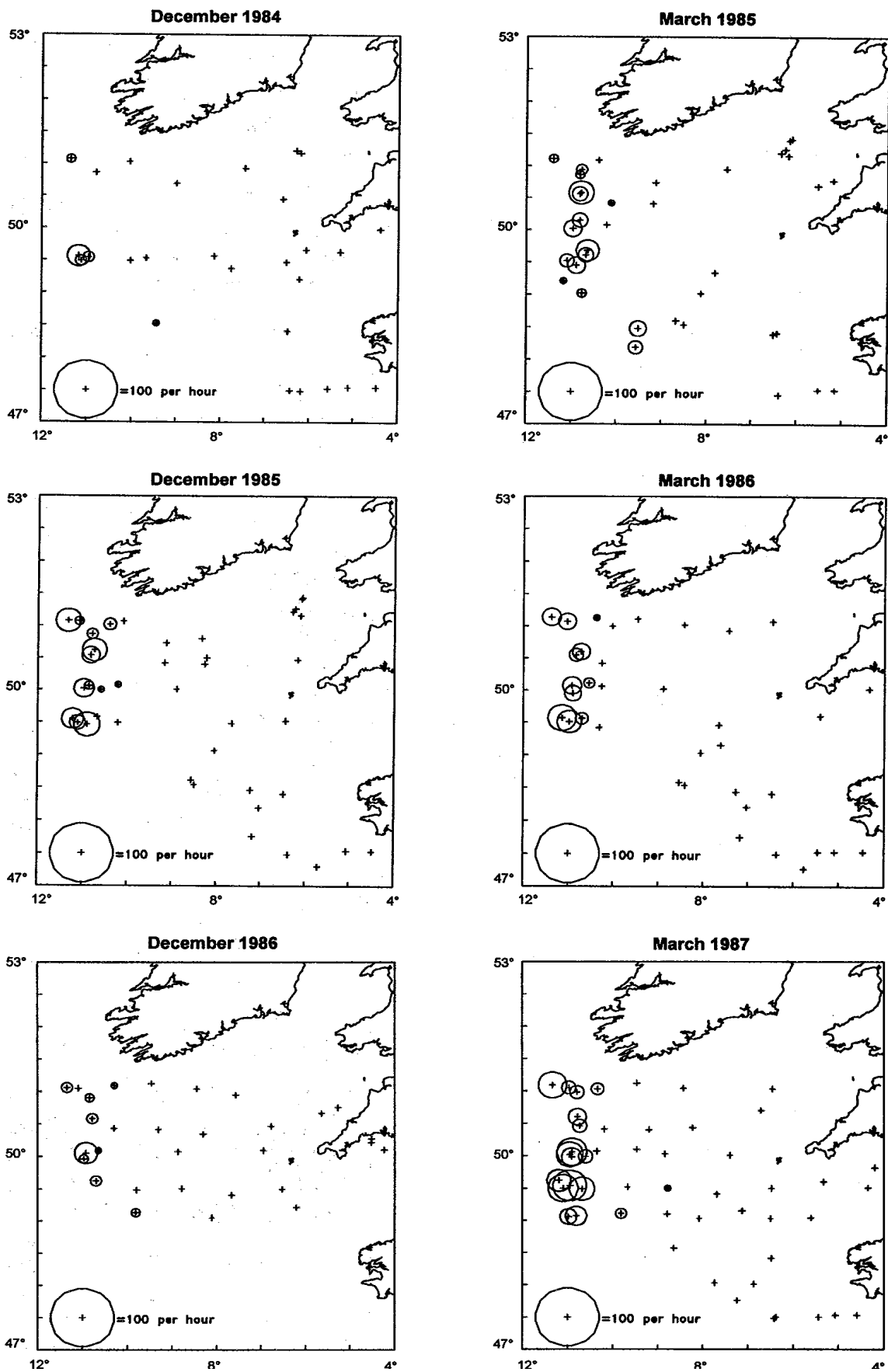


Figure 10. Four-spot megrim (*Lepidorhombus boscii*). Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

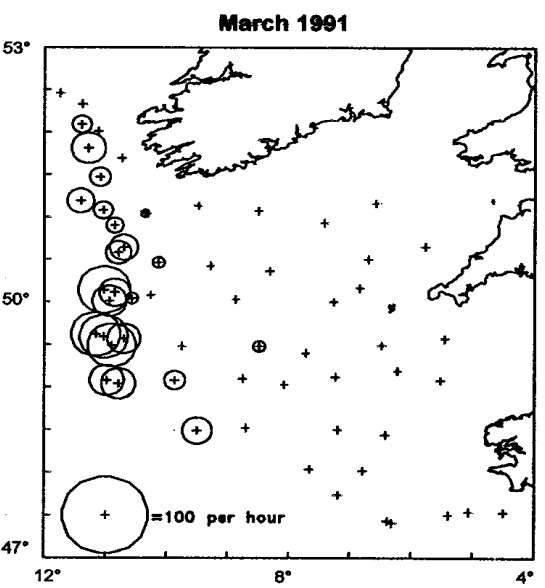
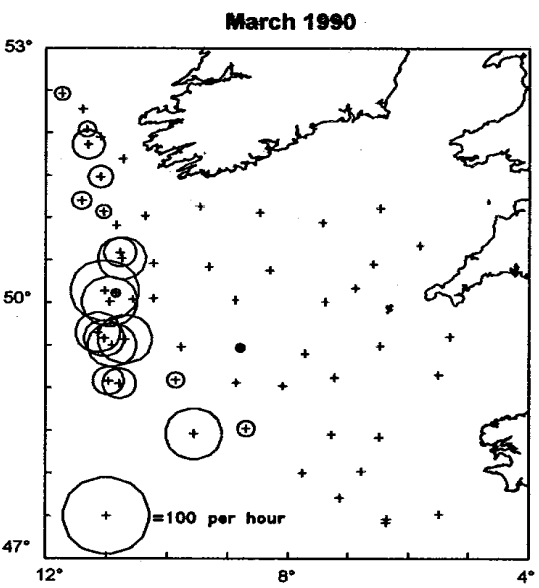
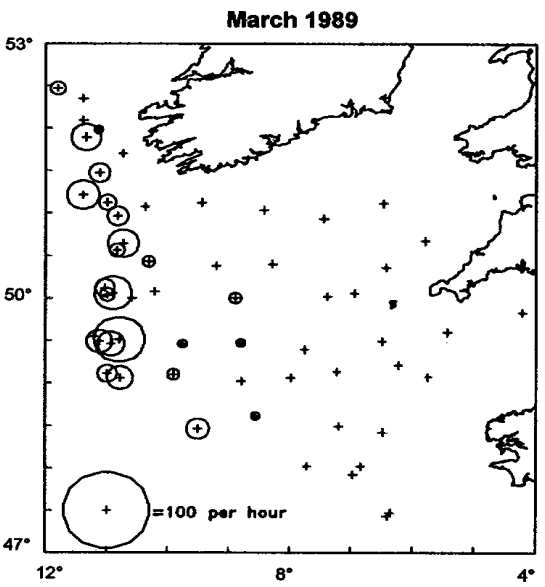
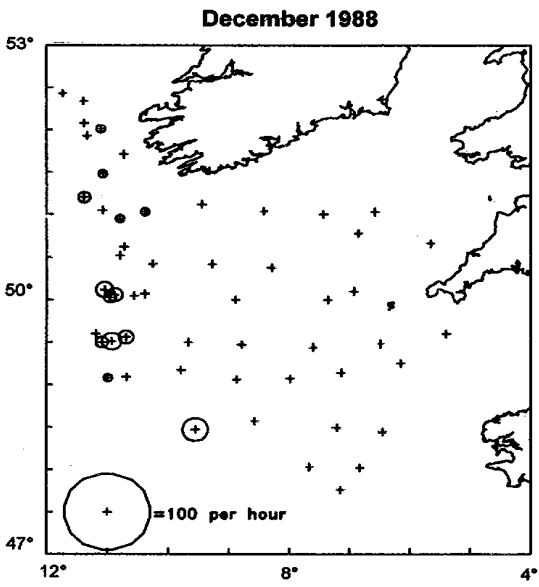
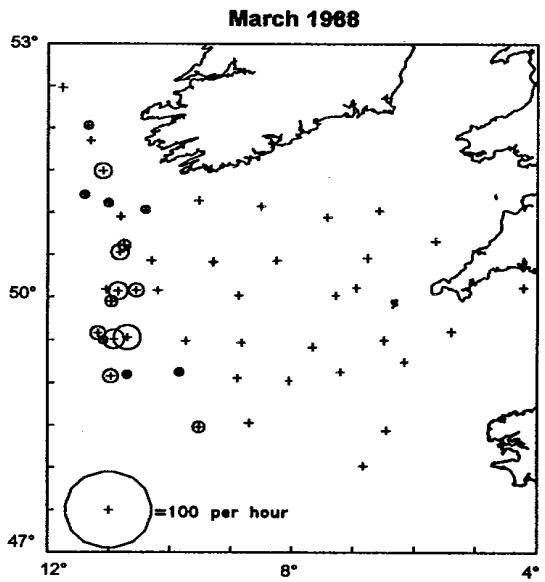
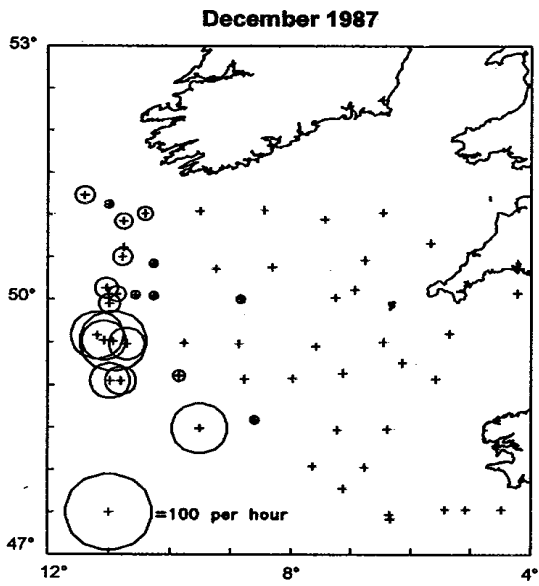


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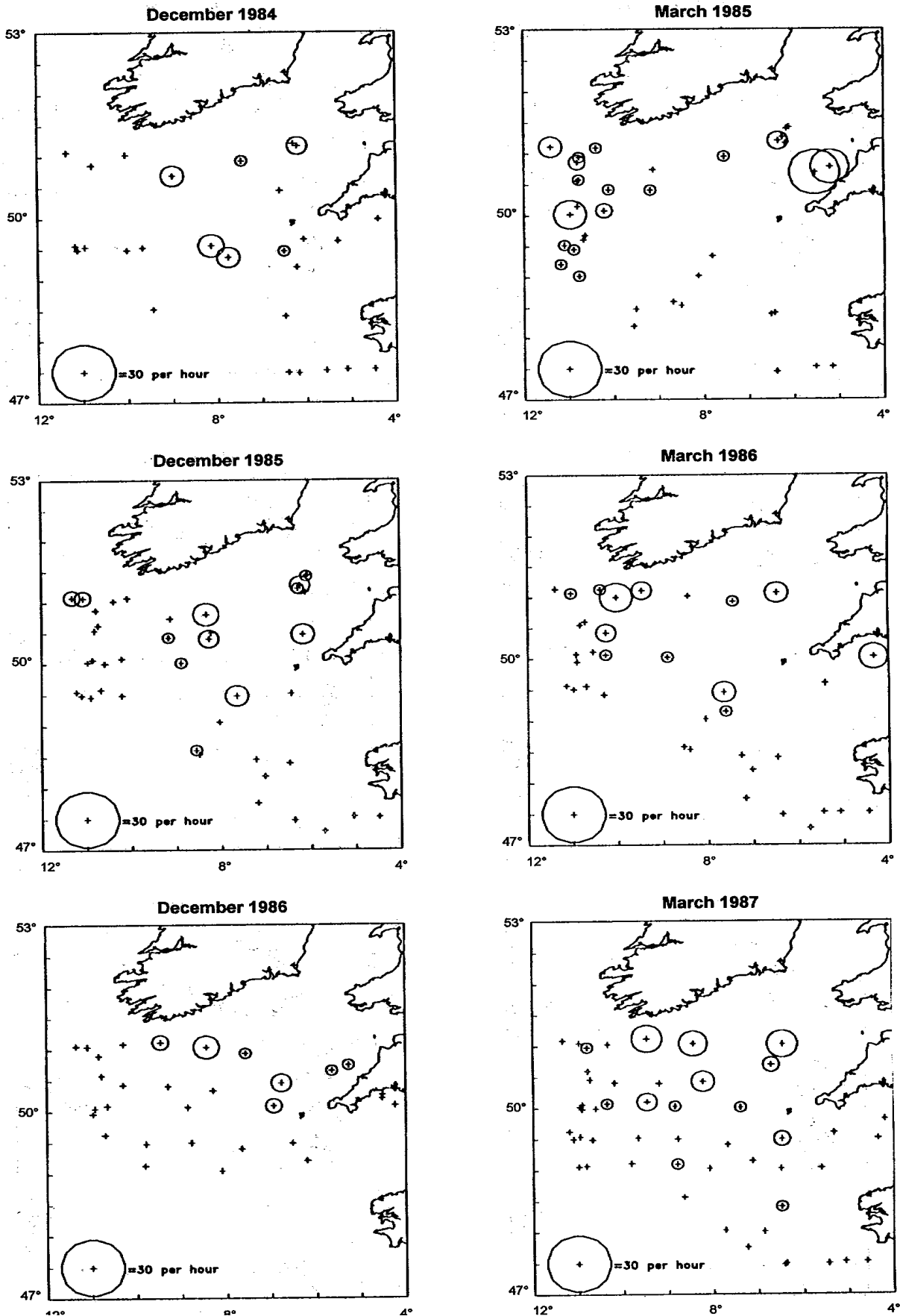


Figure 11. Cod. Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

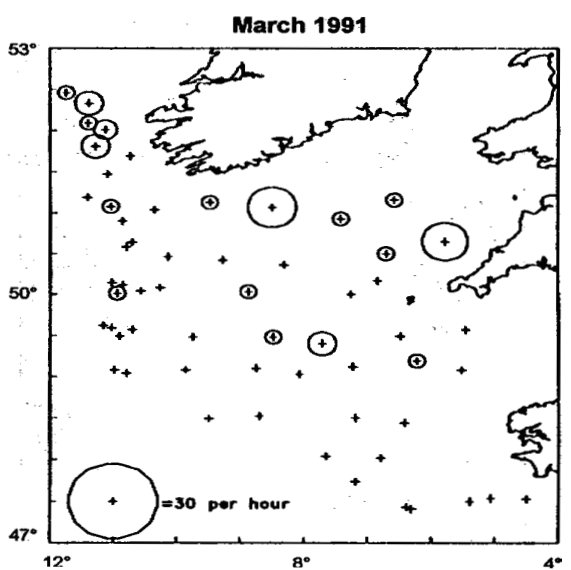
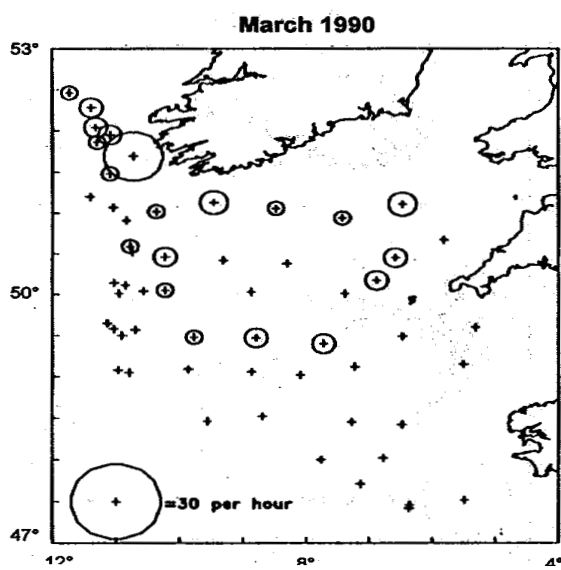
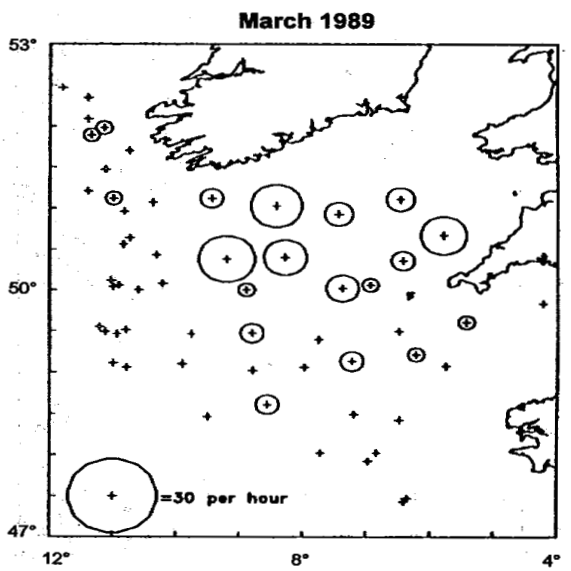
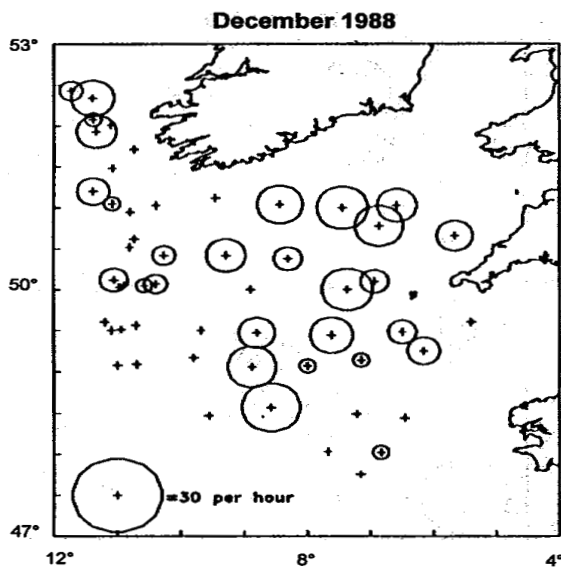
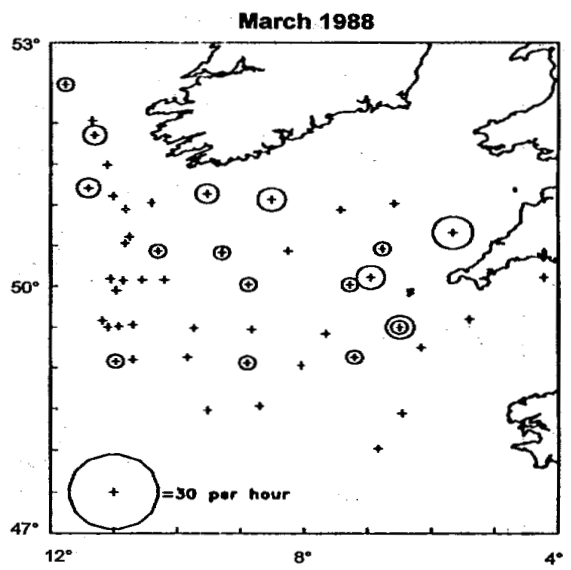
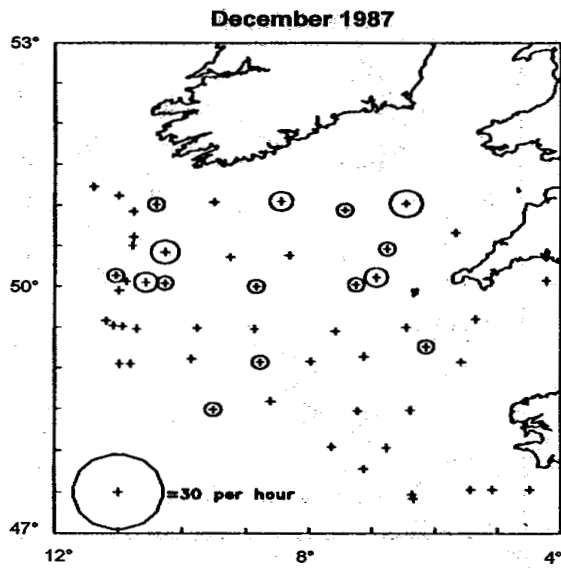


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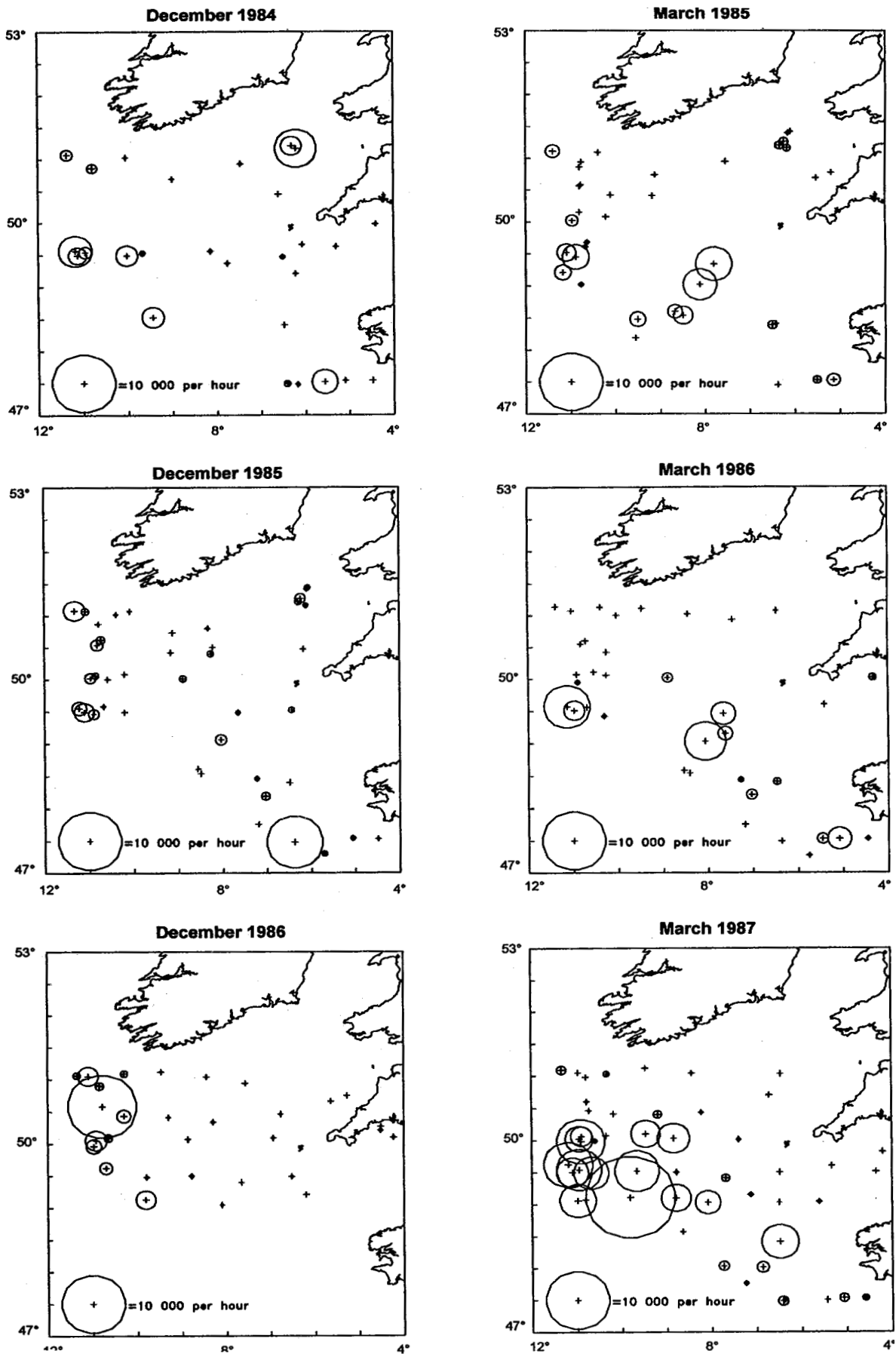


Figure 12. Blue whiting. Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

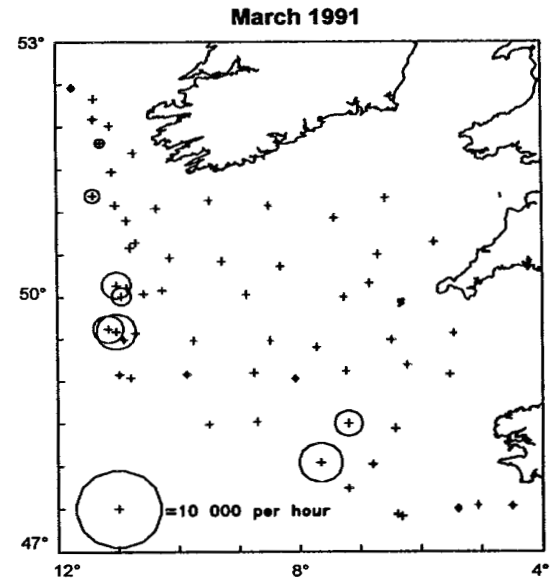
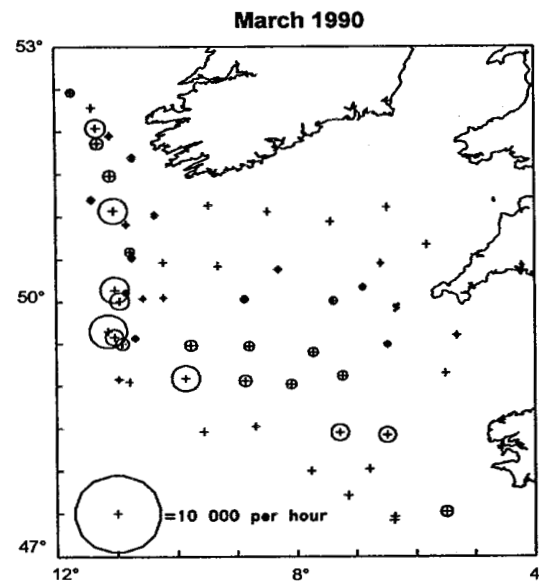
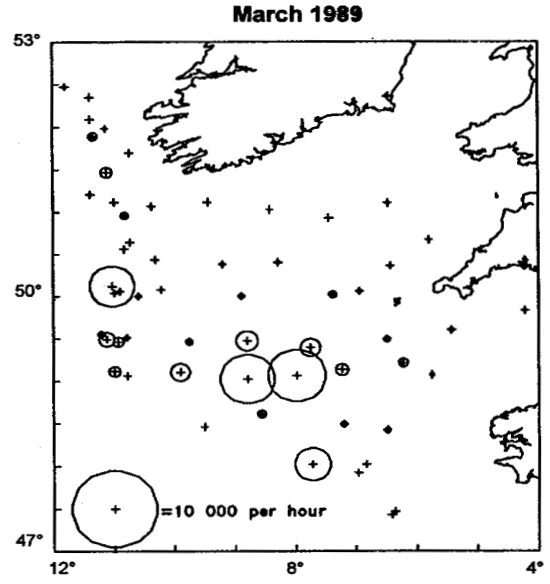
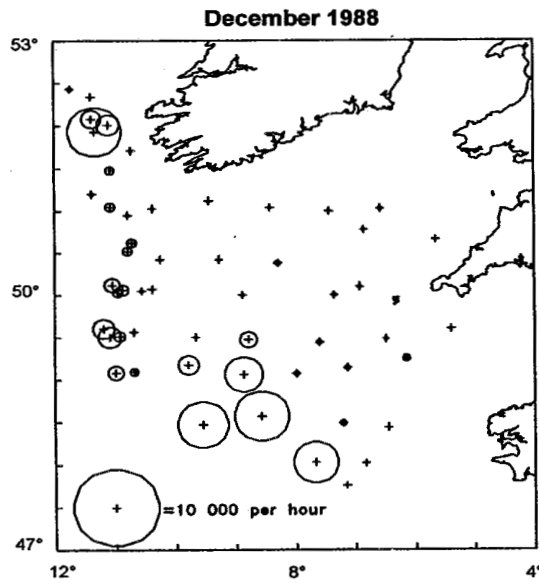
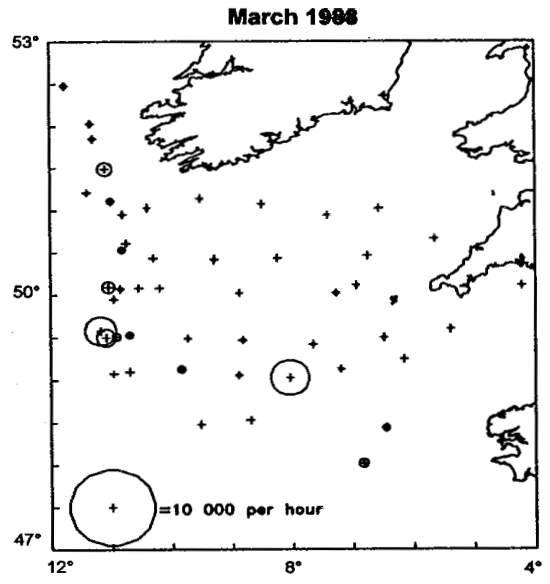
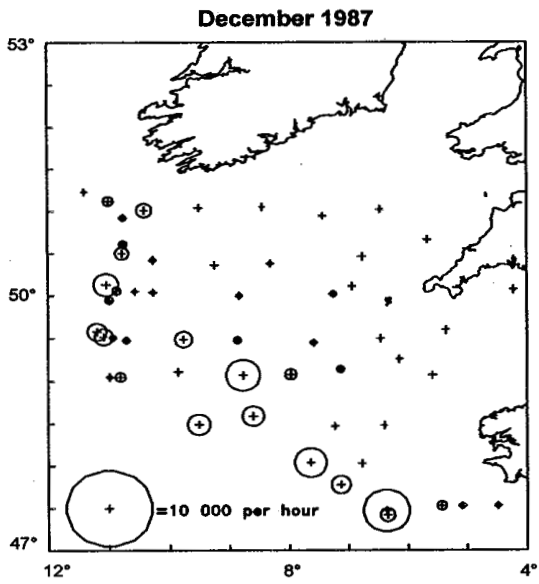


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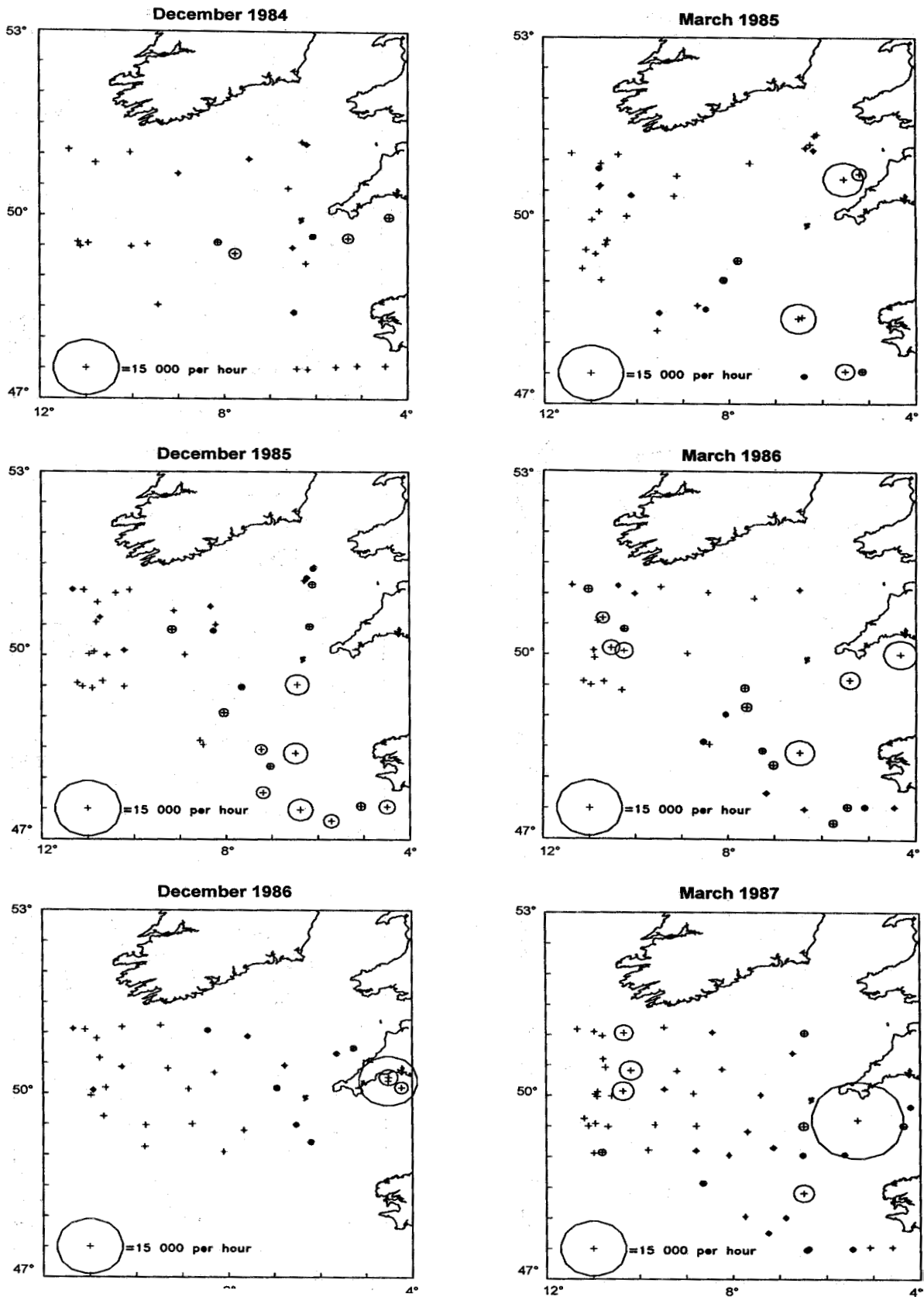


Figure 13. Poor cod. Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

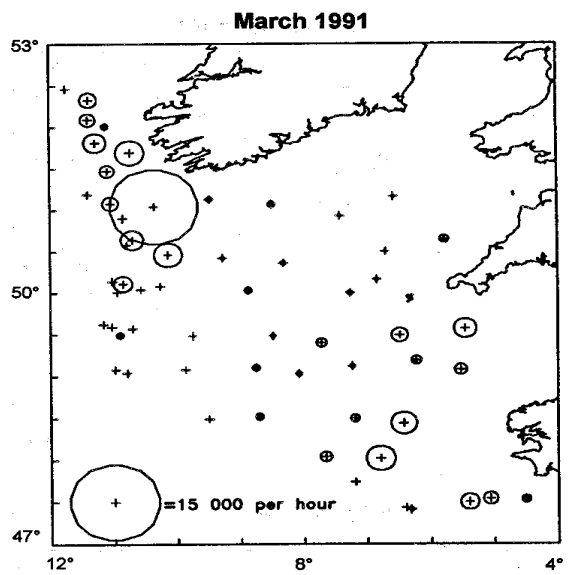
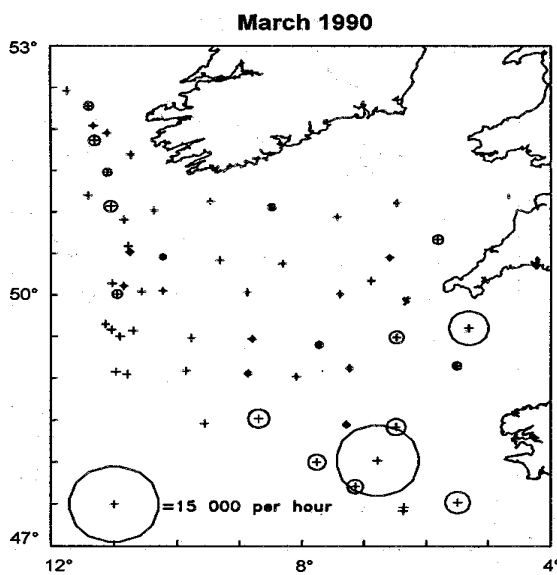
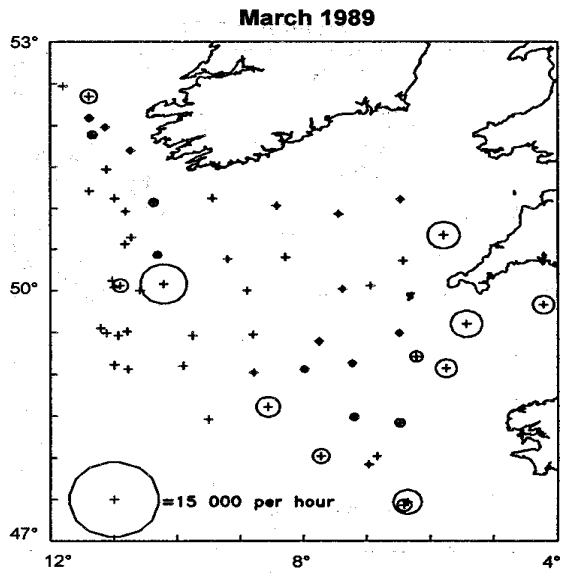
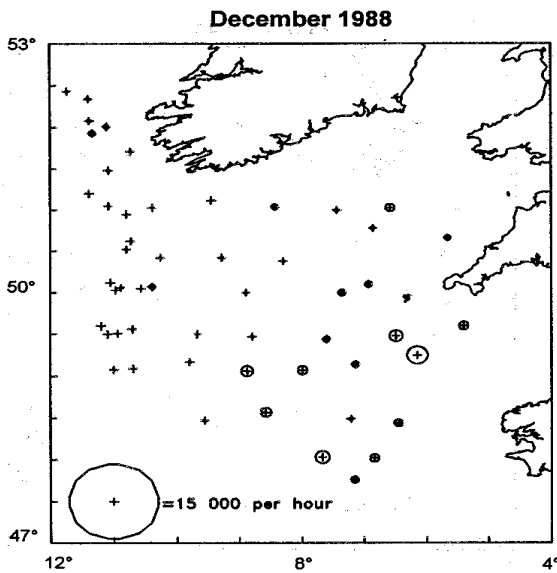
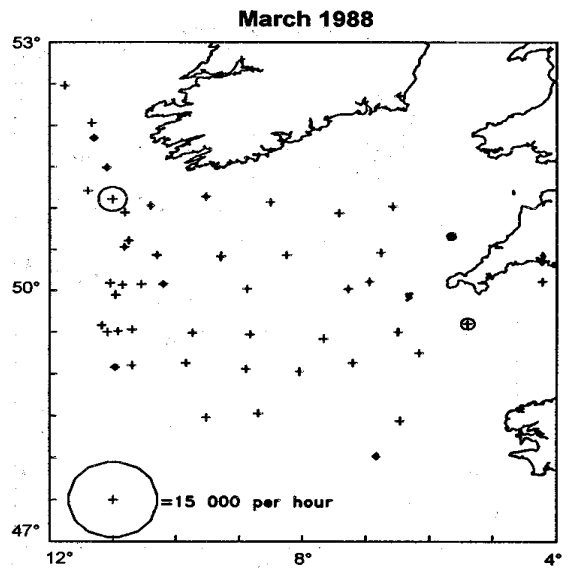
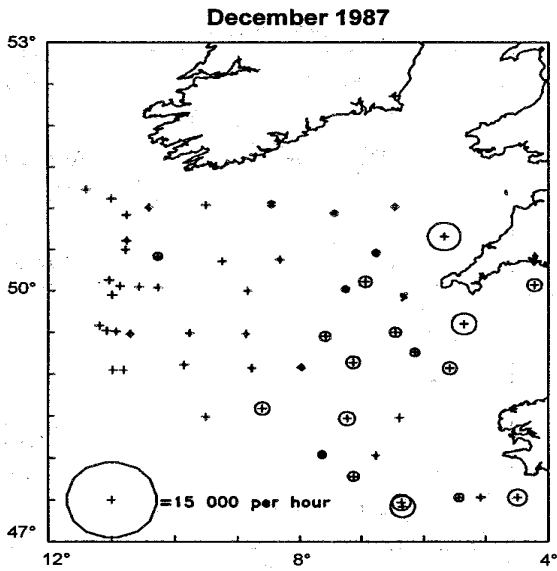


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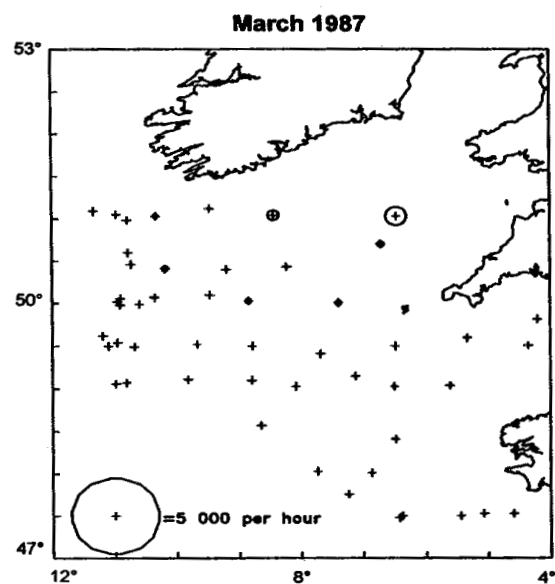
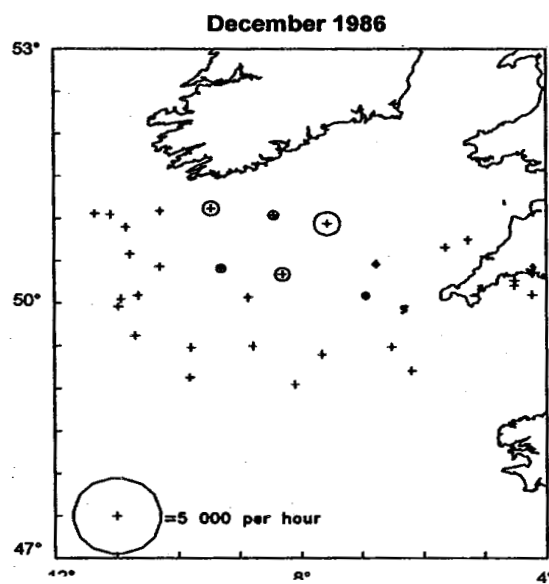
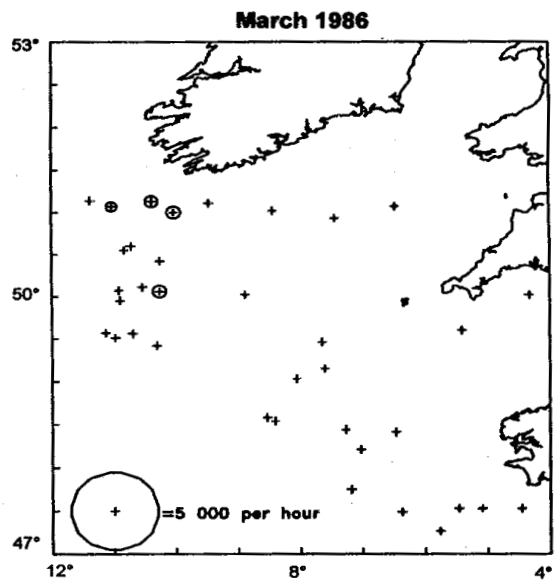
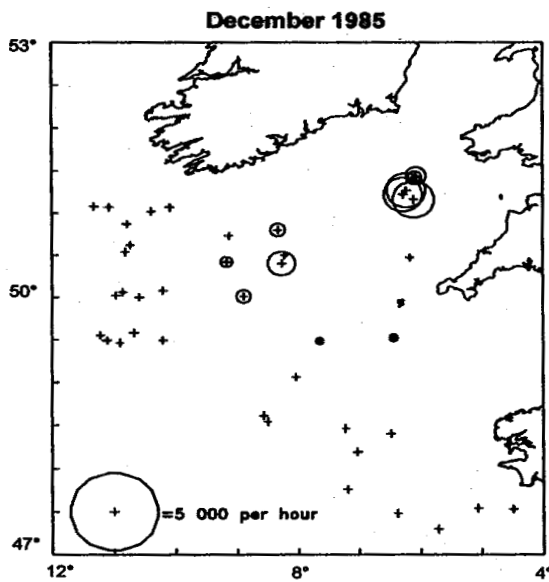
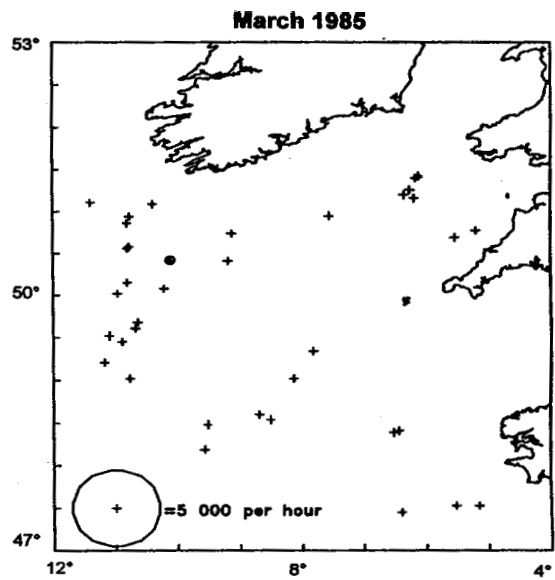
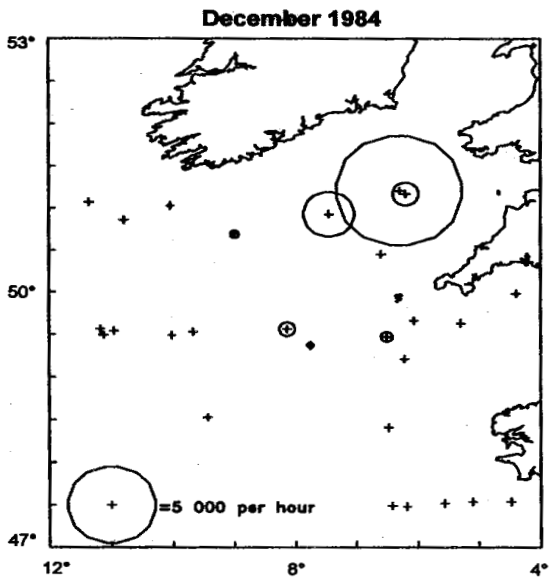


Figure 14. Norway pout. Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

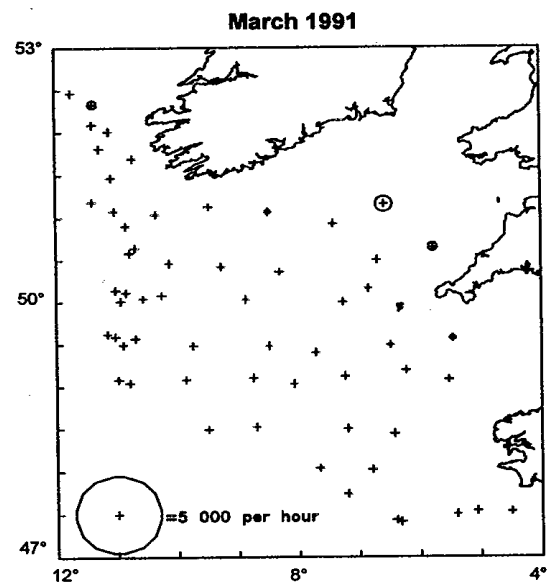
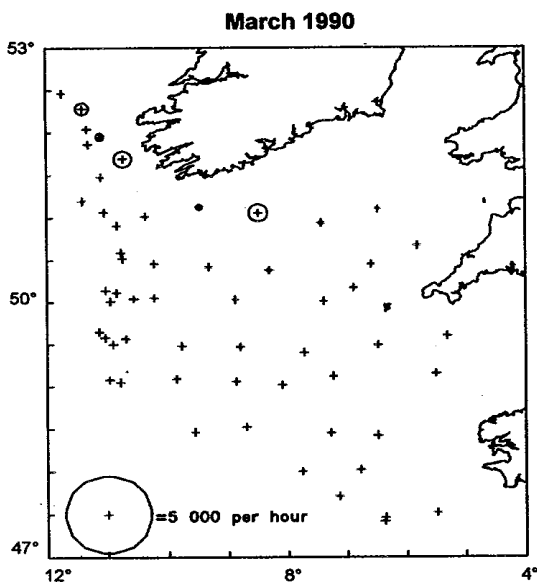
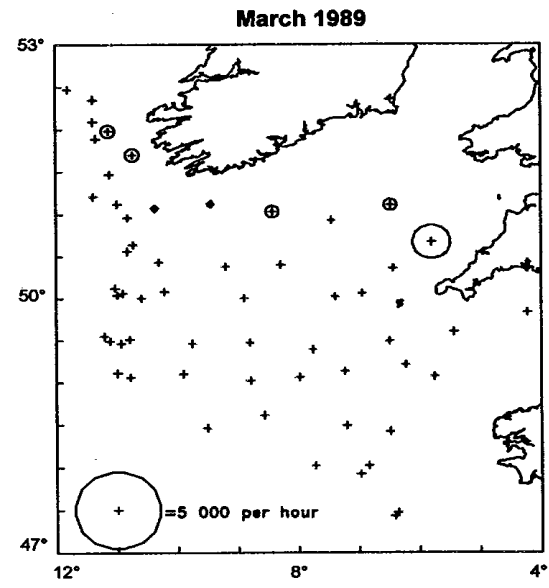
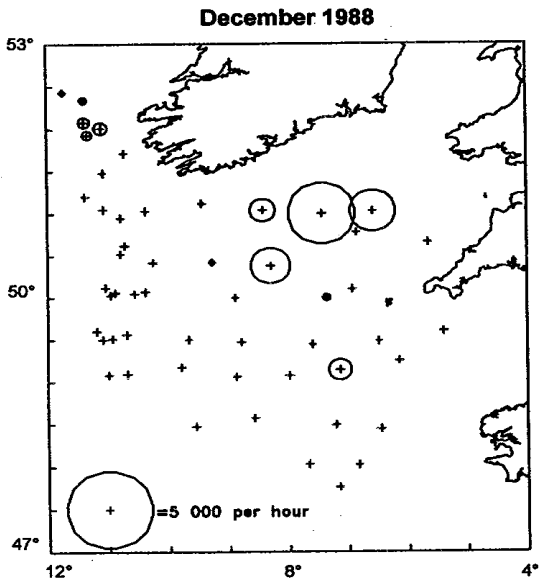
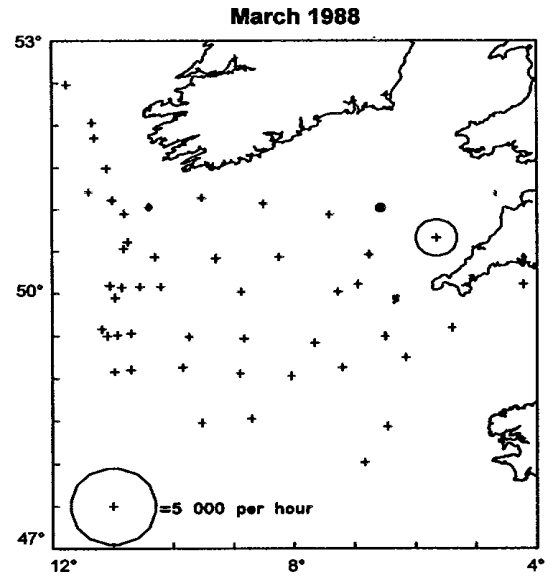
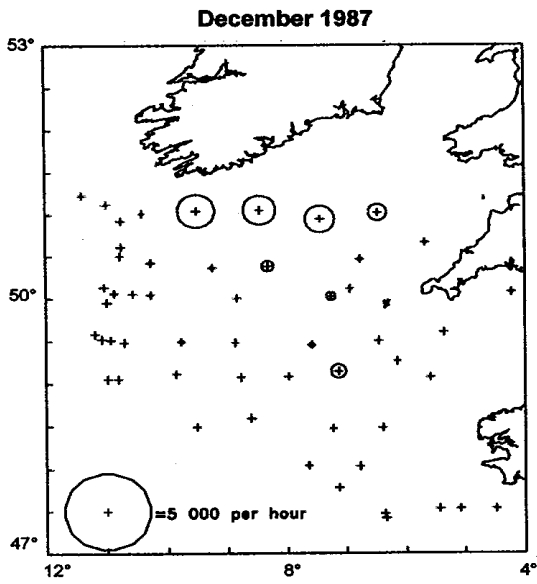


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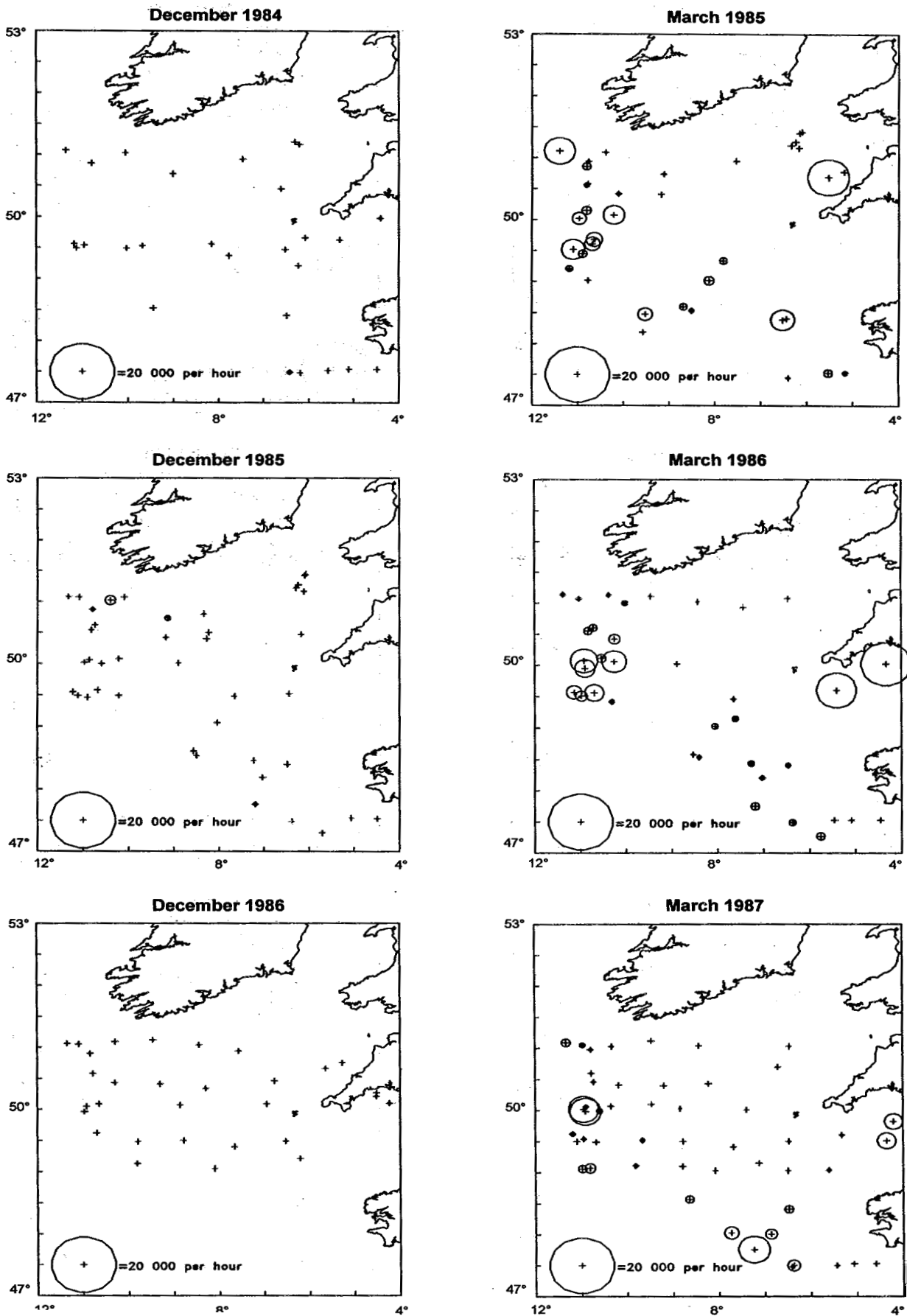


Figure 15. Mackerel (excluding 0- or 1-group). Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

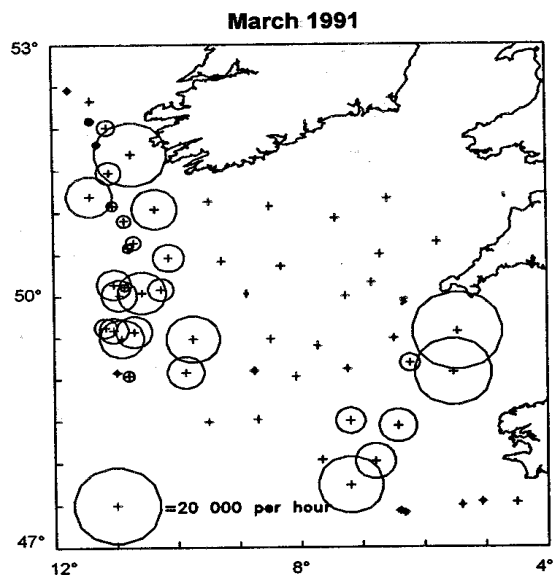
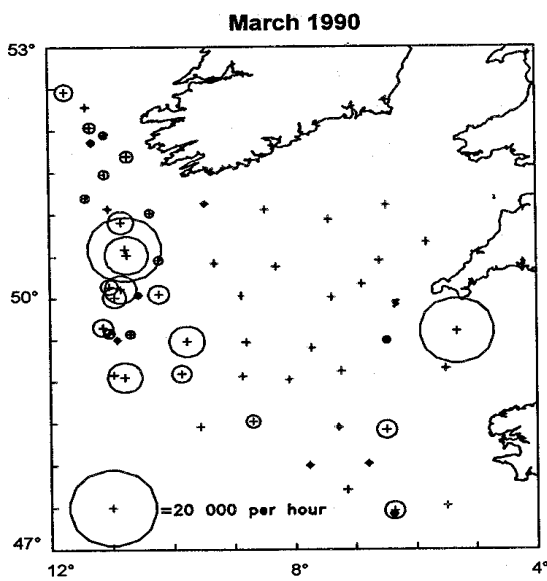
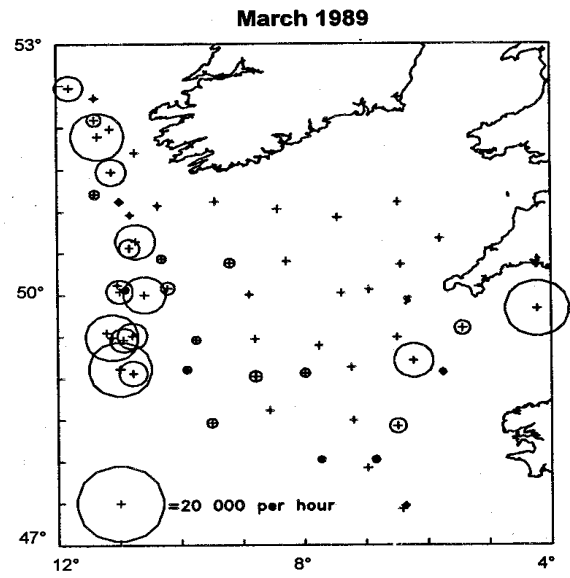
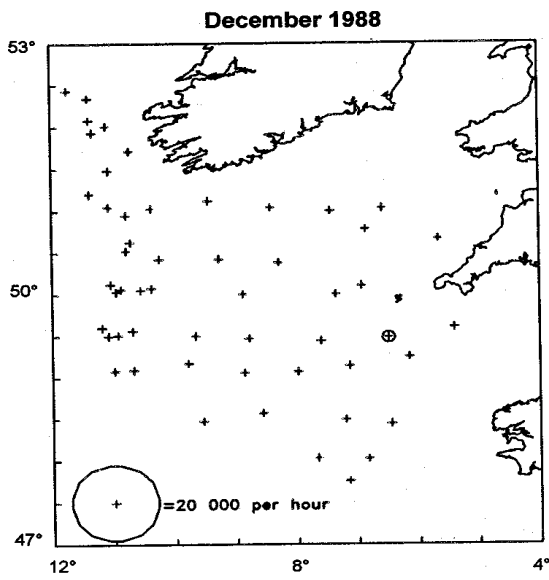
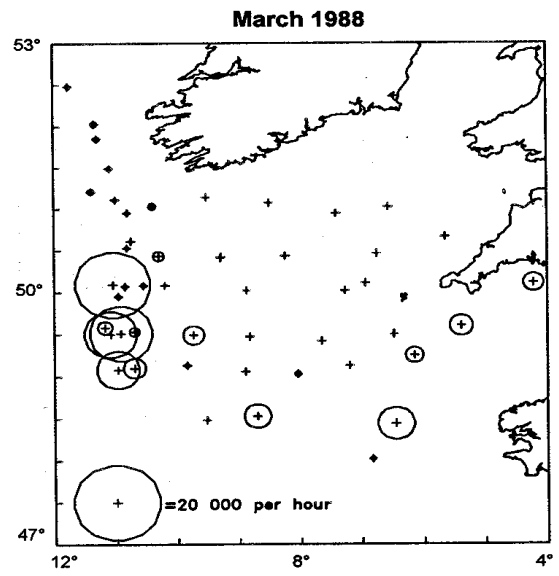
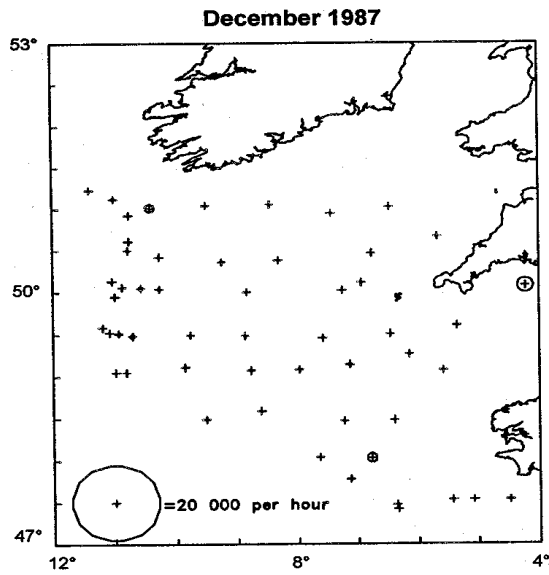


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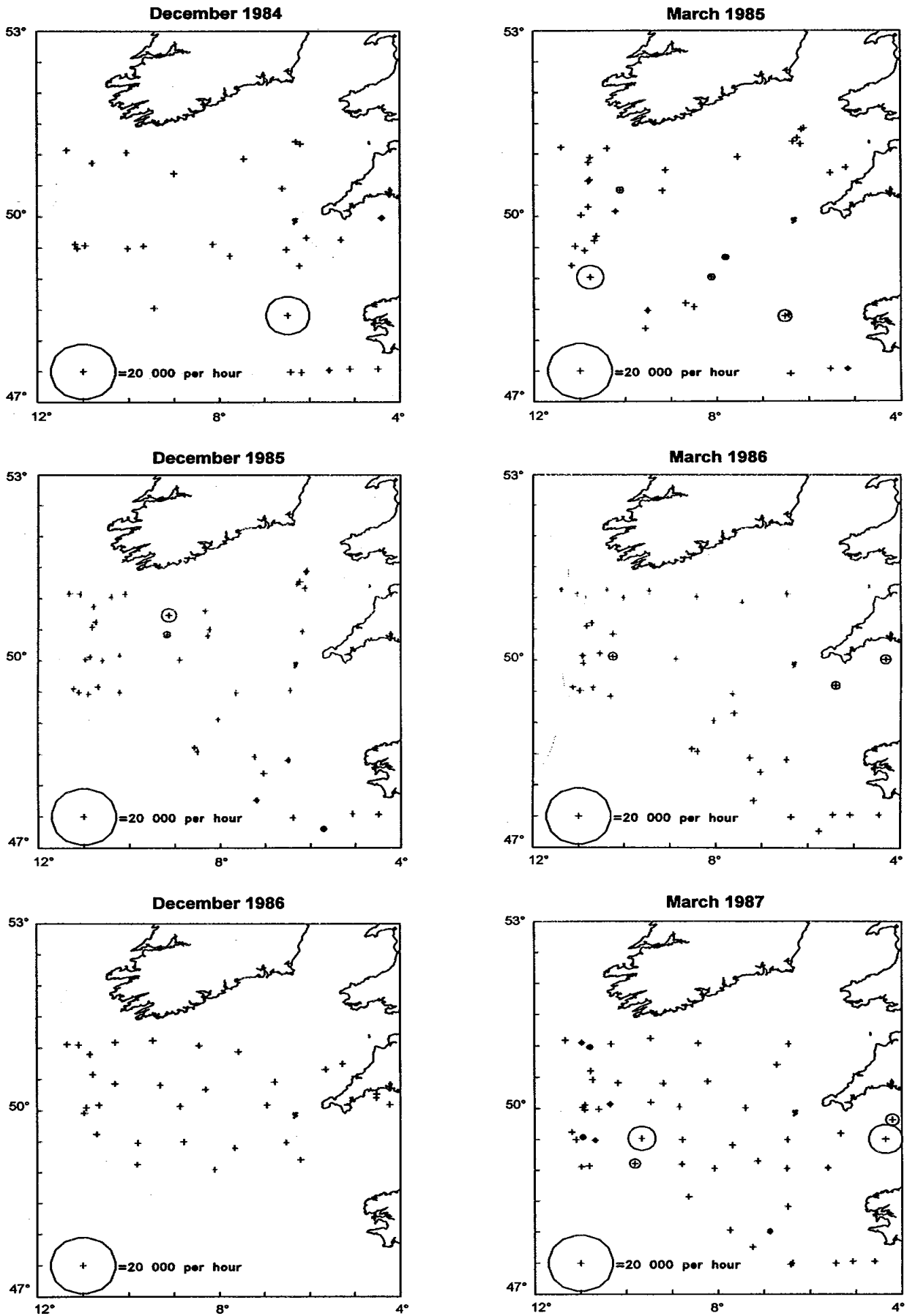


Figure 16. 0- or 1-group mackerel. Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

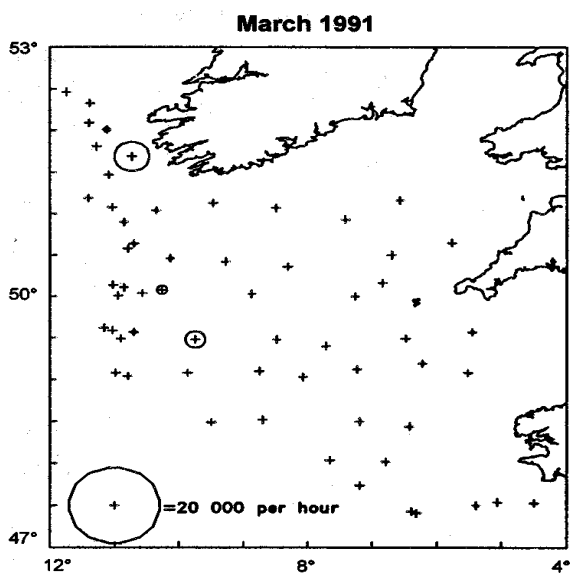
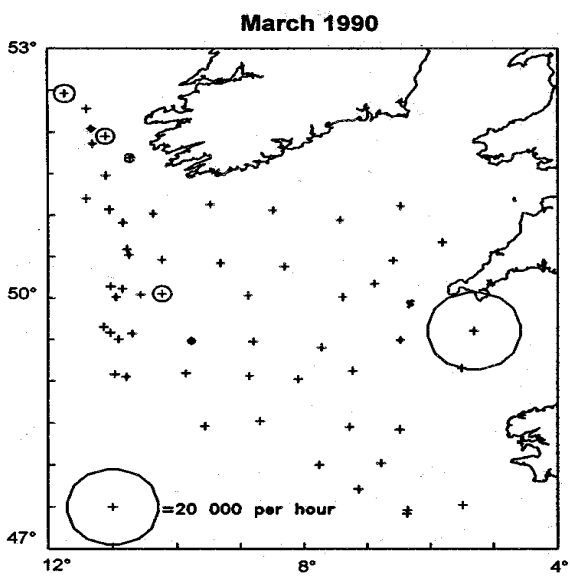
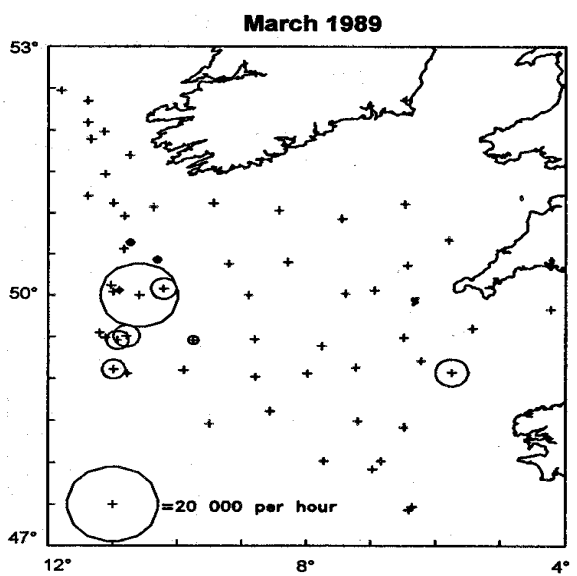
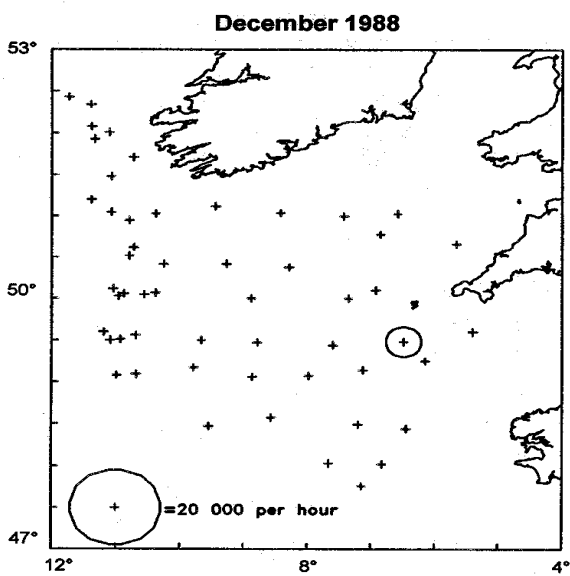
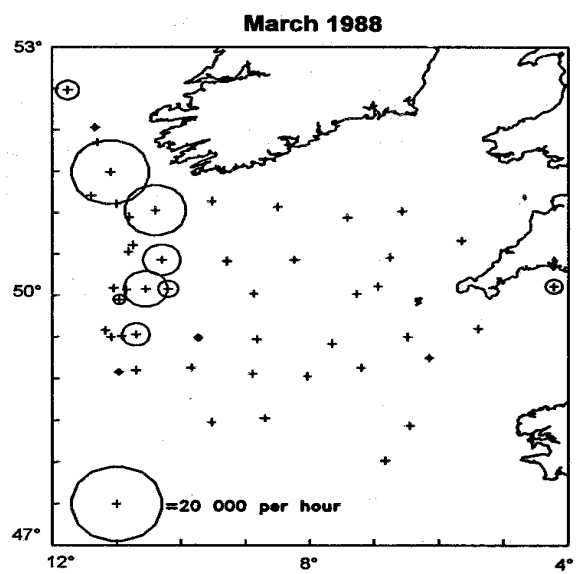
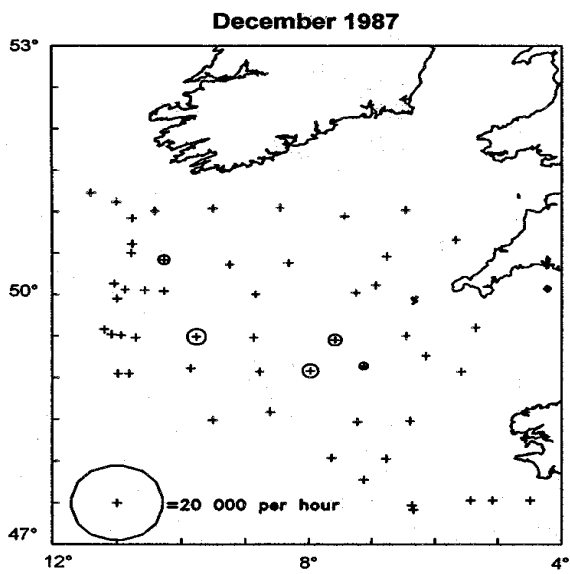


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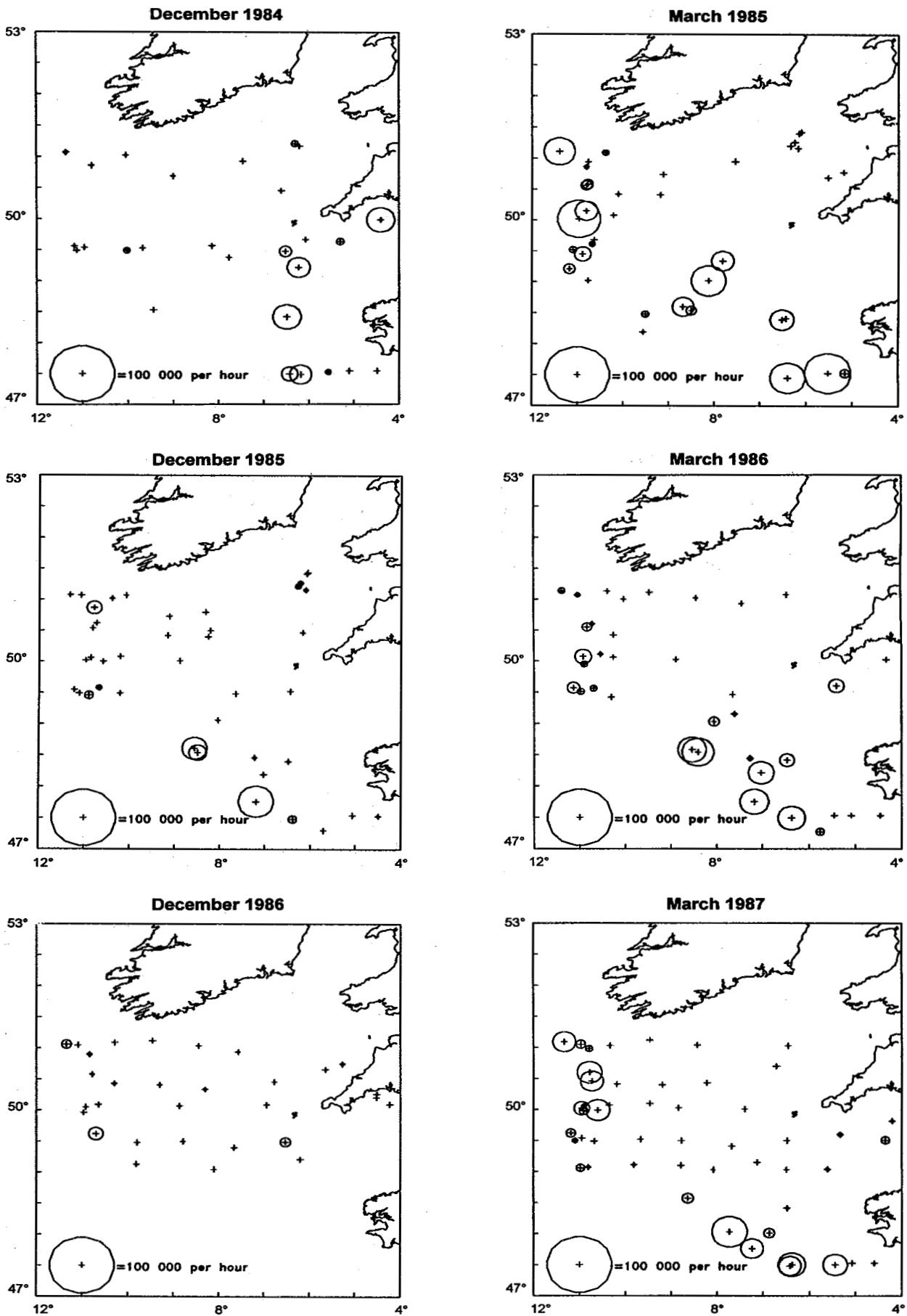


Figure 17. Horse mackerel (excluding 0- or 1-group). Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

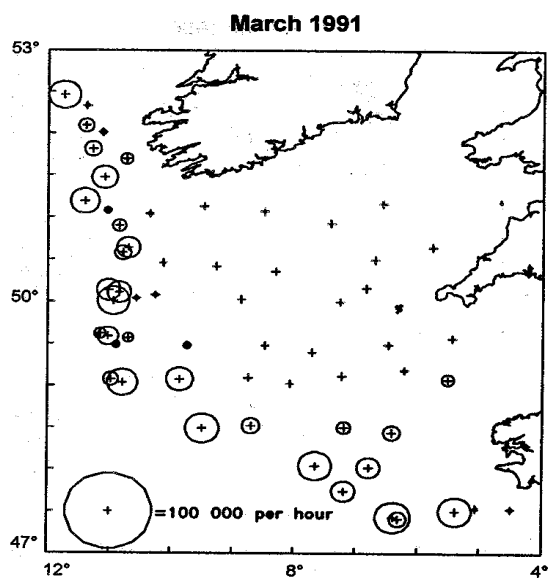
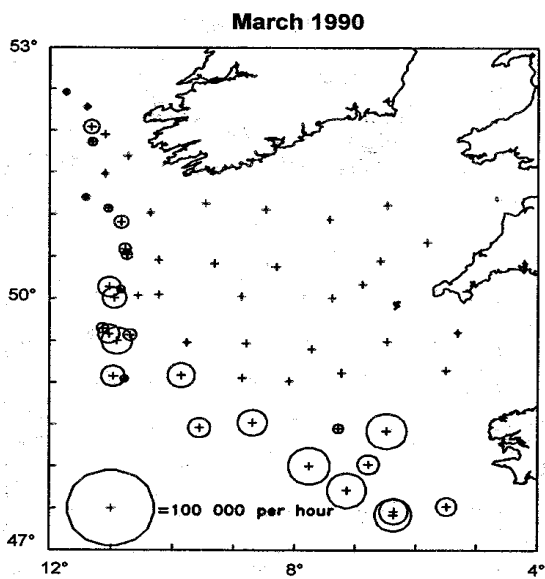
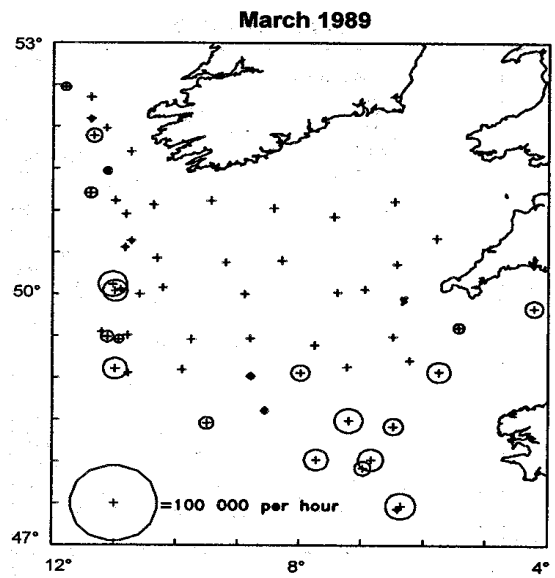
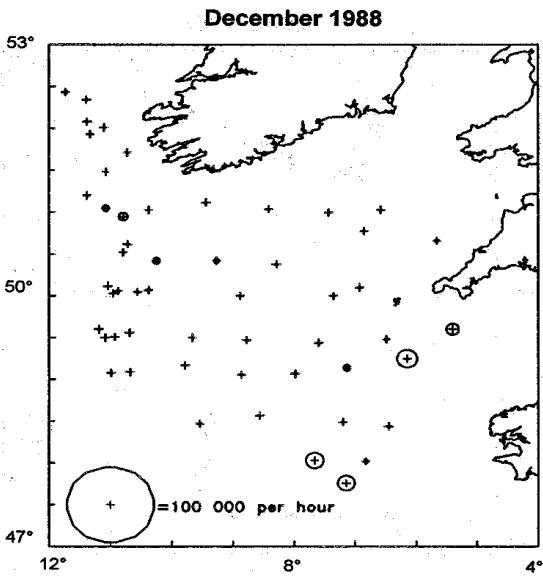
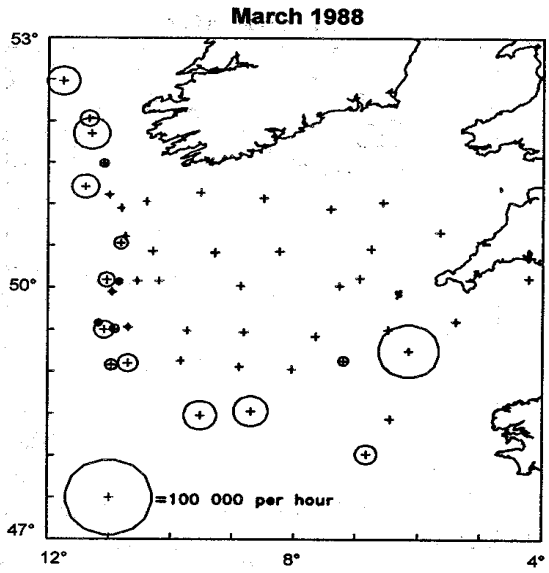
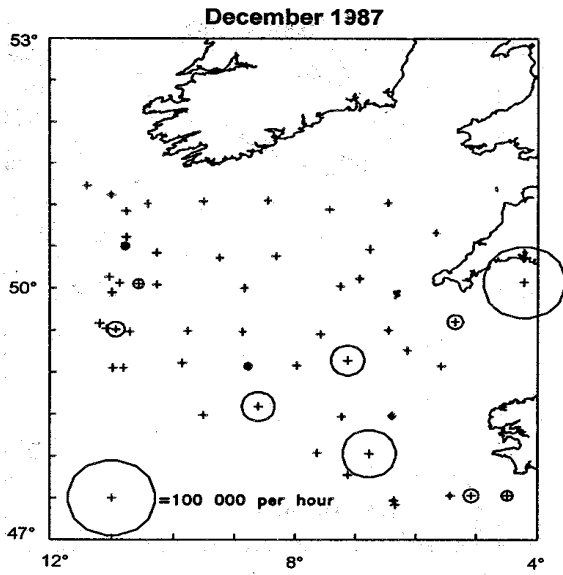


Figure 17. continued

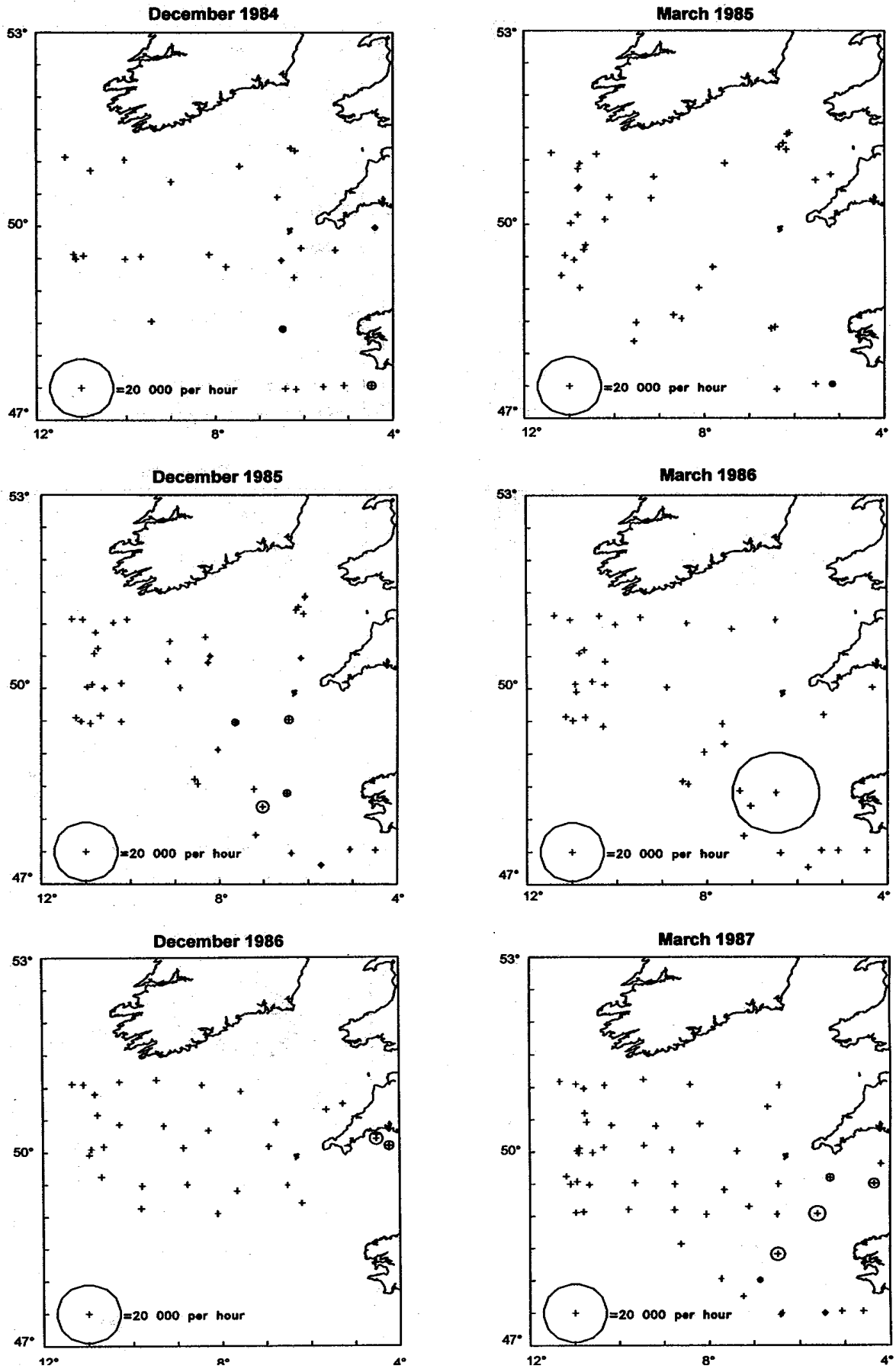


Figure 18. 0- or 1-group horse mackerel. Abundance (numbers per 60 min trawl haul) at each station for surveys undertaken between December 1984 to March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

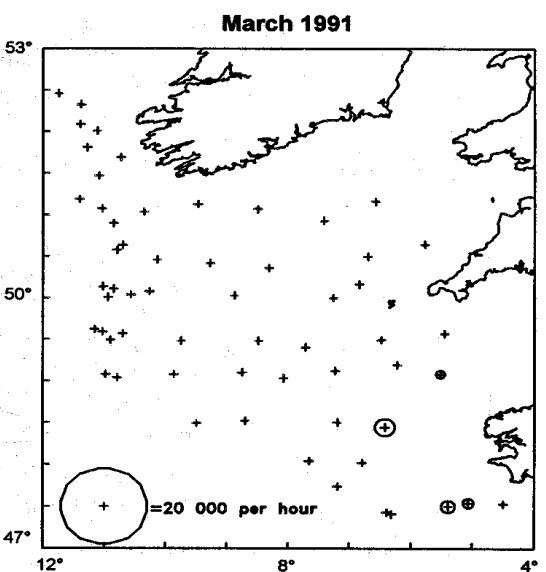
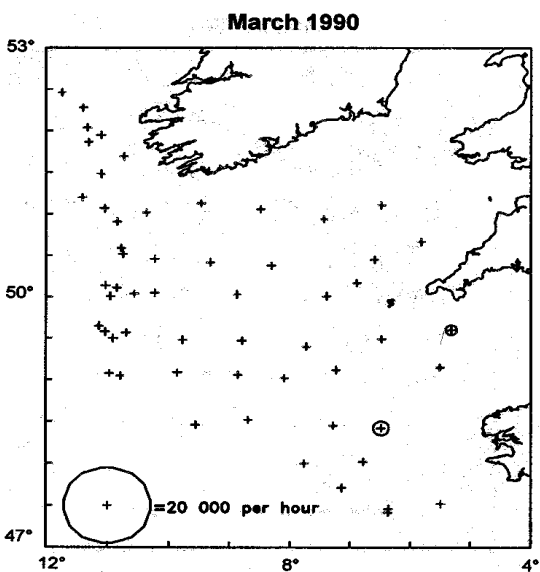
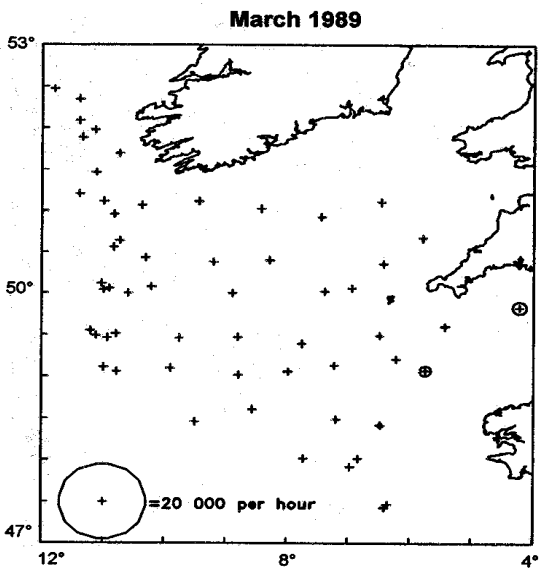
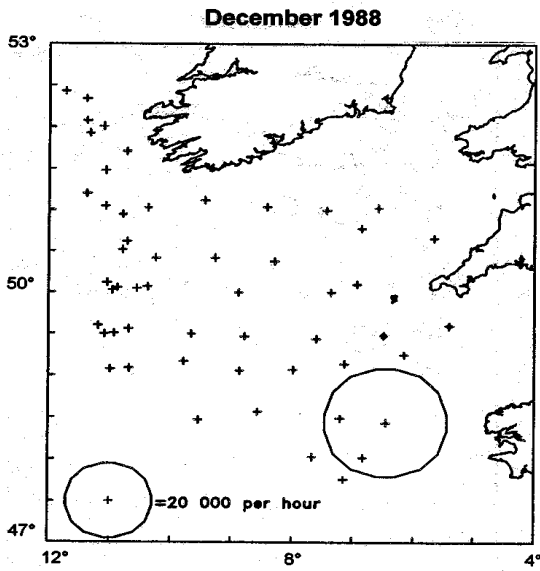
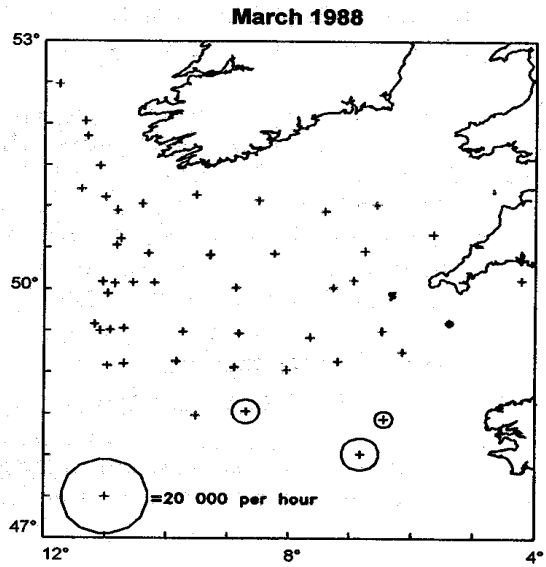
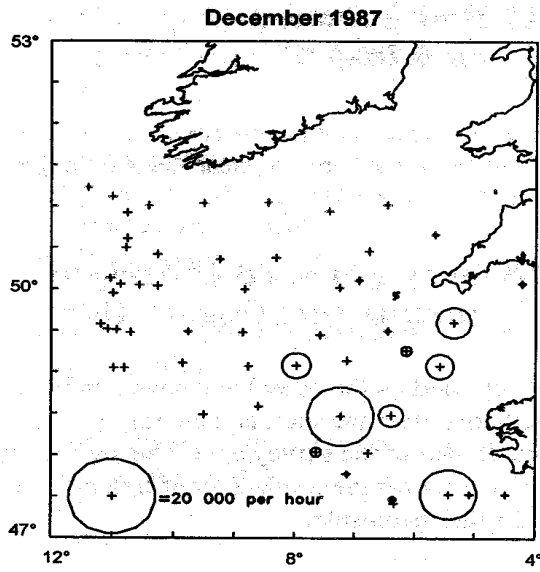


Figure 18. continued

7.15 Haddock (*Melanogrammus aeglefinus*) (Figure 19(a))

In the survey area haddock are close to the southern limit of their distribution in the north-east Atlantic. They are located on the shelf, mainly in the northern part of the area off the Irish south-west coast, off the Cornish peninsular and around the Haddock Bank/Labadie Bank area. Like cod, haddock catch rates are usually low unless an abundant yearclass recruits to the fishery.

7.16 Whiting (*Merlangius merlangus*) (Figure 19(b))

Whiting are fairly ubiquitous over the whole of the shelf area but they do not extend into the deeper waters of the shelf edge.

7.17 Red gurnard (*Aspitrigla cuculus*) (Figure 19(c))

Red gurnard have a wide distribution over the survey area but are most common near the shelf edge and to the south of the area.

7.18 Grey gurnard (*Eutrigla gurnardus*) (Figure 19(d))

Grey gurnard on the other hand have a more northerly distribution over the shelf and are rarely taken in the southern part of the survey area. The greatest abundances occur off the south-west of Ireland and around the Cornish peninsular.

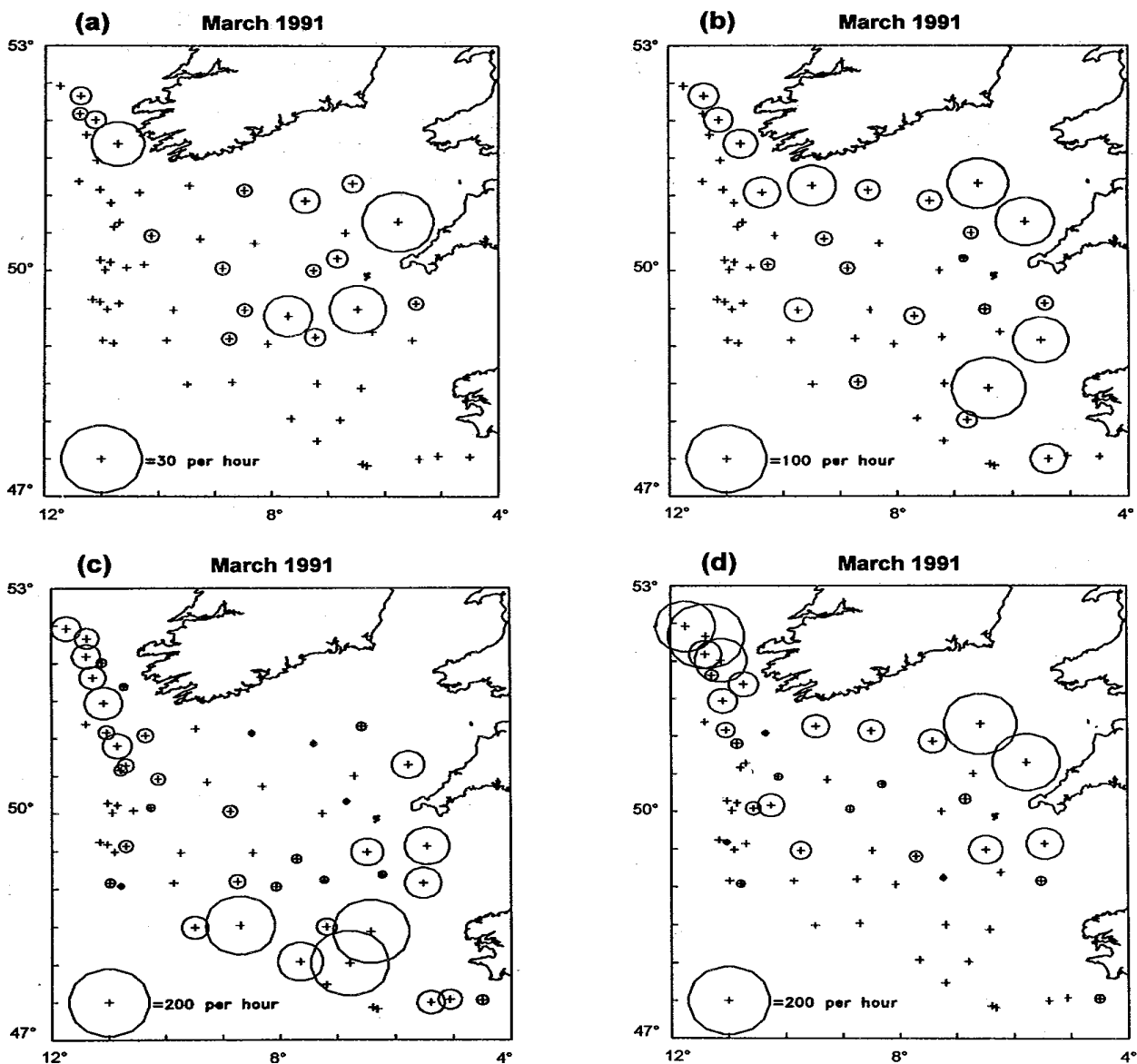


Figure 19. (a) Haddock, (b) Whiting, (c) Red gurnard, (d) Grey gurnard. Abundance (numbers per 60 min trawl haul) at each station for the survey undertaken in March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

7.19 Lesser-spotted dogfish
(*Scyliorhinus canicula*)
 (Figure 20(a))

This species is widely distributed over virtually the whole of the survey area. It is generally recorded at low densities but with occasional hauls at higher density especially off the south-west of Ireland.

7.20 John Dory (*Zeus faber*)
 (Figure 20(b))

The greatest abundance of John Dory in the survey area is along the edge of the shelf.

7.21 Boarfish (*Capros aper*)
 (Figure 20(c))

Boarfish are frequently encountered in high-density shoals when catch rates in excess of 1 tonne per hour are not uncommon. This species is normally restricted to the deeper waters of the shelf edge.

7.22 Lemon sole (*Microstomus kitt*)
 (Figure 20(d))

Lemon sole is a valuable commercial species which is widespread at low density over the shallower part of the survey area.

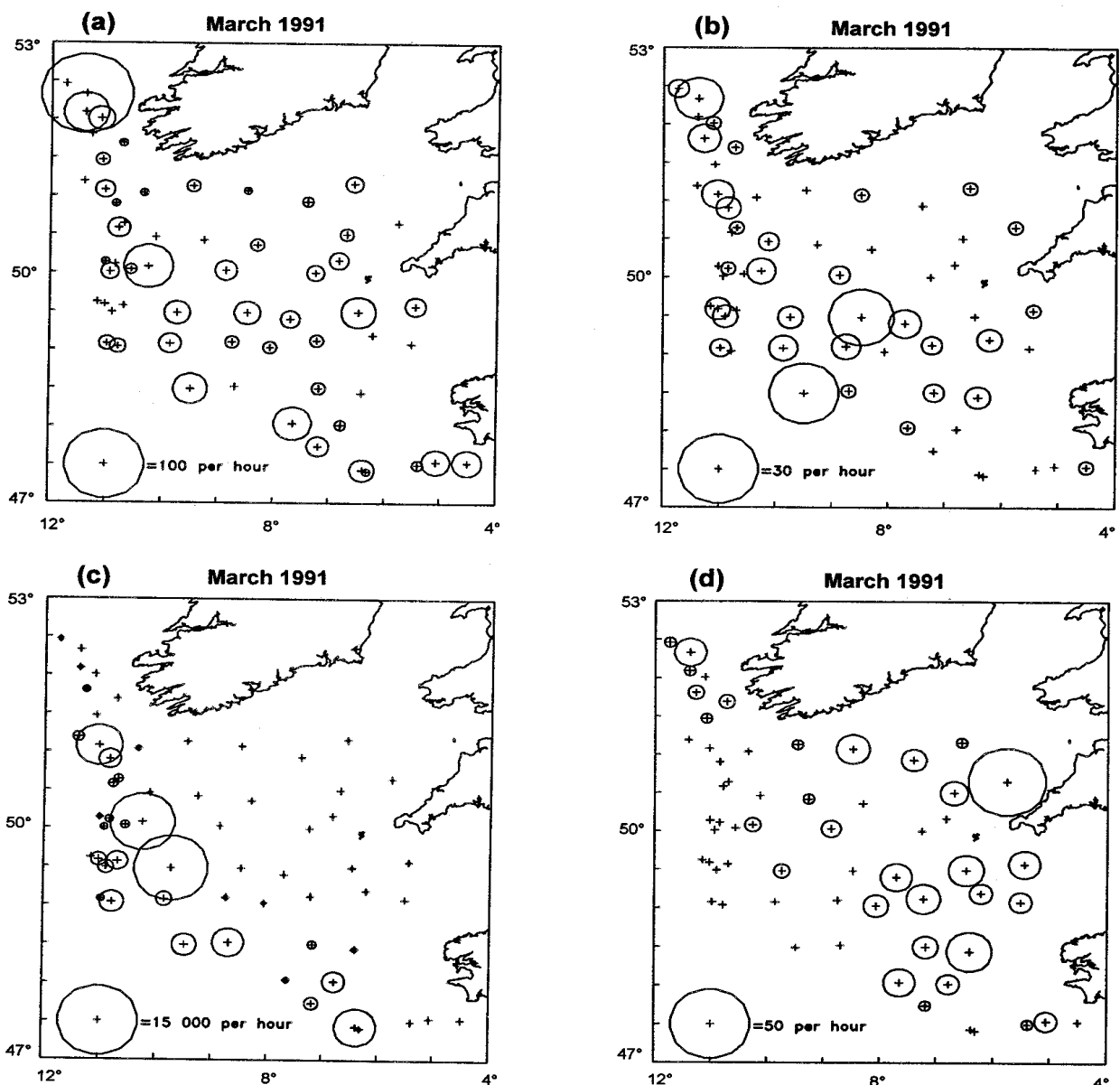


Figure 20. (a) Lesser-spotted dogfish, (b) John Dory, (c) Boarfish, (d) Lemon sole. Abundance (numbers per 60 min trawl haul) at each station for the survey undertaken in March 1991. Circles are proportional to the square root of the numbers caught. A key to the scale used for each species is given in the lower left-hand corner of each chart

8. SUMMARY

The data base for the English series of groundfish surveys in the Celtic Sea, described in this paper, covers twelve surveys in the period December 1984 to March 1991. Subsequently the survey has been maintained with annual surveys in March. The data relate to both commercial and non-commercial fish species. The surveys provide a means of monitoring the abundance and distribution of fish species in the Celtic Sea which can be related to changes in the patterns of fishing and environmental change.

Data from the surveys are contributing to the assessments of the commercial fish species of the Celtic Sea area by providing biological information used in stock assessments, by providing information on the abundance of young age groups before they recruit to the

commercial fishery, and by providing data which are used in the tuning of analytical assessments. Information is also being built up on the predator - prey relationships.

9. REFERENCES

ANON., 1993. Report of the Working Group on the assessment of mackerel, horse mackerel, sardine and anchovy. ICES CM 1993/Assess:19, 274pp (mimeo).

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