International Council for the
Exploration of the Sea

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REPORT OF THE STUDY GROUP ON BEAM TRAWL SURVEYS

Cuxhaven, Germany 20-22 April 1993

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1. INTRODUCTION

1.1 Terms of reference

At the 1992 Statutory Meeting of ICES it was resolved (C.Res. 1992/2:16) that the Group on Beam Trawl surveys will meet in Cuxhaven to:

a) carry out a detailed evaluation of the data series;

b) compare the variation in catch rates of plaice and sole among years and areas;

c) evaluate the survey designs and prepare modifications, if necessary.

1.2 Participants

R de Clerck	Belgium
U Damm	Germany
R Millner (Chairman)	United Kingdom
A Rijnsdorp	Netherlands
D Symonds	United Kingdom

2. 1992 SURVEY DETAILS

The survey areas and numbers of hauls in each rectangle are shown in Figure 2.1.

2.1 Belgium

Survey area: ICES Division 1Vb+c; Southern North Sea west of 3° east
Dates: 17 August-2 September 1992
Ship: RV BELGICA
Length 50m
Trawl beam length: a) 8m b) 4m
Number beams fished: one
Trawl duration: 30 min
Cod-end mesh: 75mm with 40mm liner
Attachments: a) 8 tickler chains and flip-up ropes. b) chain mat and flip-up ropes
Year survey started: 1985
First year used in distribution chart averages: 1989
Alterations from 1991 survey: None in the first part (17-27 August). During the second part, trawling was carried out with 4m trawl and chain mat instead of 8m trawl.

2.2 Germany

Survey area: ICES Division 1Vb; German Bight
Dates: 16-29 September 1992
Ship: RV SOLEA

Length 35m
Trawl beam length: 7m
Number beams fished: two
Trawl duration: 30 min
Cod-end mesh: 75mm with 44mm liner
Attachments: 5 tickler chains
Year survey started: 1991
First year used in distribution chart averages: 1991
Alterations from 1991 survey: Spring survey no longer included in data series: autumn survey
Started in 1991 using 7m trawl with fine mesh cod-end. Trawling limited to 30 min hauls during daylight only.

2.3 Netherlands

Survey area: ICES Division 1Vb+c; south of 56°30'N
Dates: 17 August-17 September 1992
Ship: RV ISIS
Length 28m
Trawl beam length: 8m
Number beams fished: two
Trawl duration: 30 min
Cod-end mesh: 75mm with 40mm liner
Attachments: 8 tickler chains
Year survey started: 1985
First year used in distribution chart averages in 1992 report: 1989
Alterations from 1991 survey: Up to 4 additional stations taken in each rectangle along the continental coast. Stations were allocated at equal intervals along a horizontal transect from the coast.

2.4 United Kingdom

a) Survey area: ICES Division VIId

Dates: 29 July-13 August 1992
Ship: RV CORYSTES
Length 53m
Trawl beam length: 4m
Number beams fished: one
Trawl duration: 30 min
Cod-end mesh: 80mm with 40mm liner
Attachments: Chain mat and flip-up ropes
Year survey started: 1988
First year used in distribution chart averages in 1992 report: 1988
Alterations from 1991 survey: None

b) Survey area: ICES Division VIIa; VIIf&g

Dates: VIIa, 29 Aug-3 Sept and 11 Sept; VIIf&g, 4-6 Sept, 1992

Ship: RV CORYSTES
Length 53m
Trawl beam length: 4m
Number beams fished: one
Trawl duration: 30 min
Cod-end mesh: 80mm with 40mm liner
Attachments: Chain mat & flip-up ropes
Year survey started: 1988
First year used in distribution chart averages in 1992 report: 1988
Alterations from 1991 surveys: trawl duration changed from 15 to 30 minutes in VIIa.

c) Survey area: ICES Division VIIe

Dates: 24 Sept-6 Oct
Ship: FV CARHELMAR
Length 22m
Trawl beam length: 4m
Number beams fished: two
Trawl duration: 30 min
Cod-end mesh: 80mm with 40mm liner
Attachments: Chain mat & flip-up ropes
First year used in distribution chart averages in 1992 report:
Alteration from 1991 surveys: None

3. SAMPLING PROCEDURES

3.1 Belgium

a. Commercial fish

When the catch comes on board the first step is to pick up and collect all commercial fish species. This fraction is then immediately measured to the nearest cm. When the catch of one particular species is too big the measurements are reduced to a subsample (half, one fourth, etc.). This is mainly the case for dab and bib in some areas.

During the 1992 survey an electronic bar-code measuring board ("Ichtyometre") was used for the length measurements. This automatically produced length distributions for all species.

In each length group numbers of sole, plaice and dab are kept apart for otolith sampling. The otolith extraction is generally carried out at the end of each day. A scheme is set up to ensure the collection of a minimum three otoliths per cm-class. For all brill and turbot catches the otoliths are taken and weight and sex are also recorded.

b. Non-commercial fish and benthos

The by-catch of non-commercial fish and benthos is sorted into baskets of about 40 l. One basket is chosen at random from which a subsample of a bucket (approximately

13 l) is taken. The species composition of the entire subsample is noted and the numbers of each species recorded. The numbers in the sub-sample are raised to the total for the catch at each station.

3.2 Germany

a) Fish: Sole, turbot and brill are sorted from the two beam trawls. Other fish are taken from one trawl and identified to species or species group. Sole, plaice, dab and turbot are measured to the nearest cm below and otoliths collected for ageing. All other fish species are counted and for abundant species, a sub-sample may be taken and used to estimate numbers.

b) Benthos: The catch from one trawl (usually the portside) is sorted and if necessary a 35 l basket taken as a sub-sample. Benthos are classified to species, genus or family and weighed when occurring in large quantities (e.g. heart urchins, starfish or brittlestars) otherwise counted separately.

3.3 Netherlands

a) Fish and benthos

The catches of both port- and starboard side are dumped separately in two containers on deck. The catch of one net is analysed for all fish species and epibenthic animals. The net is chosen at random at the beginning of the survey. For a selected number of species (sole, turbot, brill, rays) the other net is sorted as well. The total volume of the catch is determined in fish baskets (30 l) which are counted during the sorting process.

The catch is processed on a conveyer belt from which the larger specimens are sorted. The remaining catch is collected in fish baskets (30 l). In general the total catch volume is between 2 and 10 baskets with exceptional catches of up to 20-30 baskets on some stations mainly due to starfish or sea urchins. Smaller fish specimens and benthic animals are sorted from a sub-sample of 1 basket, which is a mixed sample from the 1 to 3 baskets selected from the catch at the beginning, middle and end of the sorting process.

All fishes are sorted from the (sub-) samples, measured to the cm below and then raised to the catch number per hour fishing. The benthic animals are counted. A selected number of species, generally species or species groups which are dominant, have been recorded since the start of the surveys in 1985 (Table 3.1).

3.4 UK (VIId, VIIa, f+g)

a) Fish and commercial crustacea

After the catch has been emptied into the pound, all fish and commercial crustacea (edible crabs, lobsters and Nephrops) are separated from the benthos. Fish are identified to species (except gobies, sandeels and small clupeidae which are identified to genus or family), weighed in bulk and individuals measured to the cm below. Plaice, sole, megrim and elasmobranchs are weighed and measured by sex. Subsampling (by weight) is occasionally necessary when the catch of a species is large (e.g. dabs and poor cod). Length stratified samples of major species including plaice, sole, lemon sole, megrim, turbot, brill, dab, whiting, cod and anglerfishes are taken for age determination.

Crustacean species are weighed by sex and the carapace lengths are recorded to the mm below.

b) Benthos

After the removal of fish the numbers of selected benthos species or groups is assessed visually and recorded using a log scale of abundance (0, 1-10, 11-100, 101-1000, 1001-10000, 10000+). A photograph is taken of the total unsorted benthos catch for later reference.

3.5 UK (VIIe)

The catch from port and starboard trawls is dropped into deck pounds and an estimate of total catch (i.e. fish + debris) is made for each trawl. The catch in the pounds is transferred to a conveyor belt where each trawl is sorted separately. All commercial fish species are picked out and measured from both nets on every haul. On selected hauls, non-commercial fish species are also picked out and measured or counted. Length stratified samples of otoliths are taken from sole, plaice, lemon sole and anglerfish. Since 1991, otolith samples have been further stratified on the basis of distance from the coast into 5 zones, comprising 0-3, 3-6, 6-12 and two zones greater than 12 miles from the coast. Edible crab (*Cancer pagurus*), lobster and scallops are measured on all hauls.

b. Benthos: Only an approximate estimate of the total catch is made, together with a list of the most obvious component species.

3.6 SURVEY DESIGN AND METHODS

Despite attempts to standard survey methodology a number of different gears and survey designs have been used, depending on different aims of the surveys and on constraints imposed by survey areas and the vessels available for the surveys. In the North Sea three separate gears have been used. The main survey area has been covered since 1985 by the Netherlands using an 8m beam trawl with 8 tickler chains. In the Southern Bight the Belgians have used a similar gear but with a flip-up rope from 1985-1991 and in 1992 adopted a 4m beam trawl with chain mat because of the problems encountered previously fishing with open gear on hard sediments. In 1992, the Germans began an autumn survey in the German Bight using a 7m beam trawl with tickler chains.

In ICES area VIIa, d, f + g, a 4m beam trawl with chain mat and flip-up ropes was adopted as the standard gear and this was also used in VIIe from 1990 onwards to replace the 6m trawl used previously.

The use of different gears causes a number of problems in comparing results across surveys and areas and a comparison of the efficiency of the different beam trawls is discussed in section 4.

A detailed description of the survey design and methods has been given previously (ICES CM1990/G:59). Because the distribution of juvenile flatfish is related to depth, a depth stratified survey design was used in area VII where considerable variation in depth was found within the survey area. Stations were allocated to three depth zones, 0-19.9m, 20-39.9m and >40m. In the North Sea surveys, depth variation was less important and station positions were allocated either randomly within rectangles or on the basis of set positions within the rectangle, independent of depth. The number of stations sampled in each depth zone is shown in Figure 3.1. In the North Sea the majority of samples fall into the middle depth zone, 20-39.9m. On the eastern margin, samples have also been taken in the 0-19.9m zone but along the English coast where shallow water occurs close to the coast, this zone is poorly sampled.

In the eastern English Channel and Irish Sea, the majority of samples are taken in the shallow near-shore zone while in the Bristol Channel and western English Channel, most samples are in the two deeper zones. Standardisation of survey methodology in these areas has been more uniform and all surveys were restricted to the third quarter of the year and most hauls taken during daylight only. Tow speed was standardised to approximately 4 knots and haul duration to 30 minutes. In the Irish Sea, the haul duration was restricted to 15 minutes in the 1988-91 surveys because of the high catch rates of some species. For the survey in 1992, hauls were standardised to 30 minutes.

Data were analysed by converting catches to numbers per hour and for comparison between all countries, standardised to an 8m beam width, assuming a linear increase in catch with beam width. Catches of the abundant commercial species were separated into age groups but other species were analysed unaged. Arithmetic mean catch rates per hour were calculated for each rectangle, sub-area or area from:

$$Ca = \Sigma R_{i/n}A$$

where Ca is the catch per hour in area or sub-area A;
R_i is the mean catch in the i th rectangle
nA is the number of rectangles in the area or sub-area A.

The mean catch per rectangle is the unweighted average of all stations in the rectangle. In rectangles when surveys by Belgium, Netherlands and the UK overlap, a mean catch rate has been calculated for the different surveys, but no correction has been made for differences in gear efficiency.

4. GEAR COMPARISONS

4.1. Introduction

The beam trawl surveys do not employ a standardised fishing gear due to differences in the nature of the sea bed and differences between vessels in their ability to handle beam trawls. In order to compare the catch rates of the various gears in use some comparative fishing experiments have been carried out in the past. The following data were analysed. The species code denotes: S = sole, P = plaice, D = dab, T = turbot, C = cod and W = whiting. The gear codes denote: 8m = 8m beam trawl; 8m+f = 8m beam trawl with a flip-up rope; 7m = 7m beam trawl; 4m+sf = 4m beam trawl equipped with a stone mat and flip-up rope. Some comparative fishing experiments were carried out by simultaneously fishing the same stations (experiment type I), others were fishing the same rectangles, sometimes the same stations, within a time period of about 4 weeks (experiment type II)

Ship (gear)	Experiment type	Number of hauls	Species	Year
1 ISIS (8m) vs ISIS (8m+f)	I	81	S,P,D,T,C,W	1988
2 CORYSTES (4m+sf) vs BELGICA	I	36	S, P, D, W	1990, 1991
3 BELGICA (8m+f) vs BELGICA (4m+sf)	II	10	S, P, D	1992
4 ISIS (8m) vs SOLEA (7m)	II		S, P, D	1992

4.2. Methods

The catch efficiency of two gears was analysed by analysis of variance (ANOVA) using the NAG statistical package GLIM (Baker and Nelder 1978) according to the model: N = [exp(a+F1+F2+F3+F2.F3] * e where N = number caught per hour fishing and F1, F2 and F3 are discrete levelled factors like station, gear and size class and F2.F3 is the interaction term of gear and size class; e is an error term with a Poisson distribution, with an expected value of 1 and a variance which is proportional to the fitted values: s2 = E(N). The deviance (R) between the observed number (%YV) and the fitted value (%FV) was calculated as R = (%YV-%FV)/SQRT(%SC*%FV) (McCullah and Nelder 1983).

4.3. RESULTS

Comparison 1: ISIS (8m) vs ISIS (8m+f)

A detailed presentation of the results of this experiment is given in Groeneveld and Rijnsdorp (1990). Here only the basic results will be summarised (Table 4.3.1.). The GLM model used was N = exp(a+station+gear) for separate age - or size groups.

Table 4.1. shows that in all species except cod the standard 8m beam trawl catches significantly more that the 8m beam trawl with a flip-up rope. The estimated catch efficiencies differ between the species from 82% in cod to 184% in plaice. A further analysis taking account of the size - or age class showed that the differences appeared to be restricted to the younger age - or size groups. Catch efficiency of the standard 8m beam trawl is higher than the 8m beam trawl with a flip-up rope for smaller younger fish, but the difference declines with increasing fish size/age and even becomes negative for larger fish (plaice, cod). The results for dab corroborates the findings for plaice and sole that the difference is restricted to size classes up to 25 cm since in dab only a few specimens exceed 25 cm in length. The reason for the

decline in catch efficiency of the standard 8m-beam trawl relative to the 8m+flip-up beam trawl remains unknown.

Comparison 2: CORYSTES (4m+sf) vs BELGICA (8m+f)

In this comparison both ships fished together for one day in 1990 and one in 1991 on stations in the Southern Bight. The pooled length compositions of the comparative hauls are shown in Figure 4.1a. Table 4.2. shows that the 4m+sf beam trawl catches equal numbers of sole as the 8m+sf beam trawl. For plaice and dab the difference in catch rates is as can be expected from the size difference in beam trawl size, because a double catch rate of the 8m+f relative to the 4m+sf gear falls within the 95% C.L. of the estimated gear effect . For sole, however, no significant difference in catch efficiency could be detected. The interaction term of gear and size class was not significant in either sole, plaice or dab. No ANOVA was carried out on the whiting data because whiting was only caught in a few hauls.

Comparison 3: BELGICA (8m+f) vs BELGICA (4m+sf)

In addition to the routine 8m+f beam trawl tows in the southwestern North Sea the BELGICA revisited 10 stations with a 4m+sf beam trawl. The pooled length compositions for both gears are shown in Figures 4.1b for sole, plaice and dab. These again shows that although the two gears differ in size they are not statistically different in catch efficiency of sole (Table 4.3.3.). For plaice, the 8m+f beam trawl is less than twice as efficient as the 4m+sf beam trawl. Table 4.3 shows that the relative efficiency was estimated at 1.46 times (95% C.L. 1.16 - 1.83). For dab, the relative catch efficiency of the 8m+f beam trawl did not differ from the expected value of 2.

Comparison 4: ISIS (8m) vs SOLEA (7m)

This first preliminary comparison comprises of 33 stations fished in similar rectangles in the German Bight during the routine survey by ISIS and SOLEA within a period of about 4 weeks. The GLM-model employed was N = exp(station+depth+gear) in which the stations were coded according to the rectangle. The model explained 64%, 71%, 42% and 23% in sole, plaice, dab and whiting respectively. The results are given in Table 4.4 and show that the 8m beam trawl catches significantly more flatfish than the 7m beam trawl, but only 50% of whiting.

The difference in catches of flatfish between both gears is much higher than expected from the difference in beam trawl width of 12%. Part of the difference can be explained by the heavier construction of the 8m gear and the larger number of tickler chains. Another factor that may have moderately contributed to the difference is that the 7m beam trawl employed a slightly larger mesh size. Further analysis of the data on a size disaggregated basis is necessary to study the contribution of the latter. It should also be realised that in the present comparison the stations and survey time was not fully controlled. It was assumed that the fish were homogeneously distributed within each ICES rectangle and that no change in abundance occured in the survey interval of about one month. The assumption of a homogeneous distribution was certainly not correct. Especially in sole the standard deviation of catch rate within a rectangle was generally larger than the mean. Future comparative fishing is necessary in order to quantitatively compare each rates of both gears.

4.4. Discussion

The experiments carried out so far showed that there was no difference in catch efficiency for sole between the 4m+sf and 8m+f beam trawl. The estimated gear efficiency parameters estimated for dab indicates that the 4m beam trawl and 8m beam trawl catch dab in proportion to the width of the net opening, but for plaice the 8m+f beam trawl tend to catch somewhat less than twice the number as the 4m+sf beam trawl. The effect of the flip-up rope, as indicated by comparison 1, appears to lower the catch efficiency of the smaller size classes, but may raise the catch efficiency for larger size classes.

4.5. Conclusion

The main conclusion that can be drawn from the available data on gear comparisons is that it is certainly not possible to derive a single factor that can be used to convert the catch numbers of one gear into that of another gear. The catch efficiency appears to be a function of both fish size and (type of) fish species. This implies that an integrated analysis of the various data set can be achieved only when the catch efficiencies of the survey gears are studied in more detail and for more species using analysis of variance techniques in which the gear type is used as an explanatory factor. To this end it is essential that the future survey design comprises of overlapping rectangles, preferably by fishing similar stations at the same time.

5. 1992 SURVEY RESULTS AND COMPARISON WITH SURVEY MEAN

5.1 Distribution and abundance by rectangle

The abundance by species and rectangles is shown in Figures 5.1-5.34 and a glossary of English and Scientific names given in Section 10. Survey means were calculated from the available historic data series. In VIId-g the means were taken over the period 1988 to 1992 although in some rectangles data will have been collected over a shorter time series. In the North Sea, means were calculated over the period 1989 to 1992.

5.1.1 Sole (Figures 5.1-5.3)

1-group

Mean distribution: The highest concentrations were found in all coastal areas. Highest catch numbers were predominantly on the western coast of the North Sea, mainly in the German Bight and the Scheldt estuary and also in Liverpool Bay.

1992 survey: In the North Sea the 1991 year class appeared to be very abundant as densities of 1-year old soles increased substantially in 1992 on both the west and east coast. In the other areas like the English Channel, the Bristol Channel and the Irish Sea the 1992 data indicated some decrease compared to the 5 year survey mean.

2-group

Mean distribution: 2-year old soles were most abundant along the eastern part of the North Sea. Peak values up to almost 140 per hour fishing were found in the German Bight and the Scheldt estuary. However the English Channel showed much lower densities. In Liverpool Bay and the northern Bristol Channel some local high abundances were found.

1992 survey: The 1990 year class appeared to be lower than the survey mean in the German Bight. However along the western coast and in the Scheldt estuary this year class was stronger than the mean. In the English Channel the abundances did not differ much from the mean, whereas in both the Bristol Channel and the Irish Sea catch rates lower than the mean were recorded.

3- and older group

Mean distribution: The 3-group and older soles showed a general offshore movement in all areas although still showing some higher catches in the coastal areas. The highest mean densities for all areas were found in the eastern part of the Irish Sea.

1992 survey: Except for some local high densities (Lincolnshire coast and Scheldt estuary) the 1992 catches in the North Sea were not very different from the mean values. In the English Channel the densities for 1992 were generally somewhat higher than the average values. In the Bristol Channel the differences varied without showing any clear trend. In the Irish Sea however the density of the mature population was higher in 1992 compared with the mean.

5.1.2 PLAICE (Figures 5.4-5.6)

1-group

Mean distribution: The North Sea 1-group was caught in the highest concentrations in the Waddensea and the Schleswig-Holstein area with a maximum of almost 2000 per hour fishing. Rather low densities were found in the English Channel and the Bristol Channel (less than 40 per hour fishing). The 1-group in the eastern part of the Irish Sea showed much higher densities than in the two former areas.

1992 survey: In all areas except the Irish Sea the 1991 year class appeared to be somewhat stronger than the average.

2-group

Mean distribution: The distribution pattern was similar to that for the 1-group in all areas. There was however a notable increase in abundance in the western North Sea along the English NE coast.

1992 survey: The 1990 year class varied without showing any different trend from the mean and it appeared therefore to be of the same strength as the average in the North Sea, the English Channel and the Bristol Channel. However in the Irish Sea the 2-group abundance increases substantially from the mean.

3-group and older

Mean distribution: The mature plaice population in the North Sea was more widely and evenly distributed than the juveniles although the German Bight still contained the highest densities. In the English Channel the spawning stock biomass was mostly concentrated in the northeastern part of VIId. Densities were low throughout the Bristol Channel. In the Irish Sea the spawning stock appeared to be evenly distributed over the coastal rectangles.

1992 survey: The spawning stock biomass in 1992 in the North Sea, the English Channel and the Bristol Channel appeared to be of a lower size than the average. On the other hand in the Irish Sea the data did not differ substantially from the mean indicating a rather stable spawning stock biomass.

5.1.3 DAB (Figures 5.7-5.10)

The information on the distribution per age group was limited to the North Sea and the eastern English Channel. In the other areas a distribution of unaged dab was presented.

1-group

Mean distribution: 1-group dab was widely distributed in the North Sea. The Schleswig-Holstein area, part of the Danish coast and the Scheldt estuary however showed the highest abundances (up to 3,500 per hour fishing). In the English Channel the 1-groups were mostly concentrated in the coastal areas.

1992 survey: The 1992 data in the North Sea indicated a general decrease in densities compared to the survey mean, although in the eastern English Channel the opposite trend was found.

2-group

Mean distribution: In the North Sea substantially higher densities in the area north of 53°30'N were recorded with a maximum of almost 1,000 per hour fishing. In the Southern Bight and the eastern English Channel the 2-group dab occurred at very low catch rates of well below 200 per hour fishing

1992 survey: The data indicated that the strength of the 1990 dab year class was somewhat above the survey mean value.

3-group and older

Mean distribution: The adult part of the dab population also showed a clear boundary between North and South as indicated by the much higher densities of more than 1,600 per hour fishing in the region north of 53°30'N. The dab was also the numerically dominant flatfish species in that area.

1992 survey There was no general trend in the abundance of the 1992 spawning stock biomass versus the survey mean.

Dab unaged

Catch rates in all other areas were well below those found in the North Sea.

5.1.4 TURBOT (Figure 5.11)

Mean distribution: The abundance of turbot was low in all areas with peak catch rates in the Waddensea and along the Danish coast.

1992 survey There was a general trend indicating that the 1992 turbot stock was somewhat denser than the survey mean value. Maximum catches in the Waddensea reached a value of 19 individuals per hour fishing.

5.1.5 BRILL (Figure 5.13)

Mean distribution: The distribution and abundance of brill was similar to that of turbot in the North Sea although more abundant in the English Channel and Irish Sea.

1992 survey: The 1992 data did not differ very much from the survey mean.

5.1.6 SCALDFISH (Figure 5.14)

Mean distribution: The scaldfish abundances averaged at about 150 per hour in the area north of 52° in the North Sea. Elsewhere scaldfish was at a much lower concentration. Some local peaks were noted in the Baie de Seine, Start Point and in the coastal areas of the western Irish Sea.

1992 survey: Generally the 1992 data indicated higher densities compared to the survey mean.

5.1.7 LEMON SOLE (Figure 5.14)

Mean distribution: Lemon sole was relatively scarce in all areas surveyed. Peak concentrations were recorded in the Humber region, the Wash, Dover Strait and Baie de Seine area and also in the Schleswig-Holstein and Waddensea region. This was one of the few flatfish to be more abundant on the English Coast than in the Waddensea.

1992 survey: No clear trend could be made when comparing the 1992 results to the survey mean data.

5.1.8 LONG ROUGH DAB (Figure 5.15)

Mean distribution: Long rough dab occurred almost exclusively in the German Bight area with highest catch rates North of 55°N. In addition some very low densities were also recorded in the northern part of the Irish Sea.

1992 survey: The 1992 catch rates indicated lower densities compared to the mean.

5.1.9 FLOUNDER (Figure 5.16)

Mean distribution: The distribution pattern of flounder was limited to coastal areas. Highest catches up to 219 per hour fishing occurred in the Schleswig-Holstein region.

1992 survey: The 1992 catch rates indicated lower densities compared to the mean.

5.1.10 SOLENETTE (Figure 5.17)

Mean distribution: Solenette was widely abundant in all areas surveyed but were generally more abundant south of 54°N in the North Sea.

1992 survey: The catches of solenette increased markedly in all regions during 1992. A maximum catch value of 736 per hour fishing was recorded in the North Sea.

5.1.11 THICKBACK SOLE (Figure 5.18)

Mean distribution: Thickback sole were almost entirely absent from the North Sea and were most abundant in the western English Channel, Bristol Channel and Irish Sea.

1992 survey: There was an increase in catch rate compared to the mean in eastern English Channel but no consistent trend elsewhere.

5.1.12 MONKFISH (Lophius spp) (Figure 5.19)

Mean distribution: Largely confined to the westerly areas although occasionally taken in the eastern North Sea.

1992 survey: An increase in abundance in the Bristol Channel although relatively similar elsewhere.

5.1.13 TUB GURNARD (Figure 5.20)

Mean distribution Tub gurnard was widely distributed in all coastal rectangles. Peak concentrations were found in the German Bight and to a smaller extent in the eastern part of the Irish Sea.

1992 survey: Most densities in 1992 were higher than the survey mean.

5.1.14 GREY GURNARD (Figure 5.21)

Mean distribution: Grey gurnard was the numerically dominant gurnard species in all areas except for the Southern Bight and the English Channel. A maximum of 124 per hour fishing was recorded in the Humber region.

1992 survey: The 1992 recorded densities showed an increase over the survey mean.

5.1.15 RED GURNARD (Figure 5.22)

Mean distribution: The distribution pattern of red gurnard was characterised by a marked concentration in the English Channel with mean catch rates up to almost 90 per hour fishing. In the Irish Sea and the Bristol Channel much lower catches of less than 10 per hour fishing were taken while in the northern part of the North Sea, red gurnard was almost absent.

1992 survey: No major changes were found in the densities in 1992 compared to the survey mean.

5.1.16 POGGE (Figure 5.23)

Mean distribution: Pogge was widely distributed in all areas, although at a lower abundance offshore. The German Bight, the Southern Bight and the eastern part of the Irish Sea showed the highest densities which peaked at 600 per hour fishing.

1992 survey: No clear trend was evident when comparing the 1992 data with the survey mean.

5.1.17 LESSER WEEVER (Figure 5.24)

Mean distribution: The lesser weever in the North Sea occurred mainly south of the 54°N. Mean catches reached maximum of about 400 species per hour fishing. Also in the eastern part of the Irish Sea some substantial quantities of about 50 per hour fishing were found. In the Bristol Channel and the English Channel the lesser weever was rather scarce.

1992 survey: In the North Sea no clear trend could be found. In the eastern part of the Irish Sea however the 1992 catch data were much higher than the survey mean.

5.1.18 DRAGONET (Figure 5.25)

Mean distribution: Dragonet was widely distributed and showed large catch rates in all regions surveyed. Peak concentrations reached almost 1,100 individuals per hour fishing in the Baie de Seine.

1992 survey: In most areas, the densities in 1992 exceeded the survey mean.

5.1.19 DOGFISH (Scyliorhinus spp) (Figure 5.26)

Mean distribution Dogfish concentrations dominantly occurred in the areas west of 2° East. Highest concentrations (up to 100 per hour fishing) were found in the Bristol Channel. In the North Sea the occurrence of dogfish was limited to the UK coast.

1992 survey: The 1992 catch data indicated a general but moderate increasing trend compared to the survey mean.

5.1.20 RAYS (Figure 5.27)

Mean distribution: The distribution pattern of rays was similar to the one for dogfish. The Humber region, the Irish Sea and the Bristol Channel clearly showed the highest densities.

1992 survey No clear trend could be found when comparing the 1992 catches to the survey mean.

5.1.21 COD (Figure 5.28)

Mean distribution: Cod was caught in low numbers north of 53°N both in the North Sea and Irish Sea. It was scarce in all southern areas.

1992 survey The 1992 catches showed a slight increase in the Irish Sea and part of the eastern N Sea compared with the survey mean.

5.1.22 POOR COD (Figure 5.29)

Mean distribution: The distribution of poor cod showed a mainly southerly and westerly pattern. Very high densities were recorded in the Bristol Channel with a maximum mean of almost 500 per hour fishing. Also in the eastern part of the Irish Sea and the English Channel poor cod appeared in dense concentrations.

1992 survey: The 1992 data varied without showing any trend around the survey mean.

5.1.23 BIB (Figure 5.30)

Mean distribution: The distribution pattern was similar to the one found for poor cod. Maximum values reached about 600 per hour fishing in the Baie de Seine.

1992 survey: The catches in 1992 were generally lower than the survey mean.

5.1.24 WHITING (Figure 5.31)

Mean distribution: With the exception of the English Channel whiting occurred in relatively large quantities in all other areas. In the North Sea however higher catches were made north of 53°N.

1992 survey: In the North Sea the 1992 catch rates were higher than the survey mean south of 53°N but generally lower further north.

5.1.25 RED MULLET (Figure 5.32)

Mean distribution: A low catch rate in all areas with peak catch rates off the Scheldt and in the Southern Bight of the North Sea.

1992 survey: Generally similar to the survey mean.

5.1.26 JOHN DORY (Figure 5.33)

Mean distribution: Limited to English Channel and westerly areas where it was caught at relatively low densities (< 1/hr).

1992 survey: Catches show a clear increase on the survey mean.

5.1.27 EDIBLE CRAB (Figure 5.34)

Mean distribution: The edible crab was widely distributed but highest concentrations occurred off the North East coast of England, the Bristol Channel and the eastern part of the Irish Sea.

1992 survey: In almost all areas the 1992 catches were characterised by an increasing trend compared to the survey mean.

5.2 OVERALL PATTERNS OF DISTRIBUTION

5.2.1 Flatfish

The survey area is dominated by two flatfish species, plaice and dab, both of which reach peak abundances north of 53°N but are found in high numbers throughout the area. Plaice forms the dominant biomass although dab is numerically most abundant. The numbers of these two species declines in the south of the survey area and solenette takes over as the most abundant flatfish. This species is also widely distributed but only reaches peak abundance south of 54°N.

The distribution of sole is determined by the position of the major estuarine nursery grounds and these are found associated with west facing coastlines. The four most important are the

Waddensea (rivers Elbe and Rhine), Scheldt estuary, Bristol channel (river Severn) and Liverpool Bay (rivers Mersey and Ribble).

Several flatfish species such as turbot and brill were widely distributed but in low abundance and others had clearly limited distributions. These included long rough dab which was mainly found in deeper water north of 54°N and thickback sole which had a predominantly westerly distribution.

5.2.2 Gadoids

The gadoids showed a strong north-south division of species with whiting and cod more abundant in the north of the survey area and bib and poor cod in the south. The separation was particularly marked in the North Sea with the division occurring around 53°N. In the Irish Sea, whiting remained the dominant species but bib and poor cod were also abundant.

5.2.3 Gurnards

The three main gurnard species showed a split in distribution and abundance similar to that found in the gadoids, with grey gurnard numerically dominant in the north and red gurnard in the south. Tub gurnard was more widespread but had a mainly coastal distribution.

5.2.4 Dogfish and Rays

Dogfish and rays were virtually absent from the survey area in the North Sea, only being found along the English coast and occasionally to the north of the survey area.

5.2.5 Relation between fish distribution and hydrographic boundaries

Patterns of distribution of fish species are linked to a range of hydrographic factors such as temperature and water movements. The split in the North Sea between those species with a more northerly distribution such as plaice, dab, cod, whiting and scaldfish and the more southerly species, including sole, solenette, bib and poor cod, roughly coincides with the boundary between mixed and stratified water masses. This is shown in Figure 5.35. Deeper oceanic water which becomes thermally stratified occurs to the north of a boundary between Flamborough and the Danish Coast with shallower well mixed water in the Southern Bight and eastern English Channel. The Irish Sea shows a similar split with stratified water offshore in the north and mixed water along the coast and in the south. The penetration of southern species further north in the Irish Sea than in the North Sea may be related to the extension of mixed water to a higher latitude along the English coast in the Irish Sea, than occurs in the North Sea.

5.3 INDICES OF ABUNDANCE BY SUB-AREA

The area covered by the surveys has been divided into 9 sub-areas and re-numbered since the previous report (Figure 5.36). Mean indices of abundance were calculated by averaging various rectangles in each of the sub-areas. The results for selected species for the period 1990-1992 are given in Table 5.1.

Sub-Area 1: This was the dominant sub-area in the North Sea for most flatfish species especially plaice, dab, flounder, scaldfish, turbot and brill. In 1990 this area had the highest catch rate for 1-group sole but this shifted to area 4 in the following 2 years. It was also important for cod and whiting in 1990 and 91 although whiting catch rates had dropped significantly by 1992 compared to sub-areas 2 and 3.

Sub-Area 2. This sub-area includes some deep water stations off the English coast as well as harder grounds than in the eastern North Sea and this is reflected in the high catch rate of lemon sole, edible crab and grey gurnard. The area has high catch rates of plaice and dab but is less important for these species than the adjacent sub-areas, 1 or 3. Particularly low catch rates of 1-gp sole and plaice compared with 2-group abundances, suggests that the juveniles were under sampled in this area.

Sub-Area 3: This sub-area occupies a central part of the northern survey area and also includes some inshore rectangles along the Dutch Waddensea. Catch rates of many species were similar to those in the adjacent sub-area 1.

Sub-Area 4. This extends over the Southern Bight and includes rectangles in the Dover Straits region of VIId. Catch densities of plaice and dab were substantially lower than further north but sole abundances were among the highest in the North Sea in 1992. Catches of bib and poor cod were greatly increased compared with areas 1-3 and whiting marked decreased.

Sub-Areas 5 and 6: These two sub-areas extend over the remainder of VIId. The catch rates of most flatfish except solenette and brill were lower than all other areas apart from the western English Channel. Poor cod and bib were abundant but whiting was virtually absent from the two areas. Some of the species with a typically southern or western distribution such as red gurnard, red mullet, John Dory and thickback sole were caught but at lower concentrations than further to the west.

Sub-Area 7: Abundances of flatfish were at a minimum in the western English Channel with the exception of thickback sole which were more common in this sub-area than elsewhere in the survey area. Catch rates of red gurnard were also at a peak but most other species were more abundant either in the North Sea or further to the west.

Sub-Areas 8 and 9: The Bristol channel and Irish Sea share a number of similarities with the sub-areas 1-3 in the North Sea, having high catch rates of sole, plaice, turbot and brill, as well as relatively high abundances of whiting, and in the Irish Sea, cod. Unlike the North Sea, however, bib and poor cod were also abundant together with dogfish and rays and a number of typically western species such as monk and thickback sole.

5.4 DISTRIBUTION AND ABUNDANCE OF BENTHOS

Details of benthos catches by station for 1992 were presented by the Netherlands for the North Sea and by the UK for the eastern English Channel, Bristol Channel and Irish Sea. The distributions and abundance of selected species were plotted in each area and are shown in Figures 5.37-5.39.

5.4.1 *Asterias rubens* (common starfish). *Asterias* one of the most commonly occurring species in all areas and was taken at most stations sampled. It was generally more abundant in coastal regions.

5.4.2 *Ophiuroidea* (brittlestars). Ophiuroids were also widespread in their distribution. In the North Sea, the highest abundances were generally inshore and they were absent from the more northerly stations. Similarly, large numbers of ophiuroids were found inshore in the Irish Sea and Bristol Channel but in the eastern English Channel, apart from the Dover Straits, they were more or less absent from coastal stations.

5.4.3 *Spatangidae* e.g. *Echinocardium* and *Spatangus* spp, (sea potatoe and heart urchins). This group was found mainly offshore in the North Sea and Irish Sea and its distribution contrasted with *Asterias* and Ophiuroids which reached peak abundance inshore. It occurred at only 4 stations in the Bristol Channel and was limited to the eastern end of the survey area in the eastern English Channel.

5.4.4 *Psammechinus miliaris* (green sea urchin). In the Irish Sea and Bristol channel, some *Echinus* spp were included in this group. The distribution of *Psammechinus* in the North Sea was broadly similar to that of the *Spatangidae*, although generally of low abundance. In the eastern English Channel, it was taken at most sites on the French coast and in mid-channel but rarely in English coastal waters. The distribution in the Irish Sea was mainly confined to an area off North Wales and, in the Bristol Channel, off the Gower Peninsular.

5.4.5 *Pectinidae* (scallops). This group includes the commercially important *Pecten maximus* and *Chlamys opercularis*. They were rarely recorded in the North Sea and Bristol Channel and, in the Irish Sea, their distributions was restricted mainly to the same grounds as the urchins (i.e. off the north Wales coast). High numbers of scallops were found offshore in the eastern English Channel with lower abundances inshore on both French and English coasts.

5.5 RELATIONSHIP BETWEEN BENTHOS AND SEDIMENTS

In the eastern English Channel survey, a 35mm underwater camera was attached to the 4m beam trawl and used to take colour photographs of the sediment at two minute intervals during each thirty minute tow. The sequence of up to 15 photographs along each two was examined and the sediment type separated on the basis of surface appearance. Three main categories were distinguished: soft sediments where the surface was predominantly muddy sand; firm sediments where there was mainly sand and hard sediments in which there was a high proportion of pebble and stones together with sand.

The main sediment type at each station is shown in Figure 5.40. The muddy sand and sandy sediments were found mainly on the inshore stations along the English coast and on both coasts in the eastern end around the Straits of Dover. There was an increase in harder sediments offshore and in a westerly direction. Hard sediments also occurred inshore of the Isle of Wight and along much of the French coast except for stations off the river Seine.

The association between sediment type and benthos in the eastern English Channel was examined by comparing the percentage occurrence of each abundance level within the three different sediment types. The results are shown in Figure 5.41 for selected species. There was no consistent association between level of abundance and sediment type, indicating that other factors such as depth, latitude and season can also influence distribution. However the percentage of stations at which the catch of each species was zero revealed some interesting differences.

Asterias was extremely abundant and less than 20% of hauls did not catch any, irrespective of sediment type. By comparison, Ophiuroids were not taken in 60 to 80% of the hauls and there was little difference between the sediment types.

Echinocardium and *Aphrodite* were absent from around 70-80% of hauls on hard or firm sediments but only from 50-60% of hauls on soft, muddy sand sediments, indicating a possible preference for softer seabed sediments. The opposite was true for *Psammechinus* and *Pectinidae* ,which were found more often in hauls on hard sediments. Sixty per cent of hauls on soft or firm sediments contained no individuals of *Psammechinus* while only 40% on hard sediments contained none. In this species, highest abundance levels (>100) were also found associated with hard sediments. *Pectinidae* were entirely absent from hauls on soft sediments, were missing in 80% of hauls on sandy sediments but in only 60% of hauls on hard substrates. Highest abundances were also recorded from hard sediments.

6. ABUNDANCE INDICES OF SOLE AND PLAICE

Estimates of year class strength were calculated for each survey and the results are shown in Table 6.1 and 6.2. Trends in abundance of 1, 2 and 3 group sole and plaice are plotted for each survey area in Figure 6.1. The relationship between different survey indices of abundance at age 1 and the VPA estimate of recruitment at age 1 is shown in Figure 6.2.

6.1. North Sea

6.1.1. Netherlands

Exploited age groups

In previous years the abundance indices of sole and plaice were calculated as the mean numbers per fishing hour by rectangle for a standard set of rectangles covered in the survey since 1985. The rectangles included in the index are shown in Figure 6.3. The age compositions per haul were derived using length-age-keys from the otoliths collected during the survey. Because the number of otoliths of the larger fish was rather small and these fishes could belong to a wide range of year classes, the age compositions have been re-analysed using the survey otolith samples and additional market samples collected in August - September. The revised survey indices are given in Table 6.1 and 6.2 and shown in Figure 6.4.

Pre-recruit estimates

Until now the beam trawl survey data have not been used to estimate year class strength of pre-recruits. Because the survey included a larger number of hauls in the coastal rectangles and shallower depth bands the mean catch rates from Table 6.1 and 6.2 may not be appropriate estimates of year class strength. Therefore we explored an ANOVA approach to correct for the spatial distribution and depth distribution of the hauls. The following GLM model was employed Y = A + D + YR + e where Y = the catch per fishing hour, A = the statistical rectangle (factor with 42 levels), D = depth, YR = year of sampling (factor with 8 levels) and e = error term. In the analysis a log link function and a Poisson error was used. In this analysis it was assumed that the spatial pattern was constant between years and that the variance within a rectangle after correcting for depth represented the between-haul variance. The ANOVA shows that statistical rectangle, depth and sampling year all contribute significantly to the variance in catch rate (Table 6.3). The parameter estimates for the year effect and depth effect are given in Table 6.4. The analysis did not include 0-group flatfish because these will partly escape through the meshes and are, in the case of plaice, distributed almost completely outside the survey area.

The scatter plots of the 1-2 group indices and 2-3 group indices indicate that subsequent surveys give a consistent estimate of year class strength in both sole and plaice, especially between the 2-3 group indices (Fig.6.5). In plaice, the 1-group index in 1988 (year class 1987) shows a rather high index whereas subsequent surveys do not indicate that this year class is a particularly strong one.

Comparison of the pre-recruit estimates of sole and plaice with VPA-estimates show that for both species the survey detected the very strong 1985 (plaice) and 1987 (sole) year classes Fig.6.6). However, no relationship was obvious for the other year classes for which the VPA-estimates were rather similar. In plaice, the high survey estimate of the 1987 year class as 1-group and to a lesser extend as 2-group did not correspond to a high VPA-estimate of this year class. The ANOVA results, which should be seen as a first step that can be taken further to include other parameters such as wind speed, wind direction and temperature, are encouraging and suggest that this survey may yield useful 1-, 2- and 3-group pre-recruit estimates of sole and plaice.

6.1.2 Belgium

For sole, the Belgian survey identifies the strong 89 and 91 year classes as 1-group but the very strong 1987 year class was not evident in the surveys until 2-group fish. This suggests that the main recruitment of this year class may have been in the north of the survey area. The distribution of the1991 year class (Fig 6.1) indicates that it is particularly abundant off the Belgian coast in comparison to the survey mean. For plaice, the strong 1985 year class was evident in the Belgian survey only as 2-group and older. The survey suggests that the 1991 year class may also be above average although this is not apparent in the Netherlands data. The relationship between the survey estimate of 1-group abundance and the VPA estimate is show in Figure 6.2. For sole, apart from the 1987 year class, there was a reasonable relationship with the VPA but plaice showed a poor correlation between the two.

6.2 EASTERN ENGLISH CHANNEL

The 1, 2 and 3-group estimates show consistent trends in year class strength of sole (Figure 6.1). All three estimate the 1988 year class as poor and 1987 as above average. The plaice estimates were more variable with the 3-group index at variance with the other year class estimates. This was reflected in the relationship with the VPA which showed reasonable correlation for sole but not for plaice (Figure 6.2)

6.3 WESTERN ENGLISH CHANNEL

Data was only available since 1989 and this indicated a strong year class in 1989 as 1, 2 and 3-group for sole and potentially a strong 1991 year class of plaice.

6.4 BRISTOL CHANNEL

Figure 6.1 showed consistent trends in year class strength for sole and all 3 age groups estimate 1987 to be substantially above average. The plaice estimates were also mainly consistent, with 1 and 2-group estimates implying a slightly above average year class in 1990.

There was good correlation between survey estimates for sole and the VPA but plaice showed no clear relationship between the two estimates (Figure 6.2).

6.5 IRISH SEA

As in all other survey areas except the North Sea the 1989 year class of sole was estimated to be above average at age 1, 2 and 3-group. The 1-group index suggests that it was approximately 8 times bigger than the average for other years but it was estimated as about twice as strong as other years at age two and three. Estimates for plaice mainly showed consistent trends between years and ages except for the 1990 year class which was estimated to be the strongest in the series at age 2 but only about average as 1-group.

There was reasonable correlation between the VPA and survey estimates for sole but not for plaice (Figure 6.2)

7. CHANGES IN ABUNDANCE OF SOME NON-COMMERCIAL FISH SPECIES IN THE SOUTHERN AND SOUTHEASTERN NORTH SEA

The survey carried out by The Netherlands started in 1985 and allows us to analyse trends in abundance of non-commercial fish species. The basic data, given in Table 7.1, show the mean catch rate by area of all species caught by sub-area (see Figure 5.35).

Over the period of 8 years species can be grouped into those which 1 - show irregular variation without a clear trend (e.g. dragonet, lesser weever, hooknose), 2 - show an increase in abundance in the most recent years (e.g. solenette, scaldfish, red mullet, red gurnard, tub gurnard, bib); 3 - show a decrease in abundance in the most recent years (e.g. long rough dab). The trends in some species should be treated with caution. Trends of those species that are distributed in the shallow coastal zone, such as gobies, eel, bib, bull rout etc are likely to be biased by the change in the number of stations fished in the shallow coastal waters. The trends in ray species may be biased because these were not always identified to the species level in the earlier years of the survey.

Fig 7.1 shows the time trends in abundance of some fish species representative for these three groups. Lesser weever, which is abundant in the southern North Sea (area #4), shows relatively small annual fluctuations without a clear trend in time. Dragonet shows a more variable pattern but no trend in time, but the annual variations in the three sub-areas occur in concert. Red mullet and solenette are two examples of species that increased in abundance in recent years. The increase in mullet is largest in the southernmost area #4 but also occurs in the central area #3. No mullet were caught in the German Bight (area #1). In solenette the increase in abundance is restricted to area #3 and area #1. Long rough dab is the only species which may have shown a decrease in abundance as illustrated by the low numbers in area #1 since 1990. However, the peak in abundance in area #3 in 1991 contrasts to the interpretation of a general decline.

The changes in abundance over the most recent years are likely to be related to the relatively warm water temperatures in these years allowing southern species to extend their range into the North Sea (e.g. red mullet) and forcing northern species to retreat from the southern and southeastern North Sea (e.g. long rough dab).

8. RECOMMENDATIONS

1. To improve survey design and analysis the Study Group recommended that:

   a) indices should be calculated by area weighting over depth bands

   b) multiplicative models should be investigated as these would allow for changes in sampling over time or space.

   c) sampling should be extended in depth zones where coverage was inadequate such as along the English North Sea coast and offshore in the Irish Sea and Bristol Channel.

2. Benthos samples should be analysed by all surveys using a standard methodology. It was recommended that a basic list of species would be recorded which included indicators of sediment type and potential indicators of beam trawl or other environmental damage. The Benthos Working Group was requested to advise on suitable indicator species.

3. A set of overlapping stations should be sampled regularly to allow gear comparisons to be made on both commercial and non-commercial species.

4. The Study Group recommended that otoliths of selected species should be collected on a 3 year cycle so that a biological database can be established for a range of non-commercial or non-TAC species. RIVO agreed to coordinate the sampling and processing scheme and will consider including the International Young Fish Surveys, as well.

5. The Study Group should work by correspondence in 1994 to analyse and report on the 1993 surveys.

6. The Study Group should meet in 1996 in Ijmuiden to carry out a further evaluation of survey data and methodology.

9. REFERENCES

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10. GLOSSARY OF ENGLISH AND SCIENTIFIC NAMES OF MAIN FISH SPECIES AND BENTHOS REFERRED TO IN THE TEXT.

Fish

sole	*Solea solea*
plaice	*Platessa platessa*
dab	*Limanda limanda*
turbot	*Scophthalmis maximus*
brill	*Scophthalmis rhombus*
scaldfish	*Arnoglossus laterna*
Lemon sole	*Microstomus kitt*
Long rough dab	*Hippoglossoides platessoides*
flounder	*Platichthys flesus*
solenette	*Buglossidum luteum*
thickback sole	*Microchirus variegatus*
monkfish	*Lophius spp.*
tub gurnard	*Trigla lucerna*
grey gurnard	*Eutrigla gurnardus*
red gurnard	*Aspitrigla cuculus*
pogge (bullhead)	*Agonus cataphractus*
Lesser weever	*Echiichthys vipera*
dragonet	*Callionymus lyra*
Lesser spotted dogfish	*Scyliorhinus canicula*
rays	*Rajidae*
cod	*Gadus morhua*
poor cod	*Trisopterus minutus*
bib (pout)	*Trisopterus luscus*
whiting	*Merlangius merlangus*
red mullet	*Mullus surmulltus*
John dory (dory)	*Zeus faber*
edible crab	*Cancer pagurus*

Benthos

common starfish	*Asterias rubens*
brittle stars (ophiuroids)	*Ophiuroidea*
sea potato	*Echino cardium spp.*
heart urchin	*Spatangus spp.*
green sea urchin	*Psammechinus miliaris*
scallop	*Pecten maximus*
queen	*Chlamys opercularis*

Table 3.1 Summary of (epi)benthos species recorded on the Beam Trawl Survey of the Netherlands since 1985

ERCHINODERMATA
Asterias rubens
Astropecten irregularis
Cancer pagurus
Echinocardium sp.
Ophiuridae
Psammechinus miliaris

MOLLUSCS
Sepia officinalis
Sepiola atlantica
Loligo forbesi
Allotheutis
Arctica islandica
Buccinum undatum

CRUSTACEA
Carcinus meanas
CORYSTES cassivelaunus
Homarus vulgaris
Hyas araneus
Liocarcinus depurator
Liocarcinus puber
Nephrops norvegicus
Pagurus bernhardus

POLYCHAETA
Aphrodite aculeata

ATHOZOA
Alcyonium digitatum

Table 4.1. Comparison 1: standard 8m beam trawl vs 8m beam trawl with flip-up rope. Estimated coefficients of the GLM model N = exp(a+station+gear) indicating the relative catch of the 8m beam trawl relative to the 8m beam trawl equipped with a flip-up rope (8m+f):

Species	Gear	S.E.	8m / 8m+f exp(gear)	95% C.L.	Significancy level
Sole					
ALL	0.497	0.111	1.64	1.32 - 2.05	P<0.01
0-2 group	1.381	0.030	3.98	3.75 - 4.22	P<0.01
3-5 group	-0.155	0.064	0.86	0.75 - 0.97	P<0.05
6+ group	0.217	0.189	1.24	0.85 - 1.81	N.S.
Plaice					
ALL	0.612	0.053	1.84	1.66 - 2.05	P<0.01
0-2 group	0.903	0.008	2.47	1.81 - 2.51	P<0.01
3-5 group	0.0015	0.011	1.00	0.98 - 1.02	N.S.
6+ group	-0.379	0.107	0.68	0.55 - 0.85	P<0.01
Dab					
ALL	0.298	0.004	1.35	1.34 - 1.36	P<0.01
10-14.9 cm	0.226	0.006	1.25	1.24 - 1.27	P<0.01
15-19.9 cm	0.359	0.006	1.43	1.41 - 1.45	P<0.01
>=20 cm	0.106	0.016	1.11	1.08 - 1.15	P<0.01
Whiting					
ALL	0.413	0.002	1.51	1.50 - 1.52	P<0.01
10-19.9 cm	0.544	0.038	1.72	1.60 - 1.86	P<0.01
20-26.9 cm	0.418	.030	1.52	1.43 - 1.61	P<0.01
>=27 cm	0.361	0.075	1.43	1.23 - 1.67	P<0.01
Turbot	0.484	0.134	1.62	1.24 - 2.12	P<0.01
Cod	-0.194	0.094	0.82	0.68 - 0.99	P<0.05

Table 4.2. Comparison 2: 8m+f BELGICA vs 4m+sf CORYSTES. Estimated coefficients of the GLM model N = exp(a+station+gear) indicating the relative catch of the 8m+f relative to the 4m+sf .

Species	Gear	S.E.	8m / 4m+sf exp(gear)	95% C.L.	Significancy level
Sole	0.0770	0.0982	1.08	0.89 - 1.31	N.S.
Plaice	0.9801	0.1398	2.66	2.01 - 3.52	P<0.01
Dab	0.5612	0.0706	1.75	1.52 - 2.02	P<0.01

Table 4.3. Comparison 3: 8m+f BELGICA vs 4m+sf BELGICA. Estimated coefficients of the GLM model N = exp(a+station+gear) indicating the relative catch of the 8m+f relative to the 4m+sf.

Species	Gear	S.E.	8m / 4m+sf exp(gear)	95% C.L.	Significancy level
Sole	0.0995	0.0697	1.10	0.96 - 1.27	N.S
Plaice	0.3771	0.1134	1.46	1.16 - 1.83	P<0.01
Dab	0.1054	0.3248	1.80	1.48 - 2.20	P<0.01

Table 4.4. Comparison 4: 8m ISIS vs 7m SOLEA. Estimated coefficients of the GLM model N = exp(a+station+gear) indicating the relative catch of the 8m relative to the 7m.

Species	Gear	S.E.	8m / 7m exp(gear)	95% C.L.	Significancy level
Sole	1.623	0.0461	5.07	4.62 - 5.56	P<0.01
Plaice	0.5438	0.0105	1.72	1.69 - 1.76	P<0.01
Dab	0.8274	0.00834	2.29	2.25 - 2.33	P<0.01
Whiting	-0.6420	0.04797	0.53	0.48 - 0.58	P<0.01

Table 5.1 Mean abundance of species (no/hr/8m trawl) by sub-area in the North Sea and Eastern Channel, 1990-1992

		1			2			3	
	1990	1991	1992	1990	1991	1992	1990	1991	1992
Sole 1	30.4	2.4	56.8	0.0	0.6	1.7	2.2	2.6	23.1
Sole 2	22.8	26.3	5.0	21.9	22.2	18.7	9.5	9.2	12.8
Sole 3+	22.2	12.6	15.0	17.6	10.8	70.9	17.7	7.6	9.2
Plaice 1	328.4	380.7	445.1	0.5	0.0	3.2	51.0	23.8	52.0
Plaice 2	204.8	219.9	215.0	25.5	34.0	34.6	32.1	37.9	35.2
Plaice 3+	172.7	86.2	49.4	53.8	9.4	54.0	55.5	17.1	21.2
Dab 1	831.8	733.5	478.9	333.9	78.6	223.1	368.7	365.1	384.5
Dab 2	579.6	230.7	451.6	150.3	165.6	291.5	544.7	199.1	362.4
Dab 3+	683.4	377.9	340.3	22.3	40.2	79.8	233.5	84.6	168.9
Dab	2095.0	1366.9	1307.4	351.5	284.4	596.0	1023.0	651.5	971.6
Turbot	6.3	3.9	4.5	0.0	0.0	1.4	2.2	1.5	0.9
Brill	1.7	1.3	3.7	0.8	1.0	0.8	1.3	0.7	1.1
Scaldfish	90.3	62.4	72.9	108.0	4.0	91.2	202.6	88.6	124.8
Lemon sole	3.3	2.7	0.6	10.8	6.8	3.4	3.8	2.9	3.4
Long rough dab	9.0	7.7	2.1	0.0	0.0	0.0	0.0	0.9	0.0
Flounder	16.4	23.0	7.0	0.0	0.2	0.0	0.0	0.1	0.2
Solenette	49.7	47.5	92.1	172.0	42.6	66.6	318.7	47.0	242.6
Tub gurnard	4.7	4.5	15.6	0.3	7.0	0.2	5.7	3.0	2.1
Grey gurnard	25.7	34.5	42.5	87.8	7.6	94.8	83.9	32.2	26.5
Red gumard	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.2	0.1
Pogge	61.8	104.9	88.9	23.0	4.8	31.4	7.1	14.1	13.5
Lesser weaver	0.7	1.2	3.0	200.0	35.2	75.2	16.3	21.2	41.4
Dragonet	174.7	47.3	151.5	140.0	62.0	44.8	80.7	27.6	32.7
Dogfish	0.1	0.0	0.0	0.0	0.0	0.4	0.3	0.3	0.2
Rays	4.6	0.7	0.4	31.0	20.8	19.3	3.7	1.3	3.5
Cod	6.5	12.9	3.4	1.3	2.4	0.8	1.8	1.2	2.6
Poor cod	2.1	0.3	0.7	0.0	0.0	0.0	0.0	1.7	0.4
Bib	19.3	0.3	0.9	14.5	11.4	1.2	5.0	17.4	1.4
Whiting	698.1	93.3	40.8	211.5	6.2	144.8	86.5	80.4	141.9
Monk	0.0	0.0	0.0	0.0		0.1	0.0	0.0	0.1
John dory	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Red mullet	0.0	0.0	0.0	0.0		0.0	0.2	0.0	0.4
Thickback sole	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Ediblecrab	1.9	2.5	11.2	27.8	19.1	33.0	32.6	4.1	8.2

Table 5.1 continued

	4			5			6		
	1990	1991	1992	1990	1991	1992	1990	1991	1992
Sole 1	14.5	10.4	74.3	2.1	4.1	0.4	9.4	7.7	2.4
Sole 2	11.4	22.5	42.1	3.1	15.2	3.9	3.2	26.2	12.0
Sole 3+	14.8	7.4	21.4	4.6	5.9	8.4	4.5	6.2	14.8
Plaice 1	23.7	14.4	50.5	1.4	4.9	3.6	1.2	6.7	7.1
Plaice 2	12.3	15.7	13.7	1.3	4.6	2.4	1.5	3.4	6.3
Plaice 3+	20.5	15.5	14.4	6.7	9.7	5.4	15.1	19.5	35.2
Dab 1	186.1	68.0	83.8	0.7	2.6	4.9	5.0	2.2	70.9
Dab 2	64.7	36.8	45.1	1.0	1.4	1.3	2.4	2.4	10.1
Dab 3+	24.1	21.1	22.7	1.8	1.6	0.7	2.6	2.3	9.2
Dab	193.7	131.5	203.5	3.4	7.6	7.1	10.0	24.5	98.9
Turbot	1.3	0.9	1.0	0.0	0.1	0.1	1.0	0.0	0.6
Brill	1.4	0.7	1.0	2.5	1.0	0.7	1.0	1.0	1.5
Scaldfish	36.3	26.4	32.5	2.5	4.7	3.9	1.0	1.6	2.7
Lemon sole	4.7	8.4	3.9	3.0	1.0	2.4	3.5	1.8	0.8
Long rough dab	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flounder	1.3	2.9	3.0	0.0	0.0	0.0	0.5	2.8	2.7
Solenette	40.3	50.3	58.8	101.0	155.3	141.5	70.5	87.9	88.2
Tub gurnard	6.1	5.1	4.2	2.5	1.3	3.5	3.0	1.2	7.4
Grey gurnard	3.2	9.4	16.8	1.0	0.2	0.3	0.0	1.0	0.1
Red gurnard	3.6	5.9	3.4	22.5	9.5	9.7	9.5	11.2	7.1
Pogge	14.4	37.0	35.2	6.5	4.0	9.6	30.0	49.8	34.6
Lesser weaver	54.5	55.9	61.6	0.5	0.1	0.3	15.0	4.4	5.6
Dragonet	154.4	63.1	81.5	35.0	39.2	45.1	187.0	401.4	660.1
Dogfish	4.0	3.1	4.2	6.5	1.7	11.0	2.0	8.7	11.6
Rays	2.0	3.2	5.6	6.0	6.0	8.2	2.5	3.4	5.1
Cod	0.9	0.5	2.3	0.0	0.0	0.0	0.0	0.0	0.5
Poor cod	46.2	34.4	12.5	338.5	170.2	134.1	211.5	235.3	82.0
Bib	200.6	36.2	24.3	147.5	30.7	27.0	315.5	106.5	146.3
Whiting	15.6	11.6	42.9	0.0	0.1	0.0	0.0	0.7	2.3
Monk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
John dory	0.0	0.0	0.1	0.0	0.9	0.5	0.0	0.2	0.7
Red mullet	0.4	1.8	2.2	0.4	0.0	0.4	0.2	0.0	0.2
Thickback sole	0.8	1.6	2.8	0.2	0.7	0.8	2.2	1.3	4.3
Ediblecrab	1.9	1.5	11.6	2.5	4.3	4.8	1.0	1.2	3.1

Table 5.1 continued

	7			8			9		
	1990	1991	1992	1990	1991	1992	1990	1991	1992
Sole 1	0.6	0.6	0.1	30.8	16.9	38.4	122.7	13.2	14.9
Sole 2	1.7	8.6	4.0	18.3	40.6	23.6	53.8	105.2	26.2
Sole 3+	3.7	5.5	11.6	7.3	8.2	21.7	33.5	17.1	86.6
Plaice 1	0.8	0.3	2.9	11.4	43.2	34.9	146.9	60.4	50.7
Plaice 2	1.2	0.5	0.6	17.0	1.8	22.7	36.7	59.8	96.1
Plaice 3+	6.3	4.2	5.5	3.4	2.5	4.1	21.5	7.5	47.3
Dab 1		0.0	0.2		ND			ND	
Dab 2		0.3	0.2		ND			ND	
Dab 3+		1.7	0.3		ND			ND	
Dab	15.7	7.5	14.3	23.0	35.2	90.0	532.0	369.7	226.7
Turbot	0.1	0.0	0.0	2.0	2.4	1.2	0.3	0.6	0.2
Brill	0.3	0.5	0.5	2.5	1.2	0.9	2.6	2.3	1.5
Scaldfish	+	1.5	14.8	0.0	0.4	0.8	26.3	24.9	25.1
Lemon sole	1.2	0.9	0.3	1.0	0.8	1.9	2.6	1.4	3.0
Long rough dab	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.3	0.1
Flounder	0.0	0.0	0.0	0.5	0.8	0.6	4.9	1.1	0.9
Solenette	+	0.0	126.2	41.0	120.8	90.7	170.3	146.0	103.0
Tub gurnard	1.0	0.6	1.8	4.5	4.4	7.4	9.4	5.1	13.2
Grey gurnard	5.0	3.5	2.8	9.5	29.2	55.7	71.4	45.7	69.3
Red gurnard	26.2	10.4	28.9	1.0	2.0	0.6	4.9	5.1	2.2
Pogge	+	0.2	2.7	0.0	0.8	1.9	43.1	36.6	37.1
Lesser weaver	+	0.0	2.7	0.0	2.0	0.6	10.3	15.7	31.3
Dragonet	+	224.8	84.7	8.5	18.8	44.7	162.9	135.4	272.4
Dogfish	6.9	6.4	13.4	52.0	43.6	83.1	24.0	17.4	34.6
Rays	2.8	3.4	2.3	13.5	14.0	22.7	14.6	16.3	17.5
Cod	0.0	0.0	0.0	0.0	0.8	1.4	29.4	10.9	9.6
Poor cod	+	156.0	123.1	217.0	221.2	236.4	236.0	37.1	69.2
Bib	+	34.3	8.3	170.0	74.4	57.9	64.0	30.9	33.2
Whiting	1.3	6.7	4.4	102.5	58.8	79.0	43.7	49.1	74.8
Monk	0.7	0.0	0.4	0.0	1.3	7.7	0.3	10.0	1.1
John dory		1.0	1.5	0.5	0.8	0.2	0.0	0.3	0.4
Red mullet		0.4	0.6	2.3	0.0	0.0	0.0	0.0	0.0
Thickback sole		2.8	16.6	12.5	11.6	15.6	4.0	2.9	10.0
Ediblecrab	0.6	1.0	2.1	3.5	3.6	2.6	7.7	9.9	10.9

Table 6.1 Catch rate of sole from Belgium, Netherlands and UK surveys in the North Sea and VIId,a,e,f&g

Belgium (No/hr/8m trawl) North Sea

Age	0	1	2	3	4	5	6	7	8	9	10+
Year											
1986		1.9	1.7	2.7	2.0	1.0		0.2			0.3
1987		0.0	5.1	1.4	1.3	1.4	0.5	0.1	0.3	0.1	0.2
1988	1.3	4.7	2.2	14.3	3.6	2.9	0.8		1.7	2.1	1.0
1989		8.8	17.2	1.9	3.3	0.8	0.2	0.4	0.2		0.5
1990		21.8	5.8	7.5	1.7	1.8	0.8		0.5	0.9	1.2
1991		7.6	12.1	3.8	4.7	0.5	0.4	0.2	0.1		0.3
1992		76.0	23.0	14.3	1.7	1.5		1.7	0.1	0.8	0.6

Netherlands (No/hr/8m trawl) North Sea

Age	0	1	2	3	4	5	6	7	8	9	10+
Year											
1985	0.0	2.4	6.0	4.0	1.6	0.6	0.2	0.0	0.0	0.0	0.01
1986	0.0	5.1	4.2	1.3	0.9	0.4	0.2	0.1	0.0	0.00	0.11
1987	0.1	5.5	8.8	2.2	0.7	0.5	0.2	0.1	0.05	0.0	0.02
1988	0.0	68.2	10.8	3.0	0.8	0.2	0.2	0.1	0.06	0.02	0.05
1989	0.9	8.0	60.5	3.2	4.1	0.5	0.2	0.1	0.0	0.02	0.04
1990	0.1	17.7	18.1	18.1	0.9	0.6	0.2	0.1	0.07	0.01	0.02
1991	0.9	3.3	17.4	5.0	9.1	0.3	0.5	0.1	0.04	0.01	0.04
1992	0.2	61.0	22.2	8.7	1.9	2.5	0.1	0.1	0.07	0.02	0.06

United Kingdom (No/hr/8m trawl) Eastern Channel (VIId)

Age	0	1	2	3	4	5	6	7	8	9	10+
Year											
1988	0.0	8.2	14.2	9.9	0.8	1.3	0.6	0.1	0.10	0.20	0.20
1989	0.0	2.6	15.4	3.4	1.7	0.6	0.2	0.2	0.03	0.01	0.70
1990	0.0	12.1	3.7	3.4	0.7	0.8	0.2	0.1	0.20	0.00	0.07
1991	0.0	8.9	22.8	2.2	2.3	0.3	0.5	0.1	0.17	0.08	0.10
1992	0.0	1.4	12.0	10.0	0.7	1.1	0.3	0.5	0.10	0.20	0.60

United Kingdom (No/hr/8m trawl) Irish Sea (VIIa)

Age	0	1	2	3	4	5	6	7	8	9	10+
Year											
1988	0.2	8.8	24.3	23.3	43.8	8.6	4.6	0.1	0.0	0.0	0.0
1989	2.0	15.8	25.9	22.1	9.9	25.0	4.9	1.8	0.0	0.0	0.2
1990	0.9	122.7	53.8	12.1	4.0	9.5	15.2	2.6	1.4	0.6	0.1
1991	0.3	13.2	105.2	17.0	2.8	1.1	2.1	8.4	2.3	0.2	0.3
1992	0.1	14.9	26.2	53.9	14.3	6.2	1.2	0.5	7.9	1.7	0.8

Table 6.1 (continued)

United Kingdom (No/hr/8m trawl) Bristol Channel (VIIf&g)

Age Year	0	1	2	3	4	5	6	7	8	9	10+
1988	2.2	6.7	26.6	3.7	1.8	0.9	0.0	0.0	0.0	0.0	0.4
1989	18.6	19.7	27.0	18.7	2.2	2.4	1.2	0.4	0.1	0.1	0.0
1990	6.9	30.8	18.2	6.2	1.9	1.0	3.4	0.5	0.0	0.0	0.5
1991	4.0	16.9	40.6	8.8	2.9	4.3	0.4	0.0	0.1	0.3	0.3
1992	0.3	30.7	18.9	12.1	3.0	2.1	1.5	0.1	0.5	0.2	1.0

United Kingdom (No/hr/8m trawl) Western Channel (VIIe)

Age Year	0	1	2	3	4	5	6	7	8	9	10+
1989	0.0	0.2	2.5	4.9	4.3	1.5	1.6	0.7	0.3	0.3	0.4
1990	0.0	0.6	1.7	3.1	1.3	1.0	0.3	0.6	0.1	0.2	0.5
1991	0.0	0.3	7.9	2.9	2.1	1.0	0.8	0.3	0.7	0.2	0.7
1992	0.0	0.2	5.8	11.6	1.5	1.3	0.5	0.3	0.2	0.4	0.5

Table 6.2 Catch rate of plaice from Belgium, Netherlands and UK surveys in the North Sea and VIId,a,e,f&g

Belgium (No/hr/8m trawl) North Sea

Age	0	1	2	3	4	5	6	7	8	9	10+
Year											
1986	0.0	0.5	6.0	5.3	5.0	1.5	0.0	0.2	0.0	0.0	0.0
1987	0.0	4.0	11.3	6.6	2.0	1.6	0.1	0.1	0.1	0.0	0.0
1988	0.0	0.2	4.0	21.5	3.2	0.4	0.1	0.2	0.0	0.0	0.0
1989	0.1	3.6	3.4	6.7	6.7	0.8	0.2	0.1	0.2	0.0	0.1
1990	0.0	2.8	4.8	4.4	5.2	7.5	0.9	0.0	0.0	0.0	0.0
1991	0.0	0.5	7.0	3.5	0.8	1.0	0.2	0.0	0.0	0.0	0.0
1992		8.0	5.0	5.0	3.0	0.0	1.0	0.0	0.0	0.0	0.0

Netherlands (No/hr/8m trawl) North Sea

Age	0	1	2	3	4	5	6	7	8	9	10+
Year											
1985	120.7	105.7	187.3	37.9	13.4	1.9	1.0	0.5	0.2	0.2	0.5
1986	12.6	534.2	106.9	45.2	8.9	4.1	0.6	0.6	0.1	0.1	0.3
1987	35.0	186.2	634.3	28.8	8.5	2.4	1.4	0.3	0.2	0.1	0.2
1988	83.7	522.6	145.9	200.8	6.6	3.0	0.7	0.6	0.1	0.1	0.2
1989	73.2	398.0	337.9	56.1	51.1	7.9	1.1	0.4	0.2	0.1	0.3
1990	14.3	114.7	113.7	62.7	20.8	9.5	1.1	0.3	0.2	0.1	0.1
1991	6.1	187.2	125.5	30.1	21.6	5.4	4.6	0.6	0.2	0.1	0.2
1992	13.8	161.0	104.9	18.5	5.5	4.4	2.6	1.3	0.3	0.0	0.3

United Kingdom (No/hr/8m trawl) Eastern Channel

Age	0	1	2	3	4	5	6	7	8	9	10+
Year											
1988	0.0	26.5	31.3	43.8	7.0	4.6	1.5	0.8	0.70	0.60	1.21
1989	0.0	2.3	12.1	16.6	19.9	3.3	1.5	1.3	0.54	0.30	1.65
1990	0.6	5.2	4.9	5.8	6.7	7.5	1.8	0.7	0.97	0.75	0.37
1991	0.0	11.7	9.1	7.0	5.3	5.4	3.2	1.2	0.99	0.06	1.24
1992	0.0	16.5	12.5	4.2	4.2	5.6	4.9	3.4	0.66	0.49	0.72

United Kingdom (No/hr/8m trawl) Irish Sea

Age	0	1	2	3	4	5	6	7	8	9	10+
Year											
1988	2.9	72.6	145.3	30.8	1.2	6.8	1.2	0.5	0.0	0.1	0.8
1989	5.9	41.3	67.6	64.8	11.3	1.4	3.4	0.3	0.0	0.0	0.1
1990	63.4	146.9	36.7	19.9	9.1	4.8	4.1	0.2	0.1	0.9	0.3
1991	6.7	60.4	59.8	8.1	4.4	0.1	0.9	1.8	0.1	0.0	0.4
1992	4.8	50.7	96.1	38.0	2.0	2.1	1.5	1.6	0.1	0.0	2.01

Table 6.2 (continued)

United Kingdom (No/hr/8m trawl) Bristol Channel

Age	0	1	2	3	4	5	6	7	8	9	10+
Year											
1988	0.4	10.9	26.2	7.5	0.0	0.7	0.7	0.0	0.0	0.2	0.0
1989	0.5	15.1	26.5	7.4	2.1	0.8	0.0	0.1	0.0	0.0	0.0
1990	0.9	11.4	15.8	6.4	2.5	0.4	0.0	0.0	0.3	0.0	0.3
1991	0.1	43.2	1.8	3.6	1.4	0.5	0.3	0.0	0.3	0.0	0.0
1992	0.2	28.4	18.5	0.8	0.4	1.2	0.3	0.3	0.0	0.0	0.1

United Kingdom (No/hr/8m trawl) Western Channel

Age	0	1	2	3	4	5	6	7	8	9	10+
Year											
1989	0.0	0.8	2.2	10.6	7.5	1.4	0.2	0.3	0.2	0.1	0.3
1990	0.0	0.8	1.1	7.0	3.4	2.4	0.0	0.2	0.1	0.1	0.3
1991	0.0	0.6	0.8	1.4	2.7	2.1	1.6	0.7	0.1	0.0	0.3
1992	0.0	4.3	1.0	1.4	0.5	1.3	0.7	0.5	0.1	0.2	0.2

Table 6.3. Percentage explained variance and corresponding F values from the ANOVA of number per fishing hour of sole and plaice according to the GLM model using a log-link function and a Poisson error: logeY = rectangle + depth +year.

* P<0.05; ** P<0.01

		Rectangle	Depth	Year	Full model
d.f.	41,586	1,586	7,586	49,586	
Sole					
1-group	%SS	29.2	0.8	21.7	70.6
	F	14.2**	15.1**	61.7**	28.7**
2-group	%SS	29.4	0.2	17.8	62.0
	F	11.1**	3.1 N.S.	39.4**	19.5**
3-group	%SS	32.5	0.1	25.6	62.4
	F	12.3**	0.9 N.S.	56.9**	1.66**
4plus-group	%SS	39.7	0.02	20.8	61.9
	F	14.9**	0.32 N.S.	45.8**	1.63**
Plaice					
1-group	%SS	24.9	5.2	10.0	79.3
	F	16.5**	148.5**	41.2**	45.8**
2-group	%SS	56.8	2.6	22.2	73.6
	F	30.8**	57.4**	70.4**	33.4**
3-group	%SS	38.7	0.2	29.6	69.0
	F	17.8**	3.67 N.S.	79.9**	26.6**
4plus-group	%SS	4.2	0.7	17.3	57.9
	F	14.2**	10.2**	34.4**	16.5**

Table 6.4. Parameter estimates of loge year effect (1985 to 1992) and depth effect on the catch rate of sole and plaice from the GLM model using a log-link function and a Poisson error: logeY = rectangle + depth +year. (See Table 6.3.)

	sole-1		sole-2		sole-3	
	mean	SE	mean	SE	mean	SE
1985	3.388	0.103	3.158	0.100	2.108	0.154
1986	3.359	0.102	3.038	0.130	1.190	0.199
1987	3.216	0.101	3.662	0.122	1.759	0.185
1988	5.601	0.090	3.721	0.122	2.323	0.177
1989	3.798	0.095	5.594	0.117	1.997	0.180
1990	4.336	0.091	4.315	0.119	3.776	0.172
1991	2.849	0.100	4.339	0.119	2.303	0.177
1992	5.600	0.089	4.563	0.118	3.066	0.174
depth	-0.0406	0.0018	-0.0182	0.00192	0.0082	0.00325

	Plaice-1		Plaice-2		Plaice-3	
	mean	SE	mean	SE	mean	SE
1985	3.408	0.269	3.681	0.164	-0.140	0.234
1986	5.519	0.269	3.350	0.164	0.310	0.236
1987	4.549	0.269	5.276	0.164	-0.053	0.236
1988	5.584	0.269	3.664	0.164	1.775	0.235
1989	5.288	0.269	4.550	0.164	0.436	0.361
1990	4.021	0.269	3.435	0.164	0.739	0.236
1991	4.503	0.269	3.522	0.164	-0.031	0.236
1992	4.610	0.269	3.516	0.164	-0.500	0.236
depth	-0.1289	0.00072	-0.0677	0.00070	0.0169	0.00141

Table 7.1. Average catch rate per fishing hour by standard area for non commercial fish species caught in August - September in the southern and southeastern North Sea by RV ISIS between 1985 and 1992. The catch rates are first averaged per rectangle and then averaged by area over the rectangles.

Area # 1

	1985	1986	1987	1988	1989	1990	1991	1992
Number of rectangles	22	17	16	18	19	21	22	19
scaldfish	7.1	10.5	5.6	24.1	48.5	73.3	29.9	67.2
lemon sole	0.6	2.8	3.7	0.7	11.5	3.5	4.0	0.6
long rough dab	9.6	18.6	20.4	21.1	21.8	9.4	8.6	2.2
flounder	14.2	1.7	1.0	0.5	1.3	17.0	6.1	7.4
solenette	2.4	10.0	7.3	9.8	51.3	41.4	53.3	81.2
Norwegian topknot	0.0	0.4	0.8	0.1	0.0	1.5	0.0	
poor cod	0.0	0.0	0.6	3.6	13.3	2.2	13.2	0.7
bib	0.0	0.7	0.1	1.5	1.0	17.5	39.0	0.9
Norway pout	0.0	0.0	0.0	0.0	0.1	0.0	1.0	0.0
ling	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
hake	0.1	0.1	0.0	0.3	0.5	0.2	0.3	0.2
4 brd rockling	1.3	3.4	4.2	5.3	5.7	2.3	2.9	2.4
tub gurnard	0.9	3.0	3.6	5.3	5.1	4.5	4.0	15.1
grey gurnard	23.8	24.8	22.1	30.4	70.3	45.4	35.8	44.7
red gurnard	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
hooknose	70.0	44.6	58.7	87.5	102.8	64.7	109.2	93.6
sprat	0.0	0.0	0.0	0.3	2.1	2.2	2.5	4.2
herring	1.1	2.2	0.3	0.1	1.5	0.1	0.2	2.8
scad	2.1	0.6	0.7	2.9	0.6	1.0	1.4	15.5
mackerel	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.1
smelt	0.1	1.1	1.6	0.4	0.0	1.0	1.3	0.8
sandeel	0.0	0.9	0.6	0.0	1.4	0.0	0.1	0.1
lesser weever	0.0	0.0	0.0	1.0	0.0	0.7	1.2	3.2
dragonet	19.4	29.2	89.6	147.5	217.5	0.7	45.8	149.0
bull rout	14.4	2.5	5.4	8.7	2.5	6.1	27.2	19.9
eel	0.0	0.0	0.0	0.1	0.3	0.0	0.4	0.1
eelpout	4.5	0.7	0.3	7.8	1.3	0.9	11.6	3.0
gobies spc	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.8
mullet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
monk	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
Cyclopterus lumpus	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Pholis gunnellus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Squalus acanthias	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scyliorhinus canicula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R radiata	1.5	0.1	0.2	0.8	0.4	0.1	0.8	0.3
R clavalta	0.0	0.0	0.0	0.0	0.3	2.3	0.0	0.0
R mont	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Galeorhinus galeus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Belone belone	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Syngnathus rostellatus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Entelurus aequoreus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dicentrarchus labrax	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 7.1 continued. Average catch rate per fishing hour by standard area for non commercial fish species caught in August - September in the southern and southeastern North Sea by RV ISIS between 1985 and 1992. The catch rates are first averaged per rectangle and then averaged by area over the rectangles.

Area # 2

	1985	1986	1987	1988	1989	1990	1991	1992
	5	5	5	7	5	5	6	9
scaldfish	16.8	21.1	28.3	97.2	107.5	219.3	14.8	164.0
lemon sole	0.0	0.0	0.0	1.5	0.4	0.1	6.4	0.5
long rough dab	0.0	4.0	0.7	1.4	0.0	0.0	40.8	0.0
flounder	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.0
solenette	29.0	61.7	61.6	141.9	171.9	172.3	79.3	337.4
Norwegian topknot	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
poor cod		0.4	3.6	0.1	3.1	0.0	0.0	42.0
bib	0.0	0.0	0.0	0.0	0.0	12.7	3.0	0.7
Norway pout	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
hake	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.1
4 brd rockling	0.0	0.1	0.5	9.3	1.2	0.7	5.7	22.5
tub gurnard	0.8	1.6	0.7	9.3	0.7	8.8	4.5	5.1
grey gurnard	33.2	52.5	47.2	28.7	36.7	8.0	36.4	24.7
red gurnard	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
hooknose	14.4	46.0	61.9	57.0	9.1	10.0	7.1	13.2
sprat	0.2	0.0	0.0	1.0	1.6	0.2	0.9	2.3
herring	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5
scad	1.0	0.9	0.5	0.1	10.8	3.3	1.0	1.0
mackerel	0.6	0.0	0.3	0.2	0.4	0.8	0.1	0.8
smelt	0.0	0.0	0.9	3.0	4.2	5.0	0.1	0.7
sandeel	0.0	1.4	0.3	0.0	0.3	0.0	0.2	0.3
lesser weever	14.2	91.7	36.4	67.6	23.1	22.9	29.6	47.6
dragonet	20.4	49.6	203.7	277.1	211.0	22.9	42.3	54.0
bull rout	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
eel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
eelpout	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
gobies spc	0.0	0.0	0.0	0.0	0.0	0.0	2.2	1.0
mullet	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.4
monk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Cyclopterus lumpus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pholis gunnellus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Squalus acanthias	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Scyliorhinus canicula	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
R radiata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R clavalta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R montagui	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Galeorhinus galeus	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Belone belone	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Syngnathus rostellatus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entelurus aequoreus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dicentrarchus labrax	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 7.1 continued. Average catch rate per fishing hour by standard area for non commercial fish species caught in August - September in the southern and southeastern North Sea by RV ISIS between 1985 and 1992. The catch rates are first averaged per rectangle and then averaged by area over the rectangles.

Area# 4

	1985	1986	1987	1988	1989	1990	1991	1992
Number of.rectangles	5	3	5	9	10	10	10	9
scaldfish	12.8	12.2	12.1	16.2	7.4	52.0	84.5	5.0
lemon sole	0.0	0.0	0.1	0.4	9.0	2.9	14.9	3.3
long rough dab	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
flounder		16.8	2.6	1.5	1.9	2.4	1.8	3.1
solenette	70.0	80.2	15.9	14.3	20.7	49.0	41.3	85.9
Norwegian topknot	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
poor cod	0.0	1.8	1.8	26.8	48.8	58.8	0.0	19.5
bib	0.0	0.0	5.4	5.3	71.4	35.3	0.2	10.7
Norway pout	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ling	0.0	0.0	0.0	0.0	0.1	0.0	2.6	0.0
hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 brd rockling	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.7
tub gurnard	1.8	1.4	2.8	0.1	14.3	7.4	4.9	5.8
grey gurnard	8.0	22.4	2.1	8.5	8.3	11.9	17.6	32.5
red gurnard	0.0	0.0	0.0	0.0	0.3	0.1	3.4	1.2
hooknose	16.8	22.0	27.5	20.4	36.8	2.3	7.8	32.9
sprat	0.0	0.0	0.0	0.1	0.0	0.3	0.0	0.7
herring	0.0	0.0	5.0	2.1	0.2	0.3	0.2	3.0
scad	0.0	4.0	3.3	0.9	6.3	1.1	0.7	4.9
mackerel	0.0	0.0	0.1	0.3	0.1	0.1	0.0	0.0
smelt	0.4	2.0	1.3	4.0	5.3	5.3	1.0	4.3
sandeel	6.4	0.6	0.8	5.6	2.0	0.2	0.5	0.7
lesser weever	227.2	104.4	128.0	146.0	139.6	103.3	103.3	118.8
dragonet	128.0	60.8	280.6	165.1	247.6	103.3	60.9	102.6
bull rout	0.0	0.0	0.3	0.0	0.1	0.0	1.2	0.0
eel	2.4	0.7	0.4	0.6	0.4	0.0	0.2	0.1
eelpout	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
gobies spc	0.0	0.0	0.0	9.8	82.7	2.1	15.8	80.0
mullet	0.2	0.0	0.0	0.0	2.3	0.3	2.4	3.4
monk	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Cyclopterus lumpus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Pholis gunnellus	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2
Squalus acanthias	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Scyliorhinus canicula	0.0	0.0	0.0	0.0	6.9	4.0	1.9	4.0
R radiata	0.0	0.0	0.0	0.3	1.9	0.1	0.0	0.0
R clavalta	0.0	0.0	0.0	0.1	0.0	0.0	0.0	2.4
R mont	0.0	0.0	0.0	0.0	0.0	0.9	0.4	0.6
Galeorhinus galeus	0.0	0.0	0.0	0.0	0.1	0.4	0.0	0.6
Belone belone	0.0	0.0	0.0	0.0	0.0	0.5	0.0	1.1
Syngnathus rostellatus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entelurus aequoreus	0.0	0.2	0.2	0.0	0.1	0.1	0.0	0.1
Dicentrarchus labrax	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1

Figure 2.1 Number of hauls in each rectangle in different survey areas

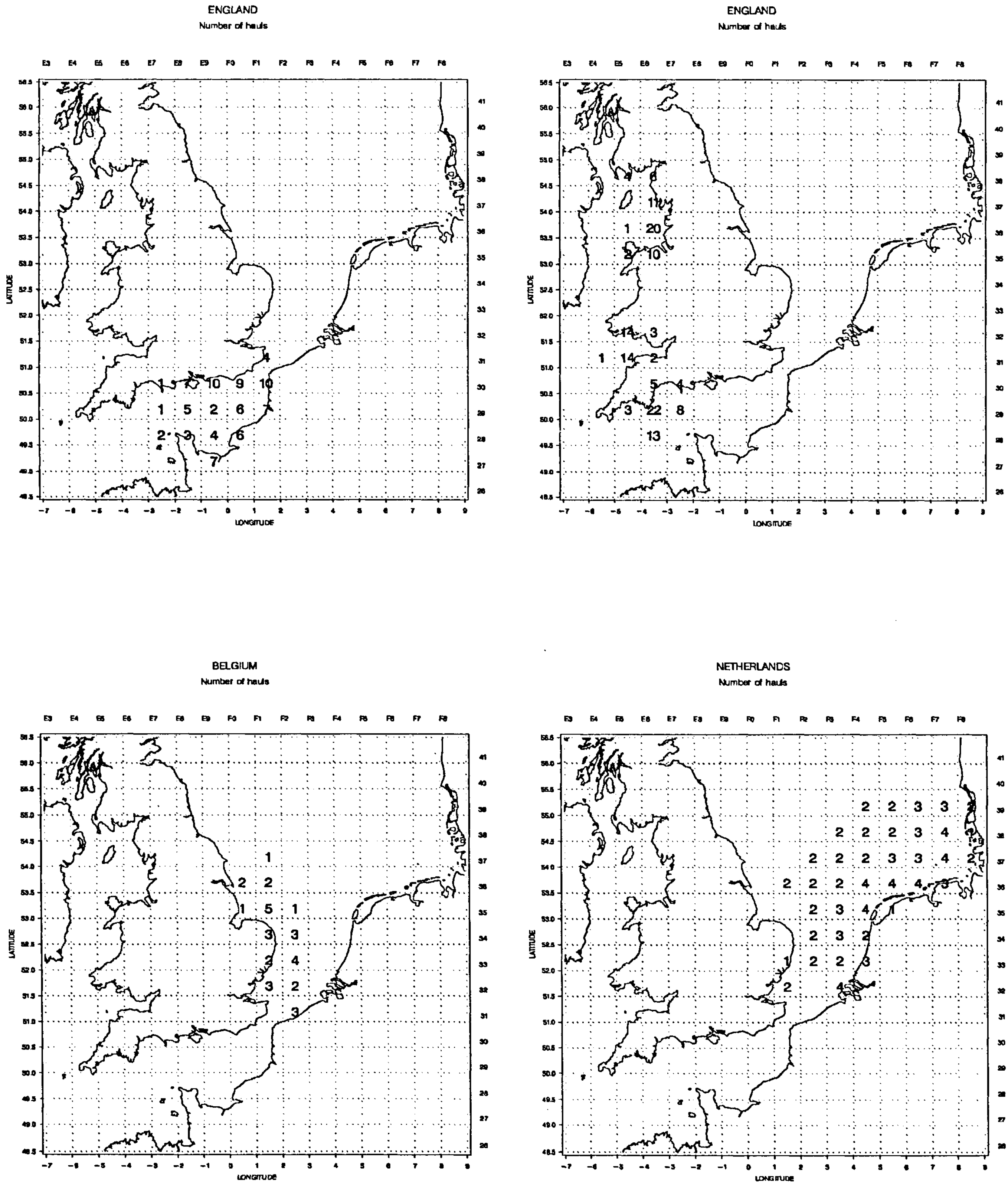
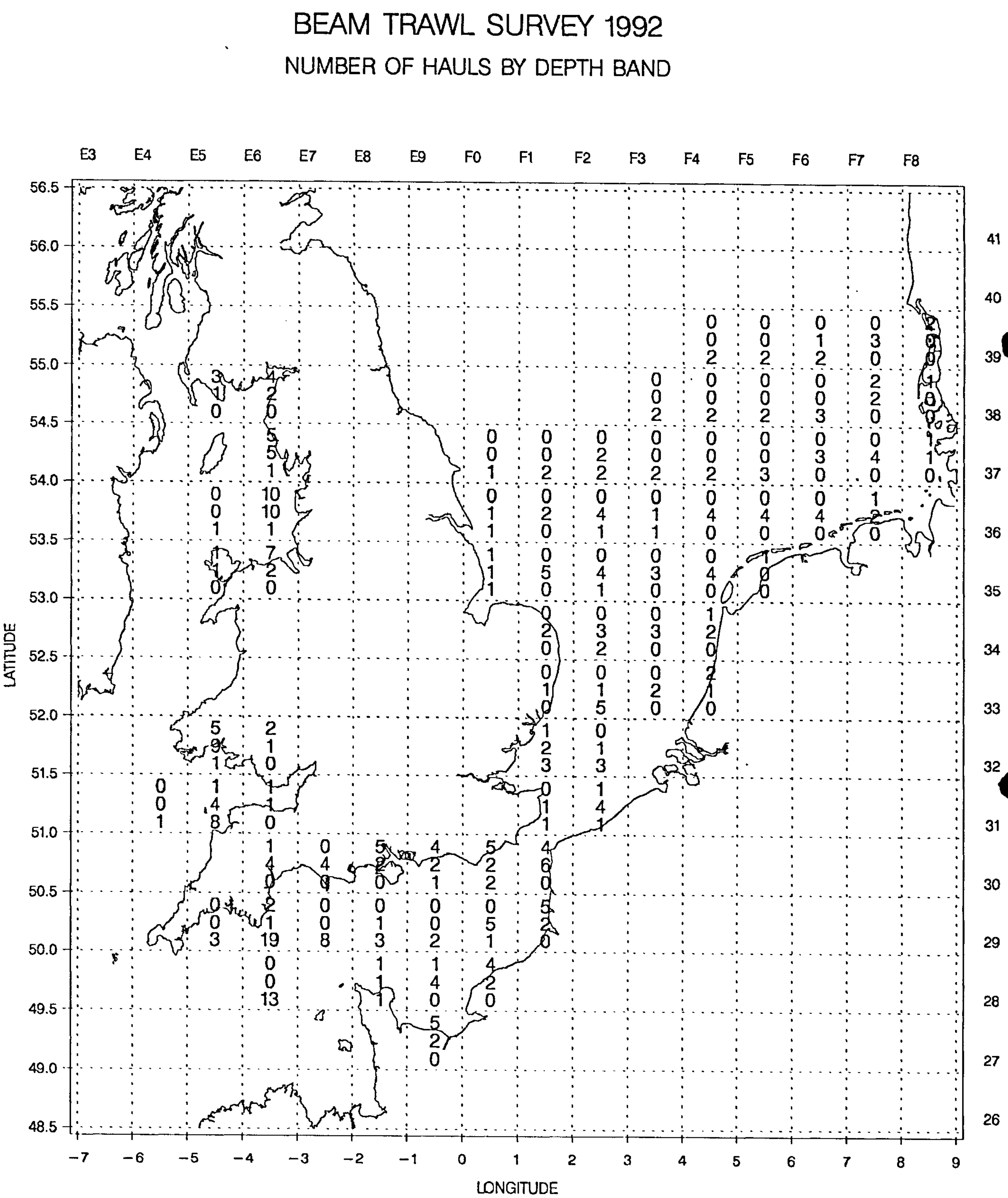


Figure 3.1 Number of hauls by depth band in each rectangle. Top figure: 0-19.9m; middle figure: 20-39.9m; bottom figure: >40m.



a.

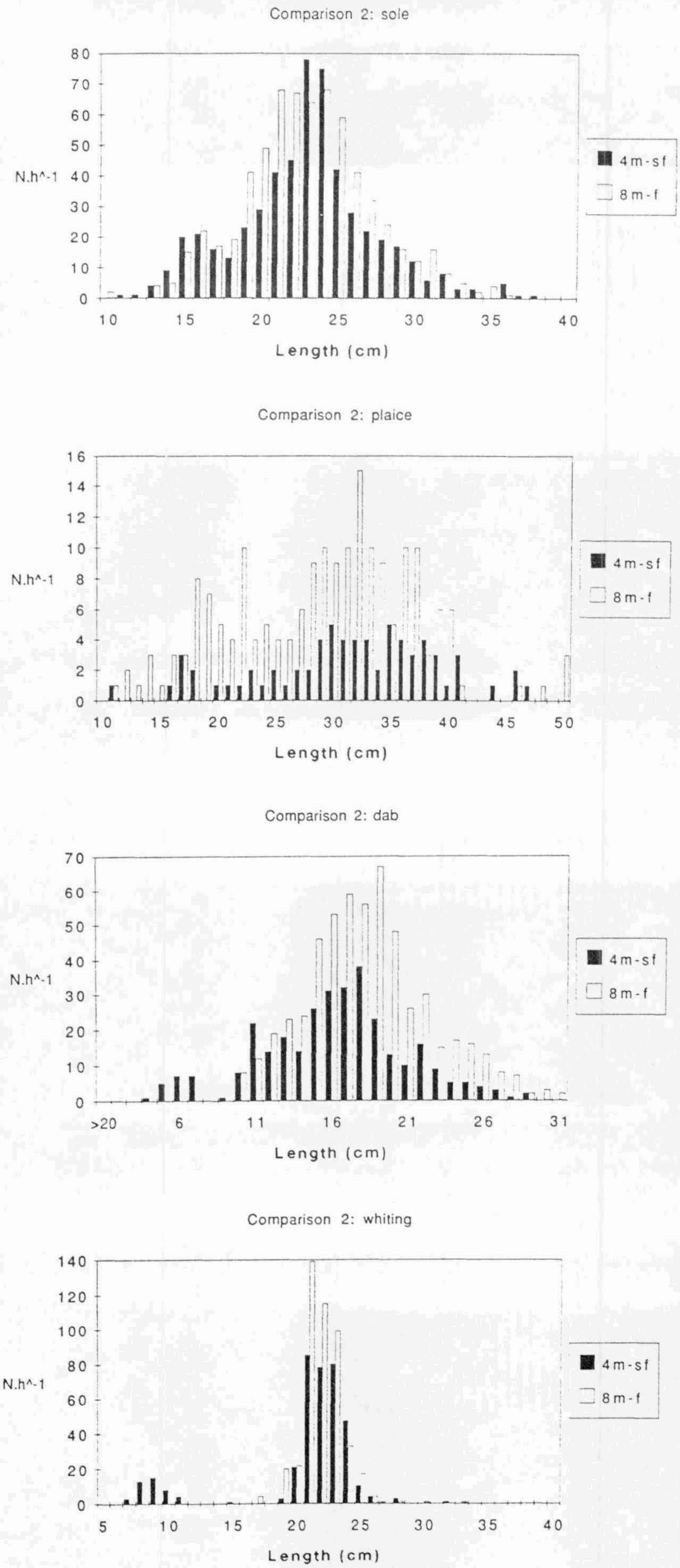
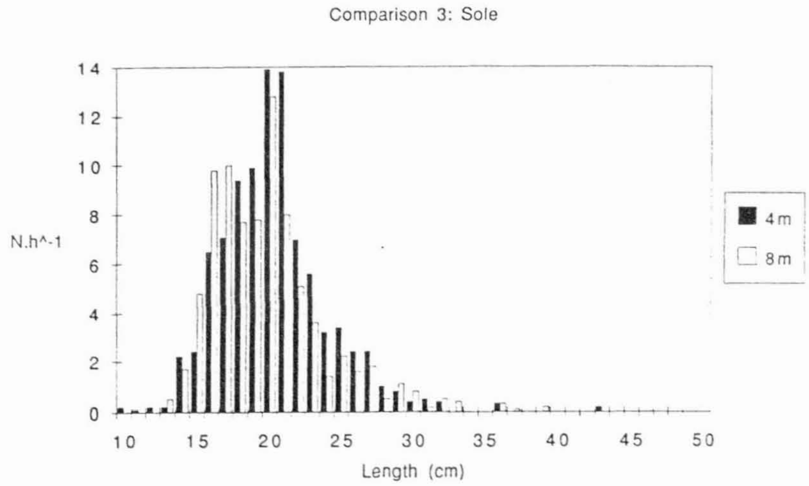


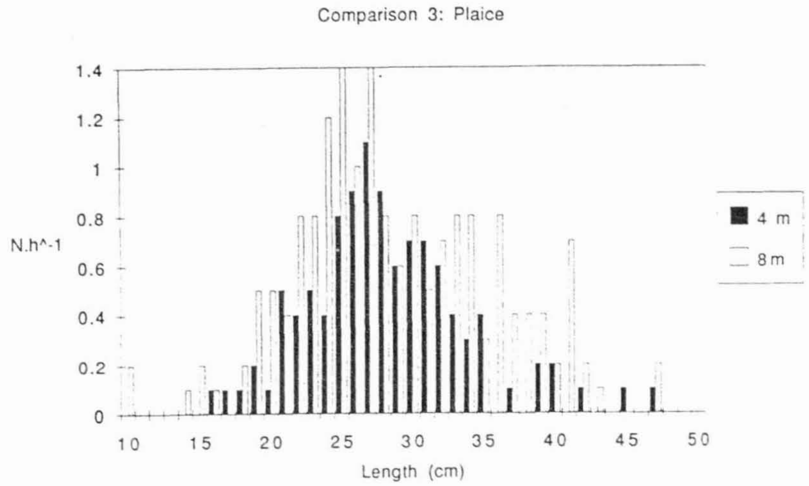
Figure 4.1 Comparisons between length distributions of selected species caught in 4m beam trawl with chain mat and flip-up rope (4m+sf) and 8m trawl with a flip-up rope (8m+f). a. CORYSTES and BELGICA. b. BELGICA.

cont'd.

Figure 4.1 (cont'd.)

b.





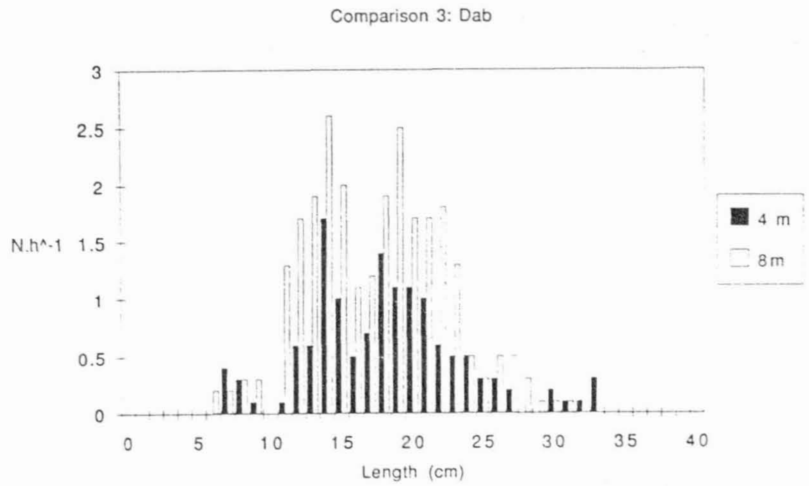


Figure 5.1 Distribution of 1-gp sole, *Solea solea*, (No/h/8m) in each rectangle.
P = present but not counted; + = <0.5/h.

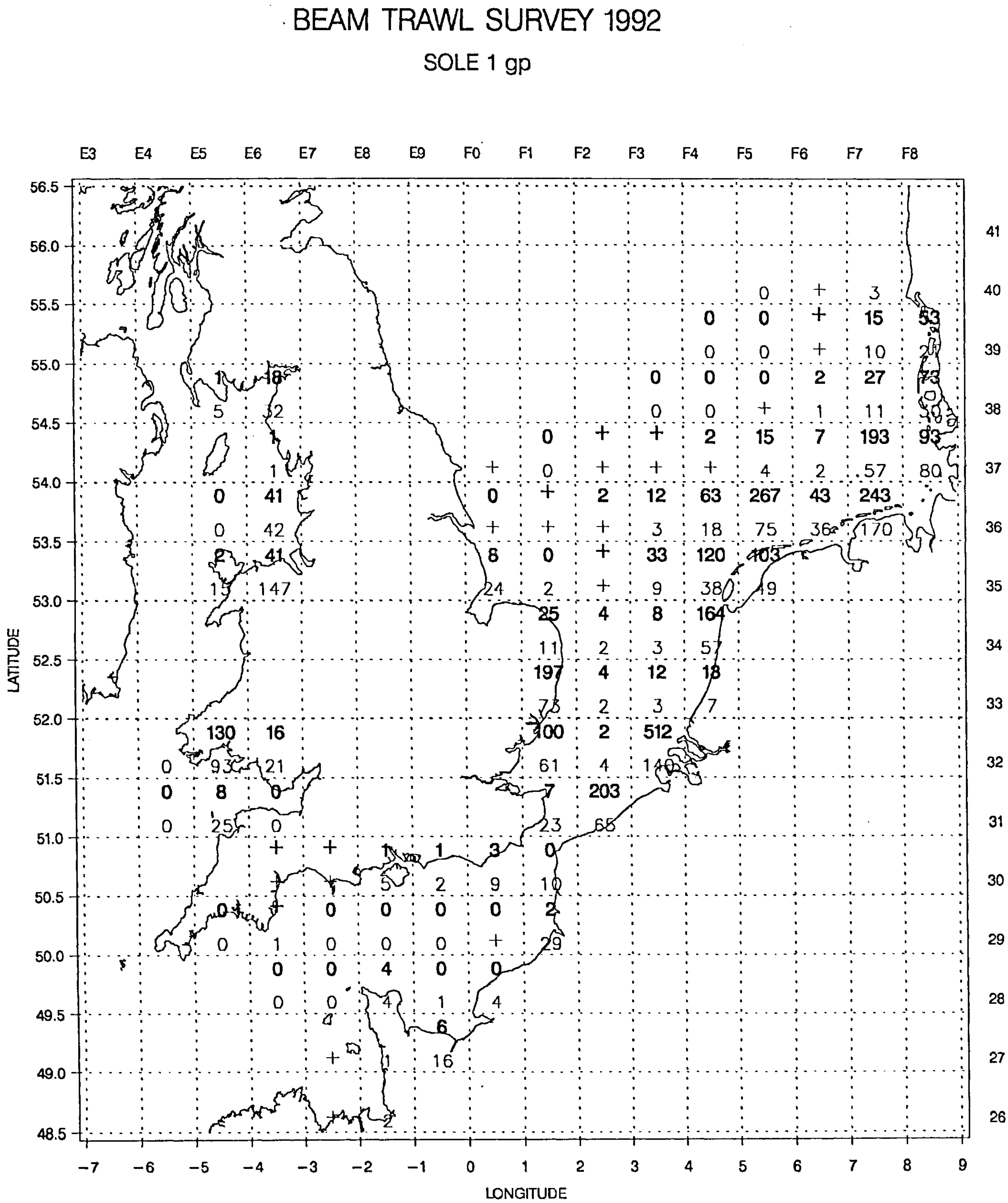


Figure 5.2 Distribution of 2-gp sole, *Solea solea*, (No/h/8m) in each rectangle.
P = present but not counted; + = <0.5/h.

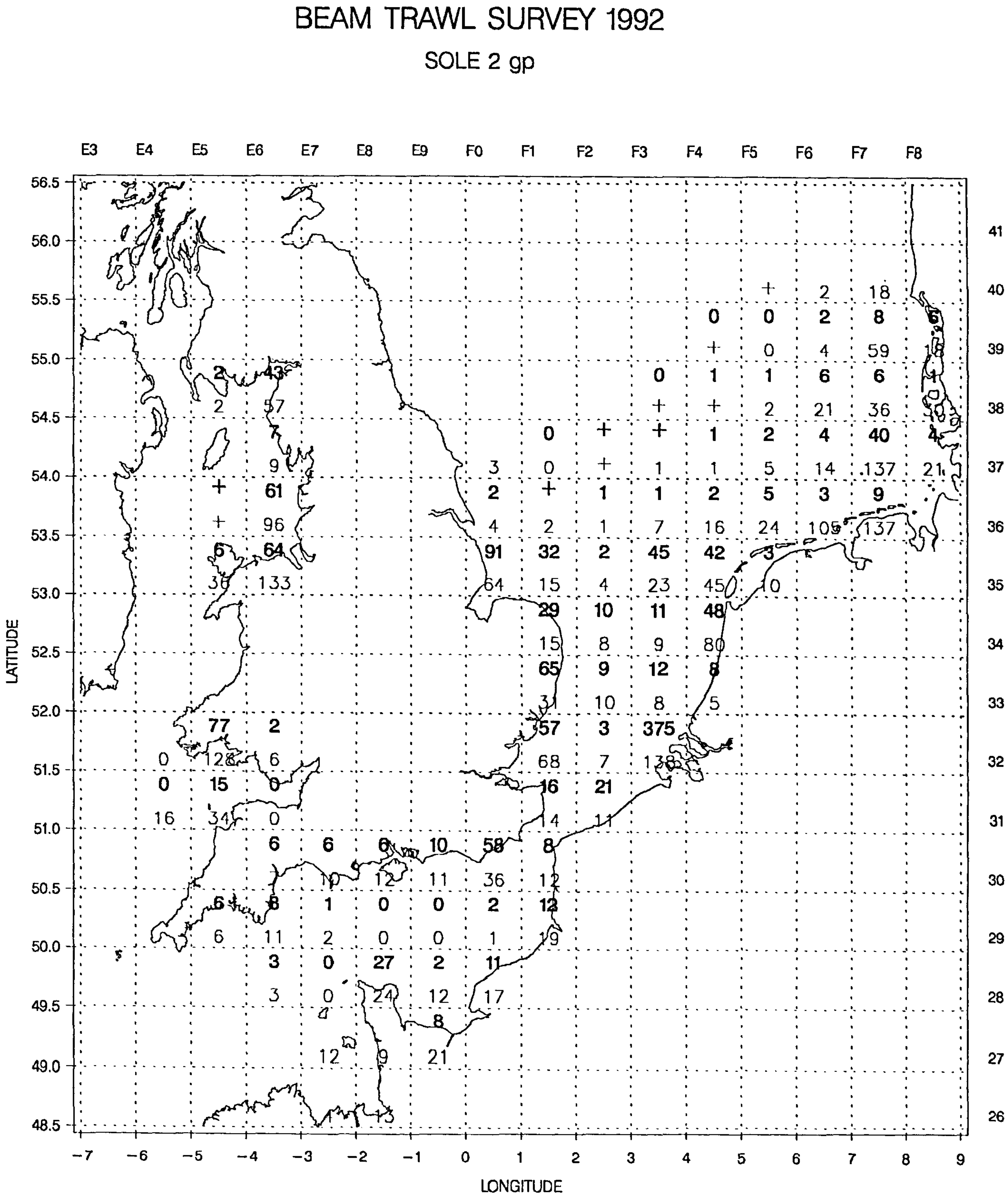


Figure 5.3 Distribution of 3+-gp sole *Solea solea*, (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

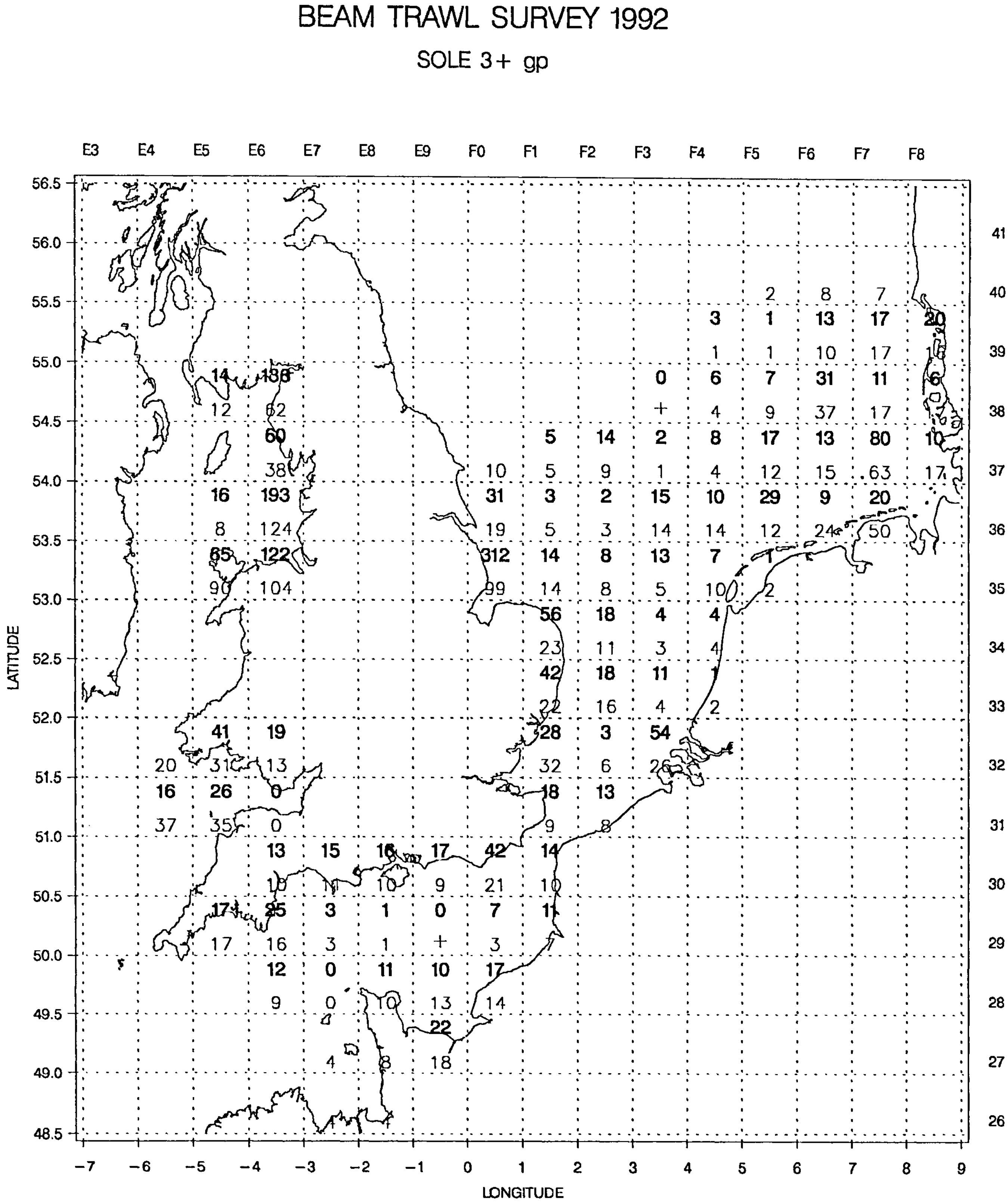


Figure 5.4 Distribution of 1-gp plaice, *Platessa platessa,* (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

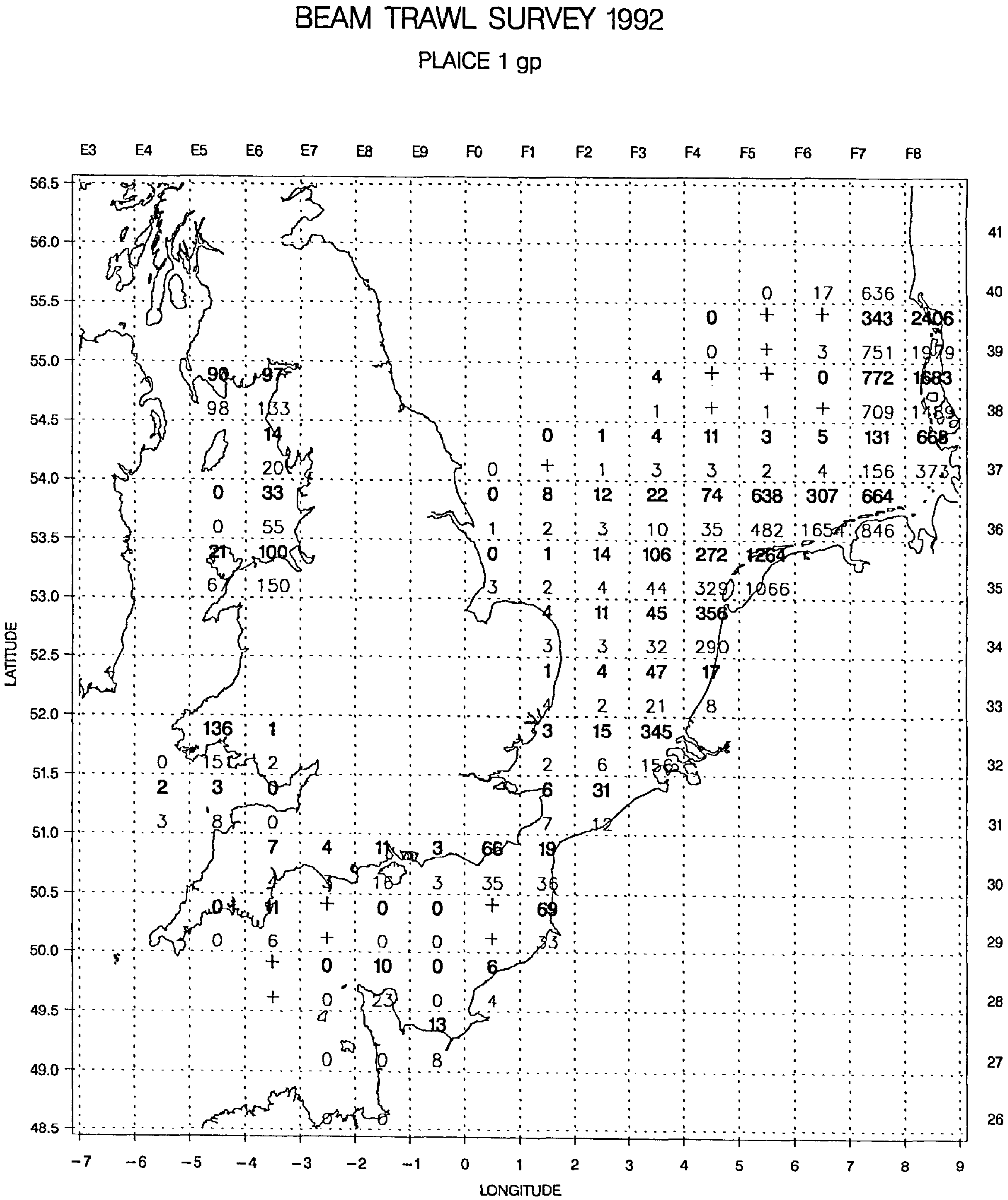


Figure 5.5 Distribution of 2-gp plaice, *Platessa platessa,* (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

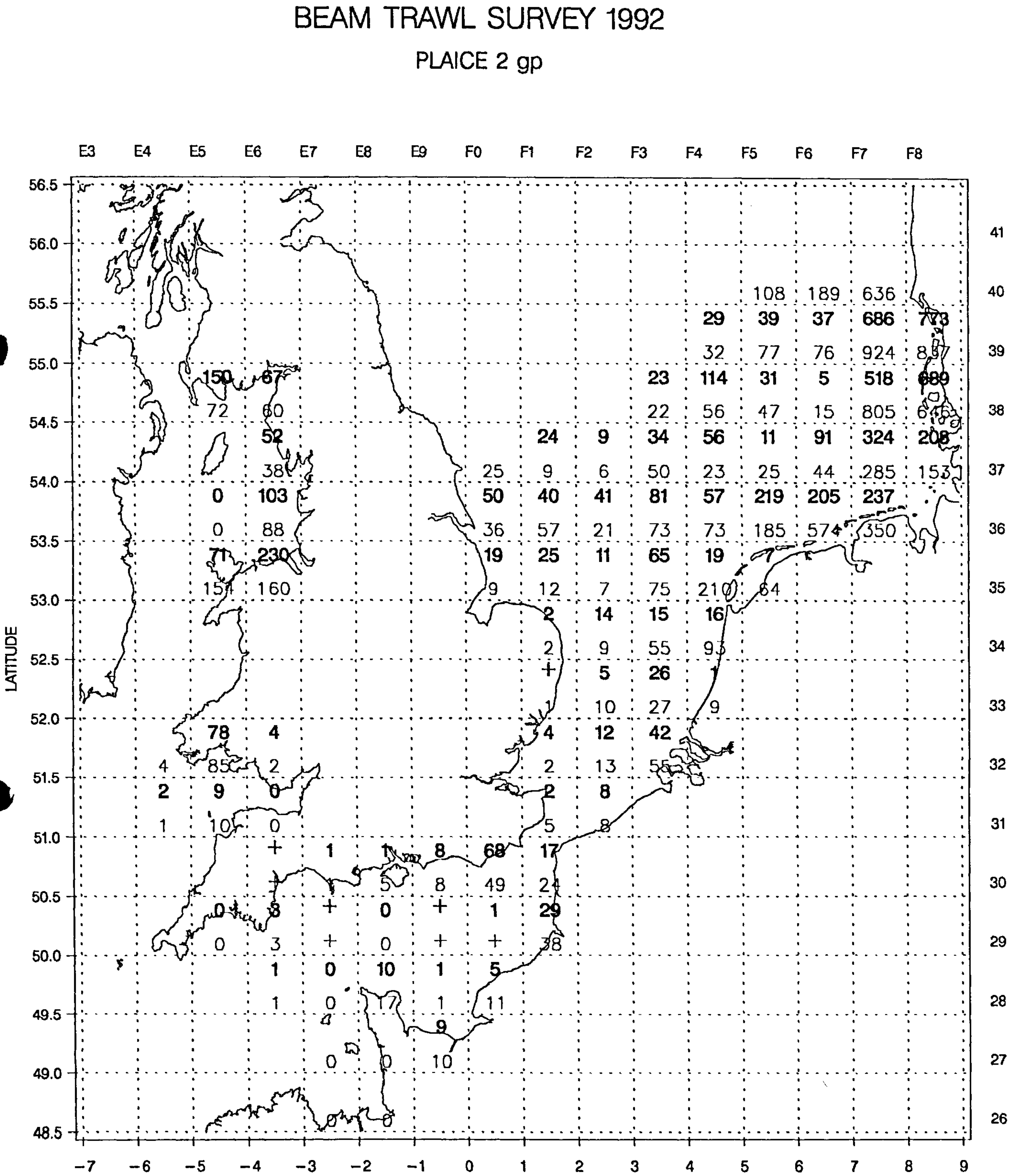


Figure 5.6 Distribution of 3+-gp plaice, *Platessa platessa,* (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

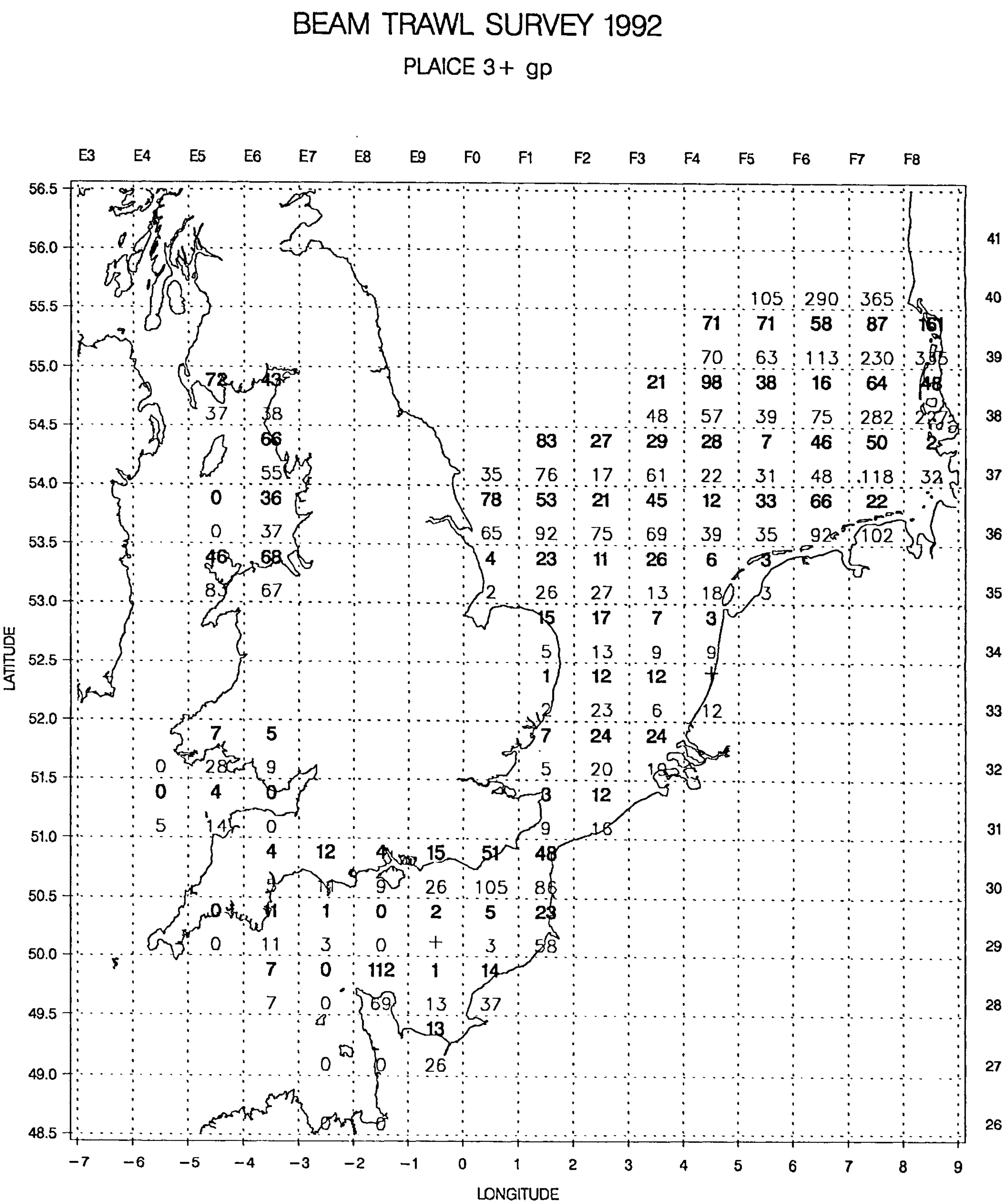


Figure 5.7 Distribution of 1-gp dab, *Limanda limanda,* (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

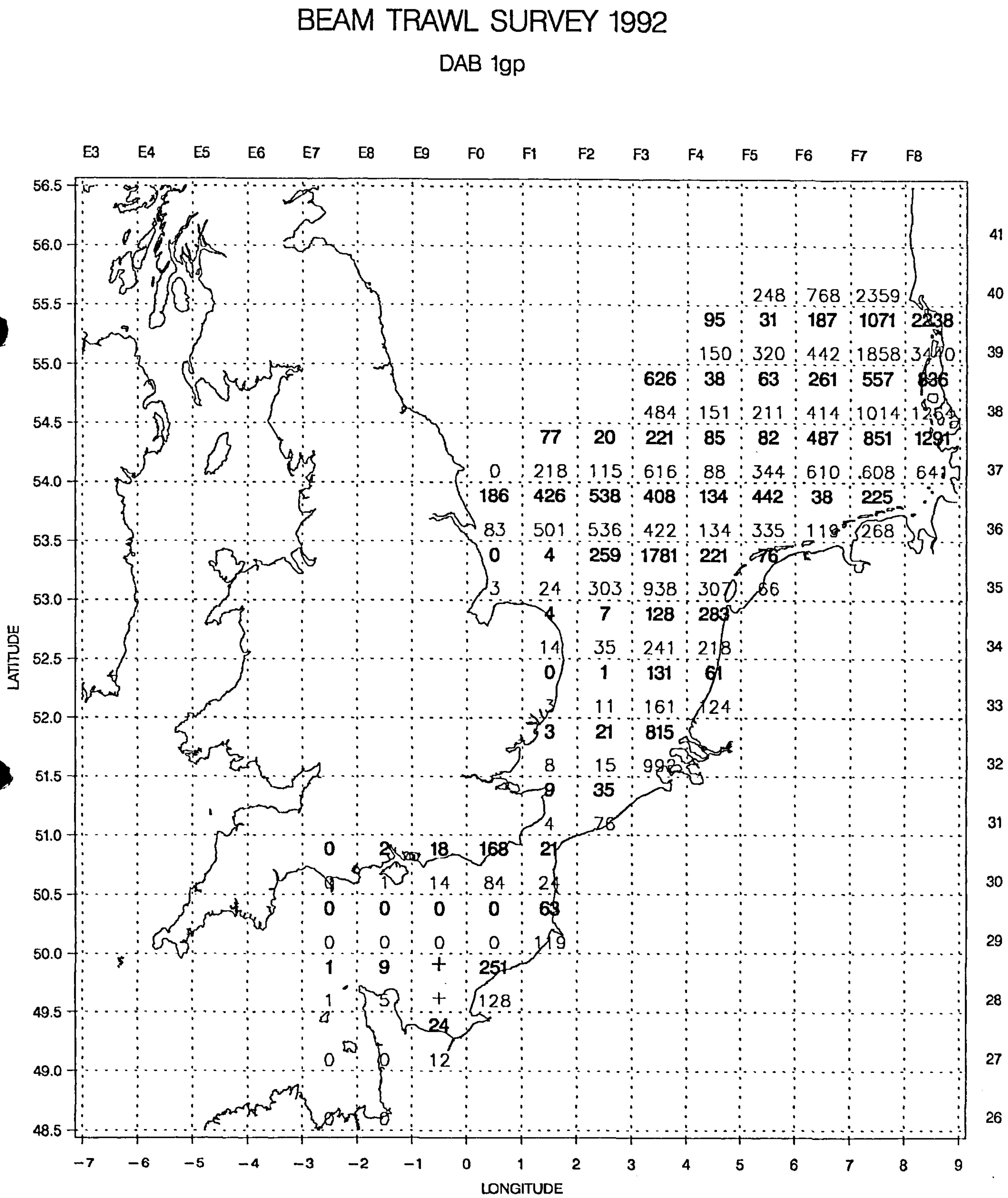


Figure 5.8 Distribution of 2-gp dab, *Limanda limanda*, (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

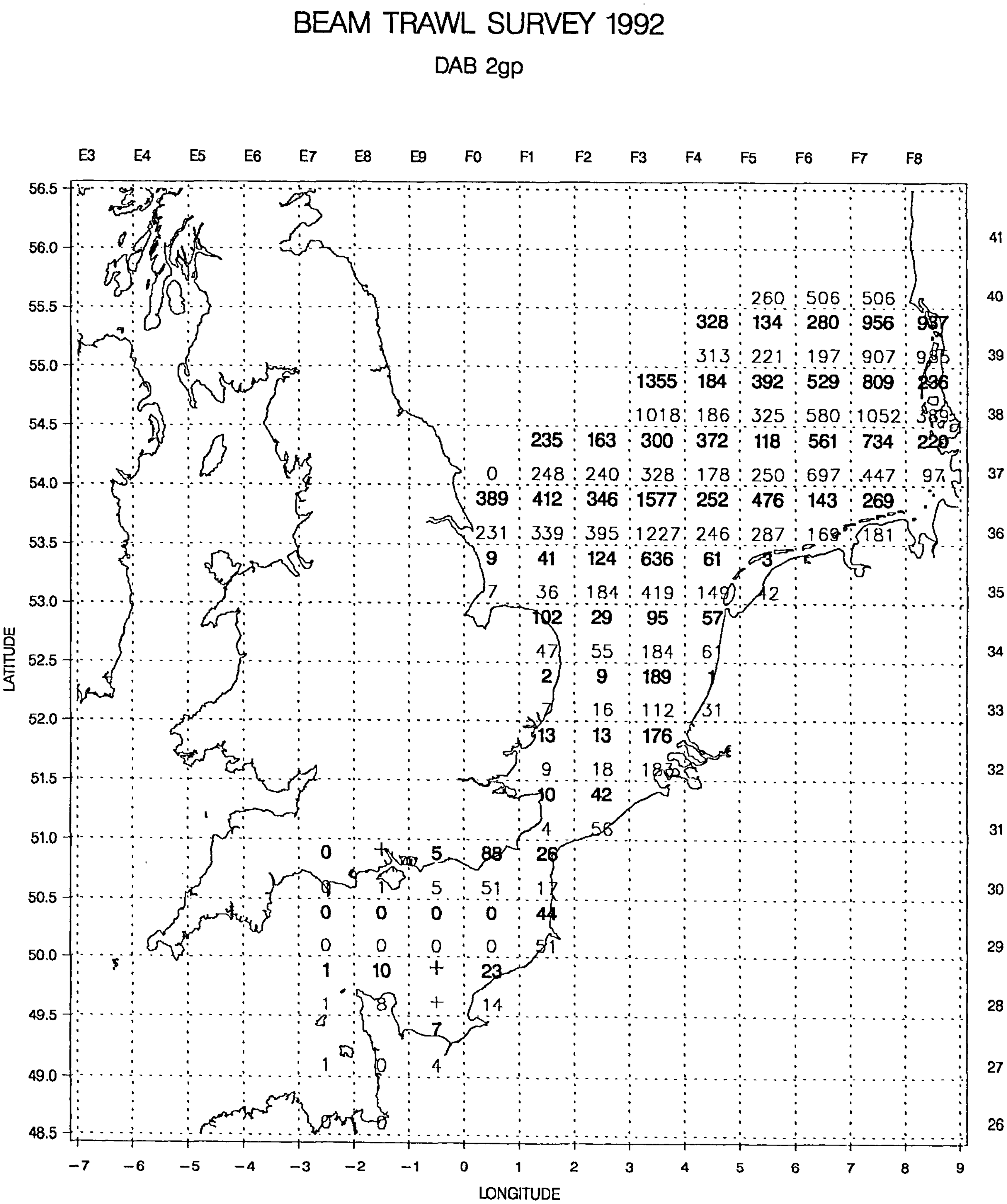


Figure 5.9 Distribution of 3+-gp dab, *Limanda limanda,* (No/h/8m) in each rectangle.
P = present but not counted; + = <0.5/h.

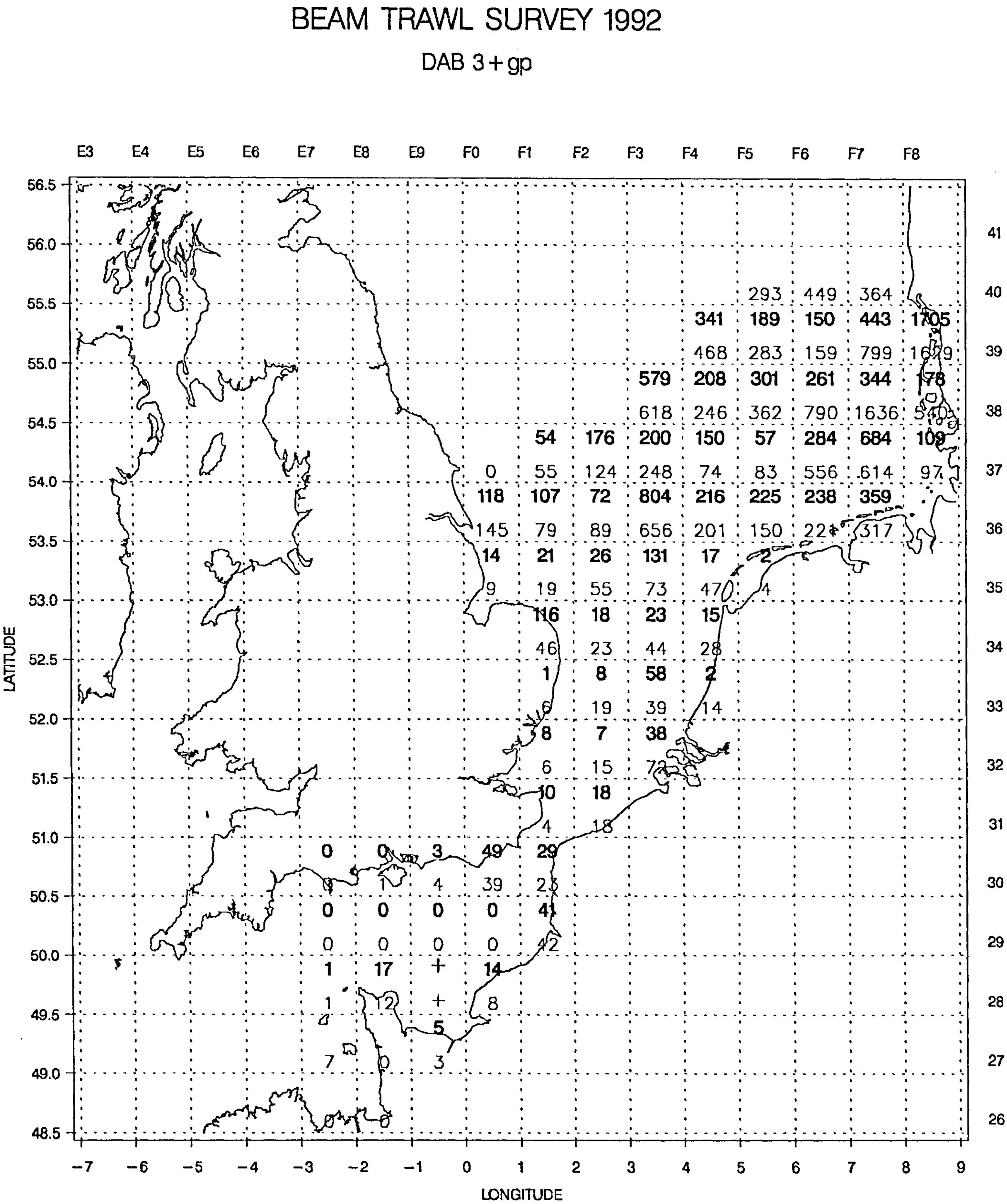


Figure 5.10 Distribution of unaged dab, *Limanda limanda,* (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

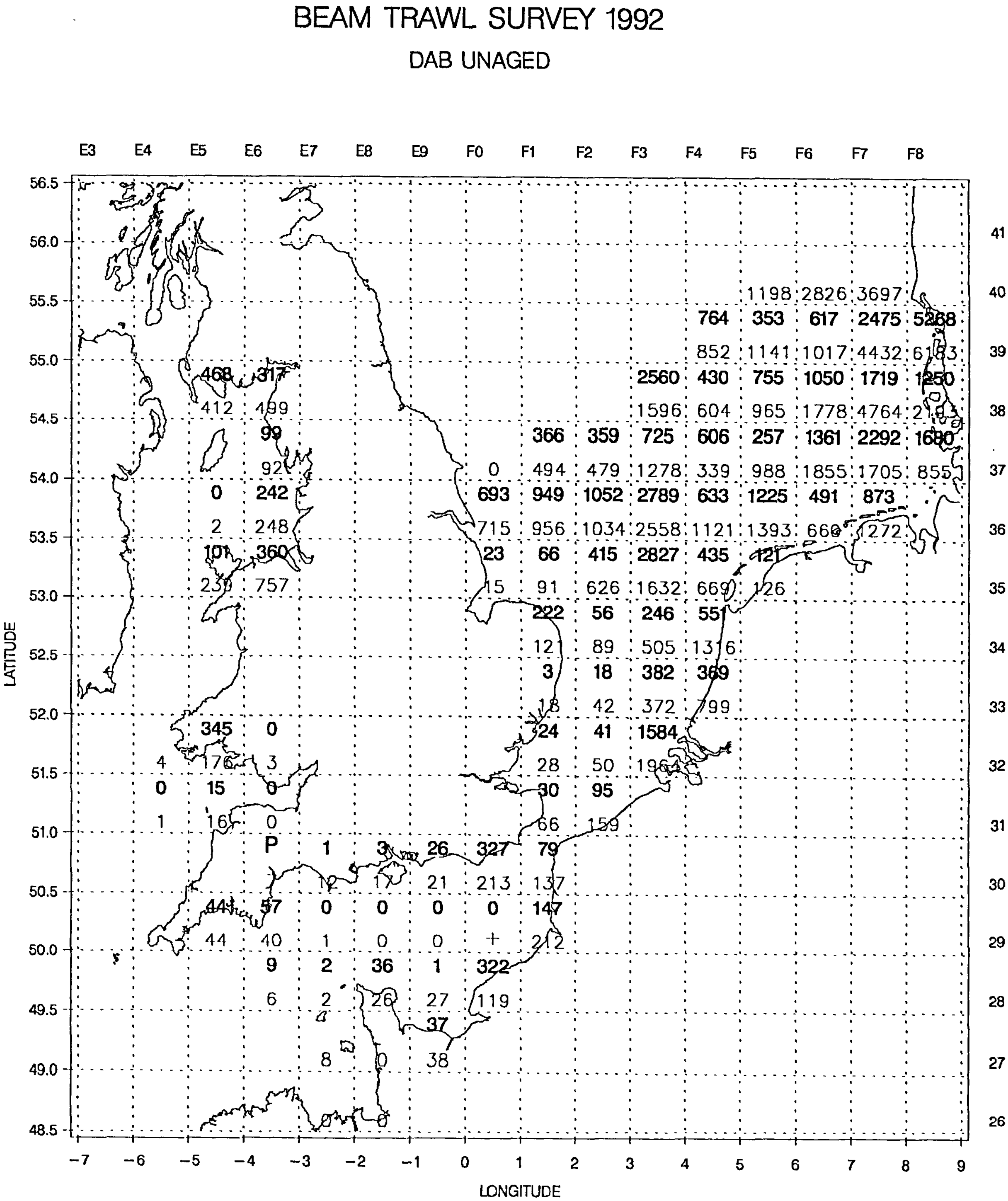


Figure 5.11 Distribution of turbot, *Scophthalmus maximus*, (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

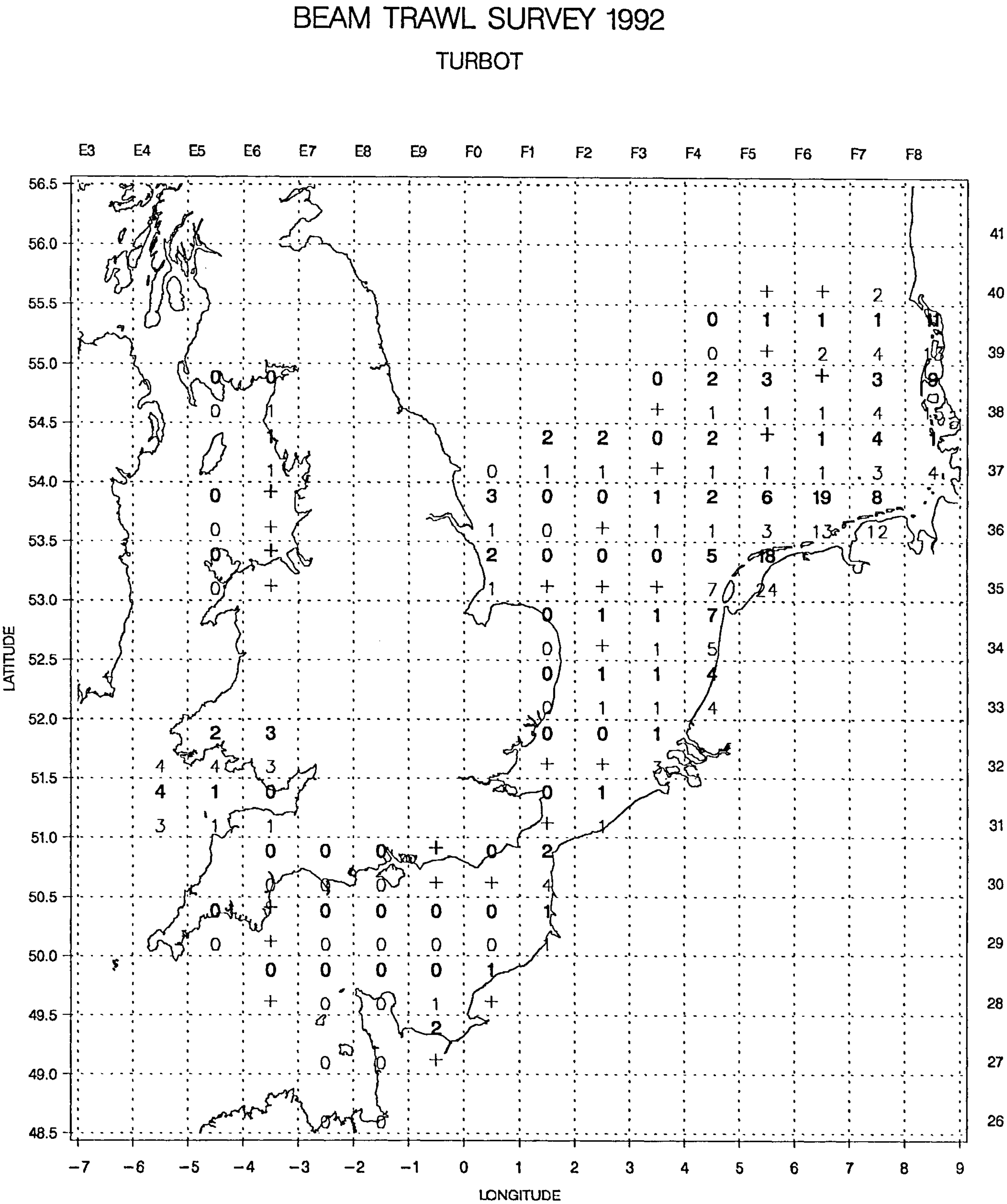


Figure 5.12 Distribution of brill, *Scophthalmus rhombus,* (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

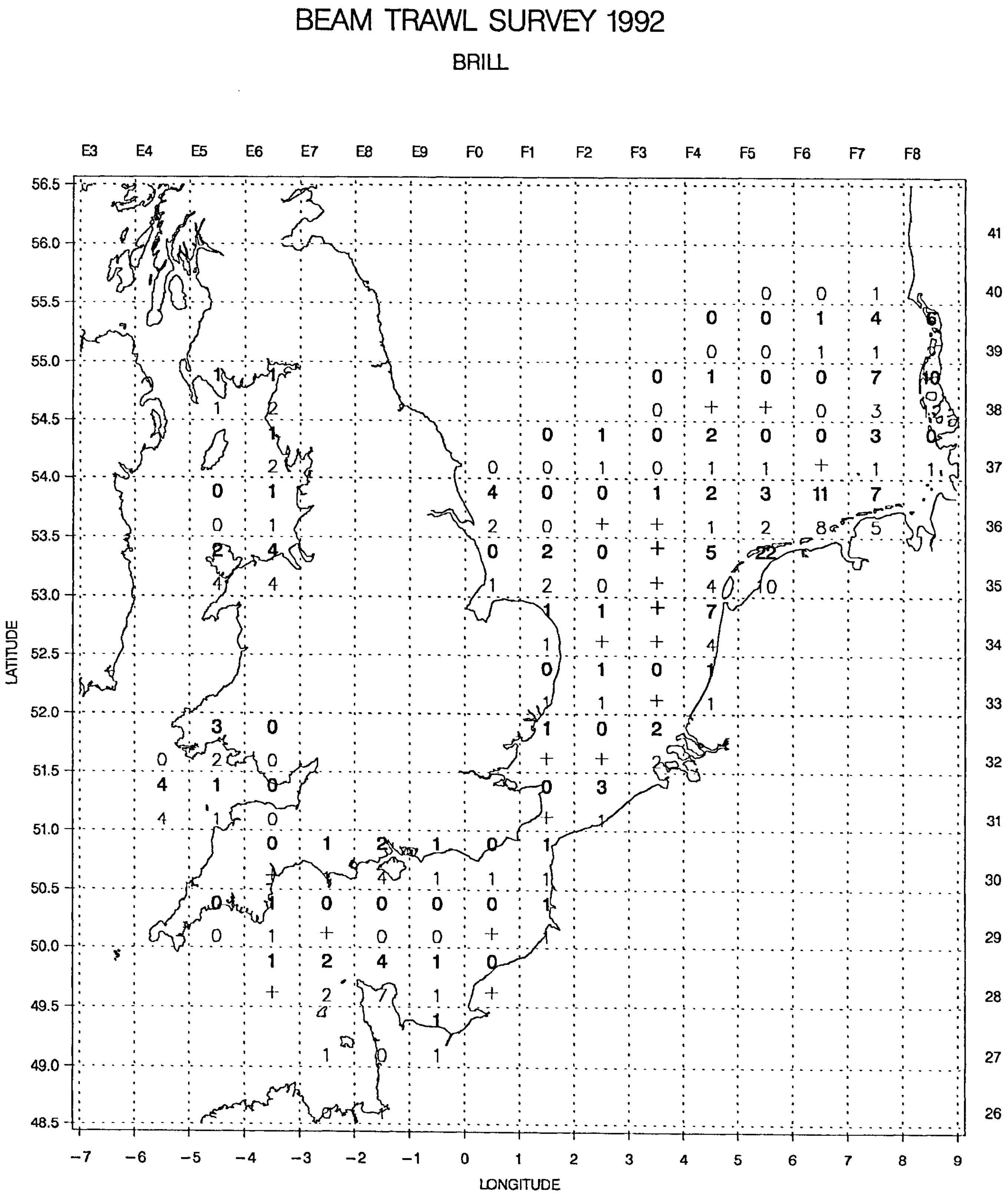


Figure 5.13 Distribution of scaldfish, *Arnoglossus laterna,* (No/h/8m) in each rectangle.
P = present but not counted; + = <0.5/h.

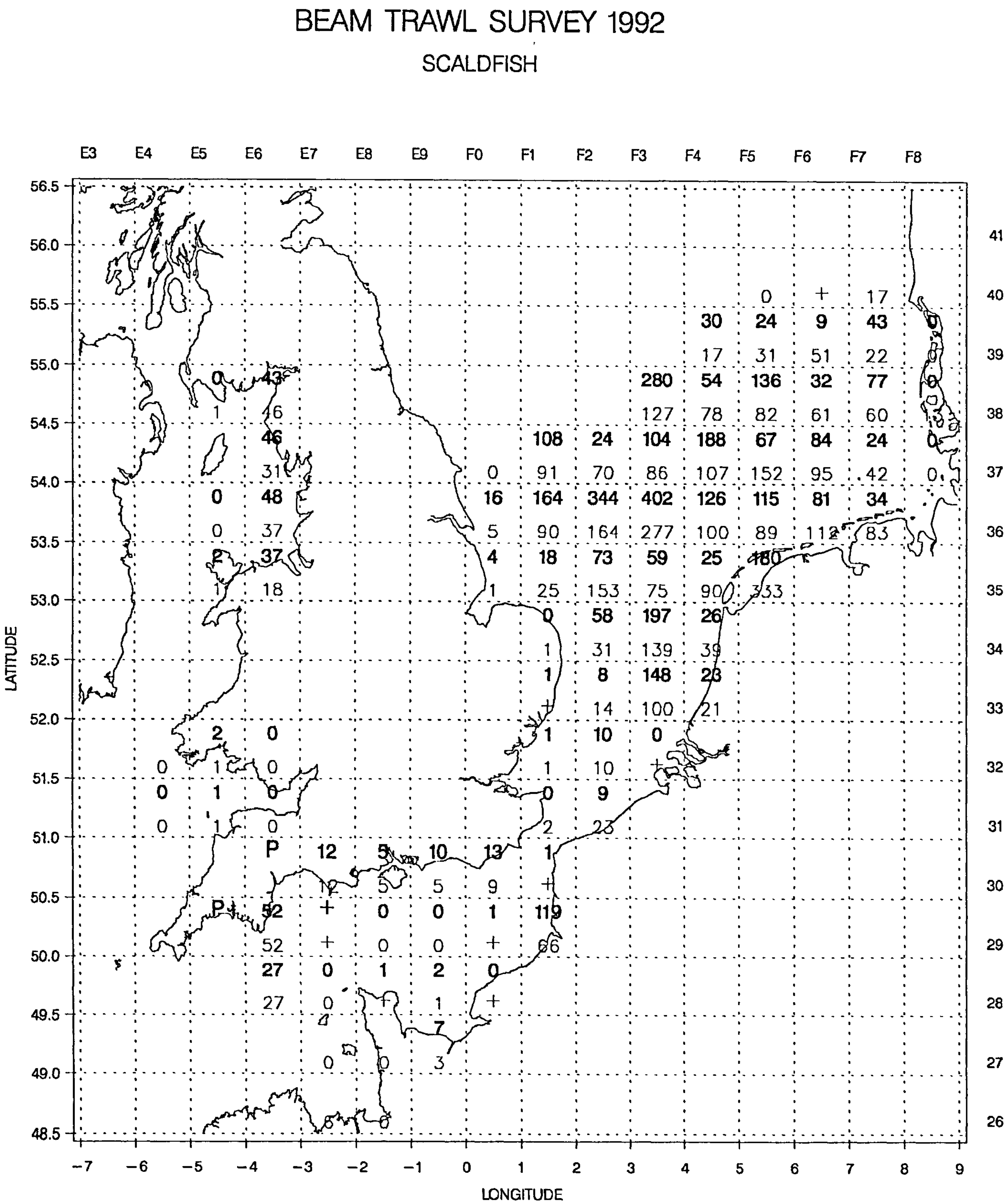


Figure 5.14 Distribution of lemon sole, *Microstomus kitt,* (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

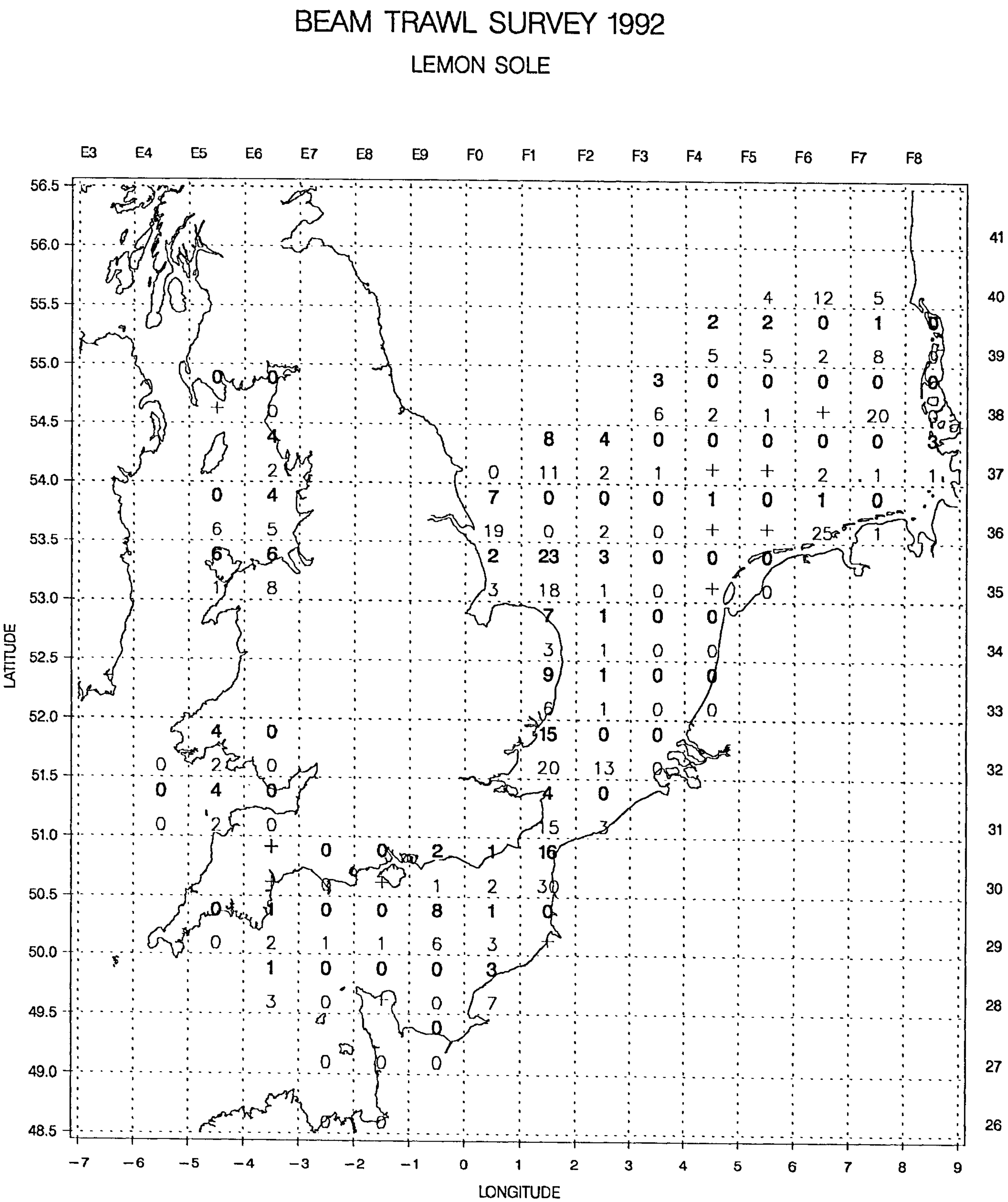


Figure 5.15 Distribution of long rough dab, *Hipploglossoicles platessoides,* (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

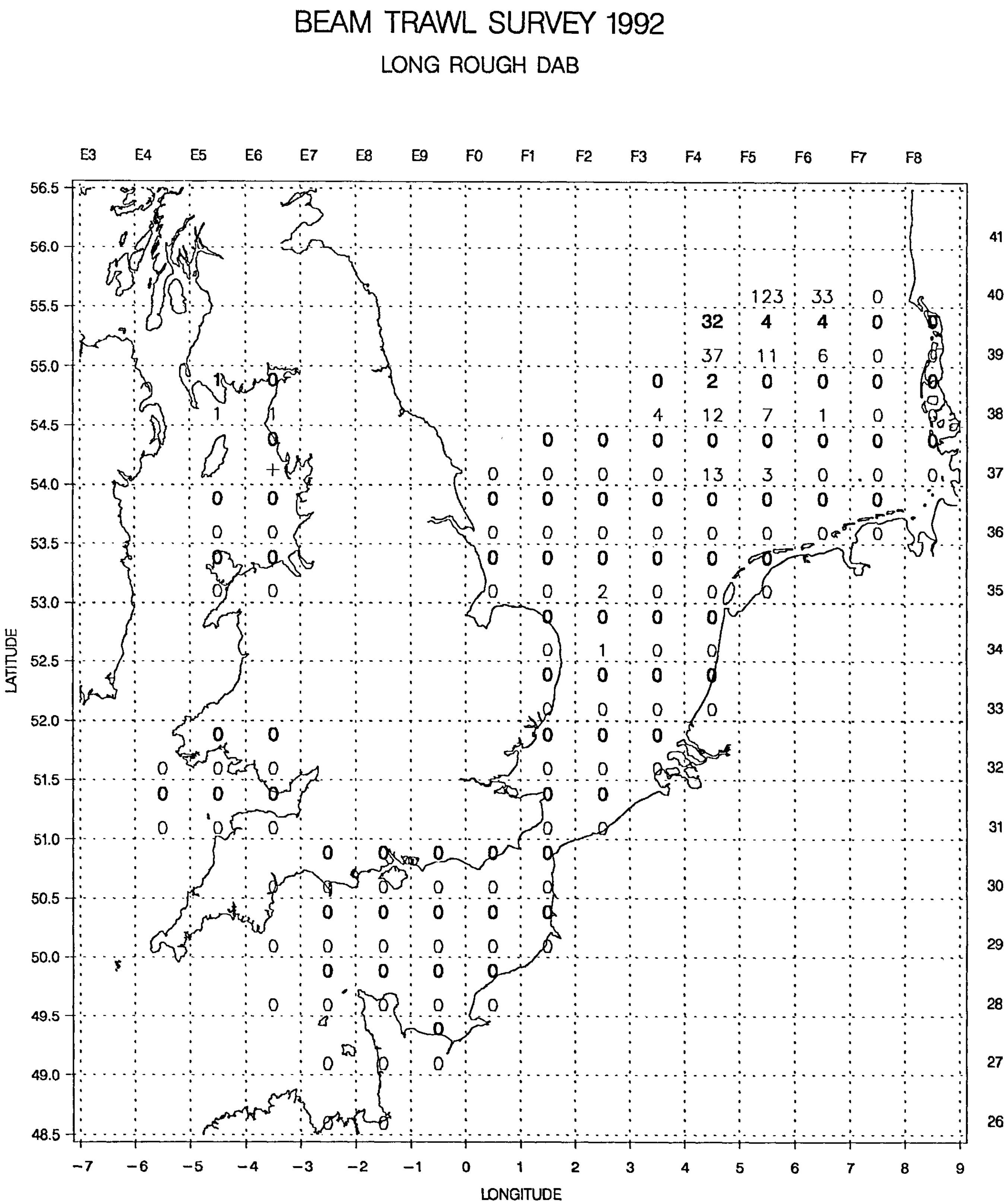


Figure 5.16 Distribution of flounder, *Platichthys flesus,* (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

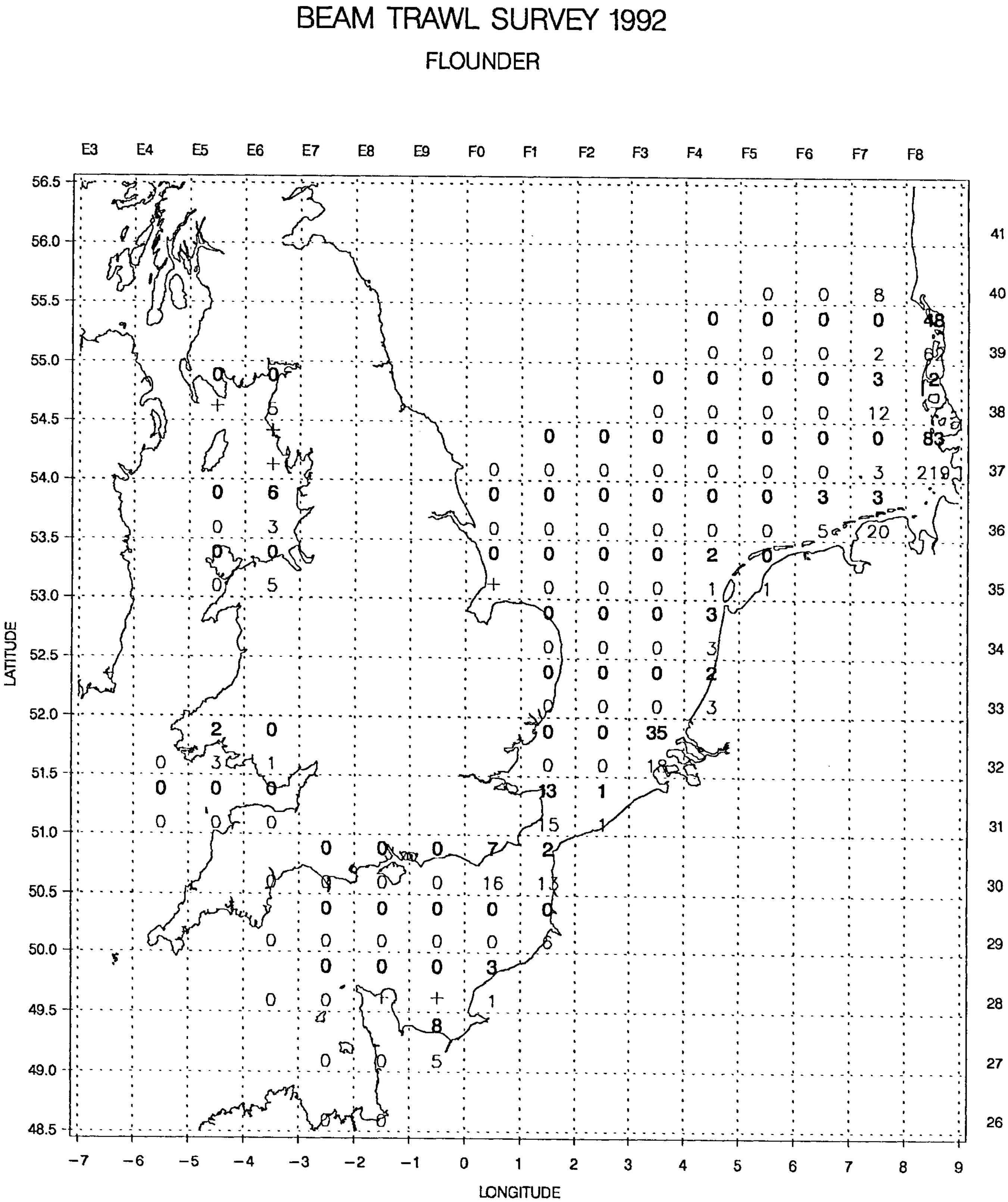


Figure 5.17 Distribution of solenette, *Buglossidium luteum,* (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

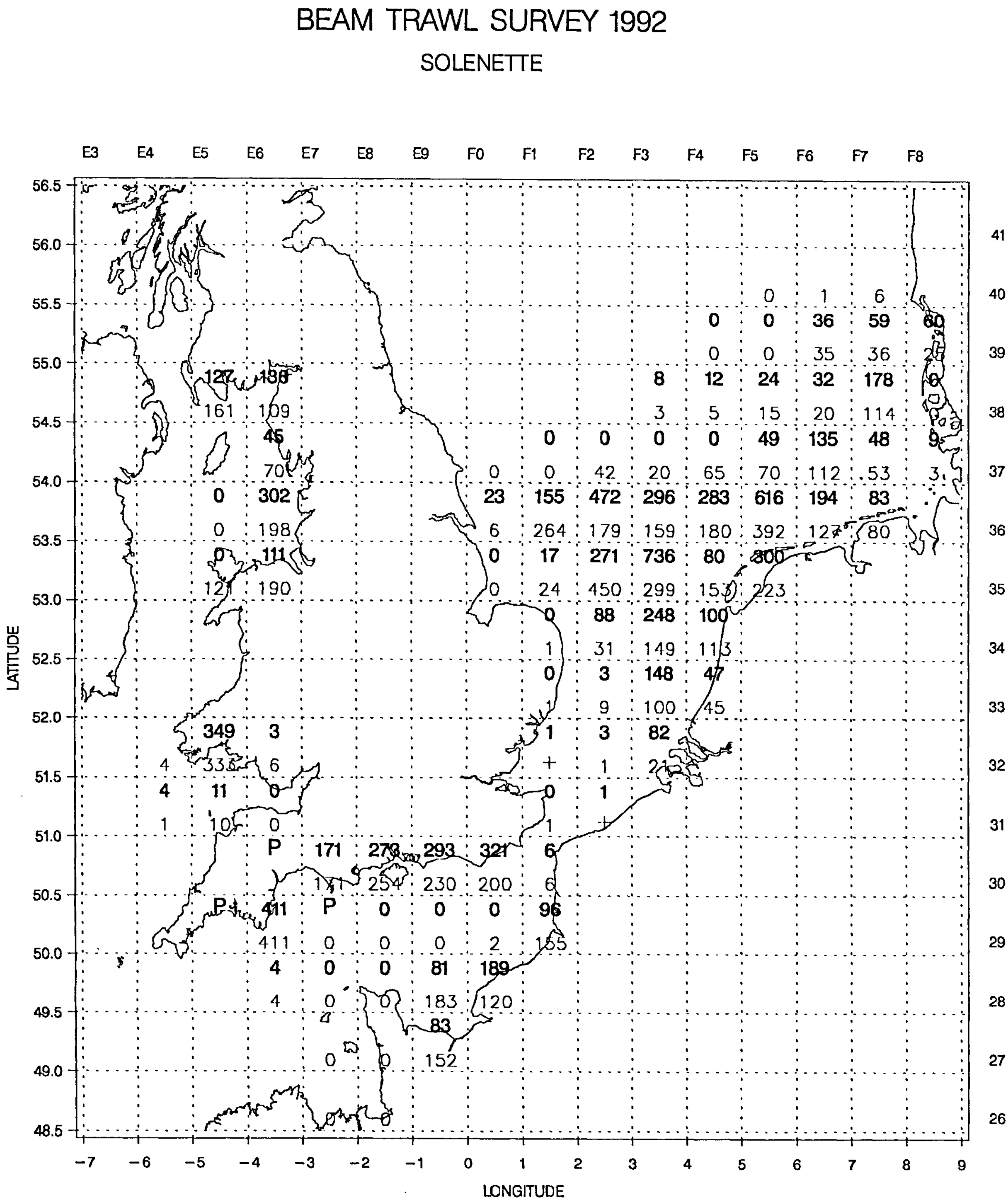


Figure 5.18 Distribution of thickback sole, *Microchirus variegatus*, (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

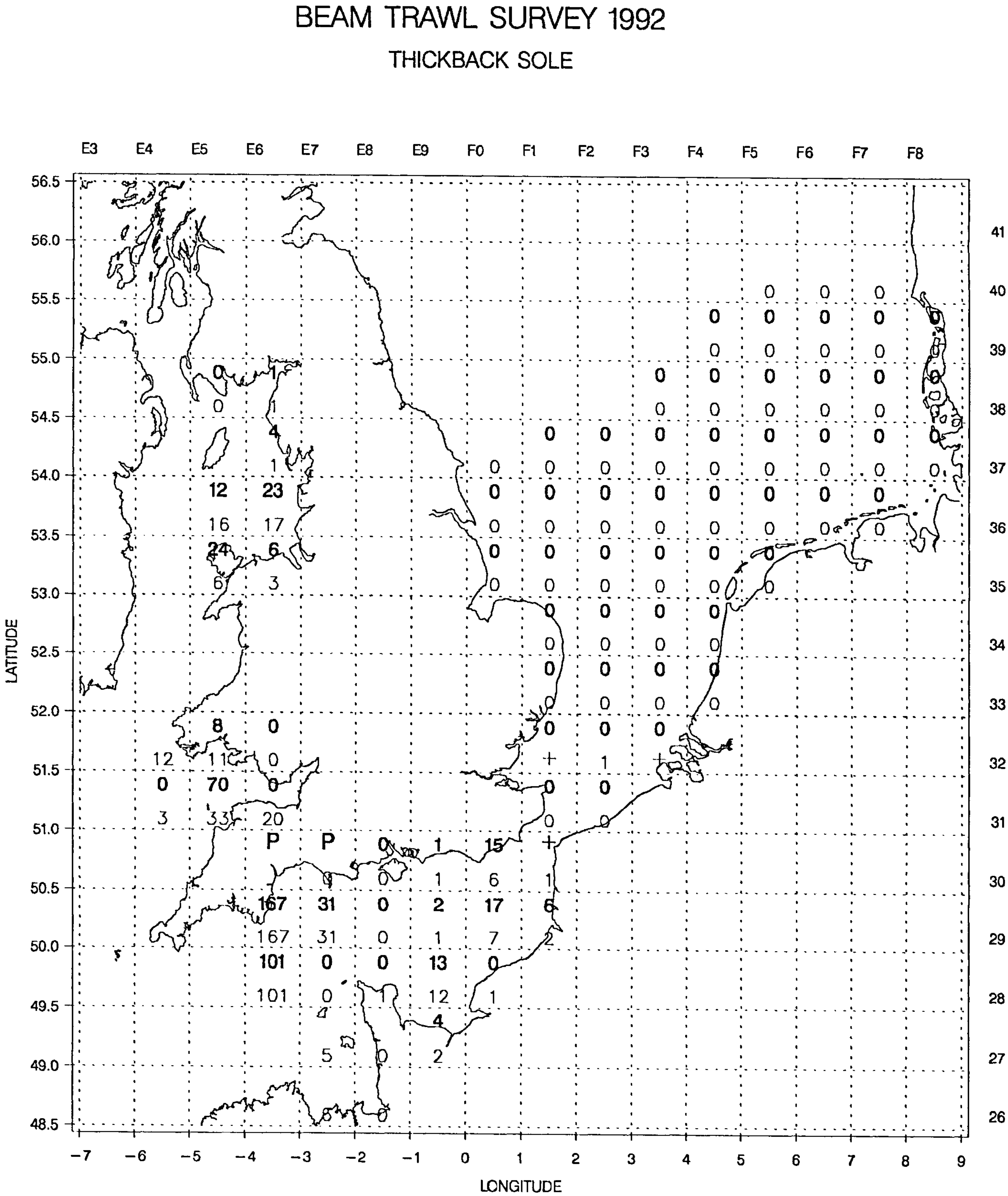


Figure 5.19 Distribution of monk, *Lophins* spp., (No/h/8m) in each rectangle.
P = present but not counted; + = <0.5/h.

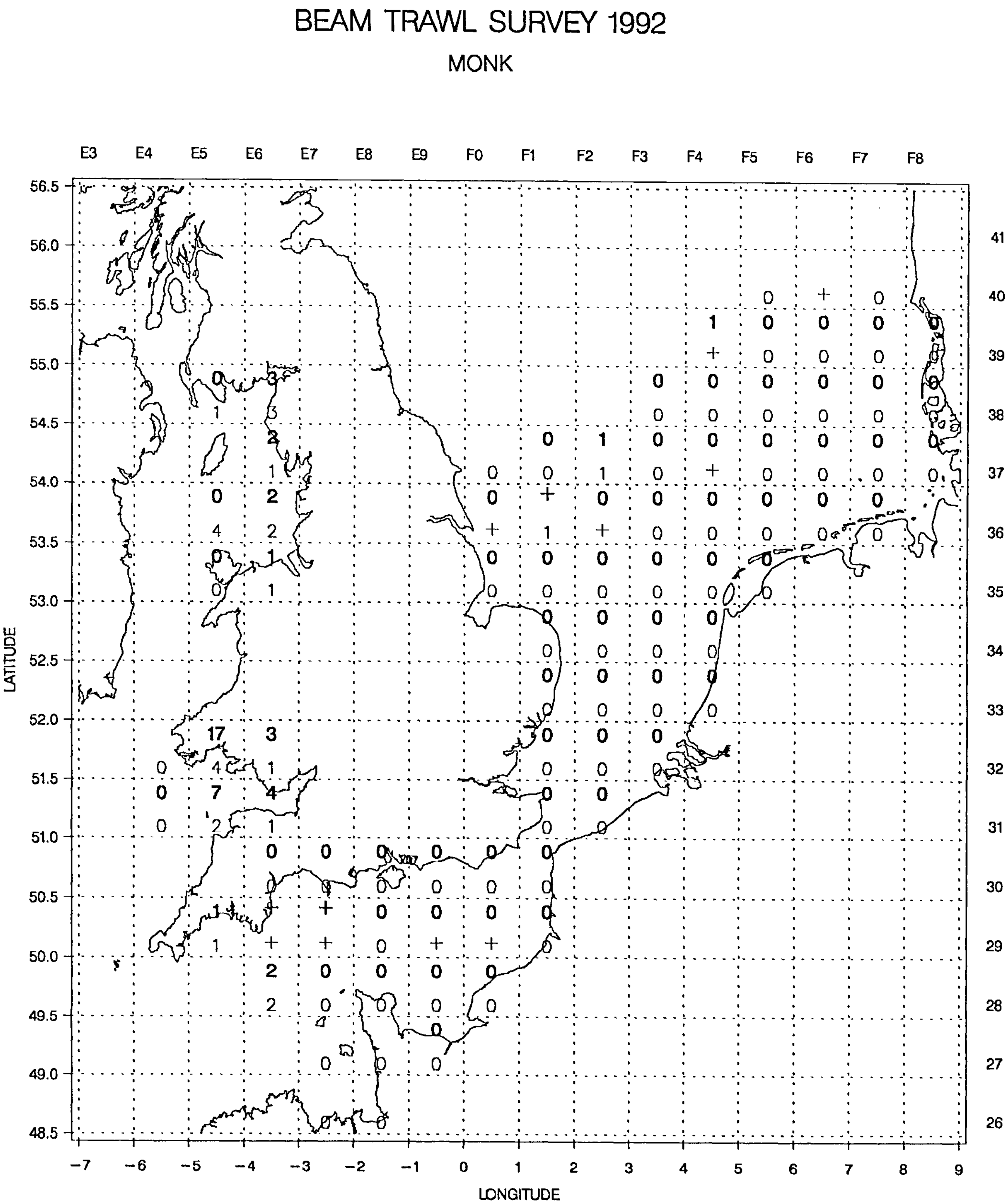


Figure 5.20 Distribution of tub gurnard, *Trigla lucerna,* (No/h/8m) in each rectangle.
P = present but not counted; + = <0.5/h.

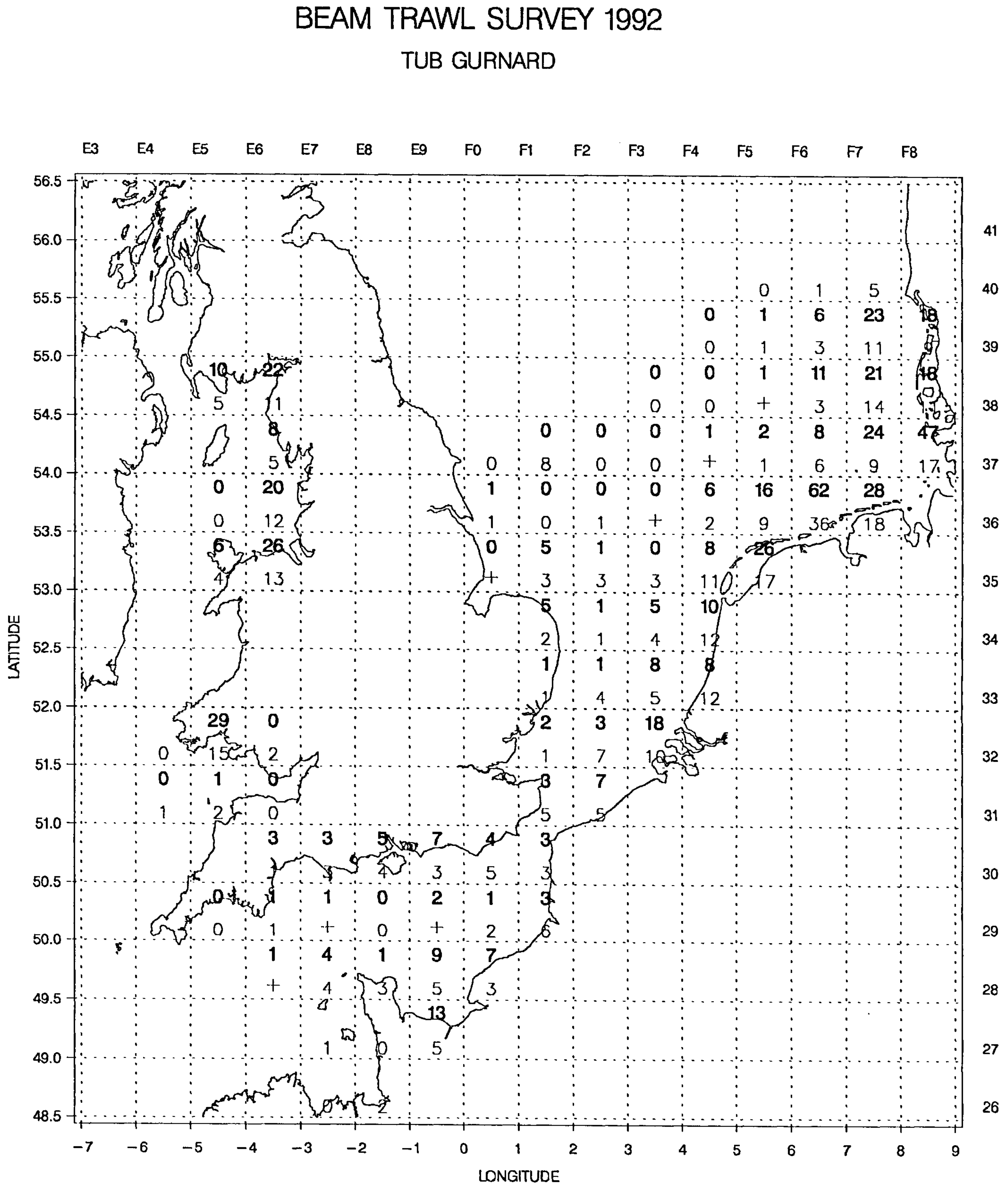


Figure 5.21 Distribution of grey gurnard, *Eutrigla gurnardus*, (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

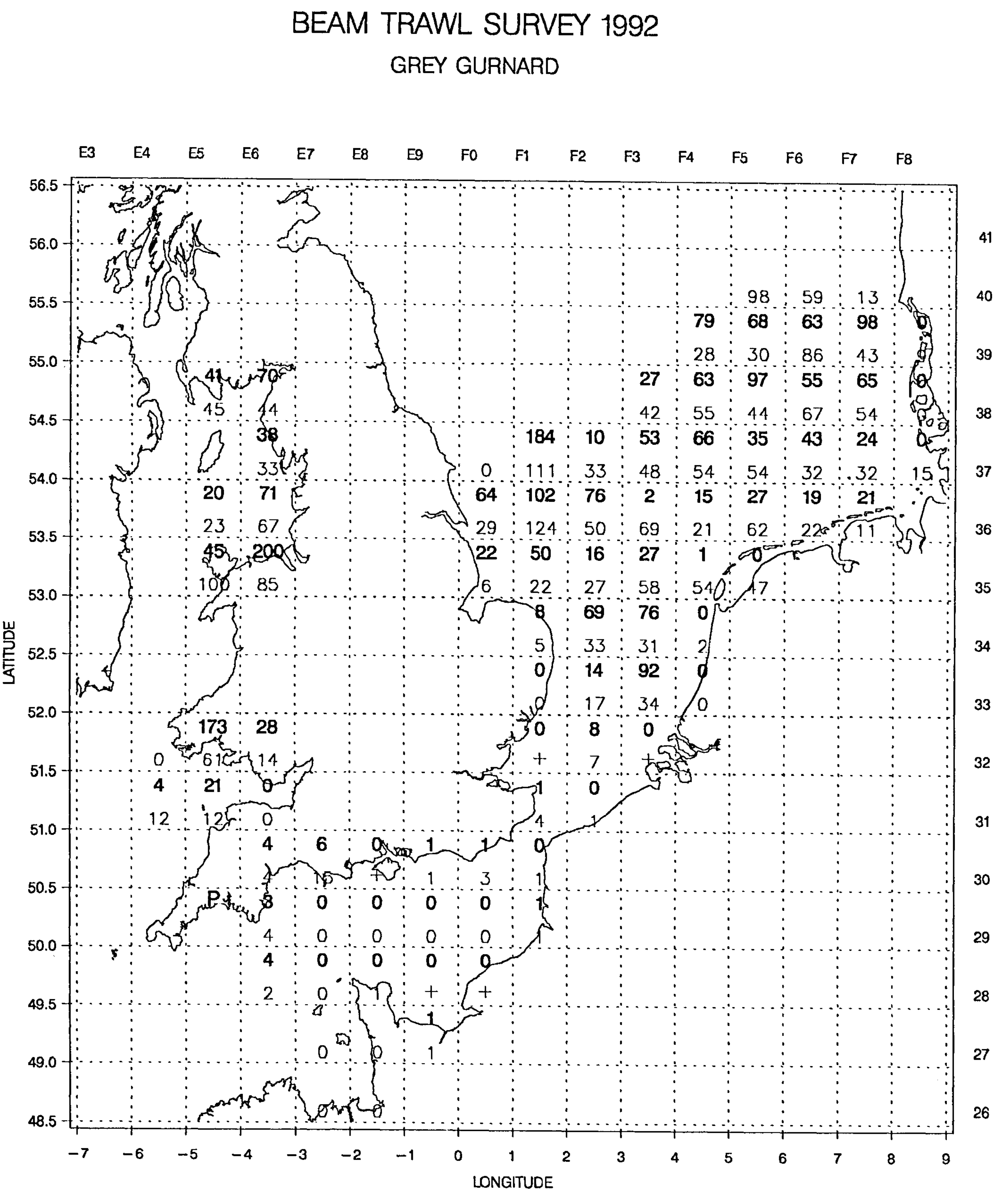


Figure 5.22 Distribution of red gurnard, *Aspitrigla cuculus*, (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

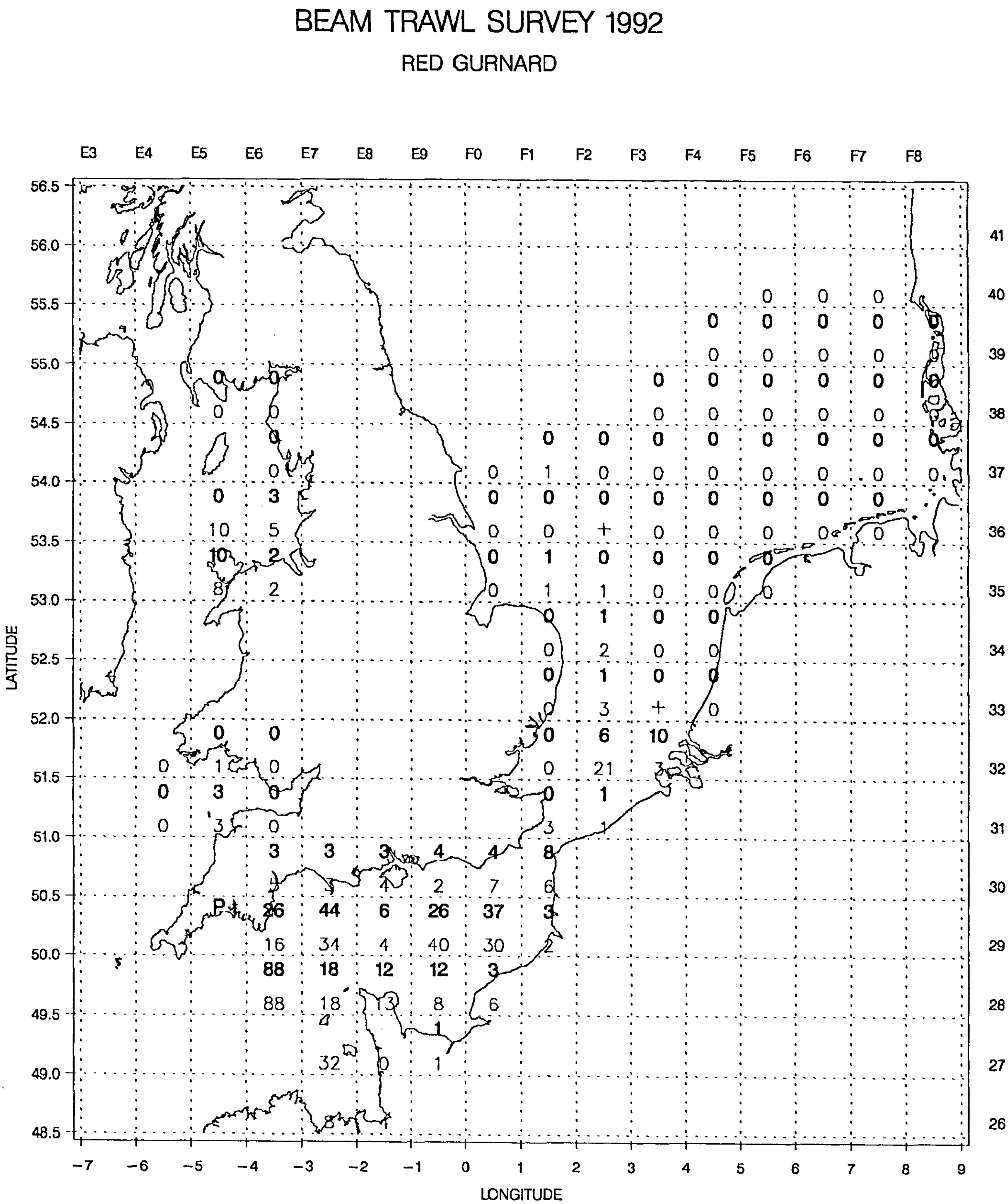


Figure 5.23 Distribution of pogge, *Agonus cataphractus*, (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

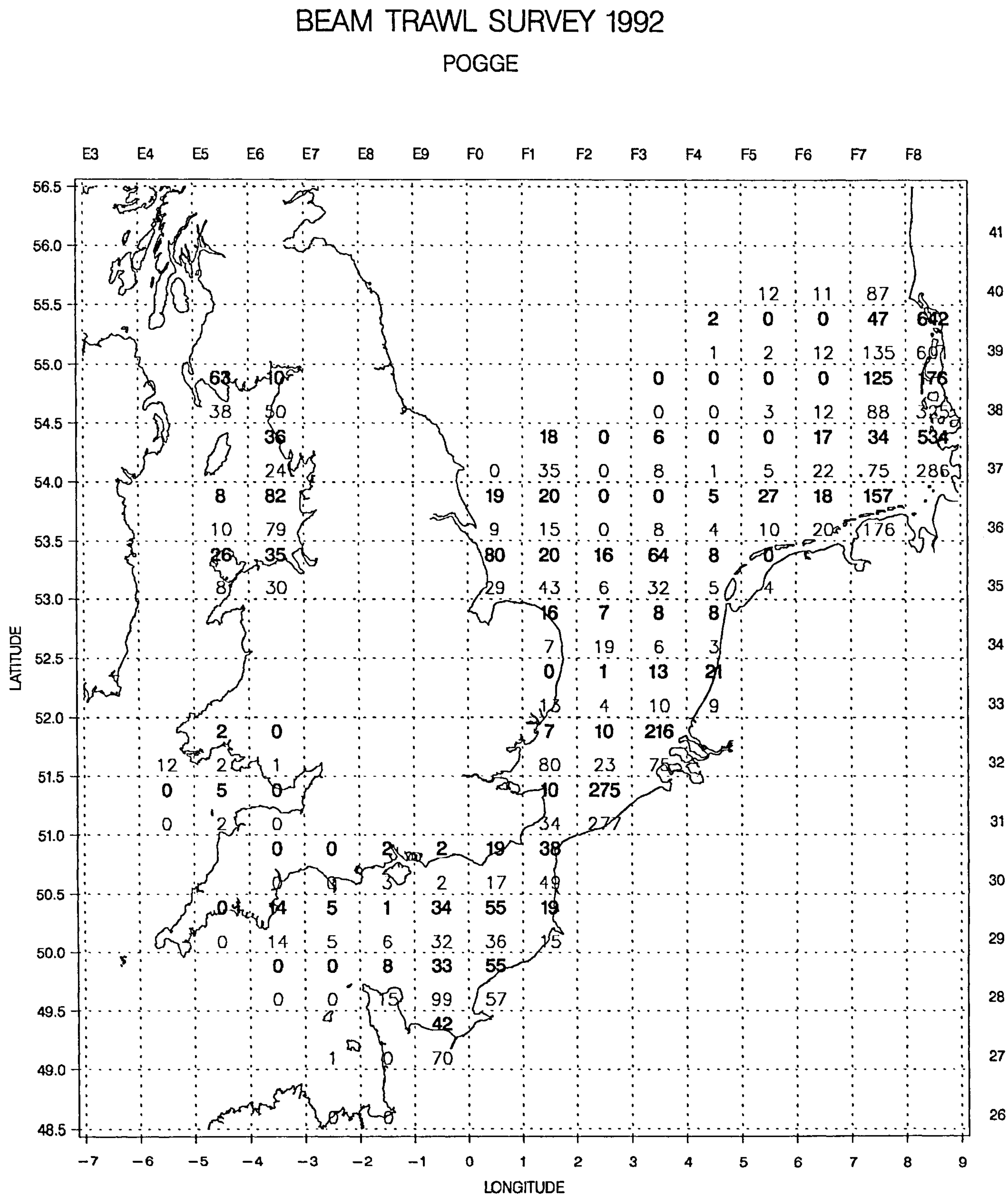


Figure 5.24 Distribution of lesser weever, *Echiichthys vipera,* (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

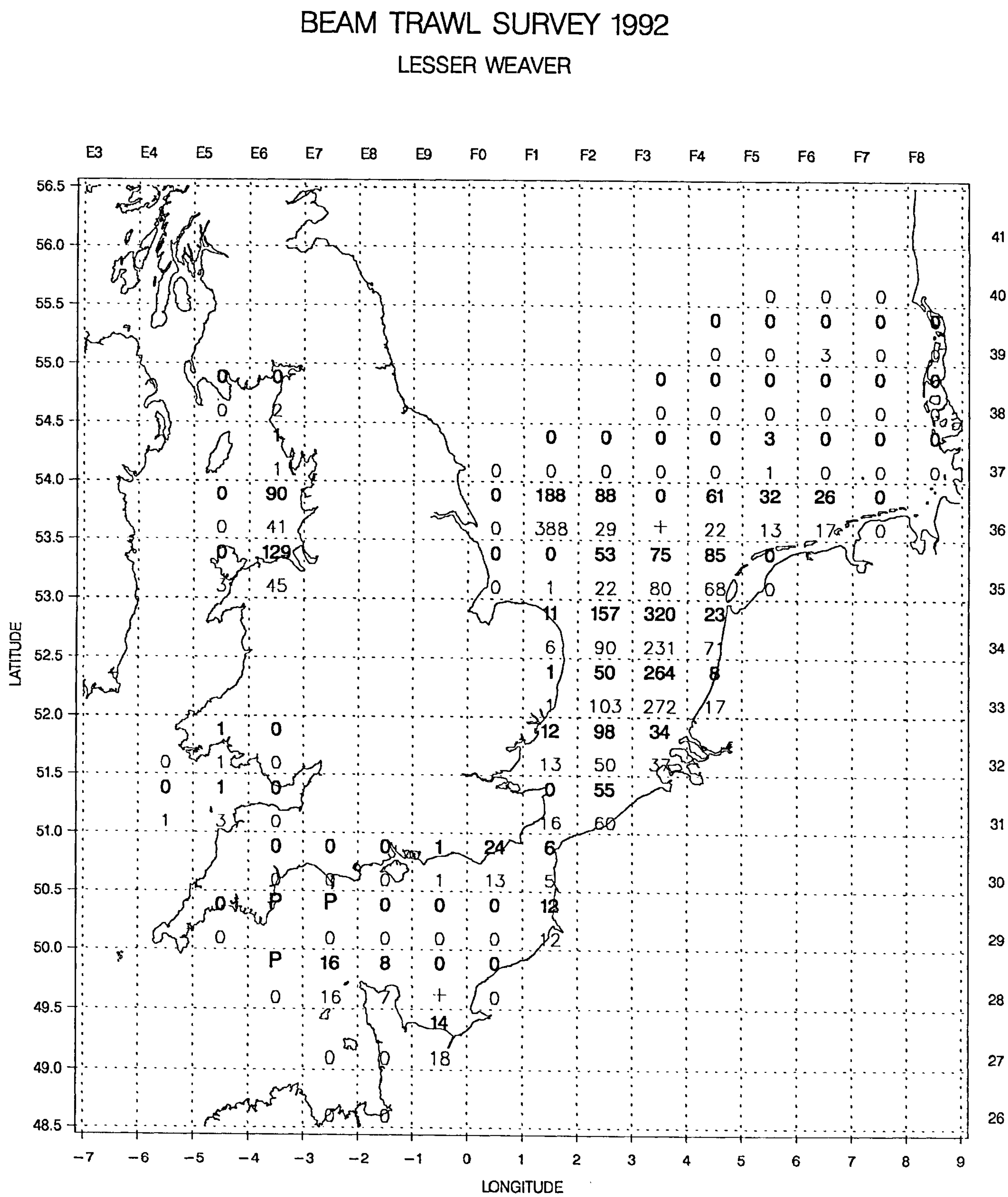


Figure 5.25 Distribution of dragonet, *Callionymus lyra,* (No/h/8m) in each rectangle.
P = present but not counted; + = <0.5/h.

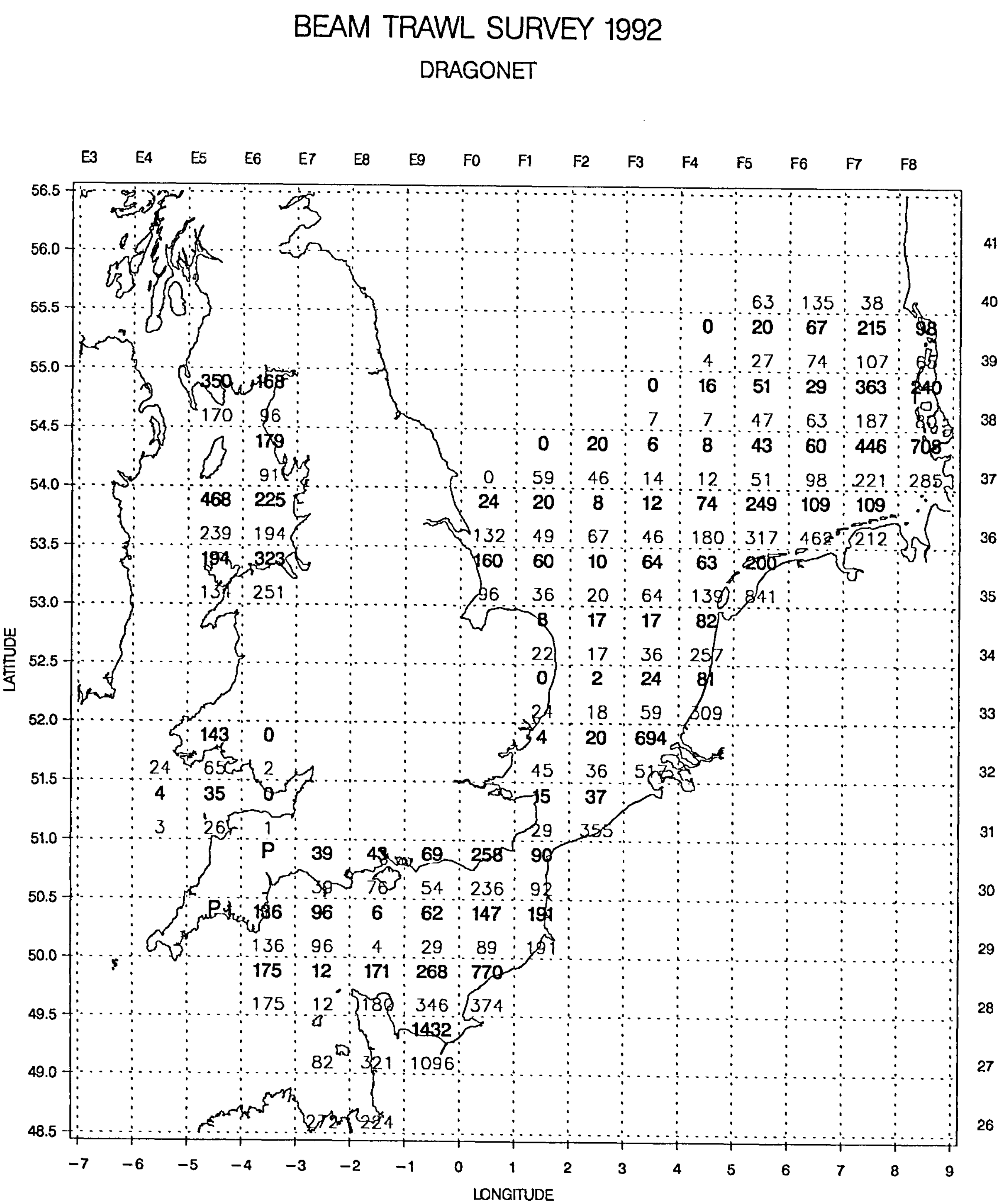


Figure 5.26 Distribution of lesser spotted dogfish, *Scyliorhinus canicula,* (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

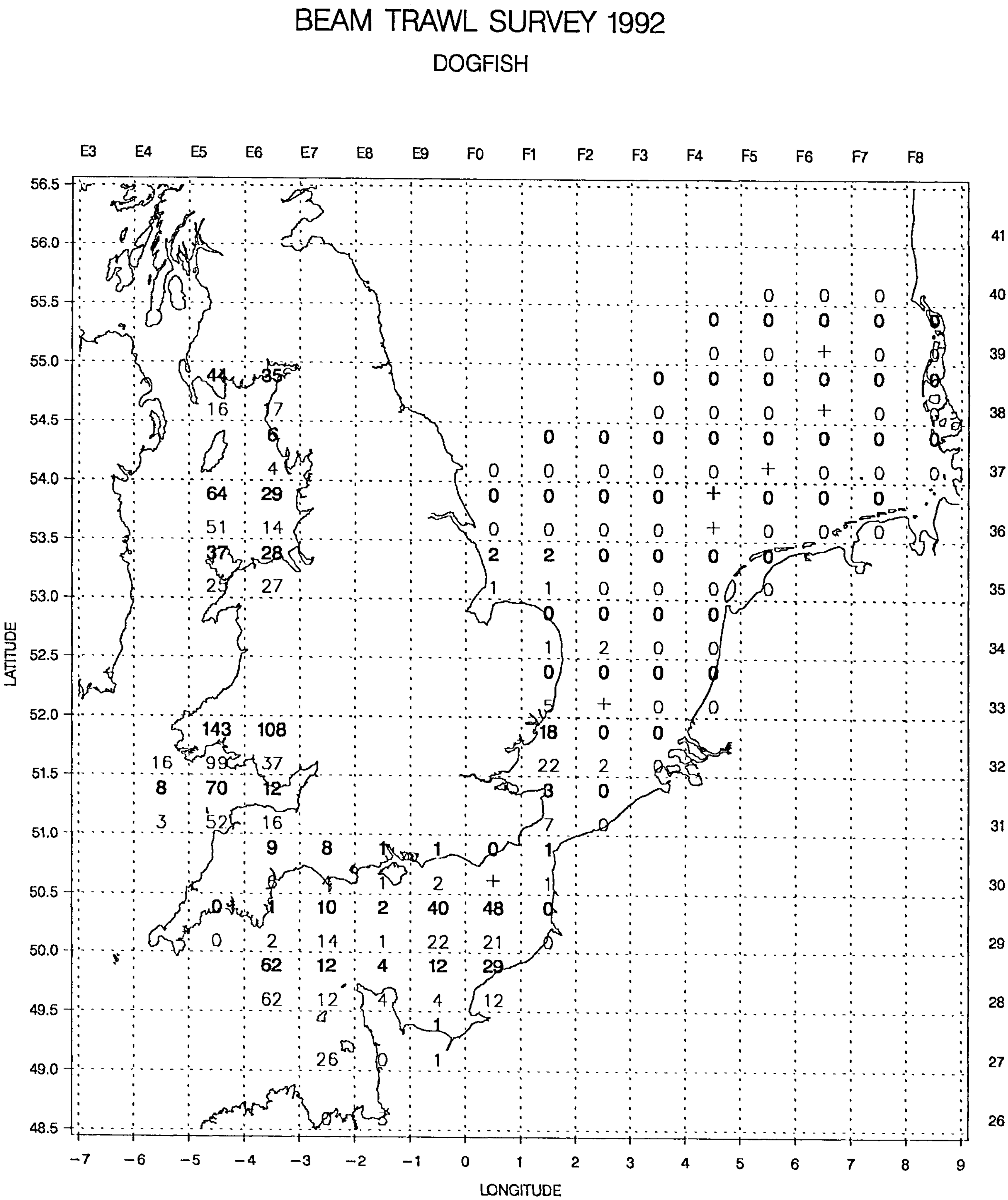


Figure 5.27 Distribution of rays, *Rajidae,* (No/h/8m) in each rectangle.
P = present but not counted; + = <0.5/h.

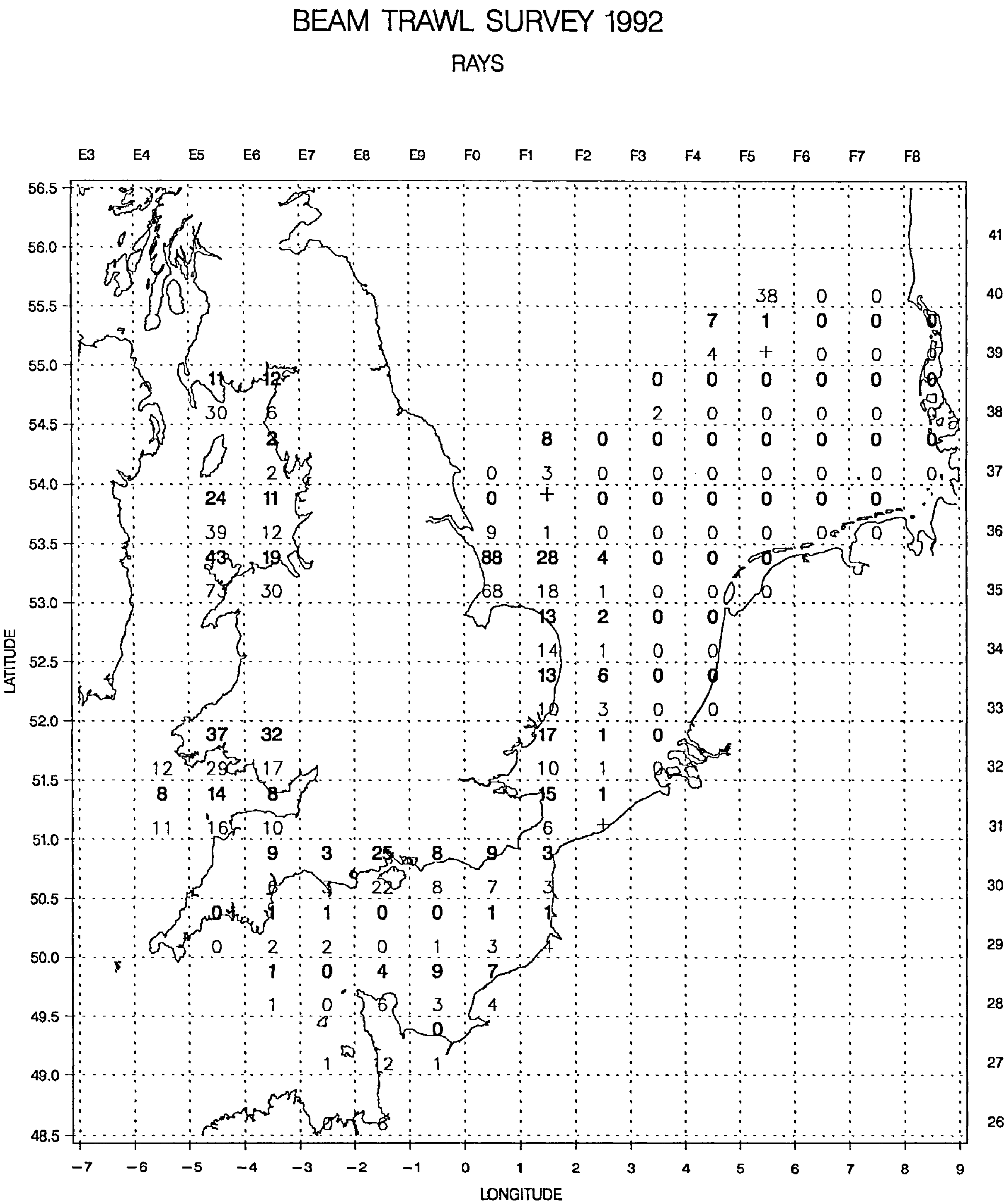


Figure 5.28 Distribution of cod, *Gadus morhua*, (No/h/8m) in each rectangle.
P = present but not counted; + = <0.5/h.

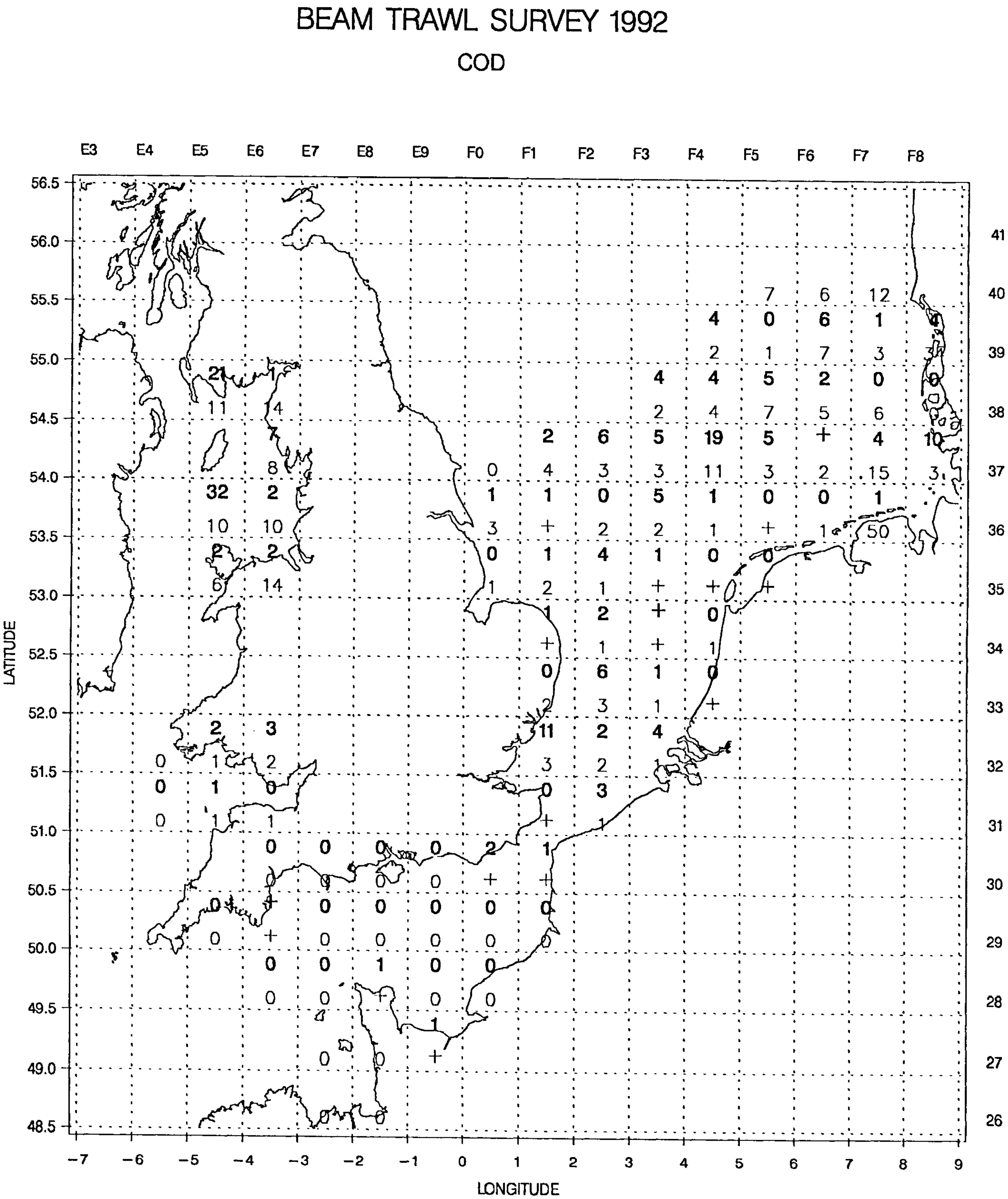


Figure 5.29 Distribution of bib, *Trisopterus luscus*, (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

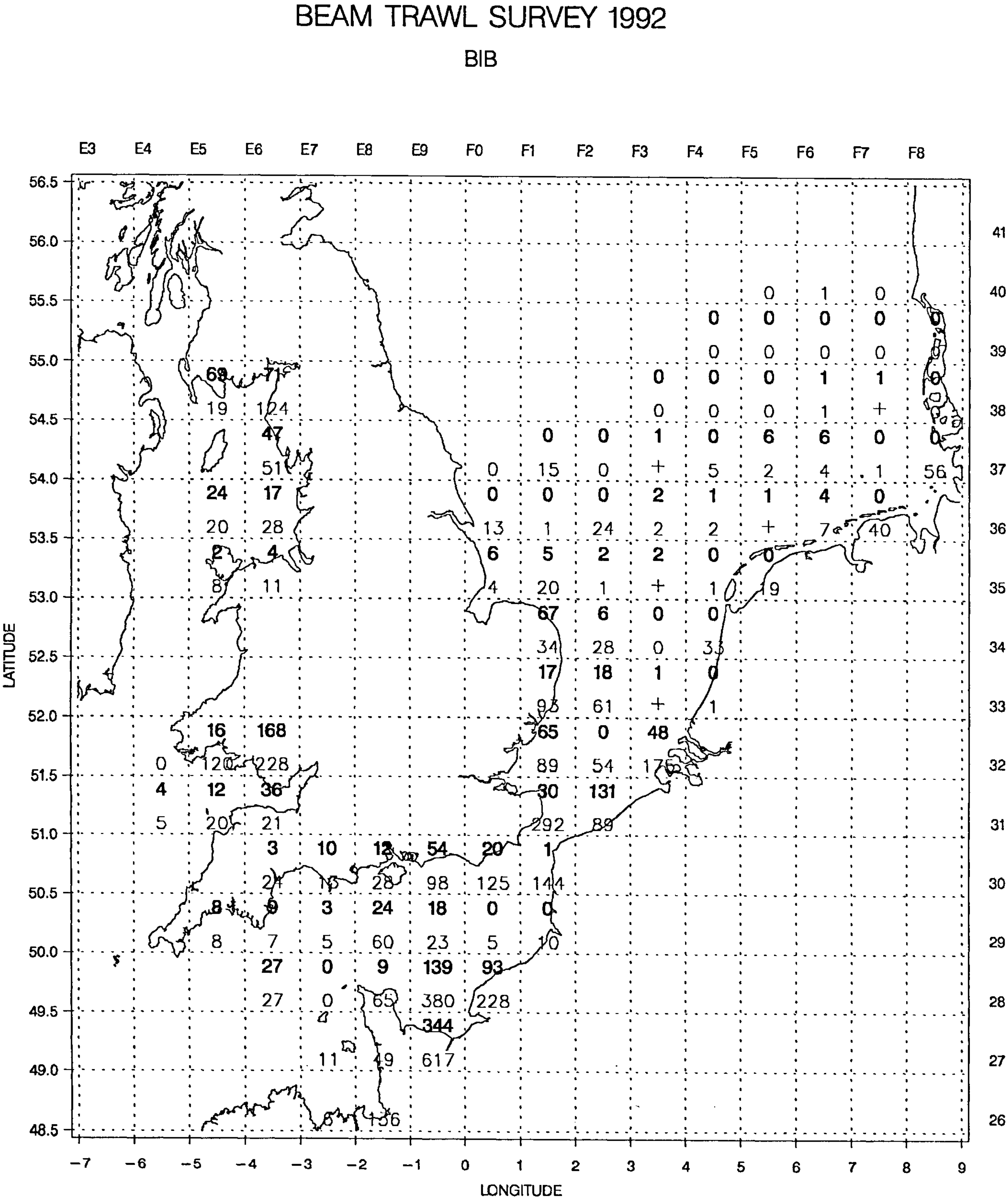


Figure 5.30 Distribution of poor cod, *Trisopterus minutus*, (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

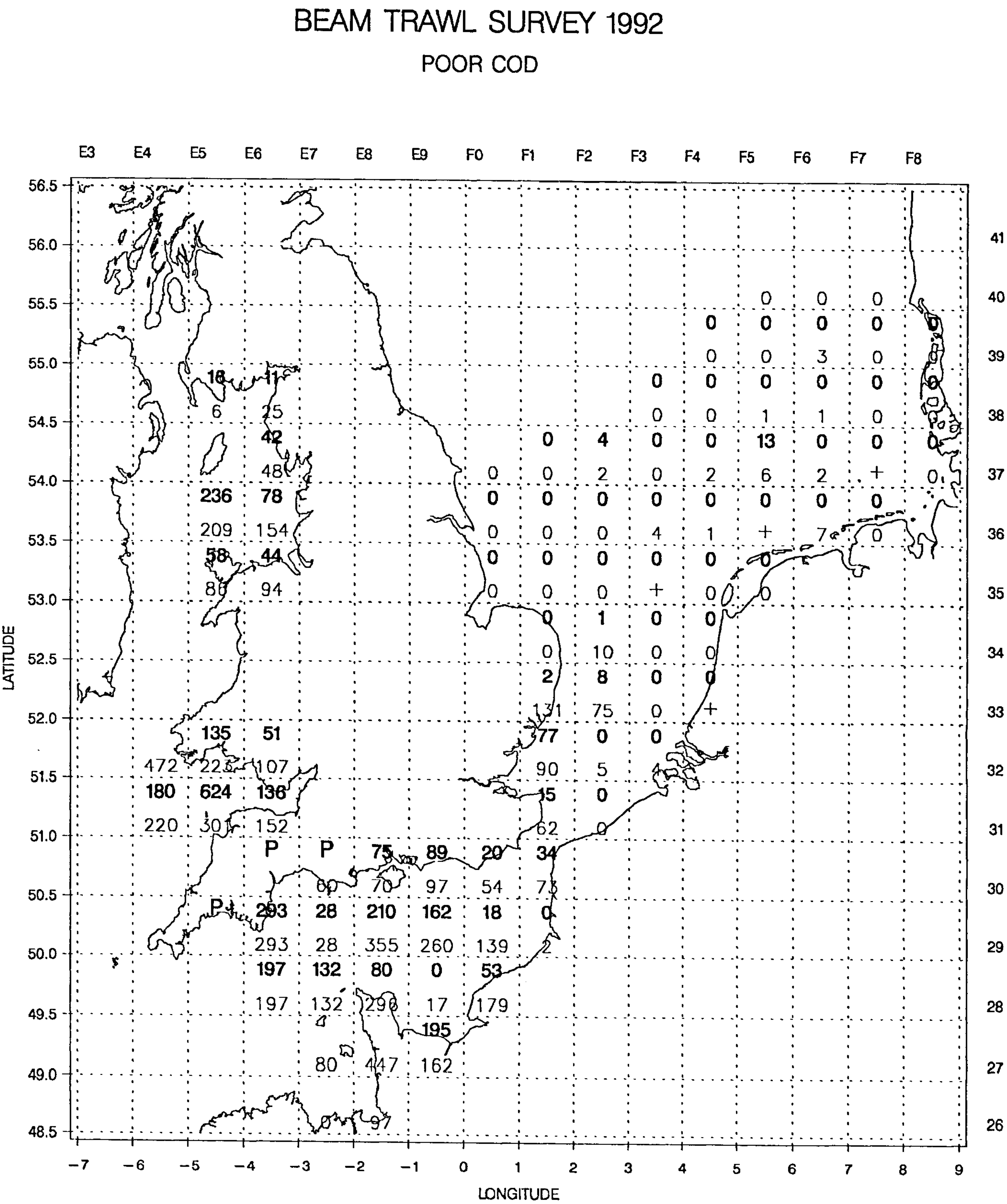


Figure 5 31 Distribution of whiting, *Merlangius merlangus*, (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

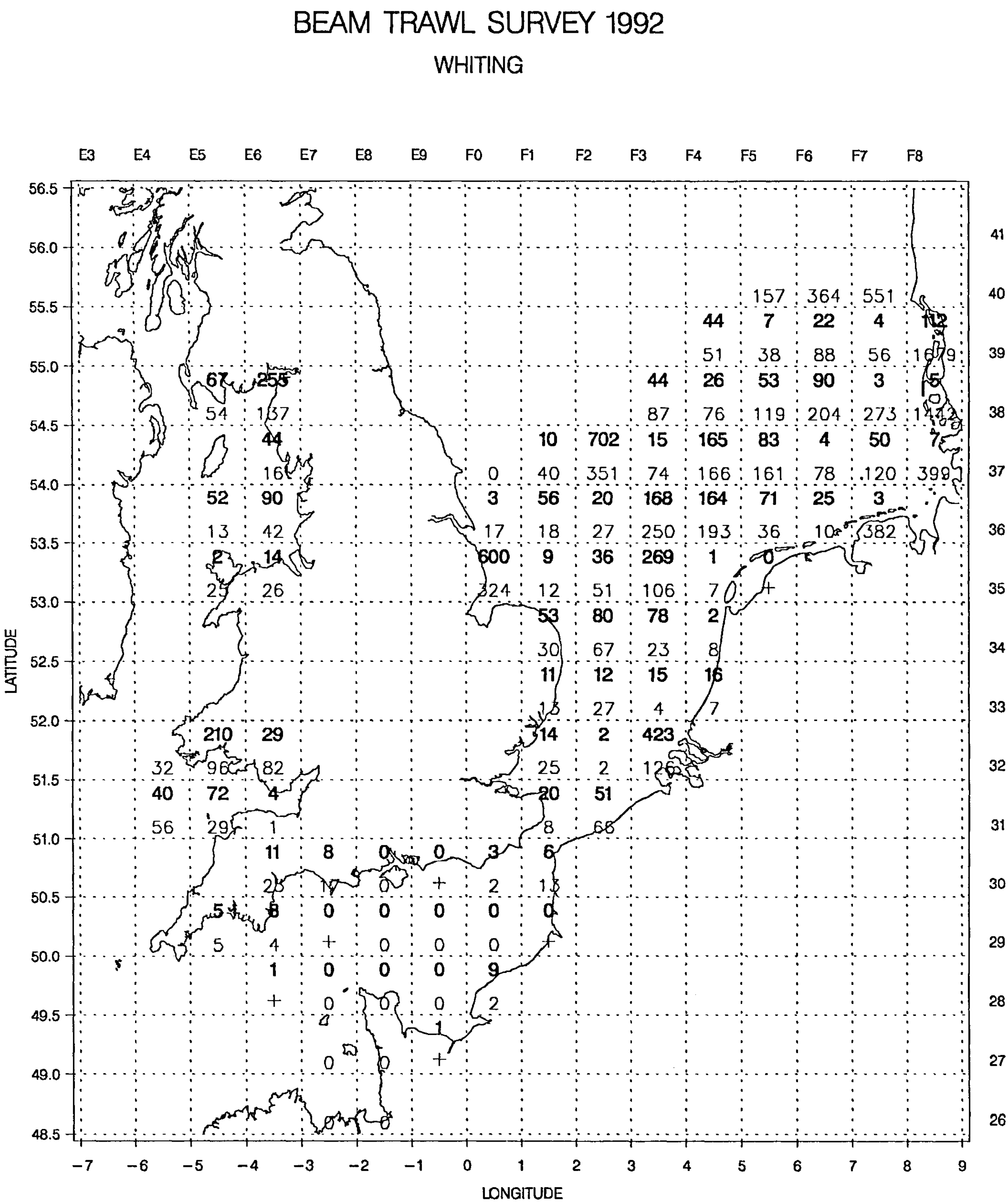


Figure 5.32 Distribution of red mullet, *Mullus surmuletus*, (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

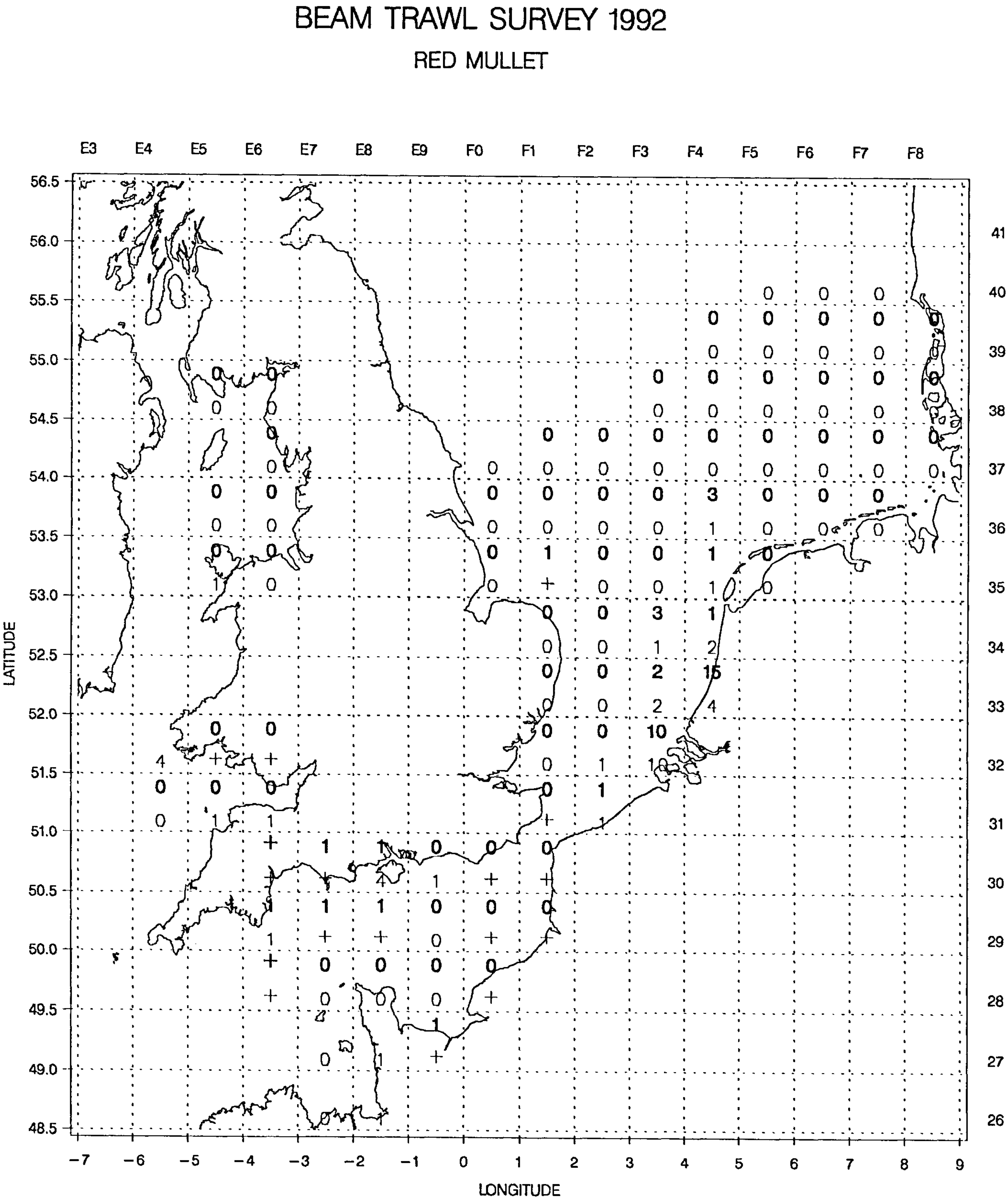


Figure 5.33 Distributionof John dory, *Zeus faber*, (No/h/8m) in each rectangle.
P = present but not counted; + = <0.5/h.

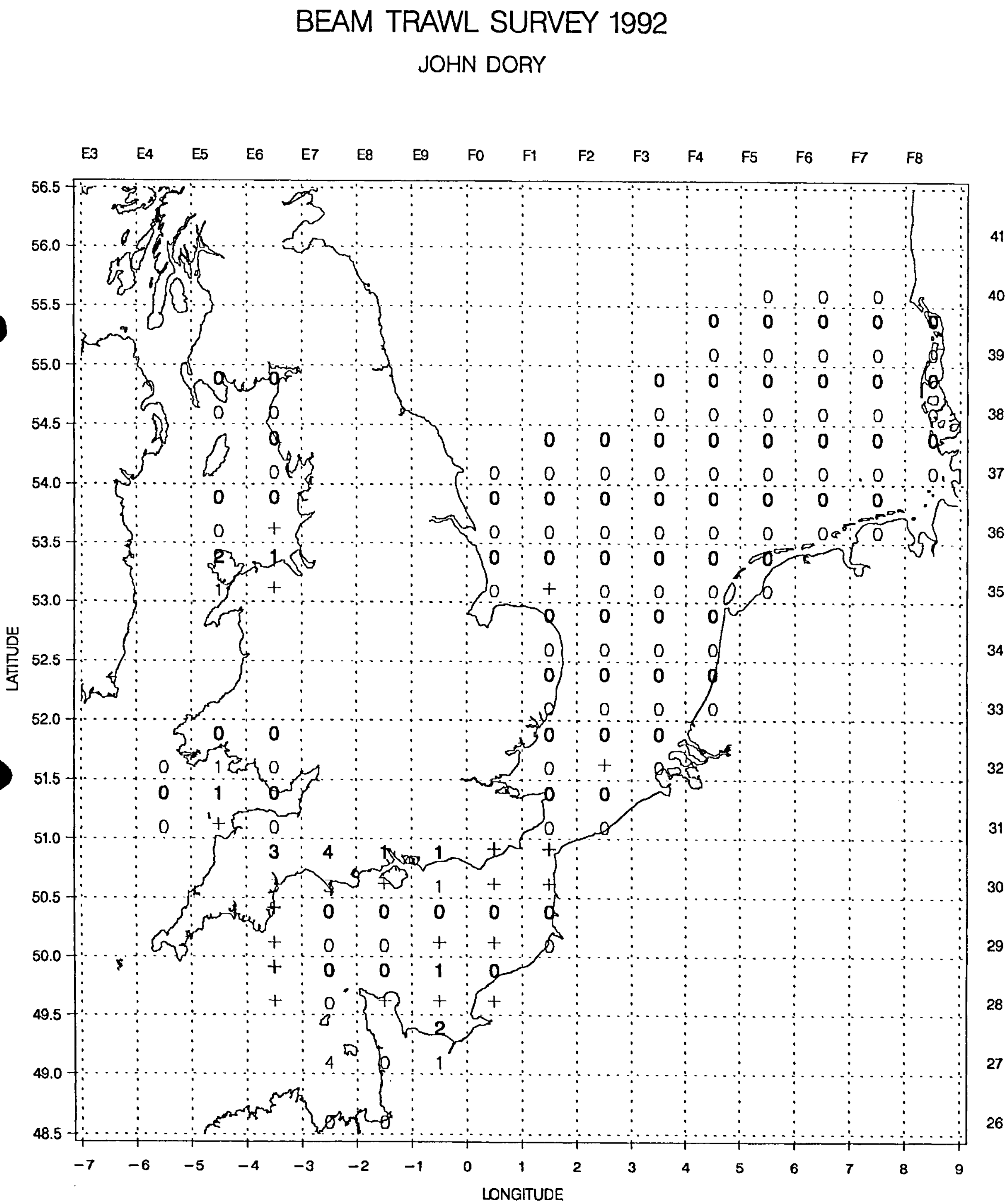


Figure 5.34 Distribution of edible crab, *Cancer pagurus,* (No/h/8m) in each rectangle. P = present but not counted; + = <0.5/h.

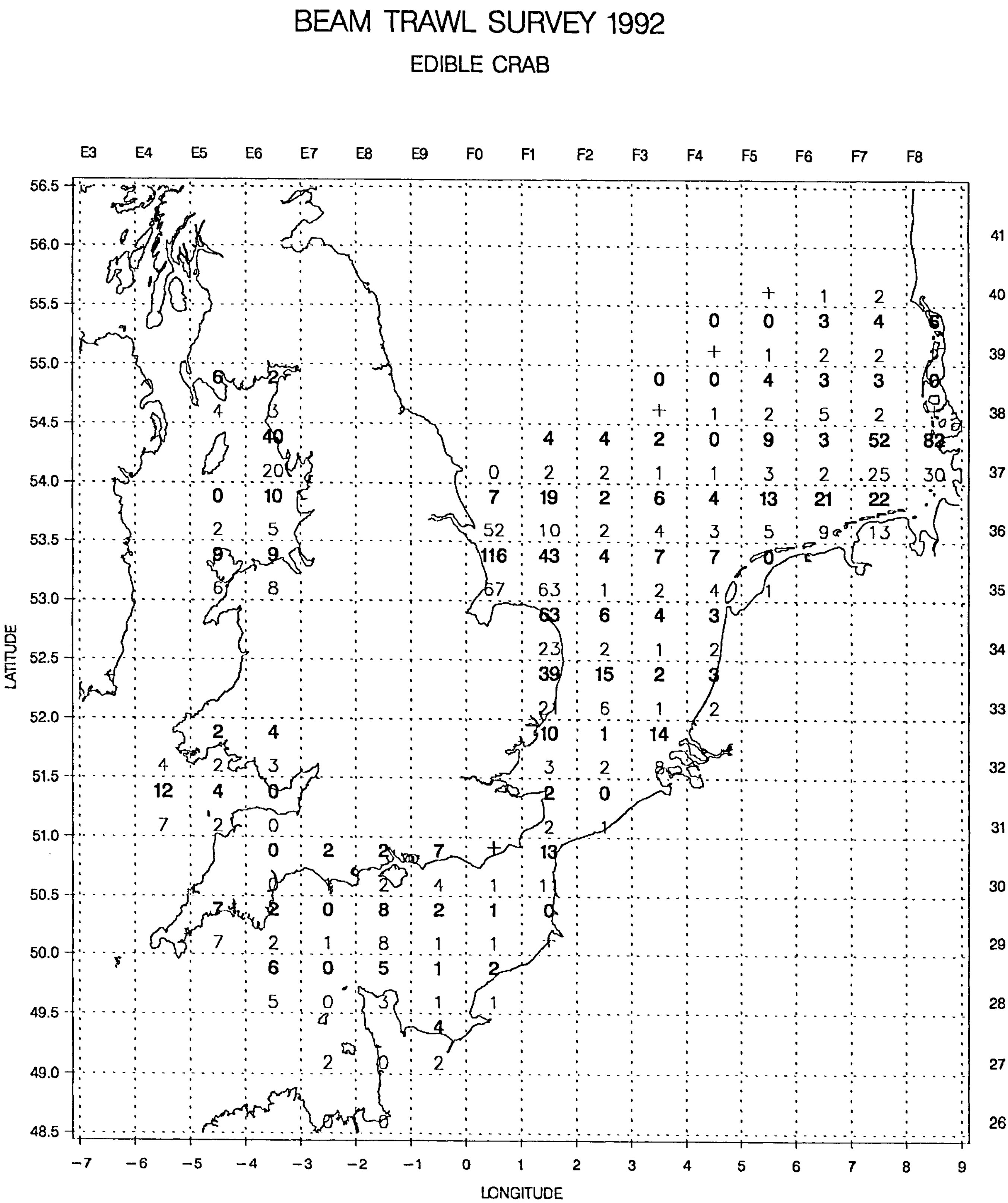


Figure 5.35 Predicted positions of frontal boundaries separating regions that are stratified in the summer and those that are well mixed throughout the year (from Pingree and Griffiths, 1978).

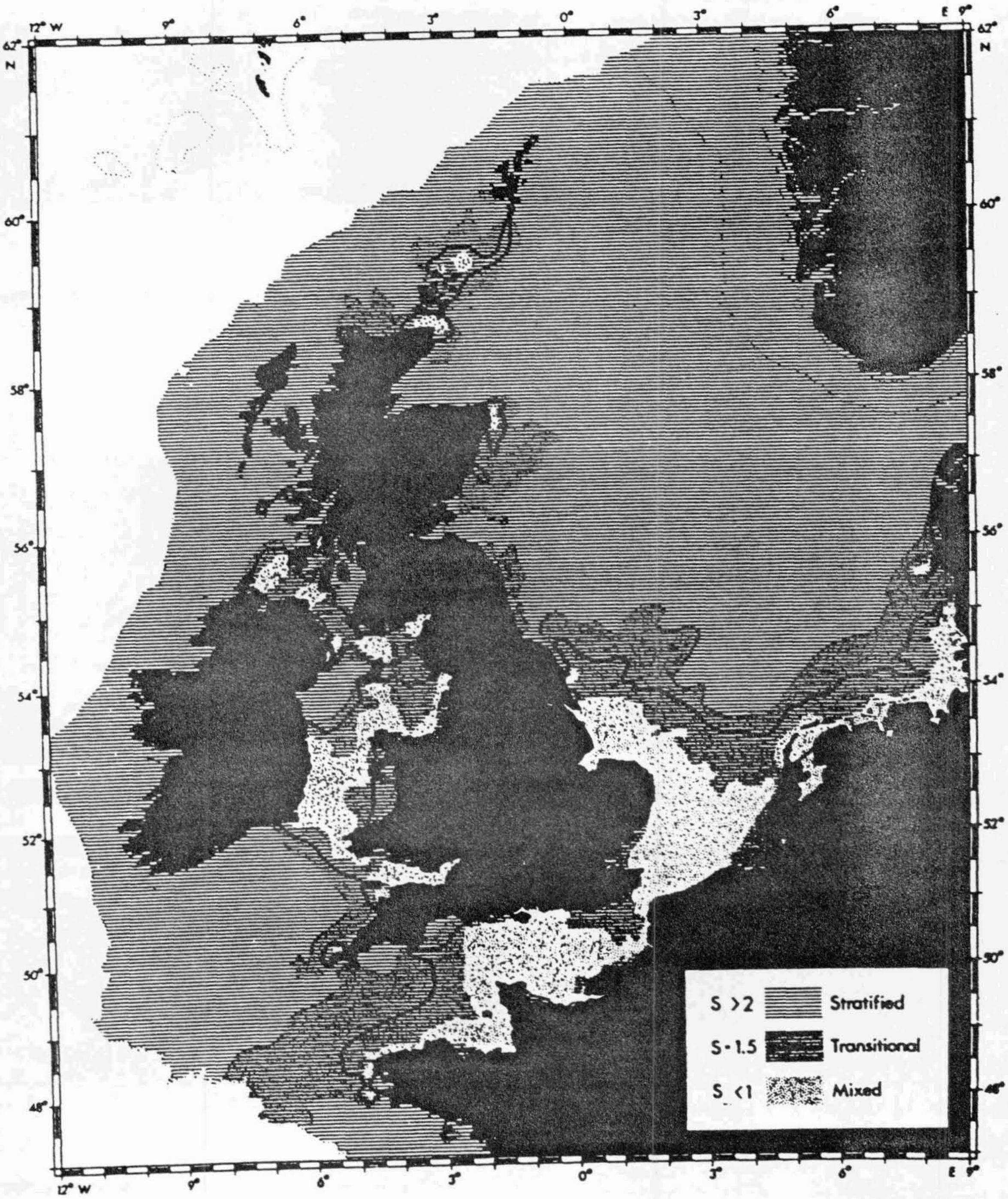


Figure 5.36 Division of the survey areas into sub-areas.

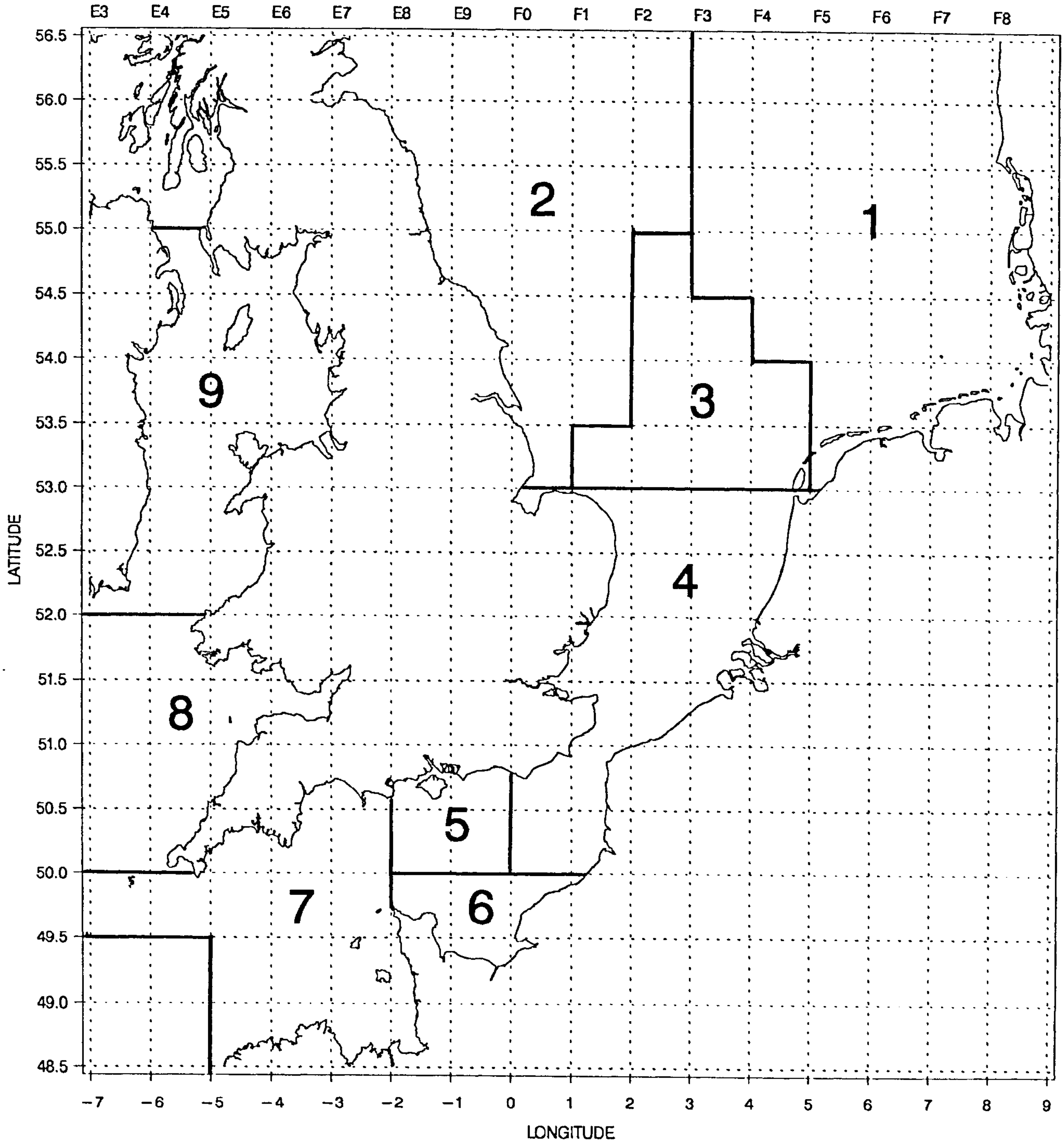
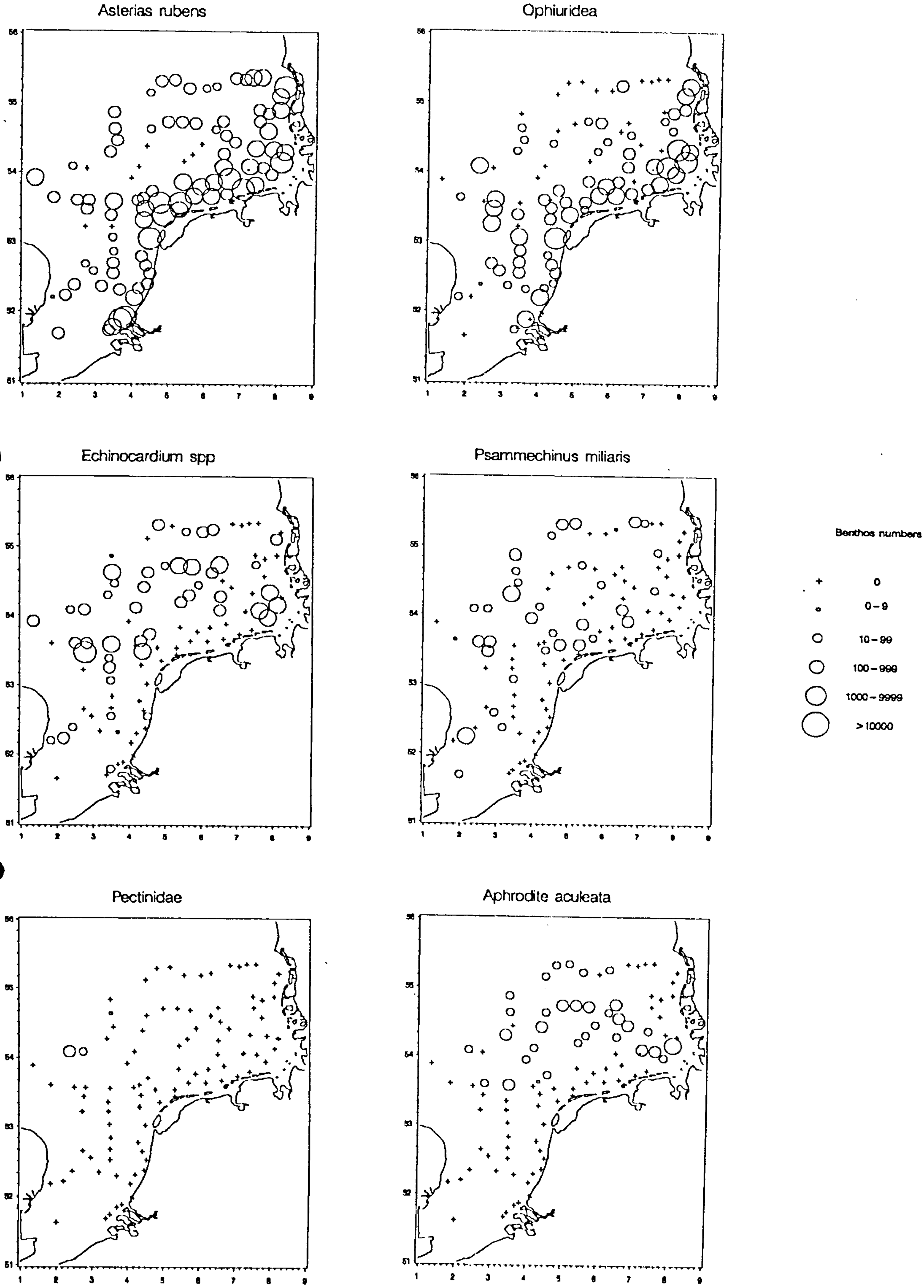


Figure 5.37 Distribution and abundance of selected benthic animals in the North Sea from 1992 surveys (+: absent; size of circle represents abundance on a log scale).



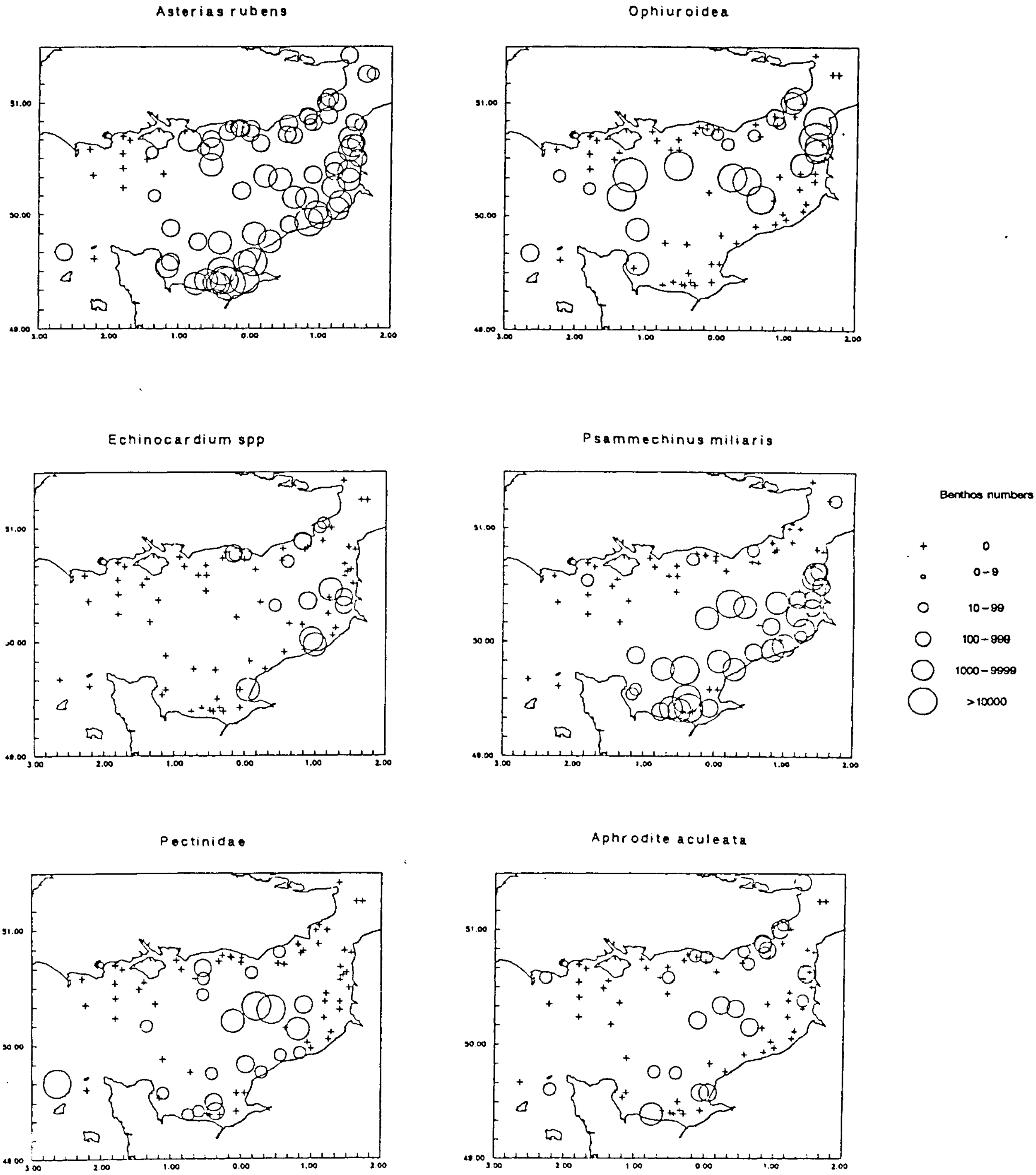


Figure 5.38 Distribution and abundance of selected benthic animals in the eastern English Channel from 1992 surveys (+: absent; size of circle represents abundance on a log scale).

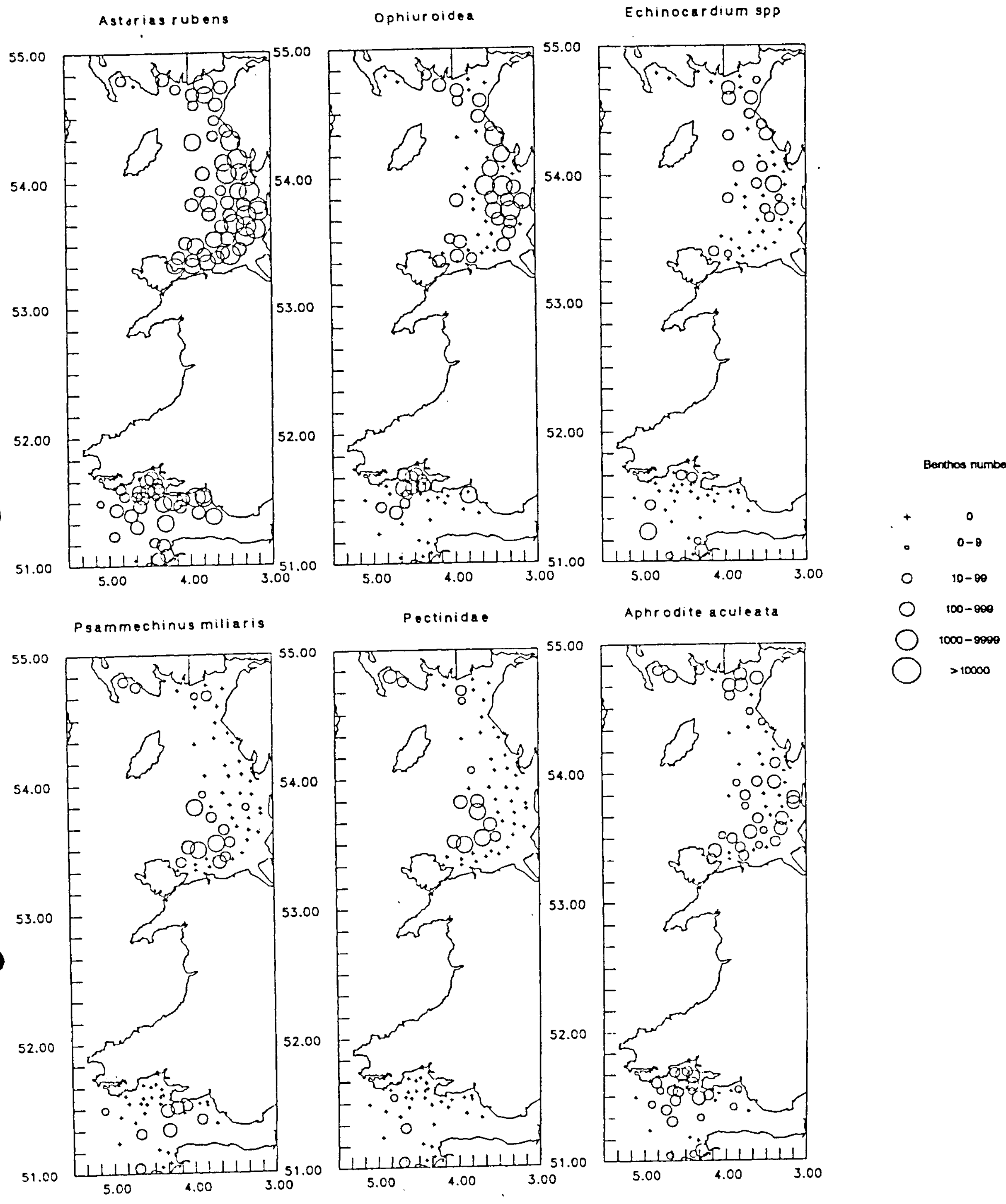


Figure 5.39 Distribution and abundance of selected benthic animals in the Irish Sea and Bristol Channel from 1992 surveys (+: absent; size of circle represents abundance on a log scale).

Figure 5.40 Distribution of mean sediment type at each station in the eastern English Channel from 1991 and 1992 surveys (□: muddy sand; O: sand; X: sand and stones).

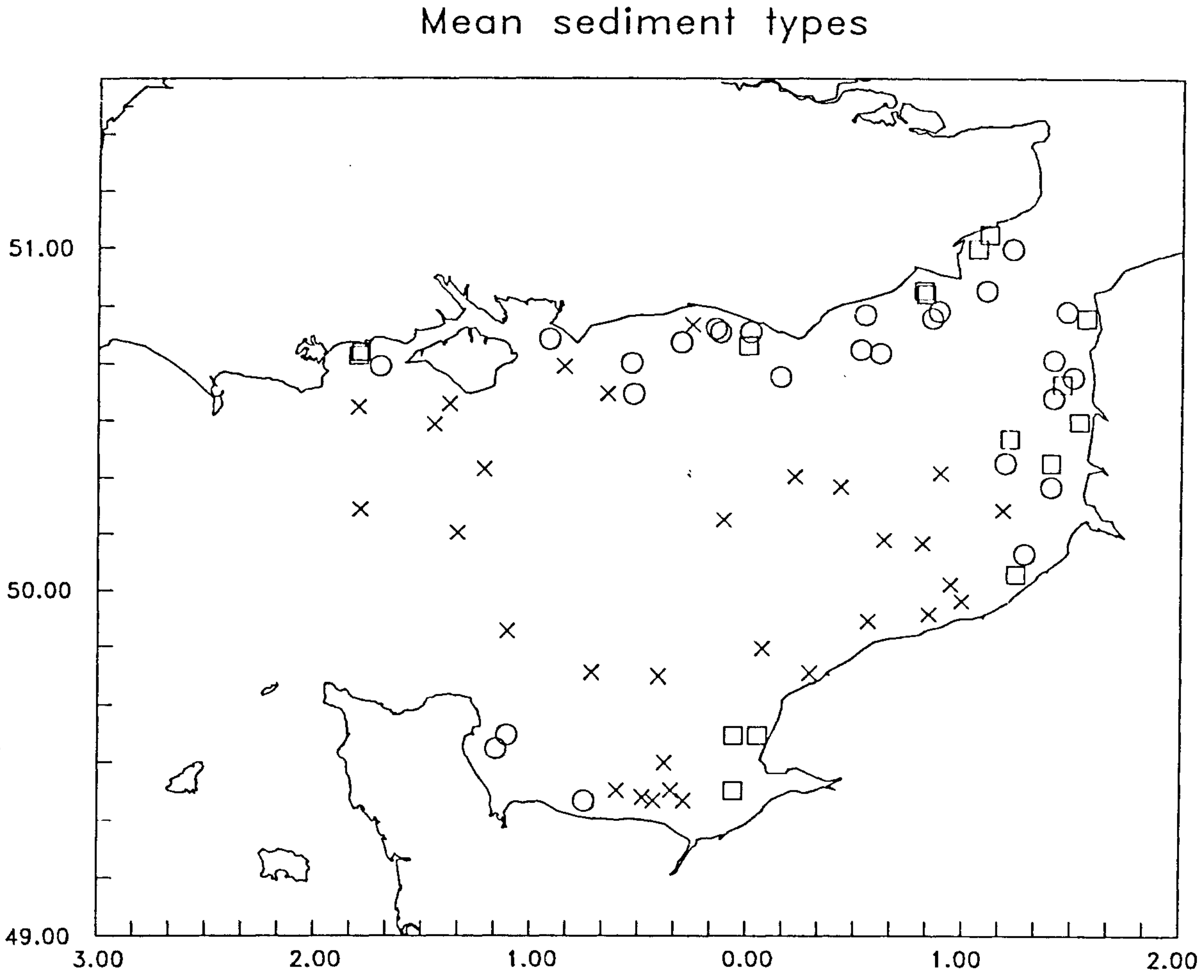


Figure 5.41 Abundance of selected benthic animals in relation to mean sediment type (□: muddy sand; O: sand, X: sand and stones).

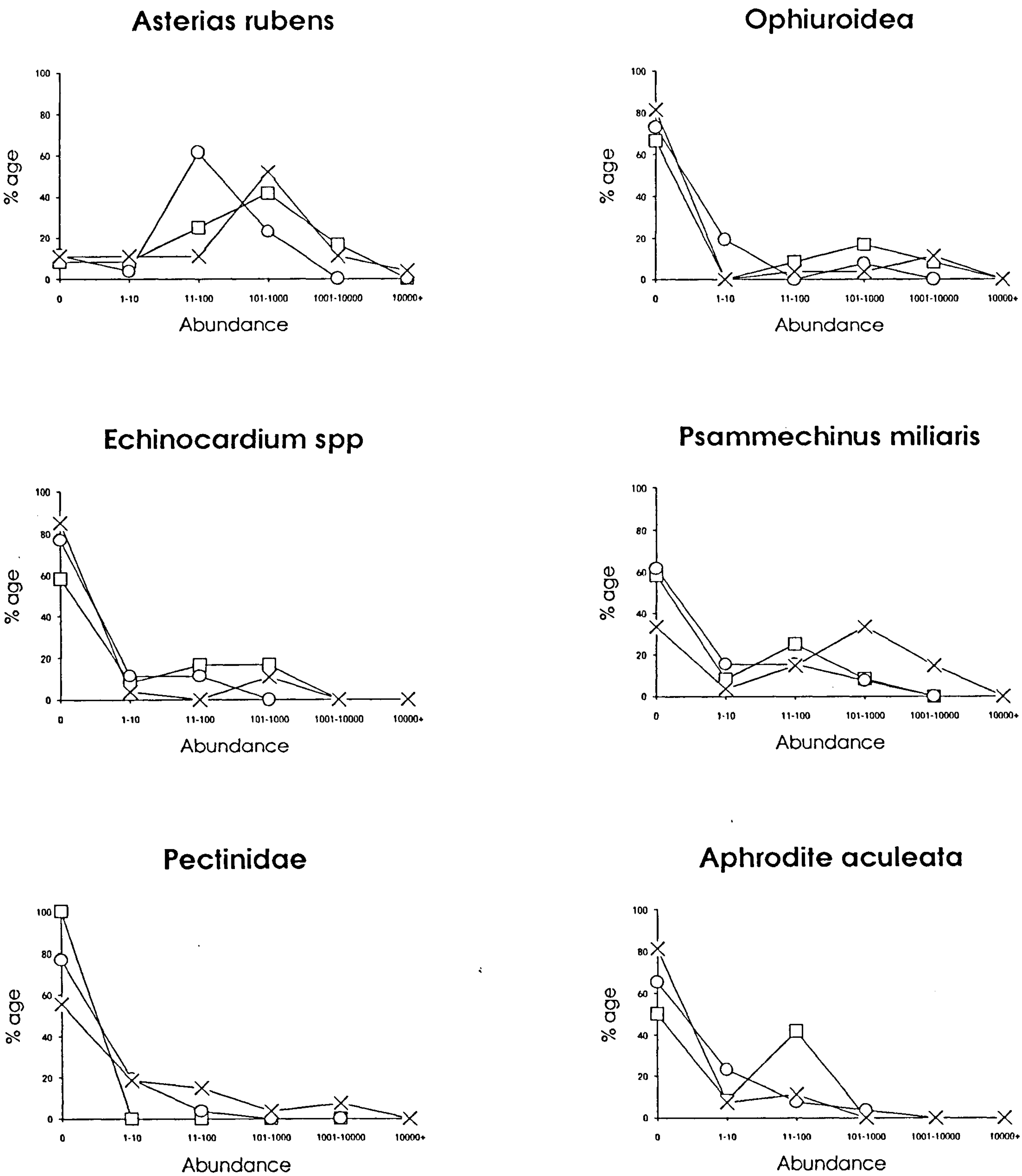


Figure 6.1 Trends in abundance of 1, 2 and 3-group sole and plaice in different survey areas.

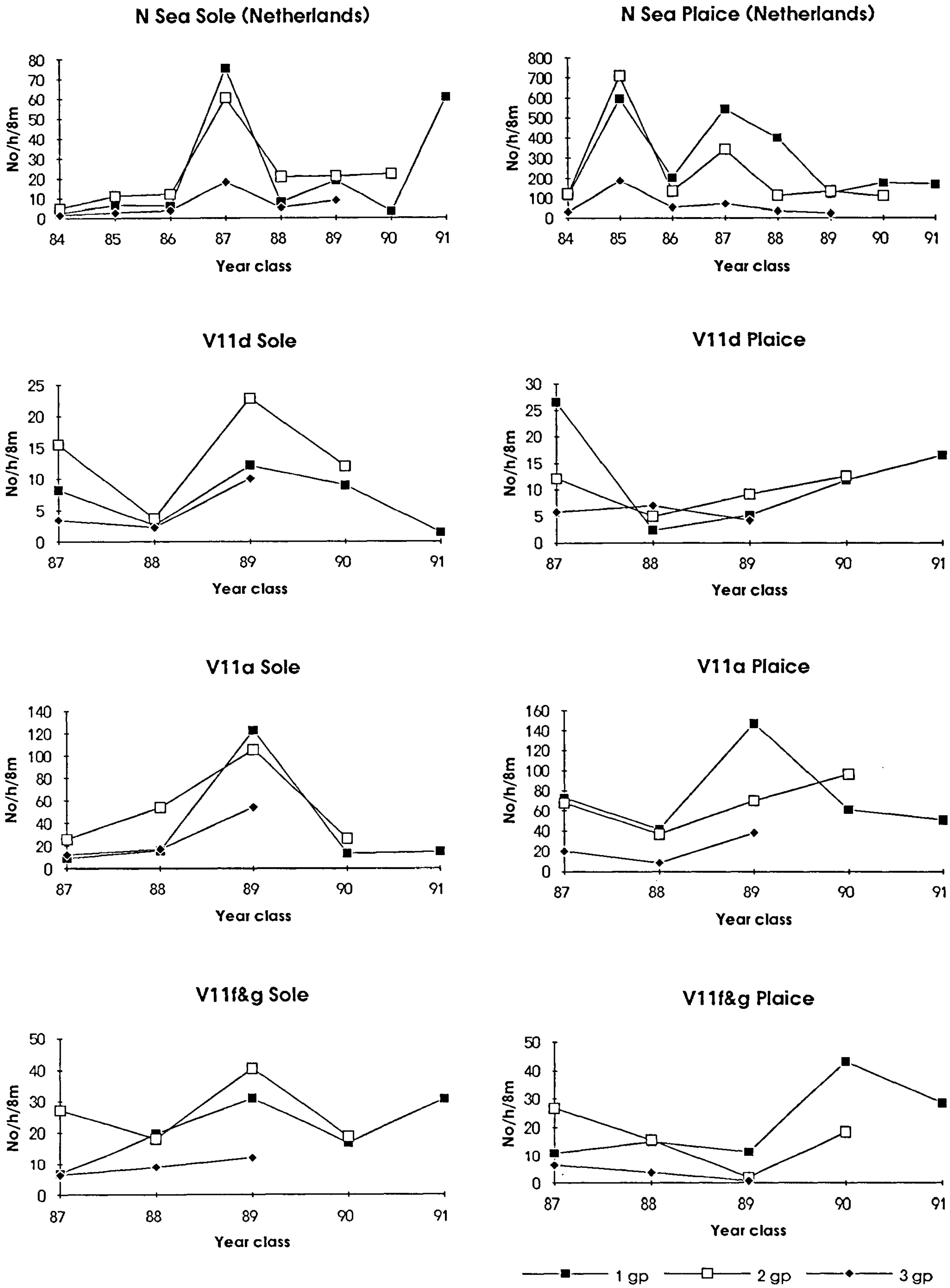


Figure 6.2 Relationship between different survey indices of abundance at age 1 and the VPA estimate of recruitment at age 1.

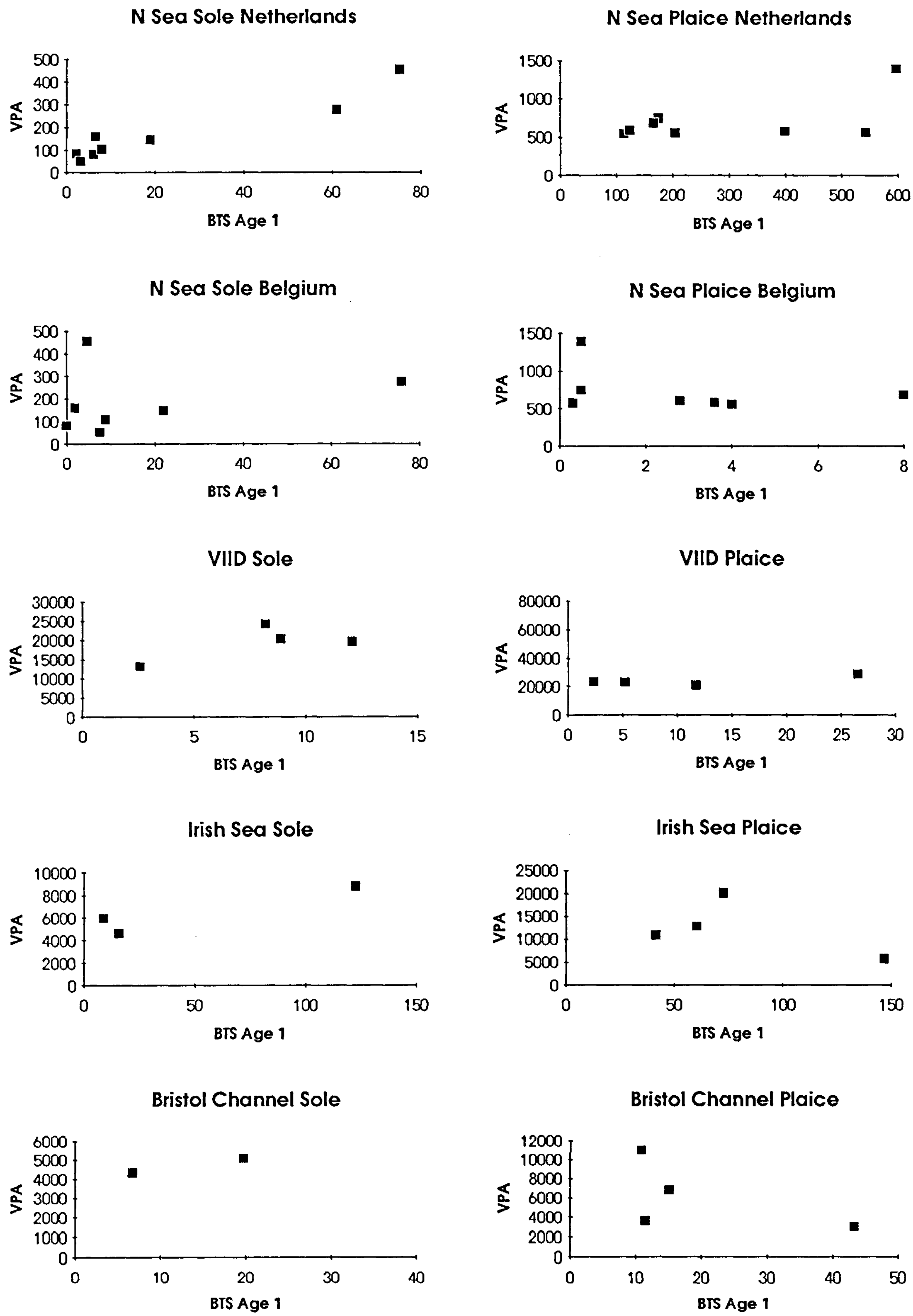
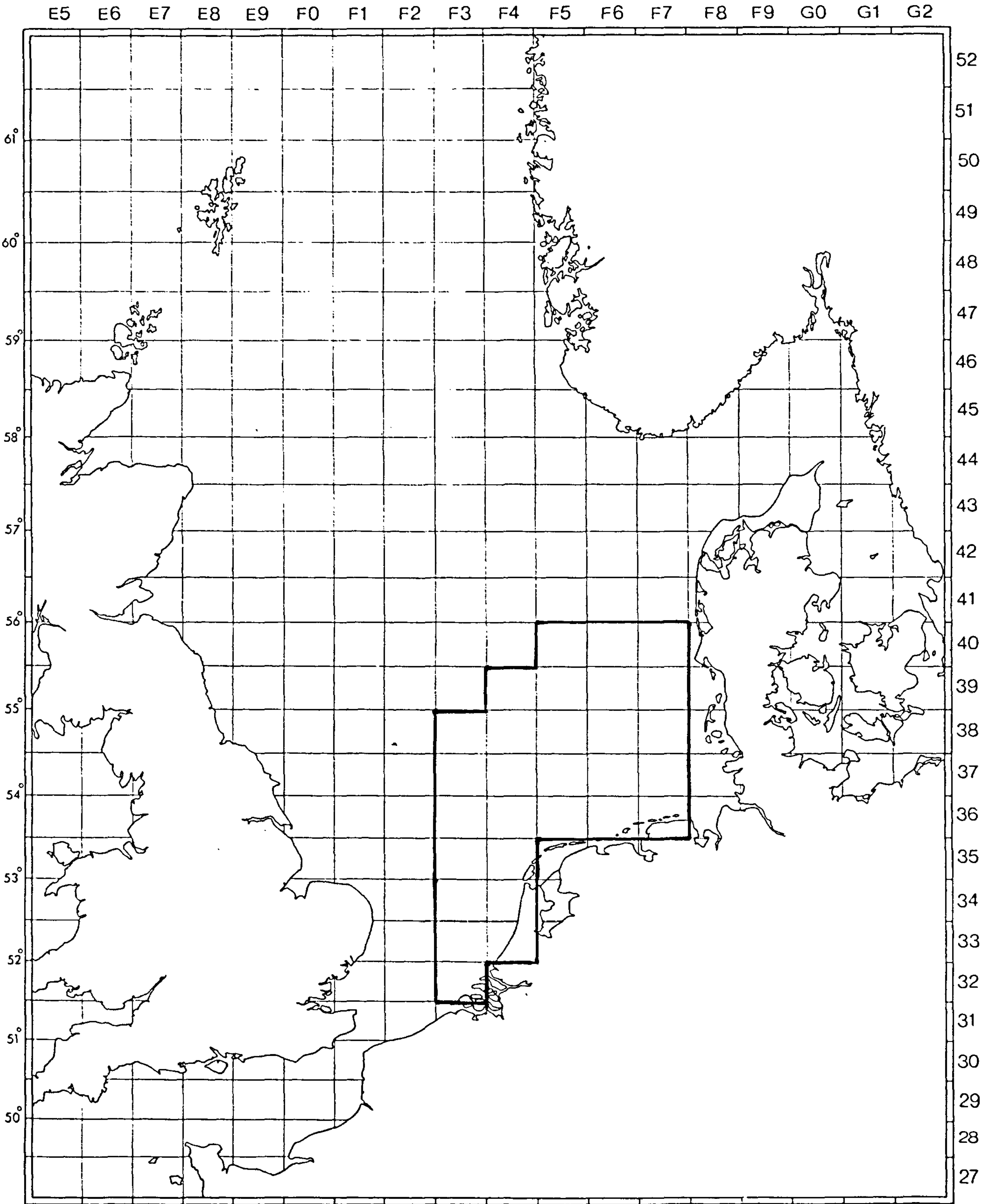
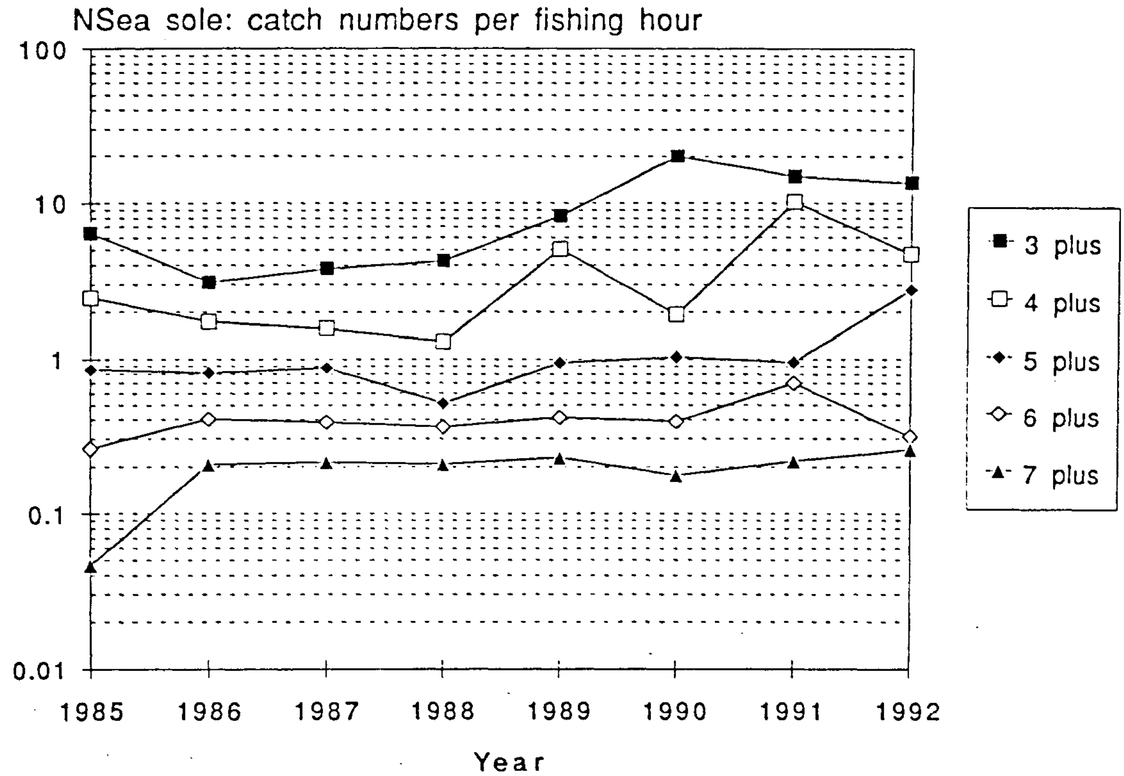


Figure 6.3 Standard set of rectangles used to calculate indices of abundance for sole and plaice in the surveys by the Netherlands.



a



b.

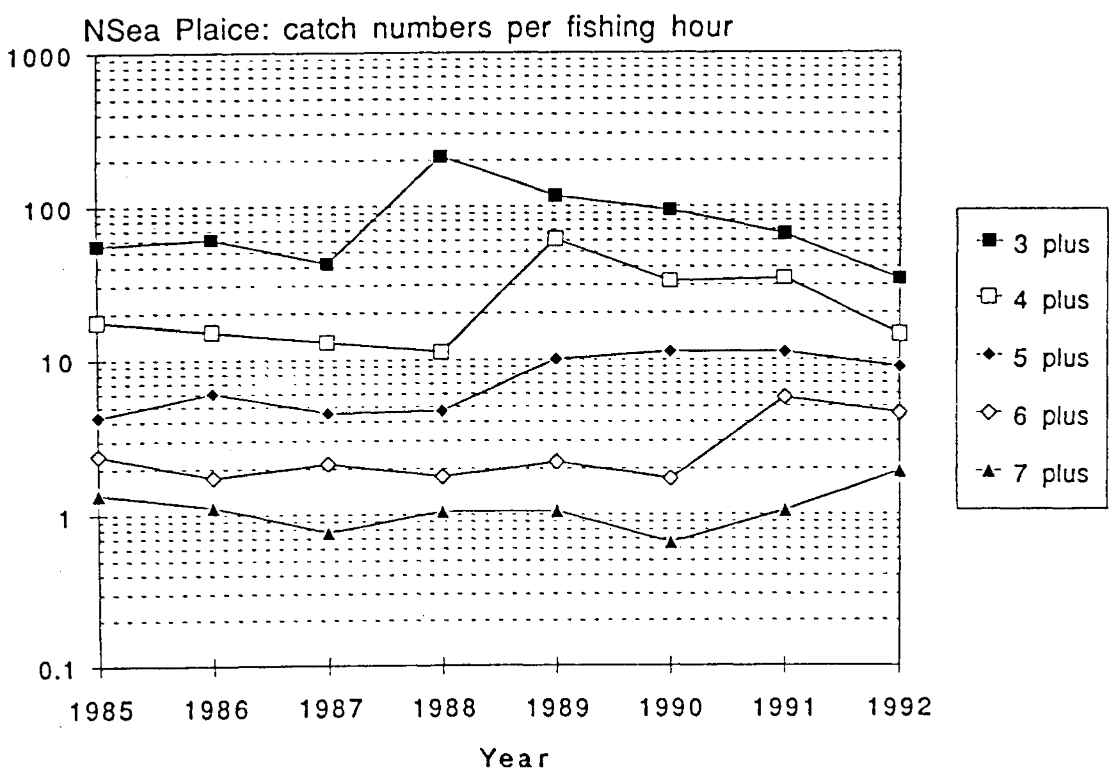


Figure 6.4 Revised Netherlands survey indices of abundance in the North Sea for (a) sole and (b) plaice.

Figure 6.5 Relationship between 1-2 group and 2-3 group indices from Netherlands surveys in the North Sea for sole and plaice.

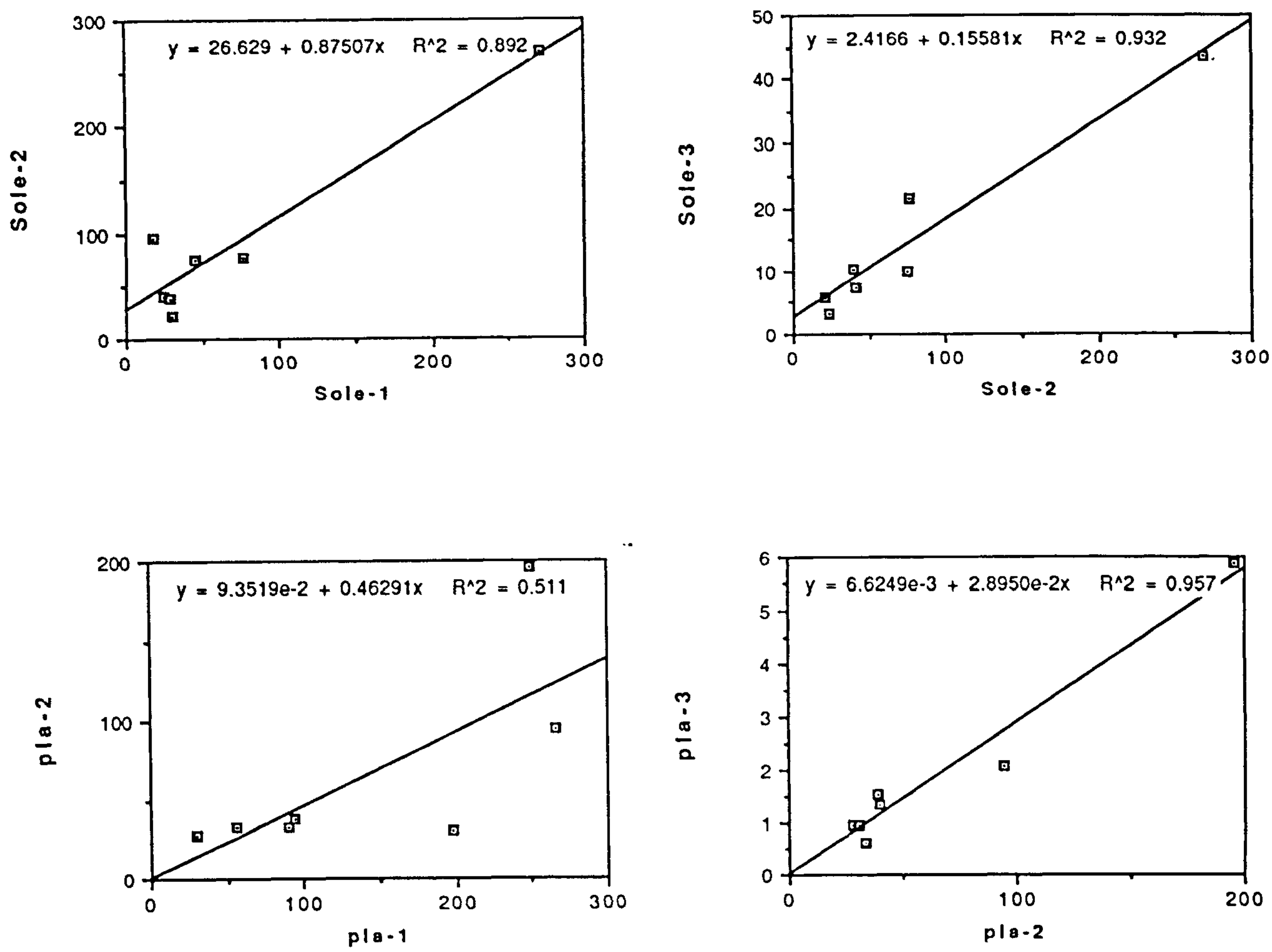
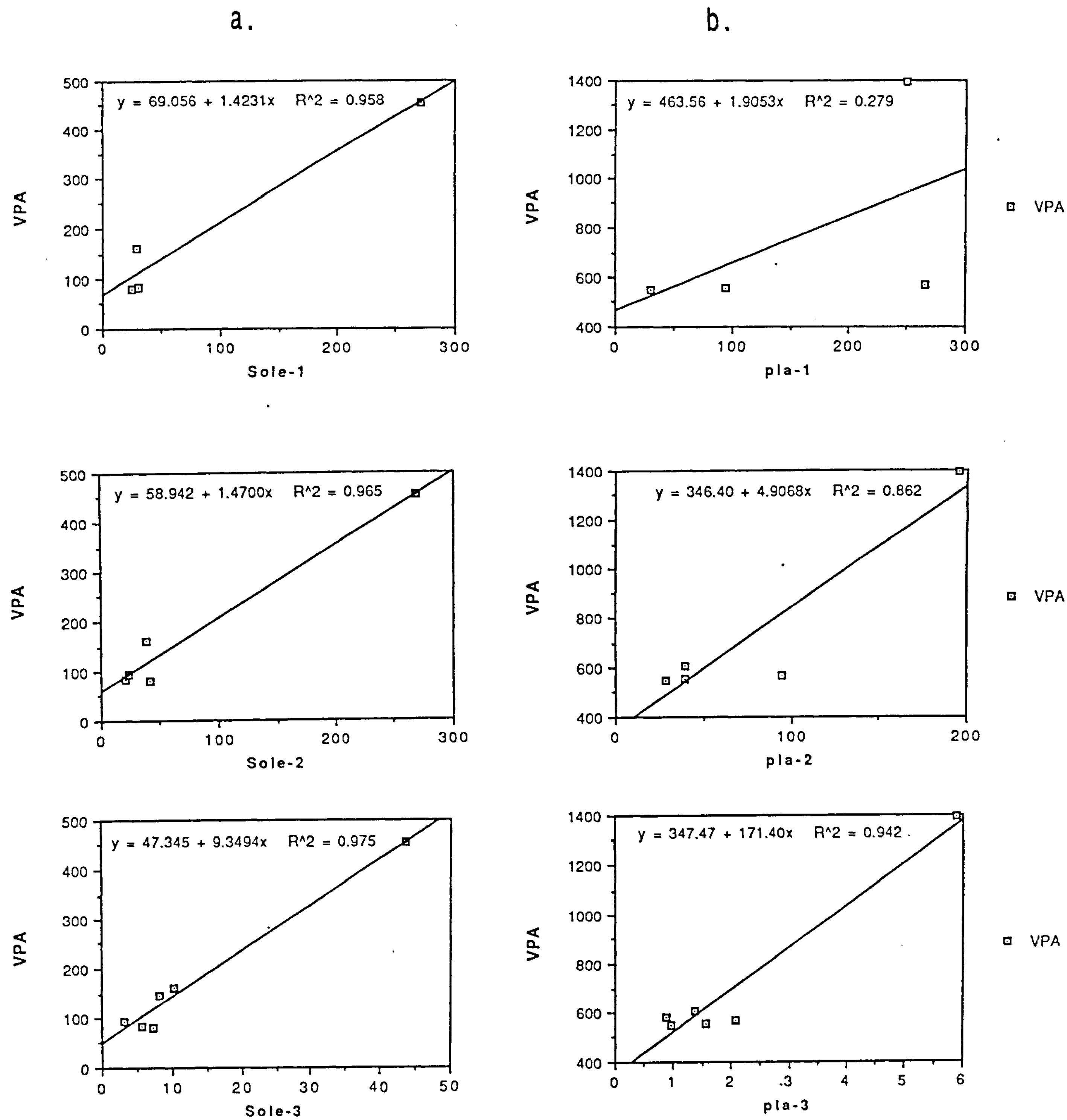


Figure 6.6 Relationship between Netherlands survey indices of abundance at age group 1, 2 and 3 and the VPA estimate of recruitment at age 1. a. Sole. b. Plaice.



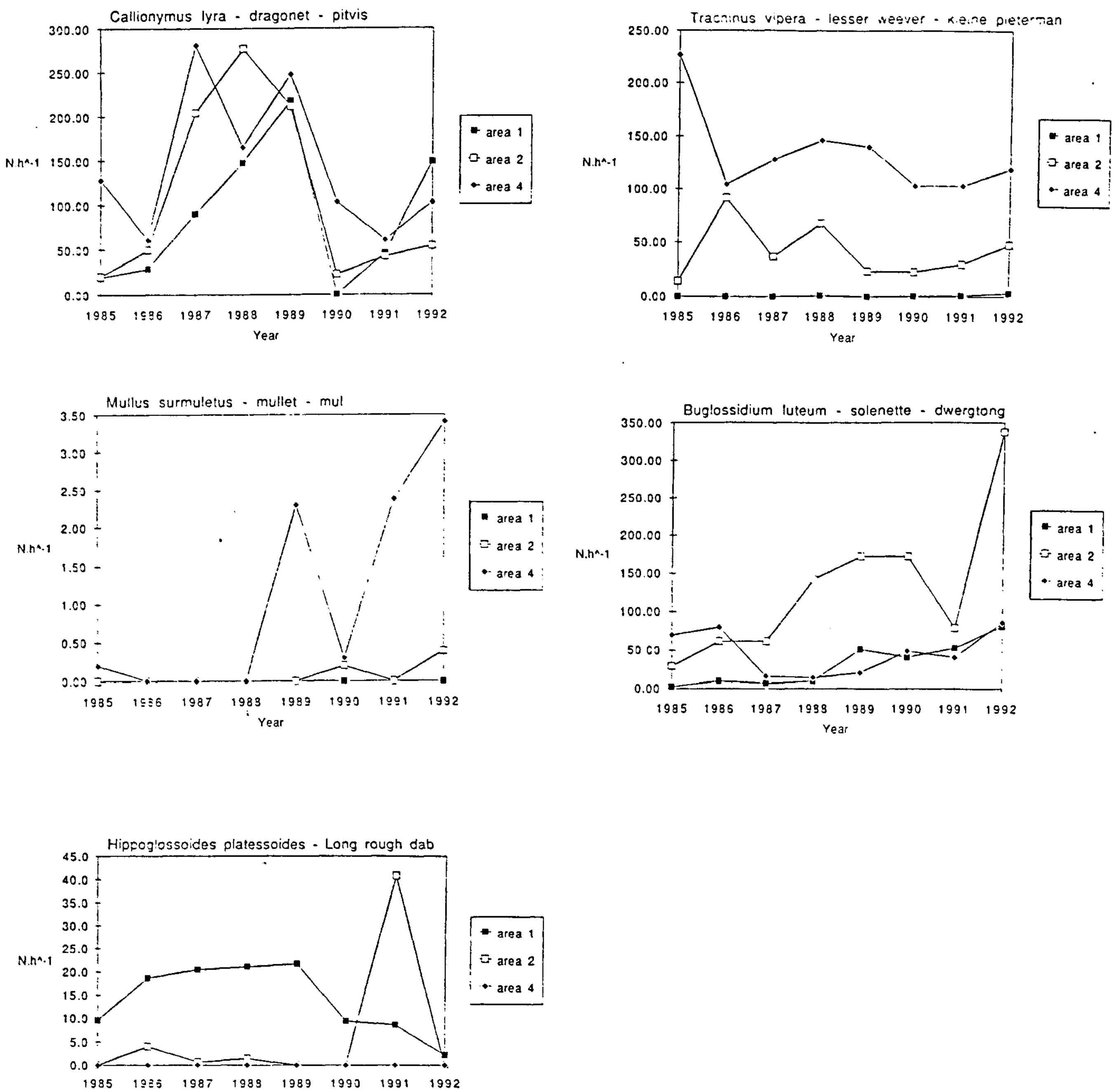


Figure 7.1 Trends in abundance of selected fish species from three areas in the North Sea.