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Preliminary results from echo-integrations in the Baltic 1976 and 1977

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Abstract

Echo-integrations in the open Baltic in 1976 and 1977 permitted to calculate the quantity of herring and sprat in Regions 24-29. During a cruise in April-June herring was most abundant in Region 27, while sprat was abundant in Region 25 and 26. During another cruise in January-February herring was apparently to a great extent within the Swedish archipelago, while sprat was concentrated to Regions 28 and 29.

1. Introduction

Echo integrators have now become rather common within the ICES area. The method gives information on the quantitative distribution of fish which can be used in stock assessment work (MIDTTUN & NAKKEN 1971, JOHANESSON & LOSSE 1973 and many recent authors).

The significance of the estimations depends on a number of factors, namely the number of species, the concentration of fish, the vertical distribution. Very favourable conditions are found when there is only one species (or very few species, with a different pattern of distribution) and when vertical distribution does not vary too much. A small water body is also and advantage. Heavy concentrations in the form of dense shoals, fish close to the surface or to the bottom make estimations difficult, if not impossible.

The Baltic, with its few species and as a closed area, can be expected to present rather good conditions for this kind of research. The Baltic has only 3 pelagic species of acoustic and fishery importance, herring, sprat and young, partly also older cod. There are no other pelagic organisms known to disturb the picture. Aurelia does from time to time occur in quantities, but not during our investigations. The investigations started in the Baltic in 1975 (LINDQUIST & GULLMAN 1975) and continued in a larger scale with cruises in 1976 and 1977. The preliminary results from these latter years are presented here. The aim has been to investigate the conditions for future work in this field and the main interest has been to get a horizontal quantitative distribution and absolute figures of herring and sprat in ton.

The authors are indebted to Mr. I. Røttingen, from the Institute of Marine Research, Bergen, who participated in the cruise in 1977 and made many valuable suggestions. The conclusions drawn in this paper are, however, in the sole responsability of the present authors.

2. Methods

The investigations were carried out in the Baltic with the R/V "Argos". Two cruises were made, one from the end of April to June 1976 and another from January to February 1977. The research vessel is equipped with a SIMRAD echosounder Ek 120 kHz and an integrator QM Mk II + MA. The settings used are given in Annex 1. Pelagic trawl fishery was carried out in order to identify the echoes. During both cruises a number of chartered commercial fishing vessels participated in the investigations. Their task was to echosound and to trawl. The results from this work were used for preparing maps of distribution of echotraces and for identification of species (for the cruise 1976 see LINDQUIST et. al. 1976).

R/V "Argos" kept a speed of 10 knots, whenever possible.

When working up the material the records from the echosounder were compared with the integrator curves and "false" echoes from density layers, steep bottom configurations and external noise were deducted from each section of integrated distance. The integrator value in mm, thus corrected, was divided by the sailed distance and the figure was put in on the course line and drawn on special charts.

For calculations of quantities the integrator values were attributed to either herring, sprat or cod. This was carried out with the guidance from the results of trawling or just from inspecting the echo records and in the best case from a combination of both.

After that, a mean value in mm/n.m. per species was calculated for each of the ICES Statistical squares (or parts of it, when coverage was too bad). This value is proportional to the mean density of fish, and was then multiplied by a conversion constant (C) in order to get absolute fish densities in ton/n.m.^{2}. The total amount of fish in a statistical square (or in a part of it) was finally calculated by multiplying with the area, c.f. maps on figs. 1-4.

The C value was calculated from soundings where single fish were recorded on the echopaper so that they could be counted. The number of fish was counted in a sequence of sounded distances and was transformed to the number of fish/n.m.^{2}. Accordingly, the mm-recordings from the integrator where divided by the distance. C was then found as the slope of the regression line from number of fish/n.m.^{2} and mm/n.m. C is expressed as number of fish/n.m.^{2} and mm. With knowledge of species and fish size (from trawling) a value of ton fish/n.m.^{2} was calculated.

There were several problems with these calculations:

1. The gain setting of the echorecorder did not correspond to the threshold value of the integrator, i.e. sometimes fish were integrated which were not visible on the echopaper.

2. More than one fish at the same distance from the transducer can be recorded as one fish but integrated according to its total echo.

3. There is no information on species and fish size when traces were scattered. Trawling was made on concentrated fish echoes and only occasionally in the neighbourhood of areas where fish was dispersed.

These difficulties resulted in that, for practical reasons, C was calculated only for herring and sprat combined, and for cod.

After several trials C was caluclated by a compilation of the data from 1976 (which were more abundant): all sections (i.e. distances sailed) in which individual fish could be counted (number of fish/n.m.^{2}) where put into a coordinate system against mm/n.m. The coordinate system was then divided into sectors, representing mean slopes of 0, 20 000, 40 000, 60 000 ..... etc fish/n.m.^{2} and mm. Unreasonable values were excluded from the first two sectors and for the rest a mean value was calculated (119 167 fish/n.m.^{2} and mm). From the trawl catches the mean size of herring (18/kg) and sprat (78/kg), was calculated. Finally a mean fish size (57/kg) was weighted against (a) the proportion herring to sprat in the areas investigated and (b) the number of sections within each of the investigated areas. By these calculations a C was obtained of 2.09 ton/n.m.^{2} and mm (119 167/57 x 1 000).

3. Distribution and Quantities

3.1. Distribution. Cruise 1976 (end April-beginning June):

Herring was found around Gotland and in great quantities off the Swedish coast in Region 27. Herring was also present to the west and to the north of Bornholm.

Sprat was most abundant in Region 26 and to the east of Bornholm.

Cruise 1977 (January-February):

Herring was found to the west and north of Bornholm and east Gotland. From investigations carried out at the same time in the archipelago of Sweden, it is known that herring occurred there in quantities (BERGSTRÖM, unpublished). An attempt was made to calculate the quantity in one place (near Askö, ANEER et.al. in prep.).

Sprat: moderate to good quantities were found east of Gotland and in the mouth of the Gulf of Finland.

3.2. Quantities

Some of the difficulties with the method have been mentioned above. It shall also be borne in mind that the transducer was mounted on the hull 4 m below the water line. This means that some 7 m are not covered by the echosounder. Close to the Swedish coast and in the archipelago there are great depth variations which permit only a thin midwater layer to become integrated. The influence of diurnal migrations was apparent in the cruise of 1976 (LINDQUIST et. al. 1976) but it is not known how much is cut off by the uppermost 7 m. In the cruise of 1977 diurnal migration was of less or no importance. The fish then kept to the depth of abt 50 m where the temperature increased.

The quantities of cod were negligible and the results will be treated in the final publication.

For herring and sprat the same C-value was used (as explained above). Any changes of C in the light of future investigations will result in a common factor for all figures.

The total quantities found are given in figs. 1-4 and in the following table, showing that in 1976 the Region 27 was very important for herring (47 % of the recorded total).

On the other hand for sprat Regions 25 and 26 were most important. In 1976 the herring showed no pronounced preference for any region (with the notable exception of the Swedish skerries, not covered by this survey). For sprat Regions 28 and 29 were important (winter concentrations).

Tab. 1. Observed quantities of herring and sprat in ton (regions are not covered completely)

Herring	24	25	26	27	28	29	Total observed	Total area $n.m.^2$
1976	7 700	88 200	1 300	58 200	14 100	25 600	120 000	29 326
1977	-	16 700	2 400	9 100	11 700	10 200	90 100	22 944
Sprat								
1976	500	47 000	30 300	2 100	10 700	6 600	97 200	29 326
1977	-	12 300	10 000	8 700	39 800	37 800	108 600	22 944

If we calculate a mean fish density for the covered areas and multiply this with the area of the Baltic proper (60 988 $n.m.^2$) we get a total of:

	Herring	Sprat
1976	250 000 tons	202 000 tons
1977	133 000 tons	289 000 tons

The results do not seem to be unreasonable, although the figures appears to be definitely too low (c.f. document P:3 to this Statutory meeting).

3. There is no information on species and fish size when traces were scattered. Trawling was made on concentrated fish echoes and only occasionally in the neighbourhood of areas where fish was dispersed.

These difficulties resulted in that, for practical reasons, C was calculated only for herring and sprat combined, and for cod.

After several trials C was caluclated by a compilation of the data from 1976 (which were more abundant): all sections (i.e. distances sailed) in which individual fish could be counted (number of fish/n.m.^{2}) where put into a coordinate system against mm/n.m. The coordinate system was then divided into sectors, representing mean slopes of 0, 20 000, 40 000, 60 000 ..... etc fish/n.m.^{2} and mm. Unreasonable values were excluded from the first two sectors and for the rest a mean value was calculated (119 167 fish/n.m.^{2} and mm). From the trawl catches the mean size of herring (18/kg) and sprat (78/kg), was calculated. Finally a mean fish size (57/kg) was weighted against (a) the proportion herring to sprat in the areas investigated and (b) the number of sections within each of the investigated areas. By these calculations a C was obtained of 2.09 ton/n.m.^{2} and mm (119 167/57 x 1 000).

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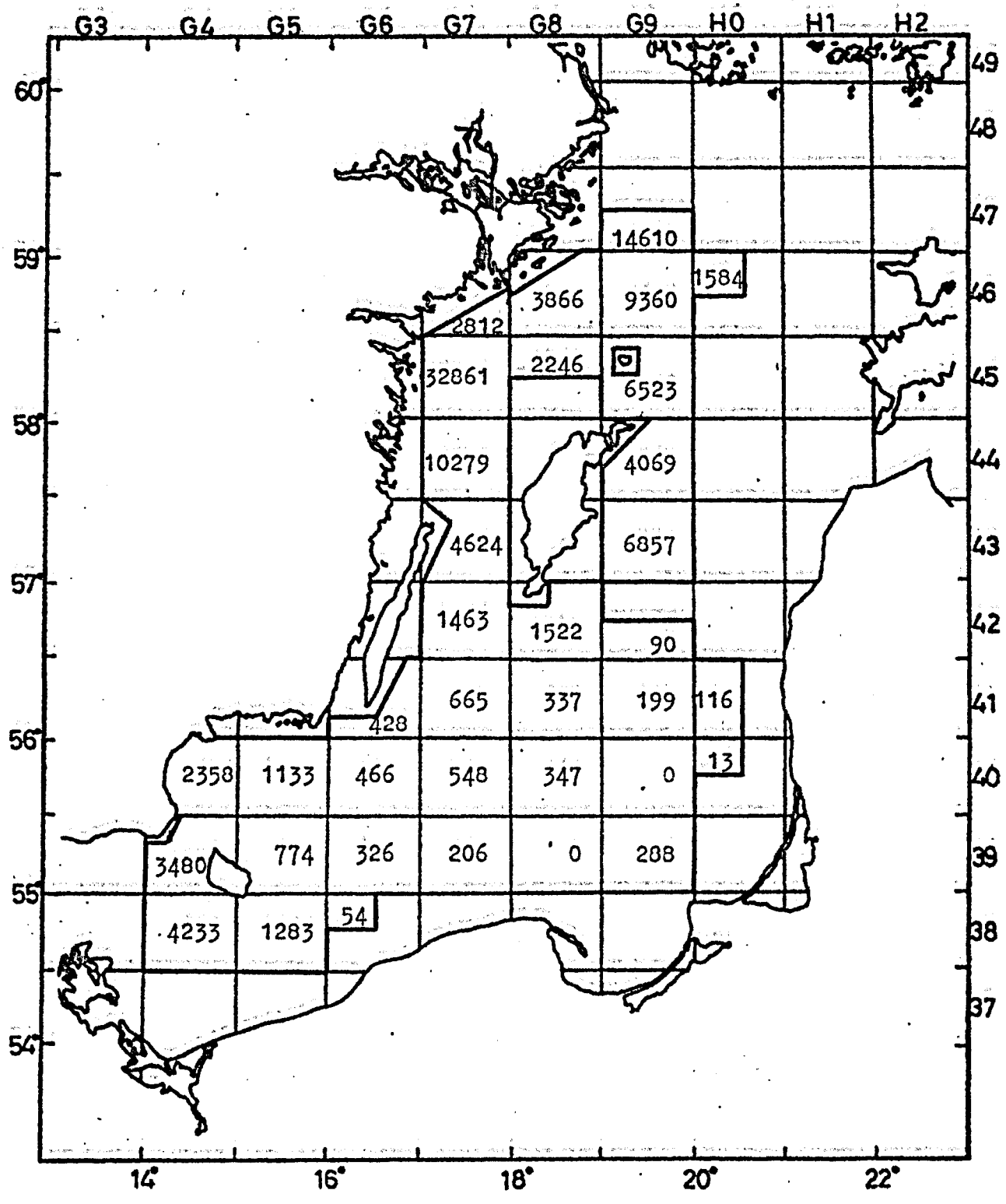

Fig. 1. Herring, total quantity in ton, April-June 1976

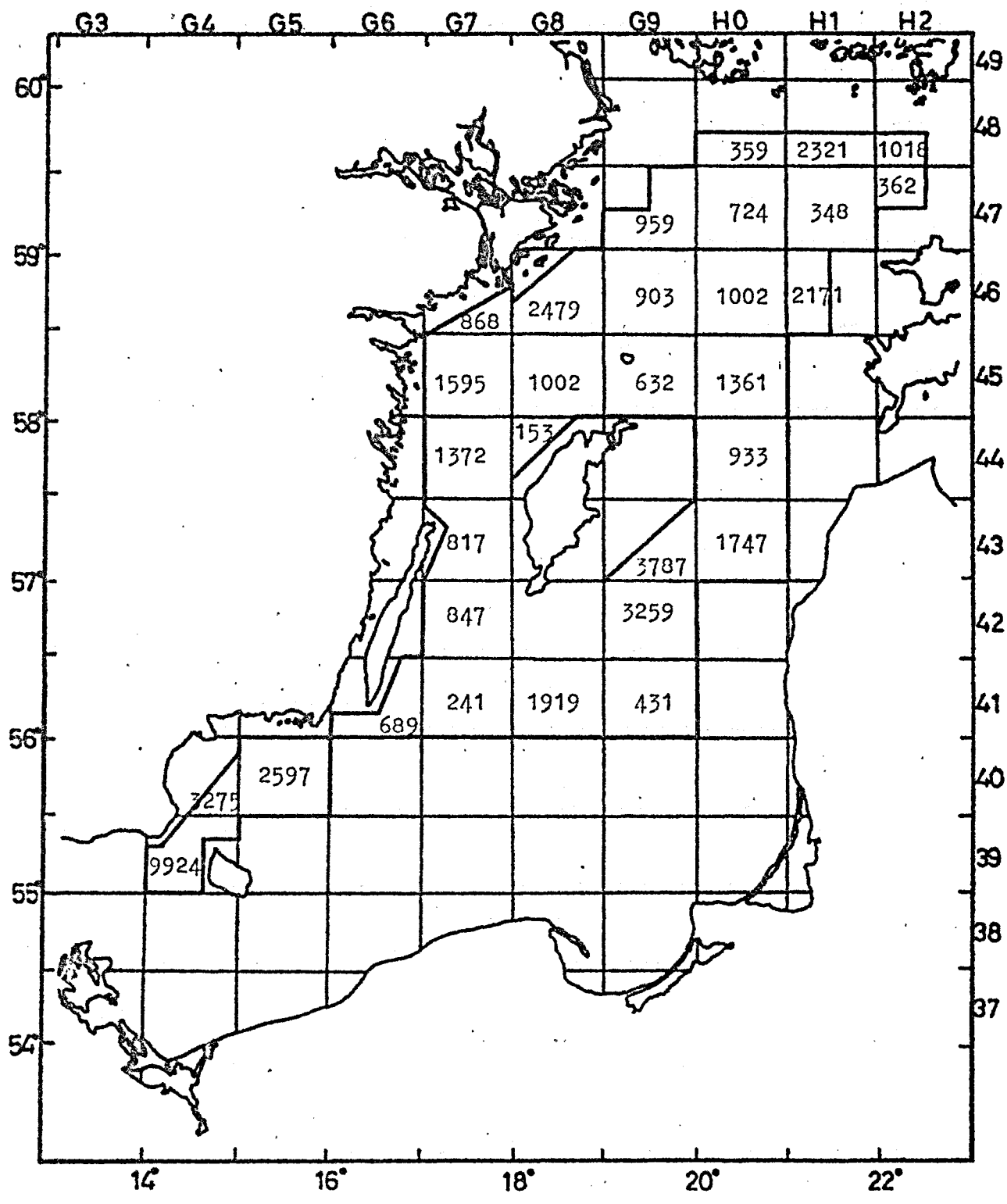

Fig. 2. Herring, total quantity in ton, January-February 1977

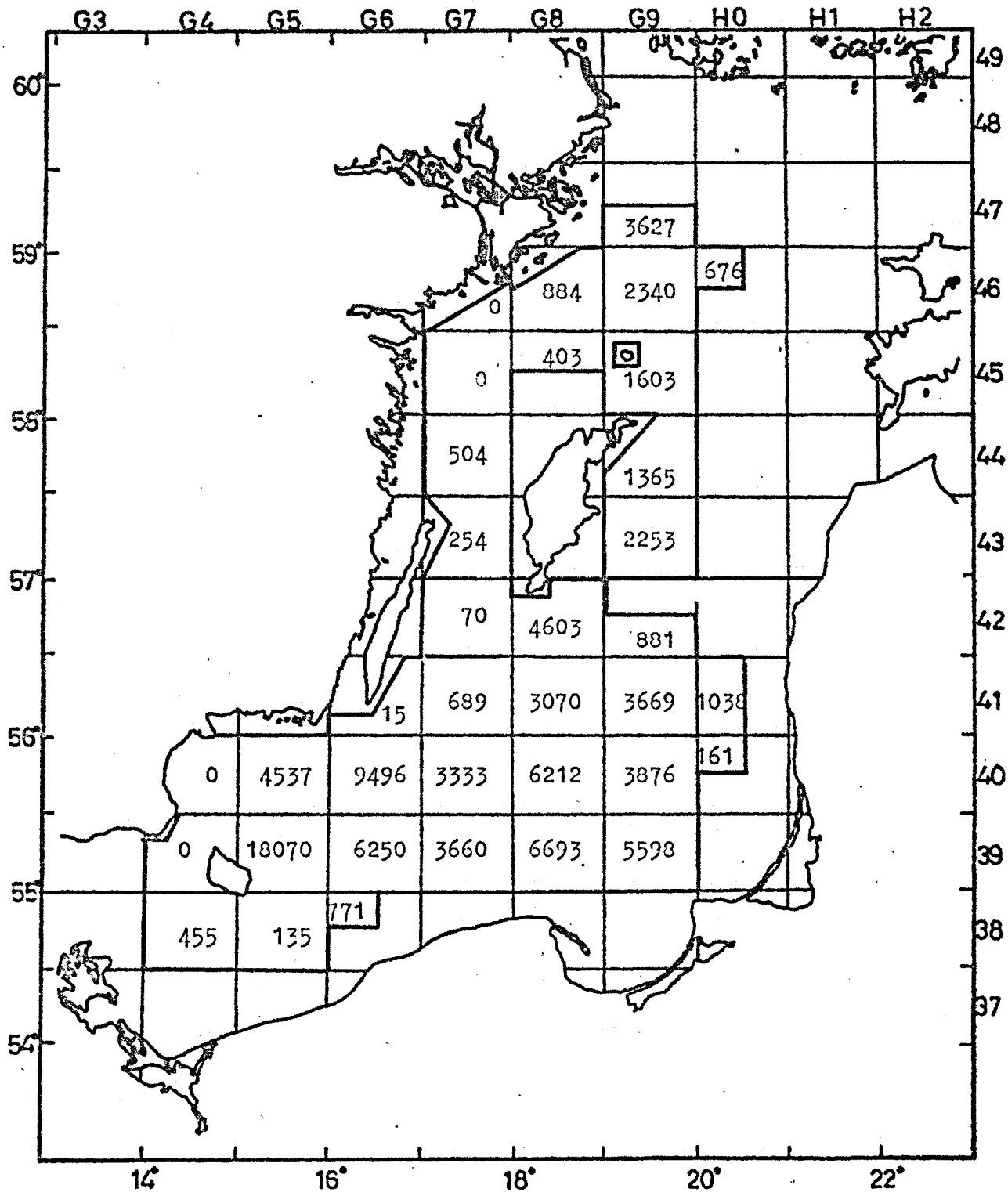

Fig. 3. Sprat, total quantity in ton, April-June 1976

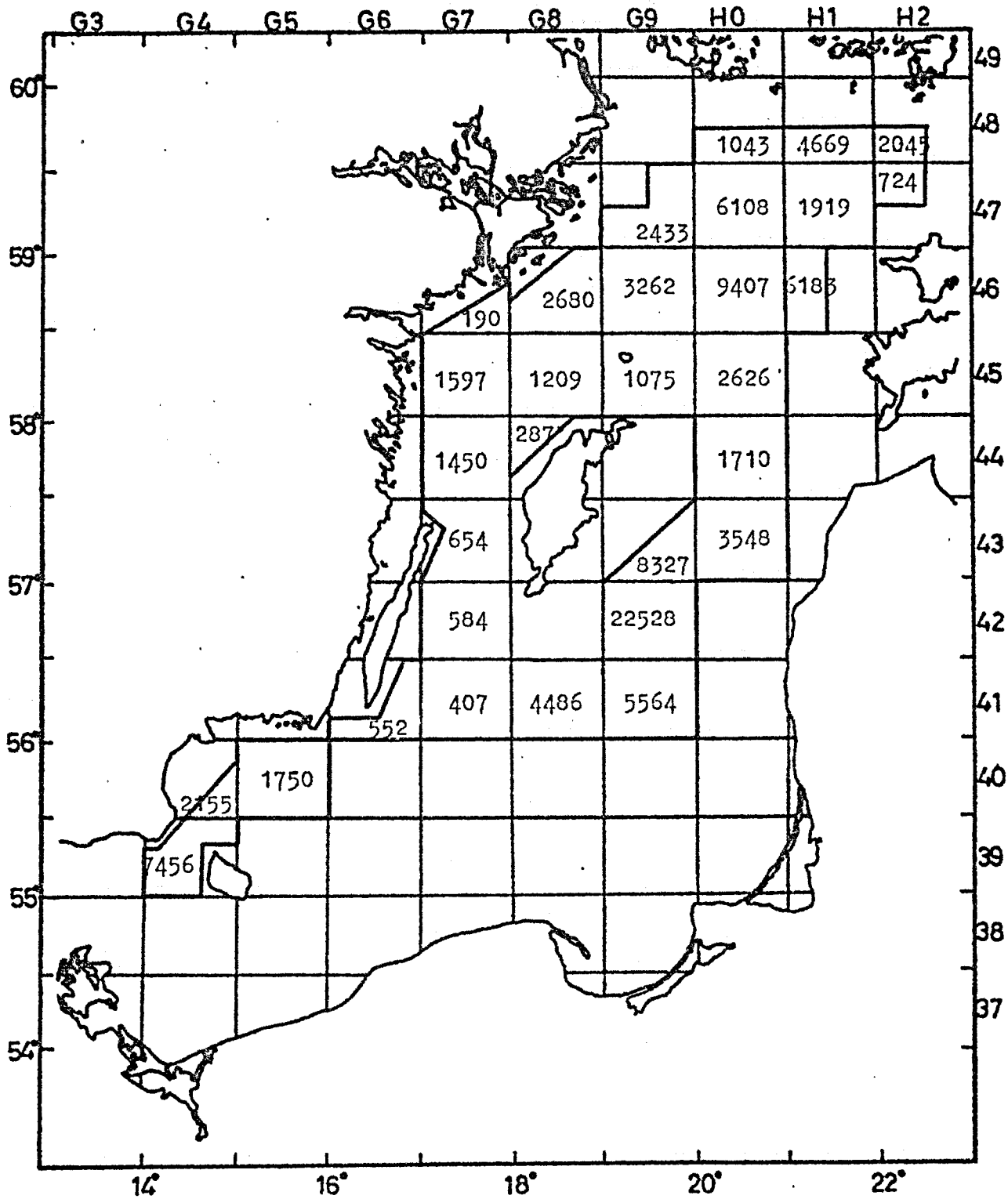

Fig. 4. Sprat, total quantity in ton, January-February 1977

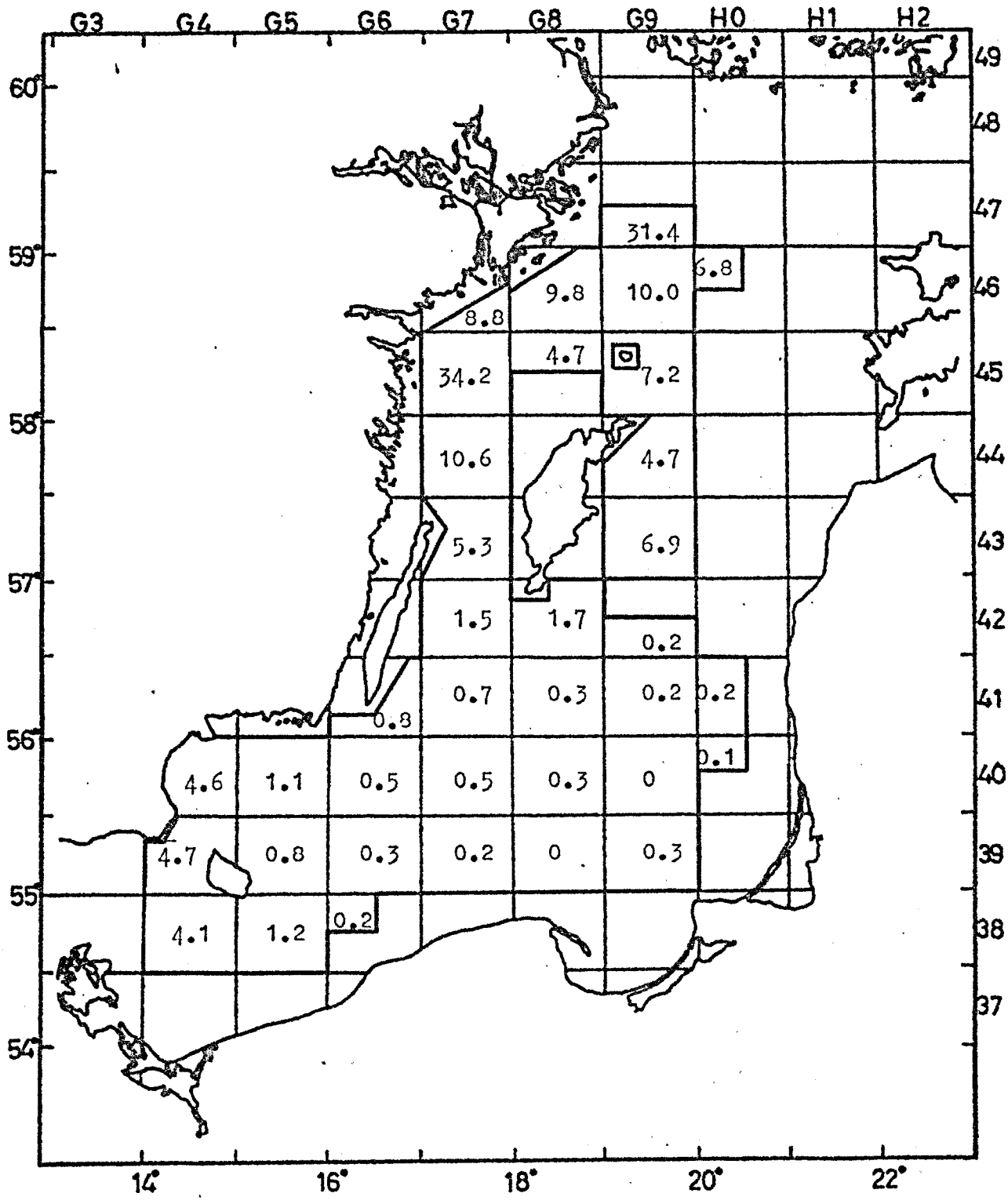

Fig. 5. Herring, ton/n.m.^{2} in statistical squares, April-June 1976

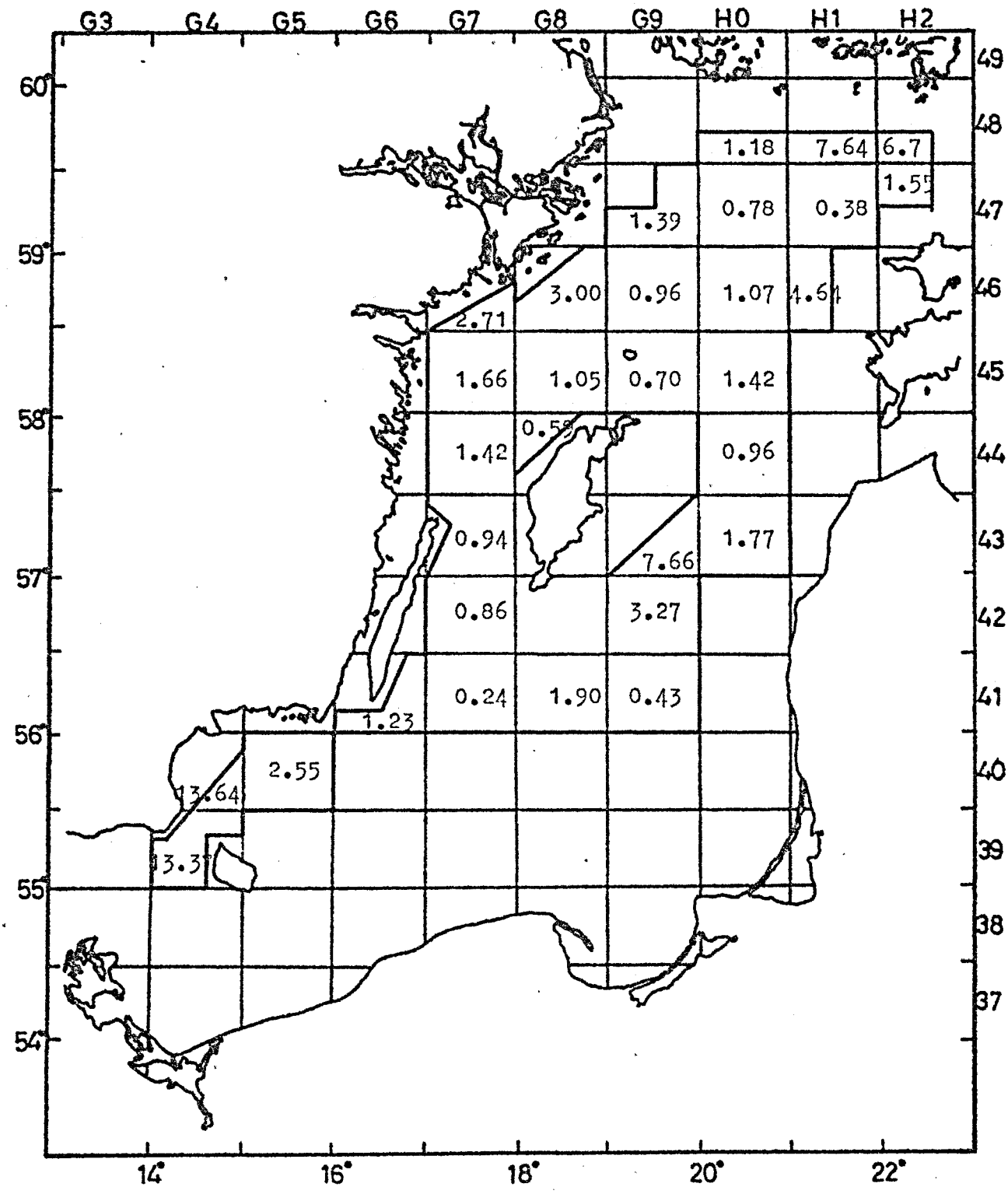

Fig. 6. Herring, ton/n.m.^{2} in statistical squares, January-February 1977

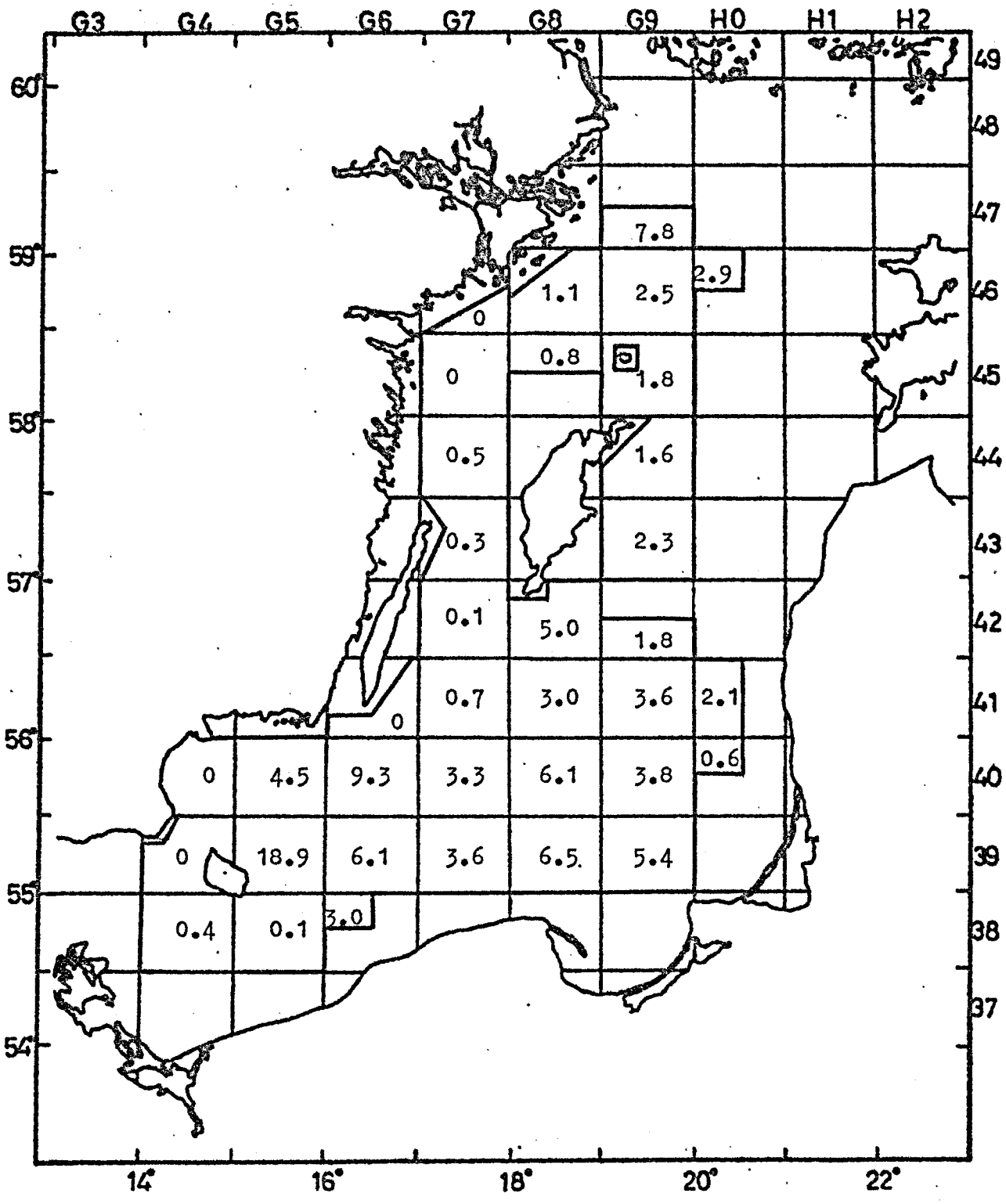

Fig. 7. Sprat, ton/n.m.^{2} in statistical squares, April-May 1976

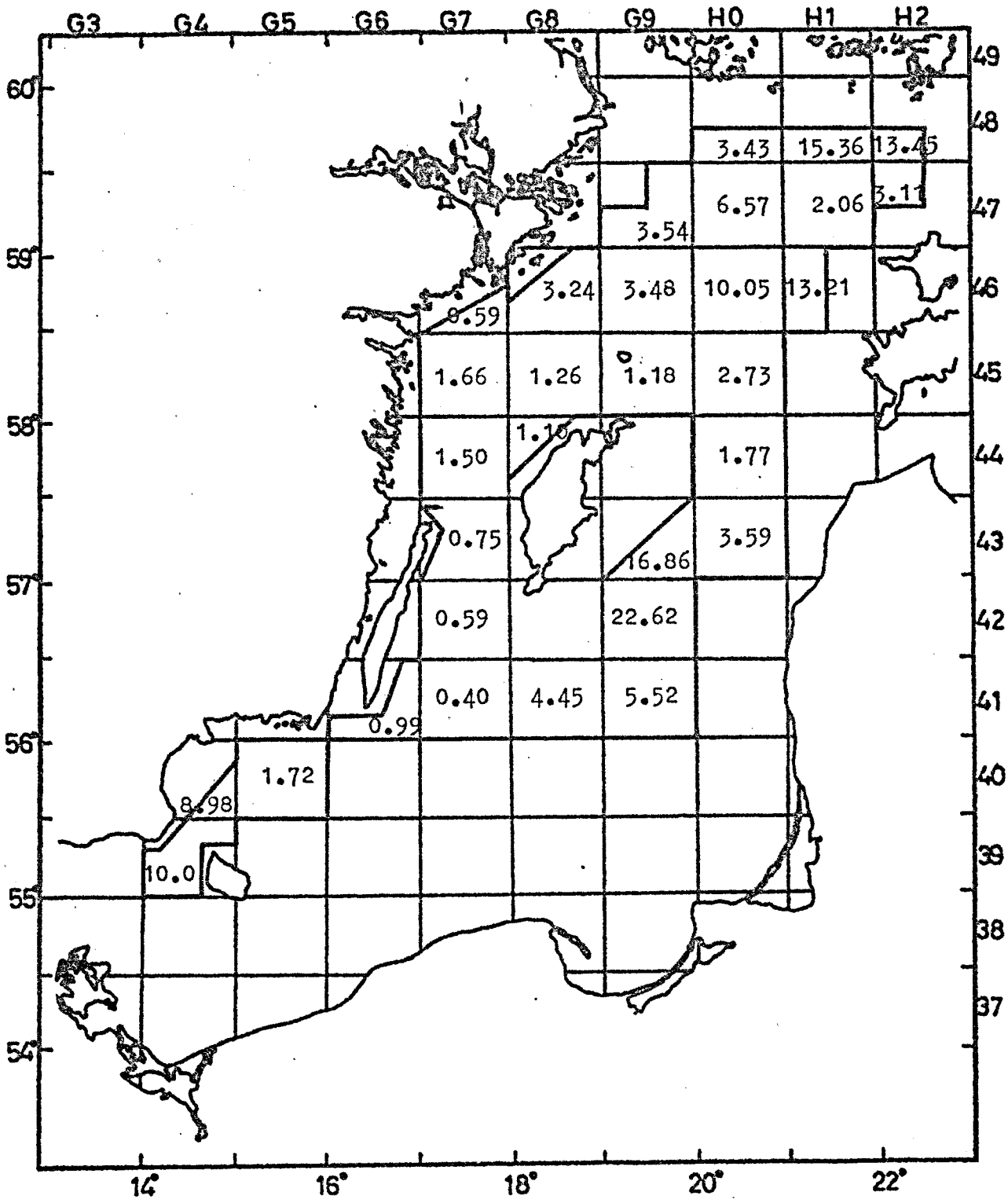

Fig. 8. Sprat, ton/n.m.^{2} in statistical squares, January-February 1977

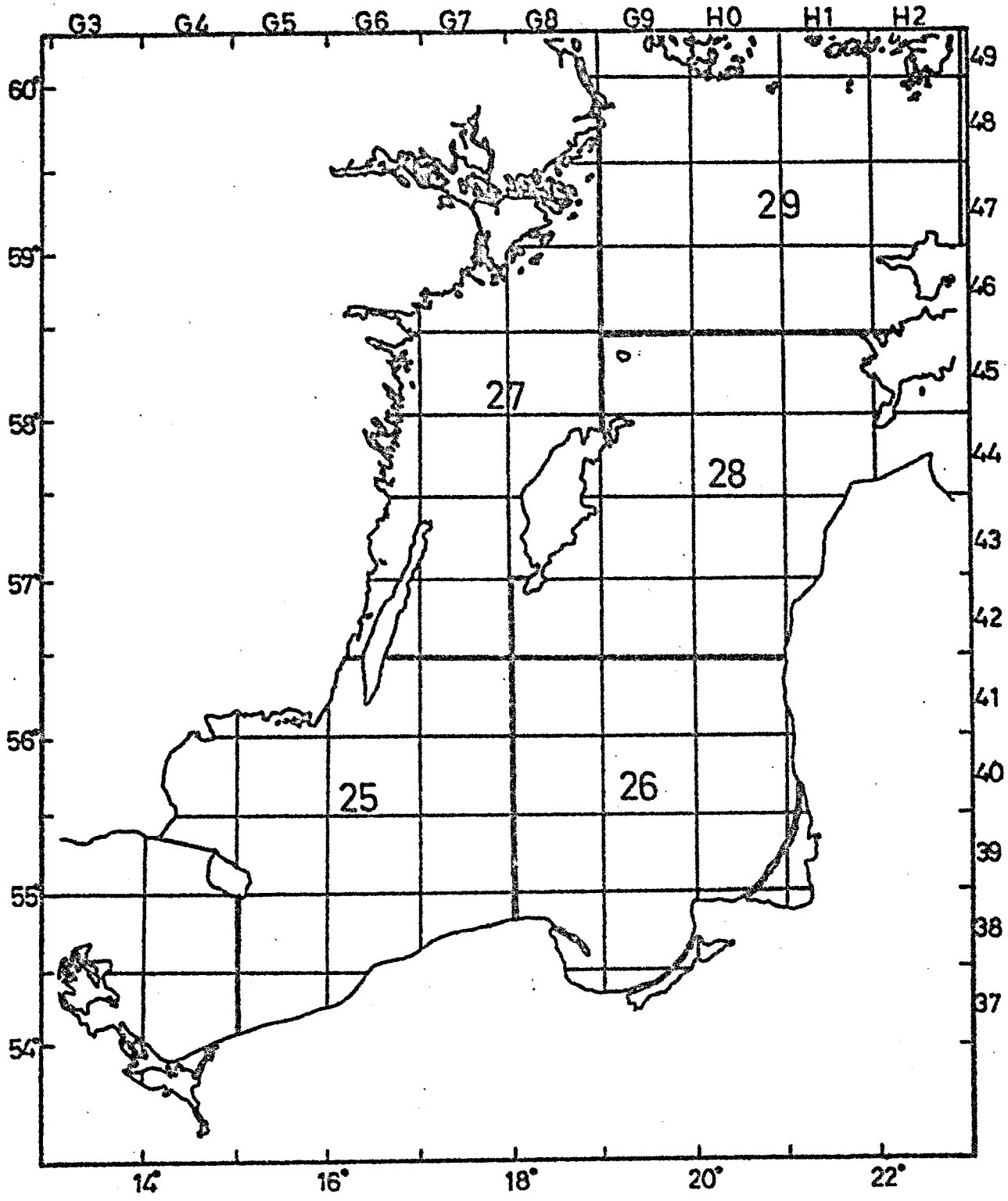

Fig. 9. ICES statistical regions