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Estimation of fish abundance by acoustics during the North Sea Young Herring Survey 1972

By

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ABSTRACT

The relative abundance of fish in the North Sea has been mapped on the basis of echo integrator readings obtained during surveys in February 1972. Variations between the readings of different frequency echo sounders, between day and night readings and between the two vessels were analysed. A comparison between the obtained pattern of distribution and the average trawl catches within statistical squares failed to demonstrate clear relationships. The emerging methodological problems are discussed.

INTRODUCTION

Acoustic surveys have proven to be useful for determining abundance and distribution of many pelagic fish species. Attempts have been made to apply this method for the studies of herring in the North Sea. As part of the North Sea Young Herring Survey in February 1971, the Norwegian research vessel "G.O. Sars" carried out an echo integrator survey of the central and southern North Sea (Anon. 1971). During the cruise several problems emerged. A marked difference existed between day and night integrator readings, direct identification of echo

recordings was problematic and the allocation of integrator values on each species according to composition of catches appeared unreliable.

The Working Group on North Sea Young Herring Surveys recommended that the acoustic surveys be continued, and in February 1972 two Norwegian research vessels took part in the international programme of investigation. The present report describes briefly the results of the cruises.

MATERIAL AND METHOD

The investigations took place during the period 9-21 February 1972 with the research vessels "G.O. Sars" and "Johan Hjort" and covered the North Sea south of 61°N and west of 7°E (Fig. 1). In the southern part, the vessels operated in the eastern and western area respectively, while both covered the northern part.

The distribution of the fish was mapped on the basis of continuous recording by calibrated echo sounders operating on frequencies 38 KHz, 120 KHz ("G.O. Sars") and 50 KHz ("Johan Hjort"). Echo integrators (Nakken and Vestnes 1970, Anon. 1972) were used to obtain measures of fish density and abundance. The integrators were on "G.O. Sars" connected to the 38 KHz sounder and on "Johan Hjort" to the 50 KHz, normally arranged to sum echoes received over every 5 nautical miles surveyed, as totals and separated in selected depth intervals. The transmitted power, the receiver gain etc. were varied according to water depth and fish density, but generally the following specifications apply: transmitter power 10 kW ("G.O. Sars"), 1 kW ("Johan Hjort"), pulse length 0.6 msec, receiver gain 0 dB, time varied gain 20 logR, integrator gain - 20 dB and threshold 1.

The recordings were identified and samples collected by bottom and midwater trawls; 32 hauls in all.

RESULTS AND DISCUSSION

A preliminary analysis of the values recorded by the integrators was made. To smoothen the data, five point moving averages were calculated, and on the basis of the plotted points isolines have been drawn (Fig. 1 and Fig. 2).

Fig. 1 shows relative fish abundance as indicated by integrator deflection obtained from the 38 KHz echo sounder of "G.O. Sars" in the southern North Sea. Similarly, Fig. 2 shows the result obtained from the 120 KHz sounder. The pattern of isolines by the two sounders are more or less the same, but much higher values were recorded by the 120 KHz sounder. The differences in recorded integrator values are believed to be associated with the size of the fish in the area. Trawl catches showed that herring with mean lengths of 16-19 cm together with whiting, some young haddock and sprat dominated in the area. Targets of this type contribute proportionally more to the integrator values recorded by the higher frequency sounder.

As in 1971, a wide difference in the day and night recordings of the integrator was noted. With a view to tracing the relation between the two sets of recordings the integrator values were examined in more detail. Within 9 statistical squares which were covered both during day and night the integrator values for 5 nautical miles were as follows:

Day	137	78	68	114	105	34	21	73	46
Night	407	215	43	220	122	57	45	92	79

On an average, the day recordings were only half of those obtained by night. The correlation coefficient between the two sets of values was 0.83. A linear regression line was fitted between day (D) and night (N) values. The equation was

$$D = 37.42 + 0.265\ N,$$

explaining 69% of the total variation in day values. Using

this relation, all recordings during the night time was converted into the corresponding day values. This conversion is applied in the figures.

The day-night difference is possibly explained by the ascent of fish from the near-bottom layer in the night. This layer is poorly covered by the sounders since echoes of fish close to the bottom can not be discriminated from the echo from the bottom and also because of the "dead zone" in the outer part of the sound beam.

The data collected by "Johan Hjort" are not amenable to direct comparison with those of "G.O. Sars" as the frequency of the sounders as well as the gain settings of the integrators etc. have been different in the two cases. A conversion was therefore established. Earlier observations by the two vessels within the same area, and the inspection of two sets of data, collected by the vessels in the present survey lead to an approximate relationship

$$\text{"G.O.S."} = 8.36\ \text{"J.H."} + 8.$$

On the basis of this equation the recordings of "Johan Hjort" were converted into equivalent values of "G.O. Sars". These values were plotted and isolines drawn (Fig. 3). The figure shows several patches of high fish abundance: on the Patch Bank, Fladen Ground, Egersund Bank and east of Newcastle. In these areas average deflections of about 200 mm were found indicating a total fish abundance about four times higher than that of most parts of the North Sea.

The distribution and abundance of fish as determined by the acoustic method can be compared to the results of the trawl survey carried out simultaneously by the ten research vessels (Postuma and Kuiter 1972). The average catch per hour trawling was calculated for each statistical square on the basis of catch reports from the following participating nations and vessels:

Denmark	"Dana"
Germany	"Anton Dohrn"
Great Britain	"Cirolana", "Explorer"
Netherlands	"Tridens"
Norway	"Johan Hjort", "G.O. Sars"
U.S.S.R.	"Vaida"

Fig. 4 gives the average catch in kilograms of all fish except flatfish and Fig. 5 gives catch of herring. Average catch of herring per statistical square is also reported, in numbers, by Postuma and Kuiter (1972).

In the northern North Sea few statistical squares were fished, but in the central and southern parts a good coverage exists. No clear relationship can be found between the catches and the integrator values. A direct comparison is, however, difficult since the trawl catches reflect the abundance of fish near the bottom, while the integrator values as used here measure abundance in the entire water column. This is demonstrated e.g. in square D 09, off Newcastle, where the highest integrator values were obtained. As evident from catches by mid-water trawl, the high values were caused by sprat occurring in the upper water layers, while the bottom trawl catches included very few sprat.

Attempts were made to assign parts of the integrator readings to the different species according to the composition of the catches and by examination of the echo sounder recordings. This procedure has been applied in similar studies in other areas, e.g. capelin in the Barents Sea and sprat in the Norwegian fjords (Dragesund, Gjøsæter and Monstad 1972, Bakken 1971 and 1972). In these cases, the fish species of interest has fully dominated the catches. Consequently the assigning of integrator values has caused few problems. In the North Sea, however, herring often constitute a minor part of the trawl catch and contribute little to the total integrator value. This is especially the case during winter when the herring have a scattered distribution. At present, the determination of herring abundance in the North Sea from

acoustic surveys, therfore, seems to be complicated, at least during winter.

Similar difficulties were encountered during the cruise of "G.O. Sars" 1-12 February 1971. Comparisons between integrator values and the average number of herring caught per square during the young herring survey failed to produce a significant correlation (Anon. 1971). The relative fish abundance in the southern North Sea in February 1971 is shown on Fig. 6. (The units do not correspond to those used in 1972.) High fish abundances were found in the Devils Hole area (E 12 - F 13) and southwest and south of the Dogger Bank. In the latter area herring made the main contribution to the integrator values, while young haddock and Norway pout were dominating further north. A general resemblance is found between the patterns of fish distribution in 1971 and 1972.

Recording paper of echo sounders in use by vessels participating in the young herring survey in 1972 has been examined in order to determine a possible correlation between recordings on the one side and size of catches and abundance estimates on the other. The recordings, however, did not lend themselves to quantitative studies: some were of poor technical quality, the make, settings etc. of the sounders varied, and only parts of the area was covered. Consequently, no correlation analyses could be carried out, but the general impression is that a poor relationship excists between recordings and catch, except when larger amounts of herring are recorded. Similar results were found by Dutch workers during their survey in 1971 (Anon. 1971).

CONCLUDING REMARKS

The acoustic surveys in 1971 and 1972 have shown that future use of echo sounders and echo integrators as a means of determining the abundance of herring in the North Sea requires consideration of certain methodological problems. First of

all, better and more reliable procedures should be found whereby the portion of the measured total fish abundance relating to herring can be calculated. This might be done either by improving sampling or by refinement of the electronic technique. In addition, consideration should be given to the time of the year chosen for the acoustic survey. The acoustic method is favoured when a true pelagic distribution of the herring is found as in the spring. In the future, investigations have to be focused on these problems.

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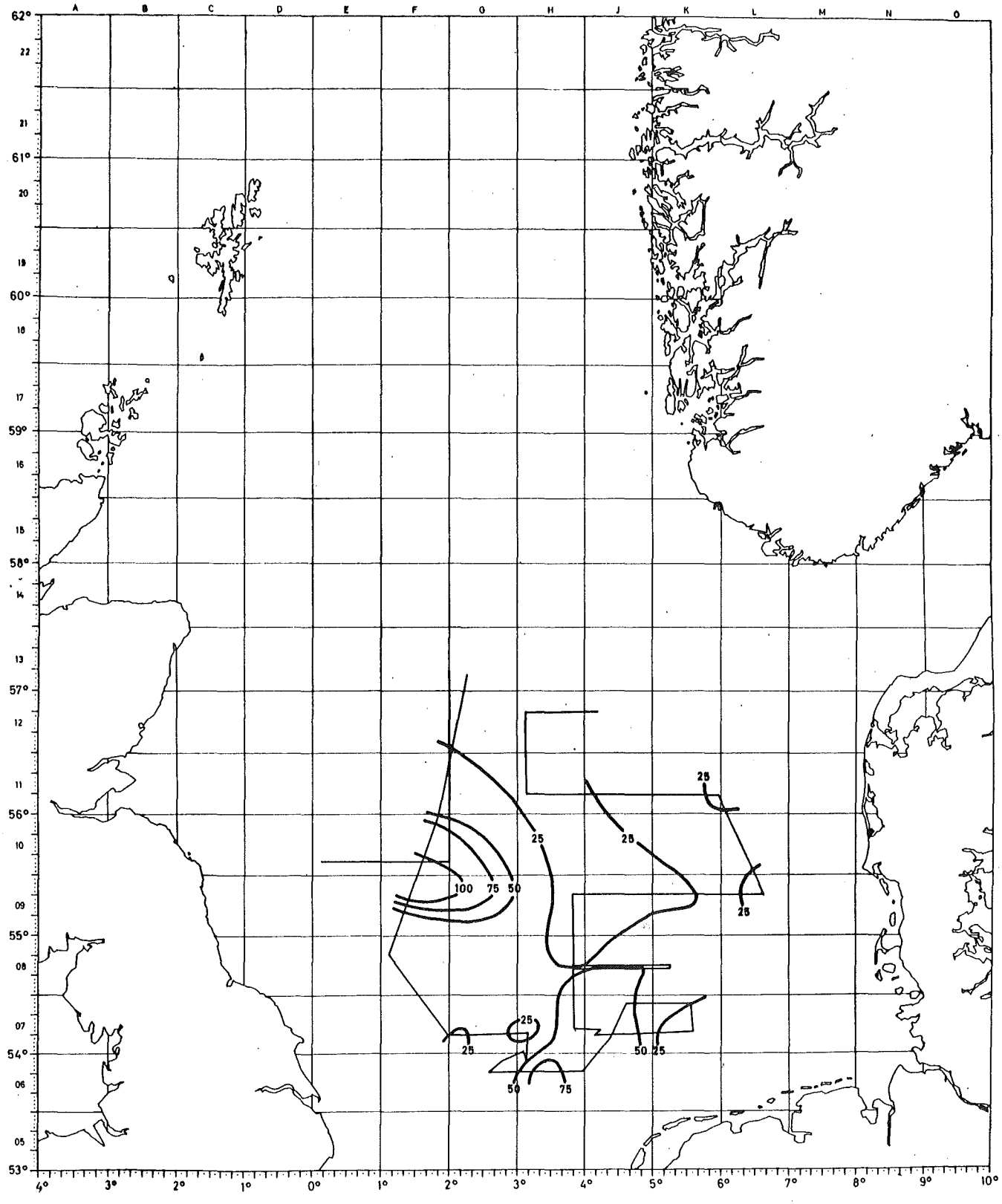

Fig. 1. Relative fish abundance, February 1972. Isolines indicate deflection (in mm) of echo integrator connected to a 38 KHz sounder.

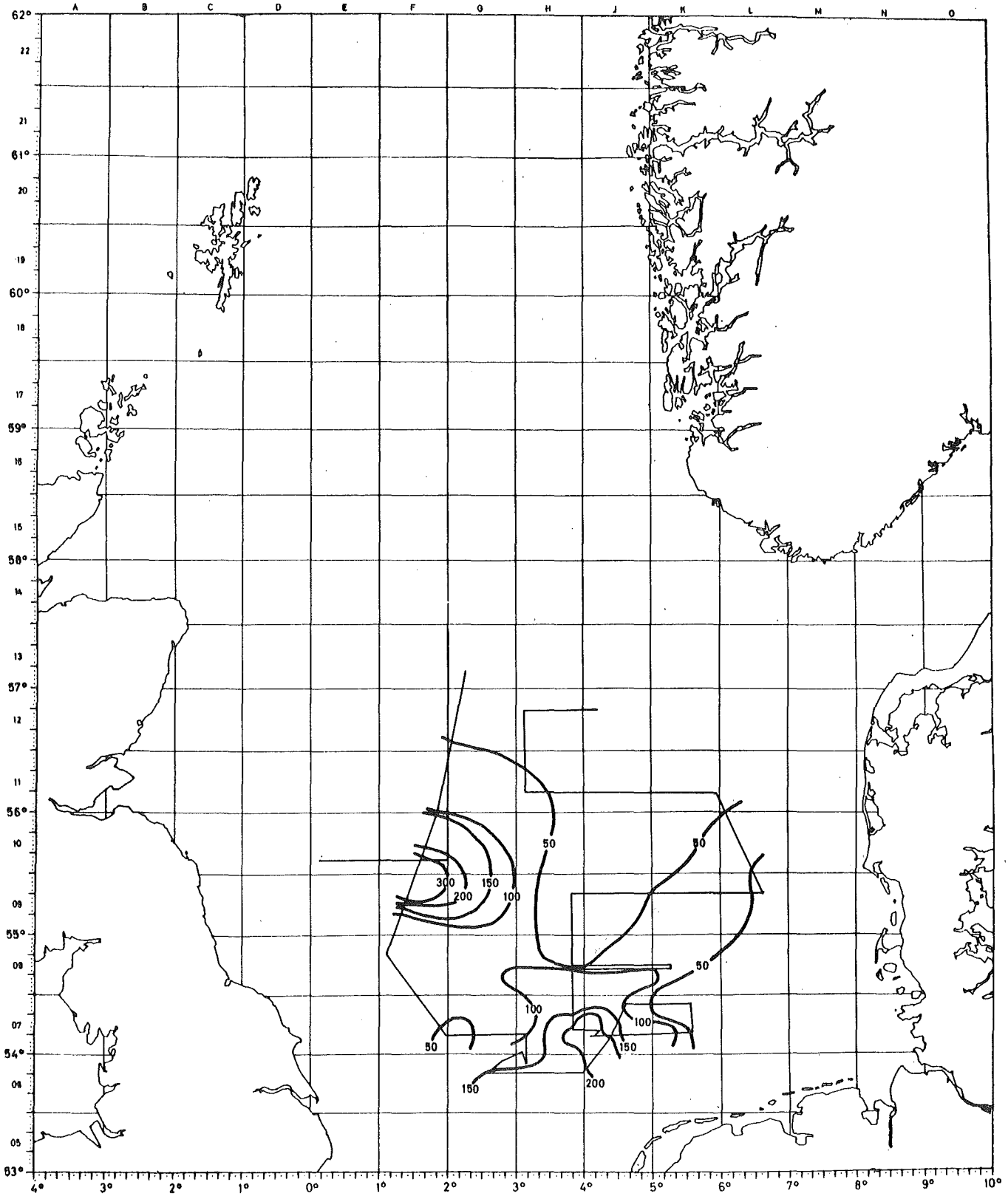

Fig. 2. Relative fish abundance, February 1972. Isolines indicate deflection (in mm) of echo integrator connected to a 120 KHz sounder.

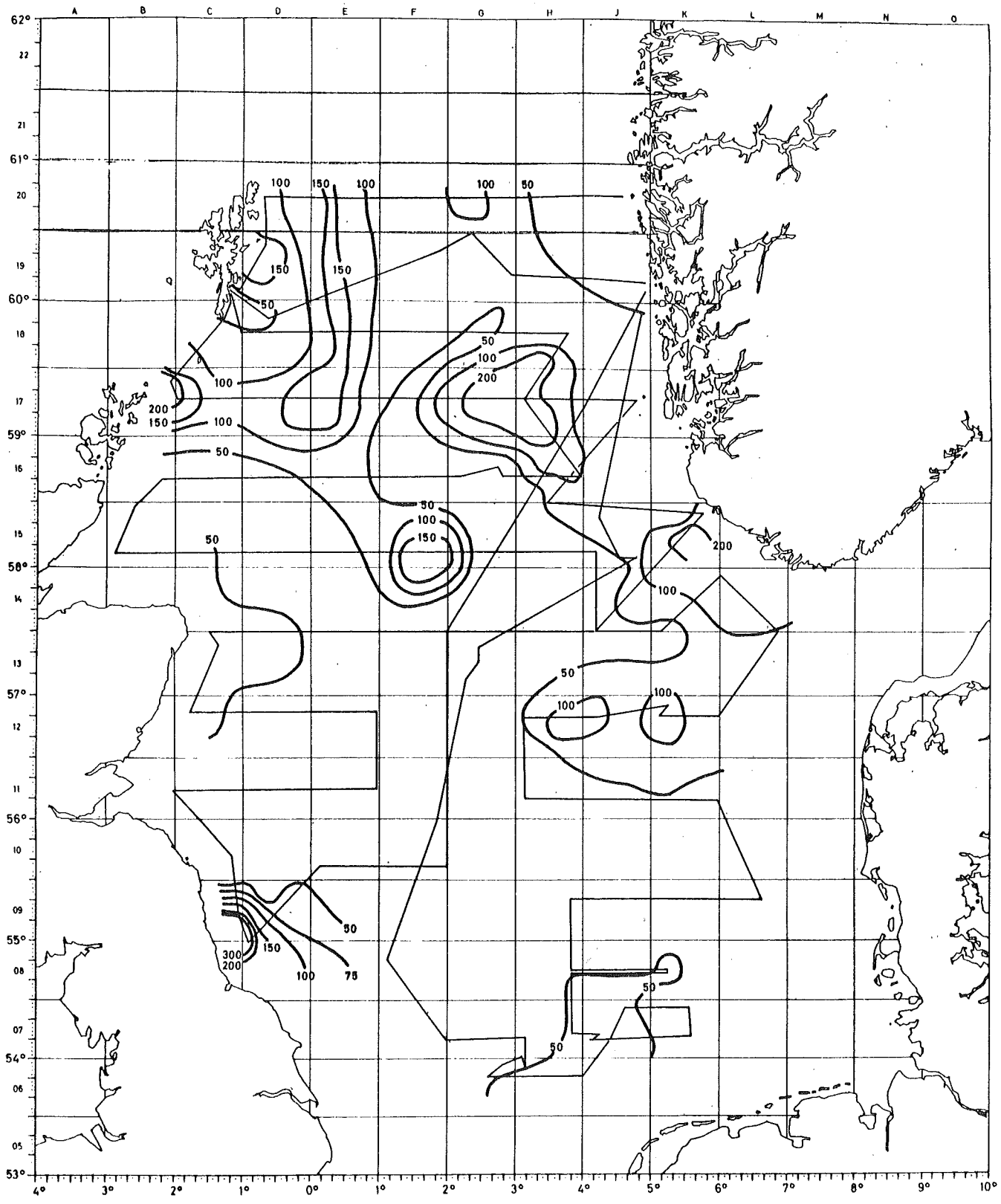

Fig. 3. Relative fish abundance. Isolines indicate deflection (in mm) of echo integrator. "G.O. Sars" and "Johan Hjort", February 1972.

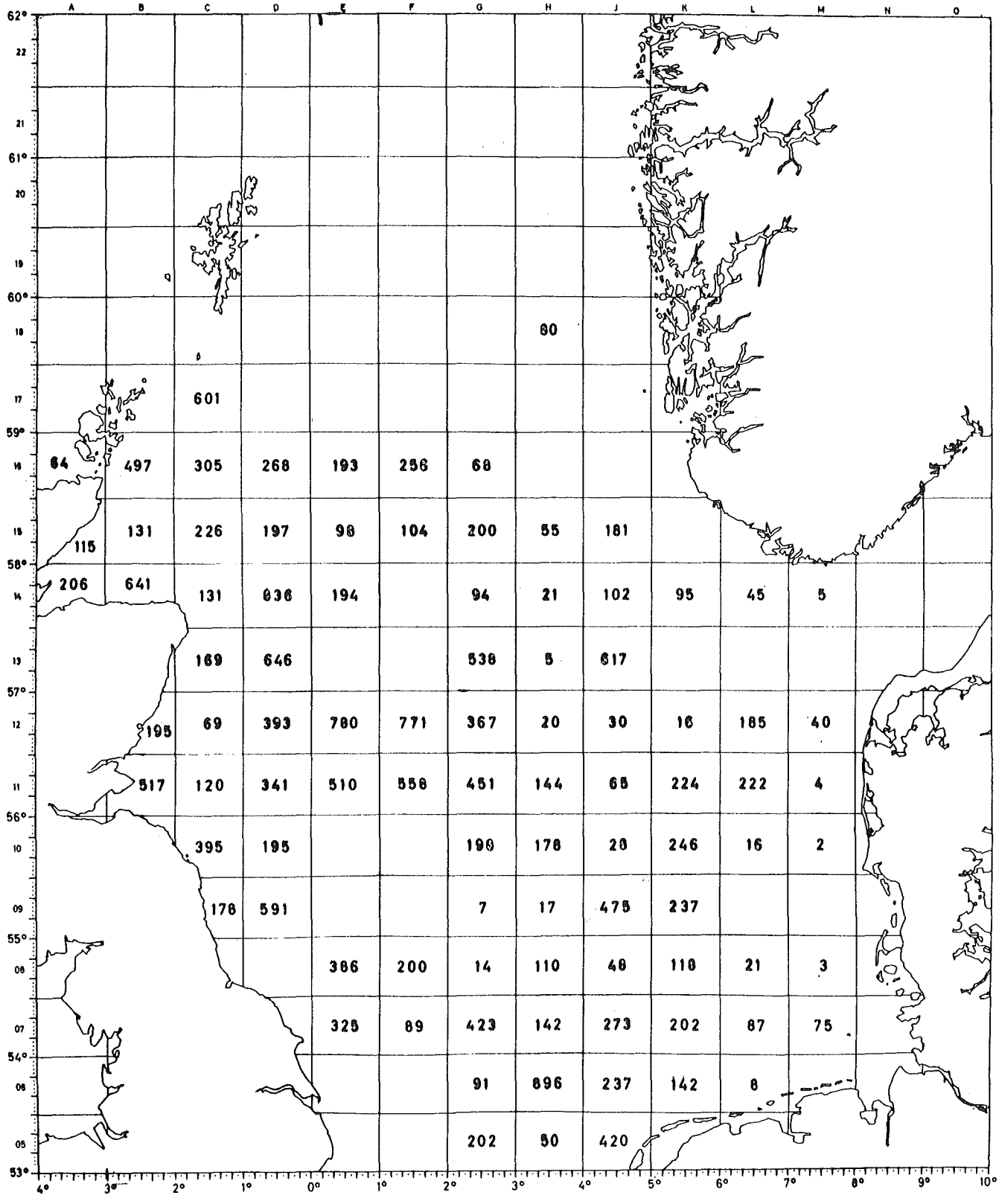

Fig. 4. Average catch (in kilograms) of all fish except flatfish. International trawling survey February 1972.

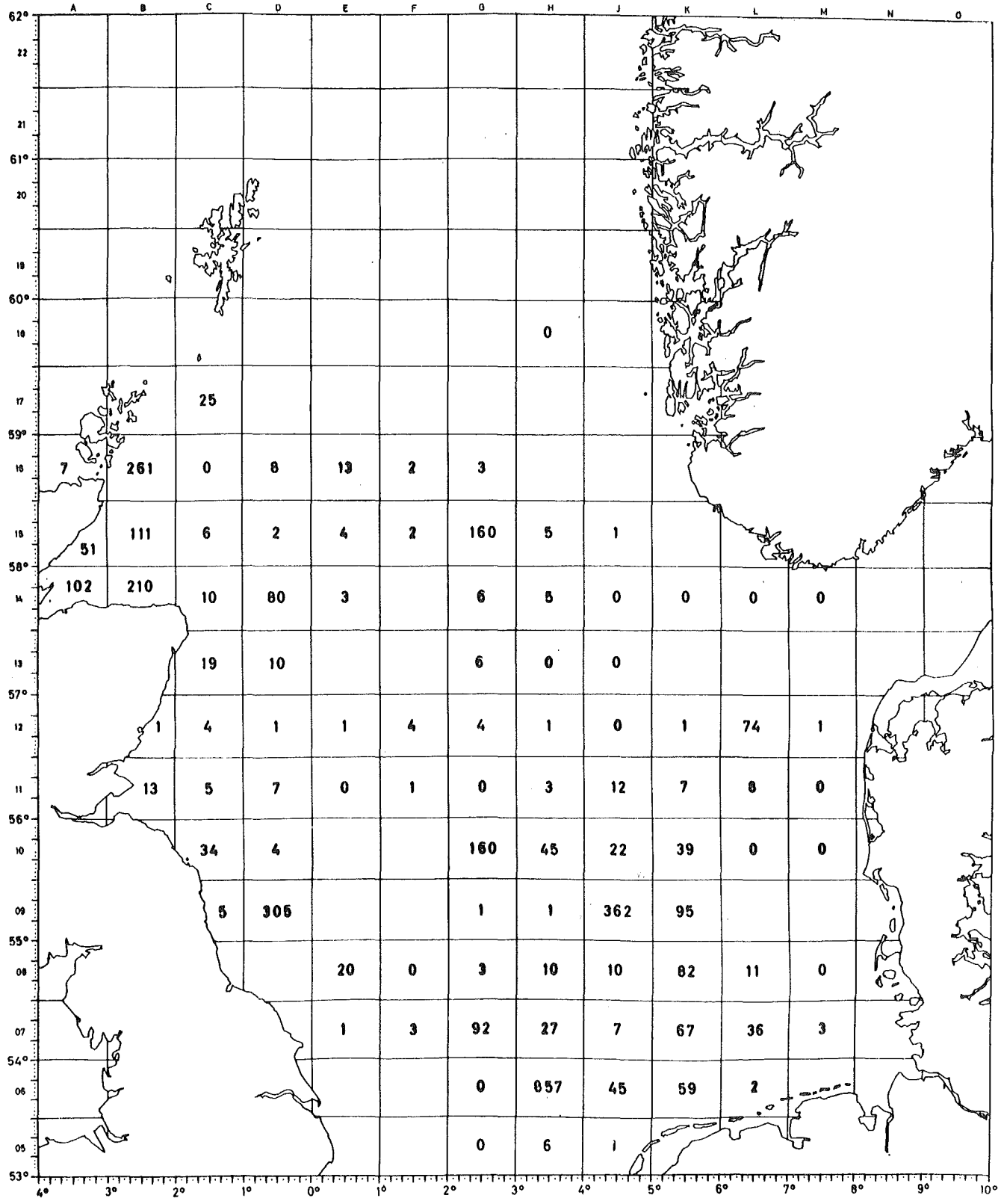

Fig. 5. Average catch (in kilograms) of herring. International trawling survey February 1972.

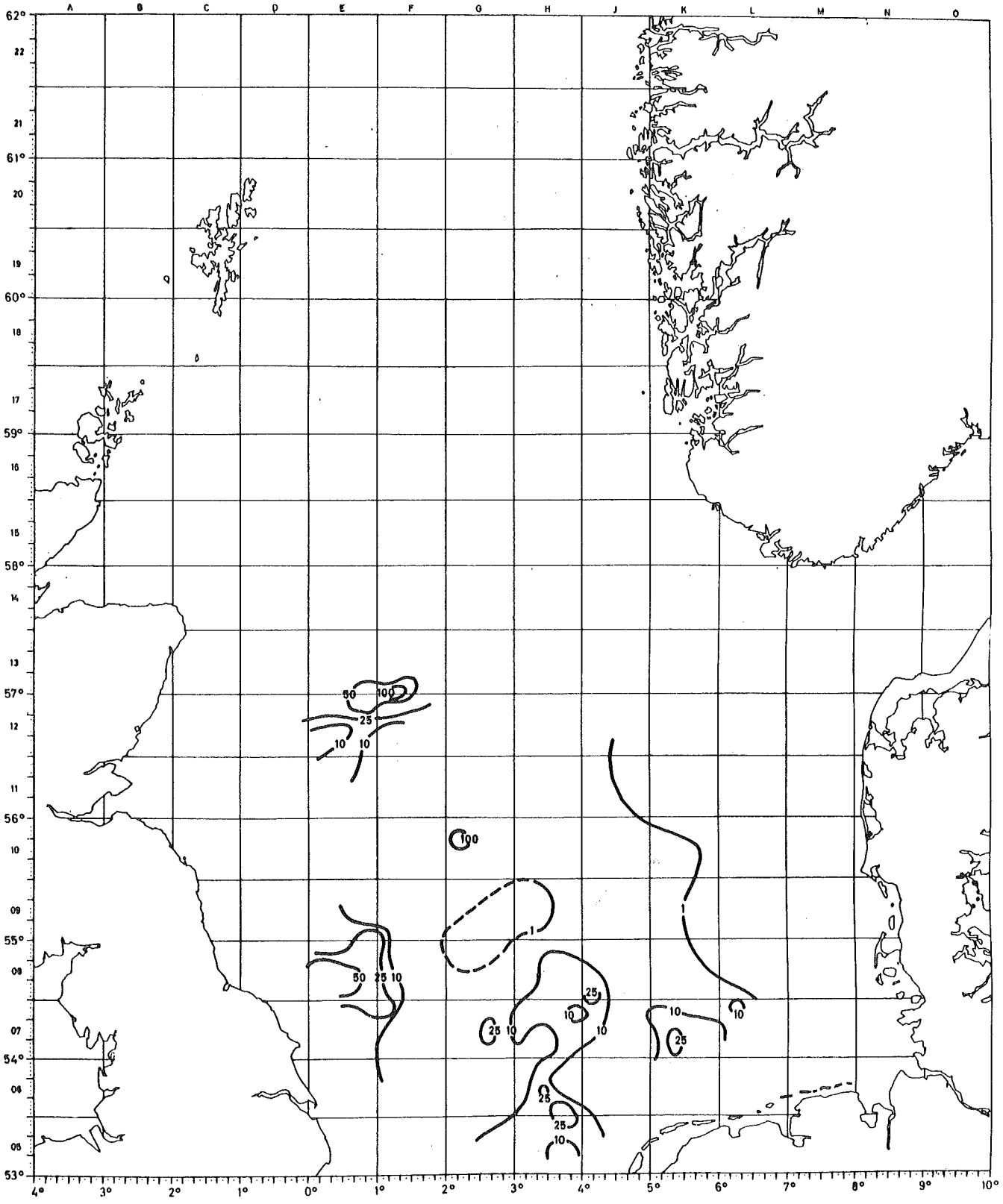

Fig. 6. Relative fish abundance, February 1971.