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AN ACOUSTIC SURVEY ON 0-GROUP GADOIDS IN THE NORTHERN NORTH SEA AND THE SHETLAND-ORKNEY AREA, JULY 1984

by

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ABSTRACT

An acoustic survey was carried out by two research vessels in July 1984 to assess the distribution and abundance of 0-group gadoids.

The 0-groups were distributed in scattering layers by night and in schools by day. Observed vertical migrations, most predominant with Norway pout, indicated fish ascending towards the surface by night. Rather little mixing between 0-group and demersal fish were observed during daytime.

Acoustic estimates of the abundance of 0-group gadoids were based on the target strength/length (L cm) relationship TS = 21.8 logL -74.0. Total estimates for the surveyed area were $124 \cdot 10^9$ Norway pout, $69 \cdot 10^9$ whiting, $42 \cdot 10^9$ haddock and $0.8 \cdot 10^9$ cod.

The timing of the survey proved satisfactory in the sense that 0-groups were recorded almost entirely in their pelagic phase and the catches could be considered fairly representative.

INTRODUCTION

An acoustic survey on 0-group gadoids in the northern North Sea during July-August 1978 gave promising results (Nakken and Rørvik 1979). Subsequent surveys on herring in the Shetland-Orkney area during July in the years 1979-1983 also indicated suitable pelagic distribution of 0-group gadoids for acoustic abundance estimation.

This paper presents the results concerning 0-group gadoids from a joint survey in July 1984. Results concerning herring and saithe are reported by Simmonds et al. (1985) and Smedstad (1985), respectively.

MATERIAL AND METHODS

In July 1984 the Norwegian acoustic herring survey in the Shetland-Orkney area was combined with an expanded coverage of the northern North Sea. R/V "G.O. Sars" and R/V "Eldjarn" made a joint survey of the northern North Sea (Fig. 1 and 2). The coverage of the Shetland-Orkney area is shown in Simmonds et al. (1985).

Observations on distribution and abundance of fish were made by echo integration combined with trawling. Technical data of acoustic instruments and trawls are presented in Table 1 and 2.

Average integrator values were printed out each five nautical mile. Echo traces were identified through trawl catches. Such identifications formed the basis for allocating integrator values to 0-group fish.

Average integrator values of 0-group fish were calculated within ICES statistical rectangles. The average species composition by numbers, of all catches taken to be representative for the 0-group recordings in each rectangle, where then used to calculate the average integrator value (M) for each species. The number (N) of each species were calculated by the equation

$$N = M \cdot 0.1 \cdot 10^{-0.1\,\overline{TS}} \cdot A$$

where A is the area of the rectangle and $\overline{TS}$ is the average target strength of the species. $\overline{TS} = 21.8 \log\bar{L} - 74.9$ where $\bar{L}$ is the average fish length in cm, was used for all 0-group species.

The echo integrator outputs were standardized for both vessels according to calibrations made with a standard sphere so that equal fish densities should give equal values on both vessels. To get a check on the results some rectangles were covered by both vessels within short intervals.

R/V "G.O. Sars" repeated a part of the survey track to make comparisons of results obtained during day and night.

RESULTS

The estimated number of each 0-group species within statistical rectangles are shown in Figure 3 and 4. The total estimates for the area covered were

$124 \cdot 10^9$ Norway pout
$69 \cdot 10^9$ whiting
$42 \cdot 10^9$ haddock
$0.8 \cdot 10^9$ cod

0-group Norway pout was distributed to the south and southeast of Shetland. It formed pure and rather dense, irregular schools 5-20 m above the bottom during day and scattering layers mixed with other 0-groups in the upper 70 m during night.

0-group whiting and haddock were distributed over most of the area investigated. Whiting dominated in the southern and haddock in the northern part. A slight admixture of 0-group cod were observed in the northern region. These species tended to form small schools in the upper 70 m during daytime which

scattered and raised slightly towards the surface by night. The duration of the night situation was 4-5 hours.

Except for a few of the largest haddock and Norway pout no 0-group gadoids were recorded in demersal trawl catches.

The overall length composition of each species are presented in Table 3. In general the average length increased from North-east to Southwest.

Table 4 compares integrator values obtained onboard R/V "G.O. Sars" and R/V "Eldjarn". This gives no evidence of systematic differences between the vessels. The correlation was low, however, due to great differences in two of the rectangles.

Figure 5 compares values obtained along the same survey track during day and night. The night values were significantly lower than the day values. The average of these observations gave 10 percent lower values during night. The most likely reason for this is that some of the 0-group stayed above the transducer depth during night, while this did not seem to occur during day. If 10 percent reduction is assumed to be representative for all nights, this would lead to an overall underestimation of about 2 percent when day and night observations are combined.

DISCUSSION AND CONCLUSION

The vertical distribution of 0-group was found to be suitable for echo integration. Only a small proportion seemed to stay above the transducer depth and most of it occurred separate from larger fish. In some areas it was difficult to separate recordings of 0-group from the recordings of plankton. In such cases, care was taken to avoid allocating too much of the integrator contribution to 0-group. Therefore the integrator values of 0-group are more likely underestimated than overestimated. This does not neccessarily lead to underestimation of the abundance, because the abundance estimates directely depends on the target strength function applied. The function

appears to give reasonable abundance estimates of larger cod and haddock in the Barents Sea (Dalen et al. 1984). It is not known, however, to which extent it represents 0-groups in the North Sea.

The conversion factor (C-value) applied during the 0-group survey in 1978 (Nakken and Rørvik 1979) represents a slightly different target strength function.

Acoustic calibrations from that period are too uncertain to make proper adjustments for this difference. Comparisons of the results from 1978 and 1984 must therefore be made with care.

The total estimates for the statistical rectangles covered both in 1978 and 1984 are as follows:

	Number of fish x 10^{-9}	
	August 1978	July 1984
Norway pout	165	57
whiting	insignificant	58
haddock	23	32
cod	insignificant	0.4

The 1984 survey showed considerably less Norway pout than the 1978 survey when comparing the estimates within the same area. The estimates for the whole area covered are, however, more similar ($124 \cdot 10^9$ in 1984 and $165 \cdot 10^9$ in 1978). In 1978 the main concentrations were found in the central part of the are covered while in 1984 large concentrations near the southern border indicate a possible continuation to the South. On the other hand the 1978 survey did not cover the area between Shetland and the Orkneys, where considerable amounts of 0-group Norway pout have been recorded during the herring surveys in the years 1979-1984.

The English 0-group surveys in August gave a low index for the 1984 year class compared with the 1978 year class, while the

International Young Fish Survey (IYFS) and the virtual population analyses for 3. and 4. quarter of 1984 indicate that these year classes are of similar size (ANON 1985a).

The most striking difference between the results is the insignificant proportion of 0-group whiting recorded in 1978 compared with 1984. This is, however, in good agreement with the pattern of distribution reported by the International 0-group gadoid survey in June-July 1978, whereby rather few whiting were caught within the area covered by the Norwegian acoustic survey, and the main concentrations were found elsewhere (Benjaminsen et al. 1978).

The estimated abundance of haddock was slightly higher in 1984 then in 1978. Preliminary results from the IYFS indicates, however, that the 1978 year class is larger than the 1984 year class (ANON 1985b).

As previously mentioned the two surveys are not quite comparable. The areas covered, the timing and the methods applied are slightly different. Even if the estimates are given as absolute numbers of fish, they should be regarded as relative, due to uncertainties concerning the target strength of 0-group gadoids. It is therefore important to repeat the survey in a standarized way for several years to evaluate the quality of the estimates of year classes strength.

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Table 1 Technical data and settings of acoustic equipment

	R/V "G.O.Sars"	R/V "Eldjarn"
Echo sounder	Simrad EK 400	Simrad EK 400
Frequency	38 kHz	38 kHz
Receiver gain	- 10 dB	- 20 dB
Time varied gain	20 logR + 2·0.008·R	20 logR + 2·0.008·R
Pulse length	1.0 ms	1.0 ms
Bandwidth	3.3 kHz	3.3 kHz
Transducer	45 x 48 cm	30 x 30 cm
Effective beam angle (10 log ψ)	- 23.2 dB	- 19.6 dB
Basic range	150 m	150 m/250 m
Source level + Voltage response	134.4 dB	141.3 dB
Integrator	NORD-10 computer	NORD-10 computer
Integrator gain	40 dB	40 dB
Integrator threshold	17 millivolts	28 millivolts
Instrument constant (C_I) for survey settings	0.087	0.104
Date of calibration	25 July 1984	14 June 1984

Table 2 Technical data of trawl equipment

	R/V "G.O.Sars"		R/V "Eldjarn"	
	Pelagic x)	Bottom	Pelagic	Bottom
Trawl type	Fotö (Mod.80) herring trawl	Campelen shrimp trawl	Capelin trawl	Campelen shrimp trawl
Vertical opening (typical)	15 m	5 m	15 m	5 m
Mesh size front (stretched)	6400 mm	80 mm	200 mm	80 mm
Mesh size cod end (stretched)	11 mm	6 mm	10 mm	6 mm
Bridle length	110 m	40 m	80 m	40 m
Door shape	Circular		Rectangular	
Door weight	750 kg		1700 kg	
Door area	4.6 m^2		8 m^2	

x) During 10-17 July a capelin trawl identical to the one on "Eldjarn" was used.

Table 3. Length frequency distribution in percent of 0-group gadoids in pelagic trawl catches.

Cm-group	2	3	4	5	6	7	8	9	10	11	12	13	Mean length	Number measured
Norway pout	0,2	4,9	19,3	39,6	27,4	6,3	2,3						5,67	922
Whiting	0,5	6,3	18,6	28,8	24,0	14,4	4,6	1,7	1,0	0,1			5,83	2293
Haddock		1,5	6,8	17,0	25,3	22,4	16,0	6,5	2,9	1,0	0,5	0,1	7,09	3266
Cod		1,0	33,7	48,0	16,3	1,0							5,33	98

Table 4. Comparison between average integrator values of 0-group fish per statistical rectangle jointy covered by R/V "G.O. Sars" and R/V "Eldjarn". Number of 5 nautical miles surveyed in brackets.

ICESrectangle	48E8	48E9	48F0	48F1	48F2	48F3	47E8	47E9	46E8	46E9	45E8
R/V "G.O. Sars"	82	101	112	52	39	15	235	88	177	108	41
	(37)	(33)	(6)	(7)	(6)	(6)	(24)	(19)	(11)	(12)	(15)
R/V "Eldjarn"	250	89	85	56	32	21	183	101	170	109	164
	(2)	(13)	(11)	(13)	(12)	(14)	(4)	(14)	(10)	(13)	(11)

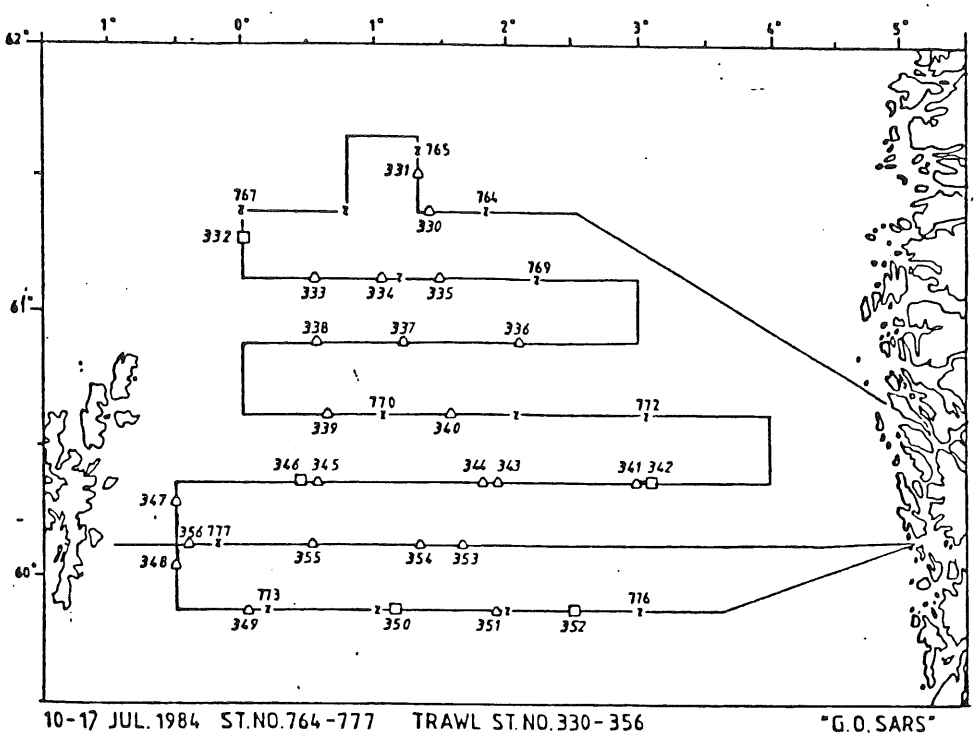


Figure 1. Survey track and stations R/V "G.O. Sars" 10-17 July 1984.

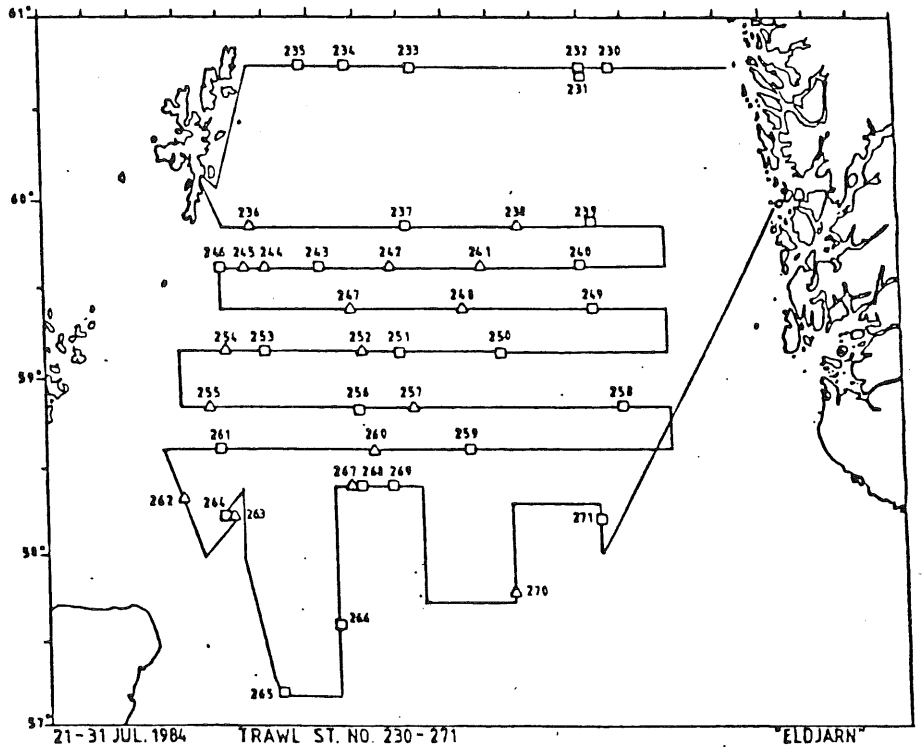
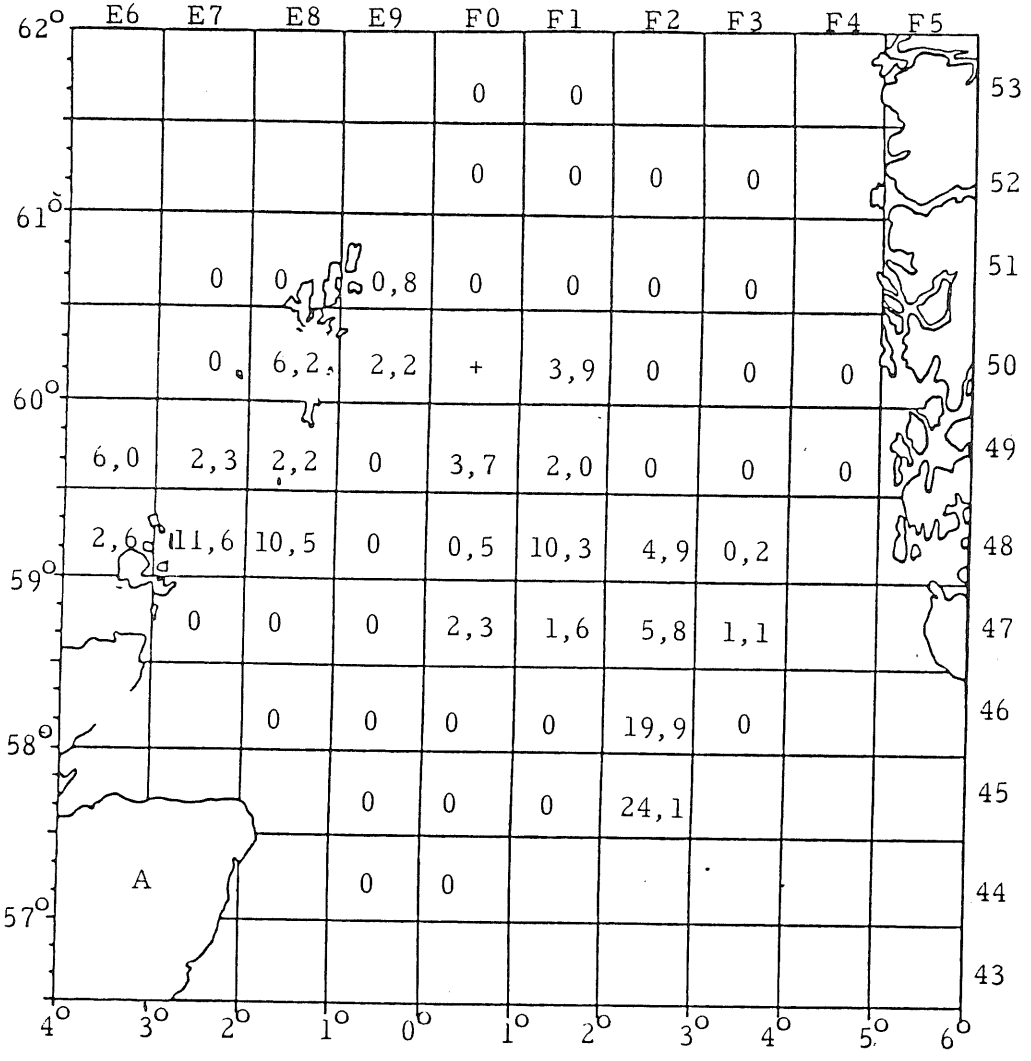


Figure 2. Survey track and stations R/V "Eldjarn" 21-31 July 1984-



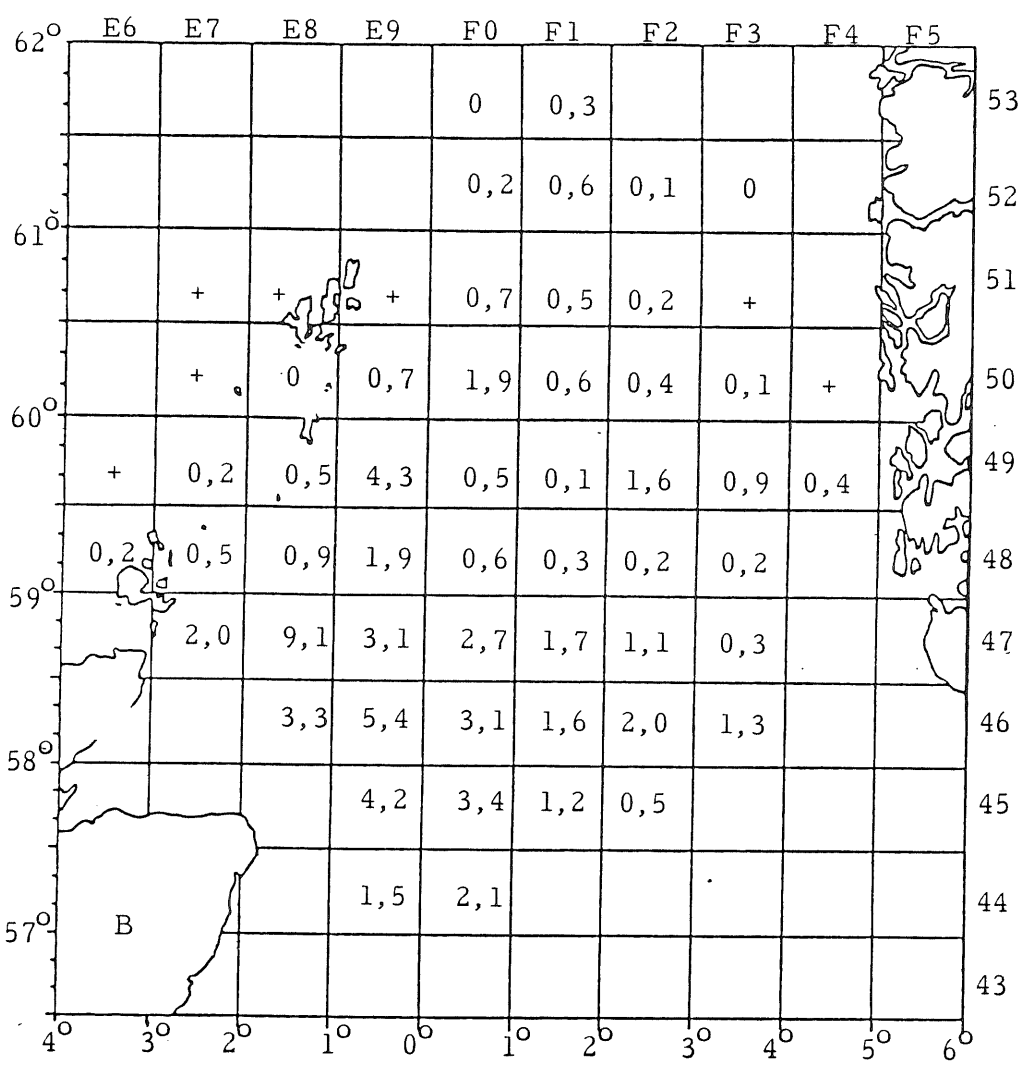
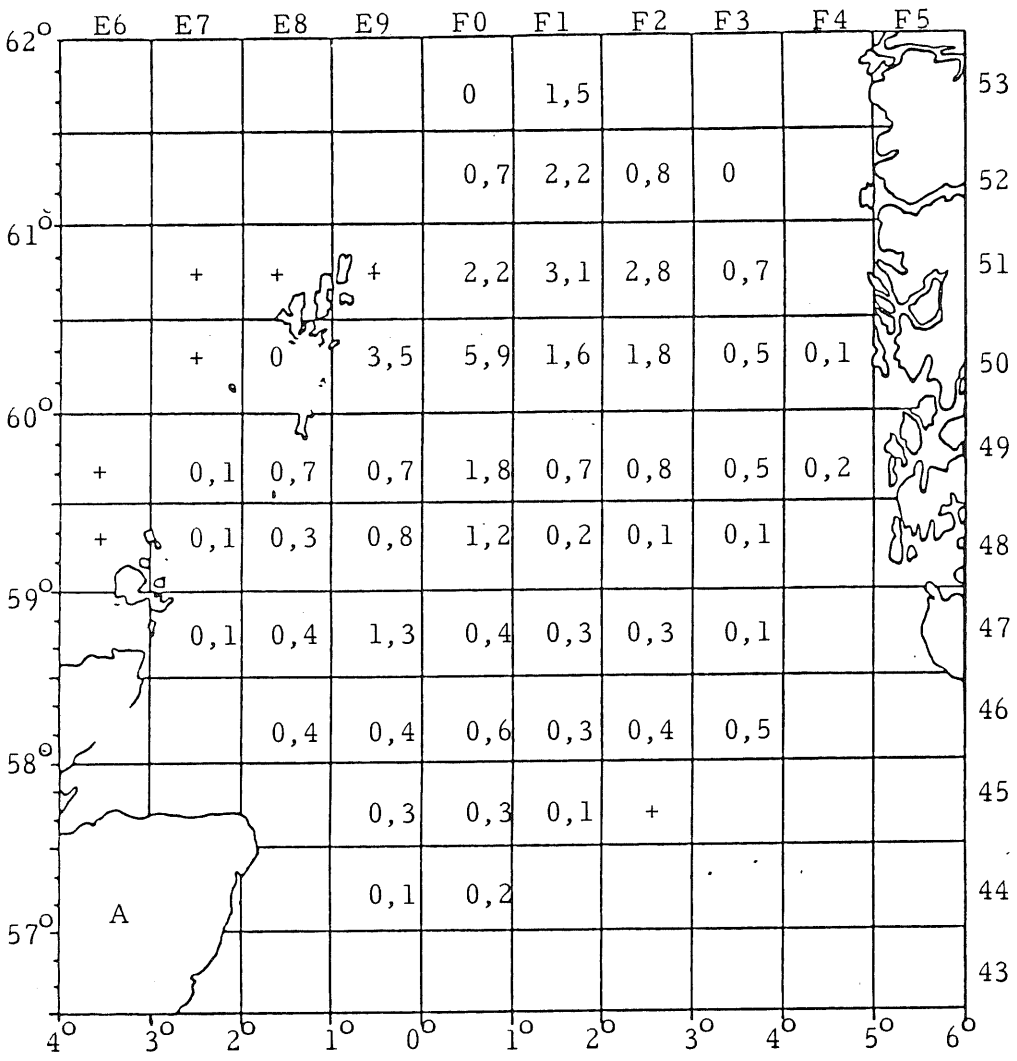


Figure 3. Estimated number in millions of Norway pout (A) and whiting (B) by statistical rectangles.



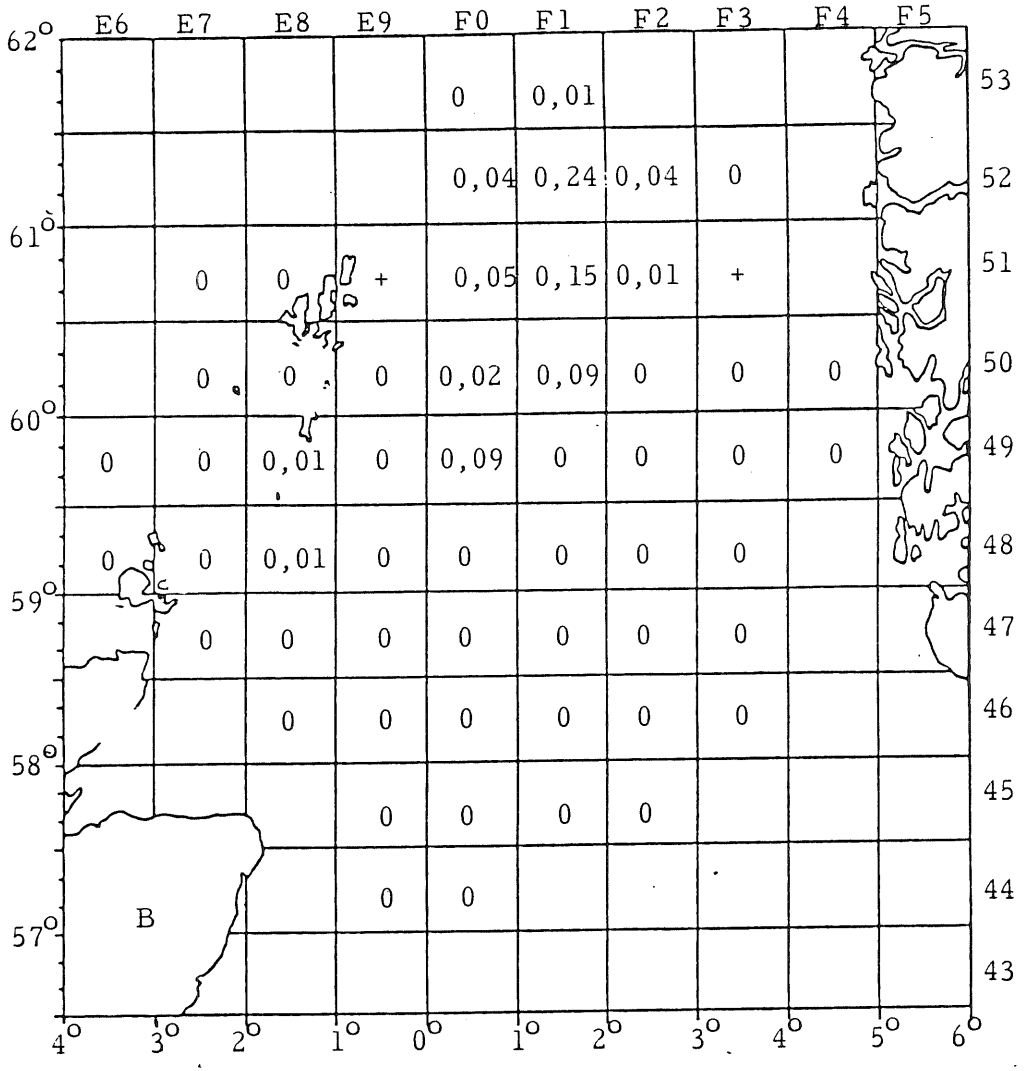


Figure 4. Estimated number in millions of haddock (A) and cod (B) by statistical rectangles.

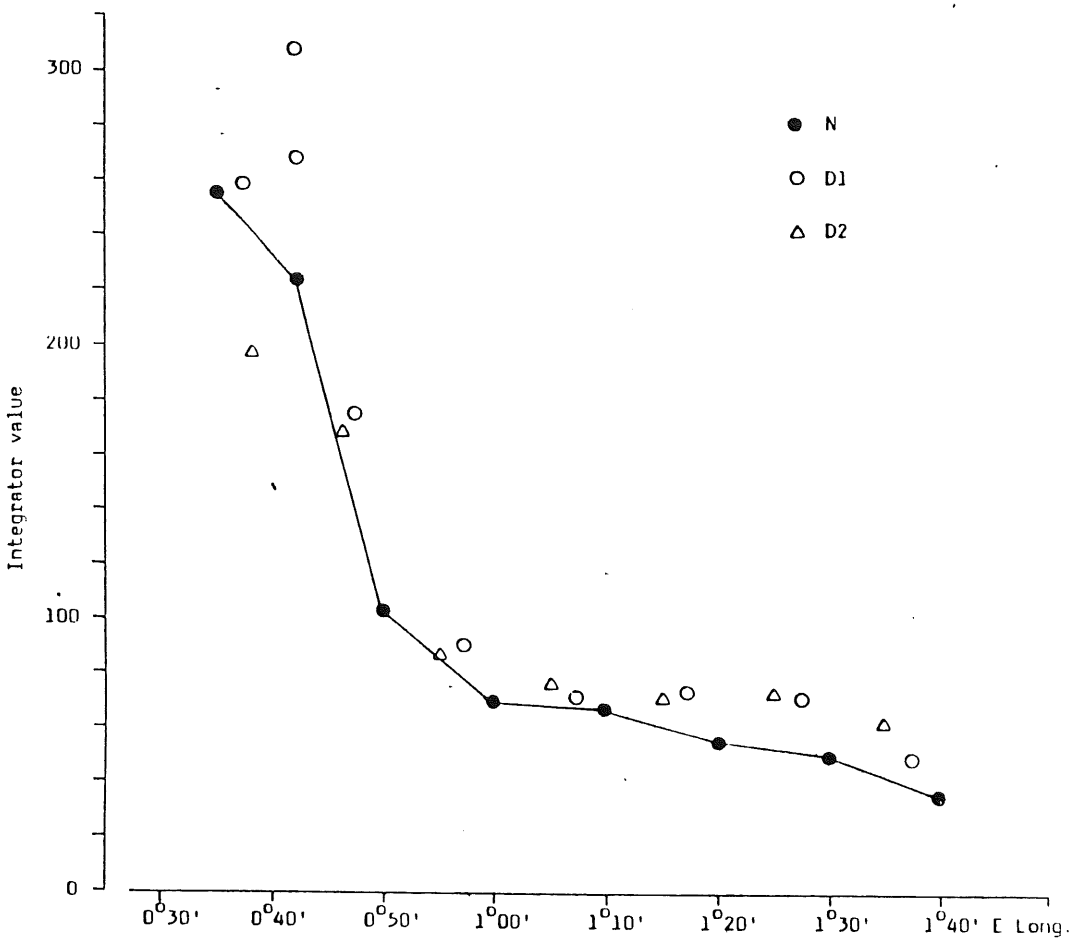


Figure 5. Integrator values of 0-group fish recorded by R/V "G.O. Sars" 13-14 July on part of the transect along N60° 22'.
N=night coverage. D1 and D2=First and second day coverage.