

International Council for the
Exploration of the Sea

C.M. 1972/F:37
Demersal Fish(Northern) Committee

ABUNDANCE ESTIMATION WITH ECHO INTEGRATOR OF ARCTIC COD
ON THE SPAWNING GROUNDS IN LOFOTEN 1972

by

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INTRODUCTION

Echo surveying of the Lofoten area during the spawning season of the Arctic cod was introduced in 1935 (Sund 1935). Towards the end of the 1950-ies a method for abundance estimation by counting traces of single fish on the echo records was developed (Midttun and Setersdal 1956, 1957, Midttun et al. 1957). However, the abundance estimates obtained in this way were evidently too low (Blindheim and Nakken 1971) and the method has mainly been employed in preparing charts of the distribution of cod in the area (e.g. Setersdal and Hysten 1959, Monstad et al. 1969, Hysten et al. 1972).

Abundance estimation based on echo integration was introduced by Dragesund and Olsen (1965). On R.V. "G.O.Sars" in March

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1971 the method was for the first time used on the cod in Lofoten and the resulting abundance estimates were assumed to be reasonable (Blindheim and Nakken 1971). R.V. "Johan Hjort" has also been equipped with an echo integrator and an acoustic survey in Lofoten was undertaken with this vessel in March 1972.

MATERIAL AND METHODS

The survey started near Svolvær 14 March at 2200 hrs (Fig. 1). During the night we surveyed the area from Svolvær to the entrance of the Ofoten Fjord which was reached at dawn. The same area was surveyed during the day, most of the time with 1 nautical mile between the survey tracks, and Skrova was passed at about 1600 hrs. West of Skrova the distance between the survey tracks was increased to 2 nautical miles. The survey was unfortunately stopped south of Henningsvær at 2200 hrs the same night because of a small damage in the vessel.

An echo integrator connected to a 50 kHz echo sounder was used for the abundance estimation. The echo integrator is described by Nakken and Vestnes (1970). The method of abundance estimation is described by Midttun and Nakken (1968, 1971) and Blindheim and Nakken (1971). The total number of cod within the surveyed area was calculated by means of isopleths.

The echo integrator was in continuous use during the survey. In addition, single fish were counted on the echo records when possible, i.e. when it was dark.

RESULTS

The distribution of cod according to the integrator during the night survey from Svolvær to the entrance of the Ofoten Fjord is shown in Fig. 2. A general increase in the concentrations towards the shore is evident.

The distribution of cod during the survey outward from the Ofoten Fjord is shown in Fig. 3. The most dense concentrations were found south-east and south-west of Skrova, east of Brettesnes, and in the Kanstad Fjord. On the basis of the deflections of the integrator it was calculated that the area covered by this survey contained approximately 2.0 millions of cod.

The area Skrova - The Ofoten Fjord was surveyed both by night and by day. In the day-time the cod chiefly occurred in small shoals, whereas the night records showed traces of single fish only. The cod also occurred on the average somewhat deeper by day (75 - 125 m) than by night (50 - 100 m). Although identical survey grids were not used, it is evident from the distribution charts that the deflections of the integrator indicated by far the highest concentrations of fish during the day survey. Calculations of the number of cod inside the area that was satisfactorily covered both night and day, gave as result a number of cod by night that amounted to only 37 % of the number obtained during the day.

Counting traces of single fish on the echo records indicated a distribution of the cod which was similar to the one contemporaneously indicated by the integrator. The number of cod thus calculated was, however, on the average only 63 % of the number according to the integrator.

DISCUSSION

Although the surveyed areas were not identical, it is clear that the 2.0 millions of cod which was the result of the abundance estimation in 1972, represents much lower concentrations of fish than in 1971 when the amount of cod estimated was in the order of 6.8 - 13.5 millions (Blindheim and Nakken 1971). The area in 1971 was of similar size and was partly overlapped by the area surveyed in 1972. The cause of the great difference is uncertain. According to calculations of the size of the spawning stock, a decrease in number of 12 - 15 % from 1971 to 1972 was to be expected (Anon. 1972). Variations in the

size of the spawning stock can therefore only be responsible for a small fraction of the difference. At the time the survey in 1972 was carried out it was evident from the fisheries that considerable concentrations of cod occurred in fjords and in shallow waters where surveying was difficult. Increasing concentrations towards the shore are also apparent from the distribution charts (Figs. 2 and 3). However, the abundance estimates in 1971 also comprised only a part of the spawning stock (Blindheim and Nakken 1971) and it is not possible to ascertain if a larger part of the stock occurred inside the surveyed area in 1971 than in 1972. It is, nevertheless, quite probable that this has been the case, and thus has been the main reason for the different results of the abundance estimates. This is corroborated by the echo records in 1972 which chiefly gave the impression of a relatively low abundance of the cod.

The dissimilarity between the results of the surveying of the inner area by night and by day is surprising (Figs. 2 and 3). Since the method was the same, the difference must be due to the behaviour of the cod. The most likely explanation seems to be that the cod have occurred closer to the shore by night and thus have been out of reach of the echo sounder. The distribution charts show that the concentrations of cod generally were increasing towards the shore both by night and by day. It therefore seems possible that a short-range migration of the cod would be sufficient to produce the observed differences in abundance. This is corroborated by the observations in 1971 (Blindheim and Nakken 1971) when a considerable migration to and from the surveyed area apparently took place overnight.

The method of counting fish with an echo integrator will generally involve some errors. In areas with steeply sloping bottom, errors will result from integration of bottom echoes. During the Lofoten survey in 1972 this happened frequently, and the problems thus created made other errors that may have occurred seem negligible. On several occasions bottom echoes completely dominated the deflections of the integrator. In such cases subtraction of the bottom's contribution was useless and the contribution from the cod had to be estimated on the basis of the echo records. These estimations were necessarily more or less subjec-

tive and deviations from the true values obviously occurred. It is impossible to judge the effects of the resulting errors. However, the fact that the most dense concentrations of cod often were found in areas where integration of bottom echoes occurred, increases the chances that significant errors were made. An increase in the number of integrator channels will obviously reduce the error considerably, unless all the fish occur close to the bottom. R.V. "Johan Hjort" has two integrator channels, whereas R.V. "G.O.Sars" has six. The abundance estimates and distribution charts from Lofoten in 1971 are therefore presumed to be more accurate than those from 1972.

There are still problems that must be solved before accurate estimations of the size of the spawning stock of cod in Lofoten can be made on the basis of acoustic surveys. The cod is hardly ever distributed in a way that makes covering of the whole spawning stock during one survey possible. All of the cod will probably never occur inside the Lofoten area contemporaneously, and some of the cod will often occur in areas that are impossible to survey satisfactorily. Variations in the behaviour of the cod in these respects from one year to another carry further complications. As long as the problems concerning the bottom echoes are not solved it will also be difficult to produce correct charts of the distribution.

SUMMARY

A survey in the inner part of the Lofoten area was undertaken with R.V. "Johan Hjort" 14 - 15 March 1972.

Abundance estimates and distribution charts were made on the basis of echo integrator deflections.

The abundance estimates were low compared with those from 1971, probably because more of the cod occurred in shallow waters out of reach from the echo sounder in 1972 than in 1971.

Inside an area the abundance of cod was found to be much higher by day than by night. The difference was probably due to migration of the cod.

Integration of echoes from the bottom in areas where the slopes were steep created severe difficulties, and this problem will have to be solved in order to make the abundance estimates more accurate.

The cod is probably never distributed in a way that makes covering of the total spawning stock during one survey possible. The distribution of the cod therefore probably creates the biggest problem in abundance estimation of the total spawning stock.

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FIGURES

Fig. 1. Survey grid 14 - 15 March 1972. H = Henningsvær, Sv = Svolvær, Sk = Skrova, B = Brettesnes, K = Kanstad Fjord, O = Ofoten Fjord.

Fig. 2. Distribution of cod during the survey 14 March 2200 - 15 March 0500. Integrator deflections: 1 = 1-9, 2 = 10-19, 3 = 20-29, 4 = 30-39 . Abbreviations of names of places as in Fig. 1.

Fig. 3. Distribution of cod during the survey 15 March 0500 - 2200. Integrator deflections: 1 = 1-9, 2 = 10-19, 3 = 20-29, 4 = 30-39, 5 = ≥ 40 . Abbreviations of names of places as in Fig. 1.

Fig. 1

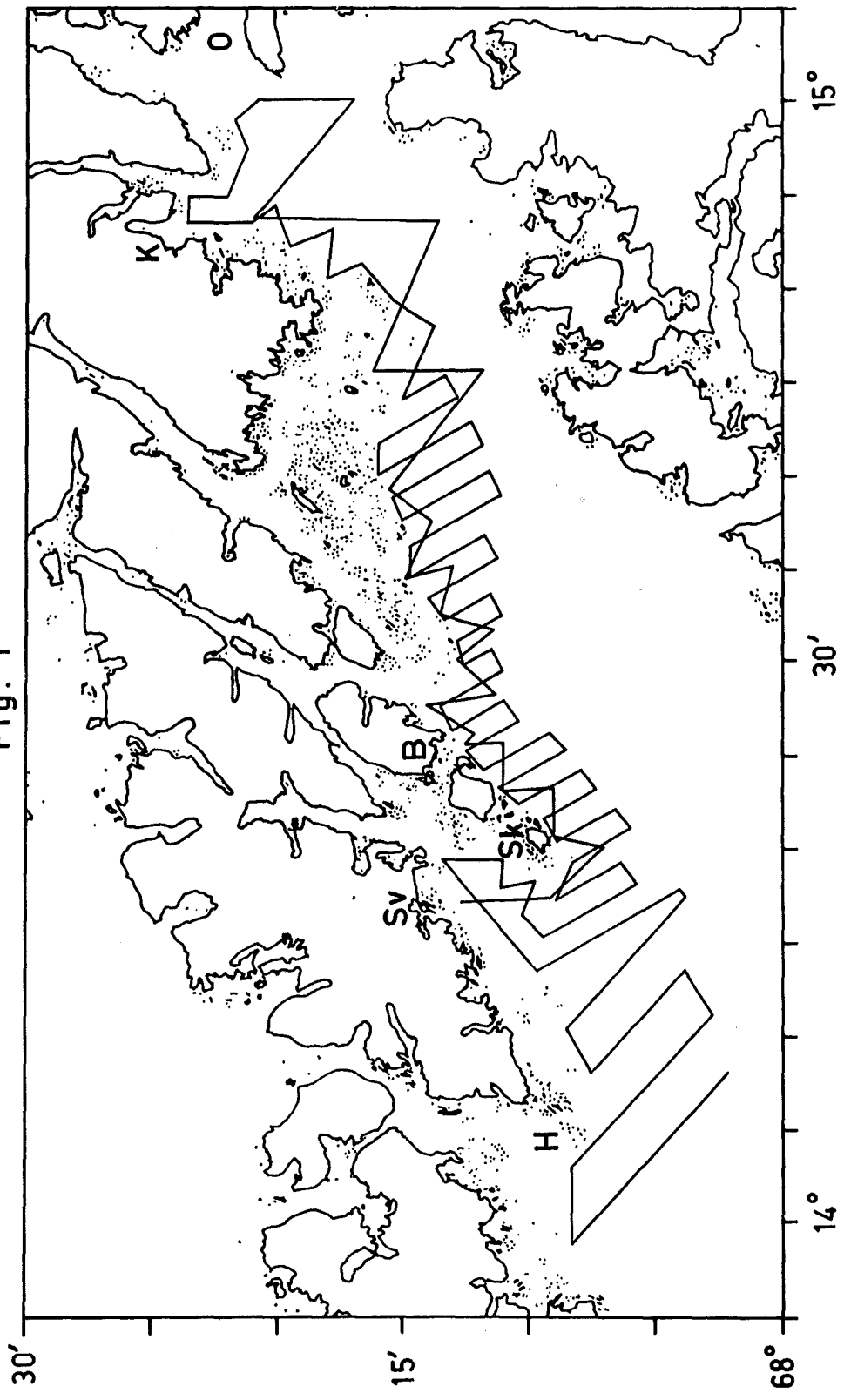


Fig. 3

