

*Brakley*

Progress Report on Joint Investigation of Arctic Cod.

by

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1. PREAMBLE

Arising from the proceedings of the Sixth meeting of the Permanent Commission in London, October 1957, the Liaison Committee of I. C. E. S. was asked to promote a study of all the available data on the dynamics of the Arctic cod stock and its associated fisheries, with a view to advising on the need for further regulation. In the first instance the above authors, under the guidance of Mr. G. Rollefsen as chairman of the Gadoid Fish Committee and with the assistance of Dr. L. K. Boerema as a second member of the Liaison Committee, were asked to collaborate in a review and analysis of the existing information.

As a first step, Mr. Beverton visited Bergen in January of this year, and discussed the general outlines of the problem with Mr. Rollefsen and Mr. Sætersdal. A programme of work was drawn up, and it was hoped to have a second meeting later in the year at which Dr. Boerema could be present. Owing, however, to the work arising subsequently in connection with the Lienesch Committee, it has unfortunately not been possible to have a second meeting, nor to make as much progress as we would have hoped. Nevertheless, we are able to report to this Committee on the outcome of our discussions at Bergen, on such progress as has been made since then, and on our proposals for how the study might best be carried through during the coming year.

2. SPECIAL FEATURES OF THE ARCTIC COD FISHERIES

An investigation of the dynamics of the Arctic cod stock is complicated by the considerable degree of segregation of the immature and mature phases of the population, with which are associated partly independent fisheries using different fishing methods. Furthermore, the immature phase is itself divided into two largely independent groups, that in the Svalbard area (including Bear Island, Spitsbergen and the Hope Island Banks) and that in the south-eastern Barents Sea (Finnmark - Murmansk). Although most of the fishing on the immature phase is by trawling (primarily by Russia and England, with some other countries taking a minor share), some long-lining is carried out by Norway along the Finnmark coast. Fishing on the mature phase (skrei) comprises several components. During the spawning season fishing is by Norway (purse-seine, long-line and gill-net) and by

some other countries (trawl) on the coastal banks off North Norway; during the rest of the year mature fish are taken together with immatures in the trawl catches, but not necessarily in the same proportion to the true abundances. The two main fisheries on immatures and the fisheries on the mature fish during the spawning season, fall roughly into the I. C. E. S. regions, and for brevity will be referred to in this way. Thus: -

Svalbard	- IIb	} immature and mature
South-eastern Barents Sea	- I	
Lofoten and outside banks	IIa)	mature

### 3. SUMMARY OF DATA AVAILABLE

The following refers only to data directly relevant to population analysis.

#### A. Catch and effort statistics

- I Norway - A long series of data of annual catch of mature fish at Lofoten, distinguishing method of capture. Reliable measures of effort in this fishery are difficult to obtain, but approximate indices are available (e. g. number of fishermen; number of vessels). Similar statistics are also available for the Finnmark fishery on immatures since 1910.
- II Russia - Figures of total catch since the nineteen twenties. The greater part of this is thought to be taken from Region I, at least in earlier years, but a precise breakdown by areas is not available. Information on fishing effort has not been published, but is probably available.
- III England - Catch and effort (hours fishing) by sub-regions from 1929 to 1939, and by rectangles since 1945. Average gross tonnage of trawlers is available since 1945.
- IV Germany - Catch and effort statistics by sub-regions are available since the beginning of the German fishery.

#### B. Length and age-composition data.

- I Norway - Length-composition of commercial catches of mature fish at Lofoten since 1913 and age-composition since 1932. Length-composition of immatures in the Finnmark fishery 1913 - 1939 and since 1949, and age-composition 1932 - 1937 and since 1949. Also R. V. data (trawl) in Region I.
- II Russia - Length and age-composition of commercial and R. V. catch in I since 1934 and in IIb since 1946.
- III England - R. V. length and age-composition in IIb since 1949. Commercial catch length-composition in I, IIa and IIb since 1950; commercial catch age-distribution in IIb since 1950 and smaller amounts from I and IIa.

- IV Germany - Length and age-distribution of commercial catch by grounds since 1929.

C. Tagging data

- I Norway - yearly since 1948 for the Lofoten fishery; since 1953 in Region I.
- II Russia - since 1930, mainly in I.
- III England - yearly since 1951, mainly in IIb.

D. Miscellaneous

- I Selectivity studies - Reliable estimates of cod end selectivity of trawls for Arctic cod and haddock are now available. Studies on the selectivity in the Skrei fisheries are in progress.
- II Maturity - Onset of maturity can be obtained from Norwegian age-composition data, which is available in spawning classes. Studies on state of gonads of immature and maturing fish have been made by England, and can be used for classification of length and age-data in a similar way.
- III Environmental factors - Large scale surveys of fish distribution in relation to hydrographic features are being made by England, Russia and Norway, which should be valuable in distinguishing between the effects of environmental changes and fishing on measures of population density.
- IV Rejection - Rejection of non-marketable small fish occurs in the trawl fisheries especially when rich yearclasses enter the fishery. England has obtained some information on this rejection, and it is hoped that data from other countries can also be provided.

4. PROPOSED PROGRAMME OF ANALYSIS OF COD DATA

- I We were agreed that in order to assess the need of conservation and to predict the effect of specific regulations, the main task is to build up a comprehensive picture of the effect of fishing by the various countries and gears in each phase of the life-history of the Arctic cod.
- II We propose that the problem can best be tackled into two main stages. The first is to estimate the total quantity of fish taken from a year-class at each age of life, and the fraction of this that is taken by each country and gear. The second is to try to obtain reliable estimates of total mortality, free from the influence of distribution and gear selectivity, and to separate this into its components of fishing and natural mortality. Almost certainly,

the fishing mortality rate will be different at different ages, but with these two kinds of information it should be possible to make satisfactory assessments. It may be noted that this procedure is essentially the same as that which has been used with some success for making assessments of the North Sea sole fisheries for the Lienesch Committee.

- III We believe that by combining catch statistics and length and age-composition data from Norwegian, Russian, English and German sources, the first part of the above programme, i. e. constructing a total annual catch-curve, can be completed for the period since 1953, and less precisely since 1949. Ideally, however, it is necessary to follow a single year-class throughout its life; we believe it may be possible to do this for the 1945 year-class as a start. To prepare a comprehensive picture of this kind it would be necessary to construct age-length keys for the various areas using all the available age-length data.
- IV Direct estimation of mortality rates from trawl fishery data is likely to be difficult. Fish are not fully represented in the catches until they are about six years old, and they are then at the threshold of maturity, after which they may again not be equally represented in the catches. It would seem that the best chance of success lies in analysis of the long series of age-composition data available to the Lofoten fishery based exclusively on mature fish; it would then be possible to use the total catch-curve to estimate the mortality rates among other age-groups. Some preliminary work is required before this can be done, however, notably an analysis of the relative selectivities of the Lofoten gears, which do not seem to have remained constant since 1950.
- V At all stages in both aspects of this programme, the tagging results from the three countries concerned would be a valuable adjunct. The need here is for the tagging data to be prepared in a standard form so that it can be combined in the way best suited for mortality estimation, e. g. distinguishing size of fish at capture and recapture, and method, area and season of capture.
- VI A more detailed analysis of the post-war changes in both the immature and mature stocks may prove useful in providing a separate check on the estimates of mortality derived from other sources. Allowance would have to be made in this for the exceptional abundance of the 1937 year-class.

## 5. HADDOCK

We were agreed that the Arctic haddock, although much less important than cod, would need to be taken into account when assessing the overall requirements of conservation, especially in relation to mesh regulation. A limited amount of length and age-composition data of commercial catches are available which should, if combined, enable a provisional assessment of the haddock fishery to be made.

## 6. FUTURE RESEARCH

Although our concern has been mainly with the analysis of existing data, it became clear during our talks that there are certain gaps in the present information which we suggest could profitably be filled by joint research projects between the countries concerned. Two of these are as follows; -

- I Comparative tagging experiments. Although Russia, Norway and England have each undertaken large-scale tagging experiments, these have been with different tags and fishing methods at different seasons and in different areas. A series of comparative tagging experiments between these countries would be of much value in making the best use of the tagging data which already exists and for future research.
- II A particularly important aspect of the problem of size selectivity between fisheries concerns the differences between the Norwegian Lofoten fishery for spawning cod and the English trawl fishery on the banks outside Lofoten during this time. It is proposed to study this case further by tagging outside as well as inside Lofoten, and by increasing the amount of sampling of the English fishery. A start was made on this project in 1958.

## 7. PROPOSALS FOR CONTINUATION OF THE PRESENT STUDY

The above report contains our proposals for how the study of the Arctic cod data could be best continued, and we would welcome any suggestions of the Gadoid Fish Committee on this subject. It will be noted that three countries, Norway, Russia and England have research vessels continuously working on the Arctic cod fisheries, and, furthermore, that the kinds of information obtained by these countries is largely complimentary - either with respect to area or maturity of fish. This being so, we feel that it is of the utmost importance that representatives of these three component interests should participate in the next stage of these investigations.