Northwest Atlantic Fisheries Organization

Serial No. N1994

NAFO SCR Doc. 91/102

SCIENTIFIC COUNCIL MEETING - SEPTEMBER 1991

The Greenland Cod at Iceland 1941-1990 and its Impact on Assessment

by

Sigfús A. Schopka

Marine Research Institute, Skúlagata 4
121 Reykjavík, Iceland

Abstract

The paper deals with the impact of Greenland immigrants on the cod stock analysis at Iceland during the period 1941-1990. The impacts are those that stock size at Iceland is overestimated and fishing mortality, especially weighted fishing mortality is underestimated. The way how the immigrants at Iceland are estimated is described and the stock size at Iceland is corrected for.

Introduction

Tagging experiments at Iceland show that cod in Icelandic waters is more or less a unit stock. From more than one hundred thousand cod tagged since 1948 less than 10 recaptures have been recorded outside the Icelandic fishing grounds. On the other hand it is well known that cod from Greenland waters both West and East-Greenland stocks do migrate in some years even on a large scale to Iceland. These immigrations do affect the stock abundance at Iceland and hence the management of the stock. It is therfore important in order to understand the flucuations in the stock at Iceland to be able to distinguish between the two cod stock components, i.e. the Icelandic and the Greenlandic components.

In general there is no exact solution available to the problem at present. Theoretically tagging experiments would solve this under the assumption that all recaptures were available for analysis and that tagging mortality, fishing mortality and natural mortality for both components are known. As these assumptions are never met analysis of tagging experiments have only given average estimates (Anon, 1981). Other parameters which are different for these stocks, as otolith structure (Rätz 1990), growth rate etc. have not yet answered this question sufficiently.

In this paper an attempt is made to analyse the immigration by studying the changes in the fishing mortalities for those year classes at Iceland which are subject to such an immigration.

Material

For this analysis data on catch in numbers were available back to 1941. Data for the most recent years i.e. 1971 and later are basically the same as in Anon. 1991, with some modifications for cod older than 14 years. For the period 1955-1970 basic data are the same as in Anon. 1976, but data on the Icelandic fisheries have been revised, based on more detailed information how catches were distributed by gears and areas. Also mean weight at age have been revised which give more reliable SOP-figures than those which can be calculated from the data in Anon. 1976. Estimated catch in numbers for the period 1941-1952 are entirely based on Icelandic age-length-keys. Prior to 1953 only length composition data were available for the German fisheries but in the period 1953-1954 also age composition data. By using the Icelandic age-length keys the German length composition data were used to account for that fishery.

COD SYMPOSIUM, SEPTEMBER 1991

Another important cod fishery at Iceland in those years was the UK fishery. The only available information on that fishery prior to 1955 are catches and effort data by fishing grounds and by time of the year. Icelandic age-composition data for same time and grounds were then used to convert the UK landings into catch in numbers data.

Method

For the cod fisheries at Iceland catch by age reaches normally a peak at the agegroups 4 or 5 years. For a typical Greenland year class entering Iceland grounds catch in numbers rises again for fish at age 7 or 8 years or even 9 years old in case of a strong year class as the 1945 year class (Fig. 1). From the available catch in numbers data an ordinary VPA was run. Input F for the oldest age group was chosen 0.5 but terminal F's in 1990 are the same as in Anon. 1991. It turned out as expected that for some year classes fishing mortalities for the younger age group were extremely low. Based on the assumption that the exploitation pattern had not changed, fishing mortalities for these age groups should not be lower than for the surrounding year classes at same age and the difference can be explained as an effect of an immigration. To account for this, F on these age groups can be increased. In the present paper F was increased to a level of a similiar order as that of the surrounding year classes at the same age, or to a level representing the likely fishing pattern. An example of the method for the 1960-1964 year classes is shown in Tables 1 and 2. It should be noted that the underlined F-values in Table 2 are chosen as input values. If groundfish survey data or effort data are available, F values can be selected by tuning (Gunnar Stefánsson pers. comm.). In case of Icelandic cod such data are only available for the most recent years. It can of course be argued if the F-values chosen here are the right ones, but it is the authors opinion that they can be seen as fairly realistic.

Results

The method shown in Tables 1 and 2 for 1960-1964 year classes was used for the whole period in view. By doing so more information on the immigrating year classes could be achieved. Following year classes include immigrants: 1936, 1937, 1938, 1942, 1945, 1950, 1953, 1956, 1961, 1962, 1963, 1973 and 1984 (Fig. 2). It is also quite possible that some cod from other year classes might as well have migrated to Iceland but these migrations were so small that they could not be detected if they existed to the noise in the data.

Most abundant of all the Greenland year classes in the period in question is the outstanding 1945 year class. According to landings from this yearclass in the late forties and the beginning of the fifties this year class turned out to be of an average size at Iceland (Fig. 2). Suddenly in 1953 and the following years, this year class showed up in large quantities on the spawning grounds off the SW-coast of Iceland (Fig. 1). According to the present analysis two third for this year class on Iceland grounds were immigrants from Greenland. For other Greenland year classes around one third or less of the year class size at Iceland were immigrants from Greenland.

In earlier years prior to 1972 when Greenland year classes were more frequent at Iceland one or more Greenland year classes could be at the same time in the stock at Iceland every year. In such cases the VPA overestimates the stock size at Iceland considerably, as the VPA backcalculates the immigrants and Icelandic cod as a one single stock also including the immature young cod component still at Greenland as a part of the Icelandic immature stock at Iceland (Fig. 3).

The impact of the immigrants on the assessment is greater than reflected by year class strength only. This is due to the fact that the immigrants are almost entirely large mature cod, which have more impact on the biomass estimate of the stock than on the stock size in numbers. As an example of this let us look again on the 1945 year class. If no fish of the 1945 year class had immigrated in 1953 the expected biomass of 8 years old fish would have been around 200 thousand tons. The large scale immigration changed that figure to more than 900 thousand tons of 8 year old fish !

The migration of an immigrating year class is normally spread over 2-3 years and therefore more than one immigrating year class can be at the same time in the stock at Iceland. This increases further the discrepancy in the backcalculations of the stock. The difference was greatest in the years around 1950 when the actual stock biomass at Iceland was overestimated by 40-60%. When the 1973 and 1984 year classes immigrated to Iceland the stock biomass was overestimated by 15-20% (Fig. 3).

Even though the fishing mortality at younger age of an immigrating year class is lower than for the surrounding year classes the average unweighted fishing mortality for the most exploited agegroups does not differ much when comparing the Icelandic stock component to the combined estimates (Fig. 4). On the other hand if fishing mortality is weighted by the year class strength much larger difference appears compared to unweighted fishing mortality, depending on the magnitude of the immigration, and the relative year class strength at Greenland and Iceland. This was especially pronounced in early 1950s.

Discussion

According to the analysis presented here immigration took more often place prior to 1970 than during the last two decades. This might be connected to a much poorer state of the stock at Greenland especially West Greenland after 1970. On the other hand the three last year classes which have emigrated from Greenland i.e. 1963, 1973 and 1984 year classes are all known to be of some extent of Icelandic origin i.e. have drifted as eggs/larvae from the spawning grounds at Iceland. Due to lack of research prior to 1963 no observation is available on larval drift from Iceland but it may be concluded that as the three above mentioned year classes were of Icelandic origin the other previous immigrating year classes could also have orginated from the spawning at Iceland. If this is the case the decline in frequency of larval drift towards Greenland may be caused by changes in the environment and/or can also be connected with the reduction of the stock at Iceland.

From the year class strength shown in Fig. 2 the size of the year class at age 3 has fluctuated by a factor of 7. It should however be noted that the yearclass strength in Fig. 2 only reflects the numbers in the stock at Iceland. A part of the year classes which drifted to Greenland were exploited there and therefore the actual size of these year classes are underestimated. If data are available for the Greenland fisheries it might be possible to throw some light on the actual size of these year classes. When studying the stock recruitment relationship for the cod stock at Iceland or fluctuations in the recruitment in relation to the environment such information is important.

Even though calculation from tagging experiments at Greenland indicate an average emigration rate of 0.05 at West Greenland and a value of 0.29 at East Greenland (Anon 1981) the emigration fluctuates considerably between years depending on year class strength, age at maturity etc. Other year classes than those defined here as immigrating year classes might also have included some migrants, but in comparison to the stock size at Iceland, two or three millions immigrants are hardly detectable and do not affect the assessment at all.

More serious consequences for the stock assessment at Iceland could happen when a strong immigrating year does show up on the Icelandic grounds. This was not a problem earlier when fishing was unlimited and VPA was unknown. At that time everybody was happy if more fish was seen on the fishing grounds also the fishery scientists. After the stock declined and the fishery needed to be restricted immigrants could be an extra problem of the assessment and hence the management. In 1980 and 1981 the 1973 year class showed up in large quantities on the spawning grounds off the SW coast of Iceland. Backcalculations by VPA **increased the stock size** of the younger age of that year class and hence the **fishing mortality in the years 1977-1979 decreased** in the new analysis compared to the assessment made the year before.

As this was shortly after the extension of Icelandic fisheries jurisdiction which lead to the sharp reduction of foreign fishing effort in 1977 and 1978, this decline in fishing mortality (weighted F's was used at that time) was consequently interpreted as a part of the overall reduction of the fishing effort, and the impact of the immigration which could not be quantified very well at that time, was underestimated.

The cod stock at Iceland was therefore thought to be in a better state i.e. larger biomass and lower fishing mortality, especially on the younger age groups. TAC recommendations for 1982 of 450.000 tonnes were based on this assessment. Even though cod catches were somewhat restricted at that time (effort limitations), the stock was in such a bad shape that the total catch (388.000 tonnes in 1982) did not reach the recommended TAC.

It is important both for the assessment and management of the Icelandic cod fisheries that information on larval drift and the size of the stock components is collected. This can be done by carrying out more extensive O-group and ground fish surveys in the Iceland-Greenland areas.

Acknowledgement

The author wish to thank the following scientists for their help in providing data on the U.K. and German fisheries at Iceland during the years 1946-1954: A.C. Burd, D. Cushing and B.W. Jones, Lowestoft, U.K. and late A. Mayer, Hamburg, Germany.

References

Anon., 1976. Report of the North-Western Working Group. ICES, C.M. 1976/G:6

Anon., 1981. Report of the Working Group on Cod Stocks off East Greenland. ICES, C.M. 1981/G:6.

Anon., 1991. State of Marine Stocks and Environmental Conditions in Icelandic Waters 1991. Prospects for the Fishing Year 1991/92. Hafrannsóknastofnunin. *Fjölrit nr.* 25, Reykjavík, 1991, 153 pp. (In Icelandic).

Rätz, H.J. 1990. The Assessment of the Migration of Atlantic Cod (*Cadus morhua L.*) between the Stocks off East and West Greenland by Means of Otolith Typing. NAFO SCR Doc. 90/34, Ser. No. N 1751, 42 pp.

Table 1. Cod at Iceland. F at age from an ordinary VPA run for the 1960-1964 year classes.

	Year class				
Age	1960	1961	1962	1963	1964
3	0.12	0.08	0.10	0.08	0.09
4	0.28	0.17	0.20	0.16	0.25
5	0.41	0.16	0.24	0.19	0.40
6	0.42	0.13	0.25	0.22	0.40
7	0.52	0.27	0.31	0.30	0.52
8	1.08	0.44	0.57	0.38	0.60
9	0.76	1.05	0.60	0.70	0.68
10	0.69	1.11	1.03	1.11	1.04

Table 2. Cod at Iceland. F at age from a VPA run where F-values have been increased to account for the immigration of 1961-1963 year classes.

	Year class				
Age	1960	1961	1962	1963	1964
3	0.12	0.11	0.12	0.10	0.09
4	0.28	0.25	0.21	0.23	0.25
5	0.41	0.27	0.31	0.30	0.40
6	0.42	0.24	0.35	0.40	0.40
7	0.52	0.60	0.50	0.50	0.52
8	1.08	0.70	0.70	0.70	0.60
9	0.76	1.05	0.80	0.70	0.68
10	0.69	1.11	1.03	1.11	1.04

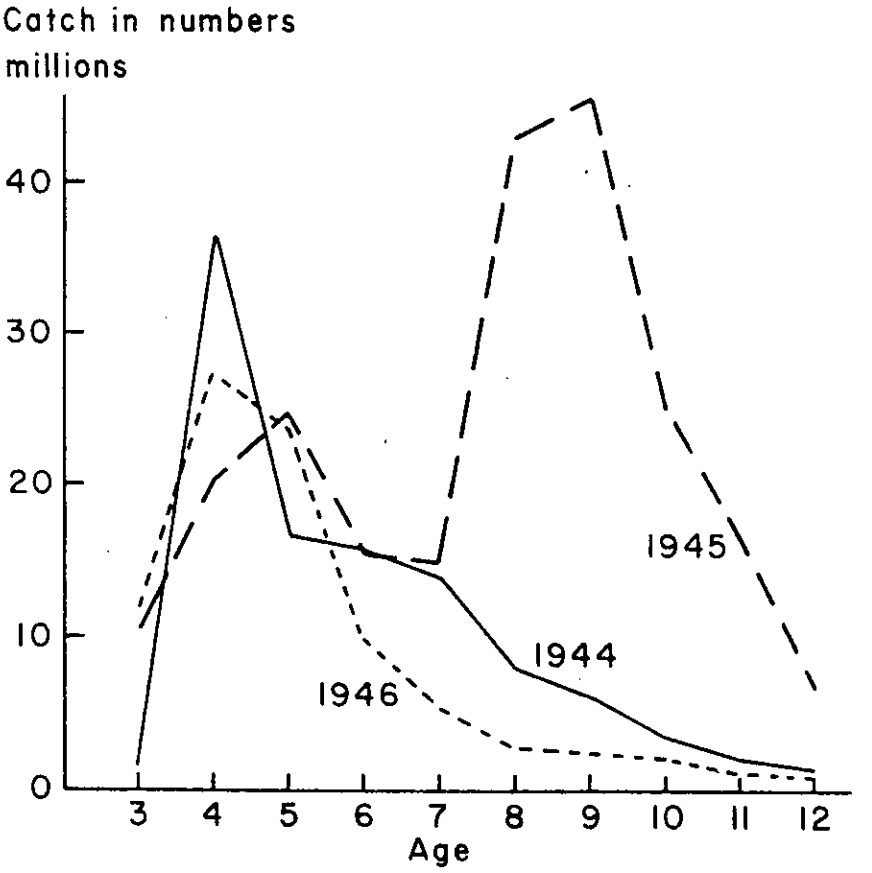

Fig. 1. Cod at Iceland. Catch at age for the 1944-1946 year classes.

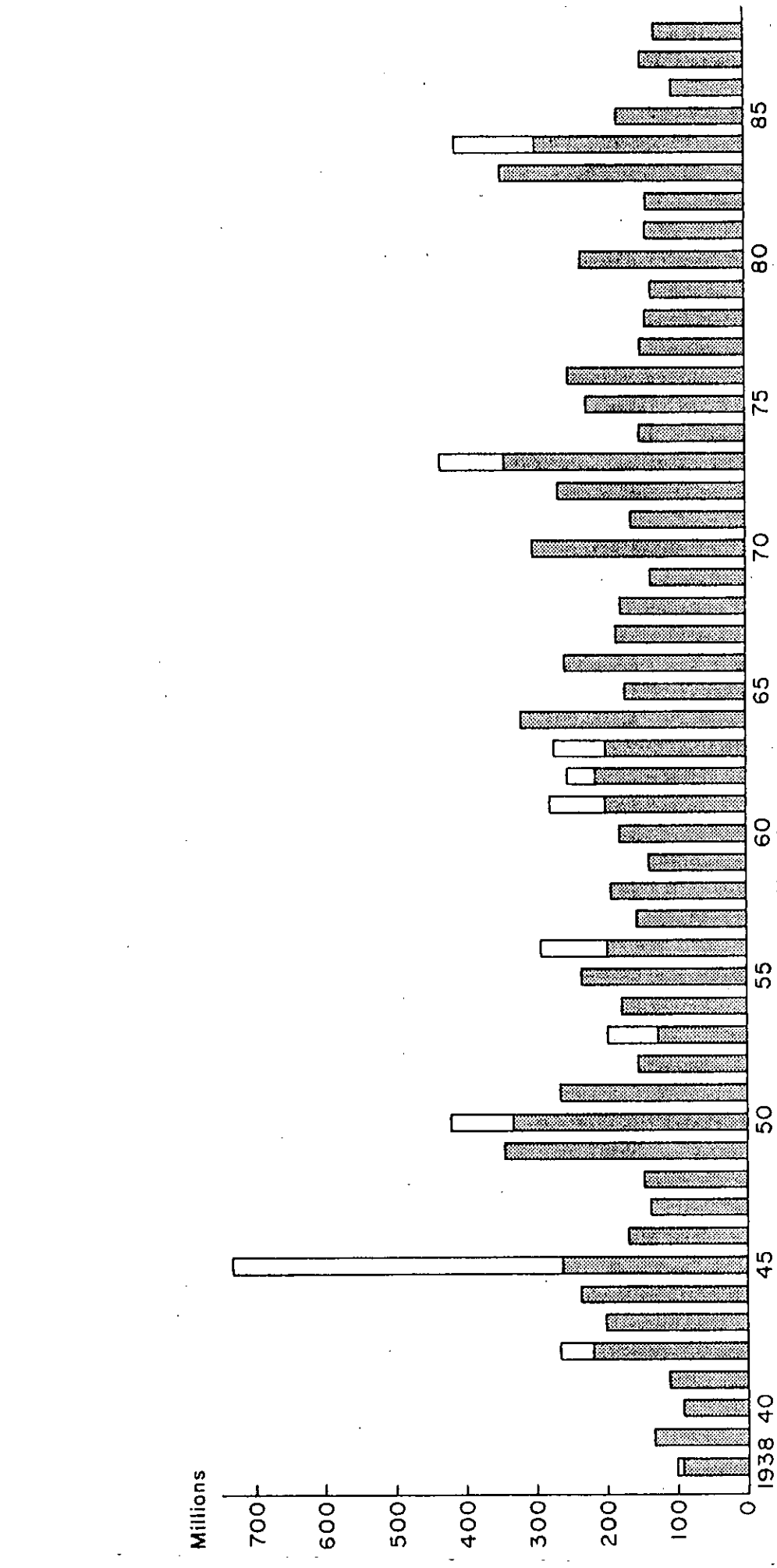

Fig. 2. Cod at Iceland. Year class size at age 3. Shaded columns: Icelandic cod. Open columns: Immigrants.

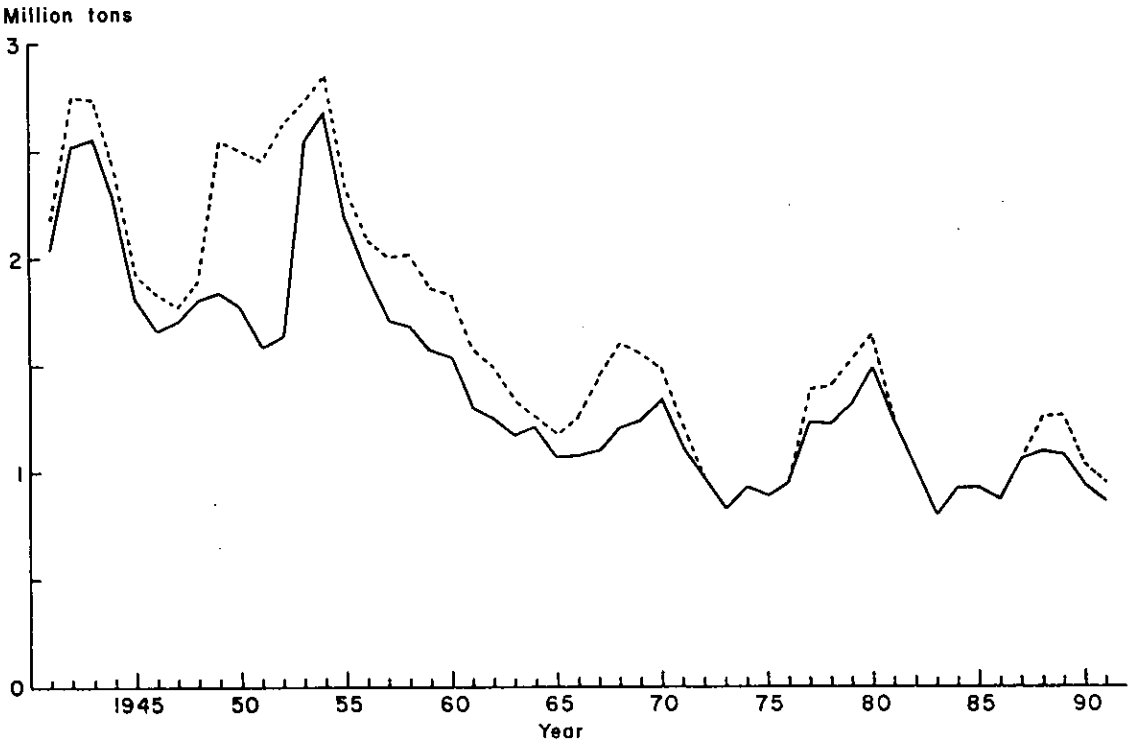

Fig. 3. Cod at Iceland. Stock biomass estimates. Broken line: Ordinary VPA run. Solid line: VPA run based on expected or likely fishing mortality at Iceland. This line should reflect the stock biomass at Iceland each year.

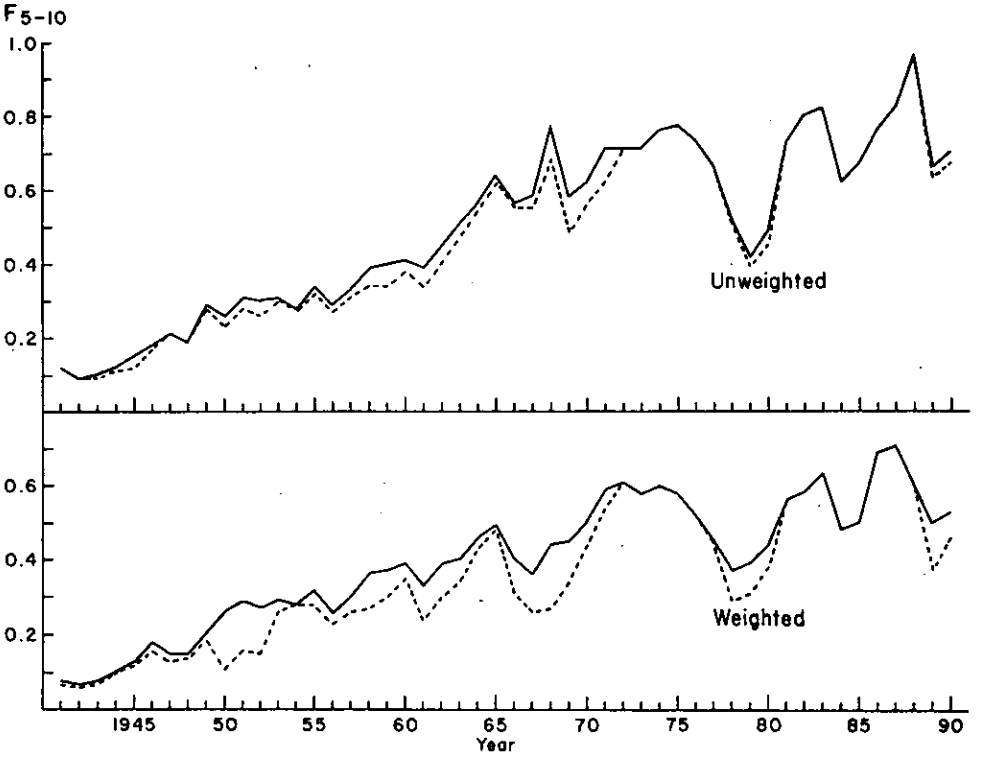

Fig. 4. Cod at Iceland. Upper part: Unweighted mean fishing mortality for the age groups 5-10. Lower part: Weighted mean fishing mortality for the age groups 5-10. Broken lines: Ordinary VPA run. Solid lines: VPA run based on expected or likely fishing mortalities at Iceland.