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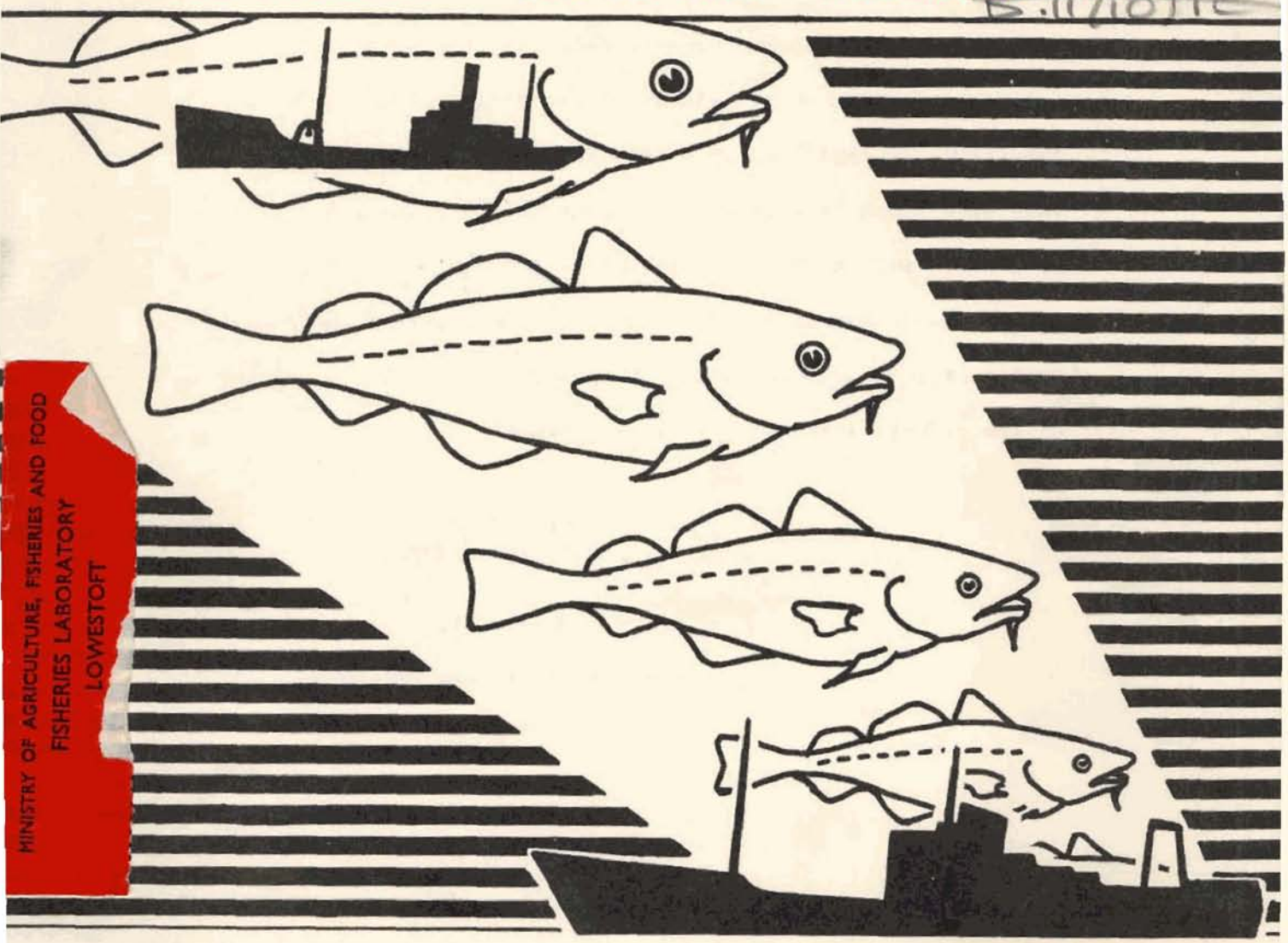
MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

FUTURE PROSPECTS IN THE DISTANT WATER FISHERIES



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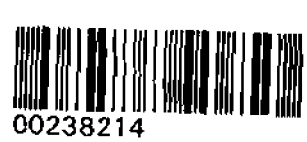

Laboratory Leaflet (New Series) No. 8

Future Prospects in the Distant-Water Fisheries

1. INTRODUCTION

This account of the present state of the fish stocks exploited by the United Kingdom distant-water fleet, and the immediate prospects of the fisheries based on them, is offered as an aid to policy and planning. Clearly the appropriate size and make-up of the fleet should be closely related to the expected yield from the fish stocks, and economic assessments must take into account the interplay of fishing effort and productivity which largely determines this yield. Because the fishing fleets of many nations exploit the same fish stocks, predictions of yield must necessarily be based to some extent upon subjective judgments of likely future changes in fishing by individual countries, but nevertheless the general short-term trends may be stated with some firmness. Longer-term prospects are more difficult to judge but some guidance is possible.

The conception of the sea as a limitless reservoir of fish is long out-dated. Within each of the numerous separate fish stocks of the north Atlantic the mature fish breed once a year, producing an enormous, yet finite, number of young fish. Each stock therefore contains only a limited number of fish available for capture, and the catch taken will depend upon

(i) the abundance of fish

(ii) the amount of fishing

and (iii) conditions in the sea which make fish more or less liable to capture.

Of these factors the precise fishing conditions in the sea are unpredictable, but, though seasonal changes may be important, over a whole year their short-term effects usually balance out, so that in the long run the catch and catch rate depend essentially upon the first two factors - the abundance of the stock and the amount of fishing. These will be shown to be closely connected, but to define their relationship, and to be able to predict future catch rates, we need to be able to measure them both.

2. METHODS

(a) Estimation of abundance

The abundance is measured by the catch per unit of fishing effort. A trawler fishing for a given period of time will sweep a certain area

of sea bed, so that the catch per unit time of fishing gives an index of the number of fish per unit area and hence an index of the abundance of the stock. The catch per unit fishing effort is therefore defined as the weight (or number) of fish caught by a standard trawler using standard gear for a standard unit of time.

For the majority of stocks in the east Atlantic the most reliable unit of effort is the catch per hour of United Kingdom trawlers, but its use has been complicated by increases in fishing power of the trawlers as their size and engine power have gone up. By comparing records of a large number of vessels, this fishing power factor has been found to be closely proportional to the gross tonnage, over the size range of 'conventional' trawlers* in the distant-water (D.W.) fleet; so the standard unit of effort used throughout this report is the catch per 1,000 ton-hours.

This unit of effort can be used to calculate the average catch rate of any tonnage class of trawler but it implies that, when fishing the same ground, a 400-ton motor trawler will on average catch as much in $2\frac{1}{2}$ hours as a 1,000-ton motor trawler will catch in one hour. In practice this parallel is not exact owing to the characteristics of particular vessels and their skippers: as a single unit, vessel + skipper + gear, not all 400-ton trawlers are equal, but so far as we can tell all the vessels within a given tonnage/propulsion class have equal potential fishing power.

This catch per unit of effort will also vary during the course of a year. In cod fisheries the catch rates are generally highest in the early summer, but in this account, in order to provide a more ready comparison with trawler annual running costs, the catch per unit effort is based upon the complete year's fishing and is calculated as total catch divided by the number of 1,000 ton-hours fished (i.e. hours fished x mean tonnage of vessel fishing, in thousands).

The annual average catch per unit effort given here may not correspond exactly with other estimates derived in a slightly different way, for example, from the catches of selected boats, but for the present purpose this does not matter. We are chiefly interested in changes from the present level, and these can be expressed as proportions, so that if stock abundance has changed by say 10%, this will be recorded consistently whether the change is measured in tons round fresh, or kits gutted, etc.

This measure of abundance is available in English units for the D.W. fisheries of the north-east Atlantic since 1930, but in the north-west Atlantic comprehensive statistics have been collected only since 1952. During this time United Kingdom fishing has covered only a small part of

*See Appendix 1.

this area, so that other units of effort have been used, the best being the catch per day's fishing, or catch per day on the grounds, by large French, Spanish and, in particular, Portuguese trawlers fishing cod for salting. Like the British, German trawlers have not fished the area for a sufficiently long period for their results to be of value in the present context.

(b) Estimation of the total amount of fishing

The total amount of fishing is calculated as the number of ton-hours fishing that English vessels would have to do to account for the whole international catch. For example, in 1960 English trawlers fished 97 million ton-hours of effort in the Barents Sea and caught 70 thousand tons of cod. The total international catch of cod in the area in that year was 380 thousand tons so that, in order to account for this total, English vessels would have needed to fish 97 x $^{380}/_{70}$ or 530 million ton-hours. This method, which is entirely valid for comparative purposes, is necessary because statistics of fishing effort are not available for all countries; even if they were it would be difficult to combine into a single measure of effort the fishing activities of the wide variety of fleets that fish the North Atlantic grounds.

These basic statistics of catch, catch per unit effort and fishing effort are given in Tables 1-6 for the years 1950-1963 for Barents Sea cod and haddock, Bear Island cod, Norway Coast cod and haddock, and Icelandic cod and haddock. The sources from which the data are derived are listed in Appendix 2.

In the fisheries mentioned above the post-war changes in catching rates have several features in common. The total international fishing effort in the different fisheries has increased by varying degrees but the total catch itself has not increased in proportion. Indeed, in some of the fisheries the total catch is somewhat less than it was during the mid-1950s. This is a consequence of the reduced abundance of fish within the stocks, as shown by the decline in the average catch per 1,000 ton-hours. For comparison, the average number of kits landed per day absent has also been given in the tables to show how this measure has been more or less maintained through the increased fishing power of the trawlers. The apparent constancy of kits/day tends to obscure the true decline in the abundance of the fish stocks. The difference between the two measures is shown more clearly in Table 7 where the value of the catch per 1,000 ton-hours is compared with the value of the catch per day absent.

The actual increase in the total fishing effort on the stocks of the north-east Atlantic (Barents Sea, Bear Island, Norway Coast, Iceland and Faroes) is illustrated in Figure 1, together with the United Kingdom contribution to this. Data for 1962-63 are not yet complete for the north-east Atlantic but there is reason to expect the increase to have

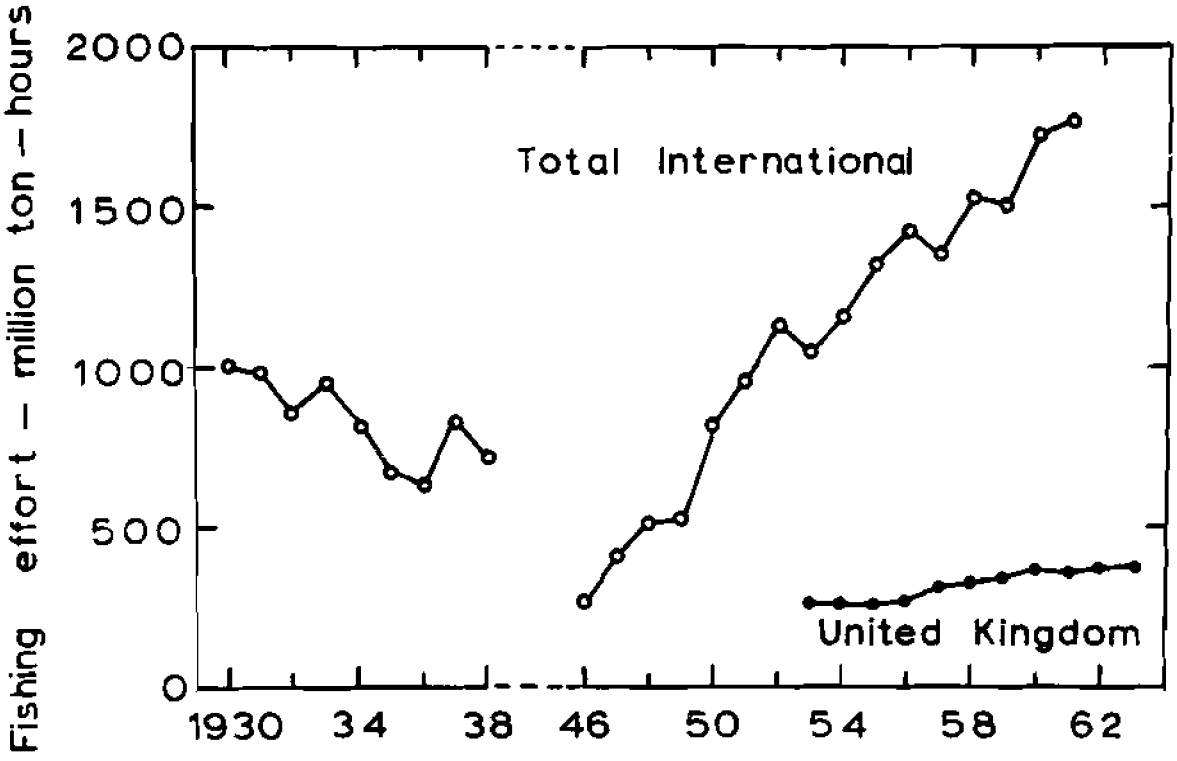

Figure 1 The total international fishing effort in the north-east Atlantic (Barents Sea, Bear Island, Norway Coast, Iceland and Faroes) 1930-1962, and the United Kingdom effort in recent years.

levelled off with the diversion of effort by the United Kingdom, and other nationalities, to the north-west Atlantic.

This build-up of the fishing effort is especially important because, as will be shown below, the decrease in abundance of the stocks is directly related to the increase in fishing and, should the present trend be continued, the United Kingdom D.W. fleet will have three choices of further development to maintain its present level of operation, viz:-

(i) some further increase in the catching power of individual vessels, e.g. vessel size - provided that costs do not rise in proportion;

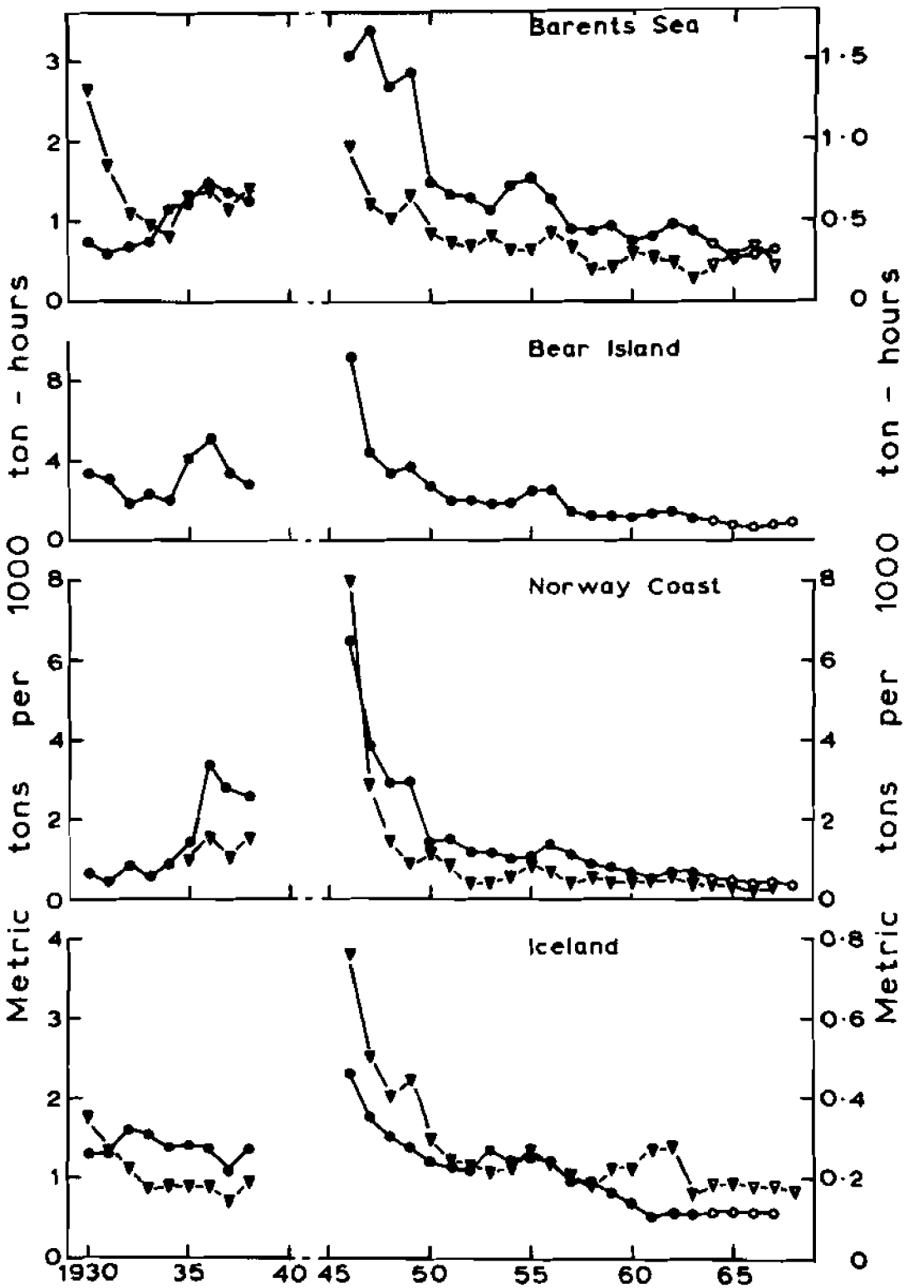

Figure 2 Changes in catch per unit effort in United Kingdom distant-water fisheries 1930-1963 (cod, shown by circles and left-hand scales, and haddock, shown by triangles and right-hand scales). The short-term forecast is shown by open symbols.

(ii) improved design of vessels and/or gear so that the catch can be taken at reduced cost;

(iii) diversion of effort to more remunerative grounds.

In order to provide a rational background for this decision this report sets out an assessment of the present catch per unit effort in the north Atlantic stocks, together with estimates of the future yields which may be expected.

(c) The relationship between catch per unit effort and the amount of fishing, and the prediction of catching rates from these data

Figure 2 illustrates the changes in the catch per 1,000 ton-hours since 1930 in each of the main distant-water fish stocks of the north-east Atlantic (Tables 1-6). However, fishing effort varies from year to year and, as they stand, this figure does not measure the decrease of stock abundance caused by increased fishing. The technique used to establish this is shown in Figure 3, using Icelandic cod as an example. The average catch per 1,000 ton-hours in any one year is plotted against the total amount of fishing by all countries in that and the two preceding years. This is done to allow for the fact that the abundance of the

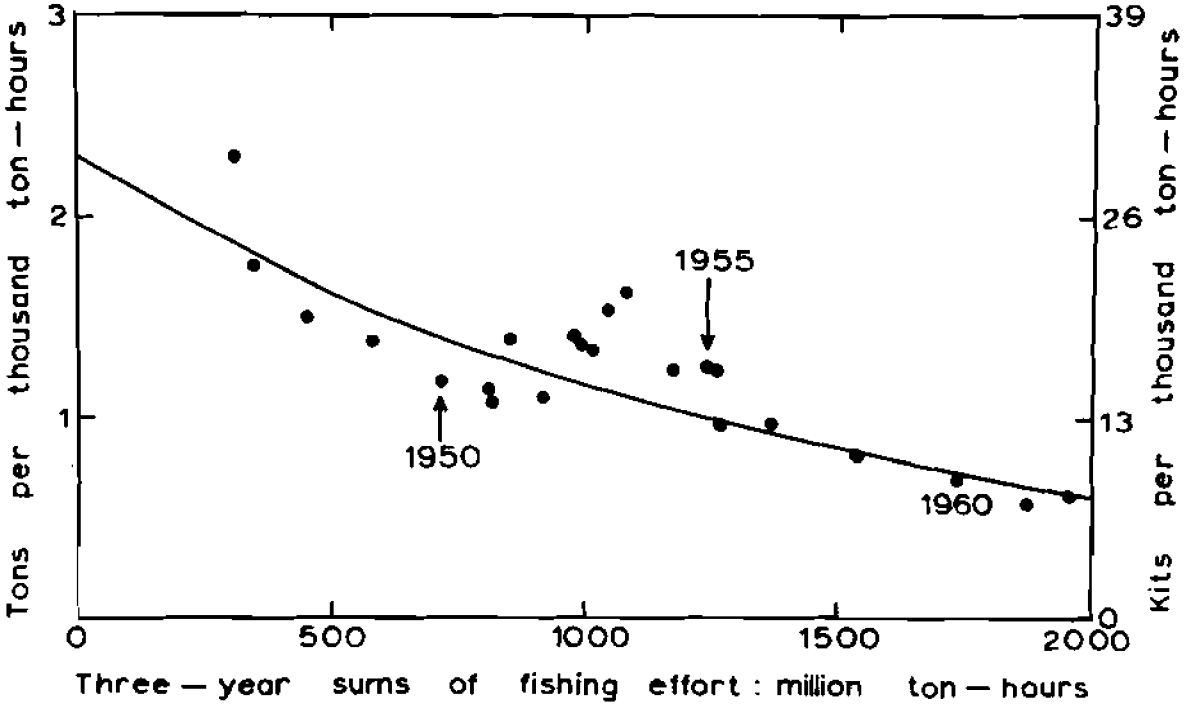

Figure 3 The relationship between catch per unit effort and fishing effort on Icelandic cod.

present stock is affected not only by the contemporary amount of fishing but also by fishing during several previous years. This basic relation has been determined for each of the stocks given in Tables 1-6, excluding the special case of the Norway Coast fishery.

The very obvious decline in catch per unit effort in Figure 3 follows from the effect of fishing upon the average lifespan of individual fish. As the intensity of fishing increases, the chances of a particular fish avoiding the gear are reduced; so fish tend to be caught at a younger age, and, more important, at a correspondingly smaller size.

This and similar records for the Barents Sea and Bear Island cod fisheries can be combined into a single illustration relating the decreasing catch per unit effort to the increased fishing. This is shown in Figure 4. (Data from the Faroes cod fishery are also included but not tabulated). In this generalisation the catch per unit effort is now expressed as a proportion of the stock that was present before fishing

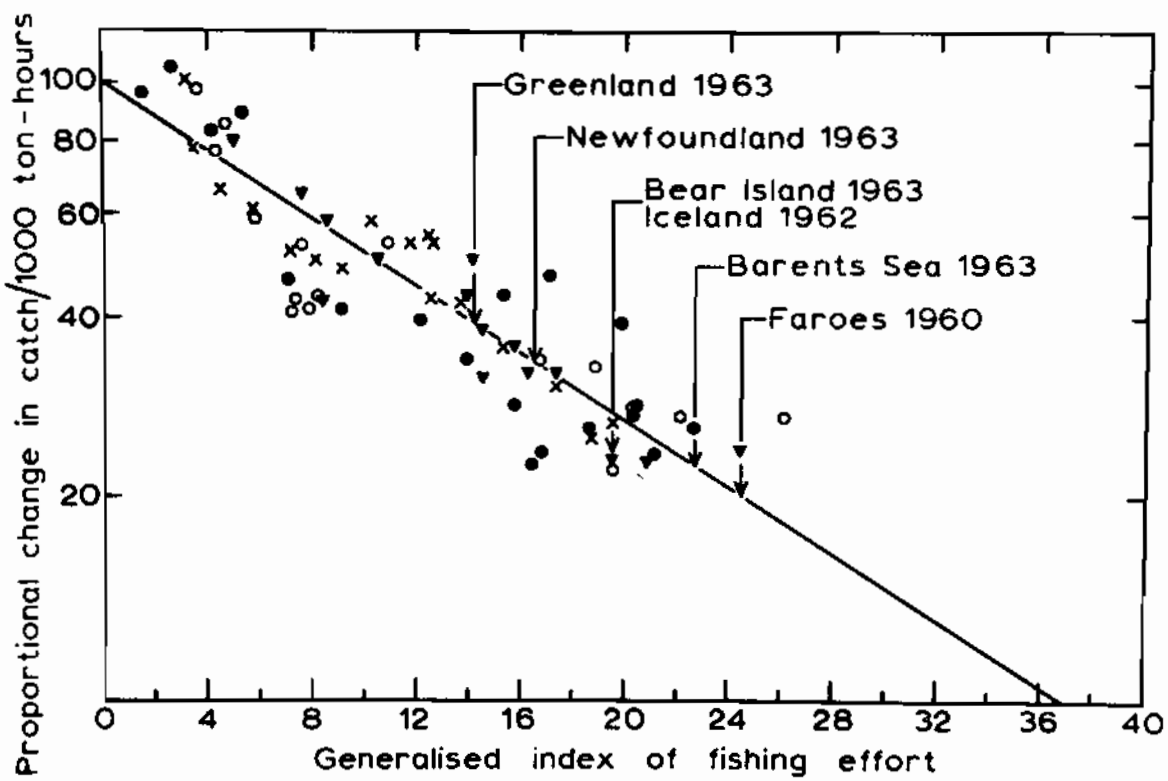

Figure 4 The generalised relationship between the abundance of fish and the amount of fishing in the United Kingdom distant-water cod fisheries. - Key. ● Barents Sea x Iceland ○ Bear Island ▼ Faroes

first began. Thus at 10 units of effort the average catch per unit effort has been reduced to 53.4% of its "unfished" level, and if the effort is doubled to 20 units (of effort) the catch per unit effort falls to 24.4% of its "unfished" level, and so on.

From time to time it has been supposed that other factors, e.g. climatic change, might account for the declining catches in the last decade, but this is not so; Figure 4 leaves no doubt that the increase in fishing is the principal, if not the only, cause of the decline. Some further evidence supporting this conclusion is discussed in Appendix 3.

The second feature of Figure 4 is the amount of scatter on either side of the statistically fitted average trend. This is mainly due to variation in the strength of individual year-classes: strong year-classes derived from spawnings in years when conditions for the survival of fry were favourable will give points above the average, and poor year-classes will give points below. Two other factors contribute to the scatter:-

(1) in some years, owing to variations in environmental conditions, e.g. sea temperature, or weather, fish may be more or less easily caught. This can have a marked effect on total catch, with the result that the catch per unit effort may temporarily over- or underestimate the true abundance of the stock. This happened at Newfoundland in 1958 when unusually warm conditions enabled the cod to disperse over a wide area and led to very poor catches. These changes cannot be predicted, but in general they have a short-term seasonal effect and seldom cause much departure from the average calculated over a whole year.

(2) in recent years, in areas where fishing has become very heavy, there has been a tendency to reject fewer of the smaller fish just above the minimum size limits. In such circumstances the landed catch per unit effort will overestimate the abundance of young fish in comparison with former years.

These scattering effects can be seen in the present situation in certain of the north-east Atlantic fisheries marked in Figure 4. The catches per 1,000 ton-hours at Bear Island in 1963, and at Iceland in 1962, were below average owing to a succession of poor year-classes. On the other hand, in the Barents Sea the figure for 1963 has been partially offset by reduced discard rates; fishermen are now bringing to market a larger proportion of their catch of fish which are only slightly above minimum landing sizes. Had they continued to bring back the same proportion of small fish as they did in 1955, then present catches would be about one third lower.

Provided the strengths of future year-classes continue to fluctuate

to about the same degree around the same average as they have in the past thirty years, then for half the time the annual catch rates will be within limits of plus or minus 20% of average, and once in every twenty years there will be an extremely good, or an extremely bad, year-class bringing the stock 40% above (or below) average. To put this another way: in these four major cod fisheries (Barents Sea, Bear Island, Faroes, Iceland) four new year-classes appear each year, so that, on average, once in five years a very good or very bad year-class will appear in one of the fisheries. These limits of variation are wide, but biological systems are intrinsically highly variable, and the assessment cannot be improved with the information available. Still, it is worth remembering that newly-built trawlers are expected to repay capital in 10-15 years, and to have a considerably longer working life, so that during this period the catch rates they encounter can be expected to lie within 10% of the average trend* which is determined by the amount of fishing and which is here used as a basis for prediction.

In interpreting Figure 4 it must be appreciated that the catch per unit effort is expressed in proportional units and the effort itself in multiples. At a given level of effort the actual catch rates will vary in different fisheries according to the characteristics of the stocks. For example, in Figure 4, the average catch per unit effort at Bear Island corresponding to the recent level of fishing effort would be 1.29 tons per 1,000 ton-hours, and at Iceland 0.67 tons per 1,000 ton-hours, but both represent a stock abundance of about 30% of the original "unfished" level in the two fisheries.

Knowing the relationship between catch per unit effort and the amount of fishing, and knowing the present level of fishing in each fishery, it is possible to calculate the proportional change in catch rate that can be expected for any given change in effort. Thus, taking the example of Iceland and Bear Island again, the total international effort in 1963 had an index of just below 20 units, giving, on the average line, a catch rate 29% of that in the unfished stock. If, in the next five years, the rate of fishing increases by 10% the total effort will rise to 22 units and catch rates will fall to 25% of that in the unfished stock. This represents a decline of 14% from the 1963 level (25 being 86% of 29).

These changes are shown in Figure 5 for the north Atlantic cod fisheries; the actual catch rates corresponding to the 100% point of each stock, i.e. the average catch per unit effort at the 1963 level of fishing, are as follows (in tons per 1,000 ton-hours):-

Barents Sea	0.75	West Greenland)	
		)	1.3 - 1.5
Bear Island	1.29	Newfoundland)	
Iceland	0.67		

*Where the annual variation is $\pm$ 20% over 15 years then, statistically, the long-term average catches will vary by 20% x $\frac{1}{\sqrt{15}}$ = about 5%.

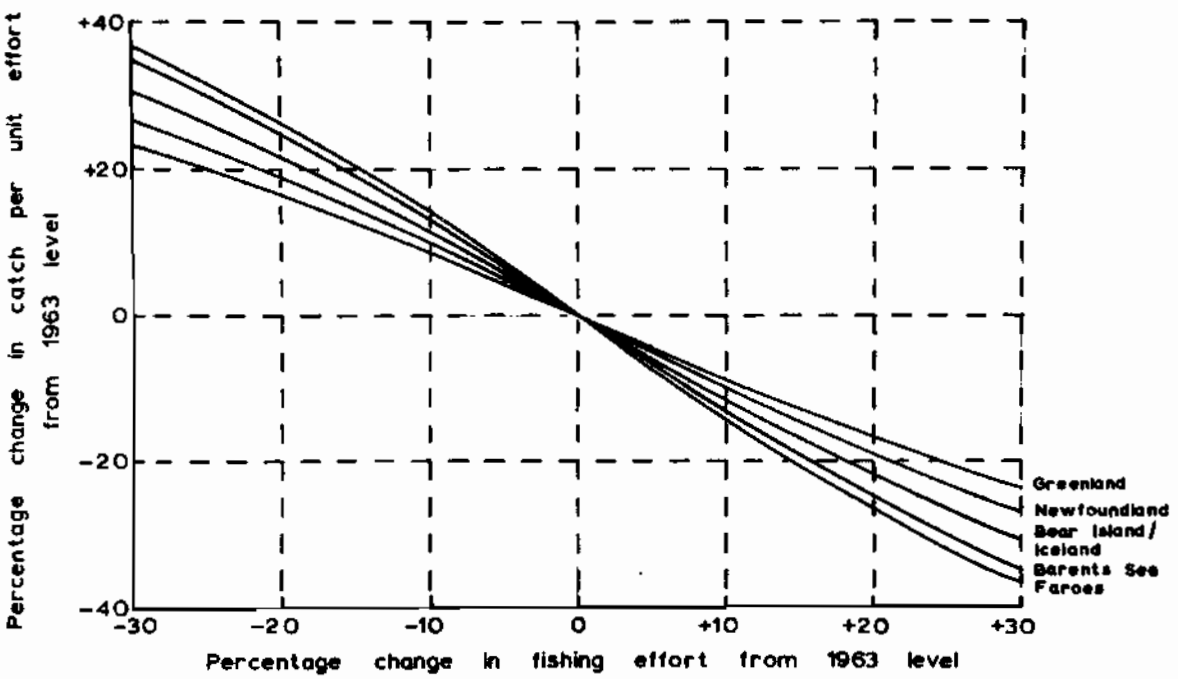

Figure 5 Proportional changes in the average catch per unit effort in United Kingdom distant-water cod fisheries for given changes in fishing effort from the level obtaining in 1963.

The information in Figures 4 and 5 represents the average catch per unit effort as tons per 1,000 ton-hours fishing. The actual catch rate in 1963, and in every other year, will deviate from it according to the relative strengths of the contemporary year-classes. Future catches are thus determined by forthcoming changes in fishing effort and the expected year-class strength, which cannot be forecast with precision. In particular, international fishing fleets are now sufficiently mobile to switch from one area to another according to their short-term profitability, with the result that the overall distribution of effort can change rapidly. The broad changes of effort expected in each of the cod fisheries are discussed below, together with information that is available concerning the incoming year-classes.

Haddock stocks at Iceland and in the Barents Sea have been analysed in the same way, and, although not illustrated in detail, the proportional changes in catch rates with increasing effort can be taken to be closely similar to those given in Figure 5 for the Newfoundland cod fishery.

3. REGIONAL FISHERIES: EASTERN ATLANTIC

(a) North-east Arctic cod

The fisheries of the Barents Sea, Bear Island and Norway Coast are based upon a single stock of cod. These fish originate as fry from the spawning grounds around the Lofoten Islands, from whence they drift in mid-water with the tail end of the Gulf Stream into the Barents Sea and on to the Spitzbergen Shelf. The young fish go to the bottom in the autumn of their first year in these two main areas and remain in the same general area until they are themselves ready to spawn at about 7 years of age. They are large enough to be of interest to trawlermen at 4 years of age. Consequently in these early years of their life the Barents Sea and Bear Island codling can be regarded as separate stocks. The Norway Coast fishery depends mainly upon mature fish, so its yield is determined largely by the effect of fishing on the codling whilst they are still in the Barents Sea and at Bear Island.

(i) Barents Sea cod (Table 1)

Most of the fishing is done by Russian vessels, with Norway and England also taking appreciable quantities, whilst in particularly good years, e.g. 1956-57, other countries, principally France, Faroes and Germany, have taken significant quantities.

When Russian fishing effort is expressed in equivalent English units, it appears that the rapid expansion between 1950 and 1956 was followed by a sharp reduction in activity in 1957-59. However, at that time Russian catches of redfish from this area were increasing (see Table 15), so the apparent decrease in fishing for cod probably reflects a change in the main objective of the Russian fleet. Since 1960 Russian fishing for cod has apparently increased again, passing its original level to reach its highest ever level in 1963, when it accounted for two-thirds of all fishing in the Barents Sea, five times as much as the English effort. However, recently built Russian factory and refrigerated ships are more suited to long-range working, so it seems unlikely that Russian effort in the Barents Sea will continue to increase rapidly.

When the Norwegian catch is expressed in terms of English effort it appears that their fishing effort has been fairly steady since 1957 except for an apparent peak in 1958. This was an unusual year in which the Norwegians concentrated on large cod to a greater extent than the English trawlers, so the method of calculation may have overestimated the total fishing effort in that year.

English effort has shown no persistent trends. Low values between 1953 and 1959 were due to the diversion of ships to other north Atlantic grounds, and for the next few years effort has been assumed to be steady at the average of the past four years. This may overestimate our contribution, but since we provided only 15% of the total international effort in 1963 quite large changes in English activity would have relatively little effect upon the general picture.

Fishing effort in the east Atlantic by other countries has declined since the peak of 1956, due to the diversion of ships to the west Atlantic. It is reasonable to expect that their effort in 1962-63 was, and in the near future will remain, close to the average for the years 1957-61.

It is not possible to predict accurately the changes in fishing effort in particular areas by individual countries, but for the purposes of making a forecast of catching rates some allowance for change has been made by assuming that the total effort will increase by rather less than 10% per year.

Concerning the relative strength of the youngest year-classes, the best information comes from routine Russian research surveys using small-meshed gear.

In these data the 1948, 1949 and the 1950 classes were more numerous than any other year-classes. Surveys carried out by the R.V. ERNEST HOLT at Bear Island, where the year-class pattern is broadly similar to that of the Barents Sea, also showed these groups to be outstandingly abundant when they were 2-3 years old and before they came into the commercial fishery. Their appearance coincided with the rapid increase in Russian fishing activity in the Barents Sea, and it was these year-classes that gave the good catches of 1955-56 when the cod were 5-7 years old. From 1964-68 the fishery will depend mainly on the year-classes of 1958-64 but of these only the 1958 class appears to have been above average; 1960 was below average and 1961 much below average. It is too early to be sure of the exact size of the 1962 class but it is not exceptionally strong.

In Table 8 (i) the expected increases in fishing effort are summed to give a total effort which is related to the catch rate expected under average conditions (Column A). This is then multiplied by a factor (Column B) which estimates the year-class strength in the fishery relative to the average, and the product of these two (Column C) gives the expected catch rate per 1,000 ton-hours. The final column converts this to kits per day for a 700-ton trawler. These results imply a continued decline in catching rates, except for a small improvement in 1966-67, but this will not bring catch rates back to previous levels.

(ii) Bear Island/Spitzbergen cod (Table 2)

Owing to a steady increase in Russian fishing activity the extent of English participation in the Bear Island fishery has fallen from 70% in 1950 to 40% in 1963. Both English and Russian fishery statistics record a continuous decline in catching rates except for the two years 1955 and 1956, when the three consecutive good year-classes 1948-50 were present in the fishery (see above). As happened in the Barents Sea, other countries besides Russia, England and Norway visited the area in the good years, but owing to considerable fluctuation in Russian effort from year to year it is difficult to predict the future trend. Basically higher catch rates may make this area more attractive to freezer trawlers than the Barents Sea, so it is expected that fishing effort will continue to increase slowly at around 10% a year.

Russian small cod surveys in the area did not begin until 1959-60 and as yet have not built up a basis for comparison with the most recent year-classes; our information on year-class strength therefore depends mainly upon the results of Russian scout trawlers and English records of the proportion of very young fish in the catch. Catches between 1964 and 1967 will be most influenced by the 1957-63 year-classes; these are the same groups that will appear in the Barents Sea stock and, as noted above, none of them seems likely to be more than average (1961 appears very poor indeed).

The result of combining these increases in effort with the year-class strength in Table 8 (ii) is to show catch rates declining till 1966 as these poor age groups go through the fishery. Thereafter there may be some recovery, but even so no great increase in catch rates to the levels of the mid-1950s can be expected during the next five years.

(iii) Norway Coast cod (Table 3)

The cod caught on these grounds are mostly mature individuals of 8 or more years of age coming from the Barents Sea and Bear Island feeding grounds. Their numbers are thus heavily affected by increased fishing in these two areas and it is not surprising that the catch per unit effort of English trawlers has fallen to less than half its 1950 level. Because of the long exposure of the cod to fishing before they reach the Norway Coast fishery the catch rate is determined by the intensity of fishing in the previous 5 years, rather than in the previous 3 years as in the feeding fisheries, so the rate of fall in the catch per unit effort is all the more rapid. The drop since 1956 corresponds with the expansion of fishing in the feeding fisheries just before 1956. Since then, as has already been shown, the average fishing effort in the north-east Arctic has tended to increase and will continue to do so.

The year-classes that will reach the Norway Coast in the next four years are already in the feeding fisheries, and since none of them was exceptionally strong the decline of the Norway Coast cod fishery is expected to continue.

(b) North-east Arctic haddock

(i) Barents Sea haddock (Table 4)

The fishing effort deployed on the haddock stock is not exactly the same as that on cod, because of the different fishing interests of the fleets involved. The average catch of haddock recorded depends as much on the proportion of the fleet which is concentrating on haddock as it does on the abundance of the fish themselves. Nevertheless, as with cod, it is clear that the recent decline in catches is due primarily to the increase in fishing.

For present purposes it is assumed that fishing effort on haddock will follow the same pattern as for cod, but excluding the proportion of fishing effort carried out by 'other' countries since these do not appear to fish for haddock when they do visit the Barents Sea.

The year-class strength of haddock shows very marked fluctuations, which accounts for the widely varying success of the haddock fisheries. The 1950 class gave English trawlers good catching rates in 1956, and two consecutive year-classes, 1956 and 1957, gave the good fishing in 1960-62. Clearly the English fishery depends mainly on the abundance of 4-6 year-old haddock, so that in 1964-67 it will depend upon the 1958-1962 year-classes. Russian surveys of young haddock indicate that the 1959 class is at least of average strength and the 1960 and 1961 year-classes may be well above average. The overall trend in haddock catches is given in Table 8 (iii), constructed in the same way as for cod. In 1964 the remnants of the good 1956 and 1957 year-classes and the incoming stronger 1960 and 1961 groups will have offset the effect of the poor age groups in the middle range, so holding the catch rate at the average level. Thereafter some increase is expected with the progress through the fishery of the 1960 and 1961 groups.

(ii) Norway Coast haddock (Table 3)

Less is known of the biology of haddock in this area but it appears that the fish found at Norway Coast, as in the case of cod, are the larger mature fish drawn from other areas. The general picture for cod seems also true of haddock, viz; that recent increases in fishing in the feeding areas can be related to the fall in catch per 1,000 ton-hours. The peak catch per unit effort in 1962 was due to the rich 1956 year-class which had previously given

good catches in the Barents Sea in 1960. Future trends in haddock catches at the Norway Coast may also be expected to follow the pattern of Barents Sea landings, with a two-year time lag. Thus the above-average 1960 and 1961 year-classes, which should improve the Barents Sea catches in 1965, will not make a major contribution at the Norway Coast before 1967.

Estimates of future catch rates for both cod and haddock at the Norway Coast are given in Table 8 (iv), but owing to the complex basis of the fishery this forecast is less precise than those for the feeding fisheries.

(c) Iceland cod (Table 5)

In 1956 the total international effort at Iceland stood at 450,000 English units, but in 1957 a proportion of the continental fishing effort was diverted to Iceland from the declining north-east Arctic grounds, and by 1961 the effort had risen to 700,000 units. However, Icelandic effort has now reached a plateau and German effort is mainly concentrated at Greenland and Newfoundland. Moreover, with the majority of the English distant-water fleet, and a part of the middle-water fleet fishing Iceland it does not seem that British effort has the capacity to increase much more, though there may be some further diversion from the north-east Arctic and Faroe. Russian vessels at Iceland are principally interested in herring, and their participation in the cod fishery is relatively small; the fishery on bottom-living species is too distant for their conventional trawlers and unprofitable for their factory vessels. Overall the fishing effort is expected to remain steady, or even to decrease slightly, during the next few years.

As yet there are no routine surveys of young cod at Iceland similar to the Russian surveys in the north-east Arctic, so that our only measure of recent year-classes comes from English catch records. These are not now strictly comparable with those of earlier years, because of the effects of recent limit extensions, but there is no indication of an outstanding new year-class. The last above-average year-class of 1958 has passed out of the fishery, and, assuming year-class strength to remain at average levels during the next year or two, the catch per unit effort can be expected to remain fairly steady.

(d) Iceland haddock (Table 6)

The distribution of haddock at Iceland is somewhat different from that of cod. Belgian and Scottish trawlers are able to take important quantities of haddock without much effect on the cod fishery. However, it is expected that most future building of new vessels by these and other countries (except Iceland) will be of freezer and factory trawlers, employed further afield. In predicting future catching rates some allowance has been made for expansion of the total international fishing effort by assuming it to increase by about 2% per year.

The Icelandic haddock stock shows very wide fluctuations in year-class strength; this means that, although recent increases in effort

have in general caused a decline in average catch rates, the fishery may suddenly be restored for a short period by the appearance of a very strong brood. Thus the English catch rates of 1961 and 1962 stemmed from the two consecutive outstanding year-classes of 1956 and 1957, but in 1963 catch rates fell again as these age groups passed out of the fishery. Such data on recent year-class strengths as are available suggest that the 1958 and 1959 classes are average and the 1960 class good.

In Table 8 (v) information on effort and year-class strength is combined to predict future trends.

(e) East Greenland cod (Table 9)

The East Greenland and Iceland cod stocks are closely related, but because the East Greenland stock occupies only a relatively limited geographical area it may already be fairly heavily exploited despite the low level of actual fishing. This conclusion is based upon the change in age composition of the stock. When fishing first increased in the late 1950s the catches contained a high proportion of old fish; these have now been fished out and the average age is similar to that of cod at Iceland itself. Consequently there is no great potential for increased catches.

Recent catches are given in Table 9. Our knowledge of this fishery is not sufficient to provide quantitative predictions but it is expected that the total catch will remain small compared with those of Iceland and West Greenland.

These short-term predictions for the north-east Atlantic are not very encouraging, and although new techniques may be developed to catch cod off the bottom and so may augment catches, it is certain that the west Atlantic grounds will become an increasingly important source of supply. Past records of fishing in these areas are less extensive than for stocks in the east Atlantic, but the information available is analysed below in much the same way as for the other regions already discussed.

4. REGIONAL FISHERIES: WESTERN ATLANTIC

The fishing in this area from Greenland west and south to New England may be divided into four categories:-

(a) fishing by coastal states (Greenland, Canada, United States);

(b) European salt-cod fishing (mainly by France, Portugal and Spain with, occasionally in the past, the United Kingdom);

(c) factory-ship and mother-ship operations (mainly U.S.S.R. and some United Kingdom);

(d) conventional distant-water and freezer-trawlers (mainly Germany and United Kingdom).

A number of different cod stocks are involved, but since the highly mobile second and third fishing groups can, and do, switch their activities from one area to another, it is appropriate to consider first the ICNAF (International Commission for the Northwest Atlantic Fisheries) area as a whole*. Comprehensive catch statistics are only available for the years since 1952; Table 10A gives the total international and United Kingdom catch of cod, broken down into fishing areas, while Table 10B gives the proportional contribution of each main country since 1960. The peak catches for the United Kingdom in 1952 are to some extent misleading, being predominantly catches from an exceptional fishery off south Greenland which has never been repeated. From 1952-1960 catches were steady, excluding a poor yield in 1958 caused by unusual hydrographic conditions at Newfoundland. Since 1960 landings have increased, mainly due to bigger catches by Germany and the U.S.S.R. and, in terms of areas, higher landings from Greenland and Labrador.

Estimates of changes in the total amount of fishing have necessarily been based upon the salt-cod fisheries of France, Spain and Portugal (group (b) above), because the records of coastal states do not give a good measure of trawler fishing, and the most recent developments of groups (c) and (d) do not cover a sufficiently long period. An estimate of the increased fishing (relative to 1953 as 100%) is given in Table 11. The total number of days fished by the five main classes of vessel - otter trawlers (900-1,800 tons) of France, Portugal and Spain, Spanish pair trawlers and Portuguese dory vessels - is expressed relative to the effort in 1953 in Column 1. The proportion of the total catch taken by these groups is given in Column 2 and this is used to raise the figure in Column 1 to give a measure of total effort required to take the total catch. This is given in Column 3, and in Column 4 this is again referred to 1953 as the base line. The resulting trend is shown in Figure 6 for comparison with the increase in effort in the north-east Atlantic. This crude approach indicates an increase of the order of 50% in the amount of fishing in the ICNAF area, mainly since 1958. This is rather more than the increase in catch (see Table 10A), indicating some fall in the overall abundance of fish. This was of course inevitable: one cannot expect to increase fish catches without decreasing the number of fish in the sea.

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*The ICNAF area comprises West Greenland and all the continental shelf of the eastern sea-board of Canada and the United States, down to and including Georges Bank.

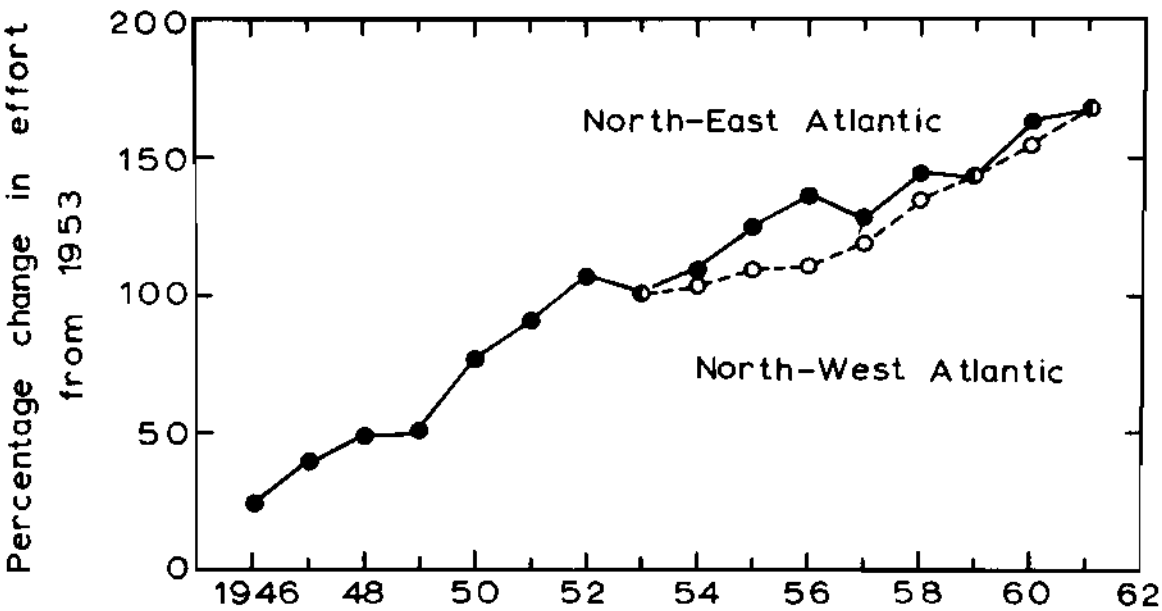

Figure 6 Proportional changes in fishing effort in the north-east and north-west Atlantic, relative to the fishing effort in 1953 as 100 per cent.

A rather better appraisal of the north-west Atlantic cod stocks can be obtained from the analysis of individual stocks, but conclusions are inevitably based upon a shorter period than for the north-east Atlantic stocks. Coupled with this is the absence of any substantial amount of United Kingdom fishing during the 1950s, so that estimates of the amount of fishing, and therefore average catch rates, must necessarily be based upon the results of foreign trawlers.

The most extensive statistics of fishing effort are those used above, taken from the records of the salt-cod fishermen. Recently Portuguese trawlers have averaged 10-12 hours fishing per day on the grounds at Greenland and 12-16 hours a day elsewhere in the north-west Atlantic. At Greenland their catch per hour has been slightly higher than that of the larger English D.W. trawlers of 700-800 tons, so that, in comparing areas, a day on the ground by a Portuguese trawler is equivalent to around 10,000 English ton-hours.

(a) West Greenland cod (Table 12)

Cod stocks at Greenland are, climatically, more delicately balanced than elsewhere owing to long-term variations in the warm and cold currents running along the coast. At the beginning of this century there were few cod at Greenland but since the early 1920s the area has warmed up and the cod stock has increased very greatly. Presumably, if the climatic trend were reversed, the cod would again disappear, but there is no evidence to suggest that this will happen in the near future.

There are two stocks of cod at Greenland which are important to the trawl fishery; they are divided north and south at about 62°N, with the southerly stock extending around Cape Farewell to east Greenland and Iceland. There is an area of overlap between the stocks, so that national statistics cannot always distinguish from which stock the catch has been taken, and for the present purpose it is simpler to regard them as one large stock. In fact the northern stock provides 80% of the catch where the locality of origin is known.

At least ten countries fish off West Greenland regularly, but the feature of recent catches has been the increase in the German effort which in 1963 took 30% of the total catch. The southern European salt-cod fisheries have always been important, but though Portugal continues to take 20% of the total catch, the Spanish fishery has been decreasing since 1959. The United Kingdom share increased in 1963 to 7% of the total and the 1964 figure may well be higher.

The overall trend in catches in Table 10A shows that the total catch remained fairly steady around 250,000 tons until 1961. Since then there has been a substantial increase, mainly from the northern part of the stock.

Fishing effort and catch per unit effort data are available for several groups of vessels, but none gives full coverage of all areas at all seasons; hence differences in detail appear in the various measures. The catches per unit effort of five groups of otter trawlers (from Faroes, France, Germany, Portugal and Spain respectively) are given in Table 12A, and in 12B these are expressed relative to the level in 1954 to give a measure of the proportional change in catch per unit effort. Using the changes in total catch related to 1954 in the same way thus gives an estimate of the recent change in the total amount of fishing. These last three columns of Table 12B indicate that although total catch remained steady until 1960, fishing effort has been increasing over the whole period, and the catch per unit effort declining.

However, at Greenland, records from such a short series of years are not sufficient to make it certain that a decline in catch rates has been caused by the increased fishing, because here stocks are especially noted for wide variations in year-class strength. The peak catch rate

around 1955 is almost certainly associated with a very strong year-class in 1947 (being less heavily fished than eastern stocks at that time, the cod made their greatest contribution to the catches at a higher age). On the other hand the 1962/63 catch rates also may be rather high, owing to the presence of the outstanding 1956 class in the southern stock and the 1957 class in the north.

By analogy with the history of the east Atlantic stocks it is fairly certain that the trends in the catch statistics are related to the increased fishing, and the estimated 40% decrease in the catch per unit effort has been associated with an increase in fishing effort of $2\frac{1}{2}$ times, to locate the present level of Greenland fishing on the generalised illustration Figure 4. From this is obtained the proportional change in catch rate for a given change in effort shown in Figure 5. This can only be a tentative estimate, but it appears reasonable in relation to the other stocks shown. The Barents Sea was at this level of exploitation in 1953, Bear Island in 1956 and Iceland in 1958. The subsequent history of catch rates in these stocks has been shown.

At West Greenland fishing effort is likely to be increased in the future, with more British trawlers (especially freezer vessels) and very likely more Russian and Polish vessels.

The year-class strengths of Greenland cod are quite well known from Danish research surveys. There seems to be a relation between the warmth of the water in summer, and the survival of baby cod in that year. Recent surveys revealed average broods in 1958 and 1959 followed by good year-classes in 1960 and 1961. The broods of 1962 and 1963, however, seem to be very weak.

Combining the expected trend in effort with the year-class strength we expect the catch rate to fall in 1964, but to be held steady at that level or even to increase in 1965 and 1966 (despite the increased fishing effort) as the 1960 and 1961 year-classes come through. Thereafter there will be a sharp fall in catch rates in 1967 and 1968.

In comparing this prediction with the results of previous years' fishing at Greenland, allowance must be made for the change in English practice from autumn fishing off south Greenland to early summer fishing west and south. In 1963 this switch increased the average English catch rate for the whole year by a third, to 1.5 tons per 1,000 ton-hours, though the stock, if anything, decreased. (In 1962 slightly larger Portuguese trawlers averaged 16.6 tons per 10-12 hour day.) Assuming this seasonal change to be maintained, the average catch rates per 1,000 ton-hours of conventional trawlers (700-800 tons) are estimated as follows:-

1964	1965	1966	1967	1968
1.3	1.3	1.3	0.9	0.9

but these figures are clearly very imprecise.

(b) Labrador cod (Table 13)

Cod in this area seem to be of one stock with some mixing with the stocks in the northernmost part of the Newfoundland area. Recent total catches are shown in Table 10A. Before 1952 most of the catch came from a very heterogeneous inshore Canadian fishery which took 80,000 tons in 1940, but by 1950 this fishery had declined to around 10,000 tons a year and it has since been replaced in importance by the offshore trawl fishery. At first fishing was mainly by French and Portuguese vessels, but recently Spanish effort has increased (hence the decrease at West Greenland) together with German and Russian fishing. These last two countries are now fishing for cod, having been diverted from a brief but intensive redfish fishery which was at its peak during 1959 and 1960.

As in the English fishery at Greenland, there has been a change in the seasonal pattern of fishing at Labrador from the autumn (September-November) to the early summer (April-June) when the catch per day is much higher. This change took place about 1960, so that it has been necessary to rely on catch rates in the Portuguese autumn fishery to show trends in the abundance of the stock over a longer period. These catch rates, together with the total catch and derived fishing effort, are expressed relative to the 1954 level in Table 13. The trends indicate that a twenty-fold increase in effort (four-fold since 1959) has only resulted in a ten-fold increase in catch. This implies reduced catch rates, but the information is not as reliable as for other regions. However, it is known that fewer old fish are now being caught, with a consequent marked fall in the average size of cod. It seems possible that the peak catch of 1961 marked the rapid removal of stocks of old fish accumulated during the period of relatively light fishing and that henceforth the fishery will depend more heavily upon the incoming year-classes, as do the more heavily fished stocks elsewhere.

Nothing is yet known about the fluctuations in year-class strength of Labrador cod, but it seems probable that variations of water temperature, making the fish more or less catchable, will also be important here. The low catch rate of 1958 was caused by this kind of change which cannot as yet be predicted in advance.

For the reasons given above, our knowledge of Labrador cod is too sketchy for the current state of the fishery to be illustrated in Figure 4 but, as an informed guess, the fishing effort may be said to be likely to remain at the present level, with the catch rate falling to 6-10 tons per day on the grounds fished by Portuguese trawlers - i.e. about 1.0 tons/1,000 ton-hours English.

(c) Newfoundland cod (Table 14)

The Newfoundland area contains several different stocks of cod which mix to varying degrees. They can be grouped into three sub-areas that

are virtually distinct, so that the fishing in one sub-area has no influence on the cod catches in the adjacent sub-areas: these are

(i) the banks east and north-east of Newfoundland (where the stock may mix with Labrador cod;

(ii) the southern coast and Grand Banks;

(iii) Flemish Cap.

Total catches are highest on the first group of banks, but since fishing effort is able to switch rapidly from one region to another within a trip, depending upon the fishing reports, it is preferable to deal with the area as a whole for the present purpose. The most extensive catch statistics again come from the European salt-cod fishing fleet and show no conspicuous trend during the last eight years; nor do the records of the other major country, Newfoundland itself. Russia takes around 10% of the catch.

As on the other west Atlantic grounds, in the absence of English data the best estimate of trends in the fishing has been obtained by relating the catch rates of the five main groups of vessels (defined in Table 14) to their catch rates in 1954 and using the average of these to calculate changes in fishing effort required to account for the entire catch, again expressed relative to 1954. This information (in Table 14) shows increased effort around 1960, but in general catch rates of Portuguese trawlers have fluctuated around a steady average level of about 19 tons per day or 1.5 tons per hour's fishing (Portuguese trawlers) - i.e. about 1.4 tons per 1,000 ton-hours English.

No major change in effort is foreseen in the near future. Some countries which have fished these grounds for many years are now showing an increasing interest in the South Atlantic, and other east European countries are only just developing their long-range fleets, so that the expansion of their effort may not be rapid. The pattern of fishing by the U.S.S.R. has also changed recently, with greater emphasis falling upon silver hake which in 1963 comprised 60% of their demersal landings as opposed to 25% in 1962. Fishing by locally based vessels will probably increase, but the overall level is not expected to show any dramatic change, and variation from the present mean catch rate is likely to be due more to year-class variation and other enviromental factors than to fishing.

Portuguese catch records go back to 1935, and the change in fishing since that earlier date has been used to give a rough location of present fishing at Newfoundland on the generalised scale in Figure 4. The proportional change in catch rates with effort at this level is also added to Figure 5. Very little change from the average rate of recent years is expected, especially since the year-class strength seems less variable than in other areas. Russian young cod surveys began here in

1961/62 but it is too early to assess the results, so in the absence of other data the best estimate is that the catch per unit effort will continue at around 19 tons per day by Portuguese trawlers, about 1.4 tons per 1,000 ton-hours English - slightly better than at Greenland.

(d) Newfoundland haddock

Haddock is mainly confined to the southern part of the Newfoundland area where it has been heavily fished by Canadian and Spanish vessels; Russian fishing was also very intensive during 1960 and 1961. The total catch has fallen steadily from 104,000 tons in 1955 to 14,000 tons in 1963, owing to a succession of poor year-classes on top of earlier heavy fishing. Haddock catches at present are mainly incidental to the cod fishery and the catch per unit of effort in recent years does not provide a reliable measure of the stock.

The last good year-class. the 1955 brood, gave a temporary improvement in catches in 1960/61, but Canadian research surveys of young haddock give no indication of the more recent appearance of a good year-brood. Since a good brood must be at least 4-5 years old before it will have any impact on the fishery, catches cannot improve appreciably before 1967/68 at the earliest.

(e) New England/Nova Scotia cod

Cod in these regions are nearing the southern limit of their natural range, and in total catch they are less productive than at Greenland or Newfoundland. Since 1954 Portuguese trawlers of 901-1,800 ton class have averaged 22.3 tons per day on the grounds, and Spanish trawlers of the same class have averaged 15.6 tons per day fished. Neither series of data shows a marked trend. Spanish trawlers take about 30 per cent of their west Atlantic catch from the Nova Scotia area but it contributes less than 10 per cent of the Portuguese and French catches. It is concluded that these catch rates, which fail to attract many French and Portuguese trawlers, are unlikely to interest conventional English distant-water trawlers in the near future apart from the occasional trial visit.

(f) Redfish (Table 15)

There are many uncertainties about the biology of redfish that make understanding of the present state of the stocks and prediction of the future difficult. For example redfish are not restricted to the relatively shallow banks as are cod and haddock, so they cannot be so clearly divided into stocks by deep-water channels. Consequently the relation of redfish on various grounds to each other and to the oceanic redfish is not yet known. Judging from the catch statistics in Table 15, redfish in the different regions are distinct (at least for short periods) because peak catches occur at different times, but they all show a common

pattern of a peak when fishing begins, followed by decline. This was most marked at Labrador where catches rose from 78,000 tons in 1958 - the first year of appreciable fishing - to 83,000 tons in 1960, but they have since fallen rapidly to 6,000 tons in 1963. No area has maintained a steady high catch: Iceland has declined steadily since 1953, East Greenland since 1955, north-east Newfoundland since 1959, Flemish Cap since 1958, and even the present steady catches of around 15,000 tons in the New England area are only about a quarter of those of the four peak years 1941-44. These trends are exaggerated by the diversion of effort from one ground to another as catch rates fall, but on the other hand the total catch is boosted by vessels of other countries, e.g. English trawlers which, without having a specific redfish fishery, have nevertheless recently tended to bring back more of their incidental catch of redfish than in former years.

This pattern of catches is consistent with the known high age and slow growth of redfish. The early redfish fisheries concentrated upon the original unfished stocks which contained the fish accumulated over many years. Once these had been reduced the fisheries have had to rely more heavily upon the annual production of redfish, and this is apparently low compared with cod. The long-term prospects for redfish are not good, at least on the present grounds. Yet there is evidence of a large potential fishery south-west of Iceland if some method of catching the fish in quantity could be found. This is deduced from the numbers of baby redfish spawned in the areas, which indicate a stock of about 100 million mature females and, presumably, a similar number of mature males. However, these females may form part of the Iceland-East Greenland redfish stock where the annual catch already amounts to about 50 million mature females per year, so that the evidence of an untapped resource here cannot yet be relied upon.

It is clear from the foregoing discussion that future redfish catches cannot easily be forecast. If no new grounds are found in the north Atlantic and no highly specialised technique is developed in the next four years, then future catches will probably follow the general pattern outlined above of a decline from the peak to a comparatively low steady yield on each ground.

5. SUMMARY OF SHORT-TERM FORECASTS (Tables 16 and 17)

The short-term forecasts contained in the text are summarised in Table 16 and have been added to Figure 2 to put them in perspective with catches of earlier years. The catch per 1,000 ton-hours in round fresh tons converted into kits of gutted fish per day's absence of a 700-ton motor trawler is also given in the Table. Thus the catch in kits per day at West Greenland is expected to average out at a higher level than at Newfoundland, owing to differences in steaming time, although the stock abundance will be slightly less.

As we have seen, these catch rates are estimated from the expected changes in international fishing in the various areas, but the prediction from them of the actual United Kingdom catch is very much less accurate. This is because there may be rapid changes in the distribution of our own fishing between say the north-east Arctic and the north-west Atlantic, which would affect our own catch but yet would have relatively little effect on the overall intensity of international fishing effort, so that the catch rates themselves would not be influenced. A very tentative prediction is set out in Table 17, showing the possible English effort and the anticipated catch assuming English effort at Greenland to go up by 10-20% per year, and at Newfoundland by 50% at first, then more slowly. The total United Kingdom fishing effort in each year is summed as millions of ton-hours fishing by conventional trawlers.

6. THE LONG-TERM PROSPECTS

It is certain that with increasing world demand the fishing pressure on all fisheries will likewise gradually increase and, because the number of fish in the sea is biologically limited, it then follows that the catch rates will decline on a pattern similar to that shown in Figure 4. Apart from possible biological and climatic changes this can be regarded as a certain trend, with only the limited variation discussed earlier (page 8). Hence, under the present international 'free for all' system, it is a matter of time (i.e. the rate of increase of effort) and economics before particular fisheries become unprofitable to particular countries. Consequently it is of interest to review the probably long-term trend in fishing.

Fishing vessels are readily classified by their mobility, and hence the grounds available to them. Least mobile of the vessels considered here are the small inshore and near-water vessels of Norway, Iceland, Greenland and Canada. The effort of these countries (except probably Greenland) has increased lately, and probably will continue to increase. For Iceland, though, if increased attention is paid to processing and to the sale of processed as opposed to fresh or salted fish, the number of people employed purely on the catching side may well decrease, and hence the fishing effort may level off of even fall.

More mobile, but still limited to trips of no more than 3-4 weeks, are the conventional distant-water trawlers (mainly German and British) and certain other vessels, such as the Faroese long-liners, when these are fishing for fresh fish and not salting. For these ships the critical question is not the catch per hour's fishing but the catch per day at sea (including steaming time). Thus for them the Icelandic grounds, because of less steaming, become almost as profitable as Greenland despite the considerably lower catch per hour. New German construction of conventional trawlers has ceased, and British construction seems to be ending, in favour of the freezer trawler. The effort of these ships is therefore likely to decrease.

Finally there are the vessels whose range can be measured in months and that fish virtually anywhere. The salt-cod fleets of Spain, Portugal and France are, by their market, confined to cod, but again new construction seems to have slowed or stopped, being replaced by stern-fishing freezer trawlers, many of which are destined for the south Atlantic grounds. This group of highly mobile vessels also includes Russian and other mother-ship operations, but the biggest element is the modern freezer or factory trawler. Very large numbers of these have been built, or are being built or are on order for Russia and other East European countries (Poland, East Germany, Rumania) and there is also a large Japanese fleet. These countries (including Japan) operate in the North Atlantic, and future trends in this area depend critically on the proportion of the total freezer and factory ship effort that is exerted in the North Atlantic. The expanding Japanese and European fleets have met in the South Atlantic, and there are probably now no substantial wholly unexploited trawling grounds. The important question is: how well can the lightly exploited grounds stand up to the increased pressure?

For biological reasons the demersal stocks of the South African and Patagonian Shelf grounds are restricted to the area of the continental shelf, and this geographical limit, in itself, places some restriction upon the amount of fishing that either of these areas can absorb. The hake stocks, which are the most important, are not yet sufficiently well known to delimit their boundaries with any confidence but in neither case do they appear to occupy an area larger than that of the ICNAF cod stocks, and the South African grounds are probably considerably smaller. This means that the reaction of the stocks to fishing is likely to be much the same as in the North Atlantic, especially since the hake appear to grow at much the same rate as cod, i.e. a fish of small commercial size is about four years old. Thus, although both the South African and Patagonian grounds are at present supporting very high catch rates, if they attract a substantial increase in fishing effort there will be a decline, and possibly a sharp one, since these grounds have been only lightly exploited up till now.

The conclusion must be that a large increase in factory-ship or mother-ship operations will lead to a general decline in stocks. Because the fleets are highly mobile, particularly the Russian, this is likely to result in a very equal distribution of catch per hour on all grounds. Thus, at the present catch rates, Newfoundland is attractive to factory ships, and Labrador and West Greenland slightly less so, so that future fishing at Newfoundland by factory trawlers is likely to increase; the same is true at Greenland and Labrador, though to a slightly lesser extent.

A rough estimate of the average catch per 1,000 ton-hours by conventional trawlers in the western grounds in ten years' time, is:-

Newfoundland	)	
	)	
Labrador	)	1.0
	)	
Greenland	)	
Iceland		0.5 .

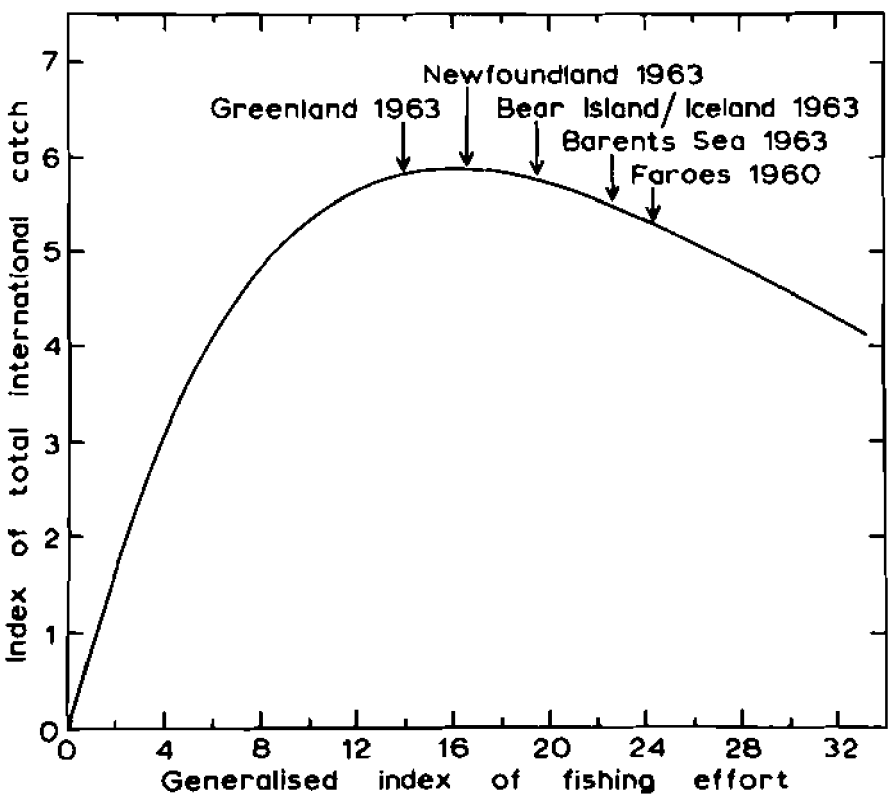

Figure 7 A generalised relationship between the total catch and the total amount of fishing on the distant-water cod stocks fished by United Kingdom vessels.

Catches in the north-east Arctic depend very much on future Russian policy. The Russian ships fishing there could, if acting with a mothership or as long-distance freezer vessels, make better catches on the more distant south and west Atlantic grounds. If they do this the catch rates in the Barents Sea and Bear Island will probably rise, but otherwise will stay low or even decline further. This uncertainty gives wide limits to the estimates, though in terms of catch per hour the Bear Island region will most probably continue to be better than the Barents

Sea. Reasonable long-term estimates of the catch per unit effort are:-

Barents Sea	0.4-0.7
Bear Island	0.5-0.8 .

Finally, at these anticipated levels of fishing the total international catch in the North Atlantic will probably be little more than it is now. This can be seen by computing from the average catch per unit in Figure 4 the implied increase in total catch with increasing fishing effort. In Figure 7 this shows that so far as total production is concerned further increases of effort on intensively fished stocks merely serve to distribute the same yield over a greater number of fishing units, with proportionately greater operating costs.

In some stocks the level of production could actually be improved by reducing the amount of fishing, so that, for the purpose of obtaining the maximum amount of protein for the minimum of fishing effort, there is much to be said for some control of the amount of fishing. The study of the effects of such a control, and of methods whereby it could be introduced as a workable proposition, forms one of the most urgent and important tasks of the regulatory commissions, the Northeast Atlantic Fisheries Convention and the International Commission for the Northwest Atlantic Fisheries.

The fishing power of trawlers

The absolute relative fishing power, i.e. catch per unit time, of trawlers of different design characteristics is analysed by a comparison of the catches of trawlers that are known to have fished together at the same time and place. This has been done for large numbers of steam and motor trawlers of 'conventional' design, the results showing that the fishing power of D.W. trawlers is proportional to their gross tonnage, and that at an equivalent tonnage motor trawlers are slightly more powerful than steam trawlers. However, the intrinsic variation in fishing success is so great that a very large number of individual comparisons were necessary before this conclusion could be reached. The number of English freezer and factory trawlers in operation is so small that it is not yet possible to extend the comparison to these larger vessels, and it may be that at this size the fishing power is no longer proportional to their tonnage. No data are yet available to compare conventional trawlers with freezer or factory trawlers when they are known to have fished together, and the only broad conclusions available are taken from catch rates averaged over the whole year from the same fishing region. These comparisons really measure fishing performance, since the results include skipper ability and the precise choice of grounds and time of year of fishing etc., so that the implication must be viewed with caution. These comparisons of fishing performance in 1962 and 1963 showed that, on average, conventional trawlers, freezers, and factory trawlers each caught much the same quantity of cod per unit time at Greenland and at Newfoundland, i.e. about 1 round fresh ton per hour. The tonnage ratios of these vessel types were 1.0 : 1.8 : 3.5 respectively, indicating that, for their tonnage, the freezers and factory trawlers are not correspondingly better at catching the fish, although they are able to fish a greater number of hours per day absent from port. The ton-hour, therefore, is probably not a good measure of effort by freezer trawlers.

Sources of information

ICES	Bulletin Statistique	:	catch and effort statistics for the East Atlantic.
ICNAF	Statistical Bulletin	:	catch and effort statistics for the West Atlantic.
ICES	Annales Biologiques	:	biological data including age and length composition of catches.
ICNAF	Sampling Year Book	:	age and length composition of catches.
ICES	Statistical Newsletters	:	detailed data on catches and effort, plus age/length data not published elsewhere.
MAFF	Sea Fisheries Statistical Tables	:	details of British catches and fishing effort, including tabulated summaries of unpublished information from F 1 forms.

MAFF Fish Stock Record, 1956-1963 and previous data.

In addition many mimeographed documents are presented at the annual meetings of ICES and ICNAF; the Research Reports of each member country submitted annually to ICNAF have been particularly useful.

The factors responsible for the decline in catch per unit effort in North Atlantic fish stocks

The predictions set out in this paper are based upon the direct relationship between stock abundance and the amount of fishing, as illustrated in Figure 5. This is interpreted as simple cause and effect. Statistically it is highly improbable that such a close relationship could have arisen by chance, but it may be suggested that the decline has been brought about by factors other than fishing. For example, a progressive decline in year-class strength in the various stocks could produce the same effect, or the relationship might be measuring an 'apparent' decline only, when in fact the stocks have merely become more difficult to catch, either by changes in their geographical distribution or in their behaviour.

There are various reasons, supported by the results of British and international research, which make these alternative possibilities unacceptable. In Britain and in other countries regular age censuses of each major stock are carried out, based upon market sampling and information collected by research vessels. These records have shown the death rate to increase as the fishing has intensified, so that now, in the more heavily fished areas of the north-east Arctic and at Iceland, the death rate in the stocks is about 60 per cent per year.

The decline in abundance accompanying this increased death rate has occurred independently in different regions, and more or less rapidly, depending upon the changes in fishing effort. Had some natural factor been responsible for the general decline, we would have expected much the same changes in each stock, independent of the changing amount of fishing.

The natural factors that might have affected the abundance of the stocks are, for the most part, connected with long-term climatic trends. An example of this climatic influence on abundance did occur at West Greenland in the early 1920s as the area warmed up and permitted the spread of the cod stocks, but there is no hydrographic evidence of any long-term trend since then of the magnitude that could account for the observed extent of the decline in abundance over the whole of the North Atlantic. Certainly there has been no major shift in the distribution of the stocks. Cod and haddock are biologically restricted to the continental shelf areas for at least a part of the year, and since all the available shelf area in the North Atlantic is now fished to some extent, either by ourselves or by other countries, it is not possible that a shift in distribution could have remained undiscovered. Moreover results of the continuing United Kingdom and international tagging experiments show the same migration patterns within each stock that have now been known for many years.

There still remains the possibility that the apparent decline in abundance has followed a change in behaviour of fish, for example that they now remain in mid-water to a greater extent. There is no evidence of the required systematic change in behaviour although, of course, such changes do influence the short-term success of fishing operations. There are also purse-seine, gill-net and long-line fisheries in congregations of the adult fish which are off the bottom, but the catch per unit effort in these fisheries shows the same declining abundance recorded by the trawlers.

There can be no doubt that fishing is the main cause of the general decline in stock abundance. But this does not necessarily imply a deterioration of the stocks: the catch per unit effort has fallen to a level which is serious from the economic point of view of maintaining a viable fleet, but in most stocks the total international catch is as high as ever. This is perhaps the most conclusive evidence that natural factors cannot be responsible for the declining abundance, as it is measured by the catch per unit effort. The fish are still there, but so many vessels are fishing that each can only take a small part of the total and a declining catch per unit effort is the inevitable consequence.

Table 1. International fishing statistics : Barents Sea : Cod

	Total catch ('000 tons round fresh		Mean tonnage U.K. trawlers		Tons per 1,000 ton-hours	Kits per day		Fishing effort (million ton-hours English)				
	U.K.	Total Internat.	Steam	Motor		Steam	Motor	U.K.	U.S.S.R.	Norway	Others	Total
1950	137	356			1.47	54.3		93	92	45	18	248
1951	129	408			1.30	59.0	73.0	99	146	52	16	313
1952	131	524			1.27	56.4	74.7	103	203	72	34	412
1953	59	442			1.12	48.5	52.1	53	233	90	20	396
1954	72	597	605	580	1.41	68.1	67.5	51	290	60	24	425
1955	91	831	607	582	1.51	74.0	56.4	61	350	83	57	551
1956	68	787	615	561	1.25	63.9	50.2	54	410	91	75	630
1957	38	400	634	573	0.87	50.2	42.9	44	210	135	68	457
1958	46	389	648	640	0.83	52.7	53.7	56	177	185	52	470
1959	55	323	646	661	0.91	54.5	63.2	61	132	127	30	358
1960	70	380	654	684	0.72	49.6	60.0	97	250	140	43	530
1961	74	369	666	707	0.76	62.0	63.8	95	262	112	11	474
1962	83	(600)	675	700	0.91	65.0	75.4	92	386	(130)	(40)	(650)
1963	65	(580)	682	674	0.84	58.1	68.8	78	437	(130)	(40)	(686)

Table 2 International fishing statistics : Bear Island/Spitzbergen : Cod

	Total catch ('000 tons round fresh		Mean tonnage U.K. trawlers		Tons per 1,000 ton-hours	Kits per day		Fishing effort (million ton-hours English)					
	U.K.	Total Internat.	Steam	Motor		Steam	Motor	U.K.	U.S.S.R.	Norway	Germany	Others	Total
1950	96	164			2.61	92.7		37	21	3	1	2	63
1951	104	140			1.91	88.6	84.5	54	11	5	2	2	74
1952	61	106			1.95	87.7	98.0	31	13	5	-	5	54
1953	51	104			1.84	90.1	81.4	27	18	2	2	6	56
1954	59	99	620	610	1.82	89.7	95.9	32	16	3	-	3	54
1955	104	153	616	602	2.36	107.1	112.2	44	9	6	1	5	65
1956	164	323	633	802*	2.41	115.7	137.0	68	29	19	13	6	134
1957	89	257	642	661	1.36	82.8	84.7	66	74	27	17	6	192
1958	80	229	664	684	1.21	81.5	88.4	66	105	12	2	3	189
1959	101	243	664	737	1.20	83.1	98.9	82	98	18		2	197
1960	43	101	663	752	1.01	74.0	96.3	43	50	12		3	101
1961	65	216	673	760	1.24	90.9	116.4	54	102	21			179
1962	67	219	696	759	1.31	94.1	115.8	50	96	(20)			163
1963	43	(114)	697	730	0.99	74.4	86.8	44	52	(20)			117

*Trial voyage of 'Fairtry' included

Table 3. International fishing statistics : Norway Coast : Cod and Haddock

	Total catch ('000 tons round fresh)				Tons per 1,000 tons-hours		Mean tonnage U.K. trawlers		Kits per day				Fishing effort (U.K. only)
	Cod		Haddock						Cod		Haddock		
	U.K.	Total Internat.	U.K.	Total Internat.	Cod	Haddock	Steam	Motor	Steam	Motor	Steam	Motor	
1950	15	256	12	30	1.40	1.09			45.7		35.3		11
1951	23	325	14	28	1.43	0.87			60.3	78.5	35.9	21.2	16
1952	34	291	9	20	1.16	0.31			53.6		14.7		29
1953	23	192	6	16	1.17	0.30			51.7	41.3	14.6	17.9	20
1954	17	184	8	22	0.99	0.44	625	630	48.4	39.4	23.5	20.0	18
1955	19	238	14	35	1.04	0.76	626	633	51.0	46.2	40.1	25.8	18
1956	28	313	13	41	1.39	0.65	624	611	69.9	45.4	34.5	26.7	20
1957	27	205	9	25	1.12	0.37	635	623	54.8	49.0	17.6	19.3	27
1958	23	247	13	29	0.87	0.48	661	680	52.2	55.3	29.5	27.2	27
1959	22	261	10	28	0.82	0.36	665	724	45.8	54.9	20.2	23.2	26
1960	26	226	13	27	0.66	0.33	662	686	44.0	48.3	21.8	27.1	39
1961	17	201	11	25	0.56	0.35	667	736	38.9	52.9	25.1	26.1	31
1962	22	?	14	?	0.65	0.41	675	718	42.5	53.3	28.0	32.3	34
1963	19	?	9	?	0.65	0.32	692	706	45.2	58.2	22.8	26.7	29

Table 4. International fishing statistics : Barents Sea : Haddock

	Total catch ('000 tons round fresh)		Mean tonnage U.K. trawlers		Tons per 1,000 ton-hours	Kits per day		Fishing effort (million ton-hours English)				
	U.K.	Total Internat.	Steam	Motor		Steam	Motor	U.K.	U.S.S.R.	Norway	Others	Total
1950	48	91			0.42	19.1		93	57	38	5	176
1951	33	87			0.33	15.2	34.5	99	102	51	6	261
1952	33	104			0.32	14.9	15.9	103	147	66	6	328
1953	22	105			0.41	18.4	20.5	53	115	85	2	256
1954	16	126	605	580	0.30	15.2	17.6	51	243	117	7	402
1955	19	157	607	582	0.31	16.0	18.8	61	306	126	10	506
1956	23	164	615	561	0.42	22.8	23.5	54	219	105	10	390
1957	15	87	634	573	0.33	19.1	21.9	44	100	115	3	264
1958	10	78	648	640	0.19	10.2	19.8	56	(137)	216	-	437
1959	12	(58)	646	661	0.20	11.3	17.2	61	(71)	185	10	295
1960	30	(121)	654	684	0.33	21.3	27.2	97	162	129	3	378
1961	26	157	666	707	0.27	20.8	23.2	95	296	185	4	574
1962	21	?	675	700	0.23	16.9	18.3	92	391	?	?	?
1963	10	?	682	674	0.13	8.9	9.6	78	485	?	?	?

Table 5. International fishing statistics : Iceland : Cod

	Total catch ('000 tons round fresh)		Mean tonnage U.K. trawlers		Tons per 1,000 ton-hours	Kits per day		Fishing effort (million ton-hours English)				
	England	Total Internat.	Steam	Motor		Steam	Motor	U.K.	Faroes	Germany	Iceland	Total
1950	90	321			0.97			97		25	205	332
1951	103	327			1.13	42.3	97.1	94		24	162	289
1952	95	392			1.13	44.8	36.9	86	14	30	210	347
1953	174	515			1.36	46.3	49.1	129	12	33	194	379
1954	166	546	510	525	1.24	58.5	56.2	135	12	36	247	441
1955	139	537	505	520	1.29	55.4	68.5	109	15	36	244	416
1956	128	482	517	531	1.25	57.6	76.7	105	13	26	234	386
1957	144	453	539	598	1.01	60.1	75.5	144	21	24	249	449
1958	151	520	545	530	0.98	52.5	61.1	156	18	41	291	531
1959	113	460	552	503	0.82	47.3	50.4	138	10	45	344	561
1960	109	474	582	480	0.69	47.0	44.8	158	17	55	427	687
1961	97	383	588	456	0.54	38.2	31.2	185	19	43	437	709
1962	103	?	579	439	0.60	38.9	28.6	178	?	?	?	(650)
1963	121	?	610	441	0.60	43.0	28.1	208	?	?	?	(650)

Table 6. International fishing statistics : Iceland : Haddock

	Total catch ('000 tons round fresh)		Mean tonnage U.K. trawlers		Tons per 1,000 ton-hours	Kits per day		Fishing effort (million ton-hours English)			
	England	Total Internat.	Steam	Motor		Steam	Motor	U.K.	Germany	Iceland	Total
1950	35	65			0.28			125	21	96	232
1951	21	54			0.23	10.3	9.9	96	26	94	231
1952	18	45			0.22	9.2	8.1	98	28	69	207
1953	28	53			0.22	9.1	10.4	133	23	69	244
1954	28	62	510	525	0.21	9.5	12.5	139	28	99	292
1955	27	64	505	520	0.25	9.7	10.2	112	28	87	253
1956	23	62	517	531	0.23	11.7	15.2	106	35	96	271
1957	28	76	539	598	0.20	11.2	7.9	148	40	157	386
1958	27	70	545	530	0.18	9.8	14.2	161	34	166	400
1959	29	64	552	503	0.22	12.6	12.2	142	19	126	298
1960	31	86	582	480	0.20	13.6	13.5	163	30	212	432
1961	46	108	588	456	0.26	17.5	19.9	189	16	199	422
1962	51	?	579	439	0.29	17.1	18.6				
1963	39	?	610	441	0.19	10.4	14.0				

Table 7. The total value of all demersal species per unit of fishing effort by method of propulsion

	Steam									
	£/1,000 ton-hours					£/day absent				
	Barents Sea	Norway Coast	Bear Island	Iceland	Faroes	Barents Sea	Norway Coast	Bear Island	Iceland	Faroes
1955	82.4	63.4	97.1	76.6	62.5	304	313	333	264	166
1956	82.5	87.9	93.9	81.5	59.2	320	336	344	299	177
1957	71.0	69.0	66.6	73.9	62.5	310	303	309	298	204
1958	65.8	74.6	64.0	71.9	54.4	322	343	331	301	204
1959	63.9	76.3	58.8	70.7	49.3	299	318	310	310	201
1960	61.4	67.9	53.7	64.1	51.3	323	339	289	328	236
1961	57.0	64.4	59.1	63.6	38.6	317	339	332	325	180
1962	57.5	63.0	57.2	61.3	47.7	313	311	313	298	200
1963	56.0	64.1	52.8	57.2	46.0	300	342	312	299	169
	Motor									
1955	91.8	76.3	111.3	74.9	80.6	336	264	313	289	217
1956	89.3	75.3	78.4	91.1	76.6	320	294	467	330	167
1957	83.0	71.2	67.3	67.8	71.0	337	308	317	337	213
1958	87.2	84.3	69.0	73.4	60.8	391	397	360	327	220
1959	74.1	74.6	60.5	75.2	57.2	363	380	381	302	210
1960	70.1	63.8	61.8	74.6	52.2	400	378	384	299	208
1961	62.7	64.8	68.9	74.5	43.5	389	410	460	294	165
1962	58.9	64.2	62.0	70.6	45.8	364	394	399	289	167
1963	61.1	65.6	55.8	70.9	59.7	353	413	366	272	196

Table 8. Short-term forecasts for north-east Atlantic fisheries

Year	(i) Barents Sea: Cod						(ii) Bear Island/Spitzbergen: Cod						(iii) Barents Sea: Haddock**			
	Units of total fishing effort	Catch per 1,000 ton-hours*			Kits per day		Units of total fishing effort	Catch per 1,000 ton-hours			Kits per day		Units of total fishing effort	Catch per 1,000 ton-hours		
		A	B	C	Steam	Motor		A	B	C	Steam	Motor		A	B	C
1964	720	0.76	0.90	0.68	50	56	145	1.20	0.80	0.96	70	88	680	0.19	1.00	0.19
1965	768	0.70	0.70	0.49	36	41	155	1.25	0.60	0.75	55	69	738	0.17	1.50	0.25
1966	820	6.64	0.80	0.51	37	42	165	1.15	0.50	0.57	42	52	780	0.16	(2.00)	0.32
1967	888	0.60	(1.00)	0.60	44	50	175	1.05	(0.60)	0.63	46	58	848	0.14	(1.50)	0.21
1968							185	0.95	(0.80)	0.76	56	69				

Year	(iv) Norway Coast: Cod and Haddock: U.K. only					(v) Iceland: Haddock** (Cod constant at 1963 level)		
	Units of total fishing effort	Catch per 1,000 ton-hours		Kits per day (cod and haddock)		Units of total fishing effort	Catch per 1,000 ton-hours	
		Cod	Haddock	Steam	Motor		Cod	Haddock
1964	30	0.50	0.30	55	68	455	0.60	0.18
1965	30	0.45	0.25	48	60	465	0.60	0.18
1966	30	0.40	0.25	44	55	475	0.60	0.17
1967	30	0.40	(0.30)	48	60	485	0.60	0.17
1968	30	0.35	(0.25)	41	51	495	0.60	0.16

*Catch per unit effort columns A = Catch per 1,000 ton-hours under average conditions for given effort
B = Year-class strength as % of average
C = A x B = expected catch rate per 1,000 ton-hours

**The average catch per 1,000 ton-hours for haddock is not representative of vessels fishing for haddock, so the kits per day conversion is not informative.

Table 9. International fishing statistics : East Greenland : Cod

	Total catch ('000 tons round fresh)						Catch per fishing day (Germany) tons round fresh
	Germany	Greenland	Faroes	Iceland	U.K.	Total	
1958	5.9	0.9	-	4.1	-	11	-
1959	12.6	0.6	0.5	5.4	-	19	8.0
1960	19.1	1.6	0.4	2.5	0.3	24	6.5
1961	15.0	1.2	1.2	1.4	0.9	20	4.1
1962	13.4	?	?	?	1.8		9.0
1963	13.5	?	?	?	0.7		6.4

Table 10A. International catch statistics : Western Atlantic : Cod

	Total catch ICNAF area ('000 tons round fresh)		Total catch by sub-area of capture ('000 tons round fresh)					
	U.K.	Total Internat.	West Greenland	Labrador	Newfound-land	Nova Scotia	New England	Unknown
1952	59	1,017	294	61	328	132	14	188
1953	34	906	242	128	352	159	11	13
1954	19	969	302	22	472	149	12	12
1955	6	902	265	26	429	159	12	10
1956	3	966	321	34	390	198	13	9
1957	12	958	269	32	449	188	13	7
1958	11	884	320	40	294	214	16	-
1959	16	953	234	60	425	213	16	5
1960	22	1,134	243	188	471	218	14	-
1961	18	1,304	345	265	461	202	18	3
1962	25	1,340	451	255	389	219	26	
1963	40	1,336	406	216	466	212	30	

Table 10B. Percentage of total catch by country

	1960	1961	1962	1963
Canada : Maritimes	9.5	7.9	8.6	8.4
Newfoundland	20.1	14.0	15.4	16.6
Faroes	5.3	4.8	7.2	6.9
Greenland	2.4	2.6	2.6	1.7
France	12.8	13.2	11.9	8.8
Germany	3.3	7.6	9.4	10.5
Iceland	0.5	0.8	+	0.3
Norway	3.2	3.5	2.5	2.8
Poland	-	+	0.3	0.6
Portugal	16.3	15.1	16.3	17.3
Spain	13.9	15.1	14.7	15.7
U.S.S.R.	9.1	12.1	7.5	6.1
U.K.	1.9	1.4	1.9	3.0
U.S.A.	1.4	1.5	1.5	1.4

Table 11. Estimated changes in fishing activity in the ICNAF area by otter trawlers of France, Portugal and Spain, Spanish pair trawlers, and Portuguese dory vessels.

	Total days fished	Total catch ('000 tons)	1	2	3	4
			Effort as % of 1953	Catch as % of Internat.	Total Internat. effort	Total Internat. effort as % of 1953
1953	21,366	435	100	48	208	100
1954	22,199	463	104	48	217	104
1955	23,796	441	111	49	227	109
1956	22,625	449	106	46	230	111
1957	24,337	437	114	46	248	119
1958	26,911	401	126	45	280	135
1959	28,568	414	134	45	298	143
1960	29,594	488	139	43	323	155
1961	31,767	566	149	43	347	167

Table 12A. The catch per unit effort of cod (tons round fresh) by otter trawlers at West Greenland

Year	Catch per day on grounds		Catch per day fished		
	Faroes	Portugal	France	Germany	Spain
				(501-900t)	
1954	26.2	31.9	36.9	26.8	20.6
1955	29.0	37.6	37.1	-	25.9
1956	30.4	26.4	32.5	29.9	29.3
1957	25.2	27.3	27.4	18.2	17.4
1958	20.1	26.8	24.3	19.6	18.9
1959	14.0	14.5	21.0	19.1	12.7
1960	15.1	15.9	24.0	19.8	13.0
1961	14.6	12.7	28.4	13.0	16.5
1962	16.3	16.6	31.0	16.6	14.2

Table 12B. Percentage change in catch per effort, total catch and effort relative to 1954 as 100%

Year	Otter trawlers					Mean c.p.e.	Total catch	Total effort
	Faroes	Portugal	France	Germany	Spain			
1954	100	100	100	100	100	100	100	100
1955	111	118	101	-	126	114	88	77
1956	116	114	88	112	142	114	106	93
1957	96	85	74	68	84	81	89	110
1958	77	84	66	73	92	78	106	136
1959	53	45	57	71	62	57	77	135
1960	58	50	65	74	63	62	80	129
1961	56	40	77	48	80	60	114	190
1962	62	52	84	62	69	66	149	226

Table 13. Estimated changes in fishing activity on Labrador cod, relative to 1954 as 100%

	Total Internat. catch		Portugal catch (tons) per day on grounds (Sept-Nov)	%	Total Internat. effort
	'000 tons	%			
1954	22	100	34.4	100	100
1955	26	118	15.6	45	261
1956	34	154	18.6	54	286
1957	32	145	17.1	50	290
1958	40	182	11.0	32	569
1959	60	273	13.0	38	718
1960	188	854	16.8	49	1,743
1961	265	1,204	17.0	49	2,457
1962	255	1,159	16.4	48	2,415
1963	216	982	?	?	

Table 14. Estimated changes in fishing activity on Newfoundland cod

	Total Internat. catch		Catch per effort of different fleets relative to 1954						Total Effort
	'000 tons	%	France O.T.	Portugal O.T.	Portugal Dory	Spain O.T.	Spain Pair T.	Mean	
1954	472	100	100	100	100	100	100	100	100
1955	429	91	107	98	153	132	117	121	75
1956	390	83	115	110	150	116	152	128	65
1957	449	95	99	110	133	103	149	119	80
1958	294	62	79	85	94	48	78	77	81
1959	425	90	110	111	96	66	97	96	94
1960	471	100	93	88	84	70	116	90	111
1961	461	98	112	110	102	101	105	106	92
1962	389	82							
1963	466	98							

Table 15. International catch statistics : Redfish. Total catch ('000 tons round fresh)

	Region													Total
	Barents Sea	Bear Island	Norway Coast	Iceland	East Greenland	West Greenland	Labrador	N.E. Newfoundland	Flemish Cap	South Newfoundland	Gulf St. Lawrence	Nova Scotia	New England	
1951	22	4	20	167	-	-	-	-	-	17	84	84	30	344
1952	29	3	24	127	-	-	-	-	-	46	← 33 →		21	283
1953	7	7	13	157	-	14	-	2	-	44	18	10	17	289
1954	5	4	22	141	20	16	-	-	-	37	33	22	13	313
1955	36	3	23	110	79	32	-	-	-	18	51	9	14	375
1956	12	31	20	93	61	14	-	-	13	16	47	17	14	338
1957	17	61	20	84	40	28	-	17	32	8	34	20	18	379
1958	22	49	19	90	24	18	78	86	55	18	23	32	16	530
1959	26	66	17	82	31	32	53	168	52	23	18	25	16	609
1960	15	55	18	83	38	44	83	58	8	31	13	37	11	494
1961	14	32	18	69	25	54	26	38	16	36	10	31	14	383
1962	9	15	12	75	27	60	8	15	7	39	6	37	14	324
1963	←	42	→	← 129 →		47	6	26	7	35	20	39	16	367

Table 16. Summary of short-term forecasts of catch rates

	Catch per 1,000 ton-hours (conventional trawler)					Kits per day (700-ton motor trawlers)				
	1964	1965	1966	1967	1968	1964	1965	1966	1967	1968
Cod										
Barents Sea	0.68	0.49	0.51	0.60	?	56	41	42	50	?
Bear Island	0.96	0.75	0.57	0.63	0.63	88	69	52	58	69
Norway Coast	0.50	0.45	0.40	0.40	0.35	68	60	55	60	51*
Iceland	0.60	0.60	0.60	0.60	0.60	49	49	49	49	49
W. Greenland	1.30	1.30	1.30	0.90	0.90	100	100	100	69	69
Labrador	← 1.0 - 0.60 →									
Newfoundland	← c.a. 1.40 →					90	90	90	90	90
Haddock										
Barents Sea	0.19	0.25	0.32	0.21	?					
Norway Coast	0.30	0.25	0.25	0.30	0.25	Kits per day not instructive				
Iceland	0.18	0.18	0.17	0.17	0.16					

*Cod and haddock

Table 17. Summary of short-term forecasts : catch and effort

	Million ton-hours fished (conventional trawler)							Catch ('000 tons round fresh)					
	1963	1964	1965	1966	1967	1968		1963	1964	1965	1966	1967	1968
Cod													
Barents Sea	75	75	75	75	75	?		65	51	37	38	45	?
Bear Island	44	50	55	60	65	70		43	48	41	34	41	53
Norway Coast	29	30	30	30	30	30		19	15	14	12	12	10
Iceland	203	200	200	200	200	200		121	120	120	120	120	120
W. Greenland	18	18	20	23	26	29		27	23	26	30	23	26
Labrador								+					
Newfoundland	9	14	18	22	26	30		12	20	25	30	35	42
Haddock													
Barents Sea								10	14	19	24	16	?
Norway Coast								9	9	7	7	9	7
Iceland								39	36	36	34	34	32
Total effort	378	387	398	410	422	434	Total cod & haddock	344	336	325	329	335	(355)
Current conventional trawler	372	372	372	372	372	372							
							All spp	406	396	383	388	395	419
Freezer (units of conventional trawler)	2	2	2	2	2	2	10-stone kits cod & haddock	4,500	4,400	4,250	4,300	4,400	4,700
Fairtry (units of conventional trawler)	4	4	4	4	4	4	All spp	5,300	5,200	5,000	5,100	5,200	5,500