COOPERATIVE RESEARCH REPORT

Series A, No. 10

Report of the North-Western Working Group, 1968

https://doi.org/10.17895/ices.pub.8123
ISBN 978-87-7482-741-2
ISSN 2707-7144

International Council for the Exploration of the Sea
Charlottenlund Slot, 2920 Charlottenlund
Denmark

February 1969

CONTENTS

INTRODUCTION

Following a request made by the Liaison Committee at the 1967 Council Meeting, the North-Western Working Group was reconvened under the chairmanship of Mr. R. Jones. The meeting was held in Copenhagen from December 4th to 13th, 1967, and the following members participated:-

R. Jones (U. K.) Chairman
J. Jónsson (Iceland)
A. Schumacher (Germany)
A. Meyer (Germany)) part-time
H. Knudsen (Denmark))

The primary task of the Group was to further assess the state of the fish stocks at Iceland with particular reference to the determination of the effect of changes in fishing effort on the Iceland cod and haddock fisheries.

ICELAND COD

Statistics relating to the landings of Iceland cod have been brought up to date in Tables 1 to 3. Total landings have continued to decline and in 1966 amounted to 357,000 tons. The catches per unit effort by both English and Iceland trawlers decreased but this was due to the fact that much of the German trawler effort was directed to catching redfish. Estimates of total effort in English trawler units showed a decline in 1966.

Fluctuations in the total yield of Iceland cod cannot be interpreted directly in relation to fluctuations in fishing effort, however. This is because landings are also influenced by the level of recruitment. This is illustrated by the data in Figure 1. These show the total landings of Iceland cod for the past thirty-five years. Also shown are the contributions to the landings (in millions of fish) of the year classes spawned eight years previously. The agreement is good. In particular it is seen that the high yield from 1930 to 1933 was associated with the good year classes of 1922 and 1924. Again, in 1954 landings were very high and can be associated with the good year class of 1945. Since then there have been fluctuations due to fluctuations in the level of year class strength, and for the future it is known that all year classes after 1959 are poor or very poor in Iceland experimental trawling material (Jónsson, unpublished data). These results show that fluctuations in year class strength can cause fluctuations in the landings large enough to mask the possible effects of changes in fishing effort. Assessments of the effects of changes in fishing effort cannot therefore be obtained from commercial statistics directly, but have to be obtained indirectly. This is done by first estimating the level of mortality in the stock due to fishing. The effect of changes in this fishing mortality on the expected yield can then be calculated and this is the method of assessment used in this report.

Numbers of Fish Landed

The Iceland cod stock is fished by several countries, some of which use different gears.

English trawlers land mainly immature cod, i. e. cod seven or less years of age. German trawlers land proportionately fewer young cod. Of the Iceland landings about 80% by weight come from a fishery operated by various gears centred on the spawning concentration of mature cod. This fishery lasts from January to May.

Estimates of the numbers of fish landed at each age are given in Tables 4 to 6 for the English and German trawl fisheries and for the Iceland spawning fisheries. These fisheries account for 83% of the landings by weight. A further 12% is landed by Iceland vessels not directed at the spawning fishery and 5% by other countries. The numbers of cod landed by these vessels were estimated indirectly. For the Iceland non-spawning fishery estimates were made using the age composition of the landings by German trawlers. For other countries, the age composition of the landings by English and German trawlers combined was used. In this way estimates of the numbers landed by all gears were obtained (Table 7).

Mortality Rates

Previous estimates of the mortality rate of Iceland cod have suggested that this might be quite high and of the order of 60-70% for all ages. In the previous report of the North-Western Working Group[1)] a value of 60% among immature cod is quoted, based on the age composition of the landings by English trawlers.

Among older cod a mortality rate of 70% per year is referred to in the previous report. This was obtained by determining the rate of decline in the numbers of fish from one spawning class to the next in the Iceland spawning fishery. In this way an estimate of the mortality rate operating within that fishery was derived.

The fact that mortality within the various fisheries is about 60-70% annually does not necessarily mean that it is as high as this throughout the entire stock. In fact, analysis of the numbers of cod landed at each age suggests that it is not. This is shown by comparing the number of 3-6 years old cod landed, with the number of 7 years and older cod landed. These, for all gears, amount to 73 and 36 million fish, respectively. Calculation shows that from a stock that experiences a 60% annual mortality, the number of 3-6 years old and the number of 7 years and older fish caught should be in the ratio of 1:0.026, i. e. corresponding to 73 million 3-6 years old fish there should only be 2 million 7 years and older fish landed. To account for 36 million 7 years and older cod it is necessary to postulate that the mortality rate on younger fish as a whole is really much smaller than this. If, therefore, some young fish experience a mortality of 60% within the trawl fisheries there must be a further source of young fish that are not fully exploited until they are 7 years old. More correctly the time of transition from being unexploited to being exploited is most likely to occur at the time of maturity, rather than at a particular age such as 7 years. It is in fact known that cod go on maturing up to at least 10 years of age and that there is a recruitment of cod up to at least this age to the Iceland spawning fishery every year.

The question then is: "Where do these fish come from"? In some years, mature cod have been known to migrate from Greenland to Iceland. This almost certainly happened in the case of the 1956 year class in 1963 and 1964. Recruitment from Greenland is not thought to account for the whole Iceland spawning fishery every year however. This means, therefore, that the fishery is also dependent on cod that, when immature, are situated around Iceland in areas not normally exploited by trawlers.

The mortality rate of the immature cod at Iceland can then be assessed in either of two ways according to the degree of mixing of the exploited and unexploited parts of the stock. In the extreme situation where no movement occurs at all, the immature stock could be treated in two

1) Coop. Res. Rep. Ser. B, 1966, Annex 1.

parts. One part would experience a mortality rate of about 60% annually and the other part would experience natural mortality only. The alternative is that there is some interchange of fish between the two parts of the stock possibly coupled with some movement away from the trawling grounds as the fish mature.

In order to determine the mortality rate on the stock as a whole in the case of the second alternative, the method described in the Appendix (p. 10) was used. This was applied to the numbers landed in Table 7, excluding the landings of the 1956 year class, because of the influence on this of immigration from Greenland.

The mortality rates are shown in Table 8 for three values of the natural mortality rate (M) of 0.05, 0.15 and 0.30. The values given are for the total instantaneous mortality coefficient (Z) and the values of 1.2 shown for eleven and twelve years old fish are equivalent to 70% annually. It should be noted that below eleven years of age, the estimates which apply to the stock as a whole are lower than the estimates obtained within the individual fisheries. This is especially so in the case of the younger fish.

Fishing mortality, and its subdivision into components due to the Iceland spawning fishery and to "Others" is shown in Table 9.

Effects of Changes in Growth and Recruitment

Since changes in effort would lead to changes in the size of the stock it is possible that this in turn could influence such stock characteristics as growth, recruitment or natural mortality. There are no data on the effect of changes in stock density on natural mortality but there are some relating to growth and recruitment.

In the case of growth, Jónsson (unpublished data) has related stock density (in terms of landings per unit effort by Iceland trawlers) to the mean length of the 8-12 years old cod in the Iceland spawning fishery. The mean lengths have been converted to weights, and the results are plotted in Figure 2. They show that there has been an increase in the mean weights of 8-12 years old cod since 1930. In the period 1960-64, for example, 8-12 years old cod were 31% heavier, age for age, than 8-12 years old cod in the period 1930-1934.

In the case of recruitment and stock size, further data from the Iceland spawning fishery suggest that the output from year classes spawned when the stock density was high, were higher than the output when the density was lower (Jónsson, 1966). Changing from a low to a high stock density could, therefore, be associated with changes in growth and recruitment acting in opposite directions. Their effects could partly offset each other, although the data indicate that the gains from increased recruitment could easily exceed the losses from reduced growth rates.

Applying these results is more difficult since both the growth and recruitment data have been collected over a period during which there have been changes in, for example, the temperature and salinity of the Arctic. There is no way of knowing, therefore, to what extent a reversal of the process, i.e. a return to higher stock densities, would in fact lead to either a decrease in growth rate or an increase in recruitment.

No account has therefore been taken of this factor in the assessments but it is useful to note the effect this would have if it did occur. With a reduction in effort, the gains would become higher than those shown in the tables of assessments. With an increase in effort the gains would become lower.

Changes in Effort

Assessments have been made of the effects of changes in fishing using the mortality estimates in Table 8 and the method of Jones (1961). As a first approximation, it was supposed that

a given change in effort would affect the fishing mortality rate at each age by the same proportion. This is equivalent to making the second of the two hypotheses above, i. e. that there is mixing between the exploited and unexploited parts of the immature stock.

Assessments

Assessments depend on the assumptions made about the distribution of the immature fish.

Either (a) there is mixing between the exploited and unexploited parts of the immature stock

or (b) the exploited and unexploited parts are independent until maturity is reached. (Note the unexploited part of the immature stock may then be either at Iceland or at Greenland).

In the time available to the Group it was only possible to make detailed assessments for alternative (a) and these are described below. Whereever possible, the probable effects of adopting alternative (b) are also given.

According to alternative (a) the Iceland cod stock as a whole is not subject to so high a mortality rate as has been supposed in previous reports. The assessments suggest that at the 1960-1966 level of effort, the yield per recruit is much closer to the theoretical optimum than would be concluded if mortality rates of 60-70% were thought to apply to the stock as a whole.

According to alternative (b) the exploited part of the immature stock supports a fishery with a relatively high rate of mortality. The yield per recruit in this fishery is therefore likely to be lower than the theoretical maximum with a lower fishing effort. However, it is quite possible that a reduction in effort, by allowing more fish to survive to maturity would allow more fish to reach the Iceland spawning fishery.

There are various ways in which fishing effort may be varied and four of these have been treated in detail.

1. Iceland spawning fishery kept constant.
   Changes in effort by other gears only (Table 10).
2. Effort on the Iceland spawning fishery varied.
   Other gears kept constant (Table 11).
3. Equal changes in effort by all gears (Table 12 and Figure 3).
4. An increase in the effort at Iceland due to the arrival of trawlers from outside that area (Table 13).

Assessments for alternative (a) are given in Tables 10 to 13. The values in Tables 10 to 12 show the expected changes (as percentages) in the yield per recruit in the various fisheries. These are given for various percentage changes in the mean fishing mortality rate from the mean level operating from 1960-1966. For practical purposes these can be interpreted as percentage changes in fishing effort from the mean 1960-1966 value. Assessments are given for three values of natural mortality (M) equal to 0. 05, 0. 15 and 0. 30. Data supplied by Jónsson to the previous North-Western Working Group report suggest that the natural mortality rate of mature cod in the Iceland spawning fishery lies between 0. 15 and 0. 30. Assessments were also made for a natural mortality rate of 0. 05, however, to allow for the possibility that the natural mortality rate of immature cod was lower than that of mature cod. The values given therefore provide a range of assessments for each category of change.

1. Icelandic spawning fishery kept constant. Effort changed in all other gears. Assessments of the effects of changes in effort by all gears other than those engaged in the Iceland spawning fishery are given in Table 10 for alternative (a).

English and German trawlers; alternative (a): A decrease in effort would decrease the yield. An increase in effort would increase the yield.

Alternative (b): A reduction in effort could increase the yield for values of M = 0.05 and 0.15. If something between alternatives (a) and (b) is taken as the most realistic position it can be concluded that a reduction in effort would decrease the yield, but not as much as in Table 10. Similarly an increase in effort would not increase the yield as much as in Table 10.

Iceland spawning fishery; alternative (a): A reduction in effort by other gears would increase the yield. An increase in effort would decrease the yield. If alternative (b) is adopted the losses and gains would not be as great as those shown in Table 10.

All gears; alternative (a): A reduction in effort would increase the yield. An increase in effort would decrease the yield.

Alternative (b): For a reduction in effort, alternative (b) would reduce the losses in the trawl fishery but would also reduce the gains to the Iceland spawning fishery. The effect on the values in Table 10, for either a reduction or an increase in effort can only be determined by further assessments.

2. Changes in effort in the Iceland spawning fishery only. These assessments, for alternative (a) are given in Table 11. It is not likely that alternative (b) will affect these assessments very much and as a first approximation the assessments in Table 11 can be used for both alternatives.

For the English and German trawlers, a decrease in effort on the Iceland spawning fishery would increase their yield. An increase in effort would decrease it.

For the Iceland spawning fishery, a decrease in effort would decrease its yield. An increase in effort would increase it.

For all gears a reduction in effort on the Iceland spawning fishery would lead to very small changes. An increase would lead to negligible gains.

3. Changes in effort by all gears equally. Assessments for alternative (a) are given in Table 12 and Figure 3.

English and German trawlers; alternative (a): A reduction in effort would reduce the yield. An increase in effort would increase the yield. The adoption of alternative (b) would reduce both the losses and the gains.

Iceland spawning fishery; alternative (a): A reduction in effort would increase the yield. An increase in effort would reduce the yield. Adoption of alternative (b) would reduce both the losses and the gains.

All gears; alternative (a): The effect of changes in effort are critically affected by the level of natural mortality adopted. Either increases or decreases in the total yield could result from a change of effort in either direction. The effect of alternative (b) on these assessments can only be determined by further calculations.

4. An increase in trawler effort due to the arrival of vessels from outside Iceland (Table 13). Here the situation is considered in which the Iceland effort is increased due to the participation in the fishery there of trawlers previously fishing elsewhere, such as in the north-eastern Arctic. Adopting alternative (a) the effect on total yields can, to a first approximation be seen from the values tabulated in Table 10. All vessels previously fishing at Iceland would however experience a decrease in catch per unit effort and the extent of this, for the various classes of vessel, is shown in Table 13.

If alternative (b) is adopted, English and German trawlers would experience greater losses in catch per unit effort than those shown in the Table. Catches per unit effort in the Iceland spawning fishery would not decline so much however.

In these calculations it has been assumed that any increase in effort would be equivalent to an increase in both English and German trawler efforts by equal amounts.

Effect on Catch per Unit Effort and the Size Composition of the Catches. In all cases, the catch per unit effort would increase, when the fishing effort decreased and would decrease when the fishing effort increased.

In all cases, where effort was increased, the catch would contain relatively more young and fewer old fish. Conversely a decrease in effort would give relatively more old and fewer young fish (Figure 4).

Mesh Assessments

Mesh assessments for Iceland cod were made in the previous report of the North-Western Working Group. These depended on estimates of the parameter E that measures the proportion of the fish released by a larger mesh that would subsequently be recaptured in the fishery. Because of the much lower values of mortality calculated in this report for the young cod, estimates of E have had to be revised and have been found to be about 0.25, 0.5 and 0.8 according to the values of natural mortality adopted (0.30, 0.15, 0.05 respectively). In the previous report, values of E of 0.6 and 0.8 were used. If values of M of 0.15 or 0.30 are adopted, the values of E are lower than the previous ones, and this means that the small gains predicted in the previous report will be too large and that the correct values will be a few percent lower. Similarly, any long-term losses would become a few percent greater. Only if one accepts the very low value of M = 0.05 does E become 0.8 permitting the estimates in the previous report to remain unchanged. Mesh assessments from the previous report are shown in Table 14.

ICELAND HADDOCK

The basic data relating to the landings of Iceland haddock and the fishing effort to which it is subject have been brought up-to-date in Tables 15 and 16. Estimates of the numbers of haddock landed at each age are given in Tables 17 to 19 for the landings by English, German and Scottish trawlers. The numbers landed by all other gears have had to be estimated from these. This was done by using the German trawler age-composition data to estimate the numbers landed by Iceland trawlers and long-liners, and by using the English trawler data to estimate the numbers landed by Iceland Danish seine and all other countries. In this way estimates of the total numbers landed at each age were obtained (Table 20).

Mortality Estimates

Mortality estimates were determined from the estimated total numbers landed at each age using the same methods as were used for cod. Total mortality estimates (Z) were determined for two values of M (0.15 and 0.30), and the results are shown in Table 21. These are higher at all ages than those obtained for cod.

Changes in Effort

The effects of various percentage changes in effort from the mean 1960-66 level were determined, assuming that the changes in each case affected all gears equally. The results are shown in Table 22 and Figure 5 for English and German trawlers. The results depend on the value of natural mortality adopted. With a value of M = 0.30, the yield appears to be close to its maximum value at the 1960-66 level of effort. For M = 0.15 gains up to 4% are predicted for 40% reduction in effort. The actual value of the natural mortality rate is not known, but it was felt that this value should lie somewhere between 0.15 and 0.30.

As in the case of cod any changes in stock density resulting from a change in effort could influence the growth rate, and recruitment. The magnitude of such effects cannot be computed exactly, but they should nevertheless be kept in mind as factors that could influence the estimates in Table 22. As was found for cod, fluctuations in recruitment can influence the landings of haddock very considerably. The high yield from 1961-63 for example (Table 15) was due to the influence of the very good year class of 1957, and the subsequent decline in landings is mainly due to the gradual disappearance of this year class from the fishery.

Another factor that must be taken into account is that direct estimates of the numbers landed at each age were only available for about 50% of the total landings. Estimation of Iceland long-line catches of haddock using German trawler age-composition data, for example, may have led to bias in the estimates. These estimates, therefore, should be revised once more extensive data can be obtained.

Mesh Assessments

Mesh assessments for Iceland haddock were made in the previous report of the North-Western Working Group. As in the case of cod, these depend on the values, 0.6 and 0.8, used for the parameter E. Revised estimates suggest that for 2 to 3 years old fish, E should not differ much from 0.6. Mesh assessments in the previous report for values of E = 0.6 are likely therefore to be the more appropriate ones to take and these are shown in Table 23.

RECOMMENDATIONS

The North-Western Working Group recommended that further effort should be made to collect age-composition data from the landings of Iceland haddock and cod from the Iceland non-spawning fishery.

The Group further recommended that after these data have been collected for at least two years, that the effort assessments for the Iceland cod and haddock should be re-assessed.

REFERENCES

Gulland, J. A.	1965	"Estimation of mortality rates". Annex to Arctic Fisheries Working Group. Report of Meeting in Hamburg, 18.-23. January 1965. ICES, C.M.1965 (3) (mimeo.).
Jones, R.	1961	"The assessment of the long-term effects of changes in gear selectivity and fishing effort". Mar. Res., No. 2.
Jónsson, J.	1966	"Abundance, recruitment and growth in the Icelandic stock af cod". ICES, C. M. 1966 G:13. (mimeo)

APPENDIX

For determining mortality rates when F varies with age, a modification of the methods described by Jones (1961) and by Gulland (1965) has been used. The method described by Gulland (1965) for determining the fishing mortality rate makes use of the ratios of the numbers of fish caught at a particular age to the numbers subsequently caught at older ages.

If Cn is the catch of a particular year class at age n and V_{n+1} is the number caught at age n+1 and all subsequent ages it is the ratio $\frac{Cn}{V_{n+1}}$ or more conveniently its reciprocal

$\frac{V_{n+1}}{Cn}$ that is used as the basis for the assessments.

This is incorporated in the relationship,

$$\frac{Zn\, e^{-Zn}}{Fn\,(1-e^{-Zn})} = \frac{V_{n+1}}{Cn\;E_{n+1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

to determine values of Fn and Zn for any value of M.

In this equation the parameter En is defined by

$$En = \frac{Fn\,(1-e^{-Zn})}{Zn} + e^{-Zn}\;E_{n+1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Given E_{n+1}, Equation (1) can be solved for Fn and Zn and then Equation (2) can be used to give En and so on.

If a year class has not passed completely through a fishery, or if it is appropriate to use the data from a year class in two successive years only, the values of Vn will be unknown. In that case it is appropriate to consider the ratio of the catches of a year class in two successive years (i. e. Cn and C_{n+1}). Then let

$$Cn = \frac{Fn}{Zn}\,(1-e^{-Zn})\;Nn$$

where Nn is the number alive at the beginning of age n, and similarly let

$$C_{n+1} = \frac{F_{n+1}}{Z_{n+1}}\,(1-e^{-Z_{n+1}})\;N_{n+1}$$

but $N_{n+1} = Nn\, e^{-Zn}$ so that $C_{n+1} = \frac{F_{n+1}}{Z_{n+1}}\,(1-e^{-Z_{n-1}})\;e^{-Zn}Nn$

Now, consider their ratio

$$\frac{C_{n+1}}{Cn} = \frac{A_{n+1} \quad e^{-Zn}}{An}$$

where

$$An = \frac{Fn}{Zn} \; (1-e^{-Zn}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

or on re-arranging terms

$$\frac{e^{-Zn}}{An} = \frac{C_{n+1}}{Cn \cdot A_{n+1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Thus given A_{n+1}, Equation (4) can be solved for Fn and Zn, and Equation (3) can be used for determining An and so on.

Years	Iceland	England	Germany	Faroes	Scotland	France	Norway	Holland	Belgium	Denmark	Sweden	Total
1923	106,391	-	15,450	35,868	26,882	2,862	287	801				188,541
1924	146,237	75,120	32,662	31,481	2,448	2,841	468	1,315				292,572
1925	159,030	86,414	30,980	29,185	1,402	3,487	445	1,593				312,536
1926	126,890	81,347	37,292	38,608	1,997	3,967	519	1,308				291,928
1927	164,783	96,517	40,071	37,651	1,451	2,505	391	918		25		344,312
1928	177,328	101,066	33,330	49,563	1,328	3,567	322	841	677	17		368,039
1929	201,074	98,240	37,467	54,223	2,642	2,812	1,085	746	2,106	22	65	400,483
1930	261,278	119,120	45,034	53,002	3,403	5,230	3,691	1,444	1,581	15	-	496,798
1931	224,504	140,898	49,345	53,670	2,830	8,739	7,339	1,339	1,082	36	-	489,782
1932	208,081	164,837	55,413	48,387	5,741	17,623	3,476	605	1,035	173	4	505,375
1933	247,329	157,639	49,935	46,148	4,174	15,271	16,163	-	1,204	67	-	537,930
1934	223,729	145,597	28,442	28,028	1,259	16,413	14,899	45	626	77	-	459,115
1935	182,926	153,444	36,440	28,776	1,819	6,218	15,284	-	1,283	130	-	426,320
1936	102,354	140,639	39,184	13,866	2,248	5,156	8,310	-	1,511	49	1	313,318
1937	111,285	144,312	36,294	19,706	1,955	11,727	1,180	-	1,395	47		327,901
1938	114,359	128,160	42,136	22,405	1,950	6,070	5,180	60	1,860	25		322,205
1946	199,165	36,846	11,011	15,000*	4,756		188	27	894			267,887
1947	200,242	52,369	10,817	15,000*	4,068	1,905	57	-	5,150			289,608
1948	213,177	90,702	11,193	15,000*	4,147	2,830	13	242	3,184	8		340,496
1949	221,419	91,125	24,120	15,000*	4,954	1,538	108	-	4,387	16		362,667
1950	197,433	108,901	30,327	15,000*	5,218	98	892	970	4,249	267		363,355
1951	183,252	103,485	33,805	15,000*	2,652	579	3,831	342	5,591	45		348,482
1952	237,314	94,568	41,808	15,014	1,560		4,108	99	4,940	16	16	399,943
1953	263,516	173,798	56,005	16,215	1,418		7,465	-	7,634	-	10	526,061
1954	306,191	165,694	45,253	15,365	1,467		7,224	116	6,220	-		547,530
1955	315,438	138,705	48,236	18,667	1,028		7,053	-	9,002	1		538,130
1956	292,586	127,786	30,071	16,187	2,529		4,575	-	6,975			480,709
1957	247,087	144,265	23,292	20,924	1,360		8,231	2	6,748			451,909
1958	284,407	150,517	37,849	17,875	1,204		6,829	-	9,946		56	508,683
1959	284,259	112,740	35,562	7,680	1,347		5,460	-	5,456			452,504
1960	295,668	109,414	37,939	11,781	1,236		3,429	-	5,556			465,023
1961	233,874	96,539	21,776	10,602	2,066	77	4,214	70	5,427			374,645
1962	221,820	105,144	34,157	8,657	3,112	100	4,700	453	8,199			386,342
1963	232,839	123,185	33,034	6,254	3,180		3,510					402,002
1964	273,584	122,207	19,336	6,887	4,582		2,688					429,284
1965	233,483	128,136	15,274	5,246	6,781		419	512	3,747			333,598
1966	223,974	109,038	9,851	3,414	4,849		469	78	2,987			356,661**

Table 1. Total landings of cod from Iceland (Round fresh weight in metric tons)

* Estimated.
** Including 1,995 - U.S.S.R.

Table 2. Catches per unit effort of Iceland cod.

Years	A England	B Germany	C Iceland	Relative C.P.U.E. England	Relative C.P.U.E. Germany
1924	1,337	2.5		1,096	0,746
1925	1,559	2.2		1,278	0,657
1926	1,327	2.6		1,088	0,776
1927	1,209	2.9		0,991	0,866
1928	1,073	2.3		0,880	0,687
1929	1,021	2.7		0,837	0,806
1930	1,343	3.3		1,101	0,985
1931	1,328	3.5		1,089	1,045
1932	1,635	4.7		1,340	1,403
1933	1,562	4.3		1,280	1,284
1934	1,390	2.6		1,139	0,776
1935	1,416	3.2		1,161	0,955
1936	1,398	3.0		1,146	0,896
1937	1,088	3.2		0,892	0,955
1938	1,361	3.4		1,115	1,015
1946	2,310	5.1		1,893	1,522
1947	1,766	3.8		1,448	1,134
1948	1,527	3.0		1,252	0,896
1949	1,397	3.3		1,145	0,985
1950	1,190	3.3		0,975	0,985
1951	1,155	3.2		0,947	0,955
1952	1,116	3.2		0,915	0,955
1953	1,353	4.0		1,109	1,194
1954	1,237	3.2		1,014	0,955
1955	1,272	4.5		1,043	1,343
1956	1,249	3.5		1,024	1,045
1957	993	2.6		0,814	0,776
1958	980	3.8		0,803	1,134
1959	822	4.2		0,674	1,253
1960	701	3.8	1,185	0,575	1,134
1961	569	2.7	663	0,466	0,806
1962	611	4.3	462	0,501	1,284
1963	626	4.0	365	0,513	1,194
1964	546	2.1	411	0,448	0,624
1965	567	1.5	475	0,465	0,447
1966	604	1.0 x)	517	0,495	0,299

A: Tons per million ton hours (steam trawlers)

B: Tons per day fished

C: Tons per million ton hours.

x) German value low because effort mainly directed towards redfish.

Table 3. Estimates of fishing effort on Iceland cod.

Years	A England	B Germany	C Iceland	Total effort
1924	53,599	12,962		208,768
1925	53,553	13,899		194,183
1926	59,178	14,617		212,390
1927	76,918	13,834		274,367
1928	89,909	14,526		327,449
1929	91,540	14,055		373,209
1930	85,773	13,833		357,698
1931	103,807	14,003		360,833
1932	99,717	11,726		305,732
1933	100,325	11,691		342,309
1934	104,202	10,840		328,549
1935	107,724	11,278		299,257
1936	100,420	12,966		223,736
1937	132,650	11,432		301,381
1938	94,167	12,274		236,736
1946	15,952	2,174		115,971
1947	29,543	2,858		163,373
1948	59,306	3,725		222,635
1949	65,202	7,117		259,504
1950	91,510	8,851		305,369
1951	89,109	9,957		300,030
1952	83,825	11,732		354,496
1953	128,143	13,349		387,889
1954	133,521	13,546		441,153
1955	108,789	10,442		422,101
1956	101,840	8,307		383,122
1957	144,229	8,375		451,725
1958	153,601	9,865		519,171
1959	137,455	8,683		551,744
1960	157,309	9,731	38,300	668,563
1961	171,282	7,795	46,139	664,745
1962	177,962	7,938	28,038	653,832
1963	210,897	8,371	39,116	688,157
1964	234,447	9,185	36,735	823,612
1965	225,425	9,965	43,609	694,095
1966	181,784	9,630	38,708	591,717

A: Thousand ton hours. Motor and steam trawlers combined.

B: Days fishing.

C: Thousand ton hours.

$$\text{Total effort} = \text{English effort} \times \frac{\text{Total catch}}{\text{English catch}}$$

Table 4. Numbers of cod landed (millions) from Iceland by English trawlers.

Age \ Year	1960	1961	1962	1963	1964	1965	1966	Total
2	0.7	1.6	0.5	0.8	1.7	1.2	1.7	8.2
3	6.7	10.8	7.1	8.8	10.6	13.4	9.6	67.0
4	16.6	12.4	16.7	18.0	16.6	22.0	20.1	122.4
5	12.5	10.1	8.8	11.7	12.9	13.4	12.9	82.3
6	4.4	4.5	6.4	5.1	5.9	5.4	5.5	37.2
7	1.5	2.2	2.6	4.9	2.3	3.0	1.8	18.3
8	0.40	1.0	1.0	1.3	2.3	1.2	1.0	8.2
9	0.52	0.60	1.0	0.57	0.58	1.3	0.27	4.8
10	0.41	0.33	0.23	0.53	0.09	0.23	0.43	2.2
11	0.42	0.43	0.12	0.15	0.07	0.04	0.06	1.3
12	0.18	0.14	0.25	0.11	0.07	0.06	0.04	0.8
13+	0.06	0.07	0.12	0.12	0.08	0.08	0.02	0.6
Total	44.4	44.2	44.8	52.1	53.2	61.4	53.4	353.3
Equivalent weight landed (000' tons)	109.4	96.5	105.1	123.2	122.2	128.1	109.0	

Table 5. Numbers of cod landed (millions) from Iceland by German trawlers.

Age \ Year	1960	1961	1962	1963	1964	1965	1966	Total
2	-	-	-	-	0.04	0.08	0.01	0.13
3	0.25	0.27	0.30	1.63	0.19	0.54	0.44	3.62
4	1.81	0.63	2.90	2.08	0.91	0.94	0.84	10.11
5	1.63	0.90	1.46	2.04	1.14	0.49	0.35	8.01
6	0.66	0.56	1.47	0.93	0.92	0.35	0.11	5.00
7	0.98	0.28	0.79	1.85	0.41	0.41	0.05	4.77
8	0.72	0.85	0.19	0.35	1.60	0.19	0.51	4.41
9	0.60	0.29	1.01	0.11	0.12	0.74	0.09	2.96
10	2.10	0.27	0.44	0.49	0.02	0.03	0.22	3.57
11	0.62	0.65	0.15	0.12	0.09	0.01	0.01	1.65
12	0.04	0.17	0.37	0.04	0.01	0.02	0.01	0.66
13+	0.02	0.02	0.10	0.14	0.07	0.01	0.01	0.37
Total	9.43	4.89	9.18	9.78	5.52	3.81	2.65	45.26
Equivalent weight landed (000' tons)	37.9	21.8	34.2	33.0	19.4	15.3	9.9	

Table 6. Numbers of cod landed (millions) from Iceland by the Iceland spawning fishery.

Age \ Year	1960	1961	1962	1963	1964	1965	1966	Total
2	-	-	-	-	-	-	-	-
3	0.2	-	-	0.4	0.8	5.7	0.6	7.7
4	1.4	0.4	0.4	1.0	2.3	3.6	2.2	11.3
5	6.2	1.7	1.2	1.4	1.6	3.0	2.8	17.9
6	3.9	5.5	2.6	2.2	2.9	2.4	4.6	24.1
7	4.3	3.9	7.0	6.3	4.4	3.6	3.5	33.0
8	4.3	4.5	2.6	5.3	12.5	3.8	6.5	39.5
9	4.7	3.0	6.5	2.0	7.3	7.9	1.9	33.3
10	8.1	2.5	2.1	5.4	1.6	1.0	5.2	25.9
11	2.5	5.7	1.6	1.4	2.9	0.82	0.28	15.2
12	0.48	0.94	2.9	0.86	0.72	0.59	0.14	6.63
13+	0.04	0.31	0.37	1.5	1.7	0.56	0.14	4.62
Total	36.1	28.4	27.3	27.8	38.7	33.0	27.9	219.15
Equivalent weight landed (000's tons)	229.2	179.3	176.6	176.9	240.9	195.2	168.1	

Table 7. Numbers of cod landed (millions) from Iceland by all countries.

Age \ Year	1960	1961	1962	1963	1964	1965	1966	Total
2	0.8	1.9	0.6	0.9	2.0	1.7	2.0	9.9
3	8.6	13.9	9.2	14.5	13.0	22.9	13.9	96.0
4	25.7	17.5	27.4	26.3	23.2	32.0	29.6	181.7
5	25.3	17.1	15.3	19.8	18.9	19.9	19.2	135.5
6	11.0	12.9	13.8	10.2	12.0	9.9	11.3	81.1
7	8.9	7.6	12.0	16.8	8.1	8.6	5.9	67.9
8	6.8	8.8	4.3	7.6	19.5	5.8	10.5	63.3
9	7.0	4.7	10.2	2.9	5.3	12.4	2.7	45.2
10	14.7	3.9	3.5	7.4	1.8	1.4	7.0	39.7
11	4.8	8.6	2.1	1.8	3.3	0.9	0.4	21.9
12	0.8	1.7	4.1	1.1	0.8	0.7	0.2	9.4
13+	0.7	0.5	0.9	2.0	2.0	0.7	0.2	7.0
Total	115.1	99.1	103.4	111.3	109.9	116.9	102.9	758.6

Table 8. Iceland cod. Showing estimates of the total instantaneous mortality rate (Z) at different ages.

	Age 2	3	4	5	6	7	8	9	10	11	12
M 0.05	0.06	0.19	0.39	0.43	0.37	0.40	0.50	0.68	0.86	1.2	1.2
M 0.15	<0.16	0.25	0.41	0.44	0.40	0.44	0.54	0.71	0.88	1.2	1.2
M 0.30	<0.31	0.36	0.46	0.49	0.47	0.51	0.60	0.75	0.91	1.2	1.2

Table 9. Iceland Cod.
Estimates of fishing mortality (F) due to various gears.
(N = Negligible)

	M = .05			M = 0.15			M = .30		
Age	Iceland spawning	Others	Total	Iceland spawning	Others	Total	Iceland spawning	Others	Total
2	-	.01	.01	-	N	N	-	N	N
3	.011	.129	.14	.008	.092	.10	.005	.055	.06
4	.021	.319	.34	.016	.244	.26	.010	.150	.16
5	.050	.330	.38	.038	.252	.29	.025	.165	.19
6	.095	.225	.32	.074	.176	.25	.051	.119	.17
7	.170	.180	.35	.141	.149	.29	.102	.108	.21
8	.280	.170	.45	.242	.148	.39	.186	.114	.30
9	.421	.209	.63	.375	.185	.56	.301	.149	.45
10	.532	.278	.81	.479	.251	.73	.401	.209	.61
11	.798	.352	1.15	.729	.321	1.05	.625	.275	.90
12	.799	.351	1.15	.729	.321	1.05	.625	.275	.90
13+	.850	.300	1.15	.776	.274	1.05	.665	.235	.90

Table 10. Iceland Cod. Effect of changes in effort by all gears other than those engaged in the Icelandic spawning fishery.

		% change from 1960-1966 fishing mortality rate				
Gear	M	-60	-40	-20	+20	+40
England	.05	-37	-20	-8	+5	+11
	.15	-44	-26	-11	+8	+15
	.30	-50	-31	-14	+11	+23
Germany	.05	-31	-14	-6	+2	+2
	.15	-39	-22	-10	+6	+10
	.30	-47	-27	-14	+10	+18
Iceland spawning	.05	+136	+76	+32	-24	-41
	.15	+97	+56	+24	-19	-34
	.30	+59	+35	+16	-13	-25
All gears	.05	+47	+27	+12	-10	-16
	.15	+25	+14	+6	-5	-13
	.30	+3	+2	0	-1	-1

Table 11. Iceland Cod. Effect of changes in effort by the Iceland spawning fishery only.

		% change from 1960-1966 fishing mortality rate				
Gear	M	-60	-40	-20	+20	+40
England	.05	+17	+10	+4	-3	-7
	.15	+13	+8	+3	-3	-6
	.30	+9	+5	+3	-2	-4
Germany	.05	+26	+15	+7	-5	-10
	.15	+20	+12	+5	-4	-9
	.30	+15	+9	+4	-4	-7
Iceland spawning	.05	-24	-11	-5	+3	+5
	.15	-31	-16	-7	+6	+10
	.30	-40	-23	-10	+8	+15
All gears	.05	-1	+1	0	-1	-2
	.15	-7	-3	-1	+1	+1
	.30	-13	-8	-3	+2	+4

Table 12. Iceland Cod. Effect of changes in effort by all gears equally.

		% change from 1960-1966 fishing mortality rate				
Gear	M	-60	-40	-20	+20	+40
England	.05	-18	-9	-3	+1	+2
	.15	-32	-18	-7	+6	+10
	.30	-44	-26	-12	+10	+19
Germany	.05	-2	+2	+2	-2	-6
	.15	-18	-10	-2	+2	+2
	.30	-39	-24	-6	+6	+10
Iceland spawning	.05	+72*	+52*	+28	-20	-34
	.15	+52*	+36*	+17	-13	-25
	.30	+5	+9	+5	-6	-11
All gears	.05	+37	+23	+10	-8	-14
	.15	+4	+5	+3	-3	-5
	.30	-24	-12	-5	+3	+6

* These values computed approximately.

Table 13. Iceland Cod. Effect on the existing fisheries of increase in effort due to the arrival of trawlers from outside the Iceland area.

(expressed as percentages decline in the landings per unit effort by boats fishing at Iceland before the change)

		% change from 1960-1966 fishing mortality rate	
Gear	M	+20	+40
England	.05	-13	-23
	.15	-10	-18
	.30	-7	-12
Germany	.05	-16	-28
	.15	-12	-22
	.30	-8	-15
Iceland spawning	.05	-24	-41
	.15	-19	-34
	.30	-13	-25
All gears	.05	-17	-31
	.15	-14	-25
	.30	-10	-18

Table 14. Percentage change in yield per recruit for various changes in mesh-size.

Gear Group		E	Changing effective mesh-size from 100 m to				
			110	120	130	140	160
England	Immediate loss		0.7	1.8	3.8	6.2	13.3
	Long-term	0.6	0.4	0.8	0.8	0	-2.8
	Gain	0.8	0.5	1.7	2.4	2.1	0.7
Germany Iceland (non-spawning)	Immediate loss		0.1	0.3	0.7	1.3	3.3
	Long-term	0.6	1.0	2.4	4.1	5.2	8.4
	Gain	0.8	1.4	3.3	5.7	7.3	12.4
Iceland spawning fishery	Immediate loss		-	-	0.1	0.2	0.5
	Long-term	0.6	1.1	2.7	4.7	6.4	11.6
	Gain	0.8	1.5	3.6	6.3	8.6	15.6
Other (non-trawl) gears	Immediate loss		-	-	-	-	-
	Long-term	0.6	1.1	2.7	4.8	6.6	12.1
	Gain	0.8	1.5	3.6	6.4	8.8	16.2
Total	Immediate loss		0.3	0.7	1.4	1.9	4.2
	Long-term	0.6	0.8	2.0	3.3	4.6	7.4
	Gain	0.8	1.2	2.9	4.9	6.7	11.3

Years	Iceland	England	Germany	Faroes	Scotland	France	Norway	Holland	Belgium	Denmark	Sweden	Total
1923	10,000*		5,729		5,986			3				21,718
1924	10,000*	20,131	7,777		294			267				38,469
1925	10,000*	20,317	6,821		70	9		272				37,489
1926	6,260	23,240	9,136		12	9		213				38,870
1927	9,834	36,205	11,824		166	-		226		10		58,265
1928	11,088	37,350	10,901		349	-		229	234	80	4	60,235
1929	13,055	32,963	10,313	1	427	45		257	426	42	23	57,552
1930	10,863	30,125	9,584	75	468	-	7	365	304	100	-	51,891
1931	7,118	27,446	8,062	45	438	17	51	148	119	210	-	43,654
1932	4,933	22,409	7,124	96	478	264		82	140	296	30	35,852
1933	4,683	16,824	6,284	29	220	242		-	225	341	10	28,858
1934	5,937	17,777	4,724	51	256	174		6	206	545		29,676
1935	6,313	18,762	4,037	35	275	99		-	342	569		30,432
1936	4,205	17,428	4,866	118	364	49		-	366	840		28,363
1937	4,053	17,470	5,146	134	379	71		-	372	695		28,320
1938	4,609*	17,780	4,608	115	301	75		6	442	644		28,580
1946	14,120	12,078	4,601	150*	1,679			45	472			33,145
1947	18,601	14,901	3,762	150*	2,246			-	2,019			41,679
1948	24,862	23,610	7,553	150*	2,907			350	1,314	57	21	60,824
1949	30,264	28,683	10,499	150*	3,960			-	2,120	96	179	75,951
1950	27,099	26,886	7,300	150*	2,271			759	1,640	603	41	66,749
1951	22,173	21,576	7,326	150*	1,365			220	2,857	362		56,029
1952	15,166	18,571	7,734	168	660			41	4,063	84		46,487
1953	14,954	28,268	6,384	219	708			-	4,295	-		54,828
1954	21,322	28,872	6,133	435	611			89	5,187	3		62,652
1955	21,703	27,936	7,153	359	683			-	7,105	6		64,945
1956	22,054	23,748	8,750	610	980			-	6,147			62,289
1957	31,302	28,663	7,796	1,168	1,137			29	6,631			76,726
1958	28,624	27,483	6,311	1,376	966				5,738			70,498
1959	26,534	30,002	3,794	1,025	811				2,412			64,578
1960	41,988	31,803	6,238	1,330	936				5,198			87,493
1961	51,360	47,164	4,067	770	2,314	125		49	4,237			110,086
1962	54,288	51,862	3,965	919	4,024	164		204	4,189			119,615
1963	51,834	39,538	3,064	2,108	3,818			198	1,884			102,444
1964	56,586	33,269	2,077	1,200	4,877			181	857			99,047
1965	53,506	37,543	1,753	1,006	3,761		40	89	1,235			99,127
1966	36,028	19,706	1,139	968	1,498				676			60,141**

Table 15. Landings of haddock from Iceland (Round fresh weight in metric tons).

* Estimated

** Including 69 m.tons - USSR.

Table 16. Landings per unit effort of haddock from Iceland.

Years	A England	B Germany	C Iceland	Relative C.P.U.E England	Relative C.P.U.E Germany
1924	373	0.6		1,323	0,870
1925	378	0.5		1,340	0,724
1926	391	0.6		1,387	0,870
1927	469	0.9		1,663	1,304
1928	414	0.8		1,468	1,159
1929	359	0.7		1,273	1,014
1930	350	0.7		1,241	1,014
1931	264	0.6		0,936	0,870
1932	224	0.6		0,794	0,870
1933	167	0.5		0,592	0,724
1934	170	0.4		0,603	0,580
1935	173	0.4		0,613	0,580
1936	172	0.4		0,610	0,580
1937	131	0.5		0,464	0,724
1938	189	0.4		0,670	0,580
1946	757	2.2		2,684	2,899
1947	496	1.3		1,759	1,884
1948	393	2.0		1,393	2,899
1949	435	1.4		1,543	2,029
1950	288	0.8		1,021	1,159
1951	238	0.5		0,844	0,724
1952	220	0.6		0,780	0,870
1953	220	0.4		0,780	0,580
1954	216	0.5		0,760	0,724
1955	258	0.6		0,915	0,870
1956	233	1.1		0,826	1,595
1957	201	0.7		0,713	1,014
1958	178	0.6		0,631	0,870
1959	219	0.5		0,777	0,724
1960	211	0.3	221	0,748	0,435
1961	260	0.5	212	0,922	0,724
1962	268	0.5	274	0,950	0,724
1963	152	0.4	223	0,539	0,580
1964	111	0.2	227	0,394	0,290
1965	126	0.2	201	0,446	0,290
1966	74	0.1	158	0,262	0,145

A: Tons per million ton hours (steam trawlers)

B: Tons per day fished

C: Tons per million ton hours

Table 17. Numbers of haddock landed (millions) from Iceland by English trawlers.

Age \ Year	1960	1961	1962	1963	1964	1965	1966	Total
1						0.02	0.06	0.08
2	2.70	2.12	0.76	1.06	1.06	0.84	0.77	9.31
3	24.69	5.23	3.45	8.32	3.22	5.24	1.81	51.96
4	16.69	18.67	6.67	2.64	9.14	3.51	2.50	59.82
5	2.95	6.94	18.55	3.71	2.78	11.63	2.44	49.00
6	0.35	1.42	3.88	8.28	1.32	1.22	3.55	20.02
7	0.16	0.09	0.38	1.76	3.15	0.70	0.44	6.68
8	0.06	0.06	0.03	0.13	0.61	1.09	0.15	2.13
9	0.04	0.08	0.09	-	0.09	0.12	0.15	0.57
10+	0.06	0.13	0.06	0.04	0.05	0.05	0.08	0.47
Total	47.70	34.74	33.87	25.94	21.42	24.42	11.95	200.04

Table 18. Numbers of haddock landed (millions) from Iceland by German trawlers.

Age \ Year	1960	1961	1962	1963	1964	1965	1966	Total
2		0.21			0.02		0.02	0.25
3		0.13	0.35	0.38	0.08	0.21	0.03	1.18
4	2.00	0.73	0.38	0.24	0.15	0.10	0.05	3.65
5	1.20	1.04	1.18	0.26	0.12	0.18	0.03	4.01
6	0.20	0.19	0.50	0.90	0.08	0.06	0.20	2.13
7	0.10	0.02	0.11	0.16	0.37	0.05	0.02	0.83
8	0.07	0.02	0.01	0.01	0.10	0.19	0.01	0.41
9	0.13	0.01	0.00	0.00	0.00	0.05	0.02	0.21
10+	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.10
Total	3.74	2.36	2.54	1.96	0.93	0.85	0.39	12.77
Equivalent weight landed (000's tons)	6.24	4.07	3.97	3.06	2.08	1.75	1.14	22.31

Table 19. Numbers of haddock landed (millions) from Iceland by Scottish trawlers.

Age \ Year	1960	1961	1962	1963	1964	1965	1966	Total
1	-	0.03	0.03	0.04	0.01	0.07	0.02	0.20
2	-	0.25	0.90	0.87	0.57	0.22	0.19	3.00
3	0.01	0.80	0.22	2.24	0.64	0.54	0.24	4.69
4	0.40	0.90	0.65	0.12	0.96	0.40	0.26	3.69
5	0.13	0.60	1.35	0.29	0.23	0.74	0.10	3.44
6	0.02	0.08	0.30	0.61	0.43	0.09	0.22	1.75
7	0.01	0.04	0.04	0.14	0.43	0.17	0.01	0.84
8+	0.05	0.01	0.03	0.03	0.15	0.27	0.05	0.59
Total	0.62	2.71	3.52	4.34	3.42	2.50	1.09	18.20
Equivalent weight landed (000' tons)	0.79	2.01	3.50	3.32	4.25	3.28	1.30	

Table 20. Numbers of haddock landed (millions) from Iceland by all countries.

Age \ Year	1960	1961	1962	1963	1964	1965	1966	Total
1			0.03	0.04	0.01	0.03	0.10	0.21
2	3.27	5.28	1.86	2.23	2.32	1.28	1.95	18.19
3	29.89	8.37	8.84	18.92	6.89	12.94	3.63	89.48
4	34.96	33.21	13.82	7.25	16.46	7.53	5.38	118.61
5	12.34	21.39	39.36	9.08	6.72	20.47	4.55	113.91
6	1.90	4.09	11.32	25.46	4.13	3.32	11.65	61.87
7	0.93	0.34	1.90	4.99	13.72	2.38	1.10	25.36
8	0.59	0.32	0.20	0.39	3.35	6.82	0.57	12.24
9	0.99	0.27	0.13	0.03	0.20	1.55	1.02	4.19
10+	0.34	0.27	0.13	0.15	0.22	0.28	0.25	1.64
Total	85.21	73.54	77.59	68.54	54.02	56.60	30.20	445.70

Table 21. Iceland haddock. Showing estimates of the total mortality rate (Z) at different ages.

	Age	2	3	4	5	6	7	8	9
M	0.15	0,19	0.40	0.64	0.85	0.85	0.80	0.96	1.17
	0.30	0.33	0.49	0.69	0.86	0.87	0.86	1.02	1.28

Table 22. Iceland haddock. Effect of changes in effort by all gears equally.

		% change from 1960-1966 fishing mortality rate				
Gear	M	-60	-40	-20	+20	+40
English and German trawl	0.15	-4	+4	+3	-5	-10
	0.30	-20	-8	-2	+0.4	+0.2

(1) Estimates for English and German trawlers were similar and so mean values are given in the Table.

(2) Owing to the lack of comprehensive age composition data the trawl estimates above must also be used as the best estimates for "all gears".

Table 23. Iceland Haddock. Percentage change in yield per recruit for various changes in mesh-size.

Gear Group		E	Changing effective mesh-size from 100 m to 110	120	130	140
England	Immediate loss		2.5	8.0	15.9	25.1
	Long-term Gain	0.6	-0.9	-2.6	-6.7	-12.3
Germany	Immediate loss		0.6	4.1	6.9	12.5
	Long-term Gain	0.6	1.1	1.6	3.2	2.5
Scotland	Immediate loss		3.1	8.2	14.5	21.5
	Long-term Gain	0.6	-2.4	-2.8	-5.2	-8.1
Danish seine	Immediate loss		0.3	3.5	8.2	16.4
	Long-term Gain	0.6	1.4	2.2	1.7	-2.1
Other (non-trawl) gears	Immediate loss		-	-	-	-
	Long-term Gain	0.6	1.7	5.9	10.9	17.1
T o t a l	Immediate loss		1.5	4.7	9.6	15.3
	Long-term Gain	0.6	0.2	0.9	0	-0.8

Table 24. Age/length/weight relationship of Iceland cod and haddock - fresh gutted weights (German and Iceland data).

Age (years)*	COD		HADDOCK	
	Length (cm)	Weight (g)	Length (cm)	Weight (g)
1	20.0	80	25.0	180
2	37.2	450	36.0	430
3	50.7	1235	46.0	975
4	60.9	2005	52.0	1410
5	69.2	2875	56.0	1760
6	75.7	3600	60.0	2220
7	81.2	4300	64.0	2705
8	85.2	4770	67.0	3075
9	88.2	5240	69.0	3325
10	90.4	5610	70.5	3535
11	92.4	5990	72.0	3770
12	94.2	6320		
13	96.0	6670		
14	98.0	7060		

* Data given for about July-September in each case and averaged for all areas.

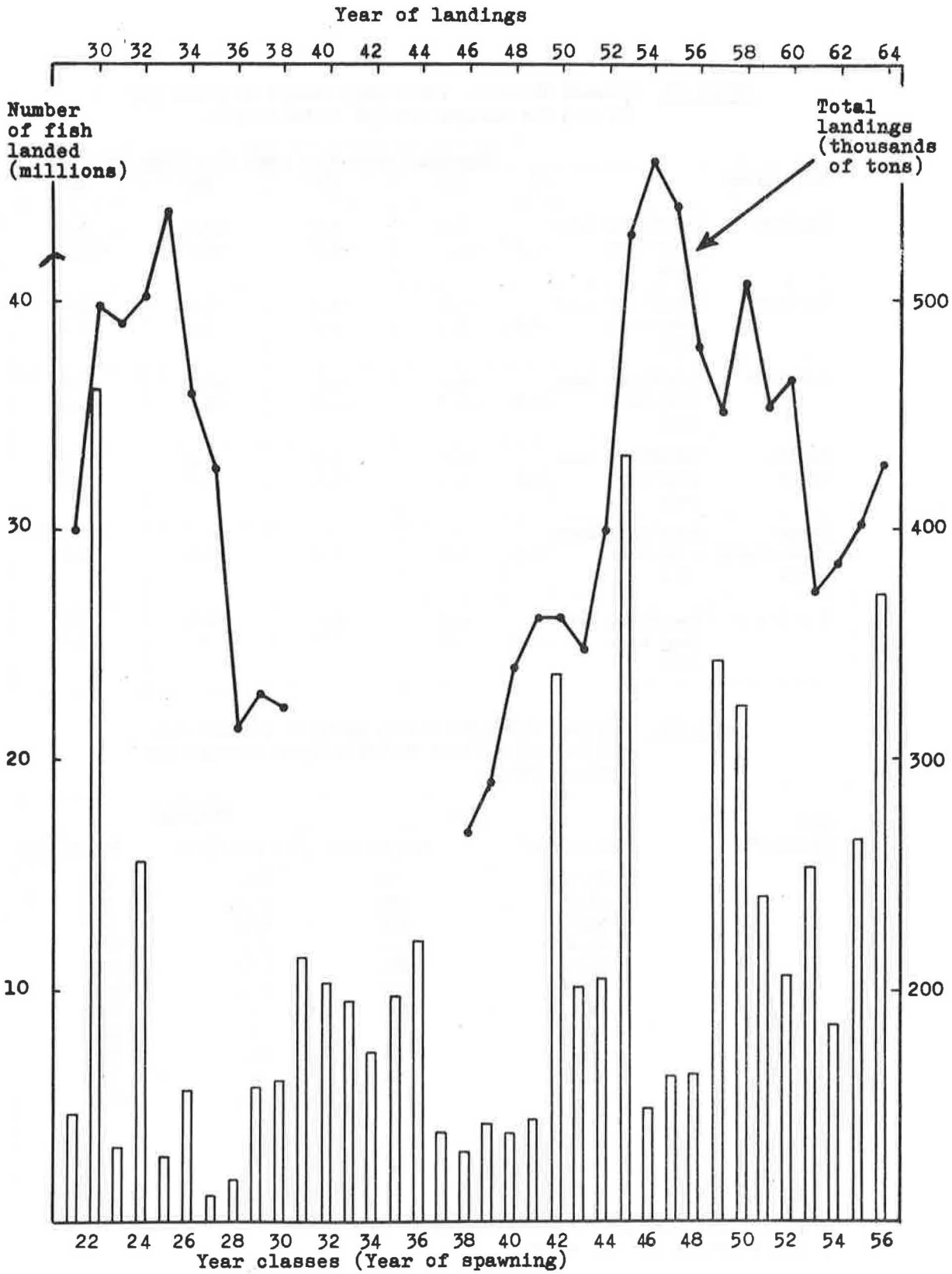

Figure 1. Iceland cod. Relationship between total yield and year class strength.

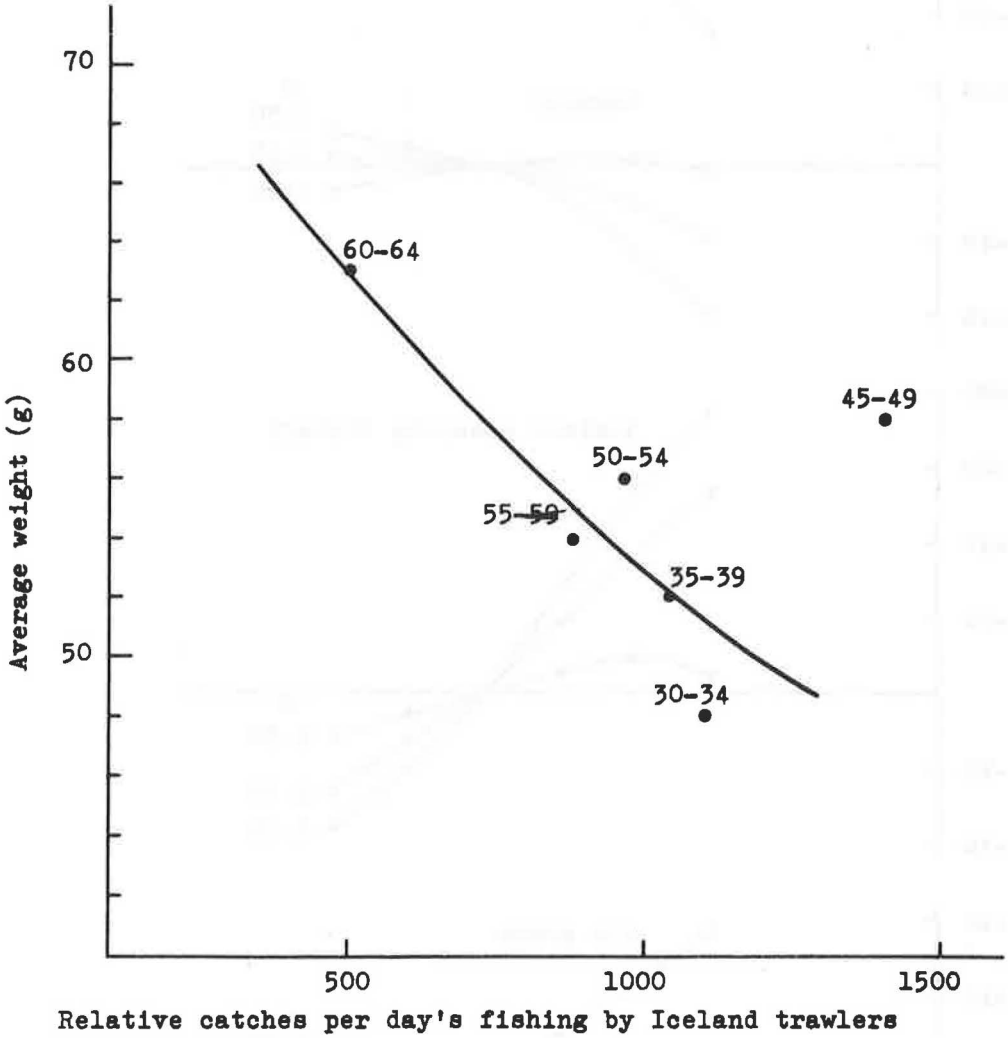

Figure 2. Iceland cod. Relationship between mean weight of 8-12 year old fish and size of stock.

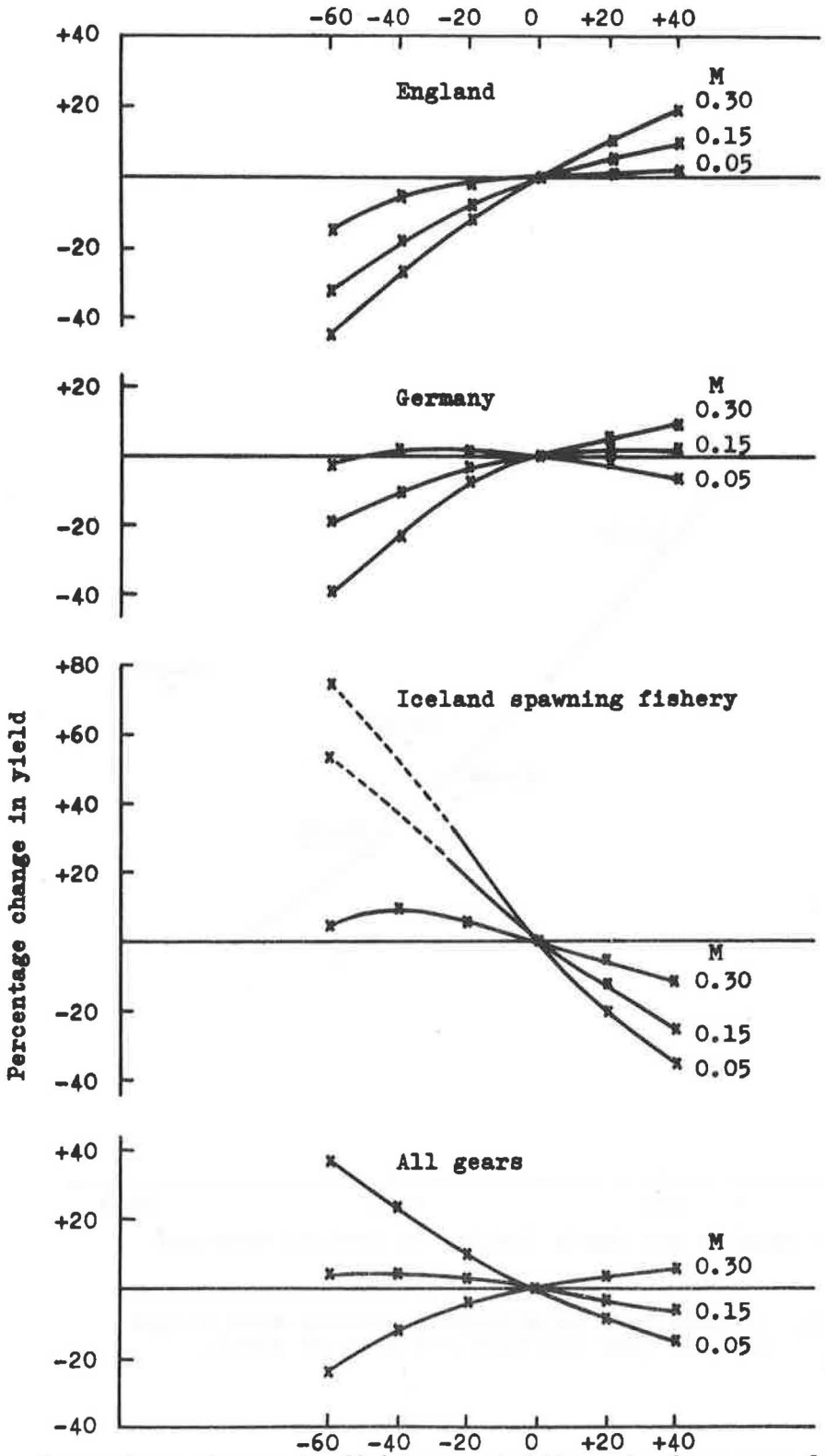

Figure 3. Iceland cod. Assessments for changes in effort by all gears.

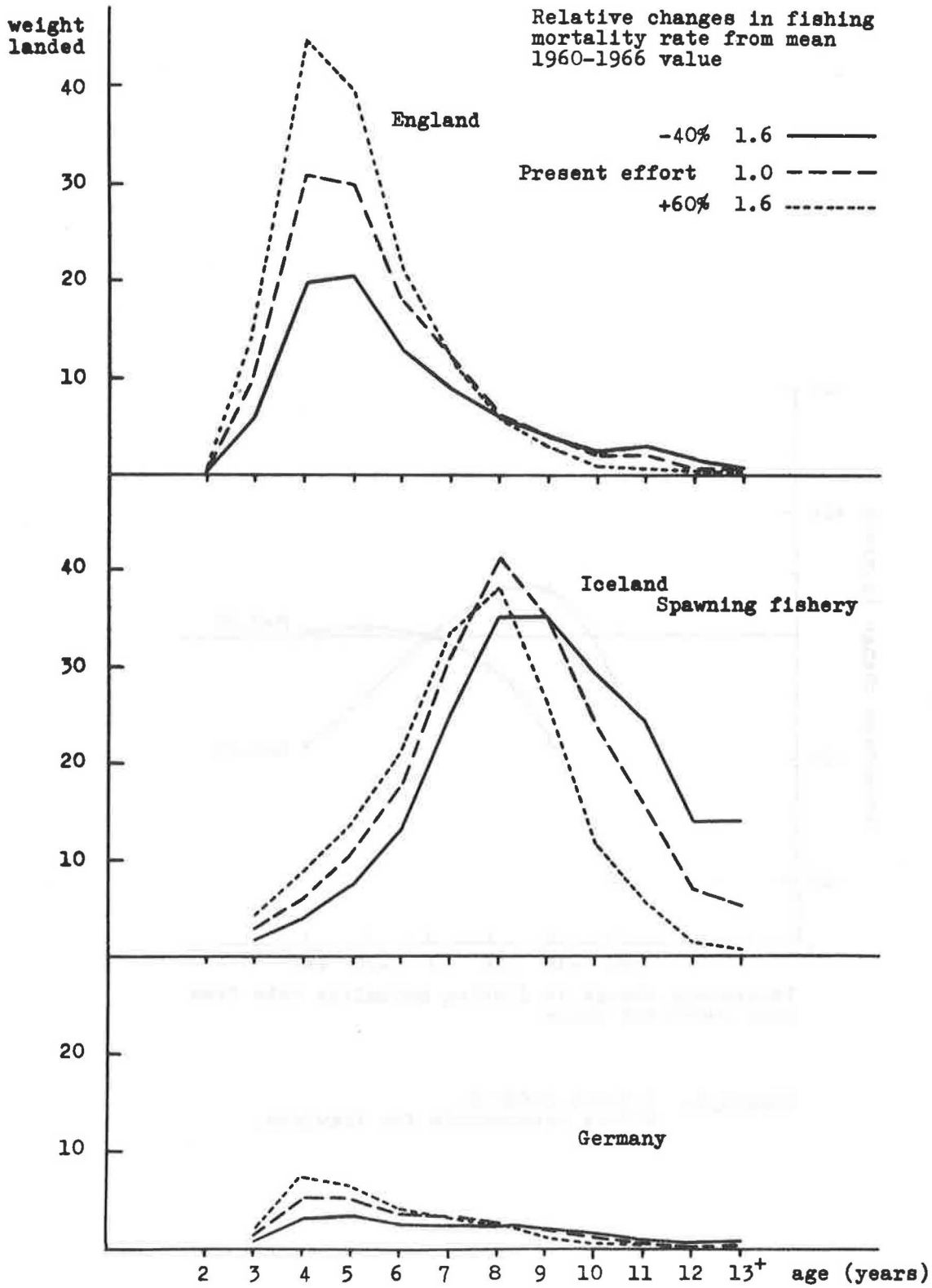

Figure 4. Iceland cod. Predicted weights landed at each age for various changes in effort (M=0.15)

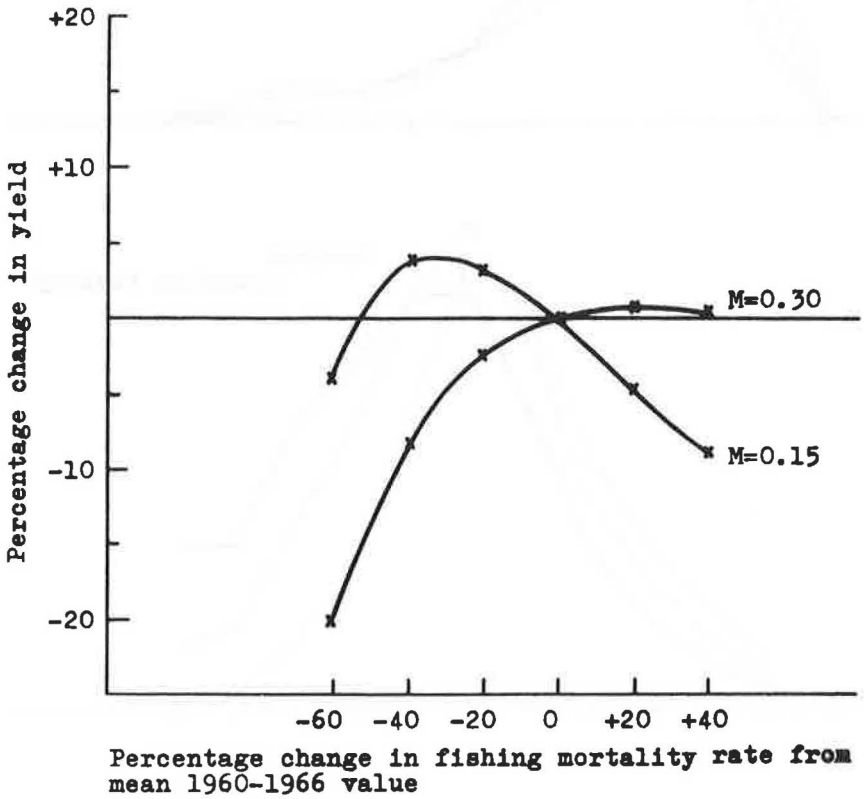

Figure 5. Iceland haddock.
Effort assessments for trawlers.