INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

RESTRICTED

Serial No. 2490
(B.g.7)

ICNAF Comm.Doc.71/1

ANNUAL MEETING - JUNE 1971

Report of Mid-year Meeting of Assessment Subcommittee
25-30 January 1971

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I. Introduction

The Subcommittee met at ICES headquarters in Charlottenlund Slot, Denmark from 25-30 January 1971. Twenty-eight scientists from twelve member countries, two scientists from FAO and the Executive Secretary attended. A special session on seal assessment was convened on 25 January. The main work of the Subcommittee was divided between two working groups - one for herring chaired by Mr Derek Iles, and one for groundfish.

The report which follows reflects a satisfactory progress in assessments which is due primarily to the activities of many scientists prior to the meeting, and the large attendance of appropriate biologists. We hope this report will reward member nations for their efforts, and encourage them to continue.

The Subcommittee was materially aided by the accommodations and efficient service of the ICES secretariat.

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III. Chairman's Synopsis

The prime function of the Subcommittee is to evaluate and condense detailed studies which themselves summarize a large amount of data into concise information and advice to the Commission through STACRES. This process also provides a feed-back to initiate needed research by pointing out the lack of knowledge for many critical problems.

The advice and conclusions frequently go beyond the facts of a specific study when broader inferences and judgments seem valid and important. Validity is assured because of the experience and knowledge, the uninhibited exchange of ideas and criticism, and the objectivity of some of the best scientists of many nations.

The perspective of the present report may be enhanced by some general comments. The catches of some major species taken from the ICNAF area in 1960 and 1969 are shown below (thousands of metric tons).

[1] also participated in Seal Assessment Meeting

	1960 Landings	%	Rank	1969 Landings[a)]	%	Rank
Cod	1134	55	1	1518	43	1
Redfish	288	14	2	220	6	4
Herring	180	9	3	954	27	2
Haddock	159	8	4	71	2	[illegible]
Flounders	90	4	5	287	8	3
Hake	63	3	6	201	6	5
Mackerel	7	-	-	91	2	6
		93			94	
Total - all finfish	2078			3558		

a) contains estimates only of landings by non-member countries

The total landings increased by 71% over the period, but the seven species listed accounted for 93-94% in both years.

Cod: Relative importance dropped, but still No. 1. See Section IV-B-4 for general comments.

Redfish: Relative importance and rank dropped. No assessments of effects of fishing and potential yields available.

Herring: Relative importance and rank increased. The five-fold increase resulted from expansion of fishery to include all available stocks, and included the virtual decimation of one of the largest stocks (52-6). Decreasing abundance and, hence, catch rate has and will further cause diversion of effort to other species. This is a case where the total stock was probably overexploited before an assessment could be made.

Haddock: Relative importance decreased. By 1970, the total catch will have dropped even further. The assessments now available indicate the following situation:

Stock	Probable max equilibrium yield	Max. land. and year	1969 land.	Catch quota 70-72	Annual 71-72 landings to maintain 1970 stock to 1973	Land. in 1971 at 1969 fishing rate	Stock size at max. equil. yield (millions fish)	Stock size 1970 (millions fish)
4V-W	25	38(1959)	11	none	6	12	60	33
4X	18	42(1966)	30	18	12	12	50	15
5	50	155(1965)	25	12	12	12	145	21
Total	93		66	-	30	36		

(All in 000s tons, except stock size.)

A maximum equilibrium yield for the ICNAF area (excluding Grand Banks which would be small) of 90,000-100,000 tons seems possible. The 1969 catch was two-thirds of this; 1971 catches, even if the present fishing effort were maintained, would be one-third of this. The landings in 1971-1972 to just maintain the very low 1970 stock level would be less than 30,000 tons per year, perhaps as low as 15,000-20,000 tons. It would require a period of no fishing for at least 5 years to rebuild the stocks to former levels, and there is no guarantee that it is possible. However, the investment required is something less than 100,000 tons of fish (5 years at less than 20,000 tons) taken with ever decreasing catch rates. The pay-off is possible return to landings of 100,000 tons per year.

Flounders: Rel[illegible] importance and rank increased. With one exception [illegible] there is little information on potential yields and effect[illegible] [illegible].

Hake: [illegible] increased importance and rank (in 1965 it was second rank [illegible] over [illegible] of total groundfish). Effort has decreased recently and [illegible] time to assess the status of stocks.

Mackerel: From [illegible] to sixth rank and [illegible] of landings. In 1970 landings may be double [illegible]. No assessments available, and very little data available.

From the haddock [illegible] it is obvious that rectification of past mistakes is sometimes [illegible] slow. However, for several important stocks, e.g. cod, hake, mackerel, perhaps [illegible] flounders, the productivity may be maintained and maximized with the immediate application of conservative management schemes.

IV. State of Fisheries

A. Seals

The following were present for Harp seal assessment discussions:

R.J.H. Beverton (UK), Convener
G.E.M. Smith (Canada), Rapporteur
D.E. Sergeant (Canada)
T. Øritsland (Norway)
F.O. Kapel (Denmark)
F. Smidt (Denmark)
D.J. Garrod (UK)
J.A. Gulland (FAO)
A.T. Pinhorn (Canada)
B.E. Brown (USA)
H.A. Regier (FAO)

Dr Sergeant (Canada) presented his paper "Calculation of production of Harp seals in the western North Atlantic" (ICNAF Res.Doc. 71/7). The methods of collecting the data and [illegible] types of bias or possible bias and their effects on [illegible] were discussed in considerable detail.

Mr Øritsland (Norway) also presented his paper "Progress report on Norwegian studies of Harp seals at [illegible] Newfoundland" (ICNAF Res.Doc. 71/8). This paper along with that of Dr Sergeant [illegible] most of the basic information for subsequent discussion and the data from the two papers were partly complimentary and partly supplementary.

Mr Kapel (Denmark) [illegible] the Harp seal work in Greenland of which he has recently taken [illegible]. [illegible] Greenland catch in recent years has been in the order of 10,000 [illegible].

The [illegible] that the stocks fished on the Front and in the Gulf are [illegible] population. The analyses below refer to the total seal population.

Estimates [illegible] the [illegible] production of young Harp seals have been made by [illegible]:

Aerial survey	3[illegible],000 in 1959-1960
Capture-recapture	[illegible] in 1966-1968
Index of [illegible] and catch	[illegible],000 in 1960-1969
[illegible] age and catch	280,000 in 1967-1969

Bearing in mind the possible sources of error and bias in the different methods, the agreement is [illegible] a production of 300,000-400,000 pups annually during the 1960's [illegible] with the highest level of annual catches during this period (280,000 in 1965 and 1968).

The figures also suggest that there has been a decrease in production, especially since the aerial survey method provides a lower bound to the production, which could be rather higher to the extent that seals were missed. Recent age-frequency samples also suggest a declining production since the 1950's because the younger animals are relatively less abundant. In round figures, the recent production of pups has probably been:

1960	400,000
1965	350,000
1970	300,000

In an earlier paper (ICNAF Res.Doc.69/31) Sergeant described a method to estimate the equilibrium catch of pups from a knowledge of adult and juvenile mortality, and the reproductive rate. For example, consider a stock of 300,000 adult females (the likely stock in 1971), if the adult mortality rate is 10%, 30,000 females will die during the year and the population will be in equilibrium if this is equal to the number of females reaching maturity.

The 300,000 females will produce 270,000 pups (assuming a 90% pregnancy rate) of which (270,000 - C) will survive the harvesting period, where C = catch of pups. If 40% of these survive to maturity, and half are female, the total number of females reaching maturity is 0.5 x 0.4 x (270,000 - C).

Therefore, the equilibrium catch is given by

$$0.5 \times 0.4\ (270{,}000 - C) = 30{,}000$$

or

$$270{,}000 - C = 150{,}000$$

or

$$C = 120{,}000$$

The equilibrium catch was similarly calculated for other values of adult mortality and immature survival. These are set out in the table below:

Sustainable harvest of pups from an adult stock of 300,000 females

Adult mortality	Survival of pups to maturity			
	20%	40%	50%	60%
6%	90,000	180,000	198,000	210,000
8%	30,000	150,000	174,000	190,000
10%	-	120,000	150,000	170,000
12%	-	90,000	126,000	150,000
14%	-	60,000	102,000	130,000

The best estimate of adult natural mortality comes from analysis of the age-composition data collected in the early 1950's, just after a period of low exploitation during the 1940's. This gave a figure of 10% per year. The survival of pups to maturity at 5 years was believed to be around 40%. The natural mortality in the present depleted adult population may be less than 10%. However, considerable catches of both juveniles and adult animals are at present being taken at the rate of around 5% per year. The present total deaths of adults is probably at least 12% per year and possibly as much as 14%. If catching of seals other than pups continues at the present level, any catch of pups greater than 90,000 would further decrease the stock. However, if catching of all animals other than pups were stopped, then the adult mortality might be no more than 8% and also the survival of immature would improve, perhaps to 50%. In that case, catches of up to 174,000 pups could be taken without decreasing the stock. The Group believed that the choice between the alternative strategies of 174,000 pups and no older animals or 90,000 pups and unchanged harvest of older animals or any intermediate strategy would have to be made on economic and social grounds, on which they could offer no advice.

There was considerable discussion on the relation of the present population and sustainable yield to the maximum sustainable yield and the population producing it. This would depend on the proportion that the present stock is of the equilibrium, unexploited stock, and the extent to which the mortality and reproductive rates might change to compensate changes in abundance. It was noted that one important compensatory change - a decrease in average age at first maturity - had taken place in the 1950's. No further reduction in age at maturity had occurred in the 1960's - in fact, there is some evidence that it increased. Also the pregnancy rate is now so high (90%) that further increases in it are not likely. Thus, any further reduction in stock will likely result in a proportional decrease in sustainable yield.

The Group believed that the present stock is less than that giving the maximum sustainable yield and that therefore action should be taken to increase the stock, i.e., the quota should be set at less than the present sustainable yield. It noted that the present ICNAF quota (200,000 plus landsmen's catch of approximately 40,000) is well in excess of the sustainable yield, even if the killing of all older seals were stopped. The effect of maintaining this quota will be a progressive decline in the population and in the possible catch from it. It may be pointed out that because of the long potential life-span of seals, any rehabilitation of a depleted seal stock will be a slow process.

B. Cod

1. Subarea 1.

In the Assessment Report for 1970 (Redbook 1970, Pt. 1, p. 40), predictions for the 1970 and 1971 catches were made on the assumption that 1969 catches were about 225,000 tons and F equalled 0.6 for fully recruited age-groups. The 1970 catches were predicted to be about 178,000 tons by an F value of 0.6 and 224,000 tons by an F value of 0.8. Actual catches in 1970 are not yet known but information from some countries indicate that the catch is likely to be somewhat less than the 1969 catch which is now estimated to be about 230,000 tons.

New assessments for Subarea 1 cod including predictions for the 1970-1972 catches have been made based upon the most recent catch statistics and age composition of landings and stock in 1968 and 1969 (ICNAF Res.Doc. 71/9). Information on newly recruited age-groups in the 1970 fishery is, of course, better now than last year so that the prediction for the 1970 catches differs somewhat from that in the last year's report. There is a very close agreement between scientists engaged in this work as to the actual number of cod by age-groups present in the stock and landed, but the value of F in 1969 and the size of the newly recruiting year classes cannot yet be measured as accurately as desired. Concerning these new year classes, 1965 and 1966, the former is thought to be the more abundant although the 1966 year-class may be of some importance in the northern divisions (1B-1C and partly 1D). However, neither seems to be comparable in size to the abundant year-classes of 1960, 1961 and 1963, so that generally the stock has declined from the relatively high level in the mid-1960's, and the annual catches in the years 1970-1972 are, therefore, not expected to be more than roughly half the annual catch in the former period, even with increased effort (Fig. 1).

Taking into account the evident reduction in fishing activity from 1968 to 1969 and 1970, it seems likely that F for fully recruited age-groups has declined from the estimated value of 0.8 in 1968 to a value of not more than 0.6 and possibly less in 1970. Considering also the generally agreed variation of F between age-groups predictions for 1970-1972 catches have been made as follows:

1968	1969	1970	1971	1972
				174 (0.50)
		190 (0.50)	183 (0.50)	
				227 (0.70)
382 (0.80)	[illegible]			
				157 (0.50)
		221 (0.60)	201 (0.60)	
				205 (0.70)

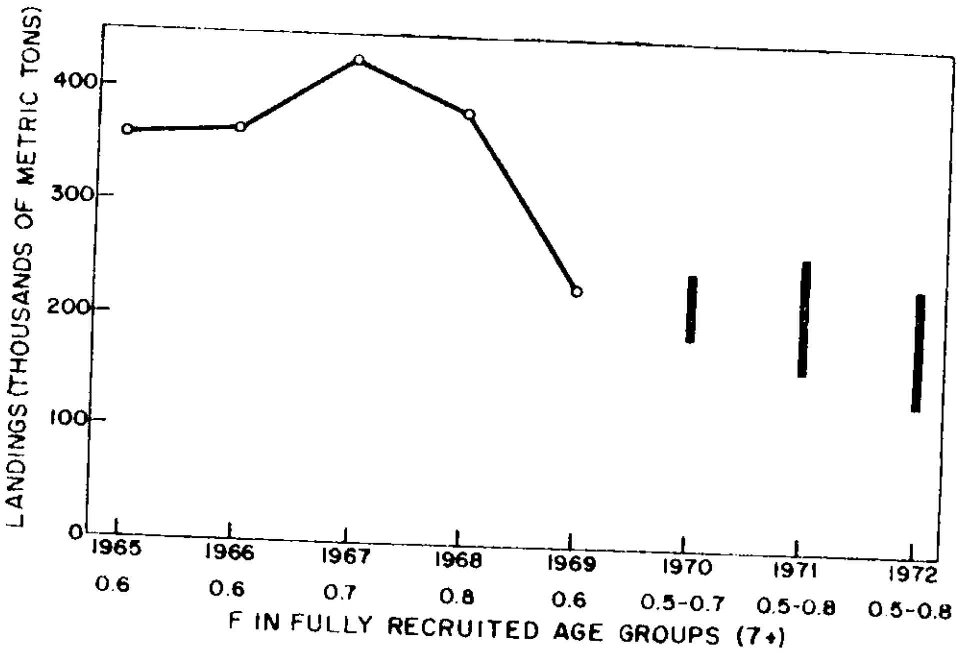

Figure 1. Subarea 1 Cod: nominal catch.

As will be seen from the table the catches in 1972 depend not only on the F value in that year but also on F values in preceding years. The data indicate, for example, that increasing F over the period 1970-1972 by 27% (1.5 to 1.9) would produce only a 14% increase in landings (547 to 627). In Fig. 2 the prediction for the 1972 catch can be readily seen for any likely variation of F values in 1970-1972.

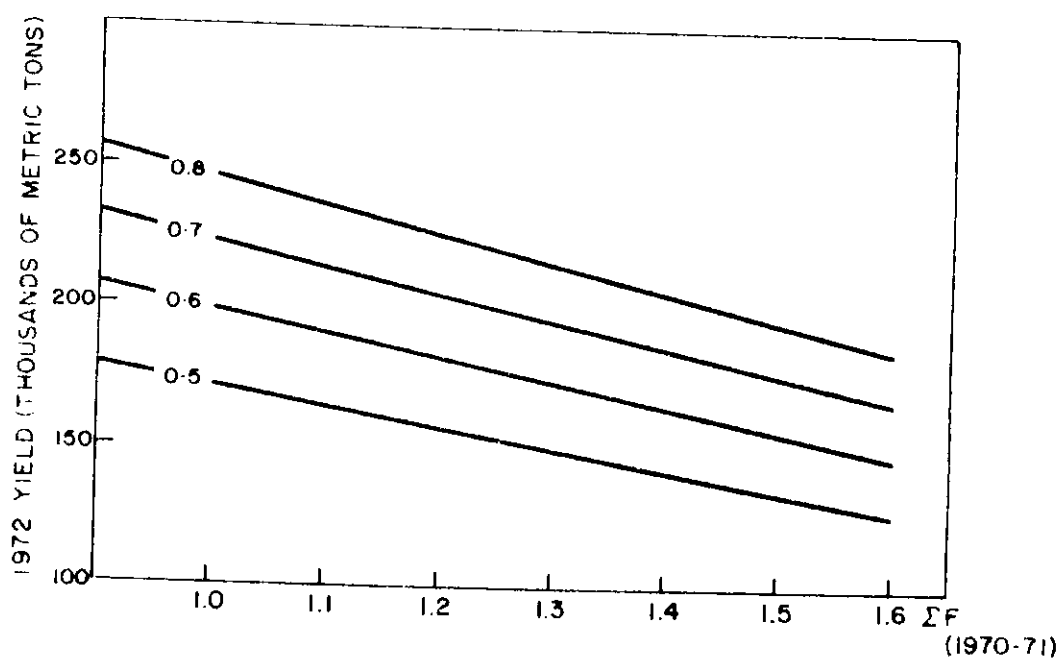

Figure 2. Subarea 1 Cod: yield in 1972 at different levels of F in 1970, 1971 and 1972.

The Subcommittee reiterates their statement made in 1970 that although the present level of F may not exceed the value of F of 0.6 corresponding to the level giving the maximum sustainable yield-per-recruit (Fig. 3), any improvement (in ice-conditions or stock abundance) relative to other fishing areas will again attract effort in excess of that giving the maximum sustainable yield-per recruit. Therefore the need to regulate fishing and especially to prevent a sudden expansion to a level of F beyond that of 1969-1970 still exists.

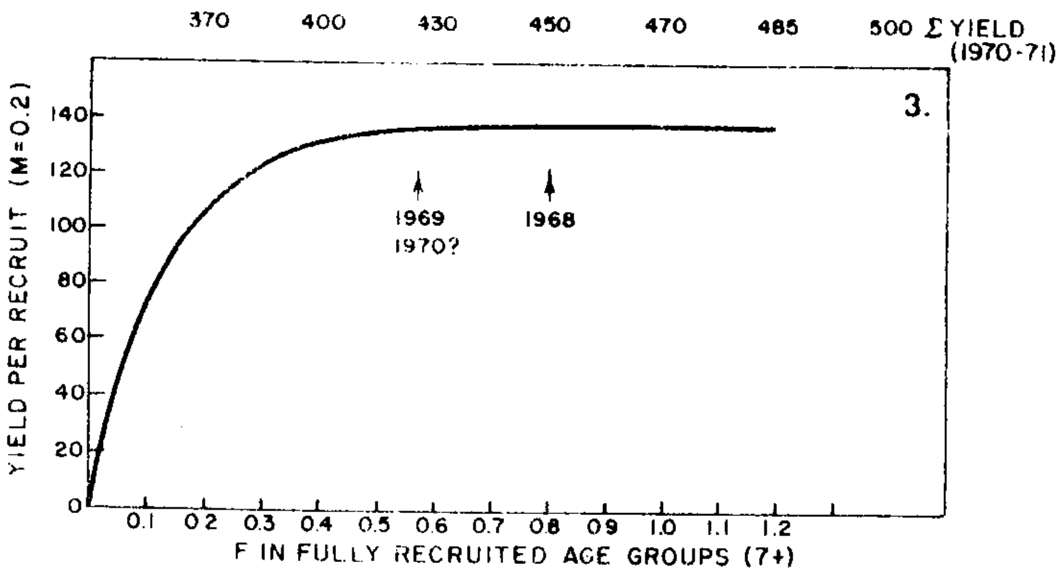

Figure 3. Subarea 1 cod: yield per recruit (M = 0.2).

It has been known for a long time that a proportion of the mature cod at Greenland migrate to Iceland although no return migration has yet been observed. At the meeting in December 1970 the ICES Northwestern Working Group made a quantitative estimate of this migration based upon Danish tagging experiments. These experiments have also been used by the Assessment Subcommittee as one of the means to estimate F in Subarea 1. For their purpose the Northwestern Working Group pooled experiments carried out in the years 1946-1964 (the period during which F in Subarea 1 is known to have increased) so their estimate of F in Div. 1E and 1F is not directly comparable to that reported by the Assessment Subcommittee which applies throughout Subarea 1 in particular years. It was noted that the proportion of mature (70 cm+) cod migrating from Greenland to Iceland varies considerably between regions at Greenland, being about 55% from East Greenland and about 15% from Div. 1E-1F; the emigration to Iceland from Div. 1A-1D is thought to be much less. The net emigration from Subarea 1 is thus only about 5% and this is included as a natural mortality factor in the calculations of yield from West Greenland given above.

The effect on yields from the Iceland fisheries has been reported by the Northwestern Working Group.

2. Subareas 2 and 3

a) Div. 2J

Catch/effort assessments presented to the 1970 Annual Meeting (ICNAF Res.Doc. 70/67) indicated that the level of fishing in the area during 1964-1968 generated a fishing mortality close to that providing the long-term maximum of yield-per-recruit. A new assessment (ICNAF Res.Doc.71/10) using the virtual population technique on age composition data from 1959-1968 indicates that fishing mortality (F) in fully recruited age groups increased from about 0.06 in 1959 to 0.3 in the 1963-1967 period, about five-fold. Landings at the same time increased from [illegible],000 tons in 1959 to [illegible],000 tons in 1967, [illegible],000 tons in 1968 and [illegible],000 tons in 1969. The increased fishery has caused a marked reduction in the proportion of older age groups in the population and the fishery has become increasingly dependent on younger age groups recruiting to the fishery. The total number of cod in the exploited population has fluctuated only moderately in the period with no trend being evident, because recruitment has been somewhat higher in recent years. These trends are confirmed by USSR data on age compositions of the commercial fishery and on young fish surveys in Div. 3K, the area from which cod recruited to the northern area are believed to come (ICNAF Res.Doc. 71/11).

Cod are fully recruited to the fishery at 8 years of age, while very few 3-year-olds are caught, the 50% recruitment age being 6 years. A revised yield-per-recruit calculation incorporating these partial recruitment estimates produced a curve similar to that from the previous assessments, and substantiates the conclusion that further increases in fishing mortality will not give a long-term increase in yield. Increased catches would reduce the abundance of the stock. However, because of the marked effect on fishing success of year-to-year variations in distribution of the stock caused by the hydrographic conditions, the trend has been to concentrate fishing more and more in periods when cod concentrations are most dense. Thus, the reduced abundance may not be immediately reflected as reduced catch-per-unit-of-effort in this stock.

Data presented by USSR indicated that the increased catches in 1968-1969 were made possible by improved recruitment in the early 1960's and this is also indicated from the virtual population analysis. USSR young fish surveys indicate that the 196[illegible] and 1965 year-classes are less abundant, but that the 1966 and 1967 year-classes which will contribute to the fishery in 1972 are relatively stronger.* However, it must be stressed that at Labrador actual catches in some years may be as much influenced by peculiarities of cod distribution in relation to temperature variations as by abundance of recruiting year classes, especially since year-class fluctuation seems to be only in the order of 3-4 times in this area.

b) Subarea 3

No new assessments are available for Subarea 3 but previous assessments presented to the 1970 Annual Meeting indicated that the fishing effort on some stocks is probably beyond that generating the maximum sustained yield-per-recruit. In view of the relationship between the present and previous assessments for Subarea 2 given above, it is unlikely that planned virtual population assessments for some of these areas will greatly alter the conclusion that the level of effort is at least near the point of maximum sustained yield and perhaps beyond it.

The reduction of the cod catch in Div. 3NO from the high 1967 level of 2?2,000 tons to 110,000 tons in 1969 reflects a reduction in effort in this area. The very strong 1964 year class which was primarily responsible for the marked increase in landings from 3NO in 1967 has almost disappeared from the landings, even though the fish were only 5 years old in 1969. As a result the fishery in this area is now heavily dependent on the younger year classes recruiting to the fishery. Since the fluctuations in year-class strength are great in Div. 3NO, and to a lesser extent in Div. 3Ps, an increased variability in stock abundance and catches can be expected, especially if the increased effort were sustained.

USSR research surveys to the southern Grand Bank area indicate that the 1967 year-class was poor, followed by a stronger 1968 year-class but a poorer 1969 year-class. The fishery in this area in 1971 is therefore expected to be less productive than in the 1967-1968 period and will probably return to a level close to that prevailing before the entrance of the strong 1964 year-class (80,000-100,000 tons).

Although the assessments are incomplete, the evidence suggests that the [illegible] will decrease in 19[illegible]. Maintaining or increasing fishing mortality will not [illegible] yield per recruit, and may result in lower yields over the [illegible].

[illegible]. [illegible] area 4 (Div. 4X)

Cod landings from Div. 4X increased from less than 15,000 tons in 19[illegible] to over 35,000 tons in 1968. This was largely due to the rapid expansion [illegible] otter and pair trawling on the offshore banks of Browns and La Have. In 1969, the [illegible] year for which data are available, landings declined slightly [illegible] tons, due to a decrease in landings from the inshore fishery. The stocks supporting the inshore and offshore fisheries are believed to be independent.

Inshore Fishery

Landings from the inshore fishery (mainly Bay of Fundy and within 12 miles of southwest Nova Scotia coast) prosecuted almost entirely by Canadians handlining and longlining from small boats, probably averaged about 14,000 tons in the 19[illegible]-1958 period. Total mortality rate (Z) at this time averaged 0.45. Inshore landings in the period 1958-1969 also averaged 14,000 tons. Effort in the line fisheries off southwestern Nova Scotia, from where the bulk of the inshore landings come, has either remained constant, or more probably, decreased whereas effort by otter trawlers in the Bay of Fundy has increased. However, total inshore effort between 1958 and 1969 may not be much different from that in 19[illegible]-195[illegible]. Therefore, Z in the inshore stocks is probably still close to [illegible].

Offshore Fishery (ICNAF Res.Doc. 71/12)

Expansion of otter trawling started in the early 1960's and annual landings from the offshore fishery increased from less than 3,000 tons prior to 1963, to 1[illegible],6[illegible] tons in 1969, averaging 15,000 tons in the 1965-1969 period. The average value of Z in 1965-1969 was estimated at 0.90. Assuming M = 0.20 implies F = 0.70. The constant parameter yield-per-recruit model indicates that maximum yield per-recruit from this stock is obtained at F = 0.35. The model predicts that a 13% long-term increase in yield-per-recruit would accrue from a 50% reduction in F from 0.70 to 0.35. F in 1969 may have increased [illegible], assuming it was proportional to the observed increased fishing effort.

An estimate of the population numbers of age-groups 4 and over at the beginning of 1970 was obtained from a knowledge of numbers caught and mortality [illegible] of each age group in 1969. From this, estimates of the likely yield in 1970 for various values of F have been obtained. Although no accurate estimate of the contribution of 2- and 3-year-olds to catches in 1970 can be made, these age groups normally contribute only about 6% to the weight of the catches. Thus, this lack of data is not likely to result in a large error in the calculations. If F remained at the estimated 1969 level of 0.90, the catch in 1970 would be about 1[illegible],[illegible]00 tons. With an F of 0.35, the catch at the 1970 level of abundance would be about 6,000 tons, indicating the magnitude of immediate reduction in catch from this stock required to give maximum yield-per-recruit.

Because of the poor year classes produced in 1964, 1965, and 1966 which in 19[illegible] would constitute the normally most important age groups in the catch, reduction of catch, even of the order given above, may not result in increased [illegible].

[illegible]. General conclusions

We now have reasonable assessments for cod in Subarea 1, Div. 2J, and Div. 4X. [illegible] complete information is available for Subareas 3 and 5 [illegible]. The additional studies substantiate the Subcommittee's conclusions of last year that

(i) the available fishing capacity capable of being deployed on cod stocks is greatly in excess of that required to secure the maximum yield-per-recruit,

(ii) the high yields of 196[illegible]-196[illegible] were achieved by decreasing the stocks accumulated under previous lower levels of exploitation and because of a period of [illegible] recruitment,

iii) the estimates made by the Subcommittee indicate that yield will probably decrease from the 1969-1970 level, barring short-term increases due to increased fishing effort,

iv) increases in effort on any of the cod stocks will cause a deterioration in the fisheries and the stocks. At best, it is probable that over the long run, no more than a total catch of 1,300,000 tons (compared with 1,860,000 tons in 1968 and 1,263,000 in 1969) would be taken with increased effort, but it is possible, depending on the stock-recruitment relation, that there might be a decrease in total catch.

The apparent decrease in effort on cod in the Northwest Atlantic in 1969-1970 to a level near the maximum yield point was caused by decreased availability and stock size; a large part of the effort was shifted to cod stocks in the Northeast Atlantic. The stocks of cod in the latter area are declining and it is likely that the effort will be shifted back to the Northwest by 1973. The Subcommittee wishes to stress that immediate action to limit fishing on all cod stocks in the Northwest Atlantic would be most propitious.

C. Haddock

1. Div. 4V-W

Last year's assessment indicated that this stock had been rather heavily exploited in recent years. The exploited stock (4-12-year-old fish) had declined by more than two-thirds from 1957-1969; the abundance in 1969 was the lowest on record. Landings during this period averaged 27,500 tons annually, reaching a maximum of 55,518 tons in 1958, and a minimum of 10,912 tons in 1967. Landings in 1969 were 11,146 tons.

The 1962-1964 year-classes were heavily exploited as immature fish in 1965, thus reducing the yield normally obtained when fished as four-year-olds and greater. The 1965-1968 year-classes were relatively poor (about 10 million fish each). Thus, even with a fishing mortality in 1968-1969 close to that producing maximum equilibrium yield-per-recruit (0.5), the exploited population decreased from 33 million fish in 1967 to 25 million fish in 1969.

A research vessel survey completed in July 1970 provided better estimates of the strength of the 1967 and 1968 year-classes and initial estimates of the strength of the 1969 year class. Estimates of the effort, quantity and age composition of landings for the 1969 fishery are now available. Updated predictions of the stock status through 1973 are given in Table 1(ICNAF Res. Doc. 71/13).

Estimates of the strength of the 1967 and 1968 year-classes at recruitment to the fishery in 1970 and 1971 at age 4 remain unchanged from previous estimates of 9 million fish and 5.5 million fish, respectively. Estimated abundance of the 1969 year-class at age 1 in 1970 indicates that this year-class is probably also poor, and it is estimated that abundance at recruitment at age 4 in 1972 will be about 10 million fish. Thus, assuming F remains in 1970-1973 at about 0.50, the value giving maximum yield-per-recruit, the available population is predicted to decline from 33 million to around 22 million fish in 1972-1973. The yields would decrease from 12,500 tons in 1970 to 8500 tons in 1973.

The Subcommittee felt that this stock is already so low that there is a danger that the average future recruitment may be impaired, and therefore, fishing should at most be no more than that which would keep the stock at its present level. For total removals to balance recruitment in 1972-1973, F should be reduced to about 0.28. This corresponds to a catch of about 6,500 tons. Thus, if stock decline below the 1971 level is to be prevented, the annual catch in 1972-1973 should not exceed this amount. If fishing is greater in 1970-1971 than predicted, the 1972 quota would have to be less than 6,500 tons to achieve this goal.

A long-term management objective would be to increase the stock to about 60 million fish, which should give a maximum equilibrium yield of about 25,000 tons annually with recruitment at the average level experienced prior to 1960. Also, measures should be taken to prevent the taking of large numbers of juvenile haddock in incidental catches of fisheries for other species,

TABLE 1. 4T-V-W haddock: available population, removals, recruits, fishing mortality (F), and yield 1967-1973.

	CALENDAR YEAR						
	1967	1968	1969	1970	1971	1972	1973
Available population x 10^{-6}	33.0	30.5	30.3	32.7	28.2	21.6	22.0
Removals x 10^{-6}							
Total	13.2	14.0	12.1	13.6	12.1	9.6	9.1
Fishing	8.0	9.4	7.4	8.5	7.8	6.3	5.7
Natural	5.2	4.6	4.7	5.1	4.3	3.3	3.4
Recruits at age 4 x 10^{-6}	10.0	10.6	14.5	9.0	5.5	10.0	?
Fishing mortality F	0.47	0.57	0.43	0.50	0.50	0.50	0.50
Landings (metric tons)	11,000	13,500	11,000	12,500	11,500	10,000	8,500
	Observed values			Estimated values			

Note: The estimated numbers in the available population, removals and recruits do not balance exactly from 1967-1969 because calculations were done independently in each year.

particularly the summer silver hake fishery on Sable Island Bank.

2. Div. 4X

In the assessment presented last year (Redbook 1970, Pt. I, p. 45-46), it was estimated that total mortality (Z) on fully recruited age-groups (age 6+) averaged about 0.8 in 1967-1968. Analysis of groundfish survey data from 1963 to 1968 provided an estimate of M = 0.2, so that F = 0.6. These latter data also provided estimates of the relative strength of the year-classes 1961-1967. Estimates of the available stock were derived from landings data, and combined with the estimates of pre-recruit strength from the survey cruises, catches in 1969 and 1970 were predicted.

Thus, if F remained constant at 0.6 through 1969 and 1970, it was estimated that the available stock would yield 23,000 tons in 1969 and 12,000 tons in 1970.

Actual catches of haddock in Div. 4X in 1969 and 1970 were about 30,000 and 12,000 tons, respectively, indicating that F in both years probably exceeded the high 1968 value of 0.60. Recent surveys of pre-recruit year-classes indicate that those of 1968-1970 are equally as poor as those of 1964-1967. This indicates that no significant improvement in recruitment to the fishery is likely prior to 1975 at the earliest, and stock abundance will continue to decline unless F is reduced considerably below current levels. Thus, an annual quota of 18,000 tons is ineffectual in maintaining stock abundance and quotas should be reduced to considerably less than 12,000 tons.

3. Subarea 5

The preliminary report for catch in 1970 was 11,660 tons compared to the quota of 12,000. The fishery was closed 13 October when 80% of the quota was reached. Preliminary analysis of data from the autumn groundfish survey indicates no significant change in the population between 1969 and 1970.

Previous estimates had indicated that additions to the stock in 1970 would be close to the 12,000-ton quota. Revisions of last year's assessment have not yet been completed, but it is still valid in terms of projected status through 1971 (Table 2).

No young-of-the-year fish were caught on the 1970 U.S. autumn research vessel survey. Thus, the 1970 year-class is very poor, and recruitment in 1972 will be very low, probably much less than that needed to replenish losses. The Subcommittee stresses that continuing the fishery at 12,000 tons will not allow for improvement of stock abundance and probably will lead to a further decrease by the end of 1972.

TABLE 2. Estimates of available population and recruitment for Subarea 5 haddock (in millions of fish).

	1935-1960	1968	1969	1970	1971	1972
Available Pop. (age 2+) incl. recruits	145	52	20	21	28	19+ recruitment
Removals:						
Total	63	33	15	9	9	
Fish	41	28	12	6 x)	6 x)	
Nat.	22	5	3	3	3	
Recruits (age 2)	54	16	1	16	16	

x) under regulation, 2 kilo per fish

D. Herring

1. Current fishery trends (Tables 3-5)

In 1970 total herring landings (preliminary) for the ICNAF statistical area declined by about 120,000 tons from the 1969 figure of 878,000 tons, but non-member country landings are not available for either year. There was an increase in landings in Div. 4T (Gulf of St. Lawrence) following an increase in effort, but all other fisheries reported reduced landings.

In Subarea 3 (south coast of Newfoundland) the decline was not marked for the year as a whole; higher catches in the early months of the year almost compensated for a poor fishery in the last few months of 1970. On the Nova Scotian Shelf (Div. 4VW) a marked decline in landings from the Banquerau area (Div. 4V) was only partly compensated for by increased landings from Emerald and Middle Bank (Div. 4W).

In Div. 4X, southwest Nova Scotia and Bay of Fundy, the Nova Scotian summer-fall fishery on spawning stocks recorded lower landings. There was also a marked reduction in landings from the juvenile fisheries of the New Brunswick (western) side of the Bay of Fundy. Inshore fisheries along the US coast (Div.5Y) continued their decline, and again, the juvenile fisheries were affected most, recording a 40% drop from the already low 1969 catch.

Both Poland and the Federal Republic of Germany reported slightly higher landings from Div. 5Z and Subarea 6 in 1970, but these were more than offset by much lower USSR landings. In these areas diversion of effort to mackerel in periods when herring concentrations were scarce was a significant feature of the 1970 fishery.

2. Identity of stocks

Subarea 3 (Newfoundland) and Div. 4T (southern Gulf of St. Lawrence)

Enough evidence is now available, both from the results of 1970 tagging experiments, and from other sources, to demonstrate the movement of herring into and out of the Gulf of St. Lawrence.

The herring stock which supports the winter fishery off the south coast of Newfoundland (Subarea 3) is the same as that exploited in the southern Gulf summer fishery (Div. 4T). It has also been shown that the spring and autumn spawning stocks fished in the Gulf of St. Lawrence are distinct and that both are recognizable, intermingled components of the Newfoundland winter fishery. It is estimated that for the last five years, at least, two-thirds of the herring in landings of the Newfoundland fishery were autumn spawners.

Div. 4V and 4W (Scotian Shelf)

Evidence is accumulating that two distinct stocks or stock-complexes over-winter on the Scotian Shelf. One inhabits the Banquerau and eastern Cape Breton area (Div. 4V) and the other the Emerald Bank and Middle Bank area (Div. 4W). They differ in age composition, growth rate, otolith structure and gonad development. The possibility that Banquerau herring are part of the Gulf of St. Lawrence stocks and that Emerald Bank fish are part of the southwest Nova Scotia autumn-spawning stock (Div. 4X) is being investigated.

Subareas 5 and 6

The distinction between adult stocks in Subarea 4 on the one hand and Subareas 5 and 6 on the other is supported by more recent information from the study of spawning concentrations, but the evidence does not necessarily exclude some degree of mixing. In particular, more information is required to determine the status of herring spawning populations on Jeffreys Ledge and Stellwagen Bank in Subarea 5.

Similarities of certain meristic characteristics, especially the right pectoral fin count, between Gulf of Maine juvenile herring year-classes and the same year-classes as adults on Georges Bank were found for year-classes

1960 through 1963. The similarities were not confirmed for the subsequent year-classes. The conclusions are thus ambiguous, and further research along these lines is required. Previous biochemical studies indicated two separate stocks.

A significant difference in mean vertebral count was found between juvenile herring of the same year-class on the Nova Scotia and New Brunswick side of the Bay of Fundy. This suggests that the Bay of Fundy may be a division point for stocks to the east and west. The possibility that the New Brunswick sardines may be related to Gulf of Maine stock and the Nova Scotian fall autumn-spawning stock should be investigated.

Recent research on the identity of stocks has, thus, clarified some issues, but in some areas has emphasized the possible complexity of the stock relationships.

3. Assessment of state of stocks

Subareas 3 and Div. 4T

In the Newfoundland winter fishery, although 1970 landings were about the same as in 1969, catch/effort declined by an estimated 15%. Preliminary indications are that a decline in catch/effort occurred in the summer fishery in Div. 4T as well. During the past five years the fisheries in the area have been largely dependent on pre-1960 year-classes; in the Newfoundland fishery in 1970 these year-classes still constituted about 50-60% by number of the total catch. Unless recruitment to the exploited stocks increases considerably the winter herring fishery along the south and west coast of Newfoundland must inevitably decline.

Div. 4V, 4W and 4X

Declining catches from the Banquereau area (Div. 4V) have resulted in diversion of USSR effort to Emerald and Middle Banks (Div. 4W) and Federal Republic of Germany effort to Subareas 5 and 6.

The Nova Scotian fishery on fall spawners (Div. 4X) declined in 1970 despite the recruitment of a large 1966 year-class to the adult stock. This year-class made a substantial contribution to catches and maintained spawning concentrations at reasonable levels.

Div. 4X and Div. 5Y juvenile fisheries

In both Div. 4X and Div. 5Y the juvenile fisheries declined sharply from the already low 1969 levels. The New Brunswick juvenile weir fishery (Div. 4X) produced only 15,000 tons in 1970, compared with 25,000 tons for 1969; the US juvenile fisheries in Div. 5Y produced 13,000 tons for 1970 and 24,000 tons for 1969. This implies that both the 1967 and 1968 year-classes are relatively small, since there has been little change in fishing effort over the last 6 years.

Div. 5Z and Subarea 6

Total landings in 1970 declined to about 210,000 tons from the 1969 figure of 264,000 tons primarily because of a marked decrease in USSR landings. Increases were reported for the Polish and Federal Republic of Germany fleets.

The age structure of catches shows that the very large 1960 and 1961 year-classes are now much reduced in numbers and make only a small contribution to the fishery. As they were followed by the three weak year-classes 1962 through 1964, the relatively good year-classes of 1965 and the larger one of 1966 now dominate the fishery. The 1966 year-class (as four-year-olds) accounted for almost half the total numbers in the 1970 catch and the 1965 year-class almost a quarter.

Catch-per-unit-effort data for 1970 is not fully available but will be provided for the June 1971 meeting by USSR and the Federal Republic of Germany.

There was a further contraction in the area of spawning concentrations of herring on Georges Bank which led to diversion of effort to mackerel by both the Polish and USSR fleets. It was thought that this would mean that stock abundance has declined far more than is indicated by available USSR catch/effort data, but a quantitative estimate of the bias would be difficult.

The technique for an attempt to solve this problem is set out in Section 6. Data which would be required for such an analysis was not available to the Working Group, but is obtainable from the basic USSR statistics and may subsequently be available. In the absence of correction factors for shrinkage of fishery area and diversion of effort to other species, it is not possible to derive reliable estimates for total mortality. Total mortality estimates tabulated for past years (Z = 0.7 - 0.8 for 1967-1969) are likely to be underestimated and have presumably become progressively more severely underestimated in most recent years.

Two sets of data produced by USSR (Table 6) provide upper and lower limits of relative decrease in stock size of 99% and 75%, respectively. The (uncorrected) catch/effort data for September, when fish are most concentrated for spawning and can thus provide the most consistent series of data available, probably underestimates the rate of stock decrease (75%) while the estimates of spawning stock size from egg-grab surveys (99%) probably overestimates the decrease. USSR data showing a progressive reduction in area in which large catches have been made, and in the size of spawning areas (which at the same time have become much more fragmented in recent years) support the contention that stock size has decreased markedly. The results of US R/V *Albatross IV* spring surveys in Subarea 6 also indicate a marked decrease in abundance of the stock which subsequently spawns on Georges Bank.

While the evidence is clear that the stock is now very much reduced it is not completely certain that fishing is implicated as the sole or major causal factor. Marked, unmeasured fluctuations in recruitment would tend to mask the effect of an intensive fishery.

The prospects for the 1971 Georges Bank herring fishery (and for other years immediately following it) could not be determined because some of the length and age data for the latter part of 1970 were not yet available. Polish data suggest that the 1966 year-class is large only in comparison with the weaker year-classes preceding it and does not compare with the 1960 and 1961 year-classes which until recently have supported the fishery. It is important to determine whether or not the 1966 year-class had fully recruited to the adult fishery in 1970, but even if the degree of recruitment was high (which appears likely) an increase in landings in 1971 is unlikely unless effective effort is increased substantially. Such an increase in effort seems unlikely in view of declining catch rates and the way effort is already being diverted from herring to other species, particularly mackerel.

The Gulf of Maine sardine year-classes of 1967 and 1968 are not large, so that if they do recruit to the Georges Bank stock in 1971-1972, an increase in recruitment rate cannot be expected to provide for any recovery of the spawning stock abundance. While the importance of stock size for subsequent recruitment is not demonstrable at the present state of our knowledge, that recruitment would be adversely affected by the marked reduction in stock size as is indicated by some of the data should not be ignored, particularly if fishing on the stock is unregulated in the future.

4. Research requirements

The Subcommittee noted that while progress had been made in elucidating stock relationships in the ICNAF area, problems of major importance still remain unsolved, notably the inter-relationships between the adult and juvenile herring in Div. 4X and Subarea 5. Research effort should be intensified in this field and in these areas. It is hoped that, in view of their relevance to this problem, the most recent results of biochemical analysis of herring populations will be made available as soon as possible and that coordination of efforts in this field will be initiated at the 1971 Annual Meeting, by discussion between experts.

It is important that a system of up-to-date and consistent reporting of data from herring samples be set up for all stocks and covering a wide range of biological characteristics, including meristic counts, morphometric measurements, length and age at maturation, sex ratios, and genotypic frequencies from biochemical analyses. This would facilitate the Subcommittee's evaluation of these data by direct comparison. It is suggested that member countries produce tables of relevant data for the 1971 June meeting so that a mutually agreeable format for future reporting may be decided.

The Subcommittee noted that joint, multi-nation surveys in the Georges Bank area in 1969 and 1970 had provided valuable information and recommends that every opportunity be taken to plan similar operations in the future. After discussion it was recognized that the extent to which this is possible depends on the availability of research vessel time but notes that the USSR plans research in Div. 5Z and Subarea 6 for the months August to November 1971, and hopes that other member countries will announce their intentions for this area as soon as possible so that opportunity can be taken at the 1971 June meeting to discuss details of coordination.

The Subcommittee was informed that Canadian scientists plan to study the dispersion of herring larvae and the subsequent distribution of 0-group and 1-group herring in the Southern Gulf of St. Lawrence in the summer of 1971 (Redbook 1970, Pt. 1, p. 55) and that the possibility of US and Canadian studies in the same field in Div. 4X and 5Y are also being considered for the autumn of 1971 and the spring of 1972. The Scotian Shelf area (Div. 4W and 4V) was recognized as an important area in which coordinated programmes should be planned, and there was exchange of information between Canadian and USSR scientists on immediate plans for research in the area. The possibility of a coordinated programme for early 1972 in this area should be discussed at the 1971 June meeting. Part of these field studies should include tagging experiments.

Another important aspect of research is the analysis of catch, effort and age composition to provide estimates of population abundance, mortality rates and the effects of fishing. For some fisheries, meaningful data collections need to be initiated, or are just starting. For others, the basic data is available for a number of years, but proper analysis requires that it be brought forward in more detailed time/area units than is now available.

Estimates of rate of recruitment, size of year-class strength, knowledge of the factors affecting recruitment are lacking for all herring stocks. Studies designed to provide such information should be initiated as soon as possible.

5. Otolith ageing comparisons

Arrangements for another Study Group session at the 1971 June meeting will be made by Canadian scientists who will present results of earlier studies. Member countries and individual experts will be informed of these arrangements as they are made. The opportunity will be taken at that time to standardize the conventions that are used in age determination by otolith.

6. Catch per unit effort as a measure of relative abundance in the herring fishery

Catch and effort statistics for a particular stock are conventionally stratified by national fleet, class of ship within a national fleet, months, division and year-class. When data from corresponding cells are compared from year to year, they provide a measure of the decrease in abundance over that time interval, and thus a measure of the total mortality rate.

One of the ways in which a "simple" catch-per-unit-effort index, as described above, becomes unreliable is when the spatial and temporal distributions of the stocks or of the fleet or of both change markedly from year to year. In the herring fishery of Georges Bank, the area in which adequate catches have been made has decreased noticeably from year to year, with a result that the ships have fished herring only while suitable catches could be made and have then shifted to other species when herring were not sufficiently abundant. The simple catch-per-unit-effort index only provides a measure of relative abundance or fish density in areas and time intervals fished, but does not give any measure of the extent of area over which this density was obtained and thus does not provide an unbiased measure of total stock abundance.

Perhaps the simplest way to include the area variable into the model is to stratify the total area in which the stock is distributed into equal area units, tabulate catch and effort data (by time interval, national fleet, ship class, etc.) separately for each area unit, calculate a catch-per-unit-effort index of each, and then sum them to provide an overall index of total stock abundance. This method of further stratifying the data may not, however, fully correct for the practice of shifting ships from one species to another when - say - preset weekly catch quotas are not met. If there are one or more months within the year in which catches are always adequate to prevent reassignment of ships to another species, then the corresponding data should provide relatively unbiased indices of total stock abundance, when catch-per-unit-effort indices within area units are all summed.

TABLE 3. Herring landings (in thousands of tons) by area (stock). Juvenile catches are in parentheses where known.

Year	Div. 5Z+ Subarea 6	Div. 5Y	Div. 4X	Div. 4VW	Div. 4T	Div. 4R	Sub-area 3	Total
1960[a)]	...	70(69)	...	...	...	...	6	180
1961	68	26(24)	58	3	19	1	4	179
1962	151	72(71)	68	12	34	2	5	344
1963	97	70(69)	65	5	40	2	6	285
1964	130	29(28)	93	3	39	5	3	302
1965	41	34(32)	124	7	44	5	8	263
1966	143	29(26)	189	3	37	7	23	431
1967	219	30(29)	190	2	63	6	79	595
1968	373	63(32)	227	24	112	7	145	951
1969[x)]	264	40(24)	142	123	154	3	145	878
1970[x)]	210	25(15)	110	80	194	3	135	757

a) Subarea 4: 105

x) provisional, non-member countries not available

E. Yellowtail Flounder

Subarea 5 (ICNAF Res.Doc. 71/14)

The assessment of this stock has been revised to include data on magnitude and age composition of the 1969 catch. Generalized production models have been rerun using catch data (as opposed to landings). Preliminary 1970 catch statistics and data from research vessel surveys from 1963 to 1970 have been included in determination of the status of the fishery as of 1970. Predictions through 1971 of the changes in status considering the 1971 catch quotas, have been made.

Yield-per-recruit

Evidence from application of the Beverton and Holt yield model, Ricker simulation model and a Gulland-type mesh selection study indicates that yield-per-recruit would increase with a decrease in effort of 33% and an increase in age at first capture of about one year. A combination of both measures gives the greatest improvement. Current US fishing practices result in approximately

TABLE 4. Herring landings (in thousands of tons) in Subareas 1-5 and Subarea 6 by year and country (juvenile catch in parentheses where available).

Year	Canada	USA	USSR	Fed.Rep. Germany	Iceland	Norway	Romania	Poland	Non-member	Total
					Subareas 1-5					
[illegible]	1[illegible]	7[illegible]([illegible]9)	-	-	-	-	-	-	-	1[illegible]
[illegible]	85	2[illegible](25)	68	-	-	-	-	-	-	179
[illegible]	112	72(71)	160	-	-	-	-	Ø	-	3[illegible]4
[illegible]	115	7[illegible](69)	100	-	-	-	-	Ø	-	2[illegible]5
[illegible]	1[illegible]1	2[illegible](28)	135	-	-	-	-	Ø	-	[illegible]2
[illegible]65	1[illegible]3	35(32)	[illegible]2	-	-	-	2	1	-	263
[illegible]	256	31(26)	119	-	-	-	3	15	1	425
[illegible]	[illegible]5	32(29)	124	28	-	-	2	38	21	550
[illegible]	[illegible]	[illegible](32)	130	81	-	-	2	64	75	922
[illegible]x)	[illegible]	31(24)	166	96	13	1	Ø	37	NK	826
1970x)	4[illegible]3	25(15)	105	87	?	?	?	42	?	714
					Subarea 6					
1966	-	3	3	-	-	-	-	-	-	6
1967	-	1	3	-	-	-	-	-	1	5
1968	-	2	16	Ø	-	-	-	12	1	29
1969x)	-	1	[illegible]	-	-	-	-	13	NK	52
1970x)	-	+	[illegible]	+	?	?	?	18	?	43

x) provisional

TABLE 5. Estimated 1970 herring landings (in thousands of tons) by country[1] and area.

Country	Subarea 3	Div. 4RS	Div. 4T	Div. 4V	Div. 4W	Div. 4X	Div. 5Y	Div. 5Z	Subarea 6	Total
Canada	-	-	180	-	10	110	-	-	-	300
Canada	135	3	14	3	-	-	-	-	-	155
Germany	-	-	-	5	-	-	-	82	-	87
Poland	-	-	-	-	2	-	-	40	18	60
USA	-	-	-	-	-	-	25	-	-	25
USSR	-	-	-	20	40	-	-	45	25	130
Total	135	3	194	28	52	110	25	167	43	757

[1] Non-member country data not available.

TABLE 6. Data from USSR herring fishery on Georges Bank, 1963-1970. Catch-per-unit-effort data are from the month of spawning, September, and relate to medium-sized trawlers and to only those catches in which at least 70% of the catch consisted of herring.

Year	Catch-per-unit-effort in September (kilogram x 10^{-1}/hr fishing)	Data from egg surveys: Spawning area km^2	Eggs 10^{-6}kg	Spawning population 10^{-6}kg
1963	62.7	no data	no data	no data
1964	78.3	38.8	427.8	1,180
1965	no fishing	24.3	299.5	530
1966	no fishing	19.1	76.5	150
1967	50.0	no data	no data	no data
1968	32.5	5.7	46.1	130
1969	18.6	4.0	25.7	60
1970	no data	1.9	6.9	12

37% of the catch being discarded because the fish are too small to market. A reduction in effort and an increase in mesh size will allow much of this discard to escape. With a low natural mortality rate (M = 0.2) a significant proportion will later enter the landings at greater weight. Thus, in addition to the expected benefits to catch from measures to increase yield per recruit, the benefits to landings will increase by an even greater percentage as the proportion of the catch which would be discarded is less. Estimates of the percent long-term gains to landings are given below:

Mesh size (synthetic) in mm	1965-1968 F = 1.2	33% red. F = 0.8

		Percent long-term gains	
114		-	8-11
129		10-25	17-31
145		17-40	57

The upper range is probably higher than can be obtained because of difficulties in accounting for discards in the knife edge selection assumption of the Beverton-Holt model.

Southern New England

Preliminary estimates of the catch in 1970 indicate a reduction from the 35,600 tons in 1969 to about 23,000 tons. Catch-per-day fished in the US food fishery has remained about the same in 1969-1970 (3.3 tons) which is well below the 5.7-ton peak in 1964. The proportion of fish in the catch which were discarded increased in 1970 and the actual fish landed per days fished decreased from 1969 (2.8 tons) to 1970 (2.5 tons). Standard effort decreased from 10,800 days in 1969 to about 6,600 in 1970 which is comparable to the 6,500 to 8,400 range occurring from 1965 to 1968.

Analysis of data on catch and effort since 1943 and age composition for 1943-1947 and 1960-1969 indicate that the fishing mortality coefficient (F) has increased from 0.6-7 in 1943-1947 to 1.0-1.2 in the period 1960-1968 and possibly increasing to 1.3-1.4 in 1969. Comparison of estimates of total mortality between the two periods in relation to changes in fishing effort for the same years indicate that natural mortality is less than 0.2.

Survey cruise data from both US and USSR surveys indicate decrease in abundance from 1969 to 1970 (see below).

Year	Nos. fish/tow		Wt. fish/tow	
	USA	USSR	USA	USSR
1969	54.3	62.7	31.7	33.5
1970	39.2	39.6	23.9	28.4

Length frequencies obtained on the surveys from 1963 to 1970 reveal a severe reduction in relative abundance of the age 1 fish (first mode in frequencies) and a contraction of the length range of the second mode (age 2+ fish) indicating more dependence of the fishery on fewer year-classes. Indices of year class strength estimated in the autumn at age 1 show the 1967-1969 year-classes to be considerably below the 1962-1966 Av. (see below).

Year-class	Index (Nos. of fish)
1962-1966 Av.	20.2
1967	9.0
1968	7.9
1969	8.3

The 1971 quota of 11,000 tons would reduce F to 0.6 if the population was at the 1968 level. However, the F achieved will undoubtedly be higher, perhaps even above the desired 0.8 because the population will already be less in 1971 than it was in 1968. In 1971, the catch mainly will be composed of the 1966-1969 year-classes. Depending on the strength of the 1970 year-class and the effects of the 1971 catch, the 1972 quota may need to be below the 1971 level to achieve a desirable F. Spring 1971 research cruise information will be available for the 1971 June meeting and will aid in determining the 1972 quota.

Generalized production models have given estimates maximum equilibrium yields of around 16,000 tons on a long-term basis. This figure is in line with the above calculation.

Georges Bank

Preliminary estimates of the catch in 1970 indicate it to be essentially the same (21,000 tons) as in 1969. Catch-per-day fished of US vessels increased from 3.1 tons to 3.3 tons which is still considerably below the 1964 level of 5.6 tons. The US catch-per-day of fish large enough to be landed, however, dropped from 2.7 tons to 2.5 tons. Effort was almost the same in the two years, being 6,700 days fished in 1969 and 6,400 in 1970.

Survey cruise data for US and USSR surveys indicate a decline in stock abundance in 1970 from fall 1969:

Year	Nos. fish/tow USA	Nos. fish/tow USSR	Wt. fish/tow USA	Wt. fish/tow USSR
1969	23.1	62.7	15.9	41.4
1970	12.2	28.7	8.3	17.8

However, past year-to-year changes in survey indices have been more variable for Georges Bank than for Southern New England. Indices of year-class abundance at age 1+ indicate that the 1967-1968 year-classes are about average when compared to those from 1962 to 1966,although the 1969 index is lower.

Year-class	Index (Nos. of fish)
1962-1966 Av.	6.8
1967	9.7
1968	6.0
1969	4.5

The length frequency distribution from survey cruises have remained about the same from 1963 to 1970, but there is a slight indication of a lesser proportion of larger size fish in 1970.

Based on estimated 1968 stock size, the 1971 quota of 16,000 tons would reduce F to about 1.0-1.1 if F was 1.2 in 1968 but if F was 1.0, then the reduction would be to 0.8-0.9. It is likely that in 1968 the F was perhaps closer to the 1.0 figure as the effort was about 30% less than the 1969-1970 values. The estimates of maximum equilibrium yield from the Generalized Production Models range from 9,000 to 18,000 tons which bracket the quota value. Estimates of stock size on Georges Bank based on survey cruises are less than the corresponding estimates for Southern New England. Thus, any change in quota would be expected to be in a downward direction for the immediate future, but this depends on recruitment rate expected in 1972.

Subarea 6

The relationship between the stock in Southern New England and in Subarea 6 is not known. Since the latter area will not be regulated one effect of the quota may be to redirect effort to Subarea 6. Survey cruise indices for yellowtail flounder in that area are down in the autumn of 1970 from 1969. If there is a significant intermixing of the fish in Southern New England and Subarea 6, then heavier fishing in Subarea 6 could abrogate the desired effect of the quota in the former area.

V. Groundfish Surveys

The Subcommittee reviewed the preliminary report of the Groundfish Survey Working Group, which met in the preceding week. The form developed by the Working Group for submitting data to the Assessment Subcommittee was of particular concern, and some modifications were suggested.

Because of the importance of this data to assessments, the Subcommittee requested that the Chairman of the Survey Working Group mail copies of the form to appropriate offices of member countries prior to the 1971 June meeting in order to evaluate such data and the form at that meeting. Available data for cod and haddock in areas corresponding to stock compositions were requested. Length data should be given by 2-cm intervals for haddock and 3-cm intervals for cod.

VI. The Mixed Fishery Problem

Proposals for limiting the catch of haddock in Div. 4W made at the 1970 Annual Meeting included a closure of spawning grounds to all trawling during the peak spawning season. The proposal was deferred largely because of objections that the closed area would interfere with fisheries for other species, particularly cod. Panel 4 requested that the Subcommittee examine the actual potential conflict to assess the magnitude of the problem.

Data on species mixture in Canadian catches (ICNAF Res.Doc. 71/15 and 71/16) in the area of concern were made available and indicated that cod and haddock, particularly, were mixed in trawl catches to a significant degree. Some flounders and other species also occurred in the catches. The proportion of cod and others in the catches was less by about half when haddock was the main species sought, but still the quantities of haddock in trips when cod was the main species were rather high. Canadian line trawl catches were less mixed than otter trawl and this type of gear presents less of a conflict. Examination of data on catches in the subarea as a whole for other countries indicated that catches of haddock were a small proportion of landings, but this broad type of data does not provide the required information. Scientists of several countries indicated that this specific closure would interfere with other fisheries which were of more importance. Analysis of survey catches would provide a measure of the potential mixture. In any case, additional data on mixture in individual trawl hauls in the area and time concerned, must be analyzed to provide a more exact answer.

In general, such closures will create problems in the southern areas of ICNAF because of the many species. Closure of spawning areas would not be expected to result in any direct significant biological benefits. It is utilized primarily to prevent catches from being concentrated in a short time span. The consequences of closures are thus primarily related to economic or administrative factors. They could be negative in the sense that the period of highest catch rate is closed. Also because fishermen are able to adjust their fishery strategy, such closures may not in fact achieve even the desired result. For example, the closed area in Subarea 5 was supposed to reduce the haddock catch rate by 20% over the two-month period. In fact, the accumulated catch rate decreased only by 10%. The problem of spreading catches over the year is better solved by more direct methods such as seasonal quotas. Because of the lack of evidence of biological significance, any administratively convenient method should be utilized which minimizes the adverse effects of regulation of one species on another. Where the species mixture is not too great, exemptions for fisheries on non-regulated species which allow a nominal percent of regulated species catch, might provide a solution. All such catches should, of course, be included in the quota.

VII. Implementation of Catch Quotas

The present regulations for catch quotas for haddock and yellowtail flounder require that the Executive Secretary notify countries when 80% of the quota has been reached, and that countries then prohibit fishing for the regulated species within 10 days. The balance of 20% allows for: a) unregulated catches taken between the time 80% of the quotas is actually reached, and the time these statistics have been reported to ICNAF and the Executive Secretary can notify governments; b) unregulated catches taken between the time of notification by the Executive Secretary and the closing date; and, c) incidental catches taken after the closing date by ships fishing for other species.

The first test of this procedure was the 1970 haddock regulations. The Div.4X quota was not reached. Eighty percent of the Subarea 5 quota was reached in the last few days of September. This was notified to governments by the Executive Secretary on 13 October and closure was effected by 23 October. The actual catch was 97.5% of the quota; the excess over the 80% was made up as follows:

a) catches taken before 13 October..........7%

b) catches between 13 October and closure.. 3%

c) incidental catches after closure.........7%

In this case, the procedure was successful in getting very close to the target for the annual catch, but this was to some extent a matter of chance. If, for instance, the 80% level had been reached earlier in the year, or at a time of high catches, the incidental catches, or the catches during the reporting and notification period could have been much higher, and the target quota considerably exceeded. Conversely, if the 80% level had been reached later, the incidental catches would have been lower and the total catches for the year would have fallen further below the target quota.

These effects are in themselves significant disadvantages to the present system. A further disadvantage is the difficulties they may cause for certain types of national regulations. For instance, fishermen may object to a system that would spread fishing more evenly through the year because this would result in a reduction in their catch for the year (e.g. 90% of the quota instead of 105%). The Subcommittee therefore believes that consideration should be given to a more flexible system, which would allow a closer approach to the target quota. The closing date may be chosen without any reference to a fixed proportion of the quota. Instead it would be based on real time estimates of the present catches, the quantity likely to be taken before closure could be introduced and likely incidental catches after closure. Essential information would be the time taken to effect closure (1970 experience suggests a period of about a month for the complete procedure of collection of national statistics, reporting to ICNAF, processing at ICNAF, notification to countries, and introduction of national closures), the probable catch rate during this period and the rate of incidental catches. With this information, the date on which closure should be applied to ensure that the quota should be reached by the end of the year, can be calculated. The Commission might frame its recommendations so that the decision on the closing date can be made by the Executive Secretary, without specifying in detail in the recommendations the exact percentage upon which the decision would be taken. To reduce uncertainty about the procedure a tabulation should be made and circulated in advance of the assumed unrestricted catch rates and incidental catch rates to be used in calculating the closing date. A possible procedure and example is set out below. It should be noted that the values in the table are hypothetical. If desired, it would be possible for STACRES to make fair estimates of the rate of unregulated catches for the haddock and flounder fisheries. Estimates of incidental catches in the Subarea 5 haddock fishery may be based on experience during 1970.

In this table the first four columns would be set out before the beginning of the season. Columns 1 and 3 give the amount of catches which would be expected to be taken during the remainder of the year if the procedure for closure was started on the first of the month concerned. For the purposes of this example it was assumed that the closure procedure would take a month. For example, the figures for August are the expected unrestricted catches in August (6% of the target quota) and the expected incidental catches in September-December (10% of the target). Column 5 would be completed during the year as catches are reported. Column 6 gives the expected total annual catch if the closure procedure is started at the beginning of the month concerned. This reaches 100 percent around the middle of October; closure procedure would therefore be started when the catch statistics for the first half of October are available, hopefully with the result that closure would be effective by the middle of November. The final column, 7, gives the accumulated catch at which closure proceedings should start (and = 100 - (a) + b) + c)) for the next month. The symbols a), b), and c) refer to the first paragraph of text of this section.

Example of calculation of closing date. Catches are expressed as a percentage of the quota.

Month	Expected catches during month prior to closure a) & c)	Incidental catches after closure: Per month	Accum.	4 Expected catch after closure [illegible]	5 Accum. catch to first of month	6 Expected catch for year	7 Accum. catch value for closure decision
Jan	9		[illegible]	[illegible]	[illegible]	36.[illegible]	[illegible]
Feb	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mar		[illegible]	[illegible]	23.[illegible]	[illegible]	[illegible]	[illegible]
Apr		[illegible]	[illegible]	[illegible]	35.[illegible]	[illegible]	72.5
May	10	[illegible].5	[illegible].5	[illegible]	46.3	73.8	[illegible]
Jun	8	[illegible]	[illegible]	[illegible]	57.[illegible]	78.[illegible]	80.5
Jul	7	[illegible].5	[illegible]	19.5	66.[illegible]	85.7	84.[illegible]
Aug	6	[illegible].5	[illegible]	16.0	73.5	89.5	[illegible]
Sep	6	[illegible].5	7.5	13.5	80.1	93.6	[illegible]
Oct	6	2.[illegible]	[illegible]	[illegible]	87.2	95.2	[illegible]
Nov	6	[illegible]	[illegible].5	5.5	94.[illegible]	100.6	94.0
Dec	6	2.5	–	6.0	–	–	–