1950

International Commission
for the
Northwest Atlantic Fisheries

1970

RESTRICTED

Serial No.2344
(B.g.7)

ICNAF Comm.Doc.70/3

ANNUAL MEETING - JUNE 1970

Report of Interim Meeting of the Assessment Subcommittee
London, 26-30 January 1970

CONTENTS

The Assessment Subcommittee held its mid-term meetings in London, 26-30 January 1970. Scientists from eight member countries and observers from FAO and Japan attended. The Executive Secretary served as Rapporteur.

List of attendees:

Canada - G.F.M.Smith, T.D.Iles, R. Halliday, A.W.May
Denmark - Sv. Aa. Horsted
Germany, Fed. Rep. - A. Schumacher, K. Schubert
Poland - F. Chrzan, M. Fila
Portugal - R. Monteiro
USSR - A.S.Bogdanov, Y. Riazantsev
UK - A.C.Burd, B.B.Parrish (Chairman, Working Group on Herring), D. Garrod
USA - R. Hennemuth (Chairman), V. Anthony
FAO - J. Gulland
Japan - K. Mimura
ICNAF - L.R.Day

This is a provisional report which is circulated in advance of the 1970 Annual Meeting to provide more time for countries to consider the significance of the findings and the actions which might be required. A final report with up-to-date statistics will be prepared and submitted to the R&S Committee at the Annual Meeting.

In addition to assessment of the cod and haddock stocks, a special working group, chaired by B.B.Parrish, was organized to determine the current status of the herring fisheries.

I. Status of the Fisheries

A. COD

1. Subarea 1

In the Assessment Report for 1969 (Redbook 1969, Part I, Appendix I), the Subcommittee pointed out that assessment of Subarea 1 cod should take into account the evident age-specific variation of fishing mortality rate because recruitment takes place over a span of years. Furthermore, the Subcommittee noted that changes in the pattern of fishing itself - especially the recent tendency of trawler fleets to concentrate their effort on spawning grounds to obtain higher catch-per-unit effort - would tend to increase the variation of fishing mortality rate among age-groups.

Two independent analyses have been carried out since the last meeting using different techniques. These have provided estimates of M = 0.2 consistent with the previous estimate, and confirmed that fishing mortality (F) on younger age-groups (3-6) is only about one-quarter that on age-groups 7+. There is also some indication that F continues to increase with age beyond age 7 owing, in part at least, to the pattern of fishing described above.

The studies also confirmed that F had doubled from 1955 to 1965, when it was about 0.8-0.9 for fully recruited age-groups. It has been reported previously that this level of F is probably beyond that giving the maximum sustainable yield-per-recruit. As pointed out in the 1969 report, a reduction of fishing effort by up to 25% of this level (i.e. reducing F from 0.8 to 0.6) would not result in any significant loss of yield-per-recruit and would increase the catch-per-unit-effort (on a per-recruit basis). Based on 1967 figures for catch and age composition and assuming F in 1968 to be slightly increased over that in 1967, two more or less independent studies predicted the 1968 catch to be 360,000 and 349,000 tons, respectively. The actual catch in 1968 was reported to be 353,000 tons (excluding an unknown but assumed rather small catch by non-member countries).

Catches for 1969-70 have been estimated from both studies based on the 1967 data, assuming F to have remained at the 0.8 level and assuming the 1965 year-class was moderate to good. Catches in 1969 and 1970 are expected to be less than that of 1968, probably less than 300,000 tons, even if the high level of F is maintained. These estimates are subject to rather great uncertainty primarily because the strength of the 1965 and 1966 year-classes are not very well known.

Preliminary reports of the 1969 fishery indicate a considerable decrease - probably more than 100,000 tons - in catch compared to that in 1968. Part of this decrease is due to a lesser abundance of fish as indicated in the predictions for 1968, 1969 and 1970 catches, but reports indicate that the main part of the decrease was due to a decrease in fishing effort. The reason for this decrease in effort seems to be either the extremely bad ice conditions in the first half of 1969 (otter trawlers fishing on spawning grounds) or better catches-per-unit-effort in other areas (Portugese dories). Although the apparent reduction in fishing activity in 1969 may have reduced the fishing mortality rate to something less than that corresponding to the maximum sustainable yield, any improvement in ice conditions and stock abundance relative to other areas will again attract great effort to the subarea. This is especially true if a good year-class should recruit to the fishery and might be followed by the events that were experienced in the Georges Bank haddock fishery - a short term, very large increase in fishing mortality leading to reduced yield-per-recruit and leaving a depressed stock when the effort moved elsewhere. This is undesirable, so that, although F in Subarea 1 may have returned temporarily close to (or even below) the optimum level, the need to regulate fishing, and, more particularly, to prevent sudden expansion of fishing, still exists.

2. Subareas 2, 3, 4 and 5

a) State of Cod Stocks

No new assessments have been made since 1968. At that time, the available information for Subarea 2 and Div.3KL (based on data through 1966) indicated that fishing was at a level producing at least 80% of the long-term maximum sustainable yield-per-recruit. The catch in 1968 was 828,000 tons, an increase of 36% since 1966. Lacking further assessments, we can only reiterate the 1969 conclusion that it is unlikely that long-term yield can be maintained at the 1968 catch level.

In Div.3NO, the cod catch in 1967 of 222,000 tons was about three times greater than the 1962-66 average. A reduction to 160,000 tons in 1968 may reflect a reduction in effort. However, in both 1967 and 1968, landings consisted largely of the abundant 1964 year-class, and year-classes since 1964 have been considerably less abundant. Total yield from the 1964 year-class will be less than it would have been if these fish had not been fished so heavily at the time of first recruitment to the fishery (1967 - age 3). If the increased effort of 1967-68 is sustained, it will cause large year-to-year variations in yield from this stock because of increased dependence of the fishery on one or two recruiting year-classes. Year-class survival in Div.3NO is more variable than in the larger, more northern stocks.

The Subcommittee wishes to emphasize the critical and urgent need for assessment of all these stocks which provide 80% of the total ICNAF cod landings, and urges that those countries with access to data apply every effort to complete assessments as quickly as possible.

b) Mesh Assessments (Subarea 2 and 3 cod)

At the 1969 Annual Meeting, the Subcommittee examined a mesh assessment for cod of Div.3NO. This was based on 1964-68 data, and confirmed previous mesh assessments which indicated long-term increases in catch-per-recruit would be obtained with mesh size increases from 76 mm to 130 mm (5 inches), and even to 150 mm (6 inches).

At the same time, the Subcommittee noted that comparable assessments based on recent data should be made at least for the large cod stock of Subarea 2 and Div.3KL, in view of the recent large increase in fishing in these areas, and the practice of many fishing fleets of operating in several ICNAF areas during a given fishing trip.

Assessments undertaken during the past year by the St. John's Biological Station based on data collected during 1964-68 have been completed for Div.2J, Div.3KL and Div.3Ps. In each area, effective mesh size in use during the period was assumed to have been 114 mm (4 1/2 inches).

Summary of mesh assessments for Subarea 2 and 3 cod

Div.	Mesh increase from 114 mm to	Immediate loss (%)	Approximate long-term change to trawls (M=0.2)
2J	130	7.5	+4.2
	140	22.8	+5.5
	150	37.2	+2.8
3K-L	130	4.2	+4.0
	140	13.3	+6.8
	150	22.5	+6.8
3Ps	130	4.6	+4.5
	140	14.4	+6.3
	150	23.8	+5.7

Thus, in general, small to moderate long-term increases in yield-per-recruit in Subareas 2 and 3 as a whole could be obtained with increases in mesh size from the 114 mm (4 1/2 inches) presently in use to 130 mm (5 inches). Short-term losses for such an increase would be small (less than 10% in all areas). For increases beyond 130 mm, there is a possibility of small long-term losses in the Subarea 2 fisheries (if natural mortality, $M > 0.2$); and also in Div.3KL for an increase to 150 mm if $M=0.3$. In each area, however, with the exception of Div.3NO, the short-term loss approaches or exceeds 20% for increases beyond 130 mm.

3. General Conclusions

Although it has not been possible to provide up-to-date assessments, the Subcommittee believes that the Commission should give consideration to limitation of fishing on all the cod stocks in the ICNAF Area. At best, it is probable that no more than the present total catch would be taken with increased effort, but it is possible, depending on the stock-recruit relation, that there might be a decrease in total catch.

The overall catch quota in 1971 and 1972 in the Convention Area necessary to keep fishing mortality from increasing cannot be estimated precisely, but it is almost certainly less than the 1968 catch of 1,800,000 tons.

B. HADDOCK

1. Div.4VW

The Subcommittee believes that this stock has been fully exploited in recent years. Abundance of 4-12 year-olds declined about two-thirds from 1957 to 1968. The 1967 and 1968 abundance levels were the lowest on record. During 1958-68, landings from this stock averaged 27,500 tons annually, reaching a maximum of 55,518 tons in 1965 and a minimum of 10,912 tons in 1967. Fishing effort on the adult stock declined with declining abundance. However, the abundant 1962 and 1963 year-classes were heavily exploited as immature fish in 1965, reducing considerably the potential yield of these year-classes over that obtainable if they had not been fished until 5 years of age and older.

A fishing mortality (F) of 0.5 appears to result in maximum yield to the traditional fishery. This is obtained with a fishing effort of about 60,000 hours (Canadian large otter trawler units), which is about the level obtaining in 1967-68. Exact data on pre-recruit abundance are not currently available, but indications are that all year-classes subsequent to 1963 are poor. Assuming 1964 and subsequent year-classes are half as abundant as the near average year-classes of 1958 and 1959, (and this is an optimistic estimate), the catch in 1969 should not have exceeded 11,000 tons and in 1970 should not exceed 9,000 tons to maintain fishing mortality (F) at the optimum level of 0.50.

Regulation of the haddock fisheries of Div.4X and 5Z could result in increased effort in Div.4VW, particularly during the closed season (March-April) in the former divisions. Availability of Div.4VW haddock at this season is frequently high even at low levels of abundance. Thus, increased effort at this time could result in a very high fishing mortality rate, and have detrimental effects on future yields.

The Subcommittee believes that action preventing an increase in effort on this stock is desirable, and stresses that changes in the nature of the fishery which effectively reduce the age at recruitment to the fishery are detrimental. Possible measures to protect juveniles from incidental capture in large numbers by fisheries for non-regulated species should receive further consideration.

2. Div.4X

At its 1969 meeting, ICNAF recommended that catches of haddock in Div.4X should not exceed 18,000 tons in each of the three years 1970-1972. This Subcommittee reviewed the previous estimates of possible catches from Div.4X in the light of the most recent data from the fishery and groundfish surveys. Most of these data apply to the area to the south and east of Nova Scotia, called Sampling Area 42, but the results have also been extrapolated to include the Bay of Fundy area - Sampling Area 41.

Sampling Area 42. Analysis of commercial catch-per-unit-effort data indicate that total mortality (Z) on fully recruited age-groups (6+) averaged about 0.8 in 1967-1968. US groundfish survey data was used to estimate M=0.2, so that F=0.6. These values have been used in conjunction with the age composition of the total catch and estimated recruitment of 3-year-olds to estimate the total stock of age-groups greater than two at the beginning of 1969 and 1970, presuming fishing mortality to have remained steady.

The surveys indicate consistent differences in the strength of the 1961, 1962 and 1963 year-classes in the ratio 1:2:4, respectively. Subsequent year-classes have been much weaker and are taken as 10% of the 1963 year-class, though this may be too generous.

Year-Class	61	62	63	64	65	66	67
Index	1.0	2.0	4.0	0.4	0.4	0.4	0.4

Actual numbers of fish in the population at age three were estimated for the year-classes subsequent to 1964 by direct comparison of the indices with the stock of 3-year-olds of the 1961-1963 year-classes as estimated from the commercial catch data.

The estimated available stock in 1969 and 1970, with a fishing mortality of F=0.6, would yield 17,000 tons in 1969 and 9,000 tons in 1970.

Sampling Area 41. Catches in Sampling Area 41 have not been evaluated in detail. Stock data indicate variations in recruitment are broadly similar to those recorded for haddock in Sampling Area 42, but the fish are recruited at a younger age. It follows that if mortality has not changed, the catches in Sampling Area 41 will show much the same proportional changes as those expected in Sampling Area 42, but would occur a year or two earlier. For example, catches in Sampling Area 41 fell from 17,000 tons in 1967 to 8,000 tons in 1968, whereas in Sampling Area 42 this change, which stems from the passage through the fishery of the 1963 year-class, is expected to become evident in 1969. It is, thus, estimated that haddock catches in Sampling Area 41 in 1969 will be about three-quarters of the catch in 1968 (*i.e.* 6,000 tons) and one-third in 1970 (3,000 tons), presuming constant fishing mortality.

Total catches from Div.4X are expected to be of the order of 23,000 tons in 1969, and 12,000 tons in 1970, compared with 31,000 tons in 1968, provided F remains constant.

This analysis suggests that the annual quota of 18,000 tons set for the period 1970-72 is too high to ensure that fishing mortality will not increase beyond its 1968 level.

3. Subarea 5

The US catch of haddock from Subarea 5 in 1969 was about 18,700 tons compared with 25,440 tons in 1968. An additional 3,000 tons was probably removed by other fishing fleets, so that total removals may be close to 22,000 tons for 1969. This is equivalent to about 11 million fish, using the mean weight per fish of 1.9 kilos in the US landings, and represents a fishing mortality coefficient of about 0.5.

The bulk of the catch, 16,692 metric tons, came from Georges Bank. The US standard fleet caught 2.5 tons per day (1,351 fish per day) on the average in 1969 compared to 2.8 tons in 1968. For 1969 this is equivalent to 6,382 standard days effort. However, the standard fleet of vessels accounted for less than 10% of the effort during the year, and has ceased to exist entirely at this point. Hence, estimates of abundance and effort derived from this fleet for 1969 are not very reliable. A new index using all vessels of the fleet is being prepared, but not in time for this report. Average catch-per-tow in the autumn survey cruises decreased by 50% from 1968 to 1969.

The age composition of US catches in 1969 and 1968 is presented below. The fishery is still dependent mostly on the 1963 year-class, but the contribution from the 1966 year-class (3-year-olds) was significant.

	Percent Age Composition (No's Fish)								
	1	2	3	4	5	6	7	8	9+
1968	0	11	3	8	57	14	2	1	3
1969	0	0	14	4	6	55	14	2	5

The autumn survey of the US *Albatross IV* indicated that the 1969 year-class was about as poor as the preceding five.

Preliminary estimates of available population, recruitment, and removals through 1971 are presented in Table 1. If the proposed regulations on limitation of catch become effective in 1970, these data indicate some small improvement in stock by 1972.

Table 1. Estimates of available population and recruitment for Subarea 5 haddock (in millions of fish).

	1935-60	1968	1969	1970	1971	1972
Available Pop. (age 2+)	145	52	33	20	28	35
Removals:						
Total	62	37	14	8	9	
Fish.	44	31	11	6*	6*	
Nat.	18	6	3	2	3	
Recruits (age 2)	54	18	1	16	16	

*Under regulation, 2 kilos per fish

Direct estimates of population numbers from the trawl surveys (Table 2) are rather lower than those of Table 1. Thus the survey estimate of about 13 million fish in 1969 (spring) compares to an estimate of about 28 million fish, adjusted for four months catch, based on commercial data. The trawl survey may underestimate to some extent the population because the trawl captures less than 100% of fish in its path. On the other hand, the landings of three-year-olds (1966 year-class) in 1969 was only about 1.2 million fish. If there were 18 million recruited (as two-year-olds in 1968), as estimated in Table 1, considerably more should have been caught considering the fishing rate was probably 60% or greater due to the desirability of smaller-sized fish (scrod) on the US market.

Because of the possible overestimate of population size in Table 1, it should be noted that the regulation in 1970 and 1971 may only hold the population at about the level obtaining in the beginning of 1969, perhaps not even that.

Table 2. Estimated total numbers of haddock (in millions) from research vessel surveys.

		Age 2+			Total		
Year	Season	Georges Bank	Gulf of Maine	Total	Georges Bank	Gulf of Maine	Total
1963	Summer	19.6	14.7	34.3	117.1	18.9	136.0
	Autumn	45.9	20.5	66.4	186.5	65.5	252.0
1964	Winter	52.7	19.5	72.2	111.6	30.0	141.6
	Summer	82.2	22.4	104.6	552.0	73.5	625.5
	Autumn	100.3	8.3	108.6	248.6	12.2	260.8
1965	Winter	267.6	25.7	293.3	276.6	26.6	303.2
	Summer	339.3	15.3	354.6	369.3	21.2	390.5
	Autumn	117.3	16.0	133.3	130.8	16.4	147.2
1966	Winter	73.2	13.4	86.6	73.3	13.4	86.7
	Autumn	33.7	11.0	44.7	42.8	11.0	53.8
1967	Autumn	13.9	11.5	25.4	21.8	11.5	33.3
1968	Spring	17.4	5.5	22.9	17.5	5.5	23.0
	Autumn	7.3	8.0	15.3	7.4	8.0	15.4
1969	Spring	9.3	3.4	12.7	9.3	3.4	12.7
	Autumn						

C. HERRING

1. Development of the Fisheries

In its 1969 report, the Subcommittee drew attention to the rapid increase in recent years, and especially since 1966, in the exploitation of herring in Subareas 3, 4 and 5 (extending into Subarea 6 in 1966-67). The total herring catch from the ICNAF Area (adults and juveniles combined) increased from 180,000 tons in 1960-61 to 951,000 tons in 1968 (Tables 3 and 4). This increase was due primarily to the growth of fisheries on adult herring. The first major development in the fishery on adults took place on a previously unfished stock on Georges Bank in the early 1960s when annual catches rose to over 100,000 tons. They remained near that level until 1967 when they increased to 218,000 tons, with a further increase to 323,000 tons in 1968. In Subareas 3 and 4, the development of the fishery on adults took place later than on Georges Bank, mostly after 1965. In Subarea 4, catches increased from less than 100,000 tons in 1965 to over 250,000 tons in 1968 (and from provisional data, also in 1969), and in Subarea 3 from less than 10,000 tons in 1965 to around 150,000 tons in 1968 and 1969.

Table 3. Herring landings (metric tons x 10^3) by area (stock). Juvenile catches are in parentheses where known.

Year	Div.5Z + Subarea 6	Div. 5Y	Div. 4X	Div. 4VW	Div. 4T	Subarea 3	Div. 4R	Total
1960[a]	...	70(69)	...	...	...	6	...	180
1961	68	26(24)	58	3	19	4	1	179
1962	151	72(71)	68	12	34	5	2	344
1963	97	70(69)	65	5	40	6	2	285
1964	130	29(28)	93	3	39	3	5	302
1965	41	34(32)	124	7	44	8	5	263
1966	143	29(26)	189	3	37	23	7	431
1967	219	36(29)	190	2	63	79	6	595
1968	373	63(32)	227	24	112	145	7	951
1969		(23)						

[a]Subarea 4 : 105

Table 4. Herring landings (metric tons x 10^3) in ICNAF Area by year and country (juvenile catch in parentheses where available).

Year	Canada	USA	USSR	Fed.Rep. Germany	Romania	Poland	Non-Member
1960	...	70(69)	-	-	-	-	-
1961	85	26(25)	68	-	-	-	-
1962	112	72(71)	160	-	-	ø	-
1963	115	70(69)	100	-	-	ø	-
1964	141	28(28)	133	-	-	ø	-
1965	183	35(32)	42	-	2	1	-
1966	256	31(26)	119	-	3	15	1
1967	345	32(29)	124	28	2	38	21
1968	528	42(32)	130	81	2	64	75
1969		33(23)*					
* Provisional data							
				Subarea 6			
1966	-	3	3	-	-	-	-
1967	-	1	3	-	-	-	1
1968	-	ø	16	ø	-	12	1

2. Identity of Stocks

In assessing the state of the exploited stocks of adult and juvenile herring in each of the main fishing areas and the effects of fishing on them, it is important to know (a) the extent to which the main exploited groups of adults can be treated as independent stocks, and (b) the adult stocks from which the concentrations of juveniles exploited along the Canadian and US east coasts are derived and the stocks to which they subsequently recruit on reaching maturity.

Information relating to (a) is available from Canadian and US investigations of biological characters of adult herring spawning in Subareas 3, 4 and 5. These results show that the total population in this area is composed of a number of distinct stocks (or groups of stocks). In particular, they indicate that the groups of adult herring exploited on Georges Bank (Div.5Z), in the Bay of Fundy, and in the Newfoundland-Gulf of St. Lawrence area, on which the recent large increases in fishing have been centred, are distinct from one another and can be treated as separate stocks for assessment purposes. They also indicate that the Georges Bank stock is distinct from adult herring spawning in the Gulf of Maine (Div.5Y) and over the Scotian Shelf (Div.4Vs and 4W), which have recently been subject to limited exploitation. However, the distinction between the Gulf of Maine and Scotian Shelf groups and the Bay of Fundy spawners is less clear.

It is not possible at present to define with any certainty the sources of the juvenile herring concentrations off the Canadian and US coasts and the adult stocks to which they subsequently recruit. However, most of the information currently available suggests that few, if any, of these herring are derived from and recruit to the Georges Bank stock. Further detailed studies of the inter-relationships between the juvenile and adult stocks are currently in progress.

3. Assessment of State of Adult Stocks

a) Georges Bank (Div.5Z)

The data in Tables 3 and 4 show that, apart from 1965 when fishing effort was diverted from herring to other species, the annual catch after 1961 fluctuated between 97,000 and 150,000 tons until 1967 when it increased sharply to over 200,000 tons. It increased again to over 370,000 tons in 1968 and provisional data indicate that it remained at about this level in 1969.

Average catch-per-hour for USSR medium and large trawlers for the years 1962-1969 are tabulated below, together with estimates of total fishing effort, obtained by dividing total catch-per-hour.

Year	Catch (000's tons)	Catch-per-unit-effort (tons/hr fishing) USSR medium trawlers	USSR large trawlers	Estimated total international fishing effort (000's of hours) Medium trawlers units	Large trawlers units
1962	151	1.16	1.19	130	127
1963	97	1.77	1.06	55	92
1964	131	1.01	0.67	130	196
1965	40	(0.27)*	(0.23)*		
1966	137	(0.12)*	(0.89)		(154)
1967	218	0.82	0.67	266	325
1968	373	0.64	0.65	583	574
1969**	350	0.41	0.5-0.6	854	600-700

*Estimates for 1965 and 1966 not representative due to diversion of main fishing to other species
**Preliminary

These data show that the catch-per-unit effort of both the medium and large trawlers decreased after 1963, to reach in 1969 a level approximately one-third of that in 1962-1963. At the same time the estimated total international fishing effort increased greatly.

Herring fishing on Georges Bank by other European countries started later than that of the USSR, but their fisheries have also experienced a decrease in catch-per-unit-effort during the past three years. Catch-per-unit-effort for Polish trawlers decreased sharply from 13.2 tons per day fishing in 1967 to 6-7 tons per day fishing in 1969. German trawlers, which only commenced fishing on Georges Bank in 1967, experienced a decrease from 50 tons per day to 38 tons per day between 1967-1969.

These data point, therefore, to a large decrease in the abundance of the herring stock on Georges Bank during the period and especially since 1967. This is confirmed by independent estimates of spawning stock size obtained by Soviet investigators from surveys of egg concentration over the spawning grounds in 1964-1969. The decrease in egg production which they have observed indicates a 90% decrease in spawning stock size during this period.

German and USSR commercial data, and US survey sampling data on the age composition of the exploited stock during the period since 1964 indicate that the exploited stock has consisted mainly of the 1960 and 1961 year-classes, both of which were of above average strength, and that all year-classes recruiting subsequently have been weak. It is clear, therefore, that unless the year-class recruiting to the fishery in 1970 is strong, adult stock abundance and catch-per-unit-effort will decline further.

Estimates of the annual total mortality rate (Z) from the abundance-at-age data for the years 1967-69 were between 0.7-0.8. It is likely these are underestimates because of apparent bias in catch-per-unit-effort as a measure of stock abundance.

The above information describes the effects of a rapid and intense exploitation of a virgin population, leading to a 70-90% decline in spawning stock density. Part of this decline may be attributed to poor recruitment since the entry of the 1960 and 1961 year-classes in 1963 and 1964. The important question is the effect of stock reduction on recruitment. It is not possible with the evidence at hand to specify the possible relation. But, it has been concluded from studies of other herring fisheries that a very small spawning stock may cause sustained low recruitment. Studies of other herring fisheries also imply that the value of Z estimated for Georges Bank is close to or beyond the level giving the maximum of yield-per-recruit.

The Subcommittee concludes from this preliminary analysis that reduced fishing intensity

a) will not reduce yield-per-recruit,
b) will increase catch-per-unit-effort, and
c) may provide for increased recruitment.

b) Bay of Fundy (Div.4X)

The fishery for juvenile herring along the New Brunswick shore of the Bay of Fundy has been in existence for many years yielding an average of between 50,000 to 60,000 tons per year through most of the 1960s. Recently a fishery for adult herring has developed in the southeastern part of the Bay off the coast of Nova Scotia, and in 1965-1968 fishing effort in this fishery increased markedly to give in 1968 landings of about 150,000 tons of adult herring. In 1969, however, landings decreased sharply to just over 100,000 tons despite a continued high fishing intensity. In both 1968 and 1969, the fishery exploited also the juvenile stages of the large 1966 year-class to some degree. A marked decrease in stock abundance was reflected in a 30% decrease in the catch-per-unit-effort in the fishery from 1967 to 1969. In recent years, a large proportion of landings, *e.g.* 90,000 tons landed in 1968, cannot be classified by size or area of origin. Hence, any conclusions drawn about trends in this fishery must be provisional. Data on the abundance of the fully recruited age-groups in the exploited stock are insufficient to allow estimates to be made of the changes in total and fishing mortality rates during the period of rapid growth of the fishery in this area. However, the rapid increase in fishing effort and catch and the accompanying decrease in catch-per-unit-effort point to a high rate of exploitation in the years since 1965. It seems likely that maintaining or increasing the rate of exploitation will result in a further decrease in average stock abundance and catch-per-unit-effort.

c) Newfoundland (Subarea 3 and Div.4R)-Gulf of St. Lawrence (Div.4T)

Since 1966 there has been a large increase in the exploitation of herring spawning in the spring and summer in the Gulf of St. Lawrence and occurring in pre-spawning concentrations in winter off the west and southwest coasts of Newfoundland. The exact relation between the stocks supporting the two fisheries is not yet determined. Fishing has increased in both of these areas as shown in Tables 3 and 4.

Like the Bay of Fundy fishery, the major increase has taken place very rapidly. Too few data on changes of stock abundance, mortality rates, recruitment levels, etc. are yet available for detailed assessments to be made of the effect of the recent increase in fishing. It is essential, in view of the large removals, that good catch and effort data be obtained in order to permit determination of the effects of fishing.

4. Juvenile Herring Fisheries

Fisheries for "sardine" herring (age-groups 1-3) have been conducted along the coasts of New Brunswick (Canada, Div.4X) and Maine (USA, Div.5Y) for many years. The landings for the latter fishery in the years 1960-1969 are presented in Tables 3 and 4. Up to and including 1967, landings in New Brunswick were mostly sardine from the Bay of Fundy. In 1968 and 1969, a proportion of these landings, at present unknown, was from other fishing areas and included adult fish.

In the US fishery, the catch and catch-per-unit-effort has declined during this period. This has been most marked in the western (southern) sector of the fishery, where the catch-per-unit-effort has declined steadily since 1962 to a level in 1966-68 which was about one-half that of 1962. This was due to a progressive decrease in the abundance of the herring stock in this area which reflected a decline in the strengths of year-classes entering the coastal waters off the western Maine coast; indeed, no strong year-class has appeared there since the 1961 year-class recruited in 1963.

The total landings and landings per weir in the Canadian fishery in the Bay of Fundy have fluctuated without major trend during this period due to variations in the abundance and/or availability of successive year-classes recruiting to the juvenile stock; no marked decline in the strengths of year-classes, as has occurred in the western Maine area can be detected in recent years, although catch-per-unit-effort data for 1969 indicate that stock abundance in that year was relatively low.

In view of the present uncertainty regarding the origin of the juvenile herring and the adult stocks to which they subsequently recruit, it is not possible to assess the effect, if any, of the recent increases in exploitation and

the decrease in stock abundance in the adult stocks on Georges Bank and the Bay of Fundy on the quantities of herring recruiting to the exploited juvenile stocks or the effect of the juvenile fishery on the exploited adult stocks. However, since no increase in the catch of juvenile herring has taken place since the mid-1960s at least up to 1968, even if all of the recruits to the Georges Bank stock were derived from the stock exploited along the Maine and New Brunswick coasts, it is clear that the recent reduction in recruitment to the Georges Bank stock cannot be attributed to the juvenile herring fishery.

5. Research Requirements

The Subcommittee noted a number of important gaps in the present knowledge of the general biology and population dynamics of the juvenile and adult components of the exploited herring stocks on which research effort should be concentrated. There are two aspects of paramount importance. First, inter-relations between the stocks of adult and juvenile herring currently exploited in Subareas 4 and 5. The Subcommittee considers that particular attention should be given to extending the application of serological and biochemical methods of analysis in association with meristic character analysis to this problem. In addition, consideration should be given to (i) determining the effectiveness in relation to the range of possible loss and recovery rates of conducting large-scale tagging experiments on juvenile herring to provide information on the rates of exploitation and to identify the adult stocks to which they subsequently recruit, (ii) studies of the dispersal of larvae and early 0-group fish from the main centres of spawning, especially on Georges Bank and in the Bay of Fundy.

Second, the estimation of changes in stock abundance and mortality rates in the adult stocks. The Subcommittee considers that, in addition to the continued use of data on catch, fishing effort and age composition from the commercial fisheries for this purpose, attention should be given to quantitative egg production surveys, including evaluation of accuracy and precision, as conducted on Georges Bank by USSR investigatores in recent years, to provide estimates of absolute stock abundance.

6. Herring Scale and Otolith Comparisons

The results of the most recent herring scale and otolith comparison involving seven countries and reported in ICNAF Res.Doc.69/29 show that considerable differences in ageing techniques still exist.

The problem was considered by herring experts from Canada, Germany, Poland, USSR and USA and it was proposed that a study group examine material at some time during the 1970 Annual Meeting. The immediate aim would be to decide on acceptable criteria for labelling year-classes and for identifying growth zones at otolith margins.

It was suggested that Canada be responsible for the preparation for the study group meeting.

II. Adequacy of Sampling

This problem was referred to the Subcommittee by R&S at the 1969 Annual Meeting. Several summaries of sampling adequacy relative to 1966 and 1967 were prepared and discussed.

One of the major problems stems from the difficulty of sampling at sea, which is required because a large share of the fish is processed before landing. There are two solutions available: i) send special technicians with the fleet, or pay reliable crew members to sample, or ii) arrange to have special samples of whole fish frozen and brought back to port. These may have to be purchased at the going price. In any case, the government bureaus concerned need to allocate more resources to this activity.

Most major species, except cod, *i.e.* haddock, redfish, yellowtail flounder, hake, are sampled with a reasonable degree of adequacy. An exception is redfish in Div.3NO by the USSR and Div.4RT by Canada. Haddock catches by the USSR in 1966 were not sampled, but research vessel catches were sampled and reported. The desirability of the latter type of data is discussed elsewhere, but samples of the actual commercial catches (landings) are important.

The length sampling summary for cod in 1966-67 is presented in Table 5.

It is rather obvious that, for too many stocks and countries, the proportions of landings that are adequately sampled (category 4) are very small. For example, over 40% of the total catch was not sampled at all, or only on a token basis, and only 34% falls in the adequate classification. For some important stocks - Div. 1A-1D, Div.3NO, Div.4VsW - adequate samples are reported for less than 15% of the catch. Four countries - Germany, France, Portugal and Spain - had from 56 to 87% of their catch falling in the inadequate category. If the distribution of samples among seasons and divisions were considered, the situation would appear even worse.

Table 5. Percentage of total cod catch (average for 1966 and 1967) by sampling category (1=0-50 fish/1,000 tons; 2=51-100 fish/1,000 tons; 3=101-150 fish/1,000 tons; 4=over 150 fish/1,000 tons).

	Sampling Category				
By Country	1 Not adequate	2	3	4 Adequate	Total Catch 1966 and 1967 (m.t.x 10^3)
	%	%	%	%	
Denmark (F)				100.0	129
" (G)				100.0	57
Germany	56.5	28.8	8.7	6.0	368
Iceland				100.0	1
Norway		56.2	31.3	12.5	32
UK	14.7	3.1	16.3	65.9	129
Poland	5.6		48.9	45.5	90
France (M)	73.9		7.6	18.5	291
Portugal	56.5	28.3	15.2		435
Spain	87.3			12.7	474
Canada (N)	0.3	1.4		98.3	363
" (M)	3.5	20.8	23.4	52.3	226
USSR	25.0	46.3		28.7	268
USA				100.0	25
Non-member	100.0				126
Total	43.4	14.2	8.2	34.2	3,014
By Stock Divisions					
1A-1D	70.6	18.3	1.5	9.6	677
1E-1F	6.3		33.3	60.4	96
2G-3K	54.1		12.5	33.4	824
3L	14.5	28.3	9.9	47.3	434
3M	52.3	7.7	10.8	29.2	65
3N-3O	60.7	34.9	-	4.4	341
3Pn	53.8			46.2	26
3Ps	11.1			88.9	72
4R	43.6	4.3		52.1	94
4S	46.7	46.7		6.6	15
4T-4Vn	7.4	4.6		88.0	108
4Vs-4W	69.3		14.9	15.8	114
4X	10.3	41.4	48.3		58
5Z	45.5	17.8	8.9	27.8	90
Total	47.7	14.2	8.2	29.9	3,014

The more detailed analyses from which this summary was taken are available for examination, but the gross deficiencies are great enough to emphasize the severity of the problem.

The Subcommittee, therefore, recommends

1. that the Executive Secretary contact the appropriate personnel in each country that has not provided adequate samples by our criteria in order to determine the causes thereof and stimulate solution, in accordance with the recommendation by R&S in 1969;

2. that the panels for each of the subareas take up the problem where inadequate sampling is indicated so as to assure administrative support of this activity;

3. that the Commission adopt as a minimum sampling requirement the measurement by each country of 200 fish for every quarter of the year and division in which 1,000 or more tons of fish are caught.

The Subcommittee noted that data on age composition is also vital to assessment, but must be reviewed in the light of accuracy of ageing. This is therefore a special problem not dealt with by the Subcommittee at this meeting.

III. Research Vessel Surveys

The value and feasibility of utilizing research vessel surveys to provide information for assessment and management was discussed at some length. Most countries have conducted surveys for various purposes, and a considerable background of experience was thus available within the group. The comprehensive, seasonal groundfish surveys which have been carried out since 1963 in Subareas 4, 5 and 6 by the US, and which have been conducted jointly with the USSR in the last three years, were reviewed to provide specific information about costs, precision, accuracy and planning.

The kinds of data that can be obtained from such surveys depends to a large extent on the design. The US survey, for example, has provided seasonal estimates of population density of haddock which have led to prediction of recruitment two years in advance and estimates of mortality rates - both natural and fishing. This information, obtained independently of the commercial fishery, has led to increased confidence in the application of regulatory measures. Similar information for many other species of groundfish is being obtained. This kind of data reflects the primary, immediate needs of ICNAF for the other major stocks of fish. Indeed, for several species, *e.g.* silver and red hake, survey data may provide the only means of accurate assessment.

The USSR presented a preliminary plan for an integrated, area-wide survey, designed to provide data on the entire life history process from egg to spawning, exploited adults. It was agreed that such an undertaking was, of course, ideal from the point of view of a more complete understanding of the processes of fish production and recruitment. The plan is somewhat beyond the scope presently being considered, but represents a needed view over the current valley of research efforts.

The required scope of a groundfish survey effort applied to the whole of the ICNAF Area implies the necessity for an integrated multi-nation effort. The costs of such surveys will have to be borne by all ICNAF countries, and to be most effective, surveys will have to be closely coordinated through ICNAF. The successful performance at the present time of periodic surveys in the southern half of the ICNAF Area, and the fact that other, albeit less comprehensive, surveys in other subareas are undertaken from time to time indicates that the integration and extension of effort to cover the whole of ICNAF is not unreasonable. A gain in information is likely just from the coordination of present survey cruises, which would include a standardized survey procedure. However, the importance of additional effort, particularly in Subareas 2 and 3, for accurate assessment of the status of fisheries must be stressed. In addition, it is important to maintain such surveys, on an annual basis at least, for several years to provide a time series of observations.

The Subcommittee recommends that a detailed evaluation of an ICNAF groundfish survey be undertaken as soon as possible, and that this could best be accomplished by a working group at the next Annual Meeting. The success of this group depends on the attendance of qualified scientists.

IV. Adequacy of Research and Assessment

The foregoing assessment of stocks shows rather clearly that the status of fisheries is known with some degree of confidence only for the haddock stocks and perhaps for cod in Subarea 1. However, it is the opinion of the Subcommittee, based on past studies and judgements of stock productivity evaluated against current fishery development, that many of the important groundfish and herring stocks are heavily exploited - in all likelihood at or beyond the level of effort which provides for maximized yield and economic return. All of the cod stocks, herring in Subarea 5, silver hake, yellowtail flounder in Subarea 5, and perhaps other flounder stocks are of particular concern.

The current state of ignorance is due to one or more of the following reasons:

1. Very rapid development of fishing;
2. Inadequate data;
3. Inadequate assessment efforts.

Removals from a given stock have doubled or more within one year in some cases, but have commonly changed from 20 to 50% annually. If the status is not determined prior to such increases, it is very much more difficult to obtain the necessary assessment in time to prevent possible serious over-exploitation.

A summary of inadequate length composition data is given in Table 5. For example, in 1967 only three countries (Denmark, UK and Canada) sampled more than half of their cod catches adequately. For specific stocks, the situation is even more serious - only 5% of the landings from the major cod fishery in Div.3NO are adequately sampled (the term adequate really means bare minimum for assessment). Data on age composition, pre-recruit strength of year-classes, and abundance are even more inadequate.

Perhaps most important of all is the lack of adequate assessment studies. Eight of the fourteen member countries sent scientists to this meeting, and of these none are working full time on assessment of the major fishing stocks of the ICNAF Area. For Subarea 1 cod, projections had to be based on 1967 data, because the 1968 data, which were available, could not be processed rapidly enough due to lack of staff. For cod in Subareas 2, 3, 4 and 5, for which landings in 1968 of 1.4 million tons amounted to 38% of total ICNAF landings of all species, no valid assessment of current status is available, and no country (with the exception of Canada for Div.4T-4Vn stocks) has scientists assessing the status of these stocks at the present time. The situation is much more bleak when species other than cod and haddock are considered.

The Subcommittee believes that the present level of assessment studies and associated research is much too low in relation to the needs of the Commission and to the benefits which will be obtained from good management based on sound scientific advice. The cost of such advice is insignificant in relation to expected economic gains. At the present level of research, which seems if anything to be decreasing, the guiding principle of the Commission that no regulatory action be taken until clear and definite scientific studies of the effects are available cannot work to provide for rational exploitation.

The solution to this problem depends on the recognition of the inadequacies as outlined above, and a commitment to rectify them. The Subcommittee, therefore, recommends

1. that additional staff and money be allocated to the Secretariat to provide for basic data analysis, and

2. that member countries in each Panel make definite commitments for scientists to initiate studies of the stocks which are deemed to be most crucially in need of assessment. The guidance and coordination of such studies is the function of R&S through the Assessment Subcommittee.