International Commission for the Northwest Atlantic Fisheries

Serial No. 5419

ICNAF Sum. Doc. 79/VI/11
Addendum 1

ANNUAL MEETING - JUNE 1979

Report of Assessments Subcommittee, 28 March-9 April 1979

Appendix III of the Assessments Subcommittee Report contains the "Report of Joint Session of Assessments and Biological Surveys Subcommittees", which was held at St. John's, Newfoundland, on 5 April 1979. Additional information was available for discussion at the Annual Meeting as indicated below.

Addendum

to

Report of Joint Session of Assessments and Biological Surveys Subcommittee

A further analysis of catch per unit effort data from Newfoundland vessels for yellowtail flounder and American plaice in Div. 3LNO in 1976-78 (Res. Doc. 79/VI/110) showed that the usual estimate of CPUE was biased toward underestimation. This bias is negligible when more than 50 trips are used to estimate CPUE but becomes large as the number of trips decreases below this level. A jack-knife statistic effectively reduces this bias to negligible levels and is recommended for cases where CPUE is based on few trips. Variances in estimated CPUE in this analysis were much more than earlier estimates. The non-zero intercepts reported for some regressions of catch on effort were puzzling and detailed examination of these could lead to improved estimates.

An analysis of catch per unit effort from the Canadian Observer Program data in Subareas 2 to 4 in January and February 1979 was presented (Res. Doc. 79/VI/111). Catch rates in the first days of observed fisheries were not lower than those observed later. Strong serial correlation in day to day catch rates was observed. Tow to tow variation in catch per hour was less than that observed for research vessel catches. Catch per hour was found to be more stable than catch per day. The author stressed that conclusions should not be extended beyond the cases considered. It was noted that variation in availability, detectable in detailed analysis, appeared to be at least as significant as tow to tow variation in the cases examined. The Subcommittees recognized the value of this analysis in exposing the nature and extent of variance of commercial CPUE estimates and the scope for refinement in methods of analyzing such data.

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REPORT OF ASSESSMENTS SUBCOMMITTEE

28 March-9 April 1979

Chairman: G. E. Winters

The Subcommittee met at the Newfoundland Environment Center, St. John's, Newfoundland, during 28 March-9 April 1979 to review the state of and advise on catch levels in 1980 for certain stocks in Statistical Area 0 and Subareas 1 to 4 (Com. Doc. 79/VI/6, 16), to consider proposals for changing the mesh regulation for redfish in Div. 3M (Com. Doc. 78/VI/12) and the implementation of a uniform mesh size for the silver hake and squid fisheries in Subarea 4 (Sum. Doc. 79/VI/5), and to evaluate, in collaboration with the Biological Surveys Subcommittee, the accuracy of commercial fishery-based indices of abundance (*Redbook* 1978, page 39). The agenda is given in Appendix I. Scientists attended from Canada, Cuba, Denmark, France, Federal Republic of Germany, German Democratic Republic, Japan, Norway, Poland, USSR and USA (Appendix II).

Since the 1978 catch statistics available at this meeting were confined to species and stocks being assessed by the Subcommittee, it was agreed that the Chairman, in collaboration with the ICNAF Secretariat, would prepare the usual summary of fishery trends from more complete statistics that would be available at the 1979 Annual Meeting. Therefore, Section I, containing a summary of fishery trends in 1978, will be prepared for inclusion in this report prior to its adoption by STACRES. The results of the discussions on catch trends and the status of the stocks are given in Sections II and III below. A summary of other matters considered by the Subcommittee is given in Section IV.

In accordance with a recommendation of STACRES at the 1978 Annual Meeting (*Redbook* 1978, page 39), Dr W. G. Doubleday convened a joint session of the Biological Surveys and Assessments Subcommittees on 5 April 1979 to evaluate the accuracy of abundance indices from commercial fishery statistics. A summary of the discussions for this session is given in Appendix III.

I. FISHERY TRENDS

[This section including Table 1 to be inserted at the 1979 Annual Meeting]

II. SUMMARY OF RECENT CATCHES AND TACs

The Subcommittee used as the basis for discussion the Canadian request for advice on 12 stocks which lie completely or partly within its 200-mile fisheries zone in Subareas 2 to 4, and 2 stocks which overlap the Canadian and Danish fisheries zone in Statistical Area 0 and Subarea 1 (Com. Doc. 79/VI/6). The Subcommittee also reviewed the cod and redfish stocks in Subarea 1 at the request of the European Economic Community (EEC) (Com. Doc. 79/VI/16), and the three stocks which lie completely outside of the national fisheries zones in Div. 3M.

In reviewing the state of the various stocks, the Subcommittee took account of the Canadian and EEC views on options to be considered in providing advice on the scientific basis for management in 1980 (Com. Doc. 79/VI/6, 16). A summary of recent catches and TACs relevant to stocks reviewed at the present meeting of the Subcommittee is given in Table 2, together with advised TACs for 1980, where specific advice could be given. Details of the stock reviews are given in Section III below.

Table 2. Summary of recent catches (1974-78) and TACs (1974-79) for stocks reviewed at the April 1979 Meeting of the Assessments Subcommittee, together with advised TACs for 1980.

Species	Stock area	Nominal catches (000 tons)					TACs (000 tons)						
		1974	1975	1976	1977	1978[1]	1974	1975	1976	1977	1978	1979	1980
Cod	1	48	48	33	38	37	107	60	45	31	...[2]	...[2]	( )[3]
	2GH	4	7	6	4	5	20	20	20	20	20	20	(20)
	2J+3KL	373	288	214	173	136	657	554	300	160	135	170	( )[3]
	3M	25	22	22	25	33	40	40	40	25	40	40	( )[3]
	3NO	73	44	24	18	15	101	88	43	30	15	25	( )[3]
Redfish	1	3	9	14	31	10	-	-	-	-	13	...	( )[3]
	3M	35	16	17	20	16	40	16	16	16	16	20	(20)
	3LN	22	18	21	16	12	28	20	20	16	16	18	(25)
Silver hake	4VWX	96	116	97	37	48	100	120	100	70	70	70	( )[3]
A. plaice	3M	2	2	1	1	1	2	2	2	2	4	2	(2)
	3LNO	46	43	52	44	50	60	60	47	47	47	47	(47)
Witch	2J+3KL	16	12	11	8	7	22	17	17	17	17	17	(17)
	3NO	8	6	6	6	3	10	10	10	10	10	7	(7)

Table 2. (Cont'd)

Species	Stock area	Nominal catches (000 tons) 1974	1975	1976	1977	1978[1]	TACs (000 tons) 1974	1975	1976	1977	1978	1979	1980
Yellowtail	3LNO	24	23	8	12	15	40	35	9	12	15	18	(18)
G. halibut	0+1	14	25	16	13	12	-	-	20	20	20	25	(25)
	2+3KL	27	29	25	32	38	40	40	30	30	30	30	(35)
R. grenadier	0+1	12	5	9	3	6	-	10	14	8	8	8	(8)
	2+3	28	27	21	15	21	32	32	32	35	35	35	(30)
Argentine	4VWX	17	15	7	2	2	25	25	25	20	20	20	(30)

[1] Provisional statistics.
[2] Catches restricted to Greenlanders' fishery and to by-catch (regulated by percentage allowances).
[3] See relevant subsection of Section III for comments and options.

III. STOCK ASSESSMENTS

1. Cod in Subarea 1 (Res. Doc. 79/VI/59)

a) Fishery trends

The total nominal catch of cod in 1977 was about 38,000 tons, exceeding the TAC for that year by about 23%, although fishing by trawlers was stopped in the first half of the year. The local inshore catches, which were as low as 5,200 tons in 1976, increased to about 14,000 tons in 1977 with a further increase to about 18,000 tons in 1978. Recent catches and TACs are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	107	60	45	31	...[1]	...[1]
Catch (000 tons)	63	48	48	33	38	37	

[1] Catches limited to Greenlanders' fishery and to by-catch (regulated by percentage allowances).

Only Greenland vessels were allowed a directed cod fishery in 1978. Although fishing by trawlers was stopped by May, the total nominal catch, including the above-mentioned 18,000 tons in the inshore fishery, is provisionally reported to be about 37,000 tons. This figure includes about 1,000 tons reported as by-catch by non-Greenlandic vessels fishing for species other than cod. Taking into account the stringent regulations for by-catch of cod (10% in fisheries for redfish, 3% in fisheries for Greenland halibut and roundnose grenadier) and the fact that as much as 10,000 tons of the total catch of finfish in the area in 1978 are reported as "unspecified", it cannot be precluded that the actual removal of cod (including possible discards) was higher than 37,000 tons in 1978.

The proportion of the total catch of cod by trawlers in Subarea 1 increased from about 37% in 1977 to about 52% in 1978. Fishing by Greenland trawlers in the first quarter of 1979 was at least as good as in 1978. Although some of them have already been stopped (converted to shrimp fishing), it seems likely that the total catch by Greenland vessels in 1979 will be about the same as that in 1978 (i.e. 35,000 tons).

b) Trends in distribution, abundance, and stock composition

For the offshore trawl fishery (Greenland trawlers), there was a further significant increase in overall catch rate by about 160% from 1977 to 1978. However, since about 80% (by numbers) of the catch in 1977, as well as in 1978, consisted of the 1973 year-class, part of the increase in catch rate (by weight) could be explained by the growth, but the major factor may have been a considerable increase in availability (catchability) in the first part of the year when trawlers found dense shoals. These shoals were, however, found in a rather limited area. In the first months of 1979, when the catch rate was at least as good as in 1978, acoustic surveys and the location of the fishery have confirmed that the shoals are found in a very limited area. Thus, although the catch rate is very good, it is not possible to use it for direct estimation of overall stock abundance. The offshore fishing in 1978 took place in the southern part of Div. 1C and southwards, with hardly any offshore fishing for cod in Div. 1A and 1B.

As mentioned above, the 1973 year-class made up by far the major part (80% by numbers) of the catches in 1977 and 1978. It was expected that the same year-class would have been the major contributor to the offshore trawl fishery in the first quarter of 1979. However, in the main fishing area (southern part of Div. 1C), the major part of the catches in the first quarter of

1979 seems to consist of rather small cod of the 1974 and 1975 year-class, whereas the 1973 year-class seems to be decreasing in relative importance quicker than expected. In Div. 1D, the 1973 year-class still seems to be the most important one at the beginning of 1979, but fishing here has been much less intensive than in the southern part of Div. 1C. Since the inshore fishing by pound net is expected to be based mainly on the 1974 and 1975 year-classes, it seems likely that the relative importance of the 1973 year-class will decrease substantially in 1979 compared with 1977 and 1978.

c) Assessment parameters

Mortality rates. On the basis of trends in fishing effort and catches, the Subcommittee at its April 1977 Meeting concluded that fishing effort had decreased by about 25% from 1975 to 1976, and at its April 1978 Meeting that effort decreased further from 1976 to 1977, so that the range of fishing mortality (F) in 1977 was between 0.16 and 0.20 for fully-recruited age-groups. Although the number of hours trawled in the directed cod fishery has decreased further (by about 38%) from 1977 to 1978, the analyses do not indicate a further decrease in fishing mortality. Rather, it appears that fishing effort has concentrated on the dense, easily available shoals, and the analyses in fact point to the likelihood of an increase in F for the age-groups forming these shoals in 1978, primarily age-groups 4-6.

The trend in exploitation seems to be that, when a new, relatively strong year-class recruits to the fishery after a period of very low stock size, the fishery concentrates on this year-class, and older age-groups, if they tend to be separated from the younger fish, may be less heavily fished. This may have been particularly so in 1978, as gillnets and longlines which exploited the older fish have virtually vanished from the offshore fishery.

Analyses were, as formerly, carried out with a constant F for fully-recruited age-groups (age 6+), but the results seemed so unrealistic that the hypothesis of a constant F had to be rejected. Analyses were then made under the assumption of F varying with age in 1979. Furthermore, the analyses were carried out for a likely range of catch composition in 1979, as evidenced by catches and sampling in the first quarter of 1979. The catch compositions and F-values used in the analyses are given in Table 3, the total numbers in the catch corresponding to an expected catch of about 37,000 tons in 1979 (Res. Doc. 79/VI/59).

Table 3. Catch composition and fishing mortality by age-group used in the analyses of the Subarea 1 cod stock under two assumptions of recruitment of the 1973 year-class in 1979.

Assumptions		Catch (000 fish) and F by age-group									
		3	4	5	6	7	8	9	10	11	12+
A. Lower estimate of recruitment of the 1973 year-class	Catch	200	9000	6000	4000	200	20	20	10	5	1
	F	0.05	0.30	0.30	0.30	0.15	0.10	0.05	0.03	0.02	0.01
B. Upper estimate of recruitment of the 1973 year-class	Catch	200	5000	3000	9000	200	20	20	10	5	1
	F	0.05	0.20	0.30	0.30	0.15	0.10	0.05	0.03	0.02	0.01

In order to take into account possible discarding of commercially-undersized fish of the youngest age-group, the natural mortality (M) was set at 0.3 for age 3. As in previous analyses, M was set at 0.20 for ages 4 to 6 and at 0.25 for older ages (to include emigration rate).

Year-class estimates. Due to uncertainty as to the absolute size of the important 1973 year-class, the Subcommittee at its April 1978 Meeting had to assume a rather wide range of values for this year-class (120-200 million fish at age 3). The present analyses indicate that the size of this year-class at age 3 was in the range of 100-145 million fish. The year-class was fished rather heavily during 1976-78, with removals (excluding discards) estimated to have been at least 45 million fish. Therefore, the contribution of the 1973 year-class to the fishery in 1980 and following years is expected to be low relative to that of younger age-groups. The residual numbers of the 1973 year-class at the beginning of 1979 are 17 and 38 million fish respectively for assumptions A and B of Table 3, residual numbers of the 1974 year-class by 1979 are 25 and 13 million fish respectively. These figures were used in the forecasts.

The analyses do not yet allow for firm conclusions about the absolute strengths of year-classes younger than that of 1974. The size of the 1975 year-class at age 3 has tentatively been

estimated at 75 million fish, and the strengths of the 1976 and 1977 year-classes at age 3 were set at 20 and 50 million fish respectively. While the strengths of the 1978 and 1979 year-classes were set at 20 and 40 million fish respectively for use in the projections, they have no influence on the projections of spawning stock size up to 1983.

d) Results of assessment

Projections of catch for 1980-82 and of resultant spawning biomass were carried out for the two sets of assumptions on the 1979 stock status given above and for various fishing strategies (Table 4). While the absolute values, especially for spawning biomass, depend upon the assumptions made, they do, however, demonstrate the relative changes between the various fishing strategies. In the last line of Table 4, the spawning stock at the beginning of 1983 is compared with the 1971 level.

Table 4. Cod in Subarea 1: projected catch and spawning biomass (000 tons) for different management strategies as explained in the text. The spawning biomass relates to the start of the year. The lower and upper values of the ranges given relate to the lower and upper estimates of recruitment of the 1973 year-class in 1979 (assumptions A and B in Table 3). Fishing mortality (F) relates to fully-recruited age-groups.

Fishing strategy No.		1	2	3	4
1979	Spawning biomass	66-127	66-127	66-127	66-127
	Fishing mortality (F)	0.30	0.30	0.30	0.30
	Projected catch	36-39	36-39	36-39	36-39
1980	Spawning biomass	96-121	96-121	96-121	96-121
	Fishing mortality (F)	0.27-0.25	0.40	0.05	0.11-0.10
	Projected catch	35	49-53	7-8	15
1981	Spawning biomass	145-176	131-158	174-205	167-198
	Fishing mortality (F)	0.28-0.26	0.40	0.30	0.10
	Projected catch	35	43-46	43-46	15
1982	Spawning biomass	133-159	110-130	158-181	175-201
	Fishing mortality (F)	0.36-0.34	0.40	0.30	0.11
	Projected catch	35	34-35	33-34	15
1983	Spawning biomass	144-169	126-136	169-190	214-237
	As % of spawning biomass in 1971	54-63	47-51	63-70	80-88

Variation in spawning biomass (age-groups 6 and older) during 1972-79 relative to that in 1971 is indicated as follows:

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979
Index	100	71	39	44	29	15	10	8	25(A) 47(B)

Recruitment of the relatively good 1968 year-class helped to maintain the spawning stock in 1974, but the stock decreased rapidly thereafter with poor year-classes maturing. The recruitment of the 1973 year-class to the spawning stock in 1979 will mean some increase in spawning biomass, and so will probably the recruitment of the 1975 year-class by 1981. It must be emphasized that the spawning stock is presently at a very low level, and that the 1971 stock size, to which comparison is made in the foregoing tables, was only about one-quarter to one-third as large as the stock sizes of the 1950's and 1960's.

The projections for all strategies in Table 4 are based on the assumption that a catch of 36,000-39,000 tons will be taken in 1979. Strategy 1 illustrates the resultant spawning stocks in 1981 to 1983 by maintaining a catch of 35,000 tons. Strategy 2 indicates the catches and spawning biomasses if the exploitation rate closely corresponds to fishing at $F_{0.1}$ during 1980-82. Strategy 3 shows the effect of nearly closing the fishery in 1980 and thereafter fishing

at a level corresponding to that assumed for 1979. Strategy 4 shows the effects on spawning stock size by maintaining a catch of 15,000 tons during 1980-82.

The recent trend in exploitation indicates that the possibilities for increasing the stock size, created by the recruitment of the 1973 year-class, have not been used to the extent that was advised. The further potential for rebuilding the spawning stock by the relatively good 1975 year-class is also not likely to result in an increase in stock size, since it appears that exploitation of this year-class has already started. Rebuilding of the stock to the state where the spawning stock approaches the 1971 level and comprises more than just one good year-class still requires a low level of fishing. Of the strategies listed in Table 4, only Strategy 4 leads to a spawning stock by 1983 which approaches that of 1971.

The Subcommittee points out that the recent fishing pattern implies a lower yield-per-recruit than would result by allowing more individuals of newly-recruited year-classes to reach maturity. In view of the present low stock size and the recent fishing pattern, the Subcommittee still advises that rebuilding and maintenance of the spawning stock to a level considerably above the present level should be the main concern for management.

2. Cod in Divisions 2G and 2H

a) Fishery trends

Nominal catches in the 1970's have been much lower than catches in the 1960's. The highest catch recorded was in 1966 when 94,000 tons were caught. Since the establishment of a TAC of 20,000 tons in 1974, reported catches have been substantially below this level, due, at least in part, to ice conditions in recent years.

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	20	20	20	20	20	20
Catch (000 tons)	+	4	7	6	4	5*	

* Provisional

b) Assessment

Concern was expressed about the use of commercial catch rates in assessing the status of this stock due to variability in catch rates caused by ice conditions. However, it was noted that the coefficient of variation of catch rates is comparable to that for other cod stocks. A general production model analysis indicated that the stock has been relatively stable in recent years. Calculation of the relative strength of the 1967-73 year-classes at age 5, assuming that F was 0.13 over the past few years, indicates that the 1973 year-class is substantially stronger than previous ones.

Catch curve analysis for age-groups 7-12 in 1978 indicates an average F of 0.13 for the 1970's when catches averaged about 8,000 tons. Fishing at $F_{0.1}$ during that period would imply a catch of 13,000 tons. Since this stock is probably related to that in Div. 2J+3KL, for which an increase in biomass of about 50% from 1978 to 1980 is projected, fishing at $F_{0.1}$ in 1980 implies a catch of 20,000 tons. The Subcommittee therefore advises that the TAC of 20,000 tons be maintained for 1980.

3. Cod in Divisions 2J, 3K and 3L

a) Fishery trends

Nominal catches of cod declined from an average of about 640,000 tons in 1966-70 to about 380,000 tons in 1971-75 and less than 200,000 tons in 1977 and 1978. Trends in recent TACs and catches are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	666	657	554	300	160	135	170
Catch (000 tons)	355	373	288	214	173	136*	

* Provisional

b) Assessment parameters

Sampling reported by Canada, Federal Republic of Germany, German Democratic Republic, Poland and USSR was used to derive the age composition of catches in 1978.

Reports on catch and effort by USSR and Spain to the Canadian FLASH system indicated that the standardized effort values adjusted to catches by all countries were 6,650 and 29,350 days respectively. The regressions of fishing mortality on fishing effort, taken from Res. Doc. 78/VI/66, led to estimates of F in 1978 of 0.27 and 0.29 respectively. The estimate of 29,350 days fished for the Spanish standardized effort was adjusted to 293,500 hours on the basis of the ratio of about 10 fishing hours per fishing day (from Table 6 of *ICNAF Stat. Bull.* Vol. 26). A terminal F of 0.27 was used for 1978. The results of cohort analyses indicated that fishing mortality calculated for 1977 at the April 1978 Meeting of the Subcommittee was slightly lower than that derived at this meeting.

Regressions of the geometric mean abundance of ages 1, 2 and 3 of each year-class from USSR young fish surveys against the numbers of age 4 cod from the virtual population analysis (VPA) were not significant. A similar regression using estimates of ages 2 and 3 cod from Federal Republic of Germany surveys was also not significant. The regression of the abundance of age 3 cod in USSR surveys and the abundance of corresponding year-classes from the latest VPA for the 1959-1975 year-classes was used to estimate recruitment. The abundances of the 1973, 1974 and 1975 year-classes at age 4 were thus estimated at 580, 510 and 400 million fish respectively. The estimate of the abundance of the 1973 year-class at age 4 from the cohort analysis was 400 million, and an average value of 500 million was selected for this year-class. The 1976 year-class is apparently weak and was assigned an arbitrary value of 200 million fish at age 4. A nominal value of 500 million was assigned to all subsequent year-classes.

For the stock size and catch projections, the partial recruitment pattern (same as used in the previous assessment except new values for ages 4 and 5 to reconcile stock sizes in 1978 with observed catches of ages 4 and 5 cod in 1978) and the mean weights-at-age (from Canadian sampling in 1978) are as follows:

Age	4	5	6	7	8	9	10	11	12	13	14
% recruited	14	47	76	87	93	97	100	100	100	100	100
Weight (kg)	0.70	0.99	1.59	2.53	3.40	4.26	4.75	5.51	7.32	8.25	8.43

c) Catch projections

Catch and spawning biomass projections (age 7 and older) are given in Table 5 for the years 1980-82, assuming that a TAC of 170,000 tons will be taken in 1979, for three different levels of fishing mortality.

Table 5. Cod in Div. 2J+3KL: projections of catch and spawning biomass (000 tons) in 1980-82 for three levels of fishing mortality.

	F = 0.10		F = 0.16		$F_{0.1}$ = 0.20	
Year	Catch	Spawning biomass	Catch	Spawning biomass	Catch	Spawning biomass
1979	170	409	170	409	170	409
1980	110	802	172	802	212	802
1981	145	1,341	217	1,275	259	1,232
1982	176	1,739	254	1,579	296	1,480

The Subcommittee notes that under all three options of F in 1980 the spawning stock biomass is projected to reach by 1981 the lower range of the target spawning stock biomass (1.2-1.8 million tons) advised at the April 1977 Meeting of the Subcommittee.

4. Cod in Div. 3M (Res. Doc. 79/VI/46, 63, 70, 74)

a) Fishery trends

Catches have varied considerably since 1960, probably in response to wide fluctuations in recruitment. In the periods 1960-64, 1965-69 and 1970-74, the average catches were 26,000, 43,000 and 33,000 tons respectively. Recent catches and TACs are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	40	40	40	25	40	40
Catch (000 tons)	23	25	22	22	25	33*	

* Provisional

Data concerning tagging of cod in 1964, vertebral averages, and growth rates were considered as confirming the discreteness of the Flemish Cap cod stock.

b) Biological studies

A feeding study of cod in Div. 3M during January-February of 1978 and 1979 (Res. Doc. 79/VI/70) showed that the major prey of cod greater than 60 cm was redfish, and that the major prey of cod less than 60 cm changed from hyperiid amphipods in 1978 to small redfish in 1979 in response to the appearance of a successful redfish year-class. In both years benthic invertebrates were unimportant as food, and cannibalism was not extensive.

Studies of the growth rate of cod and the size ranges of redfish available (Res. Doc. 79/VI/74) indicate that, in the absence from the Flemish Cap of large resident populations of capelin and launce, the growth rate of cod may depend largely on the size spectrum of redfish available.

In view of the paucity of published information on trophic dynamics of the Flemish Cap and the indication that such information may considerably aid management, the Subcommittee urges that unpublished data relevant to food and feeding in general, and to the Flemish Cap in particular, be made available, and that greater emphasis be placed on studies of trophic dynamics.

c) Assessment parameters

Examination of the age compositions of cod, both from the commercial fishery in 1976-78 and research vessel surveys in 1977-78, confirmed that the stock in these years consisted largely of age 5 and younger fish with the 1973 year-class strongly predominating. Research vessel surveys in 1979 indicated that fish of the 1973 year-class were mainly mature. Length compositions of cod in 1975 from the commercial fishery, particularly in the later part of the year, indicated that the 1973 year-class as 2-year-olds in 1975 may have been taken in considerable numbers, with possible discarding by some vessels.

A general production model analysis showed that the standardized catch rate in 1978 from limited effort data (Canadian vessels and reports on fishing activity of other vessels) was 0.54 tons per hour compared with 0.70 tons per hour in 1977. The estimate of equilibrium yield at 2/3 F_{MSY} is about 10,000 tons for 1980. This compares with estimates in the range of 10,000-22,000 tons for 1979 derived at the April 1978 Meeting of the Subcommittee based on a variety of effort standard for 1977. The Subcommittee notes, however, that general production models assume an equilibrium condition in the stock and do not take into account recruitment fluctuations.

Estimates of fishing mortality in 1978 were derived from a number of sources. A comparison of catch-at-age per unit effort in 1977 and 1978 resulted in an estimate of $F = 1.08$. An estimate of $F = 1.72$ was derived from research vessel abundance indices for 1978-79. The commercial catch-at-age data were adjusted to take into account year-class strength as shown in the USSR young fish surveys and led to an estimate from the 1978 catch curve of $F = 1.14$, reflecting the average fishing mortality during the 1970's. On the basis of the standardized effort estimated for 1978 and the catchability coefficient from the general production model, an estimate of $F = 1.12$ was indicated for 1978. The Subcommittee agreed to use 1.3 (the average of the above-mentioned estimates) as the value of terminal F in 1978.

The size of the 1973 year-class at age 3 was calculated by cohort analysis to have been about 93 million fish. Using the abundance estimates from USSR research vessel surveys, estimates of the sizes of the 1973-77 year-classes at age 3 were calculated on the basis of the geometric means of the numbers of 1-, 2- and 3-year-old cod caught per hour as compared with the estimate of 93 million fish for the 1973 year-class. The sizes of the 1974 to 1977 year-classes at age 3

were thus estimated to be 17.2, 2.7, 0.1 and 4.3 million fish respectively.

The partial recruitment values for ages 3 and 4 were adjusted to reconcile the numbers caught and the calculated stock sizes of these two year-classes in 1978, and those for age 5 and older were derived from selection ogives and average length-at-age data. The resultant F-values used for 1978 are 0.057 for age 3, 0.225 for age 4, 1.17 for age 5 and 1.3 for age 6 and older.

d) Catch and biomass projections

Projections of catch and stock biomass (tons) in 1980 and 1981 at F_{max} = 0.27 were made for three levels of catch in 1978 ranging from 10,000 to 25,000 tons (Table 6).

Table 6. Cod in Div. 3M: projections of catch and stock biomass (000 tons) in 1980–81 for three different levels of catch in 1979.

		1979 catch = 10000			1979 catch = 20000			1979 catch = 25000		
	1978	1979	1980	1981	1979	1980	1981	1979	1980	1981
Stock biomass (age 4+)	57.0	32.0	34.0	33.0	32.0	17.0	18.0	32.0	9.5	10.0
Projected catch	35.0	10.0	7.0	-	20.0	3.5	-	25.0	1.7	-
Spawning biomass	13.0	22.0	31.0	30.0	22.0	14.0	15.0	22.0	7.0	7.5

The Subcommittee noted that these estimates are quite sensitive to the various input values used, but that the projections clearly show increasingly reduced stock biomass and spawning stock size by 1981 with increasing catches in 1979.

In its advice to the Commission in 1978 (*Redbook* 1978, page 58), the Subcommittee pointed out the conflicting evidence available from research vessel surveys and from general production models, which led to estimates of yield in 1979 ranging from 16,000 to 40,000 tons, and advised that the TAC for 1979 should not exceed 40,000 tons. Furthermore, it was noted that the adoption of a TAC of 40,000 tons for 1979 might make it necessary to reduce the yield in 1980, since the absolute abundance of the strong 1973 year-class in the catches was expected to decline after 1980, especially if the size of this year-class has been over-estimated.

From new evidence examined at this meeting of the Subcommittee, it appears that the size of the 1973 year-class was over-estimated, and, depending on the actual size of the catch in 1979, the projected yields at F_{max} (0.27) in 1980 will be small, less than 7,000 tons in any case. It was pointed out that the projected reduction in spawning stock in 1980 is a matter of concern.

e) Opinion of USSR scientists on the assessment

According to the opinion of the USSR scientists, the value of F derived from commercial catch data for 1977 and 1978 and on Canadian trawl survey results for 1978 and 1979 is seriously overestimated. Combined age compositions for two years could not be a reliable basis for estimation of F in 1978, and trawl survey data create doubt due to the lower number of sets per square mile in the 1979 survey.

Use of geometric mean [(ℓn(age 1) + ℓn(age 2) + ℓn(age 3))/3] for interpretation of USSR young cod survey data has no biological basis, because it is not possible to compare average number per hour trawling of ages 1, 2 and 3 due to differences in vertical distribution. The strength of the 1973 year-class was therefore under-estimated.

The calculations shown below do not indicate a serious decline in biomass of cod and the subsequent projected catches for 1980. The size of the 1973 year-class at age 3 in 1976 is estimated at 162 million fish as follows:

Year-class	Abundance at age 3 from USSR surveys		Stock size at age 3
	No.	ℓn(No.)	(10^6)
1962	29	3.37	92 (from VPA)
1973	392	5.97	162 (estimated)

Using this estimate for 1976, the size of the 1973 year-class in 1978 and the relevant F-level are estimated as follows:

Year	1973 year-class (10^3) Catch	Stock	$\frac{F}{Z}(1-e^{-Z})$	F
1976	28,370	162,000	0.175	0.215
1977	15,509	118,600	0.131	0.156
1978	17,749	81,040	0.219	0.278

From these estimates, fishing mortality of the 1973 year-class in 1978 was at the level of 0.3. Assuming that fishing mortality for age 5+ was 0.9, the stock biomass in 1978 would be 127,000 tons. The average F for all age-groups would in this case be 0.35.

It should be noted that an over-estimated F of 1.3 indicates a total stock biomass in 1978 of 57,000 tons, which is one-half of that estimated with F = 0.28. As the observed difference in the estimates of F cannot be resolved and the resulting TAC levels for 1980 range from 7,000 to about 40,000 tons, as well as taking into account an evident decline in stock biomass (but not to the extent indicated by the over-estimated F-level) and the STACRES advice of last year (*Redbook* 1978, page 58) on the reduction of the TAC for 1980, it is the opinion of USSR scientists that a TAC level for 1980 of 25,000-30,000 tons is not considered to be too high.

5. Cod in Divisions 3N and 3O (Res. Doc. 79/VI/45, 67)

a) Fishery trends

Catches have declined from a high of 227,000 tons in 1967 to 15,000 tons in 1978. During 1973-77, the catches were substantially less than the corresponding TACs. The catch rates of Spanish pair trawlers have declined from 1.7 tons per hour in 1967 to approximately 0.2 tons per hour in 1978. The calculated MSY for this stock is approximately 100,000 tons. Trends in recent TACs and catches are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	103	101	88	43	30	15	25
Catch (000 tons)	80	73	44	24	18	15*	

* Provisional

b) Assessment parameters

Catch-at-age data for 1973-78 were used in a cohort analysis to determine fishing mortalities and stock sizes. The calculation of input parameters in 1978 was subject to some uncertainty, mainly with regard to the value of terminal F. Four values of F were considered: 0.20 and 0.35 were obtained from regressions of weighted F's (ages 4+) against Canada-N otter trawl fishing effort and 0.41 and 0.51 from regressions of weighted F's (ages 4+) against Spanish pair trawl effort (tonnage class 4, unadjusted and standardized). A value of 0.35 was selected as terminal F in 1978 by weighting the four estimates of F in proportion to the significance of the regressions. Estimates of recruitment at age 3 in 1977, 1978 and 1979 were determined from a regression of abundance at age 3 from the cohort analysis with terminal F = 0.35 against the abundance of age 2 cod from USSR young fish surveys. These recruitment values at age 3 were estimated to be 40.0, 40.8 and 18.9 million fish in 1977, 1978 and 1979 respectively. These values are on the average about one-fifth of those for the 1965-69 period. Recruitment of age 3 cod in 1980 was taken to be 27 million, the average of the 1970-73 estimates of recruitment at age 3 from cohort analysis (F_T = 0.35 in 1978).

c) Results of assessment

The stock size in 1978 was calculated by cohort analysis, and a catch projection was made for 1980 with F = 0.19 (approximately F_{max}) and assuming that the 1979 TAC of 25,000 tons will be taken (Table 7).

The Subcommittee also reviewed a general production model analysis which utilized catch and effort data for all of the major fleets fishing in the area up to 1977 with an estimate for 1978. The results indicated a general decline in catch-per-unit effort and that fishing at

Table 7. Cod in Div. 3NO: projection of catch in 1980 at F_{max}.

Year	Recruitment at age 3 (millions)	Terminal F	Catch (tons)
1978	40.8	0.355	15,700
1979	18.9	0.377	25,000
1980	27.0	0.190	16,500

2/3 F_{MSY} in 1980 would probably produce a catch of about 15,000 tons.

The Subcommittee concluded that the stock is in a very depressed condition. This is evident when it is considered that fishing at F_{max} in 1980 would produce a catch of 16,500 tons from a stock with the MSY level calculated at about 100,000 tons. If the TAC of 25,000 tons is taken in 1979, the fishing mortality generated (0.38) will be twice the F_{max} level (0.19).

The basis for the recommended TAC of 25,000 tons in 1979 (*Redbook* 1978, page 59) was mainly a general production model analysis. It appears now that this was an optimistic outlook and might demonstrate the inappropriateness of general production model analyses when a stock is not in equilibrium. It was emphasized that, when a stock reaches such a low level of abundance, its size becomes very difficult to estimate, and that concern for the stock is more important than the actual catch level to be obtained at a given value of F.

The Subcommittee, noting the very depressed state of this stock and the advantages to be obtained not only in terms of increases in yield-per-recruit but also the protection of the spawning stock, and noting the apparent rebuilding of the cod stock in Div. 2J+3KL as a result of reduced fishing mortality, advises that the catch for 1980 should be held at the lowest possible level in order to implement the rebuilding of the stock.

6. General Remarks on the State of Cod Stocks in the Convention Area and Their Management

The Subcommittee noted that there is a general pattern in most of the cod stocks of the Convention Area. This refers not only to the common phenomenon that some of the good year-classes are the same for many stocks but specifically to the state of the stocks in relation to the fisheries and to former stock levels. For a stock like the one in Subarea 1, environmental conditions play a major role, but, under any given environmental conditions, the stocks should still be managed in a way to ensure the best possible long-term yields.

For a number of stocks which are in a depressed state, it is evident that fishing concentrates more than ever before on newly-recruited year-class, thereby not achieving the best possible yield per recruit and not allowing the stock, especially the spawning stock, to rebuild. Although small spawning stocks may occasionally produce relatively good year-classes, the chances of obtaining more and better year-classes seem better ensured by maintaining a larger spawning stock than that at present found in these depressed stocks. The Subcommittee considers it worthwhile noting that the only cod stock in which considerable rebuilding has occurred in recent years is that in Div. 2J+3KL, where the exploitation rate has been kept lower than F_{max} in the most recent years.

In general, the Subcommittee considers that the tendency toward pulse-fishing of newly-recruited, single year-classes should be a matter of concern in the management of the cod stocks.

7. Redfish in Subarea 1 (Res. Doc. 79/VI/54, 69)

a) Fishery trends

Nominal catches have fluctuated widely over the period for which statistics have been reported to ICNAF, increasing from 150 tons in 1951 to a maximum of 61,000 tons in 1962 but decreasing generally thereafter to a low level of about 3,000 tons in 1971-74. Catches increased again in 1975-76 and very sharply in 1977 to 31,000 tons. A precautionary TAC of 13,000 tons was set for 1978 and provisional statistics indicate a total catch of about 10,000 tons.

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	-	-	-	-	13	...
Catch (000 tons)	3	3	9	14	31	10*	

* Provisional

Up to 1976, the fishery was to a great extent a mixed fishery (cod and redfish). Besides the reported nominal catch, it is highly likely that much discarding of redfish has taken place in the cod fisheries. The shrimp fishery is known to take substantial by-catches of small redfish which in nearly all cases are discarded. Although further data are necessary to fully evaluate the problem, the information reported to the November 1978 Meeting of STACRES (Sum. Doc. 79/VI/1) indicates that the total by-catch could be about 10,000 tons, corresponding to approximately 200 million fish.

Up to 1967, the fishery was distributed over Div. 1C to 1F with a minor proportion taken in Div. 1B. Fishing took place mainly in Div. 1E and 1F during 1970-74 but changed back in 1975 to a distribution pattern similar to that in the previous period. Although the fishery has to a great extent been a mixed fishery, the somewhat different depth distribution of cod and redfish indicates that it is to some extent possible to fish directly for either of the two species.

The ICNAF statistics as reported do not separate the fishing effort in the mixed fishery by species. However, examination of the data for Federal Republic of Germany otter trawlers of tonnage classes 5 and 6, when 50% or more of the total catch consisted of redfish, indicates that catch per unit effort has generally decreased since 1962 but with large year-to-year fluctuations.

b) Biological information

Information on the biology of redfish in Greenland waters (Res. Doc. 79/VI/54, 69) indicates that two species occur (*Sebastes marinus* and *S. mentella*), but they are not, and cannot likely be, separated in the fisheries statistics. The areal distribution of the two species in Subarea 1 is almost identical, but distribution according to depth is distinct. *S. marinus*, on which the commercial fishery is based, occurs generally within the depth range of 150-300 m, whereas *S. mentella* normally is found at greater depths.

Plankton surveys show that spawning takes place in the Irminger Sea and to some extent also south of Greenland to approximately 50°N latitude. From the spawning (breeding) areas the larvae drift to West Greenland waters, where major nursery areas occur in Div. 1A and 1B. Generally, the mean size of redfish increases from north to south, which indicates a migration reverse to the larvae drift. Tagging experiments in the Godthåb Fiord (Div. 1D) have demonstrated a migration of adult fish from West to East Greenland waters. Since extremely few spawning redfish have been observed at West Greenland, the migration to East Greenland seems to be a spawning migration.

c) Assessments

The first attempts to assess the yield of redfish by various levels of fishing are presented in Res. Doc. 79/VI/54 and 79/VI/69, using a general production model and an analytical model respectively. Standardized effort was taken as the number of days fished by Federal Republic of Germany trawlers of tonnage class 5 and 6 where 60 and 50% (in the two papers, respectively) of the catch were made up of redfish. Since the monthly effort data reported in the ICNAF Statistical Bulletins represent in many instances the combined fishing effort for both redfish and cod, and since the proportions of these species in the catches have varied greatly as the stocks have fluctuated over the years, use of a criterion such as indicated above to estimate fishing effort aimed at redfish add a certain degree of uncertainty to the analyses. Furthermore, in general production models, it is assumed that the stock is in an equilibrium state, but this is unlikely to have been the case over the years for which the analyses were carried out.

In the analytical assessment, trends in recruited biomass, in the age structure of the catch, and in recruitment to the fishery seemed to be not sufficiently reflected since a standard age-length key had to be used due to lack of age determination. Consequently, another generalized production model (Schaefer model modified by Gulland) was calculated (Res. Doc. 79/VI/69) based on the two sets of standardized effort data available from the research documents. The calculations are based on an 11-year running average for a period in which the exploitation of a previously unfished stock was changing to a more normal situation. Only for an 11-year running average was the slope of the regression of CPUE on effort negative. All other periods showed a positive slope or an extremely low correlation coefficient. The results from both series of data indicate a MSY level of about 10,000 tons and an equilibrium catch at 2/3 F_{MSY} of about 9,000 tons. These figures are similar to that from the initial analytical assessment for the maintenance of the present level of exploitation. In the light of these results it should be pointed out that the previous advice that fishing should not be allowed to expand beyond the 1977 catch level (*Redbook* 1978, page 60) was meant only to prevent an uncontrolled continuation of the expansion of the fishery as observed in most recent years and was not connected with any scientific analysis.

The results of the present analysis indicate that the catch in 1977 was far beyond the MSY level

and it should be lowered to that level until more detailed analysis can be provided. It was further pointed out that discarding of small redfish in the shrimp fishery would not have affected the present fishery for commercial-sized redfish, but since this might lead to reduced recruitment to the exploitable stock in the near future, a reduction in the TAC may be required in future years.

The Subcommittee also points out that, since the spawning areas of the stock are not inside the Convention Area but at East Greenland and in the Irminger Sea (ICES Subarea XIV), studies of the stock and fisheries in this area should be considered in cooperation with ICES.

8. Redfish in Division 3M (Res. Doc. 79/VI/62, 73)

a) Fishery trends

Catches of redfish were generally low during the 1960's and increased to a high of 42,000 tons in 1972. Trends in TACs and catches since 1973 are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	40	16	16	16	16	20
Catch (000 tons)	22	35	16	17	20	16*	

* Provisional

b) Abundance indices

Length frequencies from Canadian commercial sampling in 1978 indicated that redfish ranging in size from 27 to 42 cm made up the bulk of the catches. The length frequencies also showed that a relatively good year-class was being recruited to the fishery. This was substantiated by the Canadian research survey in 1978 (Res. Doc. 79/VI/62). The USSR and Canadian research surveys showed an abundance of pre-recruit redfish. However, the USSR survey showed a general increase in abundance of redfish from 1978 to 1979 while the Canadian survey showed a decrease. This was partly explained by an unusually large catch in one stratum in the 1978 Canadian research survey.

c) Assessment

Two assessments of this redfish stock, using the general production model, were considered (Res. Doc. 79/VI/62, 73). The equilibrium yield at 2/3 F_{MSY} from the two models ranged from 15,000 to 17,000 tons. Both indicated that the catch rates of recent years have increased, including 1977 with an associated catch of 20,000 tons. Since the stock appears to be in relatively good condition considering both research survey data and commercial catch rates, the Subcommittee advises that the TAC for 1980 should remain at 20,000 tons.

9. Redfish in Divisions 3L and 3N (Res. Doc. 79/VI/61, 72)

a) Fishery trends

Nominal catches of redfish declined from a high of 45,000 tons in 1959 to 14,000 tons in 1970, and fluctuated between 16,000 and 34,000 tons during 1971-77. TACs and catches since 1973 are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	28	20	20	16	16	18
Catch (000 tons)	33	22	18	21	16	12*	

* Provisional

b) Abundance Indices

Length frequencies from Canadian commercial sampling in 1978 indicated that redfish ranging in size from 29 to 41 cm made up the bulk of the catches. Abundance indices from the USSR research surveys have shown an increase in catch rate over the last three years. Moreover, Canadian research length frequencies indicate a relatively high proportion of 10-16 cm redfish in the shallower water in Div. 3L.

c) Assessment

Three separate assessments, using different effort standards in the general production model were reviewed by the Subcommittee. In general, the catch per unit effort appears to be continuing to increase and this correlates well with the USSR survey results, indicating that this stock is in relatively good condition. Two of the effort standards used were not lagged which would result in an over-estimate of the MSY. The lagged effort data were standardized on tonnage class without consideration for differing catch rates which occurred between midwater and bottom trawls in the last five years. Equilibrium yields at 2/3 F_{MSY} from the three assessments were 24,000, 27,000 and 32,000 tons respectively. Noting the variation in yield resulting from the different effort standards but keeping in mind the evidence of increasing abundance from survey data, the Subcommittee advises that the TAC be increased from 18,000 tons in 1979 to 25,000 tons in 1980.

10. Silver Hake in Divisions 4V, 4W and 4X (Res. Doc. 79/VI/42, 48, 49, 75)

a) Fishery trends

The fishery on this stock began in 1958, and from 1962 to 1975 USSR vessels took approximately 98% of the catches. Catch limitations were imposed on the fishery in 1974 and area and gear restrictions have been in effect since 1977. The provisional catch in 1978 was 48,000 tons, 91% of which was taken by USSR. Recent TACs and catches are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	100	120	100	70	70	70
Catch (000 tons)	299	96	116	97	37	48*	

* Provisional

The 1977 and 1978 TACs were not reached, due possibly to such factors as by-catch limitations, area and gear restrictions, low recruitment to the hake fishery, the large biomass of squid and the mixed nature of the hake-squid fishery in the last two years, and different hydrographic conditions.

b) Biological studies

Age and growth of silver hake have been studied in several ageing workshops, and a summary (as recommended by STACRES) has been prepared (Res. Doc. 79/VI/42) for use by scientists in ageing silver hake to help standardize techniques. Minor revisions were suggested to update this paper. Future otolith exchanges were recommended to maintain consistency in ageing.

A study on the feeding of silver hake was made from data collected on a series of cruises during 1976-78 (Res. Doc. 79/VI/49). It was noted that small silver hake feed heavily on small crustaceans, mainly euphausiids and mysids, whereas larger hake feed mainly on smaller fish, including other hake and squid. It was shown that silver hake have a variety of prey types and appear to be opportunistic in feeding patterns.

c) Abundance estimates

The Subcommittee examined three sets of abundance indices for the period 1972-78, namely, catch in numbers per 30-min haul from USSR autumn surveys in Emerald Basin, population numbers for age-groups 2 and older from the USSR assessment, and population numbers for age-groups 1 and older from the Canadian assessment, as listed in the following table:

Source	1972	1973	1974	1975	1976	1977	1978
USSR surveys (no./30-min)	963	875	1,342	2,629	1,508	-	1,232
USSR assessment (10^6)	5,445	4,180	2,131	1,792	1,667	1,142	3,249
Canadian assessment (10^6)	5,505	4,458	3,168	3,247	2,782	1,775	1,686

It was noted that the survey abundance indices are not consistent with the population estimates of either the USSR or the Canadian stock assessments.

d) Assessment parameters

Catch composition. Canadian estimates of catch compostiion by age for 1970-77 (Res. Doc. 79/VI/48) were reworked by using new age-length keys based on the ageing criteria agreed to in 1978 (Sum. Doc. 78/VI/10). The age composition of the catch in 1978 was determined by applying to the length frequencies an age-length key derived from samples collected through the International Observer Program and aged according to the above-noted criteria. In the light of continued differences in USSR and Canadian catch-at-age data, the Subcommittee agreed to use the Canadian catch-at-age table as the basis for this assessment.

Natural mortality. Since no new estimates of natural mortality were available, it was agreed to use M = 0.4 in order to be consistent with 1977 and 1978 assessments on which previous management advice was based.

Weight-at-age. Average weight-at-age data, used for the 1979 assessment and also to determine the yield-per-recruit estimate of $F_{0.1}$ = 0.558, are as follows:

Age (years)	1	2	3	4	5	6+
Mean weight (g)	43	100	168	218	340	560

Partial recruitment. Starting F-values for ages 2 to 5 were regressed against fishing effort and adjusted to give the best fit, using the historical partial recruitment values (1970-76) as a guide. A change in partial recruitment was noted for 1977 and 1978, due probably to a change in recruitment or the area and gear restrictions introduced in 1977. Consequently, the partial recruitment values used for 1978 were altered slightly from the historical pattern. However, the historical pattern (1970-76) was used for the catch projections.

Age (years)	1	2	3	4	5	6+
Partial recruitment (1970-76)	0.16	1.00	0.81	0.72	0.70	0.58
Partial recruitment (1978)	0.11	1.00	0.88	0.80	0.77	0.67

Recruitment values of the 1976 and 1977 year-classes from the virtual population analysis were used for the catch projections.

e) Catch projections

Recruitment is the most important factor in the catch projections, and, for this reason, three recruitment options were considered. For the first option, recruitment was assumed to be equal to the geometric mean of historical values at age 1 (approximately 1,000 million fish). This projection indicates a catch in 1979 of 60,000 tons (less than the TAC of 70,000) if fishing occurs at $F_{0.1}$ and a catch of 55,000 tons at $F_{0.1}$ in 1980. The projection is extremely dependent on recruitment, 64% of the 1980 catch being dependent on the assumption about the strength of the 1978 and 1979 year-classes (1,000 million fish). For the second option, if the size of the 1978 and 1979 year-classes is assumed to be 1,900 million fish at age 1 (as indicated by possible correlation between silver hake recruitment and squid biomass), the 1980 catch at $F_{0.1}$ would be 80,000 tons. On the other hand, if these year-classes consist of 750 million fish at age 1 (the average recruitment of the 1975-77 year-classes at age 1 from cohort analysis), the 1980 catch at $F_{0.1}$ would be 40,000 tons. Given the uncertainties concerning the recruitment of incoming year-classes in 1980, the Subcommittee advises a TAC for 1980 within the range of 55,000-80,000 tons. However, if more precise advice as to the level of the 1980 TAC is required, a reassessment of this stock after the completion of the 1979 fishery is advised.

11. American Plaice in Division 3M

This stock has been regulated since 1974 with catches approximately in the range of 1,000-2,000 tons during 1973-77. The 1978 provisional catch was about 1,300 tons. Catches from this stock are entirely by-catches in the cod and redfish fisheries. The TAC was increased from 2,000 to 4,000 tons for 1978, on the basis of improved reasearch vessel abundance indices, but was reduced to 2,000 tons for 1979. Research vessel data for 1978 indicated a decline in abundance but, because of the by-catch nature of this fishery, the Subcommittee advises that the TAC should remain at 2,000 tons for 1980.

12. American Plaice in Divisions 3L, 3N and 3O

a) Fishery trends

The highest recorded catch from this stock was 94,000 tons in 1967. Since then, catches were

lower and the average catch in the past six years was approximately 48,000 tons. TACs and catches since 1973 are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	60	60	60	47	47	47	47
Catch (000 tons)	53	46	43	52	44	50*	

* Provisional

b) Abundance

Average number per set from Canadian research vessel surveys in 1978 increased slightly over 1977 values, although the average weight per set declined marginally. Catch per hour by Canadian otter trawlers increased by about 10% in 1978.

c) Assessment parameters

Length and age composition and mean weight-at-age data were derived from Canadian commercial sampling of catches from the three ICNAF divisions in most months of 1978. Quarterly age-length keys and monthly catch data were used to estimate the numbers caught by age-group.

The fishing mortality in 1978, used to initiate the cohort analysis, was derived from the regression of F-values for fully-recruited age-groups on fishing effort for 1964-76, producing values of 0.56 and 0.50 for males and females respectively.

d) Assessment results

Stock size and catch projections for 1979-86 were carried out using recruitment values (91 million males and 215 million females) derived from cohort analysis and fishing mortalities equivalent to $F_{0.1}$ (0.45 for males and 0.40 for females). The evidence available both from the cohort analysis of commercial data and from research surveys indicates an increase in the size of recent recruiting year-classes. Trends in past and projected stock sizes and catches are indicated in Table 8.

Table 8. American plaice in Div. 3LNO: trends in past and projected stock sizes and catches, 1964-1986.

	1964	1967	1971	1973	1978	1980	1983	1986
Spawning population (10^6)	391	371	248	259	447	431	456	457
Spawning biomass (000 tons)	296	286	214	186	292	320	352	348
Catch (000 tons)	38.4	94.4	67.9	52.8	48.0	46.5	57.7	58.0

On the basis of the information available, the Subcommittee advises a TAC of 47,000 tons for 1980. It is noted that, if the favourable indications of recruitment do, in fact, materialize, future increases in yield will be expected to accrue from this stock.

13. Witch Flounder in Divisions 2J, 3K and 3L (Res. Doc. 79/VI/39, 44, 64)

a) Fishery trends

Nominal catches increased from 4,400 tons in 1961 to 24,000 tons in 1973 and have declined steadily to 6,500 tons in 1978. The TAC for 1975 was reduced from 22,000 tons to 17,000 tons on the basis of an analytical assessment of the stock with fishing mortality at the $F_{0.1}$ level. Recent TACs and catches are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	22	17	17	17	17	17
Catch (000 tons)	24	16	12	11	8	7*	

* Provisional

b) Stock boundaries

Information based on similarities in length distribution and sexual maturity (Res. Doc. 79/VI/39) indicates that witch flounder in Div. 2J+3KL and Div. 3NO probably comprise a single stock. However, because of the natural barrier of cold water over the shallow areas of the Grand Bank, there is probably little or no mixing of these components, at least the adults (Res. Doc. 79/VI/44), as limited tagging results showed very little migration from the tagging locations. The Subcommittee was informed that more detailed investigations were in progress concerning stock discrimination of this species, and consequently agreed that consideration of stock boundaries be deferred until the results of the studies are made available.

c) Assessment

The results of research vessel surveys by Canada in Div. 3L since 1971 and by Federal Republic of Germany in Div. 3K since 1972 show that the average catch in numbers per haul has shown little fluctuation over the period, indicating a stable state in this stock. Age composition data from the commercial fishery showed considerable numbers of fish up to age 20 for males and age 25 for females, indicating a low level of exploitation. This was also brought out in the concave appearance of the catch curves. Although average Z-values appeared to be high, the Subcommittee considered that this may be due to higher natural mortality of the older age-groups. With all evidence indicating no over-exploitation of this stock, the Subcommittee advises that the TAC of 17,000 tons should remain in effect for 1980.

14. Witch Flounder in Divisions 3N and 3O (Res. Doc. 79/VI/65)

a) Fishery trends

Nominal catches increased from 4,700 tons in 1969 to 15,000 tons in 1971 and subsequently declined to about 6,000 tons during 1975-77. The provisional catch of 2,800 tons in 1978 is the lowest reported in 12 years. Recent catches and TACs are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	10	10	10	10	10	7
Catch (000 tons)	7	8	6	6	6	3*	

* Provisional

b) General production model analysis

The Subcommittee reviewed a general production model analysis presented in Res. Doc. 79/VI/65. The fishing effort used to generate the model was from Canadian stern trawlers in a directed witch flounder fishery. Although the fishing effort has declined steadily over the past five years, the catch per unit effort has not shown much change. While management of this stock at 2/3 F_{MSY} implies a catch of 6,000-7,000 tons at the equilibrium level, the catch at 2/3 F_{MSY} in 1980 is more likely to be about 3,000-4,000 tons, based on the trend in catch per unit effort in recent years.

c) Cohort analysis

Canadian commercial sampling data for 1974-78 were used in the analysis. Since the fishery has been conducted primarily by Canada and USSR, it was agreed that the Canadian data would adequately reflect the total fishery. The terminal F-values used to initiate the calculations were derived from estimates of total mortality (Z), based on catch-at-age per unit effort from Canadian stern trawlers in 1977 and 1978 (F = 0.66 for males and 0.36 for females). Partial recruitment was derived from a matrix of catch-at-age (numbers) and F-values, averaged over the 1974-77 period. These values were plotted and partial recruitment curves fitted to the points. The values used in the analysis were taken directly from the curves. Because of anomalous catch-at-age data for 1978, only the 1974-77 data were used in the cohort analysis, and stock sizes were projected to 1979 from 1977 using the 1978 catch.

With estimated recruitment of 5.3 million males and 5.7 million females at age 8 and assuming a catch of 7,000 tons in 1979, the catch projected for 1980 is approximately 7,000 tons if fishing is conducted at the $F_{0.1}$ levels (0.43 for males and 0.33 for females). Therefore, the Subcommittee advises that the TAC should remain at 7,000 tons for 1980.

15. Yellowtail Flounder in Divisions 3L, 3N and 3O

a) Fishery trends

Nominal catches increased from 3,100 tons in 1965 to 26,400 tons in 1970 and to 39,300 tons in 1972. The stock has been subjected to TAC regulation since 1973. Recent TACs and catches are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	50	40	35	9	12	15	18
Catch (000 tons)	33	24	23	8	12	15*	

* Provisional

b) Abundance indices

Catch and effort data from Canada (Newfoundland) commercial otter trawlers indicate a gradual increase in the catch per hour since 1976, which is now approximately equivalent to the 1974 level. Research vessel survey data, however, indicate a decline in average number and weight per set from 1977 to 1978, but this may, in part at least, be attributed to the intensity of the survey coverage conducted in 1978.

c) Assessment parameters

Length and age composition and mean weight-at-age data were derived from Canadian commercial sampling of catches from the three divisions in most months of 1978. Quarterly age-length keys and monthly catch data were used to estimate the numbers caught at age from the monthly length frequencies.

Fishing mortality for the fully-recruited age-groups in 1978, used to initiate the cohort analysis, was derived from the regression of weighted F-values of fully-recruited age-groups on the directed commercial effort for 1969-76, resulting in F = 0.53.

Recruitment at age 4 (110 million fish) used for the yield projections was the average of values for 1976-77 from the cohort analysis.

d) Assessment results

It was noted that the fishing mortality generated to take the catch of 16,000 tons in 1978 was 0.53, somewhat higher than $F_{0.1}$ (0.40), and it appears that a similar value would be required to take the 1979 TAC of 18,000 tons. The value used for recruitment at age 4 in 1978 has a major effect on the catch projection for 1980, since these fish at age 6 in 1980 will probably account for at least 20% of the total catch.

While the recovery of the stock from the low levels encountered in 1974-76 appears to be encouraging, it also appears that recovery will be gradual. The Subcommittee advises that the TAC for 1980 be set at 18,000 tons, the projected value of the yield at $F_{0.1}$ with assumed recruitment at the average value for 1976-77.

16. Greenland Halibut in Statistical Area 0 and Subarea 1 (Res. Doc. 79/VI/60)

a) Fishery trends

The nominal catch increased from less than 5,000 tons prior to 1972 to 14,000 tons in that year. The catch declined to 10,000 tons in 1973 and then peaked at 25,000 tons in 1975. Recent trends in catch and TAC are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	-	-	20	20	20	25
Catch (000 tons)	10	14	25	16	13	12*	

* Provisional

Lacking adequate data to properly assess this stock, a precautionary TAC of 20,000 tons was introduced in 1976 and retained for 1977. It was subsequently increased to 25,000 tons for 1978, based on new information presented by the USSR in 1977.

b) Assessment

A virtual population analysis, presented to the April 1978 Meeting of the Subcommittee (Res. Doc. 78/VI/53), indicated that the yield from this stock could be as high as 35,000 tons, but this assessment did not include 1977 data. While the Subcommittee welcomed this new assessment, the uncertainty about the state of the stock was enough to advise a continuation of the precautionary TAC of 25,000 tons for 1979.

Although no assessment was presented at the present meeting, some data presented by Canada indicated that recruitment prospects were promising. It was difficult, however, to determine the contribution that these recruiting year-classes would make to the commercial fishery, with no information on recruitment levels in previous years. Consequently, the Subcommittee advises that the TAC for 1980 remain at the precautionary level of 25,000 tons.

c) Future research requirements

The Subcommittee noted the general lack of sampling data available for proper evaluation of this stock. It was noted that Res. Doc. 78/VI/53 contained, in graphical form, USSR length and age composition data by sex for the years 1969-76. The Subcommittee considered that these data would be a valuable addition to the ICNAF data base and, therefore,

recommends

that scientists from the various countries whose vessels have been or are now fishing for Greenland halibut in Subarea 1 and Statistical Area 0 submit all available length compositions and age-length keys by sex (data not previously submitted) to the ICNAF Secretariat as soon as possible.

In view of the possible stock relations between Greenland halibut in Statistical Area 0 and Subarea 1 and in Subareas 2 and 3, the Subcommittee agreed that similar data for Greenland halibut in Subareas 2 and 3 (if not previously submitted) should also be reported to the ICNAF Secretariat for incorporation into its sampling data base.

17. Greenland Halibut in Subarea 2 and Divisions 3K and 3L (Res. Doc. 79/VI/71)

a) Fishery trends

Nominal catches ranged from 25,000 to 30,000 tons annually during 1971-76 and increased to about 38,000 tons in 1978, more than 60% of which was taken in the Canadian inshore gillnet fishery. A TAC of 40,000 tons was introduced in 1974 and subsequently reduced to 30,000 tons for 1976 based on an analytical assessment. Recent TACs and catches are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	40	40	30	30	30	30
Catch (000 tons)	29	27	29	25	32	38*	

* Provisional

b) Assessment

Biological studies have shown that this fishery is composed mainly of the smaller immature fish which inhabit the Continental Shelf, while the larger mature fish are found on the deep slopes where most are inaccessible to the commercial fishery. The lucrative fishery of 1978 was largely based on strong 1970-73 year-classes (Res. Doc. 77/VI/11), and research vessel surveys during 1978 have shown that these strong year-classes are now followed by what appears to be a strong 1974 year-class which should enter the fishery in 1980. Biomass estimates of Greenland halibut indicated high levels of abundance in Div. 2J and 3K during November-December 1978, and the Subcommittee agreed that, despite the sensitivity of the catchability coefficient used in the estimates and the difficulties encountered in obtaining an accurate value of catchability, These estimates of biomass were comparable to those derived by analytical assessment.

The fishing mortality during 1977-78 appeared to be very close to the $F_{0.1}$ level, based on survival of fully-recruited age-groups in the commercial fishery from 1977 to 1978, with the

average catch during this period being 35,000 tons. Considering this and the evidence of good year-classes entering the fishery, the Subcommittee advises that the TAC for 1980 be increased to 35,000 tons.

c) Research requirements

The Subcommittee noted that intensive research activity on the problem of stock discrimination was begun during 1978, using a variety of methods such as tagging, biochemical analysis, meristic and morphometric analysis and parasitogical studies. The Subcommitte agreed that these studies should be continued in order to elucidate stock relationship in Statistical Area 0 and Subareas 1 to 3. Noting the importance of making a proper analytical assessment of this stock, the Subcommittee

recommends

that all available data on Greenland halibut be compiled as soon as possible during the year in order to provide better advice on the management of this stock when it is assessed early in 1980.

18. Roundnose Grenadier in Statistical Area 0 and Subarea 1 (Res. Doc. 79/VI/57)

a) Fishery trends

Nominal catches fluctuated in the range of 3,000-12,000 tons during 1971-78. A TAC of 10,000 tons was introduced in 1975, increased to 14,000 tons for 1976 and subsequently reduced to 8,000 tons based on an assessment at the April 1976 Meeting of the Subcommittee. Recent TACs and catches are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	-	10	14	8	8	8
Catch (000 tons)	5	12	5	9	3	6*	

* Provisional

b) Assessment

The Subcommittee reviewed an updated general production model assessment for the period 1968-77 (Res. Doc. 79/VI/57). This model indicated an MSY of 8,000 tons with a catch of 6,700 tons at 2/3 F_{MSY}. These values agreed favourably with those estimated in the analytical assessment presented in 1978 (Res. Doc. 78/VI/45). Because the dynamics of this stock are at present uncertain, the Subcommittee advises that the TAC for 1980 remain unchanged at 8,000 tons.

19. Roundnose Grenadier in Subareas 2 and 3 (Res. Doc. 79/VI/57)

a) Fishery trends

Nominal catches, after peaking at 75,000 tons in 1971, fluctuated in the range of 15,000-28,000 tons during 1972-78. A TAC of 32,000 tons was introduced in 1974 and increased to 35,000 tons for 1977, based on an assessment at the April 1976 Meeting of the Subcommittee. Recent TACs and catches are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	32	32	32	35	35	35
Catch (000 tons)	18	28	27	21	15	21*	

* Provisional

b) Assessment

The Subcommittee reviewed an updated general production model assessment for the 1967-77 period (Res. Doc. 79/VI/57), which indicated an MSY of 31,000 tons and a catch of 27,500 tons at 2/3 F_{MSY}. A review of Res. Doc. 78/VI/54, assuming M = 0.15, indicated a sustainable yield of 30,000 tons at $F_{0.1}$. In view of the general declining trend in catch-per-unit-effort data for recent years, the Subcommittee advises that the TAC be set at 30,000 tons for 1980.

20. Argentine in Divisions 4V, 4W and 4X

a) Fishery trends

Following a peak catch of 17,000 tons in 1974, the nominal catch of argentine declined to about 2,000 tons in 1977 and 1978, substantially below the TAC of 20,000 tons. Recent TACs and catches are as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	25	25	25	20	20	20
Catch (000 tons)	1	17	15	7	2	2*	

* Provisional

b) Assessment

The only new analysis presented to the Subcommittee indicated that catch rates of Japanese trawlers were very similar in 1977 and 1978. It is noted that there appears to be little mixing between adjacent stock components, that the primary concentrations fished historically lie in the general area of disputed jurisdiction between the USA and Canada, and that this area has not been accessible for fishing by third parties since 1977. The 20,000 tons calculated to be the long-term sustainable yield refers to the entire stock in Div. 4VWX and, if this level of catch is taken from stock components on the eastern and central Scotian Shelf only, substantial over-exploitation of these components will likely occur. However, catches in 1977 (2,500 tons) and 1978 (1,900 tons) have been low and Japanese catch-per-unit-effort data indicate that stock abundance did not decline over these years. Insufficient data have been made available to conduct an analysis of the current status of this stock, and the Subcommittee can only reiterate its previous advice that the estimated MSY level of catch is 20,000 tons in Div. 4VWX.

21. Shrimp in Statistical Area 0 and Subarea 1

Data related to the fishery for shrimp and research data for 1978 were presented and discussed at the Special Meeting of STACRES at Bergen, Norway, in November 1978, and advice on management in 1979 was given (Sum. Doc. 79/VI/1).

The Subcommittee acknowledges the request by Canada and the EEC for advice on management in 1980 at the same time as most of the other stocks in the Convention Area are assessed. It is, however, noted that, although some progress has been made in observing pre-recruit shrimp, such data are not yet sufficiently evaluated to allow the Subcommittee to take them into account in the assessments. It is, therefore, still more appropriate to assess the stock of shrimp and advise on conservation measures for 1980 at a meeting near the end of 1979 when data for that year become available. The Subcommittee also noted that the laboratories involved in research on shrimp would have practical difficulties in working up shrimp data at the same time as data for other stocks and, for this reason, a meeting later in the year to assess shrimp would be more appropriate.

IV. OTHER MATTERS

1. Consideration of Proposal for Changing the Mesh Regulation for Redfish in Div. 3M (Com. Doc. 78/VI/12; *Redbook* 1978, page 45)

The Subcommittee was informed that documentation for this item was incomplete and agreed that consideration be deferred to the 1979 Annual Meeting of STACRES.

2. Consideration of Uniform Mesh Size for the Silver Hake and Squid Fisheries in Subarea 4 (Res. Doc. 79/II/3, 35; Sum. Doc. 79/VI/5)

Considering the parameters investigated for squid and silver hake (Res. Doc. 79/II/3, 35), the Subcommittee noted that a change from 60- to 90-mm mesh size in the codends would likely result in no long-term loss in yield for either squid or silver hake, very little short-term loss for silver hake, and no short-term loss for squid. While possible increases in yield per recruit could not be precisely quantified for either species, an increase in mesh size from 60 to 90 mm would result in a reduction in fishing mortality on immature silver hake (age 1) and may result in an increase in the fishing effort associated with the $F_{0.1}$ level. Recognizing that the data are insufficient to accurately quantify the effect of such a change in mesh size, the Subcommittee agreed that the best way to acquire the necessary data would be from a large-scale experimental fishing program and recommended that such a program be implemented. It was indicated that this program should include at least 15%

of each of the national fleets of vessels involved in the silver hake-squid fishery in 1980, with designated vessels using trawls with 90-mm mesh codends and fishing, whenever possible, in proximity to the remainder of the fleet.

3. Consideration of Commencement Date for the Squid Fishery in Future Years (Sum. Doc. 79/VI/5)

The Subcommittee, noting that documentation for this item was incomplete, agreed that consideration be deferred to the 1979 Annual Meeting of STACRES.

4. Review of Proposed Sampling Forms

In the report of the *ad hoc* Working Group on Standardization of Reporting Procedures for Sampling Data (Sum. Doc. 79/VI/1), it was noted that, while a form (CFS-1) for reporting length samples had been approved, time did not permit the development of a form for the reporting of age samples. However, a list of contents was proposed and the Secretariat was requested to design a draft form based on the list. The draft form (CFS-2) was circulated for comment in December 1978.

The Subcommittee considered it opportune to review the draft form for age samples. Minor modifications and amendments were approved and the Secretariat was requested to prepare a revised version for review by the Subcommittee on Statistics and Sampling at the 1979 Annual Meeting.

5. Timing of Future Assessment Meetings

The Subcommittee discussed the implications of attempting to provide precise management advice in April for stocks for which information is very inadequate or even lacking prior to the meeting. Before 1975, the Subcommittee met in May during the period scheduled for the Annual Meeting. Starting in 1975, at the request of commissioners who wished to have the management advice in advance of the Annual Meeting and at the request of scientists who considered that the allotted time was inadequate to review the many stocks under regulation at that time, STACRES agreed that stock assessments be carried out well in advance of the Annual Meeting. Thus, the Assessments Subcommittee has met regularly in early April since 1975. In an effort to avoid overlap with meetings of ICES Working Groups, ICES has regularly been informed of the scheduled dates of the ICNAF Assessments Subcommittee Meeting well in advance of the ICES Annual Meeting in the autumn, but this has not avoided an overlap of the Assessments Subcommittee Meeting and meetings of ICES Working Groups. A greater degree of liaison between the scientific bodies of ICES and ICNAF is essential.

In view of the recent extension of coastal state jurisdiction over fisheries, the reduction in the number of stocks for which management advice is requested, and the need for more detailed and complete data on which to base the assessments, the Subcommittee

recommends

that future stock assessments be carried out in May immediately preceding the Annual Meeting, to allow for the compilation of more complete statistical data, the pre-meeting distribution of relevant documentation, and the possible reporting of some data for the early months of the current year.

The Subcommittee noted, however, that, in the case of such short-lived species as shrimp, capelin and squid, and other stocks on which fishing is occurring mostly on recruiting year-classes, a meeting near the end of the year, when information on the fishery in that year is available, would be necessary, in order to provide the best possible advice for management in the following year.

V. ACKNOWLEDGEMENTS

The Chairman expressed his appreciation to the participants for their cooperation during the course of the meeting and to the Secretariat for their usual efficient work. On behalf of the participants, Mr Horsted thanked the Chairman for his guidance at this and other STACRES meetings since November 1978, and requested that he convey to the Director and Staff of the Newfoundland Environment Center the gratitude of STACRES for the hospitality and facilities provided.

APPENDIX I

AGENDA FOR ASSESSMENTS SUBCOMMITTEE MEETING

28 March-9 April 1979

1. Opening (Chairman: G. H. Winters)

   a) Adoption of agenda
   b) Plan of work
   c) Rapporteurs

2. Review of catch statistics and fishing activity in 1978.

3. Stock assessments

   a) Stocks lying completely outside the Canadian 200-mile fisheries zone and not overlapping the zone of any other state:
      - Cod (3M)
      - Redfish (3M)
      - American plaice (3M)

   b) Stocks lying within or partly within the Canadian 200-mile fisheries zone for which Canada requests scientific advice for management (Com. Doc. 79/VI/6):
      - Cod (2GH, 2J+3KL, 3NO)
      - Redfish (3LN)
      - Silver hake (4VWX)
      - American plaice (3LNO)
      - Witch flounder (2J+3KL, 3NO)
      - Yellowtail flounder (3LNO)
      - Greenland halibut (2+3KL)
      - Roundnose grenadier (2+3)
      - Argentine (4VWX)

   c) Stocks in the northern part of the ICNAF Area, as suggested by Canada (Com. Doc. 79/VI/6) and with the concurrence of the other coastal state concerned (Com. Doc. 79/VI/16):
      - Greenland halibut (0+1)*
      - Roundnose grenadier (0+1)*
      - Shrimp (0+1)*

   d) Stocks lying within the European Economic Community fisheries zone in the northern part of the ICNAF Area (Com. Doc. 79/VI/16):
      - Redfish (1)
      - Cod (1)

4. Evaluation of accuracy of commercial fishery based indices of abundance, in cooperation with the members of the Biological Surveys Subcommittee (*Redbook* 1978, page 39).

5. Other matters

   a) Consideration of Canadian proposal for changing the mesh regulation for redfish in Div. 3M (Com. Doc. 78/VI/12); *Redbook* 1978, pages 45-46)

   b) Consideration of a uniform minimum mesh size for the silver hake and squid fisheries in Subarea 4 (Sum. Doc. 79/VI/5)

   c) Consideration of commencement date for the squid fishery in future years (Sum. Doc. 79/VI/5)

   d) Review of proposed sampling forms (Sum. Doc. 79/VI/1, 5)

   e) Timing of future meetings for stock assessments

6. Adjournment

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* Statistical Area 0 as used here includes the area west of Subarea 1 from 61°00'N to 78°10'N, as adopted by STACRES at its November 1977 Meeting (Sum. Doc. 78/VI/1).

APPENDIX II

LIST OF PARTICIPANTS IN ASSESSMENTS SUBCOMMITTEE MEETING

28 March-9 April 1979

CANADA

Mr B. Atkinson	Research and Resource Services, P. O. Box 5667, St. John's, Nfld.
Mr C. A. Bishop	" " "
Mr W. R. Bowering	" " "
Dr J. E. Carscadden	" " "
Mr S. Gavaris	" " "
Mrs C. Gavaris	" " "
Mr G. Hurley	" " "
Dr W. D. McKone	" " "
Mr D. S. Miller	" " "
Mr A. T. Pinhorn	" " "
Dr T. K. Pitt	" " "
Mr D. A. Roff	" " "
Mr S. J. Smith	" " "
Mr S. Stevenson	" " "
Mr R. Wells	" " "
Dr G. H. Winters	" " "
Mr D. Clay	Marine Fish Division, Bedford Institute of Oceanography, P. O. Box 1006, Dartmouth,
Dr R. G. Halliday	" " " N. S.
Mr D. E. Waldron	" " "
Mr T. Amaratunga	Resource Branch, Fisheries and Oceans Canada, P. O. Box 550, Halifax, N. S.
Mr J. J. Caddy	" " "
Mr T. W. Rowell	" " "
Dr P. J. G. Carrothers	Biological Station, Fisheries and Oceans Canada, St. Andrews, N. B.
Mr J. J. Hunt	" " "
Mr J. S. Beckett	Fisheries Research Branch, Fisheries and Oceans Canada, 240 Sparks St., Ottawa, Ont.
Dr W. G. Doubleday	" " "
Mr D. Rivard	" " "

CUBA

Mr A. Mari	Centro de Investigaciones Pesqueras, Miramar, Havana

DENMARK

Mr Sv. Aa. Horsted	Grønlands Fiskeriundersøgelser, Jaegersborg Allé 1B, 2920 Charlottenlund
Mr J. M. Jensen	" " "

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Mr A. Forest	Institut des Pêches Maritimes, B. P. 26, 97500 St. Pierre and Miquelon

FEDERAL REPUBLIC OF GERMANY

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GERMAN DEMOCRATIC REPUBLIC

Dr W. Mahnke	Institut für Hochseefischerei, 251 Rostock-Marienehe
Mr B. Vaske	" "

JAPAN

Mr T. Sato	Far Seas Fisheries Research Laboratory, 1000 Orido, Shimizu, Shizuoka

NORWAY

Mr T. Benjaminsen	Institute of Marine Research, P. O. Box 2906, 5011 Bergen-Nordnes

POLAND

Dr A. J. Paciorkowski	Sea Fisheries Institute, Skr. Poczt 184, 81-345 Gdynia

UNION OF SOVIET SOCIALIST REPUBLICS

Dr V. A. Rikhter	Atlantic Research Institute of Marine Fisheries and Oceanography (AtlantNIRO), 5 Dmitry Donskoy Street, Kaliningrad
Dr A. S. Seliverstov	Polar Research Institute of Marine Fisheries (PINRO), 6 Knipovich Street, Murmansk
Mr V. K. Vasiliev	Foreign Department, Ministry of Fisheries, 12 Rozhdestvensky Boul., Moscow K-45

UNITED STATES OF AMERICA

Mr R. K. Mayo	National Marine Fisheries Service, Northeast Fisheries Center, Woods Hole, Massachusetts 02543

SECRETARIAT

Mr V. M. Hodder	International Commission for the Northwest Atlantic Fisheries, P. O. Box 638, Dartmouth, N. S.
Mrs V. C. Kerr	"
Mr G. M. Moulton	"
Mr R. A. Myers	"
Mrs P. M. Wadman	"

APPENDIX III

REPORT OF JOINT SESSION OF ASSESSMENTS AND BIOLOGICAL SURVEYS SUBCOMMITTEES

Convener: W. G. Doubleday

The Assessments and Biological Surveys Subcommittees met jointly on 5 April 1979 at the Newfoundland Environment Center, St. John's, Newfoundland, Canada, to evaluate commercial fishery based indices of abundance, in accordance with the recommendation of STACRES at the 1978 Annual Meeting (*Redbook* 1978, page 35). Participants attended from Canada, Cuba, Denmark, France, Federal Republic of Germany, German Democratic Republic, Japan, Norway, Poland, USSR and USA. The convener noted that, as a result of discussions between the Assistant Executive Secretary, the Chairman of the Assessments Subcommittee and himself and in order to minimize and distribute the workload on individual scientists, scientists were requested to examine the precision and accuracy of commercial fishery based indices of abundance and include such information in documents on stock assessments for the April 1979 Meeting, as specified in Circular Letter 79/12 dated 31 January 1979. However, the short interval between the receipt of 1978 fishery statistics and the beginning of the Assessments Subcommittee Meeting prevented most scientists from carrying out the requested analyses.

Analyses were presented on the precision of catch per day fished for yellowtail flounder and American plaice by Canada (Newfoundland) vessels in Div. 3LNO during 1976-78. Tables 1 and 2 show the results of the analysis of variability in catch per day fished. Only catch per trip and days fished per trip were used in the study and an estimator was derived to overcome this problem. In some cases, negative estimates of variance were calculated and are shown as asterisks(*). Non-zero estimates of coefficients of variation within months were comparable to those observed for research vessel surveys.

Analyses were also presented on the accuracy of catch per hour fished for cod in Div. 2GH, 3M and Div. 3NO. Tables 3 to 5 represent coefficients of variation between mean monthly catch per hour for groups of vessels and months found to be indistinguishable by a multiple range test in studies of standardization of fishing effort presented at this meeting. Since months and countries are grouped, variation within months is likely to be over-estimated. These estimates are also comparable to those observed in research vessel surveys.

There followed a general discussion on sources of variation in commercial fishery based indices of abundance. The great difficulties associated with the definition of fishing effort in mixed fisheries was emphasized. It was noted that fishing power of a fleet may vary even though the number of vessels in a particular tonnage category remains the same due to changes in mean tonnage or horsepower within a tonnage class and changes in the composition of the mixed fishery. Commercial catch per unit effort, however, is usually considered more reliable than research vessel abundance indices for fully-recruited ages but less reliable for estimation of recruitment. Catch per unit effort data from fisheries on pelagic schools is of very limited value. It was also noted that the correspondence between research and commercial indices was better at high levels of stock abundance than at low levels due to increasing catchability of commercial fishing at lower stock sizes.

Usually catch per day is considered a more reliable index for pelagic stocks than catch per hour which ignores searching time. In the case of southern Gulf of St. Lawrence herring, a significant correlation has been reported between catch per day of purse seiners and catch per tow of stratified groundfish surveys over a ten year period. Cooperative searching by fleets fishing together sometimes occurs.

The expanding use of observers on commercial fishing vessels is permitting the collection of data nearly as detailed (although less accurate) as from research vessel surveys. However, the resulting indices of abundance are not comparable due to selection of areas of fish concentration. Due to uncertainty about the distribution of the stock, coverage of the whole area of distribution, as provided by research vessel surveys, are needed to interpret such data. The likely inaccuracy of estimates of by-catch weight and the composition of commercial vessels was pointed out. From observer data, catch per hour seemed to be a more stable index than catch per day for the cod and witch flounder fisheries.

The joint meeting recognized the value of evaluating commercial fisheries abundance indices but noted that much background work must be completed by individual scientists before general conclusions can be drawn, and therefore

recommends

that experts be encouraged to critically evaluate commercial fishery based abundance indices used in their assessments, but that general international discussion be delayed until progress is seen in a variety of cases.

Table 1. Variation in catch per day fished for yellowtail flounder by Canadian (Nfld) stern trawlers in Div. 3LNO, 1976-78.

Year	Month	Catch	Days fished (f)	Catch per day (c/f)	Standard error (c/f)	Coefficient of variation
1976	1	110056	17	6473	3638	0.562
	2	62449	12	5704	1830	0.321
	3	448248	73	6140	3610	0.538
	4	1786241	290	6159	1756	0.285
	5	1653397	349	4738	2286	0.482
	6	91965	18	5109	2535	0.496
	7	33162	12	2764	1196	0.433
	8	36251	8	4531	2762	0.610
	9	64164	15	4277	1466	0.343
	10	98720	25	3949	***	-
	11	32135	10	3214	2218	0.690
	12	27354	4	6838	1321	0.193
1977	1	-	-	-	-	-
	2	20540	2	10270	-	-
	3	20613	3	6871	***	-
	4	58817	9	6536	2216	0.339
	5	789334	135	5847	***	-
	6	544590	102	5339	***	-
	7	695510	107	6500	***	-
	8	607208	104	5838	2421	0.414
	9	147226	28	5258	1937	0.365
	10	40349	9	4483	***	-
	11	1110295	127	8743	***	-
	12	304590	37	8232	1194	0.145
1978	1	64351	7	9193	***	-
	2	26934	6	4489	2891	0.644
	3	75972	10	7597	2879	0.377
	4	521003	81	6432	***	-
	5	622459	88	7073	***	-
	6	449212	87	5163	1383	0.268
	7	241948	36	6721	520	0.077
	8	433756	61	7111	***	-
	9	751934	90	8355	***	-
	10	2315655	202	11464	***	-
	11	1864515	220	8475	***	-
	12	412358	53	7780	3915	0.503

Table 2. Variation in catch per day fished for American plaice by Canadian (NFLD) stern trawlers in Div. 3LNO, 1976-78.

Year	Month	Catch	Days fished (f)	Catch per day (c/f)	Standard error (c/f)	Coefficient of variation
1976	1	3173862	474	6696	2927	0.437
	2	2304302	358	6437	2438	0.379
	3	1468651	223	6586	4158	0.631
	4	988469	144	6864	3962	0.577
	5	2239267	442	5066	2359	0.466
	6	4301261	692	6216	2876	0.463
	7	4346847	685	6346	2659	0.419
	8	4479693	645	6945	3071	0.442
	9	5987151	818	7319	3973	0.543
	10	3888018	607	6405	3743	0.584
	11	3256646	600	5428	2405	0.443
	12	1878124	303	6198	2439	0.394

Table 2. (Cont'd)

Year	Month	Catch	Days fished (f)	Catch per day (c/f)	Standard error (c/f)	Coefficient of variation
1977	1	-	-	-	-	-
	2	1583169	240	6597	2879	0.436
	3	347521	83	4187	1693	0.404
	4	326753	67	4877	2486	0.510
	5	2099067	325	6459	2884	0.447
	6	4411884	624	7070	2275	0.322
	7	3915143	594	6591	2098	0.318
	8	4243493	655	6479	2013	0.311
	9	3543436	580	6109	2419	0.396
	10	3660567	721	5077	1906	0.375
	11	3800535	583	6519	2845	0.436
	12	2782674	416	6689	2290	0.342
1978	1	1125598	183	6151	2377	0.387
	2	784302	127	6176	3625	0.581
	3	654653	102	6418	2149	0.335
	4	734985	171	4298	2344	0.545
	5	2613159	420	6222	1874	0.301
	6	5151022	745	6914	2445	0.354
	7	5090181	664	7666	3095	0.404
	8	5584416	667	8372	3568	0.426
	9	3829811	485	7897	3863	0.489
	10	4204110	507	8292	2837	0.342
	11	2666119	374	7129	2796	0.392
	12	3404557	364	9353	5606	0.599

Table 3. Coefficients of variation of catch rates (tons/hr) for groups of vessels considered homogeneous in Div. 3M. Values labelled (a) represent the years 1960, 1961 and 1963; (b) the years 1962, 1966-69, 1971 and 1974; and (c) the years 1964-65, 1970, 1972-73 and 1975-76. The numbers of observations are given in parentheses.

Country-gear		Jan, Apr-Dec	Feb, Mar
FRG	OT 7		
POL	OT 7	(a) 0.413 (15)	
POR	OT 6	(b) 0.582 (94)	(b) 0.662 (21)
USSR	OT 7	(c) 0.629(118)	(c) 0.854 (28)
SPA	PT 4		
CAN-N	OT 4		
ICE	OT 5		
NOR	LL 4		
NOR	OT 4	(b) 0.652 (42)	
SPA	PT 5	(c) 0.643 (86)	(c) 1.057 (15)
SPA	OT 6		
USSR	OT 5		
USSR	OT 6		
CAN-N	OT 5		
UK	OT 5	(c) 0.532 (21)	
UK	OT 6		

Tonnage classes: 7 = 2000+; 6 = 1000-1999; 5 = 500-999; 4 = 150-499.

Table 4. Coefficients of variation of catch rates (tons/hr) for groups of vessels considered homogeneous in Div. 2GH during 1958-76, excluding 1972 and 1973. The numbers of observations are given in parentheses.

Country	Gear	Jan, Mar Apr-May	Sep, Dec	Jun-Aug Oct-Nov
POR	OT 7	0.415 (22)		
NON-MEM	OT 7			
FRG	OT 7	0.621 (82)	0.805 (20)	0.573 (33)
ICE	OT 5			
POL	OT 7			
POR	OT 6			
SPA	OT 6			
USSR	OT 7			
FRG	OT 6	0.605 (27)		0.911 (14)
NOR	OT 4			
NOR	OT 6			
USSR	OT 6			
NON-MEM	OT 6			

Tonnage classes: 7 = 2000+; 6 = 1000-1999; 5 = 500-999; 4 = 150-499

Table 5. Coefficients of variation of catch rates (tons/hr) for groups of vessels considered homogeneous in Div. 3NO, and values for some individual country-gears. Values labelled (a) represent the year 1967; (b) the years 1963-64, 1966, 1968, 1970-72, 1974-76; and (c) the years 1959-62, 1965, 1969, 1973. The numbers of observations are given in parentheses

Country-gear		Jan-Mar, Jun-Jul Nov-Dec	Apr-May Sep-Oct
CAN-M	OT 4	(a) 0.767 (39)	(a) 0.356 (19)
POR	OT 7	(b) 0.664 (236)	(b) 0.741 (118)
SPA	PT 4	(c) 0.821 (135)	(c) 0.473 (69)
SPA	PT 5		
SPA	PT 6		
BUL	OT 7		
CAN-M	OT 5		
CAN-N	OT 3		
CAN-N	OT 4		
CAN-N	OT 5	(a) 0.435 (21)	(a) 0.552 (18)
FRA-M	OT 6	(b) 0.765 (103)	(b) 0.629 (53)
ICE	OT 5	(c) 0.635 (54)	(c) 0.494 (36)
NOR	LL 5		
ROM	OT 7		
UK	OT 5		
UK	OT 6		
USSR	OT 5		
USSR	OT 5		
SPA	OT 6	(b) 0.973 (50)	(b) 0.765 (27)
		(c) 0.884 (43)	(c) 0.653 (220
SPA	PT 4	(a) 0.788 (16)	
		(b) 0.650 (141)	(b) 0.556 (78)
		(c) 0.591 (83)	(c) 0.416 (44)
POR	OT 6	(b) 0.506 (22)	
		(c) 0.680 (18)	
USSR	OT 7	(a) 0.557 (14)	

Tonnage classes: 7 = 2000+; 6 = 1000-1999; 5 = 500-999; 4 = 150-499; 3 = 50-149.