International Commission for the Northwest Atlantic Fisheries

Serial No. 5235

ICNAF Sum.Doc. 78/VI/16
(Addendum)

ANNUAL MEETING - JUNE 1978

Report of Assessments Subcommittee, 4-11 April 1978

Chairman: A.T. Pinhorn

I. FISHERY TRENDS

1. General Trends in the ICNAF Area

Provisional nominal catches in the Northwest Atlantic for 1977 were compiled from STATLANT 21A returns of Member Countries of ICNAF in 1977, from the USSR Research Report (Sum.Doc. 78/V/9) for that country and from preliminary statistics compiled for the Assessments Subcommittee Meeting in April for Italy (Sum.Doc. 78/VI/28). No catch statistics for 1977 were available for France (SP) and the 1977 catches were therefore assumed the same as the 1976 catches. These are all summarized by Subarea in Table 1, together with comparable figures for 1976. It is important to note that the catch figures for 1977 used in this section of the report may differ slightly from those used in Sections II and III, the latter figures having been based on preliminary advance statistics provided prior to the April 1978 Meeting of the Subcommittee.

The total nominal catch of all finfish and invertebrates declined from 3.4 million tons in 1976 to 2.9 million tons in 1977 (15%), after having declined from 3.8 million tons in 1975. The total groundfish catch declined from 1.31 million tons in 1976 to 1.16 million tons in 1977 (11%); within this category, significant declines occurred in cod (10%) mainly in Subareas 3 and 4, redfish (12%) in Subareas 2 to 4, silver hake (36%)

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mainly in Subarea 4, red hake (70%) in Subarea 5 and Statistical Area 6 and roundnose grenadier (38%) in Statistical Area 0 and Subareas 2 and 3. A significant increase occurred in haddock catches (58%) in Subareas 4 and 5. The total pelagic fish catch declined from 885,000 tons in 1976 to 635,000 tons in 1977 (28%); within this category, herring catches declined by 12% mainly in Subarea 5, mackerel by 67% in Subareas 4 and 5 and Statistical Area 6 and other pelagics by 15% in Subarea 5 and Statistical Area 6. Catches in the "other fish" category declined from 462,000 tons in 1976 to 316,000 tons in 1977 (32%); within this category total catches of capelin declined by 37% mainly in Subarea 3. The total catch of invertebrates increased slightly from 771,000 tons in 1976 to 809,000 tons in 1977 (5%). Increases occurred in catches of squid (40%) in Subareas 3 and 4 and Statistical Area 6 with decreases occurring in Subarea 5. Catches of other invertebrates were almost identical in both years. It should be noted that fluctuation in catches from 1976 to 1977 do not necessarily imply fluctuations in stocks but may in some instances be due to conservation measures.

2. Statistical Area 0

The total nominal catch of all species decreased from 8,000 tons in 1976 to 5,000 tons in 1977. The 1977 catch consisted essentially of 4,000 tons of Greenland halibut and 1,000 tons of roundnose grenadier compared to 5,000 tons and 3,000 tons in 1976 respectively. No catches of cod were reported in 1976 or 1977.

3. Subarea 1

The total nominal catch of all species increased from 132,000 tons in 1976 to 151,000 tons in 1977 (14%). The catch of cod increased from 33,000 tons in 1976 to 39,000 tons in 1977 (18%), redfish from 14,000 tons to 31,000 tons (121%) and "other fish" category from 2,000 to 11,000 tons

(450%) mainly due to increases in the "Finfish not specified" category. Catches of flounders were about the same as in 1976, whereas catches of roundnose grenadier declined from 6,000 tons to 2,000 tons (67%) and catches of shrimp from 50,000 tons to 42,000 tons (16%).

4. Subarea 2

The total nominal catch of all species increased from 175,000 tons in 1976 to 190,000 tons in 1977 (9%). The catch of cod increased from 41,000 tons to 47,000 tons (15%), flounders (mainly Greenland halibut) from 11,000 to 14,000 tons (27%), capelin from 95,000 to 108,000 tons (14%) and shrimp from less than 500 tons to 3,000 tons. Catches of redfish declined from 16,000 to 7,000 tons (56%) and roundnose grenadier from 7,000 to 3,000 tons (57%). Catches in the "other fish" category increased from 1,000 to 6,000 tons due mainly to increases in the "Finfish not specified" category.

5. Subarea 3

The total nominal catch of all species declined from 812,000 tons in 1976 to 622,000 tons in 1977 (23%). The groundfish catch declined from 491,000 to 420,000 tons (14%); in this category declines occurred in cod (21%) and redfish catches (12%), while catches of other species grouns remained similar to 1976. The total catch of pelagic fish increased from 34,000 to 39,000 tons (15%) because of an increase in mackerel catches from 5,000 to 9,000 tons. Catches in the "other fish" category declined from 272,000 to 126,000 tons (54%) due entirely to a decrease in capelin catch from 266,000 to 116,000 tons. Catches of invertebrates increased from 15,000 to 37,000 tons (147%) due mainly to an increase in squid catches from 11,000 to 32,000 tons (191%).

6. Subarea 4

The total catch of all species declined from 755,000 to 647,000 tons (14%). The total groundfish catch declined from 414,000 to 311,000 tons (25%). Within this category cod catches declined by 9%, redfish by 39%, silver hake by 61%, and flounders by 20%. Some of these decreased (e.g. redfish and silver hake) resulted from conservation measures introduced in the Scotian Shelf area of Subarea 4. Haddock catches increased from 19,000 to 25,000 tons (32%) due to improvement in some of the haddock stocks in the area. Catches of other groundfish species remained approximately the same in both years. The total catch of pelagic species declined only slightly (5%) because of a decrease in mackerel catches from 28,000 to 15,000 tons, the catch of herring being about 200,000 tons in both years. The total catch of "other fish" declined from 38,000 to 20,000 tons (47%) due to declines in argentine from 7,000 to 2,000 tons (71%) and other fish from 31,000 to 16,000 tons (48%) mainly due to declines in dogfish, skate and finfish(NS) catches. Total invertebrate catches increased from 75,000 to 100,000 tons (33%) due entirely to increases in catches of squid from 31,000 to 55,000 tons (77%).

7. Subarea 5

The total catch of all species declined from 645,000 in 1976 to 517,000 tons in 1977 (20%). Total groundfish catch increased slightly from 198,000 to 212,000 tons (7%). Increases occurred in cod (30%), haddock (133%), redfish (18%), pollock (23%), flounders (14%) and other groundfish catches (54%), while decreases occurred in silver hake (9%) and red hake (67%) catches. Total pelagic catches declined from 249,000 to 75,000 tons (70%) due to declines in herring (44%), mackerel (94%) and other pelagic (69%) catches. These latter declines probably resulted from a combination of stock declines and management measures which affected the

level of fishing effort in some of these areas. Total invertebrate catches increased from 178,000 to 218,000 tons (22%). Declines in squid catches from 24,000 to 10,000 tons were more than offset by increases in other invertebrate catches from 153,000 to 208,000 tons.

8. Statistical Area 6

The total catch of species declined from 900,000 tons in 1976 to 786,000 tons in 1977 (13%). This decline was accounted for almost entirely by declines in mackerel (54%) and other invertebrates (12%).

Table 1. Nominal catches (000 tons) in 1976 and 1977*. (The symbol + indicates less than 500 tons.)

Species	SA 0		SA 1		SA 2		SA 3		SA 4		SA 5		SA 6		Total	
	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
Cod	-	-	33	39	41	47	272	214	149	135	30	39	+	+	525	474
Haddock	-	-	-	+	-	-	+	1	19	25	6	14	+	1	26	41
Redfish	+	+	14	31	16	7	82	72	56	34	11	13	+	-	179	157
Silver hake	-	-	-	-	-	-	+	+	97	38	69	63	13	14	179	115
Red hake	-	-	-	-	-	-	-	-	1	+	21	7	8	2	30	9
Pollock	-	-	+	+	1	-	1	1	24	23	13	16	+	+	40	40
Flounders	5	4	14	13	11	14	110	108	49	39	35	40	10	11	233	229
Roundnose grenadier	3	1	6	2	7	3	14	12	-	-	-	-	-	-	29	18
Other groundfish	-	-	13	13	2	2	12	12	19	17	13	20	11	11	68	75
Herring	-	-	+	+	1	+	29	30	199	200	93	52	1	1	322	283
Mackerel	-	-	-	-	-	-	5	9	28	15	102	6	106	49	242	79
Other pelagics	-	-	-	-	-	+	+	-	1	1	54	17	265	255	321	273
Argentine	-	-	-	-	-	-	+	-	7	2	+	-	-	-	7	2
Capelin	-	-	+	+	95	108	266	116	+	2	-	-	-	-	361	226
Other fish	+	-	2	11	1	6	6	10	31	16	20	12	33	33	94	88
Squids	-	-	-	-	-	+	11	32	31	55	24	10	26	32	92	129
Shrimp	+	+	50	42	+	3	+	-	5	5	1	+	1	1	57	51
Other invertebrates	-	-	-	-	-	+	4	5	39	40	153	208	426	376	622	629
All species	8	5	132	151	175	190	812	622	755	647	645	517	900	786	3427	2918

* Nominal catches for 1977 are based on STATLANT 21A reports compiled for the 1978 Annual Meeting except for USSR, for which catches were derived from the USSR Research Report (Sum.Doc. 78/VI/9) and for Italy for which catches were derived from preliminary statistics compiled for the Assessments Subcommittee Meeting in April 1978. No catches for 1977 were available for France (SP) and the 1976 catches were used for 1977.

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REPORT OF ASSESSMENTS SUBCOMMITTEE - APRIL 1978

Chairman: A. T. Pinhorn

The Subcommittee met at ICNAF Headquarters, Dartmouth, Canada, during 4-11 April 1978 to review the state of and advise on catch levels in 1979 for certain stocks in Statistical Area 0 and Subareas 1 to 4 (Com. Doc. 78/VI/3, 5), and to examine the feasibility of an effort regulation for *Illex* in Subareas 3 and 4 (Sum. Doc. 78/VI/3). The agenda is at Appendix I. Representatives attended from Canada, Cuba, Denmark, France, Federal Republic of Germany, German Democratic Republic, Japan, Poland, Portugal, Spain and USSR and observers from USA (Appendix II).

The review of the status of the stocks and catch levels was carried out in two working groups of the Subcommittee as follows: Working Group No. 1 (convened by E. C. Lopez-Veiga) reviewed the relevant stocks of cod, redfish, Greenland halibut, roundnose grenadier and shirmp; and Working Group No. 2 (convened by G. H. Winters) reviewed the relevant stocks for American plaice, witch flounder, yellowtail flounder, silver hake, argentine, capelin and squid. The results of these discussions are given in Section III below. In connection with the discussions on squid, an *ad hoc* working group was set up (convened by F. Nagasaki) to study the feasibility of an effort regulation for *Illex* in Subareas 3 and 4, and its report is at Appendix III.

I. FISHERY TRENDS

(Since the 1977 catch statistics available to the Subcommittee were confined to species and stocks under review at the present meeting, the usual summary of fishery trends will be prepared from more complete catch statistics which will be available at the 1978 Annual Meeting and issued as an addendum to this report prior to its adoption by STACRES. Table 1 of this report will be included in that addendum.)

II. SUMMARY OF RECENT CATCHES AND TACs

The Subcommittee used as the basis for discussion the Canadian request for advice on 14 stocks which lie completely or partly within its 200-mile fisheries management zone in Subareas 2 to 4, and three stocks which overlap the Canadian and Danish fisheries zones in Statistical Area 0 and Subarea 1 (Com. Doc. 78/VI/3). The Subcommittee reviewed the cod and redfish stocks in Subarea 1 at the request of the European Economic Community (EEC) (Com. Doc. 78/VI/5), and the three stocks which lie completely outside of the national fisheries zones in Div. 3M. The Subcommittee also examined the feasibility of an effort regulation for *Illex* in 1979, in accordance with the recommendation of STACRES at its meeting in Havana, Cuba, in February 1978 (Sum. Doc. 78/VI/3).

In reviewing the state of the various stocks, the Subcommittee took account of the Canadian view on options to be considered in providing advice on the scientific basis for management in 1979 (Com. Doc. 78/VI/3). 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 1979. Details of the stock reviews are given in Section III below.

Table 2. Summary of recent catches (1973-77) and TACs (1974-78) for stocks reviewed at the April 1978 Meeting of the Assessments Subcommittee, together with advised TACs for 1979 and some for 1978 in parentheses.

Species	Stock area	Nominal catches (000 tons)					TACs (000 tons)					
		1973	1974	1975	1976	1977[1]	1974	1975	1976	1977	1978	1979
Cod	1	63	48	48	33	36	107	60	45	31	( )[6]	(<26)
	2GH	+	4	7	6	4	20	20	20	20	20	(20)
	2J+3KL	355	373	288	214	170	657	554	300	160	135	( )[7]
	3M	23	25	22	22	25	40	40	40	25	40	(40)
	3NO	80	73	44	24	15	101	88	43	30	15	(25)
Redfish	1	3	3	9	14	28	-	-	-	-	-	(28)
	3M	22	35	16	17	16	40	16	16	16	16	(20)
	3LN	33	22	18	21	16	28	20	20	16	16	(18)
Silver hake	4VWX	300	96	116	97	35	100	120	100	70	(81)	(70)
A. plaice	3M	1	2	2	1	1	2	2	2	2	4	(2)
	3LNO	53	46	43	52	43	60	60	47	47	47	(47)
Witch	2J+3KL	24	16	12	11	8	22	17	17	17	17	(17)
	3NO	7	8	6	6	6	10	10	10	10	10	(10)

Species	Stock area	Nominal catches (000 tons) 1973	1974	1975	1976	1977[1]	TACs (000 tons) 1974	1975	1976	1977	1978	1979
Yellowtail	3LNO	33	24	23	8	11	40	35	9	12	15	(18)
G. halibut	0+1	10	14	25	16	13	-	-	20	20	(25)	(25)
	2J+3KL	29	27	29	25	31	40	40	30	30	30	(30)
R. grenadier	0+1	5	12	5	9	2	-	10	14	8	(8)	(8)
	2+3	18	28	27	21	15	32	32	32	35	35	(35)
Argentine	4VWX	1	17	15	7	2	25	25	25	20	20	(20)
Capelin	2+3K	136	127	199	216	153	110[2]	160[2]	160[2]	212[2]	212[2]	(300)
	3L	4	58	34	34	25					50	
	3NO	128	101	132	110	42	148[3]	180[3]	180[3]	200[3]	141	( )[8]
	3Ps	1	2	2	+	1					9	
Squid-*Illex*	2+3	1	+	4	11	84	-	25[4]	25[4]	25[4]	(45)	( )[9]
	4	9	+	14	31						(55)	( )[9]
Shrimp	0+1	13	22	38	50	41	-	-	-	36[5]	(40)[5]	( )[10]

1 Provisional statistics for the April 1978 Assessments Meeting
2 In addition, countries without specific allocations may each take up to 10,000 tons
3 In addition, countries without specific allocations may each take up to 5,000 tons
4 In addition, countries without specific allocations may each take up to 3,000 tons
5 TAC pertains to offshore fishing grounds in Subarea 1
6 See *Redbook* 1977, p. 52-53, for options.
7 See Section III(3) for options.
8 See Section III(21).
9 See Section III(22).
10 See Section III(23).

III. STOCK ASSESSMENTS

1. Cod in Subarea 1 (Res. Doc. 78/VI/44)

a) Fishery trends

The nominal catch of cod in 1976 was 33,300 tons, 74% of the TAC for that year, and provisional statistics for 1977 indicate a small increase to about 35,600 tons. The TAC for 1977 was 31,000 tons, and the fishery was closed to offshore vessels in the middle of the year. Local inshore catches (included in the above figures) increased from 5,100 tons in 1976 to about 14,000 tons in 1977. The offshore trawlers' share of the total catch was about 58% in 1976 and 52% in 1977. The improvement in catches was mainly a result of the recruitment of the 1973 year-class to the exploited stock.

Fishing by Greenland trawlers in January and February 1978 indicates further improvement in the catch rate. By the end of March 1978, their catches had exceeded 10,000 tons. The 1973 year-class had to some extent been recruited to the spawning stock at the beginning of 1978, and this is probably the reason for good fishing on pre-spawning concentrations in the southern part of Div. 1C in the early months of 1978. Hydrographic observations in the winter of 1977/78 showed an extraordinarily strong inflow of warm water along the western slopes of the West Greenland fishing grounds, and it is likely that some immigration of cod from southwestern Greenland contributed to the improved fishing.

b) Trends in distribution, abundance and composition of the stock

For the offshore trawl fishery, there was an overall increase in catch rate of 65% from 1976 to 1977. A further increase seems to have occurred in Div. 1C in the early months of 1978. Offshore fishing in Div. 1A and 1B has been negligible in recent years.

No catch-per-unit-effort data are available for the inshore fisheries, but the improved fishing may by itself have stimulated fishermen to the extent that effort may have increased from 1976 to 1977. However, the fact that inshore catches more than doubled from 1976 to 1977 points to an improvement in the stock, at least in Div. 1C to 1F.

More than 75% of the total catch in 1977 (by number as well as by weight) and about 75% of the catches in January-February 1978 consisted of fish of the newly recruited 1973 year-class. Cod

older than 6 years were scarce in the 1977 catches except in gillnet catches. Younger cod, especially age 2, were observed in inshore poundnet catches, from which they were discarded. The age compositions of the catches in 1976 and 1977 are given in Table 12 of Res. Doc. 78/VI/44.

c) Assessment parameters

Fishing mortality. From analyses of trends in fishing effort and catches, the Subcommittee concluded at its April 1977 Meeting that effort had decreased by about 25% from 1975 to 1976, when F for fully recruited age-groups was considered to be about 0.25. Although there was an increase in catch from 1976 to 1977, the catch/effort data indicate that the effective fishing effort decreased further from 1976 to 1977. Applying the catch per unit effort of Greenland trawlers to the offshore catch to obtain total offshore effort and taking into account the seasonal variation in the catchability coefficient (ICES, 1973)[1] indicates that the offshore effort in 1977 was about 1/3 below that in 1976. At the same time, the inshore effort may have increased somewhat, although the main reason for the increased inshore catches was higher catch rates. The Subcommittee considered that F in 1977 could be between 0.16 and 0.20, and the analyses were carried out using these two values of F.

Recruitment estimates. The 1973 year-class recruited to the fishery in 1976/77. The size of this year-class may have been underestimated in previous assessments, as new analyses indicate that it may consist of as many as 200 million fish (at age 3). However, since this year-class seems to be similar in size to the 1968 year-class (both partly of East Greenland origin and both preceded by weak year-classes) and since the 1968 year-class was overestimated in the first year or two after its recruitment, the Subcommittee also considered a figure of 120 million recruits for the 1973 year-class in the analyses.

Of the younger year-classes, that of 1975 seems to be the most important, especially in the northern divisions (1B to 1D). The 1974 year-class seems to be rather evenly distributed throughout the area but is not considered to be as large as the 1973 and 1975 year-classes. The 1976 year-class seems to be poor. Environmental conditions were favourable for the 1977 year-class (better than for the 1975 year-class), but larvae were not found in the quantity that would be expected for a good year-class. Research surveys in 1978 may reveal better information about this year-class. For the purpose of this assessment, the sizes of these year-classes (millions of age 3 cod) are estimated as follows:

ICNAF Div.	Size of year-classes			
	1974	1975	1976	1977
1A-1D	25	50	10	25
1E-1F	15	25	10	25
SA 1	40	75	20	50

Partial recruitment. Since fishing has been concentrated on the 1973 year-class, the Subcommittee considered that the partial recruitment pattern used in the previous assessment (Res. Doc. 77/VI/8; *Redbook* 1977, page 53) is still valid, i.e. 60% for age 3, 72% for age 4, 88% for age 5, and 100% for older age-groups.

d) Assessment results

The results of the assessment will vary with the input values of the parameters. The greatest variation in predicted catch and spawning biomass is associated with the range of estimates of the strength of the 1973 year-class (120 to 200 million recruits at age 4) but variation is also rather large in connection with the range of values for fishing mortality in 1977 (0.16 to 0.20). Various strategies of fishing were analyzed, all of them assuming that the catch in 1978 will be 25,000 tons.

For each of the strategies, Table 3 gives the resultant minimum and maximum figures for predicted catch and spawning biomass, the latter including all age 6 and older fish although in practice maturation occurs gradually over several years from age 5. The minimum figures result from using 120 million recruits for the 1973 year-class and F = 0.20 in 1977, and the maximum figures result from using 200 million recruits for the 1973 year-class and F = 0.16 in 1977. Strategy 1 assumes that the fishing mortality in 1979-81 remains at the level of F in 1978; Strategy 2 assumes that F = 0.30 in 1979-81; Strategy 3 assumes that F = 0.40 in 1978-81; and Strategy 4 assumes that F in 1979 is equal to F in 1978 but that F in 1980-81 corresponds to $F_{0.1}$ (0.40).

[1] Report of the ICES/ICNAF Working Group on Cod Stocks in the Northwest Atlantic. ICES Coop. Report No. 33, page 49.

Table 3. 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 beginning of the year.

Strategy No.		1	2	3	4
1978	Spawning biomass	81-104	81-104	81-104	81-104
	Fishing mortality(F)	0.11-0.07	0.11-0.07	0.11-0.07	0.11-0.07
	Projected catch	25	25	25	25
1979	Spawning biomass	181-287	181-287	181-287	181-287
	Fishing mortality(F)	= F in 1978	0.30	0.40	= F in 1978
	Projected catch	26	67-93	86-118	26
1980	Spawning biomass	227-357	188-286	170-259	227-357
	Fishing mortality(F)	= F in 1978	0.30	0.40	0.40
	Projected catch	31	69-92	81-108	103-143
1981	Spawning biomass	275-397	231-259	160-214	207-289
	Fishing mortality(F)	= F in 1978	0.30	0.40	0.40
	Projected catch				
1982	Spawning biomass	269-378	200-207	119-151	153-201

The results of the analyses show that the recruitment of the 1973 year-class to the spawning biomass will lead to an improvement of the spawning biomass, about 2/3 of which in 1979 and 1980 will consist of the 1973 year-class.

The level of the spawning biomass estimated for 1979-80 is less than 1/3 and probably only 1/4 of the level in the 1950's and 1960's. The spawning biomass in 1981 and 1982 will to a large extent depend on the fishing mortality generated after 1978 but also on the strengths of the 1974 and 1975 year-classes. If these are as assumed in the assessment, the level of spawning biomass in 1979-80 can only be maintained through 1981 and 1982 if catches are kept below the level corresponding to fishing at F = 0.30.

Without having any firm advice to offer regarding a target spawning biomass, the Subcommittee considers it most prudent to ensure that the spawning biomass is maintained or even further increased, which could occur when the 1975 year-class recruits to the spawning stock by 1981 (or possibly to some extent in 1980). The Subcommittee also considers that the recruitment of the 1975 year-class to the fishery in 1978 and 1979 could lead to an early harvest of this possibly important year-class as was the case with the 1973 year-class in the 1976 and 1977 fisheries.

Although prospects for fishing are improving, the Subcommittee considers it desirable to delay any increase in catch until after 1979, and therefore advises that the 1979 catch should not exceed 26,000 tons. This would give a much better opportunity for maintaining or further increasing the spawning stock, and thereby increasing the chance of better year-classes. Environmental conditions in 1975 and 1977 seemed to have been favourable for the production of good year-classes. The very low level of spawning stock in these years may well have been a limiting factor, but the Subcommittee was not able to quantify this assumption.

A low level of fishing in 1979 would ensure a higher yield per recruit of the 1975 year-class. It would also provide a better basis for future advice, if the exploited stock and the spawning biomass were to consist of more than one good year-class, as was the case in former years. Present prediction of yields and stock sizes, and the resultant advice, is greatly dependent upon the judgement about the size of just one year-class.

2. Cod in Divisions 2G and 2H

The provisional nominal catch in 1977 was about 3,500 tons compared with a catch of 5,900 tons in 1976. During the 1970-76 period, catches ranged from 300 (in 1973) to 18,000 tons (in 1970), the average being 8,800 tons. Catches in the 1960's were much higher. On the basis of an analytical assessment in 1973, which indicated that the stock was depressed and that recruitment prospects were poor, a TAC of 20,000 tons was established in 1974.

Because fishing in this area is generally unpredictable due to variable ice conditions, the planning of biological sampling has been very difficult. In fact, the sampling has been so poor in recent years that a reassessment of the stock has not been possible. Samples from research vessel catches

by Federal Republic of Germany in October 1976 indicated that the 1973 year-class may be a successful one. Catch rates of Federal Republic of Germany trawlers indicate little change in the state of the stock from 1976 to 1977.

Lacking substantial new biological information, the Subcommittee could find no reason to recommend a change in the TAC, and therefore advises that the TAC for 1979 should remain at 20,000 tons.

3. Cod in Divisions 2J, 3K and 3L (Res. Doc. 78/VI/25, 26, 66; Sum. Doc. 78/VI/9)

Nominal catches for this stock declined from an average of 640,000 tons in 1966-70 to an average of 380,000 tons in 1971-75. The catch was 214,000 tons in 1976 and provisional statistics for 1977 indicate a further decline to about 170,000 tons. The trends in recent annual catches and TACs are as follows:

	1973	1974	1975	1976	1977
TAC (000 tons)	666	657	554	300	160
Catch (000 tons)	355	373	288	214	170

Variation in the catch per tow, from USSR research vessel surveys in Div. 3K, corresponded with the changes in yield from Div. 2J and 3L over the 1971-76 period. In addition, the catch rates in Div. 3K and 3L declined from 1972 to 1975 but increased in 1976. A further increase in catch rate from USSR surveys was indicated in 1977. In Div. 2J, the commercial catch rates in the fisheries of various countries were considerably lower in 1975 and 1976 than those prevailing in 1968-70. Preliminary USSR data for Div. 2J+3KL as a whole indicate a catch rate of 17.5 tons per day in 1977 compared with 16.5 tons per day in 1975. The catch rate for Spanish otter trawlers was 0.67 tons per hour in 1977 compared with 0.82 tons per hour in 1975. Information given in Res. Doc. 78/VI/26 indicates that, if the average mortality rate for each age-group in 1973-77 applied in 1977-79, biomass estimates for 1978 and 1979 would be 2.1 and 2.7 times the biomass in 1977.

Age compositions for 1977 were derived for each division, gear and quarter of the year as the sampling data permitted. Catches were composed largely of the 1972 and 1973 year-classes as age-groups 5 and 4 respectively.

From regressions of fishing mortality (F) and fishing effort from USSR and Spanish commercial fisheries and from USSR research surveys, the F for 1977 was estimated to be in the range of 0.3-0.5. An intermediate value of F = 0.4 was used in the virtual population analysis.

Research vessel surveys by Federal Republic of Germany have clearly shown that the 1972 and 1973 year-classes were very strong in comparison with older age-groups in the catches. The survey results for 1977 give reason for optimism in that the 1974 and 1975 year-classes may also be strong. From the numbers caught per hour of 2- and 3-year-old cod in Div. 3K, 3L and 3KL for the 1960-72 period in USSR young fish surveys and the corresponding abundance of 4-year-old cod estimated in the virtual population analysis, it was estimated that the abundances of the 1973, 1974 and 1975 year-classes as 4-year-old cod were 530, 465 and 432 million respectively. For year-classes subsequent to that of 1975, an average recruitment of 500 million was used in the analysis.

The partial recruitment pattern, estimated for 1976 from the virtual population analysis, was as follows:

Age	4	5	6	7	8	9	10	11	12	13
% recruited	47	61	76	87	93	97	100	100	100	100

This partial recruitment pattern was used for stock size calculations for 1977 and for catch predictions from 1978 onwards.

In the projections of catch and spawning biomass, the average weight-at-age estimates were those pertaining to the catches of 1977. However, the weight-at-age may be expected to vary from time to time. In addition to density-dependent growth changes, the growth rate in Div. 2J+3KL varies from south to north and the weight-at-age may therefore vary according to the area and time of capture.

From the virtual population analysis, the stock size in 1977 was estimated and catch projections made for 1979-86, under the assumption that the 1978 TAC of 135,000 tons will be caught. Estimates of catch and spawning biomass for 3 levels of fishing mortality are given in Table 4. The spawning biomass includes cod of ages 3-13; in the 1977 assessment, cod of ages 7-14 were included. The Subcommittee stresses that long-term forecasts should only be considered as indicative of trends, as the actual recruitment in future years may be much better or much worse than the average.

Table 4. Cod in Divisions 2J+3KL: projections of catch and spawning biomass (000 tons) in 1979-86 for 3 levels of fishing mortality.

	$F_{0.1} = 0.2$		F = 0.16		F = 0.10	
Year	Catch	Spawning biomass	Catch	Spawning biomass	Catch	Spawning biomass
1978	135	235	135	235	135	235
1979	197	469	162	469	102	469
1980	256	892	214	920	141	969
1981	306	1,204	262	1,279	180	1,412
1982	350	1,418	306	1,550	217	1,787
1983	388	1,654	345	1,845	252	2,198
1984	419	1,842	377	2,088	282	2,556
1985	442	1,981	402	2,277	307	2,852
1986	454	2,054	416	2,381	323	3,030

At its April 1977 Meeting (*Redbook* 1977, page 54), the Subcommittee considered that the target spawning biomass for this stock might be in the range of 1.2 to 1.8 million tons, with 1.5 million tons as the reference point. The Subcommittee notes that by 1982 the target will be reached if fishing is regulated by either of the 3 options indicated in Table 4. It further notes that the spawning stock biomass in 1982 will be composed of cod for which recruitment estimates at age 4 were not merely estimates of average recruitment but will include year-classes which have already been observed in the fishery or have been estimated from surveys.

The Subcommittee notes that the rate of rebuilding of the stock increases as fishing mortality is reduced, and that the rate of rebuilding for all 3 options is projected to be faster than that projected at the April 1977 Meeting of the Subcommittee.

4. Cod in Division 3M (Res. Doc. 78/VI/23, 27, 51, 57, 58; Sum. Doc. 78/VI/9)

The nominal catch of cod in this area declined from an average of 42,000 tons in 1965-69 to about 23,000 tons annually in 1973-76, largely due to the poor recruitment of the 1969, 1970 and 1971 year-classes. Provisional data for 1977 indicates that the catch was about 25,000 tons, composed almost entirely of cod of the 1972 and 1973 year-classes with the latter predominating. USSR research vessel survey data indicate that the 1973 year-class is exceptionally strong.

Three general production model assessments of this stock, incorporating data for 1977, were reviewed by the Subcommittee. Estimates of yield in 1979 at F_{MSY} and at 2/3 F_{MSY} range from 15,000-34,000 tons and 10,000-22,000 tons respectively.

Biomass estimates for the 1972-77 period were derived from the results of USSR research vessel surveys. The catch per tow (in numbers and weight), the area swept by the trawl and the catchability rates for cod were taken into account in determining the distribution and abundance of cod over the entire area of the Flemish Cap to a depth of 1,000 meters. The results indicate that the biomass has increased from about 40,000 tons in 1972-74 to about 165,000 tons in 1977, the increase being mainly due to the strong 1973 year-class and, to a lesser extent, the 1972 year-class. The Subcommittee observed that the strong 1973 year-class was produced from the lowest level of biomass indicated in USSR survey results for the 1972-77 period. The Subcommittee further noted that the catch per hour fishing increased by 51% from 1976 to 1977 in USSR surveys and by 47% from 1977 to 1978 in Canadian surveys. The catch per hour fishing by Portuguese side trawlers increased by 4% from 1976 to 1977.

Concern was expressed that, in making short term projections of yield, general production models do not take into account the recruitment of year-classes which are very much different from the average. It is clear that the 1973 year-class is exceptionally strong in Div. 3M, and, consequently, the catch projections for 1979 corresponding to particular levels of fishing mortality may well be underestimated. On the other hand, variability in biomass estimates derived from research vessel survey data

has been demonstrated for various stocks. If the biomass estimates for 1977 are in fact overestimated, the projected catches for 1979 may well be too high and thus produce fishing mortalities in 1979 in excess of the target level.

Given the uncertainties in determining the status of this stock due in part to the very poor commercial catch sampling in recent years, the Subcommittee points out the following:

i) If the biomass is as high as indicated by the survey results, a catch of 40,000 tons in 1979 would be appropriate. If the biomass is in fact lower than that estimated, a catch of 40,000 tons would result in a reduction of the stock, because the sizes of the year-classes following that of 1973 are estimated to be much lower than that year-class, and the prospect would be a lower yield in 1980.

ii) If the general production model assessments adequately reflect the status of the stock, yields of 16,000 tons at 2/3 F_{MSY} and 25,000 tons at F_{MSY} are indicated for 1979. If the assessments do not adequately reflect the abundance of the younger year-classes, particularly the 1973 year-class, the implication is that there would be a corresponding loss in yield in 1979.

Taking into account the above considerations, the Subcommittee advises that the TAC for 1979 should not exceed 40,000 tons. The Subcommittee does, however, point out that the adoption of this TAC for 1979 may make it necessary to reduce the yield in 1980, since the absolute abundance of the strong 1973 year-class in the catches is expected to decline after 1980, especially if the size of this year-class is overestimated in the present assessment. Retaining the present TAC (40,000 tons) in 1980 and 1981 requires that the 1973 year-class is exceptionally strong and that this year-class is followed immediately by one or more good year-classes after the relatively poor 1974 year-class.

The Subcommittee reviewed a paper about the effect of water dynamics on recruitment to the cod stock on Flemish Cap. The analysis showed a good positive correlation between the intensity of horizontal and vertical water circulation on the central part of the bank and the strength of year-classes at age 2. The Subcommittee recommended that this type of study should be continued, as it could be a good approach toward forecasting future recruitment levels.

5. Cod in Divisions 3N and 3O (Res. Doc. 78/VI/59; Sum. Doc. 78/VI/9)

Cod catches in this area declined from a high of 227,000 tons in 1967 to 24,300 tons in 1976. Provisional data for 1977 indicate a catch of about 15,000 tons. Seasonally adjusted catch rates of Spanish pair trawlers declined from 1.5 tons per hour in 1971 to 0.4 ton per hour in 1975. The catch rate increased to 1.0 ton per hour in 1976 but declined to 0.5 ton per hour in 1977.

USSR survey data indicate that the 1974 year-class is strong, and both Canadian and USSR surveys indicate that the biomass in 1977 was substantially higher than in the preceding few years. A general production model assessment, using standard methods and including data for 1977, indicates that a catch of 25,000 tons is appropriate for fishing at 2/3 F_{MSY}. Evidence from 1977 sampling data indicates that the fishing mortality in recent years has, on the average, been about 0.35, which is considerably higher than F_{max} (0.2). The Subcommittee advises a TAC for 1979 of 25,000 tons, which corresponds with the yield from fishing at 2/3 F_{MSY}. The Subcommittee further indicates that, given good recruitment prospects, a catch of 30,000 tons in 1979 would not prevent the rebuilding of the stock.

6. Redfish in Subarea 1

a) Fishery trends

Nominal catches have fluctuated widely over the 25-year period for which statistics have been reported to ICNAF. The catch increased during the early 1950's to an average of 25,000 tons in 1955-59 period, reached its highest average level (47,000 tons) in the 1960-64 period with a peak of 61,000 tons in 1962, decreased rapidly from 19,000 tons in 1965 to 5,000 tons in 1969, and remained at a low average level of 4,400 tons during 1970-75.

An increase to 13,700 tons occurred in 1976 and provisional statistics indicate a doubling of the catch to nearly 28,000 tons in 1977, primarily due to a directed trawl fishery by Federal Republic of Germany, which accounted for 91% of the total redfish catch in that year.

Up to 1976, the fishery was to a great extent a mixed fishery (cod and redfish), and data on fishing effort directly related to redfish catches were not available at the present meeting. However, the decline in catches in the late 1960's was likely to have been mainly due to a decrease in effort as fishing for cod declined. Some discarding of redfish is likely to have occurred in the trawl fishery for cod, and, in the present shrimp fishery, considerable quantities of small redfish are discarded (Sum. Doc. 78/VI/1).

b) Biological information

No information on the biology of this redfish stock was presented, due to the very short notice given regarding the inclusion of this item on the agenda for this meeting. The Subcommittee noted, however, that there are small redfish in Div. 1A and 1B, and that their mean size increases from north to south, indicating a southward migration from the northern nursery grounds. Also, tagging experiments in Godthaab Fjord (Div. 1D) confirm the hypothesis that there is a migration of redfish from West to East Greenland waters. Redfish do not appear to spawn off West Greenland, but the West Greenland stock is recruited by larval drift from the breeding areas off Southeast Greenland. Therefore, the assessment of redfish in Subarea 1 must take into consideration the fishery and the assessment of the stock off Southeast Greenland.

c) Assessment and advice on management

Partly due to the short notice given for advice on the management of this stock and partly due to the general lack of information, the Subcommittee could not do an assessment of the present state of the stock in Subarea 1, and doubted that it would be in a much better position to give advice later in 1978 when advice for the shrimp stock in Subarea 1 is likely to be considered. Since the laboratories concerned with research on redfish would need some considerable time to compile and analyze all of the available data, the Subcommittee concluded that the most appropriate time for full consideration of the assessment for this stock would be the April 1979 Meeting of the Subcommittee.

The Subcommittee was, however, concerned that, in view of the recent large increases in catch, an unregulated fishery could lead to too high exploitation of the stock. Concern was also expressed that a large fishery for redfish could lead to increased fishing mortality on cod due to by-catches of cod in the redfish fishery. The Subcommittee was not in a position to quantify such by-catches, but noted that the by-catches might be high during the pre-spawning and spawning periods when cod are in deeper water. Pending the provision of further information and an assessment of the stock, the Subcommittee advises that fishing should not be allowed to expand beyond the 1977 catch level (about 28,000 tons).

7. Redfish in Division 3M (Res. Doc. 78/VI/48, 56; Sum. Doc. 78/VI/9)

The nominal catch of redfish in this area declined from 42,000 tons in 1972 to 22,000 tons in 1973, increased to 35,000 tons in 1974 under a TAC regulation of 40,000 tons for that year. Since 1975 the fishery has been regulated by a TAC of 16,000 tons and catches have been close to that figure. The 1976 catch was 17,000, slightly higher than the TAC, and provisional statistics indicate a catch of 16,000 tons in 1977.

Examination of length frequencies from Canadian commercial catches in 1977 with both bottom and midwater trawls indicates a modal size of 31 cm for males and 32 cm for females. Redfish taken as by-catch in Spanish pair-trawl fishing for cod appear to be of commercial size, 35-37 cm for males and 36-38 cm for females (Res. Doc. 78/VI/48).

The Subcommittee reviewed general production modal assessments presented by Canada (Res. Doc. 78/VI/48) and by Cuba (Res. Doc. 78/VI/56). The fishing effort, in standard days fished by tonnage class 7 trawlers, fluctuated greatly during the late 1950's and 1960's, increased from a low of 250 days fished in 1969-70 to a high of 2,100 days fished in 1974, and declined to 600 days fished in 1976. The catch per standard day fished, for tonnage class 7 vessels using bottom trawls, reached a peak of 26 tons per day in 1958, declined to a low level in the 1960's and early 1970's, and increased to a maximum of 28 tons per day in 1976.

The Cuban assessment, utilizing data for 1957-76 with effort based on fishing by tonnage class 7 trawlers, indicated an MSY in the range of 16,000-24,000 tons. The Canadian assessment, with effort based on fishing by tonnage class 4 vessels, indicated that the stock was in good condition and that the MSY was lower at 15,000-17,000 tons. Therefore, taking into account the evidence of increasing catch-per-unit-effort, and that the points corresponding to the 1975 and 1976 catches are on or above the yield curves, depending on the effort standard used, the Subcommittee advises that the TAC for 1979 should be increased to 20,000 tons.

8. Redfish in Divisions 3L and 3N (Res. Doc. 78/VI/46; Sum. Doc. 78/VI/9)

Nominal catches fluctuated considerably prior to 1971 but generally showed an increasing trend to a high of 34,000 tons in 1971 followed by a decline to 29,000 tons in 1972 and an increase to 33,000 tons in 1973. Since then the fishery has been regulated by TACs of 28,000 tons in 1974, 20,000 tons in 1975 and 1976, and 16,000 tons in 1977 and 1978. Thus the catch declined to 22,000 tons in 1974 and was 18,000 and 21,000 tons in 1975 and 1976 respectively. The provisional catch for 1977 was 16,000 tons. Although there has been an increase in midwater trawling in this area in recent years, the greater part of the catch continues to be taken by bottom trawls. In the late 1960's and early

1970's, the major part of the catch from these divisions was taken in Div. 3N, but in more recent years there has been a shift in the fishery to the extent that about 75% of the catch in 1976 was taken in Div. 3L.

From an average level of about 15,000 hours (standard units) during 1963-1970, fishing effort increased to 32,000 hours fishing in 1971 but declined to a level of about 12,000 hours in 1975 and 1976. Catch-per-unit-effort, on the other hand, has progressively increased from a low of 1.07 tons per hour in 1971 to 1.74 tons per hour in 1976.

Length and age composition data for the commercial fishery have not been adequate for this stock over the years and sampling remained poor in 1977. The most common length groups caught by both bottom and midwater trawls range between 31 and 37 cm for both sexes. Length frequencies from research vessel catches indicate that the size of redfish increases with depth in both Div. 3L and 3N. In Div. 3L, the modal size was 27 cm for males and 29 cm for females at 270-370 m, 32 cm for both sexes at 370-550 m, and 34 cm for males and 36 cm for females at 550-730 m. In Div. 3L, on the other hand, the modal length for both sexes ranged from 23 cm at 270-370 m to 33 cm at 550-730 m. If the differences in size between divisions are indicative of different stocks, the greater fishing activity in Div. 3L relative to that in Div. 3N may have to be considered in the future management of the redfish stock in this area.

The initial assessment of this stock was given in a paper presented at the 1973 Annual Meeting[1], utilizing the Schaefer yield model to provide approximate estimates of maximum sustainable yield. The assessment has been updated by recalculating the yield curves with the same standard effort units as used previously and including data for 1971-75. At the 1976 Meeting of the Subcommittee, the TAC of 16,000 tons for 1977 was set below the long-term MSY level of 20,000 tons to allow for some rebuilding of the stock, as the heavy fishing of the early 1970's had reduced the stock to a low level. From the updated general production model assessment, there is evidence that the stock is recovering from the effects of high level of fishing in the early 1970's. There is also evidence of good recruiting year-classes in Div. 3N but not so in Div. 3L. The Subcommittee therefore advises a TAC of 18,000 tons for 1979, which corresponds to fishing at 2/3 F_{MSY}.

The Subcommittee noted that there were differences in length-at-age data, particularly at larger lengths, presented by USSR (Sum. Doc. 78/VI/9) and Canadian data for other redfish stocks, and suggested that some attempt should be made to obtain better agreement in ageing, in order to facilitate the use of analytical modals in assessing this stock.

9. Silver hake in Divisions 4V, 4W and 4X (Res. Doc. 78/VI/31, 34, 42, 55, 60, 63; Sum. Doc. 78/VI/10)

a) Fishery trends

A directed fishery for silver hake began in 1962, and since then the USSR and more recently Cuba, have accounted for most of the catches with only incidental by-catch by other countries. The catches peaked at 299,000 tons in 1973 and have been under TAC regulation from 1974. Preliminary statistics indicate a catch of about 36,000 tons in 1977, of which 32,100 tons were taken by USSR, 1,900 tons by Cuba and 1,800 tons by other countries. This is a significant decline from the 1976 catch of 97,000 tons and is about 50% of the 1977 TAC of 70,000 tons. Such factors as mesh regulation (60 mm), geographic restrictions and fishing activity and the early achievement of squid allocations probably contributed to the reduced catch in 1977. A TAC of 81,000 tons was advised by the Subcommittee for 1978.

b) Biological studies

The age and growth of silver hake have been considered at several workshops and attempts to resolve differences in estimating the age appear to have been successful. The 1978 Workshop (Sum. Doc. 78/VI/10) concluded that improvement in age determinations between various age readers has been significant and that a high level of agreement (80%) can be maintained by working participants. However, the continuing problem of first-year age validation has been identified as a limiting factor which cannot be resolved by otolith interpretation but requires supporting data on spawning duration and other information to demonstrate early growth. The Workshop participants concluded that further workshops would not be warranted at this time but that otolith exchanges be undertaken in 1978. The Subcommittee recommended that a manual on silver hake ageing should be compiled with provision for updating as required.

A study of back-calculated length-at-age (Res. Doc. 78/VI/42) indicates good correlation between otolith measurements and fish size. Age-length keys generated from the otolith measurements appear to be consistent with those derived from Canadian estimates of age as are the growth curves based on back-calculated mean length-at-age.

[1] Parsons, L. S., and D. G. Parsons. 1975. An evaluation of the status of ICNAF Divisions 3P, 3O and 3LN redfish. ICNAF Res. Bull. No. 11, p. 5-16.

As recommended by STACRES (*Redbook* 1977, page 58), mesh selection studies were carried out in 1977 through Canada-Cuba and Canada-USSR cooperative research programs (Res. Doc. 77/VI/34, 60 and 63). Independent analyses by scientists of the participating countries were in general agreement and suggested a selection factor of 3.5 for silver hake. However, the accuracy of this value may have been affected by masking, either by the method of cover attachment or by the high mixture of species in some of the experimental catches. The factor of 3.5 may therefore be lower than that representative of commercial-sized trawls and catches. Although large catches, as commonly experienced in commercial fishing operations would tend to lower the 50% retention length of silver hake, it was suggested that a selection factor of 4.0 would be more realistic for the commercial trawl fishery. Analyses of the selection ogives by age-group and mesh size, based on Canadian data, are summarized in Table 5 and the percentages released by length group and mesh size are listed in Table 6.

Table 5. Mesh selection by age (sexes combined) and by mesh size for silver hake in Div. 4VWX.

Age (yr)	Proportion of fish retained			
	40 mm	60 mm	90 mm	130 mm
1	0.59	0.40	0.34	0.11
2	0.93	0.74	0.52	0.21
3	0.99	0.87	0.59	0.25
4	1.00	0.95	0.64	0.27
5	1.00	0.97	0.69	0.34
6	1.00	0.99	0.83	0.64

Concern was expressed about the mixed species aspect of the silver hake fishery and the associated catches of squid. Mesh size regulation of the silver hake fishery would have a significant effect on the catches of squid, and vice versa. The general morphology of squid is such that there is a high potential for masking which would tend to lower the selection factor of the various meshes relative to values for homogeneous catches of silver hake.

In summary, the mesh selection studies indicate a selection factor of 4.0 for silver hake in the commercial trawl fishery and that this value is affected by catches of mixed species, particularly squid. Consequently, agreement could not be reached on a recommendation to change the mesh size from the present minimum of 60 mm. In order to obtain additional information on mesh size effect, it was suggested that, if personnel and gear were available, a codend cover be used during some future trawl surveys for silver hake to provide selection data incidental to the primary purpose of the surveys.

c) Abundance estimates

Accurate estimates of biomass based on survey data are not available for this stock. Previous analyses have shown that estimates of biomass from Canadian surveys do not agree with the results from virtual population analysis but that they may represent a relative index of abundance. Estimates from the 1977 survey were similar to those of 1976. The results of a Canadian virtual population analysis suggest a biomass (for age 2+ fish) of 120,000 tons in 1977 and a catch-per-unit-effort of about 1.26 tons per hour or a calculated effort of 2,700 days. Reported effort was about 2,200 days in 1977, indicating that the estimated biomass of 120,000 tons may be close to the actual biomass of age 2+ fish.

d) Catch composition

Two estimates of catch-at-age were available, one based on USSR data and the other on Canadian ageing. Relative to the Canadian age composition data the age frequency from USSR data was shifted by one year towards the older age-groups. This apparent difference could not be resolved, but it was noted that the 1977 age compositions did not reflect the results of discussions on ageing at the 1978 workshop. In anticipation of more comparable results for data in 1978 and subsequent years, the Subcommittee agreed to use the Canadian data on the age composition of the 1977 catch for subsequent analysis.

e) Assessment parameters

Projections of catch and biomass were presented by Canada (Res. Doc. 78/VI/62) and by USSR (Res. Doc. 78/VI/31). The latter assessment used a value of 0.5 for M and USSR catch-at-age data for 1976 and 1977. However, at its April 1977 Meeting, the Subcommittee considered it appropriate

Table 6. Escapement of silver hake by length from codends of various sizes, calculated from the results of the joint Canada-USSR mesh selection study in Div. 4VWX in October-November 1977. (Percentages are running averages of 5.)

Total length (cm)	Percent released from codends of various mesh sizes				
	40 mm[1]	60 mm	70 mm	90 mm[1]	127 mm
15	59	73	62	77	91
16	56	71	62	76	90
17	53	68	61	74	90
18	51	66	58	73	90
19	46	63	57	71	89
20	41	61	55	68	88
21	37	57	53	66	86
22	33	53	49	64	84
23	30	48	45	62	82
24	27	45	42	60	80
25	21	40	38	56	78
26	17	35	34	52	77
27	11	30	30	48	76
28	8	25	27	46	76
29	3	20	22	44	76
30	1	15	18	42	75
31	0	11	17	40	75
32		8	14	38	74
33		5	14	37	73
34		4	11	35	71
35		4	9	33	71
36		4	8	31	71
37		3	5	30	69
38		3	3	28	66
39		2	3	27	61
40		1	2	26	53
41		0	2	25	46
42			2	24	45
43			1	23	43
44			1	22	40
45			1	20	39
46			1	19	34
47			0	14	29
48				10	28
49				7	25
50				2	22
51				1	19
52				0	18
53					15
54					15
55					15
56					13
57					10
58					7
59					2
60					0

[1] Estimated values using linear interpolation of data for the 60, 70 and 127 mm mesh sizes and taking account of data from the joint Canada-Cuba mesh selection study.

to use M = 0.4 and the Canadian catch-at-age data in the virtual population analysis, and these parameters were again considered appropriate for use in the present analysis. At the same time, the USSR catch projections were noted.

The Canadian analytical assessment was based on new estimates of $F_{0.1}$ and F_{max} derived from yield-per-recruit data. Starting F values for 1976 were estimated by trial VPA and the resultant F-values (for ages 2 to 4) regressed against fishing effort to estimate 1976 fishing mor-

tality. These data were then used to project through 1977, using known catch-at-age in 1977 and the F-values required to generate the catch, and the implied partial recruitment was estimated by assuming full recruitment at age 6 (Table 7, Options 1 and 2). The partial recruitment pattern for Options 3 and 4 is discussed later in connection with the alternative projections.

Table 7. Partial recruitment values used for the various options of catch projections.

Age (years)	1	2	3	4	5	6
Options 1 and 2	0.003	0.106	0.185	0.600	0.319	1.000
Options 3 and 4	0.040	0.740	1.000	0.960	0.500	0.500

Mean weight-at-age data used in the analysis, based on Canadian length-at-age data and a new length-weight relationship, are as follows:

Age (years)	1	2	3	4	5	6
Mean weight (kg)	0.044	0.122	0.204	0.298	0.425	0.732

The use of these values substantially changed the potential yield-per-recruit and the projected catches. However, these were accepted subject to future analysis of long-term variation within age-groups.

f) Results of assessment

Yield-per-recruit estimates of $F_{0.1}$ = 0.96 and F_{max} = 2.8 were obtained on the basis of the new weight-at-age data. Recruitment at age 1 was estimated to be 730 million and 2,100 million fish for the 1975 and 1976 year-classes respectively and was assumed to be 1,000 million for subsequent year-classes. Using these recruitment values and partial recruitment for 1977, catch and biomass projections for 1978 to 1980 at $F_{0.1}$ were made. The results imply yields of 33,000 tons in 1978, 48,000 tons in 1979 and 82,000 tons in 1980 as indicated for Option 1 (Table 8) and an increase in biomass to about 380,000 tons in 1978 and later years. If the fishing mortality is increased in 1978 to attain the 1978 TAC, projected catches are 35,000 tons in 1979 and 64,000 tons in 1980 (Option 2).

Partial recruitment to a fishery regulated by a 60-mm minimum mesh size was discussed, and it was concluded that the very large change in partial recruitment as calculated from 1977 fishing data was unlikely. It was therefore agreed to recalculate the catch projections using full recruitment at age 3 with the other age-groups adjusted proportionally. The resultant recruitment pattern (Table 8, line 2) was intermediate between that calculated for 1977 and that observed historically. The new $F_{0.1}$ was calculated to be 0.597 and the additional catch projections (Table 8) were made (i) assuming that the intermediate partial recruitment and the associated $F_{0.1}$ are applied for 1978 and subsequent years (Option 3), and (ii) assuming that the TAC of 81,000 tons is taken in 1978 with the intermediate recruitment pattern (Option 4).

Table 8. Silver hake in Div. 4VWX: catch projections for 1978-80 under various options as defined in the text.

Year	Option 1	Option 2	Option 3	Option 4
1978	33,427	81,000	81,712	81,000
1979	47,848	35,453	83,287	83,615
1980	82,023	63,963	75,632	75,799

The Subcommittee noted that, if the 1977 partial recruitment pattern holds in 1978 and 1979 and the TACs are set above the levels corresponding to fishing at $F_{0.1}$, severe damage to the stock is unlikely, as only a small proportion of ages 2 and 3 fish would be available to the fishery and licence limitations would probably prevent high mortality being generated on these age-groups. If the partial recruitment pattern changes to that hypothesized, TACs of about 80,000 tons in 1978 and 1979 could be taken, but if the projections are seriously in error, damage to the stock could occur unless licencing limitations are very restrictive.

Since the basis for the catch projections under Options 3 and 4 is the more critical, the sensitivity of other associated assumptions was examined. In particular, the validity of the estimated size of the 1976 year-class was examined, and it was noted that the estimate of 2,100 million fish at age 1 made it the second strongest year-class observed in the history of the fishery. If this year-class results in being only of average size, the projected yield for 1979 would be less than 60,000 tons. To reflect the uncertainty about the size of the 1976 year-class, the Subcommittee advises a TAC of 70,000 tons for 1979.

10. American plaice in Division 3M (Sum. Doc. 78/VI/9)

This stock has been under regulation since 1974 with a TAC of 2,000 tons in 1974-77 and 4,000 tons for 1978. Catches ranged from 1,000 to 2,000 tons during 1973-76 and provisional statistics indicate a catch of about 600 tons in 1977. The American plaice catches in this area are taken entirely as by-catches in the cod and redfish fisheries. At its April 1977 Meeting, the Subcommittee advised an increase in the TAC for 1978 to 4,000 tons, on the basis of abundance indices from USSR research vessel surveys in 1976. However, in the light of 1977 survey data, the indices for 1976 appear to have been too high. The Subcommittee therefore advises that the TAC for 1979 should be reduced to 2,000 tons, an amount which should be adequate to cover unavoidable by-catches of American plaice in fisheries for other species.

11. American plaice in Divisions 3L, 3N and 3O (Res. Doc. 78/VI/35, 36; Sum. Doc. 78/VI/9)

a) Fishery trends

The highest recorded catch from this stock was 94,000 tons in 1967. Since then, catches declined to an average level of about 47,000 tons annually during 1973-76. Provisional statistics for 1977 indicate a catch of about 43,000 tons. The fishery was regulated by a TAC of 60,000 tons in 1973-75 and 47,000 tons subsequently.

b) Abundance

Although catch-per-unit-effort data (average catch per tow) from Canadian and USSR surveys indicate an increase in abundance, especially in Div. 3L, the catch rates of commercial trawlers have remained relatively the same over the past 3 years.

c) Assessment parameters

Length and age composition and mean weight-at-age data were derived from Canadian commercial sampling of the catches from each of the 3 divisions in most months. Quarterly age-length keys and monthly catch data were used to estimate the numbers caught at age in each month from the monthly length frequencies.

The fishing mortality in 1977, used to initiate the cohort analysis, was derived from the regression of fishing mortality of fully recruited age-groups on total fishing effort from 1963-75 data. Total fishing effort in 1977 was 105,000 hours (using the catch and effort data of Canadian stern trawlers as the standard), giving F-values of 0.60 and 0.45 for males and females respectively (weighted average 0.51). These values are higher than the $F_{0.1}$ values of 0.50 for males and 0.40 for females (average 0.43).

d) Results of assessment

Stock size and catch projections for 1979-86 were carried out based on fishing at the $F_{0.1}$ (0.43) level of fishing mortality and at a lower level of F = 0.33. Recruitment values used in the projections are averages of 1973-75 recruits (from cohort analysis) at age 5 for males (103 million fish) and at age 5 for females (136 million fish). The projections for the two options are listed in the following table, together with data for 1962-64, 1965-70 and 1977:

		1962-64	1965-70	1977	1979	1982	1986
A.	Fishing mortality	0.23	0.50	0.51	0.43	0.43	0.43
	Biomass (000 tons)	560	425	427	426	508	517
	Catch (000 tons)	28	72	43	43	57	59
B.	Fishing mortality				0.33	0.33	0.33
	Biomass (000 tons)				464	525	543
	Catch (000 tons)				36	51	56

Estimates of biomass for the 1962-70 period were based on cohort analysis for Div. 3LN, with estimates added for Div. 3O, based on the ratio of biomass calculated for Div. 3O to that for Div. 3LN in 1973.

The catch projection for 1979 is 43,000 tons, which corresponds to fishing at $F_{0.1}$. However, in view of the evidence of increased abundance from research vessel surveys, the Subcommittee advises that the TAC for 1979 should remain at 47,000 tons.

The projections to 1986 are intended to indicate relative trends only, since environmental fluctuations could have unpredictable effects on the population parameters, especially on the annual recruitment levels. However, Option A indicates that management at $F_{0.1}$ (0.43) would increase the potential catch to 59,000 tons by 1986 (close to the 60,000 tons TAC level before 1976). Under Option B, the biomass would increase more rapidly, but the catch would remain below that for Option A and would not reach the 60,000-ton level until sometime in the late 1980's.

12. Witch flounder in Divisions 2J, 3K and 3L (Res. Doc. 78/VI/37; Sum. Doc. 78/VI/9)

a) Fishery trends

Nominal catches from this stock increased from 4,400 tons in 1961 to 24,000 tons in 1973, but declined to 16,000 tons in 1974 (TAC of 22,000 tons), to about 11,000 tons in 1975 and 1976, and to 8,000 tons (provisional) in 1977. On the basis of an assessment in 1974, the TAC for 1975 was reduced to 17,000 tons based on management at the $F_{0.1}$ level of fishing mortality and remained at this level for 1976-78.

b) Assessment

The Subcommittee considered that the offshore otter trawl samples were more representative of the population than the inshore gillnet data, and hence the updated assessment was made using length and age data from the Canadian otter trawl fishery in 1974-77. Estimates of total mortality (Z), obtained from catch curves (numbers caught at age) based on the 1974-77 data, were Z = 0.59 for males and 0.35 for females.

Application of the Beverton and Holt yield-per-recruit model indicated that the age at first entry to the fishery (t_p) was 5 years for both sexes with mean selection ages (t_p') of 8.5 years for males and 11.5 years for females (Res. Doc. 78/VI/37). The $F_{0.1}$ level of fishing mortality was estimated to be 0.43 for males (M = 0.20) and 0.27 for females (M = 0.15).

The fishing mortality values from the catch curves (0.39 for males and 0.20 for females), which are indicative of catches in the range of 12,000-13,000 tons during the past 10 years, are slightly below those corresponding to $F_{0.1}$. Because of the uncertainty about the estimates of total mortality from the catch curves, the Subcommittee advises that the TAC for 1979 should remain at 17,000 tons.

13. Witch flounder in Divisions 3N and 3O (Res. Doc. 78/VI/40)

a) Fishery trends

Nominal catches from this stock increased from 4,700 tons in 1969 to 15,000 tons in 1971, decreased to 9,000 tons in 1972 and have been in the range of 6,000-8,000 tons during 1973-76. Provisional statistics for 1977 indicate a catch of about 6,000 tons. The TAC has remained unchanged at 10,000 tons from 1974 to 1978.

b) Assessment

The Subcommittee welcomed this first attempt to assess this stock by cohort analysis (Res. Doc. 78/VI/40), based on Canadian commercial sampling data for 1974-77. Because of the irregular nature of the fishery in Div. 3N and 3O, it was not always possible to fulfil the aim to obtain at least one length and one age sample for each month.

Since effort data were not available for 1977, it was not possible to obtain an estimate of fishing mortality from a regression of F on fishing effort. Hence, the terminal F used to initiate the cohort analysis was a value (F = 0.5 for both males and females) derived from recent catch curves (Res. Doc. 77/VI/12). Partial recruitment was derived from a matrix of catch-at-age (numbers) and the F-values averaged for 1974-77 (Res. Doc. 78/VI/40).

With estimated recruitment of 27 million males and 35 million females at age 8 and fishing at $F_{0.1}$ (0.45 for males and 0.40 for females), the projected catch in 1979 is 6,500 tons. However, in view of the inadequacy of the data, especially the uncertainty about the current level of fishing mortality, the Subcommittee advises that the TAC remain unchanged at 10,000 tons for 1979.

14. Yellowtail flounder in Divisions 3L, 3N and 3O (Res. Doc. 78/VI/36, 41; Sum. Doc. 78/VI/9)

a) Fishery trends

Nominal catches from this stock increased from 3,100 tons in 1965 to 25,600 tons in 1970 and to 39,300 tons in 1972. The stock has been subjected to TAC regulation since 1973 with TACs and catches (1977 provisional) as follows:

	1973	1974	1975	1976	1977	1978
TAC (000 tons)	50.0	40.0	35.0	9.0	12.0	15.0
Catch (000 tons)	32.8	24.2	22.9	8.6	11.2	

The assessment in 1975 indicated that the stock was being rapidly depleted and the TAC was reduced sharply to 9,000 tons for 1976.

b) Abundance indices

Catch-per-unit effort data (average number and weight of fish per set) from Canadian research vessel surveys indicate that there has been a gradual increase in abundance from the low level in 1973-74. Correlation of research vessel abundance indices with estimates of spawning biomass from cohort analyses also points toward a recovery of the stock, although it is apparently still below the biomass levels of 1971 and 1972. USSR research vessel survey data indicate somewhat lower catch rates in 1977 than in 1976.

c) Assessment parameters

Length and age composition and mean weight-at-age data were derived from Canadian commercial sampling of catches from each of the 3 divisions in each month. Quarterly age-length keys and monthly catch data were used to estimate the numbers caught at age in each month from the monthly length frequencies.

The fishing mortality for 1977 was set at F = 0.40 (fully recruited age-groups) to initiate the cohort analysis. A second value of F = 0.28 was estimated from the population structure based on research vessel data and the current numbers at age.

Recruitment estimates were derived from the correlation of average number per tow (age 4 fish) from random stratified research vessel surveys with corresponding population numbers from cohort analysis and also from the average numbers of recruits in 1974-76 from cohort analysis. Partial recruitment was derived from the average F-values calculated from the matrix of the numbers at age in 1974-77 (Res. Doc. 78/VI/41).

d) Results of assessment

Two estimates of the age structure of the population (000 fish) in 1977 were derived as follows:

	Age (years)							$F_{0.1}$
	4	5	6	7	8	9	10	
A.	85,000	62,593	43,521	25,531	14,216	4,613	867	0.5
B.	85,000	60,000	40,000	43,000	25,000	5,300	800	0.4

The first estimate of the age structure (A) was derived from the current cohort analysis. The alternative estimate (B) is based on values predicted from the regression of population numbers at age from cohort analysis (1971-75) on the average number per tow from random stratified surveys in the same period. Because of the selection pattern produced by (B), it was necessary to make a new yield-per-recruit calculation giving $F_{0.1} = 0.4$, compared to $F_{0.1} = 0.5$, with partial recruitment values as used in the cohort analysis.

Projections of yield in 1979 at $F_{0.1}$ indicate a TAC of 14,000 tons using the population structure in (A) and 18,000 tons for (B). However, in view of the improved condition of the stock from abundance indices and because of the excellent correlation of research vessel data with spawning biomass from cohort analysis, the Subcommittee advises a TAC of 18,000 tons for 1979.

15. Greenland halibut in Statistical Areas 0 and 1 (Res. Doc. 78/VI/24, 38, 45 and 53)

a) Fishery trends

Nominal catches from this stock were less than 5,000 tons prior to 1952 but increased to 14,000 tons in that year. Following a decline to 10,000 tons in 1973, the catch increased rapidly to 25,000 tons in 1975 but declined to 16,000 tons in 1976. Provisional data for 1977 indicate a catch of about 13,000 tons. Lacking adequate data for assessment, the Subcommittee in 1975 advised a precautionary TAC of 20,000 tons for 1976, which remained in effect for 1977. Countries reporting catches of Greenland halibut from these areas indicated that the fishery was directed toward that species.

b) Assessment

At its April 1977 Meeting, the Subcommittee reviewed a paper (Res. Doc. 76/VI/109) which gave estimates of stock size based on observations from USSR scouting and commercial vessels. The results suggested that the yield from this stock could be as high as 50,000 tons. However, there was some doubt about the catchability rate of the trawls used, which was reported to be 10%, and the Subcommittee advised a precautionary TAC of 25,000 tons for 1978.

New data presented at this meeting indicated that the catchability rate of the trawls used by the USSR vessels was in fact 16% rather than 10%, implying a somewhat lower estimate of the biomass than that indicated previously. A virtual population analysis presented by USSR suggested that the yield could be as high as 35,000 tons. However, this assessment did not include catch data for 1977.

It was the general consensus of the Subcommittee that, while the new assessment was quite valuable, the uncertainty about the state of the stock was sufficient to advise a continuation of the precautionary TAC of 25,000 tons for 1979. It was noted that this level of yield would allow some expansion of the fishery (catches in 1976 and 1977 were only about one-half of this TAC level) and would allow more time to evaluate some of the population parameters and thus improve the scientific advice.

c) Future research requirements

The Subcommittee noted that, although the Greenland halibut inhabiting Statistical Area 0 and Subareas 1 to 3 may be a single stock and should possibly be managed as such, there is still a lack of basic information regarding the distribution and migration of this species and agreed that the stocks (SA 0+1 and SA 2+3) should, for the present at least, be managed separately. However, the Subcommittee recommended that research programs aimed at providing information on migrations and stock discrimination be expanded.

The Subcommittee indicated the need for information on the appropriate mesh size for the Greenland halibut fishery and recommended that consideration be given to this problem.

16. Greenland halibut in Subarea 2 and Divisions 3K and 3L (Res. Doc. 78/VI/39; Sum. Doc. 78/VI/9)

Nominal catches have ranged between 25,000 and 30,000 tons annually since 1971, with more than half of the catch now being taken in the Canadian inshore gillnet fishery. Provisional statistics for 1977 indicate a catch of about 31,000 tons. The TAC was 40,000 tons in 1974 and 1975. On the basis of an analytical assessment in 1975 (*Redbook* 1975, page 32), the TAC was reduced to 30,000 tons for 1976 and has remained at that level to the present time.

The size and age compositions of commercial otter trawl and gillnet catches indicate that the larger mature fish inhabit the deeper water and are progressively more abundant in the catches from south to north. However, the major portion of the catches consist of immature fish which inhabit the shallower parts of the continental shelf.

In an updated assessment reviewed at this meeting (Res. Doc. 78/VI/39), the levels of fishing mortality (F = 1.11 for males and 0.35 for females) were considered to be maximal due to localized fishing. Consequently, the Subcommittee advises that the TAC for 1979 should remain at 30,000 tons.

17. Roundnose grenadier in Statistical Area 0 and Subarea 1 (Res. Doc. 78/VI/47, 54)

Nominal catches in 1972-76 were in the range of 4,900-12,300 tons. The provisional catch of 2,200 tons in 1977 was much lower than the 1976 catch of 8,500 tons, the decline being mainly due to a decrease in the USSR catch (8,200 to 1,700 tons). The TAC was initially set at 10,000 tons for 1975, increased to 14,000 tons for 1976, and reduced to 8,000 tons for 1977 and 1978 on the basis of an assessment presented at the 1976 Meeting of the Subcommittee (*Redbook* 1976, page 71).

The Subcommittee reviewed an updated analytical assessment (Res. Doc. 78/VI/54) based on more representative and more complete data than given previously. The assessment indicates that fishing mortality was, on the average, at the level of $F_{0.1}$. It was noted that fishing at $F_{0.1}$ and at F_{max} should give sustainable yields of 6,900-7,500 tons and 7,000-8,700 tons respectively, depending on the level of natural mortality used (M = 0.1 or 0.2). The average annual catch of 6,200 tons during 1968-76 was therefore near the lower part of the range of sustainable yield at $F_{0.1}$.

In addition to the analytical assessment, the Subcommittee reviewed a general production model assessment for the 1968-76 period (Res. Doc. 78/VI/47), which indicated an MSY of about 8,000 tons, a value within the range of estimates from the analytical assessment. The Subcommittee accordingly advises that the TAC for 1979 should remain unchanged at 8,000 tons.

18. Roundnose grenadier in Subareas 2 and 3 (Res. Doc. 78/VI/47, 54)

Nominal catches in 1972-76 were in the range of 17,600-28,400 tons. Provisional statistics for 1977 indicate a catch of 15,300 tons, which is less than the 1976 catch of 20,600 tons. The TAC for this stock was maintained at 32,000 tons during 1974-76, and increased to 35,000 tons for 1977 and 1978 on the basis of an assessment presented at the 1976 Meeting of the Subcommittee (*Redbook* 1976, page 81).

The Subcommittee reviewed an updated analytical assessment (Res. Doc. 78/VI/54), which provides the most recent estimates of fish mortalities, stock sizes and sustainable yields. The assessment indicates that fishing mortality was, on the average, at the level of $F_{0.1}$. It was noted that fishing at $F_{0.1}$ and at F_{max} should give sustainable yields of 26,100-30,700 tons and 27,700-37,000 tons respectively, depending on the level of natural mortality used (M = 0.1 or 0.2). The average annual catch of 28,000 tons during 1967-76 was therefore within the range of sustainable yield at $F_{0.1}$.

In addition to the analytical assessment, the Subcommittee reviewed a general production model assessment (Res. Doc. 78/VI/47) for the 1967-76 period, which indicated an MSY of about 32,000 tons. It is shown that catch-per-unit effort has remained reasonably constant since 1970, indicating a fairly stable biomass. Except for 1971, total effort has been below the level corresponding to that giving the MSY. Considering the results of both assessments but noting also the uncertainties associated with assessments of grenadiers, the Subcommittee advises that the TAC for 1979 should remain unchanged at 35,000 tons.

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

Nominal catches varied between 1,000 and 17,000 tons during 1972-76, the average being 9,000 tons. Provisional statistics for 1977 indicate a catch of about 2,000 tons compared with 7,000 tons in 1976. The TAC was 25,000 tons during 1974-76 but was reduced to the estimated MSY level of 20,000 tons in 1977. Very few data have become available which would allow the present state of the stock to be evaluated, but the recent low level of catches suggests that the stock is not being excessively exploited. Hence, the Subcommittee advises that the TAC should remain at 20,000 tons for 1979.

20. Capelin in Subarea 2 and Division 3K (Res. Doc. 78/VI/30, 43)

Nominal catches increased sharply from an average of about 600 tons in 1967-71 to 46,000 tons in 1972 and to 216,000 tons in 1976. Provisional statistics for 1977 indicate a catch of 153,000 tons, the decline from 1976 to 1977 being mainly attributed to a reduction in fishing effort. Recent catches and TACs for this stock are given in Table 2 (page 3).

The Subcommittee reviewed estimates of the capelin biomass from surveys by USSR and Canada in October and November 1977. The USSR estimate of 860,000 tons, obtained by acoustic-photogrammetric methods (Res. Doc. 78/VI/30), was considered to be an underestimate because the survey did not cover the area within the Canadian territorial zone and because the distribution of capelin was abnormal, making acoustic and photogrammetric methods less reliable. The Canadian estimate, based also on acoustic techniques but including areas inside and outside the territorial limit, was in the range of 507,000-635,000 tons (Res. Doc. 78/VI/43). This estimate was also considered to be minimal because the Canadian echo integration system does not estimate capelin density from surface to bottom and because the survey did not cover the entire area of capelin distribution.

Canadian and USSR sampling data revealed that the 1973 year-class was dominant. This year-class will contribute to the spawning biomass in 1978 but will not appear in the 1979 fishery. Instead, the fishery will depend on the 1975 and 1976 year-classes but their strengths are unknown. The need for pre-recruit surveys of capelin was emphasized and Canadian and USSR scientists indicated that joint pre-recruit surveys were being planned for 1978. It was noted, however, that the reliability of the predictions of year-class strength based on 1978 and future surveys will not be known until the surveys have been conducted for a number of years. Lacking sufficient new biological information on the stock, the Subcommittee advises that the TAC for 1979 should remain at the present level of 300,000 tons.

21. Capelin in Divisions 3L, 3N, 3O and 3Ps (Res. Doc. 78/VI/22, 29, 52; Com. Doc. 78/VI/3)

Nominal catches from this stock complex increased from an average of 1,900 tons in 1967-71 to 25,000 tons in 1972 and to 167,000 tons in 1975. There was a decline to 144,000 tons in 1976 and provisional statistics for 1977 indicate a decrease to 68,000 tons in 1977. In Div. 3L the catch declined from about 34,000 tons in 1975 and 1976 to 25,000 tons in 1977. In Div. 3NO the decline was more pronounced; catches were in the range of 101,000-132,000 tons during 1973-76 but decreased to 42,000 tons in 1977. In both 1976 and 1977, Norway caught less than half of its allocation in Div. 3NO. In 1977, USSR caught about 70% of its allocation in Div. 3L but less than one-third of its quota in Div. 3NO. Recent nominal catches and TACs for this stock are listed in Table 2 (page 3).

In Com. Doc. 78/VI/3, STACRES was requested to review the status of this stock and, in particular, to evaluate the possible effects of the fishery on capelin production. In the past, STACRES has advised that the fishery in Div. 3NO, concentrated on the mature portion of the stock, could remove all except the fraction of the spawning stock necessary to provide adequate future recruitment (*Redbook* 1974, page 83). Therefore, an evaluation of the effects of the fishery on the stock is restricted to consideration of stock-recruitment limits and not yield-per-recruit consideration.

The Subcommittee noted that catch rates (catch per day) of USSR and Norwegian vessels had declined from 1975 to 1977, but no agreement could be reached on the validity of catch per day fished as an index of stock abundance.

Three estimates of the size of the spawning stock in Div. 3N were available. An estimate of 1,000,000 tons was indicated by the USSR survey based on acoustic and photogrammetric techniques and underwater observations (Res. Doc. 78/VI/29). It was suggested that the survey provided an estimate of a major portion of the spawning stock. Norwegian scientists conducted a tagging experiment in 1977, which resulted in an estimate of 106,000 tons for a portion of the spawning stock (Res. Doc. 76/VI/22). The magnitude of the entire spawning stock could not be estimated because of incomplete mixing of tagged and untagged fish. The Canadian estimates of the spawning stock in Div. 3N in 1975, based on analytical methods, ranged from 80,000 to 130,000 tons (Res. Doc. 78/VI/52). The results of these analyses indicated that the stock size was much higher in 1972-74 but that it had declined and remained at its present level during 1975-77. The analyses confirmed the relative strengths of the 1969 and 1973 year-classes and indicated that the spawning biomass in 1978 was likely to be about the same level as in 1977.

Sampling data, presented by Canada, Norway and USSR, indicated that the strong 1973 year-class contributed greatly to the spawning stock in Div. 3N in 1977. Since this year-class will not contribute to the stock in any magnitude in 1979, the fishery at that time will depend on the 1975 and 1976 year-classes for which there is little or no data.

The low levels of biomass predicted from some of the analyses presented suggest that the present TAC may be too high. However, the size of the stock in Div. 3N could not be quantified or agreed upon

because of the wide range of biomass estimates. In addition, relative strengths were known for only two year-classes (1973 and 1974) produced by this stock when subjected to substantial yields, and no recruitment effects were indicated. Furthermore, the fishery in 1979 will depend on the 1975 and 1976 year-classes for which no estimates are available. It is therefore not possible at this meeting to advise on any adjustment to the present TAC for 1979. The Subcommittee also considered the suggestion that periodic closure of the fishery be enacted to allow capelin to spawn undisturbed and to allow research to be conducted, but no agreement could be reached on this matter at present.

Since more precise estimates of the biomass may be available in late 1978 when information on the 1978 fisheries in Div. 3LNO and Div. 2J+3K should be known, it was indicated that STACRES should convene a meeting in late 1978 to analyze data collected in 1978 and to advise a TAC for 1979. It was indicated that the matter of periodic closure for the fishery could be considered at the meeting, together with an evaluation of the effects of the fishery on the southern capelin stock, considering that more information on the size of the 1975 and 1976 year-classes will be available at that time.

In the meantime, the Subcommittee urged that catch and effort data should be collected on a daily basis to allow the calculation of a DeLury population estimate. The collection of maturity data should be increased, since these data not only provide information on the relative abundance of mature fish recruiting to the spawning stock but also are crucial for precise estimations of biomass using the Canadian analytical models.

22. Squid-*Illex* in Subareas 3 and 4 (Res. Doc. 78/VI/49, 60, 61; Sum. Doc. 78/VI/3)

In response to the recommendation of STACRES at its Special Meeting on Squid in February 1978 (Sum. Doc. 78/VI/3), the Subcommittee reviewed new information available on the squid fisheries in Subareas 3 and 4. Two new estimates of the size of the squid stock in Subarea 4 in 1977 were presented. The initial population size was estimated at 370 million individuals by the Leslie method[1] compared with 430 million from cohort analysis (Res. Doc. 78/VI/61). These levels of population size imply an exploitation rate of about 0.75 in 1977 compared with an estimate of 0.38 which was derived at the February 1978 Special Meeting from the ratio of catch weight to minimum biomass. However, in view of the assumptions necessary for the use of such models (M = 0 in the case of the Leslie method and a closed stock in the case of the cohort analysis), the estimates of population size are very likely substantially underestimated. Therefore, a definitive evaluation of the validity of the earlier estimates of exploitation rate for 1977 in Subarea 4 (from the February 1978 Meeting) was not possible at this time, although it was noted that these earlier estimates were also not considered reliable because they do not take into account the potential errors introduced by the high growth rate throughout the season.

Since much of the squid caught in Subarea 4 are taken in a joint squid-silver hake fishery, the Subcommittee reviewed new information on the escapement rate of squid in mesh selection experiments conducted on silver hake in 1977 (Res. Doc. 78/VI/60). The results indicated that, during the period from August to November, 25-30% of the squid would escape through the meshes of a 90-mm mesh bottom trawl and almost none from a 60-mm mesh trawl. However, these percentages would be somewhat high in the early part of the season (May-July) when the squid are smaller.

An *ad hoc* working group (convened by Dr F. Nagasaki) was set up to further consider the feasibility of effort regulation and to define the data requirements necessary for its implementation. In considering the report of the Working Group (Appendix III), the Subcommittee concluded that it could not provide any further useful advice on an appropriate effort measure than that given by STACRES at its February 1978 Meeting (Sum. Doc. 78/VI/3). This was mainly due to the lack of detailed catch and effort data (catch per haul) which would allow definition and quantification of effort levels in 1977 in relation to the estimated exploitation rate. Therefore, in considering the management approach recommended by STACRES for 1978, the Subcommittee notes that there is sufficient uncertainty in the estimates of exploitation rate and effort levels in 1977 to warrant a further consideration of new data to be collected during the 1978 fishery as a basis for more precise advice on an appropriate management strategy for 1979. Accordingly, the Subcommittee recommends that countries with detailed catch and effort data for the 1977 fishery should submit such data to the ICNAF Secretariat and that all countries with squid fisheries in 1978 should collect and report such data on a haul-by-haul basis. This information would permit a comprehensive evaluation of the feasibility of effort regulation for the squid fishery in Subareas 3 and 4.

23. Shrimp in Subarea 1 and Statistical Area 0

Data related to the fishery for shrimp in 1977 were presented and discussed at the Special Meeting of STACRES in November 1977, when advice for management in 1978 was given (Sum. Doc. 78/VI/1). The only new information available at the present meeting is updated catch statistics for 1977 (Table 2, page 4).

[1] Biometrika 39: 363-388

As noted in its report of the April 1977 Meeting (*Redbook* 1977, page 63), the Subcommittee still considers it too risky to advise on conservation measures for 1979, i.e. two years beyond the latest year for which information is available, especially due to the difficulty of predicting recruitment. The Subcommittee therefore considers it more appropriate to assess the stock and advise on conservation measures for 1979 at a meeting near the end of 1978 when data from the 1978 surveys and also from the fishery will be available. The Subcommittee stressed the need for data from trawl photographic surveys as the basis for estimating the biomass in 1978.

24. Shrimp in Subarea 2 (Res. Doc. 78/VI/28)

The Subcommittee was not requested to advise on the management of shrimp stocks in this area. However, it was noted that new information from USSR surveys (trawling combined with photography) indicate concentrations of shrimp in the region of Harrison Bank, mainly at depths between 400 and 500 m. A biomass estimate of 53,000 tons was indicated for the area surveyed.

IV. FUTURE RESEARCH REQUIREMENTS

During the course of reviewing the state of the various stocks, the Subcommittee noted some instances where data were insufficient to provide updated assessments of the stocks and a number of cases where the provision of additional information would enhance the quality of the assessments and improve the advice for management. The data requirements for these stocks are summarized as follows:

a) The almost complete lack of biological data for cod in Div. 2GH in recent years was noted, and countries fishing in the area are urged to make every effort to sample their commercial catches.

b) Substantially improved sampling of the commercial catches of cod in Div. 3M is needed to provide the basis for an analytical assessment of the stock for comparison with the results of recent general production model analyses.

c) The recent request for advice on the management of the redfish stock in Subarea 1 requires that all available data for this stock, including information on its relationship to the redfish fishery off East Greenland, be compiled and reviewed at the April 1979 Meeting of the Subcommittee.

d) Sampling of the commercial catches of redfish in Div. 3LN has been very inadequate up to 1977, requiring immediate attention by those countries involved in the fishery. Also, an attempt should be made to obtain better agreement on ageing than has been shown by the scanty age samples available in order to facilitate the use of analytical models in assessing this stock.

e) Despite the high level of agreement obtained in ageing silver hake at recent workshops, the problem of first-year age validation is a limiting factor which cannot be resolved by otolith interpretation but requires supporting data on spawning duration and early growth. It was recommended that otolith exchanges be carried out during 1978 and that a manual on silver hake ageing be compiled with provision for updating as required.

f) Concerning the mesh selection of silver hake in Div. 4VWX, it was suggested that a cover be attached to the codend of the trawls used during some future surveys for silver hake, in order to provide additional data on mesh size effects.

g) The lack of data on the distribution of the Greenland halibut stocks in Statistical Area 0 and Subareas 1 to 3 was noted, and it was recommended that research programs aimed at providing information on migrations and stock discrimination be expanded. The need for information on the appropriate mesh size for the Greenland halibut trawl fishery was also indicated.

h) The lack of suitable data for argentine in Div. 4VWX has made it difficult to evaluate the status of this stock.

i) Assessment of the capelin stocks in Subareas 2 and 3 continues to be wrought with the problem of obtaining reliable estimates of the biomass and the strengths of recruiting year-classes. In this regard, the need for pre-recruit surveys was emphasized for the stock in Subarea 2 and Div. 3K. Since the fishery in Div. 3LNO is conducted on pre-spawning and spawning concentrations of capelin, the Subcommittee urges that catch and effort data be collected on a daily basis to allow the calculation of DeLury-type population estimates, and that the collection of biological data be intensified to provide an adequate base for assessment by analytical methods. Such data for 1978 should be available for analysis at a meeting near the end of 1978.

j) With reference to the study on the feasibility of effort regulation as a management strategy for the 1979 squid fishery in Subareas 3 and 4, the Subcommittee recommended that countries with detailed catch and effort data for the squid fishery in 1977 should submit such data to the ICNAF Secretariat as soon as possible and that all countries with squid fisheries in 1978 should collect and report such data on a haul-by-haul basis, so that a comprehensive evaluation of effort regulation can be undertaken at a meeting in late 1978 or early 1979.

k) In view of the difficulty in predicting recruitment to the shrimp fishery in Subarea 1 and Statistical Area 0 too far in advance of the fishing season, the Subcommittee advises that an assessment would be more appropriate late in 1978 when data from the 1978 fishery and surveys will be available.

V. ACKNOWLEDGEMENT

The Chairman expressed his appreciation to the conveners of the working groups and to all participants for their cooperation during the course of the meeting and to the Secretariat for their usual efficient work. The participants expressed their appreciation to Mr A. T. Pinhorn for his guidance during the past 3 years as Chairman of the Subcommittee.

APPENDIX I. AGENDA FOR ASSESSMENTS MEETING, APRIL 1978

1. Opening (Chairman: A. T. Pinhorn)

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

2. Review of catch statistics and fishing activity in 1977

3. Stock assessments

   a) Stocks lying completely outside the Canadian 200-mile fisheries zone and not overlapping the zone of any other state:

      i) Cod (3M)
      ii) Redfish (3M)
      iii) American plaice (3MO

   b) Stocks lying within or partly within the Canadian 200-mile fisheries zone for which Canada requests scientific advice for management (Com. Doc. 78/VI/3):

      i) Cod (2GH, 2J+3KL, 3NO)
      ii) Redfish (3LN)
      iii) Silver hake (4VWX)
      iv) American plaice (3LNO)
      v) Witch flounder (2J+3KL, 3NO)
      vi) Yellowtail flounder (3LNO)
      vii) Greenland halibut (2+3KL)
      viii) Roundnose grenadier (2+3)
      ix) Argentine (4VWX)
      x) Capelin 2+3K, 3LNOPs)

   c) Stocks in the northern part of the ICNAF Area as suggested by Canada (Com. Doc. 78/VI/3) and agreed to by the EEC (Com. Doc. 78/VI/5):

      i) Greenland halibut (0+1)*
      ii) Roundnose grenadier (0+1)*
      iii) Shrimp (0+1)*

   d) Stocks lying completely within the EEC 200-mile fisheries zone for which EEC requests scientific advice for management (Com. Doc. 78/VI/5):

      i) Cod (SA 1)
      ii) Redfish (SA 1)

   e) As recommended by STACRES at the Meeting in Havana, Cuba, in February 1978 (Sum. Doc. 78/VI/3), regulatory measures for the squid fisheries in 1979 will also be considered. STACRES recommended "that the feasibility of an effort regulation in 1979 be further examined, requiring the submission by all countries of detailed catch and effort data for *Illex* in Subareas 3 and 4, with a view to further analysis and discussion at the April 1978 Meeting of the Assessments Subcommittee". Scientists are referred to Circular Letter 77/46 for the details of the requirements for submission of catch and effort statistics on squid.

4. Other matters

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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 MEETING, APRIL 1978

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APPENDIX III. REPORT OF *AD HOC* WORKING GROUP ON EVALUATION OF EFFORT REGULATION FOR *ILLEX* IN SUBAREAS 3 AND 4

Convener: F. Nagasaki

The Working Group was set up to review the data submitted at this meeting in response to the recommendation of STACRES at its Special Meeting in February 1978 that countries provide detailed catch and effort data for *Illex* in Subareas 3 and 4 with a view to evaluating the feasibility of an effort regulation for this stock (Sum. Doc. 78/VI/3). Other participants were T. Amaratunga, G. P. Ennis, G. V. Hurley, and D. E. Waldron. The limited amount of data presented in Res. Doc. 78/VI/49 and in some working papers were reviewed.

At the Special Meeting in February 1978, the exploitation rates of squid in 1977 were estimated to be 0.28 and 0.38 in Subareas 3 and 4 respectively. On the basis of yield-per-recruit and stock-recruitment considerations, the Subcommittee at its Meeting in April 1976 indicated that removals could be about 40% of the squid biomass (*Redbook* 1976, page 112). Thus the rate estimated for the 1977 fishery in Subarea 3 was somewhat below and that for Subarea 4 near the optimum level. However, in view of the crudeness of the methods used, the Working Group agreed that the exploitation rates quoted for 1977 were not very reliable and indicated the need for a refinement of methods to evaluate the biomass.

In order to assess the feasibility of an effort regulation for the squid fishery, it was considered necessary to quantify the effort expended to fish squid. It was concluded, however, that the quantification of effort would be difficult due to the problems associated with (i) intercalibration of effort among the different countries, vessels, gears, etc.; (ii) estimation of effort for squid in a mixed fishery; and (iii) estimation of effort for the inshore catch.

Effective fishing effort is influenced by a wide variety of factors which change with time, e.g. country, vessel size and power, gear size and type, etc., and these factors would have to be continually monitored and intercalibrated in order to quantify fishing effort. The complexities of the inshore fishery would have to be taken into account and the fishing effort quantified on a basis comparable with that for the offshore fisheries. The accuracy of the results is dependent upon the type of data available; for trawl fisheries, the accuracy would be increased if data were reported on a haul-by-haul basis.

Squid are taken not only in squid-directed fisheries but also in mixed fisheries. In the case of mixed fisheries, it is necessary to quantify the fishing effort for squid. In an effort to determine a way of delineating when the fishery was directed toward squid, the Working Group examined weekly catch data available for the 1977 fishery. The data were analyzed from the viewpoint of assuming that the fishery was directed toward squid when the quantity of squid in a weekly catch exceeded a certain proportion of the catch of all species. The results of this analysis for three levels of squid catch (i.e. 80%, 70% and 60%) are summarized in Table 1. The Working Group agreed that this type of classification should be tested with haul-by-haul data in order to determine how much of the effort in mixed fisheries should be allocated to squid.

Table 1. Summary of analysis relevant to squid-directed fisheries in Subarea 4, 1977.

Country	Squid catch (tons)	Squid catch when total catch consisted of			Percentage of fishery with by-catch		
		≥80% squid	≥70% squid	≥60% squid	<20%	<30%	<40%
Bulgaria	2,929	2,678	2,678	2,678	91	91	91
Canada	8,340	6,600	6,932	7,152	79	83	86
Cuba	3,244	2,208	2,302	2,336	68	71	72
France	455	455	455	455	100	100	100
Fed. Rep. Germany	2,775	2,775	2,775	2,775	100	100	100
Italy	2,451	2,451	2,451	2,451	100	100	100
Japan	3,144	2,067	2,285	2,618	66	73	82
Poland	3,214	3,214	3,214	3,214	100	100	100
Romania	1,053	1,053	1,053	1,053	100	100	100
Spain	2,958	2,932	2,958	2,958	99	100	100
USSR	18,233	13,000	13,906	15,370	71	76	84
Total	48,796	39,433	40,009	43,060	81	82	88

Noting that the haul-by-haul data available for 1977 through the joint scientific observer programs conducted by Canada with Cuba, Japan and USSR were not sufficient to quantify the fishing effort for the overall squid fishery, the Working Group recommends that all countries with catch and effort data on a

haul-by-haul basis relevant to the squid fishery in 1977 should submit such data to the Secretariat as soon as possible, and that all countries fishing squid in Subareas 3 and 4 during 1978 should collect such data on a haul-by-haul basis and submit them at the earliest possible time, so that analyses can be carried out and reported to a meeting of STACRES in late 1978 or early 1979.